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USDOT Integrated Corridor Management (ICM) Initiative

# System Requirement Specification for the I-394 Integrated Corridor Management System (ICMS) in Minneapolis, Minnesota

March 31, 2008
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16. Abstract

This System Requirement Specification (SRS) defines the requirements for the I-394 Corridor Integrated Corridor Management System (ICMS). These requirements describe 'what' the ICMS will do to fulfill its role as part of the overall I-394 Integrated Corridor Management approach. In some cases, the actions of the ICMS will require actions of other systems that are currently performed by the existing systems. In these circumstances, detailed functional requirements are not defined because the systems already exist and need not be built by this project. However, high level 'External Requirements' are identified describing these actions that the ICMS needs in order to function properly. This integration of systems and agencies will be accomplished by the design, development and implementation of the ICMS. The purpose of this system is to support the I-394 stakeholders at executing the Incident Corridor Management (ICM) strategies they have identified and prioritized for this corridor. Section 1 of this document provides an introduction. Section 1 provides a general system description. Section 3 presents the detailed requirements for the System of Systems for the I-394 ICMS. Section 4 presents the detailed system requirements for the individual systems of I-394 ICMS. Section 5 defines the Hardware Requirements, Section 6 describes the Interface Requirements, and Section 7 defines the Documentation and Training Requirements.

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# 1. Introduction and Document Overview

The stakeholder agencies that operate transportation systems along the I-394 Corridor on the west side of the Twin Cities Metropolitan Area (TCMA) have decided to implement and operate an Integrated Corridor Management approach throughout the corridor. Together, the stakeholder agencies have defined a set of User Needs that must be met within the corridor.

A number of existing legacy Intelligent Transportation Systems (ITS) already exist and work to manage traffic and inform travelers of the I-394 Corridor. Because of the existing systems, some portions of the User Needs are already met; however none of the User Needs are completely satisfied by the existing systems.

In order to fully meet the User Needs and operate a truly integrated corridor management approach, the stakeholders of the I-394 Corridor have agreed to develop and operate an Integrated Corridor Management System (ICMS). The ICMS will function as a system of systems that incorporates a new system referred to as the ICMS Data Hub as well as enhancements to nine (9) existing systems currently operated by a collection of State, County, and Local agencies.

This System Requirement Specification (SRS) defines the requirements for the I-394 Corridor ICMS. These requirements describe 'what' the ICMS will do to fulfill its role as part of the overall I-394 Integrated Corridor Management approach.

In some cases, the actions of the ICMS will require actions of other systems that are currently performed by the existing systems. In these circumstances, detailed functional requirements are not defined because the systems already exist and need not be built by this project. However, high level 'External Requirements' are identified describing these actions that the ICMS needs in order to function properly.

**Key Terms Used in the SRS**

Section 8 defines acronyms, abbreviations, and local definitions. However there are a few key terms used throughout the requirement definitions that are defined here in order to clarify any potential confusion:

***Send Data*** – Send data is used to describe a data exchange where one system (System A) connects to a second system (System B) and (after handshaking) sends a message or data set. System B responds to verify if the message was received properly or not.

***Receive Data*** – Receive data is the term used by a system that is waiting for other systems to send data. Using the example above, System B receives data. In order to receive data, a system must operate in a mode that is waiting all the time for other systems to connect and send data.

***Post Data –*** A system posting data 'publishes' the data or message set in a location where other systems can come and collect the data. An XML post is a common form of data post. The data post can either be in a public location, such as the Internet; or in a secure location where only authorized systems may access it. For purposes of this ICMS, all data posts will be public posts.

***Acquire Data –*** A system that acquires data follows a timed cycle to visit a location where data is posted and acquires the data. Unlike receiving data, the system must actively visit the post site and gather the data.

## *1.1 System Purpose*

The transportation, transit and emergency services agencies that support the I-394 corridor have collectively decided to pursue an Integrated Corridor Management approach. Consequently, relationships, agreements and cooperation have already increased along the corridor. This was made obvious when a tanker truck recently overturned on the I-394 highway closing I-394 and I-94 for several hours on January 9, 2008. As a result of the procedures discussed and relationships developed, the response to the event was executed in a collaborative and efficient manner.

Nonetheless, the benefits realized by cooperation and relationships are limited. The tanker truck overturning in January confirmed what the I-394 stakeholders have been discussing for over 12 months, that there is a need to physically integrate their systems together such that the full spectrum of ICM benefits can be achieved.

This integration of systems and agencies will be accomplished by the design, development and implementation of the ICMS. The purpose of this system is to support the I-394 stakeholders at executing the Incident Corridor Management (ICM) strategies they have identified and prioritized for this corridor.

## *1.2 System Scope*

Section 3 of this document presents the detailed requirements for the System of Systems for the I-394 ICMS. Section 4 presents the detailed system requirements for the individual systems of I-394 ICMS. Section 5 defines the Hardware Requirements, Section 6 describes the Interface Requirements, and Section 7 defines the Documentation and Training Requirements. Once a system is developed that meets these requirements, the I-394 ICM stakeholders will have the tools they need to effectively manage traffic on the I-394 corridor.

In order to put context to the requirements described in Section 4, the intent of this section is to describe the problems and needs that face the travelers and transportation professionals along the I-394 corridor.

Each requirement in Section 4 is derived from one or more corridor user needs. In the event that any discussion, debate, or clarification is needed on the requirements, the project team shall refer to the needs presented in this section and to the operational scenarios described in Section 2.

Table 1 presents the problems described for the I-394 corridor and the extracted needs of the ICMS.

***Table 1: Summary of Corridor Problems and Needs***

| I-394 Corridor Problem | Need of the ICMS |
|---|---|
| 1. ICMS agencies performing traveler information dissemination are not alerted to every incident or unplanned transit service problems along the corridor. | **1. Need for corridor wide status monitoring.**<br><br>The delivery of comprehensive traveler information dissemination and the performance of traffic management relies upon the operators and automated systems having real-time status information about the corridor. This need therefore relies upon:<br>• Notification of events;<br>• Sharing of information among the various agencies<br>This need is for all agencies involved in ICM operations and information dissemination to have access to the descriptions of events (planned or unplanned), transit service delivery availability, and any other operational issues that will assist in management or be of value in disseminating to the traveling public. |
| 2. Information exchange about incidents and service problems alone will not describe the impacts of the incidents across all routes and modes | **2. Need for verification of incidents and impacts.**<br><br>Reports of incidents and their impacts on the network need to be verified in order to allow information dissemination systems to properly describe current conditions. The verification may take the form of either verifying that an event or incident exists, or may involve the verification that the situation is impacting traffic in a way that merits dissemination to the public (and to determine what messages should be relayed). |

| I-394 Corridor Problem | Need of the ICMS |
|---|---|
| 3. There is currently no travel information available that describes an overall view of conditions (e.g. travel times, closures, delays) along all routes and modes | **3. Need for overall view of conditions along all routes and modes.**<br><br>Travelers need to be provided with an overall view and description of the conditions along all routes and modes of travel.<br>• The information needs to be assembled from public and privates agencies.<br>• The information needs to be provided to information dissemination systems operated by public and private agencies.<br>• Some of the information may need to be generated automatically by systems (e.g. travel times) and some of the information may need to be entered by system operators. |
| 4. Travelers are not able to access information about park-and-ride space availability at lots, and the lots are known to fill regularly. The travelers can not tell if transit is a viable option because they don't know if they can park in a nearby lot. | **4. The need to assemble and disseminate park-and-ride availability.**<br><br>The ICMS needs to assemble and disseminate information to travelers about parking availability at various park-and-ride facilities. Travelers need this information to decide if transit is a viable option. This assembly of information will support traveler information systems dissemination of the information and ultimately will allow travelers to not only understand if transit is a viable option, but if they can park their car at a nearby lot and join the transit network. |
| 5. Transportation operators throughout the corridor are not able to understand in real-time the demand placed on the corridor and which networks have excess capacity and which have limited capacity. | **5. Need for a comprehensive view of available capacity and demand throughout the corridor.**<br><br>In order to manage the corridor, the operators in the various agencies need a comprehensive view of the available capacity and demand along each route and mode of travel. This view of capacity and demand will allow transportation managers to manage traffic and provide travel information to spread demand across available capacity. |

| I-394 Corridor Problem | Need of the ICMS |
|---|---|
| 6. Many travelers do not consider transit as a viable option in their daily travel along the corridor because they lack information about transit options | **6. The need to present modal and route options to travelers.**<br><br>In order to promote as much inter-modal trips as appropriate for the corridor, the ICMS must present modal options as well as route options to travelers. This need reflects the fact that many travelers are unfamiliar with the bus routes, schedules, options for bike/bus trip combinations, and there is a need to include transit information whenever possible in traveler information reports. As a result of satisfying this need, it is hoped that the travelers will understand their options for transit, the benefits and drawbacks in selecting transit and be able to reach appropriate decisions. |
| 7. Travelers are not fully utilizing transit because of perceptions or unfamiliarity. The lack of wider use of transit continues to place single occupant vehicle (SOV) demand on the corridor. | **7. Need for Transit advantages.**<br><br>In order that transit remains a viable option for travelers, the ICMS needs to provide advantages to transit vehicles and incentives to transit riders to encourage transit rides whenever possible. |
| | **8. Need for Transit incentives**.<br><br>In order that demand for single occupant vehicle trips on the corridor may be reduced, the ICMS needs to provide incentives to travelers to consider transit whenever possible. |
| 8. Travelers do not understand which routes and modes have excess capacity, at any given time. | **9. Need for Dissemination of corridor-wide traveler information.**<br><br>In order to allow travelers to self adjust their trips and smooth demand across available capacity, the ICMS needs to present travelers with information to inform them of travel times, incidents and other alerts along all routes and modes. |

| I-394 Corridor Problem | Need of the ICMS |
|---|---|
| 9. En-route travelers tend to stick to their original planned route, because of the lack of en-route information dissemination. | **10. Need for access to information dissemination en-route.**<br><br>In order that travelers may adjust their trips en-route or as they embark on their trips, the travelers need access at key locations to information directing them to the best routes or advising them to avoid problem areas. By providing access to en-route information, the ICMS will enable travelers to select their best alternatives, and the result will be a spreading of demand across capacity as appropriate for current conditions. |
| 10. The city, county, state, and transit agencies do not have information about what the other organizations are doing to respond to incidents or recurring delays and congestion. This information would help the agencies respond in a manner that supports the entire corridor. | **11. Need for inter-agency information exchange.**<br><br>In order to support the most effective and efficient corridor-wide travel conditions, the ICMS traffic operations teams need to be informed of the activities that other agencies are performing to manage traffic and interact with the other agencies in formulating their responses. This need involves a sharing of knowledge about events as well as a sharing of strategies and activities being executed to actively manage events. |
| 11. Reports of activities of other agencies alone will not describe the situation with enough detail to allow each respective agency to optimally manage travel. | **12. Need for improved information about how other agencies are responding**.<br><br>Operators need improved information about the current and planned response activities of the other agencies throughout the corridor.<br>• Operators need a way verify the information and assess the impacts.<br>• The relevant information about the incidents and events needs to be provided to traveler information dissemination systems. |
| 12. Fire and police dispatchers and responders do not have information about incidents and events that other agencies are responding to and these other incidents often cause secondary incidents or impact the incident response they deliver on their respective roads. | **13. Need for information exchange among emergency responders.**<br><br>There is a need for information exchange among the fire and police dispatchers at the state, city, and county levels. This exchange of information will help manage incident sites more effectively and help prevent diversions from multiple incidents (on different streets) from overlapping each other. |

| I-394 Corridor Problem | Need of the ICMS |
|---|---|
| 13. The transportation agencies in the corridor lack information about incidents along arterials or the transit network. | |
| 14. Power or communication outages that impact one or more intersections can seriously impact the traffic flow along an entire corridor. Often, the agency responsible for the one intersection is different from the agencies operating (and relying on) the signals throughout the remainder of the corridor. | **14. Need for infrastructure reliability and redundancy.**<br><br>In order to not allow periodic power or communication outages at one isolated intersection to impact the flow along an entire route of travel, the ICMS must include infrastructure redundancy measures to increase reliability and prevent these impacts. |
| 15. Special events often overlap the commute time and result in increased demand for transit or highway travel. | **15. Need to provide temporary transit capacity increases and inform travelers of options.**<br><br>In order to support special event traffic to maintain limited impact on the corridor, the ICMS needs to accommodate planned peaks in demand by offering temporary capacity expansions and informing travelers of options for travel. |
| 16. Special event attendees are often not familiar with options for routes, modes of travel, and parking to reach their destinations. As a result, the optimal choices are not selected. | **16. Need for special event transportation options.**<br><br>Special event attendees need to be presented with information about options for routes, modes of travel, and parking. |
| 17. The progression of travel along the corridor is not optimized.<br>During incident conditions, the existing signal timing plans do not maximize the critical flow directions. | **17. Need for efficient throughput of vehicles throughout the corridor.**<br><br>The ICMS needs to promote efficient and consistent throughput of transit and single occupant vehicles throughout the corridor. Travelers rely on consistent commute times and experience wasted times when they must either leave early to accommodate large variations in travel time, or when they arrive late. There is a need to maintain a consistent situation of travel times throughout the corridor such that travelers can expect consistent conditions. |
| 18. Transit vehicles accessing park-n-ride locations experience extensive delays, frustrating riders and impacting the on-time performance of vehicles. | |
| 19. The freeway systems operates at or near capacity during peak periods and | |

| I-394 Corridor Problem | Need of the ICMS |
|---|---|
| therefore any slight peak in demand or restriction in capacity can cause operational breakdowns throughout the corridor. | |
| 20. If any portion of the ICMS malfunctions, incidents or operational problems will go undetected. | **18. The need to monitor status of devices and systems.**<br><br>Operators and automated systems will rely upon the data collected, exchanged and presented by the ICMS systems and devices. Therefore, in order to ensure reliable delivery of services, the ICMS needs to monitor the status of systems and devices, and report any malfunctions to appropriate agencies. |
| 21. There is no agreed measure to determine how well the corridor is performing as a whole. | **19. The need for corridor performance measures.**<br><br>The transportation operators and managers need performance measures that can be used to determine how well the corridor is performing. All operators and agencies need to agree to these performance measures, and can be used to monitor the effectiveness of the control strategies. |

## 1.3 I-394 Integrated Corridor Management Components

The I-394 ICM concept is described by four primary components:

- Existing field devices and control systems already in place in the corridor;
- A set of field devices and control systems planned to be developed and deployed by funding sources outside the ICM Project;
- The ICM System (ICMS) itself; and
- Partnerships, agreements, and actions to complement the systems being deployed.

Figure 1 illustrates the four components to the Minnesota I-394 ICM initiative.

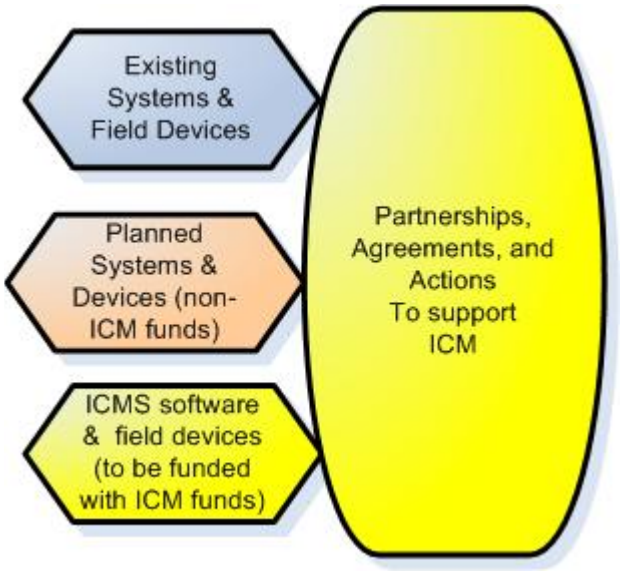


***Figure 1: Four Primary Components of the I-394 ICM Initiative***

***Existing systems and field devices*** along the I-394 corridor are recognized as external requirements to the ICMS because ICMS requirements were created with the understanding that these external entities exist and will continue to exist. If the existing entities are removed or change in function or feature, this may cause impacts to the ICMS. Section 2.7 describes these external requirements. Detailed requirements for existing systems are not defined in Section 4 because they need not be built by this project.

***Planned systems and devices funded by non-ICMS funds*** represent those devices or enhancements to existing devices that are planned and committed for deployment by state, city, or county agencies. These are also represented as external requirements because the ICMS requirements are being developed with the understanding that these entities will be deployed without the use of ICM funds. Section 2.7 describes these external requirements. Detailed requirements for existing systems are not defined in Section 4.

***The ICMS*** includes new systems and enhancements to existing systems that are described by the detailed requirements defined in Section 4 of this document. The intention is to use ICM funds to develop and deploy the ICMS software and related field devices.

***Partnerships, agreements and actions to support ICM*** have been defined to ensure that each agency understands their roles and commitments, as well as the roles and commitments of other agencies. Section 6 contains descriptions of these partnerships and procedures.

### *1.3.1 The Relationship between the ICMS and Other Systems*

The business model of the I-394 ICM Project is to make use of existing or planned system and field devices to the extent possible. This approach will seek to benefit from any external systems that are already operational and have funded budgets for ongoing operations and maintenance.

The role of the ICMS will be to augment, enhance, and support these existing systems such that the vision of ICM can be accomplished. *For example, the ICMS will not deploy a new 511 phone system, but rather enhance the existing Traffic Operations Center that operates the 511 phone system in order that it may disseminate additional 'corridor-centric' information using the existing phone system.*

Figure 2 on the following page illustrates conceptually how the ICMS (depicted in yellow in the center) will augment, enhance and support nine existing systems (represented as blue boxes around the ICMS) to interface to a variety of field devices (both existing and planned for deployment). Collectively, all components shown in Figure 2 will comprise the ICM. The ICMS (depicted in yellow) will be described in detail throughout the remainder of this document.

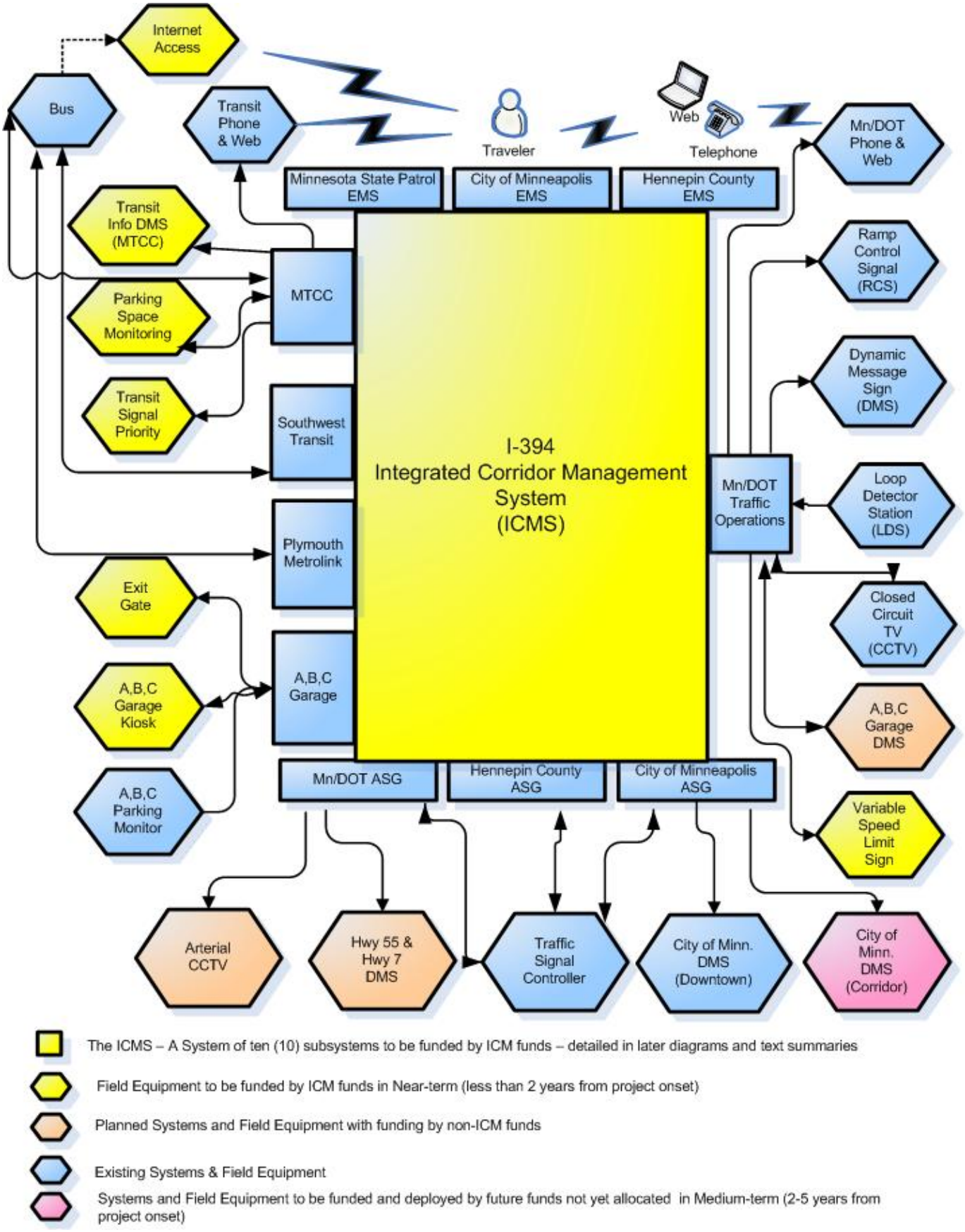


***Figure 2: Block Diagram of ICM Components***

### *1.3.2 Existing Systems and Field Devices*

There are currently a number of existing field devices and control systems that are in place on the corridor and will be key components to the overall ICM strategies. Table 2 describes these existing systems and indicates the agency committed to maintain these systems.

***Table 2: Existing Field Devices and Control Systems within the ICM Corridor and Ownership/Maintenance of the Systems***

| **Existing Field Devices and Control Systems within the ICM Corridor** | **Ownership / Maintenance Provided by** |
|---|---|
| A Traffic Operations Center (Traffic Operations) system including:<br><br>• Complete I-394 surveillance coverage through Closed Circuit Television (CCTV) cameras<br>• Dynamic Message Signs (DMS) located at limited locations along Hwy 55<br>• Full ramp meter coverage of all ramps in the corridor<br>• A 511 phone and Internet information dissemination system<br>• A condition reporting system; and<br>• Traffic management center software<br>• HOT Lane operating congestion pricing | Minnesota Department of Transportation (Mn/DOT) |
| A Metro Transit Control Center (MTCC) system including:<br><br>• Bus monitoring with AVL and real-time reporting<br>• Internet accessible transit trip planning system<br>• Transit traveler information website and phone system<br>• Bus performance monitoring and reporting system<br>• Park-and-ride facilities along the corridor | Metro Transit |
| Operational Commuter Transit Agencies operating:<br><br>• Regular routes along the I-394 Corridor with no stops on the corridor (open option for routing around the corridor) | SouthWest Transit & Plymouth Metrolink |
| The A,B,C Parking (ABC) Garage system at the termination of the corridor:<br><br>• Ability to monitor ingress and egress of vehicles<br>• Access directly to I-394 | Mn/DOT & City of Minneapolis (COM) |

| Existing Field Devices and Control Systems within the ICM Corridor | Ownership / Maintenance Provided by |
|---|---|
| The Mn/DOT Arterial Signal Group (Mn/DOT-ASG) System, including:<br><br>• Actuated signal controllers on State operated signals within the corridor<br>• Communication to signals and ability to download signal timing plans remotely | Mn/DOT |
| The City of Minneapolis Arterial Signal Group (COM-ASG) System, including:<br><br>• Actuated signal controllers on City operated signals within the corridor<br>• Communication to signals and ability to download signal timing plans remotely<br>• DMS devices along arterials in the downtown with control from within the ASG<br>• CCTV cameras located in the downtown with control from within the ASG | City of Minneapolis |
| The Hennepin County Arterial Signal Group (HENN-ASG) System, including:<br><br>• Actuated signal controllers on County operated signals within the corridor<br>• Communication to signals and ability to download signal timing plans remotely<br>• DMS devices along arterials and control from within the ASG<br>• CCTV cameras with control from within the ASG | Hennepin County (HENN) |
| The Minnesota State Patrol Emergency Management System (MSP-EMS) including:<br><br>• A Computer Aided Dispatch system to log incidents and responses<br>• Shared radio talk groups available to all responders along the corridor<br>• Access to Mn/DOT live video feed in RTMC<br>• Operators are collocated in the Mn/DOT RTMC | Minnesota State Patrol (MSP) |
| The City of Minneapolis Emergency Management System (COM-EMS) including: | City of Minneapolis |

| Existing Field Devices and Control Systems within the ICM Corridor | Ownership / Maintenance Provided by |
|---|---|
| • A Computer Aided Dispatch system to log incidents and responses<br>• Shared radio talk groups available to all responders along the corridor | |
| The Hennepin County Emergency Management System (HENN-EMS) including:<br><br>• A Computer Aided Dispatch (CAD) system to log incidents and responses<br>• Shared radio talk groups available to all responders along the corridor | Hennepin County |

### *1.3.3 Planned Systems and Field Devices*

In addition to the existing systems and field devices along the I-394 Corridor, there have been a number of recent commitments to deploy and operate additional systems and field devices. Table 3 summarizes those deployments that are planned and committed by ICM member agencies, and identifies the agency committed to fund the initiative (additional details of these requirements, including planned deployment timeframes, are included in Section 5.

***Table 3: Future Enhancements to Existing Systems and Ownership***

| Future Enhancements to Field Devices and Control Systems within the ICM Corridor | Ownership / Maintenance Provided by |
|---|---|
| Funded enhancements to the Traffic Operations Center system include:<br><br>• Deployment of freeway travel times on existing DMS on I-394 (scheduled in 2008);<br>• Deployment of automated State Patrol CAD to Mn/DOT Regional Transportation Management Center (RTMC) exchange of incident reports (scheduled in 2008); | Mn/DOT |
| Funded enhancements to the MTCC system include:<br><br>• Deployment of Transit Signal Priority (TSP) at key intersections | Metro Transit |

| Future Enhancements to Field Devices and Control Systems within the ICM Corridor | Ownership / Maintenance Provided by |
|---|---|
| as prioritized by Metro Transit (scheduled in 2008);<br>• Integration of transit arrival times and telephone interactive voice response system (scheduled in 2008); and<br>• Predicted bus arrival and departure information displayed on the Internet (scheduled in 2008). | |
| Funded enhancements to the SouthWest Transit Dispatch and Operations Center include:<br>• Deployment of a computer aided dispatch (CAD) automated vehicle location (AVL) system<br>• | SouthWest Transit |
| Funded enhancements to the ABC Garage system at the termination of the corridor include:<br>• Deployment of DMS along I-394 specifically to display messages about parking availability in the A, B, or C garages (scheduled in 2009). | City of Minneapolis |
| Funded enhancements to the Mn/DOT ASG System, include:<br>• Advanced signal coordination and retiming of the 30 signals along TH 55 (scheduled in 2011);<br>• Advanced signal coordination and retiming of the 23 signals along TH 7 (scheduled in 2011);<br>• Advanced signal coordination and retiming of the 28 signalized intersections at junctions with I-394 (signals exist on North-South cross streets) (scheduled in 2011);<br>• Deployment of approximately 44 CCTV cameras along Hwy 55 and Hwy 7 (scheduled in 2011); and<br>• Deployment of 4 DMS along Hwy 55 and Hwy 7 (scheduled in 2011). | Mn/DOT |
| Funded enhancements to the City of Minneapolis Arterial ASG System, include:<br>• Next generation master signal controller for the City of Minneapolis (scheduled in 2009). | City of Minneapolis |

### *1.3.4 The ICMS*

The ICMS is a system of systems to be deployed to accomplish those portions of the ICM vision not accomplished by existing or planned deployments. This section presents a high level summary of the ICMS, with detailed requirements presented in Section 4.

The majority of the ICMS deployments have been identified as Near-term ICMS deployments, to be developed and deployed in the initial 2 years. However, several ICMS components are identified as Medium-term deployments, to be deployed in 2-5 years from project onset. For purposes of the United States Department of Transportation (USDOT) initiative, the Near-term ICMS deployments would be included in the initial funding request; or funded by local matches. Figure 3 (on the following page) includes a block diagram of the ICMS subsystems and shows the connections between:

- Existing systems;
- Existing field devices;
- Planned ICMS software systems;
- Planned ICMS field devices; and
- Future Medium term (possible) ICMS field devices and systems.

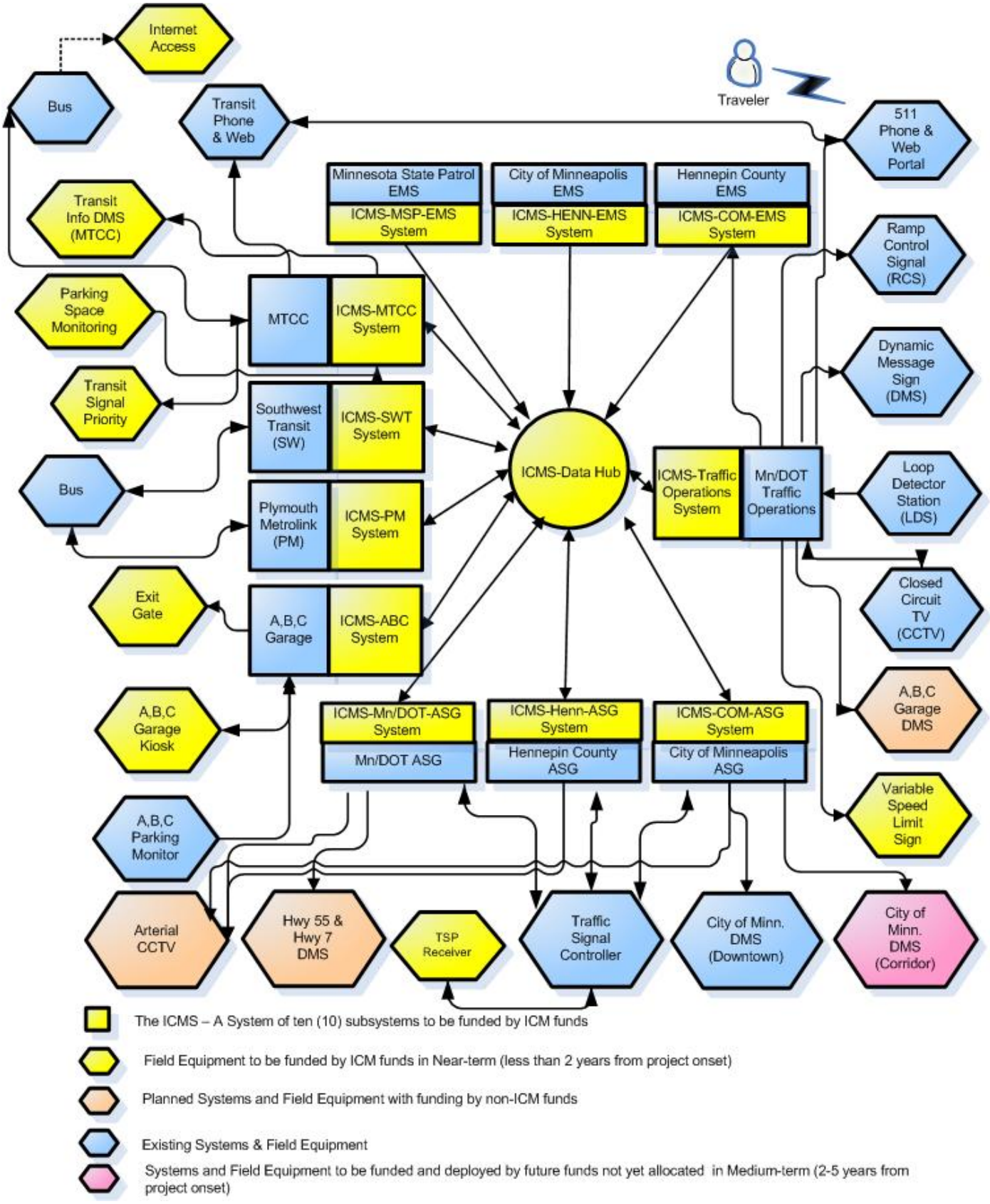


***Figure 3: Block Diagram of the ICMS Subsystems and Interconnects***

### *1.3.4.1 ICMS High Level Summary – Near Term Components*

The near term ICMS components will consist of the ICMS Data Hub (a new system), and enhancements to nine existing systems, summarized briefly as follows:

- ***The ICMS Data Hub*** will receive data and event messages from the other ICMS systems. The ICMS Data Hub will store data temporarily and post the data for other systems to download.

- ***The ICMS Enhancements to the Mn/DOT Traffic Operations System*** will:
    - Send freeway data (volume, occupancy, travel times, ramp meter) to the ICMS Data Hub;
    - Acquire and store performance data for arterial and transit systems (e.g. travel times) from the ICMS Data Hub;
    - Generate and disseminate message to the traveling public through enhancements to the 511 phone and Internet dissemination systems;
    - Interface with and control field equipment (e.g. posting ICM messages to existing DMS signs, posting messages received from the ABC garages to signs deployed for the garages);
    - Acquire park-and-ride availability messages from the ICMS Data Hub
    - Generate and disseminate messages describing park-and-ride parking availability using existing phone and Internet dissemination systems; and
    - Provide an operator interface.

- ***The ICMS Enhancements to the Metro Transit Control Center System*** will:
    - Gather data from buses to calculate performance and route status;
    - Gather data from the ICMS Data Hub about incidents, freeway and arterial travel times from the ICMS Data Hub, and insert data into the transit CAD system;
    - Send messages to Transit Signal Priority receivers on signal controllers to accomplish transit signal priority;
    - Disseminate ICM information to travelers using existing transit information dissemination systems; and
    - Allow an operator interface to configure and manage the ICMS enhancements.
    - Deploy detection equipment to monitor parking space availability at the park-and-ride lots operated by Metro Transit along the I-394 corridor;
    - Deploy DMS signs and control capability to post messages on Metro Transit operated DMS signs notifying travelers of the available spaces at parking facilities;
    - The ability to send park-and-ride availability message reports to the ICMS Data Hub

- ***The ICMS Enhancements to the SouthWest Transit System*** will:
    - Gather data from the ICMS Data Hub about incidents, and insert data into the SouthWest Transit CAD system (when installed); and
    - Display information to SouthWest Transit dispatchers.

- ***The ICMS Enhancements to the Plymouth Metrolink Transit System*** will:
    - Gather data from the ICMS Data Hub about incidents, and insert data into the Plymouth Metrolink Transit CAD system (when installed); and
    - Display information to Plymouth Metrolink Transit dispatchers.

- ***The ICMS Enhancements to the A,B,C Garage Systems*** will:
    - Acquire traffic and incident data from the ICMS Data Hub;
    - Generate messages for external DMS signs describing parking availability and send messages to the ICMS-Data Hub (parking messages will be acquired by ICMS-Traffic Operations and DMS signs controlled by the Mn/DOT Traffic Operations)
    - Generate messages describing traffic conditions, events and closures and display messages or maps on kiosks in garage;
    - Include an operator and administrator interface; and
    - Send data about any garage exit closures and recommended messages for external DMS signs to the ICMS Data Hub.

- ***The ICMS Enhancements to the Mn/DOT Arterial Signal Group System*** will:
    - Interface with field devices
        - gather volume and occupancy data from traffic controllers;
        - download new signal timings to traffic controllers;
        - send messages to arterial DMS signs
    - Calculate arterial travel times using data acquired from controllers;
    - Send arterial travel times to the ICMS Data Hub;
    - Acquire freeway travel times and incident reports from the ICMS Data Hub;
    - Provide an operator interface to view arterial data, freeway data, and incidents; and to control signal timing downloads.

- ***The ICMS Enhancements to the City of Minneapolis Arterial Signal Group System*** will:
    - Interface with field devices
        - gather volume and occupancy data from traffic controllers;
        - download new signal timings to traffic controllers;
        - send messages to existing arterial DMS signs
    - Acquire freeway travel times and incident reports from the ICMS Data Hub;
    - Provide an operator interface to view arterial data, freeway data, and incidents; and to control signal timing downloads.

- ***The ICMS Enhancements to the Hennepin County Arterial Signal Group System*** will:
    - Interface with field devices
        - gather volume and occupancy data from traffic controllers;
        - download new signal timings to traffic controllers;
    - Acquire freeway travel times and incident reports from the ICMS Data Hub;
    - Provide an operator interface to view arterial data, freeway data, and incidents; and to control signal timing downloads.

- ***The ICMS Enhancements to the Minnesota State Patrol CAD System*** will:
    - Send incident notices and updates to the ICMS Data Hub

- ***The ICMS Enhancements to the City of Minneapolis CAD System*** will:
    - Send incident notices and updates to the ICMS Data Hub

- ***The ICMS Enhancements to the Hennepin County CAD system*** will:
    - Send incident notices and updates to the ICMS Data Hub

#### *1.3.4.2 ICMS High Level Summary – Medium Term Components*

The medium term ICMS components will consist of deployments planned to occur between two and five years from project onset. These are summarized briefly as follows:

- ***The ICMS Enhancements to the City of Minneapolis Arterial Signal Group System*** will:
    - Deploy additional DMS on city operated streets in and around the corridor to be controlled by the City of Minneapolis traffic control center.
    - Deploy additional CCTV to view city operated streets in and around the corridor.

- ***The ICMS Enhancements to the Hennepin County Arterial Signal Group System*** will:
    - Deploy additional DMS on county operated streets in and around the corridor to be controlled by the Hennepin County traffic control center.
    - Deploy additional CCTV to view county operated streets in and around the corridor.

### *1.3.5 Partnerships, agreements and procedures*

The success of the I-394 Corridor ICM initiative relies on more than the hardware and software to be deployed and operated. A number of partnerships, agreements and procedures have been identified that will ensure that the systems and equipment are used properly and that the agencies work together to make best use of these systems.

In addition, two of the User Needs are not directly addressed by requirements in this SRS, these requirements (#14 and #19) relate to field equipment continuing to run without power supply and establishing common performance measures. Therefore, the first two agreements and procedures in this section specifically address User Needs #14 and #19.

**The Need for Infrastructure Reliability and Redundancy**
Several key intersections along the ICM corridor are prone to losing power to the signal controllers several times per year. In isolation, one signal without power is not a tremendous cause for alarm, however when the intersection is downstream of many other intersections along a primary commuter corridor, it is of great concern. The ICM initiative will cooperate together to deploy power backup systems at key corridor intersections in order to maintain as high a level of service as possible.

**The Need for Common Accepted Performance Measures**
User Need #19 relates to the need for common and accepted performance measures for how the corridor is performing. The ICMS will record, process and calculate data against formulas and equations, however there needs to be agreement on how 'good performance' is measured. Therefore, the ICM project partners will meet to reach consensus on performance measures that accurately reflect the performance of the corridor and can be measured adequately.

***Coordinated Signal Timing Plans***
During special events, major incidents, or other special circumstances, signal control operators may select to download signal timing plans to controllers on the I-394 Corridor. The ICMS-Data Hub will share information about what timing plans are implemented, however there is a need for each agency to have a set of pre-defined timing plans that are coordinated. This will help maintain coordination along routes that include both State and city signals. This will require cooperation as all agencies develop their special timing plans to synchronize cycle lengths and maintain coordination.

**Debriefing of Major Events**
The ICM strategies and use of the ICMS will be new to each agency. In order to develop the most effective use of the systems and devices, the agencies have agreed to conduct debriefings of major incidents with an emphasis on ICM. These debriefings will help each agency review how they used the ICMS, what impediments they had, and identify opportunities for improvement.

**Regular Meetings of Emergency Management Groups**
The ICM project development has increased dialog among the State, County, City emergency management providers and Mn/DOT. After the ICMS is implemented, this group intends to continue regular meetings (perhaps 2 per year) to maintain relationships and communication.

**Regular Meetings of Arterial Signal Management**
Mn/DOT, City of Minneapolis, and Hennepin County traffic management groups meet regularly, however the groups have recognized a value in meeting specifically to discuss coordination and the use of the ICMS. Therefore, regular meetings are planned.

## *1.4 System (ICMS) Overview – Return on Investment*

The block diagrams in Figures 2 and 3 represent the systems, field equipment, and communications to support ICM strategies along the I-394 Corridor. If these components were constructed from the ground up, with no existing systems, the costs for the I-394 Corridor alone would easily exceed $50 Million. However, the foundation of the ICM initiative is to leverage existing systems, and only build those technologies that are needed to integrate the systems together.

In addition, because of committed investments from Metro Transit, the City of Minneapolis Parking Garages, and Mn/DOT, many of the field devices needed to realize the vision of ICM are already planned for deployment using non-ICM funds.

Because of these existing systems and systems planned for deployment in the near-term, the I-394 Corridor ICMS need not perform all actions required by the ICM strategies, but can rather will augment the existing systems and integrate existing systems together.

The I-394 Corridor ICMS will perform automated functions and enable operators to perform manual functions in order to execute the Integrated Corridor Management strategies identified for the corridor.

The following section introduces the one new system proposed to be created for the I-394 ICM initiative, and the nine existing systems proposed to be enhanced by this initiative. The exact approach for enhancing the existing systems (e.g. whether new software systems are created or whether existing systems are modified) will be determined during the design phase. For the remainder of this SRS document, these enhancements to existing systems will be referred to as 'systems'. For example, the enhancements to the ICMS Enhancements to the Traffic Operations System is referred to as 'ICMS-Traffic Operations System'.

The approach of modifying existing systems to the extent possible was a strategic decision by members of the corridor. Because each of these existing systems exists today and has a budget for ongoing operations and maintenance, this was determined to be the best opportunity to maintain operation of the overall ICMS (all 12 systems) indefinitely.

# 2. General System Description

## *2.1 System Content*

The I-394 Corridor ICMS will be a system of systems that work together to address the needs throughout the corridor and achieve the vision defined in the Concept of Operations. The I-394 ICMS will include the following:

- ***The ICMS Data Hub –*** A new software system to perform the functions of gathering data, storing data, and sharing data with other systems; and

- ***ICMS Enhancements to Existing Systems –*** The ICMS project will enhance eleven (11) existing systems currently operated by corridor partners, adding features and functions specific to performing the ICM functions.

Figure 4 illustrates the ICMS Data Hub and the planned enhancements to the eleven existing systems. **Collectively, these twelve (12) systems comprise the ICMS.** Therefore, the I-394 Corridor ICMS is comprised of everything within the yellow shaded area of Figure 4.

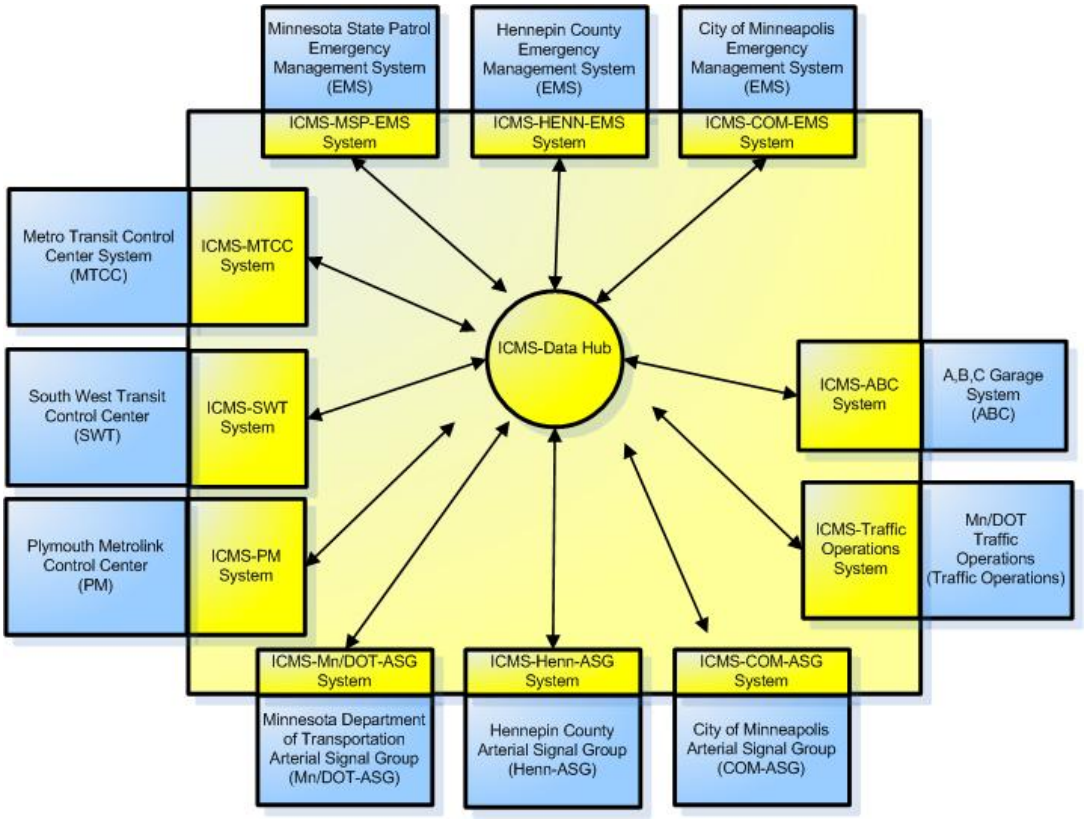


***Figure 4: System Level Diagram of I-394 ICMS***

A number of different data types will be sent to the ICMS Data Hub, process and posted for other systems to acquire. In order to ensure that a system is identified to send all required data to the ICMS-Data Hub, as well as to ensure that all data being sent to the ICMS-Data Hub is being sent because it is needed by another system, the following table has been developed to map the data suppliers (Systems) and data consumers (Systems).

***Table 4: ICMS-Data Hub Data Sources and Data Consumers***

| **Data Sources (System)** (Systems that will send data to Data Hub) | **Data Element** | **Data Consumers** (Systems that will acquire data from Data-Hub) |
|---|---|---|
| ICMS-HENN-EMS<br>ICMS-COM-EMS | Arterial Incident Reports | ICMS-MTCC; ICMS-ABC;<br>ICMS-Traffic Operations;<br>ICMS-Mn/DOT-ASG;<br>ICMS-HENN-ASG;<br>ICMS-COM-ASG |
| ICMS-MSP-EMS<br>ICMS-Traffic Operations | Freeway Incident Reports | ICMS-MTCC;<br>ICMS-ABC;<br>ICMS-Mn/DOT-ASG;<br>ICMS-HENN-ASG;<br>ICMS-COM-ASG<br>ICMS-SWT; ICMS-PM |
| ICMS-MTCC | Transit Vehicle Incidents | ICMS-Traffic Operations;<br>ICMS-Mn/DOT-ASG<br>ICMS-HENN-ASG;<br>ICMS-COM-ASG |
| ICMS-Traffic Operations | Freeway Travel Times | ICMS-MTCC;<br>ICMS-Mn/DOT-ASG;<br>ICMS-HENN-ASG;<br>ICMS-COM-ASG |
| ICMS-Mn/DOT-ASG | Arterial Travel Times | ICMS-MTCC;<br>ICMS-Traffic Operations |
| ICMS-MTCC | Transit Travel Times | ICMS-Traffic Operations |
| ICMS-Traffic Operations | Freeway Traffic Data (volume, occupancy, speed) | ICMS-MTCC;<br>ICMS-Mn/DOT-ASG;<br>ICMS-HENN-ASG;<br>ICMS-COM-ASG |
| ICMS-Mn/DOT-ASG<br>ICMS-HENN-ASG<br>ICMS-COM-ASG | Arterial Traffic Data (volume, occupancy, speed) | ICMS-MTCC |
| ICMS-MTCC | Park-and-Ride space availability | ICMS-Traffic Operations |
| ICMS-ABC | ABC Parking Message | ICMS-Traffic Operations |
| ICMS-MTCC | Transit Performance Data | ICMS-Traffic Operations |
| ICMS-Mn/DOT-ASG<br>ICMS-HENN-ASG<br>ICMS-COM-ASG | Current Signal Timing Plans | ICMS-MTCC;<br>ICMS-Mn/DOT-ASG;<br>ICMS-HENN-ASG<br>ICMS-COM-ASG |
| ICMS-Traffic Operations | Mn/PASS direction of flow, Travel Times | ICMS-MTCC; ICMS-SW;<br>ICMS-PM |

## 2.2 ICMS Business Model

The I-394 Corridor ICMS approach of modifying existing systems has the benefit that every system shown in Figure 4 with the exception of the ICMS Data Hub exists today. Further, the agency currently operating each of these nine systems (Mn/DOT, Hennepin County, Metro Transit, Minnesota State Patrol, or City of Minneapolis) has committed to operate and maintain these systems with a dedicated budget. The enhancements to these systems that are needed to accomplish the ICM strategies will expand the software, interfaces, and possibly require additional computing power and bandwidth. However, once the ICMS enhancements are funded and performed, there is a commitment from each agency who currently owns the systems to continue to maintain and operate the systems. The ICMS Data Hub is planned to be incorporated in to the Mn/DOT Traffic Operations Center and to be maintained together with the existing RTMC equipment.

In summary, the ongoing maintenance and operation of systems is covered by current funding commitments of partner agencies.

In Figure 4, the yellow boxes represent the new ICMS Data Hub and expansions to existing systems that will be performed within the ICM project, and collectively everything housed within the yellow shaded area will be considered the final ICMS.

