GRAND FORKS/EAST GRAND FORKS ITS STRATEGY PLAN

PREPARED BY:

SRF CONSULTING GROUP, INC.

January 15, 2001

GRAND FORKS/EAST GRAND FORKS METROPOLITAN AREA

METROPOLITAN INTELLIGENT TRANSPORTATION SYSTEMS STRATEGY PLAN

Prepared For

GRAND FORKS/EAST GRAND FORKS METROPOLITAN PLANNING ORGANIZATION

Prepared By

SRF Consulting Group, Inc.

January 2001

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DISCLAIMER

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SECTION 1 - INTRODUCTION

The Grand Forks/East Grand Forks (GF/EGF) Area's Intelligent Transportation Systems (ITS) Strategy Plan is an effort by the GF/EGF Metropolitan Planning Organization (MPO) and its partners to develop a plan for deploying Intelligent Transportation Systems that will improve traffic flow and traffic management in the region, resulting in a safer, more efficient transportation system. This plan will also provide valuable input to the region during the transportation planning process that will help to incorporate ITS into transportation planning and capital improvements projects thereby ensuring that ITS components are integrated with the transportation system consistent with the area's overall transportation needs.

ITS is a designation given to any number of applications that use intelligent or smart processes and technologies to improve the safety and efficiency of the transportation system and provide timely information to travelers. It is expected that the information made available by its technology will help travelers make better choices such as avoiding unsafe conditions or congested areas, or selecting better routes, modes or time of travel. In particular, ITS technology and information will make it easier for emergency response services and transportation agencies to reach the site of incidents or accidents and manage the problem more effectively. Ultimately, ITS is expected to increase the people- and vehicle-carrying capacity of the multimodal transportation system and, over time, to decrease the level of investment required to expand or replace the transportation infrastructure.

One of the initial steps taken by the MPO, who sponsored this planning study, was to invite individuals representing a variety of area interests to participate in the study via an ITS Technical Committee. Due to the short timeframe of the study, the GF/EGF MPO's Technical Advisory Committee (TAC) agreed to take on this role, providing input to the study during its monthly meetings and through reviews of and comments on the plan documents. The Committee was made up of representatives from area cities (Grand Forks/East Grand Forks), counties (Polk and Grand Forks), regional agency (GF/EGF MPO), a state agencies (North Dakota and Minnesota Department of Transportation) and the Federal Highway Administration.

Study Objectives and Tasks

The objectives of the project and tasks being performed by the project consultant (SRF Consulting Group, Inc.) and the GF/EGF Metropolitan Planning Organization include:

- Review past and present public/private metropolitan ITS-related activities and plans and collect public needs/comments on ITS.

- Analyze currently available ITS infrastructure in the area and identify deficiencies or unique opportunities for ITS in the metropolitan transportation system. This task includes inventorying signal systems, current traffic management devices and operating or communications systems, etc.

- Engage the public in the preparation of the plan through a variety of methods.

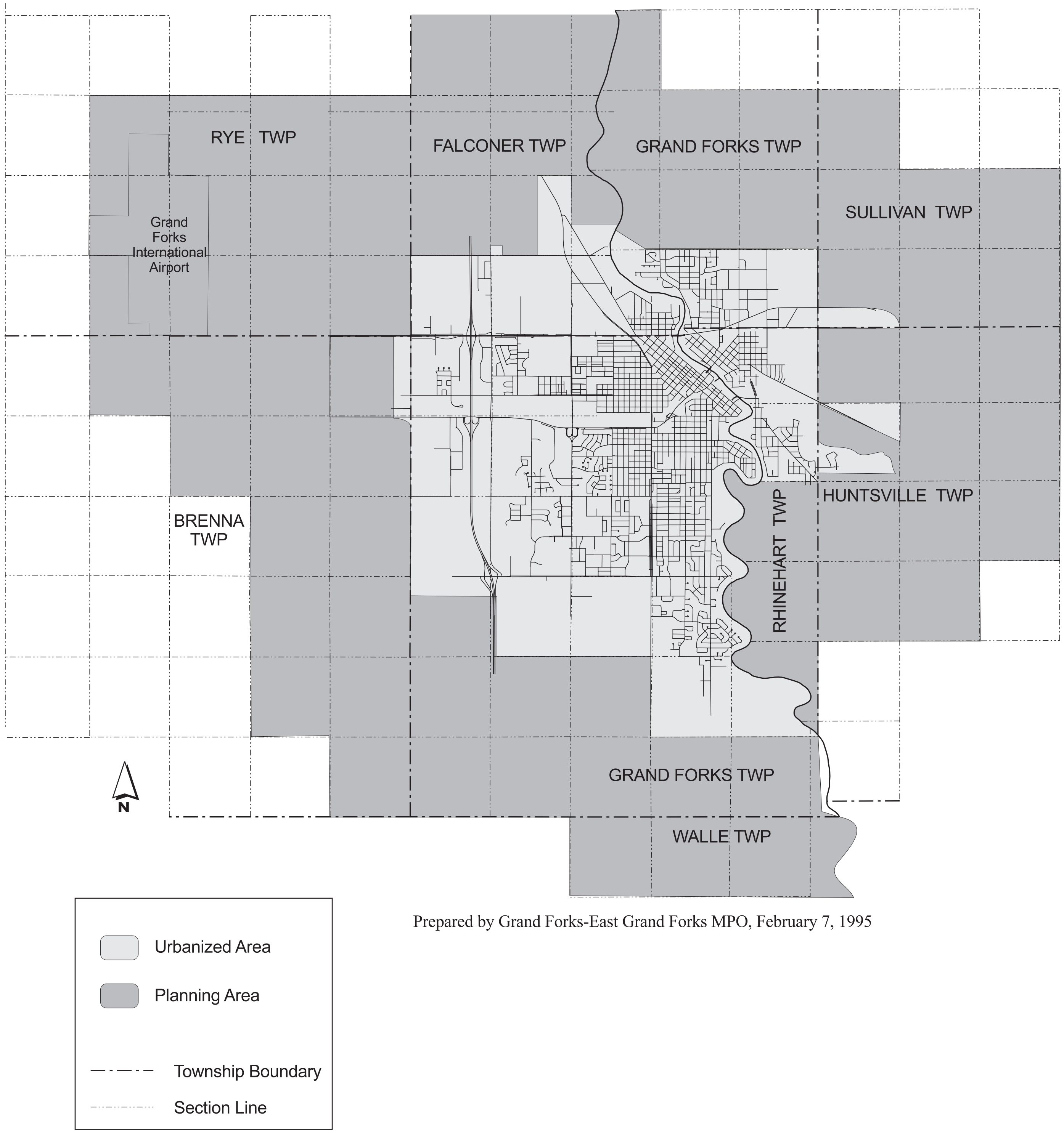
- Prepare a conceptual ITS network that integrates all appropriate projects and their technical and institutional aspects.

- Provide an estimate of the costs, funding sources and a strategy to secure funding associated with the operation/maintenance of the recommended alternative(s), including road authority designation.

- Document the plan in a report for review and approval by the GF/EGF MPO.

Public Hearing

A public hearing on the GF/EGF Area's ITS Strategy Plan was held on November 7, 2000. The purpose of this hearing was to seek comments, ideas, support and participation in the study. Attendance at the public hearing was low, but those who did attend provided valuable in-depth discussion of transportation issues in the region. Information gathered at the hearing has been incorporated into the appropriate areas of this plan.



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ITS Strategy Plan Study Area

FIGURE 1

SECTION 2 - SUMMARY OF INVENTORY

Summary of Existing Systems Inventory and Current State of ITS

Grand Forks and East Grand Forks, like most communities, have been implementing transportation enhancements that would fall under the umbrella of "ITS" technologies over the years. In many cases, ITS technology exhibits a "mainstreaming" effect, where projects are developed and demonstrated as advanced applications in one location, then gradually incorporated into the transportation planning process and then used in other places as the technology is accepted as reliable and easy to implement. The traffic signal system in Grand Forks is a good example of this process in that it exhibits more advanced vehicle detection and fiber-optic communication technologies being used alongside more basic pre-timed/non-actuated signals. Over time, this process has created a diverse collection of systems and technologies that have been chosen for their appropriateness for a specific application, without necessarily choosing a specific path for integration.

A prerequisite of creating an appropriate ITS plan for any area is determining the state of deployed and planned systems. This is necessary to ensure that any future projects avoid both incompatibility with and duplication of existing systems.

To maximize the benefits derived from investments in ITS in the future, a clear picture of the systems in place must be drawn so that existing infrastructure can be leveraged to whatever extent is possible

As part of the ITS Strategy Plan for the Grand Forks/East Grand MPO, a comprehensive inventory was conducted of existing and planned systems that may been relevant to the planning process. Systems to be surveyed and documented were identified by the TAC in September of 2000 and provided the guide for the inventory effort.

The primary focus of the inventory was to identify systems dealing with transportation and public safety concerns in the MPO and, where possible, gather specific details regarding their operation and architecture. Once these details have been gathered, the state of ITS deployment can be represented in terms of the ITS National Architecture Standards, and planning for future project deployments can take maximum advantage of the installed infrastructure base. Additionally, enhancements to existing systems can be identified where needs beyond those originally envisioned by the system's implementers can be satisfied.

The general approach in surveying systems has been to collect, at a minimum:

1. The location of a system
2. Contact person
3. The geographic area served
4. The intended customers of the systems outputs
5. The entity responsible for operating and maintaining the system
6. Data flows and inputs to the system

7. Data flows and outputs from the system
8. Communication methods used to acquire/disseminate data
9. Planned upgrades and modifications to the system

Each of these elements is presented in summary form below. Detailed inventory information, including block diagrams and descriptions of each major component/subsystem, software and communication interfaces, will be contained in an appendix to the final report. The detailed information will be useful primarily in planning specific deployment projects and during the detailed design process. It should be noted that, in some cases, component level detail (i.e., make and models of equipment) was not available from on-site staff. In these cases a generic description of a component is included with a description of its function.

In total, eight systems were identified for survey in the MPO area. These systems cover the ITS functional areas of traffic management, traveler information, public transit and emergency response. The list below groups the surveyed systems into these functional categories:

ATMS–Advanced Traffic Management Systems

1) Grand Forks/East Grand Forks Signal Systems

ATIS-Advanced Traveler Information Systems

2) #SAFE
3) UND Weather

ERS-Emergency Response Systems

4) Highway Patrol MDT
5) 911 Dispatch
6) GFPD/County MDTs

APTS-Advanced Public Transportation Systems

7) Paratransit Dispatch

In addition to the conventional four categories usually addressed in ITS planning, the underlying data communications infrastructure was surveyed to determine general parameters of coverage and capacity. However, due to the complexity of the system and the fact that it does lie outside the general umbrella of ITS, a detailed component-by-component inventory was not completed.

Infrastructure

8) Grand Forks Wide Area Network

Each system summary is presented below, grouped by ITS classification.

ATMS–ADVANCED TRAFFIC MANAGEMENT SYSTEMS

Grand Forks/EGF Signal Systems

General Description-Grand Forks

Grand Forks has a traffic control signal system typical of an urban area. Signals are concentrated in the central business district, where the highest levels of pedestrian and conflicting traffic movements are found. Some work has been done to interconnect signals in the higher traffic corridors; however, no comprehensive coordination has yet been undertaken.

Type 170 controllers are used throughout the system, either in stand-alone or master/slave configuration. Actuation by in-pavement loops or video detection is present on many signals, as are pre-emption/priority systems for emergency and transit vehicles. There are 55 intersections with signals in Grand Forks, with 28 interconnected in seven small groups. Survey-quality GPS coordinate data is available for all signal locations.

General Description-East Grand Forks

East Grand Forks, due to its smaller population and land area, has a simpler signal system. There are eight intersections with signals, none of which are interconnected. All signals use type 170 controllers in a pre-timed configuration. An acoustic-type emergency vehicle pre-emption system is planned to be implemented in the area in 2001, but has not yet been deployed.

System Locations

City Boundaries of Grand Forks, North Dakota and East Grand Forks, Minnesota

Contact Person(s)

Dan Jonasson, City of Grand Forks, North Dakota
John Thompson, City of East Grand Forks, Minnesota

Geographic Area Served

Cities of Grand Forks, North Dakota and East Grand Forks, Minnesota

System Customers

Any traveler on public streets in the GF/EGF area

Maintenance/Operations Responsibilities

City personnel maintain signals in each municipality, respectively

Data Flows and Inputs to the System

In some cases, signals are actuated, using either an in-pavement loop or a video detection unit to alter green/red times on signals. Also, some signals are interconnected to master controllers, permitting remote updating of signal timing plans and coordination of signal timing.

Data Flows and Outputs from the System

Traffic (red-yellow-green indicators) and pedestrian signals. In Grand Forks, there are also indicator lights for the emergency and transit vehicle pre-emption system.

Communication Methods Used to Acquire and Disseminate Data
Interconnected signals use either copper twisted pair wiring or fiber optic cabling to communicate serial data. Non-interconnected signals do not communicate data.

Planned Upgrades or Modifications
Additional intersections will be signalized as warranted. If the new signals fall along one of the chains of interconnection, they will be added to the system. A study is planned for 2001 to assess the future of the downtown Grand Forks unactuated and uncoordinated signals.

ATIS–ADVANCED TRAVELER INFORMATION SYSTEMS
UND Weather /#SAFE

General Description
There are actually two discrete but tightly integrated systems collecting and disseminating data to travelers.

UND Weather is a collection of efforts to obtain meteorological data from a variety of sources and create forecasts using computer models on a variety of geographic scales.

#SAFE is a telephony system that uses automated access to the UND Weather databases to create reports for travelers. The system can be accessed via telephone.

The #SAFE service is provided under contract with the Departments of Transportation in North and South Dakota. The system has recently been expanded under an agreement with the Minnesota Department of Transportation to provide road surface and work zone information for state highways and interstates in Minnesota.

System Location
University of North Dakota, Grand Forks Campus
Meridian Environmental, Grand Forks, North Dakota

Contact Person(s)
Leon Osborne, University of North Dakota

Geographic Area Served
North Dakota-Statewide
South Dakota-Statewide
Minnesota-Some roads covered now; statewide deployment planned in 2001.

System Customers
Any travelers on Interstates and State Highways in North Dakota, South Dakota or Minnesota

Maintenance and Operations Responsibilities
Data collection is primarily the responsibility of the University of North Dakota.

Data Flows and Inputs to the System
Meteorological data is input to the system databases automatically using a variety of data transports. Sources include:

- National Weather Service Backbone
- North Dakota Road/Weather Information System (RWIS)
- South Dakota
- Minnesota
- North Dakota Agricultural Weather System
- Nexrad Information Distribution System

Data Flows and Outputs from the System
Although the system produces a variety of meteorological data products and services, only the travel information aspect is highlighted here.

The product available to travelers is the #SAFE system, abbreviated-dial telephony service that allows users to input via keypad specific road segments and provides weather-related travel condition reports.

Communication Methods Used to Acquire and Disseminate Data

- Data acquisition is accomplished through:
- Satellite data (NWS Backbone)
- Public TCP/IP networks (Nexrad, Minnesota R/WIS)
- Dial-up Public Switched Telephone Network (PSTN) telephone connections (North and South Dakota R/WIS, North Dakota Agricultural Weather Network)

Dissemination is accomplished through:

- Land line and cellular Public Switched Telephone Network (PSTN)

Planned Upgrades and Modifications
Information for the state of Minnesota is being added to the system and dial-in availability is being expanded to that state as well.

ERS-EMERGENCY RESPONSE SYSTEMS
Highway Patrol (Mobile Data Terminals) MDT

General Description
The North Dakota Highway Patrol Mobile Data Terminal (MDT) system is a communications tool implemented by the Highway Patrol in February, 2000 to facilitate access from patrol vehicles to law enforcement databases and to provide vehicle-to-vehicle, as well as vehicle-to-desktop, text messaging services.

The system consists of ruggedized notebook computers mounted in 70 patrol vehicles, a small thermal printer and a data radio, which can communicate over a statewide network of ten radio repeater towers. There is also a system server and radio network interface located in Bismarck, North Dakota.

System Location
70 vehicles deployed statewide in North Dakota

Contact Person(s)
Mark Nelson, North Dakota Highway Patrol

Geographic Area Served
North Dakota-Statewide

System Customers
Highway Patrol officers and dispatchers

Maintenance and Operations Responsibilities
Highway Patrol staff maintains system, with support from radio and software vendors as necessary

Data Flows and Inputs to the System
Queries and messages from officers and dispatchers.

Data Flows and Outputs from the System
Database information in response to queries, message replies

Communication Methods Used to Acquire/Disseminate Data
To/from vehicles: 450 MHz data radio; 9600 Bits/Sec, full duplex
To/from repeater network: T-1 connection from local area networks to the MDT server in Bismarck, North Dakota

Planned Upgrades or Modifications
Automatic Vehicle Location (AVL) using Global Positioning System (GPS) technology will be implemented on some scale in 2001. Mapping capabilities will be added to the dispatcher and administrative desktop clients to permit real-time tracking of patrol vehicles.

ERS-EMERGENCY RESPONSE SYSTEMS
911 Dispatch – Grand Forks

General Description
A single 911 emergency response dispatch facility is maintained to serve the region surrounding Grand Forks, North Dakota.

Four dispatcher consoles are available, with staffing variable depending on time of day or other conditions. Each dispatcher has access to a telephone system control panel, a radio control workstation, a Computer Aided Dispatch (CAD) workstation and, at some stations, a teletype printer.

System Location
First floor, Police Building
122 South 5th Street
Grand Forks, North Dakota

Contact Person(s)
Roxane Melberg, Dispatch Supervisor, City of Grand Forks

Geographic Area Served
Generally, the City of and area surrounding Grand Forks, North Dakota

System Customers
All public for incoming calls.

Dispatched agencies include

- Grand Forks Police
- Grand Forks Sheriff's Office
- Emerado Police Department
- Emerado Rescue
- Altru Ambulance
- Aneta Fire Department
- Dahlen Fire Department
- Fordville Ambulance
- Grand Forks Airport Fire Department
- Grand Forks Air Force Base Police Department
- Hatton Fire/Rescue
- Larimore Fire Department
- Michigan Ambulance
- Northwood Fire/Rescue
- Reynolds Fire Rescue
- Grand Forks Fire Department
- Thompson Police Department
- Emerado Fire Department
- Northwood Police Department
- Northwood Ambulance
- Aneta Ambulance
- Fordville Fire Department
- Gilby Fire/Rescue
- Grand Forks Air Force Base Fire Department
- Grand Forks Air Force Base Ambulance
- Inkster Fire/Rescue
- Manvel Fire/Rescue
- Niagara Fire Department
- Oslo Fire/Rescue
- Thompson Fire/Rescue

Maintenance/Operations Responsibilities
The 911 dispatch center has dedicated operations staff who are employed by the City of Grand Forks. The staff provides maintenance with assistance from hardware and software vendors where necessary.

Data Flows and Inputs to the System
The dispatch operators manually enter most data into the CAD system. Call data will typically include:

- Caller name
- Call time
- Nature of call
- Dispatched unit
- Location dispatched
- Supplementary data provided by responder
- Event end time

Additionally, teletype information may be occasionally received by the dispatch center from state and federal sources.

Data Flows and Outputs from the System
Communication to emergency responders may include all of the inputs mentioned above, plus any special instructions

Communication Methods Used to Acquire and Disseminate Data
Inputs to the system generally come from incoming 911 calls over the public telephone network, supplementary information may come from voice radio communication

Dispatch outputs almost universally use the voice radio system.

Planned Upgrades and Modifications
None planned

ERS-EMERGENCY RESPONSE SYSTEMS
911 – East Grand Forks

General Description
A single 911 emergency response dispatch facility is maintained to serve the region surrounding East Grand Forks, North Dakota.

911 calls from telephones are routed through the Polk County Sheriff dispatch facility Crookston, Minnesota. Calls which are best responded to by the EGF PD or EGF FD are forwarded to the 911 dispatch facility.

One dispatcher console is available, with staffing provided by either EGFPD officers or civilian personnel. The dispatcher has access to a telephone system control panel, a radio control workstation, a Computer Aided Dispatch (CAD) workstation.

System Location
520 DeMers Avenue
East Grand Forks, MN 56721

Contact Person(s)
Susan Bakke, Dispatcher
City of East Grand Forks

Geographic Area Served
Generally, the City of and area surrounding East Grand Forks, Minnesota

System Customers
All public for incoming calls

Dispatched agencies include

Maintenance and Operations Responsibilities
The 911 dispatch center is operated by the City of East Grand Forks Police department. Maintenance is conducted with assistance from hardware and software vendors when necessary.

Data Flows and Inputs to the System
The dispatch operators manually enter most data into the LEADRS CAD system. Call data will typically include:

- Caller name
- Call time
- Nature of call
- Dispatched unit
- Location dispatched
- Supplementary data provided by responder
- Event end time

Data Flows and Outputs from the System
Communication to emergency responders may include all of the inputs mentioned above, plus any special instructions.

Communication Methods Used to Acquire and Disseminate Data
Inputs to the system generally come from incoming 911 calls over the public telephone network. Supplementary information may come from voice radio communication. MDTs are also deployed in the EGF PD patrol vehicles and may be used for messaging, although no direct CAD interface has been implemented

Dispatch outputs almost universally use the voice radio system.

Planned Upgrades or Modifications
None planned

ERS-EMERGENCY RESPONSE SYSTEMS
Grand Forks Police Department /Grand Forks County Mobile Data Terminals (MDTs)

General Description
The Grand Forks Police Department (GFPD)/Grand Forks County Mobile Data Terminal (MDT) system is physically identical to the system used by the North Dakota Highway Patrol. The same computers, radios and software are used, as well as the same statewide repeater network.

Primary differences have to do with system utilization rather than implementation or technology.

System Location
GFPD and County Sheriff's vehicles

Contact Person(s)
Roxanne Melberg, Dispatch Supervisor, City of Grand Forks

Geographic Area Served
City of Grand Forks and Grand Forks County

System Customers
GFPD and Grand Forks County officers and dispatchers

Maintenance and Operations Responsibilities
Grand Forks City dispatch staff maintains the system, with support from radio and software vendors as necessary

Data Flows and Inputs to the System
Generally, only teletype information received from other agencies and some administrative messages are entered into the MDT system

Data Flows and Outputs from the System
Because the system is primarily used for simple messaging, inputs and outputs are identical.

Communication Methods Used to Acquire and Disseminate Data
To/from vehicles: 450 MHz data radio; 9600 Bits/Sec, full duplex
To/from repeater network: T-1 connection from local area networks to the MDT server in Bismarck, North Dakota

Planned Upgrades and Modifications
None

APTS - ADVANCED PUBLIC TRANSPORTATION SYSTEMS
Paratransit Dispatch

General Description
Like all other transit properties, the City of Grand Forks has a responsibility to provide paratransit services to those who have mobility limitations or special needs. Grand Forks Taxi and NoDak Cab provide these services under contract to the City.

Because of the special need of the paratransit system customers, services must be demand-responsive, necessitating a scheduling and routing system for efficiently processing customer requests and determining a trip manifest for the vehicles.

At this time, customers contact the private providers directly with service requests. Routing and manifests are created manually and communication to individual vehicles is by voice radio. City staff verifies rider eligibility manually once per month by examining provider records.

It should also be noted that there was an attempt to implement the Trapeze Pass Lite software package to automate the generation of manifests for drivers and provided enhanced reporting capabilities. However, due to acceptance and implementation issues, this package is not being used.

Currently standard transit service is supplied to the City of East Grand Forks under a contract with the City of Grand Forks. Grand Forks supplies the vehicles and maintenance for the transit fleet and Grand Forks City employees operate the vehicles under the terms of this contract. Paratransit for East Grand Forks is provided by arrangement with the same private providers as Grand Forks.

System Location
At each providers facility:
Grand Forks Taxi - 519 North 7th Street, Grand Forks, North Dakota
Nodak Radio Cab Co. - 1101 5th Street North, Grand Forks, North Dakota

Contact Person(s)
Roger Foster, Director of Public Transportation, City of Grand Forks

Geographic Area Served
Cities of Grand Forks and East Grand Forks

System Customers
Paratransit customers

Maintenance and Operations Responsibilities
Generally, there is no maintenance required as most functions are performed manually.

Data Flows and Inputs to the System
Paratransit service requests, which include:

- Rider name
- Pick-up location
- Pick-up time
- Drop-off time
- Drop-off location
- Special instructions (if a manifest change is required, special equipment, etc.)

Data Flows and Outputs from the System
Monthly ridership reports to the City for rider eligibility and payment verification

Communication Methods Used to Acquire and Disseminate Data
Service requests via telephone
Monthly reports delivered via hard-copy to City
Voice radio or cellular telephone to vehicles for manifest changes, etc.

Planned Upgrades and Modifications
The City of Grand Forks has purchased "smart card" readers, which would permit the automatic validation of rider eligibility in vehicles. Deployment is tentatively set for 2001.

INFRASTRUCTURE
Grand Forks Wide Area Network

General Description
The City of Grand Forks Wide Area Network (WAN) is a complex system of interconnected subnetworks located throughout the City. Interconnections are either through leased permanent links or through dial-up modem connections. A wide variety of administrative, operations and emergency response data is shared through the network between many individual agencies.

Due to the complexity of the system and its varied non-transportation uses, a detailed survey was not undertaken. However, the sites connected, the nature of the connections and the basic hardware and software configuration used has been documented.

System Location
City of Grand Forks

Contact Person(s)
Kit McNamee, City of Grand Forks

Geographic Area Served
City of Grand Forks

System Customers
Various city and private entities, including:
Civic Auditorium and Alerus Center
Grand Forks FD, Grand Forks PD, UND Police
City Hall, Public Transportation, Community Development, Public Works

Maintenance and Operations Responsibilities
Grand Forks staff maintains and performs all non-end user operations

Data Flows and Inputs to the System
Administrative data for most city agencies, including e-mail/messaging, general file access, remote administration access, etc.

Data Flows and Outputs from the System
Administrative data for most city agencies, including e-mail/messaging, general file access, remote administration access, etc.

Communication Methods used to Acquire and Disseminate Data
Seven point to point T-1 (1.544 Mbit/sec.) connections
Two 56 Kbit/sec. connections
Five dial-up connections to a Microsoft Windows NT Sever Remote Access Server (RAS)

Planned Upgrades or Modifications
None identified

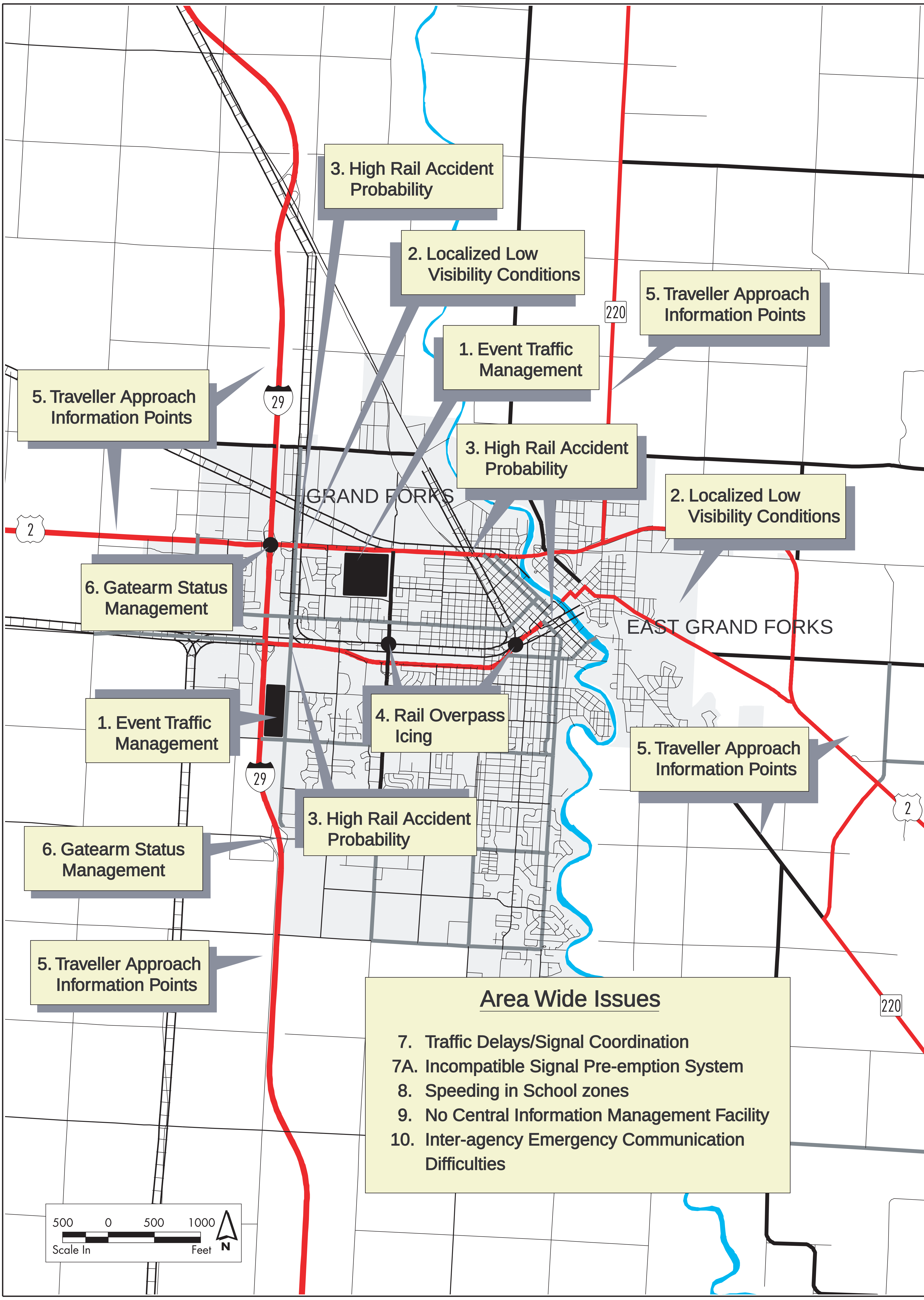
SECTION 3 - IDENTIFIED RELEVANT ISSUES

In all, ten distinct issues were identified in the Grand Forks/East Grand Forks area, which may be addressable with ITS solutions. A summary table and location map are included below, followed by a detailed description of the issue. Issues were compiled through a combination of input from the TAC, interviews with system operators and tours through the area during the planning process.

Table 1 - Identified Issues

Number	Issue Type	Location	Impact(s)	Description
1	Traffic Management	Alerus Center/Engelstad Arena	Traffic Flow/Safety	Event traffic control
2	Traffic Management	US 2 (Simplot)/US 2 (Beet Facility)	Safety	Low visibility warning
3	Traffic Management	Gateway Dr./42nd Avenue Gateway Dr./5th Street University Avenue/42nd Avenue	Safety	Rail crossing accident prevention/Barrier circumvention
4	Traffic Management	Demers Avenue/Columbia Avenue	Safety	Rail overpass icing management
5	Traffic Management	Five major approaches to GF/EGF metro area	Traffic Flow	Direction for traffic entering area
6	Traffic Management	I-29/US 2 Accesses	Safety	No remote management for access control gatearms
7	Traffic Management	Area-wide	Traffic flow	Traffic delayed by signals
7A	Transit	Area-wide	Efficiency	Incompatible priority systems planned
8	Traffic Management	Area-wide	Safety	Speeding in school zones
9	Traffic Management	Area-wide	Traffic Flow/Safety	No central information management facility
10	Emergency Response	Area-wide	Safety	Inter-agency communication difficulties

The following figure gives an overview of the geographic context of the issues in Table 1. Please note that the area-wide issues (numbers 7 through 10) are not represented on the map.



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IDENTIFIED ISSUES LOCATIONS OVERVIEW

FIGURE 2

1. Traffic Management – Alerus Center and Engelstad Arena

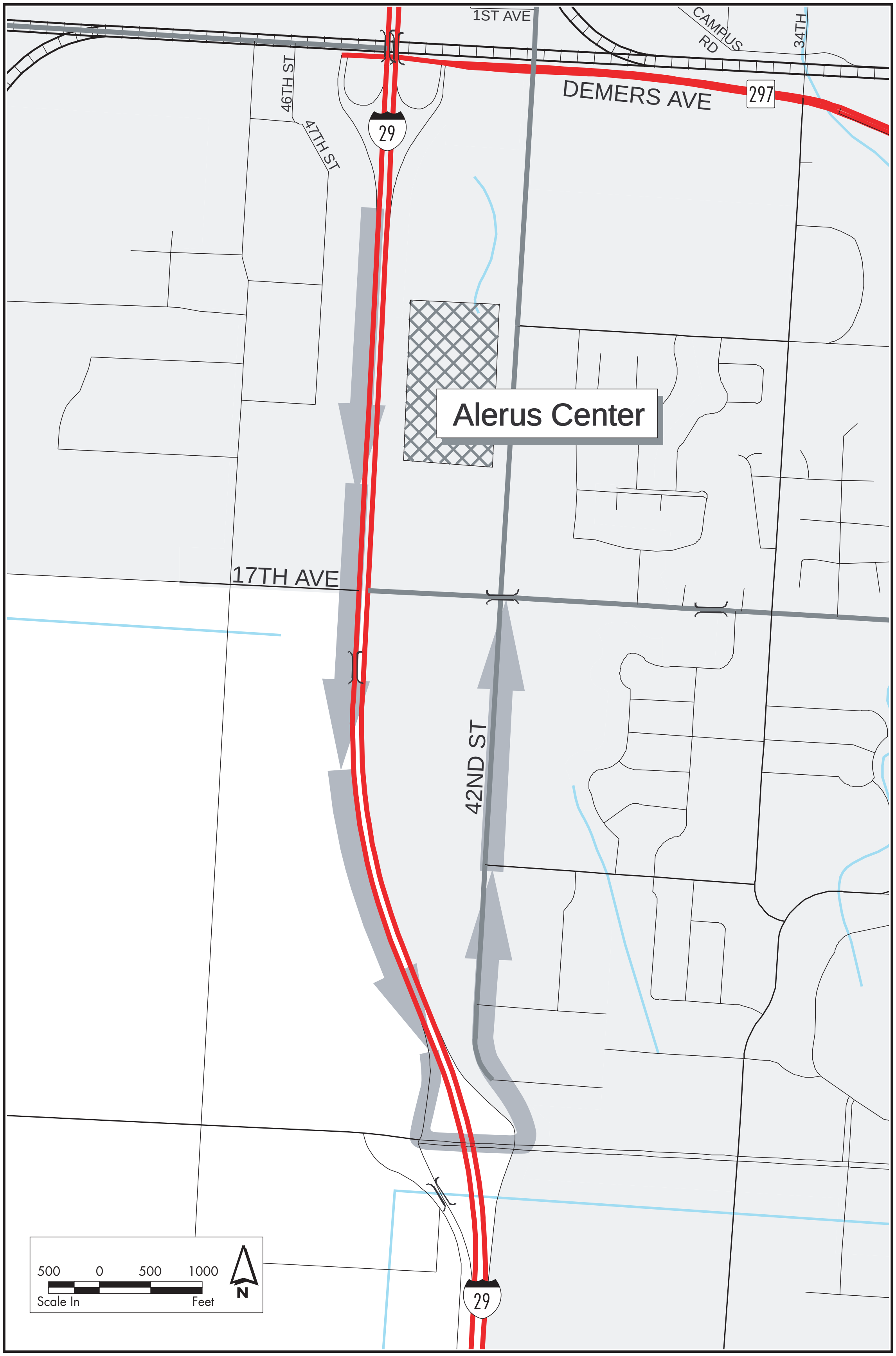
The Alerus Center is a large auditorium located on the western side of Grand Forks near I-29 /Demers Avenue interchange with a seating capacity of 20,000. Initial traffic studies have indicated that traffic should be manageable with the current system of roads and signals. However, several interviewees, particularly the North Dakota Highway Patrol, have expressed concern that certain events may generate traffic patterns that could interfere with the operation of I-29, which is immediately to the west of the center. In particular, the approach from the north side of the center is located directly opposite an at-grade rail crossing, potentially both restricting traffic flow and presenting a safety issue. The preferred approach direction is from the south side of the center, which would require a non-intuitive route for drivers.

