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USDOT Integrated Corridor Management (ICM) Initiative

Concept of Operations for the I-394 Corridor in Minneapolis, Minnesota

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16. Abstract

This Concept of Operations (Con Ops) for the I-394 Integrated Corridor Management (ICM) Program has been developed as part of the Federal Highway Administration, the Federal Transit Administration, and RITA (FHWA/FTA/RITA) Integrated Corridor Management Initiative. I-394 serves as the core of a corridor that is critical to the movement of the over one million residents of Hennepin County. This corridor (commonly referred to as the I-394 Corridor) is served by a combination of three inter-related networks (a freeway network, a series of arterial highways, and a sophisticated transit system operated by three transit agencies). A driving tour of the corridor reveals a network of transit parking facilities, high occupant vehicle (HOV) bypasses; a freeway system that serves as the primary inbound/outbound access as well as serving to connect parallel access routes; and an arterial system that is coordinated and operates effectively and efficiently. In addition, innovations such as congestion pricing through High Occupancy Toll (HOT) lanes, shoulder access to buses, and reversible commuter lanes further add to the potential of the corridor. However, the three transportation networks lack integration and inter-operability among each other. A systems engineering approach has examined the needs, defined a vision, and created a concept of operations for how an Integrated Corridor Management (ICM) system can unite the three networks of operations along the corridor to effectively manage traffic and inform travelers throughout the corridor.

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1. Concept of Operations Summary

1.1 Introduction

The West side of the Twin Cities Metropolitan Area (TCMA) supports a vast amount of commuter traffic accessing the downtown business district, as well as sporting and tourist attractions and numerous major employment centers located throughout the suburban area. In the early 1990's, a signalized arterial highway was converted to become I-394, a limited access freeway spur delivering travelers into and out of the downtown area. This interstate highway now serves as the core of a corridor that is critical to the movement of the over one million residents of Hennepin County. This corridor (commonly referred to as the I-394 Corridor) is served by a combination of three inter-related networks (a freeway network, a series of arterial highways, and a sophisticated transit system operated by three transit agencies). In the past 15-20 years, these transportation support networks have matured, expanded, and benefited from advanced technologies and Intelligent Transportation Systems (ITS). A driving tour of the corridor reveals a network of transit parking facilities, high occupant vehicle (HOV) bypasses; a freeway system that serves as the primary inbound/outbound access as well as serving to connect parallel access routes; and an arterial system that is coordinated and operates effectively and efficiently. In addition, innovations such as congestion pricing through High Occupancy Toll (HOT) lanes, shoulder access to buses, and reversible commuter lanes further add to the potential of the corridor. However, the three transportation networks lack integration and inter-operability among each other.

A systems engineering approach has examined the needs, defined a vision, and created a concept of operations for how an Integrated Corridor Management (ICM) system can unite the three networks of operations along the corridor to effectively manage traffic and inform travelers throughout the corridor. Some highlights of this concept are summarized in this brief introduction.

A Typical Corridor with Substantial Potential for Integration

Built in the early 1990's, the I-394 Freeway system has the benefit of being a truly second generation freeway system. Advanced planning was able to deploy such things as park-and-ride lots, reversible lanes, commuter parking facilities, instrumentation, and communications. As freeways throughout the Twin Cities area (and nationwide) are reconstructed or expanded, they too will house many, if not all, of the advantages supported by I-394. For these reasons, the I-394 Corridor is ready to serve as a model for ICM modeling and demonstration. The assets and configurations of the roadway network will enable the corridor to demonstrate the ICM benefits very clearly, while allowing other cities to understand how projects can be adapted to their local situation.

A Need and Potential for ICM Success

The local stakeholders' interest in ICM is based on the fact that travel demand throughout the corridor is increasing and the ability to add spare capacity at reasonable costs is continuously decreasing. As a result, incidents or minor problems during the peak periods result in extensive delays and other negative impacts on commuter traffic.

Parallel to the increases in demand, the key stakeholders throughout the area continue to add ITS systems to their individual networks. Local transit agencies, Mn/DOT and the city and county are all planning ITS projects in the coming 1-3 years that will continue to advance the state of the art services offered throughout the corridor. Finally, the I-394 Corridor supports one of the first operational ***congestion pricing*** systems in the United States. With High Occupancy Toll (HOT) pricing levels that change with changing demand, the corridor has the true potential to execute effective ICM strategies immediately.

As a result, the I-394 ICM initiative is poised to be a catalyst that will unite the expanding ITS systems together in order to collectively provide a reliable transportation corridor.

Formalization of Long-Developed Inter-agency Operational Relationships

Throughout the ICM initiative activities, the I-394 Corridor Stakeholders have observed a phenomena described best as a *formalization of partnerships that initiated over the past 15 years and have culminated together through the enthusiasm and vision afforded by the ICM initiative.*

While it is easy to assume that all agencies that cooperatively provide transportation information and management throughout a corridor would have open lines of communication, the ICM initiative afforded the team with the opportunity to blatantly ask "who communicates with whom?" What started as a simple question, has led to a series of agreements, partnerships, and relationships. Collectively, these relationships, and the near-term ICM applications of strategies already being pursued, have validated to all members that ICM can and will be successful along the I-394 Corridor.

Multi-Transit Agency Cooperation – Three transit agencies are active throughout the corridor. Two agencies operate routes within the corridor (Metro Transit and Plymouth Metrolink) and one (SouthWest Transit) uses the corridor to move riders between the suburbs and downtown. These agencies have come to the ICM project representing a common team of transit providers. They have developed relationships that would support each other by picking up each others' passengers during break-downs, exchange CAD/AVL data, and generally communicate to share whatever real-time knowledge with others.

Transit-DOT-Emergency Response Cooperation – The ICM project has revealed how critical it is for transit agencies to understand the locations of incidents on both freeways and arterials. Similarly, the project has demonstrated the value of transit agencies sharing delay, travel time, and parking information, as well as transit driver observations of

crashes or operational breakdowns on the network. These communications are being finalized in agreements that would exchange all the data by way of the DOT information clearinghouse. In the near term, agencies have reached an agreement on manual sharing of information to begin exchanging some real-time incident reports as early as summer 2007. In the long term, following the ICM systems engineering approach, the agencies look forward to automated data exchanges of these critical sets of information.

Payment-Transit-Parking Relationships – Over the past twenty years, integrated parking payment relations have been building. Parking structures owned by Mn/DOT are operated by the City of Minneapolis and excess revenue is used to update and improve I-394. It was this partnership that largely helped fund the HOV to HOT conversion that is now operational. Building upon this innovative partnership for pricing, the ICM initiative will be expanding these relations by forming inter-agency pricing agreements among transit, parking, and HOT systems. An integrated pricing study is currently being conducted, and the ICM initiative was able to meet with them at the onset of the project and promote the benefits of integrated pricing to the ICM strategy.

Immediate Strategies to Maintain the Momentum, Short Term Strategies to Complete the Vision, and Long Term Strategies Moving Towards the Future

The remainder of this Concept of Operations presents recommended applications of ICM strategies that will be implemented in the immediate term (i.e. those things that will be performed through existing relationships, contracts and funding sources), the short term (i.e. those strategies that will be the foundation of the requirements development and eventual USDOT requests for ICMS deployment funds), and long term deployments that build upon planned system changes over the next five to ten years.

The immediate deployment applications of ICM strategies have resulted from first hand discussions with the stakeholders. Often, as the ICM vision and strategies were being explained to the stakeholders, the conversation revealed very practical, immediate deployments that could be accomplished during the 2007 calendar year without special funding allocations. These immediate strategies are those that either require no infrastructure (e.g. establishing and executing manual reporting of incidents on existing emergency response talk channels on the state 800 Mhz system), or are already funded developments currently in progress.

The immediate deployment strategies will help maintain the momentum gained from the ICM Concept of Operations development, and also allow the stakeholder partnering agreements to develop and become formalized while preparations continue for the long-term ICM deployments. Finally, many of the immediate deployment strategies will also help in the requirements phase of this process, as agencies will have gained insight from their experiences and will bring this practical insight to the requirements and design phases.

The short term strategies represent those strategies that will be the subject of the remainder of this systems engineering development process, and are defined as strategies that will be fully implemented and evaluated within a 5 year timeframe. The long term

strategies and operational concepts presented in this document describe the vision that the stakeholders of the I-394 Corridor have for ongoing continual expansion of the ICM systems.

1.2 I-394 ICM Corridor Overview

1.2.1 I-394 Corridor Boundaries

The I-394 ICM corridor extends from the Minneapolis central business district (CBD) to the area's rapidly developing western suburbs. For purposes of this project, the corridor's western limit is defined as the Hennepin County border, a distance of approximately 25 miles, however the majority of strategies and technologies will be implemented within the portion of the corridor that is within the beltway (East of I-494). I-394 is the primary commuter route and runs through the heart of the corridor. The corridor is bounded by parallel routes, on the north by Hwy 55 and on the south by Hwy 7.

The corridor primarily serves commuter traffic between the western suburbs and the Minneapolis CBD and other destinations east and north on I-94. In addition, the Minnesota Twins, Minnesota's professional baseball franchise, organization is building a new stadium at the Eastern-most end of the corridor. This, as well as the Minnesota professional basketball stadium (also located at the eastern terminal of the corridor), contribute to off-peak traffic into and out of the CBD. The networks comprising the I-394 ICM corridor and their respective characteristics are described below and are illustrated in Figure 1.1.

1.2.2 I-394 Corridor Networks

Freeway Network

The freeway network in the study area provides good connectivity between major employment and housing areas of the western metropolitan area. In addition to the East-West I-394 freeway, there are three North-South freeways that offer connections between the primary commute routes. The freeways are all actively monitored and controlled from the Regional Transportation Management Center (RTMC) and include:

- I-394
- I-494
- TH 169
- TH 100

The primary freeway segment in the corridor is I-394, which provides three travel lanes in each direction as well as HOV/HOT facilities. I-494, TH 169, and TH 100 provide north-south freeway connections to the other primary arterials in the network.

Arterial Network
The arterial network is generally laid out in a grid pattern, providing excellent traffic collection and distribution functions as feeders to the freeway system, and as primary travel corridors in their own right. The key arterials in the study area are:

- United States Trunk Highway (US TH) 12;
- TH 7 and TH 55;
- County State Aid Highway (CSAH) 40,CSAH 5, CSAH 19, CSAH 101, and CSAH 73; and
- Louisiana Avenue.

US TH 12 is the continuation of I-394 west of I-494. USTH 12 has two lanes in each direction with six traffic signals located on the west end of the corridor area.

The primary east-west alternatives to I-394 are TH 7 and TH 55, both maintained by Mn/DOT. TH 7 is a principal arterial with two lanes in each direction and half-mile signal spacing. TH 7 terminates on the Eastern portion of the corridor at Lake Street (a Minneapolis city street). TH 55 is a principal arterial with a minimum of two lanes in each direction and half-mile signal spacing. TH 55 terminates into N 7th Street in Minneapolis, a divided roadway with one-directional travel in each direction.

Other potential east-west reliever routes are County State Aid Highway (CSAH) 40 and CSAH 5, both classified as Hennepin County "A" minor arterials. CSAH 5 has two lanes in each direction, with signals spaced at ¼ mile. CSAH 40 has one lane in each direction with very few signals. North-south routes connecting I-394 with the other parallel relievers include CSAH 19, CSAH 101, CSAH 73, also Hennepin County "A" minor arterials.

Louisiana Avenue, a City of St. Louis Park city street, also provides a north-south connection between TH 7 and I-394.

Please note that many characteristics of Hennepin Avenue in the City of Minneapolis were evaluated when considering Hennepin Avenue as a possible alternate route to include in the corridor ICM plan. However, due to local preferences about traffic routing, Hennepin Avenue is not one of the arterial routes identified as a potential for traffic routing.

Transit Network
The transit network is comprised of Metro Transit, the primary provider of metropolitan transit, and Plymouth Metrolink. Service provided in the area is currently limited to fixed-route (express and local) bus service and paratransit service. In addition, Southwest Transit buses use the corridor to deliver passengers who board outside the corridor to the Minneapolis CBD.

Transit stations are located at the I-394 interchanges with Louisiana Avenue and Plymouth Road. Park and ride lots are located at various locations in the corridor.

At numerous locations throughout the corridor, transit vehicles may use the shoulders during congested conditions to help maintain schedules and avoid delays.

Light rail transit is planned in the future on what is currently known as the Southwest LRT trail between downtown Minneapolis and Eden Prairie, running roughly parallel to TH 7. However, the conversion of the commuter bicycle trail to LRT is not anticipated within the near (10-year) future.

ABC Parking Garages
The ABC parking garages are located on the western edge of the CBD and are directly accessible from I-394(ramps from I-394 feed directly into the garages with no travel on arterial roads needed). There are three garages totaling 6755 spaces. Discounts are offered for carpoolers.

Commuter Bicycle Network
There are several off-road and on-road bicycle trails shown on the Hennepin County bicycle trail map within the project area. In particular, the Luce Line trail provides connectivity to the western suburbs, and the Southwest LRT trail continues into Carver County to the southwest. Both of the trails provide connections to bus transit routes operating in the corridor.

1.2.3 I-394 Corridor Stakeholders

The I-394 ICM stakeholders are listed in ***Table 1.1***, all of which are involved in some extent in the development of this Concept of Operations. The operational and management responsibilities are shown graphically in ***Figure 1.2***. Metro Transit (and other providers) operates on all of the networks. Enforcement, security, and crash investigation on these networks are the responsibility of the State Patrol (freeways), Hennepin County Sheriff's Office, and the local law enforcement agencies. Emergency services are typically dispatched by Hennepin County, and are the responsibility of the local fire departments.

Table 1.1 Stakeholders

• Minnesota Department of Transportation • Mn/DOT Office of Transit • Mn/DOT Office of Transit Bicycle and Pedestrians • Mn/DOT Office of Freight • MnPASS Phase 2 Initiative Team • Metropolitan Council • Hennepin County Emergency (police & fire) Dispatch and responders • Hennepin County traffic management	• City of Minneapolis Emergency (police & fire) Dispatch and responders • City of Minneapolis Traffc Management • Metro Transit • Plymouth Metrolink (transit) • SouthWest Transit • Minnesota State Patrol • Hennepin County Dispatch • Additional local Police/Fire Departments • FHWA

Figure 1.1 Map of the I-394 ICM Corridor

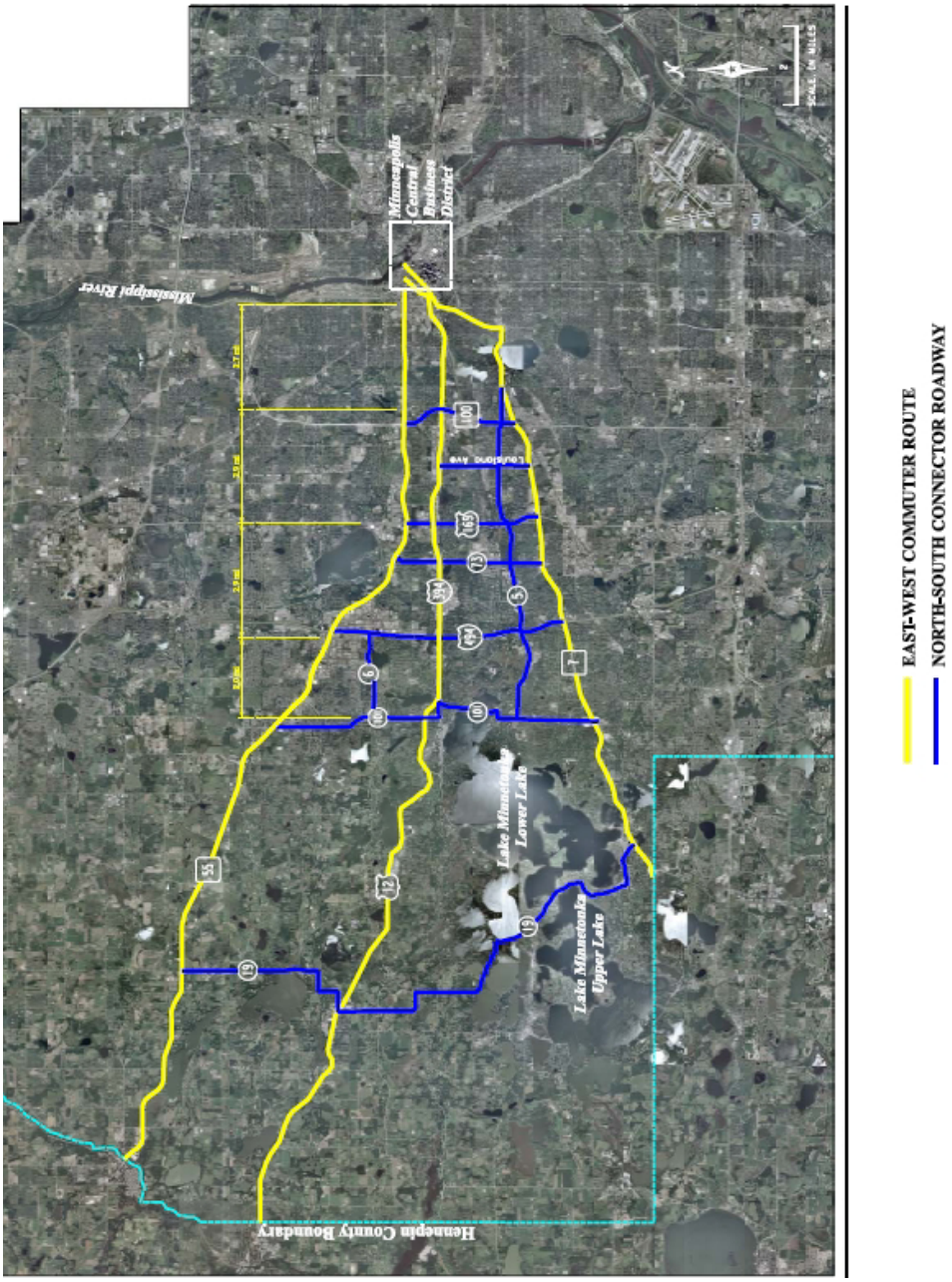
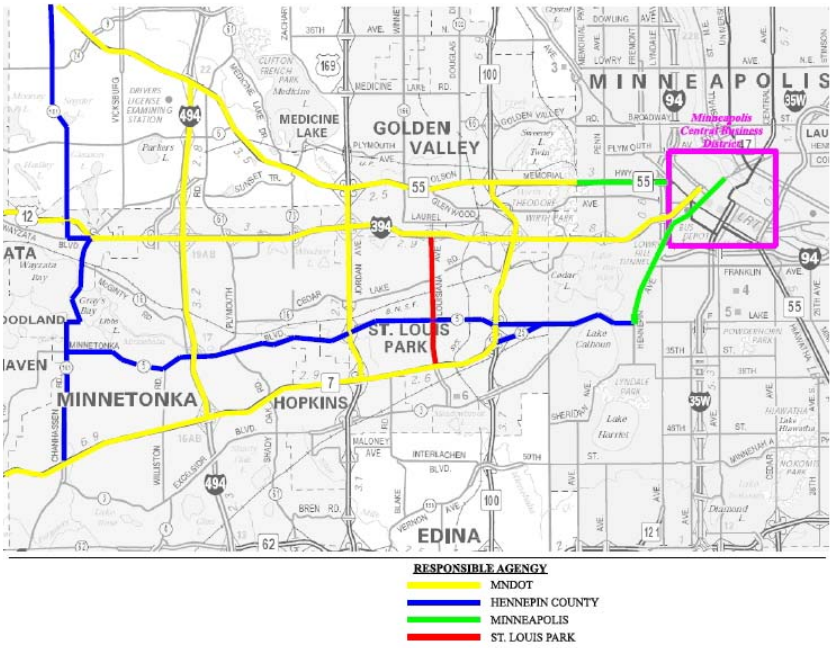


Figure 1.2 – Operational Responsibility



1.3 Corridor Operating and Institutional Conditions

The I-394 Corridor directly serves the residents of Minneapolis and its western suburbs, including St. Louis Park, Hopkins, Golden Valley, Minnetonka, Plymouth, Wayzata, and the outlying communities of the Twin Cities metropolitan area. The roadway network supports commuters who work in the CBD of Minneapolis and significant metropolitan "edge area" development nodes located at major crossroads along the corridor. During off-peak evening hours and on the weekends, this corridor also serves as a major connection to and from entertainment events held in downtown Minneapolis. Downtown Minneapolis is also home to three professional sports franchises, the Vikings football team, Timberwolves basketball team, and the Twins baseball team.

The corridor receives a large volume of traffic on its major thoroughfares. Traffic on I-394 reaches 151,000 vehicles per day near the CBD. The I-394 Corridor provides transportation options for the movement of commuters, freight, recreational, and other traffic. However, the route is primarily a commuter route evidenced by the relatively low heavy commercial vehicle percentage of 4%, and the distinct directional peaks in congestion.

The recent fast-paced growth in the area has put ever-increasing pressure on the I-394 corridor, particularly during the morning and evening rush hours. Recurring congestion is the main transportation issue facing the area. Current operational characteristics include:

- *Freeway Operations* - From Mn/DOT's 2006 Congestion Report, over 6.5 miles of I-394 is congested (below LOS D and less than 45 mph) every day. The most severe peaks occur in the evening hours from 3:00 pm to 6:00 pm for westbound travelers and during the morning rush between 6:00 am to 9:00 am for eastbound travelers.

- *Freeway Physical Constraints* – Congestion occurs on a daily basis at several bottlenecks due to physical constraints. These constraints include:
    - The Lowry Tunnel along I-94 near the eastern terminus of I-394;
    - The I-394/TH 100 interchange; and
    - The I-394/I-494 interchange

- *Arterial Operations and Constraints* –
    - On Hwy 55, Mn/DOT's Traffic Signal Congestion Level Map (2004) shows heavy to extreme congestion during the peak periods, with portions of the corridor averaging 3-4 hours of congested signal operations (where travelers are likely to sit through more than one green cycle) each day.

    - On Hwy 7, the Traffic Signal Congestion Level Map shows light congestion during the peak periods. Again, portions of Hwy 7 experience 3-4 hours of congested signal operations on average each day.

    - County Roadways – There are Physical or Signal system constraints at various locations.

    - Hennepin Avenue – Experiences significant congestion during peak periods, affecting both passenger and transit vehicles.

- *Transit Operations* – There are a combination of local transit routes using the I-394 corridor and express buses passing through the corridor. As measured during the month of January 2007, 14% of the express routes that involve some portion of I-394 ran late. Similarly, 5.48% of the local routes within the corridor ran late. Those transit routes that travel exclusively along the I-394 highway experienced late arrivals 24% of the time. Therefore, it appears that transit routes within the corridor traveling on roads other than I-394 have on-time arrivals more often. Transit does have a few alternatives to the congestion, such as the HOV lane and driving on the shoulder when travel speeds drop below 30 mph when they are operating in the off-peak direction of travel. Outside of I-394, the transit system experiences congestion along Hennepin Avenue in Minneapolis, with frequent service operating in this corridor.