Section 2.3 describes and illustrates the capabilities of each module to the I-394 ICMS.

## 2.3 ICMS System Capabilities

### 2.3.1 ICMS Data Hub

The ICMS Data Hub will serve as a data routing mechanism for the I-394 ICM Corridor. The Data Hub will:

- Allow each system to send data to the ICMS-Data Hub;
- Store data sent to the ICMS-Data Hub for a temporary time period; and
- Post data and message sets received for other systems to acquire.

As a result of this architecture, each system only needs to communicate with the ICMS-Data Hub, versus multiple connections to many systems located at many agencies.

The business model behind this concept of the ICMS-Data Hub is that the Data Hub will have minimal intelligence built in to the system and therefore require minimum updates or changes. Because other systems will send messages and data to the ICMS-Data Hub, and then acquire data and messages from it, there is no need to configure where to send data and when to acquire data. It is believed that this architecture will result in the ICMS-Data Hub being a system that requires minimal maintenance and operation. Figure 5 illustrates the interactions of the Data Hub with the other systems.

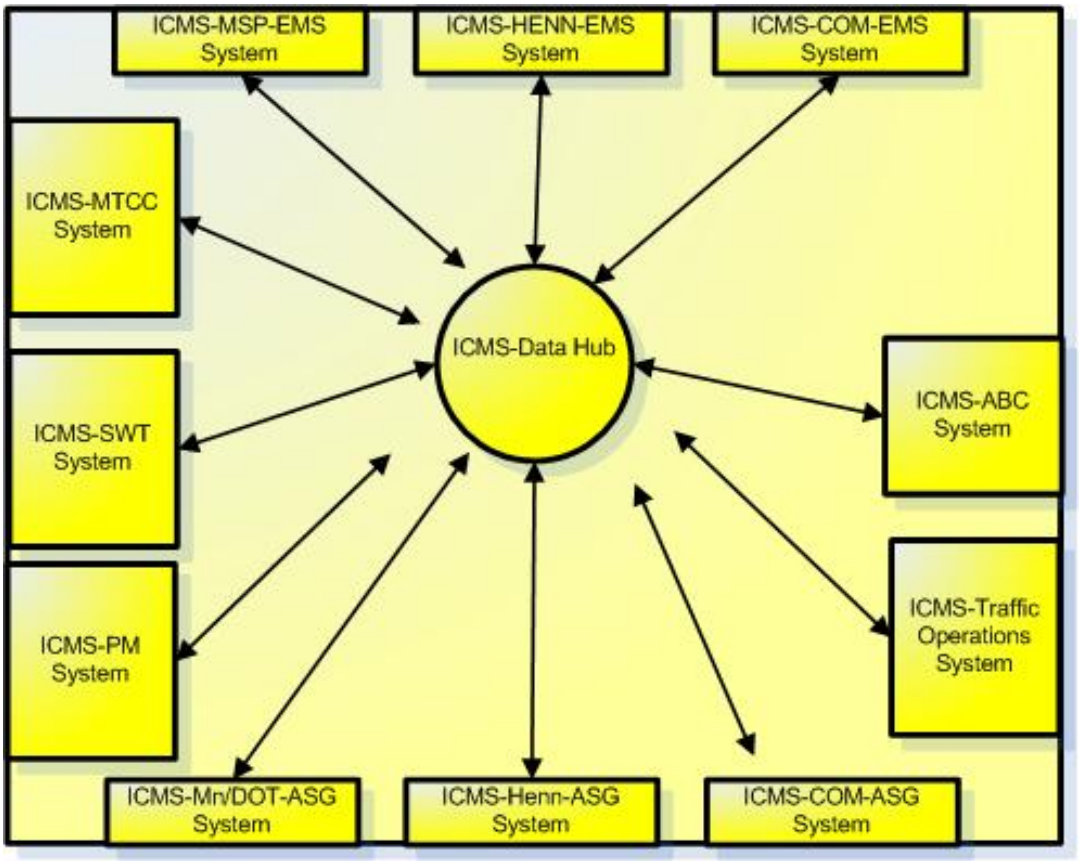


***Figure 5: Logical Architecture of the ICMS Data***

### 2.3.2 ICMS Enhancements to the Mn/DOT Traffic Operations System

The Mn/DOT Traffic Operations System, housed at the RTMC operates four primary components (traveler information system, a field device control / traffic management system, a condition reporting system, and a video switch).

Three of these primary components in the Mn/DOT Traffic Operations Center will be enhanced to expand the functionality to support the ICM needs. Collectively, these enhancements are referred to as ICMS-Traffic Operations.

The current function and planned enhancements of the three primary components are summarized as follows:

- ***The Integrated Roadway Information System (IRIS).*** The IRIS system provides device control of traffic management devices from within the RTMC (e.g. DMS, CCTV, ramp meter, and loop detector monitoring). The ICMS enhancements will expand the IRIS system to include arterial and transit data in to polling and display to operators, as well as expanded control of additional field equipment at designated locations along freeways and arterials, and transit travel time and incident information.

- ***The Condition Reporting System (CRS).*** The Mn/DOT condition reporting system allows manual entry and stores event descriptions of crashes, closures, and planned construction. The ICMS enhancements to the system will expand coverage to include arterials and transit incident and event data.

- ***511-Statewide Traveler Information System.*** The traveler information system inside the Operations Center currently operates telephone, Internet, and mobile device dissemination of freeway traffic and incident data. The ICMS enhancements will expand the traveler information system to include dissemination of arterial and transit data, as well as a holistic corridor-wide perspective.

In summary, the ICMS Enhancements to the Mn/DOT Traffic Operations System will:

- Send data to and receive data from the ICMS Data Hub,
- Control field devices that include DMS, CCTV, ramp meters and variable speed limit signs,
- Generate and disseminate travel information messages through telephone, Internet and email using the data from the ICMS Data Hub.

Figure 6 illustrates the logical architecture of the ICMS-Traffic Operations System.

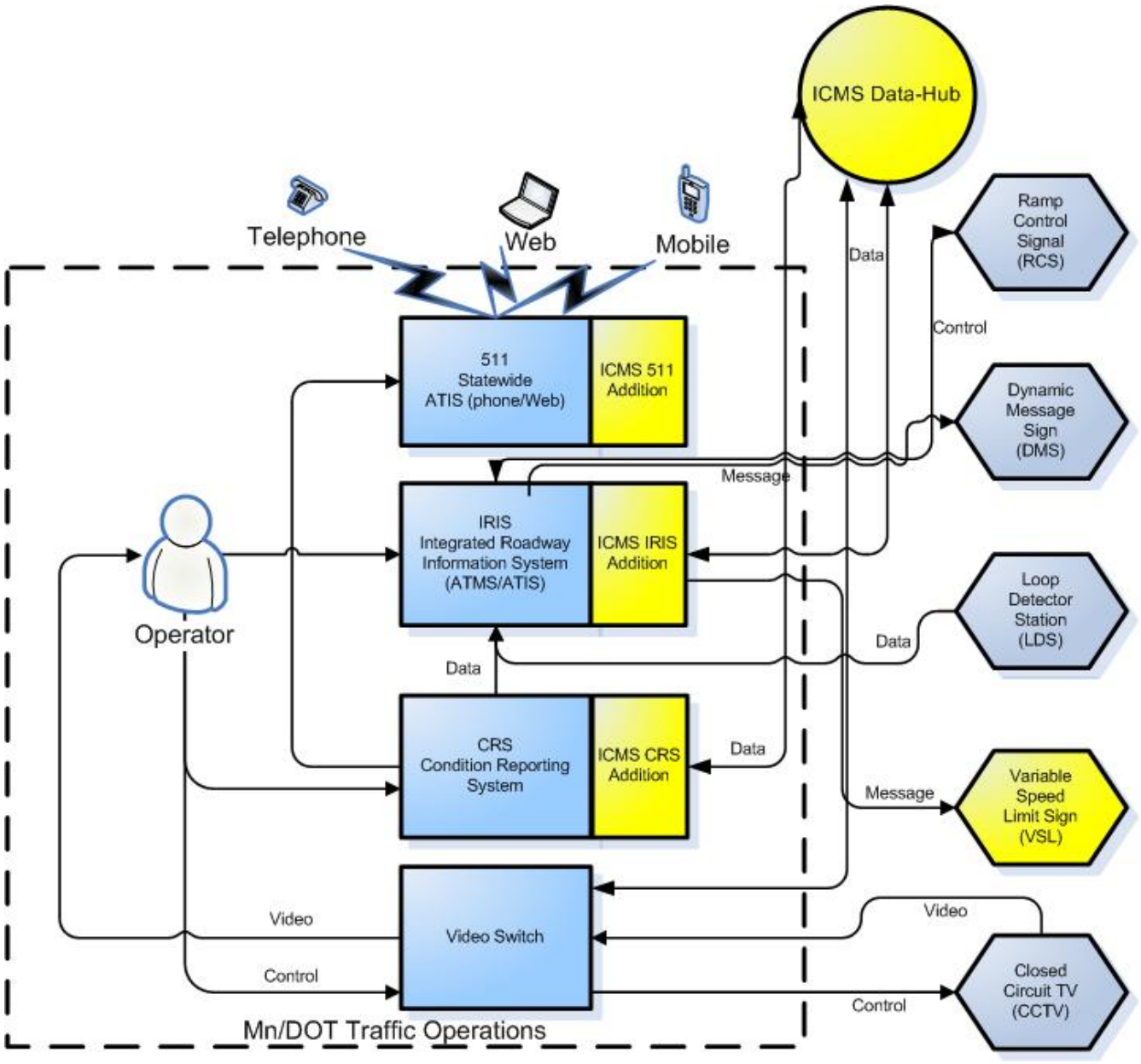


***Figure 6: Logical Architecture of ICMS-Traffic Operations***

### 2.3.3 ICMS Enhancements to the Mn/DOT Arterial Signals Group

The Mn/DOT Arterial Signals Group times and operates the signals along Highway 55 and Highway 7, within the corridor. The ICMS will enhance the functionality of the Mn/DOT ASG to include more real-time signal timing plan capabilities. In addition, the ICMS will expand the Mn/DOT ASG to measure and report the arterial travel times along Highway 55 and Highway 7.

The ICMS enhancements to the ASG (ICMS-Mn/DOT-ASG System) will include an interface to send arterial travel times to the ICMS Data Hub, an interface to receive data from the ICMS-Data Hub, and an interface to the field devices to implement timing plan changes. The logical architecture of the ICMS-Mn/DOT-ASG System is illustrated in Figure 7.

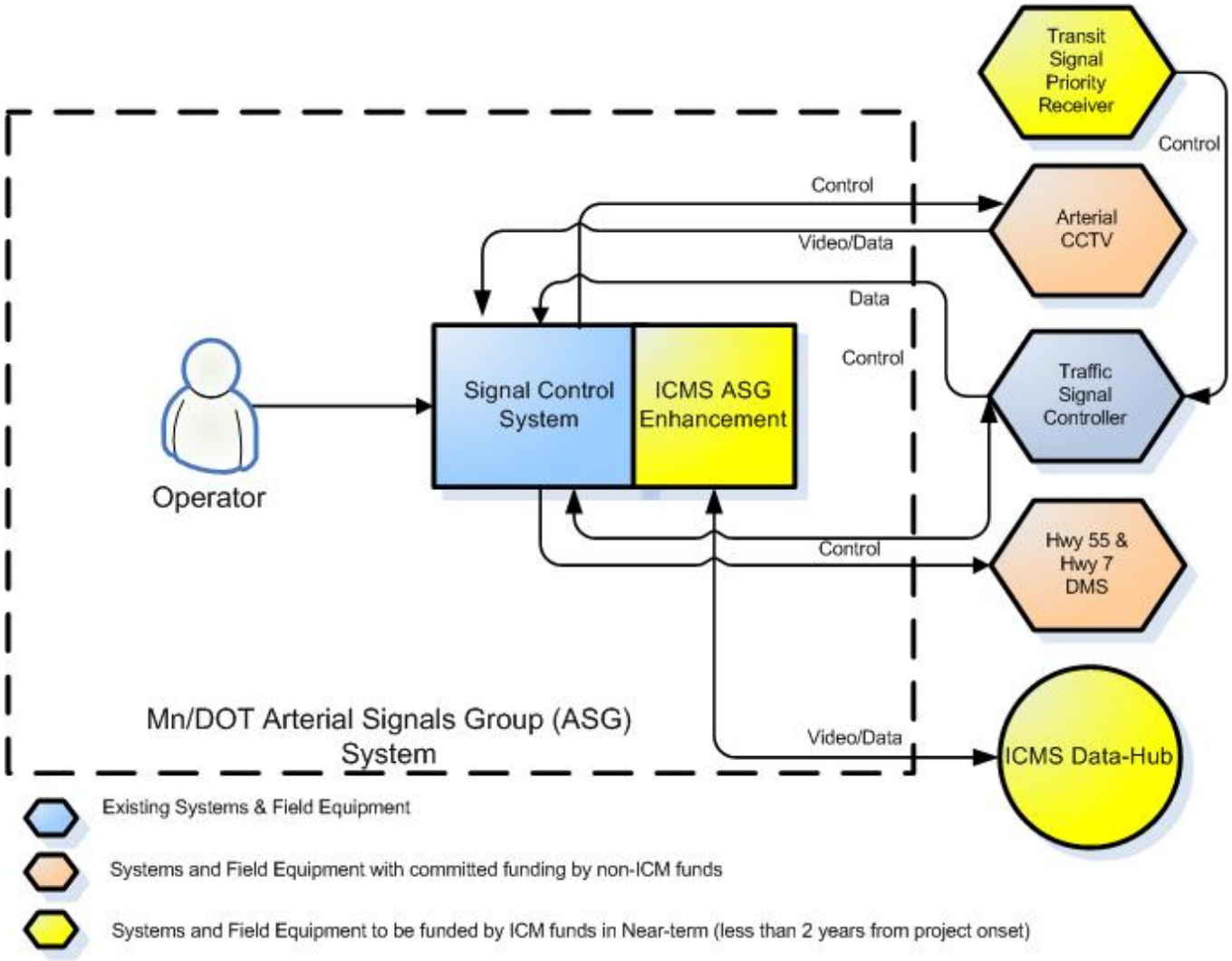


***Figure 7: Logical Architecture of ICMS-Mn/DOT-ASG***

### 2.3.4 ICMS Enhancements to the Metro Transit Control Center System

The Metro Transit Control Center provides control and communication to the Metro Transit operated buses on the corridor. The MTCC is able to communicate with buses and operates several information dissemination systems to relay messages to travelers (including a phone system, next bus arrival signs, and a transit trip planner website. The ICMS will enhance the functionality of the MTCC (ICMS-MTCC System) to send data to the ICMS-Data Hub, acquire data from the ICMS-Data Hub, perform additional data collection and dissemination at park-and-ride facilities, operate transit signal priority at key park-and-ride exits, and to offer internet access to riders.

The logical architecture of the ICMS-MTCC System is illustrated in Figure 8 below.

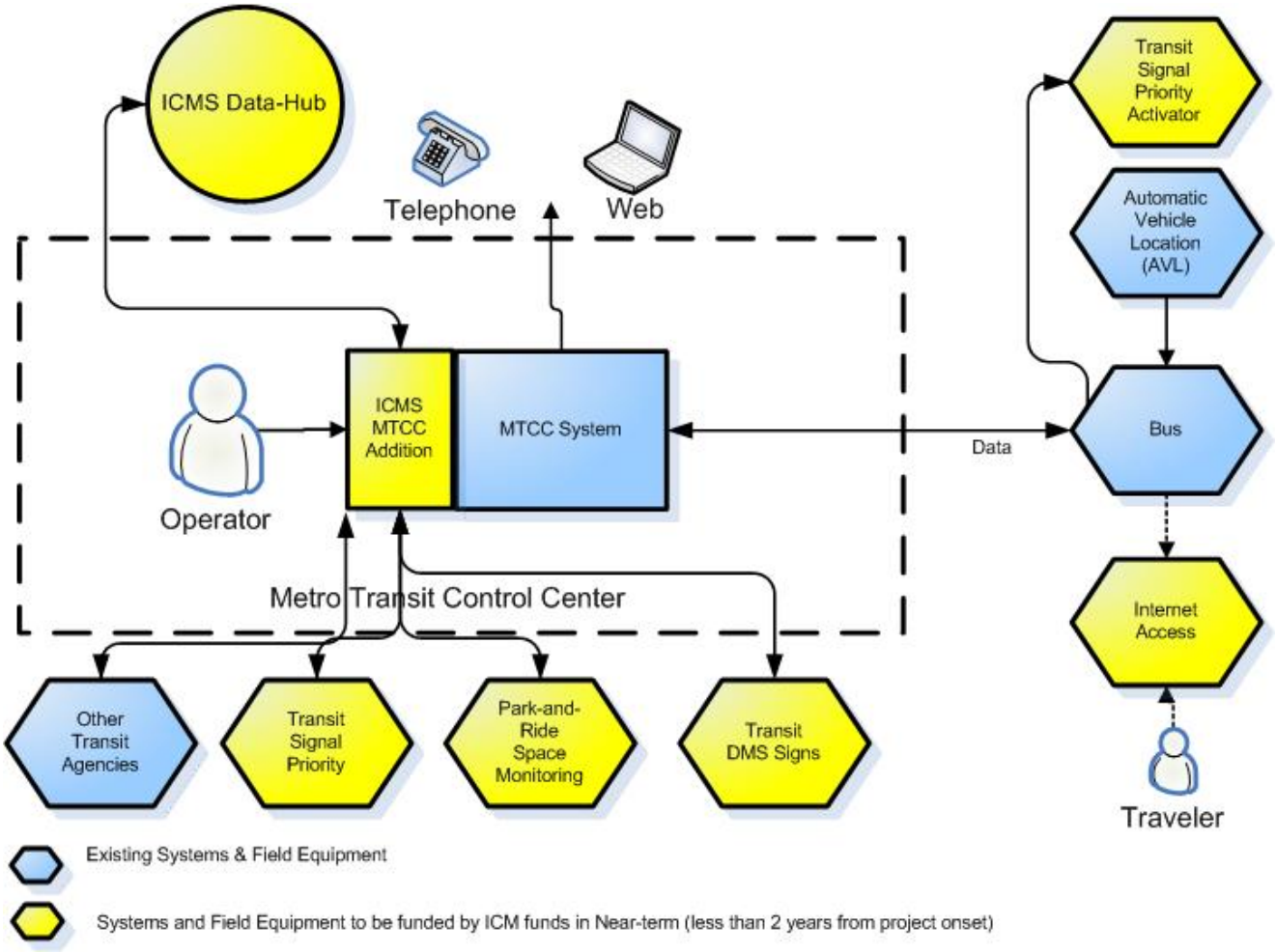


***Figure 8: Logical Architecture of ICMS-MTCC***

### 2.3.5 ICMS Enhancements to the SouthWest Transit Center

SouthWest Transit service differs from Metro Transit service in that SouthWest Transit provides commuter service from communities to the Southwest of the metro area without regular stops along the corridor. Therefore, SouthWest Transit is a user of the I-394 Corridor, but does not have scheduled passenger pickups along the corridor. Also, SouthWest Transit is a key user of the I-394 ICMS because they have the option to avoid I-394 entirely during incidents (as they have no scheduled pickups). The ICMS will enhance the functionality of the SouthWest Transit dispatch center by acquiring information describing incidents and travel times along the corridor and displaying this information to dispatchers. The ICMS SouthWest Transit enhancements are illustrated in the ICMS-SWT System logical architecture, illustrated below.

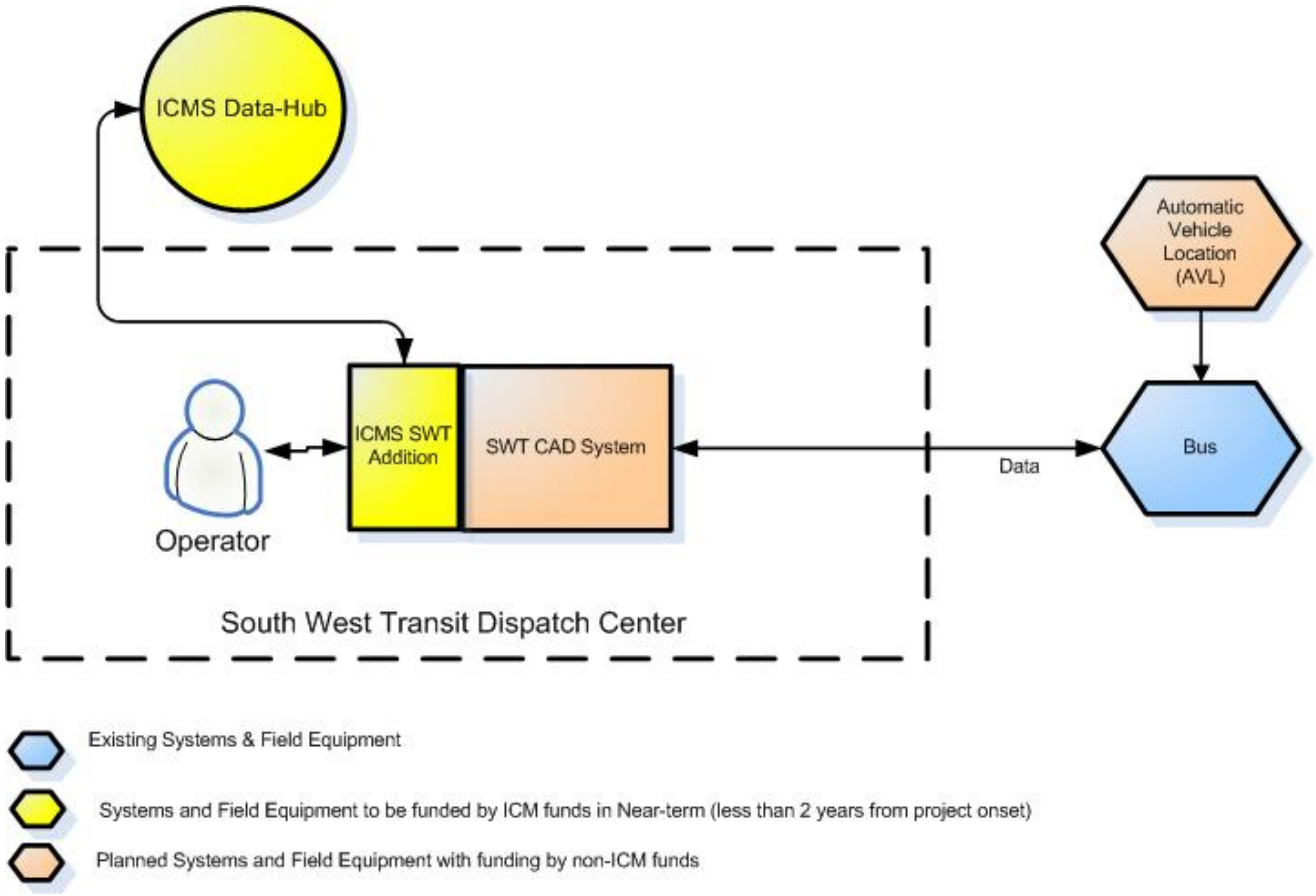


***Figure 9: Logical Architecture of ICMS-SWT***

### 2.3.6 ICMS Enhancements to the Plymouth Metrolink Dispatch

Plymouth Metrolink offers transit service primarily from the western suburbs to Minneapolis. Plymouth Metrolink picks up passengers at Park-and-Ride lots throughout the corridor. The ICMS will enhance the functionality of the Plymouth Metrolink dispatch center by adding the functionality to acquire data and information describing incidents and travel times along the corridor and displaying this information to dispatchers. The ICMS Plymouth Metrolink Transit enhancements (ICMS-PM System) are illustrated by the logical architecture of the ICMS-PM System below.

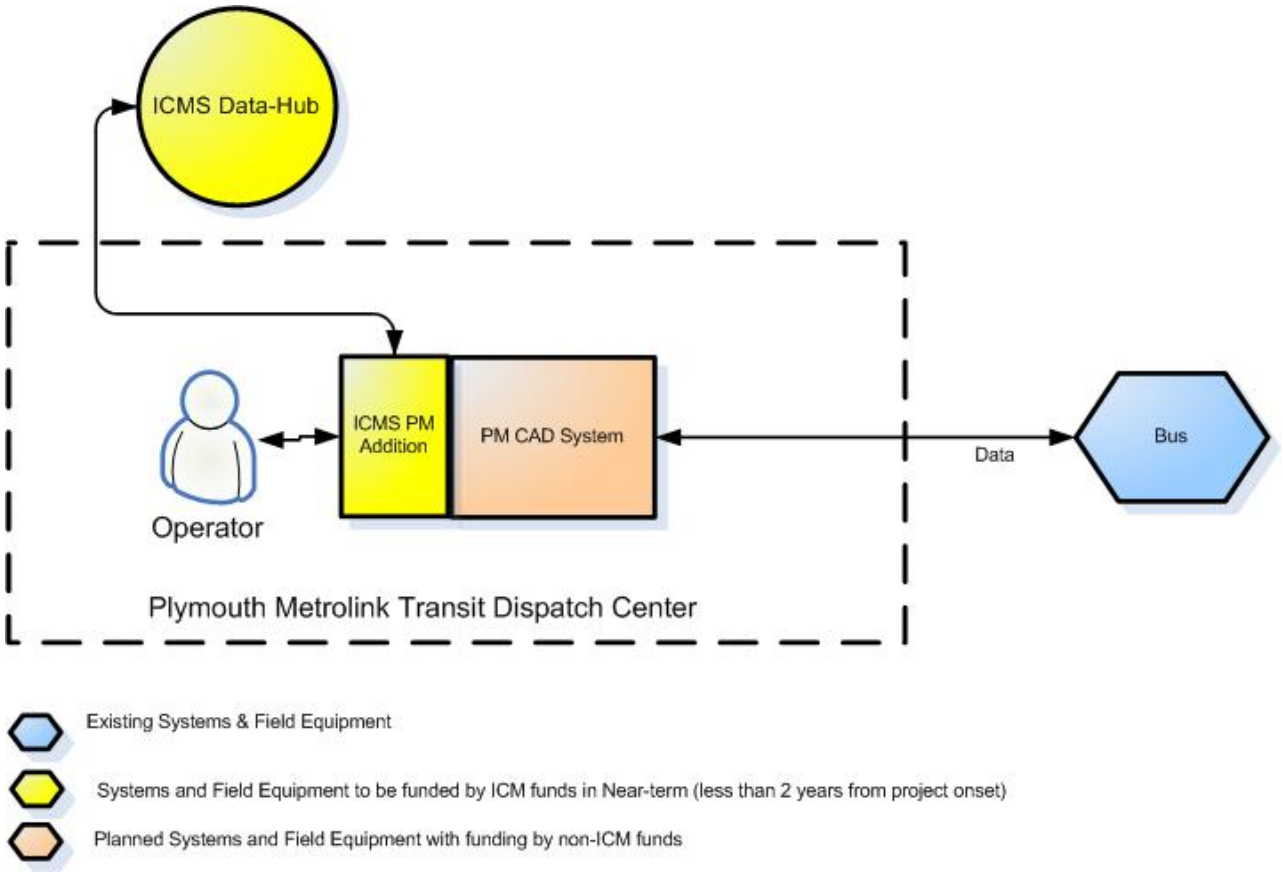


***Figure 10: Logical Architecture of ICMS-PM***

### 2.3.7 ICMS Enhancements to the A,B,C Garages

The A,B,C Garages are located at the Eastern-most edge of the I-394 ICM Corridor and provide considerable parking opportunities for commuters with direct access from the I-394 Freeway in to the garage. The ICMS Enhancements to the ABC Garage (ICMS ABC System will acquire data from the ICMS-Data Hub about incidents, events, and traffic on the corridor; disseminate information to travelers through kiosks in the garage, and allow operators to close the exit to I-394 at times when the freeway will back up in to the garage. Figure 11 below presents the logical architecture of the ICMS-ABC System.

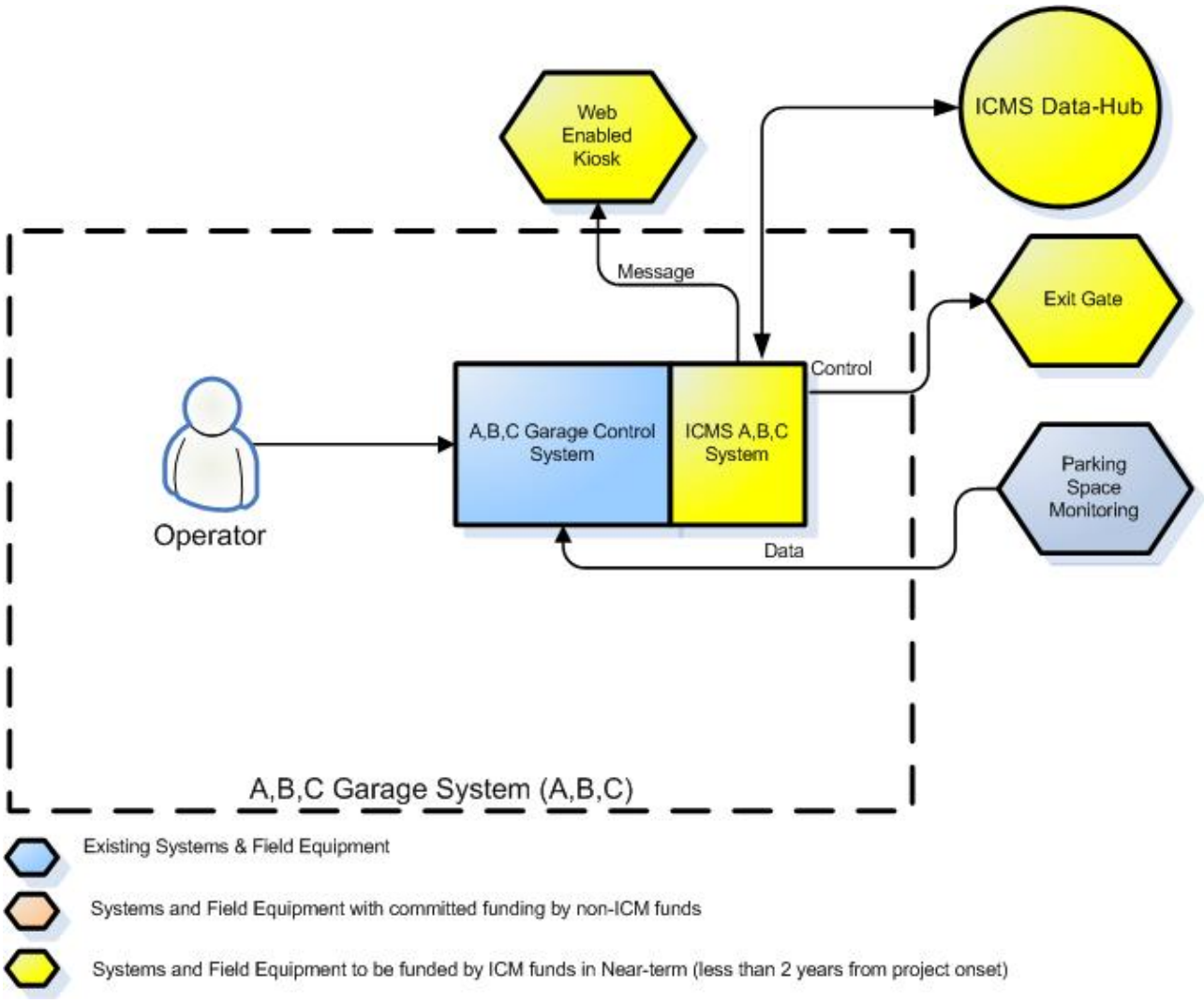


***Figure 11: Logical Architecture of ICMS-ABC***

### 2.3.8 ICMS Enhancements to the Minnesota State Patrol Emergency Management

The Minnesota State Patrol Emergency Management System operators receive reports of incidents and crashes and dispatch response teams to the scene. The ICMS will enhance the MSP-EMS (ICMS-MSP-EMS System) to push incident descriptions to the ICMS-Data Hub such that other ICMS Systems can access incident reports. Figure 12 illustrates the logical architecture of the ICMS-MSP-EMS System.

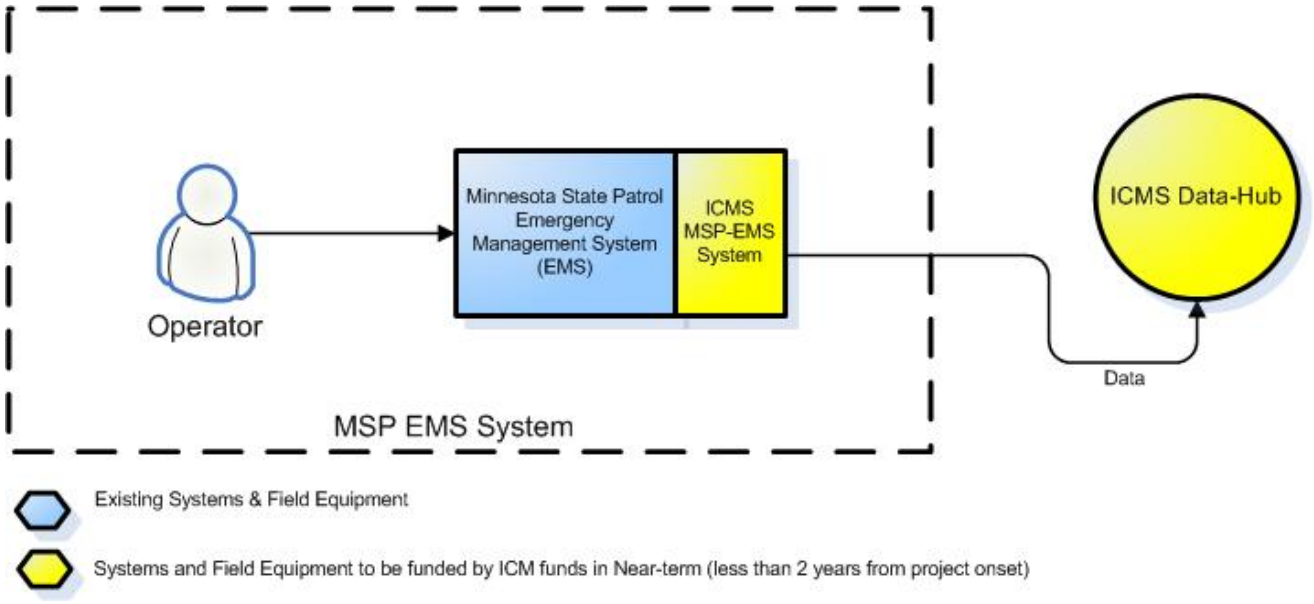


***Figure 12: Logical Architecture of ICMS-MSP-EMS***

### 2.3.9 ICMS Enhancements to the Hennepin County Emergency Management

The Hennepin County Emergency Management System EMS operators receive reports of incidents and crashes and dispatch response teams to the scene. The ICMS will enhance the HENN-EMS (ICMS-HENN-EMS System) to push incident descriptions to the ICMS-Data Hub such that other ICMS Systems can access incident reports, and to acquire incident reports from the ICMS-Data Hub that have been reported by other agencies' systems. Figure 13 illustrates the logical architecture of the ICMS-HENN-EMS System.

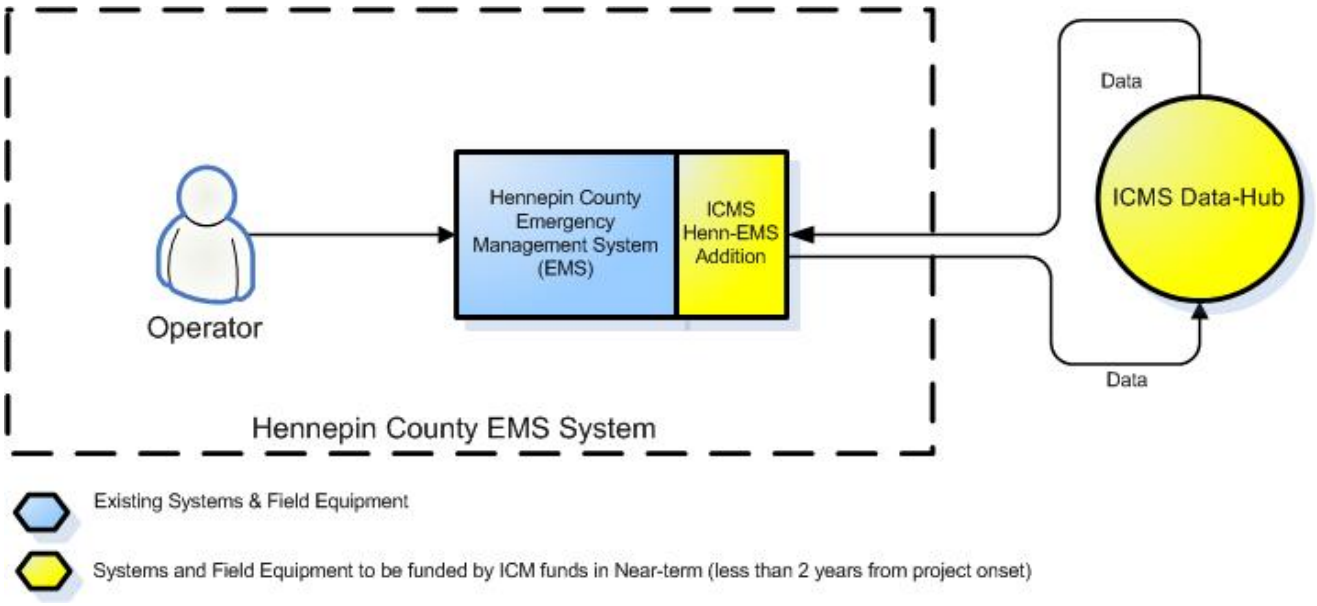


***Figure 13: Logical Architecture of ICMS-HENN-EMS***

### 2.3.10 ICMS Enhancements to the City of Minneapolis Emergency Management

The City of Minneapolis Emergency Management System operators receive reports of incidents and crashes and dispatch response teams to the scene. The ICMS will enhance the COM-EMS (ICMS-COM-EMS System) to push incident descriptions to the ICMS-Data Hub such that other ICMS Systems can access incident reports, and to acquire incident reports from the ICMS-Data Hub that have been reported by other agencies' systems. Figure 14 illustrates the logical architecture of the ICMS-COM-EMS System.

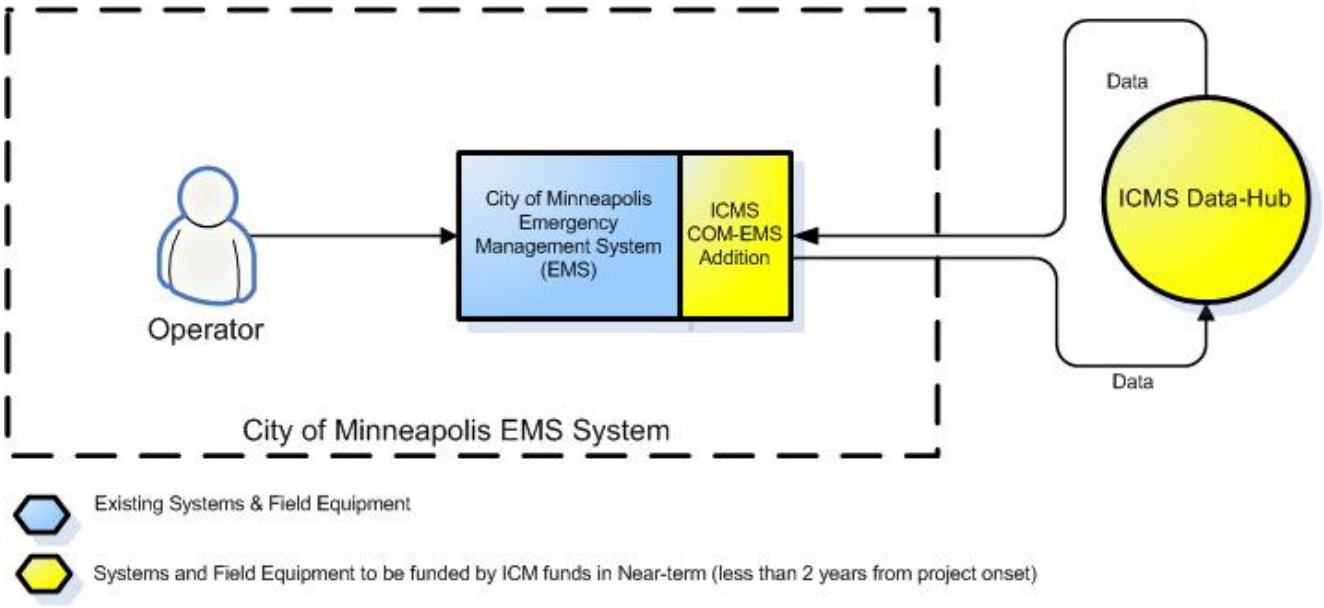


***Figure 14: Logical Architecture of ICMS-COM-EMS***

### 2.3.11 ICMS Enhancements to the City of Minneapolis Arterial Signal Control

The City of Minneapolis Arterial Signals Group operates traffic signal controllers for City operated intersections along the corridor, and in downtown Minneapolis. The City of Minneapolis also currently controls several DMS and CCTV cameras in downtown Minneapolis. While these are not technically on the corridor, they play a role in responding to incidents on the corridor. Figure 15 illustrates the logical architecture of the ICMS-COM-ASG System.

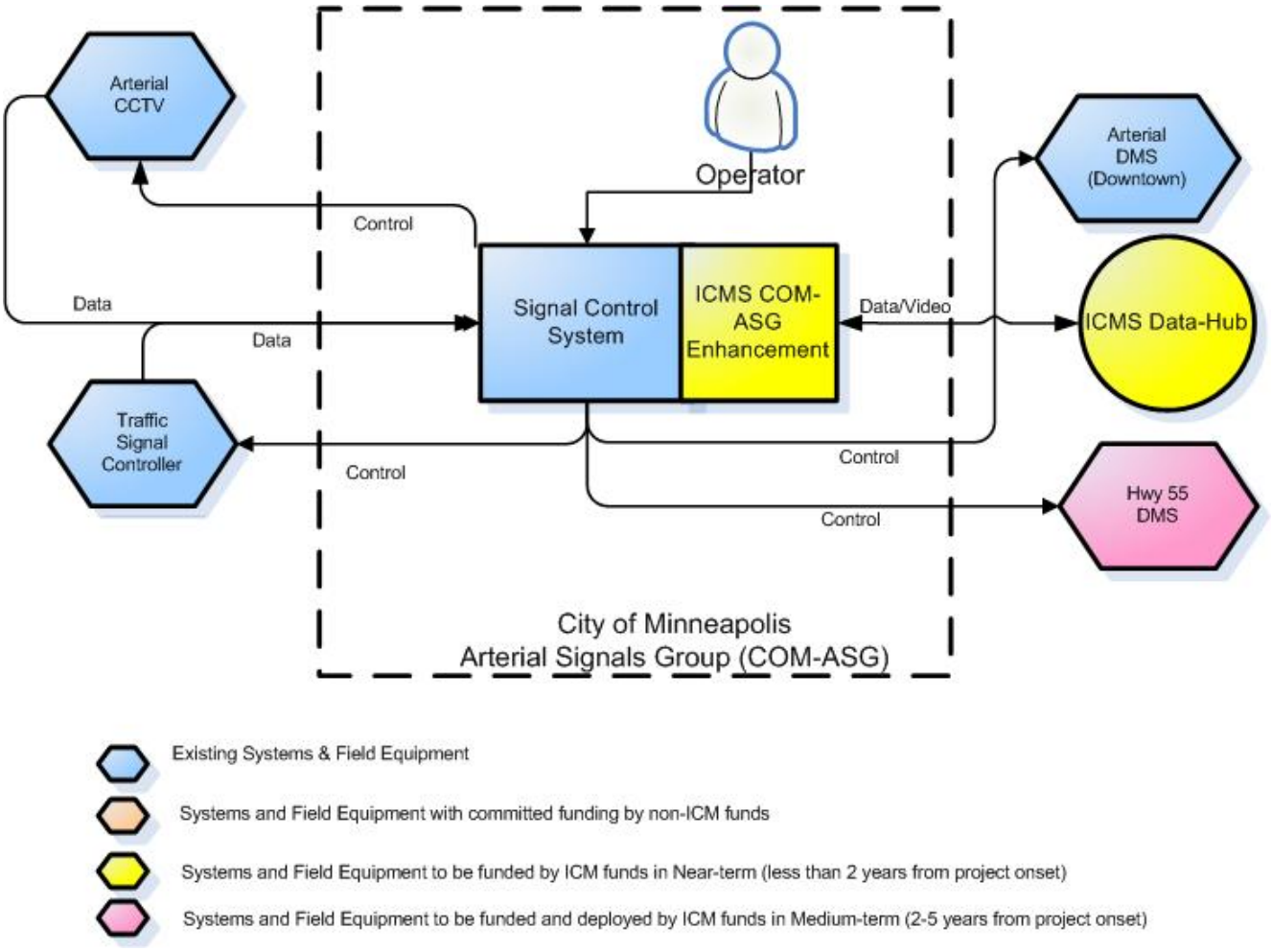


***Figure 15: Logical Architecture of ICMS-COM-ASG***

### 2.3.12 ICMS Enhancements to the Hennepin County Arterial Signal Control

The Hennepin County Arterial Signals Group operates traffic signal controllers for County operated intersections along the corridor. Enhancements to the Hennepin County ASG (ICMS-HENN-ASG System) will acquire data from the ICMS-Data Hub and display data to operators. Figure 16 illustrates the logical architecture of the ICMS-COM-ASG System.

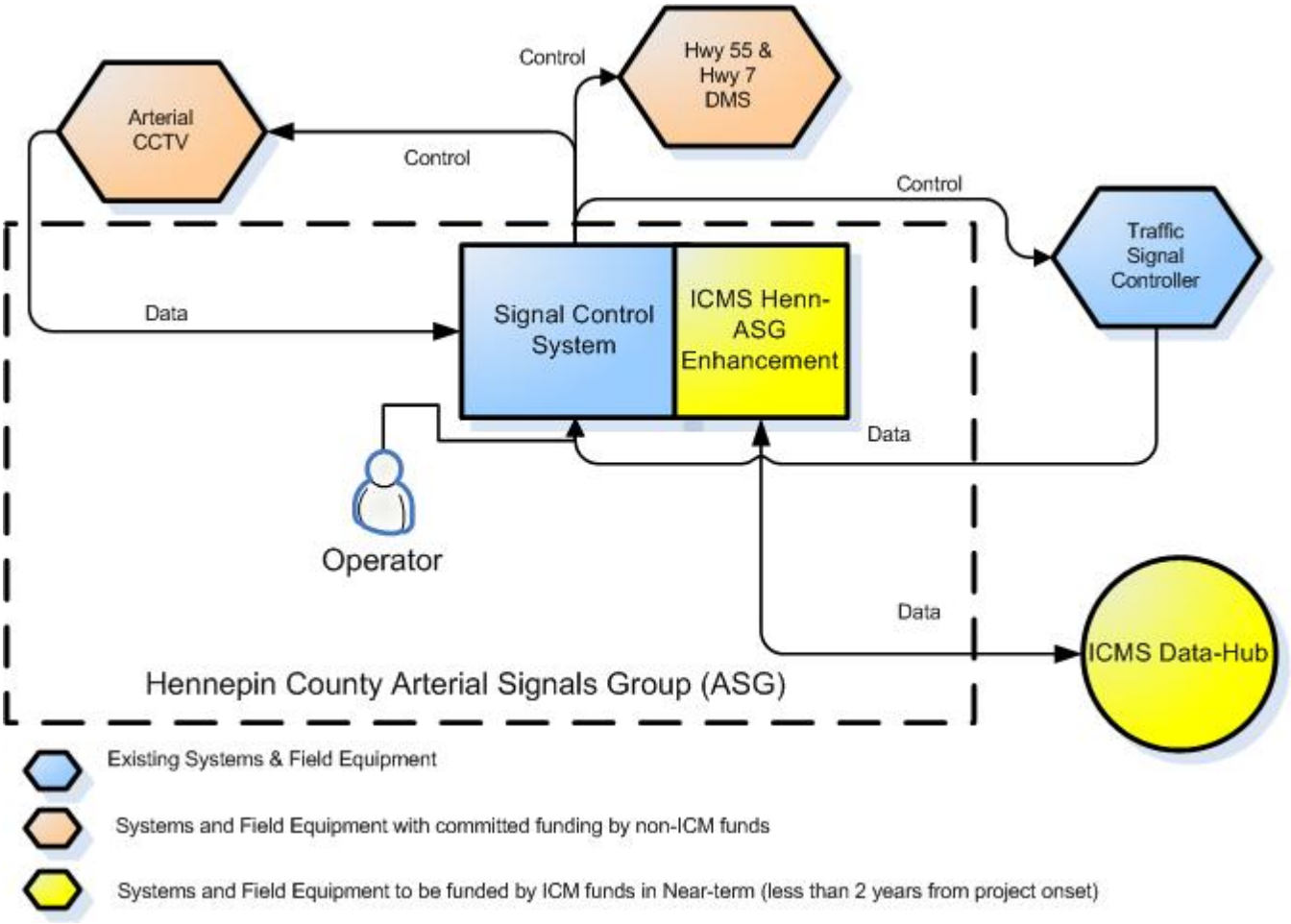


***Figure 16: Logical Architecture of ICMS-HENN-ASG***

## 2.4 System Modes and States

The ICMS must operate in a variety of modes (or states) to ensure that the system meets the operational, training, and redundancy needs of the ICM stakeholders. This section describes the various modes that shall be supported by the ICMS.

