Bismarck-Mandan MPO

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Bismarck- Mandan Regional ITS Architecture Update

Version 4.0

Final Report

December 2021

NDSU | UPPER GREAT PLAINS TRANSPORTATION INSTITUTE
ADVANCED TRAFFIC ANALYSIS CENTER

Bismarck- Mandan
Regional ITS Architecture
Version 4.0

Final Report

December 2021

The information contained in this report was obtained through extensive input from various stakeholders in the Bismarck- Mandan region. The contents of the report were written by a research team from the Advanced Traffic Analysis Center of the Upper Great Plains Transportation Institute at North Dakota State University which facilitated the development of the Regional Architecture.

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ACRONYMS

ACS	Advanced System Controller
ADA	Americans with Disabilities Act
ATAC	Advanced Traffic Analysis Center
ATC	Advanced Transportation Controller
ARC-IT	Architecture Reference for Cooperative and Intelligent Transportation
AVL	Automated Vehicle Location
Bis	Bismarck
Bis-Man	Bismarck-Mandan
Bismarck FD	Bismarck Fire Department
Bismarck PD	Bismarck Police Department
Bismarck PW	Bismarck Public Works
CAD	Computer Aided Dispatch
CAT	Capitol Area Transit
CCTV	Closed Circuit Television
CenCom	Central Dakota Communications Center
Constr	Construction
Dist	District
DMS	Dynamic Message Sign
DOT	Department of Transportation
EAS	Emergency Alert System
EV	Emergency Vehicle
FHWA	Federal Highway Administration
ISP	Information Service Provider
ITS	Intelligent Transportation Systems
LOS	Level of Service
Mandan FD	Mandan Fire Department
Mandan PD	Mandan Police Department
Mandan PW	Mandan Public Works
Maint	Maintenance
MCO	Maintenance and Construction Operations
MPO	Metropolitan Planning Organization
NDDOT	North Dakota Department of Transportation
NDHP	North Dakota Highway Patrol
OEM	Office of Emergency Management
PSAP	Public Safety Answering Point
RA	Regional Architecture
RAD-IT	Regional Architecture Development for Intelligent Transportation
SDO	Standard Development Organization
SP	Service Package
TDP	Transit Development Plan
TOC	Traffic Operations Center
Standards	
ASTM	American Society for Testing and Materials
FIPS	Federal Information Processing Standards

IEEE	Institute of Electrical and Electronic Engineers
ISO	International Organization for Standardization
ITE	Institute of Transportation Engineers
NEMA	National Electrical Manufacturers Association
NIST	National Institute of Standards and Technology
NTCIP	National Transportation Communications for ITS Protocol
SAE	Society of Automotive Engineers
Service Packages	
DM	Data Management
MC	Maintenance and Construction
PS	Public Safety
PT	Public Transportation
TM	Traffic Management
WX	Weather and Environmental Condition

Table of Contents

List of Figures ..... **i**
List of Tables ..... **i**
Executive Summary ..... **ii**
1.0 Introduction **1**
1.1 Report Organization 1
2.0 Region and Scope **2**
2.1 Geographical Boundaries 2
2.2 Scope of the RA 2
3.0 Stakeholders **4**
4.0 System Inventory **6**
4.1 Bis-Man Centers 6
4.1.1 Traffic Management Center 6
4.1.2 Transit Management Center 8
4.1.3 Emergency Management Center 9
4.1.4 Maintenance and Construction Management Center 9
4.1.5 Information Service Provider 10
4.1.6 Archived Data Management Center 10
4.2 Bis-Man Field Devices 10
4.2.1 NDDOT Field Devices 10
4.2.2 City of Mandan Field Devices 10
4.2.3 City of Bismarck Field Devices 11
4.2.4 City of Bismarck Public Works Field Devices 13
4.3 Bis-Man Vehicles 13
4.3.1 Emergency Vehicle for Bis-Man area 13
4.3.2 MCO vehicles for City of Bismarck and Mandan 15
4.3.3 Transit Vehicle for Bis-Man area 16
4.4 Bis-Man Communication Infrastructure 17
4.5 Summary of Bis-Man Inventory 18
5.0 Service Packages **21**
6.0 Operational Concept **33**
6.1 Operational Roles and Responsibilities 34
7.0 Agreements **37**
8.0 Functional Requirements **39**
9.0 ITS Standards **40**
10.0 Planning Aspects **43**
10.1 Planning and the Regional ITS Architecture 43
10.2 Regional ITS Architecture Maintenance 45
Appendix-A **46**
Bismarck-Mandan Service Packages And Information Flows **46**
Appendix-B **79**
Functional Requirements **79**

LIST OF FIGURES

Figure 1 Bismarck-Mandan Boundary Map 3
Figure 2 Bis-Man Physical Architecture 7
Figure 3 Mandan City Hall (Engineering Department) 8
Figure 4 Bis-Man Transit Facility 9
Figure 5 Signal Controller Cabinet 11
Figure 6 Video and Optical Detector for Preemption 11
Figure 7 Black Cat Radar 12
Figure 8 DMS (Public Work Department) 12
Figure 9 Brine Maker 13
Figure 10 Burleigh County Sheriff Vehicle 13
Figure 11 Bismarck Fire Department Engine 14
Figure 12 Metro Area Ambulance 14
Figure 13 Truck unit with a road temperature sensor (Bismarck PW) 15
Figure 14 Snow blower attachments for loader (Mandan PW) 15
Figure 15 Sander Control 16
Figure 16 CAT Bus 16

LIST OF TABLES

Table 1: List of Stakeholders 4
Table 2: Stakeholder Group Members 5
Table 3: List of Inventory 18
Table 4: List of Roles and Responsibilities 34
Table 5: List of Potential Agreements 38
Table 6: Sample of Functional Requirements 39
Table 7: List of Standards 40
Table 8: List of Functional Requirements 79

EXECUTIVE SUMMARY

The Bismarck- Mandan Regional Intelligent Transportation Systems (ITS) Architecture was prepared under the Bismarck- Mandan Metropolitan Planning Organization (Bis-Man MPO) leadership. The architecture was first developed in 2005, and since then, it has been updated three times in 2008, 2013, and 2021. The Bis-Man regional architecture (RA) aims to guide the implementation of ITS systems in the Bis-Man region and coordinate funding, deployment, information sharing, and operations of ITS technologies in the region. The main ITS goal areas for the Bis-Man region include enhanced traveler safety, effective traffic and transit management; coordinated incident management; and enhanced traveler information. A 15-year planning horizon was considered in the RA development.

The development of the RA was facilitated by the Advanced Traffic Analysis Center (ATAC) of the Upper Great Plains Transportation Institute at North Dakota State University. A partnership agreement was established between ATAC and the Bis-Man MPO to support RA development and maintenance.

This version of the RA is the fourth iteration in a maintenance process that aims to keep the architecture up to date in accordance with FHWA guidelines and to continue to reflect the most current ITS picture in the region. This version of the RA is based on the national Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT 9.0).

Bismarck being the capital of North Dakota, this region continues to experience population growth as well as increased economic and cultural activity. Therefore, an efficient transportation system is crucial for supporting the mobility needs of individuals and businesses in the region.

The geographical boundaries used to develop the Bis-Man RA were based on the metropolitan boundaries for the Bis-Man MPO. Major jurisdictions include:

1. City of Bismarck.
2. City of Mandan.
3. City of Lincoln.
4. Burleigh County.
5. Morton County.

In addition to these jurisdictions, the RA recognizes interfaces with statewide architectures in North Dakota. Therefore, the North Dakota Department of Transportation (NDDOT) participated in the RA development.

The RA development was guided by various regional stakeholders who owned and operated ITS in the Bis-Man region and included:

- MPO planning staff
- City engineering and maintenance staff
- Transit staff

- State DOT district engineering and maintenance staff
- FHWA representative
- Law enforcement and emergency responders
- County maintenance staff
- Agency information technology technical staff
- Other agencies responsible for system operations and maintenance

A system inventory was updated to account for existing and planned ITS systems. The majority of these systems may be classified into the following service areas: traffic and travel management, maintenance and construction management, emergency management, transit management, and advanced data management. The inventory identified systems and their functions by agency and jurisdiction.

ITS user services for the region were initially identified from previous ITS planning efforts as well as input from regional stakeholders. The National ITS Architecture was used to map these services and develop service packages supporting these services. A total of 31 Service Packages were identified in three categories of existing, planned, and future for the Bis-Man area.

Service packages are comprised of the agencies, devices, and information flows needed to achieve each ITS service. Those packages were also used to survey roles and responsibilities for each system. System interconnections and relevant information flows were identified for major ITS systems in the region. These systems include traffic management, transit management, emergency management, and maintenance and construction management.

Based on information flows, access sharing, and funding partnerships, potential agency agreements were identified. The format for each agreement includes the purpose, entities included, and items covered. Six potential agreements were identified for the Bis-Man region, including transit security, network surveillance, traffic information dissemination, incident management, data archival, and regional transportation management.

One of the most significant challenges to successful ITS deployment in the Bis-Man area is funding for ITS infrastructure, especially communications. Therefore, coordination and integration of key system components were cited as critical factors for success. Given the number and diversity of agencies involved, it is essential to capitalize on and expand existing partnerships to include new ITS systems. These partnerships can result in cost-effective strategies that meet the demands of each agency and the traveling public in the Bis-Man region.

1.0 INTRODUCTION

This document summarizes the results of the regional Intelligent Transportation architecture development for the Bismarck-Mandan Area. Intelligent Transportation Systems (ITS) refer to integrated applications of sensing, communications, computer processing, and electronics to enhance the transportation system. The regional architecture (RA) provides a tool to guide future ITS planning, define system requirements, coordinate agency roles, and integrate functions across jurisdictional lines.

The Bismarck-Mandan Regional Intelligent Transportation Systems (ITS) Architecture was prepared under the leadership of the Bismarck-Mandan Metropolitan Transportation Organization (Bis-Man MPO). The goal of the Bis-Man regional architecture (RA) is to guide the implementation of ITS systems in the Bis-Man area and coordinate funding, deployment, information sharing, and operations of ITS systems in the region. The main ITS goal areas for the Bis-Man area include enhanced traveler safety, effective traffic and transit management; coordinated incident management; and enhanced traveler information. A 15-year planning horizon was considered in the RA development.

The development and current update of the RA were facilitated by the Advanced Traffic Analysis Center (ATAC) of the Upper Great Plains Transportation Institute at North Dakota State University. ATAC has also facilitated prior RA updates in 2008 and 2013.

1.1 Report Organization

The Bis-Man RA Report is organized into several main sections to facilitate the report's use. In addition, an electronic file has been prepared using the FHWA's regional architecture development for intelligent transportation (RAD-IT) software to access the architecture and make changes or future updates.

Below is a description for each of the remaining sections of this report:

2 Scope and Region	Identifies the geographical and architecture scope
3 Stakeholders	Agencies participating in the architecture
4 System Inventory	Existing and planned ITS systems
5 Service Packages	ITS user services and service packages
6 Operational Concept	Roles and responsibilities of participating agencies
7 Potential Agreements	Regional agreements to facilitate integration
8 Functional Requirements	High-level descriptions of what the systems will do
9 ITS Standards	Brief discussion of applicable ITS standards
10 Planning Aspects	Relating planning goals to the RA
Appendix-A	Detailed Service Packages/Information Flow Diagrams
Appendix-B	Functional Requirements

2.0 REGION AND SCOPE

This section describes the geographical characteristics of the Bis-Man region. It also discusses the scope of the regional architecture, providing a high-level outline of the range of ITS services and systems used.

2.1 Geographical Boundaries

The geographical areas included in the Bis-Man RA primarily consisted of the Bis-Man MPO's metropolitan boundaries. Major jurisdictions within the region include the following:

1. City of Bismarck.
2. City of Mandan.
3. City of Lincoln.
4. Burleigh County.
5. Morton County.

In addition, the RA recognized interfaces with the North Dakota statewide ITS Architecture. The North Dakota Department of Transportation (NDDOT) and the Federal Highway Administration (FHWA) were active participants in the RA development.

2.2 Scope of the RA

The scope of the Bis-Man RA may be defined using broad ITS user services targeted for deployment within the region. The delineation of relevant ITS user services assisted in identifying relevant stakeholders and corresponding systems to be included in the RA. The range of ITS user services included the following:

1. Travel and Traffic Management
    a. Traffic control
    b. Traveler information
    c. Traffic surveillance
2. Public Transportation Management
    a. Fleet management (real-time information)
    b. Automated Passenger and Fare Management
    c. Transit Security
3. Incident Management
    a. Incident response coordination (integrated communications)
4. Information Management
    a. Data archival and analysis services
5. Maintenance and Construction Management
    a. Winter maintenance
    b. Fleet management

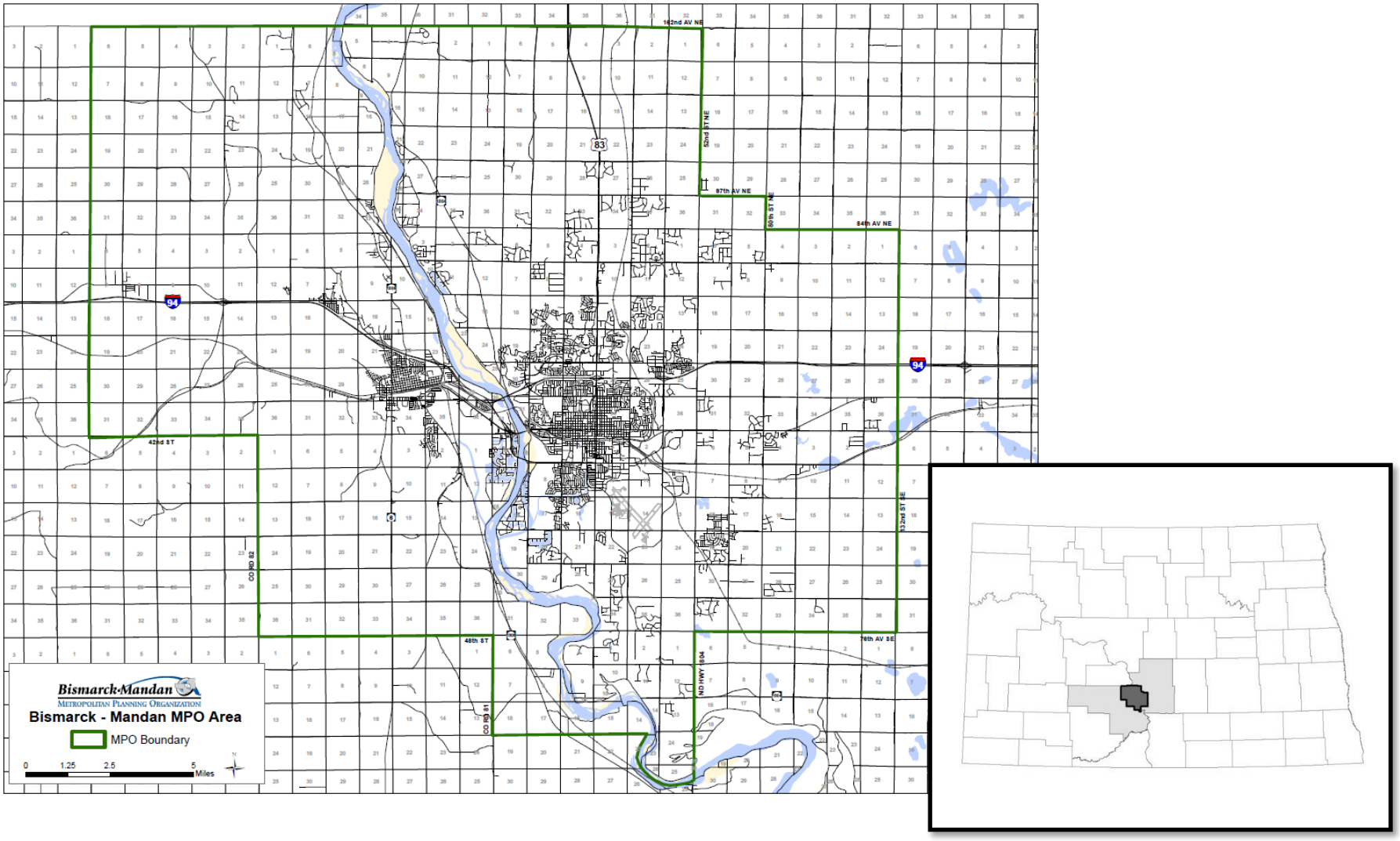


Figure 1 Bismarck-Mandan Boundary Map

3.0 STAKEHOLDERS

ITS stakeholders in the Bis-Man RA include transportation, public works, law enforcement, emergency management, transit, and other related agencies.

Table 1: List of Stakeholders

Stakeholder Name	Stakeholder Description
Bis-Man MPO	Bismarck-Mandan Metropolitan Planning Organization
Bis-Man Transit	Bismarck-Mandan Transit
Bismarck Emergency Management	Emergency Management Division for City of Bismarck
Bismarck Engineering	City of Bismarck Engineering Department
Bismarck FD	City of Bismarck Fire Department
Bismarck PD	City of Bismarck Police Department
Bismarck PW	City of Bismarck Public Works
BRFD	Bismarck Rural Fire Department
Burleigh County OEM	Burleigh County Office of Emergency Management
Burleigh County Sheriff	Burleigh County Sheriff Department
CenCom	Central Dakota Communications Center
Lincoln PD	City of Lincoln Police Department
Lincoln PW	City of Lincoln Public Works Department
Mandan Engineering	City of Mandan Engineering Department
Mandan FD	City of Mandan Fire Department
Mandan PD	City of Mandan Police Department
Mandan PW	City of Mandan Public Works
Metro Area Ambulance	Bismarck-Mandan regional ambulance service
Morton County Engineering	Morton County Highway Department
Morton County OEM	Morton County Office of Emergency Management
Morton County Sheriff	Morton County Sheriff department
ND DES	North Dakota Division of Emergency Services
NDDOT Bis Dist	NDDOT Bismarck District Engineering and Maintenance
NDHP Bismarck	North Dakota Highway Patrol - Bismarck District

Additionally, RA stakeholder groups were utilized to simplify services when many agencies from the same area of specialty participated in performing a service. One stakeholder group was created in the emergency management area.

Table 2: Stakeholder Group Members

Stakeholder Name	Stakeholder Description
Bis-Man Emergency Management Agencies	Bismarck Emergency Management
	Bismarck FD
	Bismarck PD
	BRFD
	Burleigh County OEM
	Burleigh County Sheriff
	CenCom
	Lincoln PD
	Mandan FD
	Mandan PD
	Metro Area Ambulance
	Morton County OEM
	Morton County Sheriff
	NDHP Bismarck

4.0 SYSTEM INVENTORY

This section summarizes the results of the system inventory process for the Bis-Man RA. Information developed for the inventory was obtained through extensive input from stakeholders. Survey instruments, interviews, and small group meetings were used to obtain and verify the inventory information. Follow-up interviews were conducted to identify changes for the RA update.

To facilitate the inventory process, the types of systems to be included in the inventory were defined using the National ITS Architecture. More emphasis was placed on Physical Architecture since it contains most of the ITS hardware. However, additional information about the services provided by various physical ITS entities was also collected. In this region, most of the systems could be categorized into existing ones. Systems, components, or services that have been identified for future deployment in the region are considered with a planned status.

Using the Physical Architecture, four types of entities were identified for the Bis-Man region:

1. Centers
2. Field Devices
3. Vehicles
4. Communications

These entities are explained in greater detail in the following subsections. Section 4.5 shows a summary of ITS inventory in the Bis-Man region for each stakeholder.

4.1 Bis-Man Centers

These are the locations where functions are performed (i.e., process information, issue control commands, and produce output information). There are various centers in the National ITS Architecture that provide management, administrative, and support functions for the transportation system. The center subsystems each communicate with other centers to enable coordination between modes and across jurisdictions. A representation of the Bis-Man area Physical Architecture is shown in Figure 2.

4.1.1 Traffic Management Center

The Traffic Management Center (subsystem) monitors and controls traffic and the road network. It communicates with the Roadway Subsystem to monitor and manage traffic flow and monitor the condition of the roadway, surrounding environmental conditions, and field equipment status. The traffic management system in the region covers a broad range of transportation facilities in coordination with NDDOT's Bismarck district office. The specific traffic management systems within the Bis-Man area classified by the agency are discussed in the next section.

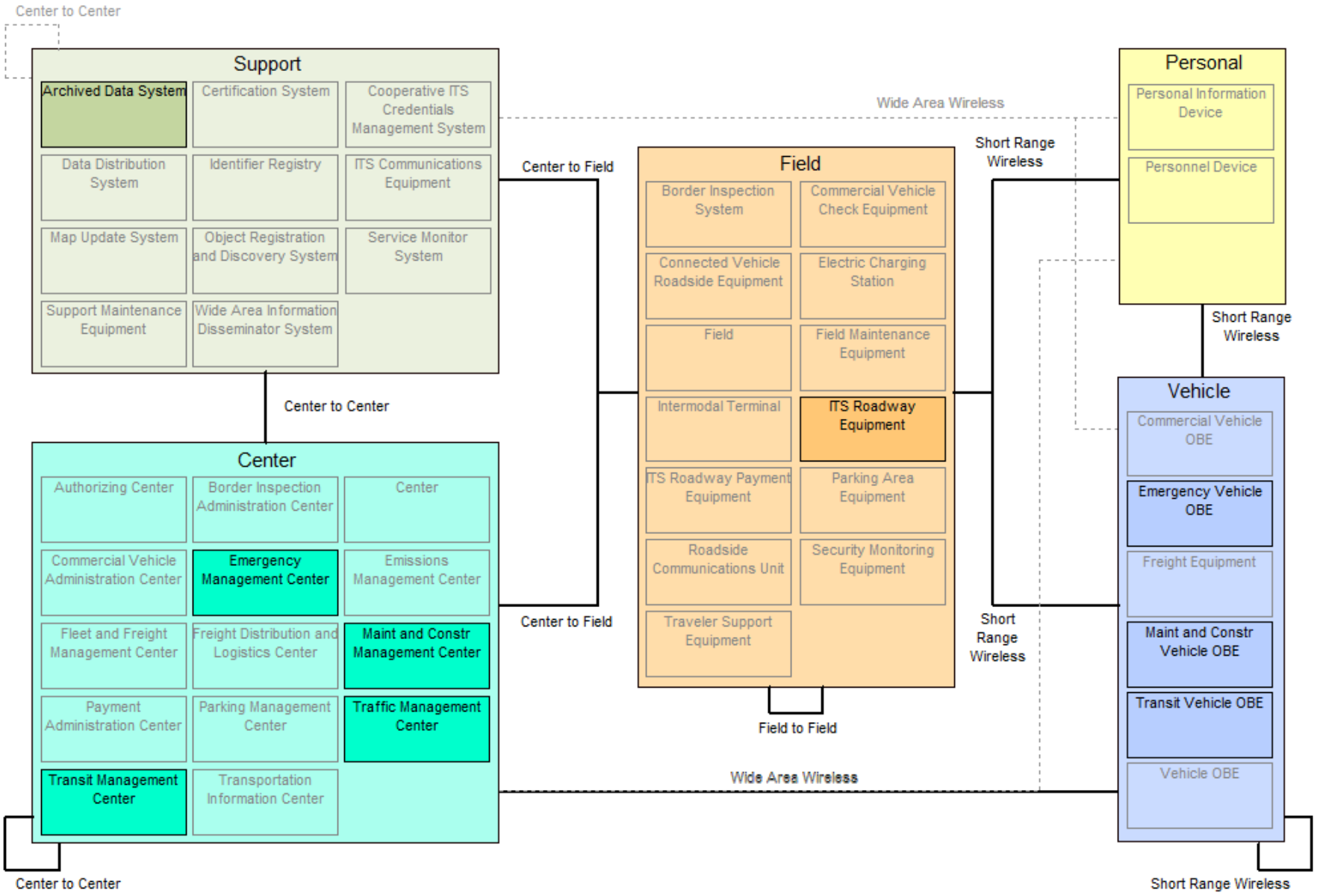


Figure 2 Bis-Man Physical Architecture

City of Bismarck Traffic Operations Center

The City of Bismarck traffic engineering department is updating their traffic signal system by swapping to ACS/3 or Econolite Cobalt controller and a centralized, coordinated centracs system. Centracs software will be used for the control and management of the city's signals. The city's majority of intersections, particularly all intersections on the Bismarck expressway corridor, are supported by video detection and eventually will be connected to the central system using fiber and wireless communications, which will enable remote monitoring and detailed traffic data collection.

City of Mandan Engineering

Most of the intersections in the city of Mandan are on the state highway system with video detection capability, so the city's engineering department works with the NDDOT on operating and managing their signal system. Some of those signals on the main street are coordinated, and others have interconnection capabilities with state-owned signals.

Figure 3 Mandan City Hall (Engineering Department)

4.1.2 Transit Management Center

Bis-Man Transit provides public transportation services for the cities of Bismarck and Mandan as well as surrounding areas. It uses different management systems for operating six different fixed routes and dynamic routes. There is a planning effort to integrate the fixed routes to the google transit service. Transit uses a sophisticated management system that provides dispatch, routing, fare management, including

revenue analysis and passenger data analysis. All transit vehicles are equipped with onboard security surveillance and AVL functionality that allows for real-time tracking. Vehicles are also fully ADA compliant with automated audible and visual stop announcements.

Figure 4 Bis-Man Transit Facility

4.1.3 Emergency Management Center

The Emergency Management center includes the functions associated with a full array, from the notification of an emergency to supporting the incident management and evacuation. Emergency management is handled by several local, county, and state agencies. The Central Dakota Communications Center (CenCom) serves as the dispatch center of the city of Bismarck, Mandan, and Burleigh County. It includes the Police and Fire department of both cities, Burleigh County Sheriff's department, Bismarck Rural Fire department, and Metro area ambulance. It is also connected with Lincoln Police and receives Morton County Communication center's dispatch communication over State radio. The NDHP dispatch is also handled through State Radio.

4.1.4 Maintenance and Construction Management Center

Currently, there are three entities that handle Maintenance and Construction Management (MCO) in the Bis-Man area, including Bismarck Public Works, Mandan Public Works, and NDDOT. These agencies are incrementally adding fleet

management capabilities and using Automated Vehicle Location (AVL) technologies. Centers have the ability to display current road conditions to the public with the coordination of the city's GIS department mapping service. County highway departments handle rural road maintenance but, as the counties have limited ITS capabilities, there are no official interfaces between the rural and metropolitan systems in the ITS RA. CenCom provides dispatch communication with Preset Response to both city's Public Works departments, specifically during wintertime.

4.1.5 Information Service Provider

Functions associated with an Information Service Provider (ISP) are currently handled through multiple agencies in the Bis-Man region. Generally, law enforcement agencies are the main point of contact for issuing travel advisories and contacting the media. Public Service announcement can be made by the respective department at City Hall. Both traffic and public works departments extensively use portable message signs for the road users in special events or in case of an incident and detour information. However, the NDDOT maintains a statewide traveler information system that uses 511 and a web page where travelers can obtain a variety of road conditions, weather, and construction information.

4.1.6 Archived Data Management Center

CenCom and IT departments of the City of Bismarck currently have the ability to collect data from their respective ITS sensors with time-limited archiving capacity. However, as more ITS devices are deployed, it is expected that archival data functions will be coordinated region-wide.

4.2 Bis-Man Field Devices

This type of physical entity refers to field devices used to support ITS systems. The majority of field devices in the Bis-Man area may be classified under the Roadway Subsystem. Below is a listing of these devices by the agency.

