Arterial Corridor Management (Snelling and Lexington)

System Requirements

December 2020

State Proj. No. 164-010-069

City Proj. No. T-1378.0

Prepared by Alliant Engineering

Table of Contents

1. Introduction

The City of Saint Paul is seeking to relieve congestion, improve traffic signal operations, and improve incident, emergency, and event management along two arterial corridors located west of downtown St. Paul. 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 during events. Upgrades to the Traffic Management System (TMS) include updating communications capabilities and traffic signal equipment, managing traffic incidents, and providing event traffic management. Improving these areas are critical to maintaining a modern transportation system. These improvements will be achieved with the installation of new traffic signal controllers, vehicle detection, advanced traffic management equipment, fiber optic communications, Dynamic Message Signs (DMS), and closed-circuit television (CCTV) cameras.

A 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. The System Requirements document how the stakeholder needs defined in the Concept of Operations are to be met. The defined requirements are directly tied to the stakeholder needs, which can be seen in **Table 2**. The document also identifies how the proposed system fits within the Minnesota ITS Architecture and presents system requirements that describe what the system must do as the basis for further design, procurement, installation, testing and operation. The final section of the document outlines potential needs and requirements for future systems that are anticipated to utilize subsystems that are to be installed as part of this project. At this time, these needs and requirements are uncertain or loosely defined. The needs and requirements are documented as a resource for future Systems Engineering documentation.

2. ITS Architecture Assessment

As an Intelligent Transportation System, it is necessary to assess where the St. Paul Arterial Corridor Management project fits within the Minnesota Statewide Regional ITS Architecture (Version 2018). As it is envisioned in the concept of operations, this project is part of the Traffic Management Service Package Area (Volume 3). This project addresses the following Traffic Management needs, as identified in the System Architecture.

- ATMS01: Provide efficient signal timing
- ATMS04: Provide cameras at locations with high incidents and areas of high importance for incident identification and verification
- ATMS05: Provide incident and congestion information to travelers
- ATMS12: Reduce clearance time for primary crashes
- ATMS13: Provide incident information to emergency management agencies
- ATMS14: Monitor operation and performance of traffic signals
- ATMS16: Identify alternate routes
- ATMS17: Provide travel information on special events.
- ATMS22: Provide a system-coordinated response for incidents
- ATMS24: Operate freeway/expressway/arterial DMS
- ATMS25: Operate video monitoring cameras

- ATMS36: Implement Integrated Corridor Management (ICM) strategies
- ATMS43: Notify travelers of snowplow operations and cleanup using DMS
- ATMS51: Collect and manage traffic signal performance measures
- ATMS52: Implement modern signal controllers
- ATMS53: Improve signal communication

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

Table 1: St Paul Arterial Corridor Management System in Minnesota ITS Architecture

System/Element	Service Package	Description
Third-Party Travel Time System	TM02: Vehicle-Based Traffic Surveillance	This element represents data collected by a third-party using vehicle probe data that collects data on traffic patterns and volumes. Data is communicated via a third-party website. Real-time and historical data may be retrieved via a third-party website.
CCTV Roadside Equipment	TM01: Infrastructure-Based Traffic Surveillance	This element represents CCTV cameras deployed along the roadside by the City of St. Paul. Cameras are controlled and monitored by Public Works and the Police Department.
Dynamic Message Sign Roadside Equipment	TM06: Traffic Information Dissemination	This element represents permanent DMS operated by the City to convey driver information on special events, maintenance and construction activity, travel time, incident management, AMBER alerts, and transportation and national emergencies.
Local TMCs	TM01: Infrastructure-Based Traffic Surveillance TM03: Traffic Signal Control ATMS06: Traffic Information Dissemination TM08: Traffic Incident Management System	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	TM03: Traffic Signal Control	This element represents traffic signals in St. Paul that are controlled by Public Works. 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 St. Paul Arterial Corridor Management project is consistent with the goals defined in the Minnesota Statewide Regional ITS Architecture, Version 2018.

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, as defined in the Concept of Operations, are listed in **Table 2** for reference purposes.