Since large-scale alterations to the geometrics of the interstate and roads surrounding the center are not feasible, the Alerus Center presents a good candidate for implementing several advanced traffic management technologies.

Similar conditions exist near the Engelstad Arena located at Gateway Drive (US 2) and Columbia Avenue, which is planned to seat 11,500 upon its completion in 2001. In this case, approaches are more direct, but a large number of left-hand turns across approaching lanes of traffic are anticipated. The current traffic plan calls for variable lane configuration (single to double left turn lanes) to be regulated by small message signs. However, there may be an opportunity for an expanded multi-purpose system in the region.

2. Traffic Management - US 2 Simplot (Grand Forks) and Business 2 Processing Facility (East Grand Forks)

During the extremely low winter temperatures experienced in the Grand Forks area, two large commercial facilities produce steam effluent, which is blown by the prevailing winds across the adjacent arterial roads. Visibility is severely restricted during these periods, dropping to near zero for short segments. Motorists receive little or no indication that driving conditions are about to change, creating potentially dangerous circumstances, particularly when road surface conditions are also degraded due to weather.



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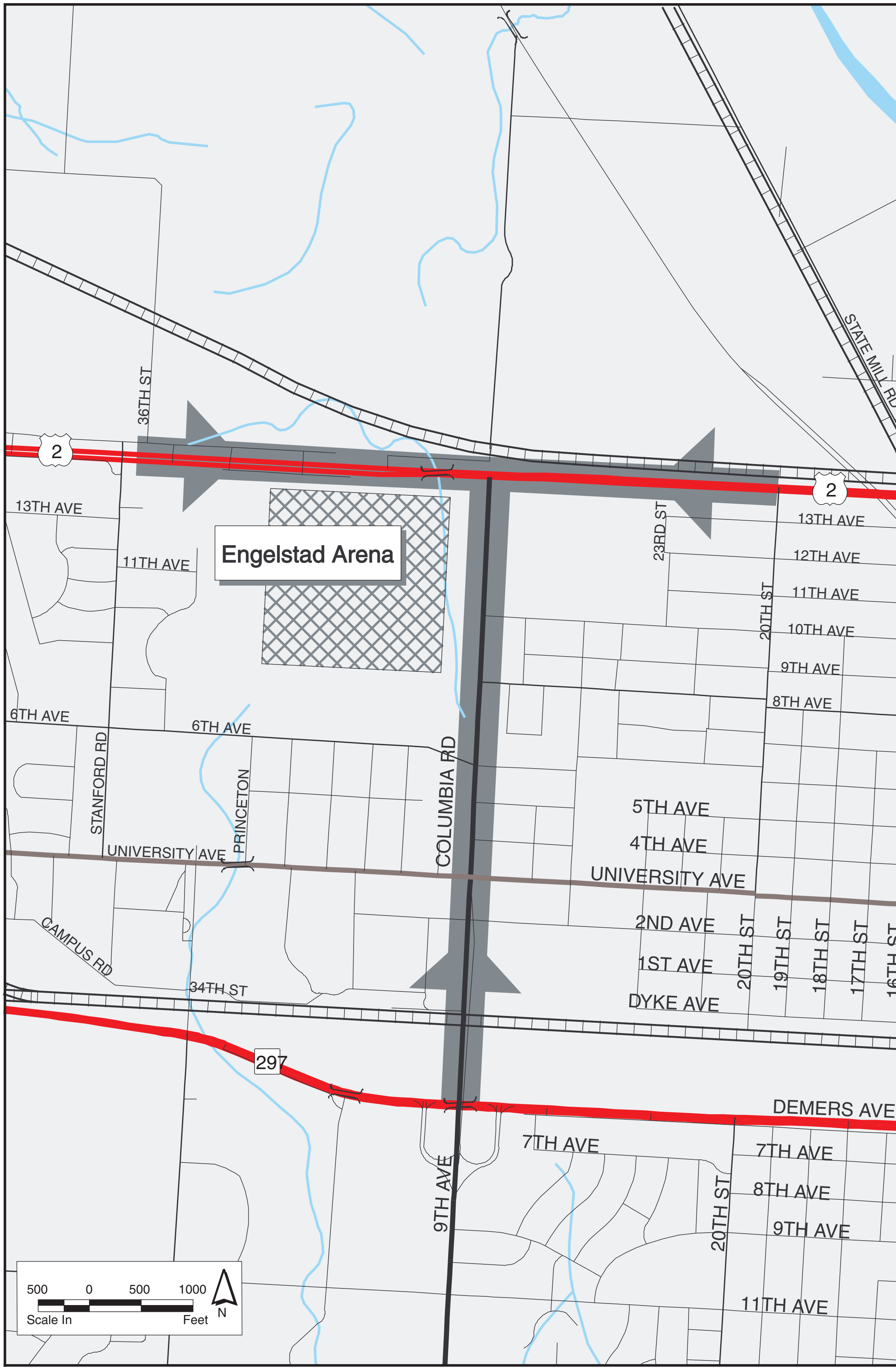
Preferred Approach to Alerus Center

FIGURE 3



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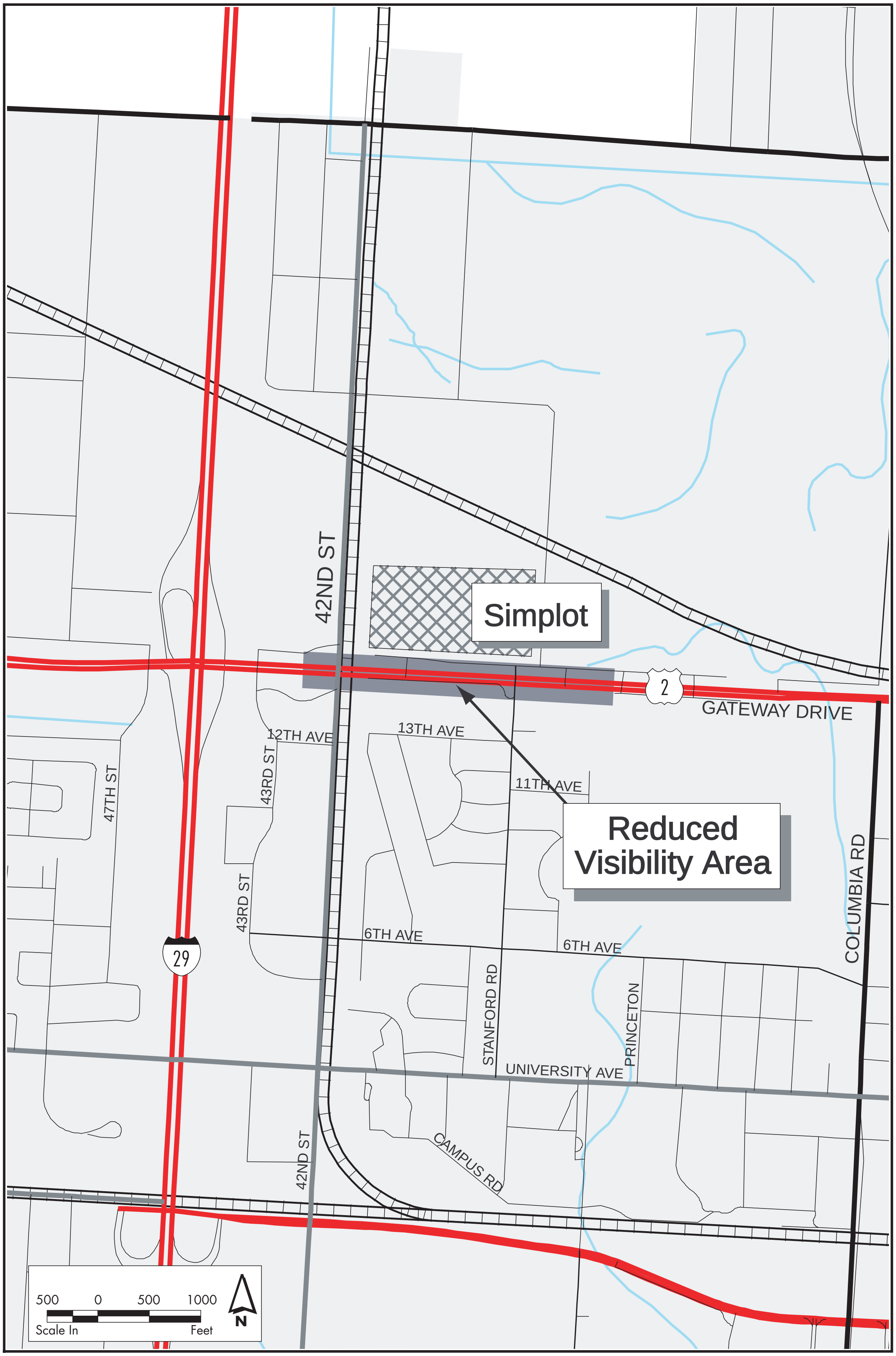
Approaches to Engelstad Arena

FIGURE 4



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Reduced Visibility Near Simplot Facility

FIGURE 5

3. Traffic Management-Accidents at Rail Crossings (Gateway Drive & 42nd Avenue, Gateway Drive & 5th Street, University Avenue & 42nd Avenue) and Driver Circumvention of Control Devices

Several at-grade rail crossings have been identified by the Federal Railroad Administration as having higher-than-average projected accident rates for car/train crashes. Due to the nature of a car/train collision, fatality and injury rates can be very high. This issue has two components:

1) Motorists unaware of trains approaching.

2) Motorists ignoring the standard flashing red lights and/or gatearms. This is largely due to these warning mechanisms being triggered by slow moving or reversing trains and motorists becoming impatient. A specific example of this behavior was cited at the rail crossing of 5th Avenue North, where the flashing crossing lights would be triggered by the proximity of a train, which could then be stationary for a substantial period of time. Motorists would then begin slowing, crossing the rails in a kind of single-lane procession.

Also, there may be an additional advantage of warning motorists prior to route decision points so they may choose to cross at intersections not blocked by trains. This problem is reported to occur throughout the area. Given the high severity of accidents, it may be prudent to invest in safety technologies even where the historical occurrence of incidents is relatively low.

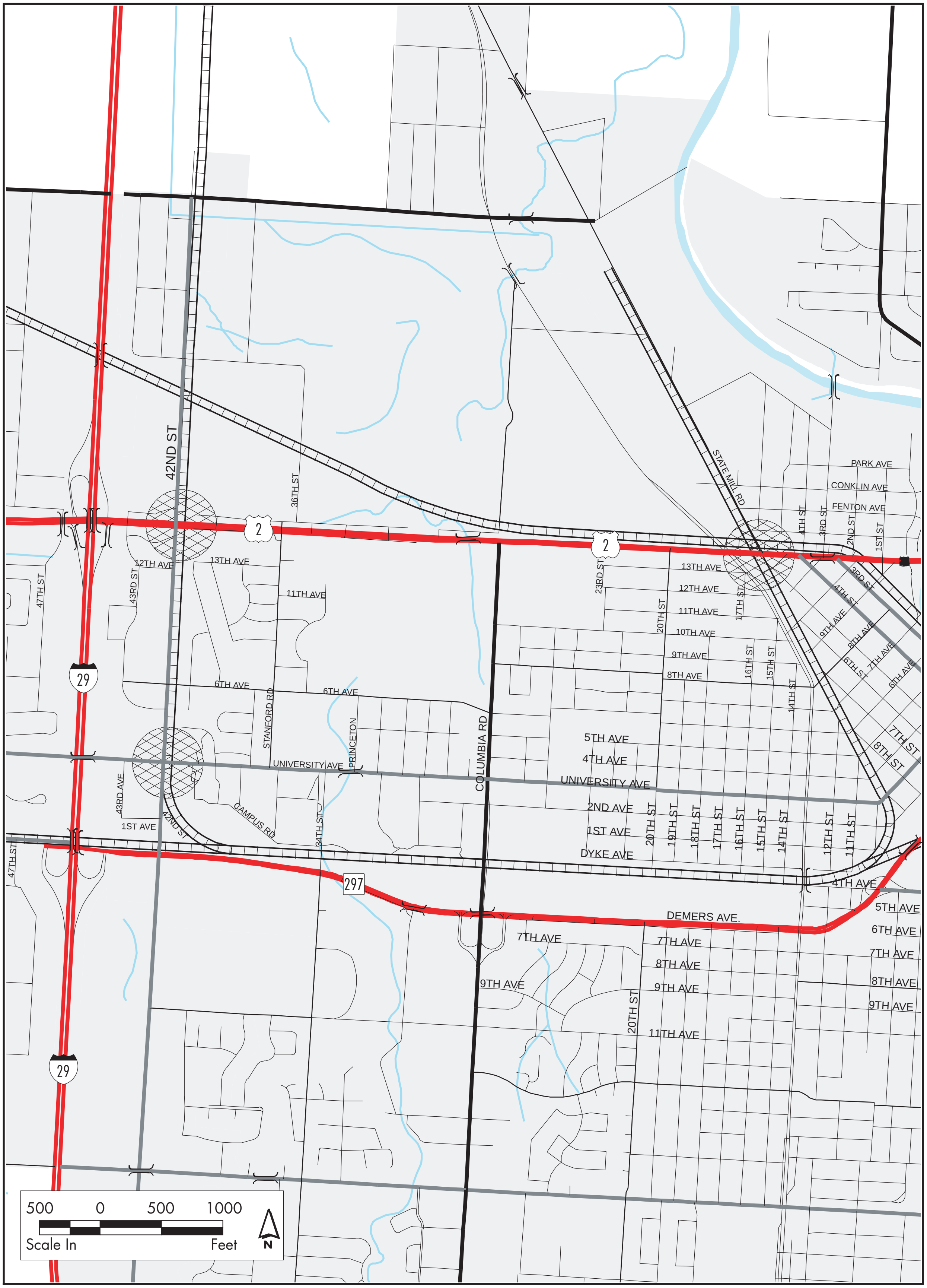
4. Traffic Management - Overpass Icing Conditions (Demers Avenue Rail Overpass and Columbia Avenue Rail Overpass)

There are two large grade-separated rail overpasses in the City of Grand Forks with large road decks. As with all bridges, the deck surface will typically exhibit icing conditions before surface roads do, as the bridge structure cools more rapidly than the ground. Timely application of de-icing chemicals is critical to the safe operation of the facility. However, it is also desirable to minimize the amount of chemicals (usually salt) applied due to runoff and vehicle corrosion concerns. Currently, there is no mechanism to permit the monitoring of bridge surface conditions, so chemicals must be applied on the basis of general weather conditions.

This may result in either over-application of chemicals, resulting in local environmental damage, or under-application, resulting in unsafe driving conditions.

5. Traffic Management - Travelers Unfamiliar with GF/EGF Area or Unsure of Event/Facility Locations

With the development of significant new entertainment and retail facilities, additional traffic from other regions (Fargo/Moorhead and Winnipeg, Canada for example) is expected to be attracted to the Grand Forks/East Grand Forks region. Since the geometrics of the transportation network have not been optimized to permit high-volume access to the new facilities, traveler information regarding routes and parking locations should be made available to travelers entering the area to minimize circulation patterns emerging as motorists try to locate parking and other facilities.



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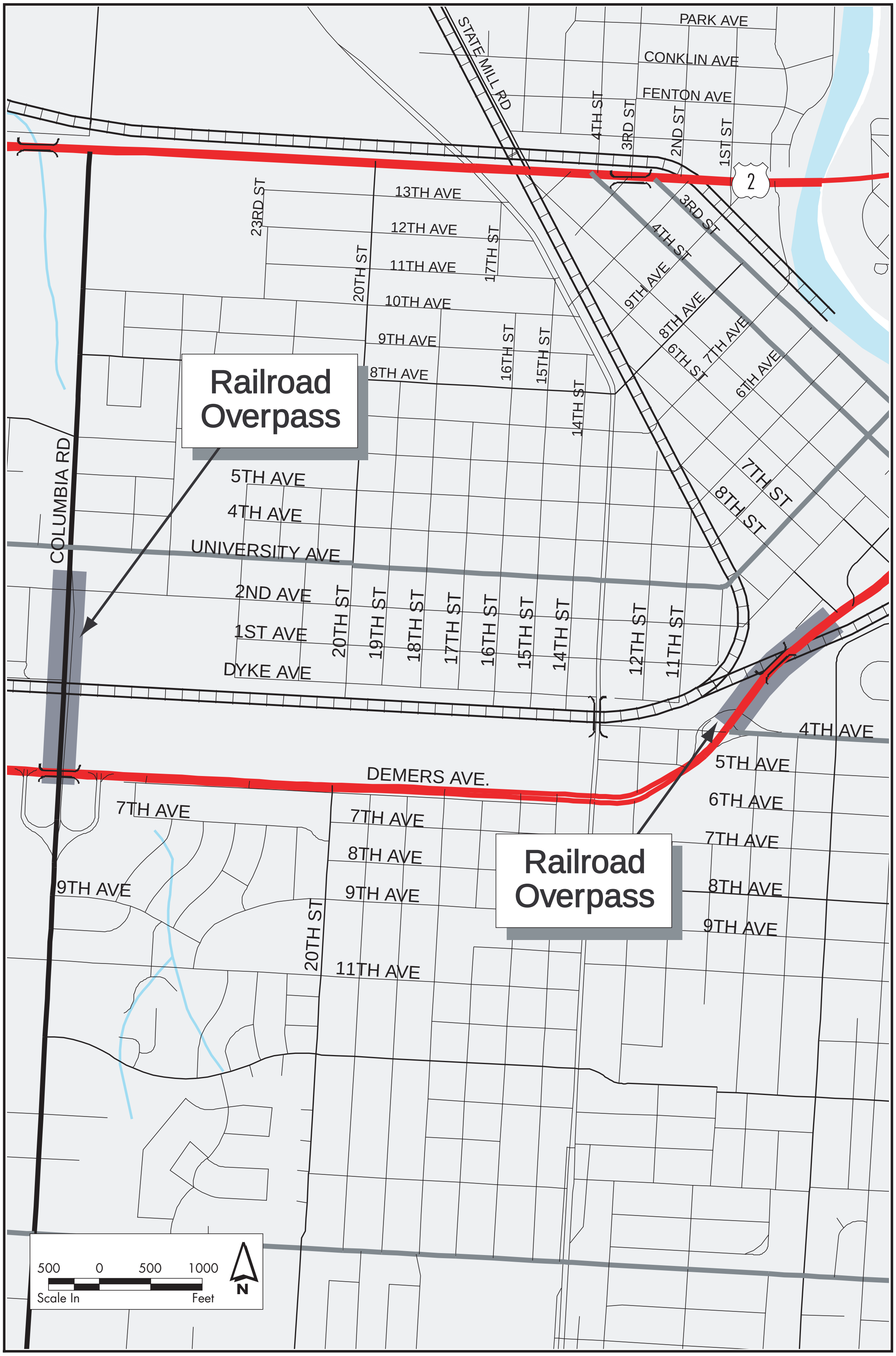
Dangerous Railroad Crossings Overview

FIGURE 6



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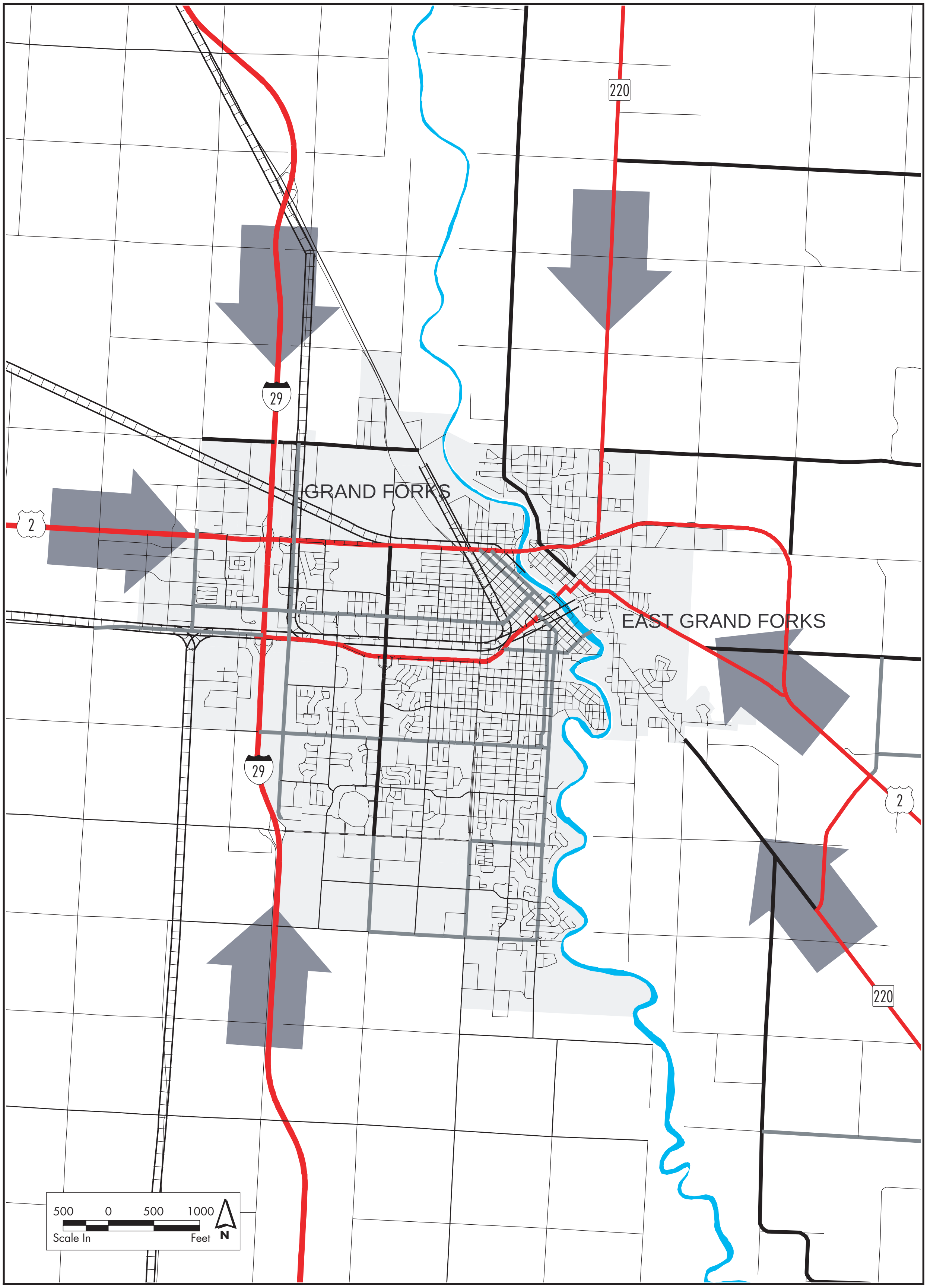
Railroad Overpasses with Potential Icy Conditions

FIGURE

7



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Primary Approaches to Grand Forks/East Grand Forks

FIGURE 8

6. Traffic Management - US 2/I-29 Gate Arm Control

During extreme weather conditions, it is necessary to close highways in the area and block access ramps to the roadways. Currently, the North Dakota Highway Patrol performs gate closure manually, with an officer driving to each site to close the gate and returning to open the gate when weather conditions improve.

This approach has several disadvantages:

1) Officers are diverted from other duties at critical bad weather times.

2) No mechanism exists to monitor the status of gatearms. For example, if an arm is damaged and pushed into the "open" position while the highway is closed, the Highway Patrol would have no knowledge unless contacted by a motorist or maintenance crew.

3) No mechanism exits to monitor for vehicles disabled near interchanges or accesses or to detect intentional gatearm circumvention.

7. Traffic Management - Traffic Flow Impeded by Uncoordinated or Unactuated Signals (Area-Wide) & Signal Compliance

As traffic volumes continue to increase in the GF/EGF area, local pockets of congestion are beginning to emerge, specifically at the Demers Ave. river crossing and near the 32nd Avenue retail developments. As more traffic begins to flow to the Cabela's area retail development in East Grand Forks, management becomes more of an area-wide issue.

Also, due to the isolated nature of signal interconnection/coordination in the area, traffic may be stopped for unnecessarily long times at red lights. This has the effect of increasing both travel times and vehicle-emitted pollution (NOx and CO).

A secondary issue was identified as signal compliance, more commonly referred to as "red light running." This motorist behavior presents obvious safety issues as vehicles enter in intersection while cross-traffic has a green light.

7A. Signal Preemption Compatibility

As a related issue, the City of Grand Forks has standardized on the 3M Opticom system for emergency vehicle signal preemption and has deployed many of the sensors on its signal system. Signal preemption is an important feature of an intelligent signal system as it permits faster (in some cases five or more minutes) response to 911 calls by giving a green light to an emergency vehicle approaching an intersection.

The city of East Grand Forks currently plans to deploy an acoustically actuated preemption system favored by the Minnesota Area Transportation Partnership (ATP-2). Unfortunately, these two systems would be incompatible, necessitating two sets of actuators to be mounted on vehicles, which need to operate in both jurisdictions.

Also, transit vehicles use the Opticom "priority" feature to lengthen green light times and improve schedule compliance. Transit vehicles operating in East Grand Forks would be unable to access any priority features.

8. Traffic Management - Drivers Exceeding Speed Limits in School Zones

During the public outreach session, it was mentioned that drivers frequently exceed the posted speed limits in school zones, creating unsafe conditions for pedestrians crossing the roads. Children crossing streets always presents a special safety consideration and compliance with special speed zones and other restrictions are an integral part of an overall safety plan.

9. Traffic Management - Centralized Management Facility (Area-Wide) and Traffic Information Access

Many of the solutions discussed above require data to be shared and processed between systems to achieve maximum benefit. For example, surveillance of traffic for event management, activation of VMS, and activation of event-driven signal timing plans would be facilitated by having one point conducting surveillance and controlling the traffic control devices.

The lack of a central management facility also makes it difficult for travelers to have access to all traveler information for the area. Although there are a number of outlets for weather, transit, road construction, event and incident information, no single mechanism consolidates all of the information sources into a single point. Several interviewees during the inventory phase indicated concern that this condition hampered the ability of the various traveler information systems to effectively reach their audiences.

10. Emergency Response - Interagency Communication Difficulties (Area-Wide)

North Dakota Highway Patrol – During the system inventory phase, the North Dakota Highway Patrol indicated that there were difficulties in communicating with county and local emergency responders, as the Highway Patrol is dispatched statewide from a facility in Bismarck and other agencies were dispatched from a facility in Grand Forks. Specifically, requests for assistance were cumbersome to relay as the local responder would have to contact the local dispatch center, which would contact the Highway Patrol's dispatch facility, which would then contact a Patrol officer in the area.

Grand Forks/East Grand Forks Fire Departments – The Grand Forks Fire Department is designated as the Hazardous Materials (HazMat) responder for a large portion of eastern North Dakota. Because of the wide variety of substances potentially involved in HazMat incidents and the specialized techniques involved with their handling, the Fire Department foresees difficulties in relaying large amounts of information regarding safety procedures to personnel via the existing voice radio system. The East Grand Forks Fire Department also has HazMat response authority for their jurisdiction and faces similar data communication issues. Additionally, there is a Mutual Assistance Agreement between the two departments, which allows joint response to incidents. There is currently only voice radio communication between the two departments.

East Grand Forks 911 Dispatch – The City of East Grand Forks currently uses a small 911 dispatch facility operated by the East Grand Forks Police Department. EGF PD staff expressed several concerns regarding the existing Computer Aided Dispatch (CAD) system:

- There is no mechanism for sharing CAD information between the Grand Forks and East Grand Forks dispatch centers
- There is no local support mechanism for the CAD system
- There is inadequate training available for the LEADRS CAD system
- The current CAD System is incompatible with the MDTs deployed in EGF PD patrol vehicles

These issues combine to create circumstances where there is potential to compromise the efficiency of 911 dispatch operations and, by effect, public safety.

SECTION 4 - ITS SYSTEM ARCHITECTURE BACKGROUND

ITS System 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 roadside or the vehicle), the interfaces or information flows between the physical subsystems, and the communication requirements for the information flows (e.g., wireline or wireless). The ITS System Architecture will ensure that the complex systems slated for implementation are completely integrated and interoperable with other systems within the surrounding region.

The Grand Forks/East Grand Forks Regional ITS Architecture is designed from the "physical" perspective. The Physical Architecture provides agencies with a physical representation (though not a detailed design) of the important ITS interfaces and major system components. The principal elements in the Physical Architecture are the 19 subsystems and architecture flows that connect these subsystems and terminators into an overall structure. For the purposes of this specific architecture design, the level of detail will span to a high-level subsystem interconnect platform. This level of detail will allow for a great deal of future expansion and customization.

The principal structural element of the Physical Architecture is the subsystem. As noted, there are 19 subsystems in the National ITS Architecture, which are grouped into four classes: Centers, Roadside, Vehicles and Travelers. Example subsystems are the Traffic Management Subsystem, the Vehicle Subsystem and the Roadway Subsystem. These correspond to existing (or future) things in the physical world: respectively traffic operations centers, automobiles and roadside signal controllers. Due to this close correspondence between the physical world and the subsystems, the subsystem interfaces are prime candidates for standardization.

- **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.

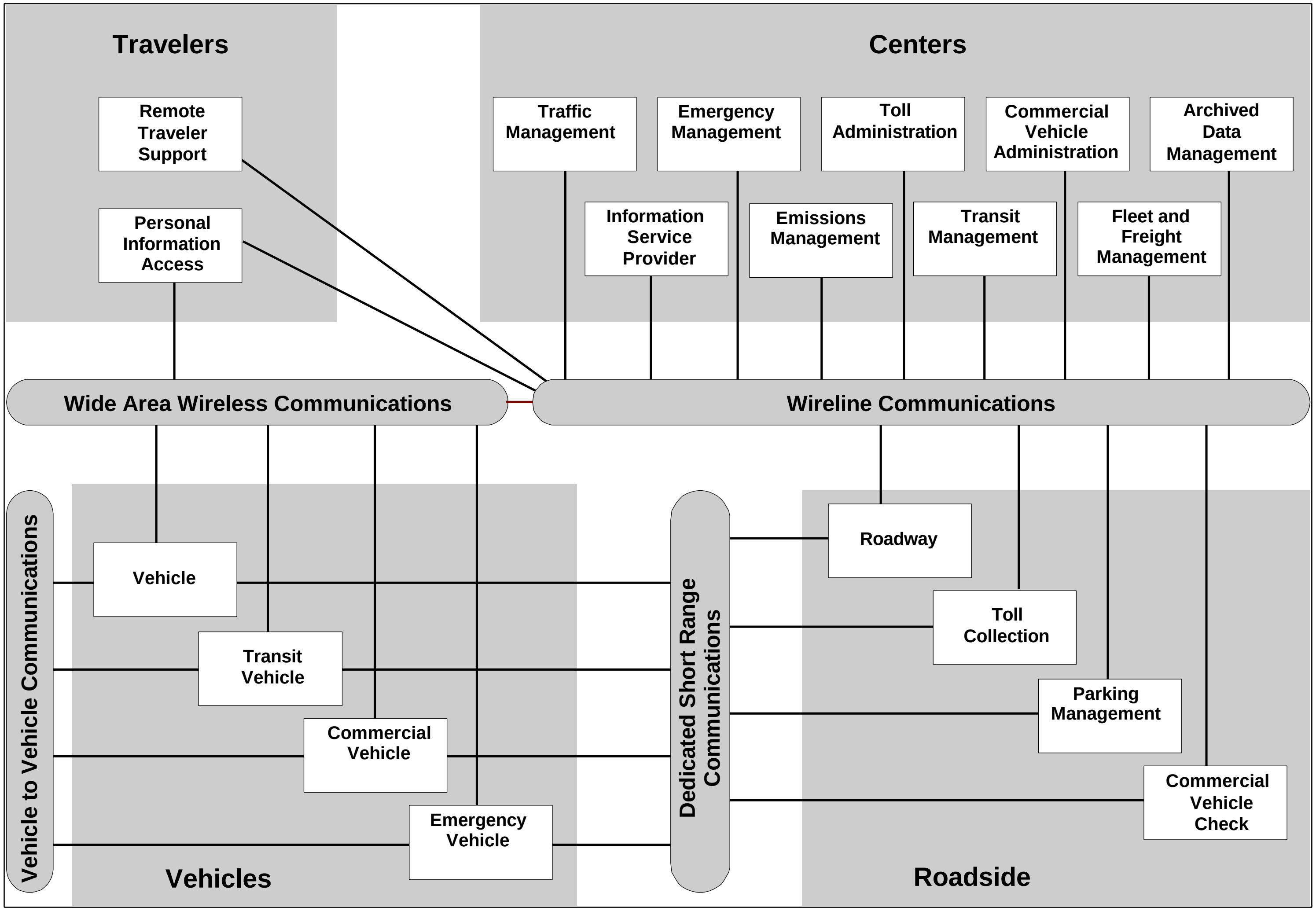
- **Center Subsystems –** These provide management, administration and support functions for the transportation system. The center subsystems each communicate with other centers to enable coordination between modes and across jurisdictions within a region. The center subsystems also communicate with 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.