4.2.1 NDDOT Field Devices

1. Sensors
    a. Weather
        i. RWIS and Surface sensors located on I-94 (NDDOT)
2. Warning/advisory devices
    a. DMS along I-94

4.2.2 City of Mandan Field Devices

1. Sensors
    a. Traffic
        i. Loop detectors
        ii. Video traffic detectors
2. Control devices

b. Traffic signal controllers

4.2.3 City of Bismarck Field Devices

1. Control devices
   a. Traffic signal controllers

Figure 5 Signal Controller Cabinet

2. Sensors
   a. Traffic
      i. Video traffic detectors

Figure 6 Video and Optical Detector for Preemption

ii.Speed Radar

Figure 7 Black Cat Radar

iii.Loop detector

3. Warning/advisory devices
    a. Portable DMS

Figure 8 DMS (Public Work Department)

4.2.4 City of Bismarck Public Works Field Devices

1. Control Devices
   a. Brine Maker

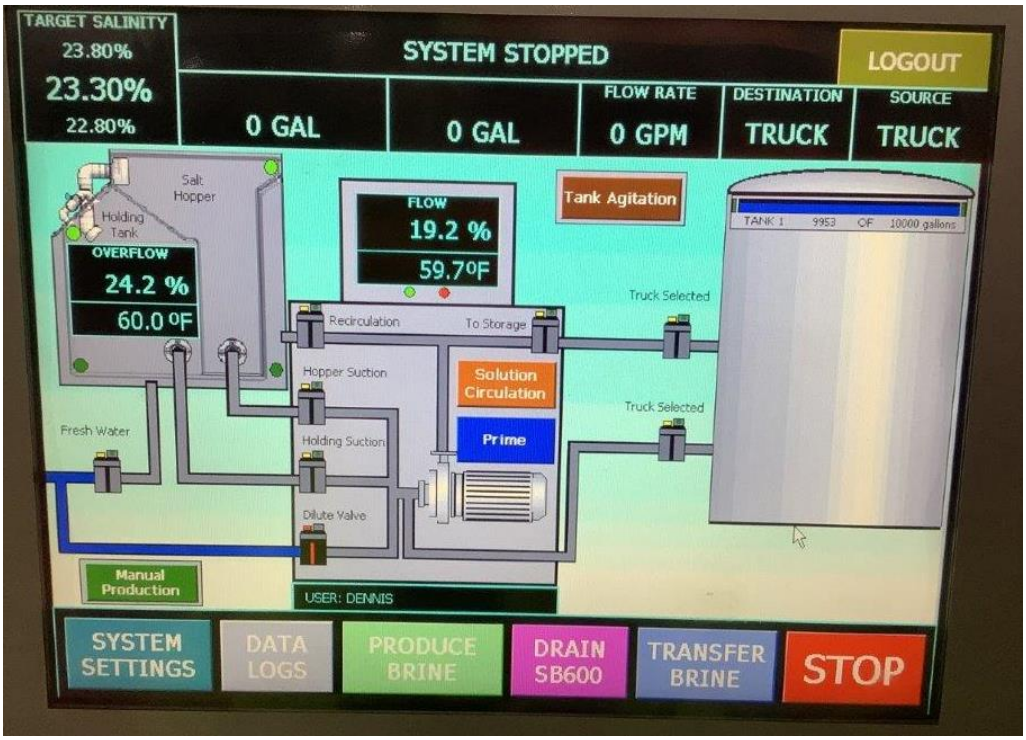


Figure 9 Brine Maker

4.3 Bis-Man Vehicles

There are three types of vehicles included in the Bis-Man RA. Only vehicles with existing or planned ITS capabilities are included, i.e., vehicles with advanced communications, navigations, monitoring, and control systems.

4.3.1 Emergency Vehicle for Bis-Man area

1. Law enforcement (AVL)

Figure 10 Burleigh County Sheriff Vehicle

2. Fire (signal preemption)

Figure 11 Bismarck Fire Department Engine

3. Ambulance (signal preemption)

Figure 12 Metro Area Ambulance

4.3.2 MCO vehicles for City of Bismarck and Mandan

1. Trucks with atmospheric sensor

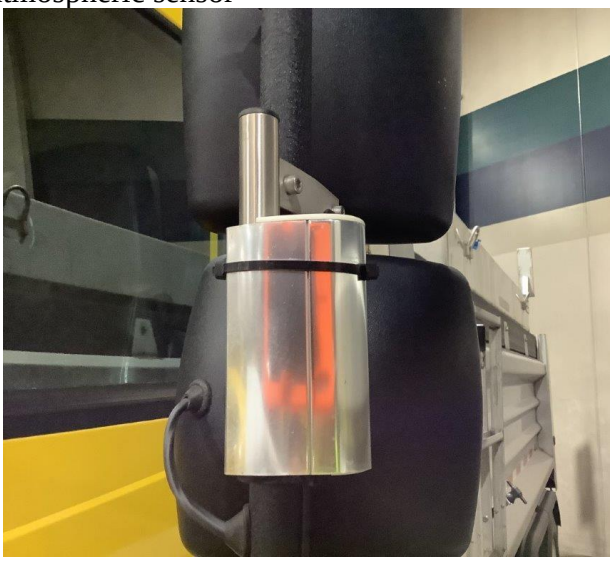


Figure 13 Truck unit with a road temperature sensor (Bismarck PW)

2. Snowplows equipped with AVL

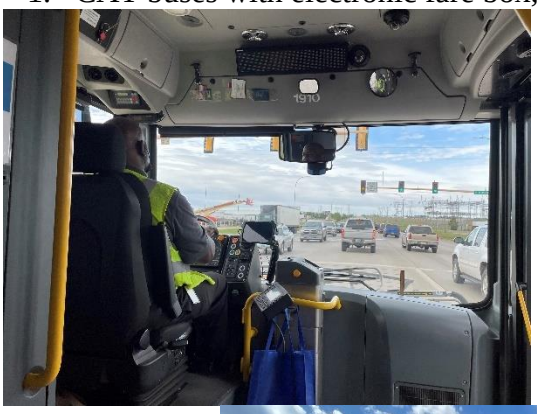
Figure 14 Snow blower attachments for loader (Mandan PW)

3. Advanced Sander control

Figure 15 Sander Control

4.3.3 Transit Vehicle for Bis-Man area

1. CAT buses with electronic fare box, security camera, and ADA compliance.



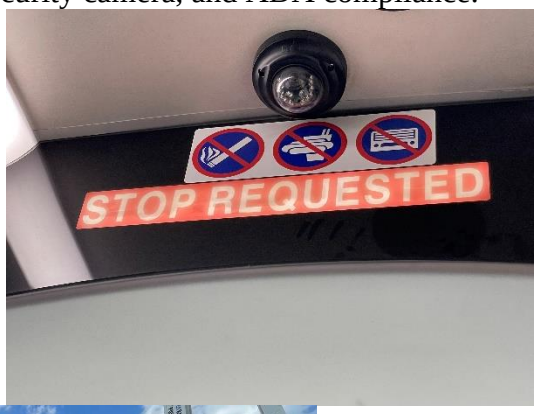


Figure 16 CAT Bus

4.4 Bis-Man Communication Infrastructure

Below is a brief description of existing and planned communication infrastructure in the Bis-Man area. It should be noted that this infrastructure has been agency-specific so far, with little integration. However, more integration activities are expected in the future as the Bis-Man RA is implemented.

1. Fiber
    a. Arterial network (Bismarck and Mandan)
2. Dial-up
    a. Some traffic signals in the City of Bismarck (Expires by summer 2022)
3. Wireless/cellular
    a. Most of the emergency vehicles
    b. DMS
    c. Public work vehicles

4.5 Summary of Bis-Man Inventory

Table 3: List of Inventory

Element Name	Element Description	Associated Physical Objects	Stakeholder
Bis-Man Data Archival	Systems (e.g., databases, models, analytical tools, user interface devices) to acquire data and analyses results from the archive.	Archived Data System	Bis-Man MPO, CenCom
Bis-Man Emergency Vehicles	Fire, police, ambulance, and other emergency vehicles in the Bis-Man area.	Emergency Vehicle OBE	Bis-Man Emergency Management Agencies
Bis-Man Transit Center	Bismarck Mandan Transit Center	Archived Data User System, Transit Management Center	Bis-Man Transit
Bis-Man Transit Drivers	Person that receives and provides additional information that is specific to operating the ITS functions in all types of transit vehicles	Transit Vehicle Operator	Bis-Man Transit
Bis-Man Transit Operator	Personnel for fleet management, maintenance operations, and scheduling activities	Transit Operations Personnel	Bis-Man Transit
Bis-Man Transit Vehicles	Bis-Man Transit vehicles	Transit Vehicle OBE	Bis-Man Transit
Bismarck Engineers	Bismarck traffic engineering personnel	Traffic Operations Personnel	Bismarck Engineering
Bismarck PW Field Devices	MCO Field Devices include sensors, displays, and cameras for operational purposes of maintenance and construction.	ITS Roadway Equipment	Bismarck PW
Bismarck PW Operations Center	Bismarck-Mandan Maintenance and Construction Operations Center including Bismarck public works, Mandan public works, and NDDOT Bismarck district	Maint and Constr Management Center	Bismarck PW
Bismarck PW Vehicles	Bismarck public works vehicles	Maint and Constr Vehicle OBE	Bismarck PW

Element Name	Element Description	Associated Physical Objects	Stakeholder
Bismarck TOC	Bismarck Traffic Operations Center	Archived Data User System, Traffic Management Center	Bismarck Engineering
Bismarck TOC Field Devices	Roadside Equipment includes any and all equipment distributed on and along the roadway, which monitors and controls traffic. This can include equipment for tolling or Black Cat radar for speed detection and reporting.	ITS Roadway Equipment	Bismarck Engineering
Central Dakota Communications Center	911 and dispatch center for City of Bismarck, Mandan, and Burleigh County	Emergency Management Center, Emergency Telecommunications System	CenCom
Driver		Driver	
Government Reporting Systems	Government Reporting Systems represents the system and associated personnel that prepare the inputs to support the various local, state, and federal government transportation data reporting requirements (e.g., Highway Performance Monitoring System, Fatality Analysis Reporting System) using data collected by ITS systems. It represents a system interface that provides access to the archived data relevant to these reports. In most cases, this system will combine data collected from ITS archives with data from non-ITS sources to assemble the required information.	Government Reporting Systems	
Lincoln PW	Lincoln Public Works Department	Maint and Constr Management Center	Lincoln PW
Lincoln PW Vehicles	Lincoln public works vehicles	Maint and Constr Vehicle OBE	Lincoln PW
Mandan Engineering Field Devices	Mandan traffic field devices	ITS Roadway Equipment	Mandan Engineering
Mandan PW Operations Center	Mandan public works operations	Maint and Constr Management Center	Mandan PW

Element Name	Element Description	Associated Physical Objects	Stakeholder
Mandan PW Vehicles	Mandan public works vehicles	Maint and Constr Vehicle OBE	Mandan PW
Mandan Traffic Engineering	Mandan traffic engineering	Archived Data User System, Traffic Management Center	Mandan Engineering
Media	Represents the information systems that provide traffic reports, travel conditions, and other transportation-related news services to the traveling public through radio, TV, and other media	Media	
Morton County Communications	Morton County communications department	Emergency Management Center	Morton County OEM, Morton County Sheriff
Morton County PW	Public Works Department of Morton County	Maint and Constr Management Center	Morton County Engineering
Morton County PW vehicles	Morton County Public Works Vehicles	Maint and Constr Vehicle OBE	Morton County Engineering
Morton County Sheriff Vehicles	Morton County Sheriff department vehicles	Emergency Vehicle OBE	Morton County Sheriff
NDDOT District Field Devices	NDDOT District field devices	ITS Roadway Equipment	NDDOT Bis Dist
NDDOT District Office	NDDOT District maintenance and construction	Maint and Constr Management Center	NDDOT Bis Dist
NDDOT District Vehicles	NDDOT District maintenance and construction vehicles	Maint and Constr Vehicle OBE	NDDOT Bis Dist
NDHP Vehicles	NDHP vehicles	Emergency Vehicle OBE	NDHP Bismarck
Pedestrians		Cyclist, Pedestrian	
State Radio	North Dakota State Radio	Alerting and Advisory System, Emergency Management Center	ND DES
Transit Fare Card	Bis-Man Transit fare card	Payment Device, Traveler Card	Bis-Man Transit

5.0 SERVICE PACKAGES

This section describes the ITS services selected for the Bis-Man area. These services were identified from previous ITS planning efforts, stakeholders' input throughout the RA development, and possible coordination with the statewide architecture update.

Utilizing service packages is the method for representing ITS services in the regional architecture. Service packages are slices of the architecture that address a specific service (e.g., traffic signal control); they are a collection of several different physical objects (systems and devices) along with the information flows needed to provide the desired service.

The following service packages were identified for the Bis-Man region. The descriptions are from the National ITS Architecture and have been augmented with the narrative about the service in Bis-Man. The status of each service package is also indicated (i.e., existing, planned, or future). Customized Bis-Man service packages and their information flow diagrams are shown in Appendix A.

DM01: ITS Data Warehouse (Existing)

National architecture description: This service package provides access to transportation data to support transportation planning, condition and performance monitoring, safety analysis, and research. Configurations range from focused repositories that house data collected and owned by a single agency, district, private sector provider, or research institution to broad repositories that contain multimodal, multidimensional data from varied data sources covering a broader region. Both central repositories and physical distributed ITS data repositories are supported. Requests for data that are satisfied by access to a single repository in the ITS Data Warehouse service package may be parsed by the local repository and dynamically translated to requests to other repositories that relay the data necessary to satisfy the request. The repositories could include a data registry capability that allows registration of data identifiers or data definitions for interoperable use throughout a region.

- Bis-Man: Data collection and archival efforts are performed within separate agencies as part of their daily functions, notably the City of Bismarck and CenCom have extensive data collection and archiving efforts. Bismarck city engineering and public works departments have the potential to contribute to this attempt. There is no other entity in the region tasked with data warehousing function.

DM02: Performance Monitoring (Existing)

National architecture description: The Performance Monitoring service package uses information collected from detectors and sensors, connected vehicles, and operational data feeds from centers to support performance monitoring and other uses of historical data including transportation planning, condition monitoring, safety analyses, and research. The information may be probe data information obtained from vehicles in the network to determine network performance measures such as speed and travel times, or it may be

information collected from the vehicles and processed by the infrastructure, e.g., environmental data and infrastructure conditions monitoring data. Additional data are collected including accident data, road condition data, road closures and other operational decisions to provide context for measured transportation performance and additional safety and mobility–related measures. More complex performance measures may be derived from the collected data.

- Bis-Man: The data currently collected and archived in DM01 is used by government agencies for operational improvements (e.g., asset management). There are no region-wide performance measures and monitoring established at this time.

MC01: Maintenance and Construction Vehicle and Equipment Tracking (Existing)

National architecture description: This service package tracks the location of maintenance and construction vehicles and other equipment to ascertain the progress of their activities. Checks can include ensuring the correct roads are being plowed and work activity is being performed at the correct locations.

- Bis-Man: Automated vehicle location (AVL) technologies for vehicle tracking are utilized on the maintenance fleet of several area agencies, including the City of Bismarck, City of Mandan Public Works, and NDDOT.

MC02: Maintenance and Construction Vehicle Maintenance (Existing)

National architecture description: This service package performs vehicle maintenance scheduling and manages both routine and corrective maintenance activities on vehicles and other maintenance and construction equipment. It includes on–board sensors capable of automatically performing diagnostics for maintenance and construction vehicles, and the systems that collect this diagnostic information and use it to schedule and manage vehicle and equipment maintenance.

- Bis-Man: City of Bismarck public works and NDDOT use an asset management software system to schedule and preventive maintenance of their fleet vehicles.

MC04: Winter Maintenance (Existing)

National architecture description: This service package supports winter road maintenance including snowplow operations, roadway treatments (e.g., salt spraying and other anti-icing material applications), and other snow and ice control activities. This package monitors environmental conditions and weather forecasts and uses the information to schedule winter maintenance activities, determine the appropriate snow and ice control response, and track and manage response operations.

- Bis-Man: All maintenance agencies in the region perform winter road maintenance. NDDOT has statewide maintenance decision support systems. Bismarck public works utilizes its own roadway treatment facility and vehicular environment sensors to determine the appropriate snow and ice control response and winter maintenance schedule.

MC05: Roadway Maintenance and Construction (Existing)

National architecture description: This service package supports numerous services for scheduled and unscheduled maintenance and construction on a roadway system or right–of–way. Maintenance services include landscape maintenance, hazard removal (roadway debris, dead animals), routine maintenance activities (roadway cleaning, grass cutting), and repair and maintenance of both ITS and non–ITS equipment on the roadway (e.g., signs, traffic controllers, traffic detectors, dynamic message signs, traffic signals, CCTV, etc.). Environmental conditions information is also received from various weather sources to aid in scheduling maintenance and construction activities.

- Bis-Man: All maintenance agencies in the region perform roadway maintenance and construction functions.

MC06: Work Zone Management (Existing)

National architecture description: This service package manages work zones, controlling traffic in areas of the roadway where maintenance, construction, and utility work activities are underway. Traffic conditions are monitored using CCTV cameras and controlled using dynamic message signs (DMS), Highway Advisory Radio (HAR), gates and barriers. Work zone information is coordinated with other groups (e.g., TIC, traffic management, other maintenance and construction centers). Work zone speeds and delays are provided to the motorist prior to the work zones. This service package provides control of field equipment in all maintenance and construction areas, including fixed, portable, and truck–mounted devices supporting both stationary and mobile work zones.

- Bis-Man: All maintenance agencies in the region make public service announcements through various city departments, agencies, television, radio, and social media. Bismarck public works have portable message signs for the road users to guide in the work zone.

PS01: Emergency Call-Taking and Dispatch (Existing)

National architecture description: This service package provides basic public safety call–taking and dispatch services. It includes emergency vehicle equipment, equipment used to receive and route emergency calls, and wireless communications that enable safe and rapid deployment of appropriate resources to an emergency. Coordination between Emergency Management Centers supports emergency notification between agencies. Wide area wireless communications between the Emergency Management Center and an Emergency Vehicle supports dispatch and provision of information to responding personnel. This service package also provides information to support dynamic routing of emergency vehicles. Traffic information, road conditions, and weather advisories are provided to enhance emergency vehicle routing. The Emergency Management Center provides routing information based on real–time conditions and has the option to request an ingress/egress route from the Traffic Management Center.

- Bis-Man: CenCom is the principal dispatch center for most emergency management agencies in the region. Morton County office of emergency management, NDDOT Bismarck district office, and NDHP can communicate with

CenCom over State radio. There is insufficient access authority for CenCom to the NDDOT's traffic camera.

PS02: Emergency Response (Future)

National architecture description: This service package supports emergency/ incident response by personnel in the field. It includes emergency vehicle equipment used to provide response status as well as video or images from either the vehicle or from emergency personnel in the field. Wide area wireless communications between the Emergency Management Center, Emergency Personnel and Emergency Vehicles supports a sharing of emergency response information. The service package also includes tactical decision support, resource coordination, and communications integration for Incident Commands that are established by first responders at or near the incident scene to support local management of an incident, including the functions and interfaces commonly supported by a mobile command center.

- Bis-Man: This service is performed by all emergency responders in the region; however, this SP is more applicable towards the coordination with statewide architecture.

PS03: Emergency Vehicle Preemption (Existing)

National architecture description: This service package provides signal preemption for public safety first responder vehicles. Both traditional signal preemption systems and new systems based on connected vehicle technology are covered. In more advanced systems, movement of public safety vehicles through the intersection can be facilitated by clearing queues and holding conflicting phases. In addition, this SP also covers the transition back to normal traffic signal operations after providing emergency vehicle preemption.

- Bis-Man: Few intersections in Bismarck have GPS capability for allowing Preemption. This service is mainly provided with optical systems in both Bismarck and Mandan signals for the Fire and Ambulance Department. The Bismarck PD is working with the engineering department on getting access to the preemption system.

PS10: Wide-Area Alert (Existing)

National architecture description: This service package uses ITS driver and traveler information systems to alert the public in emergency situations such as child abductions, severe weather events, civil emergencies, and other situations that pose a threat to life and property. The alert includes information and instructions for transportation system operators and the traveling public, improving public safety and enlisting the public's help in some scenarios. The ITS technologies will supplement and support other emergency and homeland security alert systems such as the Emergency Alert System (EAS). When an emergency situation is reported and verified and the terms and conditions for system activation are satisfied, a designated agency broadcasts emergency information to traffic agencies, transit agencies, information service providers, toll operators, and others that operate ITS systems. The ITS systems, in turn, provide the alert information to transportation system operators and the traveling public using ITS technologies such as dynamic message signs, highway advisory radios, in-vehicle displays, transit displays, 511 traveler information systems, and traveler information websites.

- Bis-Man: This service is performed by all emergency responders in the region.

PS12: Disaster Response and Recovery (Future)

National architecture description: This service package enhances the ability of the surface transportation system to respond to and recover from disasters. It addresses the most severe incidents that require an extraordinary response from outside the local community. All types of disasters are addressed including natural disasters (hurricanes, earthquakes, floods, winter storms, tsunamis, etc.) and technological and man–made disasters (hazardous materials incidents, nuclear power plant accidents, and national security emergencies such as nuclear, chemical, biological, and radiological weapons attacks).

The service package supports coordination of emergency response plans, including general plans developed before a disaster as well as specific tactical plans with short time horizon that are developed as part of a disaster response. The service package provides enhanced access to the scene for response personnel and resources, provides better information about the transportation system in the vicinity of the disaster, and maintains situation awareness regarding the disaster itself. In addition, this service package tracks and coordinates the transportation resources – the transportation professionals, equipment, and materials – that constitute a portion of the disaster response.

The service package identifies the key points of integration between transportation systems and the public safety, emergency management, public health, and other allied organizations that form the overall disaster response. In this service package, the Emergency Management Center represents the federal, regional, state, and local Emergency Operations Centers and the Incident Commands that are established to respond to the disaster. The interface between the Emergency Management Center and the other centers provides situation awareness and resource coordination among transportation and other allied response agencies. In its role, traffic management implements special traffic control strategies and detours and restrictions to effectively manage traffic in and around the disaster. Maintenance and construction provides damage assessment of road network facilities and manages service restoration. Transit management provides a similar assessment of status for transit facilities and modifies transit operations to meet the special demands of the disaster. As immediate public safety concerns are addressed and disaster response transitions into recovery, this service package supports transition back to normal transportation system operation, recovering resources, managing on–going transportation facility repair, supporting data collection and revised plan coordination, and other recovery activities.

This service package builds on the basic traffic incident response service that is provided by TM08, the Traffic Incident Management service package. This service package addresses the additional complexities and coordination requirements that are associated with the most severe incidents that warrant an extraordinary response from outside the local jurisdictions and require special measures such as the activation of one or more emergency operations centers. Many users of ARC–IT will want to consider both TM08 and this service package since every region is concerned with both day–to–day management of traffic–related incidents and occasional management of disasters that require extraordinary response.

- Bis-Man: This SP is reserved as a future package for coordination with the statewide architecture.

PS13: Evacuation and Reentry Management (Future)

This service package supports evacuation of the general public from a disaster area and manages subsequent reentry to the disaster area. The service package addresses evacuations for all types of disasters, including disasters like hurricanes that are anticipated and occur slowly, allowing a well-planned orderly evacuation, as well as disasters like terrorist acts that occur rapidly, without warning, and allow little or no time for preparation or public warning.

This service package supports coordination of evacuation plans among the federal, state, and local transportation, emergency, and law enforcement agencies that may be involved in a large-scale evacuation. All affected jurisdictions (e.g., states and counties) at the evacuation origin, evacuation destination, and along the evacuation route are informed of the plan. Information is shared with traffic management agencies to implement special traffic control strategies and to control evacuation traffic, including traffic on local streets and arterials as well as the major evacuation routes. Reversible lanes, shoulder use, closures, special signal control strategies, and other special strategies may be implemented to maximize capacity along the evacuation routes. Transit resources play an important role in an evacuation, removing many people from an evacuated area while making efficient use of limited capacity. Additional shared transit resources may be added and managed in evacuation scenarios. Resource requirements are forecast based on the evacuation plans, and the necessary resources are located, shared between agencies if necessary, and deployed at the right locations at the appropriate times.

Evacuations are also supported by PS14, the "Disaster Traveler Information" service package, which keeps the public informed during evacuations. See that service package for more information.

- Bis-Man: This SP is reserved as a future package for coordination with the statewide architecture.

PT01: Transit Vehicle Tracking (Existing)

National architecture description: This service package monitors current transit vehicle location using an Automated Vehicle Location System. The location data may be used to determine real time schedule adherence and update the transit system's schedule in real–time.

- Bis-Man: CAT buses have AVL on both fixed routes and dynamic transit vehicles.

PT02: Transit Fixed-Route Operations (Existing)

National architecture description: This service package performs automated dispatch and system monitoring for fixed–route and flexible–route transit services. This service performs scheduling activities including the creation of schedules, blocks and runs, as well as operator assignment. This service monitors the transit vehicle trip performance against the schedule and provides information displays at the Transit Management Center.

- Bis-Man: CAT provides fixed-route service and utilizes a central software system to manage operations. However, schedules and operators are assigned manually.

PT03: Dynamic Transit Operations (Existing)

National architecture description: The Dynamic Transit Operations service package allows travelers to request trips and obtain itineraries using a personal device such as a smart phone, tablet, or personal computer. The trips and itineraries cover multiple transportation services (public transportation modes, private transportation services, shared–ride, walking and biking). This service package builds on existing technology systems such as computer–aided dispatch/ automated vehicle location (CAD/AVL) systems and automated scheduling software, providing a coordination function within and between transit providers that would dynamically schedule and dispatch or modify the route of an in–service vehicle by matching compatible trips together. TI06 covers other shared use transportation options.

- Bis-Man: CAT offers dial-a-ride service and utilizes a software system to manage operations with at least a day advance reservation.

PT04: Transit Fare Collection Management (Existing)

National architecture description: This service package manages transit fare collection on–board transit vehicles and at transit stops using electronic means. It allows transit users to use a traveler card or other electronic payment device such as a smart phone. Readers located either in the infrastructure or on–board the transit vehicles enable electronic fare payment. Data is processed, stored, and displayed on the transit vehicle and communicated as needed to the Transit Management Center.

- Bis-Man: CAT uses electronic fare boxes that allow payment through a variety of methods, including a smart card and a smartphone mobile application. The fare box system comes with central software to manage fare collection. With the new transit facility, data can be downloaded wirelessly from the buses at the station.

PT05: Transit Security (Existing)

National architecture description: This service package provides for the physical security of transit passengers and transit vehicle operators. On–board equipment performs surveillance and sensor monitoring in order to identify potentially hazardous situations. The surveillance equipment includes video (e.g., CCTV cameras), audio systems and/or event recorder systems. The sensor equipment includes threat sensors (e.g., chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors) and object detection sensors (e.g., metal detectors). Transit user or transit vehicle operator activated alarms are provided on–board. Public areas (e.g., transit stops, park and ride lots, stations) are also monitored with similar surveillance and sensor equipment and provided with transit user activated alarms. In addition this service package provides surveillance and sensor monitoring of non–public areas of transit facilities (e.g., transit yards) and transit infrastructure such as bridges, tunnels, and transit railways or bus rapid transit (BRT) guideways. The surveillance equipment includes video and/or audio systems. The sensor equipment includes threat sensors and object detection sensors as described above as well as, intrusion or motion detection sensors and infrastructure integrity monitoring (e.g., rail track continuity checking or bridge structural integrity monitoring).

Most of the surveillance and sensor data that is collected by this service package may be monitored by either the Emergency Management Center or the Transit Management Center, providing two possible approaches to implementing this service package. This service package also supports remote transit vehicle disabling and transit vehicle operator authentication by the Transit Management Center.

- Bis-Man: CAT has video and audio surveillance onboard all their vehicles. The recordings are utilized for incident resolution, and CAT will be able to download recordings both locally or wirelessly in the transit facility.

PT06: Transit Fleet Management (Existing)

National architecture description: This service package supports automatic transit maintenance scheduling and monitoring. On–board condition sensors monitor system status and transmit critical status information to the Transit Management Center. The Transit Management Center processes this data and schedules preventative and corrective maintenance. The service package also supports the day to day management of the transit fleet inventory, including the assignment of specific transit vehicles to blocks and the assignment of transit vehicle operators to runs.

- Bis-Man: CAT utilizes a web portal software system to track the scheduling of routine maintenance and maintenance based on diagnostics data from the vehicle. With the operations contract with National Express, all planned maintenance is done in-house.

PT 07: Transit Passenger Counting (Planned)

This service package counts the number of passengers entering and exiting a transit vehicle using sensors mounted on the vehicle and communicates the collected passenger data back to the management center. The collected data can be used to calculate reliable ridership figures and measure passenger load information at particular stops.

- Bis-Man: The central software for the fixed-route system can report the passenger count data. Although the bus has the automatic passenger counting capability, this service is still completed manually by the driver.

PT08: Transit Traveler Information (Existing)

National architecture description: This service package provides transit users at transit stops and on–board transit vehicles with ready access to transit information. The information services include transit stop annunciation, imminent arrival signs, and real–time transit schedule displays that are of general interest to transit users. Systems that provide custom transit trip itineraries and other tailored transit information services are also represented by this service package.

- Bis-Man: In addition to electronic signs, CAT uses the web to provide real-time tracking on bus arrival and capacity.

PT09: Transit Signal Priority (Future)

National architecture description: The Transit Signal Priority service package uses transit vehicle to infrastructure communications to allow a transit vehicle to request priority at one or a series of intersections. The service package provides feedback to the transit driver indicating whether the signal priority has been granted or not. This service package can contribute to improved operating performance of the transit vehicles by reducing the time spent stopped at a red light.

- Bis-Man: CAT fixed-route vehicles are strategically planned to avoid delay due to signals. Therefore, this service package is retained for future reference with increasing traffic demand in the region.

PT16: Route ID for the Visually Impaired (Existing)

This service package assists visually impaired travelers to identify the appropriate bus and route to their intended destination. It provides information from bus stop infrastructure to visually impaired travelers portable devices that can be converted to audible information regarding the appropriate bus and route. It also allows the visually impaired traveler to query the portable device to identify route options.

- Bis-Man: All CAT buses are ADA compliant with a ramp and audible route information announcement.

TM01: Infrastructure-Based Traffic Surveillance (Existing)

National architecture description: This service package includes traffic detectors, other surveillance equipment, the supporting field equipment, and Center to Field communications to transmit the collected data back to the Traffic Management Center. The derived data can be used locally such as when traffic detectors are connected directly to a signal control system or remotely (e.g., when a CCTV system sends data back to the Traffic Management Center). The data generated by this service package enables traffic managers to monitor traffic and road conditions, identify and verify incidents, detect faults in indicator operations, and collect census data for traffic strategy development and long range planning. The collected data can also be analyzed and made available to users and the Traveler Information Center physical object.

