Bismarck – Mandan Metropolitan ITS Plan

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BISMARCK – MANDAN METROPOLITAN ITS PLAN

Final Report

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1. INTRODUCTION

The Bismarck-Mandan Intelligent Transportation Systems (ITS) Plan was developed under sponsorship from the Bismarck-Mandan Metropolitan Planning Organization (Bis-Man MPO) to guide ITS deployment in the area. There have been several ITS deployment projects in the Bismarck-Mandan area, mainly relating to advanced traffic control and traveler information. However, there has been no coordinated plan for identifying the community needs and the potential solutions ITS can provide.

Because of previous ITS deployment in the Bismarck-Mandan area, the Bis-Man MPO is required to meet federal Intelligent Transportation System Architecture and Standards requirements. The Federal Highway Administration (FHWA), with these rules, requires metropolitan areas which have used federal funds to finance ITS projects to develop a regional ITS architecture no later than April 2005. The Bis-Man MPO therefore wanted to develop a strategic document to coordinate ITS initiatives and support the development of the regional architecture.

The Bis-Man MPO was assisted by the Advanced Traffic Analysis Center (ATAC) at North Dakota State University in developing an ITS Plan. ATAC has been supporting ITS planning, deployment and evaluation in North Dakota for several years.

The following sections provide background information on the Bismarck-Mandan area, some of the major ITS activities and the various stakeholders involved in the plan development. The approach for developing the plan and the method for identifying priority ITS are also discussed.

1.1 Background

The Bis-Man MPO is centrally located in North Dakota and includes the cities of Bismarck, Lincoln and Mandan as well as portions of Burleigh and Morton counties. Table 1 below shows the latest population figures for these areas.

Table 1. Bismarck-Mandan MPO Areas and Population

Jurisdiction	2000 Population
City of Bismarck	55,532
City of Mandan	16,718
City of Lincoln	1,730
Burleigh County	69,416
Morton County	25,303

The area is served by a transportation system which includes a stretch of Interstate 94, several arterial roads and three bridges which span the Missouri River. The river divides the area in a north-south direction while I-94 runs east-west. Interstate interchanges and river bridges are key to the connectivity of the transportation network in the area and are becoming increasingly important with new development in the area. Figure 1.1 shows a map of the area with major roads.

Bismarck-Mandan has several areas of special interest. The state capitol complex, located in Bismarck, houses state government offices, the legislature and other agencies. There are three college campuses in the area: University of Mary, Bismarck State College and United Tribes Technical College. The Bismarck Civic Center, a multi-purpose activity center, hosts various entertainment and sporting events. Scheduled air service is provided to the area by the Bismarck Municipal Airport.

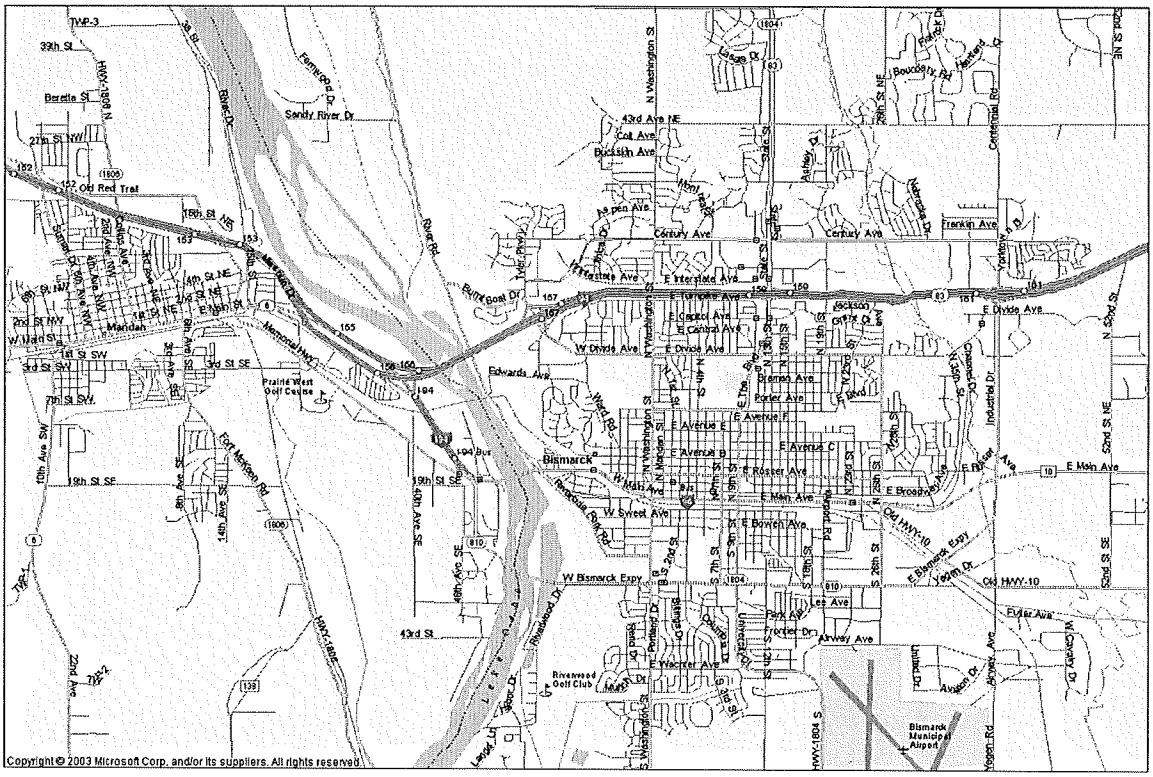


Figure 1.1 Bismarck-Mandan Area

The area's transportation system generally operates at a very good level of service. However, the system sometimes experiences short periods of heightened demand during special events or incidents. Winter weather is another issue for the area. Timely and accurate travel information during severe conditions are critical for motorist safety. A number of capacity enhancement projects have been completed in recent years on the interstate and major arterial routes. These construction projects have affected the overall system in the area and require effective traffic management. Additionally, the development of a fixed-route bus transit system is currently underway. The transit system is expected to implement technology that enhances effective management of fleet operations as well as service to customers.

1.1.1 Agencies

There are several jurisdictions and agencies responsible for transportation system operations, maintenance and enforcement that influence the development of the ITS Plan. The plan recognizes the potential roles of these partners and emphasizes inter-jurisdictional coordination. Institutional coordination makes ITS work better by achieving seamless operations in the region and maximizing overall benefits. Important aspects of this cooperation are resource sharing and partnering. The cost of deploying ITS may be prohibitive for one agency, however, effective partnerships reduce costs to individual agencies and expand functionality.

The Bis-Man MPO provides a forum for bringing most of these agencies together. The organization coordinates transportation improvements with the various agencies and assists with funding. It is expected that the ITS Plan will be closely coordinated with metropolitan transportation plans and the Transportation Improvement Program (TIP).

The cities of Bismarck and Mandan are responsible for surface street system operations. They have the major responsibility for traffic signal operations (though a few traffic signals are operated by the NDDOT) and the two cities work well together in coordinating traffic operations. In addition to city traffic engineering and public works, other local agencies, including police, fire and emergency management, are major partners in this ITS Plan development.

The NDDOT Bismarck District has a major role in system operations as well. The NDDOT operates the interstate sections in the area, provides traveler information and owns ITS hardware such as Dynamic Message Signs (DMS). The NDDOT also played a leadership role for ITS deployment statewide and can provide support and experience to metropolitan areas planning ITS deployment.

1.1.2 ITS Initiatives

Intelligent Transportation Systems have been deployed across the nation to enhance traffic safety, improve traffic operations and provide greater service to the transportation system users. The federal ITS program has grown from research and development in the early 1990s, to targeted deployment of pivotal systems in the past five years. As a result, numerous resources document experiences from ITS projects and provide insights into successful planning and deployment. One of the main goals for the federal ITS program is to ensure interoperability of ITS across jurisdictional lines, largely through the ITS Architecture effort.

The ITS Architecture provides a systematic approach for planning, design and operation of ITS. It has ultimately become an effective vehicle for identifying ITS components, specifying their functionality and outlining their relationships to each other and to other systems. The architecture allows agencies to choose systems in a need-based approach and develop relevant system functionality accordingly. The areas of ITS Architecture address the broad themes of travel and traffic management; safety and security; public transportation; emergency management; maintenance and construction; and others.

The majority of ITS activity in the Bismarck-Mandan area has largely been through the NDDOT rural ITS initiatives. However, the interfaces between statewide and metropolitan systems must be addressed in this plan and in future ITS regional architecture. Examples of such interfaces include DMS operations, use of 511 for local traveler information and the use of video surveillance on key routes.

1.2. Approach

The Bismarck-Mandan ITS Plan is intended to be a strategic document that addresses the unique needs and priorities for the area to identify ITS services and systems targeted for deployment. The plan also outlines a deployment schedule and potential resources needed to meet deployment goals. Institutional arrangements for operating ITS and sharing information from these systems are also addressed.

1.2.1 Stakeholders Involvement

The first and foremost emphasis in developing the Bismarck-Mandan ITS is on effective involvement from all stakeholders. The ATAC research team worked with the project champions early to identify potential stakeholders and develop mechanisms for obtaining their input. The goal of this approach is to ensure that suggested ITS solutions meet the area's unique needs and respond to critical issues of stakeholders. To accomplish this goal, the ITS Plan development was guided by several groups to ensure representation from all relevant parties. The two main groups are:

1. Project *steering committee* that directly oversaw the development of Bismarck-Mandan's ITS Plan and acted as a point of contact. The committee provided support, data and guidance to the ATAC project team and coordinated various stakeholders. Membership in this committee included:
   Bismarck-Mandan MPO
   Traffic Engineering, City of Bismarck
   Traffic Engineering, City of Mandan
   Bismarck-Mandan Transit
   North Dakota DOT
   FHWA North Dakota Division Office

2. Area *stakeholders* who provided input on area needs and critical issues and assisted in prioritizing desired ITS solutions. This group included:
   Law Enforcement
   Public Works
   Emergency Management
   Fire Departments
   Counties
   Areas of special interest
   Elected officials
   Citizen groups

Following is a list of stakeholders who participated in the ITS Plan development:

Paul Benning	NDDOT, Urban Engineer
Mark Berg	Bismarck City Traffic Engineer
Dennis Bullinger	Mandan Police Deputy Chief
Steve Busek	FHWA, ND Div. Safety/Traffic Engineer
Matt Erhardt	Morton County Commissioner
Jeff Forster	FHWA, ND Div. Operations Engineer
Elroy Haadem	Burleigh County Extension Agent
Greg Haug	Bismarck Municipal Airport Manager
Rob Hickcox	Bismarck Fire
Keith Hunke	Bismarck Public Works Service Operation Director
Mark Johnson	FHWA, ND Div. Transportation Planner
Greg Busch	Bismarck Public Schools Safety Director
Karen Kautzmann	Burleigh/Morton County Schools Superintendent
Tammy Lapp	Mandan/Morton County Emergency Manager
Claus Lembke	Burleigh County Commissioner
Kevin Levi	NDDOT, District Engineer

Tom Little	Mandan City Engineer
Helen Magilke	City of Lincoln
Darrell McQuay	Private Citizen
Jon Mill	Burleigh County Highway Engineer
Chuck Morman	Morton County Highway Engineer
Steve Nardello	Mandan Fire Chief
Allan Nass	Bismarck Police Sargeant
Todd Porter	Metro Area Ambulance
Dennis Rohr	Mandan Police Chief
Ed Ryen	ND Department of Transportation
Steve Saunders	Bismarck-Mandan MPO
Kermit Schaefer	City of Bismarck
Mary Senger	Bismarck/Burleigh County Emergency Manager
Brad Smith	ND Highway Patrol
Sandy Tibke	City of Mandan Commissioner
Robin Werre	Bis-Man Transit Director
Fred Wooten	Bismarck Police Lieutenant

1.2.2 Goals and Objectives

The ITS Plan is a strategic document that addresses the unique needs and priorities of the Bismarck-Mandan area and matches those needs with relevant ITS technologies. The plan provides the roadmap for types of ITS technologies, location for possible deployment, tentative dates for deploying these applications and potential resource requirements for these applications. It also addresses various agency relationships in regard to deploying and operating ITS in the area. Following are some of the specific goals and objectives for the ITS Plan development:

1. Identify high priority needs and critical transportation issues in the Bismarck-Mandan area.
   a. Involve all stakeholders
   b. Provide opportunities for various stakeholders to provide input related to:
      i. Safety
      ii. Mobility
      iii. Other community issues
   c. Coordinate needs identification with the Bis-Man MPO's existing urban transportation plans/studies

2. Identify and prioritize ITS technologies with potential solutions to needs.
   a. Raise ITS awareness among stakeholders
   b. Choose appropriate ITS user services
   c. Identify locations for possible deployment
   d. Develop priorities for deployment
   e. Estimate cost/resource requirements for targeted ITS

3. Develop ITS market packages to meet the requirements for the priority ITS user services.
   a. Link each ITS user service with market package.
   b. Identify possible interfaces with other jurisdictions, agencies and organizations

1.2.3 Major Tasks

This section summarizes the main activities conducted in the ITS Plan development. Below is a description of these tasks and the outcomes/products from each task:

1. Obtain input from steering committee on needs and critical issues in the Bismarck-Mandan area (August - September 03)
   a. Establish steering committee and stakeholders group
   b. Hold steering committee meeting
   c. Outcomes
      i. Final work plan
      ii. Suggestions for stakeholders
      iii. Scheduling of first stakeholder workshop
      iv. Initial set of needs and priority issues
      v. Availability of relevant data

2. Obtain data on existing system with special attention to traffic signal control systems, system use at key locations, system performance (safety, delay) and any existing ITS (October 03 - January 04)
   a. Send questionnaires for collecting inventory data on relevant systems
   b. Summarize data and verify with stakeholders
   c. Outcomes
      i. Relevant systems
      ii. Existing ITS

3. Hold first stakeholder workshop to obtain more insights on needs and raise ITS awareness among the relevant individuals (October 03)
   a. Outcomes
      i. System-wide issues
      ii. Agency-specific issues
      iii. Common understanding of ITS among stakeholders

4. Identify potential ITS solutions that address area needs (November 03)
   a. Outcomes
      i. ITS user services
      ii. ITS market packages

5. Hold second stakeholder workshops (November 03)
   a. Present ITS user services
   b. Discuss potential projects
   c. Discuss potential locations

6. Develop potential ITS projects (February 04)
   a. Finalize locations for ITS deployment
   b. Identify agency roles
   c. Estimate costs and resource requirements for selected ITS solutions
   d. Outcomes
      i. Project locations
      ii. Cost estimates (low, medium, high)

7. Prepare ITS Plan report
    a. Prepare final draft
    b. Hold stakeholder workshop
    c. Prepare and submit final report

1.3. Document Organization

The rest of this document is organized into four sections. Section 2 provides a brief introduction to ITS. Section 3 describes existing systems, including ITS. Section 4 outlines Bismarck-Mandan's transportation related issues. Section 5 describes priority ITS services identified for the Bismarck-Mandan area. Section 6 uses ITS user services and needs/issues to develop ITS project locations.

2. ITS

This section provides a brief discussion of ITS, including: definitions, technologies, user services and architecture. Intelligent Transportation Systems (ITS) integrate electronic sensing devices, communications and computer processing improve transportation systems operations and safety. Although many technologies were used in transportation in the 1980s and early 1990s, ITS emphasized integrating these technologies to provide maximum benefits. Further, the national ITS architecture introduced an approach which is service-driven, rather than technology-driven. Therefore, ITS meet user mobility and safety needs by deploying appropriate technologies and coordinating these technologies among various partners.