- *Park and Ride Lots* - Many of the transit riders drive to transit centers or park-and-ride lots located in the I-394 corridor. Both of the park-and-ride lots along I-

394 currently are operating beyond capacity. Therefore during many scenarios, park-and-ride lots fill and potential transit riders must either seek other lots or continue driving to their destination. Additional park-and-ride lots are approaching capacity. There are also a number of lots under construction, however anecdotal evidence suggests that demand will exceed capacity in the near future.

- *HOV/HOT Lanes* – From the *I-394 HOV Report (Mn/DOT 2006 – 3rd Quarter)*, the following is a summary of vehicles and people moved during the peak hours at Penn Avenue:
    - AM Peak Eastbound (3 General Lanes, 2 HOV/HOT lanes)
        - Vehicles – 7267 Total, 24% in HOV/HOT Lanes
        - People – 10,506 Total, 47% in HOV/HOT Lanes
    - PM Peak Westbound (3 General Lanes, 2 HOV/HOT lanes)
        - Vehicles – 7542, 22% in HOV/HOT Lanes
        - People – 10,443, 41% in HOV/HOT Lanes

I-394 HOV/HOT Reversible Lane

- ABC Garage Usage in 2006
    - 6755 – I-394 ABC Garage Capacity
    - 3515 – Total Monthly Contracts
    - 1121 - I-394 HOV Monthly Contracts (Down from 2162 in 2002)

- *Non-recurrent congestion* - is also experienced in the corridor, primarily caused by traffic incidents, special events, summer and holiday weekend travel. Weather events also cause a significant amount of non-recurrent congestion, particularly in the October-April winter season.

Figure 1.3 illustrates the location of major issues within the study corridor.

Figure 1.3 Congestion Point Location Map

1.3.1 Description of Technologies/Strategies Implemented

The various transportation and public safety agencies within the corridor have implemented a variety of policies, strategies, and Intelligent Transportation System (ITS) technologies to improve performance of their respective networks. For example:

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 1.2 describes these existing systems and indicates the agency committed to maintain these systems.

Table 1.2: 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: • Complete I-394 surveillance coverage through Closed Circuit Television (CCTV) cameras • Dynamic Message Signs (DMS) located at limited locations along Hwy 55 • Full ramp meter coverage of all ramps in the corridor • A 511 phone and Internet information dissemination system • A condition reporting system; and • Traffic management center software	Minnesota Department of Transportation (Mn/DOT)
A Metro Transit Control Center (MTCC) system including: • Bus monitoring with AVL and real-time reporting • Internet accessible transit trip planning system • Transit traveler information website and phone system • Bus performance monitoring and reporting system • Park-and-ride facilities along the corridor	Metro Transit
Operational Commuter Transit Agencies operating: • 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: • Ability to monitor ingress and egress of vehicles • Access directly to I-394	City of Minneapolis (COM)
The Mn/DOT Arterial Signal Group (Mn/DOT-ASG) System, including: • Actuated signal controllers on State operated signals within the corridor • Communication to signals and ability to download signal timing plans remotely	Mn/DOT
The City of Minneapolis Arterial Signal Group (COM-ASG) System, including: • Actuated signal controllers on City operated signals within the corridor • Communication to signals and ability to download signal timing plans remotely • DMS devices along arterials in the downtown with control from within the ASG	City of Minneapolis

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

1.3.2 Communications Infrastructure Supported within the Corridor

The following table summarizes the communications infrastructure throughout the corridor in order to describe the potential for utilizing the existing infrastructure and any needs for additional infrastructures.

Table 1.3 Corridor-wide Communications Infrastructure Summary

Center / Agency	*Communications Infrastructure Description*
Mn/DOT RTMC	• Connects to field devices (DMS, loops, cameras, ramp meters) using fiber connections • Connects to Mn/DOT Metro Traffic using fiber connections • No dedicated connection to Hennepin County, City of Minneapolis, or Metro Transit • Connects to cameras on Hwy 55 and Hwy 7 using a fiber trunk with a jump to the device that is either wireless or a fiber 'pigtail'
Mn/DOT Metro Traffic	• Connects to Mn/DOT operated signals (Hwy 55 and Hwy 7) over a closed loop system with dial-up connection at the master controller • Connects to Mn/DOT RTMC using fiber connection
Hennepin County Traffic Center	• Connects to Hennepin County operated signals over a closed loop system with phone drops at the master controller locations
City of Minneapolis Traffic Control Center on Border Avenue	• Connects to city traffic controllers using a hard-wire connection (twisted pair telephone cable) • Connects to cameras using the twisted pair telephone cable
Metro Transit	• Connects to buses using wireless AVL/CAD system • Connects to limited park-and-ride facilities with twisted pair connections

1.3.3 Other Improvements or Inter-agency Agreements Planned for the Corridor

The I-394 Corridor also supports a number of planned (or considered) improvements, as well as other deployments that will impact traffic flow. The Minnesota Twins professional baseball team is building a new stadium, and the current site is at the Eastern edge of the corridor. This stadium will introduce considerable levels of traffic moving towards the central business district during the evening peak periods.

A study is currently looking at potential transit advantages along I-394 in both the general purpose lanes and the HOT lanes. There are currently no definite dates for the planned development of any enhancements. This ConOps is not placing any reliance on the outcomes of this study, it is mentioned as a reference to other studies that will be monitored throughout the systems engineering process.

A bus rapid transit line is being considered for the Northwest portion of the corridor, and a light rail transit line is being considered in the Southwest portion of the corridor.

1.3.4 Summary of Institutional Conditions

On a day-to-day operating basis, the corridor consists of independent networks and systems containing a wealth of information. However, these systems are usually operated by a specific agency with minimal communications occurring with the other agencies. For example:

- Traveler information is available on www.511mn.org, but it does not include information about arterial conditions or transit status reports. The traveler information also lacks an overall 'corridor-wide' view that could allow travelers to understand the conditions along each mode and route option.

- Incident, construction, and driving condition information is manually and automatically entered and made available through Mn/DOT's condition reporting system; however this information is not currently accessed by other agencies responsible for managing traffic and events.

- Law enforcement and emergency services dispatch is performed by the Minnesota State Patrol (state routes), Hennepin County (county routes and many city routes in the corridor), the City of Minneapolis (Minneapolis roads), and a few isolated city dispatch centers. Information sharing and data communications between these independent dispatch centers is not regularly performed.

- The largest transit agency, Metro Transit, collects and has available information on the schedule adherence and route performance of each transit vehicle. However, dissemination of this information is limited and is not incorporated with the 511 traveler information systems to help encourage modal shifts.

- There is no coordination between the arterial signal timing and bus operations, such as providing signal priority to those buses that are running behind schedule.

- This lack of coordination also exists at transit hubs, where a lack of real-time information regarding connector buses and express route schedules may lead to increased rider's wait time and frustration.

- No dynamic information is available for transit users.

- No real-time information is available regarding parking availability at park and rides.

- Oversight of the transportation infrastructure in the I-394 study area is the responsibility of a relatively small collection of governing agencies. This limited

number of agencies greatly simplifies the amount of institutional integration that is required for implementing an ICM program in the I-394 area.

Another aspect of the Twin Cities area, in general, is the high degree of cooperation that currently exists among transportation stakeholders. The agencies have a long track record of working together in a variety of transportation initiatives. That being said, the I-394 ICM corridor does support considerable opportunities to benefit from for implementing Integrated Corridor Management.

For these reasons, no significant missing institutional integration areas were identified. This ConOps does describe plans for the creation of an ongoing ICM Management Team to ensure deployment and operations occur as planned. In addition, some additional agreements will be needed to establish collaboration arrangements that will arise between agencies and integration policies and procedures are an anticipated outcome of this project. These arrangements are dependent on the type of ICM initiative put into place. Some possible additional institutional agreements that have been identified include:

- All agencies: joint control of traffic management/operations centers
- All agencies: expand existing data sharing agreements to cover creation of a centralized data clearinghouse. This includes third party private sector access for dissemination via the Internet, broadcast media and/or in-vehicle navigation systems
- Metro Transit and other agencies: dynamic transit information to roadway users
- Metro Transit and local traffic signal agency: transit priority system

1.4 The Need for ICM

Outreach meetings were conducted with the stakeholder agencies throughout the corridor. In addition to the participation of key representatives from stakeholder agencies at the Steering Committee and Working Group meetings, the ICM project team went and met with a large number of staff members within each organization to capture the input and feedback from operators, field personnel and other operations staff. In addition, Mn/DOT had recently completed a needs assessment to identify current needs that could possibly be addressed by technology implementations. By reviewing the results of both of these studies, a preliminary set of concerns, operational deficiencies, and gaps in service have been identified and verified with ICM stakeholders. These concerns, deficiencies and gaps were compiled, and are summarized (in no specific order) as follows, and have served as input to the needs definition process:

- Stakeholders agreed there are some gaps in the travel information delivery about existing conditions, incident conditions, the operational status of the multi-modal systems, and options for travel.

- Stakeholders agreed that congestion can be mitigated if they are able to reduce demand on the infrastructure, systems, and services (i.e. highways, transit vehicles, park-n-ride lots, and parking facilities) lacking excess capacity and increase the use of those systems and services with excess capacity.

- Stakeholders agreed that there is a gap in the delivery of travel information at en-route locations and over mediums of communication that is preventing travelers throughout the corridor from receiving information when it is needed and most useful.

- Stakeholders agreed that there is an operational gap in coordination between traffic management operators at the various agencies during normal conditions and incident conditions.

- Stakeholders agreed that there is an operational gap in the coordination, communication, and cooperation among emergency (fire and police) services operations teams.

- Stakeholders agreed that there is a gap in the ability to detect and respond to incidents and special events on all roads and networks throughout the corridor.

- Stakeholders agreed that there are system and infrastructure reliability gaps that should be corrected to maintain corridor-wide movement of people and goods.

- Stakeholders agree that the special event traffic along the corridor places unique constraints on the system and that there are gaps in the information and options presented to travelers that if addressed could improve the network operations.

- Stakeholders agree that the traffic flow along the corridor can be improved, especially during incident conditions to maintain travel flow as close to normal conditions as possible.

1.4.1 I-394 Corridor Problems and Needs to be Addressed by ICM

The challenges that face travelers and operators along the I-394 Corridor have been assessed and a set of problem statements have been prepared to summarize the problems to be addressed by ICM. These problem statements, and the related needs, are summarized in Table 1.4.

Table 1.4 - I-394 Corridor ICM Needs

	Problem	Need
ConOps Section 1.4: *"Stakeholders agreed there are some gaps in the travel information delivery about existing conditions, incident conditions, the operational status of the multi-modal systems, and options for travel.."*	1. ICMS agencies performing traveler information dissemination are not alerted to every incident or unplanned transit service problem along the corridor.	**1. Need for corridor wide status monitoring.** 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: • Notification of events; • Sharing of information among the various agencies 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.** Reports of incidents and their impacts on the network need to be verified in order to allow information dissemination systems to accurately 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).

	Problem	Need
	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.** Travelers need to be provided with an overall view and description of the conditions along all routes and modes of travel. • The information needs to be assembled from public and privates agencies. • The information needs to be provided to information dissemination systems operated by public and private agencies. • 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.** 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. This 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.

	Problem	Need
ConOps Section 1.4: *"Stakeholders agreed that congestion can be mitigated if they are able to reduce demand on the infrastructure, systems, and services (i.e. highways, transit vehicles, park-n-ride lots, and parking facilities) lacking excess capacity and increase the use of those systems and services with excess capacity."*	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.** 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.
	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.** 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.** 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. 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.

	Problem	Need
	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.** 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.
"*ConOps Section 1.4: Stakeholders agreed that there is a gap in the delivery of travel information at locations and over mediums of communication that is preventing travelers from selecting the best options while en-route.*"	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.** 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.
ConOps Section 1.4: *"Stakeholders agreed that there is an operational gap in coordination between traffic management operators at the various agencies during normal conditions and incident 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.** 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.

	Problem	Need
	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**. Operators need improved information about the current and planned response activities of the other agencies throughout the corridor. • Operators need a way verify the information and assess the impacts. • The relevant information about the incidents and events needs to be provided to traveler information dissemination systems.
ConOps Section 1.4: *Stakeholders agreed that there is an operational gap in the coordination, communication, and cooperation among emergency (fire and police) services operations teams.*	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.** There is a need for information exchange among the fire, police, and transportation 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.
ConOps Section 1.4: "*Stakeholders agreed that there is a gap in the ability to detect and respond to incidents and special events on all roads and networks throughout the corridor."*	13. The transportation agencies in the corridor lack information about incidents along arterials or the transit network.	

	Problem	Need
ConOps Section 1.4: "*Stakeholders agreed that there are system and infrastructure reliability gaps that should be corrected to maintain corridor-wide movement of people and goods.*"	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.** 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.
ConOps Section 1.4: "*Stakeholders agree that the special event traffic along the corridor places unique constraints on the system and that there are gaps in the information and options presented to travelers that if addressed could improve the network operations.*"	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.** 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.** Special event attendees need to be presented with information about options for routes, modes of travel, and parking
ConOps Section 1.4: *"Stakeholders agree that the traffic flow along the corridor can be improved, especially during incident*	17. The progression of travel along the corridor is not optimized. 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.** 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 time

	Problem	Need
conditions to maintain travel flow as close to normal conditions as possible."	18. Transit vehicles accessing park-n-ride locations experience extensive delays, frustrating riders and impacting the on-time performance of vehicles.	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.
	19. The freeway system operates at or near capacity during peak periods and 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.** 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.** 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

1.5 ICM Vision, Goals and Objectives

The I-394 Corridor ICM Vision:

> ***In the future, travelers of the I-394 Corridor will be knowledgeable about the options and real-time conditions of the various routes and modes of travel throughout the corridor.*** *Through various public and private travel information outlets, travelers will understand, in real-time, the situations facing each mode or route option prior to their trip departure, as well as the likely impacts of these situations. Once a mode and route have been selected, travelers will experience a trip that is reliable, safe, and efficient. When planned or unplanned situations arise that may delay or endanger travel, a variety of resources (both automated and human) will cooperate to manage traffic and deliver information such that each drivers' experience is as close as possible to the expectations that led the traveler to select the chosen mode and route.* ***As a result, travelers throughout the I-394 Corridor will experience trips that match their expectations, reducing frustration, rushed driving, and general confusion.***
>
> *It is envisioned that the I-394 Integrated Corridor Management approach will eventually be one of 4-5 ICM approaches that exist independently but work collectively to manage traffic and inform travelers throughout the Twin Cities metropolitan area.*

I-394 Corridor ICM Initiative Goals and Objectives

The goals and specific objectives of the I-394 ICM Initiative are defined as:

Goal #1: Mobility and Reliability. The I-394 Corridor network of agencies, infrastructure, systems and supporting personnel will work together to maintain mobility and reliability of travel on a corridor basis.

Objective 1-1: To reduce the variation in travel times experienced by travelers throughout the corridor.

Objective 1-2: To maintain options for travelers to effectively travel throughout the corridor using personal vehicles, transit or bicycles.

Goal #2: Corridor-wide Capacity Utilization. Any spare capacity throughout the I-394 corridor will be used to the maximum extent possible.

Objective 2-1: To monitor and understand the ever changing available capacity of roadways, transit, parking, park-n-ride, and alternative transportation options throughout the corridor.

Objective 2-2: To encourage pattern changes (either through information sharing or incentives) to better utilize spare capacity.

Goal #3: Corridor Event and Incident Management. There will be only minor impacts of incidents on travel time throughout the corridor; both in the extent of impact and duration, and that incident management will preserve the safety of the travelers throughout the corridor.

Objective 3-1: To inform travelers of incidents, the resulting impacts, and available options in order to encourage route and mode changes.

Objective 3-2: To manage traffic around events through early notification, communication and coordination among responders, and informed reactions.

Goal #4: Holistic Traveler Information Delivery. To provide travelers and transportation professionals with a 'holistic' view of the corridor and its operations through the delivery of timely, accurate, and reliable multi-modal travel information and data exchange.

Objective 4-1: Travelers are aware of their modal and route options, and understand the current conditions facing each option.

Objective 4-2: Travelers do not experience delays without also being informed of options for avoiding or minimizing the impacts of such delays.

1.6 ICM Operational Approaches and Strategies

1.6.1 I-394 ICM Approaches

The I-394 ICM team followed the USDOT recommended process to identify a series of ICM approaches and strategies applicable to the corridor. The corridor stakeholders have identified three timelines for deployments related to the ICM initiative:

- ***Immediate (pre-ICM implementation) initiatives*** include those activities that are either currently under development, with a planned deployment prior to the Fall of 2008, or will begin development shortly with existing budgets and will be operational by the Fall of 2008. These initiatives will not be the focus of the requirements development process because their completion will be prior to the ICM design process. They will, however, be referenced in the requirements development process as constraints to the system. Planned completion dates for these activities will be referenced throughout the Concept of Operations document.

- ***Short term ICM initiatives*** include those ICM strategies for deployment that will be the focus of the requirements development process and will have a target deployment and evaluation timeframe within the next 5 years. These strategies would be those activities that would be included in the ICM funding request to the US DOT that is planned in 2008.

- ***Long term ICM initiatives*** include those strategies for deployment that are identified by stakeholders as part of the long-term vision for ICM along the corridor, however are not expected to be deployed within the next 5 years, either due to other constraints or planned deployments that will not allow these strategies to be deployed in the next 5 years. In general, these ICM initiatives will not be the focus of the detailed requirements development process, however comments about the eventual plans for these systems will be included in the requirements to ensure planning for future compatibility. In addition, these strategies will not be included in the US DOT funding request for ICM planned for 2008.

These immediate, short and long term strategies can be categorized by the following ICM approaches:

Information Sharing/Distribution: Corridor Stakeholders have recognized that there are considerable amounts of data available about the real-time conditions along the corridor. There is great interest in openly sharing this data with all stakeholders, and in converting this data into information that can directly support the operational needs of stakeholders. Data sharing and the conversion to information will support traffic, law enforcement and transit agencies in performing coordinated real-time incident responses. The Minnesota statewide condition reporting system contains all types of event information will be expanded to include incident event reports from the county, city and state emergency response dispatch systems covering the corridor. Similarly, the RTMC traffic management database will be expanded to house additional data from sensors, cameras, CAD systems and other monitoring devices throughout the corridor. Collectively, these data will be available to all stakeholders who perform incident and traffic management, and integrated into the Metro Transit Control Center (TCC) to support real-time transit route management. The information clearinghouse content for traveler information will be expanded to include transit route status reports, parking and park-and-ride information, presented together with traditional 511 reports giving travelers a 'holistic' view of the corridor. In addition, the data and information exchange will increase the value of traveler information dissemination by expanding the existing public operated information dissemination systems (511, web, DMS) to support a more corridor centric dissemination (as well as a push of information to travelers), and by making the information available to private sector information service providers. These and other strategies within the "Information Sharing/Distribution" Approach will provide the informational foundation for ICM operations. This is the first step to the integration of the individual network systems. Initially, early winner low technology data exchange strategies will be implemented. Later stages of the I-394 deployment will involve more sophisticated automatic data transfers.

Of the strategies in this approach, there are some very low cost, simple strategy executions that will be approached in the *immediate term*. These include development of a comprehensive plan detailing the roles and responsibilities for manual and automated data and information sharing targeted to meet the data needs of all response agencies. Expanded communications called out in the plan will be initially achieved through shared radio channel talk groups on the 800 Mhz wireless communications system, standard land-line and cellular telephones, pagers and emails. Other immediate data exchanges will automatically populate the Minnesota statewide condition reporting system of event information with incident event reports from the State Patrol dispatch (CAD data from the county and city responders to follow in a second phase deployment). Provisions will be made to share these event reports and other data and information collected in the RTMC with the Metro Transit Control Center. The short term manual and automated data exchanges will all be relayed to the statewide event clearinghouse and immediately be disseminated over existing ATIS systems (i.e. 511, Internet, DMS). These and other immediate term strategies will advance the corridor considerably towards the ultimate vision within the initial few months following the Concept of Operations development.

Improve the Operational Efficiency of Network Junctions and Interfaces: The reliability and performance of freeways, signalized intersections and transit routes are key factors to achieving the I-394 vision. A number of strategies are recommended to improve the efficiency of these operations and minimize the impacts of planned or unplanned incidents in order to maintain reliable travel times throughout the corridor. Some example strategies include a coordinated multi-agency incident response to adapt signal timings and ramp meter rates during commute hours, as well as coordination and communication among response agencies to activate appropriate timing plans during incidents to flush traffic and clear events quicker. In addition, priority for transit vehicles will be delivered at key intersections and routes. Battery back-up support will be implemented for intersection controllers along the route to avoid power outages at isolated locations impacting the entire corridor. These new proposed strategies will work together with existing emergency vehicle pre-emption and adaptive controllers at signalized intersections to provide effective operations throughout the corridor. The strategies use cross-network operations to improve each individual network's performance by taking advantage of another network's functions. This, in turn, builds a foundation for a corridor perspective as well as changing the focus to the traveler's trip performance.

In the very near term, a number of immediate strategies to be deployed will include the development of additional timing patterns as well as operational guidelines for the use of such timing patterns, and responsibilities for determining when to use such patterns. In addition, minimum guidelines will be established for intersection redundancy and reliability (including such things as battery back-up and communications parameters).

Accommodate/Promote Cross-Network Route and Modal Shifts: In general, traveler information (as noted above) will provide information on the operational status of the corridor and allow travelers to select mode or route shifts to help maintain a consistent travel time to their ultimate destination. Strategies specific to this approach will accommodate those travelers selecting these shifts. As some examples of strategies,

agencies may modify arterial signals or ramp meters to accommodate traffic shifting from freeways, or to recognize inclement weather travel patterns where commuters alter their normal routes. Proactive responses to incidents will include travel information delivery (both pre-trip and en-route) explaining events and resulting travel times on transit routes, HOT lanes, freeways and arterials, coupled with information about park-n-ride availability and transit seats available.

Initial and very near term strategies will focus on establishing sufficient staffing levels and valid plans of action to execute changes to signal timings, ramp meter rates, transit priority parameters, and to validate travel information messages describing conditions. With a comprehensive and agreed plan of action, implementation of strategies to promote cross network route and mode shifts will follow as funding allows.