- Bis-Man: Both City of Bismarck and Mandan traffic signals have video detection capability with communication capability over fiber, cellular and co-axial cable.

TM03: Traffic Signal Control (Existing)

National architecture description: This service package provides the central control and monitoring equipment, communication links, and the signal control equipment that support traffic control at signalized intersections. A range of traffic signal control systems are represented by this service package ranging from fixed–schedule control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests. This service package is generally an intra–jurisdictional package. Systems that achieve coordination across jurisdictions by using a common time base or other strategies that do not require real time coordination would also

be represented by this package. Coordination of traffic signal systems using real–time communications is covered in the TM07–Regional Traffic Management service package. This service package is consistent with typical traffic signal control systems.

- Bis-Man: The City of Bismack Traffic is working towards a traffic operations center (TOC) for better coordination and management of the traffic signal. Based on the different coordination and communication nature, two separate instances under this service package are proposed for the city of Bismarck and the city of Mandan.

TM06: Traffic Information Dissemination (Planned)

This service package provides driver information using roadway equipment such as dynamic message signs or highway advisory radio. A wide range of information can be disseminated including traffic and road conditions, closure and detour information, travel restrictions, incident information, and emergency alerts and driver advisories. This package provides information to drivers at specific equipped locations on the road network. Careful placement of the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information. This package also covers the equipment and interfaces that provide traffic information from a traffic management center to the media (for instance via a direct tie-in between a traffic management center and radio or television station computer systems), Transit Management, Emergency Management, and Transportation Information Centers. A link to the Maintenance and Construction Management Center allows real time information on road/bridge closures and restrictions due to maintenance and construction activities to be disseminated.

- Bis-Man: Both engineering departments make public service announcements through various city departments, agencies, television, radio, and social media 48 hours before a scheduled project starts. Depending on the project, Bismarck can ensure advanced traveler information through their DMS installation in the right place.

TM07: Regional Traffic Management (Future)

National architecture description: This service package provides for the sharing of information and control among traffic management centers to support regional traffic management strategies. Regional traffic management strategies that are supported include inter–jurisdictional, real–time coordinated traffic signal control systems and coordination between freeway operations and traffic signal control within a corridor. This service package advances the TM03–Traffic Signal Control and TM05–Traffic Metering service packages by adding the communications links and integrated control strategies that enable integrated, interjurisdictional traffic management. The nature of optimization and extent of information and control sharing is determined through working arrangements between jurisdictions. This package relies principally on roadside instrumentation supported by the Traffic Signal Control and Traffic Metering service packages and adds hardware, software, and fixed–point communications capabilities to implement traffic management strategies that are coordinated between allied traffic management centers. Several levels of

coordination are supported from sharing of information through sharing of device control between traffic management centers.

- Bis-Man: This SP is reserved as a future package for coordination with the statewide architecture.

TM08: Traffic Incident Management System (Planned)

National architecture description: This service package manages both unexpected incidents and planned events so that the impact to the transportation network and traveler safety is minimized. The service package includes incident detection capabilities through roadside surveillance devices (e.g., CCTV) and through regional coordination with other traffic management, maintenance and construction management and emergency management centers as well as rail operations and event promoters. Information from these diverse sources is collected and correlated by this service package to detect and verify incidents and implement an appropriate response. This service package supports traffic operations personnel in developing an appropriate response in coordination with emergency management, maintenance and construction management, and other incident response personnel to confirmed incidents. The response may include traffic control strategy modifications or resource coordination between centers. Incident response also includes presentation of information to affected travelers using the Traffic Information Dissemination service package and dissemination of incident information to travelers through the Broadcast Traveler Information or Interactive Traveler Information service packages. The roadside equipment used to detect and verify incidents also allows the operator to monitor incident status as the response unfolds. The coordination with emergency management might be through a CAD system or through other communication with emergency personnel. The coordination can also extend to tow trucks and other allied response agencies and field service personnel. This service package is closely related with the Public Safety service packages, which focus on services that support first responders. In particular, local management of the incident using an incident command system is covered by PS02.

- Bis-Man: Both Bismarck and Mandan utilize CenCom to report any incidents on a collector road and above. For local roads, emergency responders in the region initiate incident response.

TM13: Standard Railroad Grade Crossing (Existing)

National architecture description: This service package manages highway traffic at highway–rail intersections (HRIs) where operational requirements do not dictate more advanced features (e.g., where rail operational speeds are less than 80 miles per hour). Both passive (e.g., the crossbuck sign) and active warning systems (e.g., flashing lights and gates) are supported. (Note that passive systems exercise only the single interface between the ITS Roadway Equipment and the Driver in the physical view.) These traditional HRI warning systems may also be augmented with other standard traffic management devices. The warning systems are activated on notification of an approaching train by interfaced wayside equipment. The equipment at the HRI may also be interconnected with adjacent signalized intersections so that local control can be adapted to highway–rail intersection

activities. Health monitoring of the HRI equipment and interfaces is performed; detected abnormalities are reported to both highway and railroad officials through wayside interfaces and interfaces to the Traffic Management Center.

- Bis-Man: Traffic network in the region is extensively supported by grade-separated rail crossing. All at-grade rail crossings are equipped with wayside detection that activates gates and warning systems in addition to preempting signalized intersections.

TM17: Speed Warning and Enforcement (Existing)

This service package monitors vehicle speeds and supports warning drivers when their speed is excessive. Also the service includes notifications to an enforcement agency to enforce the speed limit of the roadway. Speed monitoring can be made via spot speed or average speed measurements. Roadside equipment can display the speed of passing vehicles and/or suggest a safe driving speed. Environmental conditions and vehicle characteristics may be monitored and factored into the safe speed advisories that are provided to the motorist. For example, warnings can be generated recognizing the limitations of a given vehicle for the geometry of the roadway such as rollover risk for tall vehicles.

This service focuses on monitoring of vehicle speeds and enforcement of the speed limit while the variable speed limits service (covered in TM20-Variable Speed Limits service package) focuses on varying the posted speed limits to create more uniform speeds along a roadway, to promote safer driving during adverse conditions (such as fog) and/or to reduce air pollution.

- Bis-Man: Bismarck traffic engineering department has speed monitoring ability with their new radar system that validates the speed allocation in an accident-pone zone. Besides, PD from both cities have speed trailers for warning drivers and enforcing the acceptable speed.

WX01: Weather Data Collection (Future)

This service package collects current road and weather conditions using data collected from environmental sensors deployed on and about the roadway. It also collects data from vehicles in the road network that can be used to directly measure or infer current environmental conditions. It leverages vehicle on-board systems that measure temperature, sense current weather conditions (rain and sun sensors) and also can monitor aspects of the vehicle operational status (e.g., use of headlights, wipers, and traction control system) to gather information about local environmental conditions. In addition, environmental sensor systems located on Maintenance and Construction Vehicles are also potential data sources. The collected environmental data is used by the Weather Information Processing and Distribution service package to process the information and make decisions on operations. The collected environmental data may be aggregated, combined with data attributes and sent to meteorological systems for data qualification and further data consolidation. The service package may also request and receive qualified data sets from meteorological systems.

- Bis-Man: This SP is reserved as a future package for coordination with the statewide architecture.

6.0 OPERATIONAL CONCEPT

This section discusses the roles and responsibilities of stakeholders in the implementation and operation of the regional systems identified in the Bis-Man RA. The operational concept outlines the roles and responsibilities of relevant stakeholders for specific ITS service areas, i.e., emergency and incident management, maintenance and construction management, traffic management, and transit service. In addition to providing a snapshot of how things are done for a specific scenario, the operational concept explores additional integration opportunities in the region with a particular focus on stakeholder involvement.

The roles and responsibilities discussion under the operational concept may be categorized into implementation roles and operational roles. Implementation roles include project development, coordination, funding, and future maintenance. Operational roles focus on the technical aspects of how ITS services are performed and explore information sharing amongst the various stakeholders.

The set of service packages for the Bis-Man area was the deciding factor used for facilitating the operational concept development. From the Service Package graphics, stakeholders were able to identify their roles and responsibilities to be performed for given events, current links with other stakeholders, and additional links or coordination that could be achieved.

The mechanism for obtaining stakeholders' input relied on using small groups of stakeholders relevant to each service package. Once the small group discussions were completed, the results (i.e., customized service packages) were presented to all the stakeholders participating in the RA development.

The following section outlines the roles and responsibilities of stakeholders in the Bis-Man RA.

6.1 Operational Roles and Responsibilities

Table 4: List of Roles and Responsibilities

RR Area Name	Stakeholder	Roles and Responsibilities Description
Data Management for Bismarck-Mandan RA	Bis-Man Transit	Collect transit data., Provide better route planning based on the passenger usage analysis.
	Bismarck Engineering	Switching to a coordinated centracs system with all intersections.
	CenCom	Coordinate with other departments to archive CAD and other dispatch records., Provide a disaster recovery data backup.
	Mandan Engineering	Setting up a coordinated system for some intersections to take the traffic data to the city hall.
Emergency and Incident Management for Bismarck-Mandan	Bis-Man Emergency Management Agencies	Respond to incidents., Coordinate with other emergency management agencies.
	Bismarck Emergency Management	Coordinate with other cities of Bismarck emergency management agencies.
	Bismarck Engineering	Coordinate with emergency management, maintenance, and construction agencies in the city of Bismarck.
	Bismarck FD	Respond to incidents in the city of Bismarck., Coordinate with other emergency management agencies in the region.
	Bismarck PD	Coordinate with other emergency management agencies in the region., Provide 911 service to the city of Bismarck., Respond to incidents in the city of Bismarck.
	BRFD	Respond to incidents in the city of Lincoln and other Rural Fire Protection District.
	Burleigh County OEM	Provide 911 service for Bismarck and Burleigh., Provides dispatch service., Coordinate emergency response.
	Burleigh County Sheriff	Respond to incidents in the Burleigh County system.

RR Area Name	Stakeholder	Roles and Responsibilities Description
	CenCom	Receives Morton County's dispatch communication over state radio., Provide PSAP 9-1-1 and dispatch services in the city of Bismarck, Mandan, Lincoln, and Burleigh County., Coordinate dispatch communication with the public works department during winter.
	Lincoln PD	Coordinate with other emergency management agencies in the region., Respond to incidents in the city of Lincoln., Provide 911 service to the city of Lincoln.
	Mandan Engineering	Coordinate with emergency management, maintenance, and construction agencies in the city of Mandan.
	Mandan FD	Respond to incidents in the city of Mandan., Coordinate with other emergency management agencies in the region.
	Mandan PD	Respond to incidents in the city of Mandan., Provide 911 service to the city of Mandan., Coordinate with other emergency management agencies in the region.
	Metro Area Ambulance	Coordinate with other emergency management agencies in the region., Coordinate with other emergency management agencies.
	Morton County OEM	Provide 911 service for Morton County., Provides dispatch to Morton County., Coordinate emergency response.
	Morton County Sheriff	Respond to incidents on the Morton County system.
	ND DES	Issue Amber Alerts., Provide dispatch for Morton County and NDHP.
	NDDOT Bis Dist	Provide resources
	NDHP Bismarck	Respond to incidents on the ND state system
Maintenance and Construction for Bismarck-Mandan RA	Bis-Man Transit	Tracks the preventative maintenance and any repair required.
	Bismarck PW	Maintenance of street lights and traffic signals in the city of Bismarck., Perform winter maintenance activities (snowplow operations, sanding, anti-icing) in the city of Bismarck., Bismarck city system roadway maintenance (cleaning, repair) activities.

RR Area Name	Stakeholder	Roles and Responsibilities Description
	Lincoln PW	Perform winter maintenance activities in the city of Lincoln., Lincoln city system roadway maintenance activities., Maintenance of street lights and traffic signals in the city of Lincoln.
	Mandan PW	Perform winter maintenance activities (snowplow operations, sanding, anti-icing) in the city of Mandan., Mandan city system roadway maintenance activities., Maintenance of street lights and traffic signals in the city of Mandan.
	Morton County Engineering	Perform winter maintenance activities (snowplow operations, sanding, anti-icing) in Morton County.
	NDDOT Bis Dist	Perform winter maintenance activities (snowplow operations, sanding, anti-icing) in the ND state system., ND state system roadway construction, and maintenance activities.
Traffic Management for Bismarck-Mandan RA	Bismarck Engineering	Coordinate with NDDOT Bis District., Design, operate, and maintain signal control in the city of Bismarck.
	Mandan Engineering	Design, operate, and maintain signal control in the city of Mandan., Coordinate with NDDOT Bis District.
Transit Services for Bismarck-Mandan RA	Bis-Man Transit	Provide dynamic transit (demand response) services in the Bismarck Mandan area., Ensure driver compliance by random checking on vehicle and driver camera., Provide real-time tracking on arrival and capacity of a vehicle to the users., Retrieve data from a stationed vehicle at the facility based on an incident or lodged complaint., Provide transit fixed route operations for the Bismarck Mandan area.

7.0 AGREEMENTS

This section briefly outlines potential agreements needed to support the Bis-Man RA. The process of identifying needed agreements relied on the Service Packages to identify potential roles and responsibilities as well as interfaces. Anytime agencies shared operations of a system or shared formal access to system control and data, a potential agreement was flagged. Discussions with stakeholders helped in finalizing the list of agreements taking into consideration existing agreements with other agencies that they have in place as well as their own agency requirements.

The table on the following page shows a summary of potential agreements in the Bis-Man area. The table provides the following information for each agreement:

1. Area
    a. The service area where the agreement is needed
2. Purpose
    a. A brief statement regarding what the agreement addresses
3. Stakeholders
    a. List of stakeholders (agencies) which would be included in the agreement
4. Issues
    a. List of specific issues to be included in the agreement

Table 5: List of Potential Agreements

Area	Purpose	Stakeholders	Issues
ITS Data Warehouse	Archival of ITS data from various agencies for the purpose of measuring and improving performance.	Bis-Man Emergency Management Agencies Bis-Man Transit Bismarck Engineering Bismarck PW Lincoln PW Mandan Engineering Mandan PW ND DES NDDOT Bis Dist	Information sharing for data archival
Network Surveillance	Share data.	Bismarck Engineering Mandan Engineering NDDOT Bis Dist	Access to sensors Access to databases Access to networks
Regional Traffic Management	Signal coordination between Bismarck and Mandan.	Bismarck Engineering Mandan Engineering	Field to field communication Data sharing
Traffic Incident Management System	Incident traffic response Sharing data (flow, video)	Bismarck PD Burleigh County Sheriff CenCom Lincoln PD Mandan PD Morton County Sheriff NDHP Bismarck	Communication links Response protocols
Traffic Information Dissemination	Coordinate traveler information	Bismarck Engineering CenCom Mandan Engineering NDDOT Bis Dist	Notification protocols Communication links
Transit Security	Response to incidents on buses	Bis-Man Transit Bismarck PD Mandan PD	Response protocols Communication links

8.0 FUNCTIONAL REQUIREMENTS

This section discusses detailed functional requirements for the user services and service packages identified for the Bis-Man region. The requirements were selected from the National ITS Architecture template based on desired functions for each system. RAD-IT software was used to build the functional requirements and produce a Functional Requirements Report.

A sample of the functional requirements is listed in the table below. The table contains the following columns with the headings described as follows:

1. Element Name: the element from Bis-Man inventory (section 4.5)
2. Functional Object: element mapping to the national ITS architecture
3. Requirement number (Req#)
4. Requirement
5. Status: Existing or planned.

Due to the length of the Functional Requirements table, it is included in Appendix B. A sample table is provided below.

Table 6: Sample of Functional Requirements

Element Name	**Functional Object**	**Req #**	**Requirement**	**Status**
Bis-Man Data Archival	Archive Data Repository	1	The center shall collect data from centers.	Existing
		3	The center shall store collected data in an information repository.	Existing
		6	The center shall include capabilities for archive-to-archive coordination.	Existing
		7	The center shall provide the capability to execute methods on the incoming data such as cleansing, summarizations, aggregations, or transformations applied to the data before it is stored in the archive.	Existing
		8	The center shall collect data from data distribution systems and other data sources.	Existing
		11	The center shall respond to requests for archive data from archive data users (centers, field devices).	Existing
	Archive Government Reporting	1	The center shall provide archive data to federal, state, and local government reporting systems.	Existing
		2	The center shall respond to requests for government report data.	Existing

9.0 ITS STANDARDS

This section identifies applicable ITS Standards identified for the Bis-Man RA. It should be noted that the development of ITS Standards is an ongoing process. Therefore, the set of applicable ITS standards should be updated as new standards are approved. The following table shows applicable standards for the Bis-Man RA based on RAD-IT output. The information in the table is arranged in the following columns:

- SDO: standard development organization
- Standard Number: name and ID number of the document containing the standard
- Standard Title
- Element: the relevant Bis-Man architecture element

Table 7: List of Standards

SDO	Standard Number	Standard Title	Element Name
Advanced Traffic Controller Joint Committee	ITE ATC 5201	Advanced Transportation Controller	Bismarck PW Field Devices, Bismarck TOC Field Devices, Mandan Engineering Field Devices, NDDOT District Field Devices
Advanced Traffic Controller Joint Committee	ITE ATC 5202	Model 2070 Controller Standard	Bismarck PW Field Devices, Bismarck TOC Field Devices, Mandan Engineering Field Devices, NDDOT District Field Devices
Advanced Traffic Controller Joint Committee	ITE ATC 5301	Intelligent Transportation System Standard Specification for Roadside Cabinets	Bismarck PW Field Devices, Bismarck TOC Field Devices, Mandan Engineering Field Devices, NDDOT District Field Devices
Advanced Traffic Controller Joint Committee	ITE ATC 5401	Application Programming Interface Standard for the Advanced Transportation Controller	Bismarck PW Field Devices, Bismarck TOC Field Devices, Mandan Engineering Field Devices, NDDOT District Field Devices

SDO	Standard Number	Standard Title	Element Name
International Organization for Standardization	ISO 21217	Intelligent transport systems -- Communications access for land mobiles (CALM) -- Architecture	Bis-Man Data Archival, Bis-Man Emergency Vehicles, Bis-Man Transit Center, Bis-Man Transit Vehicles, Bismarck FD Vehicles, Bismarck PD Vehicles, Bismarck PW Field Devices, Bismarck PW Operations Center, Bismarck PW Vehicles, Bismarck TOC, Bismarck TOC Field Devices, Burleigh County Sheriff Vehicles, Central Dakota Communications Center, Government Reporting Systems, Lincoln PW, Lincoln PW Vehicles, Mandan Engineering Field Devices, Mandan FD Vehicles, Mandan PD Vehicles, Mandan PW Operations Center, Mandan PW Vehicles, Mandan Traffic Engineering, Media, Metro Area Ambulance Vehicles, Morton County Communications, Morton County Sheriff Vehicles, NDDOT District Field Devices, NDDOT District Office, NDDOT District Vehicles, NDHP Vehicles, State Radio, Transit Fare Card, Traveler Card
National Electrical Manufacturers Association	NEMA TS 5	Portable Traffic Signal Systems (PTSS) Standard	Bismarck PW Field Devices, Bismarck TOC Field Devices, Mandan Engineering Field Devices, NDDOT District Field Devices
National Electrical Manufacturers Association	NEMA TS 8	Cyber and Physical Security for Intelligent Transportation Systems	Bis-Man Data Archival, Bismarck PW Field Devices, Bismarck PW Operations Center, Bismarck TOC, Bismarck TOC Field Devices, Central Dakota Communications Center, Lincoln PW, Mandan Engineering Field Devices, Mandan PW Operations Center, Mandan Traffic Engineering, Morton County Communications, NDDOT District Field Devices, NDDOT District Office, State Radio
National Electrical Manufacturers Association	NEMA TS2	Traffic Controller Assemblies with NTCIP Requirements	Bismarck PW Field Devices, Bismarck TOC Field Devices, Mandan Engineering Field Devices, NDDOT District Field Devices

SDO	Standard Number	Standard Title	Element Name
National Electrical Manufacturers Association	NEMA TS4	Hardware Standards for Dynamic Message Signs (DMS) With NTCIP Requirements	Bismarck PW Field Devices, Bismarck TOC Field Devices, Mandan Engineering Field Devices, NDDOT District Field Devices
National Institute for Standards and Technology	NIST FIPS PUB 140-2	Security Requirements for Cryptographic Modules	Bis-Man Data Archival, Bis-Man Emergency Vehicles, Bis-Man Transit Center, Bis-Man Transit Vehicles, Bismarck FD Vehicles, Bismarck PD Vehicles, Bismarck PW Field Devices, Bismarck PW Operations Center, Bismarck PW Vehicles, Bismarck TOC, Bismarck TOC Field Devices, Burleigh County Sheriff Vehicles, Central Dakota Communications Center, Government Reporting Systems, Lincoln PW, Lincoln PW Vehicles, Mandan Engineering Field Devices, Mandan FD Vehicles, Mandan PD Vehicles, Mandan PW Operations Center, Mandan PW Vehicles, Mandan Traffic Engineering, Media, Metro Area Ambulance Vehicles, Morton County Communications, Morton County Sheriff Vehicles, NDDOT District Field Devices, NDDOT District Office, NDDOT District Vehicles, NDHP Vehicles, State Radio, Transit Fare Card, Traveler Card

10.0 PLANNING ASPECTS

10.1 Planning and the Regional ITS Architecture

Safety & Security

Goal Statement:

Increase the safety and security of the transportation system for motorized and non-motorized users and reduce fatalities and serious injuries in the region.

Objective 1B: Provide a safe and secure environment for transit system riders.

Associated Service Package

PT05: Transit Security.

Objective1C: Enhance transportation security and reliability by developing strategies to address critical transportation assets identified that will facilitate the rapid movement of first responders and support incident management during times of emergency.

Associated Service Package

PS 03: Emergency Vehicle Preemption.

Infrastructure Condition

Goal Statement:

Emphasize the preservation of the existing transportation system that includes pavements and bridges and promote efficient system management and operations.

Objective 2B: Maintain Street signage and visibility.

Associated Service Package

MC05: Roadway Maintenance and Construction.

Objective 2D: Maintain transit fleet, equipment, and facilities in a state of good repair as identified within the Transit Development Plan (TDP).

Associated Service Package

PT06: Transit Fleet Management.

Objective 2E: Maintain traffic signals, lighting, and other transportation ITS assets at acceptable levels.

Associated Service Package

MC05: Roadway Maintenance and Construction

Congestion Reduction

Goal Statement:

Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight to reduce traffic congestion and increase the system reliability.

Objective 3A: Implement projects and programs that will reduce travel delays on corridors that have an existing or proposed Level of Service (LOS) D or worse, to a LOS C or better after the improvement is made.

Associated Service Package

TM01: Infrastructure-Based Traffic Surveillance

Objective 3B: Provide and maintain corridors functionally classified as minor arterials and above that facilitate longer-distance travel within the region.

Associated Service Package

MC05: Roadway Maintenance and Construction

Objective 3C: Improve the continuity of the multimodal systems for pedestrians, cyclists, or transit riders; through improved network connections and reduction of system gaps.

Associated Service Package

PT08: Transit Traveler Information

System Reliability for Freight Movement and Economic Vitality

Goal Statement:

Support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency; enhance the integration and connectivity of the transportation system, across and between modes, for people and freight; and increase accessibility and mobility of people and freight.

Objective 4A: Enhance the efficient and safe movement of freight and goods including investments in congestion reduction and safety improvements on the critical urban freight corridors and other designated freight corridors.

Associated Service Package

TM13: Standard Railroad Grade Crossing.

Alternative Transportation Modes to Automobile Travel

Goal Statement:

Increase accessibility and mobility of people and freight; protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and State and local planned growth and economic development patterns; and enhance the integration and connectivity of the transportation system, across and between modes, for people and freight.

Objective 5A: Consider coordination with transit agencies to improve transit route efficiency, system productivity, and community awareness by implementing transportation investments that support the transit system.

Associated Service Package

PT09: Transit Signal Priority

Objective 5B: Improve transit and rideshare opportunities for travelers commuting into Bismarck-Mandan from outside the urban area

Associated Service Package

PT01: Transit Vehicle Tracking

PT02: Transit Fixed-Route Operations

PT03: Dynamic Transit Operations

Performance Measures

Performance measurement is a crosscutting activity throughout all the goals above to set measures designed to serve as a benchmark to evaluate and quantify progress. Performance measures can be supported by these service packages:

DM01: ITS Data Warehouse

DM02: Performance Monitoring

10.2 Regional ITS Architecture Maintenance

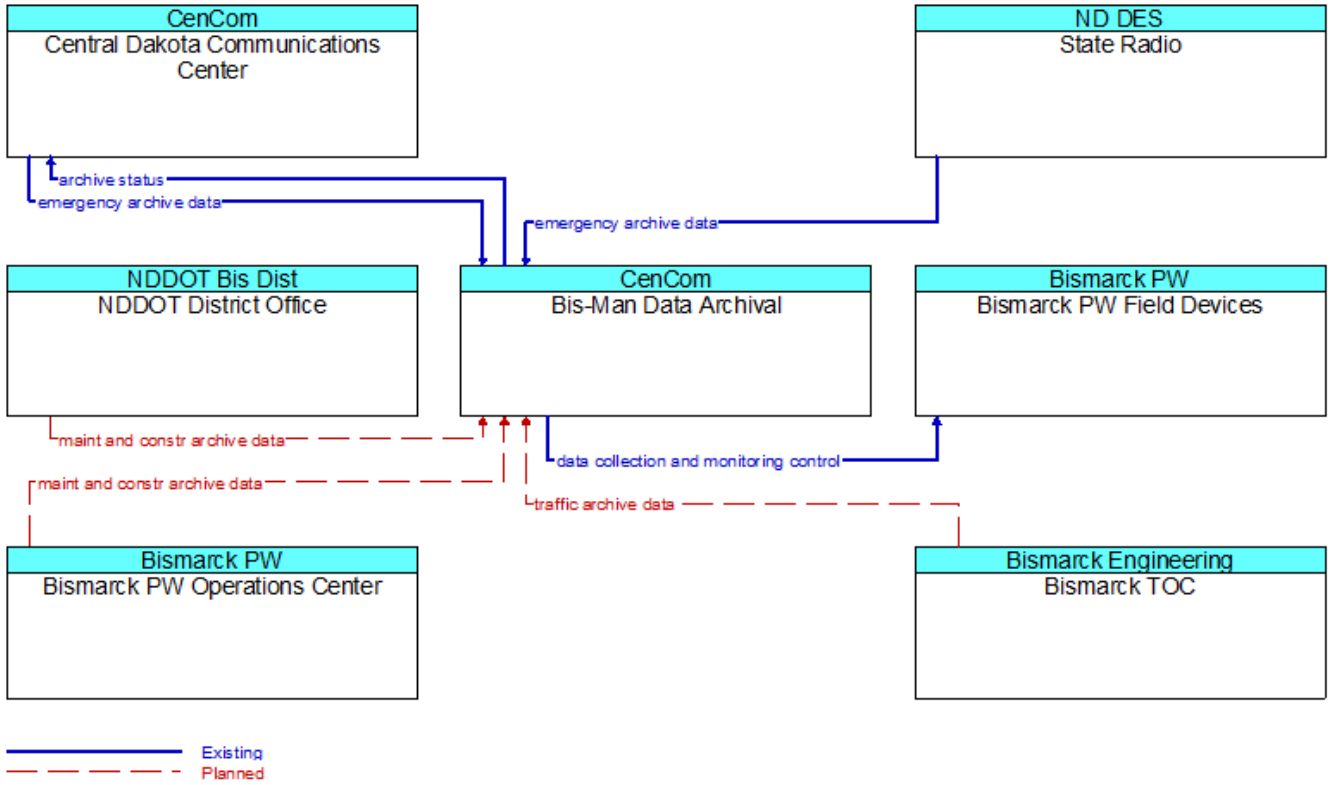
The Bismarck-Mandan MPO is responsible for maintaining and updating the Bis-Man Regional ITS Architecture. It is envisioned that the updates will be conducted every five years or as needed upon the deployment of major ITS projects in the area. The updates will account for any changes to existing systems, as well as changes to regional needs and priorities and changes in the National ITS Architecture.