- **Roadside Subsystems –** 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.

- **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.

- **Traveler Subsystems –** Traveler subsystems include the equipment that is typically owned and operated by the traveler. Although 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 is 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.

A diagram which depicts the 19 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 subsystems interconnect diagram, in which the communication links are the “sausages.” This diagram graphically displays the 19 subsystems, which are grouped into the aforementioned categories based on their function and location, and the communications media interfaces (see Figure 9 for the generic “Sausage Diagram” provided by the National ITS Architecture).



SRF Consulting Group, Inc.	**GENERIC NATIONAL ITS ARCHITECTURE "SAUSAGE DIAGRAM"**	FIGURE 9

As seen in the figure above, 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 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 – Seven terminators (environment, traffic, etc.)
- Humans – 19 terminators (driver, transit user, etc.)
- Systems – 26 terminators (event promoters, financial institution, etc.)
- Other systems – Eight terminators (other vehicle, other emergency management, etc.)

A step in 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 within a system. Figure 10 displays an example high-level interconnect diagram.

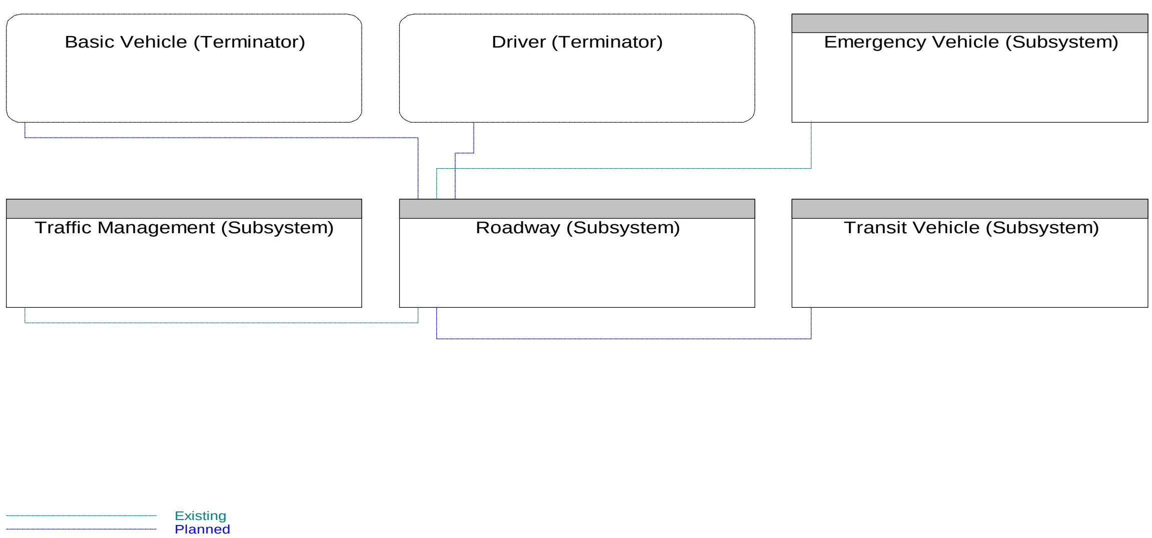


Figure 10 – Example High-Level Interconnect Diagram (Roadway Subsystem)

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

GRAND FORKS/EAST GRAND FORKS TAILORED ARCHITECTURE

The Grand Forks/East Grand Forks Regional ITS Architecture was developed by tailoring the National ITS Architecture as appropriate to meet the needs of the region. Benefits that will be gained through tailoring the National ITS Architecture into the Grand Forks/East Grand Forks Regional ITS Architecture are:

- Interoperability – The National ITS Architecture has identified where standards are needed for system interoperability (interfaces and products). Because the National ITS Architecture serves as the common foundation for ongoing ITS standards development work, factoring it into the current system enhancement will facilitate the transition to a standard interface definition the future. Using standard interfaces will provide for national and regional interoperability and interchangeability of systems and devices used in ITS travel management.

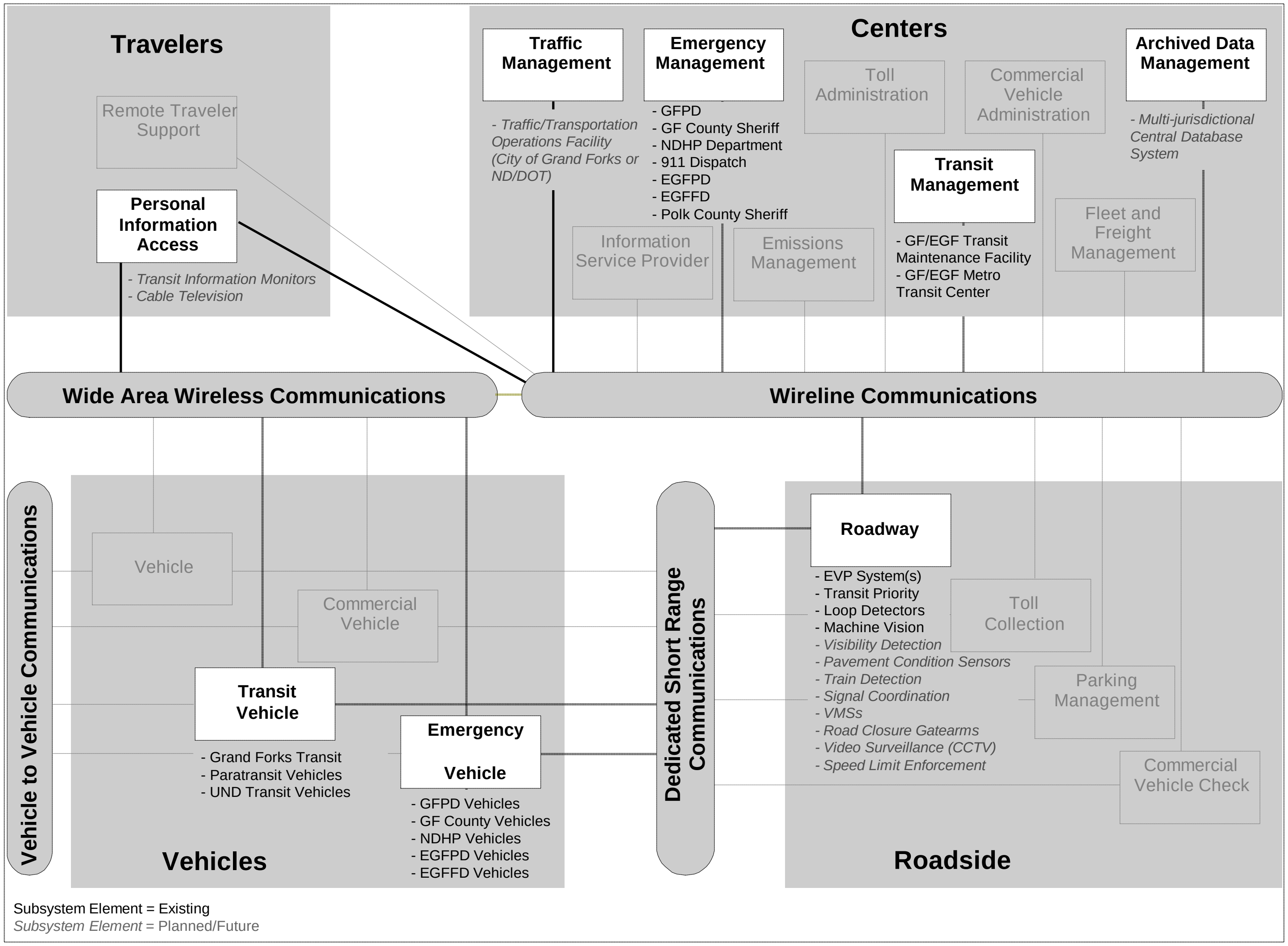
- System expandability – Use of the common structure defined across the metro area in conjunction with use of open standards will make it easier to integrate the existing systems with new ITS components and systems.

- 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 systems easier, resulting in increased information sharing. Travelers moving through the Grand Forks/East Grand Forks area will ultimately benefit from this seamless system.

- To illustrate how the Grand Forks/East Grand Forks Regional ITS Architecture can be applied on specific ITS projects, case studies were proposed and documented for a few projects identified by the Grand Forks MPO Technical Advisory Committee. These case studies present the components of the system architecture in a real-life context. The integration of the ITS components into the existing systems are examined from a physical, communications and jurisdictional view. See Appendix B for a complete description.

Figure 11 depicts the existing and proposed Grand Forks/East Grand Forks Regional ITS Architecture “Sausage Diagram.” It should be noted that the diagram contains some subsystems that have existing components today, as well as proposed components for the future. The diagram outlines at the top-level of the architecture the interconnects between the various subsystems of the overall ITS System. In addition, the diagram lays the foundation for the four types of communications that may be used for data transfer.



GRAND FORKS/EAST GRAND FORKS
REGIONAL ITS ARCHITECTURE "SAUSAGE DIAGRAM"

FIGURE 11

From this point, the architecture moves to the next level of detail, high-level interconnections. The architecture high-level interconnections view allows one to look at, from a more "physical" perspective, the actual communications lines between subsystems. Arriving at this level of detail involved a more in-depth tailoring process. Having identified the subsystems that were to be part of the ITS system, the next step was to use the existing inventory and the identified user issues (or user needs) mapped against the "generic" architecture market packages.

This process consists of four steps: first, document the existing systems into the architecture; second, map the user needs against the National ITS Architecture user services; third, map the user services against the National ITS Architecture market packages; and fourth, customize the identified market packages and their subsystem/terminator interconnections to address the initial needs. Tables 2 and 3 show the mapping exercise that was used to compare the identified issues against user services and the user services against market packages. The process stated above led to the development of the high-level architecture interconnections.

Architecture interconnections identify and classify connectivity between subsystems. The interconnections serve as the "communications highways" between subsystems. The interconnections are often identified according to communication type; in the Grand Forks/East Grand Forks Regional ITS Architecture, the interconnections communications types are not identified, so as to allow for full customization of this area in the future based on existing infrastructure issues.

In addition to being able to identify communications types, the architecture interconnects also represent information transferred between subsystems. The architecture interconnects are the highest level of an informational hierarchy. Architecture interconnects are comprised of architecture flows, which in turn are comprised of data flows, thus creating the above-mentioned information hierarchy.

For the purposes of the Grand Forks/East Grand Forks Regional ITS Architecture, the high-level architecture interconnections diagram is the furthest the tailoring process went, to allow for full customization of the information transferred in the future. Figure 12 depicts the High-Level Architecture Interconnections Diagram for the Grand Forks/East Grand Forks Area. This diagram includes existing and proposed future subsystem interconnections in the area.

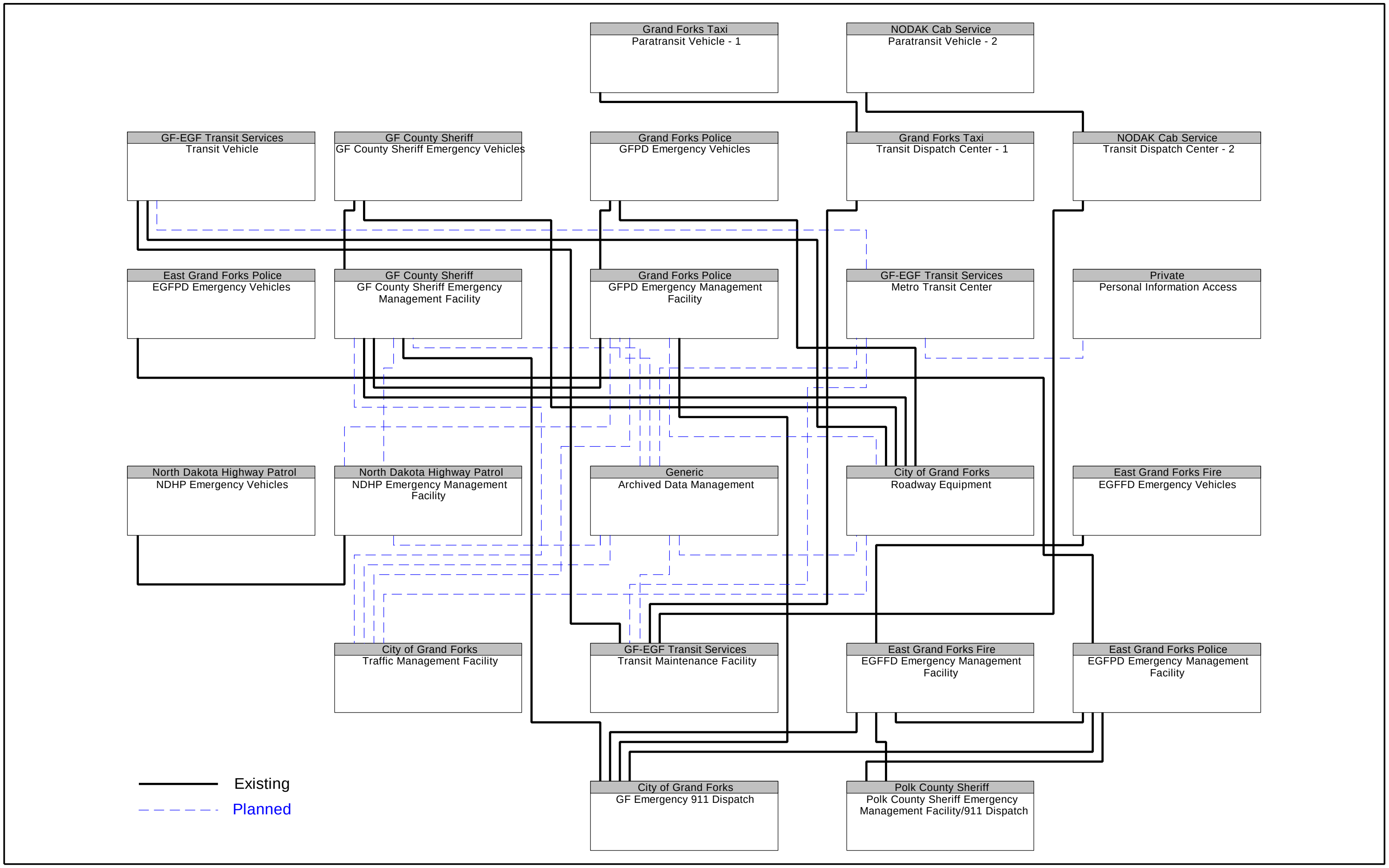
Note that there are interconnections between terminators and subsystems as described earlier; however, the diagram displays only the subsystem interconnections.

Table 2 – User Issues to User Services Mapping

		National ITS Architecture - User Services																														
Issues	Location	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 Service 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 Service	4.1 Commercial Vehicle Electronic Clearance	4.2 Automated Roadside Safety Inspection	4.3 On-Board Safety Monitoring	4.4 Commercial Vehicle Administrative Process	4.5 Hazardous Material Incident Response	4.6 Commercial Fleet Management	5.1 Emergency Notification and Personal Security	5.2 Emergency Vehicle Management	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
Event related traffic congestion: I-29 Interchange - Freeway traffic management	Alerus Center						•	•	•																							
Event related traffic congestion: Directing traffic to available parking	Alerus Center						•	•																								
Event related traffic congestion: Congestion information along interstate	Alerus Center						•	•	•																							
Reduced visibility along US 2 - approximately 1/4 mile	US 2/Simplot and Business 2 & Old Mill Rd						•	•																								
Highway rail intersection accidents	Gateway Dr & 42nd, 5th; University Ave. & 42nd						•	•			•																					
Overpass icing causing unsafe conditions	Demers Ave. and Columbia Ave.						•	•																								
Traveler information for events	I-29 & US 2 approaching City limits						•																									
Parking location and availability information	US 2 in Grand Forks for Engelstad Arena						•																									
Road closure gate arms; manual closure without condition monitoring	Access ramps to US 2 and I-29						•	•																								
Signal Coordination and Interconnection	Area-Wide						•																									
Highway rail intersection accidents - resulting from gate arm violation	Area-Wide						•	•			•													•								
Emergency response coordination	Area-Wide							•																•								
Emergency vehicle to vehicle communications for response coordination	Area-Wide																							•								
No central facility for transportation information management	Area-Wide																															•
Need for central database of weather, maintenance and/or transportation information	Area-Wide																															•
Discontinuity of signal preemption equipment	Area-Wide						•																									

Table 3 – User Services to Market Packages Mapping

	National ITS Architecture - User Services																														
National ITS Architecture Market Packages	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 Service 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 Service	4.1 Commercial Vehicle Electronic Clearance	4.2 Automated Roadside Safety Inspection	4.3 On-Board Safety Monitoring	4.4 Commercial Vehicle Administrative Process	4.5 Hazardous Material Incident Response	4.6 Commercial Fleet Management	5.1 Emergency Notification and Personal Security	5.2 Emergency Vehicle Management	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
Network Surveillance						●																									
Surface Street Control						●	●			●																					
Freeway Control						●	●	●																							
Traffic Information Dissemination						●				●																					
Regional Traffic Control						●																									
Incident Management System							●																								
Standard Railroad Grade Crossing										●																					
Advanced Railroad Grade Crossing										●																					
Railroad Operations Coordination										●																					
Road Weather Information System						●	●																								
Emergency Response																							●								
Emergency Routing						●																	●								
ITS Data Warehouse																															●



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GRAND FORKS/EAST GRAND FORKS REGIONAL ITS ARCHITECTURE
SUBSYSTEM INTERCONNECTIONS DIAGRAM

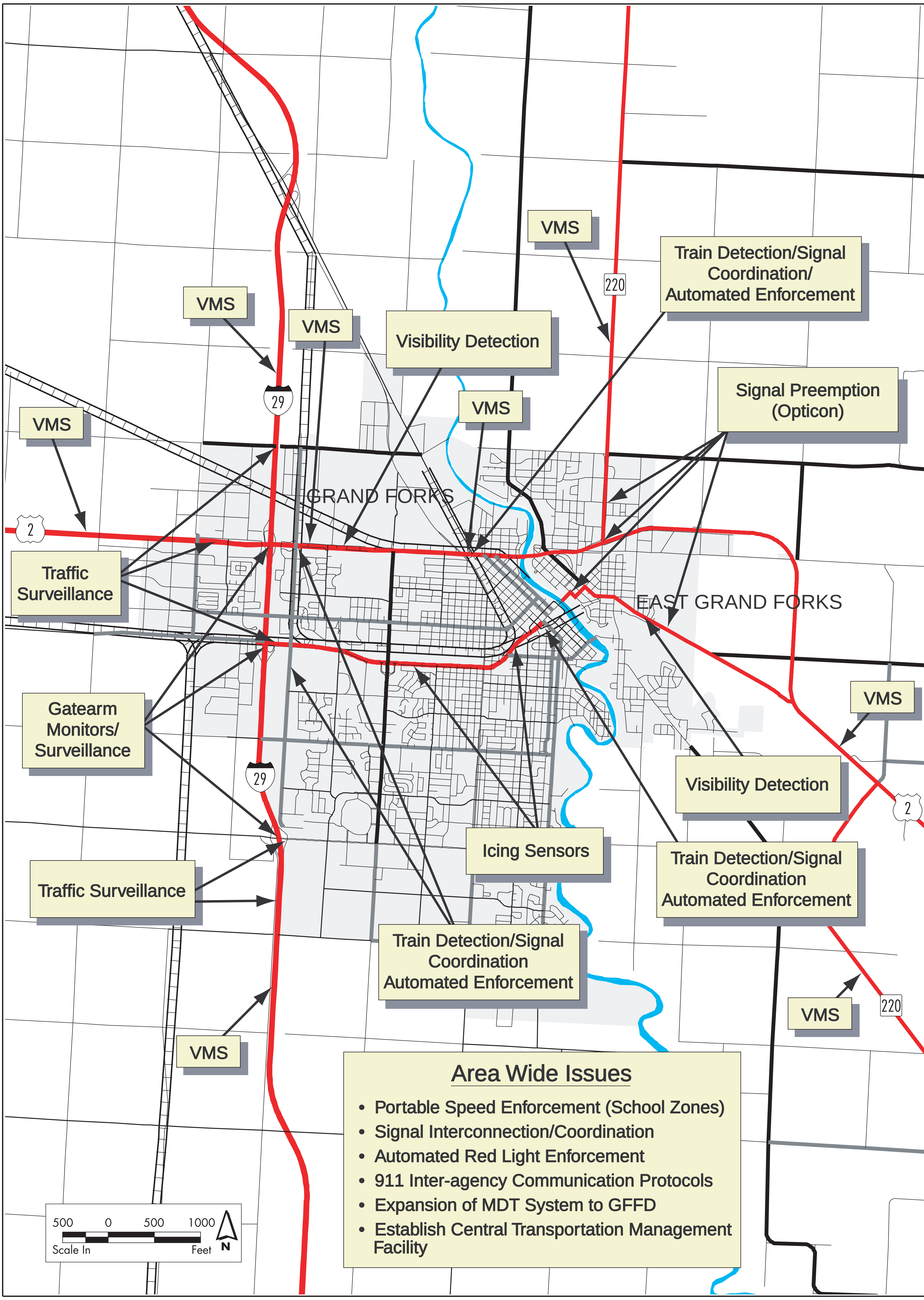
FIGURE 12

SECTION 5 - POTENTIAL ITS SOLUTIONS

Possible ITS Applications in the Grand Forks/East Grand Forks Area

Once the issues in the area have been delineated and the architectural framework for ITS deployment is articulated, the next step in the planning process is to identify and describe possible technical solutions. As is generally the case, there will be several applicable technologies for each issue. The table below summarizes the relevant technologies for each of the issues presented previously. Following the table is a detailed description of each of the solutions and, where applicable, a map (Figure 13) showing possible locations for roadside equipment.

Included in Appendix B to this report are five National Architecture Case Studies illustrating how a sample of the proposed solutions might be implemented in a manner compliant with National Architecture standards. Be aware, however, that these case studies are preliminary and conceptual and should not be considered as detailed design documents.



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PROPOSED ITS SOLUTIONS MAP

FIGURE 13

Table 4 - Summary of Possible ITS Applications

Number	Location	Description	Technologies	Unit Capital Cost (1)	Quantity	Total Capital Cost
1	Alerus Center/Engelstad Arena	Event traffic control	Signal Coordination Variable Message Signs Vehicle Detection Video Surveillance Fiber Optic Communications	$20,000 $40,000 $15,000 $20,000 $40,000/mile	1 8 TBD 3 ~6 miles	$20,000 $320,000 TBD $60,000 ~$240,000
2	US 2 (Simplot)/US 2 (Beet Facility)	Low visibility warning	Visibility Detection Variable Message Signs Hardwire Communications	$20,000 $40,000 $40,000/mile	1 2 2 miles	$20,000 $80,000 $80,000
3	Gateway Dr./42nd Ave. Gateway Dr./5th St. University Ave./42nd Ave Area-Wide	Rail crossing accident prevention Barrier circumvention	Train Detection Variable Message Signs Signal Coordination Wireless Communication Automated Enforcement Systems	$15,000 $40,000 $20,000 $15,000 $100,000	6 6 1 12 4	$90,000 $240,000 $20,000 $180,000 $400,000
4	Demers Ave./Columbia Ave.	Rail overpass icing management	Pavement Condition Sensors Variable Message Signs Maintenance Alerts (pager, etc) Wireless Communication	$10,000 $40,000 $20,000? $15,000	1 2 1 3	$10,000 $80,000 $20,000 $45,000
5	Five major approaches to GF-EGF metro area	Direction for traffic entering area	Variable Message Signs Wireless Communication	$40,000 $15,000	5 5	$200,000 $75,000
6	I-29/US 2 Accesses	No remote management for access control gate arms	Automated Gate Arms Vehicle Detection Video Surveillance Hardwire Communications Wireless Communication	$10,000 $15,000 $20,000 $40,000/mile $15,000	~4 ~8 ~4 ~0.25 mile ~4	~$40,000 ~$120,000 ~$80,000 ~$10,000 ~$60,000

7	Area-wide	Traffic delayed by signals (EVP)	RF/Hardwire interconnects Central Management Workstation	40,000/mile Variable	TBD TBD	TBD TBD
7A	Area-wide	Incompatible priority systems planned	Standardized actuation method	$10,000/ intersection	TBD	TBD
8	Area-wide	Speeding in school zones	VMS Speed detection	$40,000	1	$40,000
9	Area-wide	No central information management facility	Traffic Operations Center Telephony Web PDA Data Processing Wide Area Networking	Variable Variable Variable Variable Variable Variable	TBD TBD TBD TBD TBD TBD	TBD TBD TBD TBD TBD TBD
10	Area wide	Inter-agency communication difficulties	Create communication protocol for MDCs	Variable	TBD	TBD

Note:
(1) Only capital costs are provided. Engineering design, operating and maintenance costs are not included

1. Traffic Management- Alerus Center and Engelstad Arena

All of the possibilities outlined below focus on moving the traffic into and out of the Alerus Center and Engelstad Arena as smoothly and quickly as possible.

Informational Signs for Motorists – This possibility is already under investigation by a working group dealing with the traffic management for the Alerus Center. Eight locations have been identified by this group for the installation of Variable Message Signs (VMS) along roadways near the Alerus Center. Signs are also planned for the approaches for the Engelstad Arena. These signs may be portable, permanently installed or use a combination of the placement methods. Message sets have not yet been determined, but would provide directions and parking availability to motorists. Also, control responsibilities have not yet been assigned if such a system were to be implemented.

VMS deployment offers an effective method for directing traffic at a relatively low cost, particularly if wireless communications are used to control and monitor the signs.

Signal Coordination – In addition to indicating the proper route to motorists, the route should be made to flow as smoothly and efficiently as possible. A properly designed event signal timing plan along with signal interconnection and communication along US 2, 32nd Avenue, Demers Avenue and Columbia Avenue in particular could give directional and turn priorities to entering and exiting traffic.

Area Traffic Surveillance – To permit the maximum level of system responsiveness and customization, it may be desirable to implement a video surveillance system of the routes approaching the center for the management of large events. Real-time surveillance offers the advantages of incorporating incident information into the VMS displays and direct monitoring of traffic backups in the area, which could then used to adjust signal timings on an on-demand basis.

2. Traffic Management - US 2 Simplot (Grand Forks) and Business 2 Processing Facility (East Grand Forks)

The first issue is determining when visibility is substantially reduced, once that is accomplished, and effective mechanism for warning motorists must be implemented.

Visibility Detection – Several systems that detect visibility in a road environment are either deployed or in the evaluation phase. One such system is currently being tested in Duluth, Minnesota. Generally, these systems utilize a machine vision processor that is aligned with a series of high-contrast targets mounted at fixed distances from a camera. Based on the detected contrast of the target, visibility can then be dynamically calculated. These systems are proving to be reliable and responsive to rapidly changing conditions. One set of detectors could be placed in each of the affected segments of roadway.

Informational Signs for Motorists – Dynamic signs have been shown to be effective in alerting motorists to dangerous and variable driving conditions. Message sets for this application would likely be simple "Caution – Reduced Visibility Ahead" or possibly a reduced speed recommendation. Because of the locations of these facilities, the associated warning signs would lend themselves well to alternative uses, such as routes to the arenas or notifications about road closings.

3. Traffic Management - Accidents at Rail Crossings (Gateway Drive & 42nd Avenue, Gateway Drive & 5th Street, University Aven ue & 42nd Avenue)/Barrier Circumvention

As with the visibility issues, the solutions have two components: first, the condition of a train blocking an intersection must be detected, and second, there must be an effective mechanism to alert motorists to the condition.

Train Detection – A system employing machine vision to detect train traffic is being tested in Moorhead, Minnesota. This approach has the advantage of not requiring any interface with railroad hardware for its operation. Also, because a visual detection system is used, the camera can be mounted on a bridge or other structure, eliminating the need for equipment to be placed in the railroad right-of-way.

Informational Signs for Motorists – Because the system could function independently of the railroad's warning mechanisms, small signs could be installed, which would be triggered based on time to arrival rather than strict proximity, or any other criteria that the local units of governments deem appropriate. Signs may be multi-functional, and used for event traffic management, traveler advisory and other purposes in addition to warning of approaching trains.

Signal Interfaces – Another aspect of the system being tested in Moorhead is an interface to the traffic control signal system to minimize the number of vehicles that enter a blocked intersection, and give priority to routes that are grade-separated or are not blocked by a train. A detailed traffic study would need to be conducted to determine if this is an appropriate solution for these intersections. Also, a fully interconnected signal system is a prerequisite for this solution to be implemented.

Automated Enforcement – Nationwide, several experiments have been conducted with automated enforcement of stop sign or red light violations. Stop violations have shown decreases of up to 40 percent at intersections where the equipment has been installed. This technology may be applicable to the rail-crossing environment.

Each of these solutions may also be applicable to the more general problem of drivers circumventing crossing barriers on an area-wide basis. Each intersection where this is found to be an issue will need to be evaluated individually to determine if an ITS application is appropriate.

4. Traffic Management - Overpass Icing Conditions (Demers Avenue Rail Overpass and Columbia Avenue Rail Overpass)

Surface Condition Detection – Several technologies exist to permit real-time monitoring of bridge deck surface conditions, ranging from infrared temperature detectors to in-pavement sensor packages that can directly detect ice formation. A more detailed operational study would be required to determine the optimal cost/functionality trade-off for this particular application.

Maintenance Notification – Control of chemical application requires that maintenance personnel be made aware of the current conditions of the bridge. This can take several forms, ranging from an automated message sent to simple alphanumeric pagers issued to maintenance personnel to real-time monitoring of conditions by a central dispatch facility that can then direct maintenance vehicles as needed.

Informational Signs for Motorists – Research has shown static signs to be ineffective in modifying driver behavior for hazardous driving conditions. Simple dynamic signing could be implemented or more versatile VMS deployed as part of a multi-use metro-area VMS system. In general, dynamic signs are far more effective in modifying driver behavior, making their use appropriate in situations where safety is a concern.

5. Traffic Management - Travelers Unfamiliar with GF/EGF Area Unsure of Event Facility Locations

Informational Signs for Motorists – A system consisting of five VMS located along the US 2, I-29 and Highway 220 approaches to Grand Forks and East Grand Forks could be used to display directions to the various facilities to motorists. Message sets could include such data as appropriate exits and parking availability information.

These signs, if properly located, could also be part of a larger multi-use VMS system, which would address traffic management, safety and traveler information concerns as outlined in this document. This would mitigate the costs of accomplishing any specific goal, since expenses would be shared over many projects.

6. Traffic Management - US 2/I-29 Gate Arm Control

Remotely Monitored Gate Arms – Although the Technical Advisory Committee believes there to be traffic management issues relating to opening and closing of gate arms that would make an automated/remotely controlled system operationally unsuitable, there is value in equipping exiting gate arms with positive open/closed position detection and communications. This would permit the near-real-time detection of gate tampering and would prevent the possibility of gates being accidentally left in an incorrect position.

Video Surveillance – Small, low-cost weatherproof camera enclosures could be mounted on light poles near the access points and inexpensive wireless video transmitters can be used to transport real-time video to a central management point. This would allow the detection of both disabled vehicles and gate arm circumvention attempts.

7. Traffic Management - Traffic Flow Impeded by Uncoordinated or Unactuated Signals (Area-Wide) & Signal Compliance

System Wide Signal Interconnection/Coordination – As mentioned above, additional signal interconnections can have benefits for event traffic management, but they can also have a positive impact on day-to-day traffic operations. Grand Forks has been actively expanding the network of interconnected signals; however, this tends to be on a corridor-by-corridor basis, providing no means to coordinate between intersecting corridors. Also, there has not yet been any coordination in the East Grand Forks signal system. Maximum benefit would be realized if signals in both cities were treated as one system and timing/coordination plans were written to manage the system as a whole.

What will be necessary typically is a data communication link between each signal controller and a master controller. This link can be copper wiring, fiber optic cable, or radio. The appropriate link should be chosen on a case-by-case basis to balance cost and reliability considerations.

Automated Enforcement – The primary mechanism for addressing the problem of signal compliance is an automated enforcement system, either permanent or movable, installed at the intersections. Current state laws in North Dakota and Minnesota preclude issuing citations with such systems; however, "warnings" can be sent to violators, and such notifications have been shown to be effective in curbing compliance problems. A study would need to be conducted to determine the intersections with the greatest violation rates before equipment could be located.

7A. Signal Preemption Compatibility

Acquire Interoperable Systems – Since some emergency response and transit vehicles operate in both jurisdictions, implementing systems that use compatible actuation mechanisms is the logical path to ensuring interoperability. At this time, the Opticom system employed by Grand Forks presents the best option as it is already deployed and integrates well in to the transit aspect of signal operations since it is optically actuated and would not create the intrusive noise of an acoustic system.

Emergency vehicles operating in the East Grand Forks area and in the rural portions of the Mn/DOT district may then need to be equipped with two sets of actuation hardware. Also, the cost is generally higher for optical rather than acoustic systems.

