1. INTRODUCTION

This document summarizes the results of developing a project architecture (PA) for the Fargo-Moorhead Traffic Operations Center (FM TOC). The architecture was developed as an expanded subset from the Fargo-Moorhead regional architecture (RA). This PA will serve as a tool to guide future ITS planning in the areas of traffic management and supports the development of a regional TOC to integrate functions across jurisdictional lines. The PA will establish roles and responsibilities of participating agencies and define systems requirements.

2. SCOPE

The geographical area covered in this architecture includes the cities of Fargo, Moorhead, and West Fargo. The ITS services covered under the TOC project include the following:

1. Travel and Traffic Management
   a. Traffic control
   b. Traveler information
   c. Traffic surveillance

2. Public Transportation Management
   a. Transit signal priority

3. Emergency Management
   a. Incident management

4. Information Management
   a. Data archival and analysis services

3. STAKEHOLDERS

The development of the FM TOC PA was guided by the FM Metropolitan Traffic Operations Working Group, other stakeholders were contacted individually on an as-needed basis. The list of stakeholders includes the following:

1. City of Fargo
2. City of Moorhead
3. NDDOT Fargo District
4. Mn/DOT District 4
5. City of West Fargo
6. NDDOT Central Office
7. Metro Area Transit (MAT)
8. Red River Regional Dispatch Center (RRRDC) and the following partners:
   a. Fargo Police
   b. Fargo Fire
   c. Moorhead Police
   d. Moorhead Fire
   e. FM Ambulance
9. North Dakota Highway Patrol Fargo District
10. Minnesota State Patrol Detroit Lakes District
11. Upper Great Plains Transportation Institute (UGPTI) – NDSU
12. Metro COG
13. Federal Highway Administration (FHWA)
4. INVENTORY

This section summarizes the ITS inventory for the TOC project, inventory elements from the regional architecture were used as a starting point and changes were made to reflect the TOC needs. Inventory elements are differentiated into four different types: centers, field devices, vehicles, and communications.

4.1 Centers

These are the locations where functions are performed (i.e., process information, issue control commands, and produce output information).

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. In this PA these functions will be performed at the planned FM TOC.

2. Transit Management Center: The Metro Area Transit (MAT) provides public transportation services for the cities of Fargo and Moorhead. MAT operates several fixed routes in Fargo and Moorhead in addition to paratransit services. MAT

3. Emergency Management Center: The Red River Regional Dispatch Center (RRRDC) provides dispatch services to the cities of Fargo, Moorhead, and West Fargo, as well as Cass and Clay Counties. It also coordinates emergency management with the North Dakota Highway Patrol (NDHP), the Minnesota State Patrol (MSP), and other local law enforcement and emergency response agencies.

4. Archived Data Management: Several agencies currently collect data from ITS sensors. However, there currently is no single center for archiving or processing these data. The Advanced Traffic Analysis Center (ATAC) at North Dakota State University has been designated as the future Data Warehouse entity for the F-M area. A fiber optics communication link between the City of Fargo and ATAC exists to facilitate data transfer and access however data is only transferred manually at this point.

4.2 Field Devices

This type of physical entities refers to field devices used to support ITS systems. The majority of field devices in the F-M area may be classified under the Roadway Subsystem and they include the following:

1. Sensors
   a. Video traffic detectors
   b. Loop detectors
   c. Pucks

2. Control devices
   a. Traffic signal controllers

3. Surveillance/monitoring
   a. Pan-tilt-zoom (PTZ) closed circuit television (CCTV) cameras

4. Warning/advisory devices
   a. Permanent Dynamic Message Signs (DMS)
   b. Portable DMS where needed
4.3 Vehicles

The vehicles subsystem refers to vehicles with ITS capabilities including advanced communications, navigation, monitoring, and control system. For the TOC PA these vehicles include:

1. Emergency Vehicle signal preemption
   a. Fire
   b. Law enforcement
   c. Ambulance
2. Transit Vehicle
   a. MAT buses with electronic fare box and automated vehicle location (AVL) capabilities

4.4 Communication Infrastructure

Communications among centers and between centers and field devices is required in order to perform ITS functions. In order to perform the TOC functions, more communication infrastructure will need to be installed especially on the Minnesota side, and links between different jurisdictions communication need to be established. The following are the main modes of communication in the F-M area:

1. Fiber
   a. I-29 and I-94
   b. Arterial network (Fargo)
2. Phone drops and twisted pair
   a. Mostly in Moorhead traffic signals
3. Wireless/cellular
   a. Moorhead train detection system
   b. NDDOT portable DMS

5. SERVICES/MARKET PACKAGES

The following Market Packages were identified for the TOC project in order to support ITS needs and services. The descriptions are based on information from the National ITS Architecture. The status of each Market Package in the project is also indicated (i.e., existing or planned. Market Packages with an Existing followed by the * indicates there are portions of the Market Package already deployed but additional portions are planned for deployment). Customized F-M Market Packages and associated Information Flows are shown in more detail in Appendix A.

ATMS01: Network Surveillance (Existing)

This market package includes traffic detectors, other surveillance equipment, supporting field equipment, and fixed-point to fixed-point communications to transmit the collected data back to the Traffic Management Subsystem. 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 Subsystem). The data generated by this market 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.
ATMS03: Surface Street Control (Existing)

This market package provides the central control and monitoring equipment, communication links, and the signal control equipment that support local surface street control and/or arterial traffic management. Traffic signal control systems represented by this market package range from fixed-schedule control systems to fully traffic-responsive. Additionally, general advisory and traffic control information can be provided to the driver while en route. Systems that achieve coordination across jurisdictions by using a common time-base or other strategies that do not require real time coordination would be represented by this package. This market package is consistent with typical urban traffic signal control systems.

ATMS04: Freeway Control (Existing*)

This market package provides the communications and roadside equipment to support ramp control, lane controls, and interchange control for freeways. This package is consistent with typical urban traffic freeway control systems. It incorporates the instrumentation included in the Network Surveillance Market Package to support freeway monitoring and adaptive strategies as an option. This market package also includes the capability to utilize surveillance information for detection of incidents. Typically, the processing would be performed at a traffic management center; however, developments might allow for point detection with roadway equipment. Additionally, this market package allows general advisory and traffic control information to be provided to the driver while en route.

ATMS06: Traffic Information Dissemination (Planned)

This market 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, incident information, emergency alerts and driver advisories. This package also covers the equipment and interfaces that provide traffic information from a traffic management center to the media, Transit Management, Emergency Management, and Information Service Providers. A link to the Maintenance and Construction Management subsystem allows real time information on road/bridge closures due to maintenance and construction activities to be disseminated.

ATMS07: Regional Traffic Management (Planned)

This market package provides for the sharing of traffic information and control among traffic management centers to support regional traffic management strategies. Regional traffic management strategies that are supported include coordinated signal control in a metropolitan area and coordination between freeway operations and arterial signal control within a corridor. This market package advances the Surface Street Control and Freeway Control Market Packages by adding the communications links and integrated control strategies that enable integrated inter-jurisdictional 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 Surface Street Control and Freeway Control Market Packages and adds hardware, software, and fixed-point to 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 control between traffic management centers.
ATMS08: Traffic Incident Management (Planned)

This market package manages both unexpected incidents and planned events so that the impact to the transportation network and traveler safety is minimized. The market package includes incident detection capabilities through roadside surveillance devices (e.g. CCTV) and through regional coordination with other traffic management, maintenance and construction management and emergency management centers as well as rail operations and event promoters. Information from these diverse sources is collected and correlated by this market package to detect and verify incidents and implement an appropriate response. This market 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 center subsystems. Incident response also includes presentation of information to affected travelers using the Traffic Information Dissemination market package and dissemination of incident information to travelers through the Broadcast Traveler Information or Interactive Traveler Information market 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 field personnel. The coordination can also extend to tow trucks and other allied response agencies and field service personnel.