APPENDIX-A

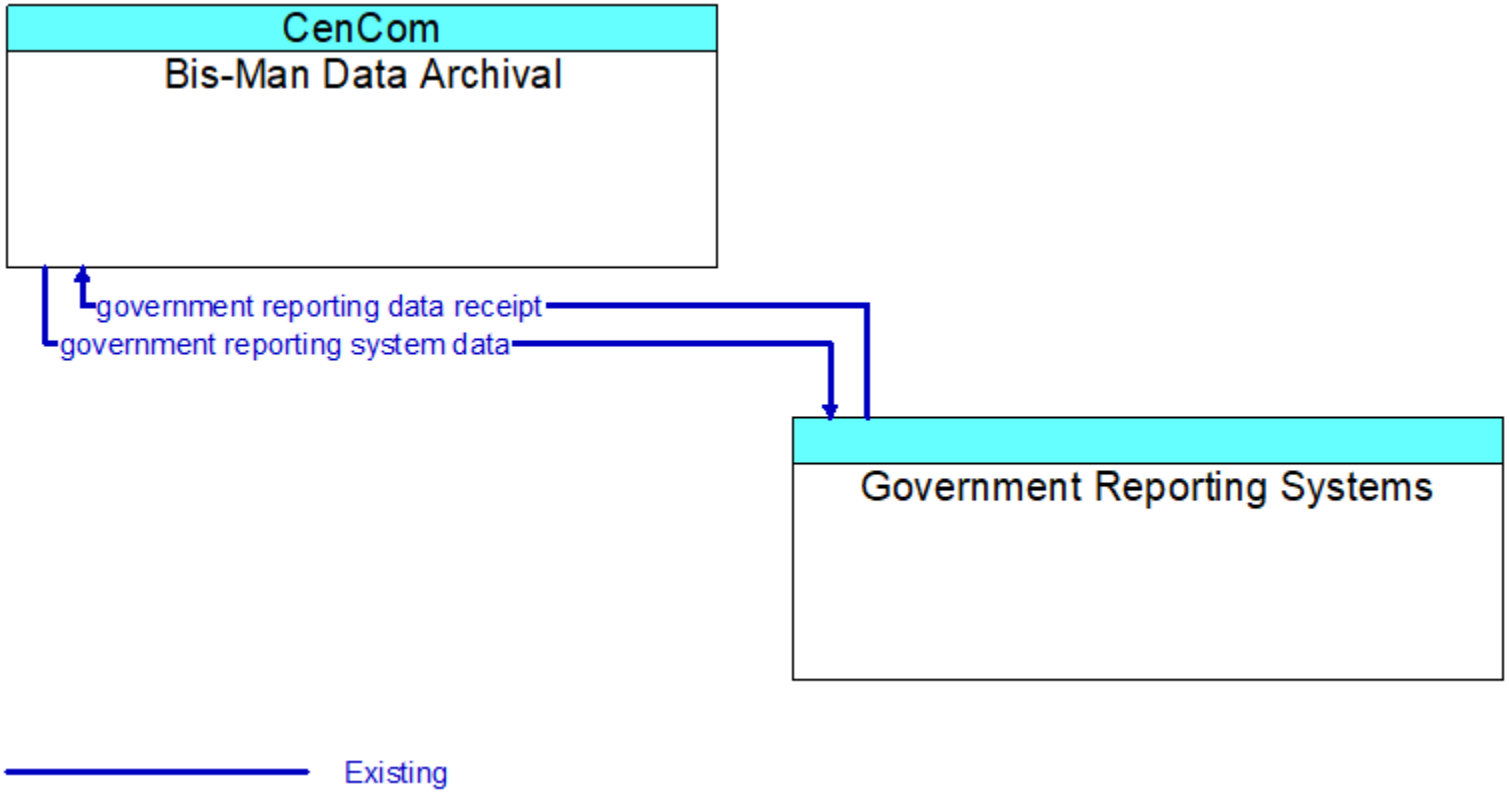
BISMARCK-MANDAN SERVICE PACKAGES AND INFORMATION FLOWS

The Service Package Diagrams are available electronically at: https://regional.atacenter.org/bisman/
Viewing electronically will allow for zooming and panning, which is required for the diagram's readability.

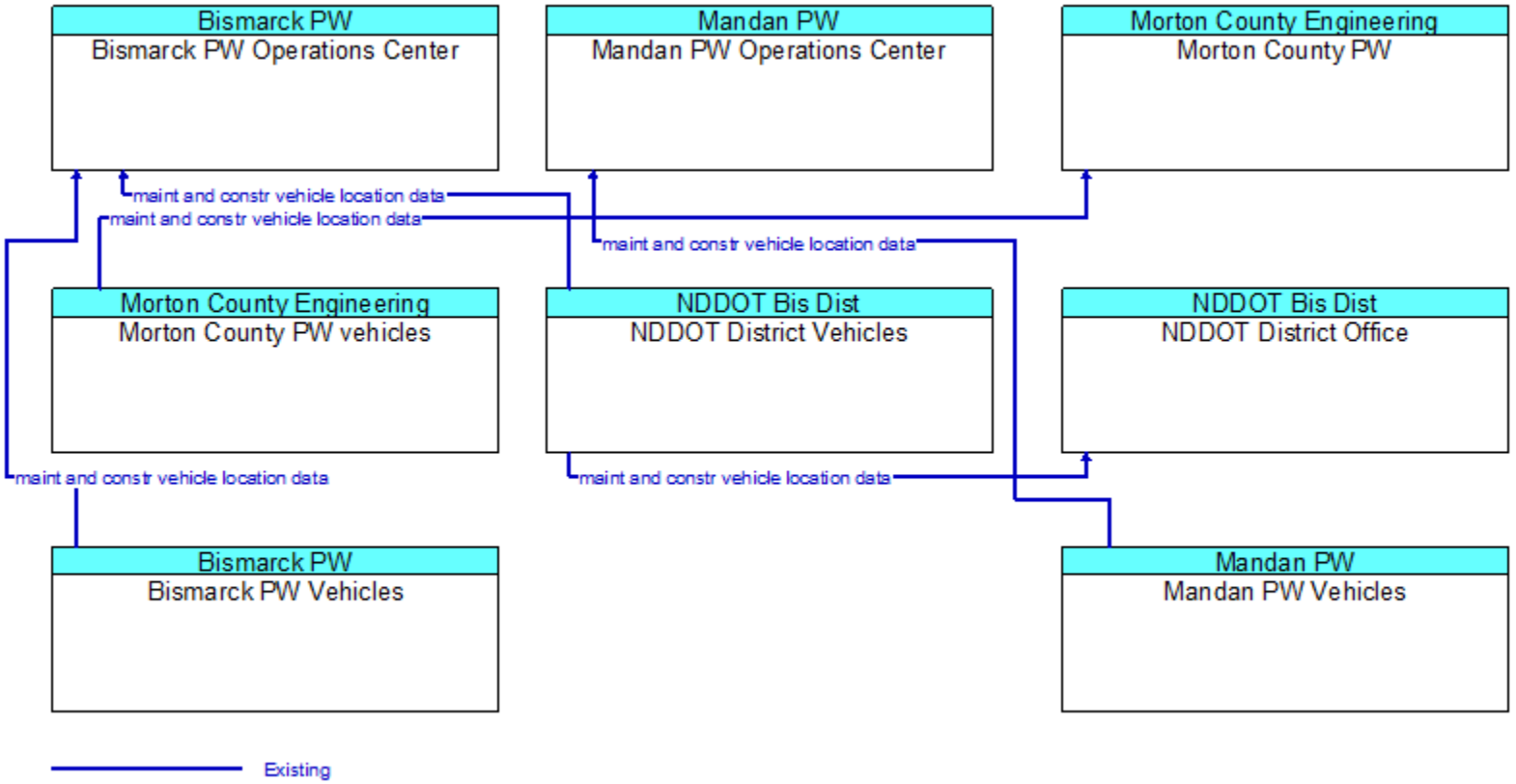
DM01 ITS Data Warehouse



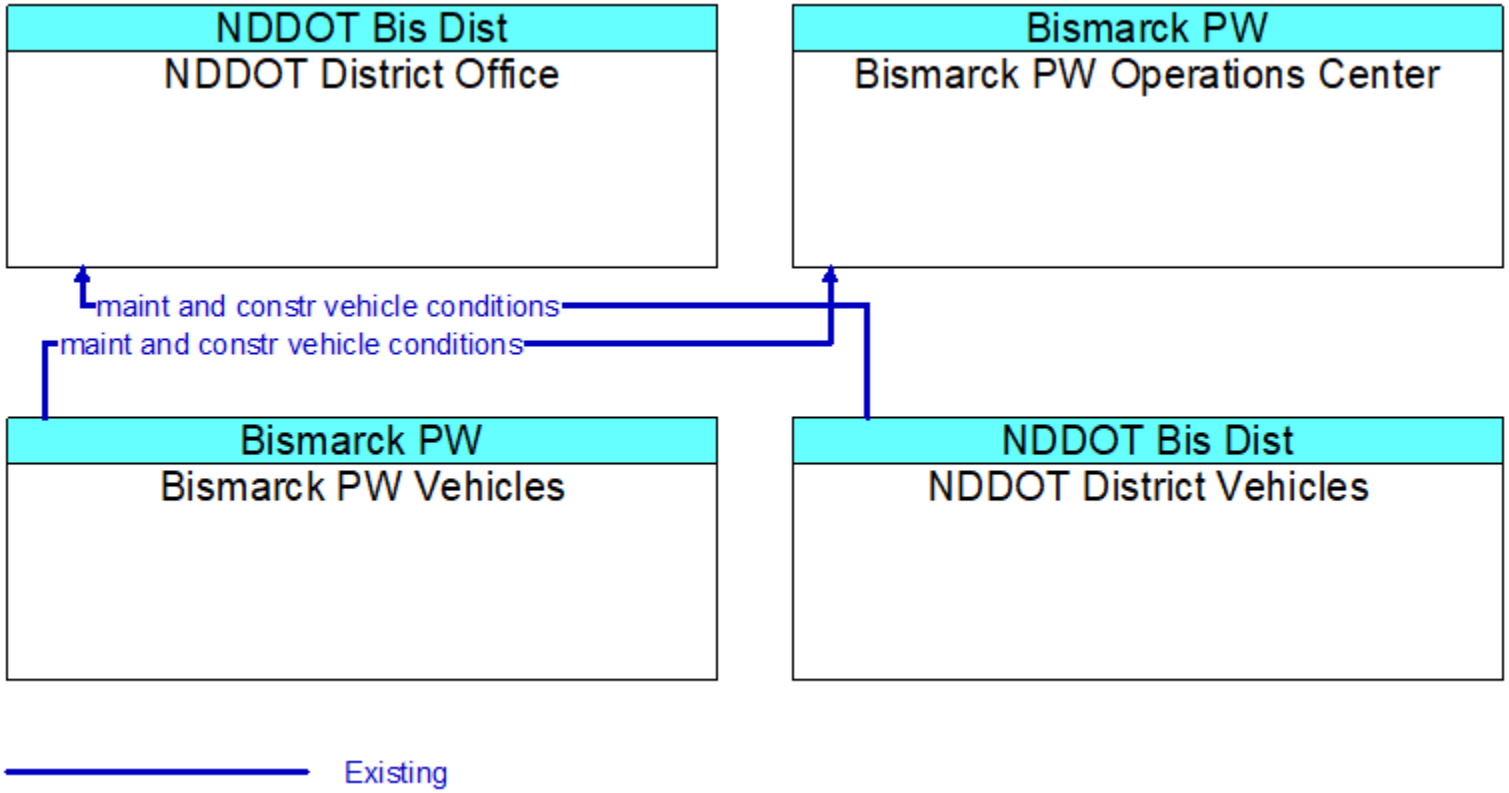
DM02 Performance Monitoring



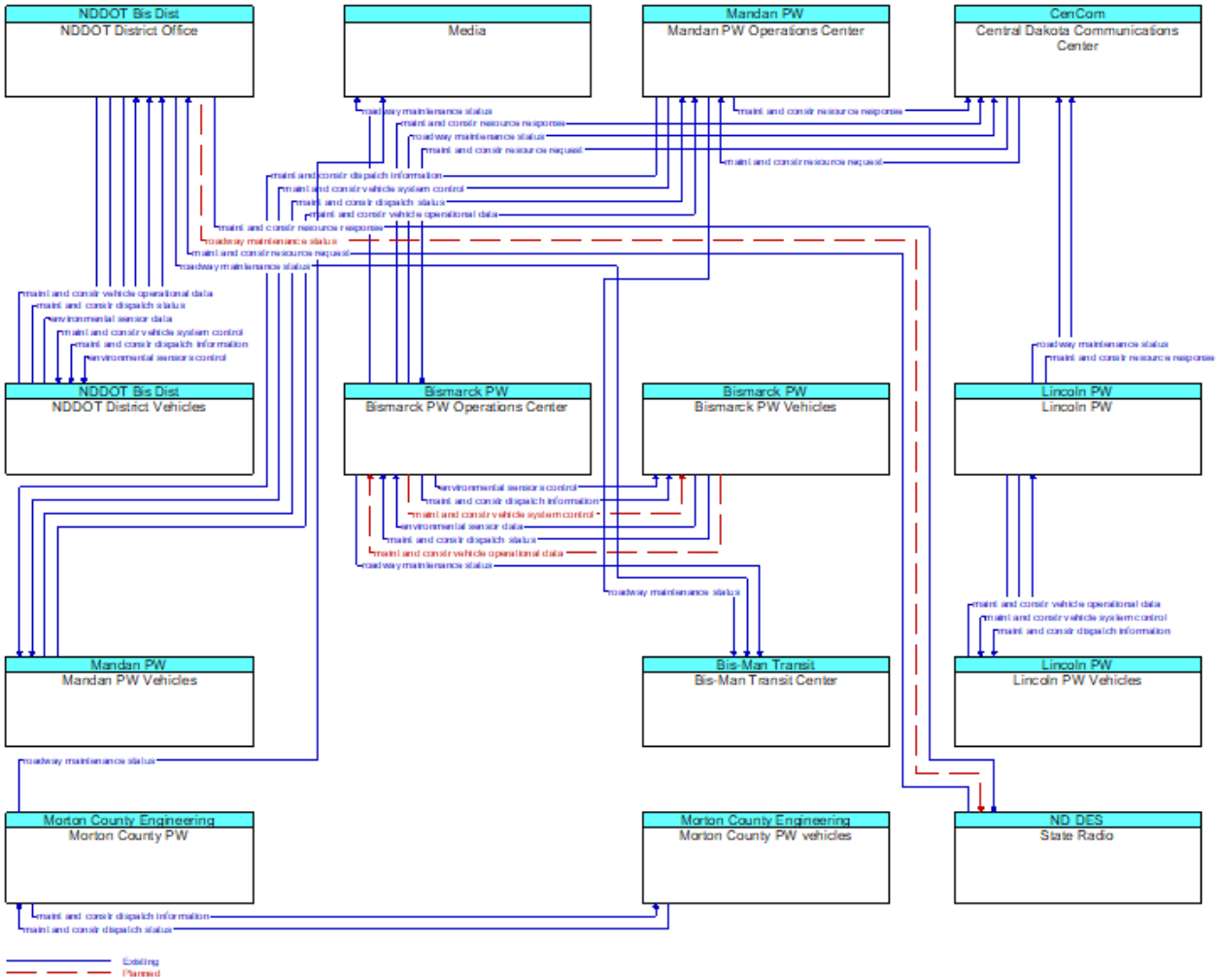
MC01 Maintenance and Construction Vehicle and Equipment Tracking



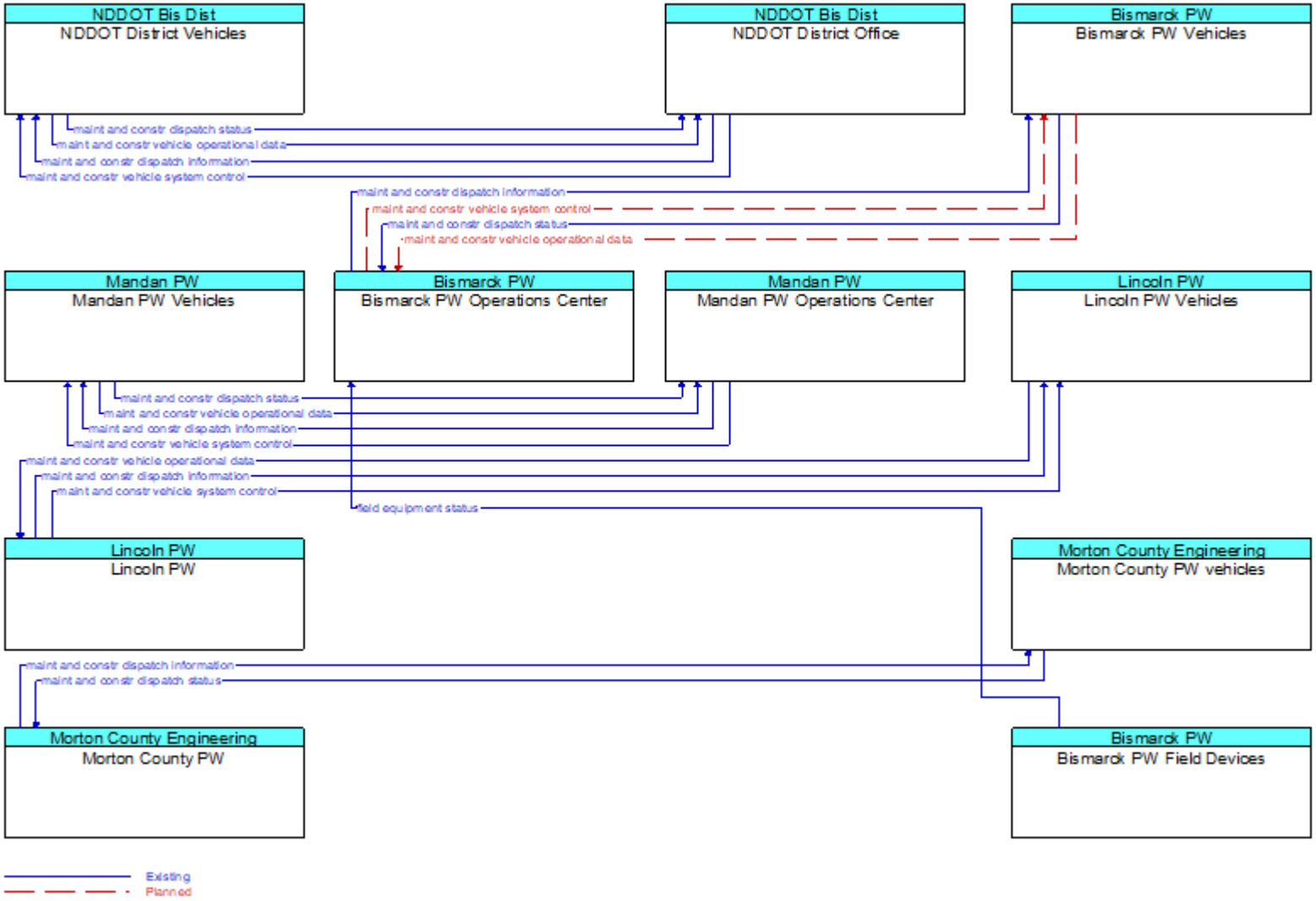
MC02 Maintenance and Construction Vehicle Maintenance



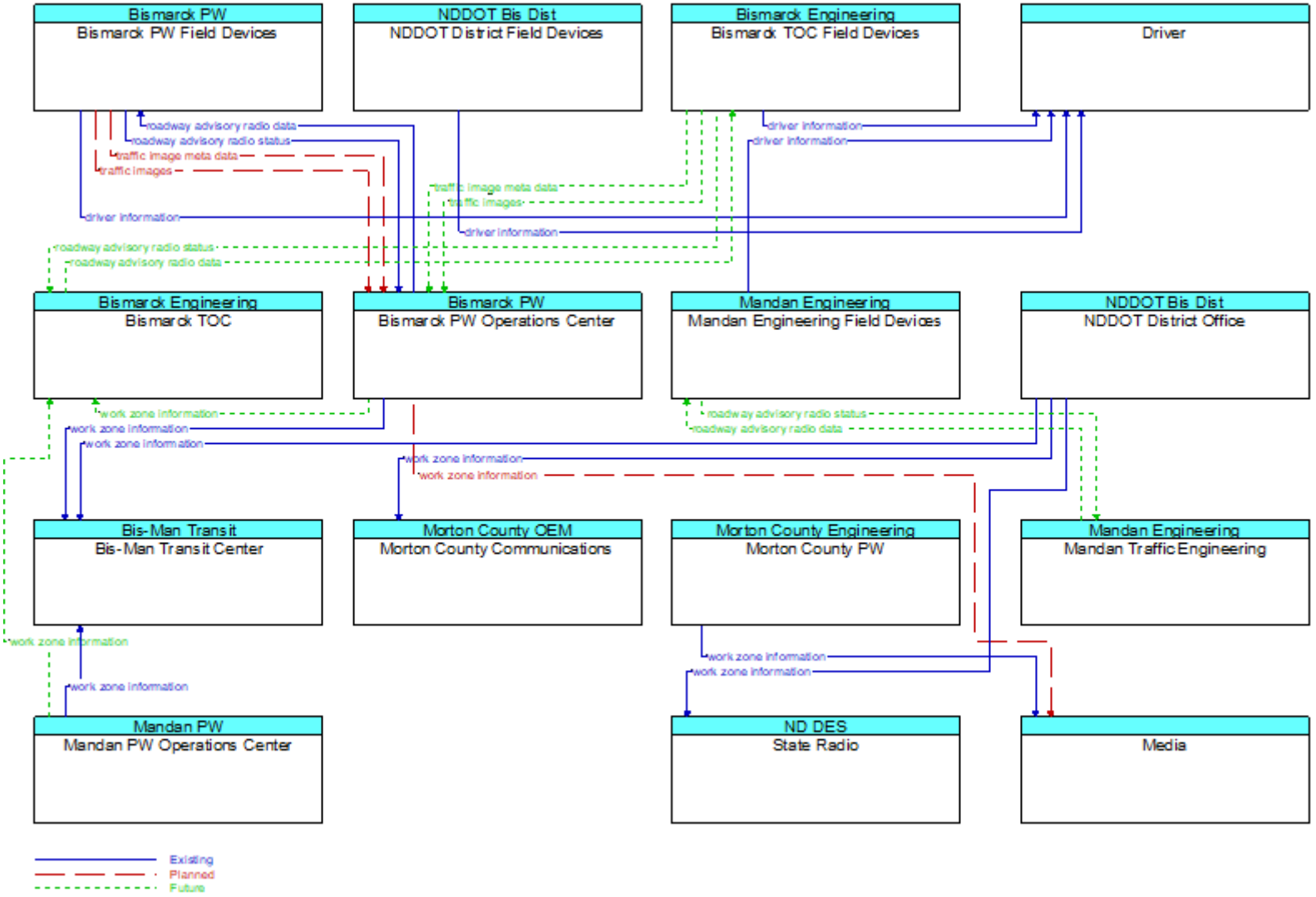
MC04 Winter Maintenance



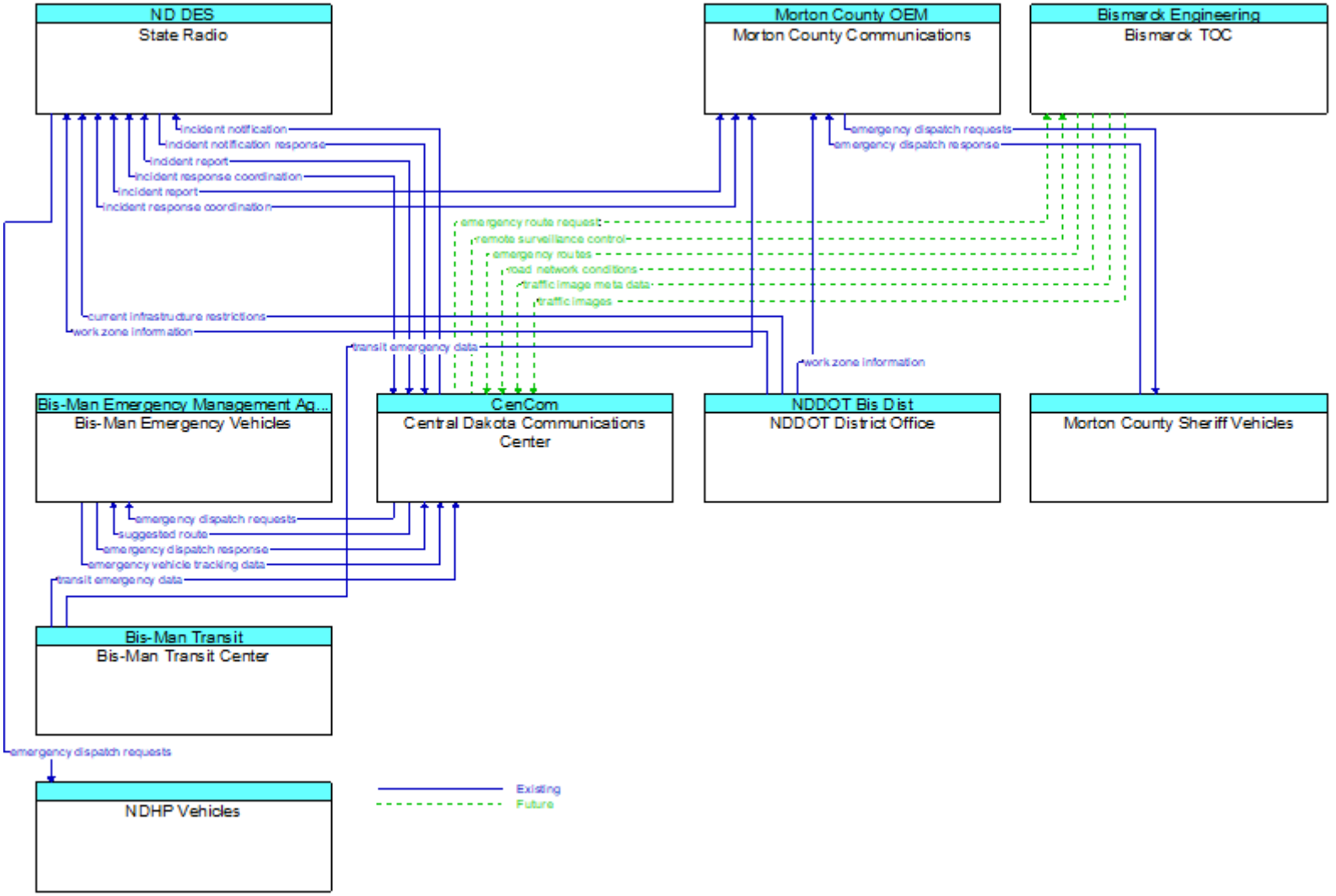
MC05 Roadway Maintenance and Construction