8. Traffic Management - Drivers Exceeding Speed Limits in School Zones

Portable Automated Speed Detection Devices – In some cases, a radar-equipped portable message sign that displays the vehicle's speed with a short "You are speeding" message when appropriate has been shown to be effective in promoting speed limit compliance. Although citations for speeding cannot be issued in this way (due to Minnesota and North Dakota state laws), the device can also be equipped with a camera allowing the identification of motorists by license plate number and a "warning" message can then be mailed to the driver's home. One example of this type of equipment is already owned by the Grand Forks Police Department and could be used to test the effectiveness of this concept.

The equipment would be mounted on a trailer to minimized costs and allow a rotation throughout the school district. When not in use for this application, the sign could also be used in roadway work zones to encourage speed restriction compliance.

9. Traffic Management - Centralized Management Facility (Area-Wide)

Creating a centralized management facility is a long-term possibility for the Grand Forks/East Grand Forks area. However, Traffic Operations and Communications Centers (TOCC) are generally expensive and technically challenging efforts. An appropriate approach might be to select one facility (such as the Grand Forks signal shop) to be the focal point for system management and slowly add additional functionality to the existing facility.

Planning should occur at an early stage to determine the optimal location for a management center, so that large-scale relocation of communications facilities and equipment is not necessary at a later date, and ample space is available for future system expansion.

Traveler Information-Consolidated Information Access (Area-Wide) - There is a telephony-based informational system (#SAFE) that provides weather-related information, and transit and construction information on the City of Grand Forks Web site (www.grandforksgov.com). As national implementation of the 511 abbreviated dial traveler information number reaches the Grand Forks area, these information sources could be consolidated into a central facility, which would supply information to the telephony system and to an expanded Web site information portal. These are longer-term solutions that would require rationalization of all traveler information into standardized formats and a coordinated database system to process and store the information. Additional development would be necessary to incorporate local (city level) information into a region or state-wide information system.

10. Emergency Response - Interagency Communication Difficulties (Area-Wide)

Since the majority of communications would be from the Grand Forks County Sheriff and Grand Forks Police Department, and those agencies share a common Mobile Data Terminal (MDT) platform and utilize a common communications backbone, it seems likely that a messaging protocol could be established that would permit direct vehicle-to-vehicle communications.

Ultimately, if the Computer Aided Dispatch (CAD) systems were interfaced to the MDT system, a semi-automated system could be developed which would permit bi-directional monitoring dispatched calls.

The Grand Forks Fire Department also has expressed a need for the ability to relay large amounts of hazardous materials handling procedure information. Similar needs have been indicated by the East Grand Forks Fire Department. Expansion of the Existing MDT system to the Fire Departments would address these needs and ensure the most efficient dissemination of critical safety data.

To address the communications and support needs of the East Grand Forks 911 dispatch operations, it is advisable for East Grand Forks to adopt the Cisco CAD system implemented in Grand Forks and create a Wide Area Network link to the East Grand Forks facility. This would afford the following advantages:

- Access to the system knowledge of Grand Forks staff
- Potential to share maintenance costs
- Potential to share training costs
- Ability to access CAD databases for joint responses to incidents and for administrative purposes
- Ability to interface the CAD system to the MDT system, if so desired
- Enhanced messaging capability between the centers

ITS Project Costs

The cost of ITS applications varies widely based on extent and quantities, geographic coverage and level of complexity of the application. In estimating ITS project costs, it is extremely important to include the cost of operating and maintaining the system in addition to the capital cost. While capital costs can often be funded in part or totally with federal and state funds, operations and maintenance costs are typically borne by the local agency and community. Both operating and maintenance should include dollar costs, as well as personnel required to operate and maintain the system after it is deployed.

In order to estimate the costs involved with the deployment and operation of the ITS projects identified in the short-range implementation strategy, data from tools such as the ITS Deployment Analysis System (IDAS), as well as past experiences in project deployments, were used to document a range of deployment and system operating costs.

Table 5 has been prepared to show current estimates of capital, operation and maintenance costs of ITS applications, as well as estimates of personnel requirements. As with previous materials developed for this Plan, the estimates presented in Table 5 are intended for use as a tool by planners and decision-makers in selecting among competing ITS projects, in the context of limited funds. This table should be expanded and updated periodically.

Table 5 - Estimated ITS Project Costs

ITS Application	Capital Cost	Operating Costs (Power, Comm. Etc.)	Personnel	Maintenance Costs Cost ($)	Personnel
1. CCTV (Camera, lens, mounting h/w)	$10,000 - $25,000/site	Low	High	High ($2,000/year/site)	(4)
2. CCTV Communication					
Fiber Optic	$20,000/mile	Minimal	N/A	Low	(4)
Twisted Pair (Signal interconnect)	$5,000/mile	Minimal	N/A	Low	(2)
Telephone Leased Line	$100 - $1,000	$50/mo. - $1,000/month	N/A	Low	(1)
Wireless Communication	$10,000 - $20,000	Minimal	N/A	Low	(2)
3. Coordinated Signal Control	$10,000 - $30,000/site	Minimal	Medium	Low	(3)
4. Variable Message Sign (Permanent)	$25,000 - $250,000/site	$20 - $150/month	Medium	Low	(3)
5. Portable Variable Message Sign	$25,000 - $60,000/site	Medium ($4,000/year)	High	Medium ($1,000 - $1,500/year)	(3)
6. Visibility Detection System	$5,000 - $30,000/site	Low	Low	Medium	
7. Train Detection	$5,000 - $20,000/site (For detection portion of system)	Low	Low	Low	(2)
8. Red Light/RR Xing Violation Detection	$75,000 - $125,000	Low	High	High	
9. Emergency Vehicle Pre-emption	$5,000 - $10,000/site	Low	Medium	Low	(3)
10. Pavement Sensors					
Pavement Sensing equipment	$5,000-$10,000/site	Low	Low	Low	(2)
Variable Message Sign	$25,000 - $40,000/site	Low	Low	Medium	(3)
Beacon Warning	$5,000	Low	Low	Medium	(2)
11. Speed Warning System	$25,000 - $30,000/site	Low	N/A	Low	(2)
12. Automated/Remotely Controlled Gate Arms	$100,000/diamond interchange	Low	Medium	Low	
13. Centralized Traffic Operations Center	Variable	High	High	High	(4)
14. Traveler Information Consolidation	Variable	High	High	High	
15. Emergency Response – Area-wide Communication (CAD)	Variable (High)	Low	High	Medium	

Notes:

1. The costs presented here are average 1998 costs; actual costs may vary depending on the specific application.
2. Personnel costs are defined by the following:
   - (1) Requires no change in maintenance personnel
   - (2) Requires some additional training to existing maintenance personnel
   - (3) Requires additional maintenance personnel with existing skills
   - (4) Requires additional maintenance personnel with new skills

Benefits of Multi-Use Components

Many of the ITS solutions listed in Table 4 contain components which could be used in several other solutions, needing only appropriate communications and integration to be completed to realize several functions from a single piece of hardware. The use of multi-purpose components has several advantages, most notably a reduction in capital outlay to implement several systems, reduced visual/aesthetic impact to the community, reduced maintenance and operating costs due to the lower number of components and reduced physical complexity, and greater flexibility in delivering information to the public. It is recommended that, wherever possible, systems be designed to maximize the use of existing components and to offer the greatest opportunities for other systems to re-use components in the future.

Specific examples of multi-use components are listed below.

VMS – Since several potential projects use Variable Message Signs (VMS) to relay information to motorists, location compromises can be made to allow multi-use. Applicable projects are:

1. Event traffic control for the Alerus and Engelstad Arenas
2. Low visibility warning for Simplot and Crystal Sugar facilities
3. Traveler information for approaches to the Grand Forks/East Grand Forks Metro Area

If each of these systems were implemented separately, a total of approximately (depending on final design decisions) 15 VMSs would be needed. If an integrated approach is taken, the same functionality can be accomplished with nine or fewer signs.

Fiber Optic Communications – One of the greatest expenses involved with any system involving roadside components is the optical cable necessary for system communications. These costs can range up to $40,000 dollars per mile for underground cable installation. Several options are available to contain these costs, one of which is to utilize the cable for multiple projects. Because other communication options are available (i.e., wireless) exact savings are difficult to determine, however, the following three projects would likely utilize fiber optics:

1. Event traffic control for the Alerus and Engelstad Arenas
2. Low visibility warning for Simplot and Crystal Sugar facilities
3. Traffic signal interconnects

It seems likely that two miles of fiber optic cabling would be duplicated if these projects were implemented separately.

Other component savings (such as workstation consolidation, etc.) will need to be determined during the design phase of projects.

Table 6 shows one possible scenario for multi-use savings. This scenario assumes an area-wide traveler information system will be constructed (Project 1), then shows additional components to be added for subsequent systems. Other scenarios are possible, depending on the scale and order of construction of ITS projects.

Table 6 – Illustration of Possible Multi-Use Savings

Number	Location	Description	Technologies	Unit Capital Cost (1)	Quantity	Total Capital Cost
1 (Initial Project)	Traveller information for the five major approaches to GF/EGF metro area	Direction/information for traffic entering area	Wireless Communications	$15,000	5	$20,000
			Variable Message Signs	$40,000	5	$320,000
			Vehicle Detection	$15,000	~8	$120,000
			Video Surveillance	$20,000	3	$60,000
			Fiber Optic Communications	$40,000/mile	~6 miles	~$240,000
2	US 2 (Simplot)/US 2 (Beet Facility)	Low visibility warning	Visibility Detection	$20,000	+1	$20,000
			Variable Message Signs	$40,000	+0	$0
			Hardwire Communications	$40,000/mile	+0	$0
3	Gateway Dr./42nd Ave. Gateway Dr./5th St. University Avenue/42nd Avenue	Rail crossing accident prevention	Train Detection	$15,000	6	$90,000
			Variable Message Signs	$40,000	6	$240,000
			Signal Coordination	$20,000	1	$20,000
			Wireless Communication	$15,000	12	$180,000
	Area-Wide	Barrier circumvention	Automated Enforcement Systems	$100,000	4	$400,000
4	Demers Avenue/ Columbia Avenue	Rail overpass icing management	Pavement Condition Sensors	$10,000	1	$10,000
			Variable Message Signs	$40,000	+3	$120,000
			Maintenance Alerts (pager, etc)	$20,000?	1	$20,000
			Wireless Communication	$15,000	3	$45,000
5	Alerus Center/Engelstad Arena	Event Traffic Control	Variable Message Signs	$40,000	+1	$40,000
			Fiber Optic Communication	$40,000/mile	~+1 mile	$40,000
6	I-29/US 2 Accesses	No remote management for access control gate arms	Vehicle Detection	$15,000	+4	~$60,000
			Video Surveillance	$20,000	~+1	~$20,000
			Hardwire Communications	$40,000/mile	+0	$0
			Wireless Communication	$15,000	~4	~$60,000
TOTAL						**~$2,020,000**

Note:
(1) Only capital costs are provided. Engineering design, operating, and maintenance costs are not included

Under the assumptions shown in Table 6, the cost for projects 1 through 6 is reduced from $2,490,000 to $2,125,000, for a reduction of 14.6 percent. Additional savings are certainly possible through the integration of ITS communications with the existing fiber optic and twisted pair wiring installed for the traffic signal system and through the purchase of larger quantities of components, qualifying for volume discounts from vendors.

SECTION 6 - INCORPORATING ITS INTO THE PLANNING PROCESS

COMPREHENSIVE ITS IMPLEMENTATION PLAN

Several factors will affect ITS implementation. At a minimum, the following characteristics should be considered to determine which projects to select for implementation:

- Current project status
- Complexity of ITS application as it relates to staging
- ITS project cost and funding
- Interjurisdictional coordination
- Ongoing ITS Technical Committee direction

The factors are explained in greater detail below.

ITS Implementation as Related to Current Project Status

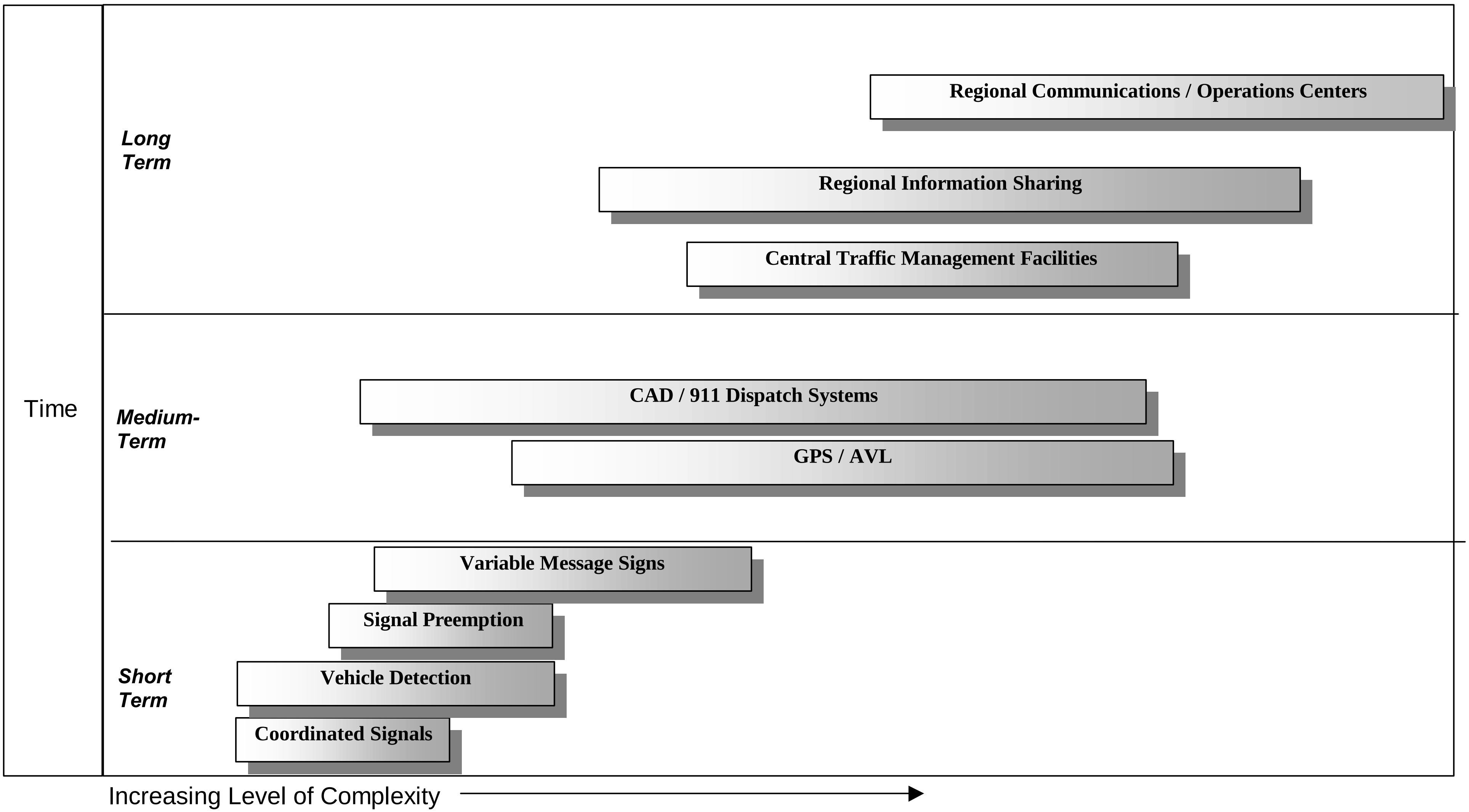
The decision to implement an ITS application as part of a transportation project, and the timing of that implementation, will depend on the status of the subject transportation project; that is, whether it is an existing project in the final stages of planning or design or a planned project.

Existing Systems, Projects or Services – For systems, projects or services that are currently in place and operating, ITS could be introduced as part of project reconstruction, service reconfiguration or fleet replacement. The types of applications that focus on existing infrastructure are aimed primarily at improving safety, system management and efficiency. These projects are eligible for ITS applications.

Systems, Projects or Services in Final Stages of Planning or Design – Projects for which environmental studies, project concept reports, etc. are being completed or are in final design may or may not be eligible for ITS applications. Projects should be reviewed carefully to determine if the introduction of ITS applications at this point in the implementation process would result in significant changes (in terms of delay or cost or both) to the project being studied or designed. If the consensus is that changes will be significant, the ITS application may be found not feasible at the time. If, however, the change is not significant, the ITS application should be considered.

This consideration applies only to current projects. As ITS is mainstreamed into the planning process, the frequency of this occurring will decrease, since ITS would be considered for all projects at the earliest stage.

Future Systems, Projects or Services Being Planned – ITS applications should be considered as an integral part of future transportation systems, projects and services, from project definition through the project development process. By doing so, ITS will be mainstreamed into the overall planning process as described previously in the project/service-based approach to planning.



Progression of ITS Projects

FIGURE 14

Complexity of ITS Application

The complexity of ITS applications varies widely. The major factors that increase project complexity include number of agencies and jurisdictions involved in the decision, extent and complexity of software, hardware and equipment required, cost and geographic coverage. Figure 14 describes the relative level of complexity of typical ITS applications. At the lower end of the complexity scale is Signal Coordination, which is an everyday type of application. At the higher end, both in complexity and timeline, is the Regional Communications/Operations Center. Centers require a great deal of cooperation and the joint efforts of multiple agencies and jurisdictions. The cost is also substantial. Figure 14 can also be used to assist decision-makers decide which ITS projects can be implemented in the short term versus medium or long term.

FUNDING

An important objective of ITS deployment is to reduce or postpone, over time, the need for transportation infrastructure investment. It is in this context that funding for ITS must be considered. Seen in this light, and as ITS is mainstreamed, the cost of the ITS elements of most transportation systems, projects or services will become an integral part of the overall transportation funding package.

In the past, the majority of ITS projects funds was derived from federal, state, county and city funds. A key factor in determining the funding source for a project is the jurisdiction having authority over the roadway for which the ITS project is being deployed. Many projects are funded by a combination of sources. For example, a county state-aid roadway project can receive funding from the state and county. An emergency signal pre-emption project can receive funding from federal, state, county and city sources, depending upon the number of legs of each intersection that fall within each of these jurisdictions. Area-wide projects quite often receive funds from state and federal sources, since these projects are viewed as providing regional benefits.

Federal Funding

Potential federal program funding sources for ITS projects include:

- National Highway System (NHS)
- Surface Transportation Program (STP)
- Congestion Mitigation and Air Quality Improvement (CMAQ)
- Intelligent Transportation Systems (ITS)

TEA-21 states that other federal-aid highway funds may be used for ITS activities as follows[1]:

[1] Source: FHWA fact sheet on ITS Eligibility for the ITS Program

National Highway System (NHS) and *Surface Transportation Program (STP)* eligibilities are clarified to specifically allow funds to be spent for infrastructure-based ITS capital improvements.

Congestion Mitigation and Air Quality Improvement (CMAQ) funding eligibilities are clarified to include programs or projects that implement ITS strategies.

The federal *Intelligent Transportation Systems (ITS)* program provides for the research, development and operational testing of ITS aimed at solving congestion and safety problems, improving transportation efficiencies in transit and commercial vehicles, and reducing the environmental impact of growing travel demand. Since many of the ITS projects identified in this plan are focused on improving safety and efficiency of the transportation system, these projects are candidates for federal ITS funds.

The Transportation Equity Act for the 21st Century (TEA-21) divided the ITS Program into two key areas - *Research and Development*, and *Deployment Incentives*.

The *Research and Development Program* is a comprehensive program of research, development and operational tests of intelligent vehicles and intelligent infrastructure systems.

The *Deployment Incentives Program* is aimed at accelerating ITS integration and interoperability in metropolitan and urban areas. Deployment projects must be selected through competitive solicitation and must meet certain detailed criteria. For metropolitan areas, funding from this category is primarily for integration of existing systems. For projects outside of the metropolitan areas, federal funds may also be used for installation of new and expanded systems. This program also includes the Commercial Vehicle Infrastructure Deployment aimed at advancing the technological capability and promoting deployment of ITS applications to commercial vehicle operations. Projects in the GF-EGF area that provide benefits to long-haul trucking on I-29 and I-94 are potential candidates for funds from this program.

Another key change in TEA-21 involves the eligibility of operations and maintenance costs for federal funds. The purpose of this legislation is to encourage and promote the safe and efficient management and operation of integrated, intermodal surface transportation systems to serve the mobility needs of people and freight, and to foster economic growth. This legislation allows NHS and STP funds to be used for the capital and operating costs for traffic monitoring, management, and control facilities or programs.

CMAQ funds are available for the establishment or operation of a traffic monitoring, management and control facility or program. It explicitly includes programs and projects that improve traffic flow such as signalization, interconnected signals, intersection improvements and ITS strategy implementation. Several issues will need to be addressed in the application process for CMAQ funds. Funds may not be available for areas not designated as pollution non-attainment areas, and there is currently no mechanism in place for local units of government to access federal funds in Minnesota.

Federal and state funds will probably continue to be dedicated to ITS research, operational tests and deployment in the near future. As ITS moves more and more to the deployment stage, future funds are likely to shift towards implementation. The Federal Highway Administration (FHWA) has stated that this is their future direction.

The FHWA has also stated their desire that ITS be mainstreamed into the overall planning process. Given these trends, the Grand Forks/East Grand Forks Metropolitan Area ITS Strategy Plan is the first step in positioning the metropolitan area to compete for federal and state funds.

Another source of funds for ITS implementation is through public/private-sector partnerships. In the past, many private-sector companies, particularly software, hardware and equipment vendors, have found it to be profitable or beneficial to enter into partnership with public-sector agencies by discounting or contributing their wares, or through in-kind contribution of personnel time. This option should be explored whenever an ITS application, especially if of some magnitude, is being considered.

INTERJURISDICTIONAL COORDINATION

One of the most recognized impediments to ITS implementation is the barriers that exist between multiple agencies and jurisdictions. When a project involves multiple entities, the review and approval process can be time-consuming, difficult and, ultimately, very frustrating for all involved. This difficulty is easy to understand given that each agency may have objectives that they have to fulfill and constituencies to which they must be responsive. And often the objectives among agencies, and even within agencies, can conflict.

There are however, many cases of successful interjurisdictional cooperation in pursuit of a common goal. One of the best examples is the Advanced Rural Transportation Information and Coordination (ARTIC) ITS project in the Arrowhead Region of Minnesota. This project, which received federal funding as an Operational Test, was based on a partnership between Mn/DOT, Minnesota State Patrol and Arrowhead and Virginia Transit to improve response time by improving communications among the agencies, reduce costs by consolidating resources in one place and reducing duplication.

Corridor Coordination

Of particular significance to the Grand Forks/East Grand Forks Area is the commercial truck traffic on Interstate 29 crossing into the United States from Canada at Pembina, North Dakota passing through Grand Forks and Fargo, North Dakota, Watertown and Sioux Falls, South Dakota, Omaha, Nebraska, and terminating in Kansas City, Missouri. Commercial Vehicle (truck) traffic has been increasing rapidly, showing a 12 percent expansion between the years of 1993 and 1997 alone, an increase of nearly 49,000 (source: Bureau of Transportation Statistics). Of key importance to the operators of commercial vehicles is timely and accurate information regarding incidents, weather conditions, weight restrictions or any other factor that may influence the travel time or route needed.

There have been several smaller-scale ITS planning and deployment efforts aimed at aiding the commercial community, as well as an effort currently underway in the Kansas City, Missouri area. Since the Grand Forks/East Grand Forks area is the first major population center encountered for southbound traffic after entering the United States and the last population center for traffic leaving it, there are a number of opportunities to interact with the commercial vehicle operators. These include:

- Issuing automated credentials
- Delivering information via variable message signs or low-power radio
- Conducting inspections
- Streamlining administrative procedures

Greatest benefit can be obtained be coordinating efforts along the I-29 corridor and, as programs are developed and deployed, the Grand Forks/East Grand Forks area should play a key role in planning for interoperability of systems.

Ongoing ITS Technical Committee Direction

Because of the relative newness of the ITS field, it has not had the time to become a part of everyday activity of transportation planners and engineers. The GF-EGF Technical Advisory Committee has provided direction to this study and has been involved with ITS issues and discussions, including ITS state-of-the-art applications. Additionally, the Committee has provided the forum for multiple jurisdictions and public and private sector agencies to understand how ITS can affect the way they do things and where their individual objectives lie.

It is recommended that this TAC continue to place a priority on the implementation of ITS in the region and strive to ensure that the proposals presented in this study are followed through. This Committee could also serve as the focus for developing and disseminating ITS education materials, tracking training opportunities for transportation professionals and decision-makers in the GF/EGF area, and establishing and maintaining uniform architecture standards for communication and equipment.

An opportunity also exists for the MPO to be represented on the Minnesota Guidestar Board of Directors. Membership would afford an excellent mechanism for keeping abreast of ITS developments in Minnesota and a way to provide input to the ITS planning process for that state. Representation would also benefit the deployment ITS projects in rural areas by providing an important source of information regarding the special concerns and needs of areas with lower urban development densities.

APPENDIX A

ITS INVENTORY SYSTEM DETAIL

System 1 – Grand Forks / East Grand Forks ITS Plan

System Name: **Mobile Data Terminal System – Highway Patrol**	Date Surveyed:9/12/00	Surveyed By: MRG

System Location	All Highway Patrol Vehicles in the Grand Forks area (22) Highway Patrol Offices Repeater Tower in Grand Forks
Contact Person	Capt. Mark Nelson North Dakota Highway Patrol 122 South 5th Street Grand Forks, ND 58201
Responsible Entity	North Dakota Highway Patrol
System Functions	Allow text & data communications between dispatch facilities and patrol vehicles as well as vehicle to vehicle communications.
Geographic Scope	Statewide
Date Operational	Current version of software installed February 21, 2000
System Customers	Highway patrol officers and administrators
System Goals	Improve communications efficiency Decrease voice communications traffic. Enable data communications between vehicles and dispatch facilities Speed data processing functions for license checks, CJIS, etc.
Operational Scenario	**Scenario One** Personnel at a dispatch facility needs to send a message to multiple vehicles simultaneously. Using a software application, the appropriate units are selected and a text message is typed in. When the “send” command is issued, the message is sent to the repeater tower and broadcast. The specified vehicles display the message for the officer in the car. **Scenario Two** An officer pulls over a motorist and reads the license plate number. The plate number is entered into the MDT and transmitted to the MDT server as a data request. The data request is processed as a query to the vehicle registration database and owner and violation data is transmitted to the MDT. The officer then reads the information on the MDT’s screen.
Upgrade Plans	Global Positioning System hardware and Automatic Vehicle Location functions to be added in 2001.

Component Delineation

Component Reference Number	1.1.1
Component Name	MDT
Type	Ruggedized Notebook Computer
Manufacturer	Panasonic
Model	CF-27
Quantity	70 (statewide)
Function	Run MDT communication software Provide interface for officers
Location	Between patrol vehicle's front seats
Interfaces Used	1.2.1;1.2.2
Interfaces To	1.1.2-Vehicle Printer; 1.1.3-Vehicle Radio

Component Reference Number	1.1.2
Component Name	Printer
Type	Compact thermal printer
Manufacturer	Pentax
Model	Pocket Jet II
Quantity	70 (statewide)
Function	Provide hard copy of MDT communications Print documentation for citizens
Location	Between patrol vehicle's front seats
Interfaces Used	1.2.2
Interfaces To	1.1.1-MDT

Component Reference Number	1.1.3
Component Name	Vehicle Radio
Type	450 MHz band portable radio (9600 bits/sec)
Manufacturer	Motorola
Model	VRM 600
Quantity	70 (statewide)
Function	Transmit/receive data for MDT

Location	Between patrol vehicle's front seats
Interfaces Used	1.2.1
Interfaces To	1.1.1-MDT

Component Reference Number	1.1.4
Component Name	Repeater Tower and Transceiver
Type	100 Foot antenna tower and 450 MHz base station radio; maximum transmit power 100 watts
Manufacturer	Motorola (radio)
Model	?
Quantity	10 in statewide system
Function	Transmit and receive data for MDT system Repeat signals to other towers statewide for MDT interconnection
Location	One in Grand forks 10 others located throughout the state of North Dakota
Interfaces Used	1.2.3; 1.2.4
Interfaces To	1.1.3-Vehicle Radio; 1.1.5 Radio Network Controller

Component Reference Number	1.1.5
Component Name	Radio Network Controller
Type	Server class computer with speciallized Motorola Radio Interface hardware
Quantity	One
Function	Provide interface between the radio and land line data transmission networks
Location	Bismarck, ND
Interfaces Used	1.2.4; 1.2.5
Interfaces To	1.1.4- Repeater Tower; 1.1.5 Hub/Switch (LAN)

Component Reference Number	1.1.6
Component Name	Wireless Network Gateway (WiNG)
Type	Sever class computer
Quantity	One
Function	Provide packet routing between the TCP/IP Wide Area Network and the Radio Data Network
Location	State Highway Patrol Offices, Bismarck, ND
Interfaces Used	1.2.5

Interfaces To	1.1.6 Hub/Switch

Component Reference Number	1.1.7
Component Name	MDC Server
Type	Sever class computer
Quantity	One
Function	Enable communications and message routing services for the MDCs Provide access to State databases
Location	State Highway Patrol Offices, Bismarck, ND
Interfaces Used	1.2.5
Interfaces To	1.1.6 Hub/Switch

Component Reference Number	1.1.8
Component Name	Hub/Switch
Type	Ethernet network signal hub or switch
Manufacturer	Varies
Model	Varies
Function	Interconnect desktop systems, printers and the tower system
Location	Various Highway patrol offices
Interfaces Used	1.2.5
Interfaces To	1.1.5 RCN; 1.1.6 WiNG; 1.1.7 MDC Server; 1.1.9 CSU/DSU; 1.1.10 Desktop Systems

Component Reference Number	1.1.9
Component Name	CSU/DSU
Type	Communications Device
Manufacturer	ADC
Model	Kentrox D-Link
Quantity	1 at each Highway patrol office
Function	Interconnect Local Area Networks at Highway Patrol offices via T-1 (1.5 Mb/s) data lines
Location	State Highway Patrol Offices throughout North Dakota
Interfaces Used	1.2.4; 1.2.5
Interfaces To	1.1.6 Hub/Switch

Component Reference Number	1.1.10
Component Name	Desktop System
Type	Intel-compatible computer
Manufacturer	various
Model	various
Function	Run the MDC software in a desktop environment. Computer has full in-vehicle MDC functionality
Location	State Highway Patrol Offices throughout North Dakota
Interfaces Used	1.2.4
Interfaces To	1.1.6 Hub/Switch

Interface Delineation

Interface Reference Number	1.2.1
Type	IEEE 1294 Parallel interface cable
Manufacturer	?
Model	?
Quantity	1 in each patrol vehicle
Function	Connect MDT to printer and provide parallel communications
Location	Front seat of patrol vehicle; connecting MDT docking cradle and printer parallel port
Interfaced Components	1.1.1- MDT; 1.1.2 Printer

Interface Reference Number	1.2.2
Type	Serial interface cable?
Manufacturer	?
Model	?
Quantity	1 in each patrol vehicle
Function	Connect MDT to printer and provide parallel communications
Location	Front seat of patrol vehicle; connecting MDT docking cradle and Vehicle radio
Interfaced Components	1.1.1- MDT; 1.1.3 Vehicle Radio

Interface Reference Number	1.2.3
Type	450 MHz radio link
Manufacturer	Motorola
Quantity	N/A
Function	Communication between vehicle radios and repeater tower
Location	N/A
Interfaced Components	1.1.4- Repeater tower; 1.1.3 Vehicle Radio

Interface Reference Number	1.2.4
Type	Leased land line– Copper “dry pair”
Manufacturer	AT&T
Model	N/A
Quantity	1
Function	Connect radio repeater to the Radio Network Controller
Location	Highway Patrol offices, Bismarck, North Dakota
Interfaced Components	1.1.4- Repeater tower; 1.1.5 Tower System

Interface Reference Number	1.2.5
Type	Category 5 4-pair cable
Quantity	N/A
Function	Interconnect computers and hubs/switches on local area network (LAN) (10 or 100BaseT)
Location	N/A
Interfaced Components	1.1.5 RCN; 1.1.6 WiNG; 1.1.7 MDC Server; 1.1.8 Hub/Switch; 1.1.9 CSU/DSU; 1.1.10 Desktop systems

Interface Reference Number	1.2.6
Type	Leased T-1 data line
Manufacturer	Provided by Qwest
Model	N/A
Quantity	1 per Highway Patrol District Office
Function	Interconnect computers on local area networks (LAN) at each office with statewide Wide Area Network
Location	N/A
Interfaced Components	1.1.9 CSU/DSU