2.1 ITS Technologies

Technologies used to support ITS may be categorized into these main categories:

1. Sensors: devices used to collect information about the transportation system infrastructure, traffic using the system and the environment affecting the system. These technologies provide critical information that is processed in order to be used by system operators or travelers. Examples include:
   a. Video cameras for monitoring the system and identifying incidents
   b. Weather sensors for identifying surface conditions
   c. Loop and video detectors for measuring traffic speeds and density

2. Communications: the glue that binds ITS components. These technologies transport information from the field to appropriate processing centers and disseminate information out to travelers. Communication plays a major role in supporting ITS and sometimes requires significant investments before full functionality is realized. ITS often use a mix of communication media to accomplish their mission. The challenge is to match needs to the capabilities of different communication technologies. Wireless communications have seen significant improvements in the last few years and provide considerable flexibility for supporting ITS. However, for ITS applications which require great reliability and bandwidth, especially those that involve continuous video (full-motion), fiber-optic technology is the most common communications medium. Figure 2.1 shows how different communications strategies could be combined to support ITS functions. Examples of common communication methods include:
   a. Land-line telephone
   b. Fiber-optics
   c. Wireless
   d. IP
   e. Hardwire

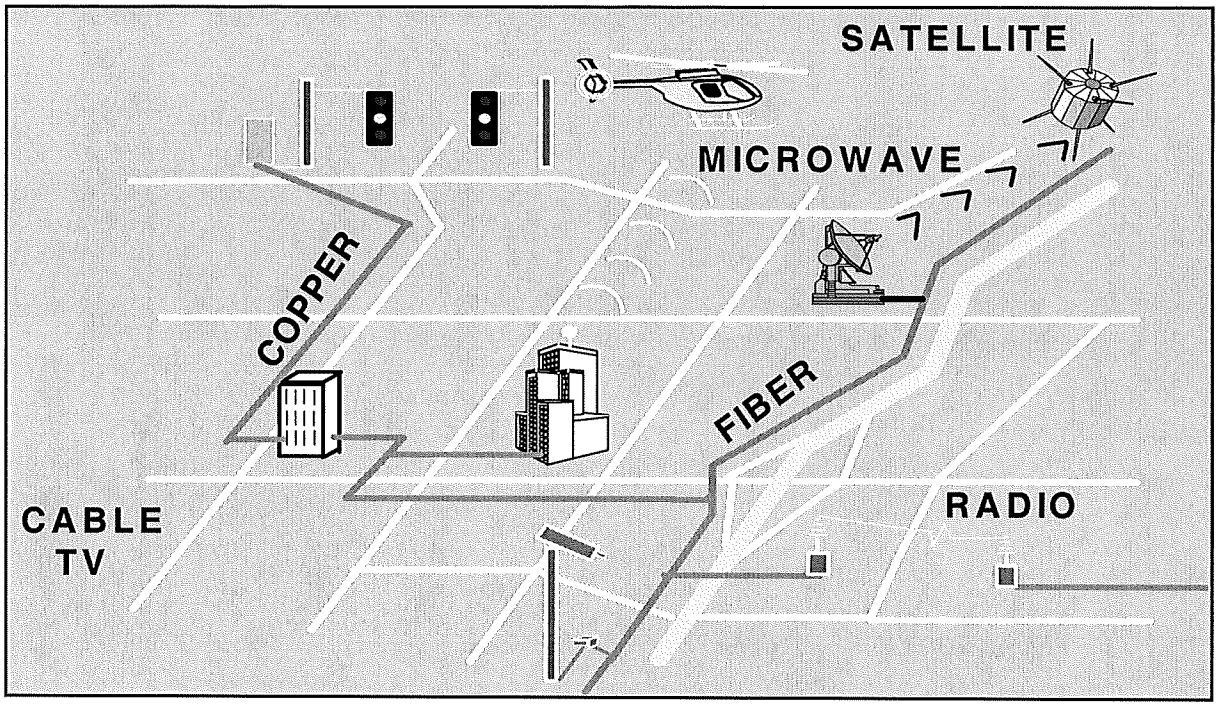


Figure 2.1 Communication Methods to Support ITS

3. Computer processing: system which receives and processes data from sensors in order to support system operational decisions and disseminate information to travelers about system status. Processing may be done either automatically or with operator intervention. Furthermore, processing may take place at a central location, a district office or in the field. Examples of these systems include:
   a. Condition database
      i. Assess system condition and issue reports
   b. 511
      i. Summarize system conditions and answer interactive requests by motorists
   c. Traffic adaptive signal control
      i. Process detector data and change traffic signal timing parameters accordingly

4. Information dissemination devices: technologies used to deliver information to system users about system conditions and non-recurring incidents. Examples of these technologies include:
   a. DMS
   b. Highway Advisory Radio (HAR)
   c. Interactive web page
   d. Kiosks

2.2 ITS Architecture and ITS Planning

The National ITS Architecture provides a tool for guiding the implementation of ITS technologies. The architecture provides a comprehensive framework that can be used to plan future ITS, define system

requirements, coordinate agency roles and integrate functions across jurisdictional lines. The architecture defines the functions that must be performed to implement a given user service, the physical entities or subsystems where these functions reside, the interfaces/information flows between the physical subsystems and the communication requirements for the information flows. Major components of the architecture include:

1. User Services: describe what the system will do from the user's perspective
2. Logical Architecture: defines the processes required to satisfy the User Services
3. Physical Architecture: forms a high-level structure around the processes and data flows in the Logical Architecture
4. Market Packages: slices of the Physical Architecture that address specific services
5. Standards: ITS standards and their relationship to the National ITS Architecture.

A regional ITS architecture is a tailored, scaled-down version of the national architecture which provides a useful tool for planning and implementing ITS within a region. From a planning perspective, the regional ITS architecture defines the ITS that regional stakeholders wish to realize over a given time frame. This plan for ITS in the region will be realized in an incremental fashion as funding and/or technology is available and institutional issues are resolved. The regional ITS architecture will be used to properly and efficiently define projects so they build upon one another.

2.2.1 ITS User Services

User services document what ITS should do from the user's perspective in the areas of safety, mobility, comfort and other needs. A broad range of users are considered, including the traveling public and system operators. The concept of user services allows system or project definition to begin by establishing the high level services that will be provided to address identified problems and needs. ITS user services are grouped into related functions called "bundles", and include the following (note that not all of these bundles are applicable for the Bismarck-Mandan ITS Plan):

1. Travel and Traffic Management

1.1 Pre-trip travel Information
1.2 En route Driver Information
1.3 Route Guidance
1.4 Ride Matching and Reservation
1.5 Traveler Services Information
1.6 Traffic Control
1.7 Incident Management
1.8 Travel Demand Management
1.9 Emissions Testing and Mitigation
1.10 Highway Rail Intersection

2. Public Transportation Management

2.1 Public Transportation Management
2.2 En route Transit Information
2.3 Personalized Public Transit
2.4 Public Travel Security

3. Electronic Payment
3.1 Electronic Payment Services

4. Commercial Vehicle Operations
4.1 Commercial Vehicle Electronic Clearance
4.2 Automated Roadside Safety Inspection
4.3 Onboard Safety Monitoring
4.4 Commercial Vehicle Administrative Processes
4.5 Hazardous Material Incident Response
4.6 Commercial Fleet Management

5. Emergency Management
5.1 Emergency Notification and Personal Security
5.2 Emergency Vehicle Management

6. Advanced Vehicle Safety Systems
6.1 Longitudinal Collision Avoidance
6.2 Lateral Collision Avoidance
6.3 Intersection Collision Avoidance
6.4 Vision Enhancement for Crash Avoidance
6.5 Safety Readiness
6.6 Pre-Crash Restraint Deployment
6.7 Automated Vehicle Operation

7. Information Management
7.1 Archived Data Function

8. Maintenance and Construction Management
8.1 Maintenance and Construction Operations

2.2.2 ITS Market Packages

Market Packages represent slices of the Physical Architecture that address specific services such as surface street control. They bring together several different subsystems, equipment packages, terminators and architecture flows to provide desired services. Market Packages are useful for identifying the various entities in the region that will be involved in supporting the desired services. They also identify potential agreements that are needed to support inter-agency operations related to these services. ITS market packages developed for the Bismarck-Mandan area are listed in Appendix I.

3. INVENTORY OF EXISTING SYSTEMS

This section provides information on existing systems relevant to the Bismarck-Mandan ITS Plan and the agencies responsible for their operations. The discussion is intended to examine possible improvements in existing systems and potential interfaces with proposed ITS in the area. The discussion is organized in five major areas as outlined in the following sections.

3.1 Traffic Operations

Components covered in this group include traffic control, condition reporting systems, traffic management and traveler information and other related systems. Emphasis in this discussion is on systems which could potentially be integrated with ITS.

3.1.1 Traffic Signal System

The City of Bismarck operates nearly 80 traffic signals city-wide. About 24 of these signals operate according to pre-timed plans. The remaining traffic signals are semi-actuated or actuated traffic signals. More than 70 of the city's traffic signal controllers have the capability of communicating with the city engineering office through use of master controllers and phone drops. The city operates 10 coordinated corridors which include 76 of the 80 signalized intersections. Figure 3.1 shows the locations of these corridors within Bismarck. Currently, State Street is the only corridor that is interconnected using fiber optics, although Main Avenue has conduit in place to add fiber later. The other corridors are all interconnected using hard wire.

The City of Mandan operates nine signalized intersections, four of which are pre-timed while the other five are actuated. Of these nine signals, there are two coordinated corridors which include eight of the signals. These corridors are hardwired and have communications through two master controllers and phone drops to the Mandan city engineering office. Figure 3.2 shows the location of these corridors within the city of Mandan.

There are no inter-jurisdictional agreements for traffic signal operations at the present time. However, that may potentially be addressed in the ITS Plan, especially for coordinating event traffic between Bismarck and Mandan.

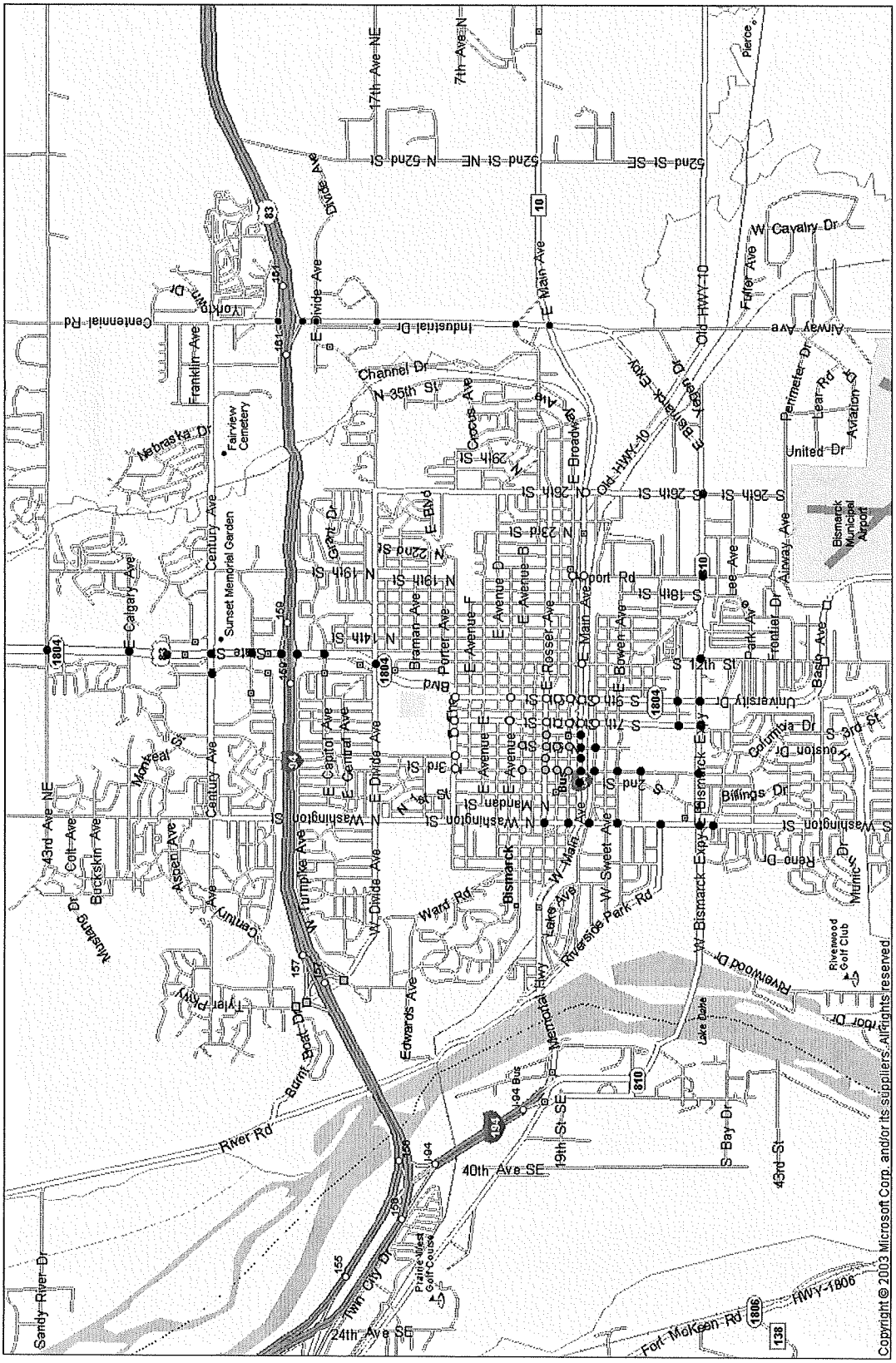


Figure 3.1 Bismarck Signalized Corridors

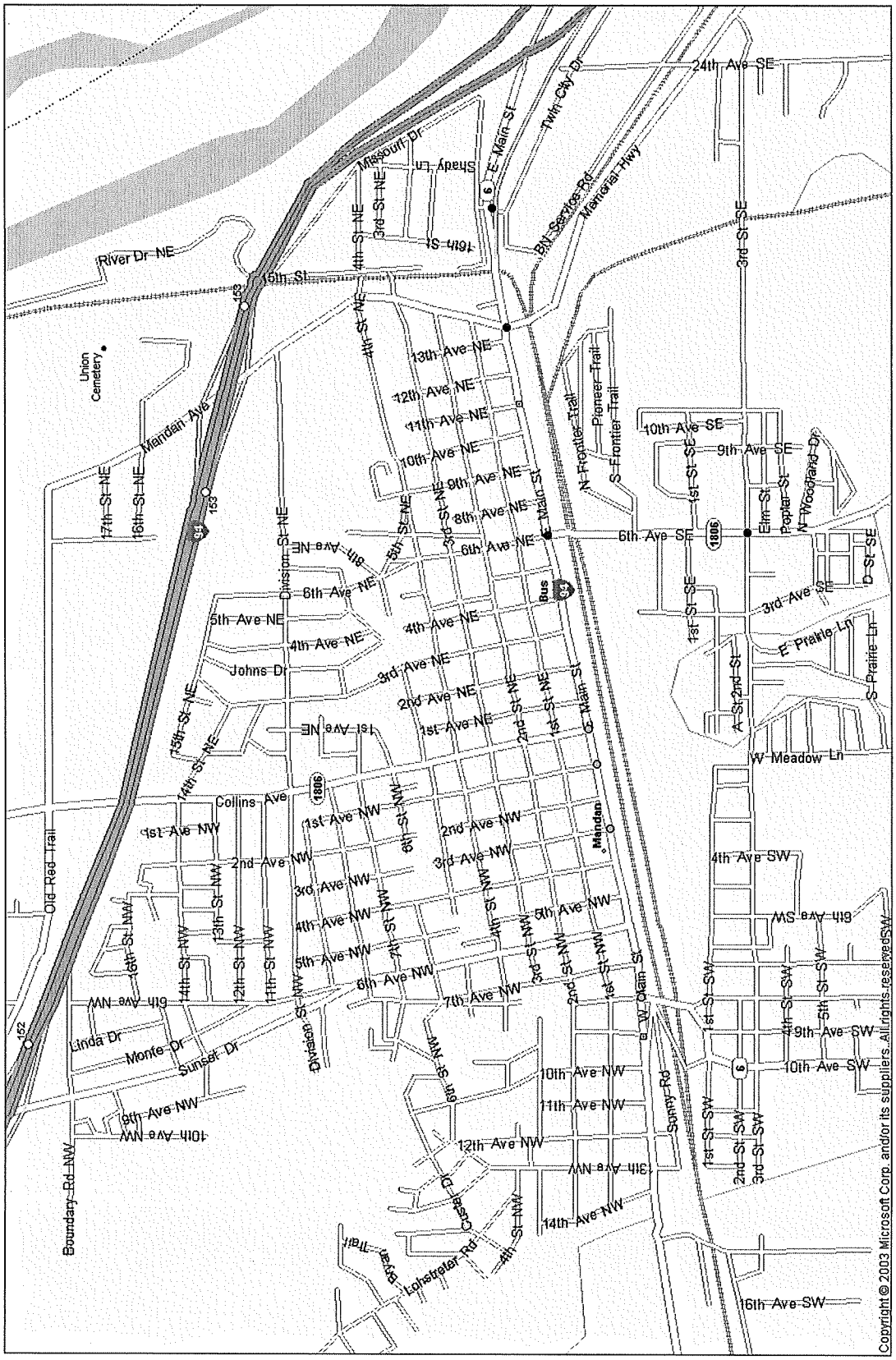


Figure 3.2 Mandan Signalized Corridors

3.1.2 Traveler Information

The NDDOT Bismarck District currently has two portable DMS, located along I-94. The signs are operated from the NDDOT's Central Operations and Maintenance office in Bismarck. Typical use of the DMS include road closures due to weather and statewide emergencies, Amber Alert messages and safety messages such as "Buckle Up" used in conjunction with statewide safety campaigns typically run on holiday weekends.

3.2. Emergency Management/Response

Emergency management functions in Bismarck and Burleigh County are currently handled by the same office. This office develops and maintains a plan to respond to and recover from known and unforeseen hazards or situations caused by an act of nature or man which may threaten, injure, damage, or destroy lives, property, or environment. The efforts are coordinated with all local law enforcement, fire services, ambulances, hospitals, public and private business, volunteer organizations, media and other state agencies (North Dakota Highway Patrol and North Dakota Division of Emergency Management). The emergency management office is located in the Communications Center which maintains and operates the enhanced 911 system, dispatching services, automatic notification system and outdoor warning sirens. The Communications Manager oversees the communications function.

The Morton County Emergency Office is responsible for the day-to-day emergency management programs and coordinates those programs with local, state and federal emergency management personnel. The office works with law enforcement, fire, ambulance, private businesses, voluntary organizations and individuals to identify potential hazards and assist in incident mitigation and response. The 911 coordinator who manages the operation of the 911 system and is responsible for 911 addressing system in Morton County is also housed in this office. A Communications Director oversees the Communications Department which is responsible for answering 911 phone calls and other emergency phone calls. The employees dispatch the appropriate emergency agencies to respond to the call. The employees also monitor all radio frequencies in Morton County.

Several media outlets are used to disseminate emergency information to the community. These include local radio and television stations. The following is a list of stations used by area emergency management:

Radio Stations:
- KQDY FM
- KSSS FM
- KCND Prairie Public
- KNDR FM
- KFYR AM
- KBMR AM
- KNDR FM
- KBYZ/KACL/KKCT FM

TV Stations:
KBME Prairie Public TV
KBMY Channel 17 TV
KXMB Channel 12 TV
KFYR Channel 5 TV
Cable Channel 12 Community Access Channel

The Bismarck Fire Department operates four fire stations, with a fifth station in the planning stages. Three of the stations offer first-in engine company service and the fourth station houses administration offices and incident management team members who provide special operations functions. The Mandan Fire Department operates from a single station, and is in the preliminary stages of planning an additional station in southeast Mandan. Both cities' departments work closely with local and regional agencies and jurisdictions to enhance incident response.

3.3 Public Works: Agencies and Systems

Snow removal and ice control are handled by each jurisdiction through their respective public works or highway departments. The NDDOT Bismarck District plows and maintains all sections of I-94. In addition it shares responsibilities for U.S. and State highways in the area with other jurisdictions. The responsibilities of each jurisdiction are laid out in formal cost participation and maintenance agreements. The NDDOT plans to install an automated anti-icing system on the Memorial Bridge in 2006/2007 in conjunction with planned reconstruction and expansion.

