# Downtown Traffic Management System Enhancements

## System Requirements

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# 1. Introduction

The City of St. Paul is seeking to improve traffic operations in the downtown area. The management of traffic in this area involves transportation agencies at the city, county and state levels, as well as local law enforcement and businesses that generate traffic for large events. Upgrades to the traffic management system include optimized signal operations and communications capabilities, actively managing traffic incidents, providing event traffic management, and upgrading the existing traffic management center. Improving these areas are critical to maintaining a modern transportation system. These improvements would be achieved with the installation of new traffic signal controllers, fiber optic communications, Dynamic Message Signs (DMS), and traffic management center upgrades.

A general concept of operations was prepared to identify challenges with the current situation and develop corresponding needs. The needs were identified by St Paul key stakeholders and documents relevant to the project. This system requirements document has been developed to further identify how the stakeholder needs have been correlated with requirements. The document identifies how the envisioned Traffic Management System (TMS) fits within the Minnesota ITS Architecture and it presents system requirements that describe what the TMS must do as the basis for further design, procurement, installation, testing and operation. The final section of the document outlines potential future needs and requirements which are not yet well-defined or are uncertain enough that they were not included in the scope of the initial TMS but are documented so that they may be monitored.

# 2. ITS Architecture Assessment

As an Intelligent Transportation System, it is necessary to assess where the TMS fits within the Minnesota ITS Architecture (Version 2014). As it is envisioned in the concept of operations, the TMS is part of the Advanced Traffic Management Systems Service Package Bundle (Volume 3). The TMS addresses the following needs identified in the architecture.

- TM01: Provide efficient signal timing
- TM04: Provide cameras at locations with high incidents and areas of high importance for incident identification and verification to improve operations (future improvement)
- TM05: Provide real-time incident and congestion information to travelers
- TM12: Reduce clearance time for primary crashes
- TM13: Provide incident information to emergency management agencies
- TM14: Monitor operation and performance of traffic signals
- TM16: Identify alternate routes
- TM17: Provide travel information on special events.
- TM22: Provide a system-coordinated response for incidents and emergencies
- TM24: Operate freeway/expressway/arterial DMS
- TM25: Operate CCTV cameras
- TM34: Provide roadway flood warnings
- TM43: Notify travelers of snowplow operations and cleanup using DMS

It may be identified in this bundle as a series of existing elements within several service packages as described in Table 1 below.

Table 1 St Paul TMS in Minnesota ITS Architecture

| System/Element | Service Package | Description |
|---|---|---|
| **Automated Traffic Recorder Roadside Equipment** | ATMS01: Network Surveillance | This element represents roadside equipment that collects data on traffic patterns and volumes. Data is communicated back to the central systems residing in TMCs. Data is also collected, processed, and archived by TMCs. |
| **CCTV Roadside Equipment** | ATMS01: Network Surveillance | This element represents CCTV cameras deployed along the roadside by various agencies and municipalities throughout Minnesota. Cameras are controlled and monitored by TMCs. |
| **Dynamic Message Sign Roadside Equipment** | ATMS06: Traffic Information Dissemination | This element represents portable and permanent DMS operated throughout the state used to convey driver information on special events, maintenance and construction activity, travel time, incident management, AMBER alerts, and transportation and national emergencies. |
| **Local TMCs** | ATMS01: Network Surveillance<br>ATMS03: Traffic Signal Control<br>ATMS06: Traffic Information Dissemination<br>ATMS08: Traffic Incident Management | This element represents local centers that facilitate traffic management on a roadway network from a central location that provides roadway monitoring, signal system control, remote equipment control, and communications with field personnel and other agencies. |
| **Traffic Signal Roadside Equipment** | ATMS03: Traffic Signal Control | This element represents traffic signals in Minnesota that are controlled by TMCs. This element supports surface street control and arterial traffic management. It represents traffic signal systems 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. |

Based on the references noted here, it is confirmed that the TMS is adequately addressed in the Minnesota ITS Architecture.

# 3. System Requirements for TMS

System requirements are verifiable details that define what the TMS will do, how well they will perform or what conditions they must perform under. The requirements presented in this section are defined in relation to the needs that were identified in the concept of operations for the TMS. The needs are listed below for reference purposes.