***Normal Operations Mode*** – Normal operations mode will be the mode in which the system operates the majority of the time. Operators will be able to interact with the system, the system will be sending and receiving data and messages among the various subsystems, and the subsystems will be interfacing with external devices.

***Partial Operations Mode –*** The architecture of the I-394 ICMS is such that as long as the ICMS-Data Hub is operational, the system can operate with as many operational subsystems that are available. For example, if the ICMS-HENN-ASG is off-line for any reason, the remainder of the systems can function. Some Systems have requirements for sending periodic messages to inform other systems that they are operational. The partial operations mode will also enable portions of the system to be developed and implemented over time.

***Start-up Mode*** – Start up mode will be used whenever a subsystem is brought off-line or restarted for any reason. During start-up mode, the ICMS-Data Hub will post messages that no information is available until such time that current data is received. Similarly, other subsystems will not send messages until the next scheduled data collection occurs.

***Failure Mode*** – The ICMS (or any subsystem) shall enter failure mode if the system loses connection to the Internet or in the event that connection to a field device or to the Data Hub is lost. During Failure Mode, the subsystems shall be configured to notify an administrator in some manner. There shall be a checklist that the administrator reviews before adjusting the ICMS from Failure Mode to Normal Operations Mode.

## 2.5 Major System Conditions

The ICMS shall operate during various conditions. The scenarios presented later in this section describe operational scenarios for situations that involve one or more of these conditions. The follow summaries describe typical conditions for the I-394 Corridor that were considered when developing the requirements.

***Inclement Weather Conditions*** – Inclement weather conditions cause slower traffic movements and therefore increased gridlock. During inclement weather conditions, the risk of incidents is increased. Inclement weather may involve limited visibility, snow or ice reducing traction, extreme cold temperatures and high winds. The impacts of these conditions could impair surveillance through reduced visibility, hinder traffic detection, and restrict capacity.

***Non-recurring Congestion*** **-** Non-recurring congestion is typically the result of incidents. Because the network operates near capacity, any incident that restricts flow on a route can create serious levels of congestion for one or more routes. During non-recurring congestion, often travelers leave their normal route and are unfamiliar with the route they are traveling.

***Special Planned Events and Construction*** **-** The corridor hosts several event venues such as a baseball stadium, basketball arena, is a feeder route to the State Fair, and experiences road construction and maintenance activities. Therefore, the ICMS must operate during conditions of planned events. During planned events, the ICMS strategies will actually begin prior to the onset of the event, and will include preparations such as the designation of additional transit parking. The role of the ICMS will be to support advance information dissemination as well as real-time dissemination.

***Recurring Congestion*** **–** The I-394 Corridor experiences recurring congestion during daily peak periods. This congestion is predicted, although the impacts of the congestion (i.e. how bad it will be) are determined by many factors, including weather, whether school is in session, and roadwork activities of neighboring roads).

***Normal Conditions*** **–** The majority of the time, the I-394 Corridor will operate under normal operating conditions. During these times, the corridor will experience free flow speeds and minimal waits when moving from one road to another. The ICMS will primarily perform the role of informing travelers of conditions during these conditions.

## *2.6 Major System Constraints*

The primary constraints on the ICMS will be the existing legacy systems that are not proposed to be changed as part of this project. These will apply a constraint to the ICMS because any interfaces with these systems are fixed. If a change is made to a an existing legacy system the ICMS functions will need to be reviewed before a change is implemented to ensure the system will still function as designed.

## *2.7 User Characteristics*

The characteristics of the users of the ICMS are important to understand and document in order that the system can be designed and developed to support the user needs. The following users (defined with characteristics) are envisioned for the ICMS:

***Agency Operators*** **–** The Mn/DOT Traffic Operations system, Mn/DOT Arterial Signal Group, A,B,C Garages, City of Minneapolis Arterial Signal Group, and Hennepin County Arterial Signals Group will all have agency operators of the ICMS. In addition, the Mn/DOT Traffic Operations operators will have access to the administrator portions of

the ICMS Data-Hub. Agency operators shall all be trained to use the ICMS subsystem(s) that they will use. In addition, operators will be comfortable using Internet tools and comfortable with viewing data in spreadsheet and/or database formats.

***Administrators*** – There are several settings in the ICMS that the requirements dictate shall be configurable by administrators using the administrator interface. These administrators are not expected to be able to edit software code, but rather will have some form of an administrator user interface that allows them to modify settings.

***Traveling Public –*** The traveling public will be a user of the ICMS primarily as a consumer of data. The ICMS, and related systems need to present information in a coordinated, and not confusing manner to the traveling public. Information dissemination systems should be co-branded, coordinated, and shall not contradict each other.

## 2.8 Assumptions and Dependencies

There were a number of assumptions made while drafting the ICMS requirements. These assumptions are summarized here:

- The existing practices of the RTMC do not allow agencies outside Mn/DOT to take control of cameras operated by Mn/DOT, with the exception of Minnesota State Patrol who are collocated in the RTMC and have control of cameras. Video feeds will be shared but pan/tilt/zoom control of cameras will not be offered to other agencies;

- Each member agency of the ICM initiative has stepped through the scenarios presented in the Concept of Operations and has taken part in a workshop to discuss ownership and maintenance of ICM systems and equipment. Each agency has accepted the role of maintaining the equipment deployed by their agency;

- Each agency recognizes that their equipment or systems are playing a critical role in the overall ICM vision, and should they allow operations to lapse it will impact their partner agencies.

### 2.8.1 External Requirements

As noted earlier in this document, the success of the ICMS depends upon existing system and systems planned for deployment with funding from outside (non-ICM) sources. Each of these systems or field devices is critical to the success of the ICM initiative and is needed for the ICMS to operate properly. Therefore, these systems are considered External Requirements. In other words, if any of these systems are decided to be terminated or changed in any way, the ICMS requirements and scenarios should be

consulted to determine if the change will impact the performance of the ICMS. These External Requirements (existing and planned deployments) are described as follows:

***External Requirements – Existing Systems and Devices***

- Mn/DOT shall operate a Regional Transportation Management Center capable of communicating with loop sensors, controlling DMS signs, controlling CCTV cameras, and controlling ramp meters;
- Mn/DOT shall operate I-394 surveillance coverage through CCTV cameras;
- Mn/DOT shall operate DMS located along the entire extent of I-394;
- Mn/DOT shall continue to operate DMS located at limited locations along arterials in the corridor;
- Mn/DOT shall continue to operate High Occupancy Toll (HOT) lanes along I-394 with variable pricing (congestion pricing) as is currently operated now;
- Mn/DOT shall operate ramp meters at every ramp on the corridor;
- Mn/DOT shall operate actuated traffic signal controllers on State operated signal within the corridor;
- Mn/DOT shall operate an information dissemination system that includes an interactive 511 phone system, and Internet display system. The information dissemination system shall show conditions and/or performance of freeways, arterials and transit at a level that would support travelers in determining which route and/or mode is the best option. As noted below, Metro Transit will operate a more detailed transit trip planning system with additional details about trip planning and parking options. The Mn/DOT information dissemination system will serve as a portal, linking visitors to the transit trip planner system, therefore offering one-stop-shop for visitors seeking travel information;
- Metro Transit shall operate a metro transit control center capable of monitoring bus location, reporting bus arrival times.
- Metro Transit shall operate a transit trip planning system, offering trip planning services over the Internet. The trip planner shall be linked from the Mn/DOT information dissemination system as well as have it's own direct URL;
- Each Emergency Response Provider shall operate a computer aided dispatch systems operated by each emergency response provider;
- Shared radio talk groups available to all responders along the corridor.
- City of Minneapolis shall operate actuated signal controllers on all city operated intersections on the corridor.
- Hennepin County shall operate actuated signal controllers on all county operated intersections on the corridor.

***External Requirements – Planned and Committed Systems***

- Mn/DOT shall disseminate freeway travel times on existing DMS on I-394;
- Mn/DOT shall perform advanced signal coordination and retiming of the 30 signals along TH 55;
- Mn/DOT shall perform advanced signal coordination and retiming of the 23 signals along TH 7;

- Mn/DOT shall perform advanced signal coordination and retiming of the 28 signalized intersections at junctions with I-394 (signals exist on North-South cross streets);
- Mn/DOT shall deploy approximately 44 CCTV cameras along Hwy 55 and Hwy 7;
- Mn/DOT shall deploy  4 DMS along Hwy 55 and Hwy 7
- Metro Transit shall implement bus arrival and departure real-time updates to the transit phone system.

## 2.9 Operational Scenarios

This subsection includes six different operational scenarios to illustrate how the ICM would assist in different situations.

### 2.9.1 Scenario #1: Major Incident in the AM Peak

***On a weekday morning about 7:30am, a serious crash occurs on eastbound I-394 just east of Hwy 100, between a truck and a passenger auto. The crash has caused serious injuries and is blocking all eastbound directional (inbound morning commute) lanes of travel for an estimated 90 minute clearance time.***

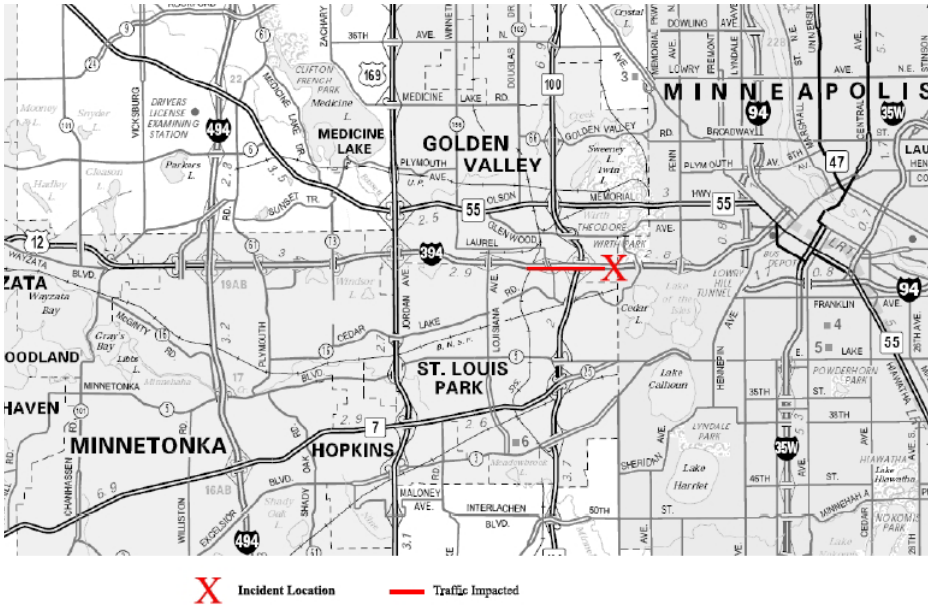


***Figure 17: Scenario 1 Illustration***

A passenger riding in a vehicle upstream of the crash has been stopped behind the crash and phones 911 to report the incident within minutes from the onset. A State Patrol dispatcher in the RTMC receives the 911 phone call and immediately creates an event in the CAD system, describing the event (location and impacts to traffic) and dispatches law enforcement and emergency services to the scene.

- Almost instantaneously, the ICMS Enhancement to the Minnesota State Patrol emergency management system (ICMS-MSP-EMS) sends a message to the ICMS-Data Hub conveying all the information contained in the CAD system to describe the event. As updates are entered into the MSP CAD system, these updates will also be

sent to the ICMS-Data Hub and will be appended to the event report stored in the ICMS Data Hub.

- The ICMS Enhancements to Mn/DOT Traffic Operations, Metro Transit Control Center, and Arterial Signal Groups at Mn/DOT, Hennepin County, and City of Minneapolis (ICMS Traffic Operations, ICMS-MTCC, ICMS-Mn/DOT ASG, ICMS, HENN-ASG, and ICMS-COM-ASG) are all set to acquire data from the ICMS-Data Hub frequently, and the next query will download the event description. As a result, each agency will view the incident within an estimated 1-3 minutes from the initial report.

- In addition to the traffic and transit response agencies, the ICMS Enhancements at Hennepin County EMS and City of Minneapolis EMS also acquire incident reports from the ICMS-Data Hub and have downloaded summaries of the incident within minutes.

- RTMC operators, after seeing the event icon, have adjusted nearby CCTV cameras to view and verify the crash. RTMC dispatchers have requested a Freeway Incident Response Safety Team (FIRST) truck to the scene for additional verification and mobile traffic management.

- The RTMC supervisor on duty has decided to open up the reversible lane (currently inbound HOV/HOT access only) to all inbound vehicles, in an attempt to flush traffic building upstream of the crash site. Remote access to the Mn/PASS facility allows this to happen within a minute, and travelers are notified by the Mn/PASS signs throughout the corridor.

- Accompanying the opening of the reversible lanes and the growing congestion due to the crash, an automated process posts variable speed limit messages of 45 MPH along I-394 to prepare vehicles for the likely slowdown and to prevent additional crashes.

- RTMC operators post messages on the Highway 7 DMS signs upstream of intersections with connector routes used by commuters to travel north in order to join I-394. The DMS messages warn of the crash on I-394 and advise travelers to remain on Hwy 7. As a result, the majority of travelers remain on Highway 7. RTMC operators post a similar message to DMS signs on Highway 55, and commuters generally stay on Highway 55, rather than diverting to I-394. Similar messages are posted on signs on the connector freeways (i.e. I-494, Hwy 169, and Hwy 100) advising of the crash and informing motorists to use Highway 55 or Highway 7 instead of I-394.

- Because the ICMS-Mn/DOT-ASG System has acquired the incident message, the Mn/DOT Arterial Signals group is informed of the incident of the event, and the signals group downloads flush plans to Highway 7 in order to accommodate the increased levels of traffic not diverting North at Highway 100. Monitoring traffic conditions on Highway 55 through CCTV and real-time traffic data, the Mn/DOT

Arterial Signals group decides not to adjust signal timing at this time as the signals are handling the additional volume with no delays.

- Because the ICMS-COM-ASG System has acquired the incident report from the ICMS-Data Hub, the city traffic group alters the signal timings on the local road that is the continuation of Highway 7 once it enters the city (Lake Street). The signal is now timed for maximum progression of inbound Highway 7, relieving the added volumes to the extent possible. City of Minneapolis traffic engineers are also monitoring downtown traffic volumes through CCTV to watch for other impacts of the backup.

- RTMC operators manually adjust several ramp meter rates using the RTMC software to maintain a steady flow along the freeway.

- Traffic operations personnel at Hennepin County, City of Minneapolis, and Mn/DOT have been sending traffic volume and signal timing information to the ICMS-Data Hub. Each system then also acquires the information from other agencies through the ICMS-Data Hub. This allows each agency to display a massive amount of traffic information to operators through an on-screen display, and this assists them in reaching decisions about the response to the incident.

- At the Metro Transit Control Center, the ICMS-MTCC System has acquired the incident report from the ICMS-Data Hub and now displays the crash at all the dispatchers' CAD stations. The opening of the reversible lanes has prevented an extensive queue from forming and the transit vehicles traveling along I-394 are experiencing minimal delays (however delays have not been eliminated). The ability of buses to use shoulders on freeways and High Occupancy Vehicle (HOV) bypass at the on-ramps has helped Metro Transit vehicles remain as close to schedule as possible.

- The Metro Transit ICMS-MTCC System has sent several messages to the ICMS-Data Hub since the incident, reporting transit travel times and arrival/departure information, as well as the available parking spaces at the park-and-ride lots.

- The ICMS-MTCC System is also informing transit riders of updated arrival/departure information using 'next departure signs' at bus stops, DMS signs at park-and-ride facilities describing the number of spaces available and transit travel times.

- The ICMS enhancements to the SouthWest Transit Dispatch Center have acquired the messages from the ICMS-Data Hub describing the incident and current response activities. Dispatchers are able to view the incident descriptions and they notice the growing delays on Highway 7 (as travelers are not moving to I-394). SouthWest Transit buses have been following a route taking them Northbound on I-494 and then Eastbound on I-394. Given that they have no passenger pickups within the corridor, they have advised all drivers to take an alternate route where they can benefit from shoulder access and experience fewer delays.

- The ICM Traffic Operations System has created messages specifically to announce the travel times on all routes and modes. These messages are being disseminated over the 511 phone system and public Internet system operated by Mn/DOT. Alternate travel times are presented for four routes/modes, including:
  - I-394 automobile travel is reporting longer travel times than normal,
  - Highway 7 is reporting longer travel times than normal,
  - Highway 55 is reporting typical travel times, and
  - Transit routes (benefiting from shoulder access, signal priority and meter bypasses) are operating with minimal delays overall.

  In addition, DMS signs throughout the corridor are posting travel time messages to keep travelers in the loop about their expected delays.

  This information, combined with reports of those park-and-ride facilities with excess capacity, has caused roughly 500 commuters to select transit, and caused 300 commuters to choose to delay their commute to work for 90 minutes while they telecommute at home.

- At the RTMC, a Radio Broadcaster is giving continuous traffic reports throughout the duration of the incident on local radio station KBEM 88.5 FM. Another RMTC operator is providing traffic information to other local radio stations and television stations through a shared 800 mHz radio channel.

- ***Scenario Event Closure & Return to Normal Operations***. The crash vehicles are towed and the area cleared within 90 minutes. The reversible lane is returned to normal status and the DMS messages terminated by RTMC staff. The ICMS-MSP-EMS System sent an update to the original incident message when the incident was cleared by patrol in the field, and the ICMS-Data Hub removed the incident from the post. Within minutes, each agency was informed that the incident was resolved (by no longer seeing the incident posted on the ICMS-Data Hub). The City and County returned all signal timings to their normal operational procedures. The ICM Management Team would be briefed on this event during the next meeting and the performance measurements presented by the ICM Program Manager for review and analysis.

***Scenario #1 Recap:***

***1. Scenario Management and Leadership***

The overall ICM management during Scenario #1 would be provided by the Mn/DOT RTMC Freeway Operations Team. On-site coordination of the incident response would be managed by the Minnesota State Patrol. On-site coordination of traffic management and recovery would be provided by the FIRST vehicle drivers. The closure of the event would be triggered by the State Patrol clearing the event, and then the Mn/DOT Freeway

Operations team would manage the incident wrap-up and eventually return all systems to normal.

### *2. Scenario Impacts on Corridor Goals and Objectives*

As a result of the ICM response procedures executed on this morning, the only major delays were experienced by those vehicles immediately behind the crash site. These vehicles were safely moved past the crash site as soon as the first emergency responders arrived. In total, 800 commuters altered their modes or departure times, and the remaining commuters arrived at their destinations (many altering their routes) within their buffer time, with the average delays being 3-5 minutes.

## 2.9.2 Scenario #2: Minor Traffic Incident

***On a weekday at about 4:30pm, a serious crash involving two cars with multiple serious injuries occurs on westbound I-394 between Hwy 100 and I-94 in the reversible HOT lanes currently running westbound, blocking those lanes with an estimated one hour clearance time.***

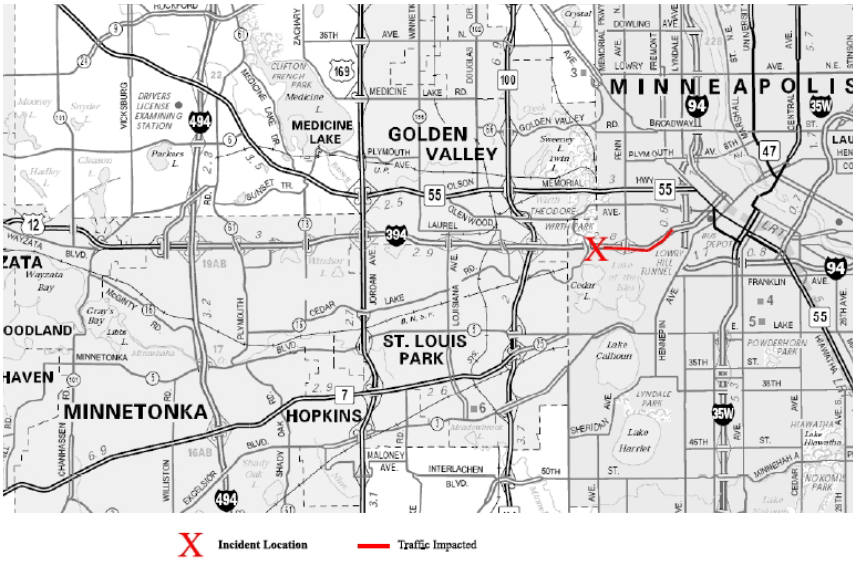


***Figure 18: Scenario 2 Illustration***

A State Patrol trooper regularly positioned on the HOT lanes to perform HOT enforcement has observed the crash from his post and immediately radios the report to the State Patrol dispatchers located in the RTMC. A State Patrol dispatcher in the RTMC creates an event in the CAD system, describing the event (location and impacts to traffic), and dispatches law enforcement and emergency services to the scene.

- Almost instantaneously, the ICMS-MSP-EMS System sends a message to the ICMS-Data Hub relaying the incident description from the MSP CAD system. The various traffic management, transit, and emergency response agencies ICMS enhancements acquire this incident report within minutes and all agencies have access to the information. Within seconds, the RTMC operators have adjusted nearby CCTV cameras to view and verify the crash.

- RTMC dispatchers immediately dispatch a FIRST truck to the entrance gate of the reversible HOT lanes in order to close the gate arms to the entrance ramps leading into the reversible lanes.

- The RTMC dispatchers (using the ICMS-Traffic Operations System) automatically posts variable speed limits at 40MPH to normalize traffic speeds and prevent future crashes.

- The RTMC posts messages on the Mn/PASS HOT signs westbound before the crash noting that the HOT lanes are closed. Beyond the crash, the westbound HOT lane of I-394 continues to operate using the congestion pricing scheme that has been in operation since 2004, adjusting prices according to congestion levels in the HOT lane.

- RTMC operators post messages on I-94 northbound and southbound approaching I-394 warning travelers of the crash on I-394. As a result, the majority of westbound traffic enters Highway 55 or continues on I-94 heading westbound. Messages are also posted on Highways 55 and 7 notifying travelers that I-394 is congested from downtown to Hwy 100.

- The ICMS Enhancement to the A,B,C Garage (ICMS-ABC) acquire the incident notification from the ICMS-Data Hub, and operators at the ABC Garage also receive an email from the Mn/PASS system about the event. Anticipating that traffic will back up into the garages, the operators proceed with closing the garage exits that lead directly to westbound I-394. In addition, kiosks located in the garages are displaying an updated traffic flow map, alerting travelers to the current conditions and describing the exit closure.

- The ICMS-ABC Garage sends a message to the ICMS-Data Hub describing that the garage exit on to I-394 is closed.

- The ICMS Enhancements to the City of Minneapolis Arterial Signals Group (ICMS-COM-ASG) acquires the incident notification as well as the notice that the A,B,C Garage exit is closed within minutes from the report. The ICMS-COM-ASG is able to display the incident (as well as traffic volume data from Hwy 55 and I-394 to the City traffic managers. Once familiar with the situation, the city operator alters the signal timings on several local roads to accommodate the expected influx of traffic as commuters use local roads because of the closure of the garage access to I-394.

- The Mn/DOT Arterial Signals group has acquired the incident report (as well as the report of the A,B,C Garage closure from the ICMS-Data Hub and the operator downloads outbound flush plans to both Highway 7 and Highway 55 to accommodate the increased levels of traffic normally on I-394. The signal timings on Highway 55 are set to accommodate the flow of travelers entering Hwy 169 southbound to join I-394 at a point where the congestion has cleared.

- At the Metro Transit Control Center, the ICMS-MTCC has acquired the incident information from the ICMS-Data Hub and now displays the crash at all the dispatchers' CAD stations. The buses will not be able to travel in the reversible HOT lane during the incident; and bus shoulder access is limited to only a portion of the westbound route. However, transit signal priority will support the buses as they exit

I-394 to drop riders at the park-and-ride and re-enter the freeway. The buses continue en-route and do experience delays similar to the average vehicle.

- SouthWest Transit operators are able to view the incident information because the ICMS-SWT has acquired the incident messages from the ICMS-Data Hub, and the dispatcher on duty selects to route their outbound vehicles away from I-394. The delays are not expected to be extensive, however the additional mileage will increase the trip time and therefore passengers are notified. Most passengers are able to call home and arrange other options to pick up children at day care or to postpone dinner plans.

- The ICMS Plymouth Transit system (ICMS-PM) has acquired the incident notification from the ICMS-Data Hubis notified of the event. Their buses typically follow a route that utilizes a combination of I-394 and Hwy 55. Today, they have diverted their buses to solely use Hwy 55. There is increased traffic on Hwy 55 and delays are resulting. However, the flush timing plans as well as the transit signal priority (activated once the buses became late) have recovered much of the delays and most buses reach their destination nearly on time.

- The ICM integrated travel information system has been informing travelers of the crash through 511, the Internet, and pushed messages to phones, blackberries and pagers. Alternate travel times are presented for four routes/modes, including:
  - I-394 automobile travel is reporting longer travel times than normal until Xenia Avenue,
  - Highway 7 is reporting typical travel times,
  - Highway 55 is reporting typical travel times, and
  - Transit routes (benefiting from shoulder access, signal priority and meter bypasses) are operating nearly on-time.

  This information, combined with parking ramp kiosks and HAR advisories has caused roughly 400 commuters to delay their departure from the ABC garages for approximately 30 minutes, while they shop or enjoy a snack or continue working. Nearly 2,000 commuters have exited the parking garages onto local streets and proceed to Hwy 55 or Hwy 7.

- ***Scenario Event Closure & Return to Normal Operations***. The crash vehicles are towed and the area cleared within 45 minutes. The reversible lane is returned to normal status and the DMS messages terminated by RTMC staff. The ICMS-MSP-EMS System sent an update to the original incident message when the incident was cleared by patrol in the field, and the ICMS-Data Hub removed the incident from the post. Within minutes, each agency was informed that the incident was resolved (by no longer seeing the incident posted on the ICMS-Data Hub).Each agency restores signal timings and DMS to their normal operational procedures.

***Scenario #2 Recap:***

### *1. Scenario Management and Leadership*

The overall ICM management during Scenario #2 would be provided by the Mn/DOT RTMC Freeway Operations Team. On-site coordination of the incident response would be managed by the Minnesota State Patrol. On-site coordination of traffic management and recovery would be provided by the FIRST vehicle drivers. The closure of the event would be triggered by the State Patrol clearing the event, and then the Mn/DOT Freeway Operations team would manage the incident wrap-up and eventually return all systems to normal. The ICM Management Team would be briefed on this event during the next meeting and the performance measurements presented by the ICM Program Manager for review and analysis.

### *2. Scenario Impacts on Corridor Goals and Objectives*

As a result of the ICM response procedures executed on this evening peak period, the only major delays were experienced by those vehicles who continued to enter I-394, however with the amount of traffic diverted the delays were not major. While some transit riders and commuters who diverted their routes experienced delays, they were notified of the likely delays in time to call friends and spouses and make alternate arrangements for evening pickups.

### 2.9.3 Scenario #3: Major Arterial Highway Incident

***A crash occurs on eastbound Hwy 55 between Winnetka Blvd. and Glenwood Avenue on a weekday at 7:45am, blocking all eastbound travel lanes for an estimated 45 minutes.***

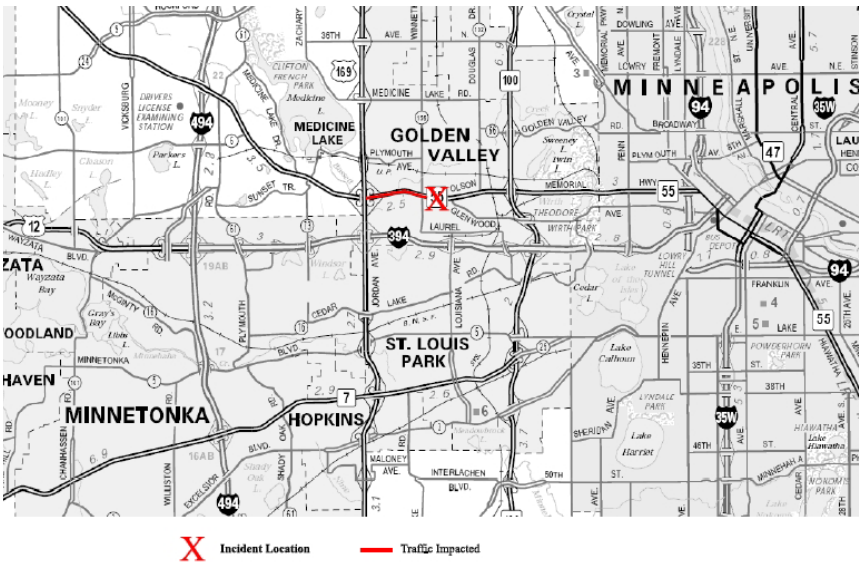


***Figure 19: Scenario 3 Illustration***

A passenger in a vehicle upstream is stopped behind the crash and phones 911 to report the event within minutes from the onset. The 911 call is answered by Hennepin County 911 dispatch, where a dispatcher enters a CAD report into the County's CAD system, describing the event (location and impacts to traffic). In addition to entering the event into CAD, the dispatcher announces the crash over the 'Inter-agency law enforcement talk channel' of the 800 Mhz system, where it is heard by the RTMC, Metro Transit, Plymouth Transit, SouthWest Transit, and City of Minneapolis. The county dispatcher dispatches law enforcement and emergency services to the scene.

- Almost immediately, the ICMS Enhancements to the Hennepin County EMS (ICMS-HENN-EMS) sends a message describing the incident to the ICMS-Data Hub. As response is dispatch to the scene and more information is updated in the CAD system, updates will be sent to the ICMS-Data Hub and appended to the incident report in the ICMS-Data Hub. The ICMS-Data Hub stores the incident report and posts messages for other systems to acquire.

- Within seconds, the ICMS Enhancements to each traffic management and emergency response system in the area have acquired the incident report. Representatives from each ICM stakeholder agency have seen an icon at their dispatch console alerting

them to the event and have accessed nearby CCTV camera images to view and verify the crash.

- Mn/DOT RTMC operators view the incident report through their reporting system (as the incident was acquired from the ICMS-Data Hub) and they alert Mn/DOT maintenance dispatch co-located in the RTMC and a cleanup crew is dispatched to the crash site.

- RTMC operators post messages on the Highway 55 DMS signs upstream of Hwy 169 in order to alert travelers and recommend diversion onto Hwy 169 (rather than proceeding on Hwy 55 and then having to exit on Winnetka prior to the crash site). Most commuters follow the recommendation and use Hwy 169 to access I-394 eastbound. As a result, a large number of vehicles have been prevented from exiting Hwy 55 at Winnetka and proceeding on local roads as they attempt to find suitable alternatives.

- The ICMS Enhancement to the Mn/DOT arterial signals group (ICMS-Mn/DOT-ASG System) acquires the incident report from the ICMS-Data Hub and traffic management personnel are able to view traffic volumes together with the reported incident. Based on the information available, the signals group downloads flush plans to Highway 55 east of the crash site to prepare to clear the queue that has formed.

- The ICMS-Mn/DOT-ASG sends a message to the ICMS-Data Hub describing the signal timing plans implemented along Hwy 55 in order for City of Minneapolis traffic control to understand the selected timing plans in the event they want to alter city signals to be synchronized with State signals.

- The ICMS Enhancements to the City of Minneapolis Arterial Signals Group (ICMS-COM-ASG System) acquires the messages from the ICMS-Data Hub describing the updated signal timing plans implemented by Mn/DOT and the traffic engineers decide to download a few flush timing plans to City of Minneapolis signals to remain coordinated with nearby Mn/DOT signals.

- RTMC operators manually adjust several ramp meter rates using the RTMC software to handle the increase flow along Hwy 169 to I-394.

- At the Metro Transit Control Center, the Automatic Vehicle Location (AVL)/CAD system has acquired the incident report and other traffic information from the ICMS-Data Hub and now displays the crash at all the dispatchers' CAD stations. There are no Metro Transit buses impacted by this event and therefore (while they remain alert to potential spikes in demand on I-394) no action is taken at this time.

- At the Plymouth Transit dispatch center, dispatchers have learned of the event through the 800 Mhz talk channel. The crash begins to create delays in the bus service and as a result of these delays, the inbound buses are relocated off of Hwy 55 on to I-394, recovering much of the delays.

- The ICM Enhancements to the Mn/DOT Traffic Operations Systems (ICMS-Traffic Operations) has generated several messages describing travel times on multiple routes and modes and has positioned these messages to be disseminated by the Mn/DOT traveler information 511 phone and Internet dissemination systems. Alternate travel times are presented for four routes/modes, including:
  - I-394 automobile travel is reporting typical travel times;
  - Highway 7 is reporting typical travel times;
  - Highway 55 is reporting stopped traffic near the crash with moderate delays upstream of the crash; and
  - Transit routes (benefiting from shoulder access, signal priority and real-time re-routes) are operating nearly on-time.

  This late timing of this event has not created many mode alterations, however many drivers along Hwy 55 have altered their routes.

- ***Scenario Event Closure & Return to Normal Operations***. The crash vehicles are towed and the area cleared within 45 minutes. The flush timing plans clear the queue quickly and Hwy 55 returns to normal within a few cycle lengths. The ICMS-HENN-EMS System sent an update to the original incident message when the incident was cleared by patrol in the field, and the ICMS-Data Hub removed the incident from the post. Within minutes, each agency was informed that the incident was resolved (by no longer seeing the incident posted on the ICMS-Data Hub). The ICM Management Team would be briefed on this event during the next meeting and the performance measurements presented by the ICM Program Manager for review and analysis.

***Scenario #3 Recap:***

***1. Scenario Management and Leadership***

The overall ICM management during Scenario #3 would be provided by the Mn/DOT Arterial Management Operations Team. On-site coordination of the incident response would be managed by the local police agency running the scene incident clearance. On-site coordination of traffic management and recovery would be provided by the Mn/DOT Maintenance Team. The management of freeway systems response to the incident would be led by the RTMC Freeway Operations Team. The closure of the event would be triggered by the local police clearing the event, and then the Mn/DOT Arterial Operations team would manage the incident wrap-up and eventually return all systems to normal.

***2. Scenario Impacts on Corridor Goals and Objectives***

As a result of the ICM response procedures executed on this morning, the only major delays were experienced by those vehicles immediately behind the crash site or entering eastbound Hwy 55 from access points beyond Hwy 169. In total, most commuters using Hwy 55 altered their routes and arrived at their destinations within their buffer time, with the average delays being 3-5 minutes.

## 2.9.4 Scenario #4: Minor Transit Incident

***A Metro Transit Bus breaks down on the eastbound on-ramp from Louisiana Ave to I-394 blocking all entering traffic on a weekday morning at about 7:30am. The breakdown involves a transmission problem that will not allow the FIRST vehicles to push the transit vehicle out of the lane of traffic.***


***Figure 20: Scenario 4 Illustration***

The transit vehicle on-board AVL communications console relays the alert to dispatchers with a verbal description of the event. The dispatcher immediately dispatches the nearest transit incident response team and a back-up bus from the nearby transit garage, and activates a transfer of the event report to the ICMS-Data Hub.

- Almost instantaneously, The ICMS Enhancements to the MTCC send a message to the ICMS-Data Hub describing the transit incident (location and expected impacts). Within minutes, the ICMS Enhancements to systems operated by other agencies have acquired the transit incident report from the ICMS-Data Hub and operators and dispatchers in each respective agency have seen the event alert at their dispatch console and most have viewed nearby CCTV camera images to view and verify the breakdown.

- RTMC dispatchers dispatch a FIRST vehicle to be positioned on Louisiana Avenue with a portable DMS message that the I-394 on-ramp ahead is blocked. Louisiana Avenue travelers bound for I-394 now continue east on a parallel frontage road to the Xenia/Park Place entrance to eastbound I-394. With the added demand to the Xenia/Park Place entrance ramp to eastbound I-394, an RTMC operator adjusts the ramp meter timing to allow for the addition traffic.

- The City of St. Louis Park traffic group is notified of the ramp closure and the diversion of traffic down the frontage road. The City monitors the situation but traffic volumes displaced by the ramp closure are minor and they determine the signals are handling the additional traffic and no changes are made.

- The ICMS enhancements at SouthWest Transit (ICMS-SWT) have acquired the incident report from the ICMS-Data Hub and operators view the report of the stalled vehicle. The report indicates that there are 14 passengers on-board. SouthWest Transit dispatchers identify an inbound vehicle approaching the scene with 20 empty seats and verbally communicate with Metro Transit offering to pick up passengers on the on-ramp. As a result, Metro Transit alters the destination of the back-up vehicle already activated to continue the passenger pick-ups that remained on the stalled vehicle's routes.

- The eastbound HOT lane of I-394 continues to operate using the congestion pricing scheme that has been in operation since 2004, adjusting prices according to congestion levels in the HOT lane.

- The Metro Transit incident response team clears the vehicle onto the available shoulder and within 30 minutes the on-ramp is reopened.

***Scenario #4 Recap:***

***1. Scenario Management and Leadership***

The overall ICM management during Scenario #5 would be provided by the Mn/DOT RTMC Freeway Operations Team. On-site coordination of the incident response would be managed by the Minnesota State Patrol. On-site coordination of traffic management and recovery would be provided by the FIRST vehicle drivers. The closure of the event would be triggered by the State Patrol clearing the event, and then the Mn/DOT Freeway Operations team would manage the incident wrap-up and eventually return all systems to normal. The ICM Management Team would be briefed on this event during the next meeting and the performance measurements presented by the ICM Program Manager for review and analysis.

***2. Scenario Impacts on Corridor Goals and Objectives***

As a result of the ICM response procedures executed on this morning, the transit riders on-board the stalled vehicle were delayed approximately 10 minutes while they waited and then boarded the SouthWest Transit bus. Commuters who typically use the on-ramp experienced approximately 3 minutes of delay using the alternate access via Hwy 100. In total, all commuters arrived within their buffer zone.

## *2.9.5 Scenario #5: Major Planned Event Scenario – Afternoon Baseball Game*

***A weekday afternoon Twins game at the new stadium with an estimated 40,000 attendees is seeing all fans leave around 4:30pm following the last out of a baseball game with a 6-5 score.***

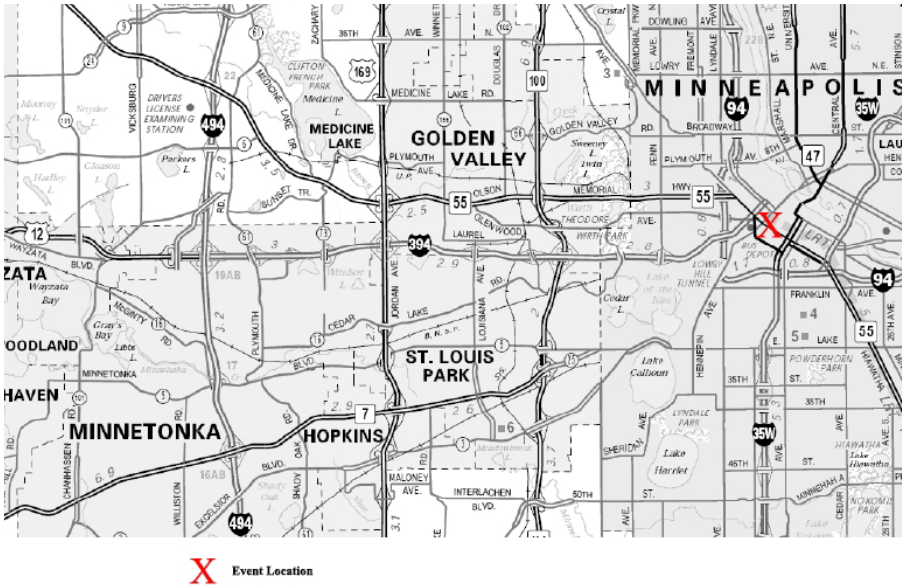


***Figure 21: Scenario 5 Illustration***

The close ball game has resulted in most fans remaining until the end of the game, which concludes at approximately the onset of the evening peak period. Roughly 20% of the attendees (8,000 individuals) to the game will now return to the western suburbs using the I-394 Corridor.

- The response to this planned event began early in the morning of the event, when the Metro Transit Control Center sent messages to the ICMS-Data Hub with information on park-and-ride availability, and transit trip planning was available on the Metro Transit website.

- Metro Transit has activated two additional temporary park-and-ride lots to support additional parking for event attendees. The ICMS-MTCC System sends reports of these temporary park-and-ride expansions to the ICMS-Data Hub. The Mn/DOT Traffic Operations system acquires this information about park-and-ride expansions and automatically updates a Mn/DOT traveler information website describing the additional parking capacity for transit riders.

- Many ball game attendees have phoned 511 or accessed the Internet to understand their travel and parking options for the game.

- Approximately 3000 attendees (1200 vehicles) have opted to park in park-and-ride lots that they were informed had availability, and have ridden transit downtown for an early lunch before the game. Many of these park-and-ride lots are temporary spill over lots that include mall and church parking lots – activated especially for such planned events. As a result of the ICM initiative, not only have parking relationships been established with these facilities, but Metro Transit has arranged shuttle services from these facilities to on-line transit stops, therefore utilizing the existing mainline routes to support the spill over lots.

- Approximately 1,000 attendees purchased their ballgame tickets on-line and were offered free downtown parking for the ballgame if they delayed their return trip home from the game until 2 hours after the game ends (beyond the peak rush hour). These attendees have selected to eat dinner downtown after the game and have printed their coupons for free parking (redeemable when they depart the garages after 6:30pm).

- Approximately 4,000 additional attendees (1,500 vehicles) have parked in the spaces available in and around the ballpark and will depart immediately following the ballgame.

- Finally, as commuters arrive at the ABC garages during this morning, a placard sign as they enter informs them that there is an afternoon Twins game and that volume in the ramps will be heavier than normal immediately following the game, as a result many commuters either will depart early or stay later to avoid the rush.

- As the ballgame concludes, the attendees who are immediately driving home head to their vehicles parked in either the ABC garages or newly built stadium garages. Overhead kiosks display maps of the network are visible while walking through the walkways leading to parking garages, and they quickly observe mostly green highways, indicating that there are no current incidents causing major delays.

- The influx of stadium traffic creates a time slice of approximately 20 minutes where the parking ramp access is heavier than normal. Many commuters have tracked the game on the Internet and have opted not to leave the office until after 5:15 so as to avoid the problems.

- The Mn/DOT arterial signals group has developed outbound stadium departure timing plans that are slightly more favorable to the mainline than PM peak plans. At approximately 4:00, in anticipation of the rush hour and the game departure, these plans are implemented, and as a result travel along Hwy 55 is near normal.

***Scenario #5 Recap:***

***1. Scenario Management and Leadership***

The overall ICM management during Scenario #5 would be provided by the ICM Management Team. The advanced notice of the incident and the need to activate pricing strategies, additional parking and transit options, and activate advanced plans, requires coordination among many agencies. The ICM Management team will play this role both during the planning (when specific duties will be delegated) and during the post-event recap to assess whether target metrics were reached. The ICM Management Team would be briefed on this event during the next meeting and the performance measurements presented by the ICM Program Manager for review and analysis.

### *2. Scenario Impacts on Corridor Goals and Objectives*

Many attendees to the ballgame are first time or seldom use transit riders, and many of those have made connections to arrive at the game. Throughout their trip home, these riders call 511 or view bus departure/arrival time signs at their stops to understand their connection points and the next departures of their buses.

The unusual daytime game was anticipated and planned for in advance with incentives for parking departure delays and transit rider ship. These strategies have reduced the number of single occupant vehicles traveling to and from the game and alleviated any parking capacity problems. Advance notice to commuters and incentives for ball game attendees not to leave immediately has reduced the spike of traffic at the time the game has ended. As a result of these precautionary measures, no operational problems occurred and the evening peak period was uneventful.

### 2.9.6 Scenario #6: Weather Incident Scenario

***An unexpected snow storm is starting around 4:00pm on a weekday in the region, with anticipated snow fall of 10 inches over the next 12 hours.***

- RTMC dispatchers decide to continue the frequency of 10 minute updates to traffic conditions broadcast on KBEM beyond the commute time. Travelers throughout the corridor may now tune to KBEM to hear a live voice talent reporting traffic problems every 10 minutes.

- The freeway lanes are moving slowly as commuters drive cautiously. In anticipation of delays in the general purpose lanes, many Mn/PASS subscribers are selecting the HOT lane, which has a currently pricing level set (automatically) at $1.25 for access to the western-most end of I-394.

- The ICMS Enhancements to the Metro Transit Control Center (ICMS-MTCC) is regularly sending messages to the ICMS-Data Hub describing transit travel times and schedule adherence information. Unfortunately, the rapid snowfall rates and diminishing roadway conditions are causing delays across all networks. However, transit riders are able to understand these delays through Internet and 511 accesses to departure times, and as a result many travelers remain indoors until the delayed buses arrive.
- The Mn/DOT Traffic Operations group has entered a report of difficult driving conditions for those portions of freeways within the ICMS Corridor into their reporting system (including a detailed description that I-394 is slick and resulting in slow traffic). These road conditions descriptions are considered events and are sent to the ICMS-Data Hub by the ICMS-Traffic Operations System as soon as they are entered. The ICMS-Traffic Operations System also sends freeway travel time, volume, occupancy, speed and other incident and event descriptions

- The ICMS-Data Hub posts the driving condition reports, transit travel times, freeway travel and arterial travel times and traffic volumes received from various systems.

- The ICMS Enhancements to the ABC Garage (ICMS-ABC System) has acquired the incident and event reports from the ICMS-Data Hub, including the description of slick conditions and slow traffic on Westbound I-394. The ICMS-ABC System displays the report to garage operators and they make the decision that the slow traffic on I-394 will cause a back-up in the garage and they implement the gate closure system, closing the exit of the parking ramp directly leading to I-394.

- ICMS Enhancements to the Mn/DOT Arterial Signals group (ICMS-Mn/DOT-ASG System) has acquired the incident report and freeway and transit travel time data from the ICMS-Data Hub. As a result of the storm, many travelers are opting not to drive the freeways, but instead to take non-mainstream (less than primary) arterials with the hopes of avoiding major congestion. Off-peak signal timings with reactive control

are left in place to accommodate the many turning movements not typically observed during peak (flush) movement.

- The entire ICM network is operating with delays as drivers of automobiles and transit vehicles drive at speeds to maintain safe travel. Because of this major incident and overall network delays, the transit signal priority is de-activated and transit vehicles progress at the same rate as other vehicles (mostly because the slow travel has congested the roads so even if signals green phases are extended for a transit vehicle, there is still congestion ahead of the signal).

- A number of automated pushes of information complement the information delivered on 511, the Internet, DMS, parking garage kiosks and Highway Advisory Radio (HAR) systems, and transit bus stop signs. As a result, all travelers have an understanding of how long the commute home will take and the stress level is lessened with this increased knowledge.

***Scenario #6 Recap:***

***1. Scenario Management and Leadership***

The overall ICM management during Scenario #6 would be provided by the Mn/DOT RTMC Freeway Operations Team working in close communication with the Mn/DOT Arterial Management Team.

***2. Scenario Impacts on Corridor Goals and Objectives***

Most commuters who traveled to their employment sites before the snow began experienced substantial delays returning home. However, due to the ICM strategies, the delays were understood and expected. Travelers understood the travel time on their route as well as the parallel route (and therefore did not seek en-route diversions), and for the most part travel home was safe and uneventful.

## 2.10 Performance Measures

Members of the I-394 ICM initiative have discussed how they will determine the effectiveness of the ICM strategies at meeting the goals and objectives set forth by the stakeholders. A preliminary list of performance measures have been identified. The preliminary performance measures, mapped against the goals and objectives of the I-394 Corridor are described in Table 5.

The collection of data and information to assess the performance measures will primarily be performed by the individual agencies as part of their regular business processes. In some instances, the ICMS will gather, process, and report data to support performance measurements. These specific requirements are described in the System of Systems level requirements.