City of Bismarck's Public Work Department operates 16 snow plows, 12 sand trucks and nine sweepers to clear and maintain city streets. The department is responsible for clearing snow on 250 miles of roads. City of Mandan's maintenance and snow plowing operations are supervised by the Public Works Department. Their fleet consists of four sanders, two graders, six loaders with 2-way plows and two sweepers.

Burleigh County is responsible for snow plowing and maintaining more than 1,500 miles of roads in the county. It utilizes five tandem-axle truck plows and five single-axle sander/plow trucks for it's operations. Morton County snow plow operations are supported by 11 motor graders, 12 trucks, four loaders and one snow blower. The graders are used on the county's gravel roads.

Outside of the cost participation and maintenance agreements, there is no formal coordination among the agencies responsible for snow removal and ice control in the Bismarck-Mandan metropolitan area. Additionally, none of the agencies have automated vehicle location (AVL) capabilities to support real-time fleet management. Two-way radio is the predominant means for communication between public works departments and their equipment operators. Any inter-agency communication is done through telephone calls. Snow removal status on area roads is not directly communicated to the traveling public.

3.4 Public Transportation

Bis-Man Transit currently provides para-transit (demand-response) service to the Bismarck-Mandan area, including a two mile radius surrounding the city limits. It provides door-to-door service 24 hours/day, 7

days/week on a dial-a-ride basis. Rides are scheduled 24 hours in advance by contacting schedulers who are available from 8 am - 5 pm seven days a week.

The system consists of 22 dial-a-ride minibuses, three vans and one car. Bis-Man Transit is housed at a facility in Bismarck which provides parking and maintenance facilities as well as office space for administrative and operations staff. The facility has a dispatch center which handles service calls and communicates with bus drivers via two-way radio.

Bis-Man Transit has obtained a federal grant from the Federal Transit Administration to launch fixed-route transit service in the area in 2004. As part of the grant, the agency is purchasing three new 29-foot busses. Fixed-route transit routes are planned and will be formally mapped using GIS. The fixed-route service will be inaugurated on May 6, 2004.

3.5 Areas of Special Interest

This section discusses locations of special interest in the Bismarck-Mandan area that could potentially be addressed in the ITS Plan. These locations include major traffic generators such as event centers and colleges, airports and other key infrastructure assets. Below is a brief discussion of these locations.

The State Capitol complex in Bismarck houses the state legislature and governor's office, as well as several state agencies. The capitol complex generates significant traffic by both government employees and visitors. The complex may benefit from ITS homeland security technologies.

The Bismarck Municipal Airport serves the Bismarck-Mandan and surrounding areas with scheduled flight service on two major airlines. The airport has been going through major reconstruction and expansion. Therefore, traffic operations in the airport vicinity are impacted by the construction. The airport administration works closely with Bismarck's traffic engineering to alleviate traffic problems.

The Bismarck Civic Center is the main event venue in the Bismarck-Mandan area. It hosts local and regional sporting and entertainment events. The center is located in the Bismarck downtown area. Event traffic uses the center's parking lots as well as adjacent downtown parking lots. In addition, Bis-Man Transit provides door-to-door service to the Civic Center for person of special needs.

The Bismarck-Mandan area has three college campuses: the University of Mary, Bismarck State College, and United Tribes Technical College. Traffic operations in the vicinity of these campuses are impacted during peak periods when employees and students are entering or leaving the campuses and before and after sporting events held on campuses. Short-period traffic congestion occurs at access points from the campuses to the city system during these times.

4. NEEDS ASSESSMENT

This section summarizes transportation-related needs and issues in the community. The discussion focuses on areas that may be addressed by ITS solutions. The information was developed through significant input from stakeholders in the area. There were several mechanisms for obtaining input from various stakeholders including stakeholder workshops, project steering committee meetings, questionnaires and others.

In order to facilitate input from stakeholders, issues were organized into two main groups: metro-wide and agency-specific. Below is a list of possible areas suggested for the stakeholders:

1. Metro-wide issues
   a. Systemwide problems/issues
   b. Traffic safety
   c. Traffic congestion
   d. Transit
   e. Special events

2. Agency-specific issues
   a. How the agency affects or interacts with the transportation system
   b. Challenges the agency faces regarding
      i. Staffing
      ii. Funding
      iii. Other
3. Major technology initiatives either in planning or being implemented

4.1 Metro-Wide Issues

This summary identifies issues and possible areas for improvement with impacts on the overall metropolitan transportation system. The information is organized in the following subsections:

4.1.1 Cross-Cutting Issues

Major issues include:

1. Communications
   a. Coverage
   b. Capacity and bandwidth
      i. Fiber
   c. Interfaces among local, county and state agencies
      i. Emergency response
   d. Support for data sharing and distributed access
   e. Interoperability

2. Emergency management
   a. Coordination among various agencies
   b. Response strategies and protocols for handling incidents at locations along jurisdictional boundaries

i. Incidents on bridges between Bismarck and Mandan should be handled by both cities, depending on nearest available emergency response unit

c. Development of hazardous material routes

3. Data sharing
   a. Traffic monitoring
      i. Support planning
      ii. Support traffic signal operations
      iii. Support design
   b. Crash data
      i. Support timely analysis to identify hazard locations
   c. Data analysis
   d. Data standards implementation

4. Institutional
   a. Coordinate plans and projects
   b. Coordinate data sharing
   c. Coordinate prioritization of projects at jurisdictional boundaries
   d. Coordinate among transportation agencies, law enforcement and emergency services

5. Traveler information
   a. Hazard warnings
      i. Flooded underpasses
      ii. Icy roads and bridges
      iii. Closed roads or bridges
   b. Accuracy of information
      i. Warning displayed only if warranted by actual conditions
   c. Timeliness of information
      i. Warning promptly removed after hazard is cleared
   d. Consistency of information

6. Traffic delays
   a. Event traffic
   b. Construction
      i. Memorial Bridge reconstruction over two years (2006-2007)
   c. Area colleges and schools
   d. Coordination of traffic signal operations along main arterial roads
      i. Downtown traffic signal progression

4.1.2 Traffic Safety

Major issues include:

1. Driver compliance
   a. Red light running
      i. Fines were increased four times with no visible improvement
      ii. Limited resources for traffic enforcement
   b. Speeding
   c. Yielding to pedestrians, especially in school zones

2. Hazard advance warning
    a. Allow travelers ample time to avoid hazard location (i.e., change route)
        i. Flooded underpasses
        ii. Closed roads and bridges
        iii. Icy roads and bridges
        iv. Incident involving hazardous material

3. Locations with high turning movement
    a. Access to schools

4. Safety prioritization criteria
    a. Proactive hazard identification and prioritization

4.1.3 Traffic Congestion

Major issues include:

1. Temporary traffic congestion
    a. Peak hour traffic
    b. Event traffic
        i. 4th of July parade
        ii. Civic Center events
        iii. College sporting events
    c. Construction/maintenance related
    d. Incident related
    e. Railroad crossings
        i. 35 to 40 trains per day

2. Traffic responsive signal control system
    a. Availability of accurate and timely traffic counts
    b. Traffic data analysis capabilities for developing responsive plans
    c. Resources for implementing plans and modifying them as conditions warrant

3. Key network components
    a. Arterial routes
        i. Washington Street in Bismarck
    b. Bridges between the cities

4. Traveler information
    a. Area-wide traffic information
    b. Make alternate routes and pre-planned evacuation available to area drivers

4.1.4 Transit

Major issues include:

1. Integration of new fixed-route system with:
    a. Existing dial-a-ride service
    b. Service to rural residents

2. Effective fleet management
    a. Expansion of service through better scheduling and equipment allocation
        i. Major service, medical and shopping centers
    b. Improved management

3. Transit bus routing
    a. Access to real-time information on system condition
        i. Traffic delays
        ii. Road and bridge closures
        iii. Construction/maintenance activities

4. Transit security
    a. Video monitoring on buses

5. Availability of transit route and schedule information to potential users

4.1.5 Special Events

Major issues include:

1. Major events
    a. Mandan 4th of July parade and celebration
    b. Bismarck's Downtown Block Party-roads are closed down for several days
    c. Bismarck's Civic Center events
        i. Downtown location presents difficulties for access routes and parking

2. Event traffic operation plans
    a. Before and after event traffic congestion
        i. Responsive traffic control strategies
    b. Parking information and management
    c. Alternative routes
    d. Emergency services access to event location or locations affected by events
    e. En route and at-location information

3. Event management and planning
    a. Community-wide information
        i. Event information
        ii. Affected areas
        iii. Expected impacts
        iv. Alternative routes to and from event
        v. Alternative routes for through traffic

4. Interagency coordination
    a. Traffic control plans
    b. Information dissemination

4.2 Agency-Specific Issues/Opportunities

This section summarizes issues identified by participating stakeholders to be relevant for their own agency. The information is organized into several categories including funding, staffing, technology and other.

4.2.1 Staffing

Major issues include:

1. Limited staffing (general)
   a. Core activities are completed first
      i. ITS is not necessarily part of core activities

2. Limited operations and management staff
   a. Operations and management receive inadequate attention

3. Limited staff for grant writing and support
   a. Inability to obtain federal and special grant funds for ITS

4. Information technology
   a. Limited staff statewide
   b. Demanding requirements for new ITS
      i. Design
      ii. Operation/maintenance/support
      iii. Technology integration

5. 911 staffing
   a. Increased volume of calls
      i. Non-emergency calls
      ii. Repeated calls for same incident (more travelers with cell phones)
      iii. Additional demands from wireless enhanced 911 and interaction with third-party call centers (OnStar)

4.2.2 Funding

Major issues include:

1. Funding constraints (general)
   a. Needs greater than available funding
   b. Prioritization
      i. ITS not integrated as part of core business

2. Communication systems
   a. Funding available for planning
   b. No funding for implementation
3. Reliance on federal funds
   a. Relatively small local and state tax base
   b. Federal grants are changing focus
      i. Little assistance in operating costs
   c. Limitations in staffing levels reduce ability to work on grants

4.2.3 Major Technology Projects

Major planned initiatives include:

1. NDDOT
   a. Anti-icing systems for bridge decks
   b. Electronic Crash Reporting System (Bismarck is looking at participating)
   c. Statewide traveler information
      i. 511
      ii. DMS
      iii. Web page

2. City of Bismarck
   a. Fiber optic network
   b. Portable DMS

3. Bis-Man Transit
   a. Fixed-route busses will be equipped with AVL and cameras for security

4. Bismarck Fire Department
   a. Mobile data computers in apparatus

5. Bismarck Police Department
   a. Automated parking ticket issuance system
   b. Have new device which does speed/traffic counts with less manpower

6. Bismarck/Burleigh County Communications
   a. Enhanced 911
      i. GIS implementation for remainder of Burleigh County
   b. Digital radio migration for public safety agencies

7. Burleigh County
   a. AVL for snow plow units
   b. Permanent traffic counters/classifiers

8. Mandan Police
   a. Mobile data computers in police cars

9. Morton County
   a. Infrastructure asset inventory using GPS completed
      i. Roads, bridges and signs
      ii. Working on developing GIS application tools
   b. AVL for snow plows

5. PRIORITY ITS

This section discusses high priority ITS technologies that meet the issues and needs of the Bismarck-Mandan area. The discussion lists selected ITS user services and illustrates the associated ITS market packages to support these services.

5.1 Bismarck-Mandan ITS User Services

Several ITS user services were identified based on stakeholders' input on the Bismarck-Mandan area transportation needs, issues and opportunities. The user services were developed using the National ITS Architecture. Functional requirements for these user services were customized to fit the unique needs and the anticipated plans for system implementations in Bismarck-Mandan.

The list of ITS user services below uses three levels of detail, which include:

Level 1 User service bundle (i.e., 1)
Level 2 User service (i.e., 1.1)
Level 3 Functions for user service (i.e., 1.1.1)

It should be noted the numbers for the user services below follow the National ITS Architecture numbering. Since only a subset of these services is used here the numbers will not be in sequence.

1. **Travel and Traffic Management**

1.1. **Pre-trip Travel Information**: assists travelers in making mode choices, travel time estimates, and route decisions prior to trip departure. Pre-trip information can be provided via Web page, 511, kiosks etc.

1.1.1. Travel services information: transit schedules, fares etc.
1.1.2. Information on current transportation situations: road closure, construction information, incidents etc.
1.1.3. Trip planning services such as transit routes and transfer points.
1.1.4. Information access alternatives for users from home, work and public stations.

1.2. **En route Driver Information**: provides information to vehicle drivers while en route.

1.2.2. Driver advisory functions that generate advisory information, such as areas to avoid due to congestion, for en route drivers.
1.2.3. In-vehicle signing capability to assist drivers with information such as detour information, road conditions, tourist attractions and resort areas etc.

1.3. **Route Guidance**: provides travelers with directions to selected destinations.

1.3.1. Directions, current traffic conditions, status of transit systems, schedule of transit systems, etc. provided to travelers.
1.3.3. Real-time video mode for issuing travel information, such as current road conditions, to travelers.

1.6. **Traffic Control**: provides functions to manage the movement of traffic on streets and highways.

1.6.2. Traffic surveillance function to detect traffic in locations such as pedestrian crossings.
1.6.3. Device control function for devices such as DMS, ramp meters etc.

1.6.4. Traffic control information provided to other elements of the ITS, i.e., variable speed limit display devices, traffic management center etc.

1.7. **Incident Management**: identifies incidents, formulates response actions and supports initiation and ongoing coordination of response actions.
1.7.1. Incident identification function: sensors to identify flooded underpasses or video surveillance to monitor event traffic.
1.7.2. Function to formulate appropriate response actions to each identified incident and revise those actions when necessary, for example, arranging a detour in case of underpass flooding.
1.7.3. Services to implement a response which is coordinated with all appropriate agencies.
1.7.4. Function to predict hazardous conditions, including the time and location of conditions, that may cause an incident, i.e., coordination with weather services to predict locations of underpasses which may flood due to impending weather.

2. **Public Transportation Management**

2.1. **Public Transportation Management**: provides automatic vehicle tracking and guiding, in-vehicle personnel management and dynamic transit vehicle scheduling.
2.1.1. Computer- assisted control of the operation of vehicles and their associated facilities: vehicle passenger loading, automatic vehicle location report etc.
2.1.2. Planning and scheduling service function to automate public transit operations.
2.1.3. Personnel management function which facilitates the management of vehicle operators, maintenance personnel etc.
2.1.4. Function to communicate between different entities such as vehicle operators, the central facility, police and fire departments etc.

2.2. **En route Transit Information**: provide travelers with real-time transit and high-occupancy vehicle information allowing travel alternatives to be chosen once the traveler is en route.
2.2.1. Information distribution function that distributes real-time information to travelers.
2.2.2. Information receipt function for acquiring data that is used in the generation of en route transit information. Real-time data may be acquired from local transit system to update data from various public or private providers.
2.2.3. Information processing function for processing data used in the generation of en route transit information.

3. **Electronic Payment Services**

3.1. **Electronic Payment**: allows travelers to pay for transportation services electronically.
3.1.2. Electronic fare collection capability such as electronic transit fare collection.
3.1.3. Electronic parking payment capability, for example: electronic downtown parking payment collection.

5. **Emergency Management**

5.2. **Emergency Vehicle Management**: provides a function for dispatchers to select and guide the appropriate emergency vehicle to an incident and a function to change signal timing to allow passage through signalized intersections.

5.2.1. Emergency vehicle fleet management system that maintains the availability status of relevant emergency vehicles, determines the appropriate emergency response vehicle and dispatches it to the incident.

5.2.2. Route guidance system that maintains the real-time traffic information in urban and rural areas, emergency response vehicle locations and vehicle destinations. The guidance system then advises the emergency response vehicle of the appropriate routes to the given destination.

5.2.3. Signal priority system that determines signal prioritization timing sequences for relevant signals.

7. **Information Management**

7.1. **Archived Data Function**: provides an archived data function to control the archiving and distribution of ITS data. The archived data user service provides the historical data archive repositories and also controls the archiving functionality for all ITS data. It collects data, analyzes historical performances, improves operation data integrity and provides historical data to transportation agencies working with planning, research and safety management activities.

7.1.1. Historical data archive system for ITS data that collects data from field equipment or devices.

7.1.2. Operational data control function to ensure integrity of operational data as received from field equipment or data collection devices.

7.1.5. Data warehouse distribution function as the ITS data source to support the ITS community user functions.

7.1.6. ITS community interface to all ITS users for the specification and retrieval of data products. The interface may be an online (Web-based) archive facilitating the analysis and download of ITS data.

8. **Maintenance And Construction Management**

8.1. **Maintenance And Construction Operations**: provides a function to support the monitoring, operating, maintaining, improving and managing of physical roadway conditions.

8.1.2. Roadway management function to monitor traffic, road surfaces and environmental conditions; forecast traffic and road surface conditions to support management of routine and hazardous road condition remediation; and communicate changes in conditions. Examples of adverse road conditions are icy bridges, fog etc. Treatments include anti-icing chemicals, fog dispersion etc.

6. ITS DEPLOYMENT

This section identifies potential ITS projects that address transportation needs and issues in the Bismarck-Mandan Area. These projects were developed based on the Bismarck-Mandan ITS user services and market packages discussed in Section 5 of this plan. It also suggests an ITS deployment strategy that suits area needs and characteristics of the stakeholders.

6.1 Suggested Deployment Strategy

The results of the issue identification and data collection suggest that the transportation system in the Bismarck-Mandan area generally operates at a very good level of service. There were few serious deficiencies that could significantly impact the system performance and its users. However, there is room for improvement.

Stakeholders participating in the plan development expressed an interest in taking advantage of ITS technologies to improve the services they provide to customers and how their agencies conduct business. At times of constrained budgets and reduced staffing levels, ITS technologies can play a key role in meeting increased demands.

There are tremendous opportunities in the area for ITS deployment if various agencies are able to cooperate and pool resources. For example, AVL technologies are of interest to public works, law enforcement, emergency services and public transportation agencies in the area. Therefore, a combined and coordinated effort to deploy these technologies is encouraged.