Manage Capacity – Demand Relationship Within Corridor – "Real-Time"/Short Term: Real-time short term capacity-demand management along the I-394 Corridor will make use of assets such as the HOT lanes, the transit control center, and operations control systems operated by the city, county and state in working together to preserve consistent travel times for corridor trips. Through cooperation and coordination of planned construction and related closures, efforts will avoid compounded capacity limitations created by multiple simultaneous activities whenever possible. During planned events (such as sporting events, State Fair, and other related activities) increased transit services may include additional parking locations with shuttle service to the mainline, temporary added capacity, and transit and parking fare adjustments will accommodate increased demand. The concept of dynamic shoulders will be explored as an opportunity to temporarily increase capacity.

Manage Capacity – Demand Relationship Within Corridor – Long Term: In order to accomplish goals for increased transit and alternate transportation, and to maintain service levels in light of increasing population and the upcoming baseball stadium within the corridor, long term strategies will be implemented to attempt to influence the permanent travel patterns of travelers throughout the corridor. Representative strategies may include integrated payment systems for HOT lanes and transit; visible priorities to transit vehicles to demonstrate the benefits of transit; better educating travelers about bike routes; park-n-ride facility locations and capacity; and finally long term increases to the capacity.

1.6.2 How ICM Strategies Will Meet the I-394 Goals and Objectives

An important aspect of the systems engineering approach is to critically assess the role each strategy (and proposed local application of the strategy) will play in order to understand 'why' it is being recommended for the corridor. Throughout the I-394 ICM initiative, stakeholders were continuously asked to defend the need for strategies, with the intent of defining a much focused set of strategies, each with a stated justification.

A table in Section 4.2 of the Concept of Operations document presents the need for each local application of the ICM strategies that is proposed. These strategies, and the specific

local applications of each strategy, have been verified with stakeholders throughout the project and again verified as stakeholders were briefed on the scenarios for incident response.

1.7 ICM Concept Operational Description

The I-394 ICM vision for a fully integrated corridor will be achieved through institutional, technical, and operational integration. The intent of this section is to describe the operational concept for the overall corridor, initially by presenting the travelers' view, then the corridor perspective, and finally by presenting the operational concept of the Integrated Corridor Management System (ICMS).

1.7.1 Travelers' View

From the travelers' perspective, travel along the I-394 Corridor will be supported by real-time traveler information describing the current conditions and travel times for the various modes and routes throughout the corridor. Travelers will understand their options for where they may park their automobiles or bicycles and ride transit vehicles; and they will understand typical travel times for various routes and modes. In real-time, they will be able to access a variety of pre-trip information sources to query current conditions and understand which mode and route is best suited to their time constraints. En-route, they will either be pushed information to personal devices or view information from field devices to alert them to changing conditions and recommending alternate modes and routes. They will have one overall account from which HOT, transit, and parking payments are made; and will experience incentives for choosing transit over single occupant vehicles through credits to either HOT lane access or parking access downtown.

In general, through open information exchange, travelers will be comfortable utilizing the entire transportation network offered to them. The benefits they will experience will be more uniform travel time, less surprises en-route, less stress and ultimately, safer travel.

1.7.2 Corridor Operational Description

With ICM operational, the operations of the I-394 Corridor will support a broader corridor-wide perspective than currently supported. On any given day, as the morning commuter traffic begins to build, a number of automated systems will gather real-time information about the parking availability; the speeds, volumes and occupancy of flow. This information, together with any incident reports from police and fire agencies will be assembled into one system and made available to all public agencies and private information service providers. As incidents or traffic builds in certain areas of the corridor, human operators will be alerted to such problems and focus their attention on these areas by viewing cameras, monitoring reports of system performance, and through open channels of voice communications. A greater amount of interagency coordination (than what exists today) will support incident and event management, with operators and

field personnel in each agency informed about current conditions and able to openly communicate as they perform their specific roles in incident response.

However, the emphasis of the corridor will not be solely upon resolving the operational problem or incident, but rather the emphasis will be upon a unified spreading of information to travelers across all routes and modes, as well as to transportation operations personnel. The I-394 Corridor ICM system will work to inform travelers and manage traffic in order to maintain consistent travel times even during incidents and heavy traffic days. This will be accomplished through traveler information systems that disseminate a 'corridor-view' suggesting options for routes, modes, and even destinations.

Finally, ICM incident management will actually begin before the incidents have occurred with active strategies to encourage modal and route shifts and parking approaches that actively spread traffic throughout the resources of the corridor.

1.7.3 Integrated Corridor Management System (ICMS) Operational Concept

The ICM System will be a system of systems, devices, and automated and manual activities that collectively work together to meet the needs of the travelers and operators throughout the corridor. Each function that the ICMS performs will be done to execute an ICM strategy or strategies, which relates to the needs of the corridor. The corridor needs are driven by the problems identified in previous sections. The systems engineering process has avoided the deployment of any portion of the system simply for the sake of deploying technology for technology sake. In addition, the systems engineering process has facilitated a process with the stakeholders such that each system that requires manual interaction (e.g. manual posting of DMS messages, manual observation of cameras) has been assigned to a stakeholder and agreed by that stakeholder.

This section presents the operational concept from the systems view, in other words the ICMS Operational Concept. Some operational concepts performed by the ICMS are already performed today by existing systems. When adequate, these existing systems will not be replaced, nor will duplicate redundant systems be built. Rather, the ICMS will ultimately be a system of systems that includes legacy (existing) systems, enhancements to existing systems, and new systems when needed. These existing and new systems are collectively referred to as the ICMS.

Data collection and assembly

The ICMS will collect and assemble a variety of data and information. The operation of each data collection activity will be spread among the various stakeholders and is addressed in another portion of the ConOps. The data collection operational concept of the ICMS is summarized as follows:

- Park-and-ride space availability will be monitored in real-time and the data assembled and communicated to the ICMS Information Clearinghouse;
- Transit schedule adherence and delays will be monitored in real-time by tracking vehicle progression. The data will be assembled and communicated to the ICMS Information Clearinghouse;
- Traffic flow data will be collected for routes throughout the corridor, including such things as volume, occupancy, and speed;
- Incident information will automatically arrive in the Information Clearinghouse being received from automated exchanges with the computer aided dispatch systems of the police and fire dispatch agencies;
- Incident information will also be entered into the Information Clearinghouse by RTMC operators after verification of the event;

Data Processing and Information Creation

In addition to data collection and assembly, the ICMS will process the collected data into information that can be used by travelers and operators to meet the needs identified for the corridor. The operational concept for information creation is as follows:

- The ICMS will calculate travel times for arterials and freeways and combine this information with transit schedule adherence information to establish a corridor-view of the travel times along various routes and modes;
- The ICMS will process the data available that describes demand and capacity (including capacity limitations caused by temporary or long term events) in order to assemble a functional view of those points or portions of the system where volume is near or exceeding capacity;
- The ICMS will process a combination of incident descriptions, travel time reports, planned event descriptions and compare these against traveler preferences in order to assemble travel reports that can support a push of information to travelers, alerting them to the impacts of current situations on the network.

Data and Information Sharing and Communication

The ICMS will share data and information among systems and users of the ICMS, and will support communication exchanges (e.g. verbal, text) among the stakeholders within each agency involved in the ICM. The operational concept for information sharing will be as follows:

- The ICMS will facilitate verbal communications such that emergency response (fire and police) dispatchers can work together and inform each other of response activities;
- The ICMS will allow all operators throughout the corridor to report incidents at any location throughout the corridor to other operators. Similarly, as the originating operator, or other operators, are able to verify incidents and impacts, the ICM will allow this two-way communication exchange such that all operators who require the information can monitor the events surrounding the incident;

- The ICMS will facilitate the viewing of CCTV images throughout the corridor by all stakeholders wishing to view these images;
- The ICMS will continuously share incident, travel time, and traffic flow information for the use by private information service providers operating throughout the corridor.

Information Dissemination

The ICMS will provide traveler information dissemination through systems that automatically deliver information to travelers, systems that require manual operator intervention to deliver messages, and through systems that share information with private sector information service providers. The system operational concept is described as follows:

- The ICMS will operate a 511 telephone system delivering a corridor perspective to travelers. This corridor perspective will present the expected conditions along optional routes and modes throughout the corridor, parking availability, transit status reports, and a summary of current events;
- The ICMS will operate an Internet website disseminating travel time information for optional routes and modes, provide information on incidents throughout the corridor, allow visitors to view camera images, and view current speeds along each route;
- The ICMS will operate trigger push systems to notify travelers when critical conditions exist or when thresholds have been crossed. The push communication will be used to alert travelers while they still have options for route or modal shifts;
- The ICMS will operate DMS signs and provide the means for operators in selected agencies to post messages to these signs. In addition, the ICMS will automatically post travel time messages to all DMS signs in the corridor;
- The ICMS will operate on-board wireless Internet services on transit buses traveling the corridor to both allow travelers to access travel information websites and to serve as an incentive to ride transit (and work productively en-route);
- The ICMS will disseminate travel information to the travelers leaving the downtown area through dissemination in parking garages, stadiums, and covered walkways.

Traffic Management and Operational Improvements

Finally, the ICMS will perform and support traffic management and operations throughout the corridor. The operational concept is as follows:

- The ICMS will operate ramp meters based on current demand conditions;
- The ICMS will operate coordinated signalized intersections along the Hwy 55 and Hwy 7 routes allowing traffic to flow progressively even across the jurisdictional boundaries that exist on both corridors;
- The ICMS will support the operation of incident plans and allow operators to manually select to download special timing plans to intersection controllers to support incident conditions;

- The ICMS will operate transit signal priority for those interchanges where buses must navigate one or more signalized intersections between park-and-ride facilities and the freeway;
- The ICMS will operate power back-up systems at intersections that are key to the corridor movement of traffic.

1.8 Required Assets and ICM Implementation Issues

1.8.1 What is needed to implement ICM along the I-394 Corridor

The ICM operational concept will be achieved along the I-394 Corridor through three key changes to the current situation. These three changes include the following:

- Changes and additions to the infrastructure and systems supporting the I-394 Corridor that are already planned and under development (with existing funding) and are seen as either critical to or beneficial to the implementation of ICM;

- Changes and additions to the infrastructure and systems supporting the I-394 Corridor that are proposed to be developed as part of the USDOT ICM Pioneer implementation; and

- Institutional framework changes that are needed to accommodate the relationships, interactions, and coordination to make ICM a success along the corridor.

The remainder of this section highlights each of these proposed changes. Table 1.4 presents the additions and changes to the infrastructure that are planned and funded under existing projects, together with anticipated completion dates. Table 1.5 presents a summary of the significant changes and additions to the I-394 Corridor that will be developed through the remainder of the ICM Systems Engineering Process to implement ICM. Finally, additional details of the institutional framework, and planned creation of an ICM Management Team are presented in Section 1.9.

While there are a number of planned additions to the corridor, and each of these will benefit the ICM deployments, none of these additions are seen as critical to the ICM approaches and strategies and some will simply benefit the ICM deployment through increased performance.

Table 1.5 Currently Planned Changes to the Corridor (with existing funding) that Will Benefit the ICM Implementation

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: • Deployment of freeway travel times on existing DMS on I-394 (scheduled in 2008); • 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: • Deployment of Transit Signal Priority (TSP) at key intersections as prioritized by Metro Transit (scheduled in 2008); • Integration of transit arrival times and telephone interactive voice response system (scheduled in 2008); and • Predicted bus arrival and departure information displayed on the Internet (scheduled in 2008).	Metro Transit
Funded enhancements to the SouthWest Transit Dispatch and Operations Center include: • Deployment of a computer aided dispatch (CAD) automated vehicle location (AVL) system	SouthWest Transit
Funded enhancements to the ABC Garage system at the termination of the corridor include: • 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: • Advanced signal coordination and retiming of the 30 signals along TH 55 (scheduled in 2011); • Advanced signal coordination and retiming of the 23 signals along TH 7 (scheduled in 2011); • 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); • Deployment of approximately 44 CCTV cameras along Hwy 55 and Hwy 7 (scheduled in 2011); and • 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:	City of Minneapolis

Future Enhancements to Field Devices and Control Systems within the ICM Corridor	Ownership / Maintenance Provided by
• Next generation master signal controller for the City of Minneapolis (scheduled in 2009).	

Table 1.6 Proposed Changes and Additions to I-394 Corridor (to be funded with ICM specific funds)

Organization	*Significant Changes or Additions*
Mn/DOT	• Additional CCTV coverage on Hwy 55 and Hwy 7 • Additional DMS sign locations upstream of key decision points, especially on arterial highways • Expanded reporting system into an Information Clearinghouse and Data Archive • Arterial street travel time calculation system integrated with RTMC • Automated data exchange interface with city, county, and transit agencies.
Metro Transit	• Real-time travel time index for current routes • Monitoring and communications of parking space availability within Metro owned park-and-ride facilities • CAD system interface able to ingest and display incidents reported to Information Clearinghouse • Transit signal priority system (on-board system including ties with schedule adherence system)
Hennepin County	• Access to the Information Clearinghouse, displaying useful information to operators based on existing data and status of equipment • Increased surveillance (CCTV) access • Upgraded traffic controllers and communications
City of Minneapolis	• Integration of 911 dispatcher CAD system with Information Clearinghouse
SouthWest Transit	• Integration with Information Clearinghouse
Minnesota State Patrol	• Integration of CAD incident reports with Information Clearinghouse
Corridor-wide	• Expanded Travel information system to include additional information (transit travel times, arterial travel times, parking information, etc.) • Expanded locations of in-field information disseminations (parking garages, transit centers)

1.8.2 Implementation Issues

A number of ***technical, operational, and institutional issues*** have been identified by the I-394 ICM stakeholders throughout the development of the Concept of Operations. Some of these issues have immediate solutions and have been planned for in this document, others represent issues with proven solutions that require only funding to implement (and therefore are less risky), while others still represent issues that are possible barriers to the overall vision of ICM and will be addressed at later stages of the systems engineering process.

- The ***technical implementation issues*** represent a combination of technical detail needed about the ICM deployments (e.g. the distribution and exact locations of additional surveillance cameras and message signs), issues regarding the interaction of systems, and issues related to the current status of systems and assets. These technical details will be addressed at the later requirements and design stages of the systems engineering process. Another example of a technical implementation issue is the need for travel time estimates for arterial street routes and transit travel that can adequately be used as comparisons against the available travel times along I-394. This issue is currently being addressed in that Metro Transit has systems capable of generating schedule adherence and route delay factors in real-time. Also, there are a number of funded research projects in Minnesota addressing arterial street travel time calculations. Therefore, these technical issues are expected to be resolved during the requirements and design portions of the systems engineering approach. Minnesota has a history of success using ITS standards for integration. The existing use of standards reduces the issues surrounding integration of systems. However, one technical implementation issue is the issue of 'semantics' or specifically the fact that the standards for message exchanges allow for many choices of phrases to be used to describe the same event. The ICM stakeholders will seek to define definitive event descriptions within the requirements phase of this project. The most serious technical issue facing the I-394 ICM integration is the need for upgraded technologies in controllers and communications to controllers. While the primary parallel routes are mostly updated and capable of supporting the needed network-wide control, there are a number of controllers on the secondary and tertiary networks that could contribute more to integrated management if they supported state of the practice technologies.

- Several ***operational issues*** must be addressed prior to ICM implementation throughout the I-394 Corridor. The majority of these issues surround the need for ICM centric operational procedures that can be agreed among all agencies. Many of these procedures have been discussed in the Concept of Operations development and agreed and documented as roles of stakeholders. However, prior to implementation, these roles will be formalized into an operations plan during system design. One key aspect of the ICM is the reporting of available parking at transit park-and-ride facilities. Technically, this is not an issue, however from an operations perspective, the park-and-ride facilities are owned by a collection of agencies and the operations/ownership of the equipment and communications to report capacity in real

time will require operational agreements to be developed in the design phase. An operational issue that has been addressed in the Concept of Operations is the fact that the City and County traffic operations centers are not fully staffed during the extent of the peak periods. The definition of roles has addressed this through a sharing of operational responsibilities, and this topic will further be addressed in the requirements phase of the project.

- Many potential ***institutional issues*** to ICM deployment and operations have been eliminated because of the long standing working relationships among the ICM stakeholders. The corridor stakeholders have identified the need for effective contracting and procurement processes that will allow cross-cutting systems to be deployed in several or all of the ICM partner agencies during the deployment phase. The decision of the I-394 Corridor stakeholders to not form a new entity for ICM, but rather to mainstream ICM into their existing agencies and modify the roles of existing groups to operate ICM will help mobilize ICM quickly and will ensure the ongoing success of ICM at minimal costs.

1.8.3 Specific Implementation Issue – Arterial Data

The ICM concept for the I-394 Corridor relies heavily upon the union of travel time information and performance metrics for the freeway, the arterial routes, and the transit routes. The freeway routes already have existing real-time monitoring and travel time calculations. The transit system has existing (and upgrades to be released Fall 2007) vehicle schedule adherence reporting. Nonetheless, arterial traffic collection and calculation of arterial travel times remains a challenge that is currently facing this corridor. Demonstrating the commitment of the local agencies to the ICM initiative, there are currently a number of recently funded and now active developments that specifically target the challenge of missing arterial data and information about travel times. These are summarized as follows:

- Mn/DOT is currently conducting a trial of cellular phone data assembly for travel time calculations along arterial streets. The system being piloted for demonstration and evaluation is deployed and operated by Airsage. Mn/DOT has begun to receive data for the ICM corridor and will soon understand the benefits and costs of such an investment;

- Local University of Minnesota Research. A current and ongoing project being conducted by the University of Minnesota is specifically seeking to research whether additional monitoring devices on traffic signals can assist in delivering very accurate arterial travel times in real-time. A recent modification to this project is now focusing on the ICM Corridor in hopes of delivering travel times along the corridor within the coming year; and

- Finally, Mn/DOT has recently begun the expansion of a current Mn/DOT accepted volume/capacity calculation to expand to real-time operations. This deployment will result in a real-time algorithm capable of generating estimated travel times for major

arterials along the I-394 Corridor. This algorithm development is starting with an emphasis on Hwy 55 and Hwy 7 and will directly benefit the ICM corridor.

The Minnesota ICM Team recognizes that arterial street travel times present many challenges. These three specific, funded and ongoing efforts demonstrate the level of urgency that the ICM Team is placing on this challenge, and the plans to have overcome this hurdle before the deployment of ICM begins in 2008, ideally in time to meet the modeling needs of early 2008.

1.9 I-394 ICM Concept Institutional Framework

1.9.1 ICM Leadership and Program Management

As the ICM systems engineering process transitions from the requirements development to the design and deployment portions, the ICM management and leadership will transition to a more defined and operational focus. This section outlines the plans for ICM leadership and management.

Current ICM leadership

Under the current ICM structure, the Mn/DOT RTMC provides the overall ICM Program Manager. An ICM Core Team is comprised of Mn/DOT Freeway Operations management, Mn/DOT Arterials Operations management, and the local transit agency management. The ICM Core Team (3 representatives) has been attending all ICM workshops and will continue to do so throughout the duration of the ICM systems engineering process. The ICM Program Manager has the support of the ICM Working Group and ICM Steering Committee, as well as technical consulting support from the private sector. This framework has worked well to support the systems engineering process and engage all the needed agencies and individuals in each city and county.

Planned ICM leadership during design, deployment and operations

Beyond the conceptual planning, requirements definition, and modeling process, the ICM Team members recognize not only the need for ongoing program management, but also some distinctions in the need for this management as opposed to the management provided during the current ConOps and requirement definition processes. The I-394 ICM strategies will be operated, managed, and maintained by a collection of local partners operating throughout the corridor. In general, individual agencies will lead the development, deployment, operations, and maintenance of key technical systems. Procurement and project management will be the responsibility of the individual agencies responsible for each deployment. Nonetheless, the corridor perspective of ICM can only be achieved if all participating agencies are united together and if each agency can rely on the other agencies to deliver what they have committed to perform.

In summary, three key roles are envisioned for the management of the ICM program:

- Program leadership (overall management, commitment monitoring, stakeholder liaisons);
- Management of the ICM Concept (monitoring and assessing performance measures, maintaining the corridor perspective, assessing annual direction); and
- Day to day operations and maintenance of ICM strategies at the local level.

ICM Program Manager Role

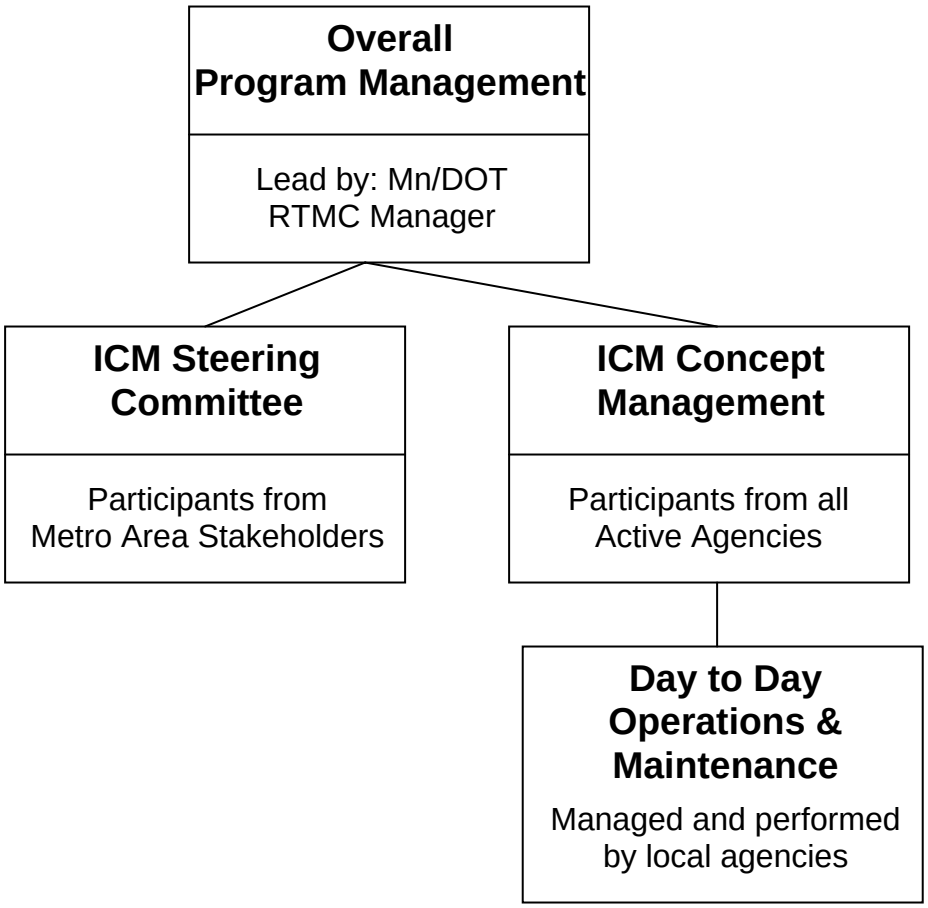
Mn/DOT will continue to provide an overall ICM Program Manager, and this individual will be a manager within the RTMC, based on the fact that the RTMC is a central focal point to transportation operations throughout the corridor. This designation will ensure that the program is always managed by an individual working daily in freeway and arterial operations, and with a vested interest in the success of ICM. The ICM Program Manager (working with staff members and support contractors) will be responsible for managing the commitments of member agencies and ensuring that commitments for deployment are delivered on-time, or that other agencies are informed of delays as soon as possible, and contingency plans are arranged.