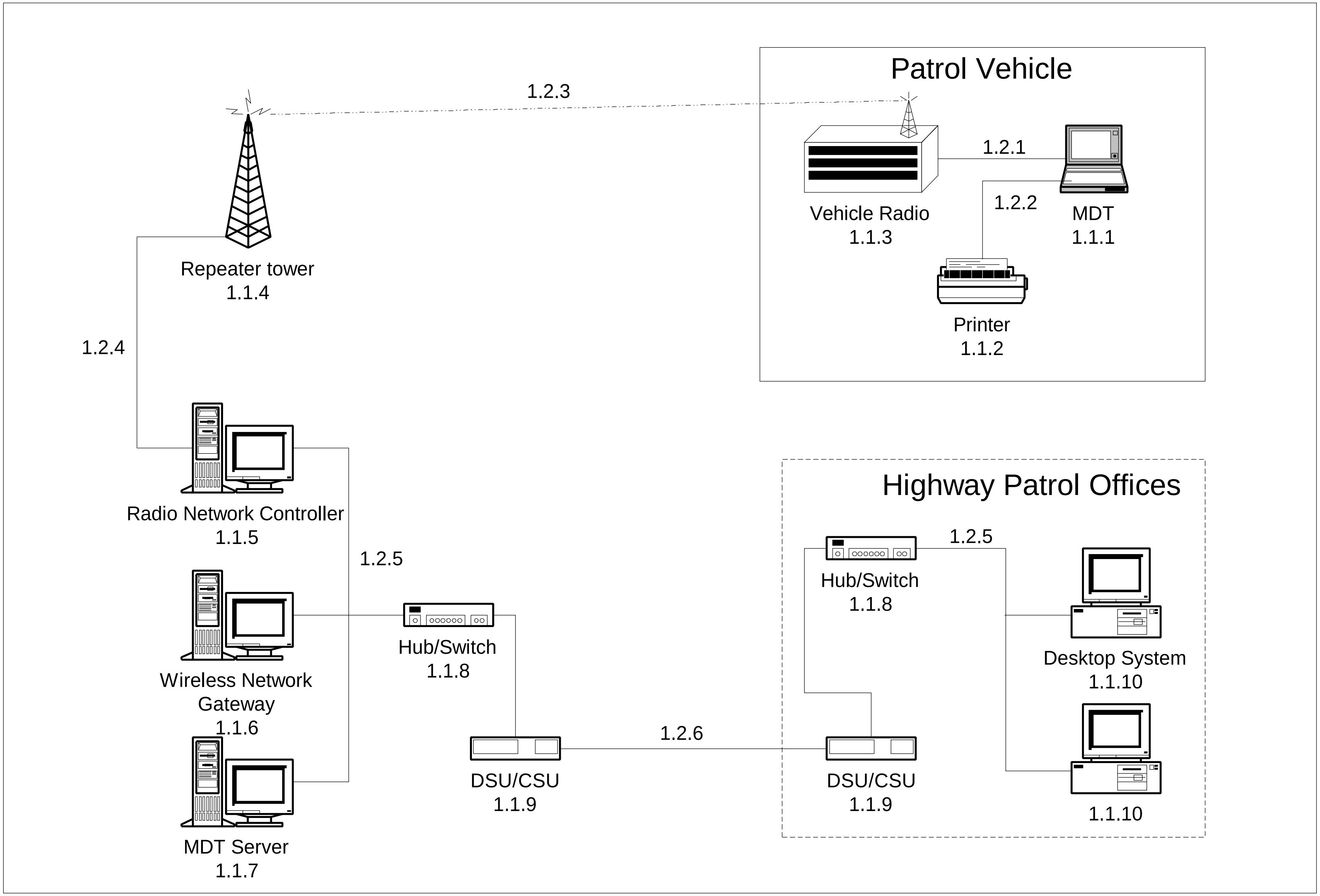
Software Delineation

Software Reference Number	1.3.1
Software Name	Windows NT
Type	Operating system
Manufacturer	Microsoft, Inc.
Version	4.0 Service Pack 4
Function	Software environment
Installed Hardware	Most Desktop computers 1.1.10; and MDC 1.1.1

Software Reference Number	1.3.2
Software Name	Premier MDC
Type	MDC Communications Client
Manufacturer	Software Corporation of America (Motorola)
Version	3.7.9 (customized)
Function	Enables MDT functions on in vehicle MDC: Messaging Database query Panic/Emergency alert
Installed Hardware	1.1.1 MDC; 1.1.10 Desktop Systems

Software Reference Number	1.3.3
Software Name	MDT Server
Type	MDT system server application
Manufacturer	Software Corporation of America (Motorola)
Function	Sends and receives messages and other data from Desktop Systems and MDTs Stores and archives data Generates usage statistics.
Installed Hardware	1.1.7 MDT

System Diagram



System 2 - Grand Forks-East Grand Forks ITS Plan

System Name: **Traffic Signal System – Grand Forks**	Date Surveyed:9/12/00	Surveyed By:MRG

System Location	53 total locations in the City of Grand Forks (41 actuated signals; 12 pretimed)
Contact Person	Dan Jonasson Traffic Engineer City of Grand Forks P.O. Box 5200 Grand Forks, ND 58206 (701) 746-2642
Responsible Entity	City of Grand Forks
System Functions	Manage traffic flow Enhance pedestrian safety
Geographic Scope	All signals are within the Grand Forks city limits
Date Operational	N/A
System Customers	General Public
System Goals	Minimize traffic delays Minimize traffic accidents
Operational Scenario	Signals operate continuously, directing traffic without intervention.
Upgrade Plans	Signals to be added: University Ave. & S. 42nd Street – Nov. 2000 17th Ave. South & S. 42nd Street – Fall 2000 32nd Ave. South & S. 34th Street – Feb. 2001 28th Ave. South & S. Columbia Rd. – 2003

Component Delineation

Component Reference Number	2.1.1
Component Name	Type 170 Controller
Type	Intersection traffic signal timing controller
Manufacturer	SafeTran (others)
Model	Type 170
Function	Store and execute signal timing plans Actuate relays to supply power to signal heads

	Receive and process vehicle detection (loop) data
Location	1 at each signalized intersection
Interfaces Used	2.2.5; 2.2.6
Interfaces To	2.1.2 Interface panel; 2.1.3 Modem

Component Reference Number	2.1.2
Component Name	Interface Panel
Type	Electrical relay and interconnect device
Function	Provide electrical connections for signal heads, detectors and auxiliary equipment Provide control interface for controller hardware
Location	1 at each signalized intersection
Interfaces Used	2.2.4; 2.2.5
Interfaces To	2.1.1 Type 170 Controller; 2.1.4 Field Wiring Strip; 2.1.5 Opticom Amplifier; 2.1.6 Loop Amplifier

Component Reference Number	2.1.3
Component Name	Modem
Type	Serial communications device (9600 bits/sec)
Function	Communications between intersection signal controllers
Location	1 at each signalized intersection
Interfaces Used	2.2.6; 2.2.7
Interfaces To	2.1.1 Type 170 Controller; 2.1.3 Modem

Component Reference Number	2.1.4
Component Name	Field Wiring Strip
Type	Electrical Terminal Strip
Function	Provide safe termination of electrical connections between signal system components
Location	1 at each signalized intersection
Interfaces Used	2.2.1; 2.2.2; 2.2.3
Interfaces To	2.1.5 Opticom Amplifier; 2.1.6 Loop Amplifier; 2.1.8 Loop Detector; 2.1.9 Opticom Sensor; 2.1.10 Signal Head

Component Reference Number	2.1.5
Component Name	Opticom Amplifier
Type	Opticom pre-emption system interface and power supply
Manufacturer	3M

Function	Provide power to the Optimcom sensor Receive signal from the Opticom sensor
Location	1 at each signalized intersection
Interfaces Used	2.2.4
Interfaces To	2.1.4 Field Wiring Strip; 2.1.2 Interface Panel;

Component Reference Number	2.1.6
Component Name	Loop Amplifier
Type	Power supply and signal amplifier
Function	Provide power to the in-pavement inductive Loop Detectors Receive and amplify signal from Loop Detectors
Location	? at each signalized intersection
Interfaces Used	2.2.4
Interfaces To	2.1.4 Field Wiring Strip; 2.1.2 Interface Panel;

Component Reference Number	2.1.7
Component Name	Intersection Cabinet
Type	Environmentally Hardened outdoor equipment cabinet
Function	House, protect and orgainze intersection signal components
Location	? at each signalized intersection
Interfaces Used	2.2.4
Interfaces To	2.1.4 Field Wiring Strip; 2.1.2 Interface Panel;

Component Reference Number	2.1.8
Component Name	Loop detector
Type	In-pavement inductive loop type vehicle detection device
Function	Indicate presence of vehicle
Location	In selected lanes at intersections with actuated signals
Interfaces Used	2.2.3
Interfaces To	2.1.4 Field Wiring Strip

Component Reference Number	2.1.9
Component Name	Opticom Sensor
Type	Electrionic photosensor
Manufacturer	3M
Function	Receives photo-strobe signal from opticom equipped emergency vehicles
Location	Various numbers at each opticom equipped signalized intersection
Interfaces Used	2.2.4
Interfaces To	2.1.4 Field Wiring Strip; 2.1.2 Interface Panel;

Component Reference Number	2.1.10
Component Name	Signal Head
Type	Intersection signal lamp housing
Function	Displays colored signals to motorists to regulate traffic flow.
Location	At each signalized intersection
Interfaces Used	2.2.2
Interfaces To	2.1.4 Field Wiring Strip

INTERFACE DELINEATION

Interface Reference Number	2.2.1
Interface Name	Opticom Field Wiring
Type	Copper wiring
Manufacturer	?
Model	3 pair/12 gauge
Function	Supply power to Opticom Detector ; send detection data to Opticom Amplifier
Location	Various numbers at each Opticom equipped signalized intersection
Interfaced Devices	2.1.4 Field Wiring Strip; 2.1.9 Opticom Detector;

Interface Reference Number	2.2.2
Interface Name	Signal Field Wiring
Type	Copper wiring
Manufacturer	?
Model	3 pair /12 gauge
Function	Supply power to Signal Head lamps
Location	At each signalized intersection
Interfaced Devices	2.1.4 Field Wiring Strip; 2.1.10 Signal Head;

Interface Reference Number	2.2.3
Interface Name	Signal Field Wiring
Type	Copper wiring
Manufacturer	?
Model	2 pair /14 gauge
Function	Supply power to Loop Detectors; connect Loop Amplifier to Loops to receive detection data.
Location	At each signalized intersection with Loop detectors
Interfaced Devices	2.1.4 Field Wiring Strip; 2.1.8 Loop Detector;

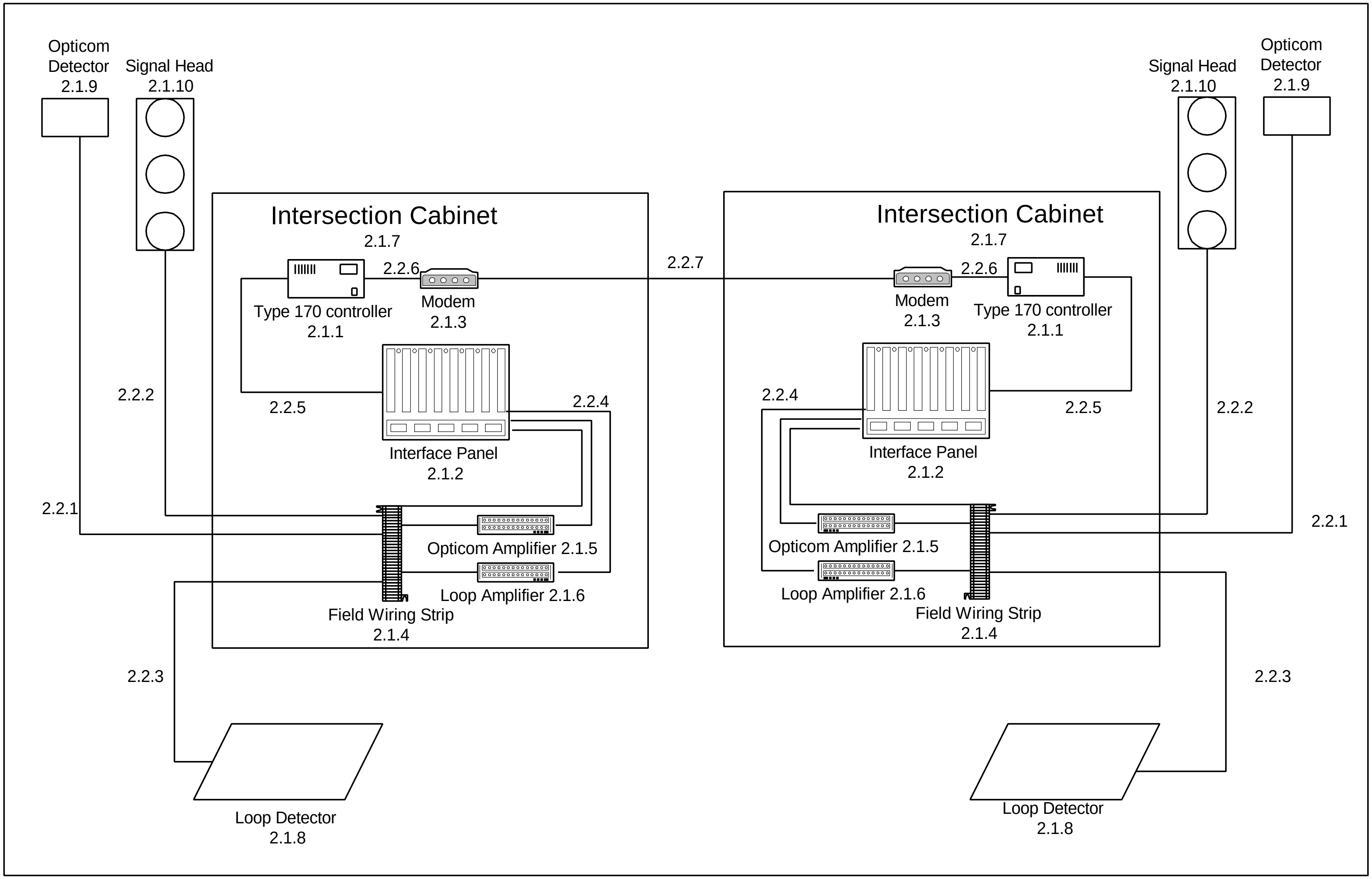
Interface Reference Number	2.2.4
Interface Name	Cabinet Wiring
Type	Copper wiring
Model	18 gauge
Function	Connect and supply power to signal components
Location	Within Signal Cabinets at each signalized intersection
Interfaced Devices	2.1.4 Field Wiring Strip; 2.1.5 Opticom Amplifier; 2.1.7 Loop Amplifier; 2.1.8 Loop Detector; 2.1.2 Interface Panel

Interface Reference Number	2.2.5
Interface Name	Controller Interface cable
Type	Proprietary multi-conductor cable with multi-pin round connectors
Function	Connect Controller hardware to interface panel to allow active intersection control
Location	Within Signal Cabinets at each signalized intersection
Interfaced Devices	2.1.1 Type 170 Controller; 2.1.2 Interface Panel

Interface Reference Number	2.2.6
Interface Name	Serial Cable
Type	RS-232 serial interface cable with 9-pin d-sun connectors
Function	Connect Controller hardware to serial communication hardware
Location	Within Signal Cabinets at each signalized intersection that is interconnected with others
Interfaced Devices	2.1.1 Type 170 Controller; 2.1.3 Modem

Interface Reference Number	2.2.7
Interface Name	Signal Interconnects
Type	Multi-conductor 19 gauge copper wire bundles or fiber optic cables
Function	Interconnect intersection signals to permit co-ordinated signal timing plans
Location	Underground between intersections
Interfaced Devices	2.1.3 Modem (1 at each connected intersection signal)

System Diagram



System 3 - Grand Forks / East Grand Forks ITS Plan

System Name: **911 Dispatch System**	Date Surveyed: 10/11/00	Surveyed By:MRG

System Location	Grand Forks Police Building 122 South 5th Street Grand Forks, ND
Contact Person	Roxanne Melberg Dispatch Coordinator (701) 746-2542
Responsible Entity	City of Grand Forks
System Functions	Receive incoming 911 and other emergency calls Coordinate emergecy responders Relay information to emergency response personnel
Geographic Scope	39 agencies covering Grand Forks County and the City of East Grand Forks
Date Operational	?
System Customers	General public Area emergency response agencies
System Goals	Provide quickest possible response to emergency calls Coordinate response to maximize efficient use of resources
Operational Scenario	Typical: Incoming 911 call rings at a dispatcher's workstation. The dispatcher uses to the telephone switch panel to select the ringing line and tracks the call on the Telephone workstation. The dispatcher then enters the information from the caller into the Cisco CAD software on the CAD workstation. After determining the appropriate agency to respond, the dispatcher selects an appropriate radio channel and relays (via voice) the call information to a response vehicle. If necessary, the responding entity will relay information back to the dispatcher, who then updates the call information in the CAD software. When the response in completed, the incident is cleared in the CAD software making the responder available for another call.
Upgrade Plans	None

Component Delineation

Component Reference Number	3.1.1
Component Name	Telephone Workstation

Type	Intel Compatible Computer
Manufacturer	Compaq
Model	Deskpro
Function	Runs software to manage and display status of the telephone system used to take incoming 911 calls
Location	One at each of four operator stations in the dispatch center
Interfaces Used	3.2.1; 3.2.2
Interfaces To	3.1.5 Telephone Switch Panel; 3.1.6 Ethernet Hub

Component Reference Number	3.1.2
Component Name	Radio Workstation
Type	Intel Compatible Computer
Manufacturer	Compaq
Model	Deskpro
Function	Display status and provide control of the radio dispatching system
Location	One at each of four operator stations in the dispatch stations
Interfaces Used	3.2.2
Interfaces To	3.1.6 Ethernet Hub

Component Reference Number	3.1.3
Component Name	CAD Workstation
Type	Intel Compatible Computer
Manufacturer	Gateway 2000
Model	Profession
Function	Run Computer Aided Dispatch (CAD) Software for operators
Location	One at each of four operator stations in the dispatch stations
Interfaces Used	3.2.2; 3.2.3
Interfaces To	3.1.11 Ethernet Switch; 3.1.15

Component Reference Number	3.1.4
Component Name	Radio Interface
Type	Proprietary hardware connecting the radio system to the Radio Workstation
Manufacturer	Motorola
Function	Connects the microphone and speakers to the operator's worksation and provides connection to the radio

	repeater
Location	One at each of four operator stations in the dispatch stations
Interfaces Used	Proprietary connection to the Radio Workstation
Interfaces To	3.1.10

Component Reference Number	3.1.5
Component Name	Telephone Switch Panel
Type	Panel with line selection, transfer and hold buttons
Manufacturer	Positron
Function	Allows operators to manage multiple incoming calls and transfer them to other numbers, if necessary
Location	One at each of four operator stations in the dispatch stations
Interfaces Used	3.2.1
Interfaces To	3.1.1 Telephone Workstation

Component Reference Number	3.1.6
Component Name	Ethernet Hub
Type	Standard multi-port 10BaseT Ethernet hub
Manufacturer	3Com
Model	Varies
Function	Permit data communications using various protocols over Ethernet frame types
Location	Several located in the dispatch center and throughout the police building
Interfaces Used	3.2.2
Interfaces To	

Component Reference Number	3.1.7
Component Name	Telephone Server
Type	Intel Compatible Computer
Manufacturer	Compaq
Model	Prosignia 200
Function	Manages telephone access for the dispatch operators
Location	Telephone/wiring close adjacent to the dispatch center
Interfaces Used	3.2.2; 3.2.6
Interfaces To	3.1.6 Ethernet Hub; 3.1.8 Telephone Switch Matrix

Component Reference Number	3.1.8
Component Name	Telephone Switch Matrix
Type	Multi-line analog private telephone switch
Manufacturer	Positron
Function	Route incoming telephone calls to operator extensions Allows operators to select from multiple outgoing lines
Location	Telephone/wiring closet adjacent to the dispatch center
Interfaces Used	3.2.6
Interfaces To	3.1.7 Telephone Sever

Component Reference Number	3.1.9
Component Name	Radio Server
Type	Intel Compatible Computer
Manufacturer	Compaq
Model	Prosignia 200
Function	Manages multiple operators access to the radio repeater network
Location	Telephone/wiring closet adjacent to the dispatch center
Interfaces Used	3.2.7
Interfaces To	3.1.6 Ethernet Hub; 3.1.10 Radio Repeater

Component Reference Number	3.1.10
Component Name	Radio Repeater
Type	800Mhz Radio Transmitter receiver on repeater network
Manufacturer	Motorola
Function	Enable voice communication between dispatch operators and emergency response vehicles
Location	Police building
Interfaces Used	3.2.7
Interfaces To	

Component Reference Number	3.1.11
Component Name	Ethernet Switch
Type	Ethernet packet switching and management device
Manufacturer	Cisco
Model	2500
Function	Interconnect sub-networks and manage data traffic at the Police Buildings
Location	Basement equipment rack, Police Building
Interfaces Used	3.2.2
Interfaces To	Various

Component Reference Number	3.1.12
Component Name	CAD Server
Type	Intel compatible computer
Manufacturer	Gateway 2000
Model	NS 7000
Function	Serves CAD applications to operator workstations (3.1.3) Performs CAD data backup
Location	Police building, second floor
Interfaces Used	3.2.2
Interfaces To	3.1.11 Ethernet Switch

Component Reference Number	3.1.13
Component Name	CSU/DSU
Type	Frame relay communication device
Manufacturer	ADC
Model	Kentrox D-Serv
Function	Interconnect city facilities via T-1 or 56K Frame lines
Location	Basement wiring panel, Police Building
Interfaces Used	3.2.2; 3.2.5
Interfaces To	3.1.11

Component Reference Number	3.1.14
Component Name	Media Converter
Type	Category 5 cable to Multi-mode fiber optic cable converter
Manufacturer	Black Box, Inc.
Model	BB 724-746-5500
Function	Connect the dispatch center LAN to the Grand Forks County Sheriff LAN for access to teletype messages
Location	Basement wiring panel, Police Building
Interfaces Used	3.2.2; 3.2.4
Interfaces To	3.1.11 Ethernet hub

Interface Reference Number	3.2.1
Interface Name	Telephone cable
Type	Proprietary interface Cable
Manufacturer	Positron, Inc.
Model	N/A
Function	Connect the telephone switch panel to the telephone workstation and permit control of line selection
Location	At each telephone workstation
Interfaced Components	3.1.1; 3.1.5

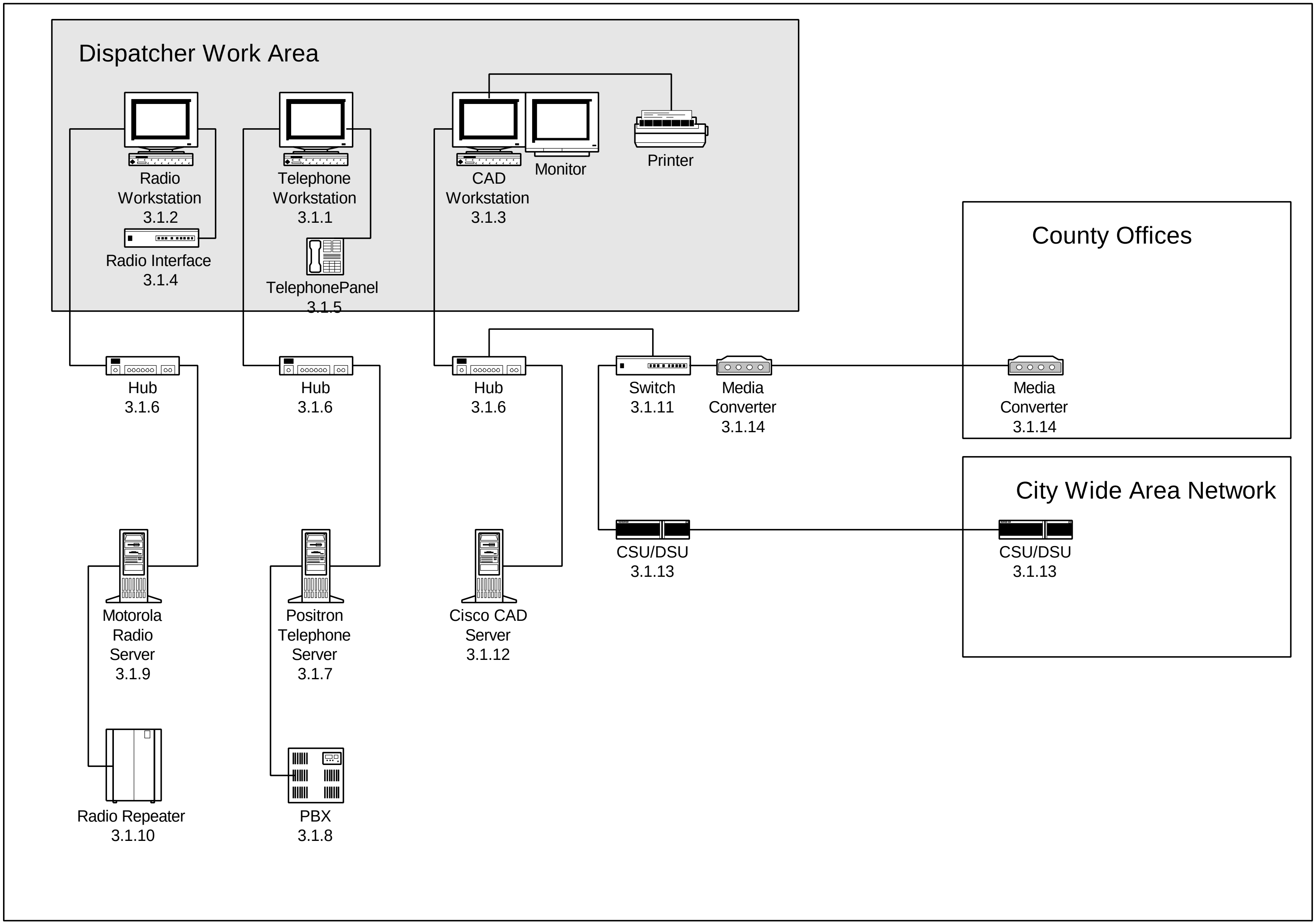
Interface Reference Number	3.2.2
Interface Name	Category 5 Unsheided Twisted Pair (UTP) cable
Type	Standard 10BaseT networking cable
Manufacturer	Various
Model	N/A
Function	Interconnect all computer, switches, hubs, and other data communications equipment
Location	Throughout the Police Building
Interfaced Components	Various

Interface Reference Number	3.2.3
Interface Name	Printer cable
Type	IEEE 1294 Parallel interface cable
Manufacturer	Various
Model	N/A
Function	Connect the CAD Workstation to the printer and provide data communications
Location	At two of the CAD workstations in the dispatch center
Interfaced Components	3.1.3; 3.1.15

Interface Reference Number	3.2.4
Interface Name	Fiber cable
Type	Mutli-mode fiber optic data cable
Manufacturer	Siecor, Inc
Model	N/A
Function	Connect the dispatch center network to the Grand Forks County Network on the opposite side of South 5th Street
Location	N/A
Interfaced Components	3.1.14

Interface Reference Number	3.2.5
Interface Name	T-1line
Type	Leased 1.5Mb/sec. data communications line
Manufacturer	Leased from Qwest Communications, Inc.
Model	N/A
Function	Transport data between facilities on the Wide Area Network (WAN)
Location	N/A
Interfaced Components	3.1.13

System Diagram



System 4 - Grand Forks / East Grand Forks ITS Plan

System Name: **Grand Forks Wide Area Network**	Date Surveyed:9/12/00	Surveyed By: MRG

System Location	Interconnecting 15 locations in the City of Grand Forks
Contact Person	Kit McNamee City of Grand Forks
Responsible Entity	City of Grand Forks
System Functions	Interconnect smaller local area networks and facilities to permit data access across the city area
Geographic Scope	City of Grand Forks
Date Operational	N/A
System Customers	City employees Data administrators
System Goals	Increase speed of data access by city employees Increase efficency by minimizing time spent searching for data Enhance city services
Operational Scenario	System functions continuously, data is transported via TCP/IP between locations on an as needed basis
Special Note	Due to the complexity of this system and the fact that it is not directly a transportation system, an extensive inventory was not conducted. However, the types of connections between locations and typical connection hardware configurations are presented.
Upgrade Plans	None

Component Delineation

Component Reference Number	4.1.1
Component Name	Ethernet Switch
Type	Multi-port Ethernet switch
Manufacturer	Cisco (typical)
Model	Varies
Quantity	N/A
Function	Provide data connection between the Local Area Network and a device connecting to the Wide Area Network
Location	At each facility with local networking
Interfaces Used	Category 5 Cabling (typical)
Interfaces To	Local Area Network computers; 4.1.2 CSU/DSU

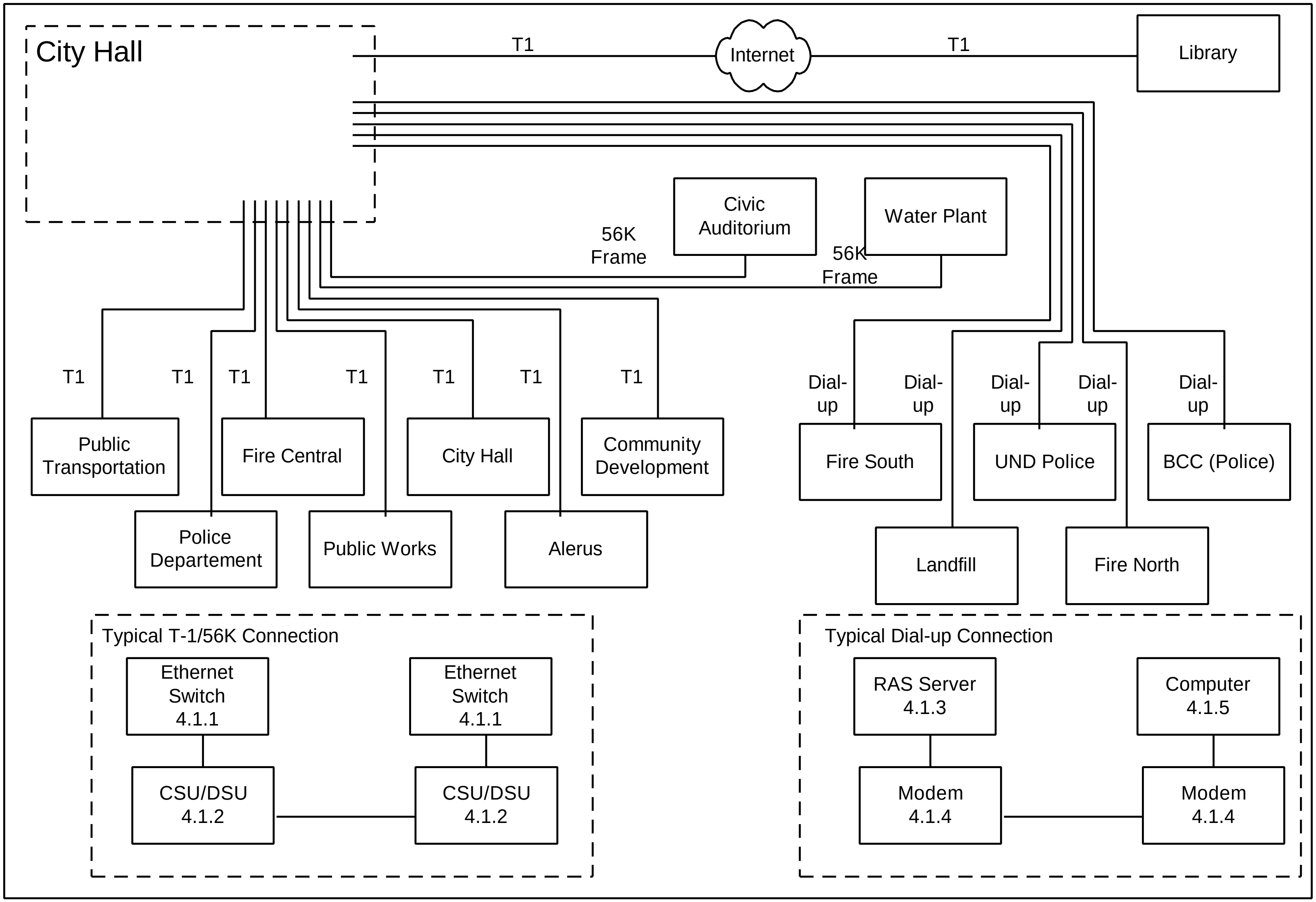
Component Reference Number	4.1.2
Component Name	CSU/DSU
Type	Ethernet to frame relay (T1/56K) connection device
Manufacturer	ADC (typical)
Model	Kenrox D-Serv (typical)
Quantity	18
Function	Enable data transport over wide area frame relay links
Location	At each location and 9 at City Hall Network Operations Center
Interfaces Used	T1; 56K Frame Relay
Interfaces To	4.1.1 Ethernet Switch; 4.1.2 CSU/DSU

Component Reference Number	4.1.3
Component Name	RAS Server
Type	Sever-class Intel-compatible server
Quantity	One
Function	Provide security authentication and connection services for remote sites with dial-up connections
Location	At each location and 9 at City Hall Network Operations Center
Interfaces Used	Connects to modems
Interfaces To	4.1.4

Component Reference Number	4.1.4
Component Name	Modem
Type	Telephone network data modem
Quantity	Five
Function	Provide dial-up connections to locations without dedicated data lines
Location	At each location and 5 at City Hall Network Operations Center
Interfaces Used	Connects to Public Switched Telephone Network (PSTN)
Interfaces To	4.1.3 RAS Server; PSTN

Component Reference Number	4.1.5
Component Name	Computer
Type	Personal computer
Location	At remote locations
Interfaces Used	Serial connection to modem
Interfaces To	4.1.4 Modem

System Diagram



System 5 - Grand Forks / East Grand Forks ITS Plan

System Name: **Mobile Data Terminal System – Grand Forks Police & Grand Forks Sheriff**	Date Surveyed:9/12/00	Surveyed By: MRG

System Location	Grand Forks Police Vehicles Grand Forks County Sheriff Vehicles Grand Forks 911 Dispatch Center Repeater Tower in Grand Forks
Contact Person	Roxanne Melberg City of Grand Forks 122 South 5th Street Grand Forks, ND 58201
Responsible Entity	City of Grand Forks/ Grand Forks County
System Functions	Transmit NCIC text information and other messages to vehicles
Geographic Scope	Grand Forks Police jurisdiction/Grand Forks County Sheriff jurisdiction
Date Operational	Current version of software installed February 21, 2000
System Customers	Police and Sheriff officers and 911 dispatchers
System Goals	Improve communications efficiency Decrease voice communications traffic.
Operational Scenario	911
Upgrade Plans	None

Component Delineation

Component Reference Number	5.1.1
Component Name	MDT
Type	Ruggedized Notebook Computer
Manufacturer	Panasonic
Model	CF-27
Quantity	8
Function	Run MDT communication software Provide interface for officers
Location	Between patrol vehicle's front seats

Interfaces Used	5.2.1
Interfaces To	5.1.2-Vehicle Radio

Component Reference Number	5.1.2
Component Name	Vehicle Radio
Type	450 MHz band portable radio (9600 bits/sec)
Manufacturer	Motorola
Model	VRM 600
Quantity	8
Function	Transmit/receive data for MDT
Location	Between patrol vehicle's front seats
Interfaces Used	5.2.1
Interfaces To	5.1.1-MDT