A relatively limited infrastructure (communications and sensors) is available to support future ITS in the area. Therefore, it is suggested that this infrastructure be programmed as part of future road construction projects in the area. A good example is the savings realized by combining fiber optics network installations with other construction projects.

In order to effectively coordinate ITS deployment with the area's transportation projects, a mapping of the Bismarck-Mandan TIP is suggested. ITS projects may be added to programmed TIP projects or added as stand-alone improvement projects.

Finally, it is recommended that a Bismarck-Mandan ITS deployment team be established. The team would provide a mechanism for the area stakeholders to discuss ITS deployment, share technical information and cooperate on projects. It is suggested that the Bis-Man MPO provides a forum for this team since MPO membership includes a majority of the ITS stakeholders.

6.2 Bismarck–Mandan ITS Projects

Bismarck-Mandan ITS projects are organized into three main groups:

1. Projects that are not location-specific (support multiple functions and agencies)
   a. Technologies which support several locations
      i. Traveler information
      ii. Fleet management

2. Projects that address a single problem at a specific location
   a. Icy bridges
   b. Flooded underpasses
   c. Red Light Running (RLR) enforcement

3. Projects that address several problems at a single location
   a. Civic Center traffic management

The following sections provide descriptions for the various ITS projects developed for the Bismarck-Mandan area. The format for the project descriptions is as follows:

Project Title:	Name of the project
Project champions:	Stakeholders with lead roles for the project
Project description:	Brief statement outlining project accomplishments
Project costs:	Estimate of costs for various components of the project based on the USDOT's ITS Benefits and Costs Database. The costs data are based on project information from the national ITS Deployment Tracking program (http://www.benefitcost.its.dot.gov/)

6.2.1 Area-Wide ITS Projects

6.2.1.1 *Bis-Man Transit Management and Security System*	
Project champions	Bis-Man Transit (manager) Bis-Man MPO
Project description	Install automatic vehicle tracking and communication systems on 3 fixed-route vehicles and 22 para-transit vehicles.
Project costs	$500 - $800 per AVL unit $150 - $250 per unit cell/wireless radio with data capacity $4,200 - $5,300 per security package $5,000 - $10,000 per workstation and supporting software
Technologies	1. AVL hardware and software 2. In-vehicle cameras for safety and security 3. Two-way wireless communications 4. Routing/scheduling software
Functions	1. Real-time information on transit vehicles location 2. Real-time information on route and/or schedule (for fixed-route) adherence 3. Dynamic routing and scheduling 4. Two-way wireless communications between transit vehicles and: a. Transit dispatch b. Emergency responders (police, fire)

6.2.1.2 *Snow Plow Fleet Management*	
Project champions	Bismarck Public Works Burleigh County Roads and Bridges Mandan Public Works Morton County Highway Department
Project description	Install automatic tracking and communication systems on city and county snow plows
Project costs	$500 - $800 per AVL unit $150 - $250 per unit cell/wireless radio with data capacity $5,000 - $10,000 per workstation and supporting software
Technologies	1. AVL hardware and software 2. Two-way wireless communications
Functions	1. Real-time information on snow plow location 2. Two-way wireless communications between snow plow and maintenance/construction dispatch

6.2.1.3 *Enhanced Emergency Management*	
Project champions	Bismarck Police Department Bismarck Fire Department Mandan Police Department Mandan Fire Department
Project description	Install automatic tracking systems on emergency vehicles
Project costs	$500 - $800 per AVL unit $150 - $250 per unit cell/wireless radio with data capacity $5,000 - $10,000 per workstation and supporting software
Technologies	1. AVL hardware and software 2. Mobile data systems 3. Wireless communications
Functions	1. Real-time information on vehicle location 2. Dynamic routing/dispatch 3. Route guidance 4. Two-way wireless communications 5. Response coordination across jurisdictions

6.2.1.4 *Area-wide Communications System*	
Project champions	City of Bismarck City of Mandan NDDOT Bismarck District
Project description	Install fiber-optics to support metro-wide operations
Project costs	$20,000 - $50,000 per mile for cable and in-ground installation[1]
Technologies	1. Fiber-optics
Functions	1. Dedicated communications for operating traffic control and ITS devices 2. Great bandwidth capacity to support video surveillance

[1] Cost would be significantly less for an aerial installation. In-ground installation would cost significantly less if implemented in conjunction with construction projects.

6.2.1.5 *Bismarck-Mandan Area-wide Traveler Information System*	
Project champions	Burleigh County City of Bismarck City of Mandan Morton County NDDOT Bismarck District
Project description	Develop an area-wide traveler information system
Project costs	Depend on technologies and deployment scale
Technologies	1. Web page 2. DMS
Functions	1. Provide travelers with pertinent road, weather and traffic information, emphasizing events and incidents. 2. Use this system to market community activities.

6.2.2 Location Specific ITS Projects

6.2.2.1 *Automated Bridge Anti-icing*	
Project champions	Bismarck Public Works Mandan Public Works NDDOT Bismarck District
Project locations	(see location map on next page) Bismarck Expressway Railroad Bridge 19th Street/I-94 overpass State Street/I-94 overpass Divide Avenue/I-94 overpass EB/WB I-94 @ MP 920 Memorial Bridge Grant Marsh Bridge
Project description	Install automated bridge anti-icing and surveillance system
Project costs	$25,000 per anti-icing unit for short span bridge (< 320 ft) $50,000 - $495,000 per anti-icing unit for long span bridge (> ½ mile) $50,000 - $120,000 per permanent DMS $10,000 - $50,000 per RWIS
Technologies	1. Road-weather sensors (including ice sensor) 2. Anti-icing unit 3. CCTV 4. Communications 5. DMS
Functions	1. Detect ice/snow on bridge deck 2. Trigger anti-icing unit when conditions warrant 3. Provide information on deck condition and unit status to maintenance manager 4. Provide surveillance capabilities of road and traffic conditions 5. Provide information to drivers through DMS

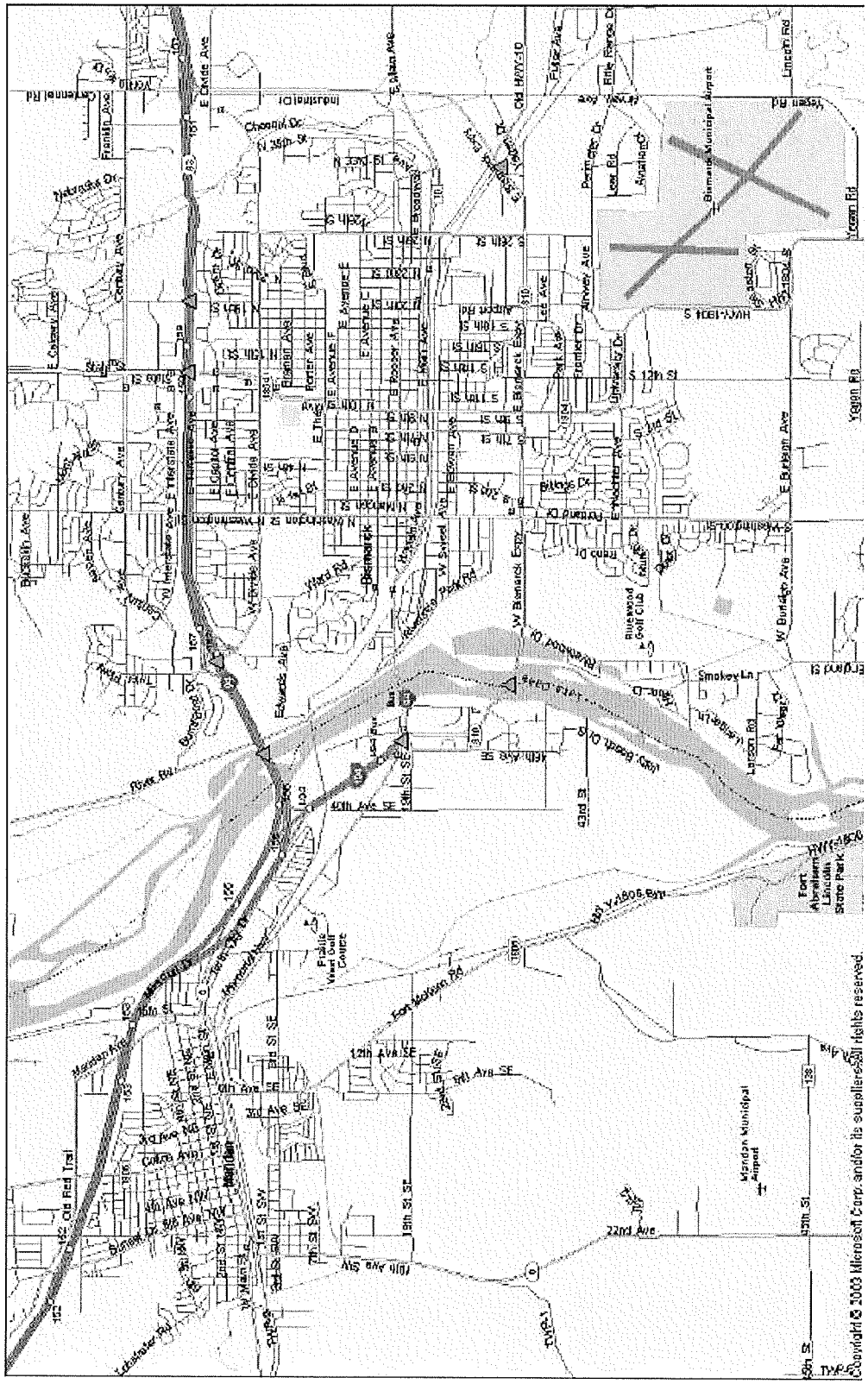


Figure 6.1 Bridge Anti-Icing Locations

6.2.2.2 *Automated Road Closure*	
Project champions	NDDOT Bismarck District
Project locations	(see location map) US 83 north of Century Ave EB I-94 WB I-94
Project description	Install automated gate closure systems
Project costs	$100,000 - $150,00 per automated gate (2 gates total) $50,000 - $120,000 per permanent DMS (4 signs total)
Technologies	1. Automated road closure gates 2. DMS
Functions	1. Automate road closure gate operations 2. Warn drivers of closed road with DMS

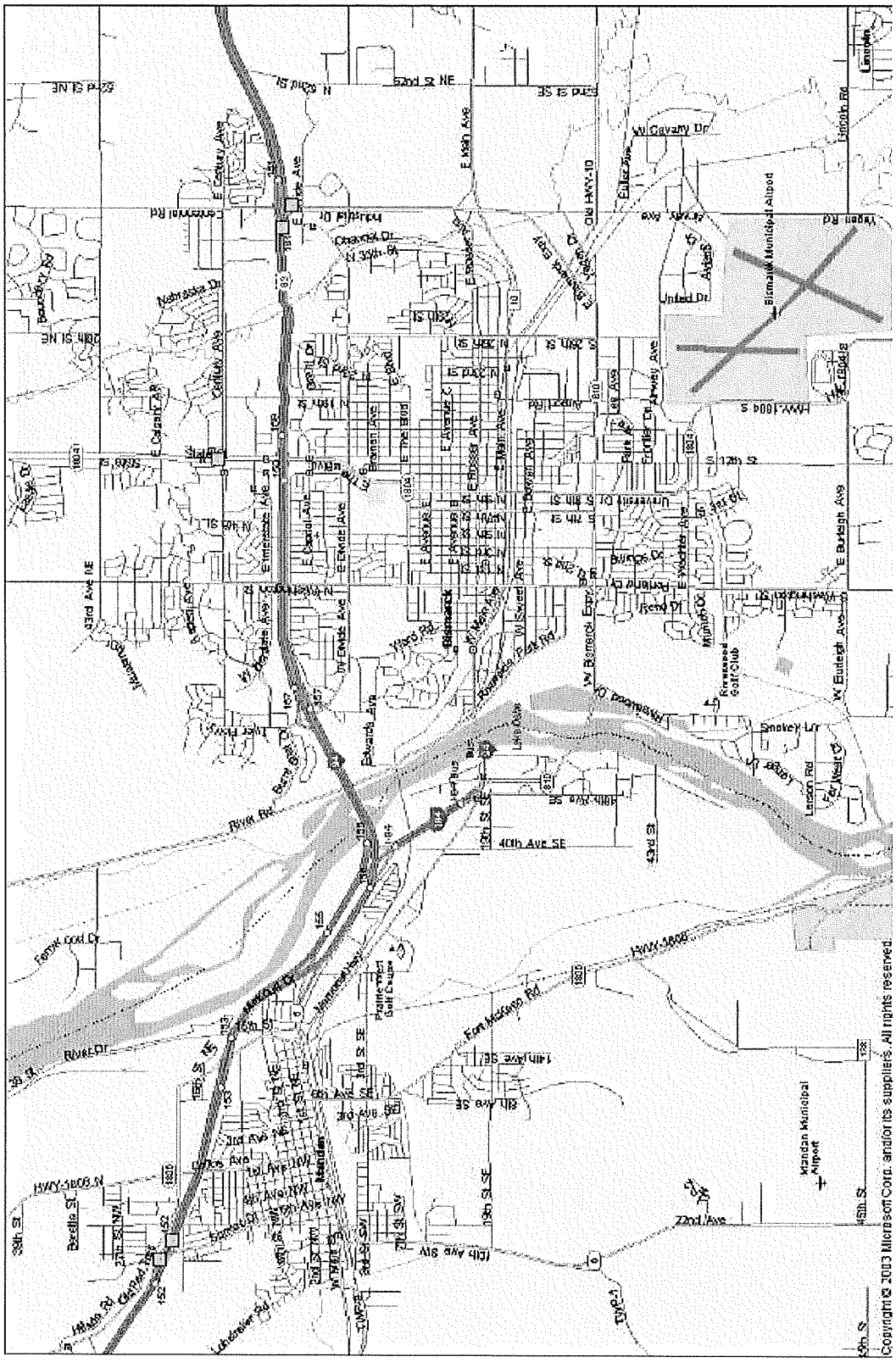


Figure 6.2 Automated Road Closure Gates

6.2.2.3 *Automated Red Light Running Enforcement*	
Project champions	Bismarck Engineering Bismarck Police Department Mandan Engineering Mandan Police Department
Project locations	(see location map on next page) Intersection of 7th Street/Main Avenue Intersection of 7th Street/Front Avenue Intersection of 9th Street/Main Avenue
Project description	Install automated red light running enforcement system
Project costs	$75,000 - $136,000 per site[1]
Technologies	1. Camera (wet film 35mm or digital) 2. Loop detectors 3. Communications
Functions	1. Detect RLR violations 2. Issue RLR tickets

[1] Note, most jurisdictions contract with a vendor to install, maintain and process functions of the RLR system in return for compensation from fines charged to violators.

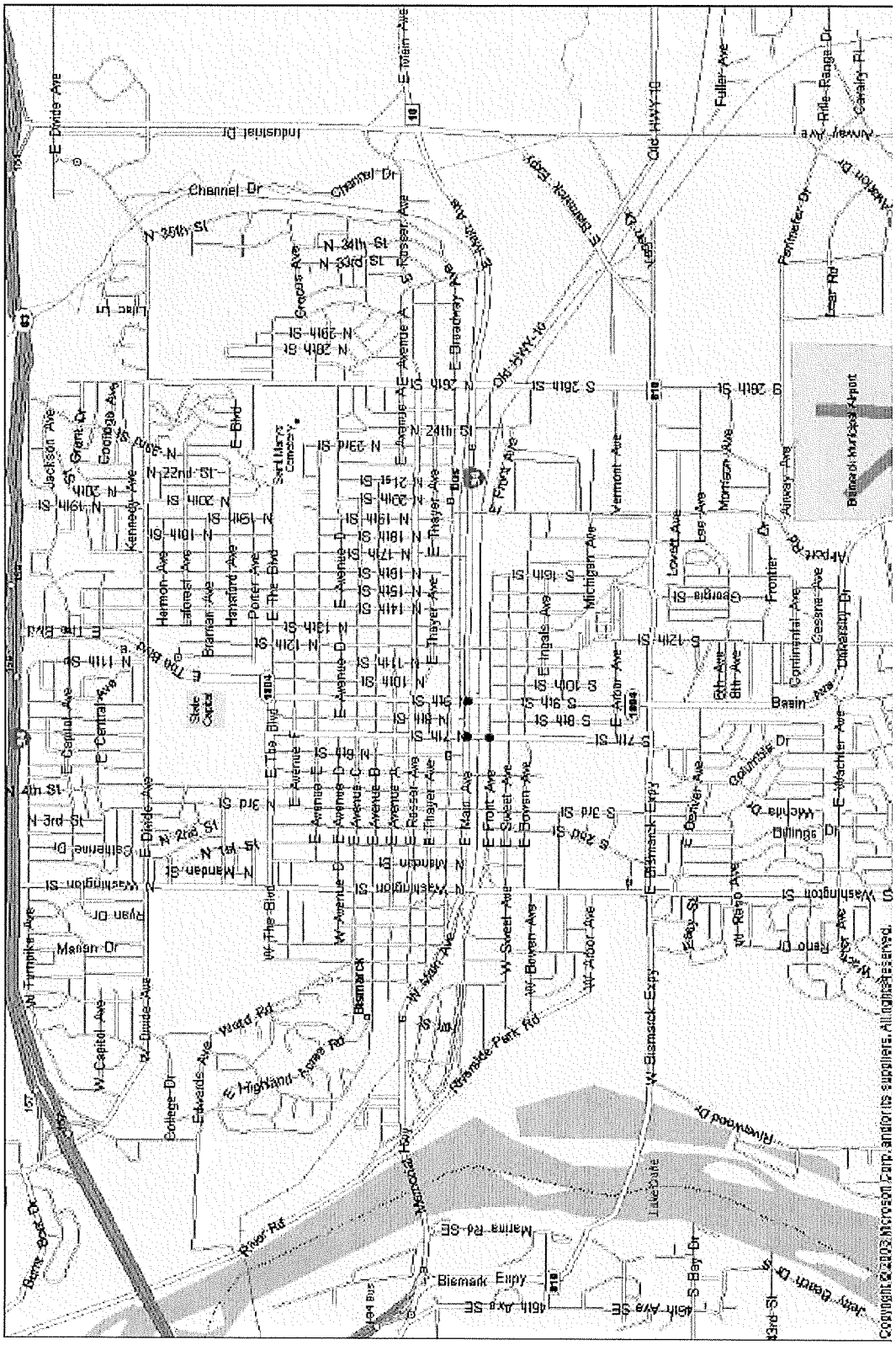


Figure 6.3 Red Light Running Locations

6.2.2.4 *Flooded Road and Underpass Warning*	
Project champions	Bismarck Public Works, Engineering Mandan Public Works, Engineering NDDOT Bismarck District
Project locations	(see location map on next page) Burleigh County, Apple Creek Rd, east of 80th Street (not shown) Burleigh County, 136th Ave NE, .75 miles east of 184th Street (not shown) Burleigh County, River Rd near Ward box culvert Bismarck, Washington Street/I-94 underpass Bismarck, 4th Street/I-94 underpass Bismarck, 7th Street/Front Avenue to Main Avenue underpass Bismarck, 9th Street/Front Avenue to Main Avenue underpass Mandan, E Main Street/Mandan Avenue to E Main Street underpass Mandan, 6th Avenue underpass, south of Main Street
Project description	Install flood detection and warning system
Project costs	$50,000 - $120,000 per location
Technologies	1. Water level detection system 2. CCTV 3. Communications 4. DMS
Functions	1. Detect rising water level at underpasses 2. Trigger warning message on DMS