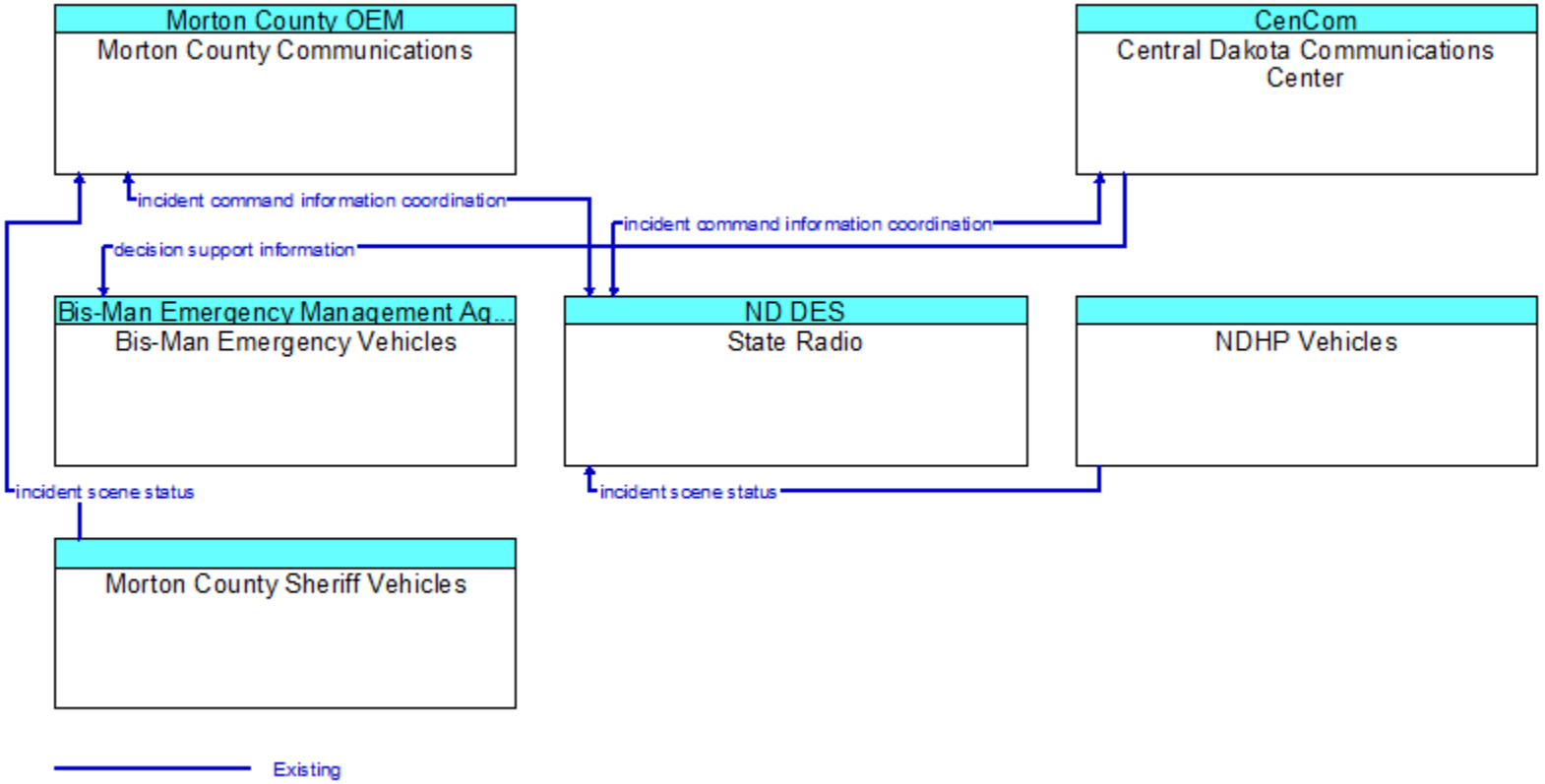
MC06 Work Zone Management



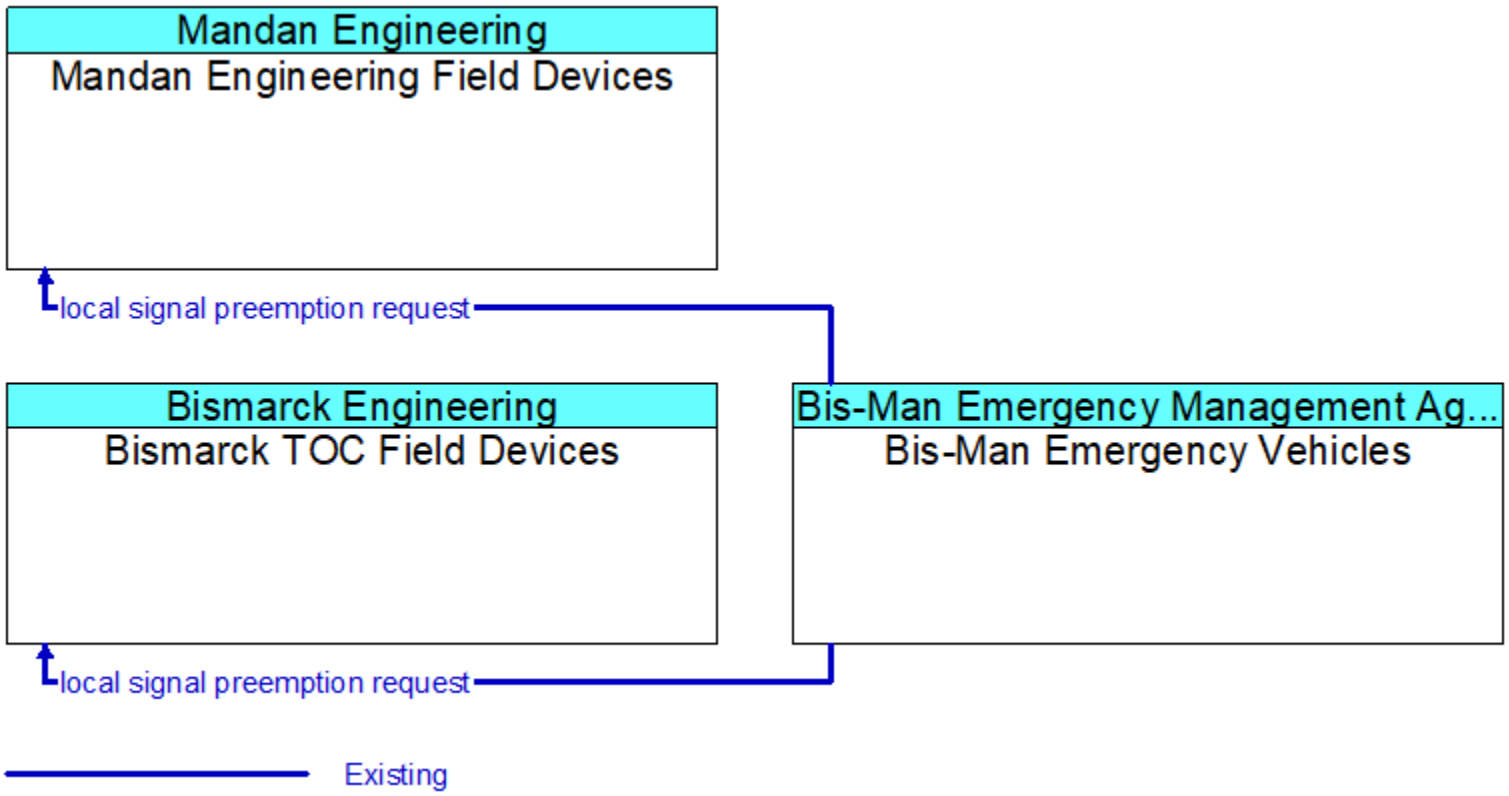
PS01 Emergency Call-Taking and Dispatch



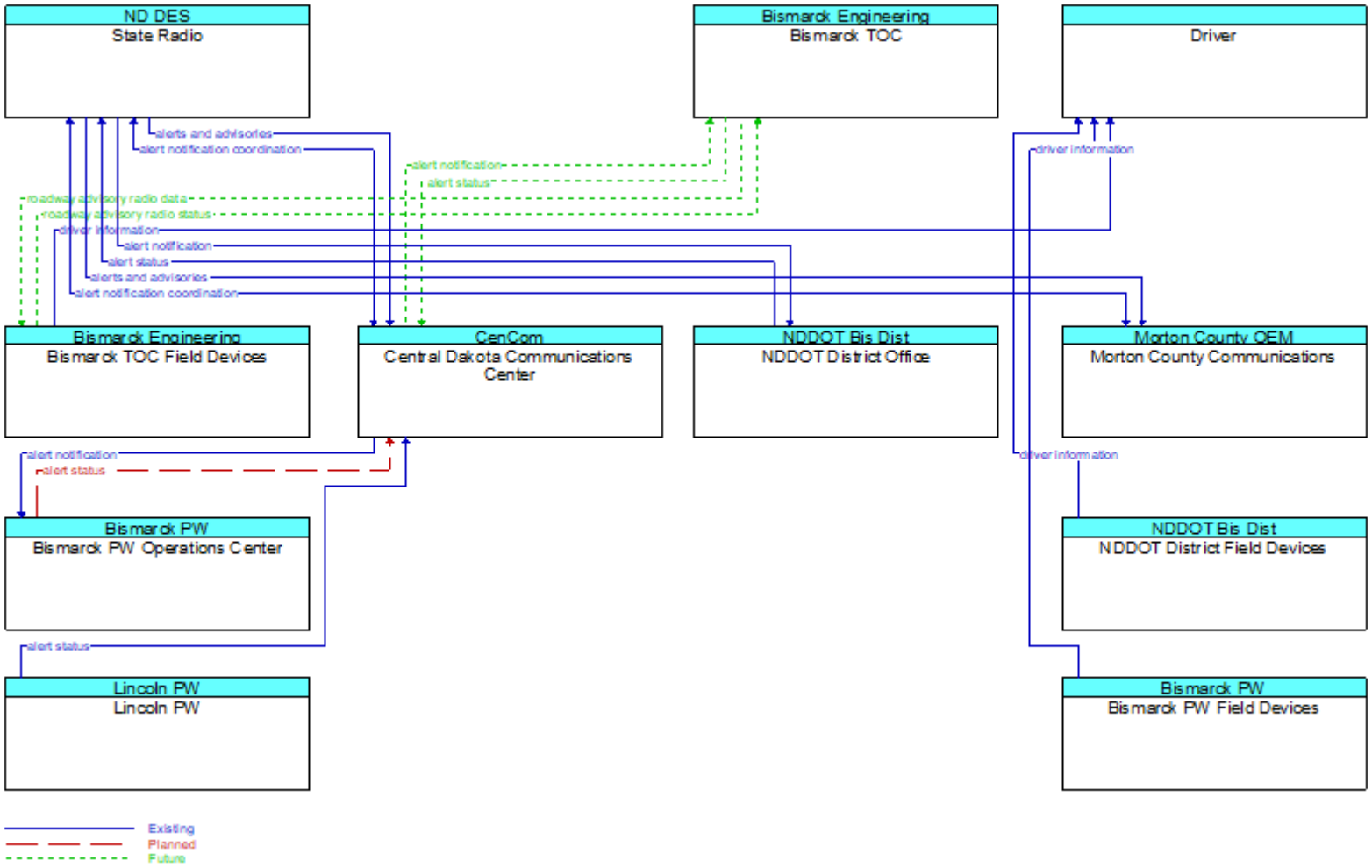
PS02 Emergency Response



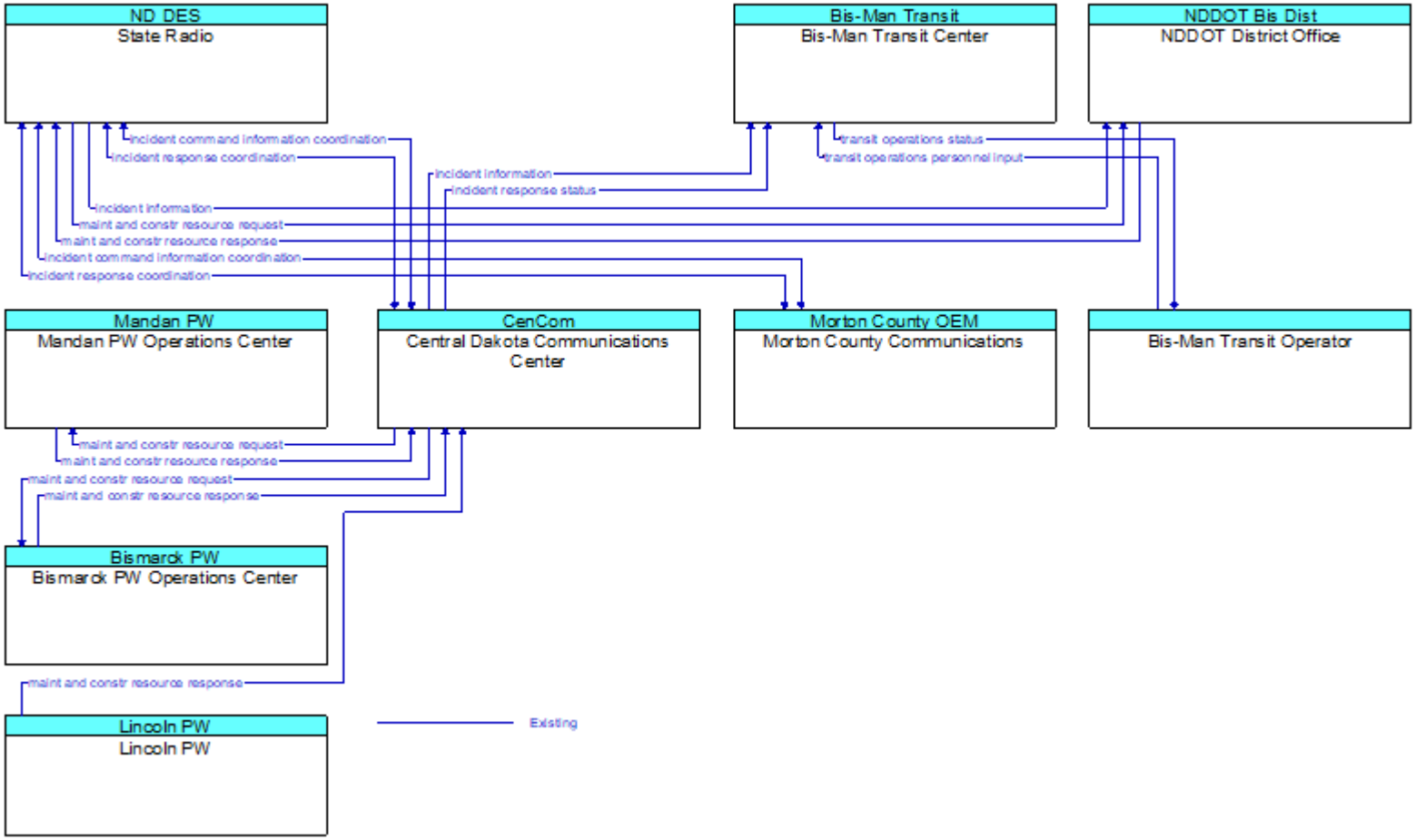
PS03 Emergency Vehicle Preemption



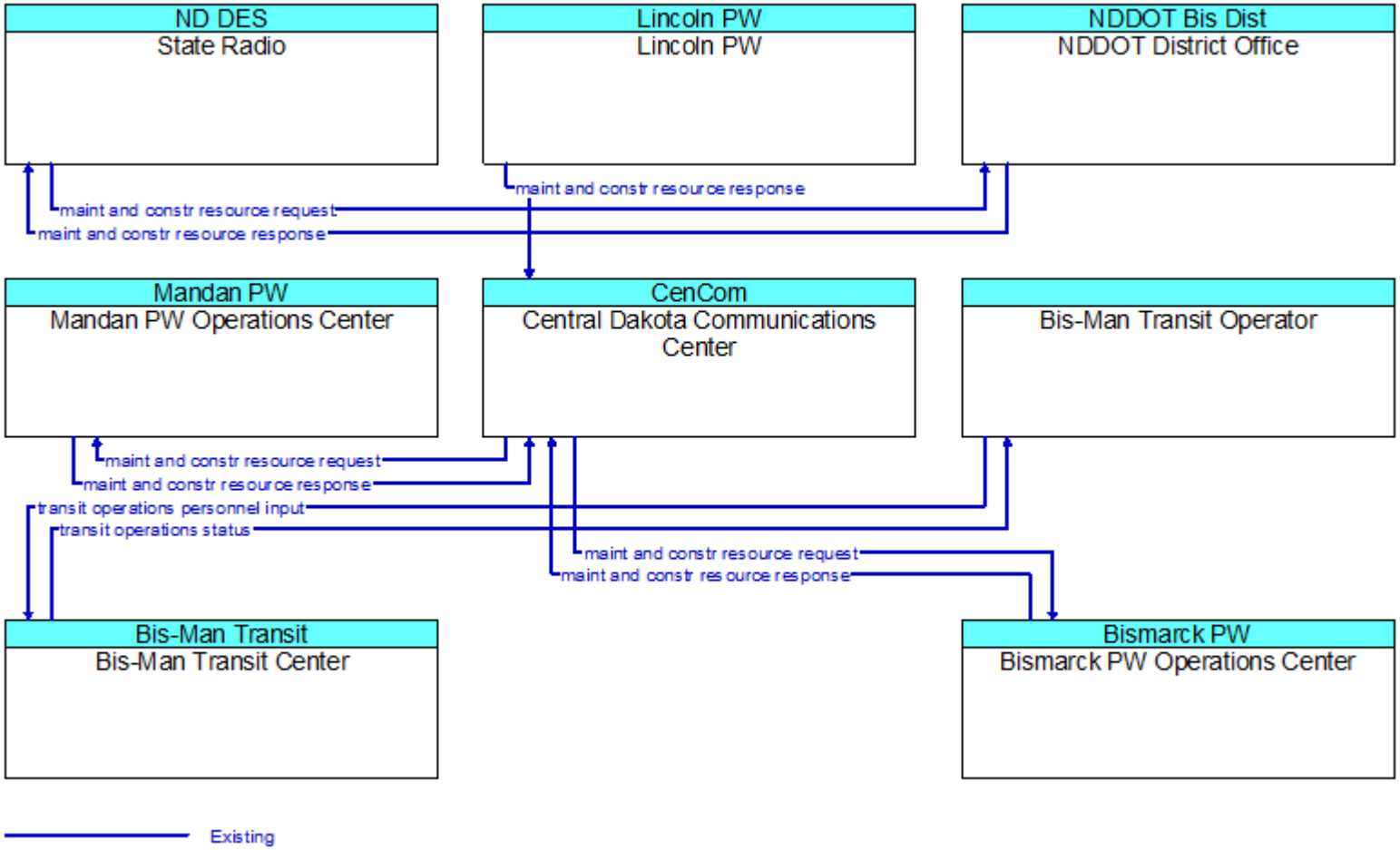
PS10 Wide-Area Alert



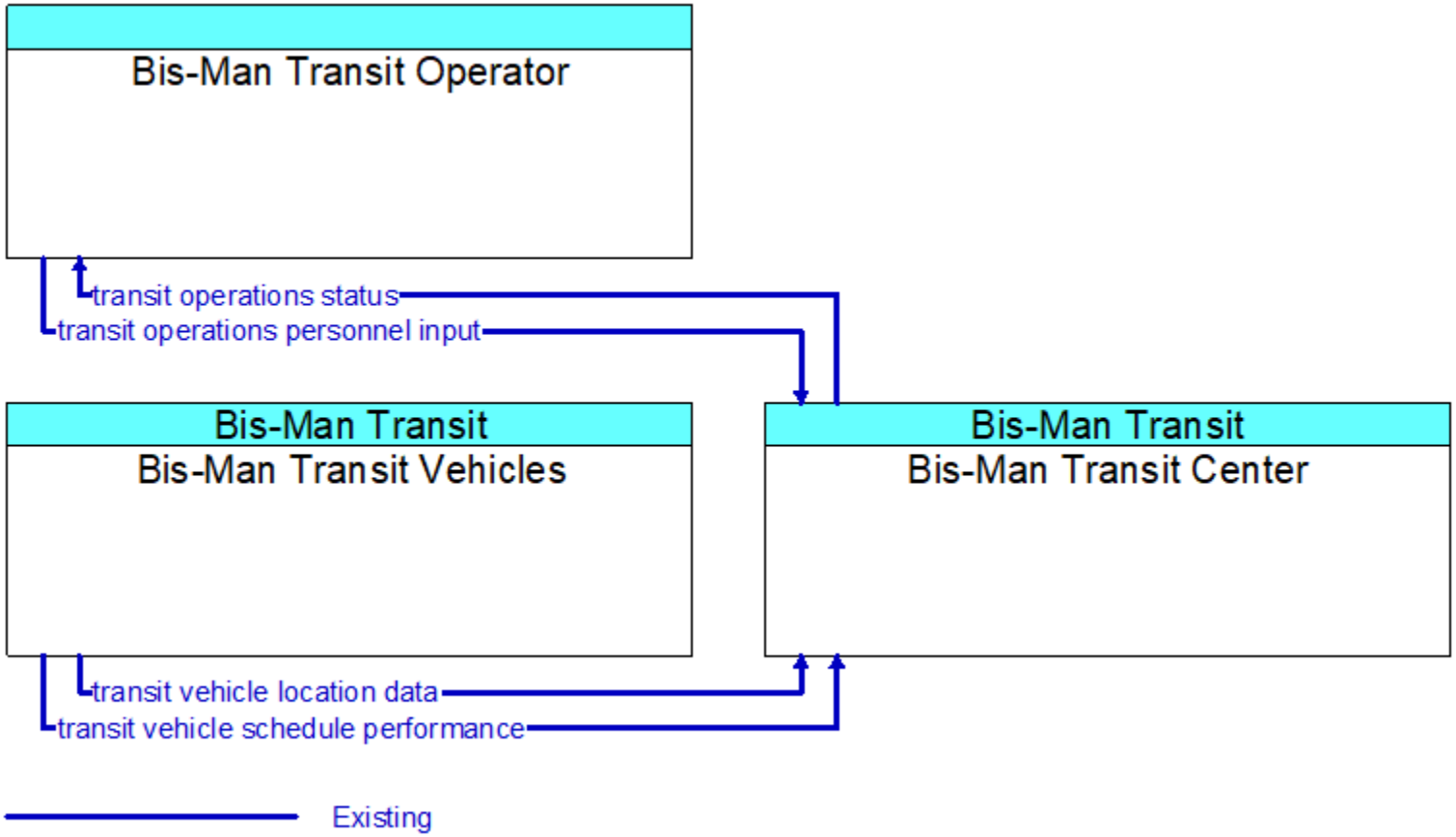
PS12 Disaster Response and Recovery



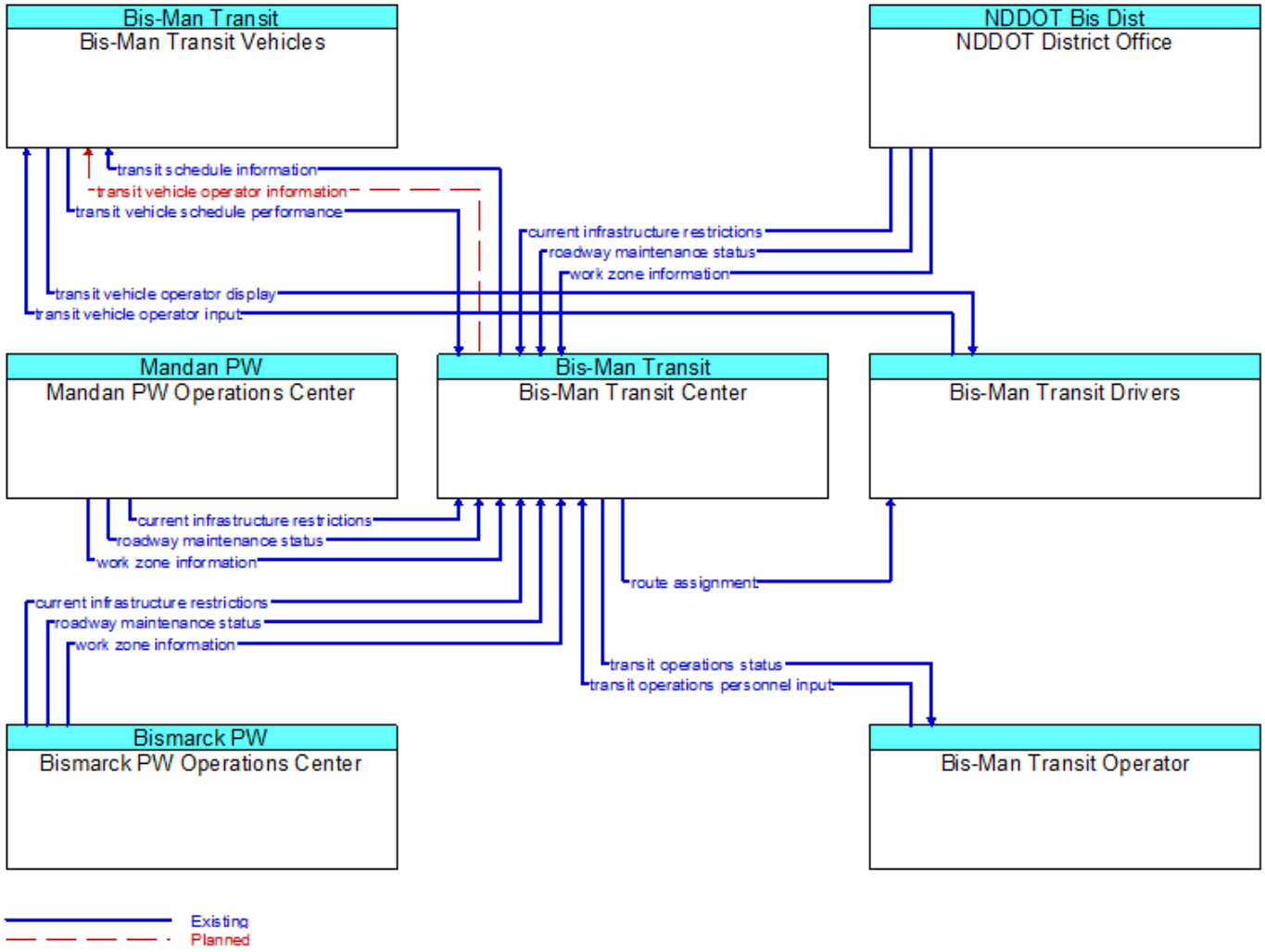
PS13 Evacuation and Reentry Management