***Table 5: I-394 ICM Preliminary Performance Measures***

| GOAL | OBJECTIVE | NEEDS RELATED TO OBJECTIVE | PERFORMANCE MEASURE |
|---|---|---|---|
| ***Mobility & Reliability*** | **Reduce the variation in travel times** | The need for incident detection and notification.<br><br>The need for efficient movement of vehicles throughout the corridor.<br><br>The need for corridor wide status monitoring.<br><br>The need for an overall view of conditions along all routes and modes. | Buffer Index – The amount of time travelers must allow to ensure they are on-time 95% of the time.<br><br>Maximum travel times experienced by travelers throughout the corridor<br><br>Range of travel times (and variability) experienced by travelers<br><br>Percentage of 'late' bus routes throughout the corridor. |
| | **Maintain options for travelers'** | The need to monitor status of devices and systems.<br><br>The need for a comprehensive view of all available capacity and demand throughout the corridor. | Average parking availability per facility and time of day<br><br>Comparisons of transit, HOV/HOT lanes, Freeways, and arterial route performance<br><br>Percentage of corridor (routes and modes) reported on in real-time (travel times, |

| GOAL | OBJECTIVE | NEEDS RELATED TO OBJECTIVE | PERFORMANCE MEASURE |
|---|---|---|---|
| | | | delays, space availability, speeds etc.) |
| ***Corridor-wide Capacity Utilization*** | **Monitor and understand the ever changing available capacity** | Need for a comprehensive view of available capacity and demand throughout the corridor. | Percentage of corridor (routes and modes) reported on in real-time (travel times, delays, space availability, speeds etc.) |
| | **Encourage pattern changes to better utilize spare capacity** | The need for transit advantages.<br><br>The need for transit incentives. | Percentage of drivers altering route or mode based on traveler information<br><br>Average capacity utilization across all modes during incidents and normal conditions. |
| ***Corridor Event and Incident Manage-ment*** | **Inform travelers of incidents & impacts** | Corridor wide status monitoring<br><br>Need for overall view of conditions along all routes and modes.<br><br>The need for dissemination of corridor-wide traveler information | Number of events where viable alternates are delivered to travelers (either via. Phone, web or push)<br><br>Number of callers receiving alternate route/mode information<br><br>Web page hits and call volumes during incident events |
| | **Manage traffic around events** | Verification of incidents and events | Number of closures where vehicles are routed onto appropriate alternate routes<br><br>Number of times alternate plans are implemented, and the real-world results.<br><br>Response/ clearance times for major events. |

| GOAL | OBJECTIVE | NEEDS RELATED TO OBJECTIVE | PERFORMANCE MEASURE |
|---|---|---|---|
| ***Holistic Traveler Informa-tion delivery*** | **Travelers are aware of their modal and route options** | Need for overall view of conditions along all routes and modes.<br><br>Need to assemble and disseminate park-and-ride availability.<br><br>The need for dissemination of corridor-wide traveler information | Web page hits, phone requests, and push deliveries of specific route/mode options |
| | **Travelers do not experience delays without also being informed of options** | Need to present modal and route options to travelers.<br><br>The need for access to information en-route. | Travelers' feedback after incidents and events. |

# 3. ICMS System of System Level Requirements

The section defines the overall System of Systems (SOS) level requirements. These requirements are defined in Table 6 to assist in determining when the overall System of Systems is performing to expectations and supporting the corridor as expected. Often, multiple individual systems are involved in each SOS level requirement, and the intent of defining and ultimately testing the SOS level requirements is not to test performance of any individual system, but rather to assess whether the overall SOS is performing adequately. Each requirement in the following subsections includes the following information:

| | |
|---|---|
| ID | Unique identifier |
| Requirement Description | Text description of actual requirement |
| Source | Identifies which User Need from Table 1 of this document that the requirement relates to |
| Allocation | Identifies the individual system(s) responsible for accomplishing the requirement. |
| Criticality | High = required to complete the ICMS<br>Medium = will improve the ICMS<br>Low = nice to have, but won't affect the completion of the ICMS |

***Table 6: ICMS-System of Systems Level Requirements***

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| SOS-1 | **ICMS notify operators of incidents:**<br>The ICMS shall provide operators and participating dispatchers with notification of incidents on State, County, and local roads (including transit incidents) within 3 minutes from the time the incident is reported to the ICMS. | User Need 1 | ICMS-Data Hub; ICMS-EMS; ICMS-Traffic Operations | H |
| SOS-2 | **ICMS notify operators of planned events:**<br>The ICMS shall provide operators and participating dispatchers with notification of planned events that have been entered into the ICMS and are expected to impact traffic at least a day in advance of the event. | User Need 1 | ICMS-Data Hub; ICMS-Traffic Operations | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| SOS-3 | **Verification of incidents:**<br>The ICMS shall provide a mechanism for traffic, transit, and emergency operators to verify incidents within 5 minutes of the incident being reported to the ICMS. | User Need 2 | ICMS-Data Hub; ICMS-Traffic Operations; ICMS-EMS | H |
| SOS-4 | **ICMS inform travelers pre-trip of travel times**<br>The ICMS shall provide travelers the currently available (within the last 2 minutes) travel times on freeways, arterials, and transit routes. | User Need 3, User Need 9 | ICMS-Data Hub; ICMS-MTCC; ICMS-Traffic Operations | H |
| SOS-5 | **ICMS inform travelers en-route of travel times**<br>The ICMS shall provide travelers en-route to their destination with the currently available (within the last 5 minutes) travel times along freeways, arterials, and transit routes. | User Need 3, User Need 9 | ICMS-Data Hub; ICMS-MTCC; ICMS-Traffic Operations | H |
| SOS-6 | **ICMS inform travelers pre-trip of parking availability**<br>During pre-trip planning, the ICMS shall provide travelers with the number of parking spaces currently available (within the last 3 minutes) at park-and-ride facilities located within the corridor based on the latest information available in the system. | User Need 4 | ICMS-Data Hub; ICMS-MTCC; ICMS-Traffic Operations | H |
| SOS-7 | **ICMS inform travelers en-route of parking availability**<br>The ICMS shall provide en-route travelers with the number of parking spaces currently available (within the last 3 minutes) at park-and-ride facilities located within the corridor based on the latest information available in the system. | User Need 4 | ICMS-Data Hub; ICMS-MTCC; ICMS-Traffic Operations | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| SOS-8 | **ICMS calculate freeway metrics**<br>The ICMS shall calculate the following corridor performance metrics for the freeway network as a whole in both directions at least once every 2 minutes:<br>• Speed<br>• Volume<br>• Excess capacity<br>• Travel time deviation from average | User Need 5, User Need 18 | ICMS-Data Hub; ICMS-ASG; ICMS-Traffic Operations | H |
| SOS-9 | **ICMS calculate arterial metrics**<br>The ICMS shall calculate the following corridor performance metrics for the arterial network as a whole in both directions at least once every 2 minutes:<br>• Speed<br>• Volume<br>• Excess capacity<br>• Travel time deviation from average | User Need 5, User Need 18 | ICMS-Data Hub; ICMS-ASG; ICMS-Traffic Operations | H |
| SOS-10 | **ICMS calculate transit metrics**<br>The ICMS shall calculate the following corridor performance metrics for the transit routes within the corridor at least once every 2 minutes:<br>• Speed<br>• Volume<br>• Excess capacity<br>• Travel time deviation from average | User Need 5, User Need 18 | ICMS-Data Hub; ICMS-ASG; ICMS-Traffic Operations | H |
| SOS-11 | **ICMS display metrics to operators**<br>The ICMS shall display the current corridor performance metrics (2 minutes or less) for freeways, arterials, and transit routes within the corridor to the ICMS operators. | User Need 5, User Need 18 | ICMS-Data Hub; ICMS-ASG; ICMS-Traffic Operations | H |
| SOS-12 | **ICMS present transit trip planning to travelers**<br>The ICMS shall provide travelers accessing the traveler information system with information about transit options and current travel times of transit vehicles. | User Need 6 | ICMS-MTCC; ICMS-Traffic Operations | H |
| SOS-13 | **ICMS provide transit advantages**<br>The ICMS shall provide signal timing priority to prevent transit vehicles from waiting longer than 30 seconds when exiting park-and-ride facilities. | User Need 7 | ICMS-MTCC; ICMS-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| SOS-14 | **ICMS provide internet to transit riders**<br>The ICMS shall provide a mechanism for transit riders to access the Internet while on board buses traveling along designated transit routes. | User Need 8 | ICMS-MTCC; ICMS-Traffic Operations | H |
| SOS-15 | **ICMS inform travelers of transit benefits**<br>The ICMS shall provide travelers with information about the benefits of transit ridership in the form of transit access lanes or parking advantages. | User Need 8 | ICMS-MTCC; ICMS-Traffic Operations | H |
| SOS-16 | **ICMS inform travelers of conditions at ABC garages**<br>The ICMS shall provide travelers with the most current information available about the conditions and travel times in monitored segments of the corridor as travelers approach the ABC garages. | User Need 10 | ICMS-MTCC; ICMS-Traffic Operations | H |
| SOS-17 | **ICMS inform travelers of parking garage availability**<br>The ICMS shall provide travelers with information about the current available parking capacity at the ABC garages while travelers are approaching the garages. | User Need 10 | ICMS-MTCC; ICMS-Traffic Operations | H |
| SOS-18 | **ICMS inform travelers of incidents and events en-route**<br>The ICMS shall provide travelers with information about current events impacting travel downstream or on nearby routes without travelers needing to request the information. | User Need 10 | ICMS-MTCC; ICMS-Traffic Operations | H |
| SOS-19 | **ICMS exchange information among agencies**<br>The ICMS shall share information about events, incidents, and conditions with other transportation and emergency response agencies within 5 minutes of receiving information. | User Need 11 | ICMS-MTCC; ICMS-Traffic Operations | H |
| SOS-20 | **ICMS support infrastructure reliability**<br>The ICMS support systems shall provide power to maintain operation of signal control devices for at least 2 hours after a power outage. | User Need 14 | ICMS-Traffic Operations; ICMS-ASG | H |
| SOS-21 | **ICMS informs travelers of transit capacity increases**<br>The ICMS shall provide travelers with notification of transit capacity increases (additional routes or additional capacity on existing routes) within 10 minutes of receiving information that additional capacity has been added. | User Need 15 | ICMS-MTCC; ICMS-Traffic Operations | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| SOS-22 | **ICMS manages traffic flow**<br>The ICMS shall provide a mechanism for arterial signal operators to select and implement signal timing plans within 5 minutes of notification of conditions or events. | User Need 17 | ICMS-ASG; ICMS-Traffic Operations | H |
| SOS-23 | **ICMS informs arterial operators of conditions**<br>The ICMS shall provide arterial signals operators with current system data and information about conditions along arterial and parallel freeways to support the selection of signal timing plans. | User Need 17 | ICMS-ASG; ICMS-Traffic Operations | H |
| SOS-24 | **ICMS provides visual surveillance to arterial operators**<br>The ICMS shall provide a mechanism for arterial signal operators to view current system images of arterial intersections. | User Need 17 | ICMS-ASG; ICMS-Traffic Operations | H |
| SOS-25 | **ICMS monitor device status**<br>The ICMS shall provide operators and administrators with reports of any devices and systems malfunctioning within 5 minutes of the malfunction being detected by the system. | User Need 18 | ICMS-MTCC; ICMS-Traffic Operations | H |

# 4. ICMS Individual System Requirements

The section includes the requirements for the ICMS to ease software development and testing. Each requirement in the following subsections as well as Section 5: Hardware Requirements includes the following information:

| | |
|---|---|
| ID | Unique identifier |
| Requirement Description | Text description of actual requirement |
| Source | Identifies which User Need from Table 1 of this document that the requirement relates to |
| Allocation | Identifies the responsibility for accomplishing the requirement |
| Criticality | High = required to complete the ICMS<br>Medium = will improve the ICMS<br>Low = nice to have, but won't affect the completion of the ICMS |

## *4.1 ICMS Data Hub System Requirements*

The ICMS Data Hub will be a new system developed for the I-394 ICM Deployment. The ICMS-Data Hub System will perform seven key functions:

- Receive and store data from ICMS-MTCC System;
- Receive and store data from ICMS-Traffic Operations System;
- Receive and store data from ICMS-ABC System;
- Receive and store data from ICMS-EMS Systems (note there are three ICMS-EMS systems proposed (MSP-EMS, HENN-EMS, COM-EMS) the ICMS Data Hub System shall treat interfaces from any EMS system in the same manner, therefore supporting future additional EMS systems sending data to the ICMS-Data Hub;
- Receive and store data from ICMS-ASG Systems (note there are three ICMS-ASG systems proposed (Mn/DOT-ASG, HENN-ASG, COM-ASG) the ICMS Data Hub System shall treat interfaces from any ASG system in the same manner, therefore supporting future additional ASG systems sending data to the ICMS-Data Hub;
- Post Data for systems to acquire; and
- Provide an Operator/Administrator Interface.

Figure 22 illustrates the ICMS-Data Hub functions and Table 7 includes the ICMS-Data Hub requirements to ease software development and testing.

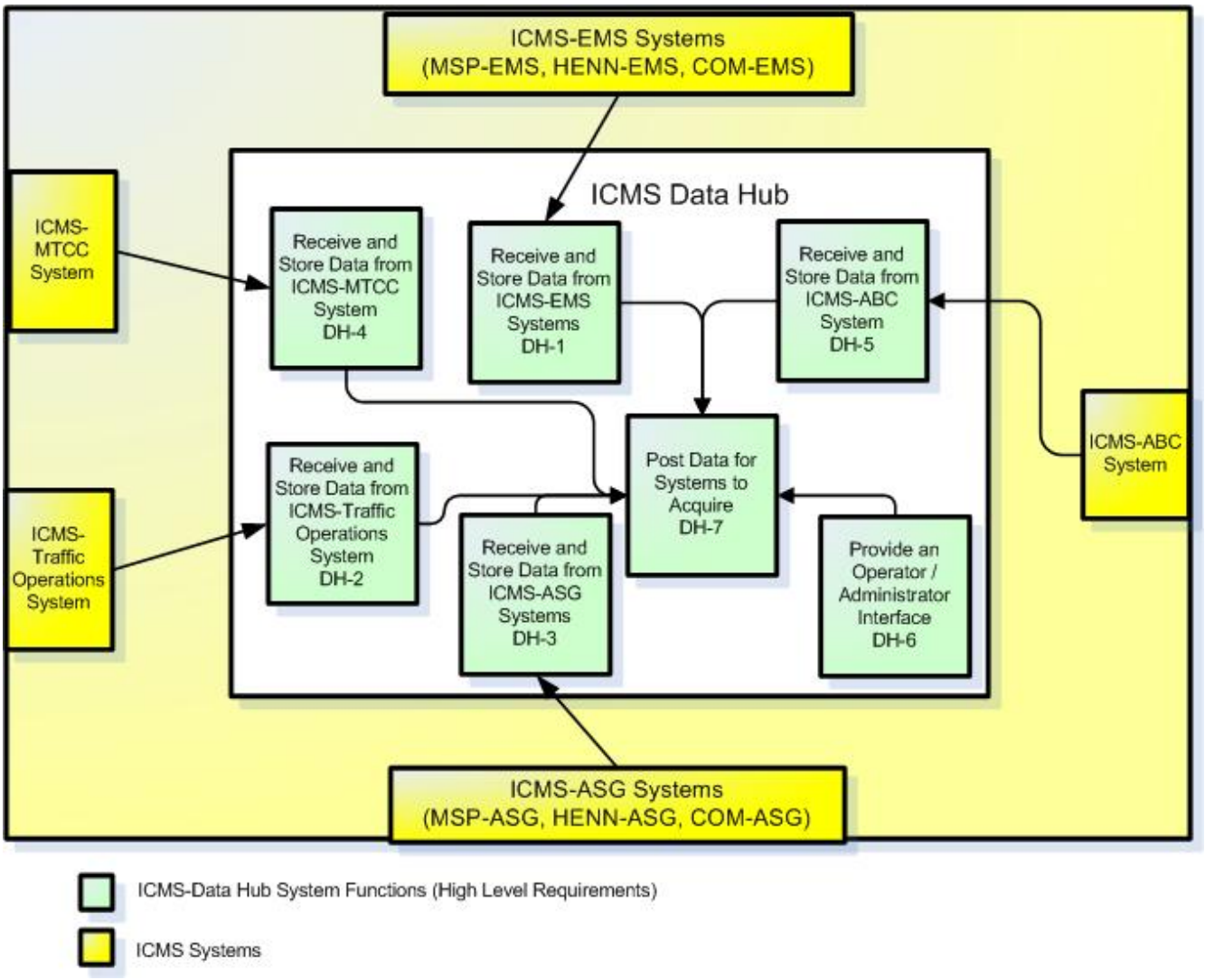


***Figure 22: ICMS-Data Hub Functions***

***Table 7: ICMS-Data Hub Requirements***

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **DH-1** | **The ICMS-Data Hub System Shall Receive and Store Messages Describing Incidents within the ICM Corridor from the ICMS-EMS Systems.** | User Need 1 | ICMS-Data Hub | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| DH-1-1 | **ICMS-Data Hub Receive and Store ICMS-EMS Incident Data: Data Exchanges**<br>The ICMS-Data Hub System shall receive and store ICMS-EMS incident data from the ICMS-EMS System , as per the ICMS-EMS to ICMS-Data Hub ICD. | User Need 1 | ICMS-Data Hub | H |
| DH-1-2 | **ICMS-Data Hub Receive and Store ICMS-EMS Incident Data: Time Log**<br>The ICMS-Data Hub System shall log the time of each test message, received from an EMS System. | User Need 1 | ICMS-Data Hub | H |
| DH-1-3 | **ICMS-Data Hub Receive and Store ICMS-EMS Incident Data: Alert of no data**<br>The ICMS-Data Hub System shall send an alert to an administrator (within 10 seconds) when no incident messages or test messages have been received for an amount of time that is configurable by an ICMS-Data Hub system administrator, noting that connections with the EMS systems may be down. | User Need 1 | ICMS-Data Hub | H |
| **DH-2** | **The ICMS-Data Hub System Shall Receive and Store Data within the ICM Corridor from ICMS-Traffic Operations System.** | User Need 1 | ICMS-Data Hub | H |
| DH-2-1 | **ICMS-Data Hub Receive and Store ICMS-Traffic Operations Incident and Event Data**<br>The ICMS-Data Hub System shall receive and store ICMS Traffic Operations incident and event data from the ICMS-Traffic Operations System, as per the ICMS-Traffic Operations to ICMS-Data Hub ICD. | User Need 1 | ICMS-Data Hub | H |
| DH-2-2 | **ICMS-Data Hub Receive and Store ICMS-Traffic Operations Freeway Traffic Data**<br>The ICMS-Data Hub System shall receive and store ICMS Traffic Operations Freeway Traffic Data from the ICMS Traffic Operations System, as per the ICMS Traffic Operations to ICMS-Data Hub ICD. | User Need 1 and 2 | ICMS-Data Hub | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| DH-2-2-1 | **ICMS-Data Hub Receive and Store ICMS-Traffic Operations Freeway Traffic Data: Traffic Details**<br>The ICMS Traffic Operations Freeway Traffic Data shall consist of the most recent volume, occupancy, and speed data for all sensor stations along:<br>• the I-394 mainline and I-394 ramps<br>• I-494 within the boundaries of the corridor;<br>• Hwy 100 within the boundaries of the corridor; and<br>• Hwy 169 within the boundaries of the corridor. | User Need 1 and 2 | ICMS-Data Hub | H |
| DH-2-2-2 | **ICMS-Data Hub Receive and Store ICMS-Traffic Operations Freeway Travel Times**<br>The ICMS-Data Hub System shall receive and store messages describing travel time along I-394, I-494, Hwy 100, and Hwy 169 from the ICMS-Traffic Operations system, as per the ICMS-Traffic Operations to ICMS-Data Hub ICD. | User Need 3 | ICMS-Data Hub | H |
| DH-2-3 | **ICMS-Data Hub Receive and Store ICMS-Traffic Operations Mn/PASS Data**<br>The ICMS-Data Hub System shall receive and store Mn/PASS Travel Time from the Traffic Operations Center. | User Need 2 | ICMS-Data Hub | H |
| DH-2-3-1 | **CMS-Data Hub Receive and Store ICMS-Traffic Operations Mn/PASS Data: Data Exchanges**<br>The ICMS-Data Hub System shall receive and store ICMS-Traffic Operations Mn/PASS Data from the Traffic Operations Center, as per the ICMS-Traffic Operations to ICMS-Data Hub ICD. | User Need 2 | ICMS-Data Hub | H |
| DH-2-3-2 | **ICMS-Data Hub Receive and Store ICMS-Traffic Operations Mn/PASS Data: Details**<br>The ICMS-Data Hub System shall receive and store ICMS-Traffic Operations Mn/PASS Data describing the direction of flow and current accessibility of the Mn/PASS lane. | User Need 2 | ICMS-Data Hub | H |
| DH-2-3-3 | **ICMS-Data Hub Receive and Store ICMS-Traffic Operations Mn/PASS Travel Times**<br>The ICMS-Data Hub System shall receive and store messages describing travel times in the Mn/PASS lanes from the Traffic Operations Center, as per the ICMS-Traffic Operations Center to ICMS-Data Hub ICD. | User Need 3 | ICMS-Data Hub | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **DH-3** | **The ICMS-Data Hub System shall Receive and Store Messages Describing Arterial Traffic Conditions with the ICM Corridor from ICMS-ASG Systems.** | User Need 2 | ICMS-Data Hub | H |
| DH-3-1 | **ICMS-Data Hub Receive and Store ICMS-Mn/DOT-ASG Arterial Traffic Data: Data Exchanges**<br>The ICMS-Data Hub System shall receive and store arterial traffic data from any Arterial Signal Group (ASG) system, as per the ICMS-ASG to ICMS-Data Hub ICD. | User Need 2 | ICMS-Data Hub | H |
| DH-3-2 | **ICMS-Data Hub Receive and Store ICMS-Mn/DOT-ASG Arterial Traffic Data: No Data Available**<br>The ICMS-Data Hub System shall receive and store Arterial Traffic Data from the ICMS-Mn/DOT-ASG indicating "no data available' if no data is available. | User Need 1 | ICMS-Data Hub | H |
| DH-3-3 | **ICMS-Data Hub Receive and Store ICMS-Mn/DOT-ASG Arterial Traffic Data: Travel Times**<br>The ICMS-Data Hub System shall receive and store Arterial Traffic Data from the ICMS-Mn/DOT-ASG describing real-time travel times. | User Need 2 | ICMS-Data Hub | H |
| DH-3-4 | **ICMS-Data Hub Receive and Store ICMS-Mn/DOT-ASG Arterial Traffic Data: Volume and Speed Data**<br>The ICMS-Data Hub System shall receive and store Arterial Traffic Data from the ICMS-Mn/DOT-ASG describing volume and speed. | User Need 2 | ICMS-Data Hub | H |
| DH-3-5 | **ICMS-Data Hub Receive and Store ICMS-ASG Special Event and Incident Signal Timing Plans Data**<br>The ICMS-Data Hub System shall receive and store Special Event and Signal Timing Plans Data from the ICMS-ASG. | User Need 17 | ICMS-Data Hub | H |
| DH-3-6 | **ICMS-Data Hub Receive and Store ICMS-ASG Special Event and Incident Signal Timing Plans Data: Selected Signal Timing Plan**<br>The ICMS-Data Hub System shall receive and store Special Event and Incident Signal Timing Plans Data from the ICMS-ASG identifying which signal timing plan was implemented. | User Need 17 | ICMS-Data Hub | H |
| DH-3-6-1 | **ICMS-Data Hub Receive and Store ICMS-ASG Special Event and Incident Signal Timing Plans Data: Time Implemented**<br>The ICMS-Data Hub System shall receive and store Special Event and Incident Signal Timing Plans Data from the HICMS-ASG identifying the time a signal timing plan was implemented. | User Need 17 | ICMS-Data Hub | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| DH-3-6-2 | **ICMS-Data Hub Receive and Store ICMS-ASG Special Event and Incident Signal Timing Plans Data: Time Deactivated**<br>The ICMS-Data Hub System shall receive and store Special Event and Incident Signal Timing Plans Data from the ICMS-ASG identifying the time a signal timing plan was deactivated. | User Need 17 | ICMS-Data Hub | H |
| **DH-4** | **The ICMS-Data Hub System Shall Receive and Store messages within the ICM Corridor from the ICMS-MTCC System.** | User Need 1 | ICMS-Data Hub | H |
| DH-4-1 | **ICMS-Data Hub Receive and Store ICMS-MTCC Transit Route Travel Time Data**<br>The ICMS-Data Hub System shall receive and store messages describing bus travel times between park-and-ride locations and downtown Minneapolis along ICM corridor routes, as per the ICMS-MTCC to ICMS-Data Hub ICD. | User Need 1 | ICMS-Data Hub | H |
| DH-4-2 | **ICMS-Data Hub Receive and Store ICMS-MTCC Park-and-Ride Data**<br>The ICMS-Data Hub System shall receive and store messages describing Park-and-Ride space availability for parking facilities within the ICM Corridor from the ICMS-MTCC, as per the ICMS-MTCC to ICMS-Data Hub ICD. | User Need 4 | ICMS-Data Hub | H |
| DH-4-2-1 | **ICMS-Data Hub Receive and Store ICMS-MTCC Park-and-Ride Data: Details**<br>The ICMS-Data Hub System shall receive and store ICMS-MTCC Park-and-Ride Data describing the lot ID, the number of spaces that exist on the lot, the number of spaces occupied, and a timestamp of when the data was collected. | User Need 4 | ICMS-Data Hub | H |
| DH-4-3 | **ICMS-Data Hub Receive and Store ICMS-MTCC Transit Incident Data**<br>The ICMS-Data Hub System shall receive and store messages describing Transit Incidents from the ICMS-MTCC system, as per the ICMS-MTCC to ICMS-Data Hub ICD. | User Need 1 | ICMS-Data Hub | H |
| DH-4-3-1 | **ICMS-Data Hub Receive and Store ICMS-MTCC Transit Incident Data: Location**<br>The ICMS-Data Hub System shall receive and store ICMS-MTCC Transit Incident Data describing the incident location. | User Need 1 | ICMS-Data Hub | H |
| DH-4-3-2 | **ICMS-Data Hub Receive and Store ICMS-MTCC Transit Incident Data: Type**<br>The ICMS-Data hub System shall receive and store Transit Incident Data describing the incident type. | User Need 1 | ICMS-Data Hub | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| DH-4-3-3 | **ICMS-Data Hub Receive and Store ICMS-MTCC Transit Incident Data: Time**<br>The ICMS-Data Hub System shall receive and store ICMS-MTCC Transit Incident Data describing incident time elements: expected duration and estimated impact. | User Need 1 | ICMS-Data Hub | H |
| **DH-5** | **The ICMS-Data Hub Shall Receive and Store Data within the ICM Corridor from the ICMS-ABC Parking Garages System.** | User Need 9 | ICMS-Data Hub | H |
| DH-5-1 | **ICMS-Data Hub Receive and Store ICMS-ABC Parking Garages Data**<br>The ICMS-Data Hub System shall receive and store messages describing ABC Parking Space Availability from the ICMS-ABC system, as per the ICMS-ABC System to ICMS-Data Hub ICD. | User Need 9 | ICMS-Data Hub | H |
| **DH-6** | **The ICMS-Data Hub System Shall Provide a Mechanism for Administrators to Enter Configurable Values from an Internet Access Point.** | User Need 9 | ICMS-Data Hub | H |
| DH-6-1 | **ICMS-Data Hub Configurable Alert Timeframe**<br>The ICMS-Data Hub System shall provide a mechanism for operators/administrators to specify the time period that would be used to trigger and send an alert if no incident or test messages are received. | User Need 9 | ICMS-Data Hub | H |
| DH-6-2 | **ICMS-Data Hub Configurable Alert Contact List**<br>The ICMS-Data Hub System shall provide a mechanism for operators/administrators to enter the email contact information for users to receive alerts. | User Need 9 | ICMS-Data Hub | H |
| DH-6-3 | **ICMS-Data Hub Configurable Post Refresh Time**<br>The ICMS-Data Hub System shall provide a mechanism for operators/administrators to enter the time period at which the ICMS Data Hub shall post data for other systems to acquire. | User Need 9 | ICMS-Data Hub | H |
| DH-6-4 | **ICMS-Data Hub Configurable Data Storage Timeframe**<br>The ICMS-Data Hub System shall provide a mechanism for operators/administrators to enter the time period that messages and data shall be stored for before being discarded. | User Need 9 | ICMS-Data Hub | H |
| DH-6-5 | **ICMS-Data Hub shall maintain security by requiring administrators to login to the system.**<br>The ICMS-Data Hub System shall require administrators to login to the system before configuring settings. | User Need 9 | ICMS-Data Hub | H |
| DH-6-6 | **ICMS-Data Hub security of operator interface**<br>The ICMS-Data Hub System shall provide a mechanism for operators to enter login and passwords to access the system. | User Need 9 | ICMS-Data Hub | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| DH-6-7 | **ICMS-Data Hub security of administrator interface**<br>The ICMS-Data Hub System shall provide a mechanism for administrators to enter login and passwords to access the system to adjust configurable values. | User Need 9 | ICMS-Data Hub | H |
| DH-6-8 | **ICMS-Data Hub security create user accounts**<br>The ICMS-Data Hub System shall provide a mechanism for system administrators to create user accounts and assign privileges. | User Need 9 | ICMS-Data Hub | H |
| DH-6-9 | **ICMS-Data Hub adjust configuration settings**<br>The ICMS-Data Hub System shall adjust configuration settings when administrators enter new values within 30 seconds and shall not require a restart of the system. | User Need 9 | ICMS-Data Hub | H |
| **DH-7** | **The ICMS-Data Hub Shall Post ICMS-Data.** | User Need 1 | ICMS-Data Hub | H |
| DH-7-1 | **ICMS-Data Hub Post Data: Time**<br>The ICMS-Data Hub System shall post data sent to the ICMS-Data Hub from the ICMS Systems within a certain time after receiving the data, this time period shall be configurable by an ICMS Administrator, as per the ICMS Data Hub Post ICD. | User Need 1 and 6 | ICMS-Data Hub | H |
| DH-7-2 | **ICMS-Data Hub Post Incident Data: Malfunctioning**<br>The ICMS-Data Hub System shall post 'no data available' if no data is received from specific ICMS Systems. | User Need 1 and 6 | ICMS-Data Hub | H |
| **DH-8** | **The ICMS-Data Hub Shall Store ICMS-Data Received from the ICMS Systems.** | User Need 1 | ICMS-Data Hub | H |
| DH-8-1 | **ICMS-Data Hub Store ICMS Data: Summary**<br>The ICMS-Data Hub System shall store messages and data received from other systems. | User Need 1 | ICMS-Data Hub | H |
| DH-8-2 | **ICMS-Data Hub Store ICMS Data: Duration**<br>The ICMS-Data Hub System shall store messages and data received from other systems for a duration that is configurable by an ICMS Administrator up to a maximum of one week. | User Need 1 | ICMS-Data Hub | H |

## 4.2 ICMS Enhancements to Metro Transit Control Center (ICMS-MTCC) Functional Requirements

This section describes the requirements for the enhancements to the MTCC (referred to as ICMS-MTCC). The enhanced MTCC will perform five key functions (data input and storage, interface to field devices, information dissemination to travelers, operator/administrator interface, and data output to ICMS Data Hub). Figure 23 illustrates the five key functions and Table 8 includes the ICMS-MTCC System requirements to ease software development and testing.

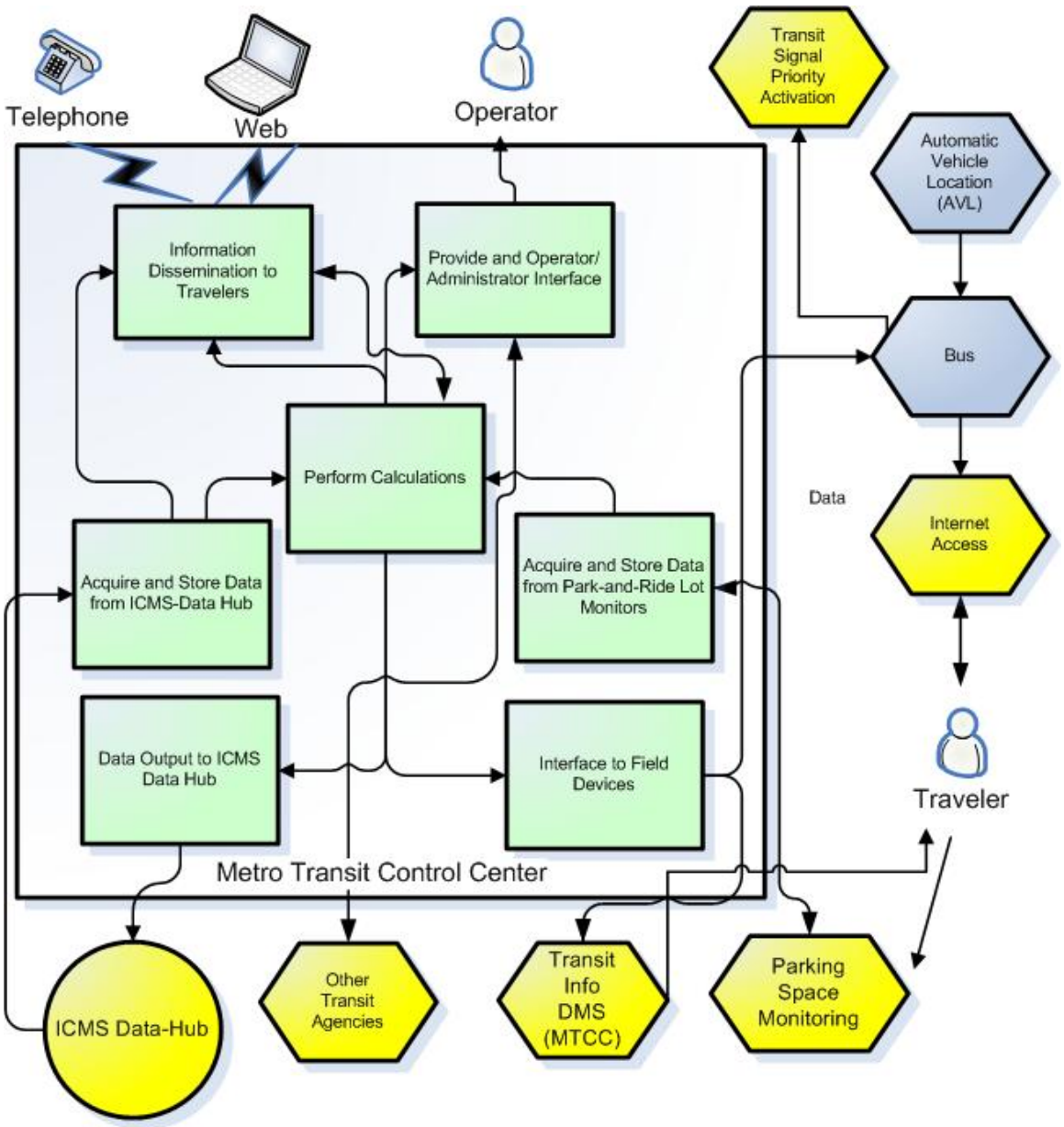


***Figure 23: ICMS-MTCC Functions***

***Table 8: ICMS-MTCC Requirements***

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **MTCC-1** | **The ICMS-MTCC System Shall Acquire and Store Data within the ICM Corridor from the ICMS-Data Hub.** | User Need 7,11,12,13 | ICMS-MTCC | H |
| MTCC-1-1 | **ICMS-MTCC Acquire and Store Incident and Event Data**<br>The ICMS-MTCC System shall acquire and store from the ICMS-Data Hub Incident and Event Data for roadways within the ICM corridor. | User Need 7,11,12,13 | ICMS-MTCC | H |
| MTCC-1-1-1 | **ICMS-MTCC Acquire and Store Incident and Event Data: Data Exchanges**<br>The ICMS-MTCC System shall interface to the ICMS-Data Hub according to requirements of the ICMS-Data Hub Post ICD to acquire and store Incident and Event Data. | User Need 7,11,12,13 | ICMS-MTCC | H |
| MTCC-1-1-2 | **ICMS-MTCC Acquire and Store Incident and Event Data: Frequency**<br>The ICMS-MTCC System shall acquire and store Incident and Event Data from the ICMS-Data Hub at a frequency that may be configured by an administrator. | User Need 7,11,12,13 | ICMS-MTCC | H |
| MTCC-1-1-3 | **ICMS-MTCC Acquire and Store Incident and Event Data: Location**<br>The ICMS-MTCC System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location. | User Need 7,11,12,13 | ICMS-MTCC | H |
| MTCC-1-1-3-1 | **ICMS-MTCC Acquire and Store Incident and Event Data: Location Detail**<br>The ICMS-MTCC System shall acquire and Incident and Event Data from the ICMS-Data Hub describing the incident or event location as a geo reference. | User Need 7,11,12,13 | ICMS-MTCC | H |
| MTCC-1-1-4 | **ICMS-MTCC System Acquire and Store Incident and Event Data: Type**<br>The ICMS-MTCC System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident type. | User Need 7,11,12,13 | ICMS-MTCC | H |
| MTCC-1-1-5 | **ICMS-MTCC Acquire and Store Incident and Event Data: Time**<br>The ICMS-MTCC System shall acquire and store any available Incident and Event Data from the ICMS-Data Hub describing the incident or event time elements: start time, vehicle arrival time, and clearance time. | User Need 7,11,12,13 | ICMS-MTCC | H |
| MTCC-1-2 | **ICMS-MTCC Acquire and Store Freeway Traffic Data**<br>The ICMS-MTCC System shall acquire and store Freeway Traffic Data from the ICMS-Data Hub. | User Need 1,7,17 | ICMS-MTCC | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| MTCC-1-2-1 | **ICMS-MTCC Acquire and Store Freeway Traffic Data: Data Exchanges**<br>The ICMS-MTCC System shall interface with the ICMS-Data Hub in accordance with the ICMS-Data Hub Post ICD to acquire and store Freeway Traffic Data. | User Need 1,7,17 | ICMS-MTCC | H |
| MTCC-1-2-2 | **ICMS-MTCC Acquire and Store Freeway Traffic Data: Frequency**<br>The ICMS-MTCC System shall acquire and store Freeway Traffic Data from the ICMS-Data Hub at a frequency configurable by an ICMS-MTCC Administrator. | User Need 1,7,17 | ICMS-MTCC | H |
| MTCC-1-2-3 | **ICMS-MTCC Acquire and Store Freeway Traffic Data: Traffic Details**<br>The ICMS-MTCC System shall acquire and store Freeway Traffic Data from the ICMS-Data Hub describing volume, occupancy, and speed data for sensor stations along:<br>- The I-394 mainline and I-394 ramps<br>- I-494<br>- Hwy 100<br>- Hwy 169. | User Need 1,7,17 | ICMS-MTCC | H |
| MTCC-1-2-4 | **ICMS-MTCC Acquire and Store Freeway Traffic Data: Travel Times**<br>The ICMS-MTCC System shall acquire and store Freeway Traffic Data from the ICMS-Data Hub describing travel times. | User Need 1,7,17 | ICMS-MTCC | H |
| MTCC-1-2-5 | **ICMS-SWT Acquire Mn/PASS direction and rate data.**<br>The ICMS-SWT System shall acquire Mn/PASS lane direction and pricing data from the ICMS-Data Hub, as per the ICMS-Data Hub Post ICD at least once every 2 minutes. | User Need 17 | ICMS-SWT | H |
| MTCC-1-3 | **ICMS-MTCC Acquire and Store Special Event and Incident Signal Timing Plans Data**<br>The ICMS-MTCC System shall acquire and store Special Event and Incident Signal Timing Plans Data from the ICMS-Data Hub. | User Need 17 | ICMS-MTCC | H |
| MTCC-1-3-1 | **ICMS-MTCC Acquire and Store Special Event and Incident Signal Timing Plans Data: Data Exchanges**<br>The ICMS-MTCC System shall interface with the ICMS-Data Hub in accordance with the ICMS-Data Hub Post ICD to acquire and store Special Events and Incident Signal Timing Plans Data. | User Need 17 | ICMS-MTCC | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| MTCC-1-3-2 | **ICMS-MTCC Acquire and Store Special Event and Incident Timing Plans: Frequency**<br>The ICMS-MTCC System shall acquire and store Special Event and Incident Timing Plans from the ICMS-Data Hub at a frequency configurable by an ICMS-MTCC Administrator. | User Need 17 | ICMS-MTCC | H |
| MTCC-2 | **The ICMS-MTCC System Shall Acquire and Store Park-and-Ride Space Information** | User Need 5,6,8,9 | ICMS-MTCC | H |
| MTCC-2-1 | **ICMS-MTCC Acquire and Store Park-and-Ride space availability information.**<br>The ICMS-MTCC System shall acquire and store Park-and-Ride space availability data for each Metro Transit operated Park-and-Ride facility in the ICM corridor from field equipment operated at the Park-and-Ride facility. | User Need 5,6,8,9 | ICMS-MTCC | H |
| MTCC-2-1-1 | **ICMS-MTCC Acquire and Store Park-and-Ride space availability information - format**<br>The ICMS-MTCC System shall interface with the Park-and-Ride facilities in accordance with the MTCC ICD. | User Need 5,6,8,9 | ICMS-MTCC | H |
| MTCC-2-2 | **ICMS-MTCC Acquire and Store Notices of Temporary Park-and-Ride Lot operation when entered into the MTCC CAD system.**<br>The ICMS-MTCC System shall acquire data describing temporary Park-and-Ride lot operation when activated within the MTCC system. | User Need 5,6,8,9 | ICMS-MTCC | H |
| **MTCC-3** | **The ICMS-MTCC System Shall Calculate Transit Travel Times.** | User Need 5,6,8,9 | ICMS-MTCC | H |
| MTCC-3-1 | **ICMS-MTCC Calculate Transit Travel Times: Route Designation**<br>The ICMS-MTCC System shall calculate transit travel times that estimate the time for a transit rider to travel from each park-and-ride facility to downtown Minneapolis. | User Need 5,6,8,9 | ICMS-MTCC | H |
| MTCC-3-2 | **ICMS-MTCC Calculate Transit Travel Times: Frequency**<br>The ICMS-MTCC System shall calculate transit travel times at a frequency configurable by an ICMS Administrator. | User Need 5,6,8,9 | ICMS-MTCC | H |
| **MTCC-4** | **The ICMS-MTCC System Shall Calculate the Park-and-Ride Lot Parking Availability.** | User Need 5,6,8,9 | ICMS-MTCC | H |
| MTCC-4-1 | **ICMS-MTCC Calculate Park-and-Ride Lot Parking Status: Frequency**<br>The ICMS-MTCC System shall calculate park-and-ride lot parking status updates using the data acquired from each Park-and-Ride lot at a frequency configurable by an ICMS Administrator. | User Need 5,6,8,9 | ICMS-MTCC | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **MTCC-5** | **The ICMS-MTCC System shall Send Data to the ICMS-Data Hub.** | User Need 5,6,8,9,10 | ICMS-MTCC | H |
| MTCC-5-1 | **ICMS-MTCC Generate and Send Transit Travel Time Messages.**<br>The ICMS-MTCC System shall generate and send transit travel time messages to the ICMS-Data Hub System for each Park-and-Ride facility to downtown Minneapolis. | User Need 10,11, 12,13 | ICMS-MTCC | H |
| MTCC-5-1-1 | **ICMS-MTCC Generate and Send Transit Travel Time Messages: Data Exchanges**<br>The ICMS-MTCC System shall interface with the ICMS Data-Hub System according to the ICMS-MTCC to ICMS-Data Hub ICD to send Transit Travel Time Data. | User Need 10,11, 12,13 | ICMS-MTCC | H |
| MTCC-5-1-2 | **ICMS-MTCC Generate and Send Transit Travel Time Messages: Frequency**<br>The ICMS-MTCC System shall send Transit Travel Time Data to the ICMS-Data Hub at a schedule frequency configurable by an ICMS Administrator. | User Need 10,11, 12,13 | ICMS-MTCC | H |
| MTCC-5-1-3 | **ICMS-MTCC Generate and Send Transit Travel Time Messages: No Data**<br>The ICMS-MTCC System shall send a message reporting that “no data available’ if the transit travel times can not be calculated for any reason. | User Need 10,11, 12,13 | ICMS-MTCC | H |
| MTCC-5-2 | **ICMS-MTCC Generate and Send Messages Describing Transit Incidents**<br>The ICMS-MTCC System shall generate and send messages describing Transit Incidents along transit routes that pass through the ICM corridor. | User Need 10,11, 12,13 | ICMS-MTCC | H |
| MTCC-5-2-1 | **ICMS-MTCC Generate and Send Messages Describing Transit Incidents: Data Exchanges**<br>The ICMS-MTCC System shall interface with the ICMS Data-Hub System according to the ICMS-MTCC to ICMS-Data Hub ICD to send Transit Incident Data. | User Need 10,11, 12,13 | ICMS-MTCC | H |
| MTCC-5-2-2 | **ICMS-MTCC Generate and Send Messages Describing Transit Incidents: Frequency**<br>The ICMS-MTCC System shall send Transit Incident Data to the ICMS-Data Hub within 3 minutes from when the incident is entered in the MTCC CAD system. | User Need 4 | ICMS-MTCC | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| MTCC-5-3 | **ICMS-MTCC Generate and Send Messages Describing Park-and-Ride status**<br>The ICMS-MTCC System shall generate and send messages describing Transit Park-and-Ride Status for each Metro Transit operated lot to the ICMS-Data Hub. | User Need 4 | ICMS-MTCC | H |
| MTCC-5-3-1 | **ICMS-MTCC Generate and Send Messages Describing Park-and-Ride status: Data Exchanges**<br>The ICMS-MTCC System shall interface with the ICMS Data-Hub System according to the ICMS-MTCC to ICMS-Data Hub ICD to send Park-and-Ride Parking Status Data. | User Need 4 | ICMS-MTCC | H |
| MTCC-5-3-2 | **ICMS-MTCC Generate and Send Messages Describing Park-and-Ride status: Data Exchanges: Frequency**<br>The ICMS-MTCC System shall generate and send Park-and-Ride Parking Status Data to the ICMS-Data Hub System each time a new Park-and-Ride calculation is performed. | User Need 4 | ICMS-MTCC | H |
| MTCC-5-3-3 | **ICMS-MTCC Generate and Send Messages Describing Park-and-Ride status: Data Exchanges No Data Available**<br>The ICMS-MTCC System shall generate and send Park-and-Ride Parking Status Data to the ICMS-Data Hub System indicating “no data available’ if no data is available. | User Need 4 | ICMS-MTCC | H |
| MTCC-5-3-4 | **ICMS-MTCC Generate and Send Transit Park-and-Ride Parking Status Data: Details**<br>The ICMS-MTCC System shall generate and send to the ICMS-Data Hub System Park-and-Ride Parking Status messages that include: the lot ID, the number of spaces that exist on the lot, the number of spaces calculated to be occupied, and a timestamp of when the data was collected. | User Need 4 | ICMS-MTCC | H |
| MTCC-5-4 | **ICMS-MTCC Generate and Send Messages Describing Temporary Park-and-Ride Lots**<br>The ICMS-MTCC System shall generate and send messages describing Temporary Park-and-Ride Lot operation to the ICMS-Data Hub System. | User Need 4,15,16 | ICMS-MTCC | H |
| MTCC-5-4-1 | **ICMS-MTCC Generate and Send Messages Describing Transit Temporary Park-and-Ride Lot Data: Data Exchanges**<br>The ICMS-MTCC shall interface with the ICMS Data-Hub System according to the ICMS-MTCC to ICMS-Data Hub ICD to send Temporary Park-and-Ride Lot Data. | User Need 4,15,16 | ICMS-MTCC | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| MTCC-5-4-2 | **ICMS-MTCC Generate and Send Messages Describing Transit Temporary Park-and-Ride Lot Data: Frequency**<br>The ICMS-MTCC System shall send Temporary Park-and-Ride Lot Data to the ICMS-Data Hub when temporary Park-and-Ride information is available in the MTCC CAD system. | User Need 4,15,16 | ICMS-MTCC | H |
| MTCC-5-4-3 | **ICMS-MTCC Generate and Send Messages Describing Transit Temporary Park-and-Ride Parking Status Data: No Data Available**<br>The ICMS-MTCC System shall send Temporary Park-and-Ride Parking Status Data to the ICMS-Data Hub indicating "no data available' if no data is available. | User Need 4,15,16 | ICMS-MTCC | H |
| MTCC-5-4-4 | **ICMS-MTCC Generate and Send Temporary Transit Park-and-Ride Lot Data: Details**<br>The ICMS-MTCC System shall generate and send messages to the ICMS-Data Hub describing Temporary Park-and-Ride Lot Data describing the lot ID, the location of the lot, the bus routes served by the lot, and the name of the event the lot was opened for . | User Need 4,15,16 | ICMS-MTCC | H |
| **MTCC-6** | **The ICMS-MTCC System Shall Disseminate Information to Transit Travelers using Existing Metro Transit Operated Traveler Information Systems.** | User Need 8,9 | ICMS-MTCC | H |
| MTCC-6-1 | **ICMS-MTCC shall disseminate transit travel times.**<br>The ICMS-MTCC System shall disseminate transit travel times to travelers using the Metro Transit information dissemination system. | User Need 8,9 | ICMS-MTCC | H |
| MTCC-6-2 | **ICMS-MTCC shall disseminate Park-and-Ride availability information.**<br>The ICMS-MTCC System shall disseminate Park-and-Ride availability information using the Metro Transit information dissemination system. | User Need 8,9 | ICMS-MTCC | H |
| **MTCC-7** | **The ICMS-MTCC System Shall Interface with Field Devices.** | User Need 7,8 | ICMS-MTCC | H |
| MTCC-7-1 | **ICMS-MTCC shall Interface with Transit Signal Priority Devices**<br>The ICMS-MTCC System shall provide a mechanism for buses or bus operators to activate Transit Signal Priority at designated locations. | User Need 7,8 | ICMS-MTCC | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| MTCC-7-2 | **ICMS-MTCC shall Interface with DMS**<br>The ICMS-MTCC System shall automatically generate and post messages to DMS located at Park-and-Ride facilities. | User Need 4,9 | ICMS-MTCC | H |
| MTCC-7-2-1 | **ICMS-MTCC shall Interface with DMS: Park-n-Ride messages**<br>The ICMS-MTCC System shall automatically generate and post messages to DMS located at Park-and-Ride facilities describing the parking availability at the facility. | User Need 4,9 | ICMS-MTCC | H |
| MTCC-7-2-2 | **ICMS-MTCC shall Interface with DMS: Transit Travel Times**<br>The ICMS-MTCC System shall automatically generate and post messages to DMS located at Park-and-Ride facilities describing transit travel times to downtown Minneapolis. | User Need 4,9 | ICMS-MTCC | H |
| MTCC-7-2-3 | **ICMS-MTCC shall Interface with DMS: Configuration of message content**<br>The ICMS-MTCC System shall provide a mechanism for operators/administrators to configure whether park-and-ride messages or transit travel time messages, or both are posted to the signs. | User Need 4,9 | ICMS-MTCC | H |
| MTCC-7-2-4 | **ICMS-MTCC shall Interface with DMS: Frequency**<br>The ICMS-MTCC System shall automatically generate and post messages to DMS located at Park-and-Ride facilities each time the Park-and-Ride calculations update the parking availability during periods of time each day that are configurable by an administrator. | User Need 4,9 | ICMS-MTCC | H |
| MTCC-7-2-5 | **ICMS-MTCC shall Interface with DMS: Protocol**<br>The ICMS-MTCC System shall communicate messages to the DMS signs in accordance with the requirements in the ICMS-MTCC Sign Control ICD | User Need 4,9 | ICMS-MTCC | H |
| MTCC-7-3 | **ICMS-MTCC shall Interface with Park-and-Ride Lots**<br>The ICMS-MTCC System shall communicate with Park-and-Ride lot vehicle counters in order to acquire the data from park-and-ride facilities. | User Need 4,5,9 | ICMS-MTCC | H |
| MTCC-7-4 | **ICMS-MTCC shall Interface with Transit Agencies**<br>The ICMS-MTCC System shall provide a mechanism for MTCC Operators to interface with other Transit Agencies within the corridor. | User Need 10 | ICMS-MTCC | H |
| MTCC-7-5 | **ICMS-MTCC shall Interface with Wireless Internet**<br>The ICMS-MTCC System shall provide a mechanism for MTCC Riders to interface with Internet Access. | User Need 7,8,10 | ICMS-MTCC | H |
| **MTCC-8** | **The ICMS-MTCC System Shall Provide an Operator/Administrator Interface.** | User Need 10,11, 12,13 | ICMS-MTCC | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| MTCC-8-1 | **ICMS-MTCC shall configure frequency of transit travel time calculations.**<br>The ICMS-MTCC System shall provide a mechanism for operators/administrators to configure the frequency at which the transit travel times are calculated. | User Need 10,11, 12,13 | ICMS-MTCC | H |
| MTCC-8-2 | **ICMS-MTCC shall configure frequency of transit travel time message send.**<br>The ICMS-MTCC shall provide a mechanism for operators/administrators to configure the frequency at which the transit travel times messages are generated and sent to the ICMS-Data Hub System. | User Need 9 | ICMS-MTCC | H |
| MTCC-8-3 | **ICMS-MTCC shall configure frequency of Park-and-Ride data acquisition.**<br>The ICMS-MTCC shall provide a mechanism for operators/administrators to configure the frequency at which the ICMS-MTCC acquires Park-and-Ride space availability data from the Metro Transit operated Park-and-Ride lots. | User Need 4,5,8,9 | ICMS-MTCC | H |
| MTCC-8-4 | **ICMS-MTCC shall configure time periods when DMS messages are posted.**<br>The ICMS-MTCC shall provide a mechanism for operators/administrators to configure periods of time each day that DMS messages are posted describing Park-and-Ride Lot availability. | User Need 4,5,8,9 | ICMS-MTCC | H |
| MTCC-8-5 | **ICMS-MTCC shall configure DMS content display.**<br>The ICMS-MTCC System shall provide a mechanism for operators/administrators to configure what messages are sent to the DMS displays. | User Need 4,5,8,9 | ICMS-MTCC | H |
| MTCC-8-6 | **ICMS-MTCC shall configure frequency for DMS message posts**<br>The ICMS-MTCC shall provide a mechanism for operators/administrators to configure the frequency that messages are posted to DMS signs. | User Need 4,5,8,9 | ICMS-MTCC | H |
| MTCC-8-7 | **ICMS-MTCC shall provide an operator interface**<br>The ICMS-MTCC shall provide a mechanism for operators to view the information and data acquired by the ICMS-MTCC from the ICMS-Data Hub and from the park-and-ride lot monitors. | User Need 4,5,8,9 | ICMS-MTCC | H |
| MTCC-8-8 | **ICMS-MTCC shall provide an administrator and operator log-in**<br>The ICMS-MTCC shall provide a mechanism for operators and administrators to log in to the system by entering a password. | User Need 4,5,8,9 | ICMS-MTCC | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| MTCC-8-9 | **ICMS-MTCC shall provide an operator interface – security of login**<br>The ICMS-MTCC shall provide a mechanism for the system administrator to create user accounts for operators and administrators. | User Need 4,5,8,9 | ICMS-MTCC | H |
| MTCC-8-9 | **ICMS-MTCC shall maintain security by requiring administrators to login to the system.**<br>The ICMS-MTCC System shall require administrators to login to the system before configuring settings. | User Need 4,5,8,9 | ICMS-MTCC | H |

## 4.3 ICMS Enhancements to Mn/DOT Traffic Operations (ICMS-Traffic Operations) Functional Requirements

The Mn/DOT Traffic Operations Center will be enhanced as part of the ICMS project. This section describes the requirements for the enhancements to the Mn/DOT Traffic Operations Center. In summary, the Mn/DOT Traffic Operations requirements are presented according to five overall functions to be performed by the operations center specifically for the ICMS (data input and storage, operator interface, message generation and dissemination, field device control, and data output to the ICMS Data Hub). Figure 24 illustrates the ICMS-Traffic Operations System functions and Table 9 includes the ICMS-Traffic Operations System requirements to ease software development and testing.