ATMS13: Standard Railroad Grade Crossing (Existing)

This market 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 roadway subsystem and the driver in the architecture definition.) These traditional HRI warning systems may also be augmented with other standard traffic management devices. The warning systems are activated on notification by interfaced wayside equipment of an approaching train. 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 subsystem.

ATIS01: Broadcast Traveler Information (Planned)

Several agencies currently collect data from ITS sensors. However, there currently is no single center for archiving or processing these data. The Advanced Traffic Analysis Center (ATAC) at North Dakota State University has been designated as the future Data Warehouse entity for the F-M area. A fiber optics communication link between the City of Fargo and ATAC exists to facilitate data transfer and access however data is only transferred manually at this point.

APTS09: Transit Signal Priority (Existing*)

This market package determines the need for transit priority on routes and at certain intersections and requests transit vehicle priority at these locations. The signal priority may result from limited local coordination between the transit vehicle and the individual intersection for signal priority or may result from coordination between transit management and traffic
management centers. Coordination between traffic and transit management is intended to improve on-time performance of the transit system to the extent that this can be accommodated without degrading overall performance of the traffic network.

**EM02: Emergency Routing (Existing*)**

This market package supports automated vehicle location and dynamic routing of emergency vehicles. Traffic information, road conditions, and suggested routing information are provided to enhance emergency vehicle routing. Special priority or other specific emergency traffic control strategies can be coordinated to improve the safety and time-efficiency of responding vehicle travel on the selected route(s). The Emergency Management Subsystem provides the routing for the emergency fleet based on real-time conditions and has the option of requesting a route from the Traffic Management subsystem. The Emergency Vehicle may also be equipped with dedicated short range communications for local signal preemption and the transmission of alerts to surrounding vehicles. The service provides for information exchange between care facilities and both the Emergency Management Subsystem and emergency vehicles.

**AD2: Archived Data Warehouse (Planned)**

This market package includes all the data collection and management capabilities provided by the ITS Data Mart, and adds the functionality and interface definitions that allow collection of data from multiple agencies and data sources spanning across modal and jurisdictional boundaries. It performs the additional transformations and provides the additional meta data management features that are necessary so that all this data can be managed in a single repository with consistent formats. The potential for large volumes of varied data suggests additional on-line analysis and data mining features that are also included in this market package in addition to the basic query and reporting user access features offered by the ITS Data Mart.

6. OPERATIONAL CONCEPT

This section discusses the roles and responsibilities of stakeholders in the implementation and operation of the F-M TOC. The operational concept outlines these roles and responsibilities for specific scenarios, e.g., traffic signal operation and maintenance, identifying and responding to traffic incidents, etc. In addition to providing a snapshot of how things are done for a certain scenario, the operational concept explores additional integration opportunities in the region with particular focus on stakeholder involvement. The roles and responsibilities can be found in Appendix B.

7. AGREEMENTS

This section briefly outlines potential agreements needed to support the F-M TOC. The process of identifying needed agreement relied on the Market 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. Some established agencies such as RRRDC and MAT have existing agreements in place.

The table on the following page shows a summary of potential agreements for the F-M TOC project. The table provides the following information for each agreement:
1. Market Package
   a. The Market Package where the agreement is needed

2. Purpose
   a. Brief statement on what the agreement addresses

3. Stakeholders
   a. List the stakeholders (agencies) which would be included in the agreement

4. Issues
   a. List specific issues to be included in the agreement
<table>
<thead>
<tr>
<th>Market Packages</th>
<th>Purpose</th>
<th>Stakeholders</th>
<th>Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD2-ITS Data Warehouse</td>
<td>Data use/storage</td>
<td>FM TOC, NDDOT-Fargo District, NDSU, RRRDC Regional Partners</td>
<td>Security Resource sharing</td>
</tr>
<tr>
<td>ATMS01-Network Surveillance</td>
<td>Share data</td>
<td>FM TOC, Fargo, West Fargo, NDDOT-Fargo District, MnDOT-District 4</td>
<td>Access to sensors, Access to databases, Access to networks/servers</td>
</tr>
<tr>
<td>ATMS03-Surface Street Control</td>
<td>Traffic operations</td>
<td>FM TOC, Fargo, NDDOT-Fargo District, MnDOT-District 4, Moorhead</td>
<td>Access to devices</td>
</tr>
<tr>
<td>ATMS04-Freeway Control</td>
<td>I-94 and I-29 freeway operations</td>
<td>NDDOT-Fargo District, MnDOT-District 4, NDDOT Central Office</td>
<td>Shared use of devices, Access to data, Communications links</td>
</tr>
<tr>
<td>ATMS06-Traffic Information</td>
<td>Coordinate traveler information</td>
<td>FM TOC, Fargo, West Fargo, NDDOT-Fargo District, MnDOT-District 4, NDDOT Central Office</td>
<td>Communications links, Notification protocols</td>
</tr>
<tr>
<td>Dissemination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATMS07-Regional Traffic Control</td>
<td>Sharing data (flow, video)</td>
<td>FM TOC, West Fargo, NDDOT-Fargo District</td>
<td>Communications links, Hardware compatibility, Operating standards</td>
</tr>
<tr>
<td>ATMS08-Traffic Incident</td>
<td>Incident traffic response</td>
<td>FM TOC, RRRDC Regional Partners, ND Highway Patrol, MN State Patrol</td>
<td>Communications links, Response protocols</td>
</tr>
<tr>
<td>Management</td>
<td>Sharing data (flow, video)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8. ITS STANDARDS

This section identifies applicable ITS Standards identified for the TOC Projects. It should be noted that ITS standards presented here may represent a superset of options, and in some cases, provide redundant capabilities. In addition, these ITS standards are at different maturity levels. Care should be taken to select the standards that best meet the needs of the project.