Table 2: List of Stakeholder Needs

Need
1. City staff and authorized users need the ability to monitor and make modifications to the TMS components (signals, DMS, CCTV) 24/7/365.
2. Travelers need directional signing in real time that is credible and assertive to guide them to alternate access points.
3. The City needs a permanent solution that allows them to efficiently manage traffic during events and incidents to augment police operations.
4. Travelers need general information about snow emergencies, temporary restrictions, or other alerts when necessary.
5. The City needs a permanent solution that can dynamically direct traffic to the alternate routes.
6. The City needs travel time data to be used to make signal timing adjustments in real time.
7. The City needs a reliable communications system that allows for redundancy in case of failure.
8. The City needs the ability to transfer large amounts of data between field devices and the TMC.
9. The City needs the capability to remotely monitor devices on the network (i.e. signal systems, DMS, CCTV cameras).
10. The City needs Advanced Traffic Controllers (ATC) that can accommodate modern traffic signal operations and future Connected Autonomous Vehicle (CAV) technologies.
11. The City needs modern signal controllers that allow for collecting signal performance measurement data.
12. The City needs an update to its traffic signal optimization capabilities along the corridors to keep up with the significant changes in the area.
13. The City needs real-time signal operation capability from a remote facility to monitor, review, and optimize timing plans during events.
14. The City needs real time CCTV capability from a remote facility to monitor, review, and efficiently manage incidents or congestion.
15. St. Paul Police need priority access to CCTVs to efficiently manage traffic incidents.

The City of St. Paul Arterial Corridor Management requirements are included in **Table 3**. 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 in **Table 2** and in the Concept of Operations.

Table 3: TMS System Requirements

Requirement The Arterial Corridor Management system shall…		Need
1.	**DMS Processing-Control Software**	
1.1.	Be accessible via a standard Internet browser.	1, 9
1.2.	Be a multi-user software.	1
1.3.	Consist of software and databases for users to access 24/7/365.	1, 9
1.4.	Be compliant with PostgreSQL database management systems.	1
1.5.	Enable user access from desktop and portable computers with St. Paul LAN connections to the server.	1, 9
1.6.	Include the ability to provide access from desktop and portable computers for authorized users outside the St. Paul LAN.	1, 9
1.7.	Support access for authorized users through the St. Paul firewall using virtual private network (VPN) access.	1, 9
1.8.	Enable computers connected via authorized users access to perform concurrent operation.	1, 9
1.9.	Have the capability for computers connected via authorized user access to communicate with DMS operated by St. Paul.	1, 9
1.10.	Communicate via fiber with DMS operated by St. Paul.	1, 7, 8, 9
1.11.	Use National Transportation Communications for ITS Protocol (NTCIP) center to field communications protocols to interface with DMS operated by St. Paul.	1, 9
1.12.	Be capable of simultaneously monitoring a minimum of 75 DMS.	1, 8, 9
1.13.	Be capable of adding DMS to accommodate future deployments.	1, 8, 9
1.14.	Control user access with individual user identities and passwords.	1, 9
1.15.	Maintain a record of access to the system according to user identities for a minimum of 365 days.	1, 9
1.16.	Allow for three levels of operating privileges based on types of user access.	1, 9
1.17.	Provide the first highest level of operating privileges for users who will perform administrative functions associated with maintaining the software.	1, 9
1.18.	Provide the second highest level of operating privileges for users who will use the software to operate the DMS.	1, 9
1.19.	Provide the third highest level of operating privileges for users who will only use the software to view information in the DMS.	1, 9
1.20.	Display DMS locations in a tabular format.	1, 3, 9
1.21.	Display DMS operational status in a table.	1, 3, 9
1.22.	Display DMS locations on a map.	1, 3, 9
1.23.	Display DMS operational status on a map.	1, 3, 9
1.24.	Include map pan and zoom capabilities.	1, 3, 9
1.25.	Allow users to define view preferences by geography and zoom level.	1, 3, 9
1.26.	Allow users to click on the DMS and view the following details:	1, 3, 9