**Needs for St. Paul TMS**

| | |
|---|---|
| 1. | The City needs a central software system that can manage the DMS. |
| 2. | City staff and authorized users need the ability to monitor and make modifications to the TMS components (signals, DMS) via a mobile device 24/7/365. |
| 3. | Travelers need directional signing that is credible and assertive to guide them to alternate access points. |
| 4. | Travelers need alternate route information to avoid closed roads due to flooding. |
| 5. | Travelers need wayfinding to public parking facilities during event times. |
| 6. | The City needs an update to its traffic signal optimization throughout the downtown area to keep up with the significant changes in the area. |
| 7. | The City needs a permanent solution that allows them to efficiently manage traffic during events and incidents to augment police operations. |
| 8. | Travelers need general information about snow emergencies, temporary restrictions, or other alerts when necessary. |
| 9. | The City needs a permanent solution that allows them to dynamically manage egress event traffic and guide traffic to alternate routes. |
| 10. | The City needs a permanent solution that can dynamically direct traffic to the alternate routes. |
| 11. | The City needs a reliable communications system that allows for redundancy in case of failure, ability to transfer large amounts of data, and the capability to remotely monitor devices on the network (i.e. signal systems, DMS, PTZ cameras). |
| 12. | The City needs modern signal controllers that can accommodate modern traffic signal operations with BRT, LRT, and future CAV technologies. |
| 13. | The City needs modern signal controllers that allow for collecting signal performance measurement data. |
| 14. | The City needs a SPM software that can analyze and report the collected data in a readable format. |
| 15. | The City needs real-time signal operation capability from a remote facility in order to monitor, review, and optimize timing plans during events. |
| 16. | Travelers need to know in real-time when train traffic impacts on Shepard/Warner Road may make it an undesirable route. |

The TMS requirements are included in Table 2. The number references in the requirements table allow for traceability back to needs and forward for design and testing. The first identification number will be used as a requirement reference number and it will be used to track requirements through design and testing. The second series of numbers refers to the stakeholder needs as they are presented above and in the concept of operations.

Table 2 TMS System Requirements

| Requirement<br>The TMS shall… | | Need |
|---|---|---|
| **1. DMS Processing-Control Software** | | |
| 1.1. | Be accessible via a standard Internet browser. | 1, 2 |
| 1.2. | Be a multi-user software. | 1, 2 |
| 1.3. | Consist of software and databases for users to access 24/7/365. | 1, 2 |
| 1.4. | Be compliant with PostgreSQL database management systems. | 1, 2 |
| 1.5. | Enable user access from desktop and portable computers with St. Paul LAN connections to the server. | 2 |
| 1.6. | Include the ability to provide access from desktop and portable computers for authorized users outside the St. Paul LAN. | 2 |
| 1.7. | Support access for authorized users through the St. Paul firewall using virtual private network (VPN) access. | 2 |
| 1.8. | Enable computers connected via authorized users access to perform concurrent operation. | 2 |
| 1.9. | Have the capability for computers connected via authorized user access to communicate with DMS operated by St. Paul. | 2 |
| 1.10. | Communicate via fiber with DMS operated by St. Paul. | 2, 11 |
| 1.11. | Use National Transportation Communications for ITS Protocol (NTCIP) center to field communications protocols to interface with DMS operated by St. Paul. | 1, 2 |
| 1.12. | Be capable of simultaneously monitoring a minimum of 75 DMS. | 1, 2 |
| 1.13. | Be capable of adding DMS to accommodate future deployments. | 1 |
| 1.14. | Control user access with individual user identities and passwords. | 2 |
| 1.15. | Maintain a record of access to the system according to user identities for a minimum of 365 days. | 2 |
| 1.16. | Allow for three levels of operating privileges based on types of user access. | 2 |
| 1.17. | Provide the first highest level of operating privileges for users who will perform administrative functions associated with maintaining the software. | 2 |
| 1.18. | Provide the second highest level of operating privileges for users who will use the software to operate the DMS. | 2 |
| 1.19. | Provide the third highest level of operating privileges for users who will only use the software to view information in the DMS. | 2 |
| 1.20. | Display DMS locations in a tabular format. | 1, 2 |
| 1.21. | Display DMS operational status in a table. | 1, 2 |
| 1.22. | Display DMS locations on a map. | 1, 2 |
| 1.23. | Display DMS operational status on a map. | 1, 2 |
| 1.24. | Include map pan and zoom capabilities. | 1, 2 |
| 1.25. | Allow users to define view preferences by geography and zoom level. | 1, 2 |
| 1.26. | Allow users to click on the DMS and view the following details:<br>• Device identification number<br>• Geographic location of DMS by latitude and longitude<br>• Date and time stamp of last TMS communication with the DMS<br>• DMS operational status according to active operational plan | 1, 2 |
| 1.27. | Allow users with the first and second highest levels of operating privileges to click on the DMS to access its control functions. Control functions are | 1, 2 |