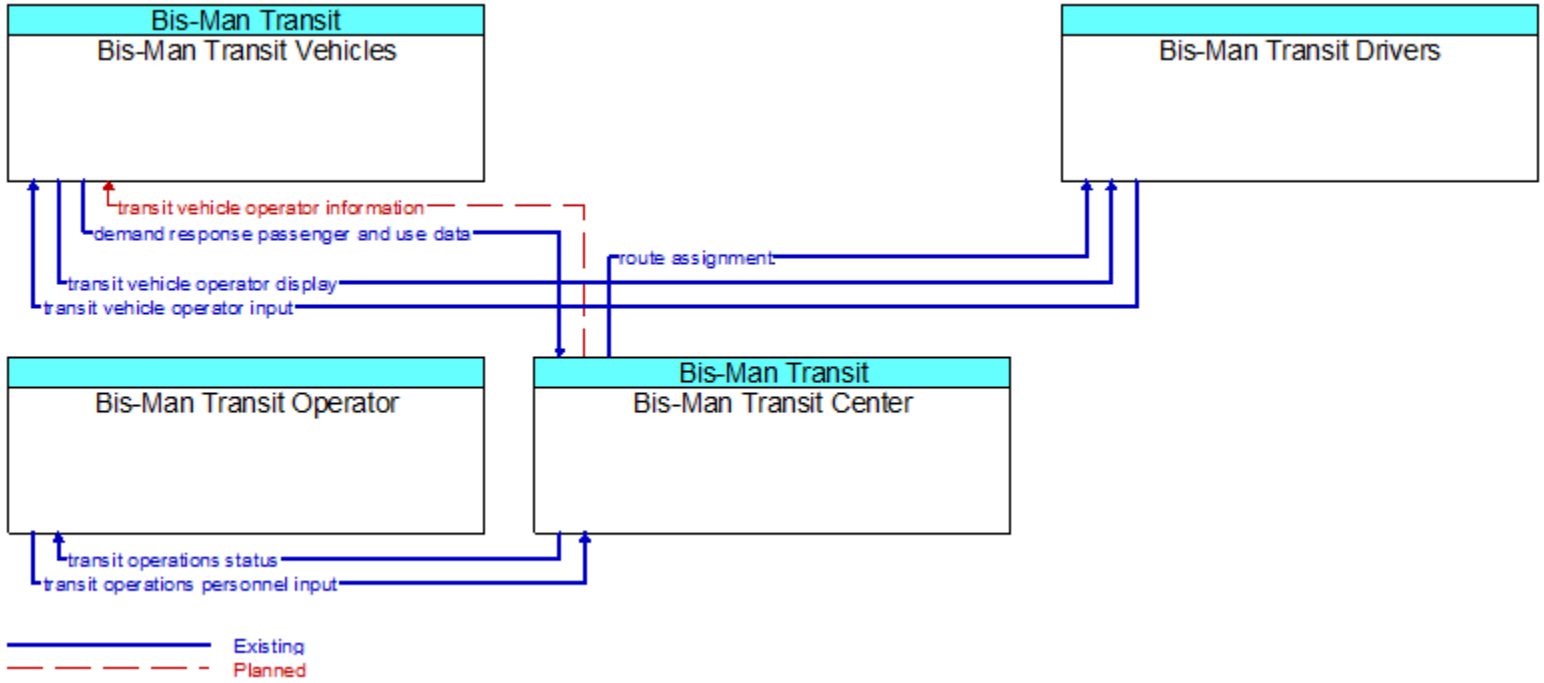
PT01 Transit Vehicle Tracking



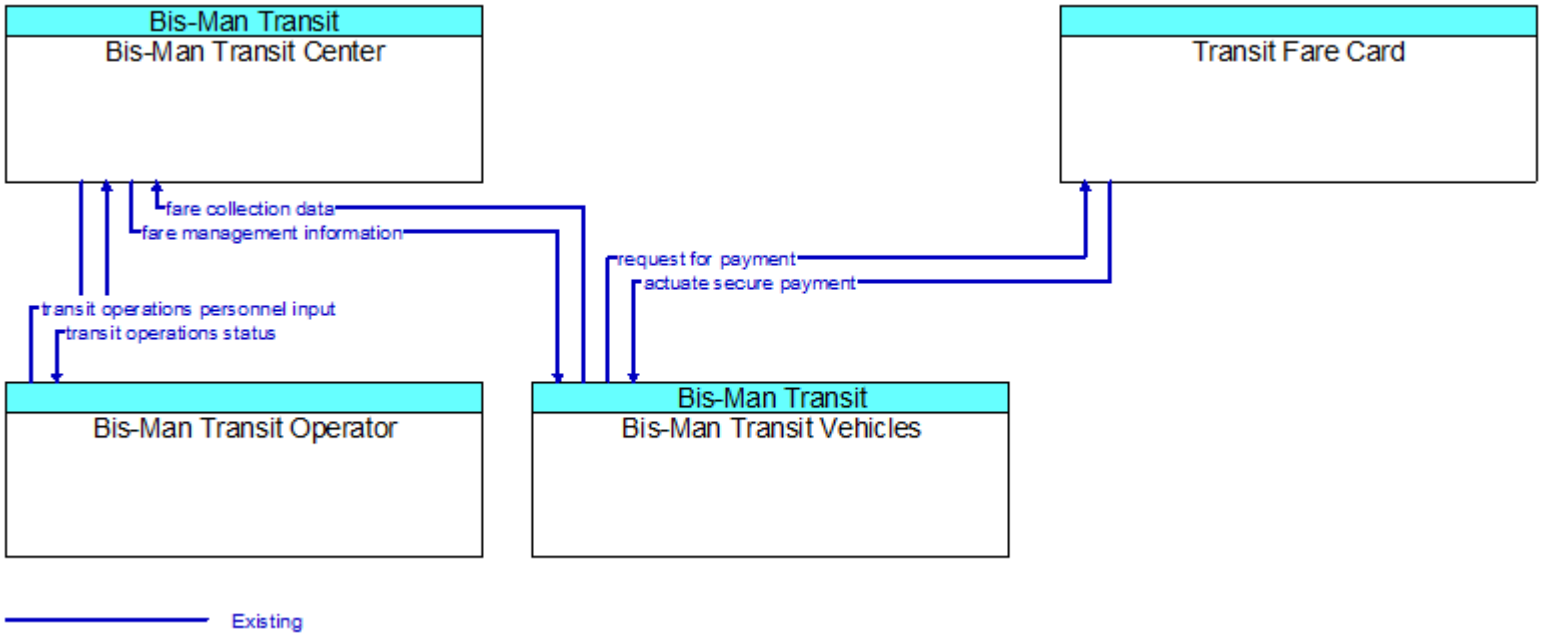
PT02 Transit Fixed-Route Operations



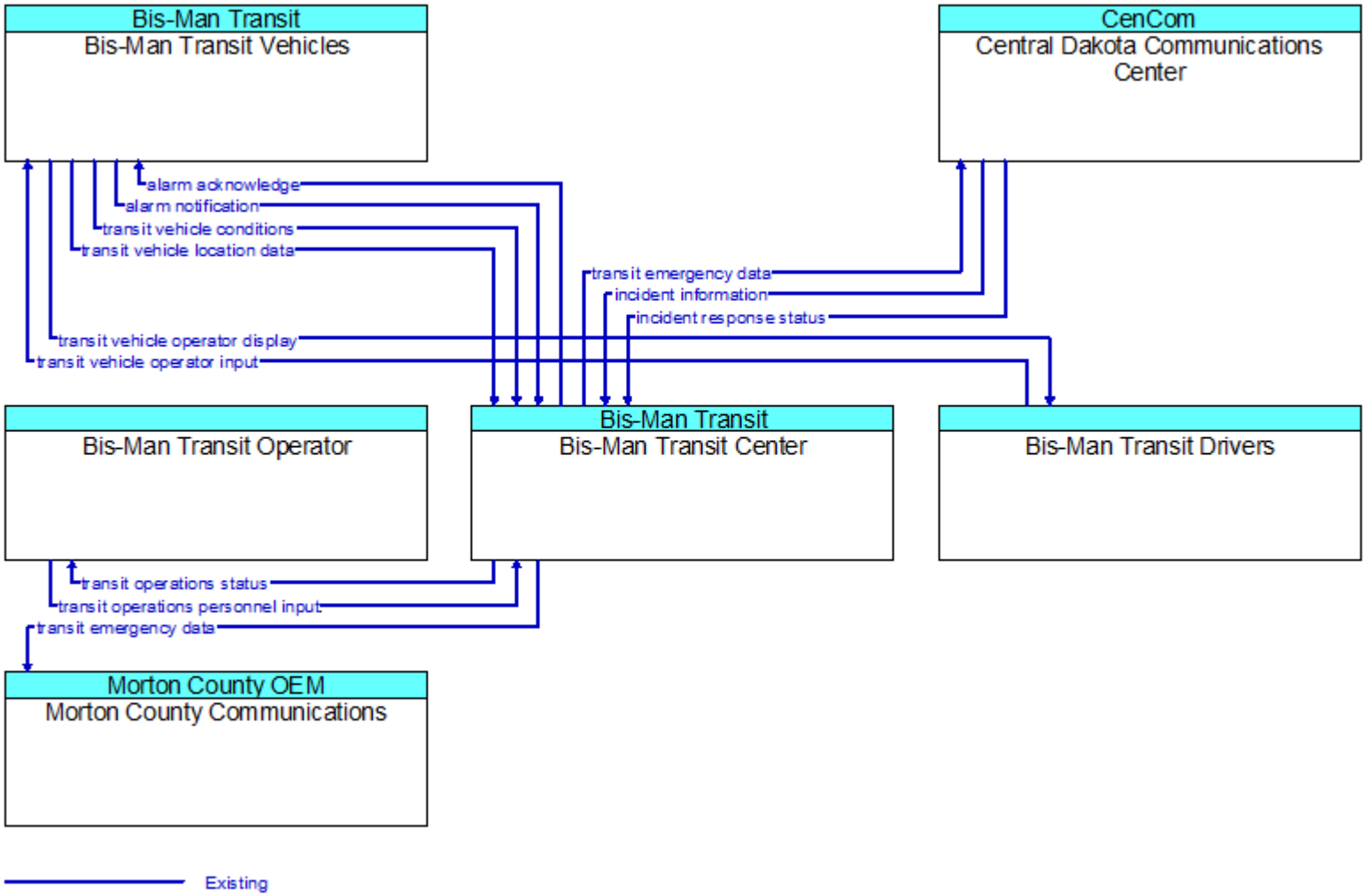
PT03 Dynamic Transit Operations



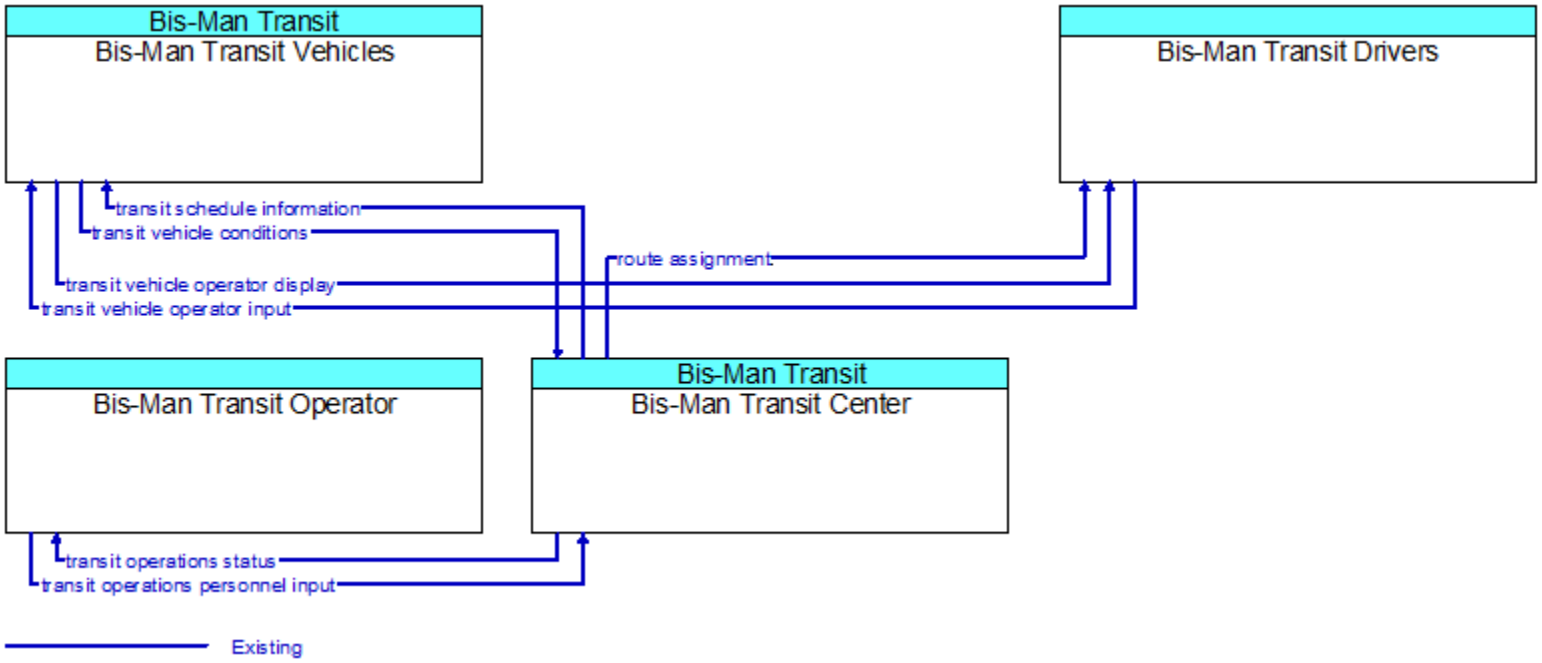
PT04 Transit Fare Collection Management



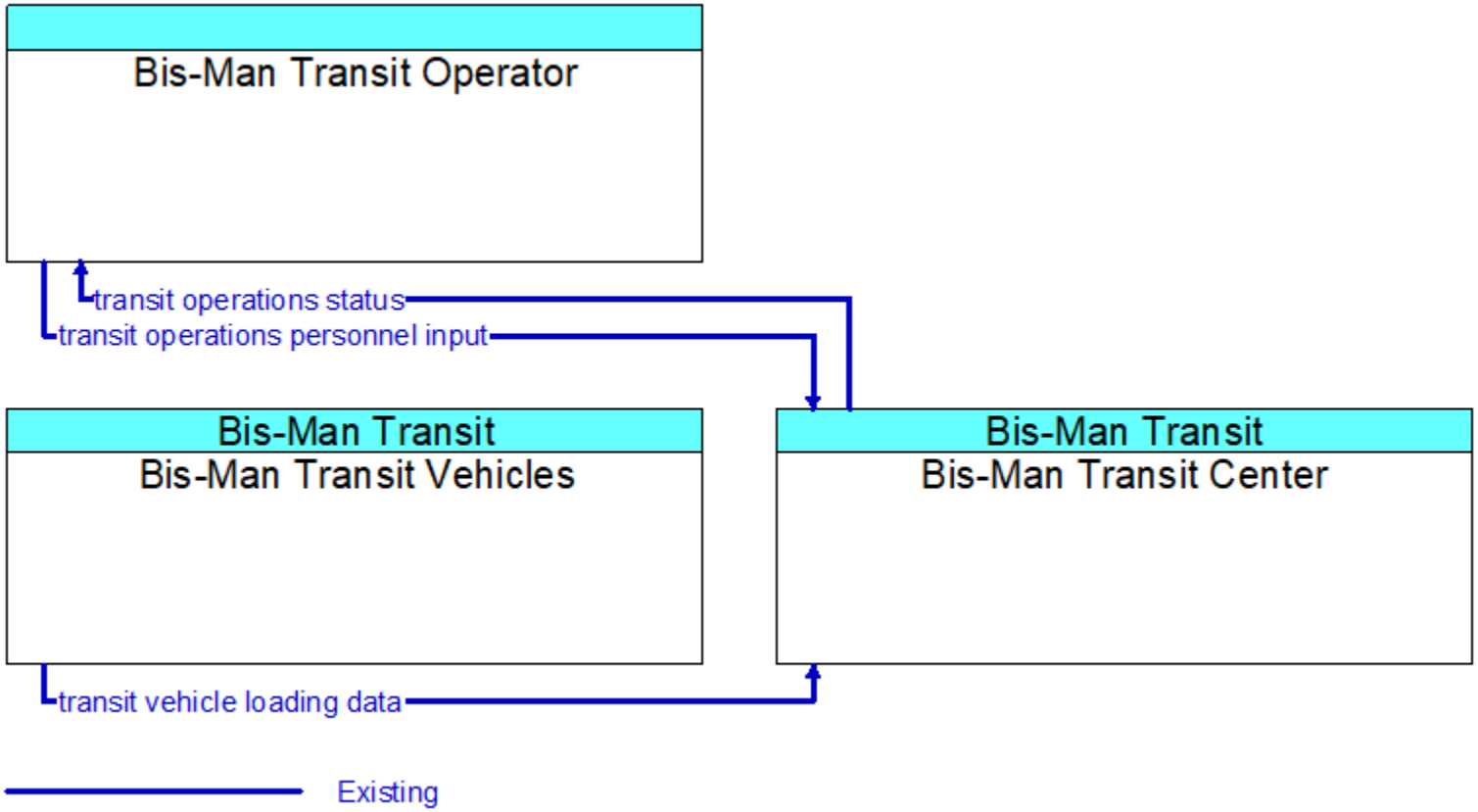
PT05 Transit Security



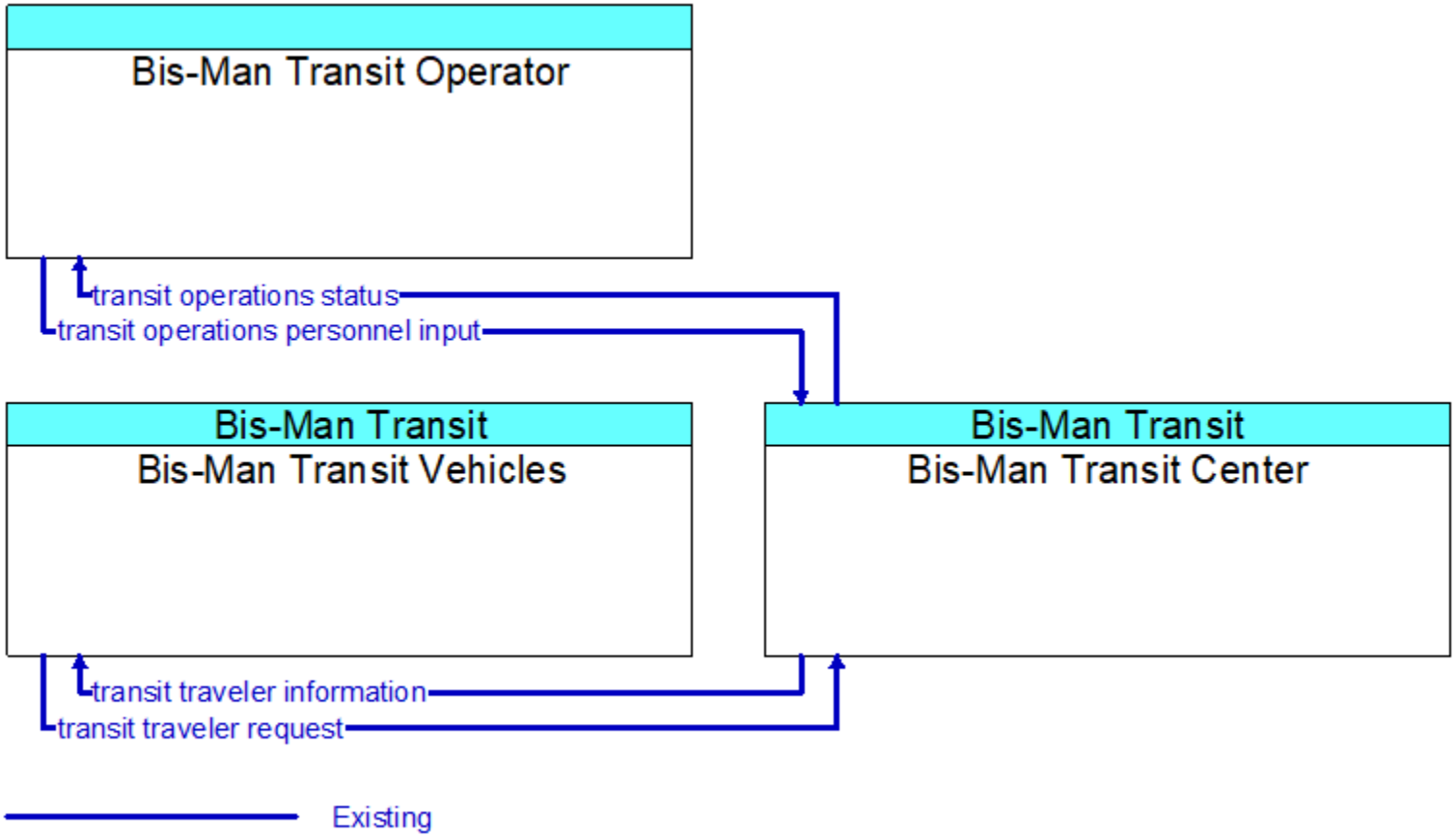
PT06 Transit Fleet Management



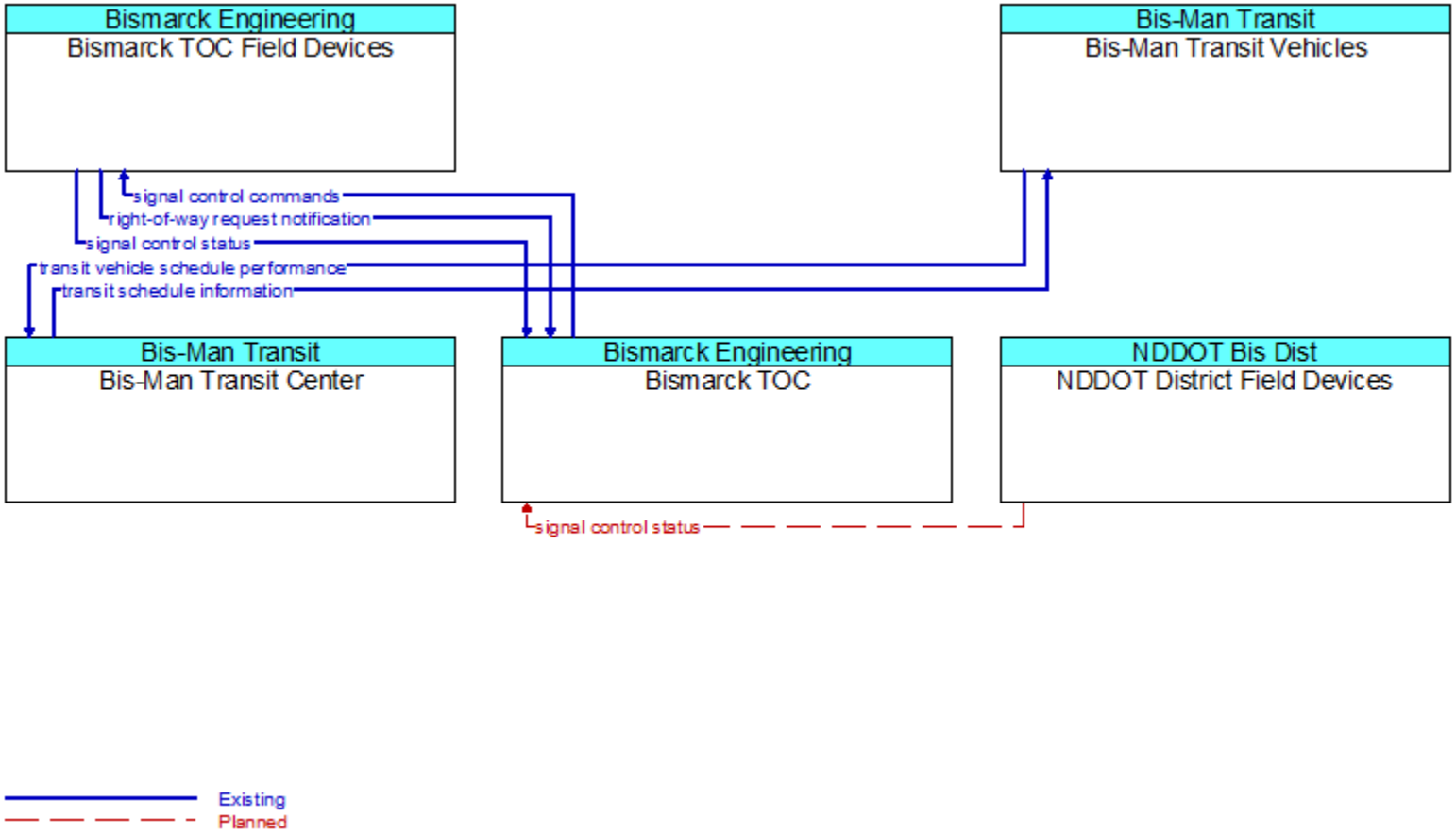
PT07 Transit Passenger Counting



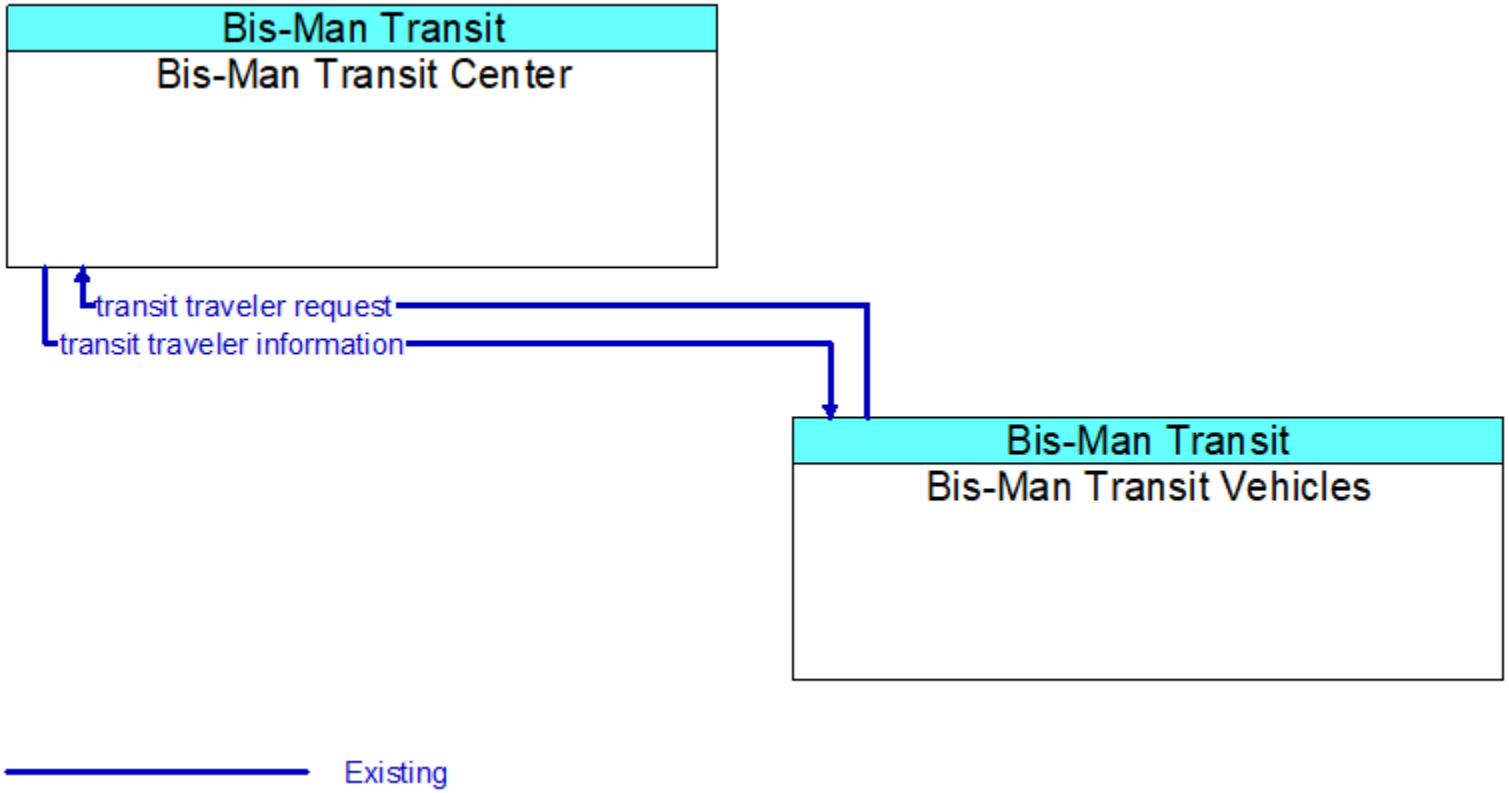