ICM Management Team

As the ICM deployment advances and transitions into operations, the ICM Management Team will be expanded to include one member from each agency with an active role in ICM management. The intent of the ICM Management Team will be to ensure that each agency performs the duties that they have committed to during the ConOps development process (at the ICM workshop, each activity for operations and maintenance were discussed and a lead agency was identified). The ICM Management Team will meet regularly with an ongoing agenda item to review current ICM procedures, performance measures, and assess any need for changes.

The ICM Working Group will not exist as it currently does, but rather as needed, project-specific working groups will form. Each working group will report to the ICM Management Team and ultimately to the ICM Program Manager. The ICM Steering Committee will exist and continue to play their current role until such time as the role of the committee can be migrated into an existing operations based committee structure. The ICM Management Team will perform the regular performance reviews and commitment monitoring, and it is hoped that the steering and direction of ICM will find a home within the operational setup of the Metropolitan area.

Figure 1.4 Proposed Organizational Structure of ICM Management for Ongoing Operations



1.9.2 Institutional Cooperation and Agency Roles

Institutional, Technical, and Operational Integration

The I-394 ICM initiative will initially require institutional integration of the partner agencies,individual staff and management personnel within each organization to establish the needed relationships, agreements, and internal staffing plans to operate the ICM strategies. Technical integration will involve the design, development and implementation of the specific technologies to support the ICM strategies in compliance with the regional ITS architecture and with the geographic coverage and technical capabilities to meet the aggressive objectives of ICM. Finally operational integration will fuse the individual operational activities of corridor partners to operate the systems as one overall system, recognizing the existing funding and organizational structure limitations facing each stakeholder agency.

Corridor-wide information assembly

The RTMC, housing a combination of Mn/DOT Freeway Operations, Maintenance Dispatch and State Patrol Dispatch, will play a central role in the corridor management. The RTMC currently operates all freeway control and 511 information dissemination over phone and Internet. The RTMC currently operates a condition reporting system and traffic management software system. Either of these may be expanded or incorporated somehow into the ultimate development of the information clearinghouse described in this Concept of Operations (to be determined in the requirements and design phases). To this extent, the RTMC will house the information clearinghouse (regardless of the approach taken to development). The information clearinghouse will be populated with critical information from the transit, parking, emergency response, arterial and freeway management systems. While the RTMC will not specifically operate all of these individual systems, it will ingest the data from these systems and perform the fusion of data required to create the holistic travel information view for the corridor.

De-centralized system operations and information sharing

In order to realize the vision of the I-394 ICM initiative, there will be several systems (hardware and software) developed and operated by partnering agencies throughout the corridor. The data and/or information generated by these systems will be assembled centrally in the RTMC information clearinghouse using established ITS standards and Internet protocols for data exchange. Therefore, a center to center data exchange system resembling a 'spoke and hub' routing scenario will be used where systems operated locally will all transfer data to the RTMC. The RTMC will assemble, normalize, process and circulate the data (and resulting information) to all partners and information service providers.

2. References

A number of resources have contributed to the development of this Concept of Operations document. These resources have ranged from verbal communications to written documentation. This section references the written documents that have contributed to the ICM ConOps development in Minnesota.

MN ITS Development and Deployment Plan Document developed by Mn/DOT ITS Deployment Assessment Project; 2007.
- Including Stakeholder needs assessment meeting summaries

Minnesota Statewide (Regional) ITS Architecture; December 2001.

Minnesota Transportation Improvement Plan

Developing and Using a Concept of Operations in Transportation Management System, FHWA TMC Pooled-Fund Study (http://tmcpfs.ops.fhwa.dot.gov/cfprojects/new_detail.cfm?id=38&new=0 .

NCHRP Synthesis 307: Systems Engineering Processes for Developing Traffic Signal Systems.

FHWA Rule 940, Federal Register/Vol. 66, No. 5/Monday, January 8, 2001/Rules and Regulations, DEPARTMENT OF TRANSPORTATION, Federal Highway Administration 23 CFR Parts 655 and 940, [FHWA Docket No. FHWA–99–5899] RIN 2125–AE65 Intelligent Transportation System Architecture and Standards.

Regional ITS Architecture Guidance Document; "Developing, Using, and Maintaining an ITS Architecture for your Region; National ITS Architecture Team; October, 2001.

3. Existing Corridor Scope and Operational Characteristics

3.1 Corridor Boundaries and Networks

The I-394 ICM corridor extends from the Minneapolis CBD to the area's rapidly developing western suburbs. For the purposes of this project, the corridor's western limit is defined as the Hennepin County border, a distance of approximately 25 miles, as shown in Figure 3.1. The corridor consists of an east-west freeway, with two parallel arterials. One arterial lies to the north of the freeway, the other to the south. Three north-south freeways connect the arterials and the freeway. The I-394 ICM corridor is primarily a commuter corridor utilized for travel between the Minneapolis central business district of employment and the western suburban residential area. The corridor begins on the west side of the Minneapolis CBD, just to the east of I-94. The corridor travels through the City of Minneapolis, before entering the near ring suburbs.

I-394, the east-west freeway, runs through the heart of the corridor and roughly delineates the northern suburbs from the southern suburbs. TH 55, the east-west arterial to the north of I-394, traverses through the Cities of Golden Valley and Plymouth, while TH 7, the southern arterial, passes through Saint Louis Park, Hopkins, and Minnetonka. TH 55 intersects I-94 at a full access interchange, while TH 7 begins at an interchange with TH 100, the easternmost north-south freeway in the corridor. The networks comprising the I-394 ICM corridor, and their respective characteristics, are summarized in Table 3.1

Table 3.1 I-394 ICM Corridor Network Characteristics

Network	Characteristics
Freeway Network (Figure 3.1)	• East-west freeway, I-394, contains three travel lanes (total) in each direction • One HOV/HOT lane (left lane) used all day; two reversible HOV/HOT lanes in eastern third of freeway segment • North-south connections to the arterial network provided by I-494, Hwy 100, and Hwy 169; Connections spaced approximately every three miles • Emergency shoulders provided • I-394 links with I-94 corridor at the edge of the CBD • I-394 terminates in the CBD • Freeway network ends west of CSAH 101

Network	Characteristics
Arterial Network (Figure 3.1)	• Three arterial networks; HWY55 to the north of I-394, Hwy 7 to the south of I-394, and TH 12 to the west of I-394 • Hwy 55 located in Golden Valley, Plymouth, and Minneapolis • Hwy 7 located in St. Louis Park, Hopkins, and Minnetonka • Hwy 12 travels from the Hennepin County border to I-494; Hwy 12 becomes I-394 east of I-494 • Two lanes of travel in both directions on all arterials (three lanes on Hwy 55 near I-94 and I-494) • Access to I-394, via freeways, approximately every three miles • Cross network connections (via surface roadways) at Hwy 73, Hwy 61, Hwy 101, and Louisiana Avenue • Hwy 55 connects directly to the Minneapolis CBD; Hwy 7 terminates at Hwy 100

Network	Characteristics
Transit Network (Figure 3.2)	• Metro Transit operates Local, Limited Stop, and Express service in the corridor area. Metro Transit provides service to Park & Rides as well as the Louisiana Avenue Transit Center and Plymouth Road Transit Center. Local peak hour headways are approximately 15 minutes, limited stop headways approximately 20 minutes and express headways approximately 30 minutes. Metro transit operates on I-394, TH 55, and TH 7 • Plymouth Metro Link operates Limited Stop and Express services between the Minneapolis CBD and the local road network in Plymouth and Golden Valley. Express service provided to Station 73 Park & Ride in Plymouth. Both Limited Stop and Express peak hour headways range between 20 and 30 minutes. Plymouth Metro Link operates on both I-394 and TH 55. A major park-and-ride facility is located at the corner of Hwy 55 and Hwy 73. The majority of bus routes head south on Hwy 73 after the park-and-ride to access I-394 heading in to the CBD • Southwest Metro Transit operates services along I-394 in the corridor. Trips originate in the Minneapolis CBD and terminate in the southwestern suburbs. Service is not provided to any of the Park & Rides within the I-394 ICM Corridor. Southwest Metro Transit buses travel along I-394 between I-94 and TH 169. Because the ICM Corridor is a throughput route for SouthWest Transit, there are options for diverting because there are no scheduled pickups or drop-offs within the corridor. • Park & Ride Lots are located throughout the I-394 ICM Corridor. These Park & Ride lots vary in size; each lot is serviced daily by either Metro Transit or Plymouth Metro Link services. Additionally, two major Transit Centers are located adjacent to I-394 – the Louisiana Avenue Transit Center and the Plymouth Road Transit Center • Figure 3.2 illustrates commuter transit routes, transit centers, and Park & Ride lots located in the corridor.

Network	Characteristics
Commuter Bicycle Network (Figure 3.3)	• Luce Line Trail travels west of TH 169, roughly bordering TH 55. The trail is maintained by the Minnesota Department of Natural Resources. The trail connects Plymouth to west-central Minnesota over 63 miles. In the I-394 ICM Corridor, the trail is surfaced with limestone • The SW LRT Trail has two segments in the I-394 ICM Corridor. The north segment travels through Minnetonka and Hopkins, between I-394 and TH 7. The south segment roughly follows TH 7 from I-494 to the Minneapolis Chain of Lakes. The trail is approximately 27 miles in length, surfaced with crushed limestone. • The Hutchinson Spur trail connects the SW LRT Trail with the Cedar Lakes Trail. This trail is asphalt paved and travels northeast through the corridor, connecting to the Cedar Lakes Trail just east of TH 100. The Hutchinson Spur Trail is approximately 4 miles in length. • The Cedar Lake Trail provided a connection to the Minneapolis CBD from the SW LRT Trail, via the Hutchinson Spur Trail. The trail is paved, and follows an east-west alignment from TH 100, along I-394, into the CBD. • Local on-street bicycle lanes are present on CR-40 between TH 55 and Wirth Park; along Cedar Lake Road between I-394 and TH 7, and CR-5 between TH 100 and TH 169.
Third Avenue Distributor (ABC) Garages	• The ABC garages are located on the west side of the Minneapolis CBD • The garages are directly accessible to I-394, with ramps internal to the garage for entering and exiting vehicles directly to the freeway. • Three garages provide 6,755 stalls • Carpoolers receive discounted parking rates

Figure 3.1 – Map of I-394 Corridor

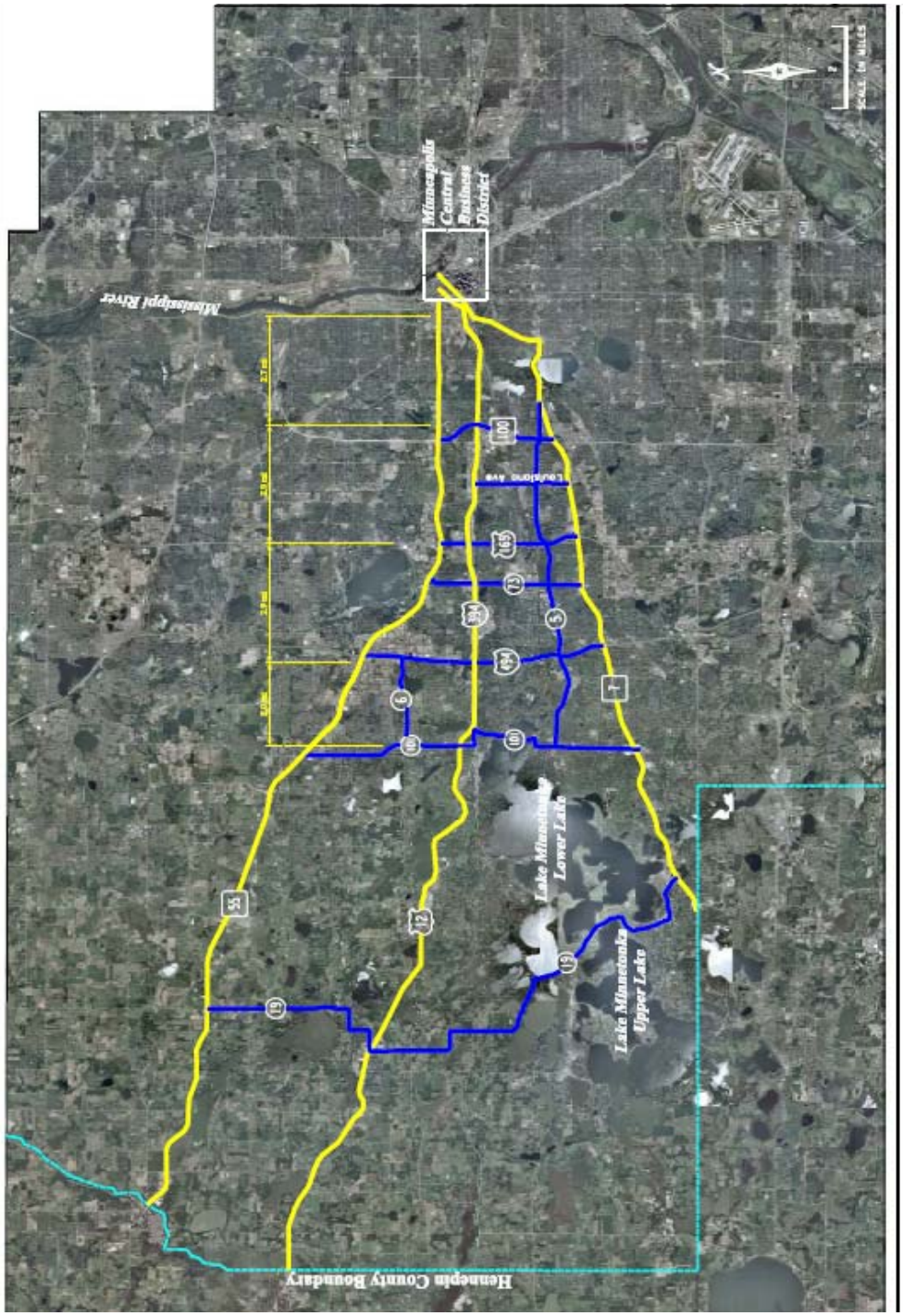


Figure 3.2 – Transit Commuter Service

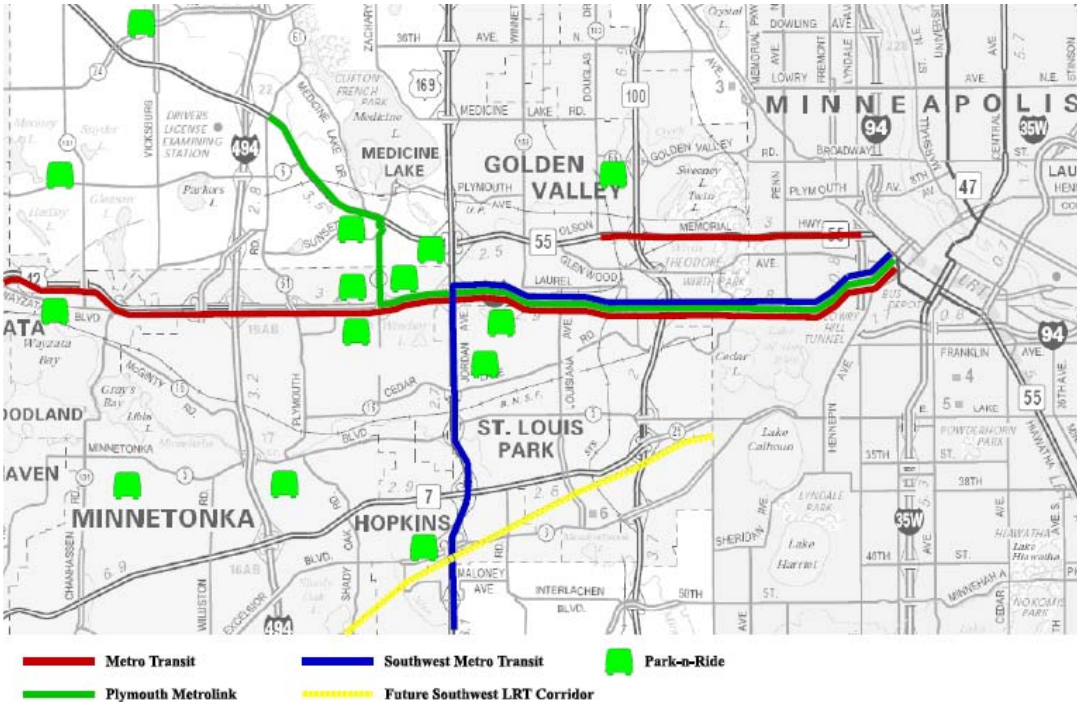
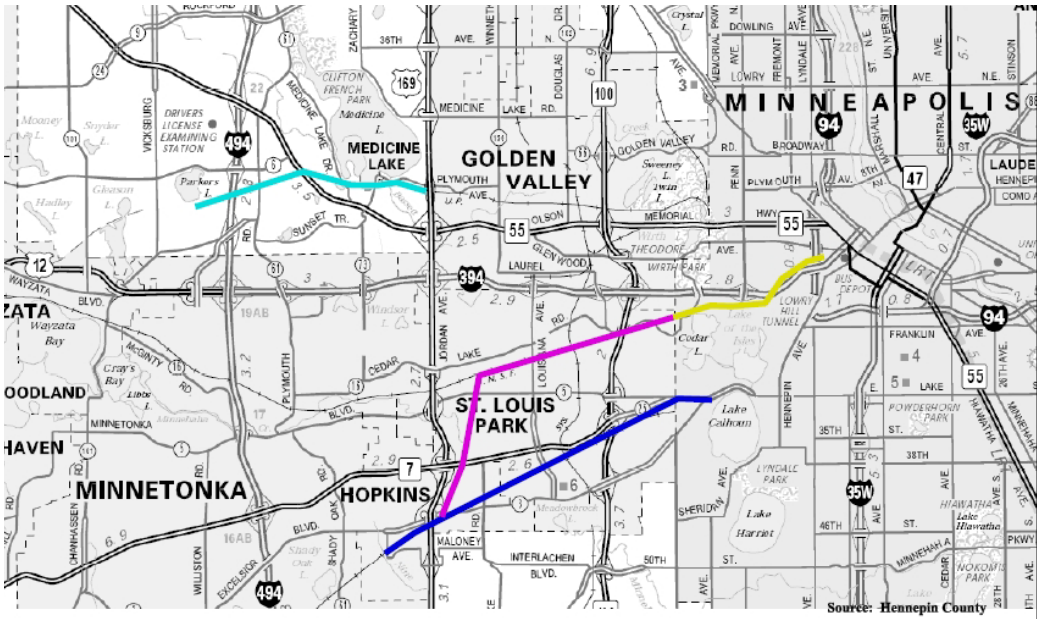


Figure 3.3 – Commuter Bicycle Network



3.2 Corridor Stakeholders

The ICM stakeholders for the I-394 corridor are listed in Table 3.2. All of these stakeholders were involved to some extent in the development of this Concept of Operations. Figure 3.4 indicates those stakeholders with operational and management responsibilities for the arterial and freeway networks.

Table 3.2 I-394 ICM Corridor Stakeholders

• Minnesota Department of Transportation • Mn/DOT Office of Transit • Mn/DOT Office of Transit Bicycle and Pedestrians • Mn/DOT Office of Freight • MnPASS Phase 2 Intiative Team • Metropolitan Council • Hennepin County Emergency (police & fire) Dispatch and responders • Hennepin County traffic management	• City of Minneapolis Emergency (police & fire) Dispatch and responders • City of Minneapolis Traffc Management • Metro Transit • Plymouth Metrolink (transit) • SouthWest Transit • Minnesota State Patrol • Hennepin County Dispatch • Additional local Police/Fire Departments • FHWA

Other agencies with operational responsibilities (not shown in Table 3.2 or Figure 3.4) include the following:

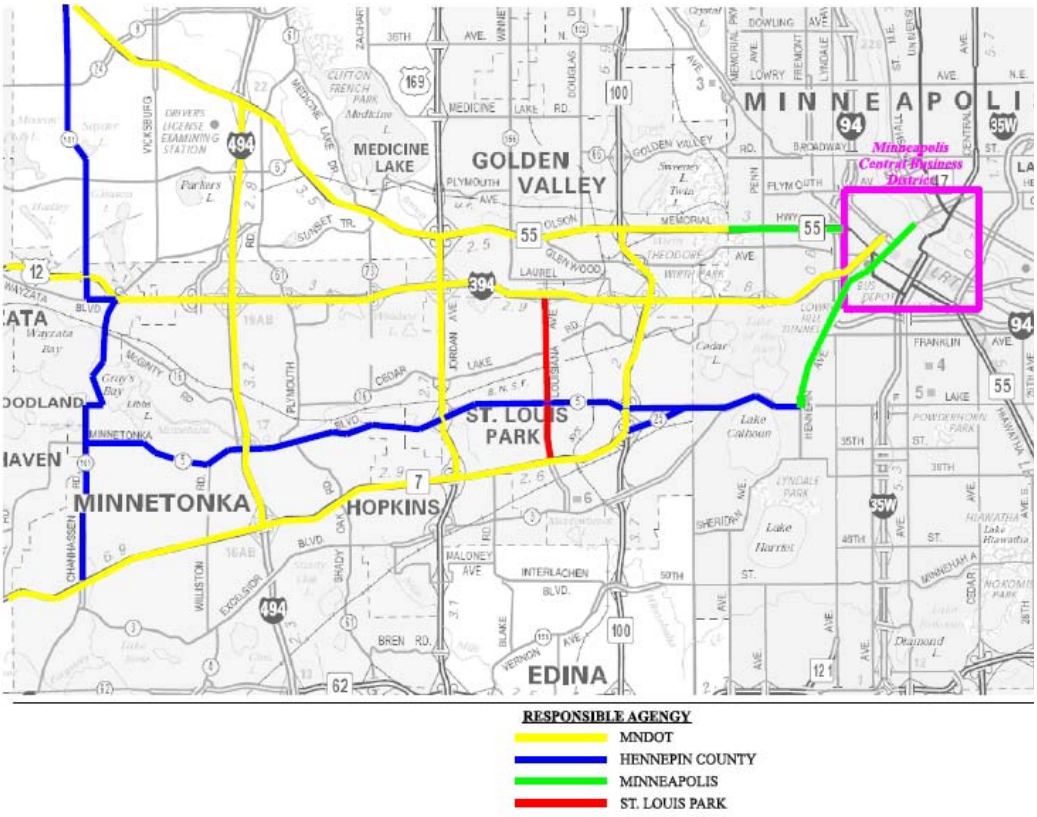
- Minnesota State Patrol – Enforcement, security, and accident investigation on the freeway

- Hennepin County Sheriff's Office – Enforcement, security, and accident investigation on Hennepin County arterials, including TH 55 and TH 7

- Local Police Departments (Golden Valley, St. Louis Park, Hopkins, Plymouth, and Minnetonka) – Enforcement, security, and accident investigation on arterials and other local streets (cross-connections).