<table>
<thead>
<tr>
<th>Standard Name</th>
<th>Document ID</th>
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<tbody>
<tr>
<td>Traffic Management Data Dictionary and Message Sets for External TMC Communication</td>
<td>ITE TMDD 2.1</td>
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<tr>
<td>NTCIP Center-to-Center Standards Group</td>
<td>NTCIP 1102, NTCIP 1104, NTCIP 2104, NTCIP 2202, NTCIP 2303, NTCIP 2304, NTCIP 2306</td>
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<tr>
<td>NTCIP Center-to-Field Standards Group</td>
<td>NTCIP 1102, NTCIP 1103, NTCIP 2101, NTCIP 2102, NTCIP 2103, NTCIP 2104, NTCIP 2201, NTCIP 2202, NTCIP 2301, NTCIP 2302, NTCIP 2303</td>
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<tr>
<td>Global Object Definitions</td>
<td>NTCIP 1201</td>
</tr>
<tr>
<td>Object Definitions for Actuated Traffic Signal Controller Units</td>
<td>NTCIP 1202</td>
</tr>
<tr>
<td>Object Definitions for Dynamic Message Signs</td>
<td>NTCIP 1203</td>
</tr>
<tr>
<td>Data Dictionary for Closed Circuit Television (CCTV)</td>
<td>NTCIP 1205</td>
</tr>
<tr>
<td>Data Collection and Monitoring Devices</td>
<td>NTCIP 1206</td>
</tr>
<tr>
<td>Ramp Meter Controller Objects</td>
<td>NTCIP 1207</td>
</tr>
<tr>
<td>Object Definitions for Video Switches</td>
<td>NTCIP 1208</td>
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<tr>
<td>Transportation System Sensor Objects</td>
<td>NTCIP 1209</td>
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<tr>
<td>Objects for Signal Systems Master</td>
<td>NTCIP 1210</td>
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<tr>
<td>Objects Definitions for Signal Control and Prioritization (SCP)</td>
<td>NTCIP 1211</td>
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<tr>
<td>Standard for Transit Communications Interface Profiles</td>
<td>APTA TCIP-S-001 3.0.0</td>
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<tr>
<td>Dedicated Short Range Communication at 915 MHz Standards Group</td>
<td>ASTM E2158-01, ASTM PS 105-99</td>
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<tr>
<td>Standard Specification for Archiving ITS Generated Traffic Monitoring Data</td>
<td>ASTM WK7604</td>
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<tr>
<td>Standard for Functional Level Traffic Management Data Dictionary (TMDD)</td>
<td>ITE TM 1.03</td>
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<tr>
<td>Message Sets for External TMC Communication (MS/ETMCC)</td>
<td>ITE TM 2.01</td>
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</table>
| Advanced Traveler Information Systems (ATIS) General Use Standards Group | SAE J2266  
SAE J2354  
SAE J2540  
SAE J2540/1  
SAE J2540/2  
SAE J2540/3 |
| Dedicated Short Range Communication at 5.9 GHz Standards Group | ASTM E2213-03  
IEEE 1609.1-2006  
IEEE 1609.2-2006  
IEEE 1609.4-2006  
IEEE P1609.3  
IEEE P802.11p |

9. FUNCTIONAL REQUIREMENTS

This section provides the detailed functional requirements for the user services and market packages identified for the hybrid F-M TOC. The requirements were selected from the National ITS Architecture template based on desired functions for each system. Turbo Architecture was used to build the functional requirements and produce a Functional Requirements Report. The organization of the Functional Requirements Report produced by Turbo may be described as follows:

1. Element: Subsystems or Centers in the regional architecture
2. Entity: stakeholders in the statewide architecture
3. Functional Area: ITS Market Package service area
4. Requirements: specific functions to be carried out by the system
5. Status: existing or planned

Appendix C.
APPENDIX A: MARKET PACKAGE FLOW DIAGRAMS
ATMS07 – Regional Traffic Management (Centralized)
APPENDIX B: OPERATIONAL CONCEPT (ROLES AND RESPONSIBILITIES)
Operational Concept (Roles & Responsibilities)
FM TOC (Centralized)

RR Area: Archived Data Management for FM TOC (Centralized)

**Stakeholder**

**FM Regional Traffic Management**

**Roles and Responsibilities**
Collect and provide data for archival

**Status**
Planned

**Stakeholder**

**MAT**

**Roles and Responsibilities**
Collect and provide data for archival

**Status**
Planned

**Stakeholder**

**MSP DL**

**Roles and Responsibilities**
Collect and provide data for archival

**Status**
Planned

**Stakeholder**

**NDHP Fargo**

**Roles and Responsibilities**
Collect and provide data for archival

**Status**
Planned

**Stakeholder**

**NDSU - UGPTI**

**Roles and Responsibilities**
Format and provide data to requesters
Perform analysis
Store data

**Status**
Existing
Planned
Planned

**Stakeholder**

**RRRDC Regional Partners**

**Roles and Responsibilities**
Collect and provide data for archival

**Status**
Planned

**Stakeholder**

**West Fargo Engineering**

**Roles and Responsibilities**
Collect and provide data for archival

**Status**
Planned

**MarketPackage**
AD2: ITS Data Warehouse (Centralized)
RR Area: Emergency Management for FM TOC (Centralized)

Emergency vehicle signal preemption.

**Stakeholder**

**FM Regional Traffic Management**

*Roles and Responsibilities*

- Maintain signal preemption equipment  
  Status: Planned
- Provide signal preemption at signalized intersections  
  Status: Planned

**Stakeholder**

**MSP DL**

*Roles and Responsibilities*

- Work with FM TOC on preemption protocols and equipment selection for MSP vehicles  
  Status: Planned

**Stakeholder**

**NDHP Fargo**

*Roles and Responsibilities*

- Work with FM TOC on preemption protocols and equipment selection for NDHP vehicles  
  Status: Planned

**Stakeholder**

**RRRDC Regional Partners**

*Roles and Responsibilities*

- Coordinate with NDHP and MSP districts  
  Status: Existing
- Work with FM TOC on preemption protocols and equipment selection for local police, fire and FM Ambulance vehicles  
  Status: Planned

MarketPackage

EM02: Emergency Routing (Centralized)

RR Area: Freeway Management for FM TOC (Centralized)

**Stakeholder**

**FM Regional Traffic Management**

*Roles and Responsibilities*

- Coordinate operations with regional partners  
  Status: Planned
- Monitor freeway conditions  
  Status: Planned
- Share information with regional partners  
  Status: Planned
- Share video images with regional partners  
  Status: Planned

**Stakeholder**

**MSP DL**

*Roles and Responsibilities*

- Monitor freeway outside of TOC operating hours  
  Status: Planned

**Stakeholder**

**NDHP Fargo**

*Roles and Responsibilities*

- Monitor freeway outside of TOC operating hours  
  Status: Planned
**RR Area: Freeway Management for FM TOC (Centralized)**

**Stakeholder**

**RRDRC Regional Partners**

**Roles and Responsibilities**
- Monitor freeway outside of TOC operation hours

**MarketPackage**
- ATMS01: Network Surveillance (Centralized)
- ATMS04: Freeway Control
- ATMS06: Traffic Information Dissemination (Centralized)
- ATMS07: Regional Traffic Management (Centralized)

**RR Area: Incident Management for FM TOC (Centralized)**

**Stakeholder**

**Fargo PW**

**Roles and Responsibilities**
- Respond to incidents with appropriate resources

**Stakeholder**

**FM Event Venus**

**Roles and Responsibilities**
- Provide event information to regional traffic and emergency management agencies
- Work with regional agencies on event plans

**Stakeholder**

**FM Regional Traffic Management**

**Roles and Responsibilities**
- Implement special events timing plans and control strategies
- Monitor, detect and report incidents
- Provide incident information to regional partners
- Provide incident travel information to public (e.g. detour information)

**Stakeholder**

**Moorhead PW**

**Roles and Responsibilities**
- Respond to incidents with appropriate resources

**Stakeholder**

**MSP DL**

**Roles and Responsibilities**
- Coordinate with other law enforcement and emergency management agencies
- Respond to incidents on MN state system

**Stakeholder**

**NDHP Fargo**
### RR Area: Incident Management for FM TOC (Centralized)

**Roles and Responsibilities**

<table>
<thead>
<tr>
<th>Role</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinate with other law enforcement and emergency management agencies</td>
<td>Existing</td>
</tr>
<tr>
<td>Respond to incidents on ND state system</td>
<td>Existing</td>
</tr>
</tbody>
</table>

**Stakeholder**

**RRRDC Regional Partners**

**Roles and Responsibilities**

<table>
<thead>
<tr>
<th>Role</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinate response</td>
<td>Existing</td>
</tr>
<tr>
<td>Provide dispatch and communications</td>
<td>Existing</td>
</tr>
</tbody>
</table>