PT08 Transit Traveler Information



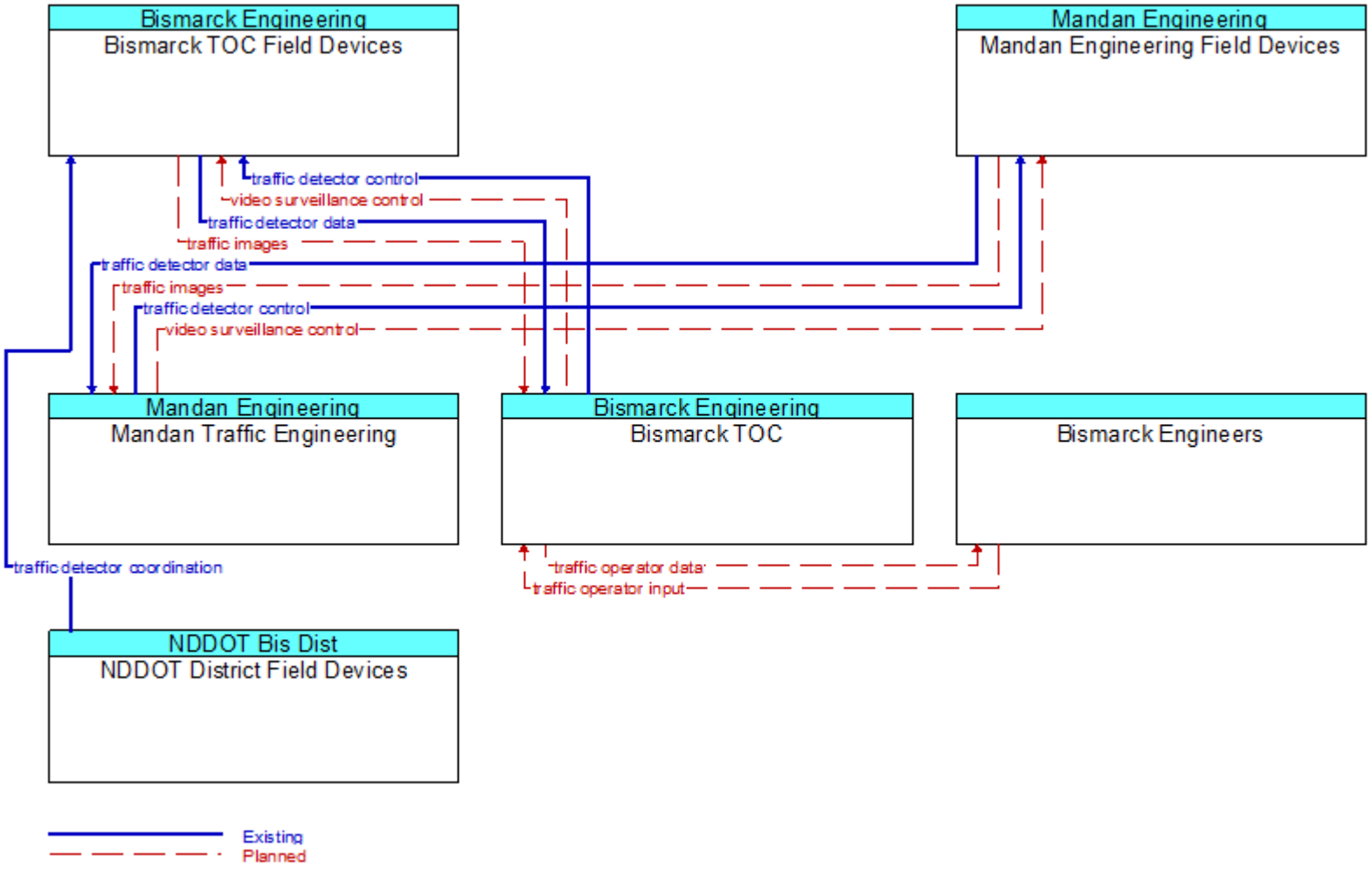
PT09 Transit Signal Priority



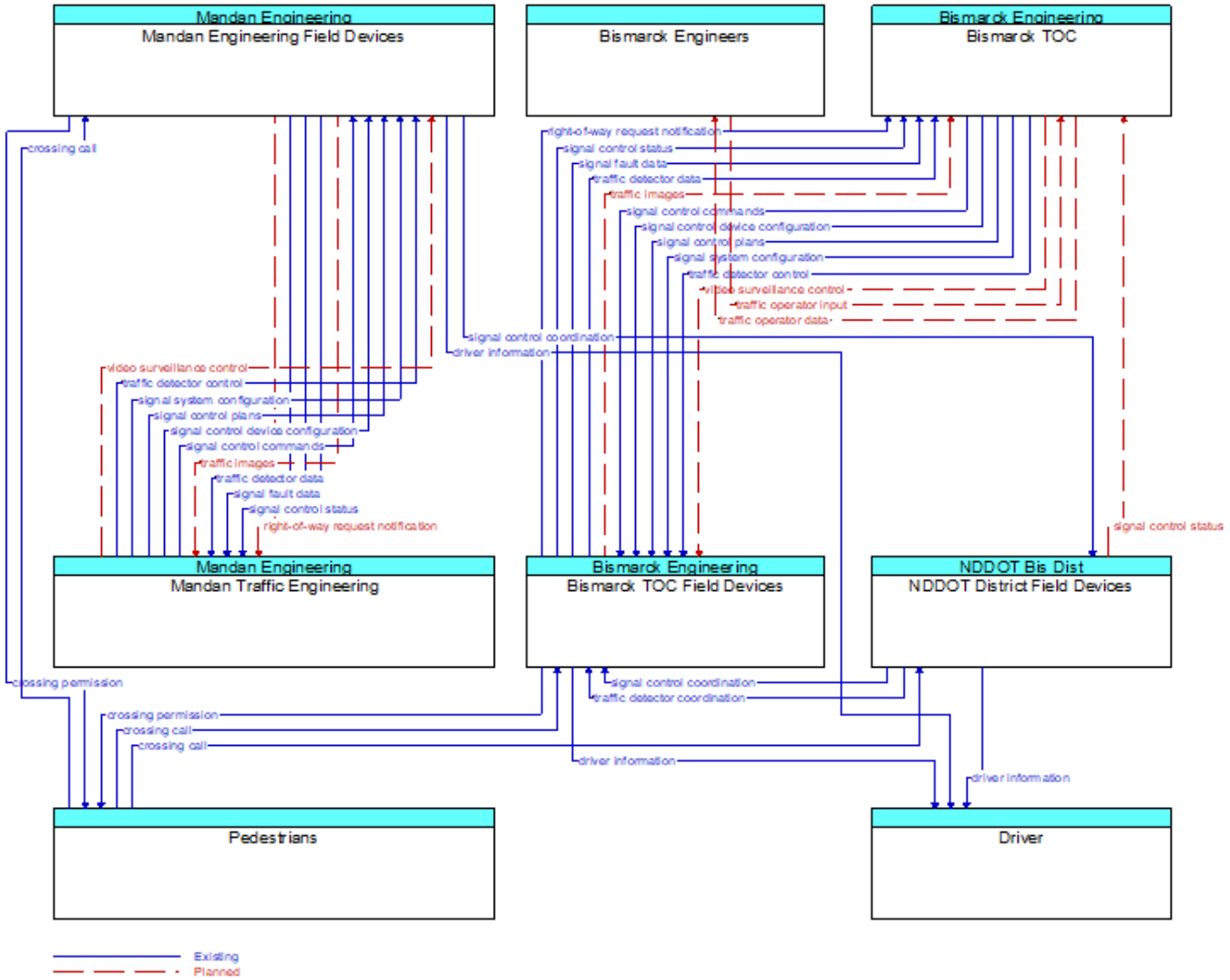
PT16 Route ID for the Visually Impaired



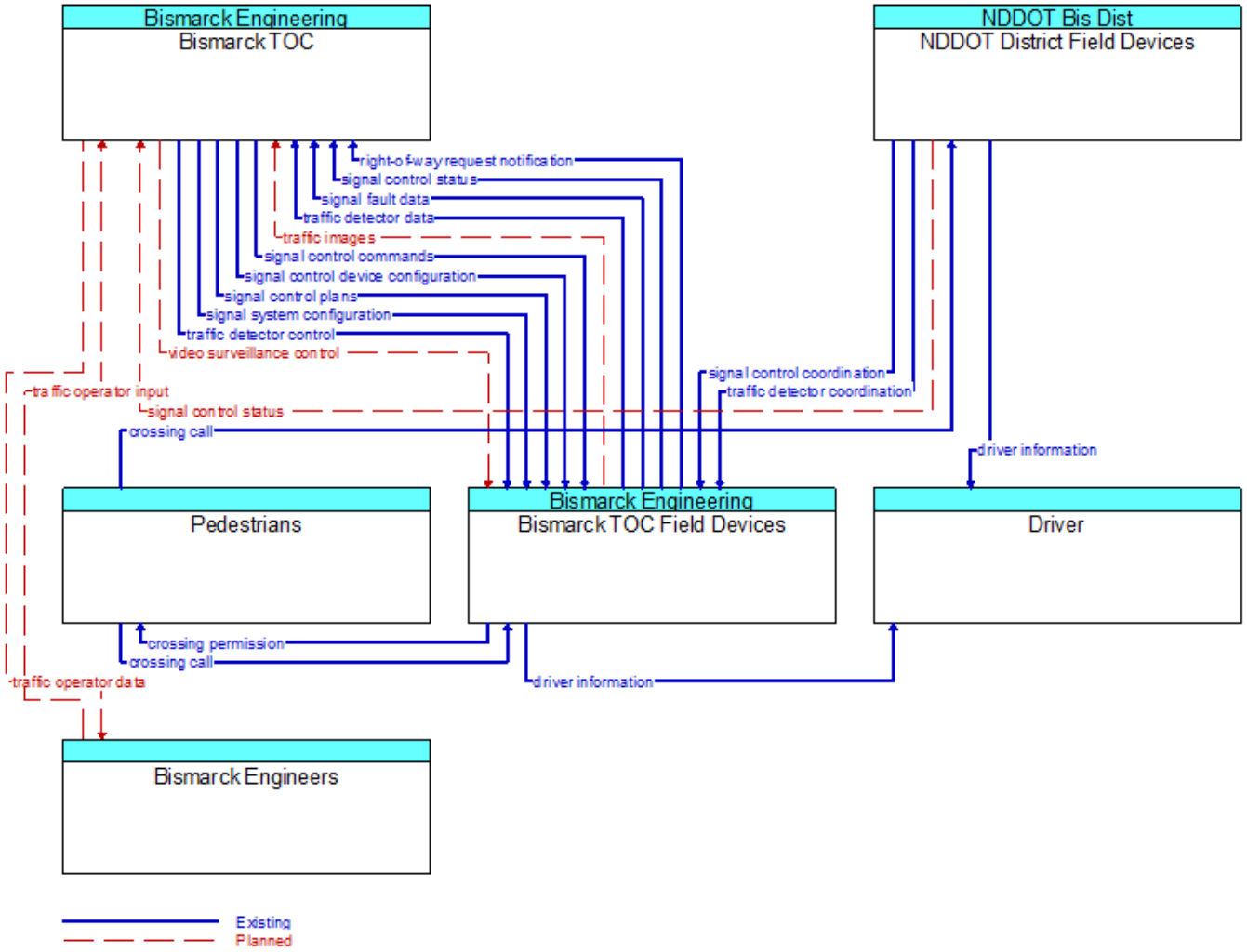
TM01 Infrastructure-Based Traffic Surveillance



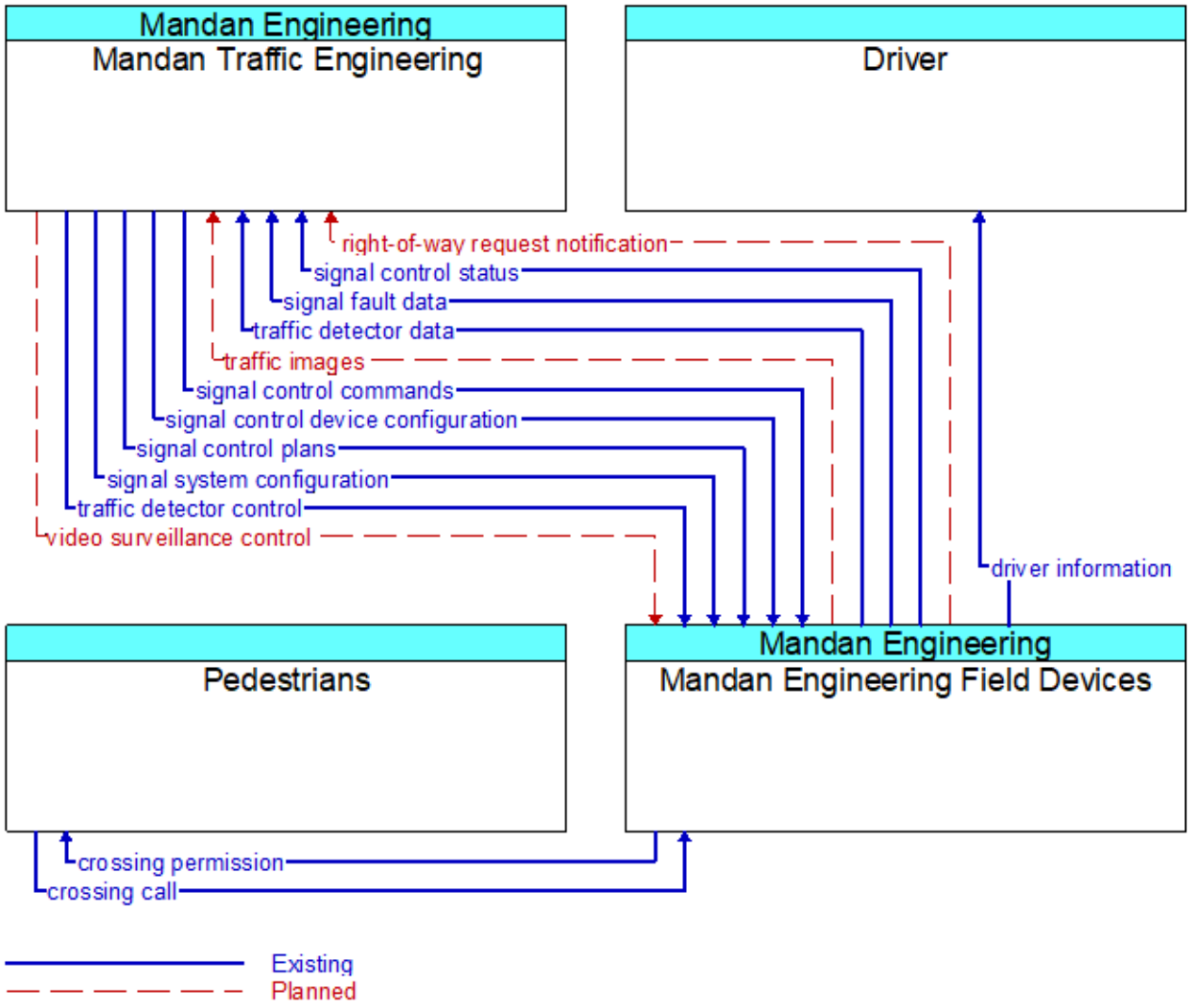
TM03 Traffic Signal Control



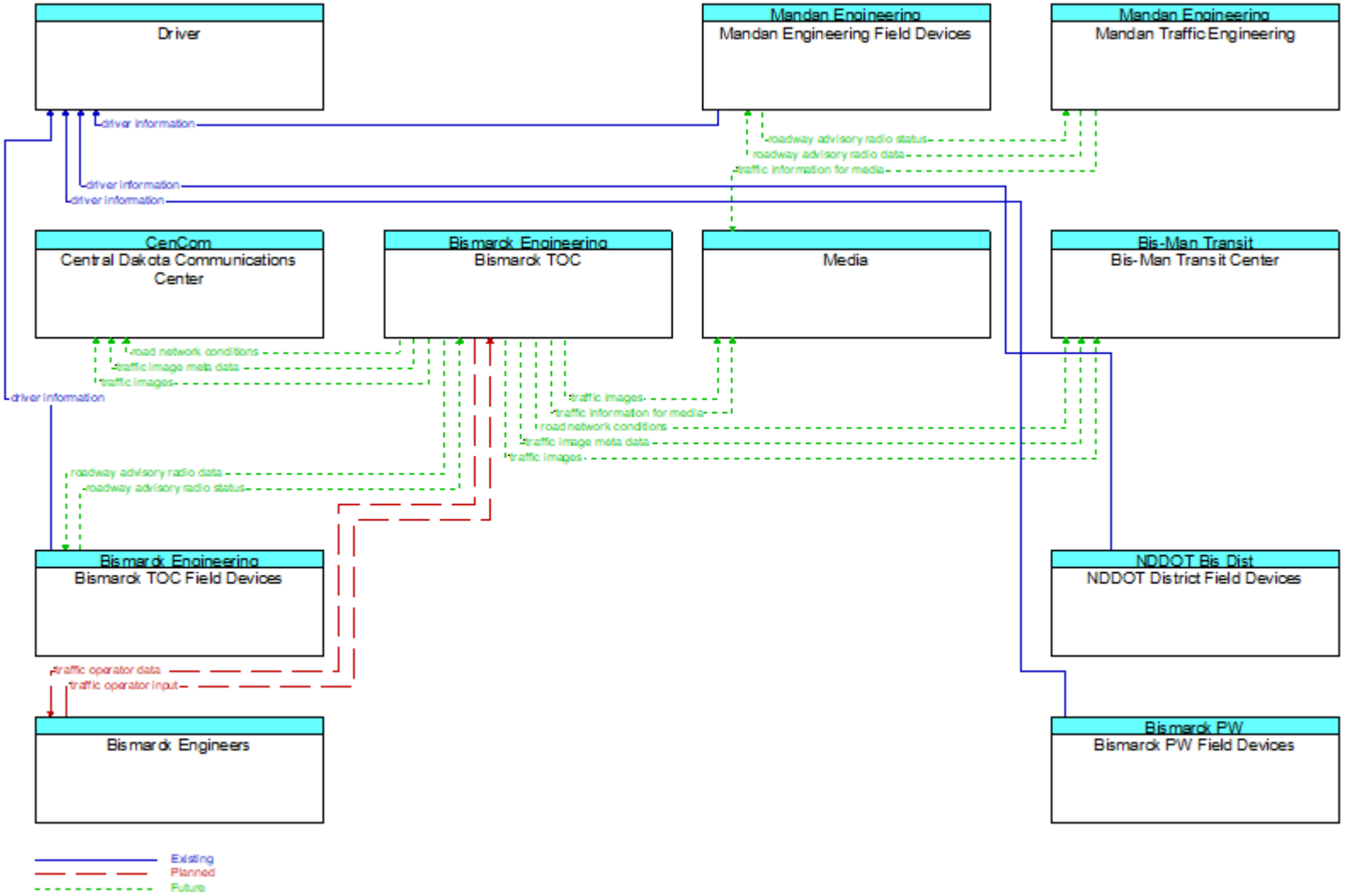
TM03 City of Bismarck Traffic Signal Control



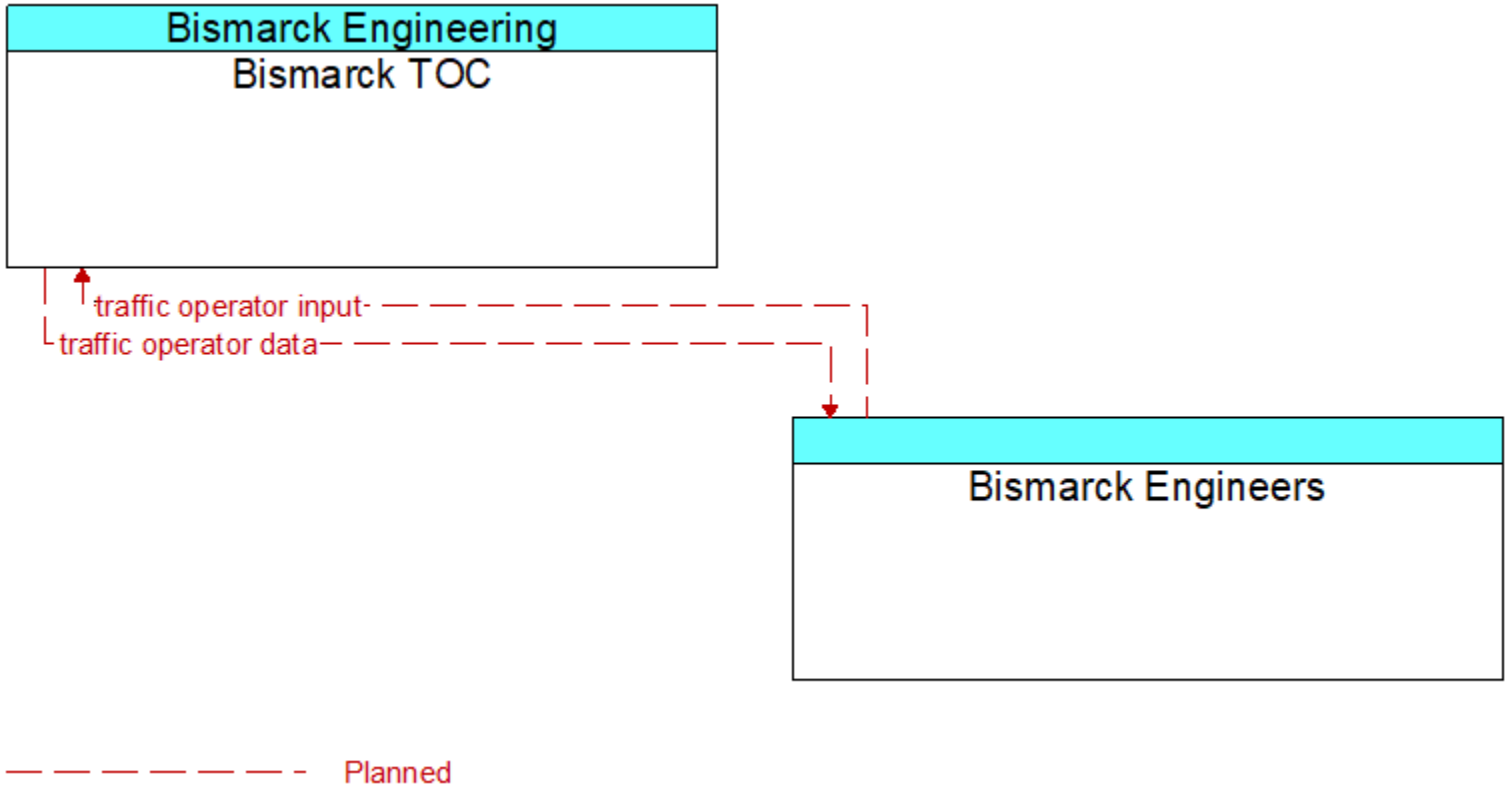
TM03 City of Mandan Traffic Signal Control