Component Reference Number	5.1.3
Component Name	Repeater Tower and Transceiver
Type	100 Foot antenna tower and 450 MHz base station radio; maximum transmit power 100 watts
Manufacturer	Motorola (radio)
Quantity	10 in statewide system
Function	Transmit and receive data for MDT system Repeat signals to other towers statewide for MDT interconnection
Location	10 located throughout the state of North Dakota
Interfaces Used	5.2.2; 5.2.3
Interfaces To	5.1.2-Vehicle Radio; 5.1.4 Radio Network Controller

Component Reference Number	1.1.5
Component Name	Radio Network Controller
Type	Server class computer with speciallized Motorola Radio Interface hardware
Quantity	1
Function	Provide interface between the radio and land line data transmission networks
Location	Bismarck, ND
Interfaces Used	5.2.3; 5.2.4
Interfaces To	5.1.3- Repeater Tower; 5.1.7 Hub/Switch (LAN)

Component Reference Number	5.1.5
Component Name	Wireless Network Gateway (WiNG)
Type	Sever class computer
Quantity	1
Function	Provide packet routing between the TCP/IP Wide Area Network and the Radio Data Network
Location	State Highway Patrol Offices, Bismarck, ND
Interfaces Used	5.2.4
Interfaces To	5.1.7 Hub/Switch

Component Reference Number	5.1.6
Component Name	MDC Server
Type	Sever class computer
Quantity	1
Function	Enable communications and message routing services for the MDCs
Location	State Highway Patrol Offices, Bismarck, ND
Interfaces Used	5.2.4
Interfaces To	5.1.7 Hub/Switch

Component Reference Number	5.1.7
Component Name	Hub/Switch
Type	Ethernet network signal hub or switch
Manufacturer	Cisco
Model	2500
Quantity	2 (possibly others)
Function	Interconnect desktop systems, printers and the tower system
Location	911 dispatch center; Highway Patrol offices in Bismarck ND
Interfaces Used	5.2.4
Interfaces To	5.1.4RCN; 5.1.5 WiNG; 5.1.6 MDC Server; 5.1.8 CSU/DSU; 5.1.9 CAD Workstations

Component Reference Number	5.1.8
Component Name	CSU/DSU
Type	Communications Device

Manufacturer	ADC
Model	Kentrox D-Serv T1
Quantity	1 at Highway Patrol office in Bismarck, ND; 1 at Police building in Grand Forks, ND
Function	Interconnect Local Area Networks at Highway Patrol offices via T-1 (1.5 Mb/s) data lines
Location	State Highway Patrol Offices throughout North Dakota
Interfaces Used	5.2.4; 5.2.5
Interfaces To	5.1.7 Hub/Switch; 5.1.8 CSU/DSU

Component Reference Number	5.1.9
Component Name	CAD Workstation
Type	Intel-compatible computer
Manufacturer	Gateway 200
Model	various
Quantity	3
Function	Run the MDC software in a desktop environment. Permit NCIC data to be entered and sent to vehicles.
Location	Grand Forks 911 dispatch center
Interfaces Used	5.2.4
Interfaces To	5.1.7 Hub/Switch

Interface Delineation

Interface Reference Number	1.2.1
Type	IEEE 1294 Parallel interface cable
Quantity	1 in each patrol vehicle
Function	Connect MDT to printer and provide parallel communications
Location	Front seat of patrol vehicle; connecting MDT docking cradle and printer parallel port
Interfaced Components	1.1.1- MDT; 1.1.2 Printer

Interface Reference Number	1.2.2
Type	Serial interface cable?
Quantity	1 in each patrol vehicle
Function	Connect MDT to printer and provide parallel communications
Location	Front seat of patrol vehicle; connecting MDT docking cradle and Vehicle radio
Interfaced Components	1.1.1- MDT; 1.1.3 Vehicle Radio

Interface Reference Number	1.2.3
Type	450 MHz radio link
Manufacturer	Motorola
Quantity	N/A
Function	Communication between vehicle radios and repeater tower
Location	N/A
Interfaced Components	1.1.4- Repeater tower; 1.1.3 Vehicle Radio

Interface Reference Number	1.2.4
Type	Leased land line– Copper “dry pair”
Manufacturer	AT&T
Model	N/A
Quantity	1
Function	Connect radio repeater to the Radio Network Controller
Location	Highway Patrol offices, Bismarck, North Dakota
Interfaced Components	1.1.4- Repeater tower; 1.1.5 Tower System

Interface Reference Number	1.2.5
Type	Category 5 4-pair cable
Quantity	N/A
Function	Interconnect computers and hubs/switches on local area network (LAN) (10 or 100BaseT)
Location	N/A
Interfaced Components	1.1.5 RCN; 1.1.6 WiNG; 1.1.7 MDC Server; 1.1.8 Hub/Switch; 1.1.9 CSU/DSU; 1.1.10 Desktop systems

Interface Reference Number	1.2.6
Type	Leased T-1 data line
Manufacturer	Provided by Qwest
Model	N/A
Quantity	1 per Highway Patrol District Office
Function	Interconnect computers on local area networks (LAN) at each office with statewide Wide Area Network
Location	N/A
Interfaced Components	1.1.9 CSU/DSU

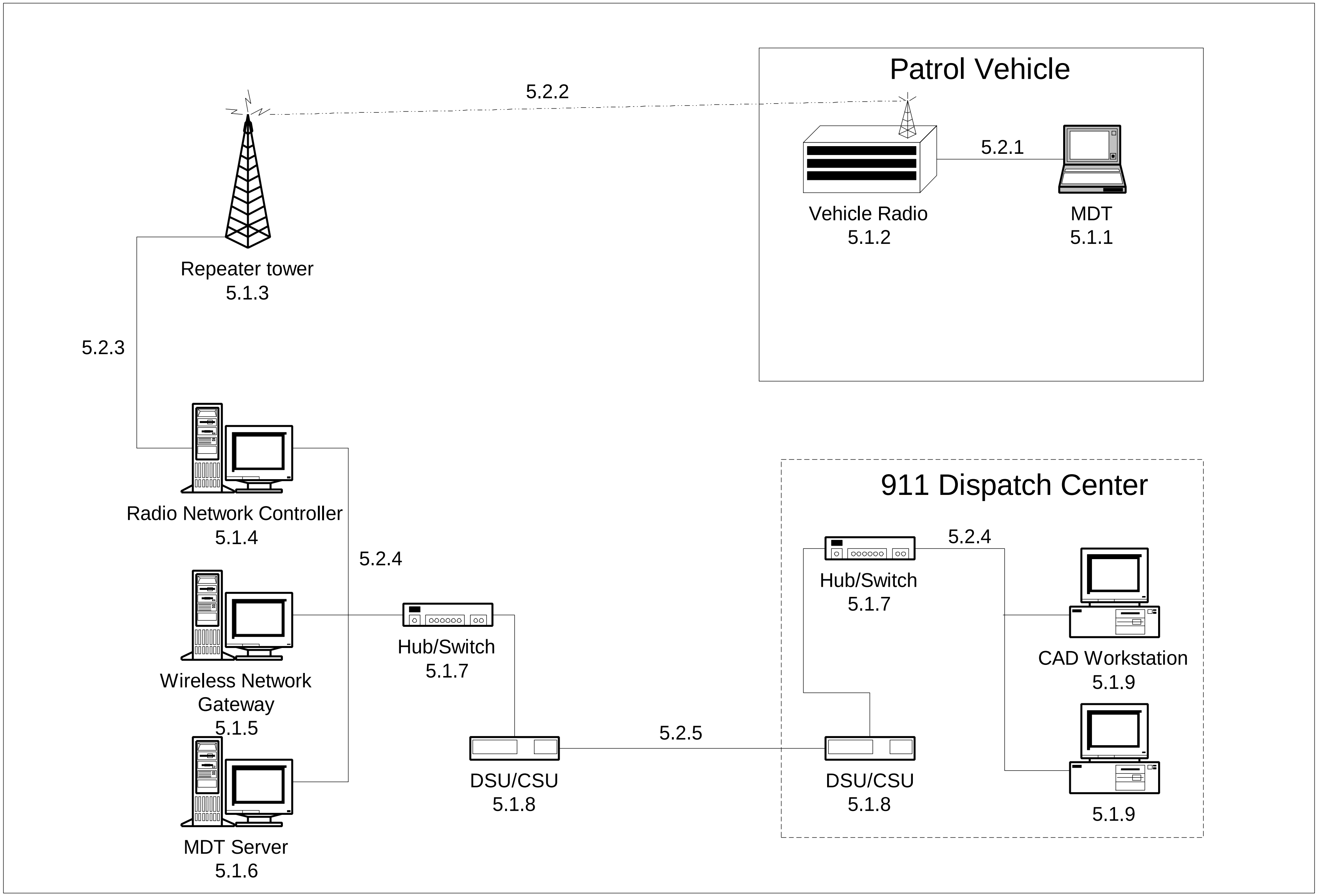
Software Delineation

Software Reference Number	1.3.1
Software Name	Windows NT
Type	Operating system
Manufacturer	Microsoft, Inc.
Version	4.0 Service Pack 4
Function	Software environment
Installed Hardware	Most Desktop computers 1.1.10; and MDC 1.1.1

Software Reference Number	1.3.2
Software Name	Premier MDC
Type	MDC Communications Client
Manufacturer	Software Corporation of America (Motorola)
Version	3.7.9 (customized)
Function	Enables MDT functions on in vehicle MDC: Messaging Database query Panic/Emergency alert
Installed Hardware	1.1.1 MDC; 1.1.10 Desktop Systems

Software Reference Number	1.3.3
Software Name	MDT Server
Type	MDT system server application
Manufacturer	Software Corporation of America (Motorola)
Version	?
Function	Sends and receives messages and other data from Desktop Systems and MDTs Stores and archives data Generates usage statistics.
Installed Hardware	1.1.7 MDT

System Diagram



System 6 - Grand Forks-East Grand Forks ITS Plan

System Name: **#SAFE / UND Weather**	Date Surveyed:10/11/00	Surveyed By: MRG

System Location	University of North Dakota – Grand Forks, ND (Weather System) Meridian Environmental – Grand Forks, ND (#SAFE Telephony system)
Contact Person	Leon Osborne University of North Dakota, Grand Forks
Responsible Entity	University of North Dakota, in cooperation with North Dakota Department of Transportation
System Functions	Acquire meteorological data Process data using weather forecasting models Deliver data via synthesized voice over telephone
Geographic Scope	Statewide in North Dakota South Dakota Minnesota
Date Operational	1998-North Dakota
System Customers	General Public (travelers) Other weather data consumers
System Goals	Improve weather forecast accuracy Improve traveler safety
Operational Scenario	**Typical:** Meteorological data enters the system via a variety of automated means. In general, a human interaction may necessary to begin a data transfer, but then all transport/processing/storage is done automatically. Once stored in the system, data is processed through a variety of custom-written software applications to determine road surface and weather conditions at given locations along selected roads. Data is also used to create "micro-forecasts" to predict weather conditions in small geographic areas. The system then processes the data and creates messages using a telephony (telephone services) server. Users can dial the #SAFE abbreviated number to access synthesized voice messages for their specific routes. System prompts generally include: • State (North Dakota, South Dakota, Minnesota) • Highway number (i.e. 29 for Interstate 29) • Direction (i.e. Northbound, Southbound) • Mile marker
Upgrade Plans	The system is being adapted to use place names/predefined segments in place of mile markers to identify the callers area of interest.

Component Delineation

Component Reference Number	6.1.1
Component Name	Commercial Weather Data
Type	Electronic weather radar information
Manufacturer	NEXRAD Information Distribution System
Function	Provides real-time radar based precipitation information
Interfaces Used	6.2.1
Interfaces To	6.1.6

Component Reference Number	6.1.2
Component Name	NWS Backbone
Type	Electronic text weather information and satellite imagery provider service
Manufacturer	National Weather Service
Function	Input standardized weather descriptions and images into the weather forecasting system
Interfaces Used	6.2.2
Interfaces To	6.1.6

Component Reference Number	6.1.3
Component Name	North Dakota Agricultural Weather Network
Type	Automated meteorological data collection network
Quantity	54 individual sites located throughout North Dakota
Function	Collect data and transmit to the University of North Dakota
Interfaces Used	6.2.3
Interfaces To	6.1.6

Component Reference Number	6.1.4
Component Name	Minnesota Road Weather Information System (R/WIS)
Type	Statewide automated meteorological and road surface data collection system
Manufacturer	Minnesota Department of Transportation
Quantity	
Function	Collect and transmit surface and weather data
Location	On highways throughout the state of Minnesota
Interfaces Used	6.2.4
Interfaces To	6.1.6

Component Reference Number	6.1.5
Component Name	North Dakota and South Dakota Road Weather Information Systems (R/WIS)
Type	Statewide automated meteorological and road surface data collection system
Manufacturer	North Dakota and South Dakota Departments of Transportation
Quantity	
Function	Collect and transmit surface and weather data
Location	On highways throughout the states of North Dakota and South Dakota
Interfaces Used	6.2.5
Interfaces To	6.1.6

Component Reference Number	6.1.6
Component Name	Weather Information Processors
Type	Various server class computers in a heterogeneous (Windows/Unix/Linux) computing environment
Manufacturer	Various
Model	Various
Function	Collect incoming data from 6.1.1 to 6.1.3 Process electronic data into pre-defined formats Transmit data for storage in 6.1.8 Database Server
Location	University of North Dakota – Grand Forks
Interfaces Used	6.2.1; 6.2.2; 6.2.3; 6.2.6
Interfaces To	6.1.1 Commercial Data; 6.1.2 NWS Backbone; 6.1.3 ND Ag. Weather Net; 6.1.9 Ethernet Switch

Component Reference Number	6.1.7
Component Name	Road Construction Information Processors
Type	Various server class computers in a heterogeneous (Windows/Unix/Linux) computing environment
Manufacturer	Various
Model	Various
Function	Collect incoming data from 6.1.1 to 6.1.3 Process electronic data into pre-defined formats Transmit data for storage in 6.1.8 Database Server
Location	University of North Dakota – Grand Forks
Interfaces Used	6.2.4; 6.2.5; 6.2.6
Interfaces To	6.1.4 MN R/WIS; 6.1.5 ND/SD R/WIS; 6.1.9 Ethernet Switch

Component Reference Number	6.1.8
Component Name	Database Server
Type	Server Class Computer with associated high-capacity disk array
Quantity	One
Function	Receive processed and formatted data from 6.1.6 and 6.1.7 Store data in a standardized database Transmit data to workstations and #SAFE servers
Location	University of North Dakota – Grand Forks
Interfaces Used	6.2.6
Interfaces To	6.1.9 Ethernet Switch

Component Reference Number	6.1.9
Component Name	Ethernet Switch
Type	Ethernet packet switching and management device
Manufacturer	Unknown
Function	Provide physical connections and data transport and management to the computers in the systems
Location	Several are used at University of North Dakota – Grand Forks and Meridian Environmental
Interfaces Used	6.2.6
Interfaces To	6.1.6-6.1.13

Component Reference Number	6.1.10
Component Name	Modeling Workstation
Type	Workstation Class Computer
Manufacturer	Digital Computers
Model	Alpha
Quantity	Varies, but a minimum of two
Function	Run UND custom developed weather modeling and forecasting software
Location	University of North Dakota – Grand Forks
Interfaces Used	6.2.6
Interfaces To	6.1.9 Ethernet Switch

Component Reference Number	6.1.11
Component Name	Query Workstation
Type	Workstation Class Computer
Manufacturer	Varies
Quantity	Varies, but a minimum of one
Function	Provide access to 6.1.8 database server for retrieval of weather and surface data
Location	University of North Dakota – Grand Forks
Interfaces Used	6.2.6
Interfaces To	6.1.9 Ethernet Switch

Component Reference Number	6.1.12
Component Name	#SAFE Data Server
Type	Server class computer
Quantity	One
Function	Access 6.1.8 Database server at pre-defined intervals to retrieve weather data Process information into #SAFE compatible formats Make data available to 6.1.13 Telephony Server
Location	Meridian Environmental – Grand Forks, ND
Interfaces Used	6.2.6
Interfaces To	6.1.9 Ethernet Switch

Component Reference Number	6.1.13
Component Name	Telephony Server
Type	Server Class Computer
Quantity	One
Function	Answer incoming #SAFE Calls Process menu commands from users Synthesize voice messages to deliver data via telephone
Location	Meridian Environmental – Grand Forks, ND
Interfaces Used	6.2.6; 6.2.7
Interfaces To	6.1.9 Ethernet Switch; 6.1.14 PSTN Interface

Component Reference Number	6.1.14
Component Name	Public Switched Telephone Network Interface
Type	Multi-line telephone system interconnection device
Quantity	One
Function	Provide electronic interface from audio hardware in 6.1.13 Telephony Server to the telephone network
Location	Meridian Environmental – Grand Forks, ND
Interfaces Used	6.2.7; 6.2.8
Interfaces To	6.1.13 Telephony Server; 6.1.15 PSTN

Component Reference Number	6.1.15
Component Name	Public Switched Telephone Network
Type	Circuit switched national public voice and data communications network
Function	Provides telephony services to the public Provides voice access data deliver channel
Provider	QWest
Interfaces Used	6.2.8
Interfaces To	6.1.14 PSTN Interface

Interface Delineation

Interface Reference Number	6.2.1
Type	TCP/IP using File Transfer Protocol
Quantity	N/A
Function	Provide data transport for NEXRAD radar data
Location	N/A
Interfaced Components	6.1.1 Commercial Data; 6.1.6 Weather Information Processors

Interface Reference Number	6.2.2
Type	Microwave data feed (via satellite)
Quantity	One
Function	Provide data transport for NWS weather data
Location	Receiver dish located at University of North Dakota – Grand Forks
Interfaced Components	6.1.2 NWS Backbone; 6.1.6 Weather Information Processors

Interface Reference Number	6.2.3
Type	Dial-up telephone connection
Quantity	One
Function	Provide a one-at-a-time connection from the University of North Dakota – Grand Forks to each of the weather data collection stations
Interfaced Components	6.1.3 ND Agricultural Weather Net; 6.1.6 Weather Information Processors

Interface Reference Number	6.2.4
Type	HTTP via TCP/IP (internet connection)
Quantity	One
Function	Provide transport from the MN R/WIS information web servers to the UND system
Interfaced Components	6.1.4 MN R/WIS; 6.1.7 Road Condition Information Processors

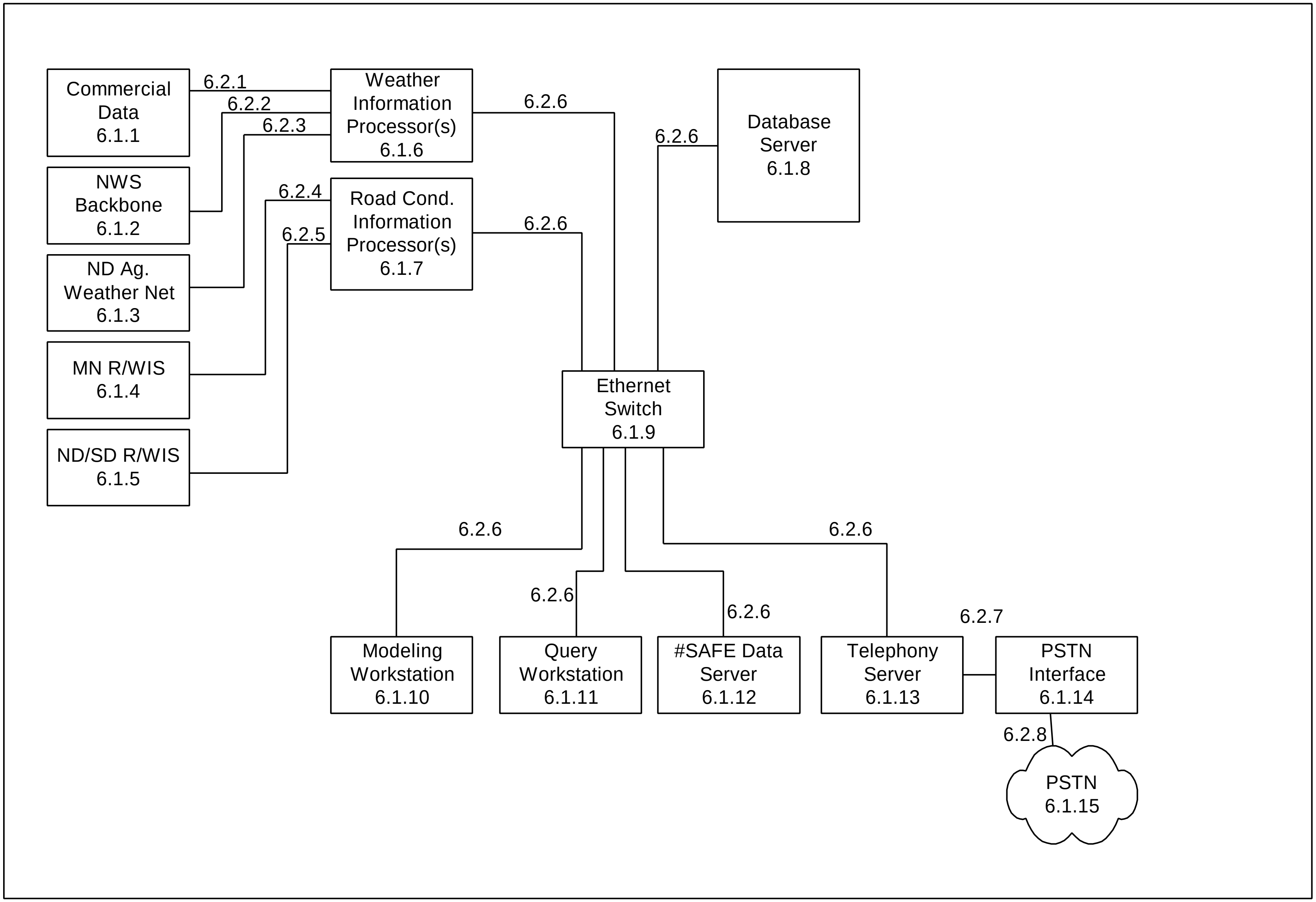
Interface Reference Number	6.2.5
Type	Dial-up telephone connection
Provider	QWest
Quantity	One
Function	Provide transport from the ND and SD R/WIS servers to the UND system
Interfaced Components	6.1.5 North Dakota and South Dakota Road Weather Information Systems (R/WIS); 6.1.7 Road Condition Information Processors

Interface Reference Number	6.2.6
Type	Ethernet TCP/IP over Category 5 twisted pair cable
Manufacturer	Varies
Function	Provide high-speed data connections between the servers and workstations in the system
Interfaced Components	6.1.6 to 6.1.13

Interface Reference Number	6.2.7
Type	Proprietary cable connection
Manufacturer	N/A
Quantity	One
Function	Interconnect telephony hardware to the physical wiring for the PSTN
Location	Meridian Environmental – Grand Forks, ND
Interfaced Components	6.1.13 Telephony Server; 6.1.14 PSTN Interface

Interface Reference Number	6.2.8
Type	Copper Twisted pair bundle
Provider	Qwest
Quantity	One
Function	Provide direct physical connection to the telephone system (PSTN)
Location	Meridian Environmental – Grand Forks, ND
Interfaced Components	6.1.14 PSTN Interface; 6.1.15 PSTN

System Diagram



System 7 - Grand Forks / East Grand Forks ITS Plan

System Name: **Paratransit Scheduling and Dispatch**	Date Surveyed:10/11/00	Surveyed By: MRG

System Location	City of Grand Forks (2 providers)
Contact Person	Roger Foster, Superintendent Grand Forks City Bus City of Grand Forks
Responsible Entity	City of Grand Forks
System Functions	Allow scheduling of paratransit trip requests Provide accounting information to the City of Grand Forks for contract payment
Geographic Scope	Cities of Grand Forks and East Grand Forks
Date Operational	N/A
System Customers	General Public (with special mobility needs), Paratransit providers, City of Grand Forks
System Goals	Provide efficient transit service to customers with special needs
Operational Scenario	**Scheduling** A qualified rider telephones one of two private paratransit providers (Grand Forks Taxi and NoDak Radio Cab) to request service. A dispatcher records the request and schedules trip. The dispatcher then creates a trip manifest for the driver to follow containing the locations and times for trips. Requests generally must be made 24 hours prior to the desired trip time **Dispatching** In general, there is only minimal communication necessary between the dispatcher and a vehicle. However, if there is a need (trip cancellation/modification) the dispatcher can contact a vehicle en-route via 2-way voice radio to relay instructions. **Billing/revenue control** Once monthly, trip and manifest information is supplied to Grand Forks City Bus in hard copy form. This information is examined to determine that all riders had current paratransit eligibility and to to determine the amount of reimbursement due to the private providers.
Upgrade Plans	Grand Forks City Bus plans to implement smart card readers to automate eligibility checking.

Component Delineation

Component Reference Number	7.1.1
Component Name	Vehicle Radio
Type	800 MHz voice radio
Manufacturer	Motorola
Quantity	One in each vehicle, total fleet size:4 handicapped accessible, plus other vehicles used as needed
Function	Allow communication between vehicles and dispatchers
Location	Dash mounted in each vehicle
Interfaces Used	7.2.1
Interfaces To	7.1.3 Dispatcher Radio

Component Reference Number	7.1.3
Component Name	Dispatcher Radio
Type	800 MHz Voice radio
Manufacturer	Motorola
Quantity	2 (one at each provider)
Function	Allow communication between vehicles and dispatchers
Location	At provider's offices
Interfaces Used	7.2.1
Interfaces To	7.1.1 Vehicle Radio

Component Reference Number	7.1.4
Component Name	Dispatcher Workstation
Type	Intel-compatible computer
Quantity	2 (one at each provider)
Function	Record trip requests, generate accounting reports
Location	At provider's offices
Interfaces Used	7.2.2
Interfaces To	7.1.2

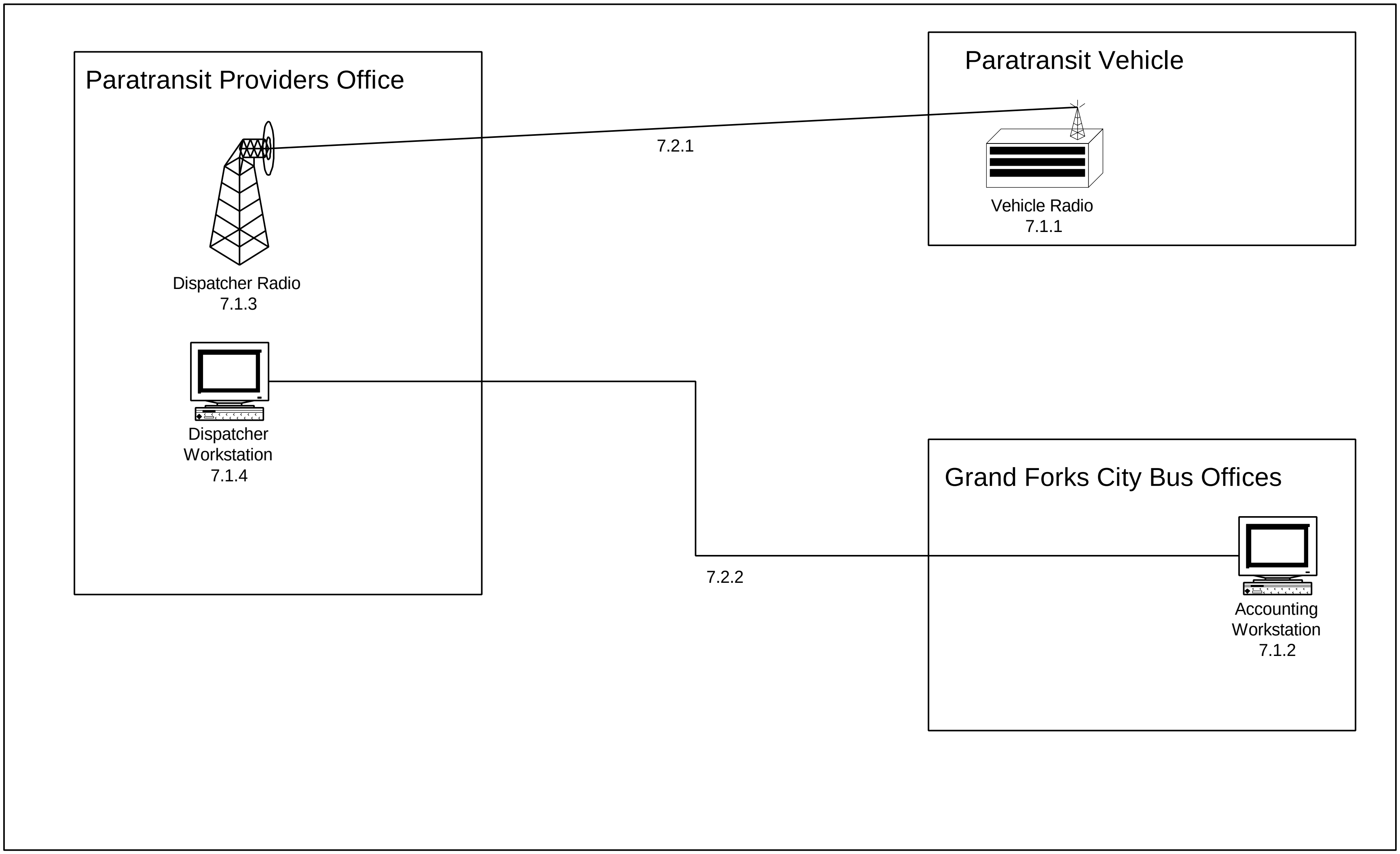
Component Reference Number	7.1.2
Component Name	Accounting Workstation
Type	Intel-compatible computer
Quantity	One
Function	Record trip documents to verify rider eligibility and generate accounting and usage reports
Location	Grand Forks City Bus Offices
Interfaces Used	7.2.2
Interfaces To	7.1.4 Dispatcher Workstation

Interface Delineation

Interface Reference Number	7.2.1
Type	800 MHz Radio link
Function	Connect vehicle and dispatcher radios
Location	N/A
Interfaced Components	7.1.1 Vehicle Radio; 7.1.3 Dispatcher Radio

Interface Reference Number	7.2.2
Type	Hard copy mail
Manufacturer	United States Postal Service
Function	Transport reports and rider forms from the providers office to the Grand Forks City Bus office where the data can be entered into accounting packages
Interfaced Components	7.1.2 Accounting Workstation; 7.1.4 Dispatcher Workstation

System Diagram



System 8 - Grand Forks / East Grand Forks ITS Plan

System Name: **Traffic Signal System – East Grand Forks**	Date Surveyed:9/12/00	Surveyed By:MRG

System Location	8 total locations in the City of East Grand Forks
Contact Person	John Thompson Traffic Engineer City of East Grand Forks
Responsible Entity	City of East Grand Forks
System Functions	Manage traffic flow Enhance pedestrian safety
Geographic Scope	All signals are within the East Grand Forks city limits
Date Operational	?
System Customers	General Public
System Goals	Minimize traffic delays Minimize traffic accidents
Operational Scenario	
Upgrade Plans	Emergency vehicle preemption systems to be added in 2001

Component Delineation

Component Reference Number	8.1.1
Component Name	Type 170 Controller
Type	Intersection traffic signal timing controller
Manufacturer	SafeTran, others
Function	Store and execute signal timing plans Actuate relays to supply power to signal heads
Location	1 at each signalized intersection
Interfaces Used	2.2.5; 2.2.6
Interfaces To	2.1.2 Interface panel; 2.1.3 Modem

Component Reference Number	8.1.2
Component Name	Interface Panel
Type	Electrical relay and interconnect device
Function	Provide electrical connections for signal heads, detectors and auxiliary equipment Provide control interface for controller hardware
Location	1 at each signalized intersection
Interfaces Used	8.2.3; 8.2.2
Interfaces To	8.1.1 Type 170 Controller; 8.1.3 Field Wiring Strip

Component Reference Number	8.1.3
Component Name	Field Wiring Strip
Type	Electrical Terminal Strip
Function	Provide safe termination of electrical connections between signal system components
Location	1 at each signalized intersection
Interfaces Used	8.2.1; 8.2.2
Interfaces To	8.1.4 Signal Head; 8.1.2 Interface Panel

Component Reference Number	8.1.4
Component Name	Signal Head
Type	Intersection signal lamp housing
Function	Displays colored signals to motorists to regulate traffic flow.
Location	At each signalized intersection
Interfaces Used	8.2.1
Interfaces To	8.1.3 Field Wiring Strip

Component Reference Number	8.1.5
Component Name	Intersection Cabinet
Type	Environmentally hardened outdoor equipment cabinet
Function	House, protect and orgainze intersection signal components
Location	1 at each signalized intersection
Interfaces Used	None
Interfaces To	N/A

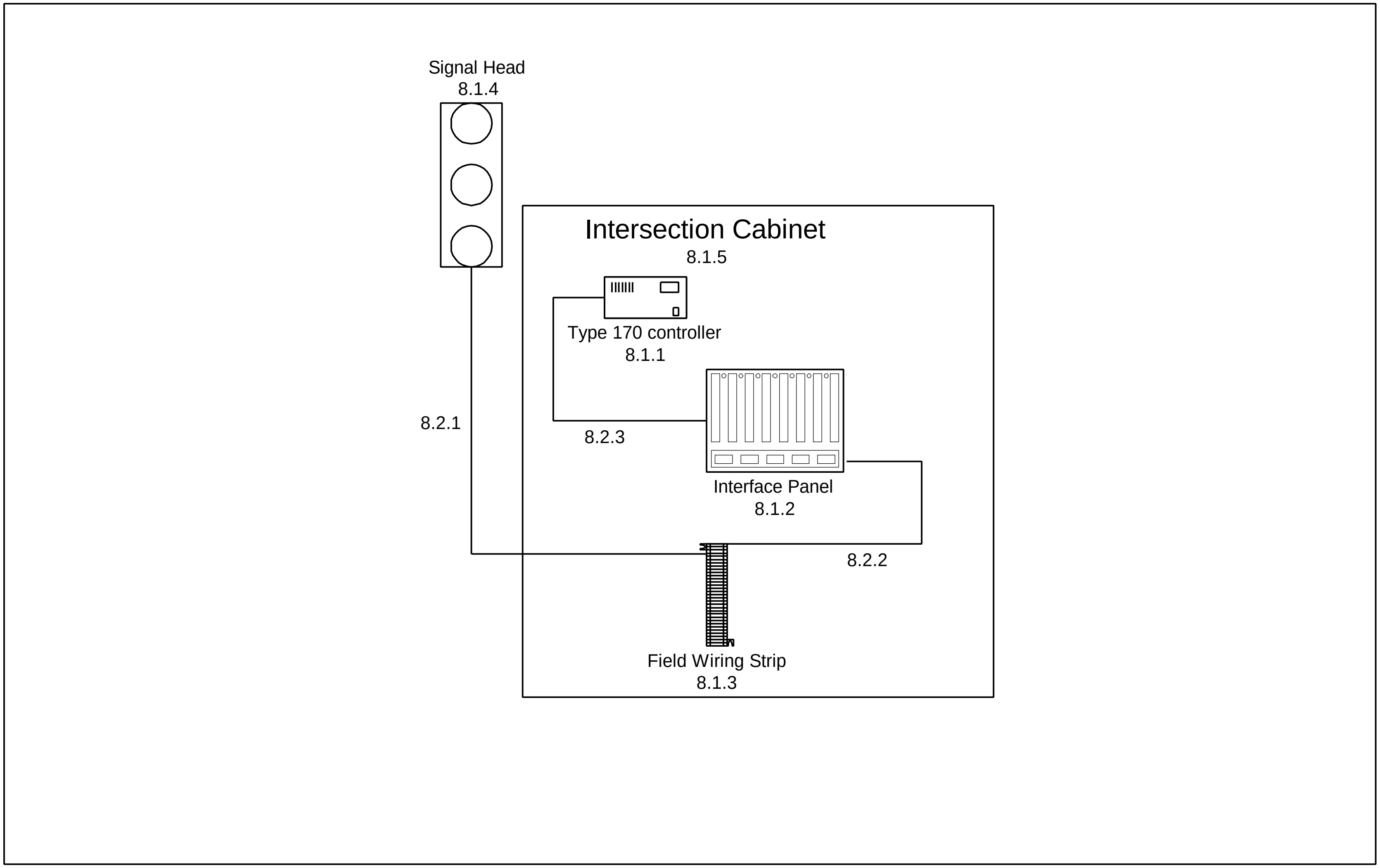
INTERFACE DELINEATION

Interface Reference Number	8.2.1
Interface Name	Signal Field Wiring
Type	Copper wiring
Model	3 pair /12 gauge
Function	Supply power to Signal Head lamps
Location	At each signalized intersection
Interfaced Devices	8.1.3 Field Wiring Strip; 8.1.4 Signal Head;

Interface Reference Number	8.2.2
Interface Name	Cabinet Wiring
Type	Copper wiring
Model	18 gauge
Function	Connect and supply power to signal components
Location	Within Signal Cabinets at each signalized intersection
Interfaced Devices	8.1.3 Field Wiring Strip; 8.1.2 Interface Panel

Interface Reference Number	8.2.3
Interface Name	Controller Interface cable
Type	Proprietary multi-conductor cable with multi-pin round connectors
Manufacturer	SafeTran, others
Function	Connect Controller hardware to interface panel to allow active intersection control
Location	Within Signal Cabinets at each signalized intersection
Interfaced Devices	2.1.1 Type 170 Controller; 2.1.2 Interface Panel

System Diagram



APPENDIX B

NATIONAL ARCHITECTURE CASE STUDIES

Case Study – Low visibility detection & Warning System

Problem Statement – During the extremely low winter temperatures experienced in the Grand Forks area, two large commercial facilities (Simplot (Grand Forks) and the Business 2 Processing Facility (East Grand Forks)) produce steam effluent that is blown by the prevailing winds across the adjacent arterial roads. Visibility can be severely reduced during these periods, dropping to near zero for short distances. Motorists receive little or no indication that driving conditions are about to change, creating potentially dangerous circumstances, particularly when road surface conditions are also degraded due to weather.