**MarketPackage**

ATMS08: Traffic Incident Management System (Centralized)

### RR Area: Surface Street Management for FM TOC (Centralized)

**Stakeholder**

**FM Regional Traffic Management**

**Roles and Responsibilities**

<table>
<thead>
<tr>
<th>Role</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinate with West Fargo on shared corridors</td>
<td>Planned</td>
</tr>
<tr>
<td>Design, operate, and maintain the signal control system in Fargo-Moorhead</td>
<td>Planned</td>
</tr>
</tbody>
</table>

**Stakeholder**

**West Fargo Engineering**

**Roles and Responsibilities**

<table>
<thead>
<tr>
<th>Role</th>
<th>Status</th>
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<tbody>
<tr>
<td>Design, operate, and maintain the signal control system in West Fargo</td>
<td>Existing</td>
</tr>
<tr>
<td>Coordinate with FM TOC on shared corridors</td>
<td>Planned</td>
</tr>
</tbody>
</table>

**MarketPackage**

ATMS01: Network Surveillance (Centralized)
ATMS03: Surface Street Control (Centralized)
ATMS06: Traffic Information Dissemination (Centralized)
ATMS07: Regional Traffic Management (Centralized)
ATMS13: Standard Railroad Grade Crossing (Centralized)

### RR Area: Transit Services for FM TOC (Centralized)

**Stakeholder**

**FM Regional Traffic Management**

**Roles and Responsibilities**

<table>
<thead>
<tr>
<th>Role</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td>Maintain TSP equipment on signals</td>
<td>Planned</td>
</tr>
<tr>
<td>Work with MAT on providing transit vehicle signal priority (TSP) on selected routes</td>
<td>Planned</td>
</tr>
</tbody>
</table>

**Stakeholder**

**MAT**

**Roles and Responsibilities**

<table>
<thead>
<tr>
<th>Role</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td>Coordinate with FM TOC for TSP equipment on MAT vehicles</td>
<td>Planned</td>
</tr>
<tr>
<td>Work with FM TOC on TSP route selection</td>
<td>Planned</td>
</tr>
</tbody>
</table>
**MarketPackage**

APTS09: Transit Signal Priority (Centralized)

**RR Area:** Traveler Information for FM TOC (Centralized)

**Stakeholder**

**Fargo PW**

*Roles and Responsibilities*  
Provide road condition information to FM TOC

*Status*  
Planned

**Stakeholder**

**FM Regional Traffic Management**

*Roles and Responsibilities*  
FM TOC collects and shares road condition information with regional partners, media, and public

*Status*  
Planned

**Stakeholder**

**Moorhead PW**

*Roles and Responsibilities*  
Provide road condition information to FM TOC

*Status*  
Planned

**Stakeholder**

**MSP DL**

*Roles and Responsibilities*  
Provide road condition information to FM TOC

*Status*  
Planned

**Stakeholder**

**NDHP Fargo**

*Roles and Responsibilities*  
Provide road condition information to FM TOC

*Status*  
Planned

**Stakeholder**

**RRRDC Regional Partners**

*Roles and Responsibilities*  
Provide road condition information to FM TOC

*Status*  
Planned

**MarketPackage**

ATMS06: Traffic Information Dissemination (Centralized)

ATIS01: Broadcast Traveler Information
APPENDIX C: FUNCTIONAL REQUIREMENTS
## Functional Requirements

**FM TOC (Centralized)**

**Element:** Fargo PW Operations Center  
**Entity:** Maintenance and Construction Management  
**Functional Area:** MCM Incident Management

Supports coordinated response to incidents - share incident notifications, manage incident response resources, and coordinate overall incident situation and response among allied response organizations.

- **Requirement:** 3  
  The center shall exchange incident and threat information with emergency management centers as well as traffic management centers; including notification of existence of incident and expected severity, location, time and nature of incident.

- **Requirement:** 4  
  The center shall coordinate planning for incidents with emergency management centers - including pre-planning activities for disaster response, evacuation, and recovery operations.

- **Requirement:** 5  
  The center shall respond to requests from emergency management to provide maintenance and construction resources to implement response plans, assist in clean up, verify an incident, etc. This may also involve coordination with traffic management centers and other maintenance centers.

- **Requirement:** 6  
  The center shall exchange road network status assessment information with emergency management and traffic management centers including an assessment of damage sustained by the road network including location and extent of the damage, estimate of remaining capacity, required closures, alternate routes, necessary restrictions, and time frame for repair and recovery.

- **Requirement:** 7  
  The center shall provide work zone activities affecting the road network including the nature of the maintenance or construction activity, location, impact to the roadway, expected time(s) and duration of impact, anticipated delays, alternate routes, and suggested speed limits. This information may be augmented with images that provide a visual indication of current work zone status and traffic impacts.

- **Requirement:** 8  
  The center shall receive information indicating the damage sustained by transportation assets, derived from aerial surveillance, field reports, inspections, tests, and analyses to support incident management.

**Element:** FM TOC  
**Entity:** Information Service Provider  
**Functional Area:** ISP Traveler Data Collection

Collects traveler information from other centers, consolidates and refines the collected data, and makes this data available to traveler information applications.

- **Requirement:** 1  
  The center shall collect, process, and store traffic and highway condition information, including incident information, detours and road closures, event information, recommended routes, and current speeds on specific routes.
Architecture

FM TOC (Centralized)

Element: FM TOC

Status

Planned

Entity: Information Service Provider

Functional Area: ISP Traveler Data Collection

Collects traveler information from other centers, consolidates and refines the collected data, and makes this data available to traveler information applications.

Requirement: 2 The center shall collect, process, and store maintenance and construction information, including scheduled maintenance and construction work activities and work zone activities. Planned

Requirement: 7 The center shall collect, process, and store event information. Planned

Functional Area: ISP Probe Information Collection

Collection and aggregation of vehicle probe data, including calculation and dissemination of route travel times and usage. Includes environmental probe data collection, aggregation and dissemination.

Requirement: 1 The center shall collect traffic probe data (speeds, travel times, etc.) from appropriately equipped vehicles and short range communications equipment. Planned

Requirement: 2 The center shall aggregate collected traffic probe data, calculate route segment travel times, route segment speeds, and route usage, and disseminate to other centers. Planned

Functional Area: Basic Information Broadcast

Broadcast dissemination of traffic, transit, maintenance and construction, event, and weather information to traveler interface systems and vehicles.

Requirement: 1 The center shall disseminate traffic and highway condition information to travelers, including incident information, detours and road closures, event information, recommended routes, and current speeds on specific routes. Planned

Requirement: 2 The center shall disseminate maintenance and construction information to travelers, including scheduled maintenance and construction work activities and work zone activities. Planned

Requirement: 6 The center shall disseminate weather information to travelers. Planned

Requirement: 7 The center shall disseminate event information to travelers. Planned

Requirement: 9 The center shall provide the capability to support requests from the media for traffic and incident data. Planned

Requirement: 10 The center shall provide the capability for a system operator to control the type and update frequency of broadcast traveler information. Planned

Functional Area: ISP Emergency Traveler Information

Distribution of emergency information to the traveling public, including evacuation information and wide-area alerts.

Requirement: 1 The center shall disseminate emergency evacuation information to the traveler interface systems, including evacuation zones, shelter information, available transportation modes, road closures and detours, changes to transit services, and traffic and road conditions at the origin, destination, and along the evacuation routes. Planned
Architecture

E. FM TOC (Centralized)

Functional Area: Information Service Provider

Entity: ISP Emergency Traveler Information

- Distribution of emergency information to the traveling public, including evacuation information and wide-area alerts.