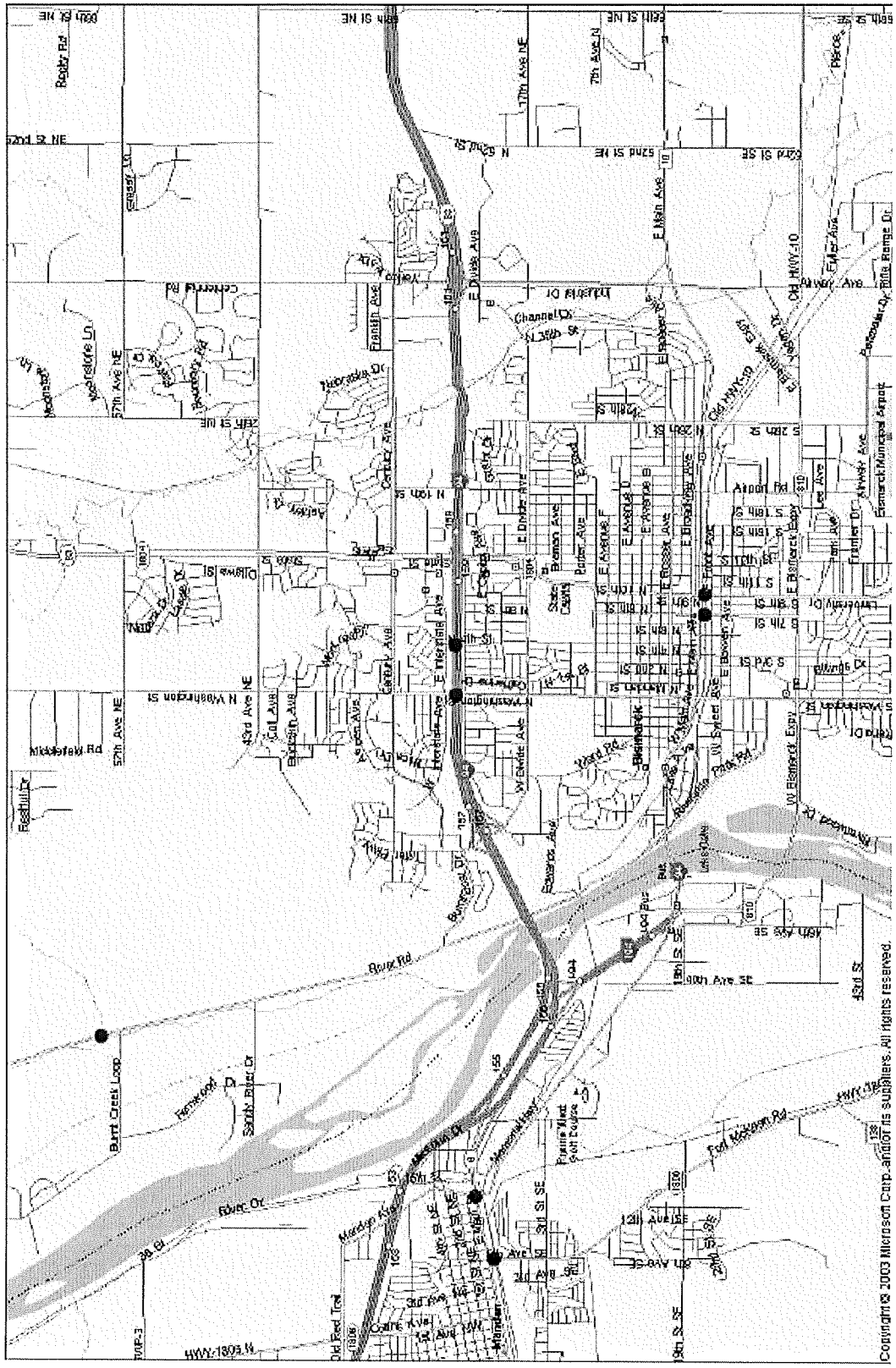
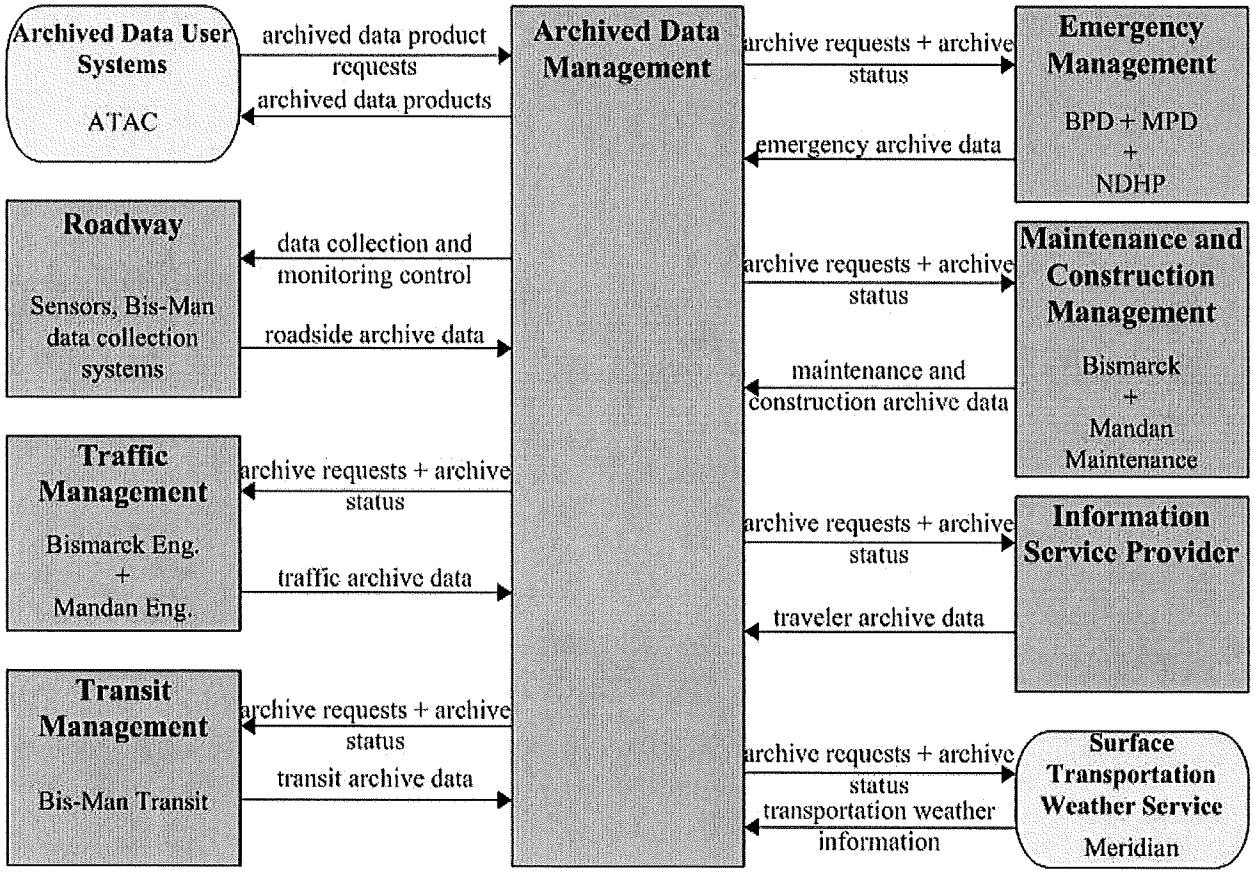