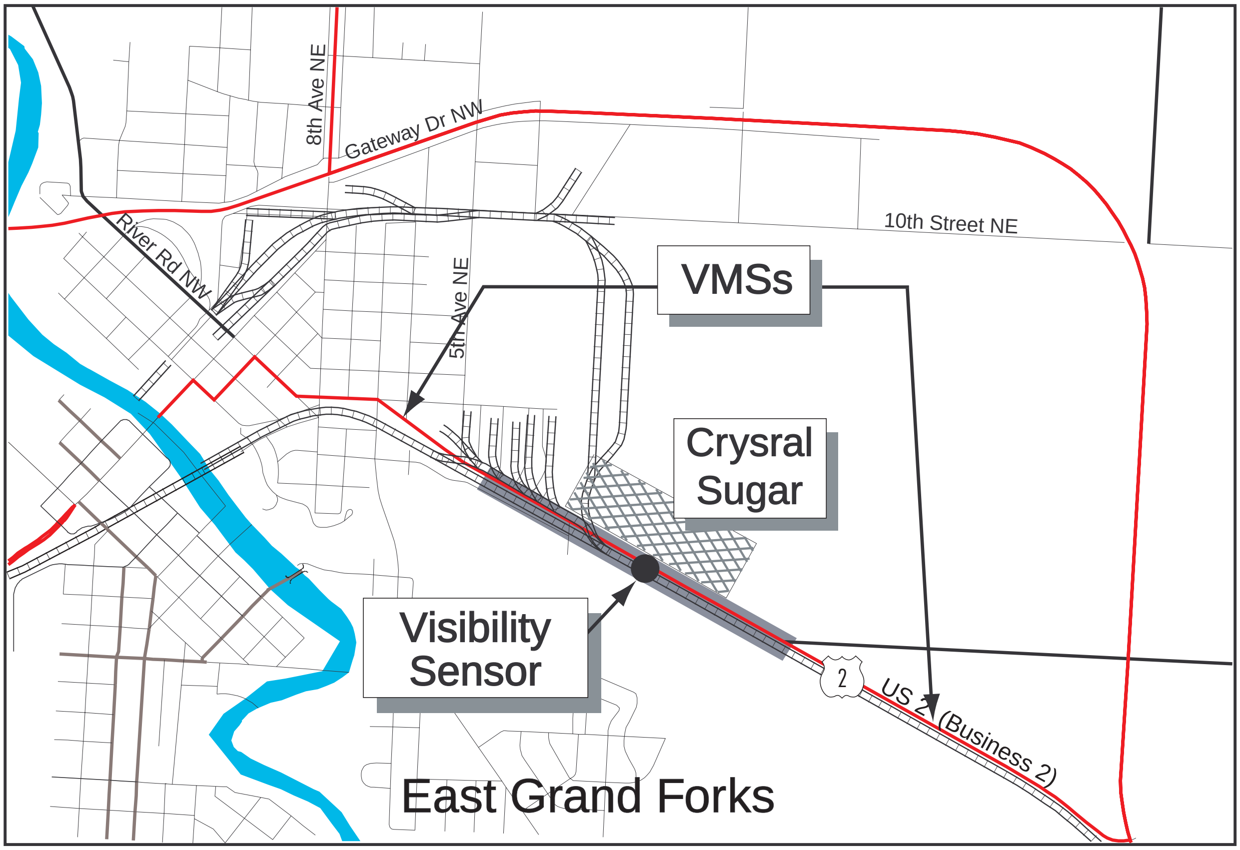
Solution – Various solutions were identified that would provide a warning to approaching motorists of the reduced visibility condition ahead. The following are examples of ITS deployments that would combat the issue effectively when implemented in concert:

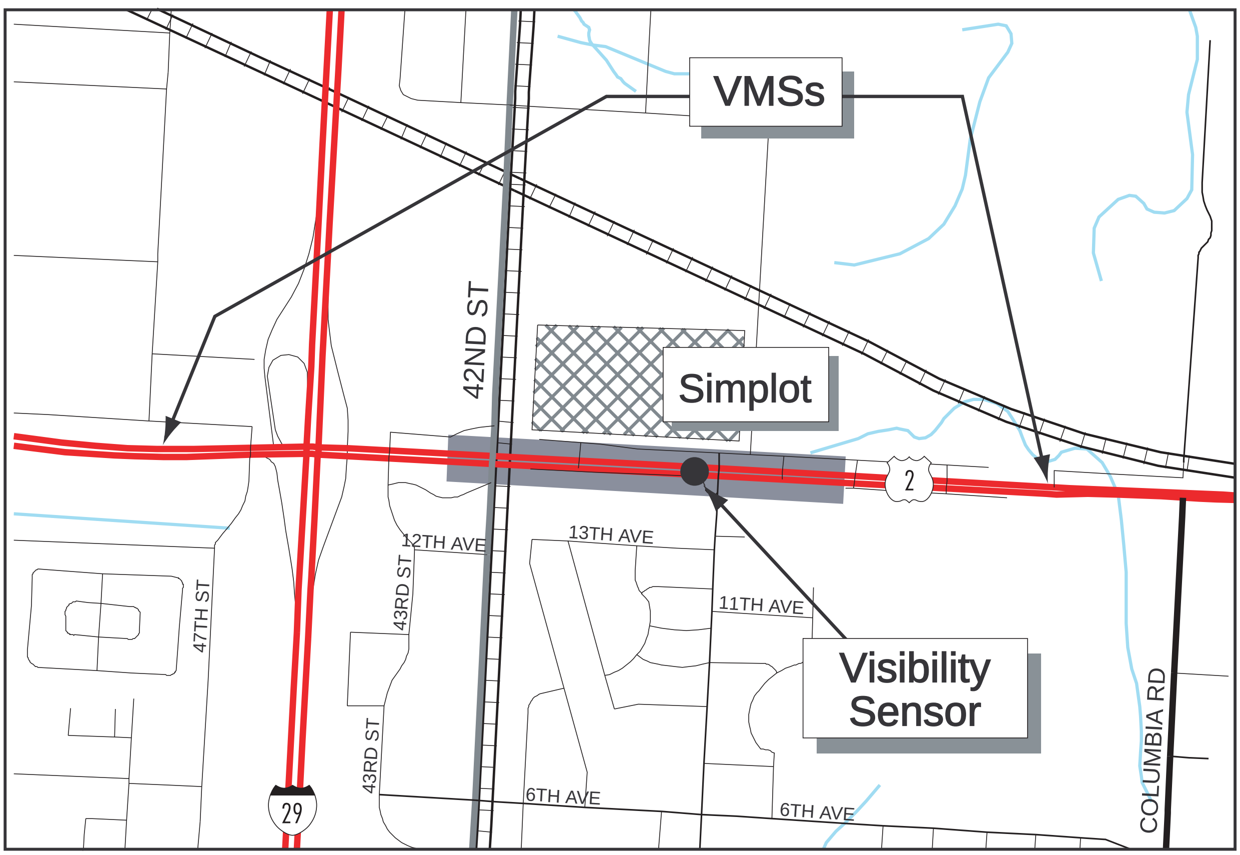
Visibility Detection – Several systems that detect visibility in a road environment are either deployed or in the evaluation phase. Generally, these systems utilize a machine vision processor that is aligned with a series of virtual high-contrast targets mounted at fixed distances from a camera. Based on the detected contrast of the virtual target, visibility can then be dynamically calculated. These systems are proving to be reliable and responsive to rapidly changing conditions. One set of detectors could be placed in each of the affected segments of roadway.

Informational Signs for Motorists – Dynamic signs have been shown to be effective in alerting motorists to dangerous and variable driving conditions. Message sets for this application would likely be simple "Caution Reduced Visibility Ahead" or possibly a reduced speed recommendation. Because of the locations of these facilities, the associated warning signs would lend themselves well to alternative uses, such as routes to the arenas or notifications about road closings.

Theory of Operations (how it works) – The visibility detection sensor would monitor the visibility levels in the area around the detection zones and sense when the roadway area visibility has degraded below a predetermined threshold. The variable message signs, installed on either side of the identified roadway segments, would provide motorists with advance warning that the roadway ahead is experiencing low visibility conditions. See Figure B-1 for the proposed geographic location of system implementation.

Using the ITS Architecture – Once a solution to the problem has been identified, and prior to the system design phase, the jurisdictions involved with the system management must agree on how the system will be operated and maintained. The Grand Forks/East Grand Forks Regional ITS Architecture "Sausage Diagram" would be used to identify the entities/subsystems that will be included as part of a solution and to define the system communications.





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Proposed Geographical Location and System Layout

FIGURE B-1

This diagram provides a checklist for system designers to ensure that an integrated system, including the appropriate jurisdictions in the Grand Forks/East Grand Forks area, is designated. The diagram is also an aid in defining the jurisdictions and centers that will be involved in the operation of the system. A multi-jurisdictional task force comprised of the agencies responsible for traffic management, safety and motorist information would normally work through the process of determining how such a system will be operated. Figure B-2 illustrates a probable outcome of this process. Note that in order to prepare the Low Visibility Detection & Warning System Architecture, the Center, Roadside, Vehicle and Traveler Subsystems must be identified appropriately where applicable.

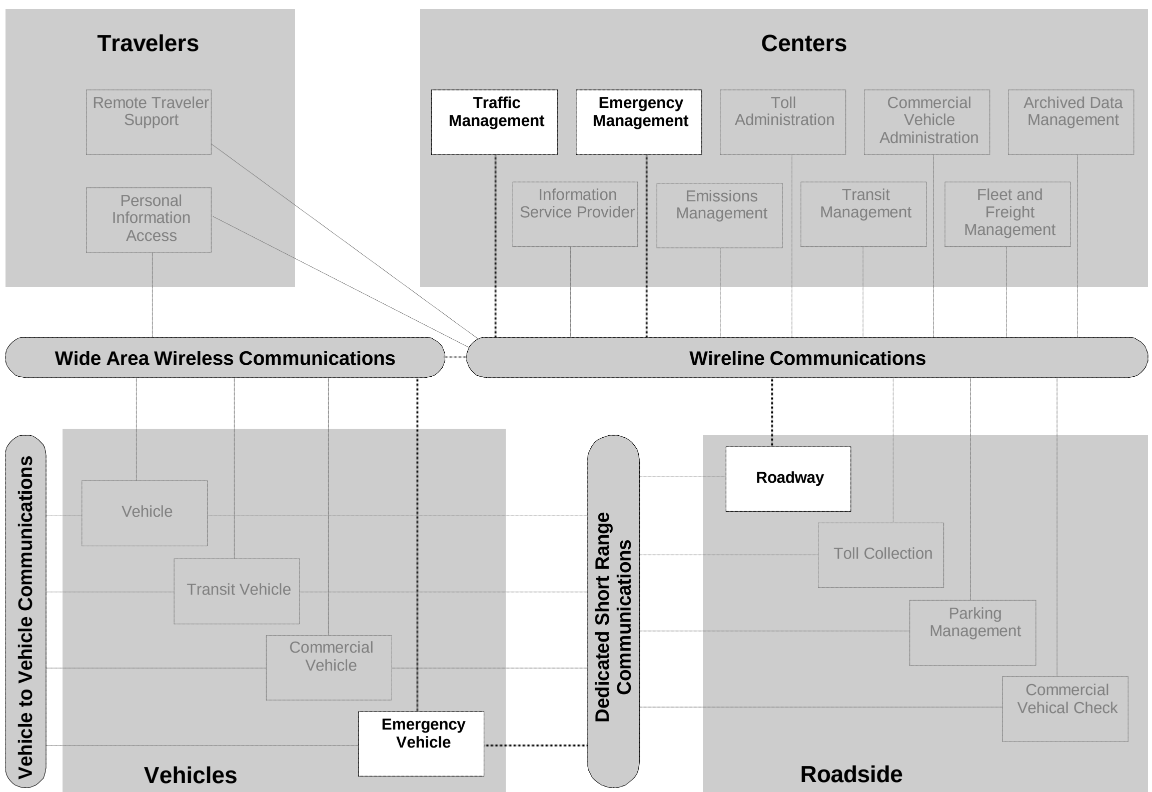


Figure B-2 - Low Visibility Detection & Warning System Architecture "Sausage Diagram"

Utilizing the architecture in this manner will help to ensure interoperability among the ITS systems in the Grand Forks/East Grand Forks area, as well as providing compliance with the National ITS Architecture.

The next step in defining the system design is to break down the architecture into its component parts and examine the system design and operations in detail. The following identifies an example system design option that would provide sufficient operational and functional capabilities to this type of system deployment.

System Design – In the system design (Figure B-3), the visibility detection sensor would be directly connected to the VMSs via copper twisted pair cable. Activation of a sign message would be made when the visibility detection transmits a command to the signs. The visibility detection controller would also transmit a notification message to the Grand Forks Police department by a dial-up connection. In the event that an operator needs to alter a sign message or manually activate the signs, the Grand Forks Police Department and City of Grand Forks Traffic Management office would have the capability of controlling each VMS via a dial up connection to the sign controller.

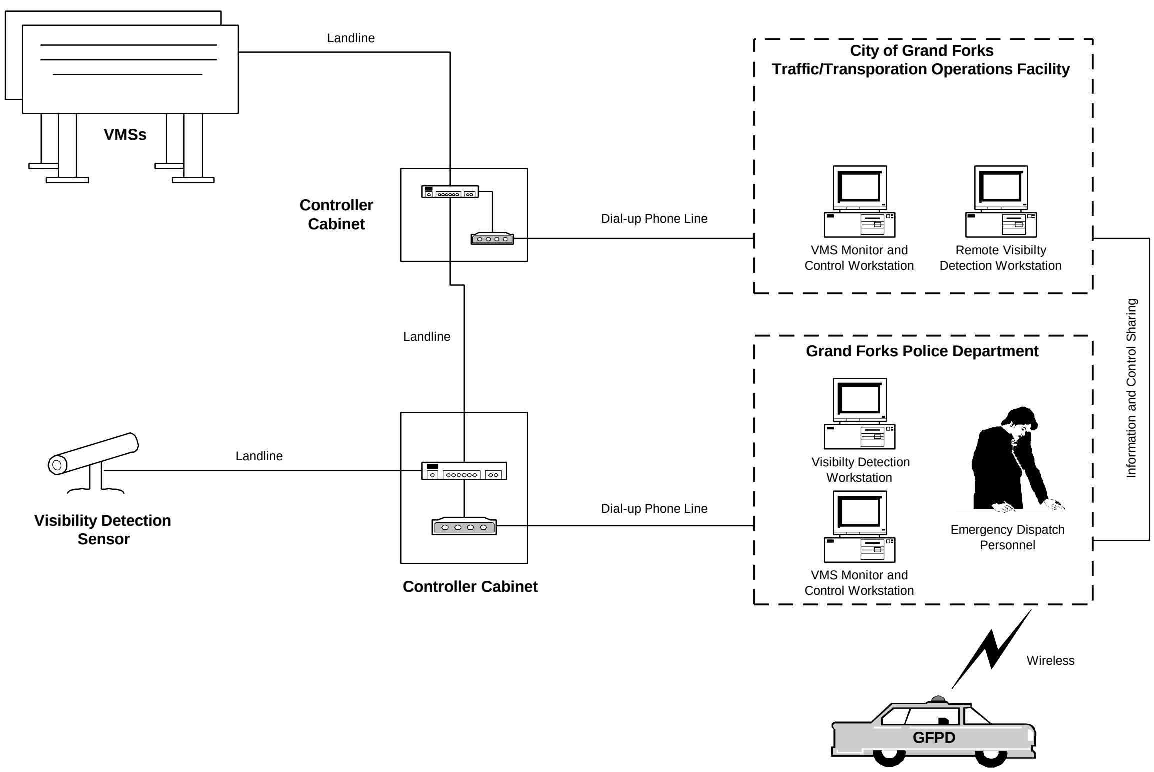


Figure B-3 –System Design Methodology

Additional Steps - Once the decision to implement the process has been made, and the appropriate jurisdictions concurred, the following steps must be followed in order to design and deploy the system:

- Identify lead agency
- Finalize preliminary design
- Prepare cost estimate
- Identify funding sources and year when funds are available
- Program the project as a separate project or part of another project
- Go through normal process of designing and building system

Case Study – Icy Road Condition Warning System

Problem Statement – There are two large grade-separated rail overpasses in the City of Grand Forks with large road decks. As with all bridges, the deck surface typically exhibits icing conditions before surface roads as the bridge structure cools more rapidly than the ground. Timely application of de-icing chemicals is critical to the safe operation of the facility. Currently, there is no mechanism to permit the monitoring of bridge surface conditions, so chemicals must be applied on the basis of general weather conditions.

Solution – Various solutions were identified that would detect icy road conditions, provide an alert of icy conditions to the proper authorities, as well as warn approaching motorists of the icy road conditions ahead. The following are examples of ITS deployments that would combat the issue effectively when implemented in concert:

Surface Condition Detection – Several technologies exist to permit real-time monitoring of bridge deck surface conditions, ranging from infrared temperature detectors to in-pavement sensor packages which can directly detect ice formation. A more detailed operational study would be required to determine the optimal cost/functionality trade-off for this particular application.

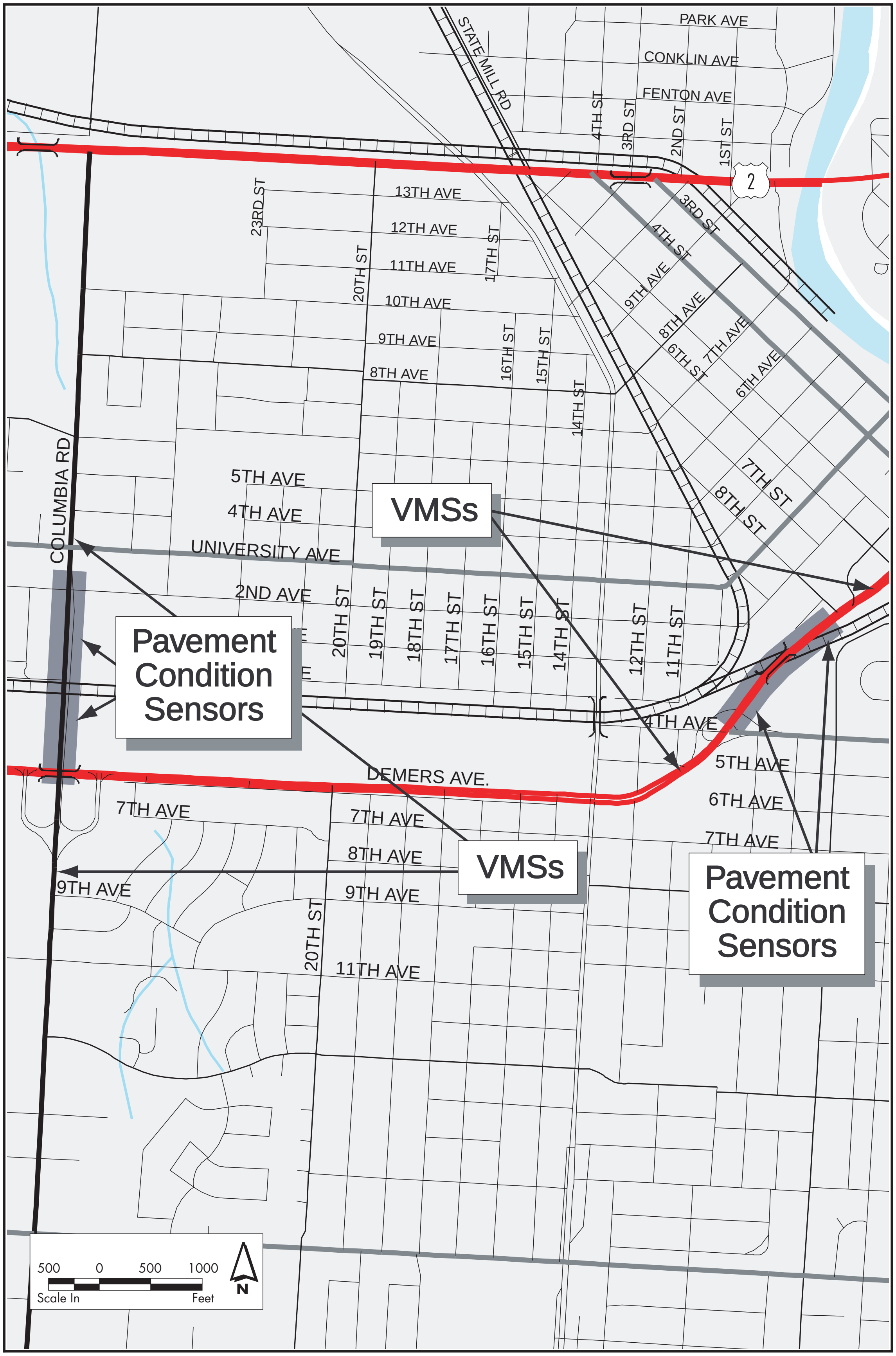
Maintenance Notification – Control of the chemical application requires that maintenance personnel are made aware of the current conditions of the bridge. This can take several forms, ranging from an automated message sent to simple alphanumeric pagers issued to maintenance personnel to a real-time monitoring of conditions by a central dispatch facility which can then direct maintenance vehicles as needed.

Informational Signs for Motorists – Research has shown static signs to be ineffective in modifying driver behavior for hazardous driving conditions. Simple dynamic signing could be implemented or more versatile VMS deployed as part of a multi-use metro-area VMS system. In general, dynamic signs are far more effective in modifying driver behavior, making their use appropriate in situations where safety is a concern.

Theory of Operations (how it works) – A number of bridge and roadway sensors are available that measure:

- Pavement temperature
- Roadway sub-grade temperature
- Pavement condition (i.e., wet, dry, ice, etc.)
- Air temperature
- Chemical content on the pavement surface (i.e., the amount of salt residue on the pavement to prevent ice build-up)

Data from the sensors is transmitted to a processing unit located in the field which in turn monitors each of the above variables to determine the pavement condition (wet, dry or ice layered). In addition to determining if the condition exists, many processing units or control center monitoring computers, with specific software packages can predict if a certain condition is likely given the current status of the variables involved (whether ice will form). This type of early warning system would allow the maintenance vehicle dispatcher to proactively dispatch salt/sand crews to the appropriate areas, as well as warn approaching motorists of the hazardous road conditions ahead. See Figure B-4 for the proposed geographic location of system implementation.



SRF Consulting Group, Inc.	**Proposed Geographical Location and System Layout**	FIGURE B-4

Using the ITS Architecture – Again, once a solution to the problem has been identified, and prior to the system design phase, the jurisdictions involved with the system management must agree on how the system will be operated and maintained. The Grand Forks/East Grand Forks Regional ITS Architecture "Sausage Diagram" would be used to identify the entities/subsystems that will be included as part of a solution and to define the system communications. Figure B-5 illustrates a probable outcome of this process.

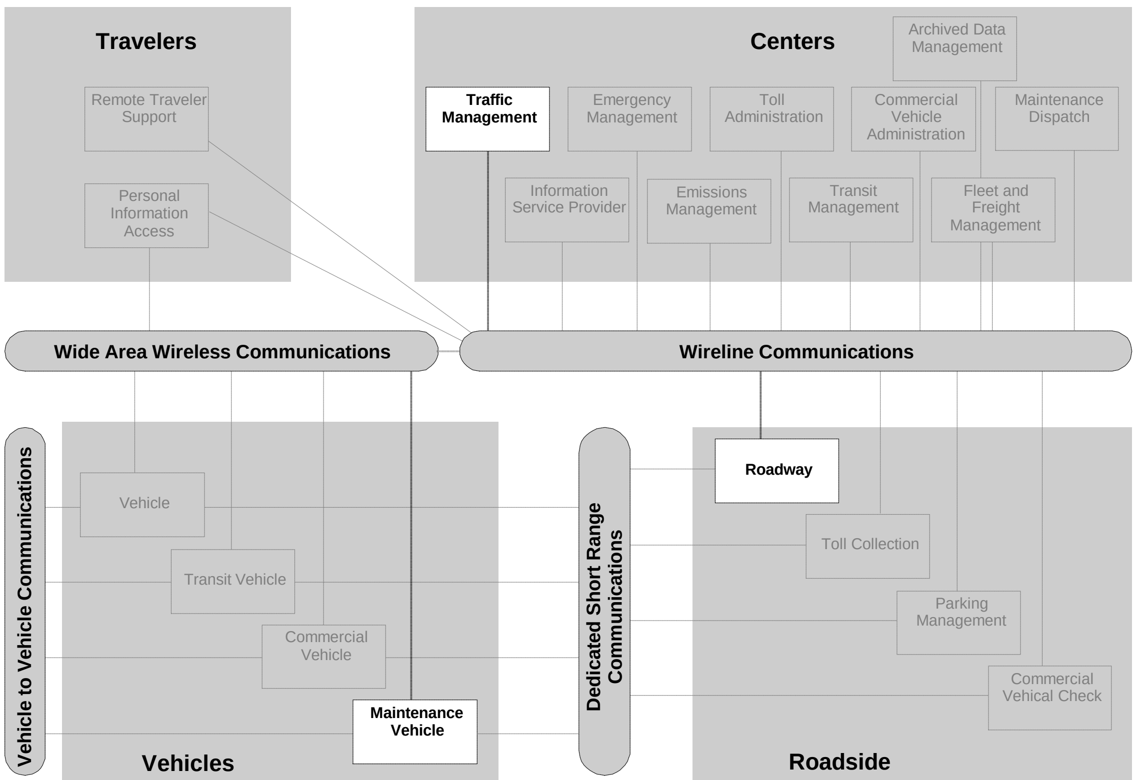


Figure B-5 – Icing Road Condition Warning System "Sausage Diagram"

Utilizing the architecture in this manner will help to ensure interoperability among the ITS systems in the Grand Forks/East Grand Forks area, as well as provide compliance with the National ITS Architecture.

The next step in defining the system design is to break down the architecture into its component parts and examine the system design and operations in detail. The following identifies an example system design option that would provide sufficient operational and functional capabilities to this type of system deployment.

System Design – In the system design (Figure B-6), the icy road condition detection sensor would be connected to its field processor/controller via copper twisted pair cable or the data from the sensor would be translated back to the control center for processing. Once adverse conditions were detected, a notification message would be transmitted to the appropriate operations personnel monitoring the system. The operator then would update the VMS in the field to warn the motoring public of the hazardous road conditions on the roadway using the predetermined message sets. In the event that the traffic operations personnel and maintenance personnel are separate entities, each management entity would have the ability to alter the sign messages on the VMSs in the field for this application.

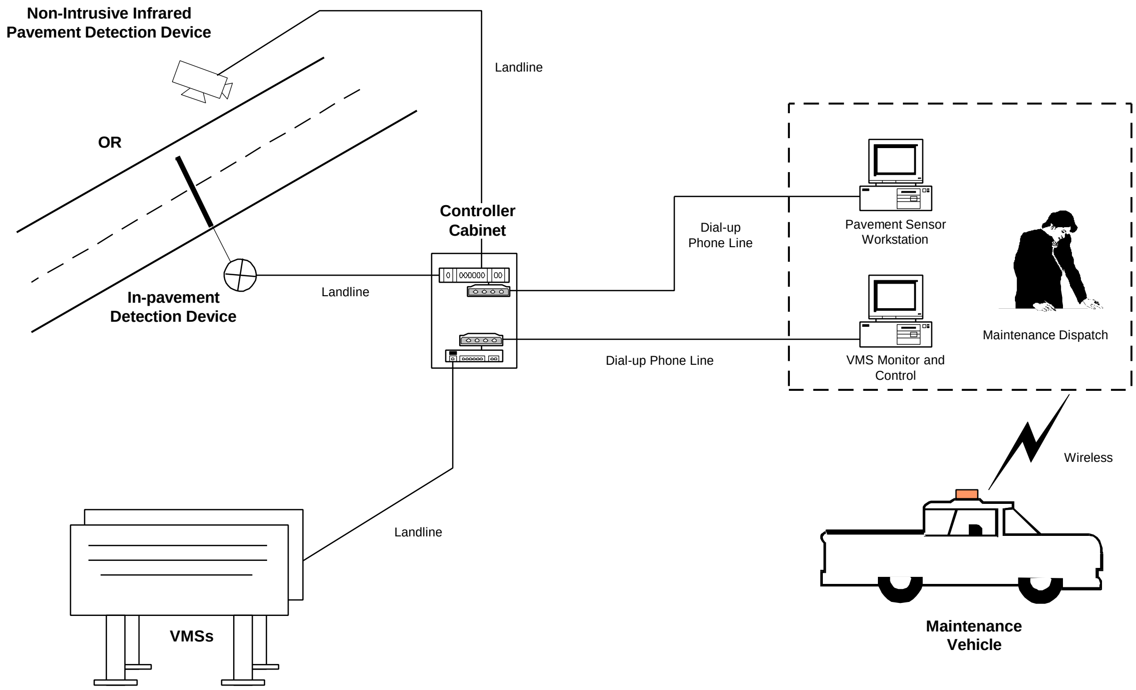


Figure B-6 – System Design Methodology

CASE STUDY – SIGNAL COORDINATION AND INTERCONNECTION

Problem Statement – As traffic volumes continue to increase in the GF/EGF area, local pockets of congestion are beginning to emerge, and with the future opening of the Alerus Center and the Engelstad Arena traffic congestion may develop, specifically at the Demers Ave. river crossing, near the 32nd Avenue retail developments and along US 2, the routes should be made to flow as smoothly and efficiently as possible. As more traffic begins to flow to the Cabela's area retail development in East Grand Forks, management becomes more of an area-wide issue.

Solution – Relatively simple signal coordination and interconnection is a common solution for this type of problem. Signal coordination and interconnection can be accomplished today with relative ease of implementation.