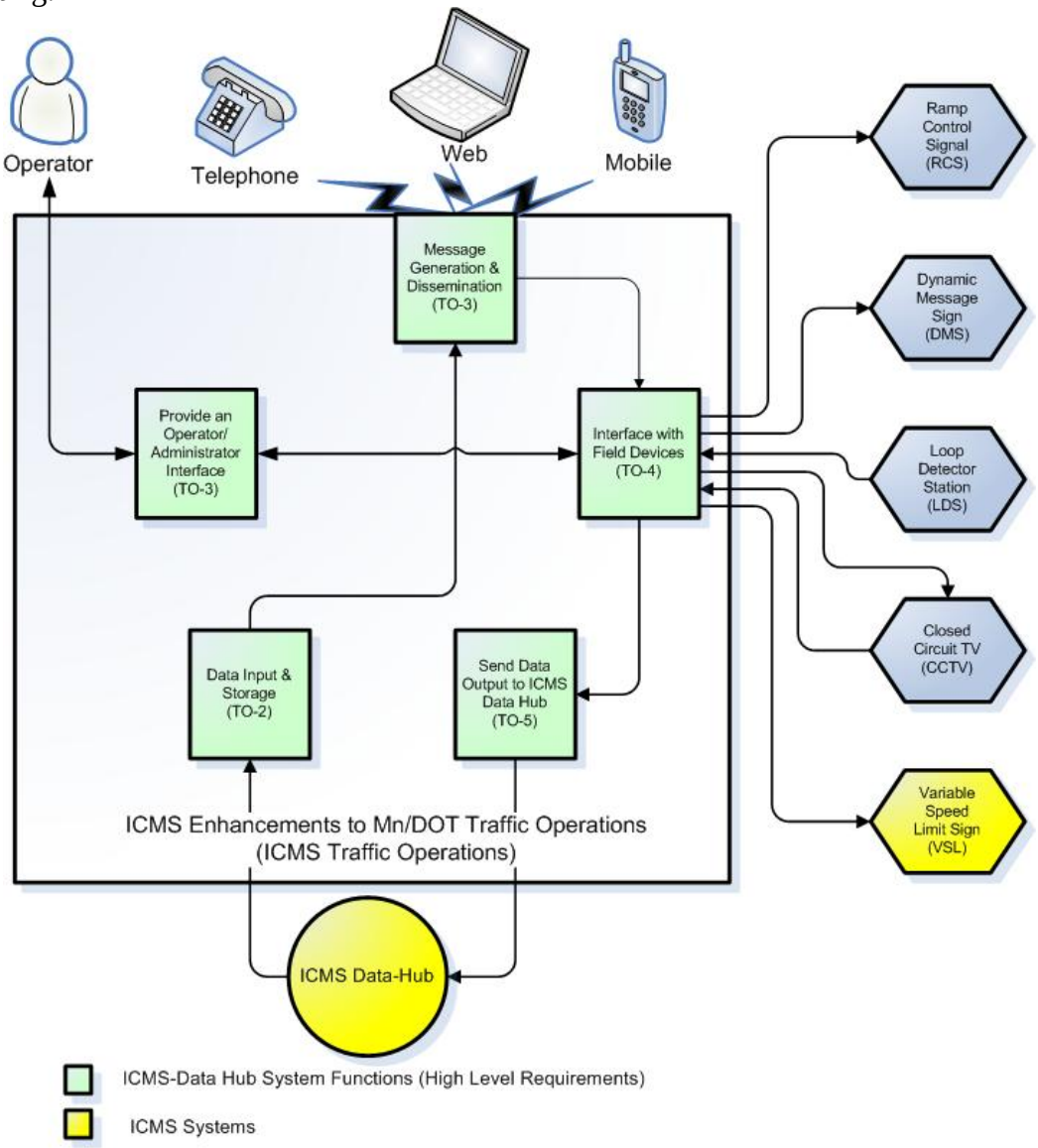


***Figure 24: ICMS-Traffic Operations Functions***

*Table 9: ICMS-Traffic Operations Requirements*

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **TO-1** | **The ICMS-Traffic Operations System Shall Acquire and Store Messages from the ICMS-Data Hub.** | User Need 1,5,6,8 | ICMS-Traffic Operations | H |
| TO-1-1 | **ICMS-Traffic Operations Acquire and Store Travel Time Data**<br>The ICMS-Traffic Operations System shall acquire and store messages describing Travel Times for Arterial Streets and Transit Routes within the ICM Corridor posted by the ICMS-Data Hub. | User Need 1,5,6,9 | ICMS-Traffic Operations | H |
| TO-1-1-1 | **ICMS-Traffic Operations Acquire and Store Travel Time Data: Data Exchanges**<br>The ICMS-Traffic Operations System shall interface with the ICMS-Data Hub System, as per the ICMS-Data Hub Post ICD to acquire and store messages describing Travel Times. | User Need 1,5,6,9 | ICMS-Traffic Operations | H |
| TO-1-1-2 | **ICMS-Traffic Operations Acquire and Store Travel Time Data: Frequency**<br>The ICMS-Traffic Operations System shall acquire and store Travel Time Data from the ICMS-Data Hub at a frequency configurable by an ICMS Traffic Operations Administrator. | User Need 1,5,6,9 | ICMS-Traffic Operations | H |
| TO-1-2 | **ICMS-Traffic Operations Acquire and Store A,B,C Parking Messages**<br>The ICMS-Traffic Operations System shall acquire and store messages describing Parking Availability in the A,B,C Garages posted by the ICMS-Data Hub System so that the ICMS-Traffic Operations system may post these messages on DMS signs controlled by the ICMS-Traffic Operations. | User Need 5,9,10 | ICMS-Traffic Operations | H |
| TO-1-2-1 | **ICMS-Traffic Operations Acquire and Store A,B,C Parking Messages: Data Exchanges**<br>The ICMS-Traffic Operations System shall interface with the ICMS-Data Hub according to the requirements of the ICMS-Data Hub Post ICD to acquire and store messages describing Parking Availability in the A,B,C Garages. | User Need 5,9,10 | ICMS-Traffic Operations | H |
| TO-1-2-2 | **ICMS-Traffic Operations Acquire and Store A,B,C Parking Messages: Frequency**<br>The ICMS-Traffic Operations System shall acquire and store Parking Availability Messages from the ICMS-Data Hub at a frequency configurable by an ICMS Traffic Operations Administrator. | User Need 5,9,10 | ICMS-Traffic Operations | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| TO-1-3 | **ICMS-Traffic Operations Acquire and Store Incident and Event Data**<br>The ICMS-Traffic Operations System shall acquire and store from the ICMS-Data Hub System Incident and Event Data (including incidents and events sent to the ICMS-Data Hub from ICMS-EMS and ICMS-Transit Systems) for all roads within the ICM Corridor. | User Need 1,10,11,12,13 | ICMS-Traffic Operations | H |
| TO-1-3-1 | **ICMS-Traffic Operations Acquire and Store Incident and Event Data: Data Exchanges**<br>The ICMS-Traffic Operations System shall interface with the ICMS-Data Hub System as per the ICMS-Data Hub Post ICD to acquire and store Incident and Event Data. | User Need 1, ,11,12, 13 | ICMS-Traffic Operations | H |
| TO-1-3-2 | **ICMS-Traffic Operations Acquire and Store Incident and Event Data: Frequency**<br>The ICMS-Traffic Operations System shall acquire and store Incident and Event Data from the ICMS-Data Hub System at a frequency configurable by an ICMS Administrator. | User Need 1,11,12,13 | ICMS-Traffic Operations | H |
| TO-1-3-3 | **ICMS-Traffic Operations Acquire and Store Incident and Event Data: Location**<br>The ICMS-Traffic Operations shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location. | User Need 1,11,12,13 | ICMS-Traffic Operations | H |
| TO-1-3-4 | **ICMS-Traffic Operations Acquire and Store Incident and Event Data: Location Detail**<br>The ICMS-Traffic Operations shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location as a geo reference. | User Need 1,11,12,13 | ICMS-Traffic Operations | H |
| TO-1-3-5 | **ICMS-Traffic Operations Acquire and Store Incident and Event Data: Type**<br>The ICMS-Traffic Operations shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident type. | User Need 1,11,12,13 | ICMS-Traffic Operations | H |
| TO-1-3-6 | **ICMS-Traffic Operations Acquire and Store Incident and Event Data: Time**<br>The ICMS-Traffic Operations shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event time elements: start time, vehicle arrival time, and clearance time. | User Need 1,11,12,13 | ICMS-Traffic Operations | H |
| TO-1-4 | **ICMS-Traffic Operations Acquire and Store park-and-ride space availability data.**<br>The ICMS-Traffic Operations System shall acquire and store from the ICMS-Data Hub System park-and-ride space availability data for all park-and-ride facilities within the ICM Corridor. | User Need 4 | ICMS-Traffic Operations | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| TO-1-4-1 | **ICMS-Traffic Operations Acquire and Store Park-and-ride availability data: Data Exchanges**<br>The ICMS-Traffic Operations System shall interface with the ICMS-Data Hub System as per the ICMS-Data Hub Post ICD to acquire and store park-and-ride space availability data. | User Need 4 | ICMS-Traffic Operations | H |
| TO-1-4-2 | **ICMS-Traffic Operations Acquire and Store park-and-ride availability Data: Frequency**<br>The ICMS-Traffic Operations System shall acquire and store park-and-ride availability Data from the ICMS-Data Hub System at a frequency configurable by an ICMS Administrator. | User Need 4 | ICMS-Traffic Operations | H |
| TO-1-5 | **ICMS-Traffic Operations Acquire and Store transit performance data.**<br>The ICMS-Traffic Operations System shall acquire and store from the ICMS-Data Hub System transit performance data for transit vehicles operating within the ICM Corridor. | User Need 4 | ICMS-Traffic Operations | H |
| TO-1-5-1 | **ICMS-Traffic Operations Acquire and Store Park-and-ride availability data: Data Exchanges**<br>The ICMS-Traffic Operations System shall interface with the ICMS-Data Hub System as per the ICMS-Data Hub Post ICD to acquire and store transit performance data. | User Need 4 | ICMS-Traffic Operations | H |
| TO-1-5-2 | **ICMS-Traffic Operations Acquire and Store park-and-ride availability Data: Frequency**<br>The ICMS-Traffic Operations System shall acquire and store transit performance data from the ICMS-Data Hub System at a frequency configurable by an ICMS Administrator. | User Need 4 | ICMS-Traffic Operations | H |
| **TO-2** | **The ICMS-Traffic Operations System Shall Generate and Disseminate Messages.** | User Need 3 | ICMS-Traffic Operations | H |
| TO-2-1 | **Generate Travel Times Messages**<br>The ICMS-Traffic Operations System shall generate travel time messages describing conditions on I-394, Hwy 55, and transit routes between park-and-ride lots and downtown Minneapolis using formats and data structures compatible with the Mn/DOT Traffic Operations 511 phone and web information dissemination systems. | User Need 3 | ICMS-Traffic Operations | H |
| TO-2-1-1 | **Generate Travel Times Messages**: **Corridor-Wide**<br>The ICMS-Traffic Operations System shall generate a travel time message that describes the corridor-wide travel time conditions along I-394, Hwy 55, and transit routes from park-and-ride lots to Downtown Minneapolis, including a comment about park-and-ride space availability. | User Need 3, 4 | ICMS-Traffic Operations | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| TO-2-1-2 | **Generate Travel Times Messages**: **Corridor-Wide Travel Times Resolution**<br>The ICMS-Traffic Operations System shall generate a corridor-wide travel time message that contains travel time estimates as numerical values rounded to the nearest whole minute. | User Need 3 | ICMS-Traffic Operations | H |
| TO-2-1-3 | **Generate Travel Times Messages**: **Corridor-Wide Travel Times Expiry**<br>The ICMS-Traffic Operations System shall generate travel time messages using stored data that is less than 5 minutes old. If new data is not available, no message shall be generated or disseminated. | User Need 3 | ICMS-Traffic Operations | H |
| TO-2-1-4 | **Generate Travel Times Messages**: **Corridor-Wide Travel Times Handling or Missing Data**<br>When generating travel time messages, the ICMS-Traffic Operations System shall omit a road in the message in the event that no current data is available to calculate travel time. | User Need 3 | ICMS-Traffic Operations | H |
| TO-2-2 | **Generate Travel Times Messages**: **Corridor-Wide Message**<br>The ICMS-Traffic Operations System shall generate corridor-wide travel time messages that include a timestamp, travel times and route description. | User Need 3 | ICMS-Traffic Operations | H |
| TO-2-3 | **Disseminate Travel Time Messages**<br>The ICMS-Traffic Operations System shall insert the generated Travel Time Messages into the existing Mn/DOT Traveler Information Systems so the messages are disseminated to the public. | User Need 3 | ICMS-Traffic Operations | H |
| TO-2-4 | **Malfunctioning Device Reports**<br>The ICMS shall create and store reports of any malfunctioning interface. | User Need 18 | ICMS-Traffic Operations | H |
| TO-2-4-1 | **Malfunctioning Device Reports: Send to Operators**<br>The ICMS-Traffic Operations shall send a report of any malfunctioning interface to ICMS-Traffic Operations operators designated during the design process. | User Need 18 | ICMS-Traffic Operations | H |
| TO-2-4-2 | **Malfunctioning Device Reports: Monitor Send Failures**<br>The ICMS-Traffic Operations shall generate a log report every time an interface fails to send data to another system. | User Need 18 | ICMS-Traffic Operations | H |
| TO-2-4-3 | **Malfunctioning Device Reports: Monitor Receive Failures**<br>The ICMS shall generate a log report every time an attempt to acquire data from an external system fails. | User Need 18 | ICMS-Traffic Operations | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| TO-2-5 | **Generate I-394 Advisory Speed Limit Messages**<br>The ICMS-Traffic Operations shall create advisory speed messages. | User Need 17 | ICMS-Traffic Operations | H |
| TO-2-5-1 | **Generate I-394 Advisory Speed Limit Messages: Calculation**<br>The ICMS-Traffic Operations System shall calculate recommended advisory speed limits for each segment of I-394 and generate messages compatibility with the data structure and standards used to post messages to advisory speed signs. | User Need 17 | ICMS-Traffic Operations | H |
| TO-2-5-2 | **Generate I-394 Advisory Speed Messages: Data Input**<br>The ICMS-Traffic Operations System shall calculate advisory speed limits using an algorithm that considers data describing the current flow, speed, and occupancy as well as any additional factors defined during the design process. | User Need 17 | ICMS-Traffic Operations | H |
| TO-2-5-3 | **Generate I-394 Advisory Speed Messages: Speed Resolution**<br>The ICMS-Traffic Operations System shall calculate recommended advisory speed limits in 10 MPH increments. | User Need 17 | ICMS-Traffic Operations | H |
| TO-2-5-4 | **Generate I-394 Advisory Speed Messages: Trigger Processing**<br>The ICMS-Traffic Operations System shall compare the recommended advisory speeds that are calculated against the posted regulatory speed limit (either static or variable if variable is in operation). | User Need 17 | ICMS-Traffic Operations | H |
| TO-2-5-5 | **Generate I-394 Advisory Speed Messages: Trigger Processing: Alert Notification**<br>The ICMS-Traffic Operations shall trigger an alert if the recommended advisory speed limit differs from the current posted speed by more than 10 MPH. | User Need 17 | ICMS-Traffic Operations | H |
| TO-2-5-6 | **Generate I-394 Advisory Speed Messages: Trigger Processing: Over-ride**<br>The ICMS-Traffic Operations operators shall have the ability to manually over-ride the Advisory Speed Limit Message. | User Need 17 | ICMS-Traffic Operations | H |
| **TO-3** | **The ICMS-Traffic Operations System Shall Provide an Operator/Administrator Interface.** | User Need 1,11,12,13 | ICMS-Traffic Operations | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| TO-3-1 | **ICMS Display Corridor Conditions to Operators**<br>The ICMS-Traffic Operations System shall provide a mechanism for Operators to control systems or field devices. | User Need 1,11,12,13 | ICMS-Traffic Operations | H |
| TO-3-1-1 | **ICMS Display Corridor Conditions to Operators**: **ICMS-Traffic Operations Display ICMS Messages**<br>The ICMS-Traffic Operations System shall store ICMS-Data Hub messages acquired and display the information contained in the messages to operators using existing display terminals. | User Need 1,11,12,13 | ICMS-Traffic Operations | H |
| TO-3-1-2 | **I-394 Speed Limit Algorithm: Display to Operators**<br>The ICMS-Traffic Operations shall provide a mechanism for ICMS-Traffic Operations System operators to view the recommended advisory speed limit that the ICMS-Traffic Operations has recommended. | User Need 17 | ICMS-Traffic Operations | H |
| TO-3-1-3 | **ICMS Allow Operator Override of VSL Device Communication**<br>The ICMS-Traffic Operations shall provide a mechanism for operators to override recommended advisory variable speed limit messages from being sent to the sign. | User Need 17 | ICMS-Traffic Operations | H |
| TO-3-2 | **ICMS Traffic Operations Acquire ICMS Messages**<br>The ICMS-Traffic Operations System shall allow administrator/operator control of configurable settings. | User Need 1,6,9 | ICMS-Traffic Operations | H |
| TO-3-2-1 | **ICMS Traffic Operations Acquire ICMS Messages: Configuration of frequency**<br>The ICMS-Traffic Operations System shall provide a mechanism for administrators or operators to configure the frequency at which the ICMS-Traffic Operations System acquires data. | User Need 6 | ICMS-Traffic Operations | H |
| TO-3-2-2 | **ICMS Traffic Operations Acquire Data from ICMS-Data Hub: Incident and Event Data**<br>The ICMS Traffic Operations System shall provide a mechanism for the administrator/operator to configure the frequency at which the ICMS Traffic Operations System acquires Incident and Event messages from the ICMS-Data Hub | User Need 10 | ICMS-Traffic Operations | H |
| TO-3-2-3 | **ICMS Traffic Operations Acquire Data from ICMS-Data Hub: Travel Time Data**<br>The ICMS Traffic Operations System shall provide a mechanism for the administrator/operator to configure the frequency at which the ICMS Traffic Operations System acquires Travel Time messages from the ICMS-Data Hub | User Need 10 | ICMS-Traffic Operations | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| TO-3-2-4 | **ICMS Traffic Operations Acquire Data from ICMS-Data Hub: A,B,C Parking Data**<br>The ICMS Traffic Operations System shall provide a mechanism for the administrator/operator to configure the frequency at which the ICMS Traffic Operations System acquires messages describing A,B,C Parking Garage Availability from the ICMS-Data Hub | User Need 10 | ICMS-Traffic Operations | H |
| TO-3-2-5 | **I-394 Advisory Speed Limit Calculation: Frequency**<br>The frequency of Advisory speed limit calculations shall be configurable by an ICMS administrator. | User Need 1 | ICMS-Traffic Operations | H |
| TO-3-3 | **Provide mechanism to create operator/administrator accounts**<br>The ICMS Traffic Operations Systems shall provide a mechanism for system administrators to create user accounts that enable operators and administrators to login to the system. | User Need 1 | ICMS-Traffic Operations | H |
| TO-3-4 | **ICMS-Traffic Operations shall maintain security by requiring administrators to login to the system.**<br>The ICMS-Traffic Operations System shall require administrators to login to the system before configuring settings. | User Need 1 | ICMS-Traffic Operations | H |
| **TO-4** | **The ICMS-Traffic Operations System Shall Control Field Devices.** | User Need 10 | ICMS-Traffic Operations | H |
| TO-4-1 | **Post Messages to Dynamic Message Signs (DMS)**<br>The ICMS-Traffic Operations System shall post and verify DMS messages. | User Need 10 | ICMS-Traffic Operations | H |
| TO-4-1-1 | **Post Messages to Dynamic Message Signs (DMS)**<br>The ICMS-Traffic Operations System shall provide a mechanism to allow operators to post messages to travelers on signs along TH 55, and TH 7. | User Need 10 | ICMS-Traffic Operations | H |
| TO-4-1-2 | **Post Messages on TH 55**<br>The ICMS-Traffic Operations System shall provide a mechanism allowing operators within the RTMC to select the messages to be displayed on DMS signs located on TH 55. | User Need 10 | ICMS-Traffic Operations | H |
| TO-4-1-3 | **Post Messages on TH 55: RTMC Control**<br>The ICMS-Traffic Operations System shall provide a mechanism for operators within the RTMC to post messages on DMS signs on TH 55. | User Need 10 | ICMS-Traffic Operations | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| TO-4-1-4 | **Visual Verification of Messages Posted on TH 55**<br>The ICMS-Traffic Operations System shall provide a mechanism for operators to visually verify the successful implementation of the DMS messages. | User Need 10 | ICMS-Traffic Operations | H |
| TO-4-1-5 | **Post Messages on TH 7**<br>The ICMS-Traffic Operations System shall provide a mechanism allowing operators within the RTMC to select the messages to be displayed on DMS signs located on TH 7. | User Need 10 | ICMS-Traffic Operations | H |
| TO-4-1-6 | **Post Messages on TH 7: RTMC Control**<br>The ICMS-Traffic Operations System shall provide a mechanism for operators within the RTMC to post messages on DMS signs on TH 7. | User Need 10 | ICMS-Traffic Operations | H |
| TO-4-1-7 | **Visual Verification of Messages Posted on TH 7**<br>The ICMS-Traffic Operations System shall provide a mechanism allowing operators to visually verify the successful implementation of the DMS messages. | User Need 10 | ICMS-Traffic Operations | H |
| TO-4-2 | **ICMS-Traffic Operations to Post ABC Garage DMS Message**<br>The ICMS-Traffic Operations System shall post messages to DMS signs on the approach to ABC Garages. | User Need 10 | ICMS-Traffic Operations | H |
| TO-4-2-1 | **ICMS-Traffic Operations to Post ABC Garage DMS Message: Send Message**<br>The ICMS-Traffic Operations shall send a message generated by the ICMS-Traffic Operations message generation subsystem to the DMS display on the approach to the ABC garage requesting that the message be displayed immediately upon receiving the DMS message from the ICMS-Traffic Operations. | User Need 10 | ICMS-Traffic Operations | H |
| TO-4-2-2 | **ICMS-Traffic Operations to Post ABC Garage DMS Message: Protocol**<br>The ICMS-Traffic Operations shall interface to the DMS on the approach to the ABC garage according to the requirements of the (National Transportation Communications for ITS Protocol) NTCIP DMS standards. | User Need 10 | ICMS-Traffic Operations | H |
| TO-4-2-3 | **ICMS-Traffic Operations to Post ABC Garage DMS Message: Remove Messages**<br>The ICMS-Traffic Operations shall interface to the DMS on the approach to the ABC garage to remove messages that are no longer active when the ICMS-Traffic Operations no longer receives messages to be posted from the ICMS ABC System. | User Need 10 | ICMS-Traffic Operations | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| TO-4-3 | **I-394 Speed Limit Algorithm**<br>The ICMS-Traffic Operations System shall post Variable Speed Limit Messages. | User Need 1 | ICMS-Traffic Operations | H |
| TO-4-3-1 | **I-394 Speed Limit Algorithm: Automatic Posts**<br>The ICMS-Traffic Operations system shall send messages generated by the ICMS-Traffic Operations System to variable speed limit signs on the ICMS Corridor describing the recommended speed limits to be posted on the signs. | User Need 1 | ICMS-Traffic Operations | H |
| TO-4-3-2 | **I-394 Speed Limit Algorithm: Manual Posts**<br>The ICMS-Traffic Operations shall send messages to variable advisory speed limit signs within 5 seconds of message creation. | User Need 1 | ICMS-Traffic Operations | H |
| TO-4-3-3 | **I-394 Speed Limit Send to Signs: Data Exchanges**<br>The variable advisory speed limit message shall adhere to NTCIP standards for protocols and data structure for communication with field devices. | User Need 1 | ICMS-Traffic Operations | H |
| TO-4-3-4 | **I-394 Speed Limit Send to Signs: Confirmation**<br>The ICMS-Traffic Operations shall receive verification from the sign that the advisory speed limit has been posted. | User Need 1 | ICMS-Traffic Operations | H |
| TO-4-3-5 | **I-394 Speed Limit Send to Signs: Confirmation Latency**<br>The ICMS-Traffic Operations shall display the verification from the sign that the advisory speed limit has been posted within 1 second of receipt. | User Need 1 | ICMS-Traffic Operations | H |
| TO-4-3-6 | **I-394 Speed Limit Allow Operator Override of VSL Device Communication: Default Display**<br>The ICMS-Traffic Operations shall display the legally posted speed limit on the signs in the event ICMS-Traffic Operations operators override the VSL Device Communication. | User Need 1 | ICMS-Traffic Operations | H |
| TO-4-4 | **DOT-TO-Video Sharing**<br>The ICMS-Traffic Operations System shall share streaming video to the City of Minneapolis (traffic and EMS), Hennepin County (traffic and EMS), Metro Transit, SouthWest Transit and Plymouth Metrolink to view current images captured by Mn/DOT operated CCTV cameras along the corridor. | User Need 1, 2 | ICMS-Traffic Operations | H |
| TO-4-4-1 | **DOT-TO-Video Sharing: accessibility**<br>The ICMS-Traffic Operations System shall provide a mechanism where authorized agencies can view streaming video from CCTV cameras using Internet browsers and existing Internet connections. | User Need 1, 2 | ICMS-Traffic Operations | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| TO-4-4-2 | **DOT-TO-Video Sharing: control**<br>The ICMS-Traffic Operations System shall not allow agencies who are not located in the Mn/DOT RTMC control Mn/DOT cameras (pan/tilt/zoom). | User Need 1, 2 | ICMS-Traffic Operations | H |
| **TO-5** | **The ICMS-Traffic Operations System Shall Send Data to the ICMS Data Hub System.** | User Need 1 | ICMS-Traffic Operations | H |
| TO-5-1 | **ICMS-Traffic Operations System Send Incident and Event Data**<br>The ICMS-Traffic Operations System shall send messages describing Incidents and Events reported in the Traffic Operations System on State Operated Highways within the ICM Corridor to the ICMS-Data Hub System. | User Need 1 | ICMS-Traffic Operations | H |
| TO-5-1-1 | **ICMS-Traffic Operations Send Incident and Event Data: Data Exchanges**<br>The ICMS-Traffic Operations System shall interface to the ICMS-Data Hub according to the requirements of the ICMS-Traffic Operations to ICMS-Data Hub ICD when sending Incident and Event Data. | User Need1 | ICMS-Traffic Operations | H |
| TO-5-1-2 | **ICMS-Traffic Operations Send Incident and Event Data: Frequency**<br>The ICMS-Traffic Operations System shall send Incident and Event Data to the ICMS-Data Hub each time an incident or event is entered into the Reporting System by a Traffic Operations operator. | User Need 1 | ICMS-COM-ASG | H |
| TO-5-1-3 | **ICMS-Traffic Operations Send Incident and Event Data: No Data Available**<br>The ICMS-Traffic Operations System shall send messages to the ICMS-Data Hub indicating “no data available’ if no data is available. | User Need 1 | ICMS-COM-ASG | H |
| TO-5-2 | **ICMS-Traffic Operations Send Freeway Traffic Data**<br>The ICMS-Traffic Operations System shall send messages describing Freeway Traffic Data (volume, occupancy and speed) for those portions of Mn/DOT operated freeways within the ICMS Corridor to the ICMS-Data Hub. | User Need 1 and 2 | ICMS-Traffic Operations | H |
| TO-5-2-1 | **ICMS-Traffic Operations Send Freeway Traffic Data: Data Exchanges**<br>The ICMS-Traffic Operations System shall interface to the ICMS-Data Hub according to the requirements of the ICMS-Traffic Operations to ICMS-Data Hub ICD when sending messages describing Freeway Traffic Data. | User Need1 | ICMS-Traffic Operations | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| TO-5-2-2 | **ICMS-Traffic Operations Send Freeway Traffic Data: Frequency**<br>The ICMS-Traffic Operations System shall send messages describing Freeway Traffic Data to the ICMS-Data Hub each time Freeway Traffic Data is acquired by the existing Traffic Operations Center. | User Need 1 | ICMS-COM-ASG | H |
| TO-5-2-3 | **ICMS-Traffic Operations Send Freeway Traffic Data: No Data Available**<br>The ICMS-Traffic Operations System shall send messages to the ICMS-Data Hub indicating "no data available' if no data is available. | User Need 1 | ICMS-COM-ASG | H |
| TO-5-3 | **ICMS-Traffic Operations Send Mn/PASS Data**<br>The ICMS-Traffic Operations System shall send Mn/PASS Data to the ICMS-Data Hub describing the current travel time and direction of flow in the Mn/Pass Lane. | User Need 2 | ICMS-Traffic Operations | H |
| TO-5-3-1 | **ICMS-Traffic Operations Send Mn/PASS Data: Data Exchanges**<br>The ICMS-Traffic Operations System shall interface to the ICMS-Data Hub according to the requirements of the ICMS-Traffic Operations to ICMS-Data Hub ICD when sending messages describing Mn/PASS Travel Times. | User Need1 | ICMS-Traffic Operations | H |
| TO-5-3-2 | **ICMS-Traffic Operations Send Mn/PASS Data: Frequency**<br>The ICMS-Traffic Operations System shall send messages describing Mn/PASS Travel Times to the ICMS-Data Hub each time a travel time is calculated by the Mn/PASS system. | User Need 1 | ICMS-COM-ASG | H |
| TO-5-3-3 | **ICMS-Traffic Operations Send Mn/PASS Data: Mn/PASS Not in Operation**<br>The ICMS-Traffic Operations System shall send messages to the ICMS-Data Hub indicating "Mn/PASS Not in Operation" if the Mn/PASS lane is not operational. | User Need 1 | ICMS-COM-ASG | H |

## 4.4 ICMS Enhancements to the A, B, and C (ICMS-ABC) Garage System Requirements

The ABC Garages will be enhanced as part of the ICMS project. This section describes the requirements for the enhancements to the ABC Garages (referred to as ICMS-ABC). The enhanced ABC will perform four key functions (data input from ICMS Data Hub, field device control, operator/administrator interface, and data output to ICMS Data Hub). Figure 25 illustrates the ICMS-ABC System functions and Table 10 includes the ICMS-ABC System requirements to ease software development and testing.

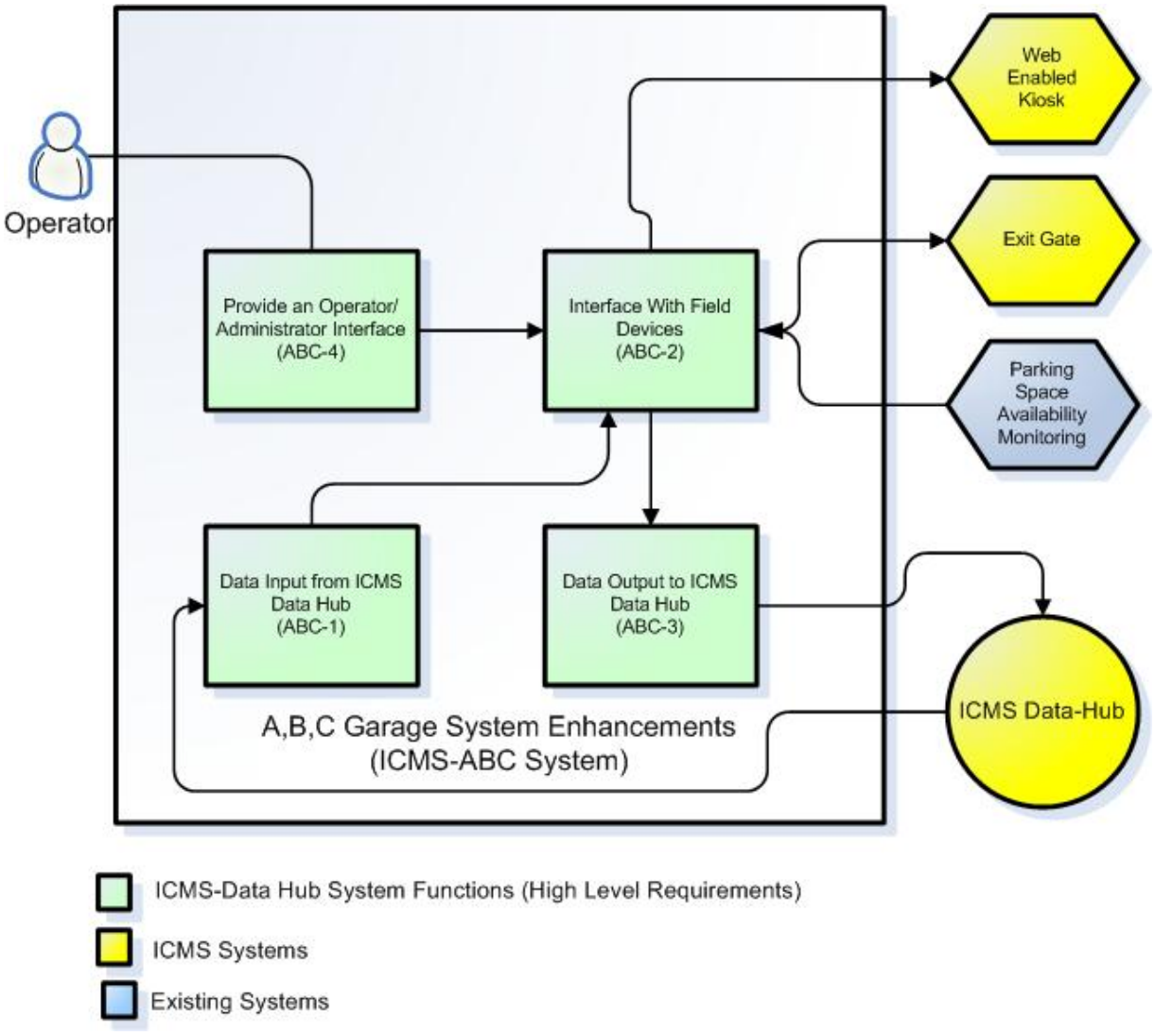


***Figure 25: ICMS-ABC Parking Garages Functions***

*Table 10: ICMS-ABC Parking Garages Requirements*

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **ABC-1** | **The ICMS-ABC System Shall Acquire and Store Data from the ICMS-Data Hub.** | User Need 8,9,10, 13 | ICMS-ABC | H |
| ABC-1-1 | **ICMS-ABC System Acquire and Store Incident and Event Data**<br>The ICMS-ABC System shall acquire and store from the ICMS-Data Hub Incident and Event Data (including traffic and weather events) for all roads within the ICM Corridor. | User Need 8,9,10, 13 | ICMS-ABC System | H |
| ABC-1-1-1 | **ICMS-ABC System Acquire and Store Incident and Event Data: Data Exchanges**<br>The ICMS-ABC System shall interface with the ICMS-Data Hub as per the ICMS-Data Hub Post ICD to acquire and store Incident and Event Data. | User Need 8,9,10, 13 | ICMS-ABC System | H |
| ABC-1-1-2 | **ICMS-ABC System Acquire and Store Incident and Event Data: Frequency**<br>The ICMS-ABC System shall acquire and store Incident and Event Data from the ICMS-Data Hub at a frequency configurable by an ICMS Administrator. | User Need 8,9,10, 13 | ICMS-ABC System | H |
| ABC-1-1-3 | **ICMS-ABC System Acquire and Store Incident and Event Data: Location**<br>The ICMS-ABC System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location. | User Need 8,9,10, 13 | ICMS-ABC System | H |
| ABC-1-1-4 | **ICMS-ABC System Acquire and Store Incident and Event Data: Location Detail**<br>The ICMS-ABC System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location as a geo reference. | User Need 8,9,10, 13 | ICMS-ABC System | H |
| ABC-1-1-5 | **ICMS-ABC System Acquire and Store Incident and Event Data: Type**<br>The ICMS-ABC System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident type. | User Need 8,9,10, 13 | ICMS-ABC System | H |
| ABC-1-1-6 | **ICMS-ABC System Acquire and Store Incident and Event Data: Time**<br>The ICMS-ABC System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event time elements: start time, vehicle arrival time, and clearance time. | User Need 8,9,10, 13 | ICMS-ABC System | H |
| **ABC-2** | **ICMS-ABC System Shall Interface with Field Devices.** | User Need 6,8,9 | ICMS-ABC System | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| ABC-2-1 | **ICMS-ABC Close Exit Gates.**<br>The ICMS-ABC System shall provide a mechanism for operators of the ABC garages to close exit gates such that vehicles can not pass the gate. | User Need 6 | ICMS-ABC System | H |
| ABC-2-1-1 | **ICMS-ABC close ABC Garage Exit: access point**<br>The ICMS-ABC System shall provide a mechanism for operators of the ABC garages to close the ABC Exit gates on to Westbound I-394. | User Need 6,8,9 | ICMS-ABC System | H |
| ABC-2-1-2 | **ICMS closes ABC Garage Exit: Activate internal ABC Closure Signs**<br>The ICMS-ABC System shall provide a mechanism for operators to activate signage to alert garage patrons that the exit to I-394 is closed. | User Need 6,8,9 | ICMS-ABC System | H |
| ABC-2-1-3 | **ICMS closes ABC Garage Exit: Exit Gate Closure Performance**<br>The ICMS-ABC System shall provide a mechanism for the operator to activate the needed closures and signage within 5 minutes from the decision to close the exits. | User Need 6,8,9 | ICMS-ABC System | H |
| ABC-2-1-4 | **ICMS closes ABC Garage Exit: Exit Gate Closure Personnel Requirement**<br>The ICMS-ABC System shall provide a mechanism where one operator can close all exit gates within the 5 minute parameter, without assistance from others. | User Need 6,8,9 | ICMS-ABC System | H |
| ABC-2-1-5 | **ICMS closes ABC Garage Exit: Notify Garage Patrons of Closure**<br>The ICMS-ABC System shall post a message within the parking garage that describes the current closure of access to I-394. | User Need 6,8,9 | ICMS-ABC System | H |
| ABC-2-1-6 | **ICMS closes ABC Garage Exit: Post Alternate Route Information**<br>The ICMS-ABC System shall post messages describing alternate routes that parking patrons can view before departure. | User Need 6,8,9 | ICMS-ABC System | H |
| ABC-2-2 | **Disseminate Traveler Information in ABC Garages**<br>The ICMS-ABC System shall generate and display messages or map images on kiosks in the ABC garage describing corridor conditions to travelers approaching their vehicles. | User Need 6,8,9 | ICMS-ABC System | H |
| ABC-2-2-1 | **Disseminate Traveler Information in ABC Garages: Visual Display - Kiosk**<br>The ICMS-ABC System shall post messages to Internet based kiosks located in the ABC garages. | User Need 6,8,9 | ICMS-ABC System | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| ABC-2-2-2 | **Disseminate Traveler Information in ABC Garages: Impending Event Traffic Alerts**<br>The ICMS-ABC System shall display information to travelers in the garages about special events that have been acquired by the A,B,C Garage System. | User Need 6,8,9 | ICMS-ABC System | H |
| ABC-2-2-3 | **Disseminate Traveler Information in ABC Garages: Parameters of Impending Event Traffic Alerts**<br>The ICMS-ABC System shall display notices of planned events and parking impacts acquired by the ICMS-ABC System beginning at 12:01 AM on the day of the planned event. | User Need 6,8,9 | ICMS-ABC System | H |
| **ABC-3** | **ICMS-ABC System shall send Messages to the ICMS-Data Hub System.** | User Need 5,8,9 | ICMS-ABC System | H |
| ABC-3-1 | **ICMS-ABC Send Parking Message to ICMS-Data Hub**<br>The ICMS-ABC System shall send message to the ICMS Data Hub System describing the parking space availability of each garage to the ICMS Data Hub. | User Need 5,8,9 | ICMS-ABC System | H |
| ABC-3-1-1 | **ICMS-ABC Send Parking Message to ICMS-Data Hub: Data Exchanges**<br>The ICMS-ABC System shall interface with the ICMS Data-Hub System according to the ICMS-ABC to ICMS-Data Hub ICD to send Parking Messages. | User Need 5,8,9 | ICMS-ABC System | H |
| ABC-3-1-2 | **ICMS-ABC Send Parking Message to ICMS-Data Hub: Frequency**<br>The ICMS-ABC System shall send parking messages to the ICMS-Data Hub at a schedule frequency configurable by an ICMS Administrator. | User Need 5,8,9 | ICMS-ABC System | H |
| **ABC-4** | **The ICMS-ABC System Shall Provide a Mechanism for Operators/Administrators to Enter Configurable Settings from an Internet Accessible Workstation.** | User Need 5,8,9 | ICMS-ABC System | H |
| ABC-4-1 | **ICMS-ABC shall configure frequency of sending parking messages to ICMS-Data Hub.**<br>The ICMS-ABC System shall provide a mechanism for operators/administrators to configure the frequency at which the parking messages are sent to the ICMS-Data Hub. | User Need 5,8,9 | ICMS-ABC System | H |
| ABC-4-2 | **ICMS-ABC shall configure frequency of acquiring incident and event messages from the ICMS-Data Hub.**<br>The ICMS-ABC System shall provide a mechanism for operators/administrators to configure the frequency at which the ICMS-ABC System acquires messages describing incidents and special events form the ICMS-Data Hub. | User Need 5,8,9 | ICMS-ABC System | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| ABC-4-3 | **ICMS-ABC shall provide a mechanism to create user accounts.**<br>The ICMS-ABC System shall provide a mechanism for system administrators to create user accounts for operators and administrators. | User Need 5,8,9 | ICMS-ABC System | H |
| ABC-4-4 | **ICMS-ABC shall maintain security by requiring administrators to login to the system.**<br>The ICMS-ABC System shall require administrators to login to the system before configuring settings. | User Need 5,8,9 | ICMS-ABC System | H |

## 4.5 ICMS Enhancements to Mn/DOT Arterial Signals Group (ICMS-Mn/DOT-ASG) Functional Requirements

The Mn/DOT Arterial Signals Group (ASG) System will be enhanced as part of the ICMS project. This section describes the requirements for the enhancements to the ASG System (referred to as ICMS-Mn/DOT-ASG System or ICMS-Mn/DOT-ASG). The enhanced ASG System will perform five key functions (data input from ICMS Data Hub, interface with field device, display data to operator, calculate arterial travel times, and send data to ICMS-Data Hub System). Figure 26 illustrates the ICMS-Mn/DOT-ASG System functions and Table 11 includes the ICMS-Mn/DOT-ASG System requirements to ease software development and testing.