Requirement The Arterial Corridor Management system shall…		Need
	• Device identification number • Geographic location of DMS by latitude and longitude • Date and time stamp of last TMS communication with the DMS • DMS operational status according to active operational plan	
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 specified for the DMS below.	1, 3, 9
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, 3, 9
1.29.	Allow users with the first highest level of operating privileges to create operational plans.	1, 3, 9
1.30.	Allow users with the first highest level of operating privileges to modify operational plans.	1, 3, 9
1.31.	Allow users with the first and second highest levels of operating privileges to activate operational plans.	1, 3, 9
1.32.	Allow users with the first and second highest levels of operating privileges to deactivate operational plans.	1, 3, 9
1.33.	Maintain a record of operational plan activations and deactivations according to user identities for a minimum of 365 days.	1, 3, 9
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.	2, 3, 4, 5
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.	2, 3, 4, 5
2.3.	Include DMS that utilize a full matrix display area.	1, 2, 3, 4, 5
2.4.	Include DMS that display full color.	1, 2, 3, 4, 5
2.5.	Include DMS with a pixel pitch of 16mm.	1, 2, 3, 4, 5
2.6.	Include DMS that will be overhead mounted to accommodate installation site characteristics.	1, 2, 3, 4, 5
2.7.	Include DMS capable of communicating intermittently via fiber.	1, 3, 5, 7, 8, 9
2.8.	Include DMS that utilize NTCIP field to center communication protocols.	1, 3, 5, 7, 8, 9
2.9.	Include DMS that operate on 120/240 Volts AC.	1, 3, 5, 7, 8, 9
2.10.	Include DMS that are protected from degradation of power with voltage surge suppression.	1, 3, 5, 7, 8, 9
2.11.	Include DMS that allow users to post DMS messages remotely.	1, 2, 3, 4, 5, 7, 8, 9
2.12.	Include DMS that allow users to preview messages before posting them to the sign.	1, 2, 3, 4, 5, 7, 8, 9
2.13.	Include DMS that allow users to remove DMS messages remotely.	1, 2, 3, 4, 5, 7, 8, 9
2.14.	Include DMS that allow users to post pre-defined DMS messages.	1, 2, 3, 4, 5, 7, 8, 9

Requirement The Arterial Corridor Management system shall…		Need
2.15.	Include DMS that allow users to post free-text DMS messages.	1, 2, 3, 4, 5, 7, 8, 9
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
3.	**Monitoring-CCTV**	
3.1.	Display CCTV images as view only information.	1, 3, 5, 7, 8, 9, 14, 15
3.2.	Include CCTV and related cabling rated for outdoor use.	1, 3, 5, 7, 8, 9, 14, 15
3.3.	Include CCTV that provide at least three individually configurable full resolution video streams at 30 frames per second (NTSC) in all resolutions up to 704 x 480 pixels or 25 frames per second (PAL) in all resolutions up to 704 x 576 pixels.	1, 3, 5, 7, 8, 9, 14, 15
3.4.	Include CCTV that allow users to pan, tilt and zoom CCTV control remotely.	1, 3, 5, 7, 8, 9, 14, 15
3.5.	Include CCTV with day and night functionality to manage image quality.	1, 3, 5, 7, 8, 9, 14, 15
3.6.	Include CCTV capable of communicating via fiber (first preference) or cell modem (second preference).	1, 3, 5, 7, 8, 9, 14, 15
3.7.	Include CCTV that utilize NTCIP field to center communication protocols.	1, 3, 5, 7, 8, 9, 14, 15
3.8.	Include CCTV that allow video to be transmitted over IP networks.	1, 3, 5, 7, 8, 9, 14, 15
3.9.	Control user access with individual user identities and passwords.	1, 3, 5, 7, 8, 9, 14, 15
3.10.	Allow for three levels of operating privileges based on types of user access.	1, 3, 5, 7, 8, 9, 14, 15
3.11.	Provide the first highest level of operating privileges for users who will perform administrative functions associated with maintaining the CCTV.	1, 3, 5, 7, 8, 9, 14, 15
3.12.	Provide the second highest level of operating privileges for users who will operate the CCTV.	1, 3, 5, 7, 8, 9, 14, 15
3.13.	Provide the third highest level of operating privileges for users who will only view information on the CCTV.	1, 3, 5, 7, 8, 9, 14, 15
4.	**Disseminating-Email Alert**	
4.1.	Automatically push email alerts to user-defined distribution lists as operational plans are activated.	1, 13
4.2.	Automatically push email alerts to user-defined distribution lists as operational plans are deactivated.	1, 13
4.3.	Allow automatic push email alert feature to be turned on or off.	1, 13
4.4.	Allow manually pushed email alerts to user-defined distribution lists as needed.	1, 13
4.5.	Allow the creation of user-defined distribution lists for push email alerts.	1, 13
5.	**Traffic Signal Controller**	
5.1.	**Include controllers that support Bus Rapid Transit operations**	10, 12