Figure 6.4 Flooded Road and Underpass Warning Locations

APPENDIX I. BISMARCK–MANDAN MARKET PACKAGES

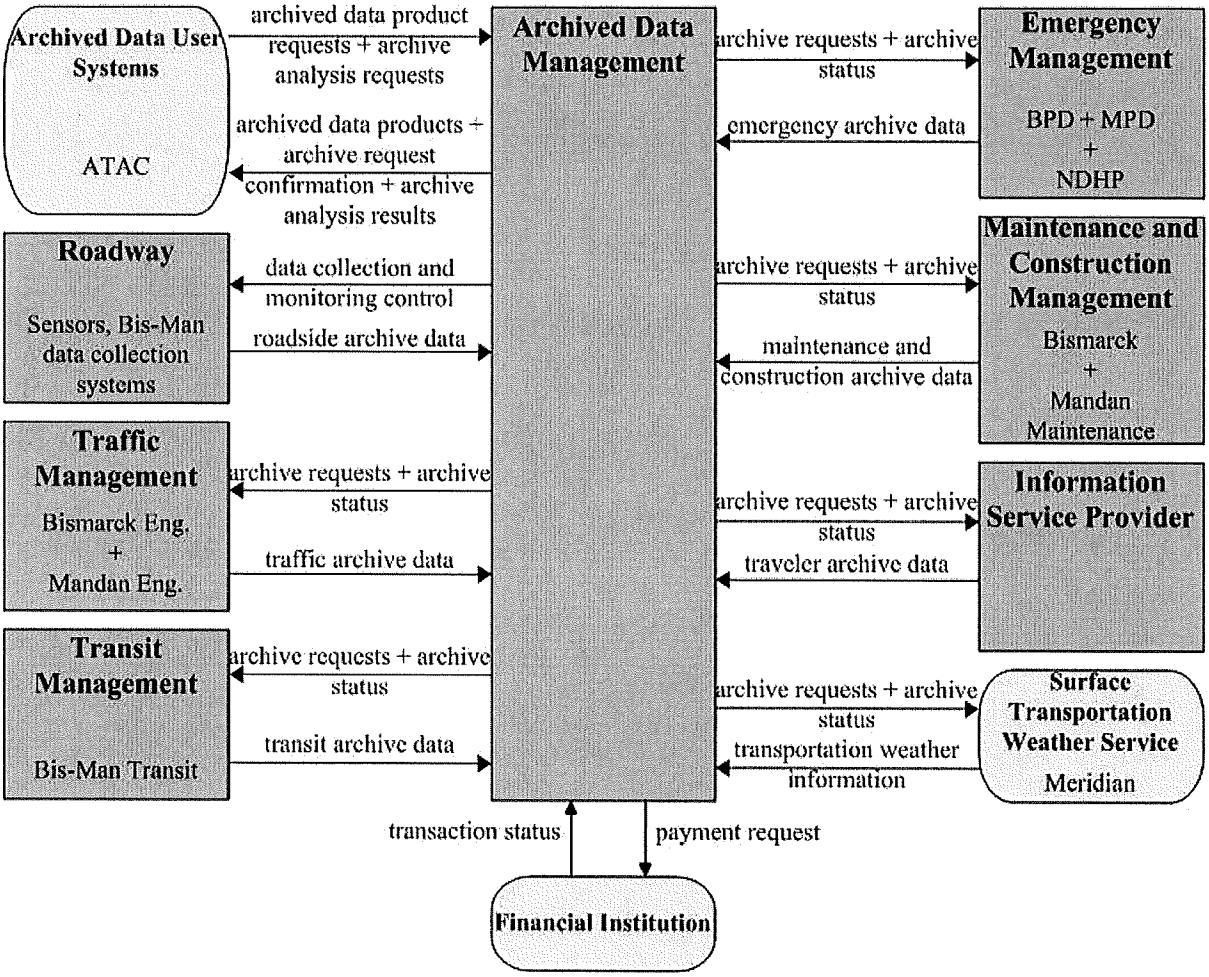
AD1 - ITS Data Mart

Bismarck-Mandan



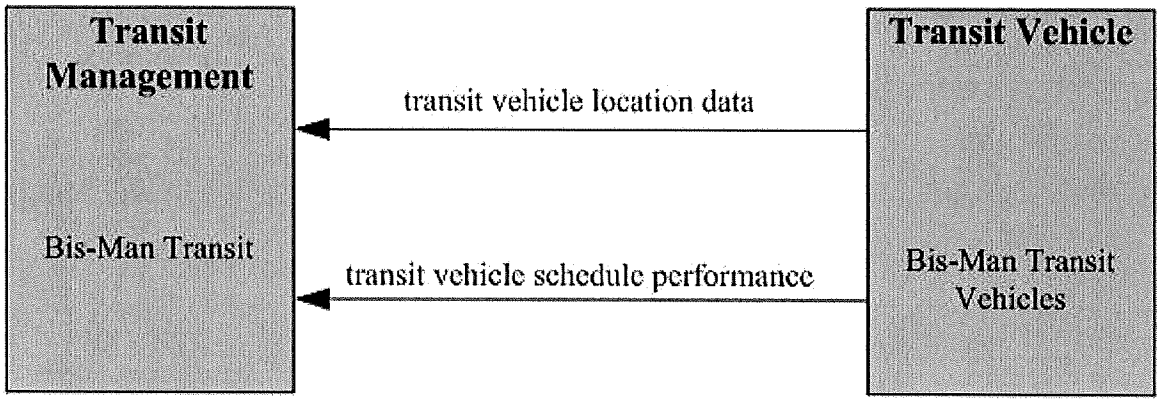
AD2 - ITS Data Warehouse

Bismarck-Mandan



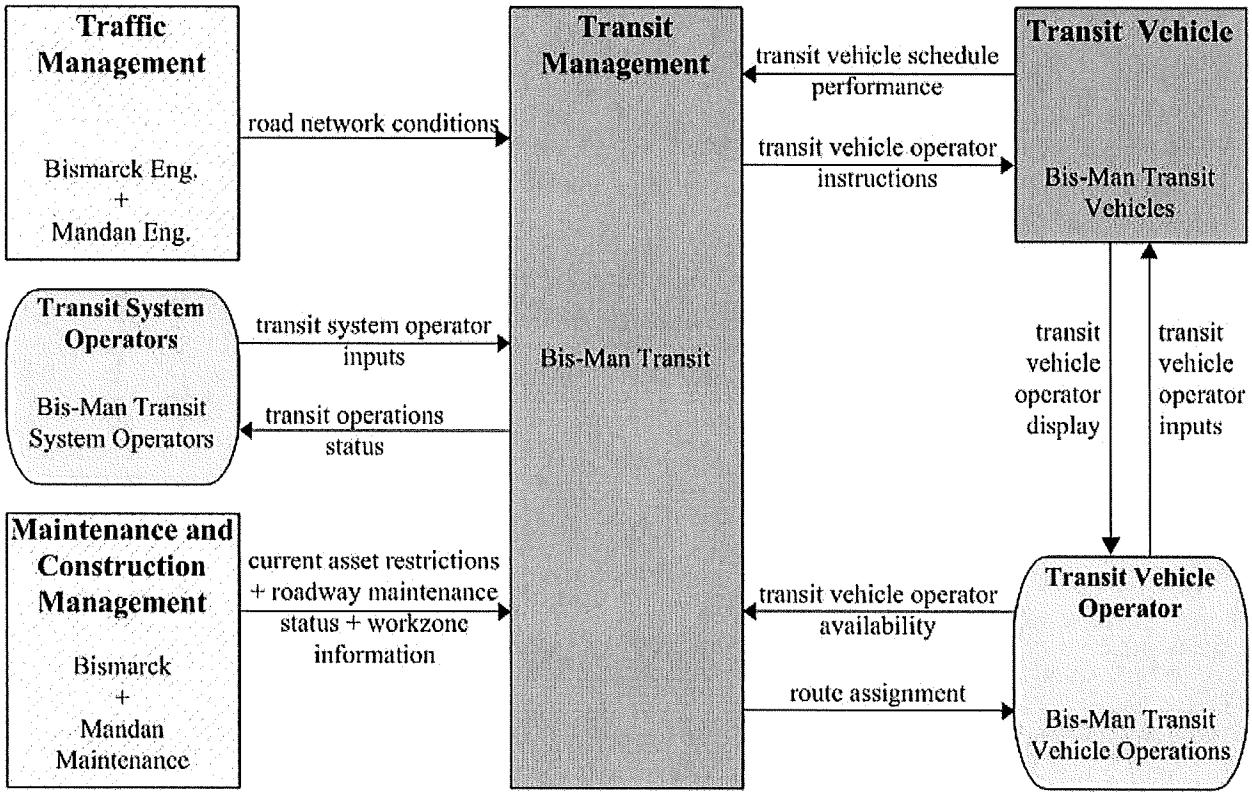
APTS1 - Transit Vehicle Tracking

Bismarck-Mandan



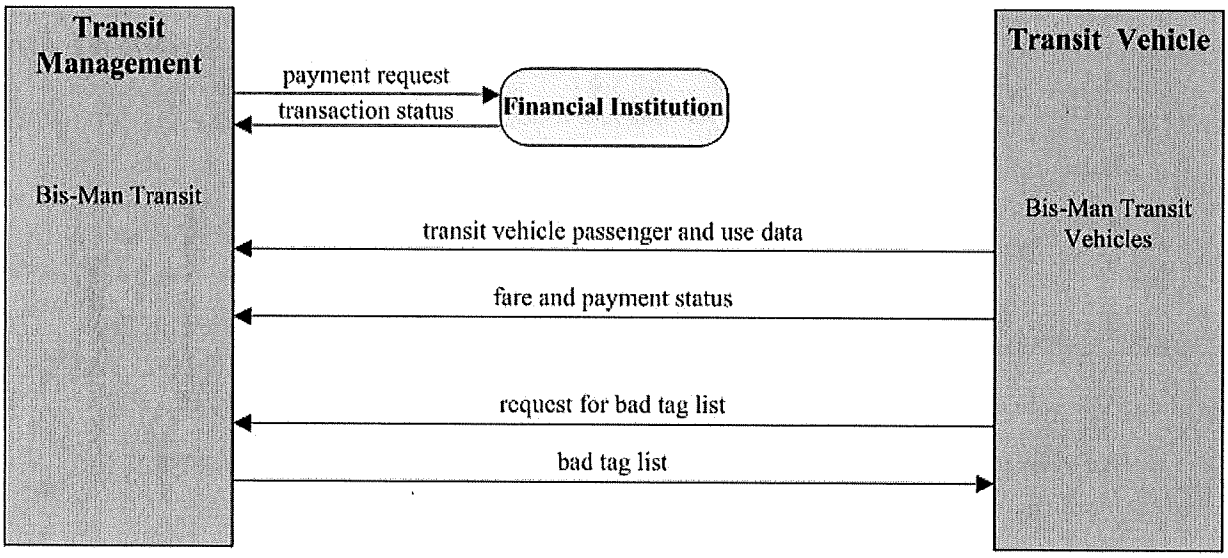
APTS2 - Transit Fixed-Route Operations

Bismarck-Mandan



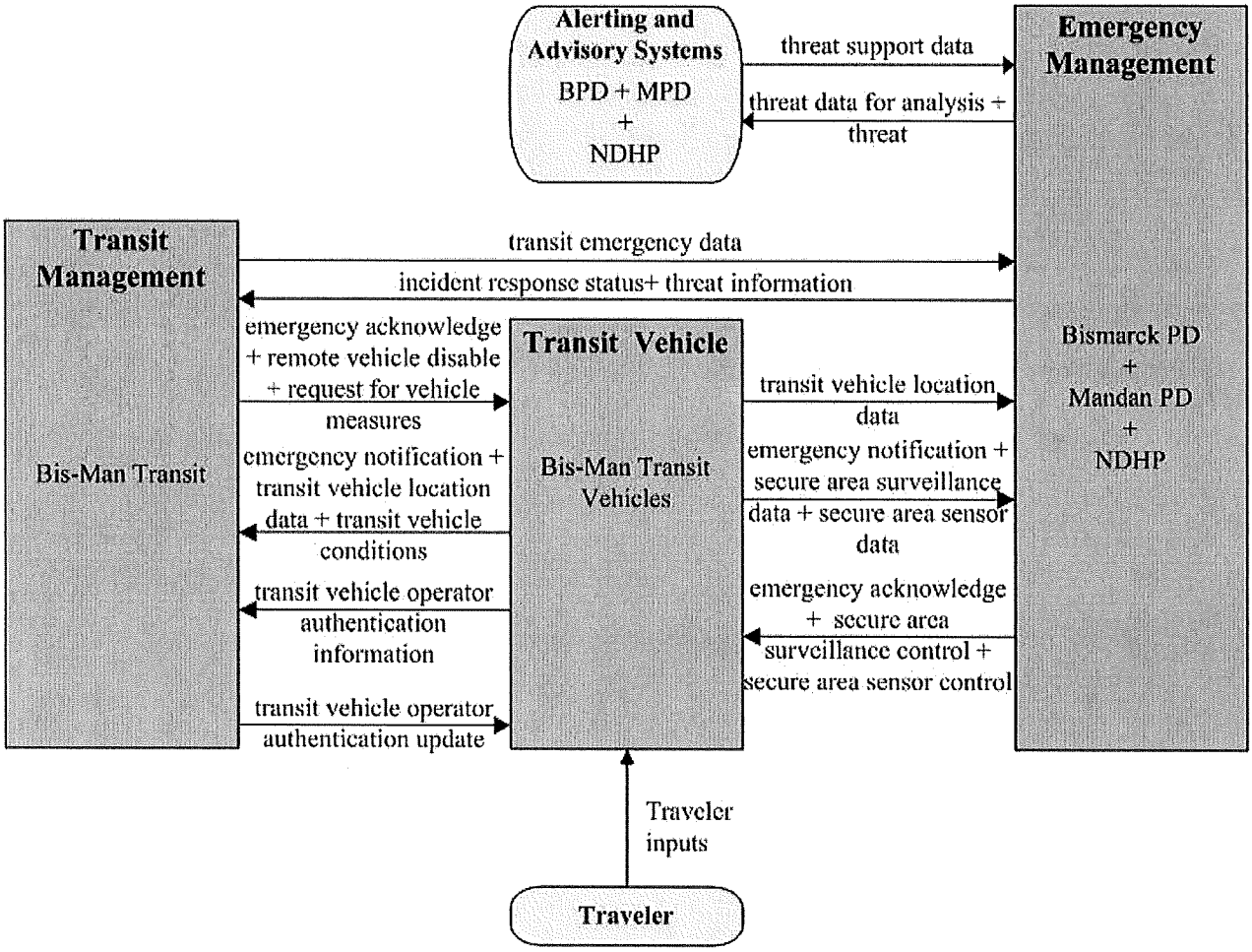
APTS4 - Transit Passenger and Fare Management