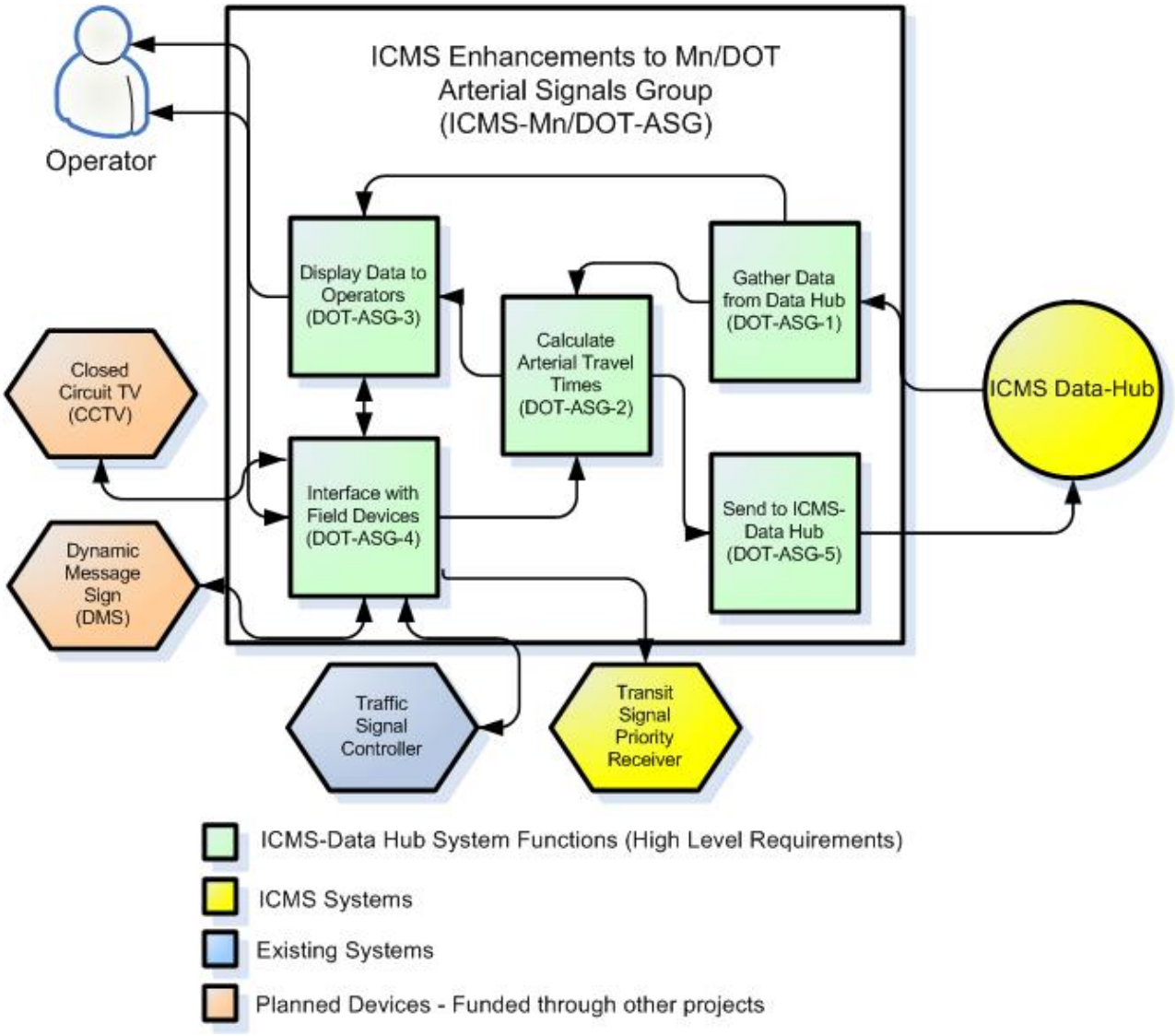


***Figure 26: ICMS-Mn/DOT-ASG Functions***

***Table 11: ICMS-Mn/DOT-ASG Requirements***

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **DOT-ASG-1** | **The ICMS-Mn/DOT-ASG System Shall Acquire and Store Data from the ICMS-Data Hub.** | User Need 2,5,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-1 | **ICMS-Mn/DOT-ASG Acquire and Store Incident and Event Data**<br>The ICMS-Mn/DOT-ASG System shall acquire and store from the ICMS-Data Hub Incident and Event Data for all roads within the ICM Corridor. | User Need 2,5,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-1-1 | **ICMS-Mn/DOT-ASG Acquire and Store Incident and Event Data: Data Exchanges**<br>The ICMS-Mn/DOT-ASG System shall interface with the ICMS-Data Hub as per the ICMS-Data Hub Post ICD to acquire and store Incident and Event Data. | User Need 2,5,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-1-2 | **ICMS-Mn/DOT-ASG Acquire and Store Incident and Event Data: Frequency**<br>The ICMS-Mn/DOT-ASG System shall acquire and store Incident and Event Data from the ICMS-Data Hub at a frequency configurable by an ICMS Administrator. | User Need 2,5,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-1-3 | **ICMS-Mn/DOT-ASG Acquire and Store Incident and Event Data: Location**<br>The ICMS-Mn/DOT-ASG System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location. | User Need 2,5,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-1-4 | **ICMS-Mn/DOT-ASG Acquire and Store Incident and Event Data: Location Detail**<br>The ICMS-Mn/DOT-ASG System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location as a geo reference. | User Need 2,5,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-1-5 | **ICMS-Mn/DOT-ASG Acquire and Store Incident and Event Data: Type**<br>The ICMS-Mn/DOT-ASG System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident type. | User Need 2,5,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-1-6 | **ICMS-Mn/DOT-ASG Acquire and Store Incident and Event Data: Time**<br>The ICMS-Mn/DOT-ASG System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event time elements: start time, vehicle arrival time, and clearance time. | User Need 2,5,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-2 | **ICMS-Mn/DOT-ASG Acquire and Store Freeway Traffic Data**<br>The ICMS-Mn/DOT-ASG System shall acquire and store from the ICMS-Data Hub Freeway Traffic Data. | User Need 17 | ICMS-Mn/DOT-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| DOT-ASG-1-2-1 | **ICMS-Mn/DOT-ASG Acquire and Store Freeway Traffic Data: Data Exchanges**<br>The ICMS-Mn/DOT-ASG System shall interface with the ICMS-Data Hub as per the ICMS-Data Hub Post ICD to acquire and store Freeway Traffic Data in order to be able to display this data to arterial signals operators to assist in selecting signal timing plans. | User Need 17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-2-2 | **ICMS-Mn/DOT-ASG Acquire and Store Freeway Traffic Data: Frequency**<br>The ICMS-Mn/DOT-ASG System shall acquire and store Freeway Traffic Data from the ICMS-Data Hub at a frequency configurable by an ICMS Administrator. | User Need 17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-2-3 | **ICMS-Mn/DOT-ASG Acquire and Store Freeway Traffic Data: Traffic Details**<br>The ICMS-Mn/DOT-ASG System shall acquire and store Freeway Traffic Data from the ICMS-Data Hub describing volume, occupancy, and speed data for sensor stations along:<br>- The I-394 mainline and I-394 ramps<br>- I-494<br>- Hwy 100<br>- Hwy 169. | User Need 17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-2-4 | **ICMS-Mn/DOT-ASG Acquire and Freeway Traffic Data: Travel Times**<br>The ICMS-Mn/DOT-ASG System shall acquire and store messages describing Freeway Travel Times from the ICMS-Data Hub. | User Need 17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-3 | **ICMS-Mn/DOT-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data**<br>The ICMS-Mn/DOT-ASG System shall acquire and store Special Event and Incident Signal Timing Plans that have been posted to the ICMS-Data Hub by other agencies operating arterial traffic signals (Hennepin County and City of Minneapolis) from the ICMS-Data Hub. | User Need 17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-3-1 | **ICMS-Mn/DOT-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data: Data Exchanges**<br>The ICMS-Mn/DOT-ASG System shall interface with the ICMS-Data Hub Post as per the ICMS-Data Hub Post ICD to acquire and store Special Events and Incident Signal Timing Plans Data. | User Need 11,12, 17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-3-2 | **ICMS-Mn/DOT-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data: Frequency**<br>The ICMS-Mn/DOT-ASG System shall acquire and store Special Event and Incident Signal Timing Plans Data from the ICMS-Data Hub at a frequency configurable by an ICMS Administrator. | User Need 11,12, 17 | ICMS-Mn/DOT-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| DOT-ASG-1-3-3 | **ICMS-Mn/DOT-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data: Selected Signal Timing Plan**<br>The ICMS-Mn/DOT-ASG System shall acquire and store messages from the ICMS-Data Hub identifying which signal timing plan was implemented at signals within the ICM corridor. | User Need 11,12, 17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-3-4 | **ICMS-Mn/DOT-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data: Time Implemented**<br>The ICMS-Mn/DOT-ASG System shall acquire and store messages from the ICMS-Data Hub identifying the time a signal timing plan was implemented. | User Need 11,12, 17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-1-3-5 | **ICMS-Mn/DOT-ASG Acquire and Store Special Events and Incident Signal Timing Plans Data: Time Deactivated**<br>The ICMS-Mn/DOT-ASG System shall acquire and messages from the ICMS-Data Hub identifying the time a signal timing plan was deactivated. | User Need 11,12, 17 | ICMS-Mn/DOT-ASG | H |
| **DOT-ASG-2** | **The ICMS-Mn/DOT-ASG System shall Calculate Arterial Travel Times.** | User Need 1,9 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-2-1 | **ICMS-Mn/DOT-ASG Calculate Arterial Travel Times: Locations**<br>The ICMS-Mn/DOT-ASG System shall calculate arterial travel times between downtown Minneapolis and intersections with I-494, Hwy 169, and Hwy 100. | User Need 1,9 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-2-2 | **ICMS-Mn/DOT-ASG Calculate Arterial Travel Times: Categorize travel conditions**<br>The ICMS-Mn/DOT-ASG System shall calculate arterial performance and classify segments of Hwy 55 into either free flowing, slow, or congested. | User Need 1,9 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-2-3 | **ICMS-Mn/DOT-ASG Calculate Arterial Travel Times: Frequency**<br>The ICMS-Mn/DOT-ASG System shall calculate arterial travel times at a frequency configurable by an ICMS Administrator. | User Need 1,9 | ICMS-Mn/DOT-ASG | H |
| **DOT-ASG-3** | **The ICMS-Mn/DOT-ASG System shall Display Data to ASG Operators.** | User Need 1,2,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-3-1 | **ICMS-Mn/DOT-ASG Mechanism to Display Arterial and Freeway Incident Data**<br>The ICMS-Mn/DOT-ASG System shall provide a mechanism for Mn/DOT ASG Operators to view Incident Data acquired and stored in the ICMS-Mn/DOT-ASG. | User Need 1,2,17 | ICMS-Mn/DOT-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| DOT-ASG-3-2 | **ICMS-Mn/DOT-ASG Mechanism to Display Arterial and Freeway Volume Data**<br>The ICMS-Mn/DOT-ASG System shall provide a mechanism for Mn/DOT ASG Operators to view arterial and freeway traffic volume data acquired and stored in the ICMS-Mn/DOT-ASG. | User Need 1,2,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-3-3 | **ICMS-Mn/DOT-ASG Mechanism to Display Freeway Time Data**<br>The ICMS-Mn/DOT-ASG System shall provide a mechanism for Mn/DOT ASG Operators to view freeway Travel Time Data acquired and stored in the ICMS-Mn/DOT-ASG. | User Need 1,2,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-3-4 | **ICMS-Mn/DOT-ASG Mechanism to Display Arterial Travel Time Data**<br>The ICMS-Mn/DOT-ASG System shall provide a mechanism for Mn/DOT ASG Operators to view arterial Travel Time Data calculated in the ICMS-Mn/DOT-ASG. | User Need 1,2,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-3-5 | **ICMS-Mn/DOT-ASG Mechanism to Display Signal Timing Data**<br>The ICMS-Mn/DOT-ASG System shall provide a mechanism for Mn/DOT ASG Operators to view signal timing plans implemented on signals controlled by the City of Minneapolis and Hennepin County to coordinate timing plans on Mn/DOT intersections. | User Need 1,2,17 | ICMS-Mn/DOT-ASG | H |
| **DOT-ASG-4** | **The ICMS-Mn/DOT-ASG System shall Interface with Field Devices.** | User Need 2,10,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-4-1 | **The ICMS-Mn/DOT-ASG System shall Interface with the Traffic Signal Controllers.** | User Need 17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-4-1-1 | **ICMS-Mn/DOT-ASG Acquire and Store Signal Phasing and Volume Data**<br>The ICMS-Mn/DOT-ASG System shall acquire and store signal phasing and traffic volume data from the Mn/DOT operated traffic signal controllers on Hwy 55 and Hwy 7. | User Need 17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-4-1-2 | **ICMS-Mn/DOT-ASG Store Special Event and Incident Signal Timing Plans**<br>The ICMS-Mn/DOT-ASG System shall store pre-created special event and incident signal timing plans. | User Need 17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-4-1-3 | **ICMS-Mn/DOT-ASG Store Special Event and Incident Signal Timing Plans: Location**<br>The ICMS-Mn/DOT-ASG System shall store pre-created special event and incident signal timing plans for Mn/DOT operated intersections along Hwy 55 and Hwy 7. | User Need 17 | ICMS-Mn/DOT-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| DOT-ASG-4-1-4 | **ICMS-Mn/DOT-ASG Mechanism to Select and Download Special Event and Incident Signal Timing Plans**<br>The ICMS-Mn/DOT-ASG System shall provide a mechanism for Mn/DOT ASG Operators to select pre-defined special event and incident signal timing plans to be downloaded to in-field traffic signal controllers. | User Need 17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-4-2 | **The ICMS-Mn/DOT-ASG System shall Interface with DMS.** | User Need 10 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-4-2-1 | **ICMS-Mn/DOT-ASG Mechanism to Operate DMS**<br>The ICMS-Mn/DOT-ASG System shall provide a mechanism for Mn/DOT ASG Operators to post messages on arterial DMS. | User Need 10 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-4-2-2 | **ICMS-Mn/DOT-ASG Mechanism to View DMS messages posted**<br>The ICMS-Mn/DOT-ASG System shall provide a mechanism for Mn/DOT ASG Operators to view current messages posted on arterial DMS. | User Need 10 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-4-3 | **The ICMS-Mn/DOT-ASG System shall Interface with Closed Circuit Television.** | User Need 2 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-4-3-1 | **ICMS-Mn/DOT-ASG Mechanism to View and Operate Visual Surveillance**<br>The ICMS-Mn/DOT-ASG System shall provide a mechanism for Mn/DOT ASG Operators to view and operate visual surveillance on the mainline approaches at each signalized intersection on Hwy 55 and Hwy 7. | User Need 2 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-4-3-2 | **ICMS-Mn/DOT ASG Provide Visual Verification of Messages Posted on TH 55**<br>The ICMS-Mn/DOT-ASG System shall provide a mechanism for Mn/DOT ASG Operators to visually verify the successful implementation of messages posted to travelers on Hwy 55 and Hwy 7. | User Need 10 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-4-3-3 | **ICMS-Mn/DOT-ASG Provide Visual Monitoring of Signal Timing Plans**<br>The ICMS-Mn/DOT-ASG System shall provide visual monitoring of traffic conditions as special event and incident signal timing plans are implemented. | User Need 17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-4-4 | **DOT-ASG-Video Sharing**<br>The ICMS-Mn/DOT-ASG System shall share streaming video to the City of Minneapolis (traffic and EMS), Hennepin County, Metro Transit, SouthWest Transit and Plymouth Metrolink to view current images captured by CCTV cameras along Hwy 55 and Hwy 7. | User Need 1, 2 | ICMS-Mn/DOT-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| DOT-ASG-4-4-1 | **DOT-ASG-Video Sharing: accessibility**<br>The ICMS-Mn/DOT-ASG System shall provide a mechanism where authorized agencies can view streaming video from CCTV cameras using Internet browsers and existing Internet connections. | User Need 1, 2 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-4-4-2 | **DOT-ASG-Video Sharing: control**<br>The ICMS-Mn/DOT-ASG System shall not allow other agencies to control Mn/DOT cameras (pan/tilt/zoom). | User Need 1, 2 | ICMS-Mn/DOT-ASG | H |
| **DOT-ASG-5** | **The ICMS-Mn/DOT-ASG System shall Send Data to the ICMS-Data Hub.** | User Need 1,2,17 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-5-1 | **ICMS-Mn/DOT-ASG Send Arterial Travel Time Data: Travel Times**<br>The ICMS-Mn/DOT-ASG System shall send to the ICMS-Data Hub messages describing real-time travel times along Hwy 55. | User Need 1,2 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-5-1-1 | **ICMS-Mn/DOT-ASG Send Travel Time Messages to the ICMS-Data Hub: Data Exchanges**<br>The ICMS-Mn/DOT-ASG System shall interface with the ICMS-Data Hub ICD according to the requirements of the ICMS-ASG to ICMS-Data Hub ICD to send Travel Time messages. | User Need 2 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-5-1-2 | **ICMS-Mn/DOT-ASG System Send Arterial Travel Times: Frequency**<br>The ICMS-Mn/DOT-ASG System shall send messages describing Travel Times to the ICMS-Data Hub each time arterial traffic data is acquired from the signal controllers. | User Need 1 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-5-1-3 | **ICMS-Mn/DOT-ASG Send Arterial Traffic Data: No Data**<br>The ICMS-Mn/DOT-ASG System shall send messages to the ICMS-Data Hub indicating “no data available’ if no Travel Time data is available. | User Need 1 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-5-2 | **ICMS-Mn/DOT-ASG Send Special Event and Incident Signal Timing Plans Data**<br>The ICMS-Mn/DOT-ASG System shall send to the ICMS-Data Hub Special Event and Incident Signal Timing Plans implemented at each Mn/DOT operated signal. | User Need 17 | ICMS-Mn/DOT-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| DOT-ASG-5-2-1 | **ICMS-Mn/DOT-ASG Send Special Event and Incident Signal Timing Plans Data to the ICMS-Data Hub: Data Exchanges**<br>The ICMS-Mn/DOT-ASG System shall interface with the ICMS-Data Hub ICD according to the requirements of the ICMS-ASG to ICMS-Data Hub ICD to send Travel Time messages. | User Need 2 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-5-2-2 | **ICMS-Mn/DOT-ASG Send Special Event and Incident Signal Timing Plans Data: Frequency**<br>The ICMS-Mn/DOT-ASG System shall send Special Event and Incident Signal Timing Plans Data to the ICMS-Data Hub each time a signal timing plan is downloaded to a signalized intersection along the corridor. | User Need 11 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-5-2-3 | **ICMS-Mn/DOT-ASG Send Special Event and Incident Signal Timing Plans Data: Selected Signal Timing Plan**<br>The ICMS-Mn/DOT-ASG System shall send Special Event and Incident Signal Timing Plans Data to the ICMS-Data Hub identifying which signal timing plan was implemented. | User Need 11 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-5-2-4 | **ICMS-Mn/DOT-ASG Send Special Event and Incident Signal Timing Plans Data: Time Implemented**<br>The ICMS-Mn/DOT-ASG System shall send Special Event and Incident Signal Plans Data to the ICMS-Data Hub identifying the time a signal timing plan was implemented. | User Need 11 | ICMS-Mn/DOT-ASG | H |
| DOT-ASG-5-2-5 | **ICMS-Mn/DOT-ASG Send Special Event and Incident Signal Timing Plans Data: Time Deactivated**<br>The ICMS-Mn/DOT-ASG System shall send Special Event and Incident Signal Timing Plans Data to the ICMS-Data Hub identifying the time a signal timing plan was deactivated. | User Need 11 | ICMS-Mn/DOT-ASG | H |

## 4.6 ICMS Enhancements to Hennepin County Arterial Signals Group (ICMS-HENN-ASG) Functional Requirements

The Hennepin County (HENN) Arterial Signals Group (ASG) System will be enhanced as part of the ICMS project. This section describes the requirements for the enhancements to the system (referred to as ICMS-HENN-ASG System or ICMS-HENN-ASG). The enhanced ASG System will perform four key functions (data input from ICMS Data Hub, interface with field device, display data to operator, and send data to ICMS-Data Hub System). Figure 27 illustrates the ICMS-HENN-ASG System functions and Table 12 includes the ICMS-HENN-ASG System requirements to ease software development and testing.

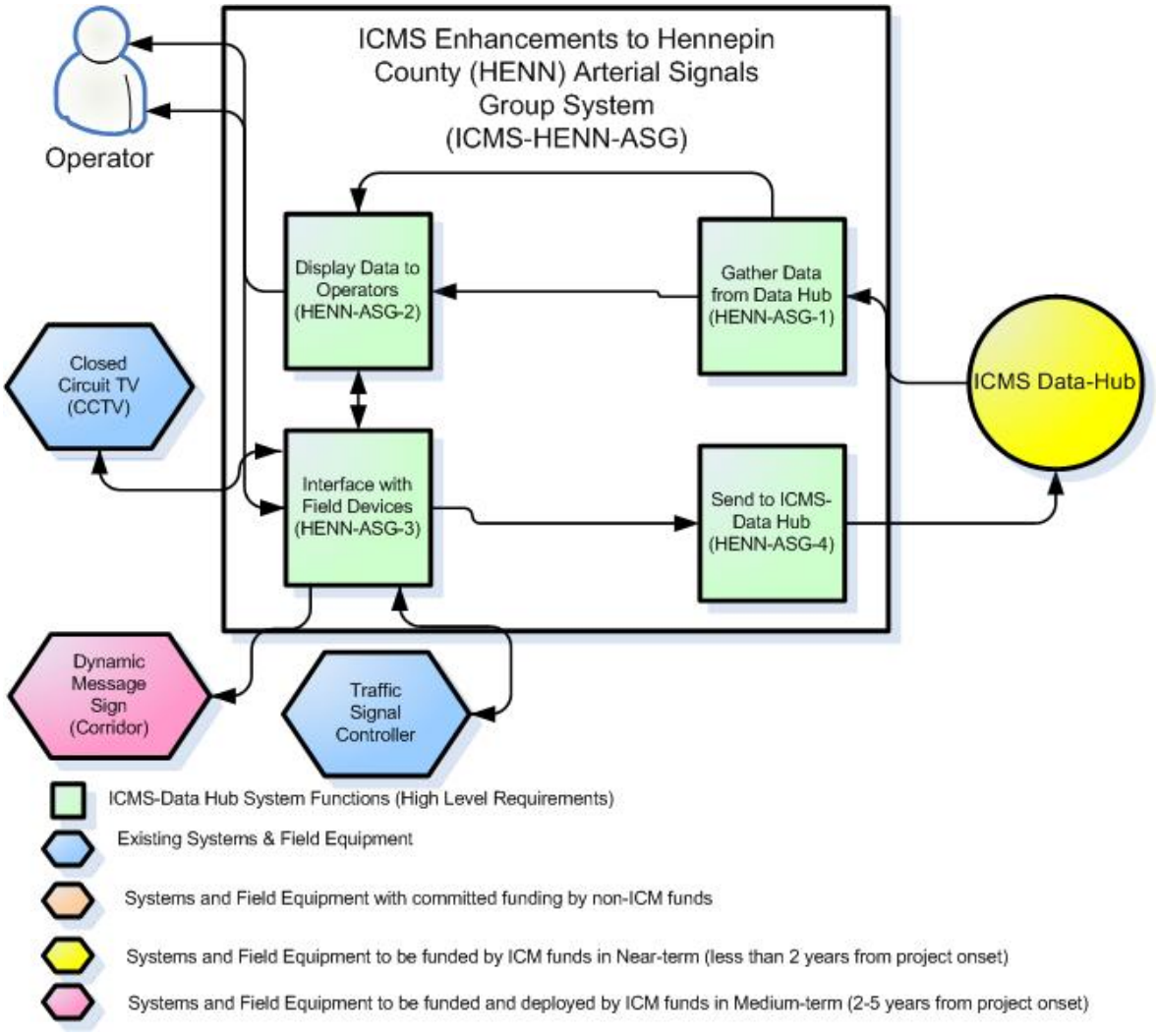


***Figure 27: ICMS-HENN-ASG Functions***

***Table 12: ICMS-HENN-ASG Requirements***

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **HENN-ASG-1** | **The ICMS-HENN-ASG System Shall Acquire and Store Data from the ICMS-Data Hub.** | User Need 2,5,17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-1 | **ICMS-HENN-ASG Acquire and Store Incident and Event Data**<br>The ICMS-HENN-ASG System shall acquire and store from the ICMS-Data Hub Incident and Event Data for all roads within the ICM Corridor. | User Need 2,5,17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-1-1 | **ICMS-HENN-ASG Acquire and Store Incident and Event Data: Data Exchanges**<br>The ICMS-HENN-ASG System shall interface with the ICMS-Data Hub as per the ICMS-Data Hub Post ICD to acquire and store Incident and Event Data. | User Need 2,5,17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-1-2 | **ICMS-HENN-ASG Acquire and Store Incident and Event Data: Frequency**<br>The ICMS-HENN-ASG System shall acquire and store Incident and Event Data from the ICMS-Data Hub at a frequency configurable by an ICMS Administrator. | User Need 2,5,17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-1-3 | **ICMS-HENN-ASG Acquire and Store Incident and Event Data: Location**<br>The ICMS-HENN-ASG System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location. | User Need 2,5,17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-1-4 | **ICMS-HENN-ASG Acquire and Store Incident and Event Data: Location Detail**<br>The ICMS-HENN-ASG System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location as a geo reference. | User Need 2,5,17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-1-5 | **ICMS-HENN-ASG Acquire and Store Incident and Event Data: Type**<br>The ICMS-HENN-ASG System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident type. | User Need 2,5,17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-1-6 | **ICMS-HENN-ASG Acquire and Store Incident and Event Data: Time**<br>The ICMS-HENN-ASG System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event time elements: start time, vehicle arrival time, and clearance time. | User Need 2,5,17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-2 | **ICMS-HENN-ASG Acquire and Store Freeway Traffic Data**<br>The ICMS-HENN-ASG System shall acquire and store from the ICMS-Data Hub Freeway Traffic Data. | User Need 17 | ICMS-HENN-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| HENN-ASG-1-2-1 | **ICMS-HENN-ASG Acquire and Store Freeway Traffic Data: Data Exchanges**<br>The ICMS-HENN-ASG System shall interface with the ICMS-Data Hub as per the ICMS-Data Hub Post ICD to acquire and store Freeway Traffic Data. | User Need 17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-2-2 | **ICMS-HENN-ASG Acquire and Store Freeway Traffic Data: Frequency**<br>The ICMS-HENN-ASG System shall acquire and store Freeway Traffic Data from the ICMS-Data Hub at a frequency configurable by an ICMS Administrator. | User Need 17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-2-3 | **ICMS-HENN-ASG Acquire and Store Freeway Traffic Data: Traffic Details**<br>The ICMS-HENN-ASG System shall acquire and store Freeway Traffic Data from the ICMS-Data Hub describing volume, occupancy, and speed data for sensor stations along:<br>- The I-394 mainline and I-394 ramps<br>- I-494<br>- Hwy 100<br>- Hwy 169. | User Need 17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-2-4 | **ICMS-HENN-ASG Acquire and Freeway Traffic Data: Travel Times**<br>The ICMS-HENN-ASG System shall acquire and store messages describing Freeway Travel Times from the ICMS-Data Hub. | User Need 17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-3 | **ICMS-HENN-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data**<br>The ICMS-HENN-ASG System shall acquire and store Special Event and Incident Signal Timing Plans Data from the ICMS-Data Hub. | User Need 17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-3-1 | **ICMS-HENN-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data: Data Exchanges**<br>The ICMS-HENN-ASG System shall interface with the ICMS-Data Hub Post as per the ICMS-Data Hub Post ICD to acquire and store Special Events and Incident Signal Timing Plans Data. | User Need 11,12, 17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-3-2 | **ICMS-HENN-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data: Frequency**<br>The ICMS-HENN-ASG System shall acquire and store Special Event and Incident Signal Timing Plans Data from the ICMS-Data Hub at a frequency configurable by an ICMS Administrator. | User Need 11,12, 17 | ICMS-HENN-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| HENN-ASG-1-3-3 | **ICMS-HENN-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data: Selected Signal Timing Plan**<br>The ICMS-HENN-ASG System shall acquire and store messages from the ICMS-Data Hub identifying which signal timing plan was implemented at signals within the ICM corridor. | User Need 11,12, 17 | ICMS-HENN-ASG | H |
| 1-3-4 | **ICMS-HENN-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data: Time Implemented**<br>The ICMS-HENN-ASG System shall acquire and store messages from the ICMS-Data Hub identifying the time a signal timing plan was implemented. | User Need 11,12, 17 | ICMS-HENN-ASG | H |
| HENN-ASG-1-3-5 | **ICMS-HENN-ASG Acquire and Store Special Events and Incident Signal Timing Plans Data: Time Deactivated**<br>The ICMS-HENN-ASG System shall acquire and messages from the ICMS-Data Hub identifying the time a signal timing plan was deactivated. | User Need 11,12, 17 | ICMS-HENN-ASG | H |
| **HENN-ASG-2** | **The ICMS-HENN-ASG System shall Display Data to Hennepin County ASG Operators.** | User Need 1,2,17 | ICMS-HENN-ASG | H |
| HENN-ASG-2-1 | **ICMS-HENN-ASG Mechanism to Display Arterial and Freeway Incident Data**<br>The ICMS-HENN-ASG System shall provide a mechanism for Hennepin County ASG Operators to view Incident Data acquired and stored in the ICMS-HENN-ASG on arterials and freeways within the ICM Corridor. | User Need 1,2,17 | ICMS-HENN-ASG | H |
| HENN-ASG-2-2 | **ICMS-HENN-ASG Mechanism to Display Arterial and Freeway Volume Data**<br>The ICMS-HENN-ASG System shall provide a mechanism for Hennepin County ASG Operators to view Volume Data acquired and stored in the ICMS-HENN-ASG on arterials and freeways within the ICM Corridor. | User Need 1,2,17 | ICMS-HENN-ASG | H |
| HENN-ASG-2-3 | **ICMS-HENN-ASG Mechanism to Display Arterial and Freeway Travel Time Data**<br>The ICMS-HENN-ASG System shall provide a mechanism for Hennepin County ASG Operators to view Travel Time Data acquired and stored in the ICMS-HENN-ASG on arterials and freeways within the ICM Corridor. | User Need 1,2,17 | ICMS-HENN-ASG | H |
| HENN-ASG-2-4 | **ICMS-HENN-ASG Mechanism to Display Signal Timing Data**<br>The ICMS-HENN-ASG System shall provide a mechanism for Hennepin County ASG Operators to view signal timing plans implemented on signals controlled by the City of Minneapolis and Mn/DOT to coordinate timing plans on county maintained intersections. | User Need 1,2,17 | ICMS-HENN-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **HENN-ASG-3** | **The ICMS-HENN-ASG System shall Interface with Field Devices.** | User Need 2,10,17 | ICMS-HENN-ASG | H |
| HENN-ASG-3-1 | **The ICMS-HENN-ASG shall Interface with the Traffic Signal Controllers.** | User Need 17 | ICMS-HENN-ASG | H |
| HENN-ASG-3-1-1 | **ICMS-HENN-ASG Acquire and Store Signal Phasing and Volume Data**<br>The ICMS-HENN-ASG System shall acquire and store signal phasing and traffic volume data from the Hennepin County operated traffic signal controllers. | User Need 17 | ICMS-HENN-ASG | M |
| HENN-ASG-3-1-2 | **ICMS-HENN-ASG Store Special Event and Incident Signal Timing Plans**<br>The ICMS-HENN-ASG System shall store pre-created special event and incident Hennepin County signal timing plans. | User Need 17 | ICMS-HENN-ASG | M |
| HENN-ASG-3-1-2-1 | **ICMS-HENN-ASG Store Special Event and Incident Signal Timing Plans: Location**<br>The ICMS-HENN-ASG System shall store pre-created special event and incident signal timing plans for Hennepin County operated intersections. | User Need 17 | ICMS-HENN-ASG | M |
| HENN-ASG-3-1-3 | **ICMS-HENN-ASG Mechanism to Select and Download Special Event and Incident Signal Timing Plans**<br>The ICMS-HENN-ASG System shall provide a mechanism for Hennepin County ASG Operators to select pre-defined special event and incident signal timing plans to be downloaded to in-field traffic signal controllers. | User Need 17 | ICMS-HENN-ASG | M |
| HENN-ASG-3-2 | **The ICMS-HENN-ASG System shall Interface with Dynamic Message Signs (DMS).** | User Need 10 | ICMS-HENN-ASG | M |
| HENN-ASG-3-2-1 | **ICMS-HENN-ASG Mechanism to Operate DMS**<br>The ICMS-HENN-ASG System shall provide a mechanism for Hennepin County ASG Operators to post messages on arterial DMS. | User Need 10 | ICMS-HENN-ASG | M |
| HENN-ASG-3-2-2 | **ICMS-HENN-ASG Mechanism to View DMS messages posted**<br>The ICMS-HENN-ASG System shall provide a mechanism for Hennepin County ASG Operators to view current messages posted on arterial DMS. | User Need 10 | ICMS-HENN-ASG | M |
| HENN-ASG-3-3 | **The ICMS-HENN-ASG System shall Interface with Closed Circuit Television.** | User Need 2 | ICMS-HENN-ASG | M |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| HENN-ASG-3-3-1 | **ICMS-HENN-ASG Mechanism to View and Operate Visual Surveillance**<br>The ICMS-HENN-ASG System shall provide a mechanism for Hennepin County ASG Operators to view and operate visual surveillance on the mainline approaches at each signalized intersection on Hwy 55 and Hwy 7. | User Need 2 | ICMS-HENN-ASG | M |
| HENN-ASG-3-3-2 | **ICMS-Mn/DOT ASG Provide Visual Verification of Messages Posted on TH 55**<br>The ICMS-HENN-ASG System shall provide a mechanism for Hennepin County ASG Operators to visually verify the successful implementation of messages posted to travelers on Hwy 55 and Hwy 7. | User Need 10 | ICMS-HENN-ASG | M |
| HENN-ASG-3-3-3 | **ICMS-HENN-ASG Provide Visual Monitoring of Signal Timing Plans**<br>The ICMS-HENN-ASG System shall provide visual monitoring of traffic conditions as special event and incident signal timing plans are implemented. | User Need 17 | ICMS-HENN-ASG | M |
| HENN-ASG-3-4 | **HENN-Video Sharing**<br>The ICMS-HENN-ASG System shall share streaming video to the City of Minneapolis (traffic and EMS), Mn/DOT, Metro Transit, SouthWest Transit and Plymouth Metrolink to view current images captured by county operated CCTV cameras along the corridor. | User Need 1, 2 | ICMS-HENN-ASG | H |
| HENN-ASG-3-4-1 | **HENN-Video Sharing: accessibility**<br>The ICMS-HENN-ASG System shall provide a mechanism where authorized agencies can view streaming video from CCTV cameras using Internet browsers and existing Internet connections. | User Need 1, 2 | ICMS-HENN-ASG | H |
| HENN-ASG-3-4-2 | **HENN-Video Sharing: control**<br>The ICMS-HENN-ASG System shall not allow other agencies to control Hennepin County cameras (pan/tilt/zoom). | User Need 1, 2 | ICMS-HENN-ASG | H |
| **HENN-ASG-4** | **The ICMS-HENN-ASG System shall Send Data to the ICMS-Data Hub.** | User Need 1,2,17 | ICMS-HENN-ASG | H |
| HENN-ASG-4-1 | **ICMS-HENN-ASG Send Arterial Traffic Data**<br>The ICMS-HENN-ASG System shall send to the ICMS-Data Hub Arterial Traffic Data to the ICMS-Data Hub. | User Need 1,2 | ICMS-HENN-ASG | H |
| HENN-ASG-4-1-1 | **ICMS-HENN-ASG Send Arterial Traffic Data: Data Exchanges**<br>The ICMS-HENN-ASG System shall interface with the ICMS-ASG according to requirements of the ICMS-ASG to ICMS-Data Hub ICD to send Arterial Traffic Data. | User Need 2 | ICMS-HENN-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| HENN-ASG-4-1-2 | **ICMS-HENN-ASG Send Arterial Traffic Data: Frequency**<br>The ICMS-HENN-ASG System shall send Arterial Traffic Data to the ICMS-Data Hub each time arterial traffic data is acquired from signal controllers. | User Need 1 | ICMS-HENN-ASG | H |
| HENN-ASG-4-1-3 | **ICMS-HENN-ASG Send Arterial Traffic Data: No Data**<br>The ICMS-HENN-ASG System shall send Arterial Traffic Data to the ICMS-Data Hub indicating "no data available' if no data is available. | User Need 1 | ICMS-HENN-ASG | H |
| HENN-ASG-4-1-4 | **ICMS-HENN-ASG Send Arterial Traffic Data: Volume and Speed Data**<br>The ICMS-HENN-ASG System shall send to the ICMS-Data Hub Arterial Traffic Data describing volume and speed. | User Need 17 | ICMS-HENN-ASG | H |
| HENN-ASG-4-2 | **ICMS-HENN-ASG Send Special Event and Incident Signal Timing Plans Data**<br>The ICMS-HENN-ASG System shall send to the ICMS-Data Hub Special Event and Incident Signal Timing Plans Data. | User Need 2 | ICMS-HENN-ASG | H |
| HENN-ASG-4-2-1 | **ICMS-HENN-ASG Send Special Event and Incident Signal Timing Plans Data: Data Exchanges**<br>The ICMS-HENN-ASG System shall interface to the ICMS-Data Hub according to the requirements of the ICMS-ASG to ICMS-Data Hub ICD to send Special Event and Incident Signal Timing Plans Data. | User Need 11 | ICMS-HENN-ASG | H |
| HENN-ASG-4-2-2 | **ICMS-HENN-ASG System Send Special Event and Incident Signal Timing Plans Data: Frequency**<br>The ICMS-HENN-ASG System shall send Special Event and Incident Signal Timing Plans Data to the ICMS-Data Hub at a frequency configurable by an ICMS Administrator. | User Need 11 | ICMS-HENN-ASG | H |
| HENN-ASG-4-2-3 | **ICMS-HENN-ASG Send Special Event and Incident Signal Timing Plans Data: Selected Signal Timing Plan**<br>The ICMS-HENN-ASG System shall send Special Event and Incident Signal Timing Plans Data to the ICMS-Data Hub identifying which signal timing plan was implemented. | User Need 11 | ICMS-HENN-ASG | H |
| HENN-ASG-4-2-4 | **ICMS-HENN-ASG Send Special Event and Incident Signal Timing Plans Data: Time Implemented**<br>The ICMS-HENN-ASG System shall send Special Event and Incident Signal Plans Data to the ICMS-Data Hub identifying the time a signal timing plan was implemented. | User Need 11 | ICMS-HENN-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| HENN-ASG-4-2-5 | **ICMS-HENN-ASG Send Special Event and Incident Signal Timing Plans Data: Time Deactivated**<br>The ICMS-HENN-ASG System shall send Special Event and Incident Signal Timing Plans Data to the ICMS-Data Hub identifying the time a signal timing plan was deactivated. | User Need 11 | ICMS-HENN-ASG | H |

## 4.7 ICMS Enhancements to City of Minneapolis Arterial Signals Group (ICMS-COM-ASG) Functional Requirements

The City of Minneapolis (COM) Arterial Signals Group (ASG) System will be enhanced as part of the ICMS project. This section describes the requirements for the enhancements to the system (referred to as ICMS-COM-ASG System or ICMS-COM-ASG). The enhanced ASG System will perform four key functions (data input from ICMS Data Hub, interface with field device, display data to operator, and send data to ICMS-Data Hub System). Figure 28 illustrates the ICMS-COM-ASG System functions and Table 13 includes the ICMS-COM-ASG System requirements to ease software development and testing.