- Emergency Services – Fire and ambulance services and HAZMAT for all networks.

Figure 3.4 – Operational Responsibility



3.3 Operational Conditions of the I-394 Corridor and Included Networks

The I-394 corridor directly serves the residents of Minneapolis and its western suburbs, including St. Louis Park, Hopkins, Golden Valley, Minnetonka, Plymouth, Wayzata, and the outlying communities of the Twin Cities western metropolitan area. The roadway network supports commuters who work in the CBD of Minneapolis and significant metropolitan "edge area" development nodes located at major crossroads along the corridor. During off-peak evening hours and on the weekends, this corridor also serves as a major connection to and from entertainment events held in downtown Minneapolis including theatres, bars and restaurants. Downtown Minneapolis is also home to the Minnesota Vikings football team, Minnesota Timberwolves basketball team, and Minnesota Twins baseball team.

The corridor currently supports a mixture of travel modes on its freeways and arterials. Some of these modes include:

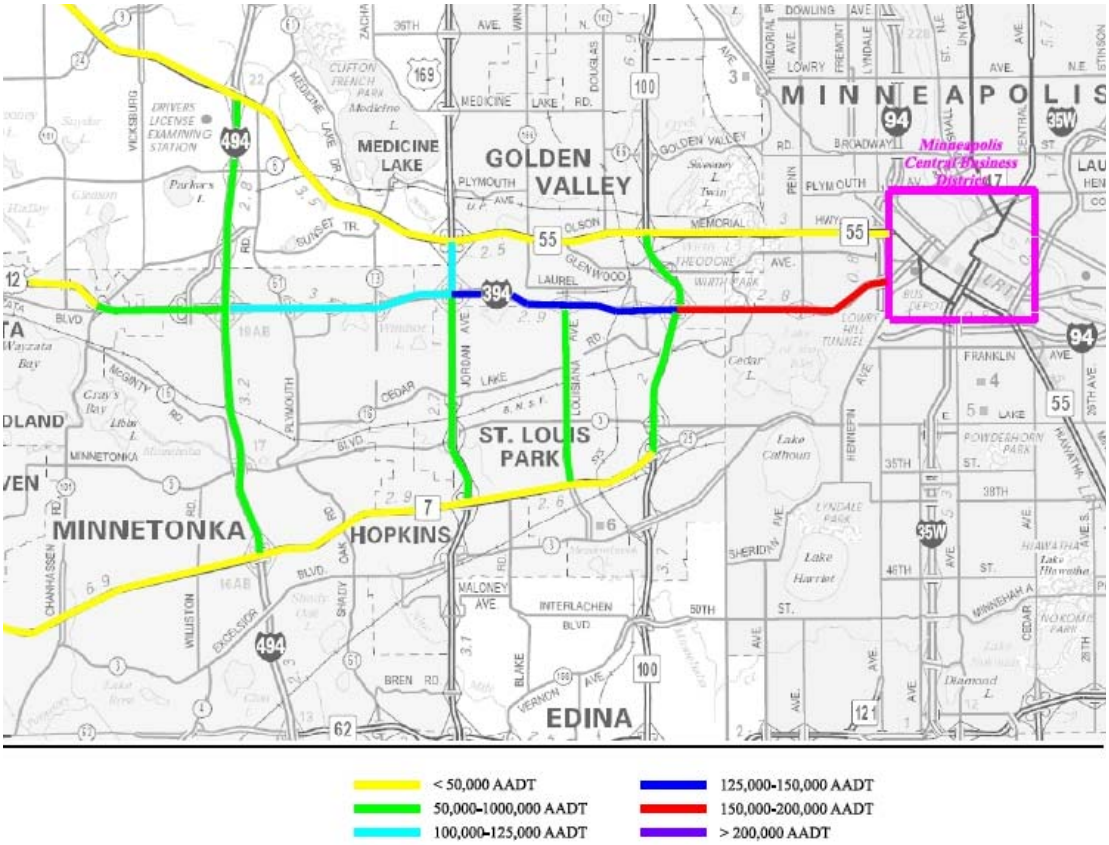
- MnPass HOT/HOV lanes
- Local and express bus service with bus shoulder operations

The corridor also has features that allow for various types of transportation:

- Park-and-ride facilities
- Major transit hubs
- Complex of parking garages located at I-394's terminus in downtown Minneapolis with a capacity for more than 6,000 vehicles.
- Commuter bicycle facilities

The corridor receives a large volume of traffic on its major thoroughfares. I-394 receives the most traffic with an average annual daily traffic (AADT) of 151,000 vehicles near the CBD and 100,000 at its western terminus. The AADT on TH 12 ranges from 79,000 to 21,000, east to west. TH 55 and TH 7 receive and AADT between 21,500 and 50,000 vehicles on their routes through the corridor. I-494, US TH 169 and TH 100 each have an AADT of nearly 100,000 through the corridor. The daily traffic volumes for the key roadways in the study area are shown in Figure 3.5.

Figure 3.5 Daily Traffic Volumes



Volume/Capacity Relationships along Arterial Routes

In addition to the AADT, another important consideration for the corridor is the ratio of the volume (demand) and the available capacity. If the volume to capacity ratio is too high, then the impacts of even the most minor events (e.g. lane merges, aggressive driving, inattentive driving) can cause operational problems and result in significant delays.

Table 3.3 presents the average volume to capacity ratios along the corridor for both the AM and PM peaks.

Table 3.3 Volume / Capacity Ratios for Current Conditions along Primary Arterials

ICM Route	Average AM Peak V/C	Average PM Peak V/C
Hwy 55	***91.75%***	***93.78%***
Hwy 7	***98.29%***	***96.67%***

Variations in Travel Time Impacting the Peak Periods

From Mn/DOT's 2006 Congestion Report, over 6.5 miles of I-394 is congested (below LOS D and less than 45 mph) every day. The morning peak period typically experiences at least two hours of this congestion level each day. The evening peak typically experiences one to two hours of this congestion level. What further complicates the evening peak period is the growing amount of reverse commute (traffic heading eastbound into the metro region) during the evening hours. The most severe peaks occur in the evening hours from 3:00 pm to 6:00 pm for westbound travelers and during the morning rush between 6:00 am to 9:00 am for eastbound travelers.

Figure 3.6 presents the average travel times (averaged over a month) for the westbound direction of I-394. The large variation in travel times away from the median travel times, illustrates the vulnerability of this corridor (and the high v/c ratio) to result in longer than normal travel times. Figure 3.7 presents the average travel times (averaged over a month) for the eastbound direction of I-394.

Please note that Figure 3.7 highlights that the eastbound (inbound) direction actually has an AM and PM peak in that direction, with variations to the maximum travel times being as large as the morning peak.

Figure 3.6 Illustration of the Range of Westbound I-394 Travel Times

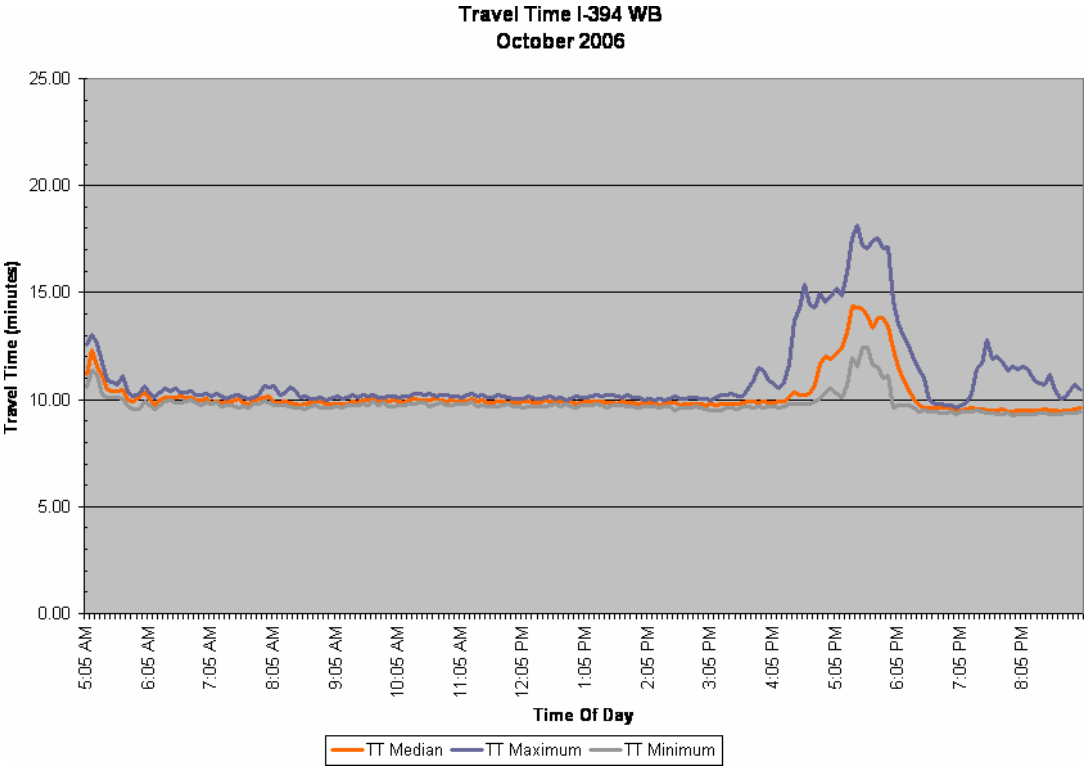
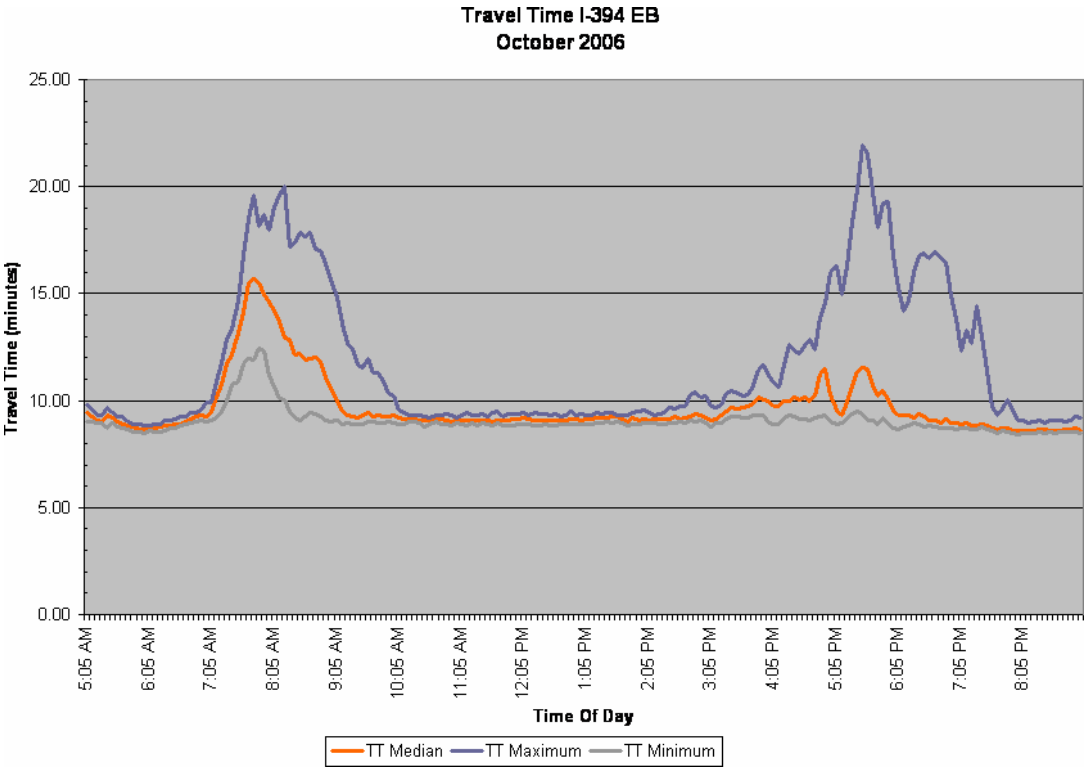


Figure 3.7 Illustration of the Range of Eastbound I-394 Travel Times



Traffic is heaviest westbound on I-394 during the pm peak hours. Specific bottlenecks include:

- I-394 exits at TH 169, TH 100 and I-494/Carlson Parkway C-D
- I-394 right lane between the I-494/Carlson Parkway C-D entrance and CR 15/101

During the am peak hours of 6:00 am to 9:00 am, the eastbound lanes of I-394 become heavily congested and drop well below level of service D, especially between TH 169 and the Minneapolis CBD. Bottlenecks include:

- TH 12 at CR 15 after TH 12 expansion
- I-394 at CR 15/101 entrance ramp area
- I-394 at CR 61
- I-394 at TH 169/General Mills Boulevard
- I-394 at I-94

Other roadways within the study area that experience significant congestion include:

- TH 100 between TH 7 and Cedar Lake Road
- TH 55 just east of TH 169

Specific corridor constraints are listed below.

Freeways

Congestion occurs on a daily basis at several bottlenecks due to physical constraints. These constraints include:

- The Lowry Tunnel along I-94 near the eastern terminus of I-394;
- The I-394/TH 100 interchange; and
- The I-394/I-494 interchange.

HOV/HOT Lanes

From the *I-394 HOV Report (Mn/DOT 2006 – 3rd Quarter)*, the following is a summary of vehicles and people moved during the peak hours at Penn Avenue:

- AM Peak Eastbound (3 General Lanes, 2 HOV/HOT lanes)
  - Vehicles – 7267 Total, 24% in HOV/HOT Lanes
  - People – 10,506 Total, 47% in HOV/HOT Lanes
- PM Peak Westbound (3 General Lanes, 2 HOV/HOT lanes)
  - Vehicles – 7542, 22% in HOV/HOT Lanes
  - People – 10,443, 41% in HOV/HOT Lanes

Signalized Arterials

TH 55 operates at an average pm peak period speed of 25-30 mph, and Mn/DOT's Traffic Signal Congestion Level Map (2004) shows heavy to extreme congestion during the peak periods. TH 7 operates at an average peak period speed of 35-40 mph. The Traffic Signal Congestion Level Map shows light congestion during the peak periods. A summary of average speeds on I-394, TH 55, and TH 7 is illustrated in Table 3.4.

Table 3.4 – Average Speed Summary – Arterials and Freeways

Route	Location	Type	Average Speed (mph)			
			AM Peak Hour (Eastbound)		*PM Peak Hour (Westbound)*	
			I-494 to TH 100	TH 100 to I-94	I-94 to TH 100	TH 100 to I-494
I-394	Central	Freeway	44	41	41	44
TH 55	Northern	Signalized Arterial	35	34	27	28
TH 7	Southern	Signalized Arterial	40	N/A[1]	N/A[1]	38

[1]TH 7 terminates at TH 100. CR 25 continues east of TH 100 and connects with Hennepin Avenue, Nicollet Avenue and I-94, all major routes into the Minneapolis CBD

* Speed limits along Hwy 55 are 55 MPH from I-494 to TH 100, 50 MPH from TH 100 to the city of Minneapolis boundary, 40 MPH from the city boundary to I-94

** Speed limits along Hwy 7 are 45 MPH from I-494 to TH 100, 35 MPH from TH 100 to I-94

Constraints on the Hennepin County roadway system include lack of left turn lanes along some corridors, minimal shoulders in some areas, some offset intersections, and some horizontal curves that require truck restrictions and 15 MPH advisory speeds.

The Hennepin Avenue corridor south of downtown Minneapolis has significant congestion that affects its ability to carry vehicular and transit vehicles. Hennepin Avenue is a four lane arterial running from Lake Street on the southeast end of the study area through the CBD. It has commercial development along the entire length and there is a substantial demand for on street parking. Left turn movements are prohibited at a number of signalized intersections in this corridor.

Signal System Constraints

The arterial system is also impacted by signal system constraints. These include difficulties coordinating due to geometrics, turning movements, offset intersections, recent construction, and increasing traffic volumes. Split phasing is required in some areas due to lack of left turn lanes, causing coordination challenges. The signal control along the Hennepin Avenue corridor south of downtown Minneapolis does not in general provide left turn phases and does not provide left turn bays. Also, there is currently, no coordination with the City of Minneapolis for traffic entering or leaving the City's signal system.

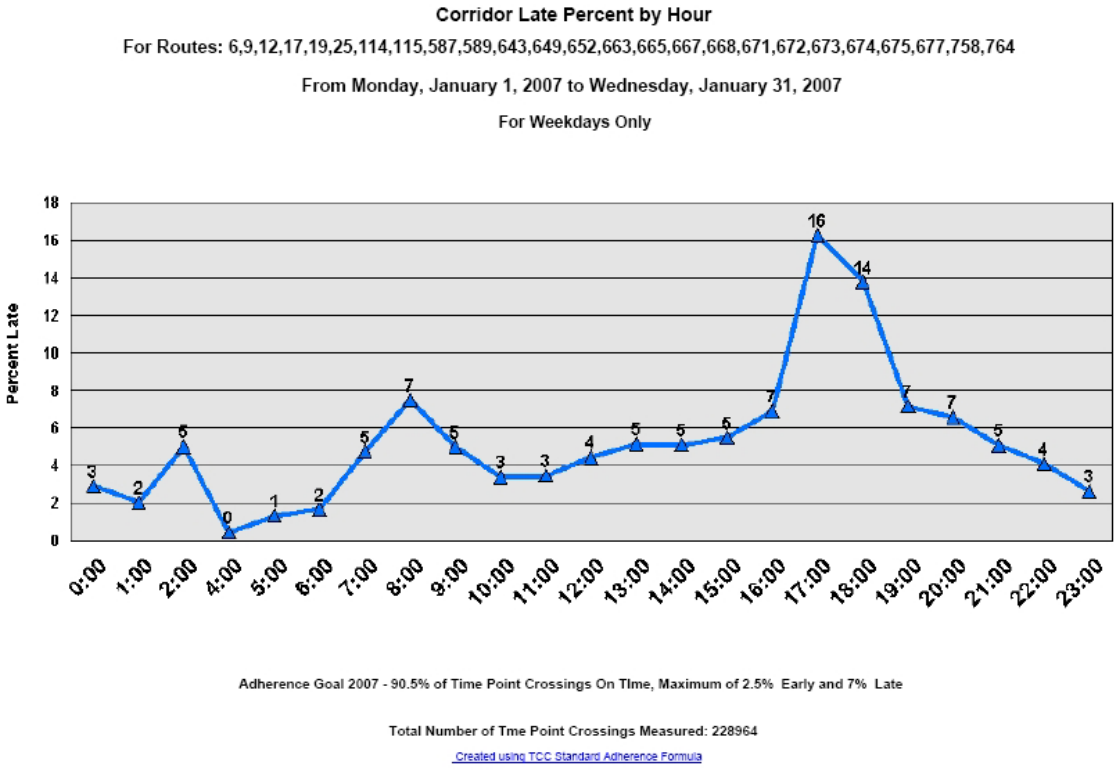
Transit Operations

Much of the transit demand in the I-394 corridor comes from weekday commuters seeking an alternative to driving to work in downtown Minneapolis. Due to the realities of providing transit service in less densely populated areas, such as the western suburbs of the Twin Cities, many of these riders drive to transit centers or park-and-ride lots located in the I-394 corridor. Both of the park-and-ride lots along I-394 currently are operating beyond capacity. Transit does have a few alternatives to the congestion, such as, the HOV lane and driving on the shoulder when travel speeds drop below 30 mph when they are operating in the off-peak direction of travel. Outside of I-394, the transit system experiences congestion along Hennepin Avenue in Minneapolis, with frequent service operating in this corridor.

On average, Metro Transit express routes through the corridor average 14% late, while local routes average 5% late. Routes that have at least part of their trip on I-394 tend to experience more delays, running an average of 22-26% late.

Corridor wide, including both express and local routes, transit schedule adherence varies significantly by time of day. In the PM peak, all routes average 14-16% late, while at most other times, the schedule adherence is much better, averaging 3-5% late. Figure 3.8 illustrates the schedule adherence for all Metro Transit buses in the corridor on an hour by hour basis.

Figure 3.8 Corridor Late Percentages



Park and Ride Lots

Many of the transit riders drive to transit centers or park-and-ride lots located in the I-394 corridor. All but one of the park-and-ride lots along I-394 currently are operating beyond capacity. Therefore during many scenarios, park-and-ride lots fill and potential transit riders must either seek other lots or continue driving to their destination.

A,B,C (ABC) Garages

The ABC garages are located on the western edge of downtown at the terminus of I-394. The following bullets summarize the usage in 2006.

- 6755 – I-394 ABC Garage Capacity
- 3515 – Total Monthly Contracts
- 1121 – I-394 HOV Monthly Contracts (Down from 2162 in 2002)

Non-recurrent congestion

The main cause of non-recurrent congestion on the corridor is caused by traffic incidents, special events, summer, and holiday weekend travel. These congestion events have a significant impact on the metro area's freeway system. Managing these events is a significant focus of the Mn/DOT and the Minnesota State Patrol. In Minnesota, weather events cause a significant amount of non-recurrent congestion. Snow storms during the October-April winter season can be a major cause of congestion.

Figure 3.9 illustrates the location of major issues within the study corridor.

Figure 3.9 Congestion Points

3.4 Existing Network-Based Transportation Management/ITS Assets

The local stakeholder agencies operate a number of networks and systems that are used to operate and manage the transportation systems throughout the corridor. Table 3.5 summarizes the current ITS systems and assets operated by these agencies that may form the basis for ICM implementation.

Table 3.5 Existing Network-Based ITS Systems and Assets

Network	Assets
Regional Transportation Management Center	• **Regional Traffic Management Center (RTMC):** Housing State DOT freeway management staff, Freeway Incident Response Safety Team (FIRST) dispatch, DOT maintenance dispatch, State Patrol metro area dispatch, and KBEM metro area FM radio traffic reporting. Staffed 5:30am – 8:30pm M-F; 10:00am – 6:00pm Sat; 11:00am – 7:00pm Sun (note: MSP and DOT Maintenance dispatch is 24/7).
Freeway Traffic Management System	• **Freeway traffic management system:** Intelligent Roadway Information System (IRIS) operated at the RTMC communicates and controls loop detector data, DMS, ramp meters, and incident reports manually entered through the condition reporting system. • **Loop Detector Stations:** Approximately 4,000 loops on the freeway system, reporting data to IRIS system, with loop spacing approximately every half mile. • **Ramp Meter System:** All freeway ramps in the corridor area are metered using time of day/day of week timing together with traffic responsive timing strategies. Ramp metering rates can be manually over-ridden and are controlled through the IRIS system. • **HOV/Transit Bypass Ramps:** All freeway ramps in the corridor offer bypass lanes/ramps for HOV and transit use, essentially avoiding the ramp meters and increasing the actual benefits to transit. • **Dynamic Message Signs:** Four DMS are located along the eastbound side and two along the westbound side of I-394. Additional DMS along freeways and arterials, including five DMS signs along US 169 displaying travel time messages during morning and evening peak periods, but not total coverage of all intersections. DMS are controlled by IRIS using NTCIP exchanges.