| Requirement<br>The TMS shall… | | Need |
|---|---|---|
| | specified for the DMS below. | |
| 1.28. | Allow creation of operational plans that specify device actions (e.g. messages posted to DMS, email alerts) based on conditions that warrant use of the system. | 1, 2 |
| 1.29. | Allow users with the first highest level of operating privileges to create operational plans. | 1, 2 |
| 1.30. | Allow users with the first highest level of operating privileges to modify operational plans. | 1, 2 |
| 1.31. | Allow users with the first and second highest levels of operating privileges to activate operational plans. | 1, 2 |
| 1.32. | Allow users with the first and second highest levels of operating privileges to deactivate operational plans. | 1, 2 |
| 1.33. | Maintain a record of operational plan activations and deactivations according to user identities for a minimum of 365 days. | 1, 2, 3, 4, 5, 7, 8, 9, 10, 16 |
| **2. Disseminating-DMS** | | |
| 2.1. | Include DMS that comply with Minnesota Manual on Uniform Traffic Control Devices, Part 2. Signs, Chapter 2L. Changeable Message Signs, Section 2L.3. Legibility and Visibility of Changeable Message Signs. | 3, 4, 5, 7, 8, 9, 10, 16 |
| 2.2. | Include DMS that comply with Minnesota Manual on Uniform Traffic Control Devices, Part 2. Signs, Chapter 2L. Changeable Message Signs, Section 2L. 4. Design Characteristics of Changeable Message Signs. | 3, 4, 5, 7, 8, 9, 10, 16 |
| 2.3. | Include DMS that utilize a full matrix display area. | 3, 4, 5, 7, 8, 9, 10, 16 |
| 2.4. | Include DMS that display full color. | 3, 4, 5, 7, 8, 9, 10, 16 |
| 2.5. | Include DMS with a pixel pitch of 16mm. | 3, 4, 5, 7, 8, 9, 10, 16 |
| 2.6. | Include DMS that will be overhead mounted to accommodate installation site characteristics. | 3, 4, 5, 7, 8, 9, 10, 16 |
| 2.7. | Include DMS capable of communicating intermittently via fiber. | 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 16 |
| 2.8. | Include DMS that utilize NTCIP field to center communication protocols. | 1, 2, 3, 4, 5, 7 8, 9, 10, 16 |
| 2.9. | Include DMS that operate on 120/240 Volts AC. | 3, 4, 5, 7, 8, 9, 10, 16 |
| 2.10. | Include DMS that are protected from degradation of power with voltage surge suppression. | 2, 3, 4, 5, 8, 9, 10, 16 |
| 2.11. | Include DMS that allow users to post DMS messages remotely. | 1, 2 |
| 2.12. | Include DMS that allow users to preview messages before posting them to the sign. | 1, 2 |
| 2.13. | Include DMS that allow users to remove DMS messages remotely. | 1, 2 |
| 2.14. | Include DMS that allow users to post pre-defined DMS messages. | 1, 2 |
| 2.15. | Include DMS that allow users to post free-text DMS messages. | 1, 2 |
| 2.16. | Automatically capture and store St. Paul operated DMS messages posted for a minimum of 365 days without operator intervention. | 1, 2, 3, 4, 5, 7, 8, 9, 10, 16 |
| **3. Disseminating-Email Alert** | | |

| Requirement<br>The TMS shall… | | Need |
|---|---|---|
| 3.1. | Automatically push email alerts to user-defined distribution lists as operational plans are activated. | 2 |
| 3.2. | Automatically push email alerts to user-defined distribution lists as operational plans are deactivated. | 2 |
| 3.3. | Allow automatic push email alert feature to be turned on or off. | 2 |
| 3.4. | Allow manually pushed email alerts to user-defined distribution lists as needed. | 2 |
| 3.5. | Allow the creation of user-defined distribution lists for push email alerts. | 2 |
| **4. Signal Performance Measure Software** | | |
| 4.1. | Allow data logging of Signal Performance Measures from the traffic controller. | 13, 14 |
| 4.2. | Include capability to automatically analyze and report SPMs | 13, 14 |
| 4.3. | Be accessible via a standard Internet browser. | 13, 14 |
| 4.4. | Be a multi-user software. | 13, 14 |
| 4.5. | Consist of software and databases for users to access 24/7/365. | 13, 14 |
| **5. Traffic Signal Controller** | | |
| 5.1. | Include controllers that support Bus Rapid Transit operations | 6, 12, 15 |
| 5.2. | Include controllers that support Light Rail Transit operations | 6, 12, 15 |
| 5.3. | Include controllers that have the ability to record high resolution data that is at least recorded in 0.1 second increments. | 13, 14, |
| 5.4. | Include controllers that support the Signal Performance Measures/Metrics developed by Indiana DOT, by providing high-resolution data logging capabilities, as defined in the Indiana Traffic Signal High Resolution Data Logger Enumerations. | 13, 14 |
| 5.5. | Include controllers that are compatible with Econolite Centracs software, which is the City's current ATMS. | 6, 12, 13, 14, 15 |

# 4. Potential Future Needs and Requirements

In addition to the immediate needs and requirements identified for the TMS in this document and the concept of operations, St. Paul and the stakeholders involved in the development of the TMS foresee some potential future needs and requirements for the system. These needs and requirements are not yet well-defined or are uncertain enough that they were not included in the scope of the initial TMS. They are, however, documented here so that they may be monitored and considered if or when more information is known.

- CCTV deployment in the downtown area is a likely upgrade. A central software system will be needed to operate and maintain the equipment. A fiber optic communications system will allow video data to be fed back to the TMC.
- Bus Rapid Transit (BRT), streetcar, and Connected and Automated Vehicles (CAV) are all envisioned to operate in some capacity in the St. Paul area in the future. The TMS system could be utilized to support those services and technologies. A traffic signal controller and central control software that can accommodate BRT, Streetcar, and CAV operations will be needed; and a fiber optic communications system will be needed to manage the large amounts of data being transmitted between the field devices and the TMC.

- Finally, it is possible that the TMS could be expanded to other corridors in the future.