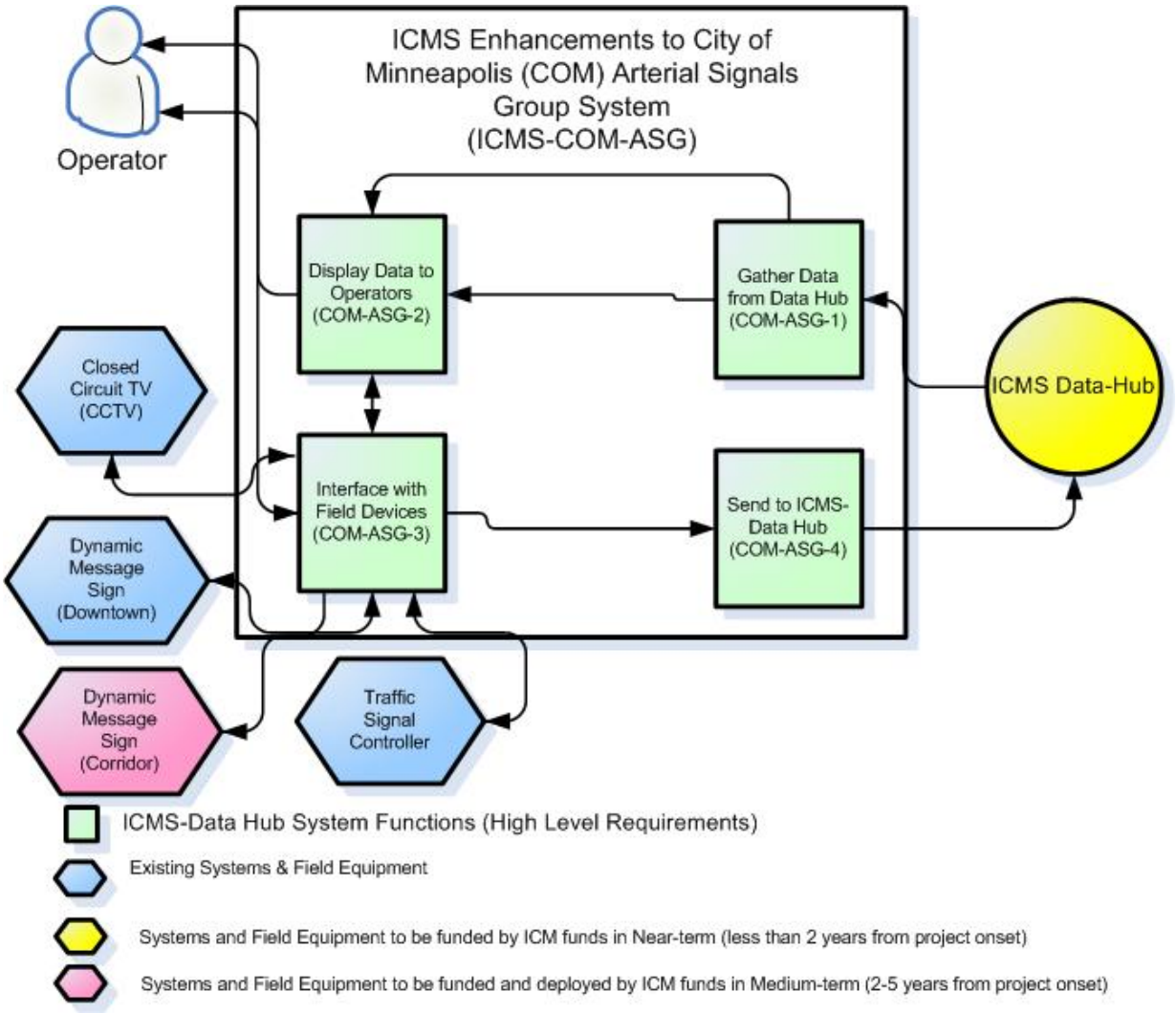


***Figure 28: ICMS-COM-ASG Functions***

***Table 13: ICMS-COM-ASG Requirements***

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **COM-ASG-1** | **The ICMS-COM-ASG System Shall Acquire and Store Data from the ICMS-Data Hub.** | User Need 2,5,17 | ICMS-COM-ASG | H |
| COM-ASG-1-1 | **ICMS-COM-ASG Acquire and Store Incident and Event Data**<br>The ICMS-COM-ASG system shall acquire and store from the ICMS-Data Hub Incident and Event Data for all roads within the ICM Corridor. | User Need 2,5,17 | ICMS-COM-ASG | H |
| COM-ASG-1-1-1 | **ICMS-COM-ASG Acquire and Store Incident and Event Data: Data Exchanges**<br>The ICMS-COM-ASG system shall interface with the ICMS-Data Hub according to the requirements of the ICMS-Data Hub Post ICD to acquire and store Incident and Event Data. | User Need 2,5,17 | ICMS-COM-ASG | H |
| COM-ASG-1-1-2 | **ICMS-COM-ASG Acquire and Store Incident and Event Data: Frequency**<br>The ICMS-COM-ASG system shall acquire and store Incident and Event Data from the ICMS-Data Hub at a frequency configurable by an ICMS Administrator. | User Need 2,5,17 | ICMS-COM-ASG | H |
| COM-ASG-1-1-3 | **ICMS-COM-ASG Acquire and Store Incident and Event Data: Location**<br>The ICMS-COM-ASG system shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location. | User Need 2,5,17 | ICMS-COM-ASG | H |
| COM-ASG-1-1-4 | **ICMS-COM-ASG Acquire and Store Incident and Event Data: Location Detail**<br>The ICMS-COM-ASG system shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location as a geo reference. | User Need 2,5,17 | ICMS-COM-ASG | H |
| COM-ASG-1-1-5 | **ICMS-COM-ASG Acquire and Store Incident and Event Data: Type**<br>The ICMS-COM-ASG shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident type. | User Need 2,5,17 | ICMS-COM-ASG | H |
| COM-ASG-1-1-6 | **ICMS-COM-ASG Acquire and Store Incident and Event Data: Time**<br>The ICMS-COM-ASG system shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event time elements: start time, vehicle arrival time, and clearance time. | User Need 2,5,17 | ICMS-COM-ASG | H |
| COM-ASG-1-2 | **ICMS-COM-ASG Acquire and Store Freeway Traffic Data**<br>The ICMS-COM-ASG system shall acquire and store from the ICMS-Data Hub Freeway Traffic Data. | User Need 17 | ICMS-COM-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| COM-ASG-1-2-1 | **ICMS-COM-ASG Acquire and Store Freeway Traffic Data: Data Exchanges**<br>The ICMS-COM-ASG system shall interface with the ICMS-Data Hub as per the ICMS-Data Hub Post ICD to acquire and store Freeway Traffic Data. | User Need 17 | ICMS-COM-ASG | H |
| COM-ASG-1-2-2 | **ICMS-COM-ASG Acquire and Store Freeway Traffic Data: Frequency**<br>The ICMS-COM-ASG system shall acquire and store Freeway Traffic Data from the ICMS-Data Hub at a frequency configurable by an ICMS Administrator. | User Need 17 | ICMS-COM-ASG | H |
| COM-ASG-1-2-3 | **ICMS-COM-ASG Acquire and Store Freeway Traffic Data: Traffic Details**<br>The ICMS-COM-ASG system shall acquire and store Freeway Traffic Data from the ICMS-Data Hub describing volume, occupancy, and speed data for sensor stations along:<br>- The I-394 mainline and I-394 ramps<br>- I-494<br>- Hwy 100<br>- Hwy 169. | User Need 17 | ICMS-COM-ASG | H |
| COM-ASG-1-2-4 | **ICMS-COM-ASG Acquire and Freeway Traffic Data: Travel Times**<br>The ICMS-COM-ASG system shall acquire and store messages describing Freeway Travel Times from the ICMS-Data Hub. | User Need 17 | ICMS-COM-ASG | H |
| COM-ASG-1-3 | **ICMS-COM-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data**<br>The ICMS-COM-ASG shall acquire and store Special Event and Incident Signal Timing Plans Data from the ICMS-Data Hub. | User Need 17 | ICMS-COM-ASG | H |
| COM-ASG-1-3-1 | **ICMS-COM-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data: Data Exchanges**<br>The ICMS-COM-ASG system shall interface with the ICMS-Data Hub Post as per the ICMS-Data Hub Post ICD to acquire and store Special Events and Incident Signal Timing Plans Data. | User Need 11,12, 17 | ICMS-COM-ASG | H |
| COM-ASG-1-3-2 | **ICMS-COM-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data: Frequency**<br>The ICMS-COM-ASG system shall acquire and store Special Event and Incident Signal Timing Plans Data from the ICMS-Data Hub at a frequency configurable by an ICMS Administrator. | User Need 11,12, 17 | ICMS-COM-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| COM-ASG-1-3-3 | **ICMS-COM-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data: Selected Signal Timing Plan**<br>The ICMS-COM-ASG system shall acquire and store messages from the ICMS-Data Hub identifying which signal timing plan was implemented at signals within the ICM corridor. | User Need 11,12, 17 | ICMS-COM-ASG | H |
| COM-ASG-1-3-4 | **ICMS-COM-ASG Acquire and Store Special Event and Incident Signal Timing Plans Data: Time Implemented**<br>The ICMS-COM-ASG system shall acquire and store messages from the ICMS-Data Hub identifying the time a signal timing plan was implemented. | User Need 11,12, 17 | ICMS-COM-ASG | H |
| COM-ASG-1-3-5 | **ICMS-COM-ASG Acquire and Store Special Events and Incident Signal Timing Plans Data: Time Deactivated**<br>The ICMS-COM-ASG system shall acquire and messages from the ICMS-Data Hub identifying the time a signal timing plan was deactivated. | User Need 11,12, 17 | ICMS-COM-ASG | H |
| **COM-ASG-2** | **The ICMS-COM-ASG System shall Display Data to City of Minneapolis (COM) ASG Operators.** | User Need 1,2,17 | ICMS-COM-ASG | H |
| COM-ASG-2-1 | **ICMS-COM-ASG Mechanism to Display Arterial and Freeway Incident Data**<br>The ICMS-COM-ASG system shall provide a mechanism for City of Minneapolis ASG Operators to view Incident Data acquired and stored in the ICMS-COM-ASG on arterials and freeways within the ICM Corridor. | User Need 1,2,17 | ICMS-COM-ASG | H |
| COM-ASG-2-2 | **ICMS-COM-ASG Mechanism to Display Arterial and Freeway Volume Data**<br>The ICMS-COM-ASG system shall provide a mechanism for City of Minneapolis ASG Operators to view Volume Data acquired and stored in the ICMS-COM-ASG on arterials and freeways within the ICM Corridor. | User Need 1,2,17 | ICMS-COM-ASG | H |
| COM-ASG-2-3 | **ICMS-COM-ASG Mechanism to Display Arterial and Freeway Travel Time Data**<br>The ICMS-COM-ASG system shall provide a mechanism for Hennepin County ASG Operators to view Travel Time Data acquired and stored in the ICMS-COM-ASG on arterials and freeways within the ICM Corridor. | User Need 1,2,17 | ICMS-COM-ASG | H |
| COM-ASG-2-4 | **ICMS-COM-ASG Mechanism to Display Signal Timing Data**<br>The ICMS-COM-ASG System shall provide a mechanism for City of Minneapolis ASG Operators to view signal timing plans implemented on signals controlled by Hennepin County and Mn/DOT to coordinate timing plans on city maintained intersections. | User Need 1,2,17 | ICMS-COM-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **COM-ASG-3** | **The ICMS-COM-ASG shall Interface with Field Devices.** | User Need 2,10,17 | ICMS-COM-ASG | H |
| COM-ASG-3-1 | **The ICMS-COM-ASG System shall Interface with the Traffic Signal Controllers.** | User Need 17 | ICMS-COM-ASG | H |
| COM-ASG-3-1-1 | **ICMS-COM-ASG Acquire and Store Signal Phasing and Volume Data**<br>The ICMS-COM-ASG system shall acquire and store signal phasing and traffic volume data from the City of Minneapolis operated traffic signal controllers. | User Need 17 | ICMS-COM-ASG | H |
| COM-ASG-3-1-2 | **ICMS-COM-ASG Store Special Event and Incident Signal Timing Plans**<br>The ICMS-COM-ASG system shall store pre-created special event and incident signal timing plans. | User Need 17 | ICMS-COM-ASG | H |
| COM-ASG-3-1-2-1 | **ICMS-COM-ASG Store Special Event and Incident Signal Timing Plans: Location**<br>The ICMS-COM-ASG system shall store pre-created special event and incident signal timing plans for City of Minneapolis operated intersections. | User Need 17 | ICMS-COM-ASG | H |
| COM-ASG-3-1-3 | **ICMS-COM-ASG Mechanism to Select and Download Special Event and Incident Signal Timing Plans**<br>The ICMS-COM-ASG system shall provide a mechanism for City of Minneapolis ASG Operators to select pre-defined special event and incident signal timing plans to be downloaded to in-field traffic signal controllers. | User Need 17 | ICMS-COM-ASG | H |
| COM-ASG-3-2 | **The ICMS-COM-ASG System shall interface with Dynamic Message Signs (DMS)** | User Need 10 | ICMS-COM-ASG | M |
| COM-ASG-3-2-1 | **ICMS-COM-ASG Mechanism to Operate DMS**<br>The ICMS-COM-ASG system shall provide a mechanism for City of Minneapolis ASG Operators to post messages on arterial DMS. | User Need 10 | ICMS-COM-ASG | M |
| COM-ASG-3-2-2 | **ICMS-COM-ASG Mechanism to View DMS messages posted**<br>The ICMS-COM-ASG system shall provide a mechanism for City of Minneapolis ASG Operators to view current messages posted on arterial DMS. | User Need 10 | ICMS-COM-ASG | M |
| COM-ASG-3-3 | **The ICMS-COM-ASG shall interface with Closed Circuit Television** | User Need 2 | ICMS-COM-ASG | M |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| COM-ASG-3-3-1 | **ICMS-COM-ASG Mechanism to View and Operate Visual Surveillance**<br>The ICMS-COM-ASG system shall provide a mechanism for City of Minneapolis ASG Operators to view visual surveillance on the mainline approaches at each signalized intersection on Hwy 55 and Hwy 7. | User Need 2 | ICMS-COM-ASG | H |
| COM-ASG-3-3-2 | **ICMS-Mn/DOT ASG Provide Visual Verification of Messages Posted on TH 55**<br>The ICMS-COM-ASG system shall provide a mechanism for City of Minneapolis ASG Operators to visually verify the successful implementation of messages posted to travelers on Hwy 55 and Hwy 7. | User Need 10 | ICMS-COM-ASG | H |
| COM-ASG-3-3-3 | **ICMS-COM-ASG Provide Visual Monitoring of Signal Timing Plans**<br>The ICMS-COM-ASG system shall provide visual monitoring of traffic conditions as special event and incident signal timing plans are implemented. | User Need 17 | ICMS-COM-ASG | H |
| COM-ASG-3-4 | **COM-Video Sharing**<br>The ICMS-COM-ASG System shall share streaming video to Hennepin County (traffic and EMS), Mn/DOT, Metro Transit, SouthWest Transit and Plymouth Metrolink to view current images captured by city operated CCTV cameras along the corridor. | User Need 1, 2 | ICMS-COM-ASG | H |
| COM-ASG-3-4-1 | **COM=Video Sharing: accessibility**<br>The ICMS-COM-ASG System shall provide a mechanism where authorized agencies can view streaming video from CCTV cameras using Internet browsers and existing Internet connections. | User Need 1, 2 | ICMS-COM-ASG | H |
| COM-ASG-3-4-2 | **COM-Video Sharing: control**<br>The ICMS-COMM-ASG System shall not allow other agencies to control City of Minneapolis cameras (pan/tilt/zoom). | User Need 1, 2 | ICMS-COM-ASG | H |
| **COM-ASG-4** | **The ICMS-COM-ASG System shall Send Data to the ICMS-Data Hub.** | User Need 1,2,17 | ICMS-COM-ASG | H |
| COM-ASG-4-1 | **ICMS-COM-ASG Send Arterial Travel Traffic Data**<br>The ICMS-COM-ASG system shall send to the ICMS-Data Hub Arterial Traffic Data to the ICMS-Data Hub. | User Need 1,2 | ICMS-COM-ASG | H |
| COM-ASG-4-1-1 | **ICMS-COM-ASG Send Arterial Traffic Data: Data Exchanges**<br>The ICMS-COM-ASG system shall interface with the ICMS-Data Hub according to the requirements of the ICMS-ASG to ICMS-Data Hub ICD to send Arterial Traffic Data. | User Need 2 | ICMS-COM-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| COM-ASG-4-1-2 | **ICMS-COM-ASG Send Arterial Traffic Data: Frequency**<br>The ICMS-COM-ASG system shall send Arterial Traffic Data to the ICMS-Data Hub each time traffic volume data is acquired from signal controllers. | User Need 1 | ICMS-COM-ASG | H |
| COM-ASG-4-1-3 | **ICMS-COM-ASG Send Arterial Traffic Data: No Data**<br>The ICMS-COM-ASG system shall send Arterial Traffic Data to the ICMS-Data Hub indicating "no data available' if no data is available. | User Need 1 | ICMS-COM-ASG | H |
| COM-ASG-4-1-4 | **ICMS-COM-ASG Send Arterial Traffic Data: Volume and Speed Data**<br>The ICMS-COM-ASG system shall send to the ICMS-Data Hub Arterial Traffic Data describing volume and speed. | User Need 17 | ICMS-COM-ASG | H |
| COM-ASG-4-2 | **ICMS-COM-ASG Send Special Event and Incident Signal Timing Plans Data**<br>The ICMS-COM-ASG system shall send to the ICMS-Data Hub Special Event and Incident Signal Timing Plans Data. | User Need 2 | ICMS-COM-ASG | H |
| COM-ASG-4-2-1 | **ICMS-COM-ASG Send Special Event and Incident Signal Timing Plans Data: Data Exchanges**<br>The ICMS-COM-ASG system shall follow the ICMS-ASG to ICMS-Data Hub ICD to send Special Event and Incident Signal Timing Plans Data. | User Need 11 | ICMS-COM-ASG | H |
| COM-ASG-4-2-2 | **ICMS-COM-ASG Send Special Event and Incident Signal Timing Plans Data: Frequency**<br>The ICMS-COM-ASG system shall send Special Event and Incident Signal Timing Plans Data to the ICMS-Data Hub each time a special signal timing plan is downloaded to an intersection within the ICM corridor. | User Need 11 | ICMS-COM-ASG | H |
| COM-ASG-4-2-3 | **ICMS-COM-ASG Send Special Event and Incident Signal Timing Plans Data: Selected Signal Timing Plan**<br>The ICMS-COM-ASG system shall send Special Event and Incident Signal Timing Plans Data to the ICMS-Data Hub identifying which signal timing plan was implemented. | User Need 11 | ICMS-COM-ASG | H |
| COM-ASG-4-2-4 | **ICMS-COM-ASG Send Special Event and Incident Signal Timing Plans Data: Time Implemented**<br>The ICMS-COM-ASG system shall send Special Event and Incident Signal Plans Data to the ICMS-Data Hub identifying the time a signal timing plan was implemented. | User Need 11 | ICMS-COM-ASG | H |
| COM-ASG-4-2-5 | **ICMS-COM-ASG Send Special Event and Incident Signal Timing Plans Data: Time Deactivated**<br>The ICMS-COM-ASG system shall send Special Event and Incident Signal Timing Plans Data to the ICMS-Data Hub identifying the time a signal timing plan was deactivated. | User Need 11 | ICMS-COM-ASG | H |

## 4.8 ICMS Enhancements to Minnesota State Patrol (ICMS-MSP-EMS) Functional Requirements

The Minnesota State Patrol (MSP) Emergency Management System will be enhanced as part of the ICMS project. Currently, the MSP dispatchers are co-located in the RTMC dispatch center, and have full access to Mn/DOT video feeds. This section describes the requirements for the enhancements to the MSP EMS (referred to as ICMS-MSP-EMS System). The enhanced MSP-EMS will perform one key function (Generate and Send Messages to ICMS-Data Hub). Figure 29 illustrates the ICMS-MSP-EMS System functions and Table 14 includes the ICMS-MSP-EMS System requirements to ease software development and testing.

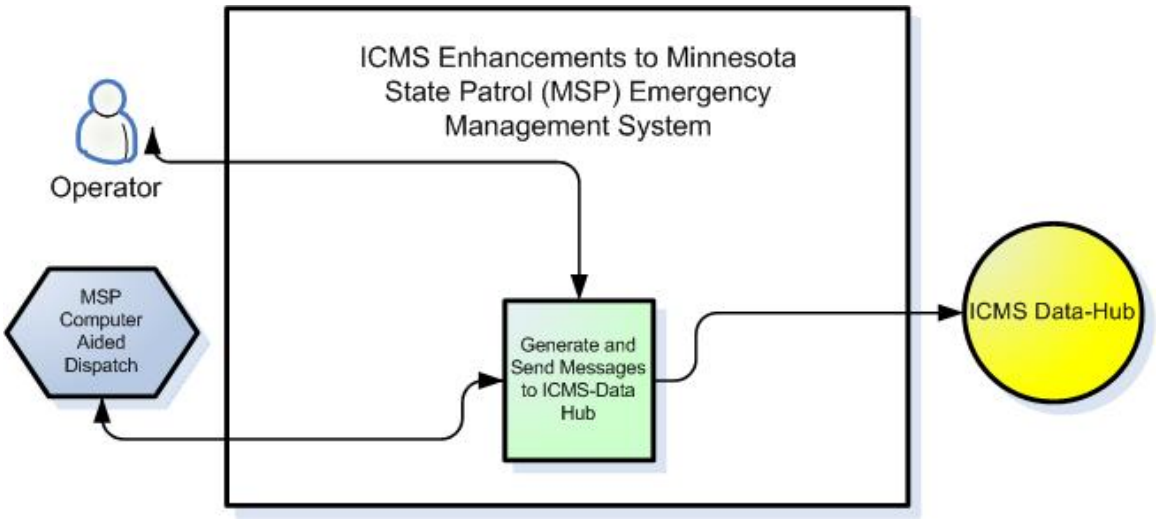


***Figure 29: ICMS-MSP-EMS Functions***

***Table 14: ICMS-MSP-EMS Requirements***

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **EMS-MSP-1** | **The ICMS-MSP-EMS System Shall Generate Messages to be Sent to the ICMS-Data Hub System Describing Incidents on Highways within the ICM Corridor.** | User Need 1 | ICMS-MSP-EMS | H |
| EMS-MSP-1-1 | **ICMS-MSP-EMS Select incidents for transmission.**<br>The ICMS-MSP-EMS shall compare each incident report entered in the CAD system against an algorithm to determine if the message shall be sent to the ICMS-Data Hub system. | User Need 1 | ICMS-MSP-EMS | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| EMS-MSP-1-2 | **ICMS-MSP-EMS generate message**<br>The ICMS-MSP-EMS shall generate a message that contains all information contained in the CAD system describing the incident. | User Need 1 | ICMS-MSP-EMS | H |
| EMS-MSP-1-3 | **ICMS-MSP-EMS Filter incident messages**<br>The ICMS-MSP-EMS shall remove any data elements from messages describing incidents that are not public information. | User Need 1 | ICMS-MSP-EMS | H |
| EMS-MSP-1-4 | **ICMS-MSP-EMS Format message sets for transmission to ICMS-Data Hub**<br>The ICMS-MSP-EMS shall assign each message a unique message ID. | User Need 1 | ICMS-MSP-EMS | H |
| EMS-MSP-1-4-1 | **ICMS-MSP-EMS Handling of message updates**<br>The ICMS-MSP-EMS shall generate messages identified as update messages to earlier messages by assigning a unique message ID that references the earlier message ID. | User Need 1 | ICMS-MSP-EMS | H |
| **EMS-MSP-2** | **The ICMS-MSP-EMS Shall Send Messages Describing Current Incidents to the ICMS-Data Hub System.** | User Need 1 | ICMS-MSP-EMS | H |
| EMS-MSP-2-1 | **ICMS-MSP-EMS Send Incident Data: Data Exchanges**<br>The ICMS-MSP-EMS shall interface to the ICMS-Data Hub System according to requirements of the ICMS-EMS to ICMS-Data Hub ICD to send Incident Data to the ICMS-Data Hub. | User Need 1 | ICMS-MSP-EMS | H |
| EMS-MSP-2-2 | **ICMS-MSP-EMS Send Incident Data: Frequency**<br>The ICMS-MSP-EMS shall send messages describing incidents to the ICMS-Data Hub after each message is generated. | User Need 1 | ICMS-MSP-EMS | H |
| EMS-MSP-2-3 | **ICMS-MSP-EMS Send Incident Data: Timing**<br>The ICMS-MSP-EMS shall send messages describing incidents to the ICMS-Data Hub within a time period from when the incident is entered in the CAD system. This time period shall be configurable by the administrator of the system. | User Need 1 | ICMS-MSP-EMS | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| EMS-MSP-2-4 | **ICMS-MSP-EMS Send Incident Data: Test Messages**<br>The ICMS-MSP-EMS shall send test messages to the ICMS-Data Hub system if a period of time has elapsed without any incidents being entered into the MSP CAD system to enable the ICMS-Data Hub to verify that the connection is still active. This period of time shall be configurable by the administrator. | User Need 1 | ICMS-MSP-EMS | H |
| EMS-MSP-2-5 | **ICMS-MSP-EMS Send Incident Data: Location**<br>The ICMS-MSP-EMS shall send Incident Data to the ICMS-Data Hub describing the incident location. | User Need 1 | ICMS-MSP-EMS | H |
| EMS-MSP-2-5-1 | **ICMS-MSP-EMS Send Incident Data: Location Detail**<br>The ICMS-MSP-EMS shall send Incident Data to the ICMS-Data Hub describing the incident location as a geo reference. | User Need 1 | ICMS-MSP-EMS | H |
| EMS-MSP-2-6 | **ICMS-MSP-EMS Send Incident Data: Type**<br>The ICMS-MSP-EMS shall send Incident Data to the ICMS-Data Hub describing incident type and severity. | User Need 1 | ICMS-MSP-EMS | H |
| EMS-MSP-2-7 | **ICMS-MSP-EMS Send Incident Data: Time**<br>The ICMS-MSP-EMS shall send Incident Data to the ICMS-Data Hub describing incident time elements: incident start time, vehicle arrival time, and clearance time. | User Need 1 | ICMS-MSP-EMS | H |
| EMS-MSP-2-8 | **ICMS-MSP-EMS Send Incident Data: Response Activity**<br>The ICMS-MSP-EMS shall send Incident Data to the ICMS-Data Hub describing incident response activity. | User Need 1 and 11 | ICMS-MSP-EMS | H |

## 4.9 ICMS Enhancements to City of Minneapolis Emergency Management System (ICMS-COM-EMS) Functional Requirements

The City of Minneapolis (COM) Emergency Management System will be enhanced as part of the ICMS project. This section describes the requirements for the enhancements to the COM EMS (referred to as ICMS-COM-EMS System). The enhanced COM-EMS will perform three key functions (Generate and Send Messages to ICMS-Data Hub, Acquire and store data from the ICMS-Data Hub, and Display information to operators). Figure 30 illustrates the ICMS-COM-EMS System functions and Table 15 includes the ICMS-COM-EMS System requirements to ease software development and testing.

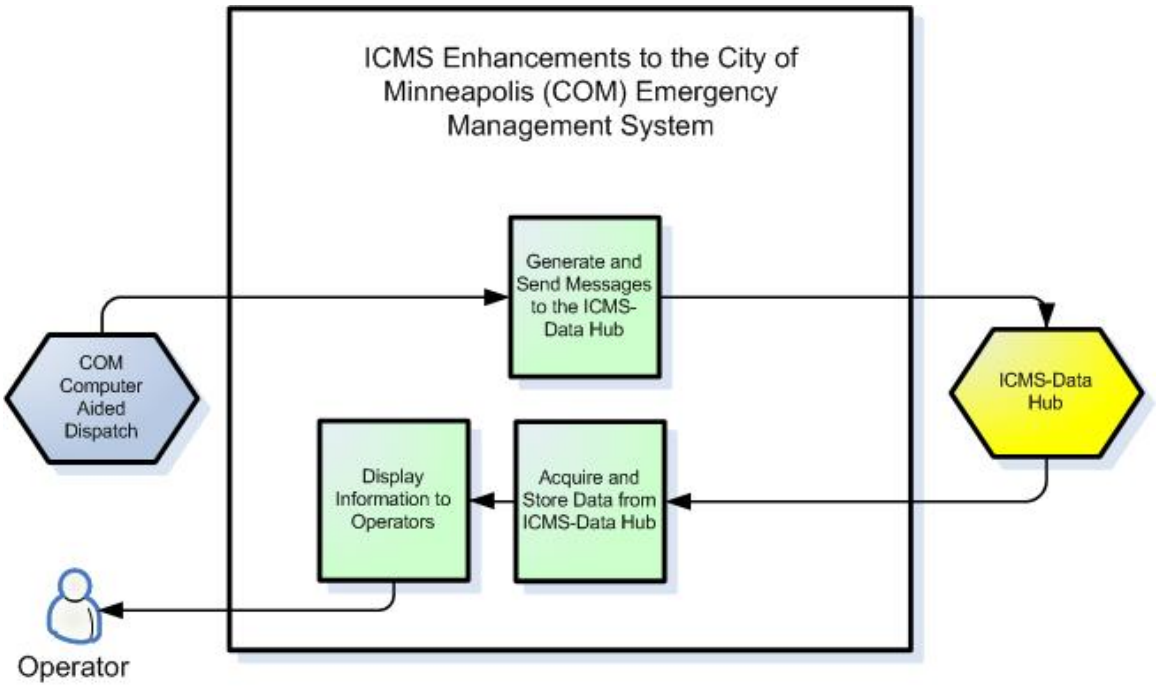


***Figure 30: ICMS-COM-EMS Functions***

***Table 15: ICMS-COM-EMS Requirements***

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **EMS-COM-1** | **The ICMS-COM-EMS System Shall Acquire and Store Incident Data Describing Incidents from the ICMS-Data Hub** | User Need 1, 10,11, 12 | ICMS-COM-EMS | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| EMS-COM-1-1 | **ICMS-COM-EMS System Acquire and Store Incident Data: Data Exchanges**<br>The ICMS-COM-EMS System shall follow the ICMS-EMS to ICMS-Data Hub ICD to acquire and store ICMS-EMS Incident Data from the ICMS-Data Hub. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-1-2 | **ICMS-COM-EMS Acquire and Store Incident Data: Frequency**<br>The ICMS-COM-EMS System shall acquire and store ICMS-EMS Incident Data from the ICMS-Data Hub at a frequency configurable by an ICMS Administrator. | User Need 1,11,10,12 | ICMS-COM-EMS | H |
| EMS-CoM-1-3 | **ICMS-COM-EMS Acquire and Store Incident Data: Location**<br>The ICMS-COM-EMS System shall acquire and store ICMS-EMS Incident Data from the ICMS-Data Hub describing the incident location. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-1-4 | **ICMS-COM-EMS Acquire and Store Incident Data: Location Detail**<br>The ICMS-COM-EMS System shall acquire and store ICMS-EMS Incident Data from the ICMS-Data Hub describing the incident location as a geo reference. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-1-5 | **ICMS-COM-EMS Acquire and Store Incident Data: Type**<br>The ICMS-COM-EMS System shall acquire and store ICMS-EMS Incident Data from the ICMS-Data Hub describing incident type and severity. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-1-6 | **ICMS-COM-EMS Acquire and Store Incident Data: Time**<br>The ICMS-COM-EMS System shall acquire and store ICMS-EMS Incident Data from the ICMS-Data Hub describing incident time elements: incident start time, vehicle arrival time, and clearance time. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-1-7 | **ICMS-COM-EMS Acquire and Store Incident Data: Response Activity**<br>The ICMS-COM-EMS System shall acquire and store ICMS-EMS Incident Data from the ICMS-Data Hub describing incident response activity. | User Need 1,10, 11,12 | ICMS-COM-EMS | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **EMS-COM-2** | **The ICMS-COM-EMS System Shall Generate Messages to be Sent to the ICMS-Data Hub System Describing Incidents on City of Minneapolis Highways within the ICM Corridor.** | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-2-1 | **ICMS-COM-EMS Select incidents for transmission.**<br>The ICMS-COM-EMS System shall compare each incident report entered in the CAD system against an algorithm to determine if the message shall be sent to the ICMS-Data Hub system. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-2-2 | **ICMS-COM-EMS generate message**<br>The ICMS-COM-EMS System shall generate a message that contains all information contained in the CAD system describing the incident. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-2-3 | **ICMS-COM-EMS Filter incident messages**<br>The ICMS-COM-EMS System shall remove any data elements from messages describing incidents that are not public information. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-2-4 | **ICMS-COM-EMS Format message sets for transmission to ICMS-Data Hub**<br>The ICMS-COM-EMS System shall assign each message a unique message ID. | User Need 1,10,1,12 | ICMS-COM-EMS | H |
| EMS-COM-2-5 | **ICMS-COM-EMS Handling of message updates**<br>The ICMS-COM-EMS System shall generate messages identified as update messages to earlier messages by assigning a unique message ID that references the earlier message ID. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| **EMS-COM-3** | **The ICMS-COM-EMS System Shall Send Incident Data Describing Incidents to the ICMS-Data Hub system.** | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-3-1 | **ICMS-MSP-EMS Send Incident Data: Data Exchanges**<br>The ICMS-COM-EMS System shall follow the ICMS-EMS to ICMS-Data Hub ICD to send Incident Data to the ICMS-Data Hub. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-3-2 | **ICMS-COM-EMS Send Incident Data: Frequency**<br>The ICMS-COM-EMS System shall send messages describing incidents to the ICMS-Data Hub after each message is generated. | User Need 1,10,11,12 | ICMS-COM-EMS | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| EMS-COM-3-3 | **ICMS-COM-EMS Send Incident Data: Timing**<br>The ICMS-COM-EMS System shall send messages describing incidents to the ICMS-Data Hub within a time period from when the incident is entered in the CAD system. This time period shall be configurable by the administrator of the system. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-3-4 | **ICMS-COM-EMS Send Incident Data: Test Messages**<br>The ICMS-COM-EMS System shall send test messages to the ICMS-Data Hub system if a period of time has elapsed without any incidents being entered into the COM CAD system to enable the ICMS-Data Hub to verify that the connection is still active. This period of time shall be configurable by the administrator. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-3-5 | **ICMS-COM-EMS Send Incident Data: Location Detail**<br>The ICMS-COM-EMS System shall send Incident Data to the ICMS-Data Hub describing the incident location as a geo reference. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-3-6 | **ICMS-COM-EMS Send Incident Data: Type**<br>The ICMS-COM-EMS System shall send Incident Data to the ICMS-Data Hub describing incident type and severity. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-3-7 | **ICMS-COM-EMS Send Incident Data: Time**<br>The ICMS-COM-EMS System shall send Incident Data to the ICMS-Data Hub describing incident time elements: incident start time, vehicle arrival time, and clearance time. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-3-8 | **ICMS-COM-EMS Send Incident Data: Response Activity**<br>The ICMS-COM-EMS System shall send Incident Data to the ICMS-Data Hub describing incident response activity. | User Need 1,10, 11,12 | ICMS-COM-EMS | H |
| **EMS-COM-4** | **The ICMS-COM-EMS System Shall Display ICMS-EMS Incident Data to COM Operators.** | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| EMS-COM-4-1 | **ICMS-COM-EMS Mechanism to Display ICMS-EMS Incident Data**<br>The ICMS-COM-EMS System shall provide a mechanism for COM Operators to view Incident Data acquired and stored in the ICMS-COM-EMS. | User Need 1,10,11,12 | ICMS-COM-EMS | H |

## *4.10 ICMS Enhancements to Hennepin County Emergency Management System (ICMS-HENN-EMS) Functional Requirements*

The Hennepin County (HENN) Emergency Management System will be enhanced as part of the ICMS project. This section describes the requirements for the enhancements to the HENN EMS (referred to as ICMS-HENN-EMS System). The enhanced HENN-EMS will perform three key functions (Generate and Send Messages to ICMS-Data Hub, Acquire and store data from the ICMS-Data Hub, and Display information to operators). Figure 31 illustrates the ICMS-HENN-EMS System functions and Table 16 includes the ICMS-HENN-EMS System requirements to ease software development and testing.

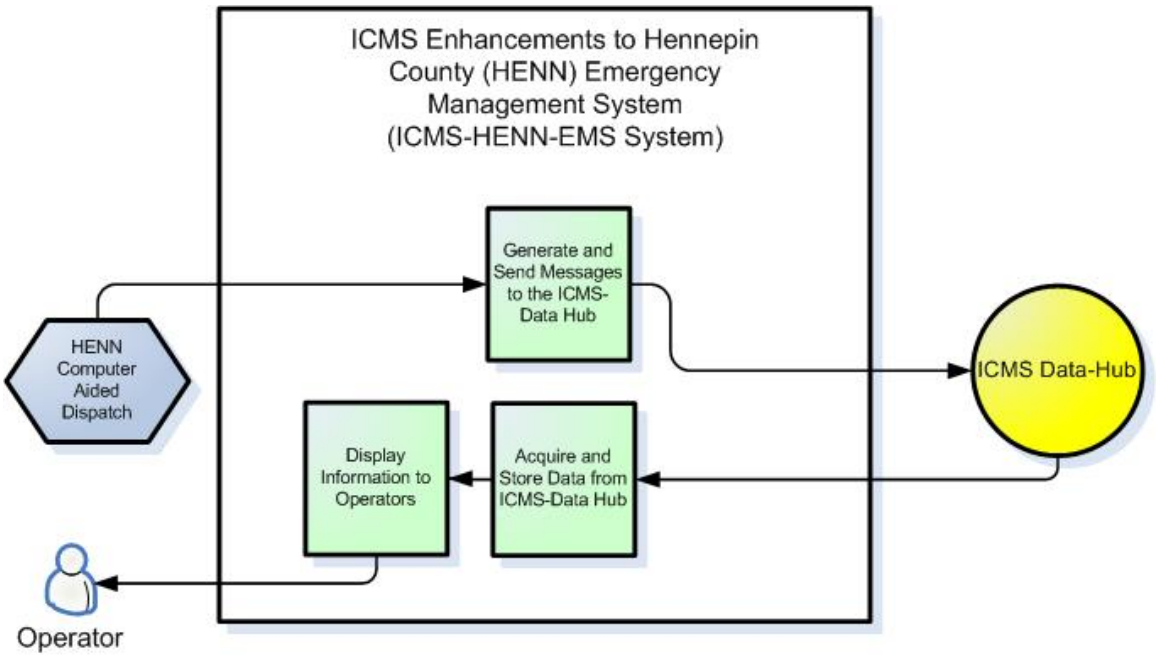


***Figure 31: ICMS-HENN-EMS Functions***

***Table 16: ICMS-HENN-EMS Requirements***

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **EMS-HENN-1** | **The ICMS-HENN-EMS System Shall Acquire and Store Incident Data Describing Incidents from the ICMS-Data Hub.** | User Need 1,10,11,12 | ICMS-HENN-EMS | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| EMS-HENN-1-1 | **ICMS-HENN-EMS Acquire and Store Incident Data: Data Exchanges**<br>The ICMS-HENN-EMS System shall interface to the ICMS-Data Hub System according to the requirements of the ICMS-EMS to ICMS-Data Hub ICD to acquire and store Incident Data from the ICMS-Data Hub. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-1-2 | **ICMS-HENN-EMS Acquire and Store Incident Data: Frequency**<br>The ICMS-HENN-EMS System shall acquire and store Incident Data from the ICMS-Data Hub at a frequency configurable by an ICMS Administrator. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-1-3 | **ICMS-HENN-EMS Acquire and Store Incident Data: Location**<br>The ICMS-HENN-EMS System shall acquire and store Incident Data from the ICMS-Data Hub describing the incident location. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-1-4 | **ICMS-HENN-EMS Acquire and Store Incident Data: Location Detail**<br>The ICMS-HENN-EMS System shall acquire and Incident Data from the ICMS-Data Hub describing incident location as a geo reference. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-1-5 | **ICMS-HENN-EMS Acquire and Store Incident Data: Type**<br>The ICMS-HENN-EMS System shall acquire and store Incident Data from the ICMS-Data Hub describing incident type and severity. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-1-6 | **ICMS-HENN-EMS Acquire and Store Incident Data: Time**<br>The ICMS-HENN-EMS System shall acquire and store Incident Data from the ICMS-Data Hub describing incident time elements: incident start time, vehicle arrival time, and clearance time. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-1-7 | **ICMS-HENN-EMS Acquire and Store Incident Data: Response Activity**<br>The ICMS-HENN-EMS System shall acquire and store Incident Data from the ICMS-Data Hub describing incident response activity. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **EMS-HENN-2** | **The ICMS-HENN-EMS System Shall Generate Messages to be Sent to the ICMS-Data Hub System Describing Incidents on Highways within the ICM Corridor.** | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-2-1 | **ICMS-HENN-EMS Select incidents for transmission.**<br>The ICMS-HENN-EMS System shall compare each incident report entered in the CAD system against an algorithm to determine if the message shall be sent to the ICMS-Data Hub system. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-2-2 | **ICMS-HENN-EMS generate message**<br>The ICMS-HENN-EMS System shall generate a message that contains all information contained in the CAD system describing the incident. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-2-3 | **ICMS-HENN-EMS Filter incident messages**<br>The ICMS-HENN-EMS System shall remove any data elements from messages describing incidents that are not public information. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-2-4 | **ICMS-HENN-EMS Format message sets for transmission to ICMS-Data Hub**<br>The ICMS-HENN-EMS System shall assign each message a unique message ID. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-2-5 | **ICMS-HENN-EMS Handling of message updates**<br>The ICMS-HENN-EMS System shall generate messages identified as update messages to earlier messages by assigning a unique message ID that references the earlier message ID. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| **EMS-HENN-3** | **The ICMS-HENN-EMS Shall Send Messages Describing Current Incidents to the ICMS-Data Hub system.** | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-3-1 | **ICMS-HENN-EMS Send Incident Data: Data Exchanges**<br>The ICMS-HENN-EMS System shall follow the ICMS-EMS to ICMS-Data Hub ICD to send Incident Data to the ICMS-Data Hub. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-3-2 | **ICMS-HENN-EMS Send Incident Data: Frequency**<br>The ICMS-HENN-EMS System shall send messages describing incidents to the ICMS-Data Hub after each message is generated. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| EMS-HENN-3-3 | **ICMS-HENN-EMS Send Incident Data: Timing**<br>The ICMS-HENN-EMS System shall send messages describing incidents to the ICMS-Data Hub within a time period from when the incident is entered in the CAD system. This time period shall be configurable by the administrator of the system. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-3-4 | **ICMS-HENN-EMS Send Incident Data: Test Messages**<br>The ICMS-HENN-EMS System shall send test messages to the ICMS-Data Hub system if a period of time has elapsed without any incidents being entered into the HENN CAD system to enable the ICMS-Data Hub to verify that the connection is still active. This period of time shall be configurable by the administrator. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-3-5 | **ICMS-HENN-EMS Send Incident Data: Location Detail**<br>The ICMS-HENN-EMS System shall send Incident Data to the ICMS-Data Hub describing incident location as a geo reference. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-3-6 | **ICMS-HENN-EMS Send Incident Data: Type**<br>The ICMS-HENN-EMS System shall send Incident Data to the ICMS-Data Hub describing incident type and severity. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-3-7 | **ICMS-HENN-EMS Send Incident Data: Time**<br>The ICMS-HENN-EMS System shall send Incident Data to the ICMS-Data Hub describing incident time elements: incident start time, vehicle arrival time, and clearance time. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-3-8 | **ICMS-HENN-EMS Send Incident Data: Response Activity**<br>The ICMS-HENN-EMS System shall send Incident Data to the ICMS-Data Hub describing incident response activity. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| **EMS-HENN-4** | **The ICMS-HENN-EMS System Shall Display ICMS-EMS Incident Data to HENN Operators.** | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| EMS-HENN-4-1 | **ICMS-HENN-EMS Mechanism to Display ICMS-EMS Incident Data**<br>The ICMS-HENN-EMS System shall provide a mechanism for HENN Operators to view Incident Data acquired and stored in the ICMS-HENN-EMS. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |

## 4.11 ICMS Enhancements to SouthWest Transit Dispatch Center (ICMS-SWT System)

The SouthWest Transit dispatch center will be enhanced as part of the ICMS project. This section describes the requirements for the enhancements to the system (referred to as ICMS-SWT System. The enhanced System will perform two key functions (data input from ICMS Data Hub, and display data to operator). Figure 32 illustrates the ICMS-SWT System functions and Table 17 includes the ICMS-SWT System requirements to ease software development and testing.

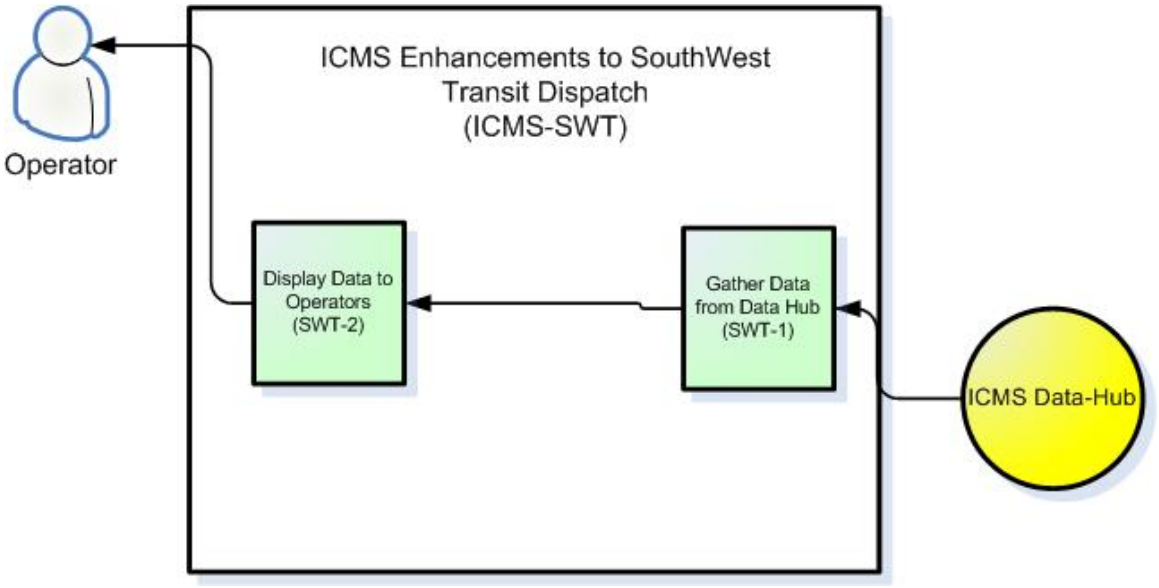


***Figure 32: ICMS-SWT Functions***

***Table 17: ICMS-SWT Requirements***

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **SWT-1** | **The ICMS-SWT System Shall Acquire and Store Data from the ICMS-Data Hub.** | User Need 2,5,17 | ICMS-SWT | H |
| SWT-1-1 | **ICMS-SWT Acquire and Store Incident and Event Data**<br>The ICMS-SWT System shall acquire and store from the ICMS-Data Hub Incident and Event Data for all roads within the ICM Corridor. | User Need 2,5,17 | ICMS-SWT | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| SWT-1-1-1 | **ICMS-SWT Acquire and Store Incident and Event Data: Data Exchanges**<br>The ICMS-SWT System shall interface with the ICMS-Data Hub according to the requirements of the ICMS-Data Hub Post ICD to acquire and store Incident and Event Data. | User Need 2,5,17 | ICMS-SWT | H |
| SWT-1-1-2 | **ICMS-SWT Acquire and Store Incident and Event Data: Frequency**<br>The ICMS-SWT System shall acquire and store Incident and Event Data from the ICMS-Data Hub at least once per minute. | User Need 2,5,17 | ICMS-SWT | H |
| SWT-1-1-3 | **ICMS-SWT Acquire and Store Incident and Event Data: Location**<br>The ICMS-SWT System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location. | User Need 2,5,17 | ICMS-SWT | H |
| SWT-1-1-4 | **ICMS-SWT Acquire and Store Incident and Event Data: Location Detail**<br>The ICMS-SWT System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location as a geo reference. | User Need 2,5,17 | ICMS-SWT | H |
| SWT-1-1-5 | **ICMS-SWT Acquire and Store Incident and Event Data: Type**<br>The ICMS-SWT System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident type. | User Need 2,5,17 | ICMS-SWT | H |
| SWT-1-1-6 | **ICMS-SWT Acquire and Store Incident and Event Data: Time**<br>The ICMS-SWT System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event time elements: start time, vehicle arrival time, and clearance time. | User Need 2,5,17 | ICMS-SWT | H |
| SWT-1-2 | **ICMS-SWT Acquire and Store Freeway Traffic Data**<br>The ICMS-SWT System shall acquire and store from the ICMS-Data Hub Freeway Traffic Data. | User Need 17 | ICMS-SWT | H |
| SWT-1-2-1 | **ICMS-SWT Acquire and Store Freeway Traffic Data: Data Exchanges**<br>The ICMS-SWT System shall interface with the ICMS-Data Hub according to the requirements of the ICMS-Data Hub Post ICD to acquire and store Freeway Traffic Data. | User Need 17 | ICMS-SWT | H |
| SWT-1-2-2 | **ICMS-SWT Acquire and Store Freeway Traffic Data: Frequency**<br>The ICMS-SWT System shall acquire and store Freeway Traffic Data from the ICMS-Data Hub at least once per minute. | User Need 17 | ICMS-SWT | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| SWT-1-2-3 | **ICMS-SWT Acquire and Store Freeway Traffic Data: Traffic Details**<br>The ICMS-SWT System shall acquire and store Freeway Traffic Data from the ICMS-Data Hub describing volume, occupancy, and speed data for sensor stations along:<br>- The I-394 mainline and I-394 ramps<br>- I-494<br>- Hwy 100<br>- Hwy 169. | User Need 17 | ICMS-SWT | H |
| SWT-1-2-4 | **ICMS-SWT Acquire and Freeway Traffic Data: Travel Times**<br>The ICMS-SWT System shall acquire and store messages describing Freeway Travel Times from the ICMS-Data Hub. | User Need 17 | ICMS-SWT | H |
| SWT-1-3 | **ICMS-SWT Acquire Mn/PASS direction and rate data.**<br>The ICMS-SWT System shall acquire Mn/PASS lane direction and pricing data from the ICMS-Data Hub, as per the ICMS-Data Hub Post ICD at least once every 2 minutes. | User Need 17 | ICMS-SWT | H |
| **SWT-2** | **The ICMS-SWT System shall Display Data to SouthWest Transit Dispatchers.** | User Need 1,2,17 | ICMS-SWT | H |
| SWT-2-1 | **ICMS-SWT Mechanism to Display Arterial and Freeway Incident Data**<br>The ICMS-SWT System shall provide a mechanism for SouthWest Transit Dispatchers to view Incident Data acquired and stored in the ICMS-SWT on arterials and freeways within the ICM Corridor. | User Need 1,2,17 | ICMS-SWT | H |
| SWT-2-2 | **ICMS-SWT Mechanism to Display Arterial and Freeway Volume Data**<br>The ICMS-SWT System shall provide a mechanism for SouthWest Transit Dispatchers to view Volume Data acquired and stored in the ICMS-SWT on arterials and freeways within the ICM Corridor. | User Need 1,2,17 | ICMS-SWT | H |
| SWT-2-3 | **ICMS-SWT Mechanism to Display Arterial and Freeway Travel Time Data**<br>The ICMS-SWT System shall provide a mechanism for SouthWest Transit Dispatchers to view Travel Time Data acquired and stored in the ICMS-SWT on arterials and freeways within the ICM Corridor. | User Need 1,2,17 | ICMS-SWT | H |

## 4.12 ICMS Enhancements to Plymouth Metrolink Transit Dispatch Center (ICMS-PM System)

The Plymouth Metrolink (operated by Plymouth Transit) dispatch center will be enhanced as part of the ICMS project. This section describes the requirements for the enhancements to the system (referred to as ICMS-PM System. The enhanced System will perform two key functions (data input from ICMS Data Hub, and display data to operator). Figure 33 illustrates the ICMS-PM System functions and Table 18 includes the ICMS-PM System requirements.

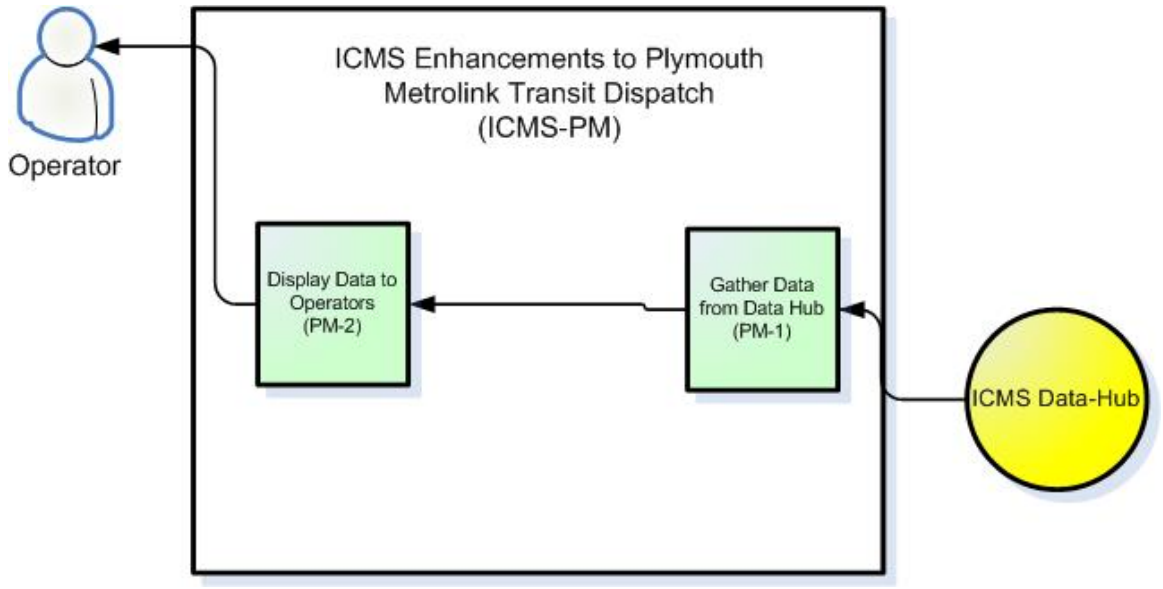


***Figure 33: ICMS-PM Functions***

***Table 18: ICMS-PM Requirements***

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **PM-1** | **The ICMS-PM System Shall Acquire and Store Data from the ICMS-Data Hub.** | User Need 2,5,17 | ICMS-PM | H |
| PM-1-1 | **ICMS-PM Acquire and Store Incident and Event Data**<br>The ICMS-PM System shall acquire and store from the ICMS-Data Hub Incident and Event Data for all roads within the ICM Corridor. | User Need 2,5,17 | ICMS-PM | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| PM-1-1-1 | **ICMS-PM Acquire and Store Incident and Event Data: Data Exchanges**<br>The ICMS-PM System shall interface with the ICMS-Data Hub according to the requirements of the ICMS-Data Hub Post ICD to acquire and store Incident and Event Data. | User Need 2,5,17 | ICMS-PM | H |
| PM-1-1-2 | **ICMS-PM Acquire and Store Incident and Event Data: Frequency**<br>The ICMS-PM System shall acquire and store Incident and Event Data from the ICMS-Data Hub at least once per minute. | User Need 2,5,17 | ICMS-PM | H |
| PM-1-1-3 | **ICMS-PM Acquire and Store Incident and Event Data: Location**<br>The ICMS-PM System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location. | User Need 2,5,17 | ICMS-PM | H |
| PM-1-1-4 | **ICMS-PM Acquire and Store Incident and Event Data: Location Detail**<br>The ICMS-PM System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event location as a geo reference. | User Need 2,5,17 | ICMS-PM | H |
| PM-1-1-5 | **ICMS-PM Acquire and Store Incident and Event Data: Type**<br>The ICMS-PM System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident type. | User Need 2,5,17 | ICMS-PM | H |
| PM-1-1-6 | **ICMS-PM Acquire and Store Incident and Event Data: Time**<br>The ICMS-PM System shall acquire and store Incident and Event Data from the ICMS-Data Hub describing the incident or event time elements: start time, vehicle arrival time, and clearance time. | User Need 2,5,17 | ICMS-PM | H |
| PM-1-2 | **ICMS-PM Acquire and Store Freeway Traffic Data**<br>The ICMS-PM System shall acquire and store from the ICMS-Data Hub Freeway Traffic Data. | User Need 17 | ICMS-PM | H |
| PM-1-2-1 | **ICMS-PM Acquire and Store Freeway Traffic Data: Data Exchanges**<br>The ICMS-PM System shall interface with the ICMS-Data Hub according to the requirements of the ICMS-Data Hub Post ICD to acquire and store Freeway Traffic Data. | User Need 17 | ICMS-PM | H |
| PM-1-2-2 | **ICMS-PM Acquire and Store Freeway Traffic Data: Frequency**<br>The ICMS-PM System shall acquire and store Freeway Traffic Data from the ICMS-Data Hub at least once per minute. | User Need 17 | ICMS-PM | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| PM-1-2-3 | **ICMS-PM Acquire and Store Freeway Traffic Data: Traffic Details**<br>The ICMS-PM System shall acquire and store Freeway Traffic Data from the ICMS-Data Hub describing volume, occupancy, and speed data for sensor stations along:<br>- The I-394 mainline and I-394 ramps<br>- I-494<br>- Hwy 100<br>- Hwy 169. | User Need 17 | ICMS-PM | H |
| PM-1-2-4 | **ICMS-PM Acquire and Freeway Traffic Data: Travel Times**<br>The ICMS-PM System shall acquire and store messages describing Freeway Travel Times from the ICMS-Data Hub. | User Need 17 | ICMS-PM | H |
| **PM-2** | **The ICMS-PM System shall Display Data to Plymouth Metrolink Transit Dispatchers.** | User Need 1,2,17 | ICMS-PM | H |
| PM-2-1 | **ICMS-PM Mechanism to Display Arterial and Freeway Incident Data**<br>The ICMS-PM System shall provide a mechanism for Plymouth Metrolink Transit Dispatchers to view Incident Data acquired and stored in the ICMS-PM on arterials and freeways within the ICM Corridor. | User Need 1,2,17 | ICMS-PM | H |
| PM-2-2 | **ICMS-PM Mechanism to Display Arterial and Freeway Volume Data**<br>The ICMS-PM System shall provide a mechanism for Plymouth Metrolink Transit Dispatchers to view Volume Data acquired and stored in the ICMS-PM on arterials and freeways within the ICM Corridor. | User Need 1,2,17 | ICMS-PM | H |
| PM-2-3 | **ICMS-PM Mechanism to Display Arterial and Freeway Travel Time Data**<br>The ICMS-PM System shall provide a mechanism for Plymouth Metrolink Transit Dispatchers to view Travel Time Data acquired and stored in the ICMS-PM on arterials and freeways within the ICM Corridor. | User Need 1,2,17 | ICMS-PM | H |

# 5. Hardware Requirements

This section presents the Hardware Requirements for the I-394 ICMS System. For purposes of this document, and this stage in the project, requirements are defined for:

- Hardware requirements of ICMS software systems – all twelve ICMS systems will have some associated requirements for the hardware that hosts the software; and
- Hardware requirements for field devices to be funded by Phase 1 ICM deployments – depicted in earlier diagrams as yellow colored items.

In other words, requirements for field devices that exist, that are planned for deployment by other projects and funding, or that are planned for future (later phases of ICM) are not included in this section. Figure 34 below illustrates those systems and field devices for which hardware requirements are defined in this section and Table 19 includes the ICMS Hardware requirements.