Network	Assets
	• **Closed Circuit Television Cameras (CCTV)**: Seventeen PTZ CCTV units along I-394 transmit video images back to the RTMC. Limited coverage of arterials is currently available. • **Freeway Incident Response Safety Team (FIRST) Program:** The FIRST program provides quick response and removal of incidents and stalled vehicles. • **HOV/HOT Lane:** A HOV/HOT lane provides congestion relief to drivers along I-394 from its beginning at I-494 to its terminus in downtown Minneapolis. Pricing varies depending upon the volume and occupancy values of the HOV/HOT lane. One third of the HOV/HOT lane is a reversible lane (offering 2 lanes of travel in the selected direction). Hours of operation for the reversible lane are EB 5:00am – 1:00pm, WB 2:00pm – 4:00am
Arterial Traffic Management Systems	• Mn/DOT operates and maintains traffic signals along Hwy 7 and Hwy 55. Signal operations are adaptive and real-time timing plan changes may be downloaded from the RTMC. • Hennepin County operates and maintains traffic signals along County Roads. Signal timing is performed at the County offices located in Medina, Minnesota. Real-time timing changes are possible, but require dial-up connections to signals, and typically are not performed without visual verification. • City of Minneapolis operates and maintains those signals that are within city limits on city streets. These include a few intersections within the I-394 corridor, however these signals are at the Eastern-most end of the corridor and therefore have a significant impact on the flow and delays along the corridor.
Variable Tolling / Pricing	• I-394 from I-494 to the downtown area offers an HOV/HOT lane. Variable pricing is automatically set, based on the traffic volume in the HOT lane.
Transit Management	• Metro Transit operates the Transit Control Center (TCC), with a complete CAD/AVL system, including voice communication called "SMARTCoM" (St. Paul / Minneapolis Advanced Regional Transit Communication Management system). • On-line Transit Trip Planner (does not currently have real-

Network	Assets
	time schedule adherence information, however this option is planned for late 2007 or early 2008). • TransitLine IVR Phone system allows callers to get route and schedule information. Current project is underway to interface this system with the CAD/AVL system in order to deliver real-time estimated bus arrivals. • 100 buses have automated passenger counters installed.
Emergency Response Dispatch Centers	• Minnesota State Patrol (MSP) answers cellular 911 calls, dispatching law enforcement and medical responses to crashes and other incidents on freeways throughout the corridor. MSP dispatchers are co-located in the RTMC and enter incidents into a Computer Aided Dispatch (CAD) system. RTMC operators have a 'view only' terminal to access current CAD events and there is a planned interface from the MSP CAD system to the RTMC condition reporting system. Onstar ® crashes with air bag deployments are automatically relayed to the RTMC condition reporting system. • Hennepin County emergency dispatchers dispatch law enforcement and medical response to incidents on the majority of major arterials throughout the corridor. Hennepin County is in the process of replacing their existing CAD system. • City of Minneapolis emergency dispatchers dispatch law enforcement and medical response to the streets operated by City of Minneapolis. The City of Minneapolis is in the process of replacing their CAD system. • 800 Mhz Radio. An 800 Mhz radio system operates throughout the corridor. There exists an Inter-system ('Intersys') talk channel that is restricted to law enforcement only activities.

3.5 Proposed Near-term Network Improvements

The Metropolitan Transportation Improvement Plan provides the roadmap for planned expansions and improvements in the Twin Cities over the coming 10 years. There are currently no plans for major construction or additions to the roadway network throughout the I-394 Corridor. The ICM Stakeholders view this as an opportune time to conduct a trial of an ICM approach in the corridor and to benefit from a situation where modeling, deployment, and evaluation can all occur with the lack of any major construction or physical additions to the corridor.

However, a number of technology-based improvements are planned or underway throughout the corridor that would extend the benefits of ICM once implemented. Many of these would be completed prior to the scheduled USDOT ICM deployment timeframe and are therefore described in this section. These include the following:

Freeway – Mn/DOT

- Increased deployment of travel time reporting on existing DMS signs (increasing the coverage of the I-394 Corridor). Currently none of the six DMS signs along I-394 display travel time messages at any time. This deployment would be an extension of the Mn/DOT developed software that currently disseminates travel times on DMS. This could be implemented without additional hardware changes and could be completed in January 2008.

- A transit advantages study is being led by Mn/DOT in partnership with Metro Transit to explore options for granting transit vehicles additional advantages along the corridor. These upgrades would most likely be long term infrastructure based enhancements. Therefore, these enhancements are not needed to complete the ICM, but rather are mentioned here to describe the ongoing collaboration along the corridor.

Transit Network – Metro Transit Authority

- Integration of real-time schedule adherence monitoring with the interactive voice telephone system is planned for 2007;

- An interface between the schedule adherence portion of the AVL system and the on-line transit trip planner (offering real-time transit departure/arrival information on the trip planner) will be completed in early 2008;

- An enhancement to the real-time telephone system operated by Metro Transit to allow callers to request a route and time stamp and receive departure alerts is now being developed and will be installed by the close of 2008.

Arterial Traffic Signal Controllers – Hennepin County

- Mn/DOT and Hennepin County have agreed to jointly fund upgrades to a limited set of signal controllers and coordinated signal timings to support the interfaces of primary arterials and freeways, with completion in 2008. This public-public partnership is a further recognition of the benefits of integration among the state and local governments. These upgrades are not a requirement for the ICM strategies and scenarios, however the partnering to deploy these upgrades is a direct result of relationships developed through ICM. The funding is now being finalized and the completion is expected in 2008.

Arterial Traffic Signal Controllers – City of Minneapolis

- The City of Minneapolis is in the early stages of planning next generation traffic signal master control software to control their network of signalized intersections. Funding is currently available and the solicitation process is beginning. The current plan for deployment is 2009. The deployment of the ICM strategies ***does not*** rely on this upgrade to the system, however the strategies and approaches to traffic management in Minneapolis will be enhanced by this upgraded system. The upgrade to the signal control system is planned to be completed in 2008.

Light Rail Transit Deployments

A Light Rail Transit (LRT) line is being strongly considered for the South border of the corridor. This line would likely not be completed within the next 10 years, however would have an impact on the long term ICM aspects of this project.

3.6 Current Network-based Institutional Characteristics

The institutional structure supporting the I-394 Corridor and surrounding metropolitan area is multi-agency, multi-functional, multi-modal, and based on a tradition of cooperation and collaboration. Decision making authority is dispersed among Mn/DOT, Hennepin County, the City of Minneapolis, Metro Transit Authority, and local law enforcement agencies. In addition, the FHWA and FTA play critical roles in the development and planning of transportation efforts.

The management and operations of various transportation systems (especially technology related systems) have been integrated to the extent possible through typically individually funded projects. As a result, the structure of the corridor is not a 'stove-pipe' scenario, but rather a series of individual systems that play roles in overall system operation. While the systems are not entirely 'stovepipe', there is a need for increased operational interaction. Some examples of these institutional integrations that will work well to support the ICM concept along I-394 are summarized as follows:

- The ***Minnesota Guidestar*** Program has existed since the early 1990s, and provides for statewide decision making and direction on the deployment and operation of ITS throughout Minnesota. The Minnesota Guidestar Program has already demonstrated projects where multiple agencies cooperate on the design, deployment and operation of ITS projects.

- ***Inter-agency payment agreements*** already exist at a basic level along the corridor. Mn/DOT owns a series of parking garages at one end of the corridor that are operated by the City of Minneapolis. All excess revenue generated from the garages must be spent along the I-394 Corridor. The excess funds from the HOT lane that was implemented in 2005 must be spent on transit related initiatives along the same corridor. The cooperation of Mn/DOT, City of Minneapolis, the parking facility, and transit already exists and will provide a solid basis for ICM strategies that plan to achieve integrated fare payments.

- ***Law enforcement and transportation interactions*** are facilitated by the fact that Mn/DOT and the Minnesota State Patrol have an existing Memorandum of Agreement signed and operational that solidifies the commitment of both parties to cooperate openly on ITS projects. This agreement will enable inter-agency strategies to be executed with minimal institutional challenges.

- Mn/DOT is leading ongoing consideration for ***transit advantages within the I-394 Corridor*** through a recently launched feasibility study that is examining ways in which the movement of transit along the corridor can be enhanced through physical or technological improvements. Metro Transit is actively partnering with Mn/DOT on this effort.

- ***Regarding major tourist attractions***, the City of Minneapolis, Mn/DOT and Hennepin County are collectively interfacing with the private agencies involved in

the development of the new professional baseball stadium that will be located at the East end of the corridor.

- The law enforcement, transportation management, and maintenance groups within each agency operate ***an Incident Command Structure*** for incident management on freeways and major arterials. Mn/DOT is leading an effort to expand incident operational protocols for evacuation procedures.

- Regarding the ICM initiative specifically**,** Mn/DOT has taken the lead in establishing ***an I-394 ICM Steering Committee***, involving management level decision makers from Mn/DOT, Hennepin County, City of Minneapolis, and Metro Transit. The role of the Steering Committee is high level direction and decision making.

- To actively work through technical and institutional topics**,** Mn/DOT has formed ***an I-394 ICM Working Group*** to actively engage all stakeholders and develop the ICM vision, approaches and strategies. The Working Group also involves Mn/DOT, Hennepin County, City of Minneapolis, and Metro Transit.

- ***Mn/DOT led the development of the Metropolitan area ITS Architecture,*** with active input from the city, county, Metro Transit, and FHWA.

3.7 Regional ITS Architecture Review

The I-394 Corridor is just one of many important corridors in the Minneapolis-St. Paul Region, and the current ITS Architecture exists for the entire metropolitan region. Therefore, the ICM systems engineering development will seek full compliance with the Regional ITS Architecture, as it will serve as a subset of it. This section reviews the Regional ITS Architecture in which the I-394 ICM initiative will function.

The Regional ITS Architecture for the Metro Area in Minnesota was developed under a Statewide Architecture completed in December 2001. No updates have been made to the Statewide Architecture since that time. This time lapse means that the System Inventory may not include all current items. Additionally, the National ITS Architecture has added more Market Packages since that time, basically with a new group of Market Packages called Maintenance and Construction Management which are very relevant to the ICMS.

The Regional ITS Architecture makes references to an inter-jurisdictional traffic system, which is a very important element to the I-394 ICM concept. It further references that the Metro TMC system capabilities are an example of such a system. It also identifies that the City of Minneapolis Signal Center may serve as a place for such a system. There are no further details as to how this can or will operate, beyond identifying system interconnects and information exchanges.

System interconnects and information exchanges are identified for some of the major ICMS stakeholders: the Metro TMC, City of Minneapolis, Metro Transit Management

Center, and State Patrol Dispatch Centers. Additionally, more generic named stakeholders are identified with system interconnects and information exchanges (i.e. event promoters, national weather service, traveler information service).

Descriptions of applicable Market Packages are provided, which serve as Concepts of Operations in many regional ITS architectures, but each is very general.

In summary, the Regional ITS Architecture provides a general framework from which to develop the ICMS ITS Architecture. The lacks of more specific details allows the ICMS program to identify additional Market Packages, system interconnects, and information exchanges which will promote the ability to deploy the desired ICMS approach strategies selected by the stakeholders.

3.8 Individual Network and Corridor Problems, Issues and Needs

3.8.1 I-394 Corridor Operational Problems

Previous sections of this document have identified operational conditions throughout the I-394 Corridor area. When the I-394 ICM Stakeholders convened initially, a number of operational deficiencies were discussed in order to gain an understanding of the needs of the corridor and, ultimately, the role ICM might play throughout the corridor to address very specific needs. The following summaries describe the problems within each individual network.

- The primary East-West commuter route, I-394, operates near capacity during each peak period. Congestion occurs daily within at least two bottleneck areas, and the presence of any incident or inclement weather seriously limits traffic flow through the highway. The HOT lanes have helped increase the utilization of the previously HOV-only lane and reduce the demand on general purpose lanes. However, during incidents and events the demand to capacity ratio for general purpose lanes still results in delays to travelers.

  While the median travel time along I-394 is an acceptable timeframe (even during the peak periods), the maximum travel times (at the 95th percentile) represent that incidents and events cause major spikes in travel times. As a result, the travel along I-394 is best summarized as acceptable during non-incident conditions but in need of improvement during incidents, in order to allow travelers to reach their destination, within a reasonable buffer zone the majority of trips.

- The two parallel arterials offer opportunities to handle some of the excess demand and alleviate I-394 congestions during incidents. However, Hwy 55 operates at an average speed of 25-30 MPH during the PM peak period, and Hwy 7 operates at an average speed of 35-40 MPH during the peak periods.

- The transit service along the I-394 Corridor offers convenient service through a combination of express and local bus routes. The corridor is widely covered by park-and-ride facilities; however these facilities are all at or near capacity. As a result, travelers exiting the freeway to make use of the park-and-ride lots are often turned away due to lack of parking spaces. Additional park-and-ride lots are under construction and still more in planning, however informing travelers about which lot has parking and which is congested is not currently performed.

- Incident response and reporting is performed by a combination of the State Patrol, County and City dispatchers. State Patrol dispatchers answer and manage incidents on the freeway system. Hennepin County 911 answers calls and responds on the state and county maintained primary arterials, and the City of Minneapolis answers calls and responds to emergencies on local roads throughout Minneapolis. Currently, the only formal interagency information sharing is that between the State Patrol and Mn/DOT, who are co-located in the RTMC. As a result, Mn/DOT and State Patrol are not typically aware of incidents on the arterial streets until such time that the backups impact the freeways.

- Bus service is enhanced by agreements that permit buses to drive on shoulders when general purpose lane travel speeds are low. While this greatly improves the efficiency of buses, incidents where vehicles block the shoulder or other blockages detracts from the advantages and currently there is no formal process for informing transit dispatchers of such shoulder problems. This is particularly critical for SouthWest Transit, who drives through the corridor without any local stops, and therefore may select any route. Advance notice of not only freeway status but shoulder status would greatly support their operations.

- Signalized intersections operations suffer from often outdated equipment lacking the ability to conveniently adjust timing parameters remotely. While the majority of signals operate adaptive control, the premise of adaptive control is typically not reactionary enough to adjust signals to flush lengthy queues.

- In addition to outdated equipment, arterial operations personnel lack visual verification capabilities at most intersections that would support real-time signal timing changes. Furthermore, while the hundreds of signalized intersections operated throughout the corridor generate volumes of data, there is a lack of efficiently assembled information that can be viewed by operators.

3.8.2 I-394 Corridor Needs

The operational problems presented in 3.8.1 were discussed with the stakeholders of the I-394 Corridor, and the following set of concerns, deficiencies and gaps were compiled, and are summarized (in no specific order) as follows. They will serve as input to the needs definition process:

- Stakeholders agreed there are some gaps in the travel information delivery about existing conditions, incident conditions, the operational status of the multi-modal systems, and options for travel.

- Stakeholders agreed that congestion can be mitigated if they are able to reduce demand on the infrastructure, systems, and services (i.e. highways, transit vehicles, park-n-ride lots, and parking facilities) lacking excess capacity and increase the use of those systems and services with excess capacity.

- Stakeholders agreed that there is a gap in the delivery of travel information at en-route locations and over mediums of communication that is preventing travelers throughout the corridor from receiving information when it is needed and most useful.

- Stakeholders agreed that there is an operational gap in coordination between traffic management operators at the various agencies during normal and incident conditions.

- Stakeholders agreed that there is an operational gap in coordination, communication, and cooperation among emergency (fire and police) services operations teams.

- Stakeholders agreed that there is a gap in the ability to detect and respond to incidents and special events on all roads and networks throughout the corridor.

- Stakeholders agreed that there are system and infrastructure reliability gaps that should be corrected to maintain corridor-wide movement of people and goods.

- Stakeholders agreed that the special event traffic along the corridor places unique constraints on the system and that there are gaps in the information and options presented to travelers, that if, addressed could improve the network operations.

- Stakeholders agreed that the traffic flow along the corridor can be improved, especially during incident conditions to maintain travel flow as close to normal conditions as possible.

Section 1.4.1 presented a table relating these concerns to problems and ultimately needs. The intent is that these needs will be satisfied through the operation of the ICMS.

3.9 Potential for ICM in the I-394 Corridor

The I-394 Corridor consists of independent networks:

- An East-West mainline freeway commuter route (general purpose lanes, HOV lanes, and HOT lanes);
- An East-West arterial (Hwy 55);
- An East-West arterial (Hwy 7);
- Three parallel freeway connector routes (I-494, Hwy 169, Hwy 100);
- Transit service offered by Metro Transit and Plymouth Transit;
- Transit throughput use by SouthWest Transit (delivering commuters to downtown from outside the corridor area); and
- A network of commuter bicycle routes.

The three East-West commuter routes serving the corridor operate at or near capacity during peak periods. Small incidents, inclement weather or other operational breakdowns create major delays during peak periods. The alternate routes, and efficient freeway access between routes, creates an ideal scenario for diversion strategies.

The connectors running North-South through the corridor offer efficient movement between the alternate East-West routes. However, these highways are heavily traveled highways with considerable through traffic of their own operating at near capacity. For travelers wishing to move from one East-West route to another, selecting the appropriate connector is critical to keeping an on-time trip.

Travelers throughout the corridor are fortunate to be served by Metro Transit and Plymouth Metrolink. Metro Transit operates a very sophisticated transit control center monitoring the progress of buses using a CAD/AVL system with schedule adherence calculation capabilities and route arrival/departure reporting capabilities. While the current on-time performance rating is acceptable, transit commutes often add time to the commute and are, therefore, sometimes perceived to be less attractive than single occupant vehicles. There is potential on the corridor for transit priority (e.g. signal priority, queue jumping) to demonstrate both real and perceived benefits of transit rider ship, and therefore instigate more modal shifts. There is a tremendous network of park-and-ride facilities, each nearly at or above capacity. Therefore, information to help travelers know if the park-and-ride facility offers an option for them would be a tremendous assistance to the corridor.

In addition to the transit service offered to residents of the corridor, SouthWest Transit operates a commuter bus service that originates outside the corridor and travels through the corridor to reach the downtown area. Therefore, the SouthWest Transit buses are not tied to any pickups or drop-offs and have full route flexibility. With the flexibility of driving on freeway shoulders, these buses often avoid lengthy delays during congested

conditions. However, stalls or other incidents in the shoulder prevent the advantages of shoulder driving and shared information would assist the SW Transit operations greatly.

The incident management situation on the corridor is performed by a combination of state, county, and city 911 dispatchers responsible for answering cellular 911 calls and dispatching response vehicles. Again, significant opportunities for integrated service have been identified. Ultimately, the corridor stakeholders envision automated data exchanges relaying CAD incident event data to the RTMC for consideration during traffic management and travel information delivery. In the near term, corridor stakeholders have already begun the process of utilizing an existing talk channel to openly communicate events on arterial streets to the RTMC.

Finally, the I-394 Corridor area is very bicycle commuter friendly, with a number of trails into the downtown. In addition, all buses operate with bicycle maps. In the near term, the ICM initiative will publish joint bus/bicycle maps, allowing commuters to pre-plan multi-modal commutes that avoid single occupant vehicles altogether.

In summary, the Western suburbs supported by the I-394 Corridor represent a rapidly growing portion of the Twin Cities metropolitan area. The capacity demand relationship is conducive to operational breakdowns across all networks. The infrastructure of HOT lanes, plentiful park-and-ride facilities, parallel routes and freeway connectors; as well as very sophisticated transit control center and RTMC presents, an ideal situation for integrated corridor management to benefit the stakeholders and travelers throughout the corridor.

3.10 I-394 Corridor Vision

In the future, travelers of the I-394 Corridor will be knowledgeable about the options and real-time conditions of the various routes and modes of travel throughout the corridor. Through various public and private travel information outlets, travelers will understand, in real-time, the situations facing each mode or route option prior to their trip departure, as well as the likely impacts of these situations. Once a mode and route have been selected, travelers will experience a trip that is reliable, safe, and efficient. When planned or unplanned situations arise that may delay or endanger travel, a variety of resources (both automated and human) will cooperate to manage traffic and deliver information such that each drivers' experience is as close as possible to the expectations that led the traveler to select the chosen mode and route. As a result, travelers throughout the I-394 Corridor will experience trips that match their expectations, reducing frustration, rushed driving, and general confusion.

It is envisioned that the I-394 Integrated Corridor Management approach will eventually be one of 4-5 ICM approaches that exist independently but work collectively to manage traffic and inform travelers throughout the Twin Cities metropolitan area.

4. ICM Operational Concept

4.1 Corridor Goal and Objectives

The Goals and specific objectives of the I-394 ICM Initiative are defined as:

Goal #1: Mobility and Reliability. The I-394 corridor network of agencies, infrastructure, systems and supporting personnel will work together to maintain mobility and reliability of travel on a corridor basis.

Objective 1-1: To reduce the variation in travel times experienced by travelers throughout the corridor.

Objective 1-2: To maintain options for travelers to effectively travel throughout the corridor using personal vehicles, transit or bicycles.

Goal #2: Corridor-wide Capacity Utilization. Any spare capacity throughout the I-394 corridor will be used to the maximum extent possible.

Objective 2-1: To monitor and understand the ever changing available capacity of roadways, transit, parking, park-n-ride, and alternative transportation options throughout the corridor.

Objective 2-2: To encourage pattern changes (either through information sharing or incentives) to better utilize spare capacity.

Goal #3: Corridor Event and Incident Management. There will be only minor impacts of incidents on travel time throughout the corridor; both in the extent of impact and duration, and that incident management will preserve the safety of the travelers throughout the corridor.

Objective 3-1: To inform travelers of incidents, the resulting impacts, and available options in order to encourage route and mode changes.

Objective 3-2: To manage traffic around events through early notification and informed reactions.

Goal #4: Holistic Traveler Information delivery. To provide travelers and transportation professionals with a 'holistic' view of the corridor and its operations through the delivery of timely, accurate, and reliable multi-modal travel information and data exchange.

Objective 4-1: Travelers are aware of their modal and route options, and understand the current conditions facing each option.