Bismarck-Mandan



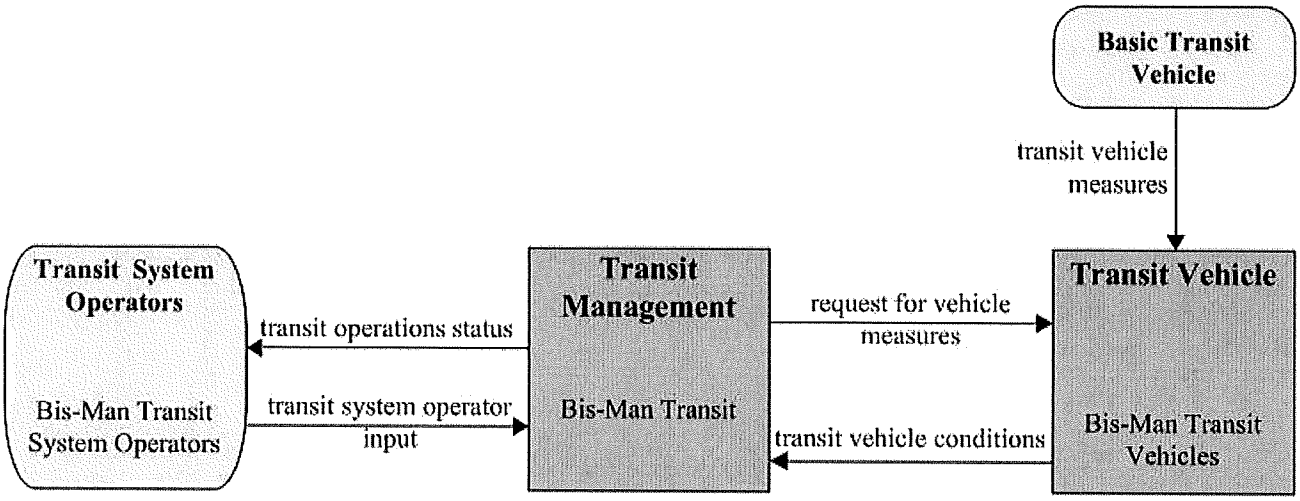
APTS5 - Transit Security

Bismarck-Mandan



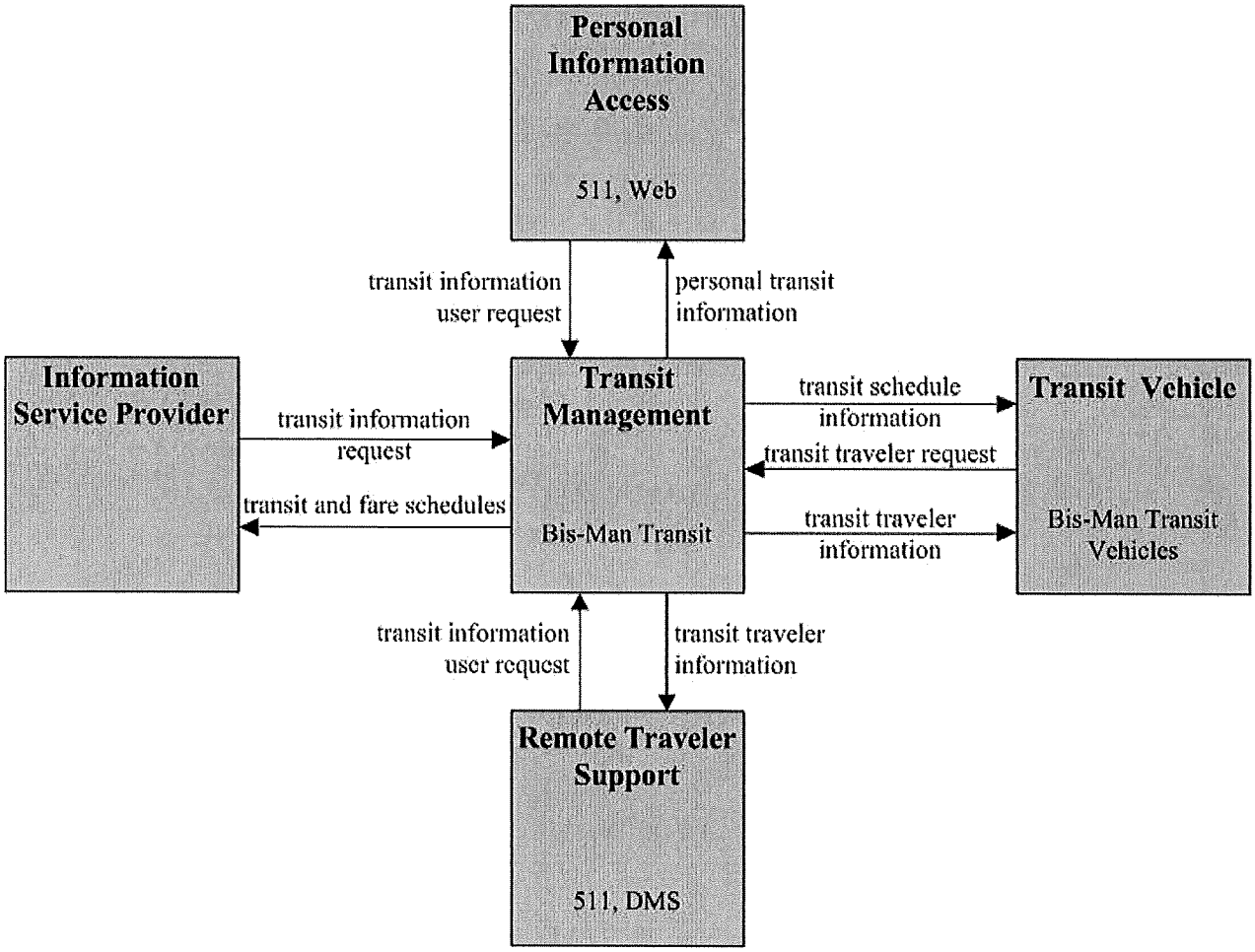
APTS6 - Transit Maintenance

Bismarck-Mandan



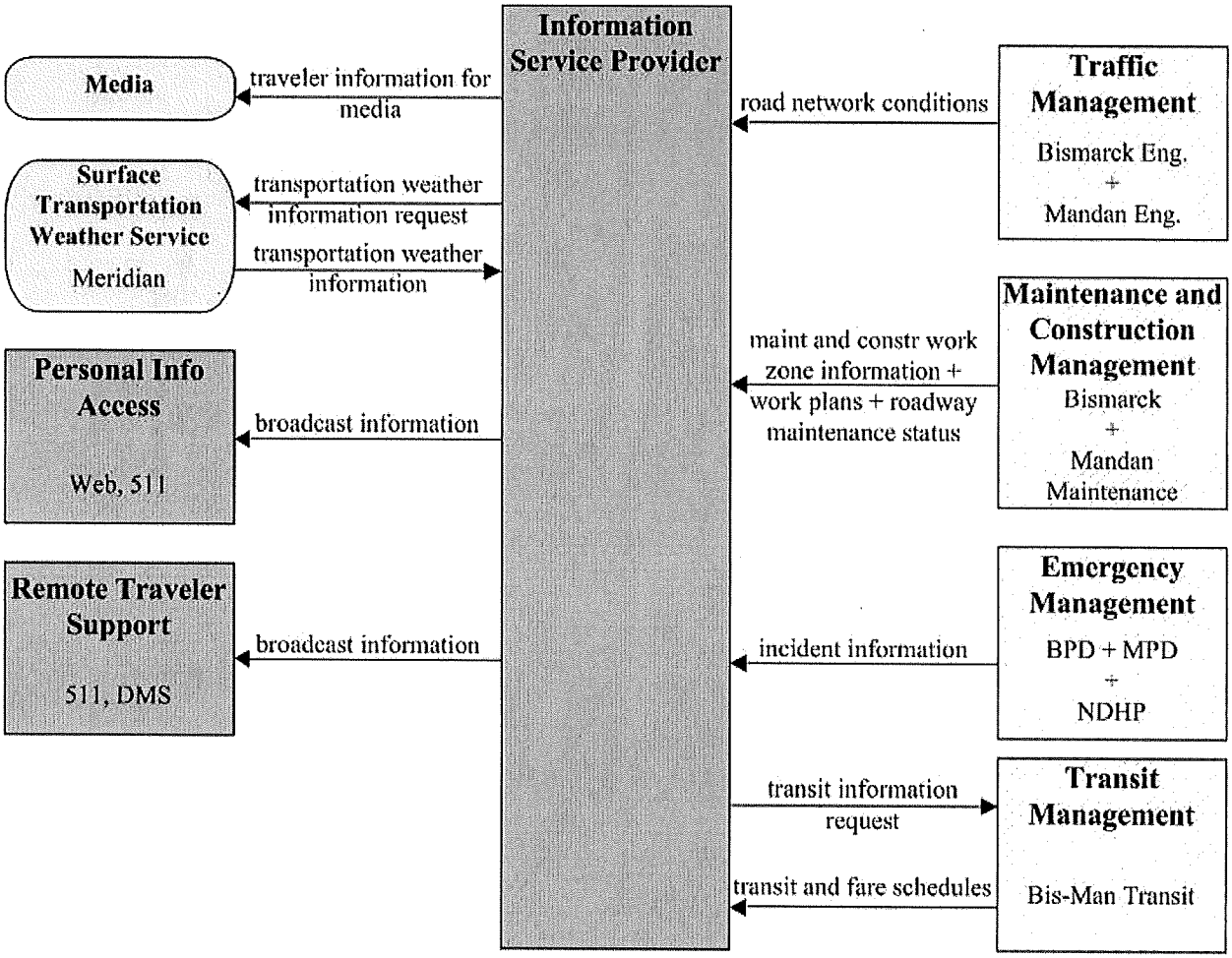
APTS8 - Transit Traveler Information

Bismarck-Mandan



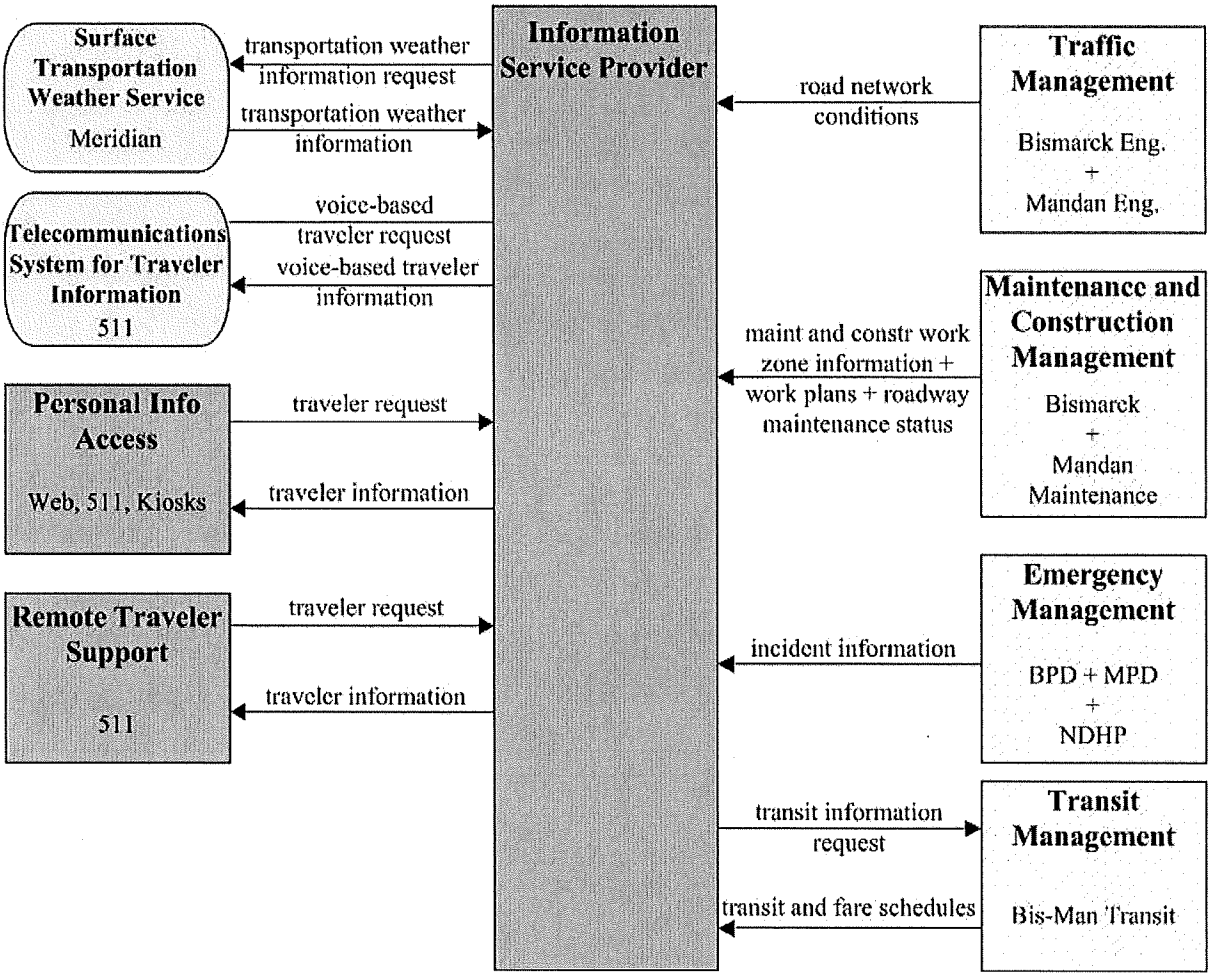
ATIS1 - Broadcast Traveler Information

Bismarck-Mandan



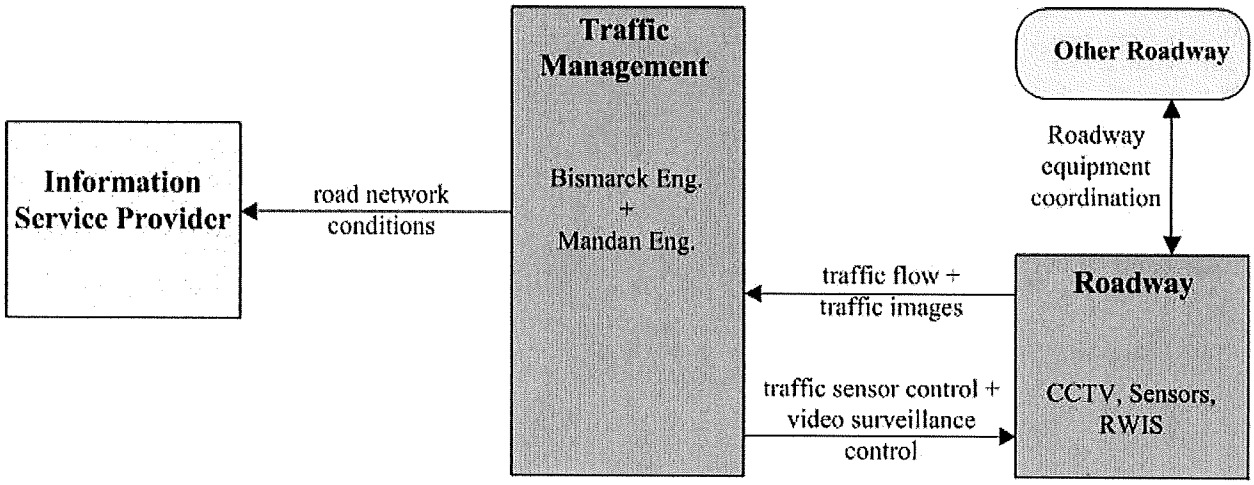
ATIS2 - Interactive Traveler Information

Bismarck-Mandan



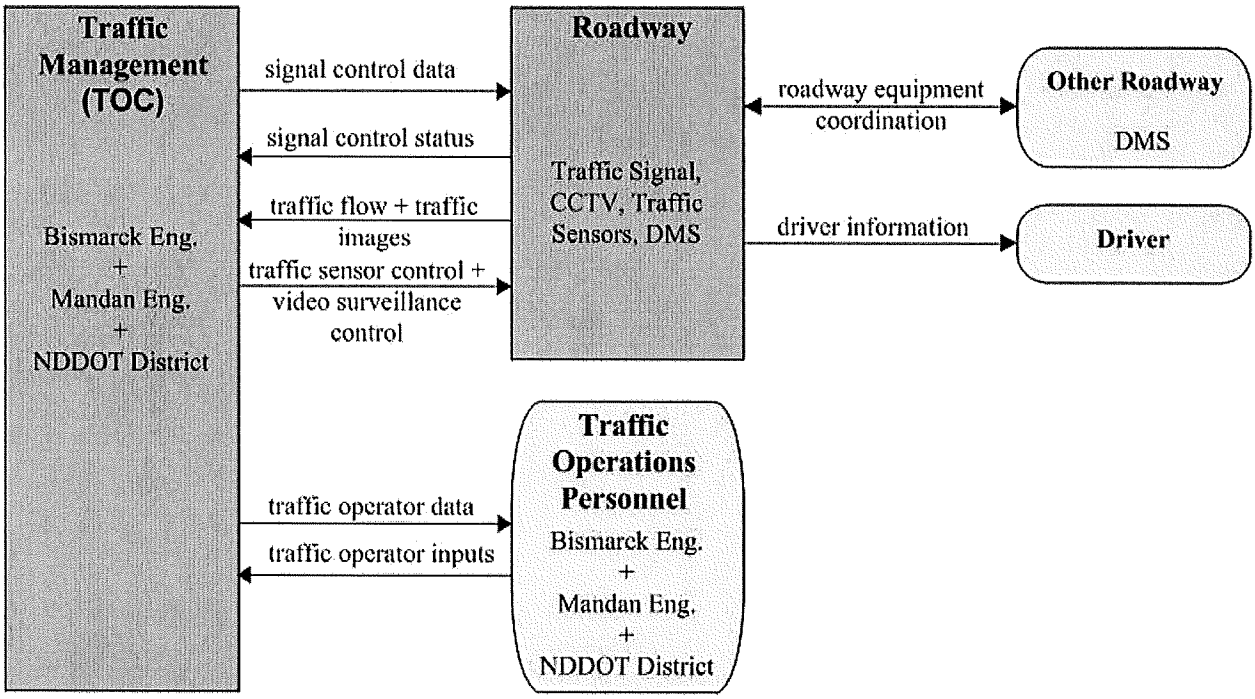
ATMS01 - Network Surveillance

Bismarck-Mandan



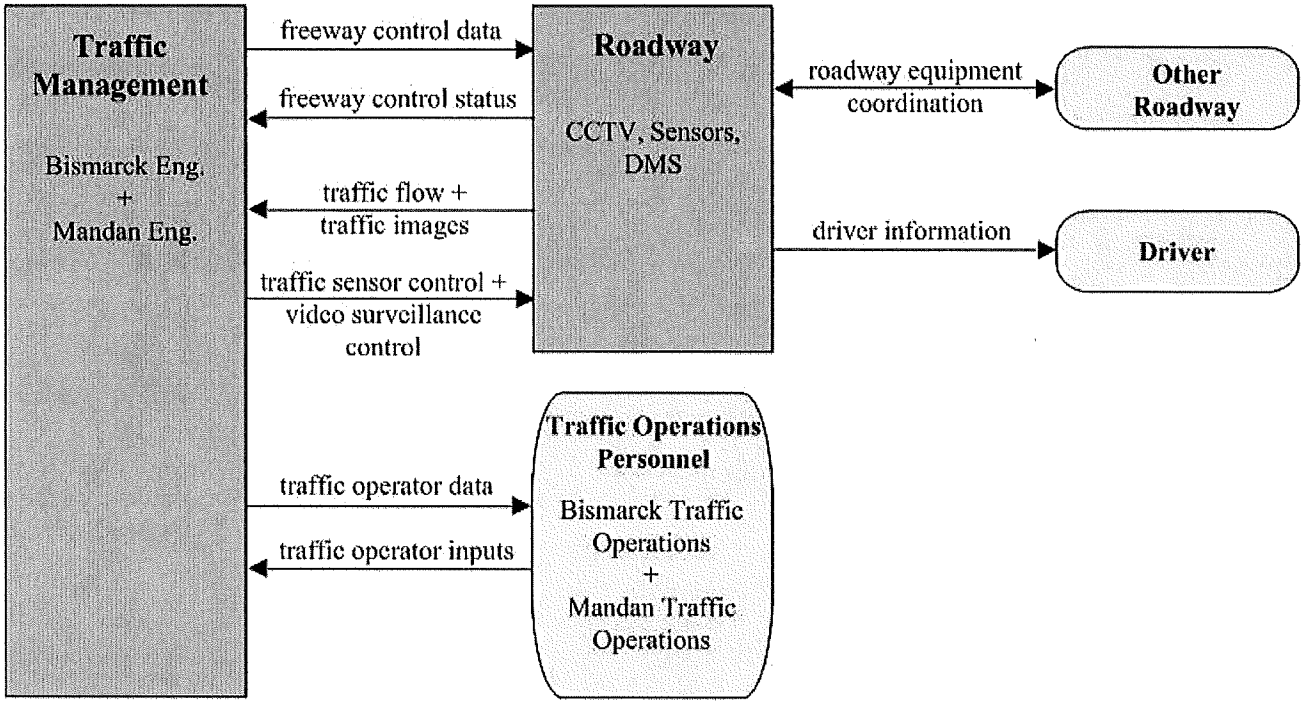
ATMS03 - Surface Street Control

Bismarck-Mandan



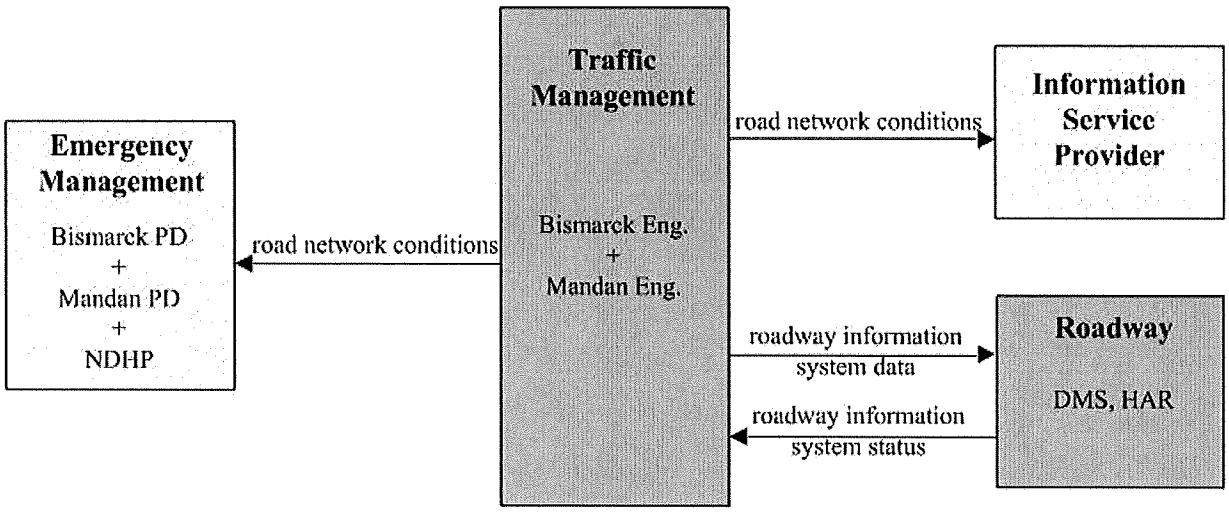
ATMS04 - Freeway Control

Bismarck-Mandan



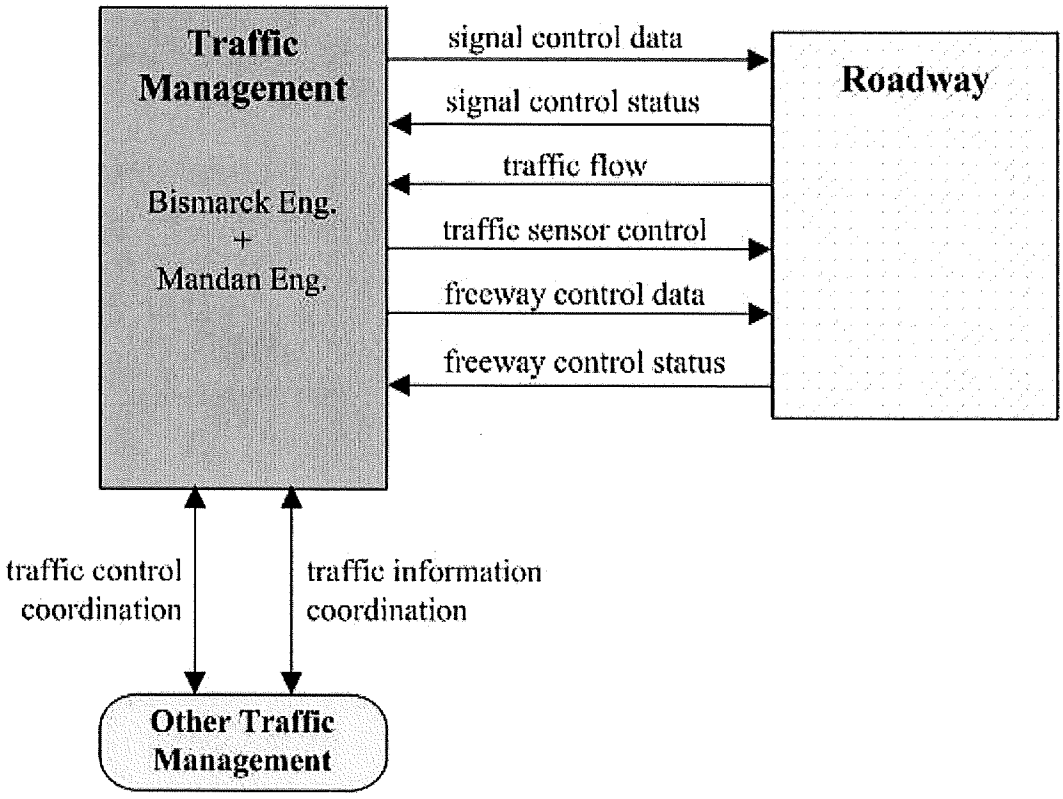
ATMS06 - Traffic Information Dissemination

Bismarck-Mandan



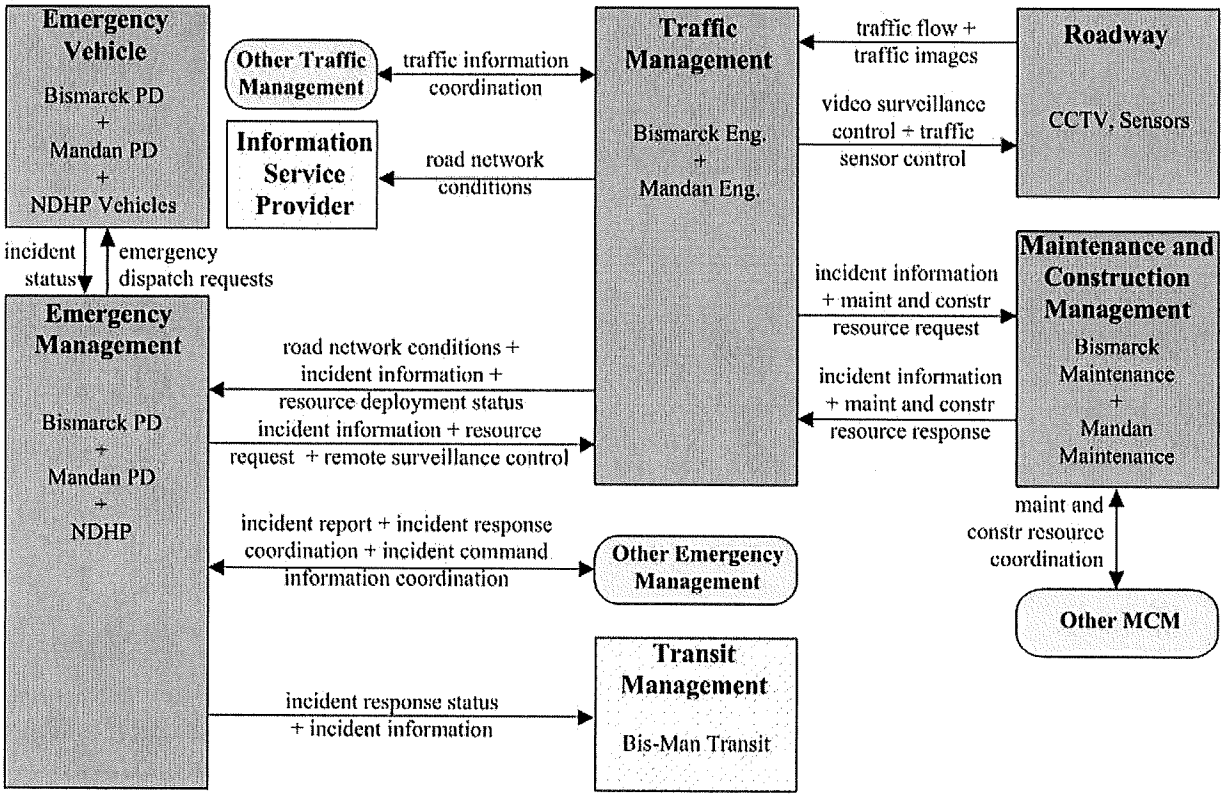
ATMS07 - Regional Traffic Control

Bismarck-Mandan



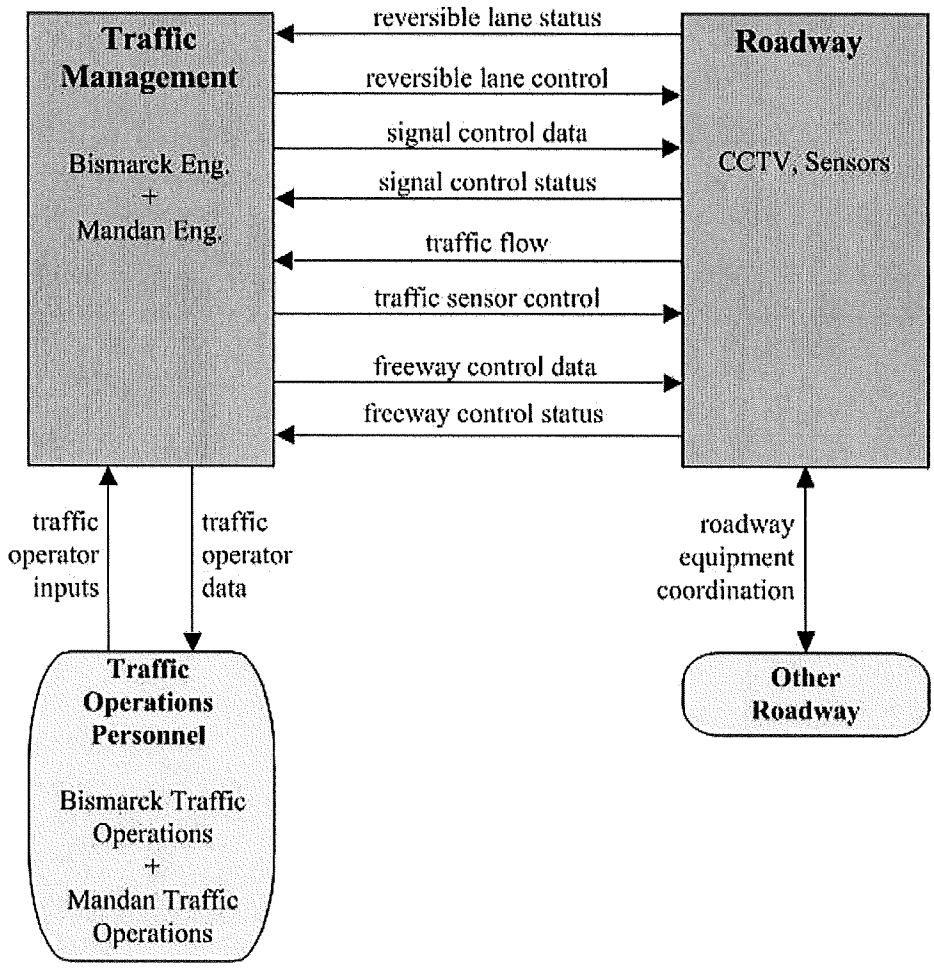
ATMS08 - Traffic Incident Management System