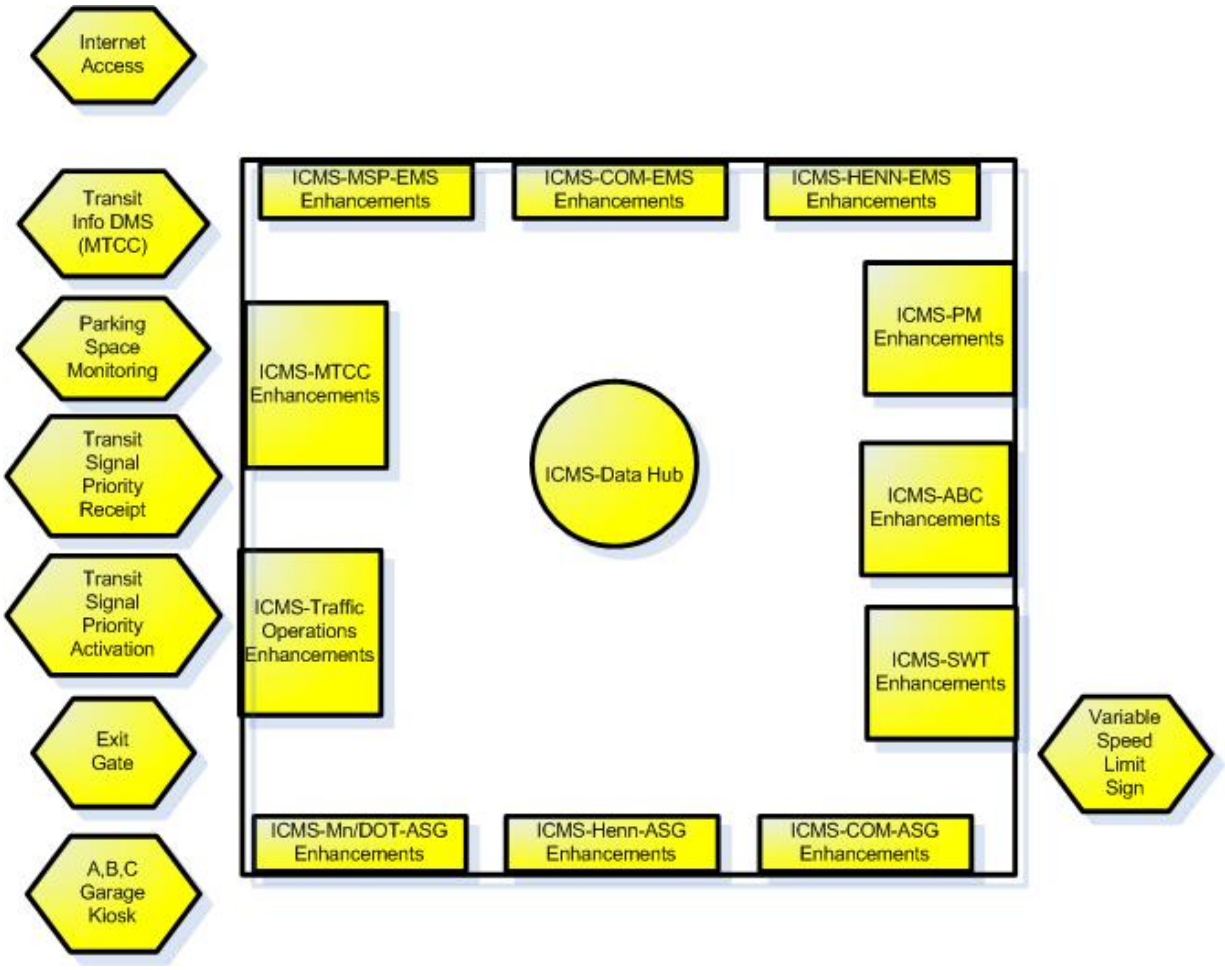


***Figure 34: ICMS Systems and Field Devices Requiring Hardware***

*Table 19: ICMS Hardware Requirements*

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **H-DH-1** | **The ICMS-Data Hub Shall be Reliable.** | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |
| H-DH-1-1 | **ICMS-Data Hub Reliable**<br>The ICMS-Data Hub shall be operational and available to users 99.9% of the time. | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |
| H-DH-2 | **The ICMS-Data Hub Shall be Redundant.** | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |
| H-DH-2-1 | **ICMS-Data Hub Redundant: Communication Paths**<br>The ICMS-Data Hub shall provide redundant communication paths. | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |
| H-DH-2-2 | **ICMS-Data Hub Redundant: Storage Methods**<br>The ICMS-Data Hub shall provide redundant data storage methods | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |
| H-DH-3 | **The ICMS-Data Hub Shall Provide Storage for ICMS-Data.** | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |
| H-DH-3-1 | **ICMS-Data Storage: Size**<br>The ICMS-Data Hub shall provide scalable data base storage for future system additions. | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |
| H-DH-3-2 | **ICMS-Data Storage: ICMS-EMS**<br>The ICMS-Data Hub shall accommodate temporary storage of 500 simultaneous ICMS-EMS Incident Data messages per day. | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |
| H-DH-3-3 | **ICMS-Data Storage: ICMS-Traffic Operations**<br>The ICMS-Data Hub shall accommodate temporary storage of 500 simultaneous ICMS-Traffic Operations Data messages per day. | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |
| H-DH-3-4 | **ICMS-Data Storage: ICMS-ASG**<br>The ICMS-Data Hub shall accommodate temporary storage of 500 simultaneous ICMS-ASG Data messages per day. | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| H-DH-3-5 | **ICMS-Data Storage: ICMS-MTCC**<br>The ICMS-Data Hub shall accommodate temporary storage of 500 ICMS-MTCC Data messages per day. | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |
| H-DH-3-6 | **ICMS-Data Storage: ICMS-ABC Parking Garages**<br>The ICMS-Data Hub shall accommodate temporary storage of 500 simultaneous ICMS-ABC Parking Garages Data messages per day. | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |
| H-DH-4 | **The ICMS-Data Hub shall Provide Internet Access to Acquire and Store ICMS-Data.** | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |
| H-DH-5 | **The ICMS-Data Hub shall Provide Internet Access to Post ICMS-Data.** | User Need 1,2,10, 11,12 | ICMS-Data Hub | H |
| **H-ABC-1** | **The ICMS-ABC Hardware Shall be Reliable.** | User Need 2,10,1 1,12 | ICMS-ABC | H |
| H-ABC-1-1 | **ICMS-ABC Reliable**<br>The ICMS-ABC Hardware shall be operational and available to users 99.9% of the time. | User Need 2,10,1 1,12 | ICMS-ABC | H |
| H-ABC-2 | **The ICMS-ABC Hardware shall Provide Storage for Incident Messages.** | User Need 2,10,1 1,12 | ICMS-ABC | H |
| H- ABC -2-1 | **ICMS-ABC Data Storage:**<br>The ICMS-ABC Hardware shall accommodate temporary storage of 50 simultaneous Incident and event messages. | User Need 2,10,1 1,12 | ICMS-ABC | H |
| H- ABC -2-2 | **ICMS-ABC Message Transmission**<br>The ICMS-ABC Hardware shall accommodate the transmission of at least 5 messages per minute. | User Need 2,10,1 1,12 | ICMS-ABC | H |
| H- ABC -3 | **The ICMS-ABC Hardware shall Provide Internet Access to Send Data to ICMS-Data Hub.** | User Need 2,10,1 1,12 | ICMS-ABC | H |
| **H-MTCC-1** | **The ICMS-MTCC Hardware Shall be Reliable.** | User Need 2,10,1 1,12 | ICMS-MTCC | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| H- MTCC -1-1 | **ICMS-MTCC Reliable**<br>The ICMS-MTCC Hardware shall be operational and available to users 99.9% of the time. | User Need 2,10,11,12 | ICMS-MTCC | H |
| H- MTCC -2 | **The ICMS-MTCC Hardware Shall Provide Storage for Incident Messages.** | User Need 2,10,11,12 | ICMS-MTCC | H |
| H- MTCC -2-1 | **ICMS-MTCC Data Storage:**<br>The ICMS-MTCC Hardware shall accommodate temporary storage of 50 simultaneous Incident and event messages. | User Need 2,10,11,12 | ICMS-MTCC | H |
| H- MTCC -2-2 | **ICMS-MTCC Message Transmission**<br>The ICMS-MTCC Hardware shall accommodate the transmission of at least 5 messages per minute. | User Need 2,10,11,12 | ICMS-MTCC | H |
| H- MTCC -3 | **The ICMS-MTCC Hardware Shall Provide Internet Access to Send Data to ICMS-Data Hub.** | User Need 2,10,11,12 | ICMS-MTCC | H |
| **H-TO-1** | **The ICMS-Traffic Operations Hardware Shall be Reliable.** | User Need 2,10,11,12 | ICMS-TO | H |
| H- TO-1-1 | **ICMS-Traffic Operations Reliable**<br>The ICMS-Traffic Operations Hardware shall be operational and available to users 99.9% of the time. | User Need 2,10,11,12 | ICMS-TO | H |
| H- TO-2 | **The ICMS-Traffic Operations Hardware Shall Provide Storage for Incident Messages.** | User Need 2,10,11,12 | ICMS-TO | H |
| H- TO-2-1 | **ICMS-Traffic Operations Data Storage:**<br>The ICMS-Traffic Operations Hardware shall accommodate temporary storage of 50 simultaneous Incident and event messages. | User Need 2,10,11,12 | ICMS-TO | H |
| H- TO-2-2 | **ICMS-Traffic Operations Message Transmission**<br>The ICMS-TRAFFIC OPERATIONS Hardware shall accommodate the transmission of at least 5 messages per minute. | User Need 2,10,11,12 | ICMS-TO | H |
| H- TO -3 | **The ICMS-Traffic Operations Hardware Shall Provide Internet Access to Send Data to ICMS-Data Hub** | User Need 2,10,11,12 | ICMS-TO | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **H-MSP-1** | **The ICMS-MSP-EMS shall be Reliable** | User Need 2,10,11,12 | ICMS-MSP-EMS | H |
| H-MSP-1-1 | **ICMS-MSP-EMS Reliable**<br>The ICMS-MSP-EMS shall be operational and available to users 99.9% of the time. | User Need 2,10,11,12 | ICMS-MSP-EMS | H |
| H-MSP-2 | **The ICMS-MSP-EMS shall Provide Storage for incident messages** | User Need 2,10,11,12 | ICMS-MSP-EMS | H |
| H-MSP-2-1 | **ICMS-MSP-EMS Data Storage: ICMS-EMS**<br>The ICMS-MSP-EMS shall accommodate temporary storage of 50 simultaneous ICMS-EMS Incident Data messages. | User Need 2,10,11,12 | ICMS-MSP-EMS | H |
| H-MSP-2-2 | **ICMS-MSP-EMS Message Transmission**<br>The ICMS-MSP-EMS shall accommodate the transmission of at least 5 messages per minute. | User Need 2,10,11,12 | ICMS-MSP-EMS | H |
| H-MSP-3 | **The ICMS-MSP-EMS shall Provide Internet Access to Send Data to ICMS-Data Hub** | User Need 2,10,11,12 | ICMS-MSP-EMS | H |
| **H-EMS-COM-1** | **The ICMS-COM-EMS System shall be Reliable** | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| H-EMS-COM-1-1 | **ICMS-COM-EMS Reliable**<br>The ICMS-COM-EMS System shall be operational and available to users 99.9% of the time. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| H-EMS-COM-2 | **The ICMS-COM-EMS System shall Provide Storage for incident messages** | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| H-EMS-COM-2-1 | **ICMS-COM-EMS Data Storage: ICMS-EMS**<br>The ICMS-COM-EMS System shall accommodate temporary storage of 50 simultaneous ICMS-EMS Incident Data messages. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| H-EMS-COM-2-2 | **ICMS-COM-EMS Message Transmission**<br>The ICMS-COM-EMS System shall accommodate the transmission of at least 5 messages per minute. | User Need 1,10,11,12 | ICMS-COM-EMS | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| H-EMS-COM-2-3 | **ICMS-COM-EMS Message Acquisition**<br>The ICMS-COM-EMS System shall accommodate the acquisition of at least 5 messages per minute. | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| H-EMS-COM-3 | **The ICMS-COM-EMS System shall Provide Internet Access to Send Data to ICMS-Data Hub System.** | User Need 1,10,11,12 | ICMS-COM-EMS | H |
| **H-EMS-HENN-1** | **The ICMS-HENN-EMS System shall be Reliable** | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| H-EMS-HENN-1-1 | **ICMS-HENN-EMS Reliable**<br>The ICMS-HENN-EMS System shall be operational and available to users 99.9% of the time. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| H-EMS-HENN-2 | **The ICMS-HENN-EMS System shall Provide Storage for incident messages** | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| H-EMS-HENN-2-1 | **ICMS-HENN-EMS Data Storage: ICMS-EMS**<br>The ICMS-HENN-EMS System shall accommodate temporary storage of 50 simultaneous ICMS-EMS Incident Data messages. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| H-EMS-HENN-2-2 | **ICMS-HENN-EMS Message Transmission**<br>The ICMS-HENN-EMS System shall accommodate the transmission of at least 5 messages per minute. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| H-EMS-HENN-2-3 | **ICMS-HENN-EMS Message Acquisition**<br>The ICMS-HENN-EMS System shall accommodate the acquisition of at least 5 messages per minute. | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| H-EMS-HENN-3 | **The ICMS-HENN-EMS System shall Provide Internet Access to Send Data to ICMS-Data Hub System.** | User Need 1,10,11,12 | ICMS-HENN-EMS | H |
| **H-MASG-1** | **The ICMS-Mn/DOT-ASG Shall be Reliable.** | User Need 2,10,11,12 | ICMS-Mn/DOT-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| H- MASG -1-1 | **ICMS-MN/DOT-ASG Reliable**<br>The ICMS-MN/DOT-ASG shall be operational and available to users 99.9% of the time. | User Need 2,10,11,12 | ICMS-Mn/DOT-ASG | H |
| H- MASG -2 | **The ICMS-MN/DOT-ASG shall Provide Storage for Messages** | User Need 2,10,11,12 | ICMS-Mn/DOT-ASG | H |
| H- MASG -2-1 | **ICMS-MN/DOT-ASG Data Storage:**<br>The ICMS-MN/DOT-ASG shall accommodate temporary storage of 20 simultaneous Travel Time messages. | User Need 2,10,11,12 | ICMS-Mn/DOT-ASG | H |
| H- MASG -2-2 | **ICMS-MN/DOT-ASG Data Storage: Implemented signal timing plans**<br>The ICMS-MN/DOT-ASG shall accommodate temporary storage of 50 simultaneous Signal Timing Plan descriptions. | User Need 2,10,11,12 | ICMS-Mn/DOT-ASG | H |
| H- MASG -2-3 | **ICMS-MN/DOT-ASG Message Transmission**<br>The ICMS-MN/DOT-ASG shall accommodate the transmission of at least 5 messages per minute. | User Need 2,10,11,12 | ICMS-Mn/DOT-ASG | H |
| H- MASG -3 | **The ICMS-MN/DOT-ASG shall Provide Internet Access to Send Data to ICMS-Data Hub** | User Need 2,10,11,12 | ICMS-Mn/DOT-ASG | H |
| H- MASG -4 | **The ICMS-MN/DOT-ASG shall Provide Operator Display of information.** | User Need 2,10,11,12 | ICMS-Mn/DOT-ASG | H |
| H-MASG-4-1 | **The ICMS-MN/DOT-ASG shall Provide Operator Display of information: Access**<br>The ICMS-MN/DOT-ASG shall provide a mechanism to display information stored in the ICMS-Mn/DOT-ASG to operators at Internet access points. | User Need 2,10,11,12 | ICMS-Mn/DOT-ASG | H |
| **H-HASG-1** | **The ICMS-HENN-ASG shall be Reliable.** | User Need 2,10,11,12 | ICMS-HENN-ASG | H |
| H- HASG -1-1 | **ICMS-HENN-ASG Reliable**<br>The ICMS-HENN-ASG shall be operational and available to users 99.9% of the time. | User Need 2,10,11,12 | ICMS-HENN-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| H- HASG -2 | **The ICMS-HENN-ASG shall Provide Storage for Messages.** | User Need 2,10,11,12 | ICMS-HENN-ASG | H |
| H- HASG-2-1 | **ICMS-HENN-ASG Data Storage:**<br>The ICMS-HENN-ASG shall accommodate temporary storage of 20 simultaneous Travel Time messages. | User Need 2,10,11,12 | ICMS-HENN-ASG | H |
| H- HASG-2-2 | **ICMS-HENN-ASG Data Storage: Implemented signal timing plans**<br>The ICMS-HENN-ASG shall accommodate temporary storage of 50 simultaneous Signal Timing Plan descriptions. | User Need 2,10,11,12 | ICMS-HENN-ASG | H |
| H- HASG-2-3 | **ICMS-HENN-ASG Message Transmission**<br>The ICMS-HENN-ASG shall accommodate the transmission of at least 5 messages per minute. | User Need 2,10,11,12 | ICMS-HENN-ASG | H |
| H- HASG-3 | **The ICMS-HENN-ASG shall Provide Internet Access to Send Data to ICMS-Data Hub.** | User Need 2,10,11,12 | ICMS-HENN-ASG | H |
| H- HASG-4 | **The ICMS-HENN-ASG shall Provide Operator Display of Information.** | User Need 2,10,11,12 | ICMS-HENN-ASG | H |
| H-HASG-4-1 | **The ICMS-HENN-ASG shall Provide Operator Display of information: Access**<br>The ICMS-HENN-ASG shall provide a mechanism to display information stored in the ICMS-HENN-ASG to operators at Internet access points. | User Need 2,10,11,12 | ICMS-HENN-ASG | H |
| **H-CASG-1** | **The ICMS-COM-ASG shall be Reliable** | User Need 2,10,11,12 | ICMS-COM-ASG | H |
| H- CASG -1-1 | **ICMS-COM-ASG Reliable**<br>The ICMS-COM-ASG shall be operational and available to users 99.9% of the time. | User Need 2,10,11,12 | ICMS-COM-ASG | H |
| H- CASG -2 | **The ICMS-COM-ASG shall Provide Storage for Messages** | User Need 2,10,11,12 | ICMS-COM-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| H- CASG -2-1 | **ICMS-COM-ASG Data Storage:**<br>The ICMS-COM-ASG shall accommodate temporary storage of 20 simultaneous Travel Time messages. | User Need 2,10,11,12 | ICMS-COM-ASG | H |
| H- CASG -2-2 | **ICMS-COM-ASG Data Storage: Implemented signal timing plans**<br>The ICMS-COM-ASG shall accommodate temporary storage of 50 simultaneous Signal Timing Plan descriptions. | User Need 2,10,11,12 | ICMS-COM-ASG | H |
| H- CASG -2-3 | **ICMS-COM-ASG Message Transmission**<br>The ICMS-COM-ASG shall accommodate the transmission of at least 5 messages per minute. | User Need 2,10,11,12 | ICMS-COM-ASG | H |
| H- CASG -3 | **The ICMS-COM-ASG shall Provide Internet Access to Send Data to ICMS-Data Hub** | User Need 2,10,11,12 | ICMS-COM-ASG | H |
| H- CASG -4 | **The ICMS-COM-ASG shall Provide Operator Display of information.** | User Need 2,10,11,12 | ICMS-COM-ASG | H |
| H- CASG -4-1 | **The ICMS-COM-ASG shall Provide Operator Display of information: Access**<br>The ICMS-COM-ASG shall provide a mechanism to display information stored in the ICMS-COM-ASG to operators at Internet access points. | User Need 2,10,11,12 | ICMS-COM-ASG | H |
| **H-SWT-1** | **The ICMS-SWT Hardware Shall be Reliable.** | User Need 2,10,11,12 | ICMS-SWT | H |
| H- SWT -1-1 | **ICMS-SWT Reliable**<br>The ICMS-SWT Hardware shall be operational and available to users 99.9% of the time. | User Need 2,10,11,12 | ICMS-SWT | H |
| H- SWT -2 | **The ICMS-SWT Hardware Shall Provide Storage for Incident Messages.** | User Need 2,10,11,12 | ICMS-SWT | H |
| H- SWT -2-1 | **ICMS-SWT Data Storage:**<br>The ICMS-SWT Hardware shall accommodate temporary storage of 50 simultaneous Incident and event messages. | User Need 2,10,11,12 | ICMS-SWT | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| H- SWT -2-2 | **ICMS-SWT Message Transmission**<br>The ICMS-SWT Hardware shall accommodate the transmission of at least 5 messages per minute. | User Need 2,10,11,12 | ICMS-SWT | H |
| H- SWT -4 | **The ICMS-SWT shall Provide Operator Display of information.** | User Need 2,10,11,12 | ICMS-COM-ASG | H |
| H-SWT-4-1 | **The ICMS-SWT shall Provide Operator Display of information: Access**<br>The ICMS-SWT shall provide a mechanism to display information stored in the ICMS-SWT to operators at Internet access points. | User Need 2,10,11,12 | ICMS-COM-ASG | H |
| **H-PM-1** | **The ICMS-PM Hardware Shall be Reliable.** | User Need 2,10,11,12 | ICMS-PM | H |
| H- PM -1-1 | **ICMS-PM Reliable**<br>The ICMS-PM Hardware shall be operational and available to users 99.9% of the time. | User Need 2,10,11,12 | ICMS-PM | H |
| H- PM -2 | **The ICMS-PM Hardware Shall Provide Storage for Incident Messages.** | User Need 2,10,11,12 | ICMS-PM | H |
| H- PM -2-1 | **ICMS-PM Data Storage:**<br>The ICMS-PM Hardware shall accommodate temporary storage of 50 simultaneous Incident and event messages. | User Need 2,10,11,12 | ICMS-PM | H |
| H- PM -2-2 | **ICMS-PM Message Transmission**<br>The ICMS-PM Hardware shall accommodate the transmission of at least 5 messages per minute. | User Need 2,10,11,12 | ICMS-PM | H |
| H- PM -4 | **The ICMS-PM shall Provide Operator Display of information.** | User Need 2,10,11,12 | ICMS-COM-ASG | H |
| H-PM-4-1 | **The ICMS-PM shall Provide Operator Display of information: Access**<br>The ICMS-PM shall provide a mechanism to display information stored in the ICMS-PM to operators at Internet access points. | User Need 2,10,11,12 | ICMS-COM-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **H-TSPA-1** | **The ICMS-MTCC shall provide a mechanism to activate signal priority devices installed on traffic signal controllers operated by the Arterial Signals group.**<br>The ICMS-MTCC TSP Activation hardware shall operate transit signal priority activation on buses. | User Need 7,8 | ICMS-MTCC | H |
| H-TSPA-2 | **The ICMS-MTCC shall provide a mechanism to activate signal priority devices: determining when to activate**<br>The ICMS-MTCC TSP Activation hardware shall determine when the bus is behind schedule and activate the TSP only when operating behind schedule by more than a given time threshold. | User Need 7,8 | ICMS-MTCC | H |
| H-TSPA-3 | **The ICMS-MTCC shall provide a mechanism to activate signal priority devices: configurable threshold**<br>The ICMS-MTCC TSP Activation hardware shall provide a mechanism to adjust the threshold describing how behind schedule the bus must be before activating signal priority. | User Need 7,8 | ICMS-MTCC | H |
| H-TSPA-4 | **The ICMS-MTCC shall provide a mechanism to activate signal priority devices: Deactivation Option**<br>The ICMS-MTCC TSP Activation hardware shall provide a mechanism to be deactivated by the ICMS-MTCC System when it is preferred that Transit Signal Priority not be activated, even if the bus is behind schedule. | User Need 7,8 | ICMS-MTCC | H |
| H-TSPA-5 | **The ICMS-MTCC shall provide a mechanism to activate signal priority devices: Conflict resolution**<br>The ICMS-MTCC TSP Activation hardware shall be able to follow established protocols for conflicts of priority/preemption devices (e.g. emergency vehicle pre-emption, other transit vehicles). | User Need 7,8 | ICMS-MTCC | H |
| H-TSPA-6 | **The ICMS-MTCC shall provide a mechanism to activate signal priority devices: Interface with Transit Buses**<br>The ICMS-MTCC TSP Activation hardware shall interact with transit vehicles (and associated CAD) systems according to the requirements defined by the existing transit vehicle and CAD system, requiring no modifications to transit vehicles. | User Need 7,8 | ICMS-MTCC | H |
| **H-TSPR-1** | **The ICMS-Mn/DOT-ASG System hardware shall receive Transit Signal Priority request activations from buses.**<br>The ICMS-MTCC TSP Receive hardware shall receive wireless, inaudible transmissions from TSP Activation equipment operating on transit buses. | User Need 7,8 | ICMS-Mn/DOT-ASG | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| H-TSPR-2 | **The ICMS-Mn/DOT-ASG System hardware shall receive Transit Signal Priority request activations from buses: Location**<br>The ICMS-MTCC TSP Receive hardware that receives transit signal priority requests shall be positioned such that buses exiting park-and-ride facilities are able to transmit a message that is received by the receiver without any interference due to natural or man-made objects. | User Need 7,8 | I ICMS-Mn/DOT-ASG | H |
| H-TSPR-3 | **The ICMS-Mn/DOT-ASG System hardware shall receive Transit Signal Priority request activations from buses: Adjust Signal Timing**<br>The ICMS-MTCC TSP Receive hardware that receives transit signal priority requests shall interface to the traffic signal controller to activate the adjustment to green time phasing programmed in the controller, according to the interface requirements of the traffic signal control device. | User Need 7,8 | ICMS-Mn/DOT-ASG | H |
| H-TSPR-4 | **The ICMS-Mn/DOT-ASG System hardware shall receive Transit Signal Priority request activations from buses: Operation Time**<br>The ICMS-MTCC TSP Receive hardware that receives transit signal priority requests shall be operational at least 99.9% of the time. | User Need 7,8 | ICMS-Mn/DOT-ASG | H |
| H-TSPR-5 | **The ICMS-Mn/DOT-ASG System hardware shall receive Transit Signal Priority request activations from buses: Access**<br>The ICMS-MTCC hardware that receives transit signal priority requests shall be accessible for maintenance without closing any lane of travel. | User Need 7,8 | ICMS-Mn/DOT-ASG | H |
| **H-DMS-1** | **Accept DMS Control Message from ICMS-MTCC**<br>The ICMS-MTCC Transit DMS Hardware provide a mechanism to receive messages sent from the ICMS-MTCC System describing the text to display on the DMS sign. | User Need 4,5,10 | ICMS-MTCC | H |
| H-DMS-1-1 | **Accept DMS Control Message from ICMS-MTCC: data exchange**<br>The ICMS-MTCC Transit DMS Hardware shall interface to the ICMS-MTCC System according to the requirements defined in the NTCIP standard for DMS message control. | User Need 4,5,10 | ICMS-MTCC | H |
| H-DMS-1-2 | **Accept DMS Control Message from ICMS-MTCC: local or remote control**<br>The ICMS-MTCC Transit DMS Hardware shall receive messages sent from the ICMS-MTCC System either locally through a Local Area Network (LAN) or remotely through an Internet connection. | User Need 4,5,10 | ICMS-MTCC | H |

| ID | Requirement Description | Source | Allocation | Criticality |
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| H-DMS-1-3 | **Accept DMS Control Message from ICMS-MTCC: Reject non-conforming messages**<br>The ICMS-MTCC Transit DMS Hardware shall reply to the ICMS-MTCC System message with a reply noting if the message can not be displayed because of lack of character spaces. | User Need 4,5,10 | ICMS-MTCC | H |
| H-DMS-2 | **Display Messages on DMS Sign**<br>The ICMS-MTCC Transit DMS Hardware shall Display characters sent by the ICMS-MTCC System within 30 seconds of receiving the message from the ICMS-MTCC System. | User Need 4,5,10 | ICMS-MTCC | H |
| H-DMS-2-1 | **Display Messages on DMS Sign: Display Options**<br>The ICMS-MTCC Transit DMS Hardware shall provide a mechanism to display three lines o f messages at a time:<br>- Transit travel time<br>- Freeway travel time<br>- Park-and-Ride Open or Closed | User Need 4,5,10 | ICMS-MTCC | H |
| H-DMS-2-2 | **Display Messages on DMS Sign: Visibility**<br>The ICMS-MTCC Transit DMS Hardware shall be sized and positioned such that travelers can view and read the sign from the freeway. | User Need 4,5,10 | ICMS-MTCC | H |
| H-DMS-2-3 | **Display Messages on DMS Sign: Mn/DOT Design Standards**<br>The ICMS-MTCC Transit DMS Hardware shall be in accordance with all Mn/DOT standards and guidelines for placement of DMS along State DOT Freeways or arterials, respectively. | User Need 4,5,10 | ICMS-MTCC | H |
| H-DMS-2-4 | **Accept DMS Control Message from ICMS-MTCC: Response to ICMS-MTCC**<br>The ICMS-MTCC Transit DMS Hardware shall send a message confirming the display of the characters on the DMS to the ICMS-MTCC System within 1 minute of posting the characters. | User Need 4,5,10 | ICMS-MTCC | H |
| **H-PARK-1** | **Measure Parking Availability**<br>The ICMS-MTCC Transit Parking Space Monitoring Hardware shall determine the number of parking spaces available at the park-and-ride facility | User Need 4,5,10 | ICMS-MTCC | H |
| H-PARK-1-1 | **Measure Parking Availability: Generate and Post Messages**<br>The ICMS-MTCC Transit Parking Space Monitoring Hardware shall generate a message to be acquired by the ICMS-MTCC System using an Internet connection. | User Need 4,5,10 | ICMS-MTCC | H |

| ID | Requirement Description | Source | Allocation | Criticality |
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| H-PARK-1-1-1 | **Measure Parking Availability: Generate and Post Messages - accuracy**<br>The ICMS-MTCC Transit Parking Space Monitoring Hardware shall generate and post a message to be acquired by the ICMS-MTCC System that is accurate to within 5% of occupancy at least 95% of the time. | User Need 4,5,10 | ICMS-MTCC | H |
| H-PARK-1-1-2 | **Measure Parking Availability: Generate and Post Messages - frequency**<br>The ICMS-MTCC Transit Parking Space Monitoring Hardware shall generate and post a message to be acquired by the ICMS-MTCC System no less frequently than once per minute. | User Need 4,5,10 | ICMS-MTCC | H |
| H-PARK-1-1-2 | **Measure Parking Availability: Generate and Post Messages–data exchange**<br>The ICMS-MTCC Transit Parking Space Monitoring Hardware shall interface to the ICMS-MTCC System according to the requirements of the ICMS-MTCC ICD. | User Need 4,5,10 | ICMS-MTCC | H |
| H-PARK-2 | **Reliability of Parking Space Monitoring Hardware**<br>The ICMS-MTCC Transit Parking Space Monitoring Hardware shall be reliable. | User Need 4,5,10 | ICMS-MTCC | H |
| H-PARK-2-1 | **Reliability of Parking Space Monitoring Hardware: Uptime**<br>The ICMS-MTCC Transit Parking Space Monitoring Hardware shall be operational at least 99.5% of the time. | User Need 4,5,10 | ICMS-MTCC | H |
| H-PARK-2-2 | **Reliability of Parking Space Monitoring Hardware: Durable**<br>The ICMS-MTCC Transit Parking Space Monitoring Hardware shall not fail due to vehicle weight or height assuming standard weight and heights of vehicles. | User Need 4,5,10 | ICMS-MTCC | H |
| H-PARK-2-3 | **Reliability of Parking Space Monitoring Hardware: Weather**<br>The ICMS-MTCC Transit Parking Space Monitoring Hardware shall remain operational and meet accuracy requirements during periods of snow, rain, and temperature ranges from -25degrees F to +110degrees F. | User Need 4,5,10 | ICMS-MTCC | H |
| H-PARK-3 | **Parking Space Monitoring Hardware Interaction with Vehicles**<br>The ICMS-MTCC Transit Parking Space Monitoring Hardware shall not cause any damage to vehicles when vehicles follow allowed traffic patterns. | User Need 4,5,10 | ICMS-MTCC | H |
| **H-BUS-1** | **ICMS-MTCC shall Operate Wireless Internet Access**<br>The ICMS-MTCC Bus Internet Hardware shall provide a mechanism for bus riders to access the internet while traveling along I-394. | User Need 7,8 | ICMS-MTCC | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| H-BUS-1-1 | **ICMS-MTCC shall Operate Wireless Internet Access: bandwidth**<br>The ICMS-MTCC Bus Internet Hardware shall operate wireless Internet access on buses with a minimum connection speed of 10 Mbps | User Need 7,8 | ICMS-MTCC | H |
| H-BUS-1-2 | **ICMS-MTCC shall Operate Wireless Internet Access: bandwidth**<br>The ICMS-MTCC Bus Internet Hardware shall provide a mechanism for travelers to access wireless Internet on buses using 802.11b/g wireless access cards. | User Need 7,8 | ICMS-MTCC | H |
| H-BUS-1-3 | **ICMS-MTCC shall Operate Wireless Internet Access: Lack of Driver Involvement**<br>The ICMS-MTCC Bus Internet Hardware shall not allow the driver to interface to the Internet system in the event of any Internet outages, in order to eliminate any requests on the driver that may impair their driving. | User Need 7,8 | ICMS-MTCC | H |
| H-BUS-1-4 | **ICMS-MTCC shall Operate Wireless Internet Access: Continuous Internet Connection**<br>The ICMS-MTCC Bus Internet Hardware convert Internet Access Points operated by Mn/DOT into a continuous Internet service corridor, in order that users of the Internet do not need to log in multiple times. | User Need 7,8 | ICMS-MTCC | H |
| **H-GATE-1** | **Limit Exit from ABC Garages**<br>The ICMS-ABC Garage Exit Gate Hardware shall provide a mechanism for operators to prevent vehicles from exiting the garage onto I-394 Westbound. | User Need 6,8,9 | ICMS-ABC | H |
| H-GATE-1-1 | **Limit Exit from ABC Garages: Operator Implementation**<br>The ICMS-ABC Garage Exit Gate Hardware shall provide a mechanism for operators to close all exits to I-394 within 5 minutes. | User Need 6,8,9 | ICMS-ABC | H |
| H-GATE-1-2 | **Limit Exit from ABC Garages: Other exit access**<br>When activated, the ICMS-ABC Garage Exit Gate Hardware shall close access to the exit towards I-394 and still allow vehicles access to other exits. | User Need 6,8,9 | ICMS-ABC | H |
| H-GATE-1-3 | **Limit Exit from ABC Garages: Visibility**<br>The ICMS-ABC Garage Exit Gate Hardware shall be visible from vehicles at a distance that allows time to stop and/or alter routes. | User Need 6,8,9 | ICMS-ABC | H |
| H-GATE-1-4 | **Limit Exit from ABC Garages: Reopen exit access points**<br>The ICMS-ABC Garage Exit Gate Hardware shall allow operators to re-open exit access points within 5 minutes from the decision to reopen the gates. | User Need 6,8,9 | ICMS-ABC | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| H-GATE-1-5 | **Limit Exit from ABC Garages: Design Standards**<br>The ICMS-ABC Garage Exit Gate Hardware shall be in accordance with all Mn/DOT and US-DOT design standards for gates located on lanes of traffic. | User Need 6,8,9 | ICMS-ABC | H |
| H-GATE-1-6 | **Limit Exit from ABC Garages: Inform Drivers**<br>The ICMS-ABC Garage Exit Gate Hardware shall display a message to drivers when activated that describes that the exit to I-394 is closed and that travelers are to use alternate exits. | User Need 6,8,9 | ICMS-ABC | H |
| **H-KIOSK-1** | **Display Traffic and Incident/Event Information**<br>The ICMS-ABC Garage Kiosk Hardware shall display messages and/or map displays acquired by the ICMS-ABC System or generated by the ICMS-ABC System. | User Need 6,8,9 | ICMS-ABC | H |
| H-KIOSK-1-1 | **Display Traffic and Incident/Event Information: Internet displays**<br>The ICMS-ABC Garage Kiosk Hardware shall display messages and/or map displays by displaying an Internet browser pointed to a web site displaying the messages acquired or generated by the ICMS ABC. | User Need 6,8,9 | ICMS-ABC | H |
| H-KIOSK-1-2 | **Display Traffic and Incident/Event Information: Visibility**<br>The messages, text or maps displayed on the ICMS-ABC Garage Kiosk Hardware shall be visible by patrons walking near the kiosk at a range of at least 10 feet away from the kiosk. | User Need 6,8,9 | ICMS-ABC | H |
| H-KIOSK-1-3 | **Display Traffic and Incident/Event Information: Reliability**<br>The ICMS-ABC Garage Kiosk Hardware shall be operational at least 99.5% of the time. | User Need 6,8,9 | ICMS-ABC | H |
| H-KIOSK-1-4 | **Display Traffic and Incident/Event Information: Weather**<br>The ICMS-ABC Garage Kiosk Hardware shall be operational at the extreme temperatures and conditions of the location determined for deployment during the design phase. | User Need 6,8,9 | ICMS-ABC | H |
| H-KISOK-1-5 | **Display Traffic and Incident/Event Information: Remote Restart**<br>The ICMS-ABC Garage Kiosk Hardware shall provide a mechanism for operators or administrators to restart/reboot the hardware remotely without having to access the site. | User Need 6,8,9 | ICMS-ABC | H |
| **H-VSL-1** | **Receive Variable Speed Messages**<br>The ICMS-Traffic Operations VSL Hardware shall provide a mechanism to receive messages sent from the ICMS-TO System describing the text to display on the VSL sign. | User Need 1,17 | ICMS-TO | H |

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| H-VSL-1-1 | **Accept VSL Message from ICMS-TO: data exchange**<br>The ICMS-Traffic Operations VSL Hardware shall interface to the ICMS-MTCC System according to the requirements defined in the NTCIP standard for DMS message control. | User Need 4,5,10 | ICMS-TO | H |
| H-VSL-1-2 | **Accept VSL Message from ICMS-TO: connection**<br>The ICMS-Traffic Operations VSL Hardware shall receive messages sent from the ICMS-MTCC System through the existing Mn/DOT Fiber network connection. | User Need 4,5,10 | ICMS-TO | H |
| H-VSL-1-3 | **Accept VSL Message from ICMS-TO: Reject non-conforming messages**<br>The ICMS-Traffic Operations VSL Hardware shall reply to the ICMS-Traffic Operations System message with a reply noting if the message can not be displayed because of lack of character spaces. | User Need 4,5,10 | ICMS-TO | H |
| H-VSL-2 | **Display Messages on DMS Sign**<br>The ICMS-Traffic Operations VSL Hardware shall Display characters sent by the ICMS-Traffic Operations System within 30 seconds of receiving the message from the ICMS-Traffic Operations System. | User Need 4,5,10 | ICMS-TO | H |
| **H-DMS-2-5** | **Display Messages on DMS Sign: Display Options**<br>The ICMS-Traffic Operations VSL Hardware shall provide a mechanism to display a two digit number representing the speed and 'MPH' below the number. | User Need 4,5,10 | ICMS-TO | H |
| H-DMS-2-6 | **Display Messages on DMS Sign: Display Colors**<br>The ICMS-Traffic Operations VSL Hardware shall display letters and numbers as black text on a yellow background. | User Need 4,5,10 | ICMS-TO | H |
| H-DMS-2-7 | **Display Messages on DMS Sign: Visibility**<br>The ICMS-Traffic Operations VSL Hardware shall be sized and positioned such that travelers can view and read the sign from the freeway. | User Need 4,5,10 | ICMS-TO | H |
| H-DMS-2-8 | **Display Messages on DMS Sign: Mn/DOT Design Standards**<br>The ICMS-Traffic Operations VSL Hardware shall be in accordance with all Mn/DOT standards and guidelines for placement of variable signs along State DOT Freeways or arterials, respectively. | User Need 4,5,10 | ICMS-TO | H |
| H-DMS-2-9 | **Accept DMS Control Message from ICMS-MTCC: Response to ICMS-MTCC**<br>The ICMS-Traffic Operations VSL Hardware shall send a message confirming the display of the characters on the VSL sign to the ICMS-Traffic Operations System within 1 minute of posting the characters. | User Need 4,5,10 | ICMS-TO | H |

# 6. I-394 ICMS Interface Requirements

The ICMS shall exchange data among subsystems of the ICMS, and with other systems by following protocols and data structures of established Interface Control Documents (ICDs). Whenever possible, the ICDs will make use of and adhere to National ITS Standards, however the ICD will typically include additional information beyond what is contained in the National standards. For example, the ICD will identify the specific phrases, terms, or data sets to be used from the standard, and describe details of how data communications are originated, performed, verified, and terminated.

The ICDs described in this section will be developed during the design process and completed and approved by the ICM Project Team prior to the onset of software coding.

***Summary of Interface Requirements for the I-394 ICMS***

**ICMS-EMS to ICMS-Data Hub ICD**

The ICMS-EMS to ICMS-Data Hub ICD shall describe the protocols and data structures to be used to exchange messages and data sets from any emergency management service (EMS) Computer Aided Dispatch (CAD) systems to the ICMS-Data Hub. The ICMS-EMS to ICMS-Data Hub ICD shall be used for the following exchanges:

- Minnesota State Patrol CAD (ICMS-MSP-EMS) to the ICMS-Data Hub
- The Hennepin County CAD (ICMS-HENN-EMS) to the ICMS-Data Hub
- The City of Minneapolis CAD (ICMS-COM-EMS) to the ICMS-Data Hub.

In addition, in the future, should any additional city or county EMS centers join the ICM project (either by geographic expansion or increased coverage in the corridor), the additional agencies will use this same ICD for data exchanges.

**ICMS-Traffic Operations to ICMS-Data Hub ICD**

The ICMS-Traffic Operations to ICMS-Data Hub ICD shall describe the protocols and data structures to be used to exchange messages and data sets from the Mn/DOT Traffic Operations Center to the ICMS-Data Hub. The messages from the Mn/DOT Traffic Operations Center may originate from the Mn/DOT IRIS Traffic Management Center software, or the Mn/DOT Condition Reporting System. Regardless of the source sending the messages, the ICMS-Traffic Operations to ICMS-Data Hub ICD shall be used.

**ICMS-ASG to ICMS-Data Hub ICD**

The ICMS-ASG to ICMS-Data Hub ICD shall describe the protocols and data structures to be used to exchange messages and data sets from any Arterial Signal Group System

(ASG) to the ICMS-Data Hub. The ICMS-ASG to ICMS-Data Hub ICD shall be used for the following exchanges:

- Mn/DOT ASG (ICMS-Mn/DOT-ASG) to the ICMS-Data Hub
- The Hennepin County ASG (ICMS-HENN-ASG) to the ICMS-Data Hub
- The City of Minneapolis ASG (ICMS-COM-ASG) to the ICMS-Data Hub.

In addition, in the future, should any additional city or county arterial signal operations division join the ICM project (either by geographic expansion or increased coverage in the corridor), the additional agencies will use this same ICD for data exchanges.

**ICMS-MTCC to ICMS-Data Hub ICD**

The ICMS-MTCC to ICMS-Data Hub ICD shall describe the protocols and data structures to be used to exchange messages and data sets from the Metro Transit Control Center ICMS Enhancement (ICMS-MTCC) to the ICMS-Data Hub.

**ICMS-ABC System to ICMS-Data Hub ICD**

The ICMS-ABC to ICMS-Data Hub ICD shall describe the protocols and data structures to be used to exchange messages and data sets from the ICMS Enhancements to the ABC Garage System (ICMS-ABC) to the ICMS-Data Hub.

**ICMS-Data Hub Post ICD**

The ICMS-Data Hub Post ICD shall describe the protocols and data structures to be used by the ICMS-Data Hub in posting messages and data sets on an Internet accessible location to be acquired by other ICMS Systems. The ICMS-Data Hub posting of messages and data will all be public information; therefore, this ICD can be used by any ICMS System, or any other system, to acquire the public information data posted by the ICMS-Data Hub.

In addition, the MTCC Park-and-Ride lots will post data and messages describing parking availability to be acquired by the ICMS-MTCC. This internal MTCC data transfer will also follow the ICMS-Data Hub Post ICD.

**ICMS-MTCC Sign Control ICD**

The ICMS-MTCC Sign Control ICD shall describe the protocols and data structures to be used by the ICMS-MTCC System to send text to the ICMS-MTCC DMS signs located at Park-and-Ride facilities. This ICD shall be based on the NTCIP DMS control protocol, however will have additional details about specific interfaces.

# 7. Documentation and Training Requirements

Because the I-394 ICMS is a System of Systems, it is conceivable that separate developers might develop different portions of the overall system. Similarly, for some of the systems, existing systems may be enhanced or expanded to address the ICMS requirements. Also, during operations, each agency will operate their systems as part of the overall ICM approach. For these reasons, Table 20 defines a set of requirements for documentation to be prepared for the systems and for training on the systems.

***Table 20: Documentation and Training Requirements***

| ID | Requirement Description | Source | Allocation | Criticality |
|---|---|---|---|---|
| **DOC-1** | **The ICMS Systems shall be documented.** | All | All | H |
| DOC-1-1 | **The ICMS Systems final deliverables shall include a basic level of software documentation.**<br>The ICMS Systems final deliverable shall include software source code documentation that includes a basic level of detail that is agreeable to all developers to be defined following the design period. | All | All | H |
| DOC-1-2 | **Documentation shall be electronic.**<br>The ICMS Systems final deliverables shall include electronic software source code documentation that is searchable and can be cut and pasted into other documents. | All | All | H |
| DOC-1-3 | **Procedures shall be documented**<br>The procedures for using the ICMS Systems shall be documented. | All | All | H |
| **TRAIN-1** | **The ICMS Operators shall be trained.** | All | All | H |
| **TRAIN-1-1** | **ICMS operators shall be trained on the overall ICMS.**<br>The operators within each agency shall receive overall high level training of the entire ICMS in order that they will understand the collective functions and procedures. | All | All | H |
| **TRAIN-1-2** | **ICMS operators shall be trained on individual systems.**<br>The operators within each agency shall receive detailed training on the functions and procedures of the ICMS system(s) they will operate and/or administer. | All | All | H |

# 8. Definitions, Acronyms and Abbreviations

This section includes a summary of the definitions, acronyms, and abbreviations used throughout the report.

## *8. 1 Definitions*

This subsection includes definitions of the boundaries of the ICMS Corridor as well as definitions of how data is transferred between ICMS Systems.

| | |
|---|---|
| ICMS Freeways | Reference to ICMS Freeways in the SRS shall include all of the following:<br>• I-394 West of I-494<br>• I-494 from TH 7 to TH 55<br>• TH 169 from TH 7 to TH 55<br>• TH 100 from TH 7 to TH 55 |
| ICMS State Operated Arterials | Reference to ICMS State Operated Arterials shall include all of the following:<br>• TH 7 from I-494 to downtown Minneapolis<br>• TH 55 from I-494 to downtown Minneapolis |
| ICMS Local Arterials | Reference to ICMS Local Arterials shall include non-state operated arterials road segments within the boundaries formed by TH 7, I-494, TH 55 and the City of Minneapolis. |
| I-394 Mn/PASS Lanes | Reference to I-394 Mn/PASS Lanes shall include the High Occupancy Toll lanes operated on I-394. |
| The ICMS Corridor | Reference to the ICMS Corridor shall inclusively include all road definitions within the corridor (ICMS Freeways, ICMS State Operated Arterials, ICMS Local Arterials, I-394 Mn/PASS Lanes). |
| Send Data | Send data is used to describe a data exchange where one system (System A) connects to a second system (System B) and (after handshaking) sends a message or data set. System B responds to verify if the message was received properly or not. |

| | |
|---|---|
| Receive Data | Receive data is the term used by a system that is waiting for other systems to send data. Using the example above, System B receives data. In order to receive data, a system must operate in a mode that is waiting all the time for other systems to connect and send data. |
| Post Data | A system posting data 'publishes' the data or message set in a location where other systems can come and collect the data. An XML post is a common form of data post. The data post can either be in a public location, such as the Internet; or in a secure location where only authorized systems may access it. For purposes of this ICMS, all data posts will be public posts. |
| Acquire Data | A system that acquires data follows a timed cycle to visit a location where data is posted and acquires the data. Unlike receiving data, the system must actively visit the post site and gather the data. |

## *8. 2 Acronyms and Abbreviations*

The following list includes the acronyms and abbreviations that were used throughout this document.

| | |
|---|---|
| ABC | A,B,C Parking |
| ASG | Arterial Signal Group |
| ATIS | Advanced Traveler Information System |
| ATMS | Advanced Traveler Management System |
| AVL | Automatic Vehicle Location |
| COM | City of Minneapolis |
| CCTV | Closed Circuit Television |
| CAD | Computer Aided Dispatch |
| CRS | Condition Reporting System |
| DH | Data Hub |
| DOC | Documented |
| DOT | Department of Transportation |
| DMS | Dynamic Message Signs |
| EMS | Emergency Management System |
| FIRST | Freeway Incident Response Safety Team |
| HENN | Hennepin County |
| HOV | High Occupancy Vehicle |
| ICMS-Data Hub | ICMS Data Hub |

| | |
|---|---|
| ID | Idenitifier |
| ICM | Integrated Corridor Management |
| ICD | Interface Control Document |
| ICMS | Integrated Corridor Management System |
| ICD | Interface Control Document |
| IRIS | Integrated Roadway Information System |
| ITS | Intelligent Transportation Systems |
| LDS | Loop Detector Station |
| MTCC | Metro Transit Control Center |
| Minn. | Minneapolis |
| Mn/DOT | Minnesota Department of Transportation |
| MSP | Minnesota State Patrol |
| NTCIP | National Transportation Communications for ITS Protocal |
| PM | Plymouth Metrolink |
| RCS | Ramp Control Signal |
| RTMC | Regional Transportation Management Center |
| SOS | System of Systems |
| SWT | Southwest Transit |
| SRS | System Requirement Specification |
| TO | Traffic Operations |
| Traffic Operations | Traffic Operations Center |
| TRAIN | Training |
| TSP | Transit Signal Priority |
| TCMA | Twin Cities Metropolitan Area |
| USDOT | United States Department of Transportation |
| VSL | Variable Speed Limit |

# 9. References

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