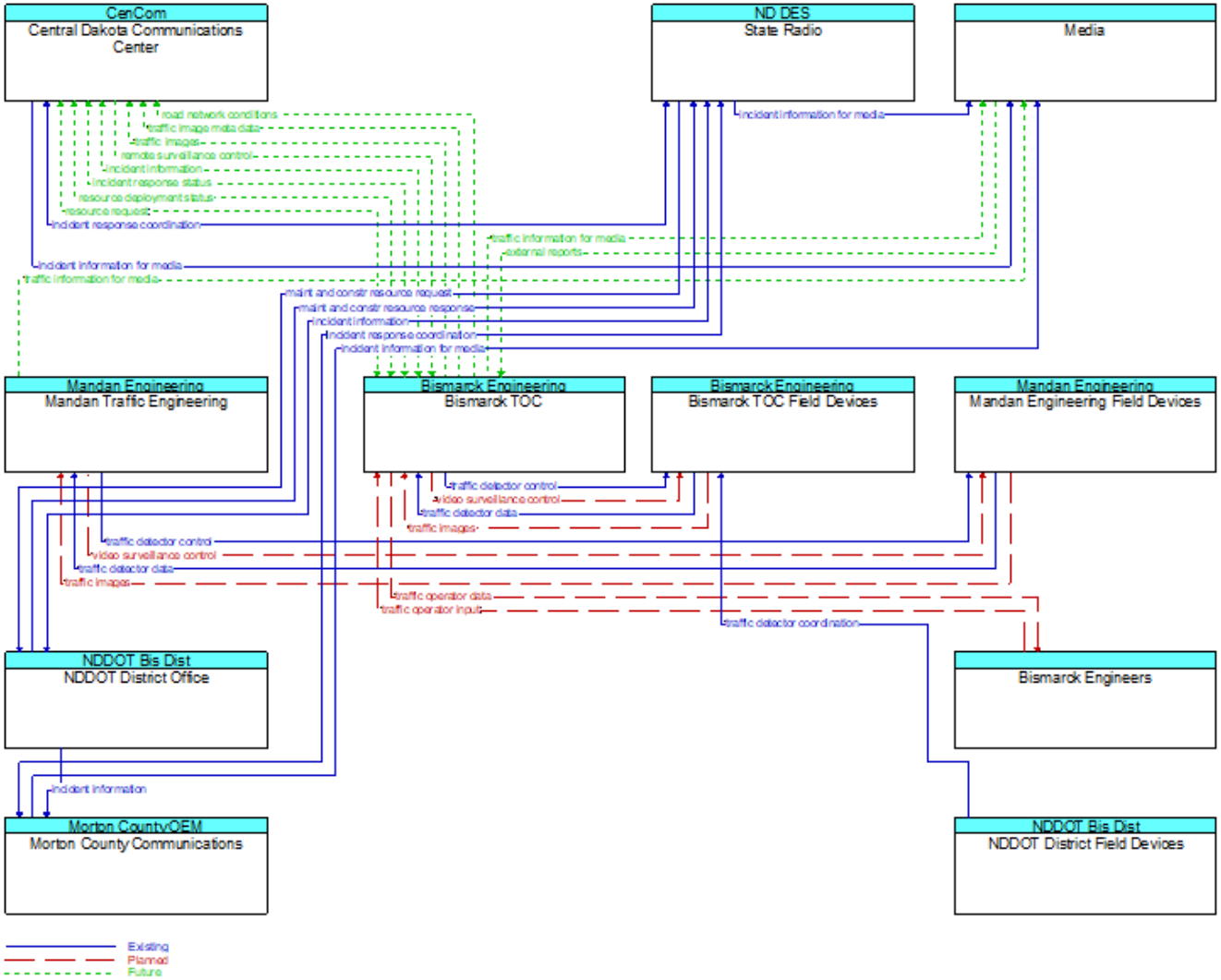
TM06 Traffic Information Dissemination



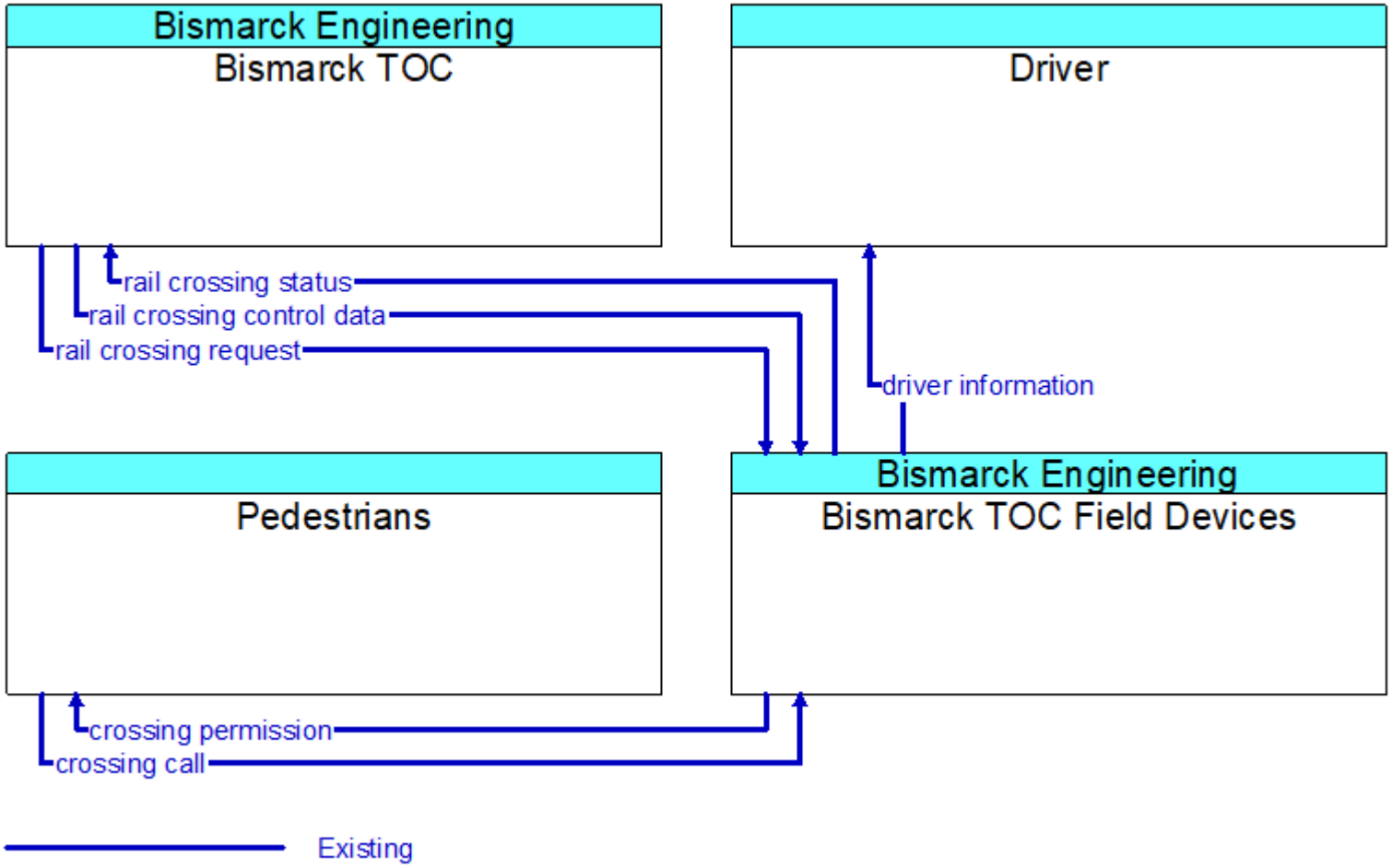
TM07 Regional Traffic Management



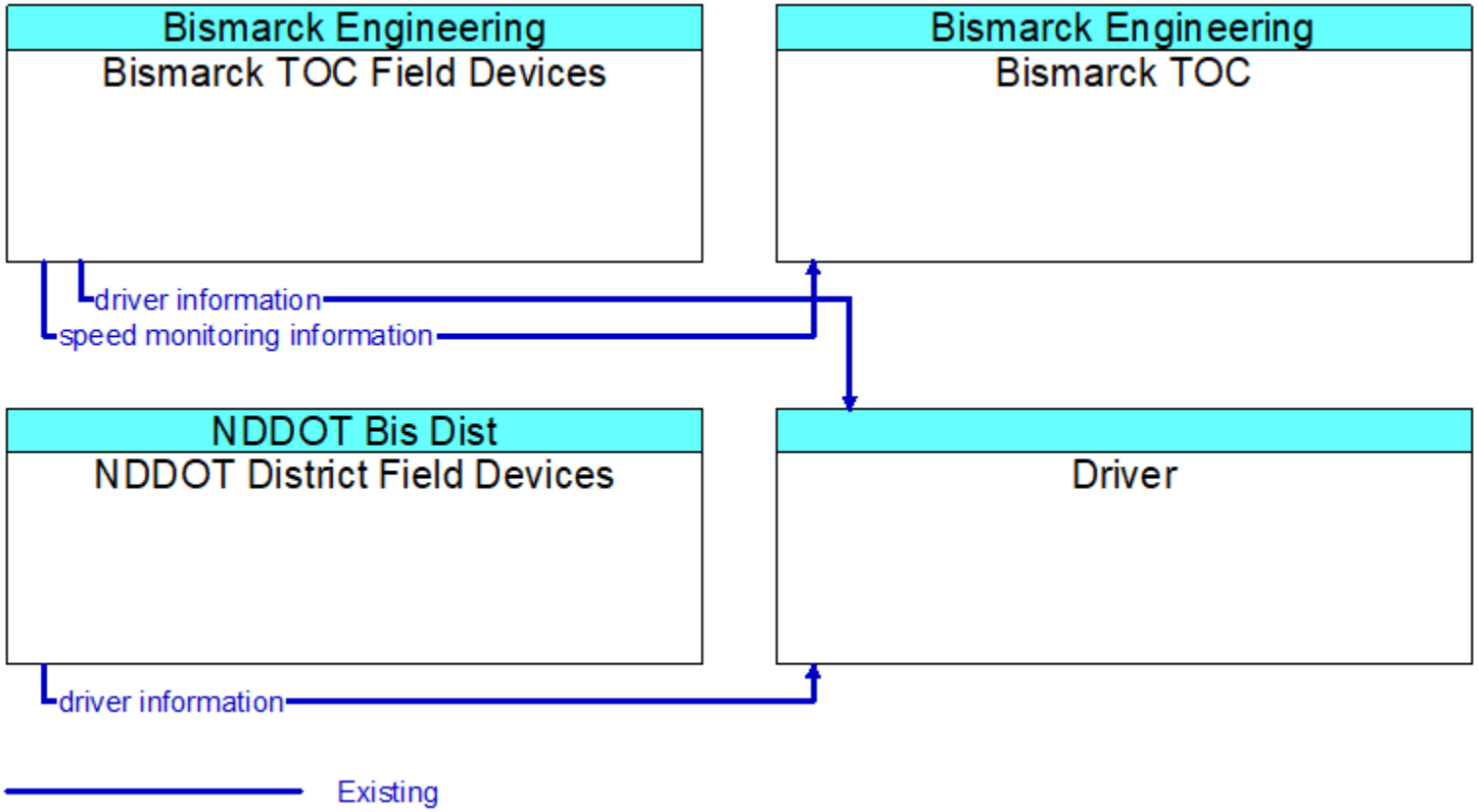
TM08 Traffic Incident Management System



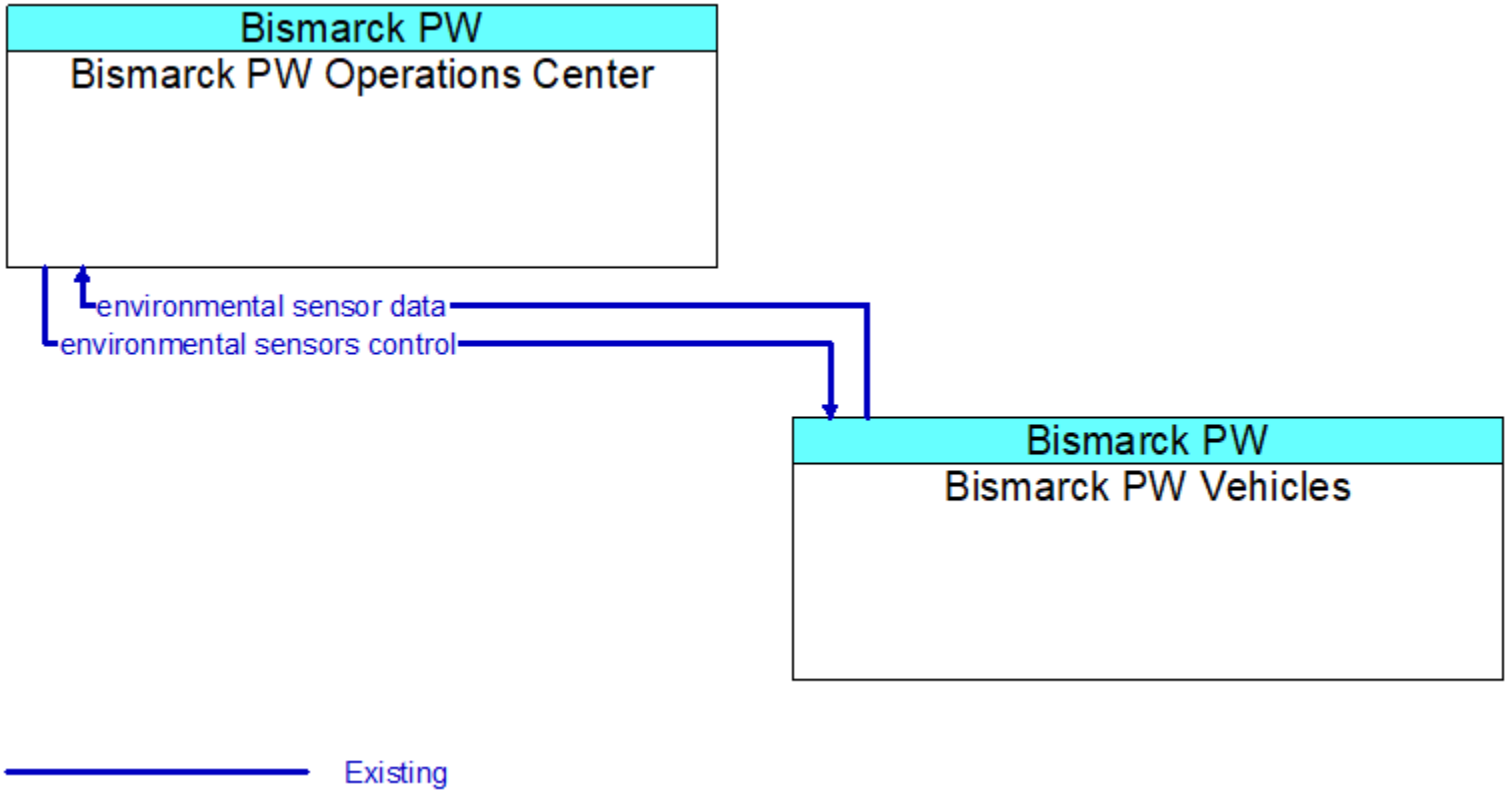
TM13 Standard Railroad Grade Crossing



TM17-Speed Warning and Enforcement



WX01 Weather Data Collection



APPENDIX-B

FUNCTIONAL REQUIREMENTS

Table 8: List of Functional Requirements

Element Name	Functional Object	Req #	Requirement	Status
Bis-Man Data Archival	Archive Data Repository	1	The center shall collect data from centers.	Existing
		3	The center shall store collected data in an information repository.	Existing
		6	The center shall include capabilities for archive-to-archive coordination.	Existing
		7	The center shall provide the capability to execute methods on the incoming data such as cleansing, summarizations, aggregations, or transformations applied to the data before it is stored in the archive.	Existing
		8	The center shall collect data from data distribution systems and other data sources.	Existing
		11	The center shall respond to requests for archive data from archive data users (centers, field devices).	Existing
	Archive Government Reporting	1	The center shall provide archive data to federal, state, and local government reporting systems.	Existing
		2	The center shall respond to requests for government report data.	Existing
Bis-Man Emergency Vehicles	EV On-Board En Route Support	1	The emergency vehicle, including roadway service patrols, shall track its current location.	Existing
		2	The emergency vehicle, including roadway service patrols, shall send the vehicle's location and operational data to the center for emergency management and dispatch.	Existing
		3	The emergency vehicle, including roadway service patrols, shall receive incident details and a suggested route when dispatched to a scene.	Existing
		4	The emergency vehicle shall send the current en route status (including estimated time of arrival) and requests for emergency dispatch updates.	Existing
		5	The emergency vehicle shall send requests to traffic signal control equipment at the roadside to preempt the signal.	Existing

Element Name	Functional Object	Req #	Requirement	Status
		6	The emergency vehicle shall provide the personnel on-board with dispatch information, including incident type and location, and forward an acknowledgment from personnel to the center that the vehicle is on its way to the incident scene.	Existing
		7	The emergency vehicle shall send patient status information to the care facility along with a request for further information.	Existing
	EV On-Board Incident Management Communication	1	The emergency vehicle shall receive dispatch instructions sufficient to enable emergency personnel in the field to implement an effective incident response. It includes local traffic, road, and weather conditions, hazardous material information, and the current status of resources that have been allocated to an incident.	Existing
		2	The emergency vehicle shall provide an interface to the center for emergency personnel to transmit information about the incident site such as the extent of injuries, identification of vehicles and people involved, hazardous material, etc.	Existing
Bis-Man Transit Center	Transit Center Connection Protection	6	The center shall send schedule adjustments to a transit vehicle in order to protect a connection made with other transit vehicles.	Existing
	Transit Center Data Collection	1	The center shall collect transit management data such as transit fares and passenger use, transit services, paratransit operations, transit vehicle maintenance data, etc.	Existing
	Transit Center Fare Management	2	The center shall provide the capability for a system operator to manage the transit fares and control the exchange of transit fare information.	Existing
		4	The center shall support the payment of transit fare transactions using data provided by the traveler cards / payment instruments.	Existing
		6	The center shall process requests for transit fares to be paid in advance.	Existing
	Transit Center Fixed-Route Operations	1	The center shall generate transit routes and schedules based on such factors as parameters input by the system operator, road network conditions, incident information, operational	Existing

Element Name	Functional Object	Req #	Requirement	Status
			data on current routes and schedules, and digitized map data.	
		3	The center shall be able to generate special routes and schedules to support an incident, disaster, evacuation, or other emergency.	Planned
		4	The center shall dispatch fixed route or flexible route transit vehicles.	Existing
		5	The center shall collect transit operational data for use in the generation of routes and schedules.	Existing
	Transit Center Operator Assignment	1	The center shall maintain records of a transit vehicle operator's performance. This may be done utilizing standardized performance evaluation criteria set forth by governmental regulations and transit operating company policies, assessing the transit vehicle operator's driving history, and assessing comments from the transit vehicle operator's supervisor(s) as well as noting any moving violations or accidents, supervisor comments, government regulations, and company policies.	Existing
		3	The center shall assign transit vehicle operators to transit schedules based on their eligibility, route preferences, seniority, and transit vehicle availability.	Existing
	Transit Center Paratransit Operations	1	The center shall process trip requests for demand responsive transit services, i.e., paratransit. Sources of the requests may include traveler information service providers.	Existing
		2	The center shall monitor the operational status of the demand response vehicles including status of passenger pick-up and drop-off.	Existing
		3	The center shall generate demand response transit (including paratransit) routes and schedules based on such factors as parameters input by the system operator, what other demand responsive transit schedules have been planned, the availability and location of vehicles, the relevance of any fixed transit routes and schedules, road network information, and incident information.	Existing

Element Name	Functional Object	Req #	Requirement	Status
		4	The center shall dispatch demand response (paratransit) transit vehicles.	Existing
	Transit Center Security	1	The center shall monitor transit vehicle operational data to determine if the transit vehicle is off-route and assess whether a security incident is occurring.	Planned
Bis-Man Transit Vehicles	Transit Vehicle On-Board Fare Management	1	The transit vehicle shall read data from the traveler card / payment instrument presented by boarding passengers.	Existing
		9	The transit vehicle shall provide fare statistics data to the center.	Existing
	Transit Vehicle On-Board Maintenance	1	The transit vehicle shall collect and process vehicle mileage data available to sensors on-board.	Existing
		2	The transit vehicle shall collect and process the transit vehicle's operating conditions such as engine temperature, oil pressure, brake wear, internal lighting, environmental controls, etc.	Existing
		3	The transit vehicle shall transmit vehicle maintenance data to the center to be used for scheduling future vehicle maintenance.	Existing
	Transit Vehicle On-Board Paratransit Operations	1	The transit vehicle shall manage data input to sensor(s) on-board a transit vehicle to determine the vehicle's availability for use in demand responsive and flexible-route transit services based on identity, type, and passenger capacity.	Planned
		2	The transit vehicle shall receive the status of demand responsive or flexible-route transit schedules and passenger loading from the transit vehicle operator.	Existing
		3	The transit vehicle shall provide the transit vehicle operator instructions about the demand responsive or flexible-route transit schedule that has been confirmed from the center.	Planned
		4	The transit vehicle shall provide the capability to log passenger boardings and alightings and make passenger use data available to the transit center.	Existing
		1	The transit vehicle shall track the current location of the transit vehicle.	Planned

Element Name	Functional Object	Req #	Requirement	Status
	Transit Vehicle On-Board Trip Monitoring	3	The transit vehicle shall record transit trip monitoring data including vehicle mileage and fuel usage.	Existing
		4	The transit vehicle shall record transit trip monitoring data including operational status information such as doors open/closed, running times, etc.	Existing
		6	The transit vehicle shall receive transit stop requests from travelers.	Existing
	Transit Vehicle Passenger Counting	1	The transit vehicle shall count passengers boarding and alighting.	Planned
		2	The passenger counts shall be related to location to support association of passenger counts with routes, route segments, or bus stops.	Planned
		3	The passenger counts shall be timestamped so that ridership can be measured by time of day and day of week.	Planned
		4	The transit vehicle shall send the collected passenger count information to the transit center.	Existing
	Transit Vehicle Security	1	The transit vehicle shall perform video and audio surveillance inside of transit vehicles and output raw video or audio data for either local monitoring (for processing or direct output to the transit vehicle operator), remote monitoring or for local storage (e.g., in an event recorder).	Existing
Bismarck PW Field Devices	Roadway Automated Treatment	1	The field element shall activate automated roadway treatment systems based on environmental or atmospheric conditions. Treatments can be in the form of fog dispersion, anti-icing chemicals, etc.	Planned
		2	The field element shall activate automated roadway treatment systems under center control. Treatments can be in the form of fog dispersion, anti-icing chemicals, etc.	Planned
		3	The field element shall return automated roadway treatment system and associated environmental sensor operational status to the maintenance center.	Planned

Element Name	Functional Object	Req #	Requirement	Status
		4	The field element shall return automated roadway treatment system and associated environmental sensor fault data to the maintenance center for repair.	Planned
	Roadway Field Device Support	3	The field element shall provide the capability for field personnel to locally control and configure this equipment.	Existing
	Roadway Traffic Information Dissemination	1	The field element shall include dynamic message signs for dissemination of traffic and other information to drivers, under center control; the DMS may be either those that display variable text messages, or those that have fixed format display(s) (e.g., vehicle restrictions, or lane open/close).	Existing
	Roadway Work Zone Traffic Control	3	Under the control of field personnel within maintenance vehicles, the field element shall include driver information systems (such as dynamic messages signs and highway advisory radios) that advise drivers of activity around a work zone through which they are currently passing.	Existing
Bismarck PW Operations Center	MCM Automated Treatment System Control	1	The center shall remotely control automated roadway treatment systems. Treatments can be in the form of fog dispersion, anti-icing chemicals, etc.	Planned
		2	The center shall remotely control the environmental sensors that upon detecting changes in environmental or atmospheric conditions, automatically activate roadway treatment systems.	Planned
		3	The center shall collect automated roadway treatment system and associated environmental sensor operational status.	Planned
		4	The center shall collect automated roadway treatment system and associated environmental sensor fault data and request repair.	Planned
		5	The center shall accept requests for automated roadway treatment system activation from center personnel.	Planned
	MCM Vehicle Tracking	1	The center shall monitor the locations of all maintenance and construction vehicles and other equipment under its jurisdiction.	Existing

Element Name	Functional Object	Req #	Requirement	Status
		2	The center shall present location data to center personnel for the fleet of maintenance and construction vehicles and other equipment.	Existing
	MCM Winter Maintenance Management	1	The center shall respond to requests from emergency management and traffic management centers for hazard removal, field equipment repair, and other winter roadway maintenance.	Existing
		3	The center shall provide status information about scheduled winter maintenance activities including anticipated closures and impact to the roadway, alternate routes, anticipated delays, closure times, and durations. The information is provided to other management centers such as traffic, emergency, transit, traveler information providers, other maintenance centers, and the media.	Existing
		4	The center shall receive equipment availability and materials storage status information from storage facilities to support the scheduling of winter maintenance activities.	Existing
		5	The center shall support an interface with a map update provider, or other appropriate data sources, through which updates of digitized map data can be obtained and used as a background for the scheduling of winter maintenance activities.	Existing
		6	The center shall collect real-time information on the state of the regional transportation system from other centers including current traffic and road conditions, weather conditions, special event and incident information and use the collected information to support winter maintenance operations.	Existing
		8	The center shall determine the need for roadway treatment based on current and forecasted weather information, current usage of treatments and materials, available resources, requests for action from other agencies, and recommendations from the Maintenance Decision Support system, specifically under winter conditions. This	Existing

Element Name	Functional Object	Req #	Requirement	Status
			supports winter maintenance such as plowing, treating, anti-icing, etc.	
		9	The center shall provide dispatch instructions for vehicle operators based on input parameters from center personnel, specifically for winter conditions. This could include a treatment route, treatment application rates, start and end times, and other treatment instructions.	Existing
Bismarck PW Vehicles	MCV Environmental Monitoring	1	The maintenance and construction vehicle shall collect environmental data from on-board sensors, including air temperature, wind speed, surface temperature, traction conditions, etc.	Existing
		2	The maintenance and construction vehicle shall transmit environmental sensor data to the center. The sensor data includes location and timestamp information.	Existing
		3	The maintenance and construction vehicle shall provide environmental sensor equipment operational status to the center.	Planned
	MCV Vehicle Location Tracking	1	The maintenance and construction vehicle shall track its current location.	Existing
		2	The maintenance and construction vehicle shall send the time stamped vehicle location to the controlling center.	Existing
	MCV Vehicle System Monitoring and Diagnostics	1	The maintenance and construction vehicle shall collect vehicle diagnostics and operating status data from the maintenance vehicle platform including engine temperature, mileage, tire wear, brake wear, belt wear, and other operational status measures as well as the status of maintenance and construction-specific systems on the vehicle.	Existing
		2	The maintenance and construction vehicle shall use the diagnostic and status information to support scheduling vehicle maintenance, monitoring safety status, and informing the vehicle operator of the conditions.	Existing
	MCV Winter Maintenance	3	The maintenance and construction vehicle shall monitor winter maintenance materials information including remaining quantity and current application rate of materials on the vehicle.	Existing

Element Name	Functional Object	Req #	Requirement	Status
		4	The maintenance and construction vehicle shall respond to winter maintenance dispatch information from the center, presented to the vehicle operator for acknowledgement and returning status.	Existing
		5	The maintenance and construction vehicle shall send operational data to the center including the operational state of the winter maintenance equipment (e.g., blade up/down, spreader pattern), types and quantities of materials used for construction and maintenance activities, and a record of the actual work performed.	Existing
Bismarck TOC	TMC Signal Control	1	The center shall remotely control traffic signal controllers.	Planned
		4	The center shall collect traffic signal controller fault data from the field.	Existing
		5	The center shall manage (define, store and modify) control plans to coordinate signalized intersections, to be engaged at the direction of center personnel or according to a daily schedule.	Existing
		8	The center shall maintain traffic signal coordination including synchronizing clocks throughout the system.	Planned
		10	The center shall adjust signal timing in respond to a signal prioritization, signal preemption, pedestrian call, multi-modal crossing activation, or other requests for right-of-way.	Existing
		14	The center shall support requests from emergency management centers to provide responding emergency vehicles with signal preemption.	Existing
Bismarck TOC Field Devices	Roadway Basic Surveillance	1	The field element shall collect, process, digitize, and send traffic sensor data (speed, volume, and occupancy) to the center for further analysis and storage, under center control.	Existing
		2	The field element shall collect, process, and send traffic images to the center for further analysis and distribution.	Existing

Element Name	Functional Object	Req #	Requirement	Status
		4	The field element shall return sensor and CCTV system operational status to the controlling center.	Existing
		5	The field element shall return sensor and CCTV system fault data to the controlling center for repair.	Existing
	Roadway Data Collection	1	The field element shall collect traffic, road, and environmental conditions information.	Planned
		3	The field element shall collect sensor status and sensor faults from roadside equipment and send it along with the recorded data to a center for archival.	Planned
	Roadway Signal Control	1	The field element shall control traffic signals under center control.	Existing
		2	The field element shall respond to pedestrian crossing requests by accommodating the pedestrian crossing.	Existing
		6	The field element shall return traffic signal controller operational status to the center.	Existing
		7	The field element shall return traffic signal controller fault data to the center.	Existing
		15	The field element shall receive requests for emergency vehicle signal preemption.	Existing
	Roadway Signal Preemption	1	The field element shall respond to signal preemption requests from emergency vehicles.	Existing
	Roadway Traffic Information Dissemination	1	The field element shall include dynamic message signs for dissemination of traffic and other information to drivers, under center control; the DMS may be either those that display variable text messages, or those that have fixed format display(s) (e.g., vehicle restrictions, or lane open/close).	Existing
		3	The field element shall provide operational status for the driver information systems equipment (DMS, HAR, etc.) to the center.	Existing
		4	The field element shall provide fault data for the driver information systems equipment (DMS, HAR, etc.) to the center for repair.	Planned
Central Dakota Communications Center	Emergency Call-Taking	1	The emergency call-taking center shall support the interface to the Emergency Telecommunications System (e.g., 911 or 7-digit call routing) to receive emergency	Existing

Element Name	Functional Object	Req #	Requirement	Status
			notification information and provide it to the emergency system operator.	
		2	The emergency call-taking center shall receive emergency call information from 911 services and present the possible incident information to the emergency system operator.	Existing
		5	The emergency call-taking center shall receive emergency notification information from other public safety agencies and present the possible incident information to the emergency system operator.	Existing
		6	The emergency call-taking center shall receive emergency notification information from public transit systems and present the possible incident information to the emergency system operator.	Existing
		9	The emergency call-taking center shall forward the verified emergency information to the responding agency based on the location and nature of the emergency.	Existing
		10	The emergency call-taking center shall update the incident information log once the emergency system operator has verified the incident.	Existing
	Emergency Dispatch	1	The center shall dispatch emergency vehicles to respond to verified emergencies under center personnel control.	Existing
		2	The center shall store the current status of all emergency vehicles available for dispatch and those that have been dispatched.	Existing
		3	The center shall relay location and incident details to the responding vehicles.	Existing
		4	The center shall track the location and status of emergency vehicles responding to an emergency based on information from the emergency vehicle.	Existing
		5	The center shall store and maintain the emergency service responses in an action log.	Existing
		6	The center shall coordinate response to incidents with other Emergency Management centers to ensure appropriate resources are dispatched and utilized.	Existing

Element Name	Functional Object	Req #	Requirement	Status
	Emergency Routing	4	The center shall receive asset restriction information to support the dispatching of appropriate emergency resources.	Existing
		7	The center shall calculate emergency vehicle routes, under center personnel control, based on the collected traffic and road conditions information.	Existing
Lincoln PW	MCM Vehicle Maintenance Management	1	The center shall collect and analyze vehicle diagnostics information from maintenance and construction vehicles. The information includes engine temperature, mileage, tire wear, brake wear, belt wear, and any warnings or alarms concerning the operational condition of the vehicle and ancillary equipment.	Existing
Lincoln PW Vehicles	MCV Roadway Maintenance and Construction	4	The maintenance and construction vehicle shall respond to dispatch information from the center, presented to the vehicle operator for acknowledgement and returning status.	Existing
		5	The maintenance and construction vehicle shall send operational data to the center including the operational state of the maintenance equipment (e.g., blade up/down, spreader pattern), types and quantities of materials used for construction and maintenance activities, and a record of the actual work performed.	Existing
Mandan Engineering Field Devices	Roadway Signal Control	1	The field element shall control traffic signals under center control.	Existing
		15	The field element shall receive requests for emergency vehicle signal preemption.	Existing
	Roadway Signal Preemption	1	The field element shall respond to signal preemption requests from emergency vehicles.	Existing
Mandan PW Operations Center	MCM Automated Treatment System Control	1	The center shall remotely control automated roadway treatment systems. Treatments can be in the form of fog dispersion, anti-icing chemicals, etc.	Planned
		2	The center shall remotely control the environmental sensors that upon detecting changes in environmental or atmospheric conditions, automatically activate roadway treatment systems.	Planned

Element Name	Functional Object	Req #	Requirement	Status
		3	The center shall collect automated roadway treatment system and associated environmental sensor operational status.	Planned
		4	The center shall collect automated roadway treatment system and associated environmental sensor fault data and request repair.	Planned
		5	The center shall accept requests for automated roadway treatment system activation from center personnel.	Planned
	MCM Winter Maintenance Management	1	The center shall respond to requests from emergency management and traffic management centers for hazard removal, field equipment repair, and other winter roadway maintenance.	Existing
		5	The center shall support an interface with a map update provider, or other appropriate data sources, through which updates of digitized map data can be obtained and used as a background for the scheduling of winter maintenance activities.	Existing
		6	The center shall collect real-time information on the state of the regional transportation system from other centers including current traffic and road conditions, weather conditions, special event and incident information and use the collected information to support winter maintenance operations.	Existing
		8	The center shall determine the need for roadway treatment based on current and forecasted weather information, current usage of treatments and materials, available resources, requests for action from other agencies, and recommendations from the Maintenance Decision Support system, specifically under winter conditions. This supports winter maintenance such as plowing, treating, anti-icing, etc.	Existing
		9	The center shall provide dispatch instructions for vehicle operators based on input parameters from center personnel, specifically for winter conditions. This could include a treatment route, treatment	Existing

Element Name	Functional Object	Req #	Requirement	Status
			application rates, start and end times, and other treatment instructions.	
Mandan PW Vehicles	MCV Vehicle Location Tracking	1	The maintenance and construction vehicle shall track its current location.	Existing
		2	The maintenance and construction vehicle shall send the time stamped vehicle location to the controlling center.	Existing
Mandan Traffic Engineering	TMC Signal Control	1	The center shall remotely control traffic signal controllers.	Planned
		4	The center shall collect traffic signal controller fault data from the field.	Existing
Morton County Communications	Emergency Call-Taking	1	The emergency call-taking center shall support the interface to the Emergency Telecommunications System (e.g., 911 or 7-digit call routing) to receive emergency notification information and provide it to the emergency system operator.	Existing
		2	The emergency call-taking center shall receive emergency call information from 911 services and present the possible incident information to the emergency system operator.	Existing
		6	The emergency call-taking center shall receive emergency notification information from public transit systems and present the possible incident information to the emergency system operator.	Existing
		9	The emergency call-taking center shall forward the verified emergency information to the responding agency based on the location and nature of the emergency.	Existing
		10	The emergency call-taking center shall update the incident information log once the emergency system operator has verified the incident.	Existing
	Emergency Dispatch	1	The center shall dispatch emergency vehicles to respond to verified emergencies under center personnel control.	Existing
		2	The center shall store the current status of all emergency vehicles available for dispatch and those that have been dispatched.	Existing
		3	The center shall relay location and incident details to the responding vehicles.	Existing

Element Name	Functional Object	Req #	Requirement	Status
		4	The center shall track the location and status of emergency vehicles responding to an emergency based on information from the emergency vehicle.	Existing
		5	The center shall store and maintain the emergency service responses in an action log.	Existing
		6	The center shall coordinate response to incidents with other Emergency Management centers to ensure appropriate resources are dispatched and utilized.	Existing
	Emergency Routing	4	The center shall receive asset restriction information to support the dispatching of appropriate emergency resources.	Existing
Morton County PW	MCM Vehicle Tracking	1	The center shall monitor the locations of all maintenance and construction vehicles and other equipment under its jurisdiction.	Existing
	MCM Winter Maintenance Management	7	The center shall dispatch and route winter maintenance vehicle drivers and support them with route-specific environmental, incident, advisory, threat, alert, and traffic congestion information.	Existing
Morton County PW vehicles	MCV Vehicle Location Tracking	1	The maintenance and construction vehicle shall track its current location.	Existing
	MCV Winter Maintenance	1	The maintenance and construction vehicle shall track the vehicle's location and status of safety systems on-board the winter maintenance vehicle.	Existing
NDDOT District Field Devices	Roadway Automated Treatment	1	The field element shall activate automated roadway treatment systems based on environmental or atmospheric conditions. Treatments can be in the form of fog dispersion, anti-icing chemicals, etc.	Planned
		2	The field element shall activate automated roadway treatment systems under center control. Treatments can be in the form of fog dispersion, anti-icing chemicals, etc.	Planned
		3	The field element shall return automated roadway treatment system and associated environmental sensor operational status to the maintenance center.	Planned
		4	The field element shall return automated roadway treatment system and associated	Planned

Element Name	Functional Object	Req #	Requirement	Status
			environmental sensor fault data to the maintenance center for repair.	
	Roadway Speed Monitoring and Warning	1	The field element shall include sensors to detect vehicle speeds, under traffic or maintenance center control.	Planned
	Roadway Traffic Information Dissemination	1	The field element shall include dynamic message signs for dissemination of traffic and other information to drivers, under center control; the DMS may be either those that display variable text messages, or those that have fixed format display(s) (e.g., vehicle restrictions, or lane open/close).	Existing
		2	The field element shall include driver information systems that communicate directly from a center to the vehicle radio (such as Highway Advisory Radios) for dissemination of traffic and other information to drivers, under center control.	Existing
		3	The field element shall provide operational status for the driver information systems equipment (DMS, HAR, etc.) to the center.	Existing
		4	The field element shall provide fault data for the driver information systems equipment (DMS, HAR, etc.) to the center for repair.	Existing
NDDOT District Office	MCM Automated Treatment System Control	1	The center shall remotely control automated roadway treatment systems. Treatments can be in the form of fog dispersion, anti-icing chemicals, etc.	Planned
		2	The center shall remotely control the environmental sensors that upon detecting changes in environmental or atmospheric conditions, automatically activate roadway treatment systems.	Planned
		3	The center shall collect automated roadway treatment system and associated environmental sensor operational status.	Existing
		4	The center shall collect automated roadway treatment system and associated environmental sensor fault data and request repair.	Planned
		5	The center shall accept requests for automated roadway treatment system activation from center personnel.	Planned

Element Name	Functional Object	Req #	Requirement	Status
	MCM Vehicle Tracking	1	The center shall monitor the locations of all maintenance and construction vehicles and other equipment under its jurisdiction.	Existing
		2	The center shall present location data to center personnel for the fleet of maintenance and construction vehicles and other equipment.	Existing
	MCM Winter Maintenance Management	1	The center shall respond to requests from emergency management and traffic management centers for hazard removal, field equipment repair, and other winter roadway maintenance.	Existing
		6	The center shall collect real-time information on the state of the regional transportation system from other centers including current traffic and road conditions, weather conditions, special event and incident information and use the collected information to support winter maintenance operations.	Existing
		8	The center shall determine the need for roadway treatment based on current and forecasted weather information, current usage of treatments and materials, available resources, requests for action from other agencies, and recommendations from the Maintenance Decision Support system, specifically under winter conditions. This supports winter maintenance such as plowing, treating, anti-icing, etc.	Existing
		9	The center shall provide dispatch instructions for vehicle operators based on input parameters from center personnel, specifically for winter conditions. This could include a treatment route, treatment application rates, start and end times, and other treatment instructions.	Existing
NDDOT District Vehicles	MCV Roadway Maintenance and Construction	1	The maintenance and construction vehicle shall track the location and status of safety systems on-board the vehicle.	Existing
		1	The maintenance and construction vehicle shall track its current location.	Existing

Element Name	Functional Object	Req #	Requirement	Status
	MCV Vehicle Location Tracking	2	The maintenance and construction vehicle shall send the time stamped vehicle location to the controlling center.	Existing
State Radio	Emergency Dispatch	1	The center shall dispatch emergency vehicles to respond to verified emergencies under center personnel control.	Existing
		2	The center shall store the current status of all emergency vehicles available for dispatch and those that have been dispatched.	Existing
		3	The center shall relay location and incident details to the responding vehicles.	Existing
		5	The center shall store and maintain the emergency service responses in an action log.	Existing
		6	The center shall coordinate response to incidents with other Emergency Management centers to ensure appropriate resources are dispatched and utilized.	Existing
	Emergency Routing	4	The center shall receive asset restriction information to support the dispatching of appropriate emergency resources.	Existing