Requirement: 3 The center shall disseminate wide-area alert information to the traveler interface systems, including major emergencies such as a natural or man-made disaster, civil emergency, child abductions, severe weather watches and warnings, military activities, and law enforcement warnings.

Functional Area: ISP Data Collection

Collection and storage of information supporting the operations of traveler information service providers. For use by operations personnel or data archives in the region.

Requirement: 1 The center shall collect traveler information data, such as parking lot data, rideshare data, road network use data, vehicle probe data, and other data from traveler information system operations.

Requirement: 4 The center shall receive and respond to requests from ITS Archives for either a catalog of the traveler information data or for the data itself.

Entity: Traffic Management

Functional Area: Collect Traffic Surveillance

Management of traffic sensors and surveillance (CCTV) equipment, collection of current traffic conditions, and distribution of the collected information to other centers and operators.

Requirement: 1 The center shall monitor, analyze, and store traffic sensor data (speed, volume, occupancy) collected from field elements under remote control of the center.

Requirement: 2 The center shall monitor, analyze, and distribute traffic images from CCTV systems under remote control of the center.

Requirement: 4 The center shall distribute road network conditions data (raw or processed) based on collected and analyzed traffic sensor and surveillance data to other centers.

Requirement: 5 The center shall respond to control data from center personnel regarding sensor and surveillance data collection, analysis, storage, and distribution.

Requirement: 7 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 traffic data.

Functional Area: TMC Probe Information Collection

Collects, assimilates, and disseminates vehicle probe data collected from roadside beacons and centers controlling transit vehicles, emergency vehicles, toll collection points, and route-guided vehicles.

Requirement: 1 The center shall collect traffic probe data from vehicles via roadside field equipment.
Architecture

FM TOC (Centralized)

Element: FM TOC

Entity: Traffic Management

Functional Area: TMC Signal Control

Remotely controls traffic signal controllers to implement traffic management strategies at signalized intersections based on traffic conditions, incidents, emergency vehicle preemptions, pedestrian crossings, etc.

Requirement: 1 The center shall remotely control traffic signal controllers. Planned

Requirement: 3 The center shall collect traffic signal controller operational status and compare against the control information sent by the center. Planned

Requirement: 4 The center shall collect traffic signal controller fault data from the field. Planned

Requirement: 5 The center shall implement control plans to coordinate signalized intersections, under control of center personnel, based on data from sensors and surveillance monitoring traffic conditions, incidents, emergency vehicle preemptions, the passage of commercial vehicles with unusual loads, equipment faults, pedestrian crossings, etc. Planned

Functional Area: TMC Traffic Information Dissemination

Controls dissemination of traffic-related data to other centers, the media, and travelers via the driver information systems (DMS, HAR) that it operates.

Requirement: 1 The center shall remotely control dynamic messages signs for dissemination of traffic and other information to drivers. Planned

Requirement: 6 The center shall distribute traffic data to maintenance and construction centers, transit centers, emergency management centers, and traveler information providers. Planned

Requirement: 7 The center shall distribute traffic data to the media; the capability to provide the information in both data stream and graphical display shall be supported. Planned

Functional Area: TMC Regional Traffic Management

Coordination between traffic management centers in order to share traffic information between centers as well as control of traffic management field equipment. This may be used during incidents and special events and during day-to-day operations.

Requirement: 1 The center shall exchange traffic information with other traffic management centers including incident information, congestion data, traffic data, signal timing plans, and real-time signal control information. Planned

Requirement: 2 The center shall exchange traffic control information with other traffic management centers to support remote monitoring and control of traffic management devices (e.g. signs, sensors, signals, cameras, etc.). Planned
Architecture

FM TOC (Centralized)

Element: FM TOC

Entity: Traffic Management

**Functional Area:** TMC Traffic Management Decision Support

Recommends courses of action to the traffic operator based on current and forecast road and traffic conditions. Recommended actions may include predefined incident response plans, signal timing plan changes, DMS/HAR messages, and freeway control strategies including ramp metering and lane controls.

**Requirement:**
1. The center shall provide center personnel with an integrated regional view of current and forecast road and traffic conditions including traffic incidents, special events, maintenance activities and other events or conditions that impact capacity or demand.

**Status:** Planned

**Requirement:**
6. The center shall provide an interface to center personnel to input control parameters for the decision support process and receive recommended actions and supporting information presentation.

**Functional Area:** TMC Incident Detection

Remotely monitors traffic sensor and surveillance systems to detect and verify incidents. Also monitors external advisory and incident reporting systems, intermodal freight depots, and border crossings for additional incident information. Identified incidents are reported to operations personnel and other centers.

**Requirement:**
1. The center shall receive inputs from the Alerting and Advisory System concerning the possibility or occurrence of severe weather, terrorist activity, or other major emergency, including information provided by the Emergency Alert System.

**Status:** Planned

**Requirement:**
2. The center shall collect and store traffic flow and image data from the field equipment to detect and verify incidents.

**Status:** Planned

**Requirement:**
3. The center shall receive inputs concerning upcoming events that would effect the traffic network from event promoters, traveler information service providers, border crossings, and intermodal freight depots.

**Status:** Planned

**Requirement:**
4. The center shall exchange incident and threat information with emergency management centers as well as maintenance and construction centers; including notification of existence of incident and expected severity, location, time and nature of incident.

**Status:** Planned

**Requirement:**
6. The center shall provide road network conditions and traffic images to emergency management centers to support the detection, verification, and classification of incidents.

**Status:** Planned

**Requirement:**
7. The center shall provide video and traffic sensor control commands to the field equipment to detect and verify incidents.

**Status:** Planned
Architecture
FM TOC (Centralized)

Element: FM TOC

**Entity: Traffic Management**

**Functional Area: TMC Incident Dispatch Coordination/Communication**

Formulates an incident response that takes into account the incident potential, incident impacts, and/or resources required for incident management. Facilitates the dispatch of emergency response and service vehicles and coordinates the response with cooperating agencies.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Requirement</th>
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<tbody>
<tr>
<td>1</td>
<td>The center shall exchange alert information and status with emergency management centers. The information includes notification of a major emergency such as a natural or man-made disaster, civil emergency, or child abduction for distribution to the public. The information may include the alert originator, the nature of the emergency, the geographic area affected by the emergency, the effective time period, and information and instructions necessary for the public to respond to the alert. This may also identify specific information that should not be released to the public.</td>
</tr>
<tr>
<td>2</td>
<td>The center shall coordinate planning for incidents with emergency management centers - including pre-planning activities for disaster response, evacuation, and recovery operations.</td>
</tr>
<tr>
<td>3</td>
<td>The center shall support requests from emergency management centers to remotely control sensor and surveillance equipment located in the field, provide special routing for emergency vehicles, and to provide responding emergency vehicles with signal preemption.</td>
</tr>
<tr>
<td>4</td>
<td>The center shall exchange incident information with emergency management centers, maintenance and construction centers, transit centers, information service providers, and the media including description, location, traffic impact, status, expected duration, and response information.</td>
</tr>
<tr>
<td>5</td>
<td>The center shall share resources with allied agency centers to implement special traffic control measures, assist in clean up, verify an incident, etc. This may also involve coordination with maintenance centers.</td>
</tr>
<tr>
<td>6</td>
<td>The center shall receive inputs concerning upcoming events that would effect the traffic network from event promoters, traveler information service providers, media, border crossings, and rail operations centers.</td>
</tr>
<tr>
<td>7</td>
<td>The center shall provide road network conditions and traffic images to emergency management centers, maintenance and construction centers, and traveler information service providers.</td>
</tr>
<tr>
<td>8</td>
<td>The center shall exchange road network status assessment information with emergency management and maintenance centers including an assessment of damage sustained by the road network including location and extent of the damage, estimate of remaining capacity, required closures, alternate routes, necessary restrictions, and time frame for repair and recovery.</td>
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</tbody>
</table>
Architecture

FM TOC (Centralized)

Element: FM TOC

Entity: Traffic Management

Functional Area: TMC Evacuation Support
Development, coordination, and execution of special traffic management strategies during evacuation and subsequent reentry of a population in the vicinity of a disaster or major emergency. Interfaces with emergency management and other traffic management centers.