Objective 4-2: Travelers do not experience delays without also being informed of options for avoiding or minimizing the impacts of such delays.

4.2 Application of ICM Approaches and Strategies

In order to identify and select the possible ICM approaches and strategies for the I-394 Corridor, a "Corridor Type / ICM Approach and Strategy" analysis was performed based on the guidance and matrices provided by the U.S. DOT that involving the entire set of corridor stakeholders. The findings of this process are summarized as follows:

- The I-394 Corridor is best classified as a 'Roadway with Managed Lanes / Tolling and Transit Utilizing Roadway ROW'.
- Various types and events requiring ICM, including recurring congestion, roadway incident, transit incident, planned event, and emergency (evacuation);
- Each of these types of incidents/events encompasses a wide range of potential durations (both short and long-term) and severities.
- Available spare capacity does exist in the corridor.

Using the ICM screening matrices available from US DOT, an initial list of potential ICM strategies were identified for the I-394 Corridor. The corridor stakeholders then participated in a series of outreach meetings (led by the core team) and a set of Working Group meetings and workshops. The corridor stakeholders discussed and evaluated each of these candidate strategies with respect to their potential effectiveness in achieving the corridor goals and objectives, and the associated operational, technical, and institutional integration issues.

In addition, the corridor stakeholders also identified the following six scenarios that the ICM strategies would need to address on the corridor:

- Daily Operations (recurring congestion);
- Scheduled event – Afternoon baseball game ending during evening peak period;
- Scheduled event – Evening baseball game beginning during evening peak period;
- Freeway incident – Major and minor;
- Evacuation;
- Infrastructure reliability (power outage) on the corridor; and
- Winter weather/storm scenario.

4.2.1 Approaches, Strategies, and Local Applications of ICM

As the ICM stakeholders discussed the possible ICM strategies that might be implemented on the corridor, the stakeholders advanced the ideas of the ICM strategies one step further and discussed specific local 'applications' of the strategies. This was

particularly useful in engaging the operations personnel because they could discuss details of how each strategy would be applied within the corridor. The use of the local applications is summarized as follows:

- The local applications allowed stakeholders to discuss enough specifics of what the ICM strategies would mean to the corridor, that they were able to effectively discuss roles, responsibilities, and impacts;

- The local applications still remain at the 'strategy' level and no specifics about technologies, vendors or details of applications are included as that will come at later stages of the systems engineering process;

- In the process of discussing the I-394 ICM strategies and local applications of those strategies, a number of near-term applications of the ICM strategies were identified. These near-term applications of the ICM strategies include those that do not typically require any additional systems or infrastructure, but may be relationships, reporting procedures or manual activities that could begin almost immediately. As an example of a near-term application of ICM strategy A-1 Manual notification, Hennepin County and Minneapolis 911 dispatchers have committed to reporting crashes that occur on the corridor over the 800 Mhz talk channel that is monitored by the RTMC. While the ultimate vision is the automated data exchange strategy and a CAD-RTMC exchange of all relevant events, this will bring immediate benefits of the RTMC learning about arterial street incidents, and help the agencies learn more about the exchange of incidents for when the eventual automated exchange is built. *Appendix A includes the draft agreement preliminarily agreed to by Mn/DOT, City of Minneapolis, and Hennepin County for manual exchanges of incident information on arterial roads. This 'concept' summary is included in Appendix A to illustrate the nature of the near term applications, and the types of concepts/agreements that will facilitate them.*

  Other near term applications of ICM strategies represent deployment projects already in development, and that will be deployed (as part of separate projects) prior to the completion of the systems engineering process.

Table 4.1 presents the I-394 ICM Approaches, candidate strategies, and the local applications (sub-bullets) considered for each strategy. In each case, the local applications are identified as either 'immediate' (pre-ICM), 'short-term' or 'long-term'. The immediate approaches are those approaches that are being developed through other existing projects or through agreements reached in current meetings. The 'short-term' approaches are those that will be developed as part of the ICM process and are planned to be operational and evaluated within the next five years. The 'long-term' approaches are those that would be deployed beyond the five year time period. The 'short-term' approaches will be the primary focus of the remainder of the systems engineering process. (Note – Table 4.1 is organized by the ICM "approaches" identified in the ICM materials developed by US DOT).

Table 4.1 ICM Approaches, Strategies, and Local Applications Considered for the ICM Corridor

Approach A: Information Sharing and Distribution

- **Manual information sharing**
  - Hennepin Co. and Minneapolis 911 dispatchers notify RTMC of events using shared radio talk groups (Immediate - Summer 2007)
  - Manual notification plan development (Immediate – Summer 2007)
  - Production of integrated bus/bike trail maps, showing where bicyclists can access transit service (short term)
  - Execution and evaluation of manual notification plan (short term)
- **Automated information sharing (real-time data)**
  - Automated State Patrol CAD to RTMC data exchange of incident data (Immediate – Spring 2008)
  - Transit Control Center access to central reporting system (Immediate – Fall 2007)
  - Automated Hennepin County and Minneapolis CAD to RTMC data exchange implementation (Short term)
  - Real-time Park-and-Ride availability monitoring and reporting (Short term)
  - Real-time transit performance (travel times and route delay) reporting (Short term)
- **Automated information sharing (real-time video)**
  - Video Sharing (IP) (Immediate and short term)
- **Information clearing-house / Information Exchange Network between corridor networks / agencies**
  - Use of current existing systems (combination of condition reporting system and IRIS system) (Immediate – Fall 2007)
  - Corridor-wide comprehensive information clearinghouse with graphical display of information reporting on data about the infrastructure status, capacity, demand, and incidents (Short term)
  - Expanded information clearinghouse to include Park-and-Ride availability (short term)
  - Expanded information clearinghouse to include Transit schedule adherence (short term)
  - Expanded information clearinghouse to include travel times for all major routes/modes (estimated or calculated) within the corridor (short term)
- **A corridor-based advanced traveler information system (ATIS) database**

that provides information to travelers pre-trip

- Expanded traveler information systems adding such things as transit delays/schedule adherence (short term)
- Expanded traveler information systems adding parking / park-and-ride availability (short term)
- Expanded traveler information systems adding arterial travel times and presenting travel times on all commute routes (short term)

- **En-route traveler information devices owned / operated by network agencies (e.g., DMS, 511, transit public announcement systems) being used to describe current operational conditions on another network(s) within the corridor**
  - Increased deployment of DMS at key arterial street locations (to inform travelers of conditions on arterial streets or to warn of incidents on freeways) (short term)
  - Increased deployment of ATIS devices in parking garages (short term)
- **A common incident reporting system and asset management (GIS) system**
  - Integration of metro transit control center with CAD reports of incidents (Short term)
- **Access to corridor information (e.g., ATIS Database) by Information Service Providers (ISPs) and other value-added entities.**
  - Private ISPs currently have access to real-time information clearinghouse. This content will be expanded by manual and automated data sharing tactics described above. (short term)

Approach B: Improved Operational Efficiency of Network Junctions and Interfaces

- **Signal priority for transit (e.g. extended green times to buses that are operating behind schedule)**
  - Transit signal priority to give priority to transit vehicles behind scheduled times (short term)
- **Signal pre-emption / "best route" for emergency vehicles**
  - Emergency vehicle preemption exists throughout most of the corridor, and would be extended. (short term)
- **Multi-modal electronic payment**
  - Explore multi-modal payment options with I-394 Transit options study (attempt to combine HOT, parking, and transit payment) (Immediate Fall 2007)
  - HOT, Transit, Parking payment coordination (short term)

- **Transit hub connection protection**
  - Transit connection information display for travelers and drivers. (short term)
- **Multi-agency / multi-network incident response teams / service patrols and training exercises**
  - Explore options for sharing of maintenance equipment (Immediate – Fall 2007)
  - Inter-agency dispatcher meetings to discuss response procedures and understand each others' information (short term)
- **Coordinated operation between ramp meters and arterial traffic signals in close proximity**
  - Active involvement from agency signals group in incident response at the RTMC (Immediate – summer 2007)
  - Increased CCTV coverage at intersections to support real-time signal timing changes (short term)
- **Promote Equipment Reliability** ***(Recommended New ICM Strategy)***
  - Develop specifications for battery backup, communications, and control at signalized intersections (short term)
  - Support battery backup capabilities at key intersections (short term)

Approach C: Accommodate / Promote Cross-Network Route & Modal Shifts

a - Passive Network Shifts ("Inform") – Accommodate any user-determined network shifts that occur in response to the Information Sharing Strategies.

- **Modify arterial signal timing to accommodate traffic shifting from freeway.**
  - Active involvement from each agency's signals group in incident response at the RTMC (short term)
  - Development of special signal timing plans (short term)
- **Modify ramp metering rates to accommodate traffic, including buses, shifting from arterial**
  - Attempt to identify and get approval for special ramp meter parameters (allowable wait time) during major incidents (short term)
  - Ramp metering modifications in response to incidents (short term)
- **Modify transit priority parameters to accommodate more timely bus / light rail service on arterial**
  - Advanced transit priority reflecting severity of incident and corridor-wide traffic conditions.(short term)

b – Promote Network Shifts ("Instruct")

- **Promote route shifts between roadways via en-route traveler information devices (e.g. DMS, HAR, "511") advising motorists of congestion ahead, directing them to adjacent freeways / arterials**
    - Information dissemination expanded to include travel times of alternate routes/modes; and locations of incidents (short term)
    - Alternate signal timings (network/corridor-wide) during major weather events (short term)
- **Promote modal shifts from roadways to transit via en-route traveler information devices (e.g. DMS, HAR, "511") advising motorists of congestion ahead, directing them to high-capacity transit networks and providing real-time information on the number of parking spaces available in the park and ride facility**
    - Use of 511, web and pushed alerts of transit parking availability and travel times of transit vehicles (short term)
    - In-field information dissemination (e.g. kiosks or HAR) to inform drivers of vehicle travel time and transit travel time (short term)
- **Promote shifts between transit facilities via en-route traveler information devices (e.g. station message signs and public announcements) advising riders of outages and directing them to adjacent rail or bus services**
    - Park-and-Ride parking and bike locker availability reporting to information clearinghouse and subsequently disseminated (short term)
- **Re-route buses around major incidents.**
    - Bus schedule rerouting based on information gained from access to information exchange network (short term)

Approach D: Manage Capacity – Demand Relationship Within Corridor – "Real-time" / Short-Term

a – Capacity Oriented

- **Lane use control (reversible lanes / contra-flow)**
    - Dynamic Shoulders allowing vehicles to drive on the shoulders during certain special events. Transit vehicles may use shoulders currently (Immediate – summer 2007)
    - Reversible lanes exist in corridor, real-time adjustments during incidents (e.g. opening reversible lanes to all traffic, redirecting direction) will be considered (Immediate – summer 2007)

- **Convert regular lanes to "transit-only" or "emergency-only"**
    - Consider transit only lanes on key routes within City of Minneapolis (long

term)

- **Add transit capacity by adjusting headways and number of vehicles**
    - The three transit agencies are continuously evaluating the need for additional capacity and will be a strategy throughout ICM (long term)
- **Add transit capacity by adding temporary new service (e.g., express bus service, "bus bridge" around rail outage / incident)**
    - Special event capacity increases to support ballpark events (short term)
    - Consider other options for increased transit capacity (long term)
- **Add capacity at parking lots (temporary lots)**
    - Temporary parking additions through nearby mall or church lots and shuttle buses to the main transit line during events (short term)
- **Increase roadway capacity by opening HOV / HOT lanes / shoulders**
    - I-394 HOV/HOT lanes may be opened during incidents if needed to flush traffic (short term)
- **Coordinate scheduled maintenance and construction activities among corridor networks**
    - Plan city, county, state maintenance and construction to impact the corridor as little as possible, and enter summaries of all activities into information clearinghouse (short term)
- **Restrict ramp access (metering rates, closures).**
    - HOV bypasses of ramp meters for transit and HOV priority exist on corridor (immediate – available now)

b- Demand Oriented

- **Variable speed limits (based on Time of Day, construction, weather conditions)**
    - Variable speed limits on I-394 to maintain steady flow and prevent incidents (short term)
- **Modify toll / HOT pricing**
    - HOT pricing is currently set based on the use of the HOV/HOT lane. Additional pricing strategies to be considered during incident situations (immediate – summer 2007)
- **Modify transit fares to encourage ridership**
    - With electronic fare integration, transit, parking and HOT incentives will be reviewed. This will include transit / parking fare modifications to support special event transit use and encourage more transit use during peak periods (e.g. one approach discussed early in the ConOps development is that if transit is used during peak periods, credits may accrue for free transit ridership and/or parking in off-peak periods) (short term)

- **Modify parking fees**
    - Fare payment integration will enable real-time parking fee modifications to support demand changes during planned events (short term)

4.2.2 The Need for Each Proposed ICM Strategy

An important aspect of the systems engineering approach is to critically assess the role each strategy will play in order to understand 'why' it is being recommended for the corridor and what existing needs will be addressed by the strategy. Throughout the I-394 ICM initiative, stakeholders were continuously asked to defend the need for strategies, with the intent of a very focused set of strategies, each with a stated justification.

The following table (Table 4.2) serves three very important roles in the initiative, and will be a cornerstone for further sections of this report. The intent of this table is as follows:

1. To identify the ICM approaches and strategies selected as appropriate for the I-394 Corridor ICM initiative;
2. To define local applications of each strategy;
3. To present the justification for each local application ('why' it is being pursued); and
4. To identify the ICM objective that each local application applies.

<Table 4.2 begins on the following page>

Table 4.2 Summary of Needs Addressed by Each Strategy and Application

ICM Strategy	Local I-394 Approach	Need Driving the ICM Strategy and Approach
A-1: Manual Information Sharing	• Hennepin Co. and Minneapolis 911 dispatchers notify RTMC of events using shared radio talk groups	There are currently no formal tools for informing the RTMC of incidents on arterial roads in the corridor. Notification will allow active management and information.
	• Manual notification plan development	The radio talk group will provide the tools for communications, however a need was cited to define exactly what events on what roadways during what timeframe would be reported to the RTMC.
	• Production of integrated bus/bike trail maps, showing where bicyclists can access transit service	The bike racks on transit buses offer opportunities for bus/bike commutes, however no maps exist showing the interactions of bike trails and bus routes, which would allow commuters to plan such trips.
	• Execution and evaluation of manual notification plan	Long term application to implement and use the notification plan developed as a short term initiative (above).
A-2: Automated Information Sharing (Real-time data)	• Automated MSP CAD to RTMC data exchange	Currently, a manual process is needed to re-enter incident information for freeways into the RTMC traveler information system. Automating this process would reduce staff time and result in more comprehensive coverage of events.
	• Transit Control Center access to central reporting system	Currently, the transit control center relies on driver notification or web pages to learn about incidents in the corridor. This will allow the control center to view real-time events as entered by Mn/DOT.
	• Automated Hennepin County and Minneapolis CAD to RTMC data exchange implementation	Currently, there is not notification of incidents on arterial streets. The short term manual notification will allow verbal notification however this will automate the data exchange for county and city roads.
	• Real-time Park-and-Ride availability monitoring and reporting.	With many Park-n-Ride facilities at or near capacity, potential transit riders need advanced information about what facilities have parking capacity, or they will likely default to driving.
A-3: Automated Information Sharing (Real-time video)	• Video Sharing (IP)	The traffic, transit and event managers along the corridor have all requested video verification of conditions and events.
A-4: Information Sharing Clearinghouse / IEN	• Use of current existing systems (combination of condition reporting system and IRIS system)	Mn/DOT currently operates a condition reporting system and a traffic management system (IRIS). In the short term, it is recommended that a combination of the two can serve to assemble the information into a temporary clearinghouse while the grander corridor clearinghouse is being built.

ICM Strategy	Local I-394 Approach	Need Driving the ICM Strategy and Approach
	• Corridor-wide comprehensive information clearinghouse with graphical display of information on data about the infrastructure status, capacity, demand, and incidents	Each stakeholder in the ICM effort has recognized the need to house all the data and present useful information to the operators to assist their daily activities of managing traffic and events on the corridor. This will also serve to support travel information dissemination strategies.
	• Expanded information clearinghouse to include Park-and-Ride availability	Currently, potential transit riders have no information on parking capacity at park-n-ride facilities. By populating the clearinghouse with real-time park-n-ride information, it will enable ATIS systems to notify potential commuters of parking status.
	• Expanded information clearinghouse to include Transit schedule adherence	Currently travelers have no indication of real-time transit travel times as compared to highway travel times. Populating the clearinghouse with this information will enable ATIS systems to disseminate it to travelers.
	• Expanded information clearinghouse to include travel times for all major routes/modes (estimated or calculated) within the corridor	Currently, travel times exist only for the I-394 freeway and allow no comparisons. Populating the clearinghouse with this information will enable ATIS systems to disseminate it to travelers.
A-5: Corridor ATIS Database (Pre-trip Info)	• Expanded 511 and 511mn.org systems adding Transit delays/schedule adherence	Current phone and web systems lack real-time comparisons of travel times for routes and modes. Adding this will allow travelers to make informed decisions.
	• Expanded 511 and 511mn.org systems adding parking / park-and-ride availability	Current phone and web systems lack parking/park-n-ride information. Adding it will inform travelers about transit options.
A-6: En-route Traveler Information Devices	• Increased deployment of DMS at key arterial street locations (to inform travelers of conditions on arterial streets or to warn of incidents on freeways)	Several incident response scenarios require notification prior to corridor connector routes, either to inform travelers of events ahead (on the same route) or about events on parallel routes.
	• Increased deployment of ATIS devices in parking garages	One departure path taken out of parking garages leads only to I-394 freeway access. Therefore, if travelers are to be warned of events and given options for alternate routes, they must receive notice prior to exiting the parking structure.

ICM Strategy	Local I-394 Approach	Need Driving the ICM Strategy and Approach
A-7: Incident Reporting / Asset Mgmt System	• Integration of metro transit control center with CAD reports of incidents	Currently, the transit control center has no formal method for learning of incidents on highways. This strategy will automatically ingest CAD events (from MSP, Hennepin County, and city of Minneapolis) into the transit control system so they are alerted to events and can manage transit vehicles to minimize delays. In addition RTMC, city and county response personnel will benefit from the common incident reporting system.
A-8: Shared Control of Passive ITS Devices	Not proposed for I-394 at this time.	
A-9: Information sharing with ISPs	• Private ISPs currently have access to real-time information clearinghouse. This content will be expanded by manual and automated data sharing tactics described above	Mn/DOT values the role of private ISPs and will supply enhanced data for the ISPs to disseminate to existing customers.
B-1: Signal Priority for Transit	• Transit signal priority to give priority to transit vehicles behind scheduled times	Transit stated a strong need to keep buses moving efficiently in order to maintain transit as an attractive option for travelers. This will reduce the number of delayed transit vehicles.
B-2: Signal Preemption for Emergency Vehicles	• Emergency vehicle preemption exists on the corridor	Emergency pre-emption helps to prevent accidents at intersections and allows emergency vehicles to reach their destination quicker.
B-3: Multi-modal Electronic Payment	• Explore multi-modal payment options with I-394 Transit options study (attempt to combine HOT, parking, and transit payment)	Multi-modal integrated payment would simplify payment for travelers and also allow for innovative pricing incentives to encourage multi-modal use, such as credits for riding transit etc. This short term solution is to work with existing payment studies to express the need for corridor-wide integrated payment.
	• HOT, Transit, Parking payment coordination	This is the long term solution to integrate payment for convenience and to support pricing strategies.
B-4: Transit Hub Connection Protection	• Transit connection information display for travelers and drivers	Transit drivers lack information about which buses have arrived at connection points and which have not. Information would inform them if they need to wait for a bus, or can depart. Travelers will feel more secure if there are reliable connections and they do not risk being stranded. Ultimately, transit will be more reliable for travelers.
B-5: Incident Response Teams, Service Patrols, Training	• Explore options for sharing of maintenance equipment	There are many situations where cleanup, traffic management, or emergency clearance could be supported by trucks or equipment from another agency (housed or located near the event). This is intended to reduce these response times.
	• Inter-agency dispatcher meetings to discuss response procedures and understand each others' information	As manual and automated incident data becomes openly shared among agencies, it was noted as critical to understand how events are reported by each agency. Therefore, coordination meetings are planned.

ICM Strategy	Local I-394 Approach	Need Driving the ICM Strategy and Approach
B-6: Coordinated Arterial Traffic Signals & Ramp Meters	• Active involvement from agency signals group in incident response at the RTMC	There is a need to manually download 'flush' timing plans to help clear queues during an incident. Also, if there is an incident on the freeway and traffic is diverting away from the freeway when signal timings are currently supporting routes to the freeway, timing plan changes are required.
	• Increased CCTV coverage at intersections to support real-time signal timing changes	There was a stated need for visual verification of queue length and volumes before downloading special timing plans.
B-7: Coordinated Arterial Traffic Signals & Rail Transit Crossings	Not proposed for I-394.	
B-8: Promote equipment reliability	• Develop specifications for battery backup, communications, and control at signalized intersections	It was recognized that the corridor is as strong as the 'weakest link' and as intersections are updated it would benefit from defining standards for equipment (reliability and connectivity).
	• Support battery backup capabilities at key intersections	There are a number of events each year where signalized intersections lose power at the Eastern terminal of the corridor. During the morning peak, this loss of signal has a drastic impact on movement through the corridor.
	• Support consistent communications and control capabilities	It was noted that all signals are candidates for connecting to download timing plan changes and therefore should be updated to support this communications.
C-1: Modify Arterial Signal Timing	• Active involvement from each agency's signals group in incident response at the RTMC	Incidents impacting arterial streets can lead to congestion or queues that require multiply cycles to clear. Downloading 'flush' timing plans was identified as a mechanism for relieving congestion.
	• Development of special signal timing plans	The various agencies throughout the corridor identified a need for special signal timings to be implemented for major incidents or events, and the need for development of these plans to be coordinated across agencies, to support efficient movement of traffic along the corridor.
C-2: Modify Ramp Metering Rates	• Attempt to identify and get approval for special ramp meter parameters (allowable wait time) during major incidents	Mn/DOT is currently limited in the length wait time that may be experienced for arterial-freeway and freeway-freeway connections. During major incidents, this often minimizes any benefits of ramp meters and therefore a need was identified to get a waiver from these requirements during major events.
	• Ramp metering modifications in response to incidents	Needs were identified for manual execution of changes to ramp metering rates during major incidents and events.