Requirement The Arterial Corridor Management system shall…		Need
5.2.	**Include controllers that can record high resolution data that is at least recorded in 0.1 second increments.**	10, 11, 12
5.3.	**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.**	10, 11, 12
5.4.	**Include controllers that are compatible with Econolite Centracs software.**	10, 11, 12, 13
5.5.	**Include controllers that support Adaptive Signal Control software**	10, 11, 12, 13
5.6.	Include controllers **that utilize NTCIP field to center communication protocols.**	1, 5, 6, 7, 8, 9, 10, 11, 13
5.7.	**Include controllers that support reporting equipment status.**	1, 6, 7, 8, 9, 10, 11, 13
5.8.	**Include controllers that support retrieving log data remotely.**	1, 6, 7, 8, 9, 10, 11, 13
5.9.	**Include controllers that store intersection data logs for a minimum of four weeks.**	1, 6, 7, 8, 9, 10, 11, 13
5.10.	**Include controllers that respond to special events and to pedestrian and bicycle flows.**	1, 3, 5, 6, 10, 11, 12, 13
5.11.	**Include controllers that provide secure and reliable signal system operations.**	1, 3, 5, 7, 10, 11, 12, 13
6. Adaptive Signal Control Software		
6.1.	**The ASCS shall be capable of controlling a minimum of 75 signals concurrently**	1, 3, 5, 9, 10, 13
6.2.	**The ASCS shall optimize any combination of cycle, offset, and split times based on current traffic conditions when enabled.**	1, 3, 5, 6, 9, 10, 11, 12, 13
6.3.	**The ASCS shall operate non-adaptively when adaptive control equipment or standard detection equipment fails.**	1, 3, 5, 6, 9, 10, 11, 12, 13
6.4.	**The ASCS shall operate non-adaptively when current traffic conditions meet specific user-defined criteria.**	1, 3, 5, 6, 9, 10, 11, 12, 13
6.5.	**The ASCS shall operate adaptively when current traffic conditions meet specific user-defined criteria.**	1, 3, 5, 6, 9, 10, 11, 12, 13
6.6.	**The ASCS shall operate adaptively to achieve specific requirements in user-defined criteria.**	1, 3, 5, 6, 9, 10, 11, 12, 13
6.7.	**The ASCS shall be able to coordinate along a user-defined route.**	1, 3, 5, 6, 9, 10, 11, 12, 13
6.8.	**Support executing user-specified adaptive operation strategies to manage queues.**	1, 3, 5, 6, 9, 10, 11, 12, 13
6.9.	**Support SAE J2735 5.9GHz DSRC Communication standard.**	1, 10, 12
7. Third-Party Travel Time System		
7.1.	**Include capability to automatically analyze and report volume and travel time metrics.**	6, 12

Requirement The Arterial Corridor Management system shall…		Need
7.2.	**Include capability to select segments/corridors to analyze and report volume and travel time metrics.**	6, 12
7.3.	**Include capability to generate volume, speed and travel time reports based on user chosen time and date ranges.**	6, 12

4. Potential Future Needs and Requirements

In addition to the immediate needs and requirements identified for the Arterial Corridor Management system 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.

- Bus Rapid Transit (BRT) currently operates along the Snelling Corridor, and Connected and Automated Vehicles (CAV) are 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 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.
- It is possible that the TMS could be expanded to other corridors in the future.