Requirement: 1 The center shall coordinate planning for evacuation with emergency management centers - including pre-planning activities such as establishing routes, areas to be evacuated, timing, etc.

Requirement: 2 The center shall support requests from emergency management centers to preempt the current traffic control strategy, activate traffic control and closure systems such as gates and barriers, activate safeguard systems, or use driver information systems to support evacuation traffic control plans.

Requirement: 4 The center shall coordinate execution of evacuation strategies with emergency management centers - including activities such as setting closures and detours, establishing routes, updating areas to be evacuated, timing the process, etc.

Functional Area: TMC Traffic Network Performance Evaluation
Measures performance and predicts travel demand patterns to support traffic flow optimization, demand management, and incident management. Collects data from surveillance equipment as well as input from other management centers including emissions, event promoters, and other TMCs.

Requirement: 1 The center shall monitor, analyze, and store traffic sensor data (speed, volume, occupancy) collected from field elements under remote control of the center to support overall network performance evaluations.

Requirement: 3 The center shall collect and store plans from event promoters for major future events possibly impacting traffic to support overall network performance evaluations.

Requirement: 5 The center shall exchange information with transit management centers including details current transit routes, the level of service on each route, and the progress of individual vehicles along their routes for use in forecasting demand and estimating current transportation network performance.

Requirement: 7 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 network performance evaluations.

Requirement: 8 The center shall provide an interface to the archive data repository to enable the operator to retrieve historical operating data for use in planning to predict future traffic patterns and conditions.

Requirement: 9 This center shall use the collected information to measure overall current and forecast network performance and predict travel demand patterns.
Architecture

FM TOC (Centralized)

Element: FM TOC

Entity: Traffic Management

Functional Area: Traffic Maintenance
Monitoring and remote diagnostics of field equipment - detect failures, issue problem reports, and track the repair or replacement of the failed equipment.

Requirement: 1 The center shall collect and store sensor (traffic, pedestrian, multimodal crossing) operational status.

Requirement: 2 The center shall collect and store CCTV surveillance system (traffic, pedestrian) operational status.

Requirement: 3 The center shall collect and store sensor (traffic, pedestrian, multimodal crossing) fault data and send to the maintenance center for repair.

Requirement: 4 The center shall collect and store CCTV surveillance system (traffic, pedestrian) fault data send to the maintenance center for repair.

Requirement: 8 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 traffic maintenance data.

Functional Area: Traffic Data Collection
Collection and storage of traffic management data. For use by operations personnel or data archives in the region.

Requirement: 1 The center shall collect traffic management data such as operational data, event logs, etc.

Requirement: 3 The center shall receive and respond to requests from ITS Archives for either a catalog of the traffic data or for the data itself.

Functional Area: TMC Transportation Operations Data Collection
Collects real-time information on the state of the regional transportation system for operational use by the center. It establishes communications with a regional repository, requests or subscribes to information relevant to the center, and distributes the received information for use.

Requirement: 1 The center shall collect real-time information on the state of the regional transportation system including current traffic and road conditions, weather conditions, special event and incident information.

Requirement: 2 The center shall support the capability for the system operator to monitor and control the information collection service.

Element: FM TOC Roadside Equipment

Entity: Roadway Subsystem

Functional Area: Roadway Basic Surveillance
Field elements that monitor traffic conditions using loop detectors and CCTV cameras.

Requirement: 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.

Requirement: 2 The field element shall collect, process, and send traffic images to the center for further analysis and distribution.
Architecture

FM TOC (Centralized)

Element: FM TOC Roadside Equipment

Entity: Roadway Subsystem

Functional Area: Roadway Basic Surveillance
Field elements that monitor traffic conditions using loop detectors and CCTV cameras.

Requirement: 4 The field element shall return sensor and CCTV system operational status to the controlling center.  
Requirement: 5 The field element shall return sensor and CCTV system fault data to the controlling center for repair.

Functional Area: Roadway Signal Controls
Field elements including traffic signal controllers for use at signalized intersections; also supports pedestrian crossings.

Requirement: 1 The field element shall control traffic signals at intersections and on main highways for urban and rural areas, under center control.  
Requirement: 2 The field element shall collect pedestrian images and pedestrian sensor data, and respond to pedestrian crossing requests via display, audio signal, or other manner.  
Requirement: 4 The field element shall monitor operation of traffic signal controllers and report to the center any instances in which the indicator response does not match that expected from the indicator control information.  
Requirement: 5 The field element shall monitor operation of traffic signal controllers and report to the center any instances in which the indicator response does not match that expected from known indicator preemptions.  
Requirement: 6 The field element shall return traffic signal controller operational status to the controlling center.  
Requirement: 7 The field element shall return traffic signal controller fault data to the maintenance center for repair.

Functional Area: Roadway Signal Priority
Field elements that provide the capability to receive vehicle signal priority requests and control traffic signals accordingly.

Requirement: 1 The field element shall respond to requests for indicator (e.g., signal) preemption requests from emergency vehicles at intersections, pedestrian crossings, and multimodal crossings.  
Requirement: 2 The field element shall respond to requests for indicator (e.g., signal) priority requests from transit vehicles at intersections, pedestrian crossings, and multimodal crossings.

Functional Area: Roadway Traffic Information Dissemination
Driver information systems, such as dynamic message signs and Highway Advisory Radio (HAR).

Requirement: 1 The field element shall include dynamic messages 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).
Architecture

FM TOC (Centralized)

Element: FM TOC Roadside Equipment

Entity: Roadway Subsystem

Functional Area: Roadway Traffic Information Dissemination

Driver information systems, such as dynamic message signs and Highway Advisory Radio (HAR).

Requirement: 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. Planned

Requirement: 4 The field element shall provide operational status for the driver information systems equipment (DMS, HAR, etc.) to the center. Planned

Requirement: 5 The field element shall provide fault data for the driver information systems equipment (DMS, HAR, etc.) to the center for repair. Planned

Functional Area: Roadway Incident Detection

Field elements that monitor traffic conditions to identify incidents. It includes traffic detectors that collect traffic flow information and identify unusual traffic conditions and advanced CCTV cameras with built-in incident detection algorithms.

Requirement: 1 The field element shall collect, process, and send traffic images to the center for further analysis and distribution. Planned

Requirement: 3 The field element's video devices shall be remotely controlled by a traffic management center. Planned

Requirement: 4 The field element shall provide operational status and fault data for the incident detection devices to the traffic management center. Planned

Functional Area: Standard Rail Crossing

Field elements at highway-rail intersections (HRIs) where operational requirements do not dictate advanced features (e.g., where rail operational speeds are less than 80 miles per hour). Includes traditional HRI warning systems augmented with other standard traffic management devices.