System Wide Signal Interconnection/Coordination **–** As mentioned above, additional signal interconnections can have benefits for event traffic management, and can have a positive impact on day-to-day traffic operations. Grand Forks has been actively expanding the network of interconnected signals; however, this tends to be on a corridor-by-corridor basis, providing no means to coordinate between intersecting corridors. Also, there has not yet been any coordination in the East Grand Forks signal system. Maximum benefit and improved operating efficiencies would be realized if signals in both cities were treated as one system and timing/coordination plans were written to manage the system as a whole.

Typically what will be necessary is a data communication link between each signal controller and a master controller. This link can be copper wiring, fiber optic cable, or radio. The appropriate link should be chosen on a case-by-case basis to balance cost and reliability considerations.

Theory of Operations (how it works) – There are isolated pockets of coordinated signals throughout the Grand Forks/East Grand Forks area, mainly in the central business district and on higher traffic corridors. The theory here is to connect those isolated systems to one another and to create other coordinated signal groupings in certain areas. Once the majority of signals are connected to one another, they would all be connected back to a central traffic/transportation management facility (note that this does not imply an elaborate management building). Operations personnel at the facility would be able to update timing plans accordingly or check the status of field controllers. See Figure B-7 for the proposed geographic location of system implementation.

Using the ITS Architecture – With a solution to the problem identified, yet prior to the system design phase, the jurisdictions involved with the system management must agree on how the system will be operated and maintained. The Grand Forks/East Grand Forks Regional ITS Architecture "Sausage Diagram" would be used to identify the entities/subsystems that will be included as part of a solution and to define the system communications. Figure B-8 illustrates a probable outcome of this process.

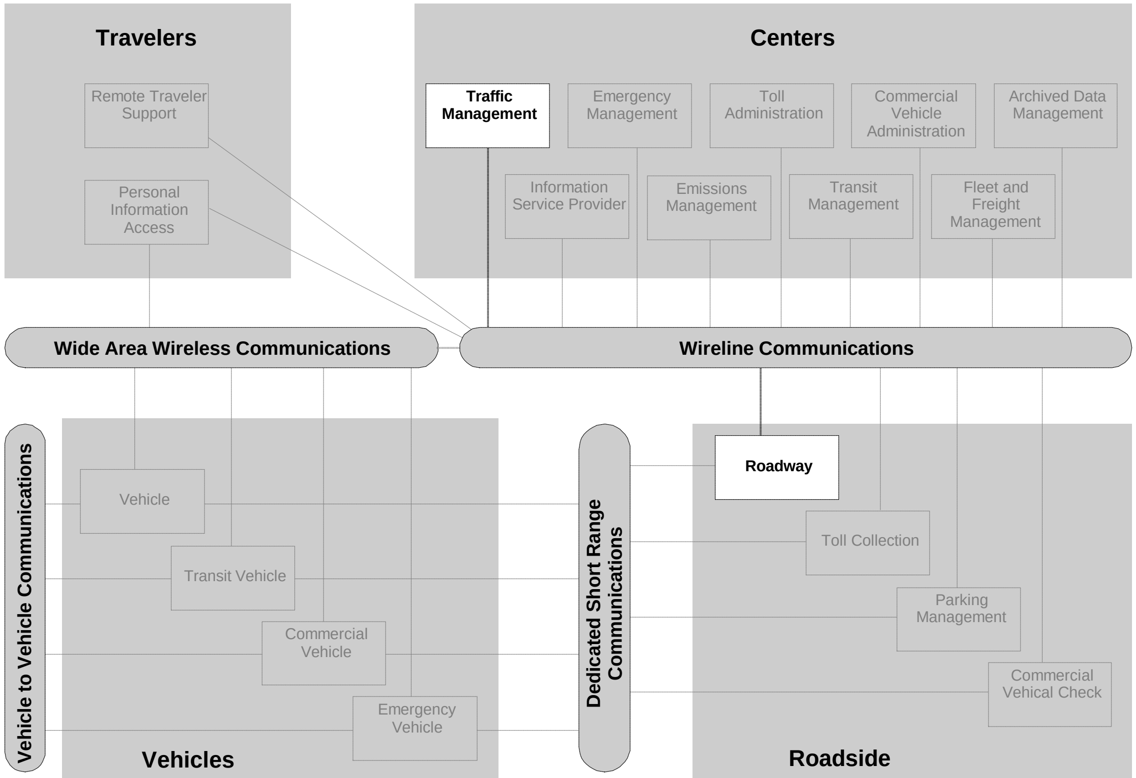


Figure B-8 – Signal Coordination and Interconnection System "Sausage Diagram"

Utilizing the architecture in this manner will help to ensure interoperability among the ITS systems in the Grand Forks/East Grand Forks area, as well as provide compliance with the National ITS Architecture.

The next step in defining the system design is to break down the architecture into its component parts and examine the system design and operations in detail. The following text identifies an example system design option that would provide sufficient operational and functional capabilities to this type of system deployment.

System Design – In this instance, a centralized control system design for signal coordination and interconnection is the most applicable. It should be noted that some signals will more than likely still operate in the master/slave configuration, with one signal controller operating multiple signals via interconnection to those signals, due to the traffic conditions in certain areas this master/slave configuration will still be necessary. See Figure B-9 for further detail.

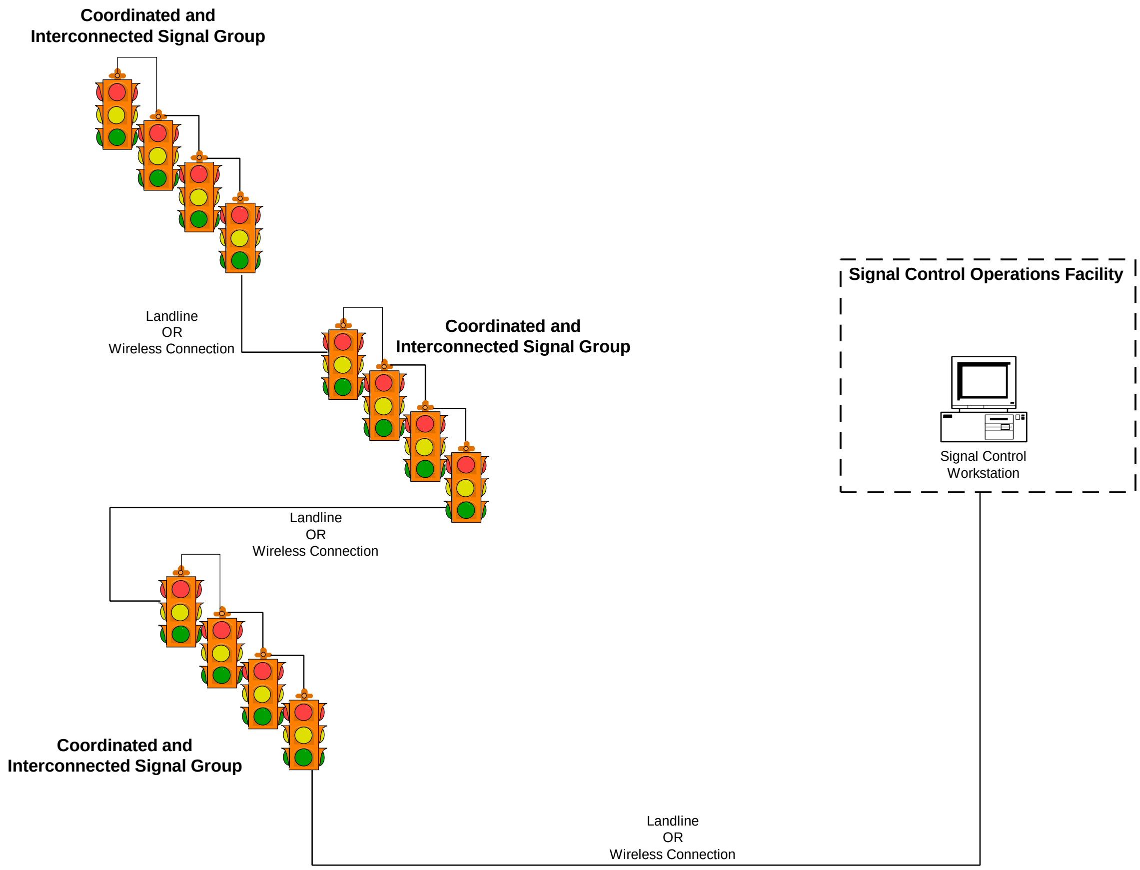


Figure B-9 – System Design Methodology

CASE STUDY – TRAIN DETECTION WARNING SYSTEM

Problem Statement – Several at-grade rail crossings have the potential for car/train crashes. Due to the nature of a car vs. train collision, fatality and injury rates are very high. This issue has two components:

1. Motorists unaware of trains approaching
2. Motorists ignoring the standard flashing red lights and/or gatearms. This is largely due to these warning mechanisms being triggered by slow-moving or reversing trains and motorists becoming impatient.

Also, there may be an additional advantage of warning motorists prior to route decision points so they may choose a route not blocked by trains, thus increasing the efficiency of their trip.

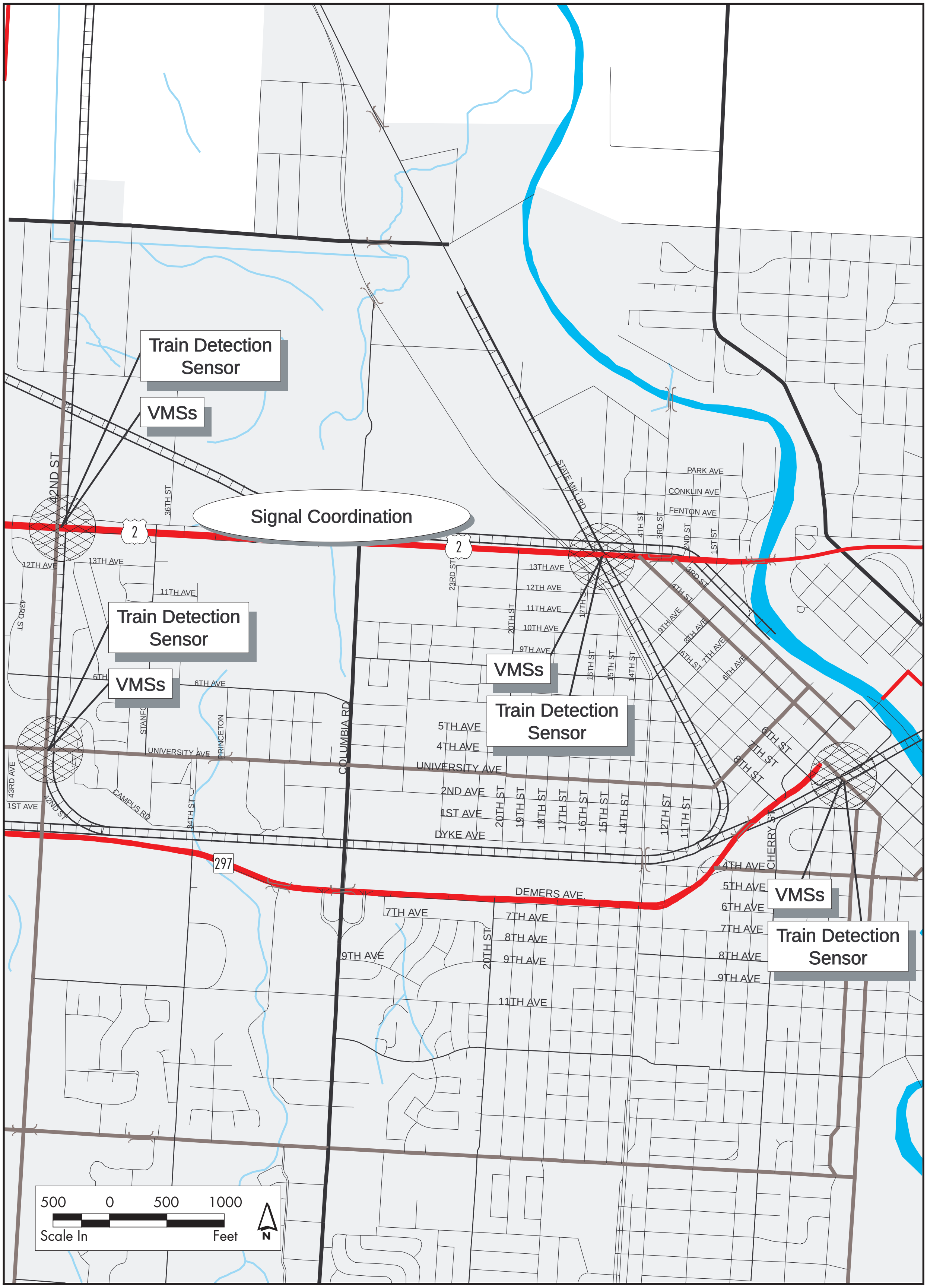
Solution – As with visibility issues, the solutions have two components: first the condition of a train blocking an intersection must be detected and second, there must be an effective mechanism to alert motorists to the condition.

Train Detection – There is currently a system employing machine vision to detect train traffic. This approach has the advantage of not requiring any interface with railroad hardware for its operation. Also, because a visual detection system is used, the camera can be mounted on a bridge or other structure, eliminating the need for equipment to be placed in the railroad right-of-way.

Informational Signs for Motorists – Because the system could function independently of the railroad's warning mechanisms, small signs could be installed that would be triggered based on a time to arrival rather than strict proximity, or any other criteria that the local units of governments deem appropriate. Signs could be kept small and message sets simple to minimize costs.

Signal Interfaces – Another possibility of the system implementation is an interface to the traffic control signal system to minimize the number of vehicles that enter a blocked intersection and give priority to routes which are grade-separated or not blocked by a train. A detailed traffic study would need to be conducted to determine if this is an appropriate solution for these intersections. Also, a fully interconnected signal system is a prerequisite for this solution to be implemented.

Theory of Operations (how it works) – The theory behind the train detection system is that a machine vision sensor (or some alternate means of detection) would detect the presence of the train along the railroad line. From there, the detection notification would be sent back to a central location for processing. Personnel staffing the operations facility would update VMSs in the field to warn motorists of the train approaching. The central processing unit could be developed with the intelligence to adjust signal timing plans along the bisecting roadways of the railroad line. See Figure 10 for the proposed geographic location of system implementation.



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Proposed Geographical Location and System Layout

FIGURE B-10

Using the ITS Architecture – Once a solution to the problem has been identified, and prior to the system design phase, the jurisdictions involved with the system management must agree on how the system will be operated and maintained. The Grand Forks/East Grand Forks Regional ITS Architecture "Sausage Diagram" would be used to identify the entities/subsystems that will be included as part of a solution and to define the system communications. Figure B-11 illustrates a probable outcome of this process.

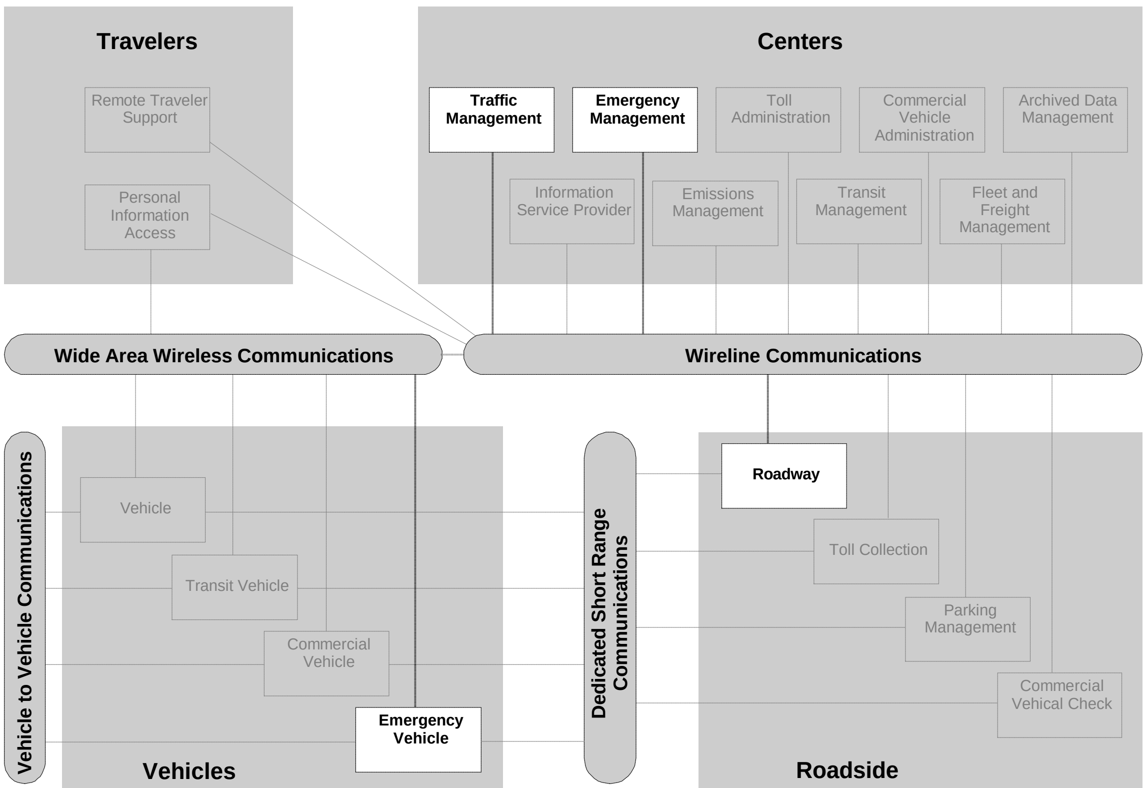


Figure B-11 – Train Detection Warning System "Sausage Diagram"

Utilizing the architecture in this manner will help to ensure interoperability among the ITS systems in the Grand Forks/East Grand Forks area, as well as provide compliance with the National ITS Architecture.

The next step in defining the system design is to break down the architecture into its component parts and examine the system design and operations in detail. The following identifies an example system design option that would provide sufficient operational and functional capabilities to this type of system deployment**.**

System Design – In the system design (Figure B-12), the train detection sensor is connected directly to a computer processor in the field that analyzes the data and sends a notification message to the central operations facility when a train is detected. Personnel monitoring the facility have the ability to update the VMSs display, depending on the train location and speed, with predetermined message sets to alert motorists of potential delays. In addition, the data from the field processor is sent to the operations facility, where it is further analyzed based on location and speed in order to update signal timing plans accordingly along the corridor. This operation will need to be automated so as to avoid labor-intensive human interaction.

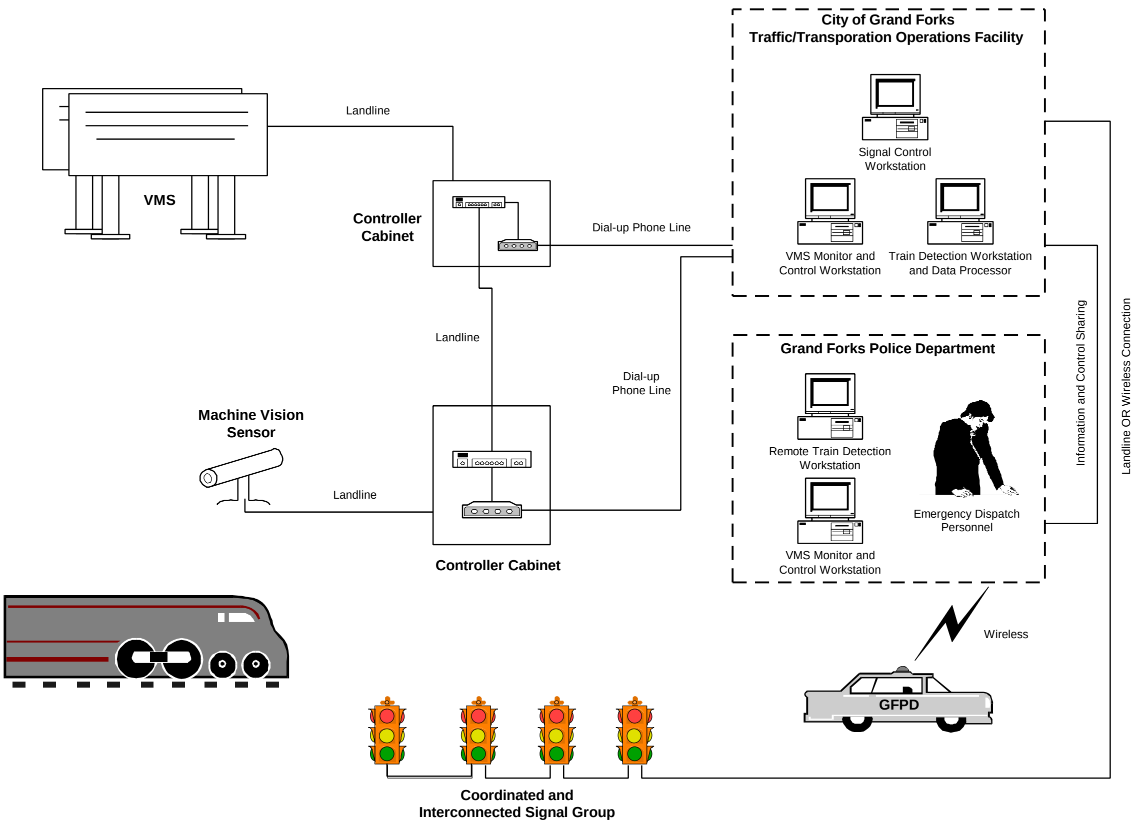


Figure B-12 – System Design Methodology

CASE STUDY – AREA-WIDE VARIABLE MESSAGE SIGN SYSTEM

Problem Statement – The various issues that came up via the needs assessment for the Grand Forks/East Grand Forks Area often pointed toward VMSs as a possible implementation solution component. Together, each of the VMSs that would be implemented as solutions to these various needs could also serve a dual purpose, an Area-Wide VMS System. US 2 (both from the east and the west), I-29 (both from the east and the west) and Hwy 220 from the southeast are all entrance corridors into and out of the Grand Forks/East Grand Forks area and have been identified as possible exclusive traveler information locations. The VMSs on these roads would be installed to provide:

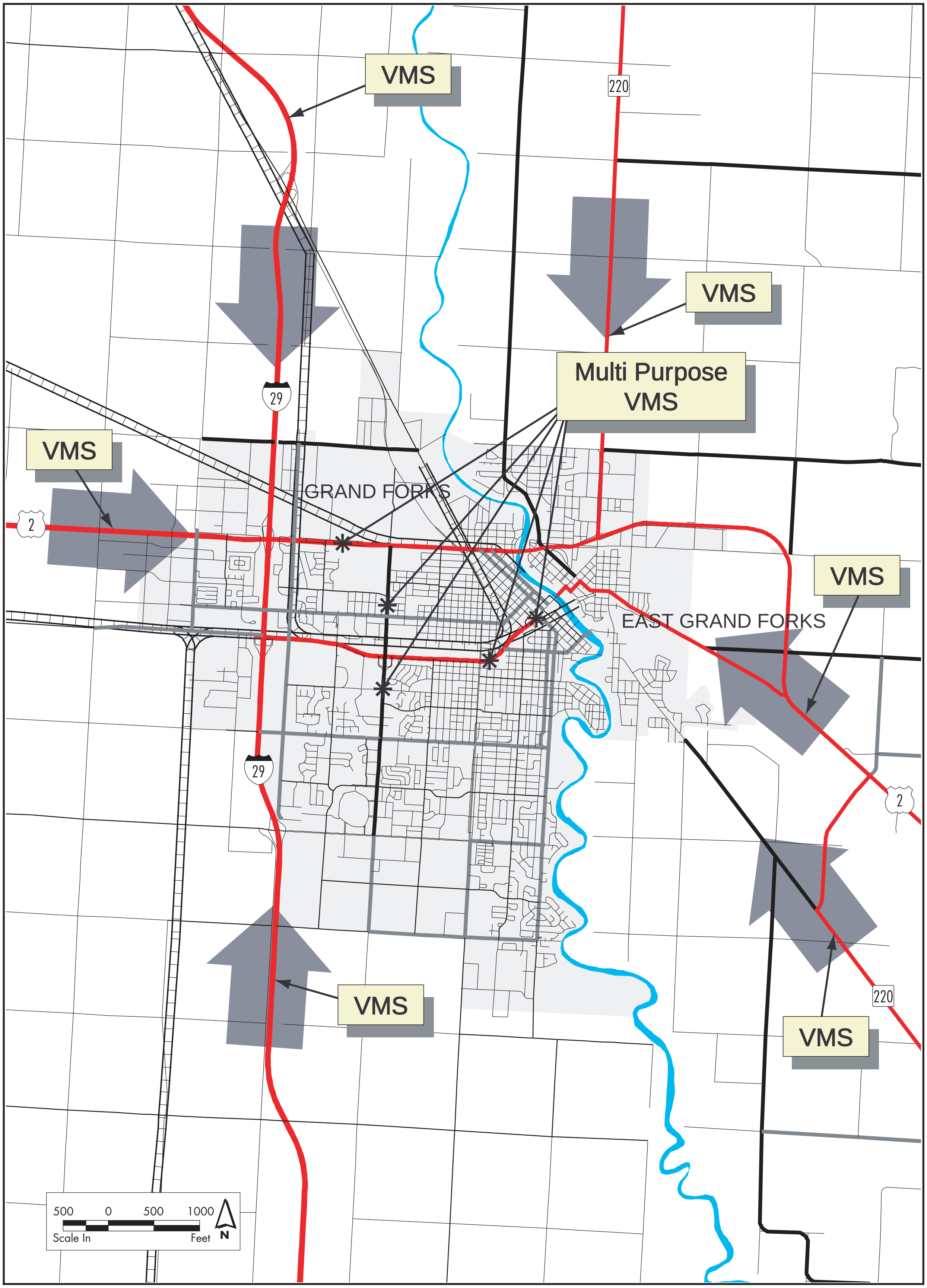
- Traveler information to tourists entering the area
- Special event signing to reduce congestion near traffic generators (Alerus Center)
- Traveler information, weather and road status information
- Incident management information

Solution – Traveler information is provided to motorists traversing the roadways in the Grand Forks/East Grand Forks area via VMSs strategically placed throughout, many of which would be operating as multi-purpose VMSs. The five major connectors routing traffic into and out of the area would be covered by this system, providing the information necessary to make informed decisions while in route.

Theory of Operations (how it works) – The advent of the amber LED over the past few years has resulted in broad acceptance of LED VMSs, which provide the ability to store pre-programmed messages in the sign controller that can be selected via a host of communications media. In addition, many sign vendors offer software packages that allow the user to develop user defined message sets appropriate for the situation being experienced. Control of a particular sign could be provided by the agency that operates the roadway, while the sign message status is simply shared with other agencies. In some instances, the sign control is shared with other agencies on an as-needed basis. For instance, traffic management controls the signs during commuting periods, while construction and maintenance utilizes the signs for nighttime maintenance or lane closures.

Dial-up phone lines or cellular connection to each sign could provide a straightforward and cost-effective solution to the sign communications. The design of the communications system is dependent upon the sign control decisions and clear, well-planned operating policies and procedures. See Figure 13 for the proposed geographic location of system implementation.

Using the ITS Architecture – Once a solution to the problem has been identified, and prior to the system design phase, the jurisdictions involved with the system management must agree on how the system will be operated and maintained. The Grand Forks/East Grand Forks Regional ITS Architecture "Sausage Diagram" would be used to identify the entities/subsystems that will be included as part of a solution and to define the system communications. Figure B-14 illustrates a probable outcome of this process.



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Proposed Geographical Location and System Layout

FIGURE
B-13

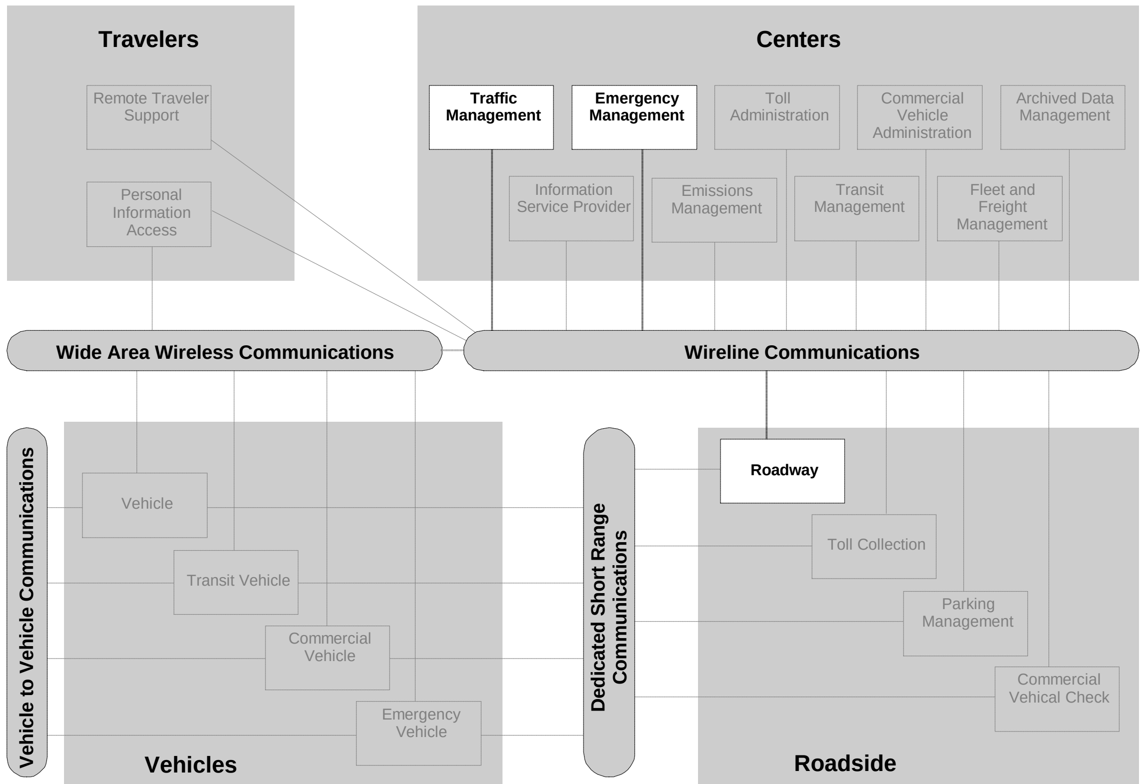

Figure B-14 – Area Wide VMS System "Sausage Diagram"

Utilizing the architecture in this manner will help to ensure interoperability among the ITS systems in the Grand Forks/East Grand Forks area, as well as provide compliance with the National ITS Architecture.

The next step in defining the system design is to break down the architecture into its component parts and examine the system design and operations in detail. The following identifies an example system design option that would provide sufficient operational and functional capabilities to this type of system deployment.

System Design – For this project system design (Figure B-15), the VMSs are connected to their respective sign controllers via a landline or wireless connection and, in some instances, may be connected to a detection device if the VMS is working together with other equipment as a multi-purpose system component (i.e., visibility detection system). The signs are then connected to a central control facility (or multiple facilities in the event that the VMS is operating as a multi-purpose system component) via a dial-up phone connection or otherwise. Each entity connected to the VMS may have the ability to assign messages (depending on control thresholds developed).

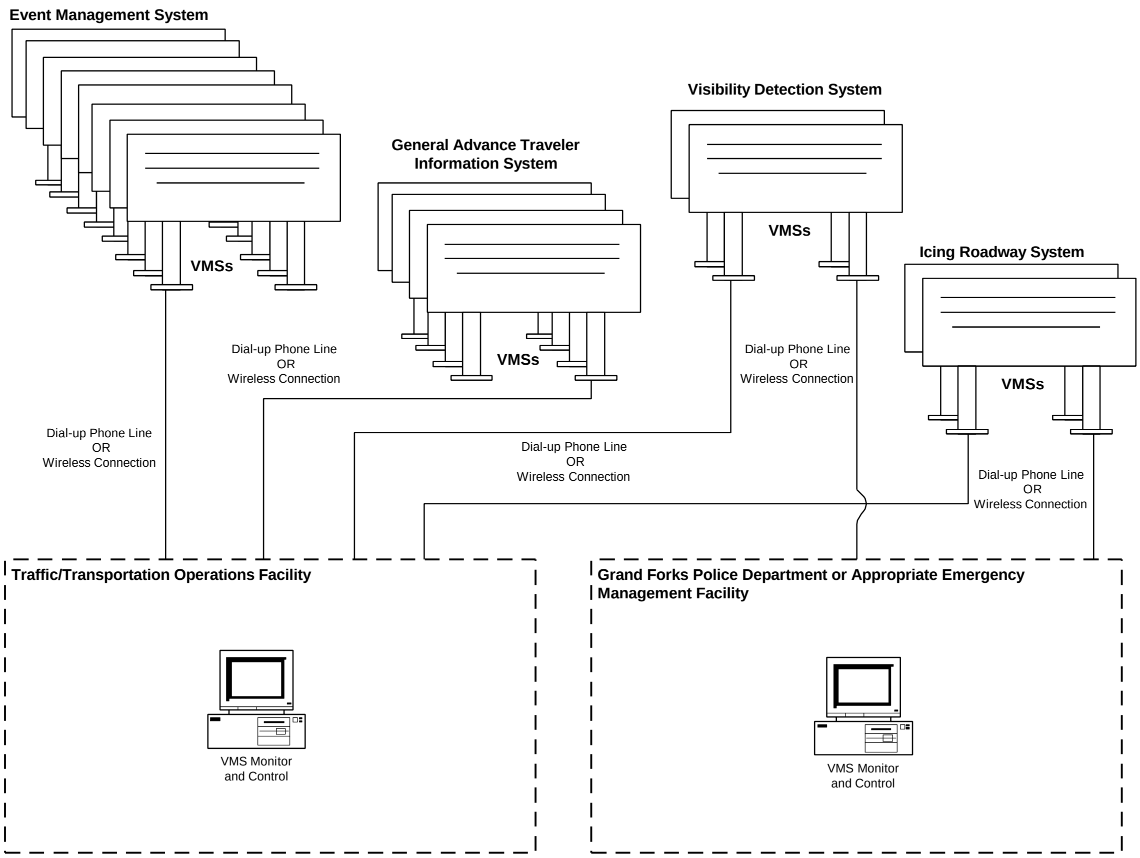

Figure B-15 – System Design Methodology