Bismarck-Mandan



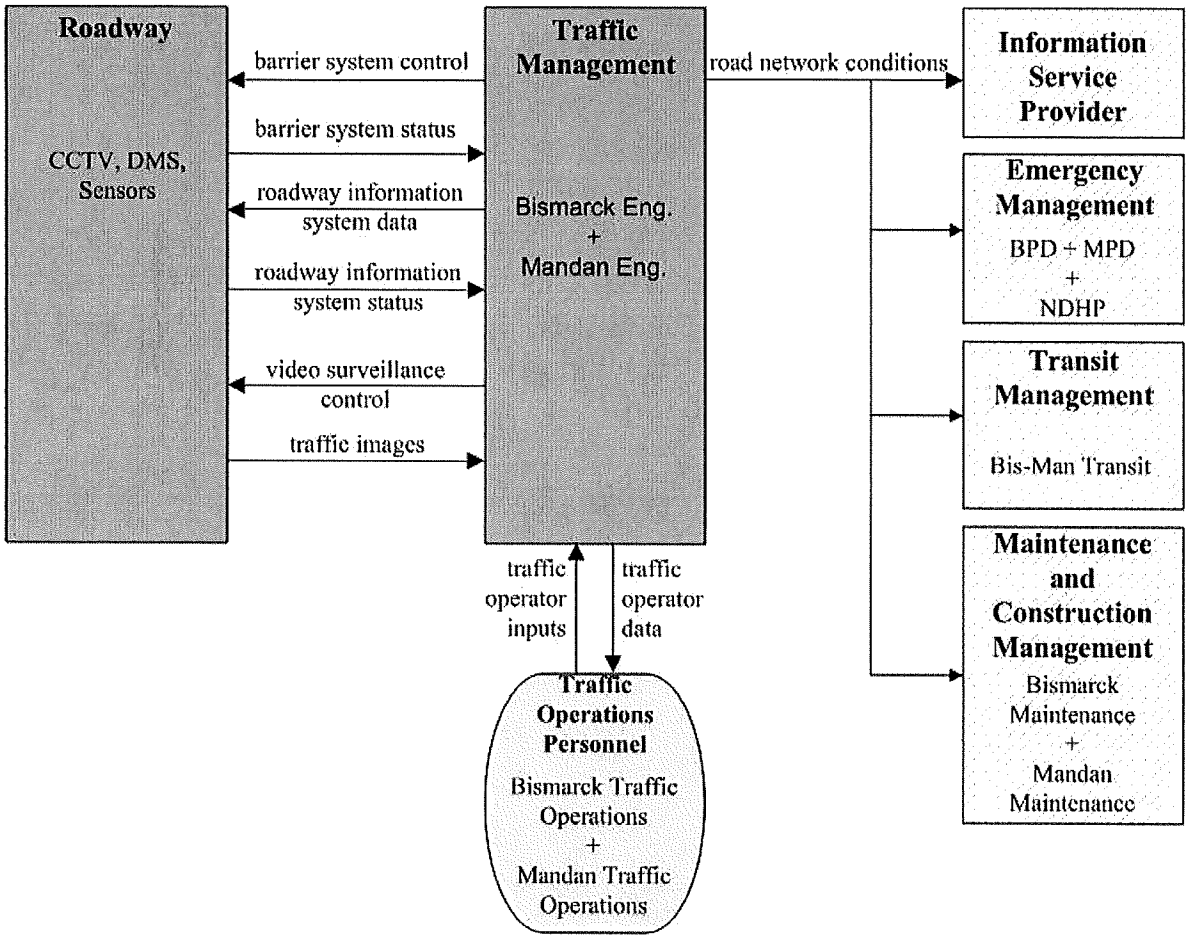
ATMS18 - Reversible Lane Management

Bismarck-Mandan



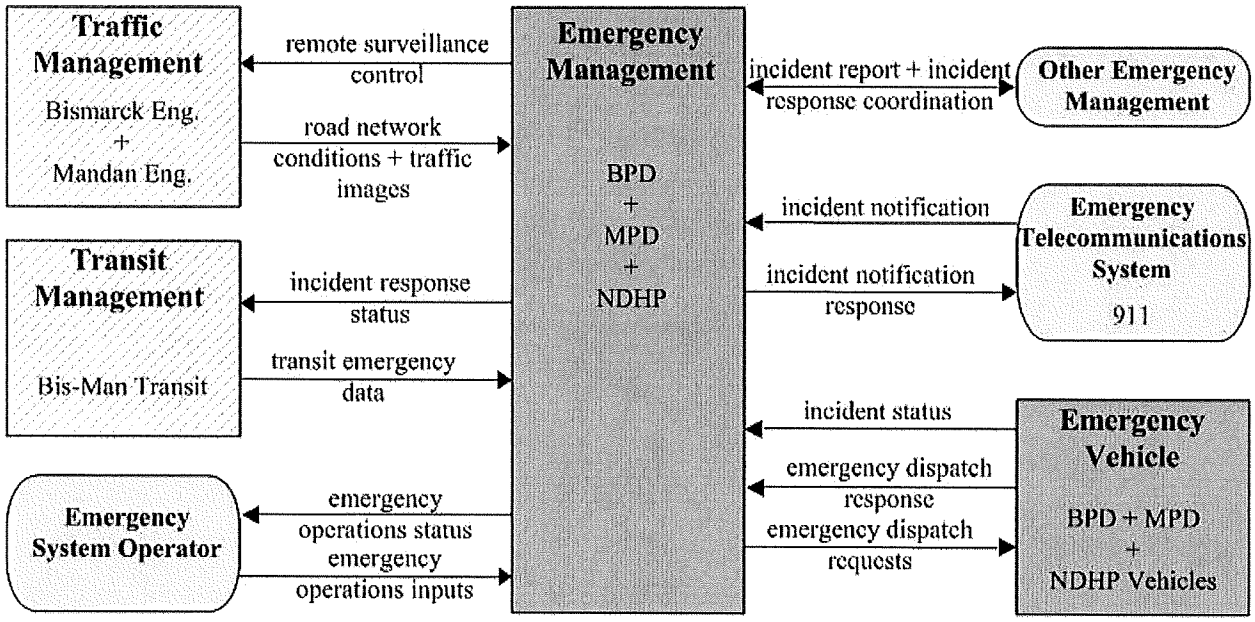
ATMS21 - Roadway Closure Management

Bismarck-Mandan



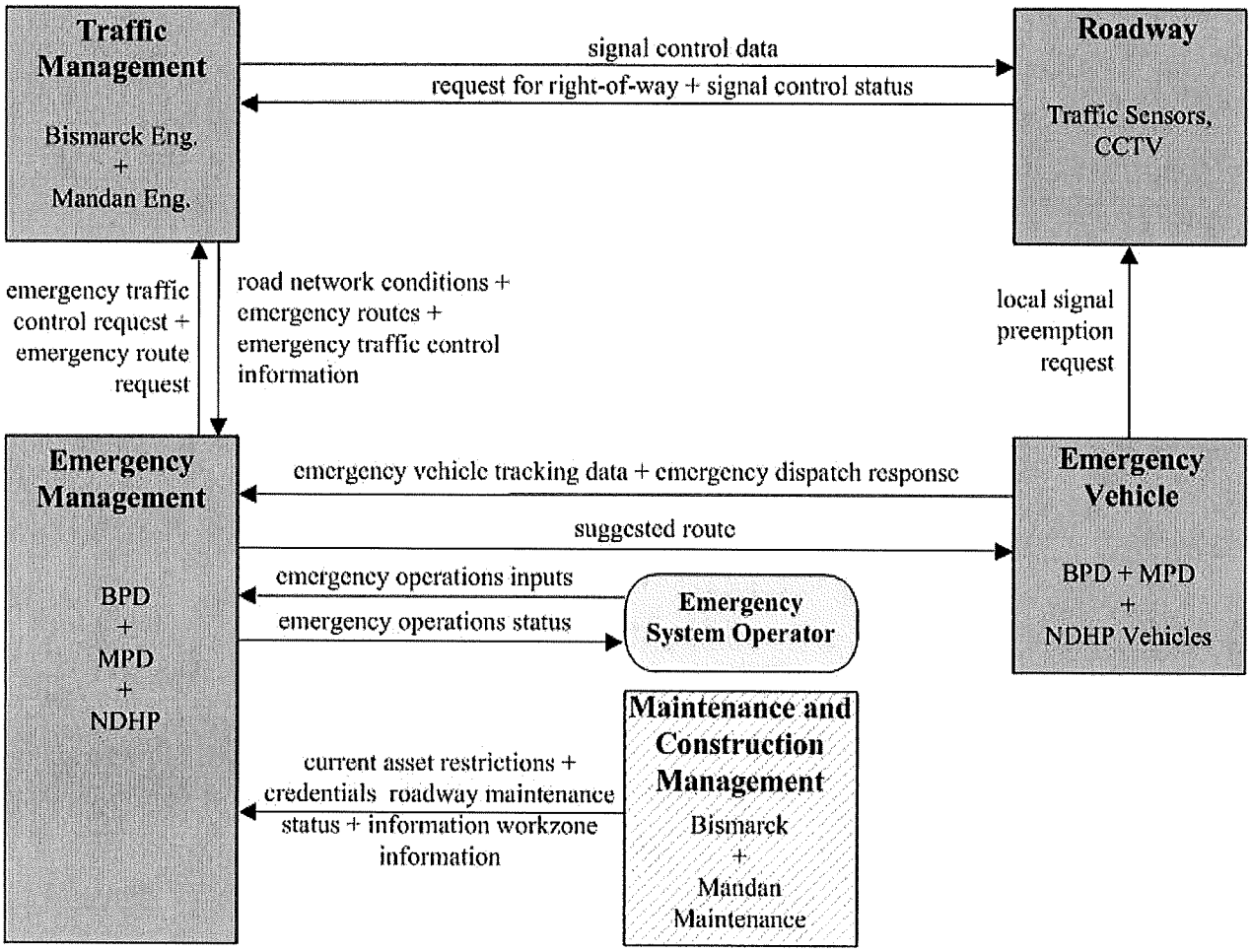
EM01 - Emergency Call-Taking and Dispatch

Bismarck-Mandan



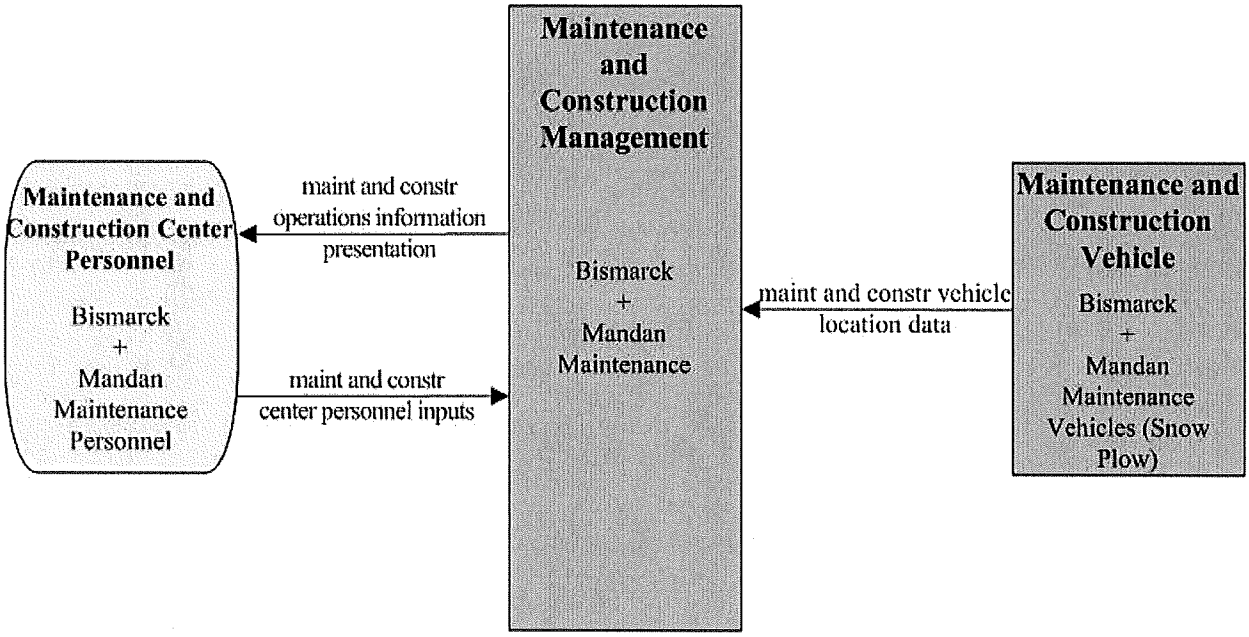
EM02 - Emergency Routing

Bismarck-Mandan



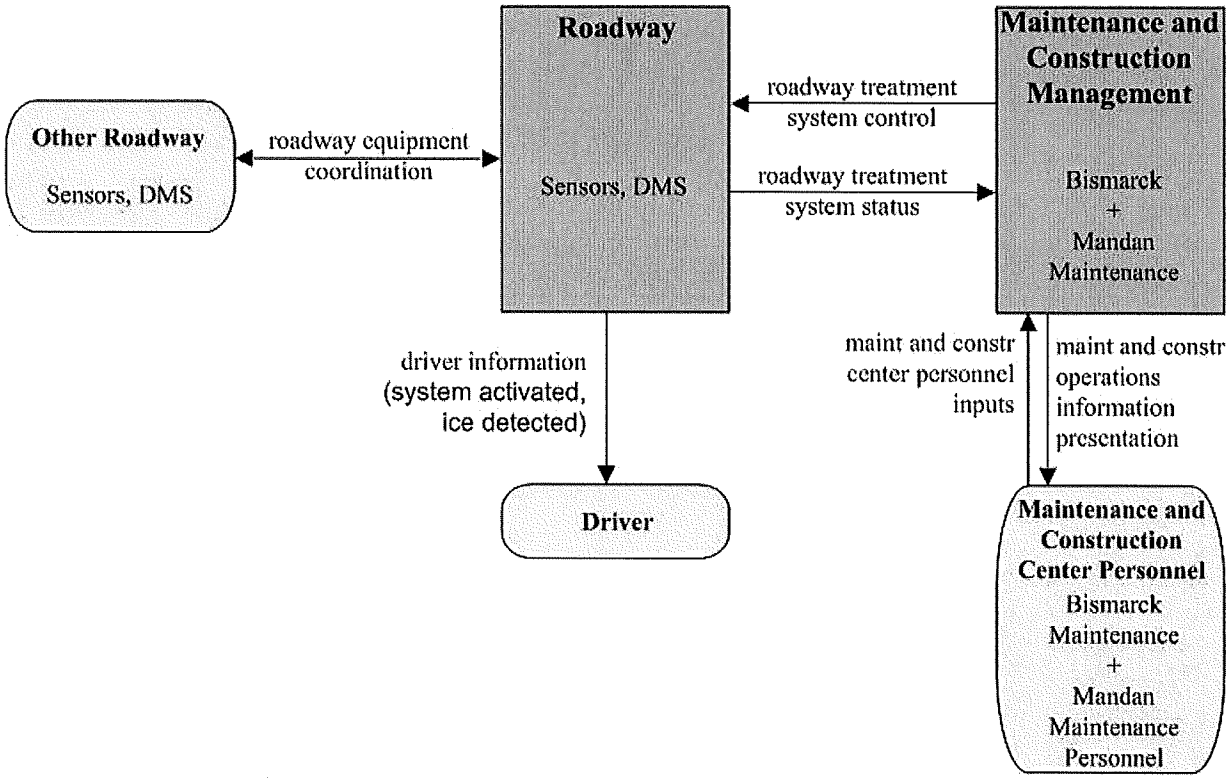
MC01 - Maintenance and Construction Vehicle and Equipment Tracking

Bismarck-Mandan



MC05 - Roadway Automated Treatment

Bismarck-Mandan



Traffic Signal System- Red Light Cameras