Requirement: 1 The field element shall collect and process, traffic sensor data in the vicinity of a highway-rail intersection (HRI). Planned

Requirement: 2 The field element shall monitor the status of the highway-rail intersection (HRI) equipment, including both the current state and mode of operation and the current equipment condition, to be forwarded on to the traffic management center. Planned

Requirement: 8 The field element shall support the integrated control of adjacent traffic signals to clear an area in advance of an approaching train and to manage traffic around the intersection. Planned

Functional Area: Roadway Data Collection

Field elements to collect traffic, road, and environmental conditions information for use in transportation planning, research, and other off-line applications. Includes the sensors, supporting roadside infrastructure, and communications equipment.

Requirement: 1 The field element shall collect traffic, road, and environmental conditions information. Planned

Requirement: 2 The field element shall include the sensors and supporting roadside devices that sense, collect, and send traffic, road, and environmental conditions information to a center for archival. Planned
Architecture

FM TOC (Centralized)

Element: FM TOC Roadside Equipment
Entity: Roadway Subsystem
Functional Area: Roadway Data Collection
Field elements to collect traffic, road, and environmental conditions information for use in transportation planning, research, and other off-line applications. Includes the sensors, supporting roadside infrastructure, and communications equipment.

Requirement: 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.

Element: MAT Center
Entity: Transit Management
Functional Area: Transit Center Signal Priority
Manage transit signal priority, monitoring schedule performance and generating requests for transit priority on routes and at certain intersections.

Requirement: 1 The center shall analyze transit vehicle schedule performance to determine the need for priority along certain routes or at certain intersections.

Element: MAT Vehicles
Entity: Transit Vehicle Subsystem
Functional Area: On-board Transit Signal Priority
On-board systems request signal priority through short range communication directly with traffic control equipment at the roadside (intersections, ramps, interchanges, etc.).

Requirement: 1 The transit vehicle shall determine the schedule deviation and estimated times of arrival (ETA) at transit stops.

Requirement: 2 The transit vehicle shall send priority requests to traffic signal controllers at intersections, pedestrian crossings, and multimodal crossings on the roads (surface streets) and freeway (ramp controls) network that enable a transit vehicle schedule deviation to be corrected.

Element: MnDOT D4 Office
Entity: Information Service Provider
Functional Area: Basic Information Broadcast
Broadcast dissemination of traffic, transit, maintenance and construction, event, and weather information to traveler interface systems and vehicles.

Requirement: 1 The center shall disseminate traffic and highway condition information to travelers, including incident information, detours and road closures, event information, recommended routes, and current speeds on specific routes.

Requirement: 2 The center shall disseminate maintenance and construction information to travelers, including scheduled maintenance and construction work activities and work zone activities.

Requirement: 6 The center shall disseminate weather information to travelers.

Requirement: 10 The center shall provide the capability for a system operator to control the type and update frequency of broadcast traveler information.

Functional Area: ISP Emergency Traveler Information
Architecture

FM TOC (Centralized)

Element: MnDOT D4 Office

Entity: Information Service Provider

Functional Area: ISP Emergency Traveler Information
Distribution of emergency information to the traveling public, including evacuation information and wide-area alerts.

Requirement: 3 The center shall disseminate wide-area alert information to the traveler interface systems, including major emergencies such as a natural or man-made disaster, civil emergency, child abductions, severe weather watches and warnings, military activities, and law enforcement warnings.

Existing

Entity: Maintenance and Construction Management

Functional Area: MCM Incident Management
Supports coordinated response to incidents - share incident notifications, manage incident response resources, and coordinate overall incident situation and response among allied response organizations.

Requirement: 3 The center shall exchange incident and threat information with emergency management centers as well as traffic management centers; including notification of existence of incident and expected severity, location, time and nature of incident.

Planned

Requirement: 4 The center shall coordinate planning for incidents with emergency management centers - including pre-planning activities for disaster response, evacuation, and recovery operations.

Existing

Requirement: 5 The center shall respond to requests from emergency management to provide maintenance and construction resources to implement response plans, assist in clean up, verify an incident, etc. This may also involve coordination with traffic management centers and other maintenance centers.

Existing

Requirement: 6 The center shall exchange road network status assessment information with emergency management and traffic management centers including an assessment of damage sustained by the road network including location and extent of the damage, estimate of remaining capacity, required closures, alternate routes, necessary restrictions, and time frame for repair and recovery.

Existing

Requirement: 7 The center shall provide work zone activities affecting the road network including the nature of the maintenance or construction activity, location, impact to the roadway, expected time(s) and duration of impact, anticipated delays, alternate routes, and suggested speed limits. This information may be augmented with images that provide a visual indication of current work zone status and traffic impacts.

Existing

Requirement: 8 The center shall receive information indicating the damage sustained by transportation assets, derived from aerial surveillance, field reports, inspections, tests, and analyses to support incident management.

Existing
Architecture
FM TOC (Centralized)

Element: MnDOT D4 Roadside Equipment

Entity: Roadway Subsystem

Functional Area: Roadway Traffic Information Dissemination
Driver information systems, such as dynamic message signs and Highway Advisory Radio (HAR).

Requirement: 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).

Requirement: 4 The field element shall provide operational status for the driver information systems equipment (DMS, HAR, etc.) to the center.

Requirement: 5 The field element shall provide fault data for the driver information systems equipment (DMS, HAR, etc.) to the center for repair.

Element: Moorhead PW Operations Center

Entity: Maintenance and Construction Management

Functional Area: MCM Incident Management
Supports coordinated response to incidents - share incident notifications, manage incident response resources, and coordinate overall incident situation and response among allied response organizations.

Requirement: 3 The center shall exchange incident and threat information with emergency management centers as well as traffic management centers; including notification of existence of incident and expected severity, location, time and nature of incident.

Requirement: 4 The center shall coordinate planning for incidents with emergency management centers - including pre-planning activities for disaster response, evacuation, and recovery operations.

Requirement: 5 The center shall respond to requests from emergency management to provide maintenance and construction resources to implement response plans, assist in clean up, verify an incident, etc. This may also involve coordination with traffic management centers and other maintenance centers.

Requirement: 6 The center shall exchange road network status assessment information with emergency management and traffic management centers including an assessment of damage sustained by the road network including location and extent of the damage, estimate of remaining capacity, required closures, alternate routes, necessary restrictions, and time frame for repair and recovery.

Requirement: 7 The center shall provide work zone activities affecting the road network including the nature of the maintenance or construction activity, location, impact to the roadway, expected time(s) and duration of impact, anticipated delays, alternate routes, and suggested speed limits. This information may be augmented with images that provide a visual indication of current work zone status and traffic impacts.

Requirement: 8 The center shall receive information indicating the damage sustained by transportation assets, derived from aerial surveillance, field reports, inspections, tests, and analyses to support incident management.
Architecture

FM TOC (Centralized)

Element: NDDOT Fargo District Office

Entity: Information Service Provider

Functional Area: Basic Information Broadcast
Broadcast dissemination of traffic, transit, maintenance and construction, event, and weather information to traveler interface systems and vehicles.

Requirement: 1 The center shall disseminate traffic and highway condition information to travelers, including incident information, detours and road closures, event information, recommended routes, and current speeds on specific routes.

Requirement: 2 The center shall disseminate maintenance and construction information to travelers, including scheduled maintenance and construction work activities and work zone activities.

Requirement: 6 The center shall disseminate weather information to travelers.

Requirement: 7 The center shall disseminate event information to travelers.

Requirement: 10 The center shall provide the capability for a system operator to control the type and update frequency of broadcast traveler information.

Functional Area: ISP Emergency Traveler Information
Distribution of emergency information to the traveling public, including evacuation information and wide-area alerts.

Requirement: 1 The center shall disseminate emergency evacuation information to the traveler interface systems, including evacuation zones, shelter information, available transportation modes, road closures and detours, changes to transit services, and traffic and road conditions at the origin, destination, and along the evacuation routes.

Requirement: 3 The center shall disseminate wide-area alert information to the traveler interface systems, including major emergencies such as a natural or man-made disaster, civil emergency, child abductions, severe weather watches and warnings, military activities, and law enforcement warnings.

Requirement: 4 The center shall provide the capability for a system operator to control the type and update frequency of emergency and wide-area alert information distributed to travelers.

Entity: Maintenance and Construction Management

Functional Area: MCM Incident Management
Supports coordinated response to incidents - share incident notifications, manage incident response resources, and coordinate overall incident situation and response among allied response organizations.

Requirement: 3 The center shall exchange incident and threat information with emergency management centers as well as traffic management centers; including notification of existence of incident and expected severity, location, time and nature of incident.

Requirement: 4 The center shall coordinate planning for incidents with emergency management centers - including pre-planning activities for disaster response, evacuation, and recovery operations.
Architecture

**FM TOC (Centralized)**

*Element:* NDDOT Fargo District Office

*Entity:* Maintenance and Construction Management

**Functional Area:** MCM Incident Management

Supports coordinated response to incidents - share incident notifications, manage incident response resources, and coordinate overall incident situation and response among allied response organizations.

**Requirement:**

5 The center shall respond to requests from emergency management to provide maintenance and construction resources to implement response plans, assist in clean up, verify an incident, etc. This may also involve coordination with traffic management centers and other maintenance centers.

**Requirement:**

6 The center shall exchange road network status assessment information with emergency management and traffic management centers including an assessment of damage sustained by the road network including location and extent of the damage, estimate of remaining capacity, required closures, alternate routes, necessary restrictions, and time frame for repair and recovery.

**Requirement:**

7 The center shall provide work zone activities affecting the road network including the nature of the maintenance or construction activity, location, impact to the roadway, expected time(s) and duration of impact, anticipated delays, alternate routes, and suggested speed limits. This information may be augmented with images that provide a visual indication of current work zone status and traffic impacts.

**Requirement:**

8 The center shall receive information indicating the damage sustained by transportation assets, derived from aerial surveillance, field reports, inspections, tests, and analyses to support incident management.

*Entity:* Traffic Management

**Functional Area:** TMC Traffic Information Dissemination

Controls dissemination of traffic-related data to other centers, the media, and travelers via the driver information systems (DMS, HAR) that it operates.

**Requirement:**

1 The center shall remotely control dynamic messages signs for dissemination of traffic and other information to drivers.

**Requirement:**

3 The center shall collect operational status for the driver information systems equipment (DMS, HAR, etc.).

**Requirement:**

4 The center shall collect fault data for the driver information systems equipment (DMS, HAR, etc.) for repair.

**Requirement:**

6 The center shall distribute traffic data to maintenance and construction centers, transit centers, emergency management centers, and traveler information providers.

**Requirement:**

7 The center shall distribute traffic data to the media; the capability to provide the information in both data stream and graphical display shall be supported.

**Requirement:**

8 The center shall provide the capability for center personnel to control the nature of the data that is available to non-traffic operations centers and the media.

*Element:* NDDOT Fargo Roadside Equipment

*Entity:* Roadway Subsystem

**Functional Area:** Roadway Basic Surveillance
Element: NDDOT Fargo Roadside Equipment

Functional Area: Roadway Subsystem

Field elements that monitor traffic conditions using loop detectors and CCTV cameras.

**Requirement:**

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.

2. The field element shall collect, process, and send traffic images to the center for further analysis and distribution.

4. The field element shall return sensor and CCTV system operational status to the controlling center.

5. The field element shall return sensor and CCTV system fault data to the controlling center for repair.

Functional Area: Roadway Traffic Information Dissemination

Driver information systems, such as dynamic message signs and Highway Advisory Radio (HAR).

**Requirement:**

1. The field element shall include dynamic messages 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).

4. The field element shall provide operational status for the driver information systems equipment (DMS, HAR, etc.) to the center.

5. The field element shall provide fault data for the driver information systems equipment (DMS, HAR, etc.) to the center for repair.

Functional Area: Roadway Data Collection

Field elements to collect traffic, road, and environmental conditions information for use in transportation planning, research, and other off-line applications. Includes the sensors, supporting roadside infrastructure, and communications equipment.

**Requirement:**

1. The field element shall collect traffic, road, and environmental conditions information.

2. The field element shall include the sensors and supporting roadside devices that sense, collect, and send traffic, road, and environmental conditions information to a center for archival.

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.

Element: NDSU Data Warehouse

**Requirement:**

1. The center shall collect data to be archived from one or more data sources.
**Element:** NDSU Data Warehouse  
**Entity:** Archived Data Management Subsystem

**Functional Area:** ITS Data Repository  
Collect and maintain data and data catalogs from one or more data sources. May include quality checks, error notification, and archive coordination.

**Requirement:** 3 The center shall store the archived data in a focused repository that is suited to a particular set of ITS data users.

**Requirement:** 5 The center shall include capabilities for error notification on the incoming archived data.

**Requirement:** 7 The center shall support a broad range of archived data management implementations, ranging from simple data marts that collect a focused set of data and serve a particular user community to large-scale data warehouses that collect, integrate, and summarize transportation data from multiple sources and serve a broad array of users within a region.

**Requirement:** 8 The center shall perform quality checks on received data.

**Requirement:** 9 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.

**Requirement:** 11 When data or a catalog of data is received from the archive, the center shall generate the requested data product for the users systems.

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**Element:** RRRDC  
**Entity:** Emergency Management

**Functional Area:** Incident Command  
Tactical decision support, resource coordination, and communications integration among emergency management agencies for Incident Commands that are established by first responders to support local management of an incident.

**Requirement:** 1 The center shall provide tactical decision support, resource coordination, and communications integration for Incident Commands that are established by first responders to support local management of an incident.

**Requirement:** 2 The center shall provide incident command communications with public safety, emergency management, transportation, and other allied response agency centers.

**Requirement:** 3 The center shall track and maintain resource information and action plans pertaining to the incident command.

**Requirement:** 4 The center shall share incident command information with other public safety agencies including resource deployment status, hazardous material information, rail incident information, evacuation advice as well as traffic, road, and weather conditions.

**Requirement:** 5 The center shall assess the status of responding emergency vehicles as part of an incident command.
Architecture

FM TOC (Centralized)

Element: West Fargo Signal Shop

Entity: Traffic Management

Functional Area: TMC Regional Traffic Management

Coordination between traffic management centers in order to share traffic information between centers as well as control of traffic management field equipment. This may be used during incidents and special events and during day-to-day operations.

Requirement: 1 The center shall exchange traffic information with other traffic management centers including incident information, congestion data, traffic data, signal timing plans, and real-time signal control information.

Requirement: 2 The center shall exchange traffic control information with other traffic management centers to support remote monitoring and control of traffic management devices (e.g. signs, sensors, signals, cameras, etc.).