ICM Strategy	Local I-394 Approach	Need Driving the ICM Strategy and Approach
C-3: Modify Transit Priority Parameters	• Advanced transit priority reflecting severity of incident and corridor-wide traffic conditions	The need was discussed for not granting transit vehicles signal priority during major events, in which often even if the bus made it through the intersection, they would meet stopped traffic.
C-4: Promote Route Shifts with Field Devices	• Information dissemination expanded to include travel times of alternate routes/modes; and locations of incidents	Currently, travelers have no information about the travel times for their mode and route options along the corridor.
	• Alternate signal timings (network/corridor-wide) during major weather events	During major weather, many travelers avoid the freeways and use major or minor arterials to commute. Feedback from operators has said the travel patterns are very different than typical commutes (i.e. travelers are not simply using arterials to reach freeways, but are using arterials to commute) therefore timing plans similar to weekend times are more appropriate.
C-5: Promote Modal Shifts with Field Devices	• Not proposed for I-394 at this time, but rather modal shifts will be addressed with en-route information	
C-6: Promote Shifts Between Transit Facilities with En-Route Information	• Park-and-Ride parking and bike locker availability reporting	Travelers have no real-time information about park-n-ride availability. If they are presented with notices that spaces are available, they will have the option of shifting modes.
C-7: Re-route buses around major incidents	• Bus schedule rerouting based on information gained from access to information exchange network	The Transit Control Center has the ability to dynamically route Metro transit vehicles around events. Also, Southwest Transit picks up all passengers outside the corridor and therefore can take any route along the corridor and would benefit from knowing the least congested.
D-1: Lane Use Control	• Dynamic Shoulders allowing vehicles to drive on the shoulders during certain special events	Currently, buses benefit from access to shoulders. This long term solution would use key shoulders as additional lanes during stop-and-go driving conditions, adding capacity when it is most needed.
D-2: Convert Lanes to Transit or Emergency Only	• Consider transit only lanes on key routes within City of Minneapolis	Where Hwy 7 enters Minneapolis, the morning congestion is severe. This solution is to work with the 'Access Minneapolis' initiative to consider dedicating one lane of an out-bound one-way street to be 'inbound transit only', reducing the time for transit vehicle in the last 1-2 miles tremendously.
D-3: Add Transit Capacity (Headways & # of Vehicles)	• Additional transit capacity is always being reviewed as an option	
D-4: Add Transit Capacity (Add New Service)	• Special event capacity increases to support ballpark events	Metro and Southwest Transit will consider additional capacity to handle the off-peak transit spikes during major events at the new Twins Stadium or basketball arena.

ICM Strategy	Local I-394 Approach	Need Driving the ICM Strategy and Approach
	• Consider other options for increased transit capacity	Metro and Southwest Transit will continue to review and consider transit capacity additions to match increases in demand.
D-5: Add Capacity at Parking Lots	• Temporary parking additions through nearby mall or church lots and shuttle buses during events	Major events such as the State Fair or extreme sporting events place unusually high transit demands. This strategy is to meet these demands for transit parking by temporarily using additional parking spaces and shuttling riders to main-line park-n-ride facilities.
D-6: Open Shoulders, HOV & HOT Lanes	• Shoulders are already used for transit vehicles, HOT access to shoulders will be considered	HOT lanes are currently used in the corridor. Transit buses currently can use shoulders during slow traffic. The consideration of using the shoulders for HOT would help spread capacity during incidents and allow some commuters to select another option for remaining within their buffer zone.
D-7: Modify HOV Restrictions	• Not proposed for I-394 at this time	
D-8: Restrict Ramp Access	• HOV bypasses of ramp meters for transit and HOV priority	This is currently implemented and allows transit vehicles to save minutes entering the freeway. It also offers incentives for carpooling.
D-9: Convert Regular Lanes to "Truck Only"	• Does not apply at this time because of the low percentage of truck traffic	
D-10: Coordinate Scheduled Main. & Const.	• Plan city, county, state maintenance and construction to impact the corridor as little as possible, and enter summaries of all activities into information clearinghouse	
D-11: Variable Speed Limits	• Variable speed limits on I-394 to maintain steady flow and prevent incidents	Variable speed limits will be used to help normalize the travel speeds and reduce incidents while improving throughput during the peak periods.
D-12: Modify Toll / Hot Pricing	• HOT pricing is currently set based on the use of the HOV/HOT lane. During major incidents HOT lanes can be opened to all traffic to relieve major events	
D-13: Modify Transit Fares	• Transit / parking fare modifications to support special event transit use	Special event rates are seen as a way to encourage transit use to major events (where parking capacity for SOV is not sufficient).

ICM Strategy	Local I-394 Approach	Need Driving the ICM Strategy and Approach
D-14: Modify Parking Fees	• Fare payment integration will enable real-time parking fee modifications to support demand changes during planned events	Special event rates are seen as a way to encourage transit use to major events (where parking capacity for SOV is not sufficient).
D-15: Variable Truck Restrictions	• Does not apply at this time because of the low % of truck traffic	
D-16: Restrict / Re-route Commercial Traffic	• Does not apply at this time	

4.3 ICM Concept Asset Requirements and Needs

The table presented in Section 4.2 demonstrates the concept for how the very real and documented needs of stakeholders along the corridor will be satisfied by the ICM strategies and local applications deployed throughout the corridor. This section presents the assets that will be required to deploy the ICM strategies and achieve operational status of the ICM concepts. Later stages of the systems engineering approach will develop the detailed requirements for these assets.

Table 4.3 below lists these ICMS asset needs, presented in the following categories:

- Network Systems – These are the required network-based systems. They are identified by the National ITS Architecture nomenclature of "Market Package" and have been identified as part of the Regional ITS Architecture review.

- Network Subsystems & Technologies – These describe additional information on the minimum network ITS-based requirements (e.g., specific field devices, hardware, system functionality).

- Information – This category lists the data and other information to be gathered by the network systems, and subsequently shared among the stakeholders and corridor travelers.

- Communication Subsystems – These assets are communications related, including the types of communications (e.g., center – to – center) as identified in the National ITS Architecture, interfaces to systems, and associated ITS standards.

- Other/Performance – This column is used for other ICM required assets that don't "fit" into the other categories, such as the few regional/multi-system market packages, institutional assets (responsibilities and policies), and support tools.

Table 4.3 I-394 ICM Concept Asset Requirements and Needs

Network Systems (Market Packages)	Network Subsystems & Technologies	Information	Communications Subsystems	Other (Operational) / Performance
- ITS Data Warehouse	- Traffic Detectors/ Surveillance	- Roadway Data Collection	- Center-to-Center	- Coordinated Traffic Control
-Transit Vehicle Tracking	- CCTV Video Surveillance	- Roadway Equipment Control	- Center to Field	- Coordinated Parking Management
- Transit Fixed-Route Operations	- Traffic Signal Control / Monitoring	- Roadway Video Images	- Roadside to Vehicle	- Multimodal Coordination
- Demand Response Transit Operations	- Traffic Signal Control Preemption and Priority Equipment	- Roadway Equipment Coordination	- Center-to-Vehicle	- Corridor Architecture Conformance
- Transit Passenger and Fare Management	- Ramp Metering System	- Roadway Signal Priority/Preemption Requests	- ITS standards for data formats and data transfer	- Information Sharing Clearinghouse/Display Formats
- Multimodal Coordination	- Lane Control Management Systems	- Traffic Violation Notification	- Video Transport Standards	- Archived Management Access
- Transit Traveler Information	- DMS and HAR Roadway	- MCM Activity Information	- Voice Communications	- Corridor Demand/Capacity Efficiency
- Broadcast Traveler Information	- Incident Detection	- MCM Resource Request	- Subsystem capacity for video transmission	- Vehicle Location Accuracy
- Interactive Traveler Information	- Incident Response Plans	- Toll Status and Request Information	- Subsystem capacity for data transmission	- Surveillance Coverage
- Network Surveillance	- Incident Reporting Systems	- Toll Tag and Transaction	- Subsystem capacity for voice transmission	- Incident Response Plans
- Surface Street Control	- Road Weather Information Systems	- Toll Violation	- Interfaces to network systems	- Decision Support Systems
- Freeway Control	- Parking Surveillance / Occupancy	- Parking Status and Coordination	- Interfaces to emergency CAD	- ICS Policies and Protocols
- HOV Lane Management	- Transit Vehicle Location Equipment	- Parking Tag and Transaction	- Interfaces to proprietary / legacy systems	- Special Event Plans
- Traffic Information Dissemination	- Transit Schedule Performance Monitoring	- Weather Information	- Interfaces to ISPs	- Common Fare/Toll Collection Technology

- Corridor Traffic Control	- Transit Center Fare and Load Management	- Archived Data Request	- Interfaces to financial systems	- Integrated Electronic Payment Back Office Operations
- Traffic Incident Management	- Remote Traveler Information Systems	- Incident Status	- Security Firewalls	- Dynamic Fare Pricing Capability
- Electronic Toll Collection	- Personal Traveler Information Systems	- Incident Coordination	- Virtual Data Exchange Networks	- Traffic Signal Priorities
- Standard Railroad Grade Crossing	- Transit Trip Planning System	- Emergency Vehicle Tracking	- Interfaces to Internet	- System Backup/Disaster Recovery
- Reversible Lane Management	- Public Safety CAD	- Emergency Resource Request	- Coordination of field components	
- Emergency Call-Taking & Dispatch	- Service Patrol Vehicles	- Transit Data Collection	- Electronic Tolling	
- Emergency Routing	- Real-time GUI Map Displays	- Transit Fare and Passenger	- Workstation/Server networks	
- Roadway Service Patrols	- Maintenance Vehicle Location Equipment	- Transit Payment Transaction		
- Evacuation and Reentry Management	- Multimodal Electronic Payment Systems	- Transit Vehicle Location		
- Maintenance and Construction Vehicle and Equipment Tracking	- Toll Highway Management	- Remote Traveler Information		
- Road Weather Data Collection	- Traveler Card Support Systems	- Personal Traveler Information		
- Weather Information Processing and Distribution	- Managed Lane Violation Systems	- En-Route Traveler Information		
- Winter Maintenance		- TMC Operator Inputs		
- Roadway Maintenance and Construction		- Transit Operator Inputs		
- Work Zone Management		- Emergency Operator Inputs		
- Maintenance and Construction Activity Coordination				

4.4 Comparison of ICM Concept Asset Requirements with Current and Potential Assets

Table 4.3 presented the assets needed to successfully implement ICM along the I-394 Corridor. Through a review of the current and future planned deployments presented in Chapter 3, this section presents those assets that are currently supported on the corridor.

In order to present the varying levels of deployment, the following methods are used to distinguish the assets:

- **Bold Type and Gray Highlight** represents those assets that are essentially deployed throughout the corridor, except for the needed integration with all corridor stakeholders.

- Underlined assets represent those that are partially deployed within the I-394 Corridor.

- No shading or underlining represents those assets that are not deployed within the corridor.

Table 4.4 Comparison of ICM Concept Asset Requirements with Current and Potential Assets

Network Systems (Market Packages)	Network Subsystems & Technologies	Information	Communications Subsystems	Other (Operational) / Performance
- ITS Data Warehouse	**- Traffic Detectors/ Surveillance**	**- Roadway Data Collection**	- Center-to-Center	**- Coordinated Traffic Control**
-Transit Vehicle Tracking	- CCTV Video Surveillance	- Roadway Equipment Control	**- Center to Field**	- Coordinated Parking Management
- Transit Fixed-Route Operations	- Traffic Signal Control / Monitoring	- Roadway Video Images	- Roadside to Vehicle	- Multimodal Coordination
- Demand Response Transit Operations	- Traffic Signal Control Preemption and Priority Equipment	- Roadway Equipment Coordination	- Center-to-Vehicle	- Corridor Architecture Conformance
- Transit Passenger and Fare Management	**- Ramp Metering System**	- Roadway Signal Priority/Preemption Requests	- ITS standards for data formats and data transfer	- Information Sharing Clearinghouse/Display Formats
- Multimodal Coordination	- Lane Control / Management Systems		- Video Transport Standards	**- Archived Management Access**
- Transit Traveler Information	- DMS and HAR Roadway	- MCM Activity Information	**- Voice Communications**	- Corridor Demand/Capacity Efficiency
- Broadcast Traveler Information	- Incident Detection	- MCM Resource Request	- Subsystem capacity for video transmission	- Vehicle Location Accuracy
- Interactive Traveler Information	**- Incident Response Plans**	**- Toll Status and Request Information**	**- Subsystem capacity for data transmission**	- Surveillance Coverage
- Network Surveillance	- Incident Reporting Systems	**- Toll Tag and Transaction**	**- Subsystem capacity for voice transmission**	- Incident Response Plans
- Surface Street Control	**- Road Weather Information Systems**	- Toll Violation	- Interfaces to network systems	- Decision Support Systems
- Freeway Control	- Parking Surveillance / Occupancy	- Parking Status and Coordination	- Interfaces to emergency CAD	- ICS Policies and Protocols
- HOV Lane Management	**- Transit Vehicle Location Equipment**	- Parking Tag and Transaction	- Interfaces to proprietary / legacy systems	- Special Event Plans
- Traffic Information Dissemination	**- Transit Schedule Performance Monitoring**	**- Weather Information**	**- Interfaces to ISPs**	- Common Fare/Toll Collection Technology

- Corridor Traffic Control - Traffic Incident Management **- Electronic Toll Collection** **- *Reversible Lane Management*** **- Emergency Call-Taking & Dispatch** **- Emergency Routing** **- Roadway Service Patrols** - Evacuation and Reentry Management - Maintenance and Construction Vehicle and Equipment Tracking **- Road Weather Data Collection** - Weather Information Processing and Distribution **- Winter Maintenance** **- Roadway Maintenance and Construction** - Work Zone Management - Maintenance and Construction Activity Coordination	- Transit Center Fare and Load Management - Remote Traveler Information Systems - Personal Traveler Information Systems **- Transit Trip Planning System** **- Public Safety CAD** **- Service Patrol Vehicles** - Real-time GUI Map Displays - Maintenance Vehicle Location Equipment - Multimodal Electronic Payment Systems **- Toll Highway Management** - Traveler Card Support Systems - Managed Lane Violation Systems	**- Archived Data Request** **- Incident Status** - Incident Coordination - Emergency Vehicle Tracking - Emergency Resource Request **- Transit Data Collection** **- Transit Fare and Passenger** **- Transit Payment Transaction** **- Transit Vehicle Location** **- Remote Traveler Information** - Personal Traveler Information - En-Route Traveler Information **- TMC Operator Inputs** **- Transit Operator Inputs** - Emergency Operator Inputs	- Interfaces to financial systems - Security Firewalls - Virtual Data Exchange Networks **- Interfaces to Internet** - Coordination of field components **- Electronic Tolling** - Workstation/Server networks	- Integrated Electronic Payment Back Office Operations - Dynamic Fare Pricing Capability - Traffic Signal Priorities - System Backup/Disaster Recovery

The identification of what assets exist on the corridor will be further reviewed during the requirements process. Some clarifications and additional information is summarized as follows:

A Traveler information system exists throughout the corridor and is part of the statewide Minnesota advanced traveler information system. However, the information lacks specific details that are critical to supporting mode and route choices during congestion or incident events. Similarly, the travel information system lacks the push capabilities that are critical for reaching the travelers and fulfilling the ICM vision.

Electronic fare payment exists in a basic form in that Metro Transit support fare cards. The existence of HOT lanes, transit, and parking facilities all operated by ICM stakeholders lends itself towards expanding the electronic fare payment systems. Further, electronic fare payment is critical towards some strategies and applications the stakeholders wish to implement to offer incentives for modal diversions.

Signal preemption exists for emergency vehicles on nearly every intersection throughout the corridor. Signal priority is strongly desired by the transit agencies to add to the other transit priorities currently supported on the corridor (shoulder use, bypass lanes, etc.).

Surveillance coverage exists throughout the corridor primarily along freeways or at major arterial/freeway junctions. Increased surveillance to verify the needs for signal timing changes is a key aspect of the ICM strategies.

DMS message signs have strategically been located throughout the corridor; however there are additional locations that are now needed to support the route diversions that are cornerstone to the ICM vision.

A summary of the significant changes and additions to the I-394 Corridor (in addition to those changes planned and funded over the coming months) to implement ICM is presented below in Table 4.5.

Table 4.5 Proposed Changes and Additions to I-394 Corridor

Organization	Significant Changes or Additions
Mn/DOT	• Additional CCTV coverage on Hwy 55 and Hwy 7 • Additional DMS sign locations upstream of key decision points, especially on arterial highways • Expanded reporting system into an Information Clearinghouse and Data Archive • Arterial street travel time calculation system integrated with RTMC • Automated data exchange interface with city, county, and transit agencies. • Expanded information dissemination system (increased information and corridor-wide view) • Expanded information dissemination (increased field

	dissemination devices.
Metro Transit	• Real-time travel time index for current routes • Monitor and communicate parking space availability within Metro owned park-and-ride facilities • CAD system interface able to ingest and display incidents reported to Information Clearinghouse • Transit signal priority system (on-board system including ties with schedule adherence system)
Hennepin County	• Access to the Information Clearinghouse, displaying useful information to operators based on existing data and status of equipment • Increased surveillance (CCTV) access • Upgraded traffic controllers and communications
City of Minneapolis	• Upgraded traffic controllers and communications • Integration of 911 dispatcher CAD system with Information Clearinghouse
SouthWest Transit	• Integration with Information Clearinghouse
Minnesota State Patrol	• Integration of CAD incident reports with Information Clearinghouse
Corridor-wide	• Expanded Travel information system to include additional information (transit travel times, arterial travel times, parking information, etc.) • Expanded locations of in-field information disseminations (parking garages, transit centers)

4.5 ICM and ICMS Operational Concept

The I-394 ICM vision for a fully integrated corridor will be achieved through institutional, technical, and operational integration. The intent of this section is to describe the operational concept from the view of the major stakeholders, the travelers, and finally from the system view. The Systems' view presents the ICMS Operational Concept

4.5.1 Travelers' View

From the travelers' perspective, travel along the I-394 Corridor will be supported by real-time traveler information describing the current conditions and travel times for the various modes and routes throughout the corridor. Travelers will understand their options for where they may park their automobiles or bicycles and ride transit vehicles and they will understand typical travel times for various routes and modes. In real-time, they will be able to access a variety of pre-trip information sources to query current conditions and understand which mode and route is best suited to their time constraints. En-route, they will either be pushed information to personal devices or view information from field devices to alert them to changing conditions and recommending alternate modes and routes. They will have one overall account from which HOT, transit, and parking payments are made; and will experience incentives for choosing transit over single occupant vehicles through credits to either HOT lane access or parking access downtown.

In general, through open information exchange, travelers will be comfortable utilizing the entire transportation network offered to them. The benefits they will experience will be more uniform travel time, less surprises en-route, less stress and ultimately, safer travel.

4.5.2 Corridor Operational Description

With ICM operational, the operations of the I-394 Corridor will support a broader corridor-wide perspective than currently supported. On any given day, as the morning commuter traffic begins to build, a number of automated systems will gather real-time information such as: parking availability, the speeds, volumes, and occupancy of flow. This information, together with any incident reports from police and fire agencies will be assembled within the information clearinghouse. As incidents or traffic builds in certain areas of the corridor, human operators will be alerted to such problems and focus their attention on these areas by viewing cameras, monitoring reports of system performance, and through open channels of voice communications. However, the emphasis of the corridor will not be solely upon resolving the operational problem or incident, but rather the emphasis will be upon a unified spreading of information to travelers across all routes and modes, as well as to transportation operations personnel. The I-394 Corridor ICM system will work to inform travelers and manage traffic in order to maintain consistent travel times even during incidents and heavy traffic days. This will be accomplished

through traveler information systems that disseminate a 'corridor-view' suggesting options for routes, modes, and even destinations.

4.5.3 Integrated Corridor Management System Operational Concept

The ICM System will be a system of systems, devices, and automated and manual activities that collectively work together to meet the needs of the travelers and operators throughout the corridor. Each function that the ICMS performs will be done to execute an ICM strategy or strategies, which relates to the needs of the corridor. The systems engineering process has avoided the deployment of any portion of the system simply for the sake of deploying technology for technology sake. In addition, the systems engineering process has facilitated a process with the stakeholders such that each system that requires manual interaction (e.g. manual posting of DMS messages, manual observation of cameras) has been assigned to a stakeholder and agreed by that stakeholder.

This section presents the operational concept from the systems view, in other words, the ICMS Operational Concept. After each concept, text in parentheses will identify the specific corridor need addressed by (and driving the need for) the ICMS operational concept.

Data collection and Assembly

The ICMS will collect and assemble a variety of data and information. The operation of each data collection activity will be spread among the various stakeholders and is addressed in another portion of the ConOps. The data collection operational concept of the ICMS is summarized as follows:

- Park-and-ride space availability will be monitored in real-time and the data will be assembled and communicated to the ICMS Information Clearinghouse;
- Transit schedule adherence and delays will be monitored in real-time by tracking vehicle progression. The data will be assembled and communicated to the ICMS Information Clearinghouse;
- Traffic flow data will be collected for routes throughout the corridor, including such things as volume, occupancy, and speed;
- Incident information will automatically arrive in the Information Clearinghouse as it is received from automated exchanges with the computer aided dispatch systems of the police and fire dispatch agencies;
- Incident information will also be entered into the Information Clearinghouse by RTMC operators after verification of the event;

Data Processing and Information Creation

In addition to data collection and assembly, the ICMS will process the collected data into information that can be used by travelers and operators to meet the needs identified for the corridor. The operational concept for information creation is as follows:

- The ICMS will calculate travel times for arterials and freeways and combine this information with transit schedule adherence information to establish a corridor-view of the travel times along various routes and modes.
- The ICMS will process the data available that describes demand and capacity (including capacity limitations caused by temporary or long term events) in order to assemble a functional view of those points or portions of the system where volume is near or exceeding capacity.
- The ICMS will process a combination of incident descriptions, travel time reports, and planned event descriptions; and compare these against traveler preferences in order to assemble travel reports that can support a push of information to travelers, alerting them to the impacts of current situations on the network.

Data and Information Sharing and Communication

The ICMS will share data and information among systems and users of the ICMS, that will support communication exchanges (e.g. verbal, text) among the stakeholders within each agency involved in the ICM. The operational concept for information sharing will be as follows:

- The ICMS will facilitate verbal communications such that emergency response (fire and police) dispatchers can work together and inform each other of response activities.
- The ICMS will allow all operators throughout the corridor to report incidents at any location throughout the corridor to other operators. Similarly, as the originating operator, or other operators, are able to verify incidents and impacts, the ICM will allow this two-way communication exchange such that all operators who require the information can monitor the events surrounding the incident.
- The ICMS will facilitate the viewing of CCTV images throughout the corridor by all stakeholders wishing to view these images.
- The ICMS will continuously share incident, travel time, and traffic flow information for the use by private information service providers operating throughout the corridor.

Information Dissemination

The ICMS will provide traveler information dissemination through systems that automatically deliver information to travelers, systems that require manual operator intervention to deliver messages, and through systems that share information with private sector information service providers. The system operational concept is described as follows:

- The ICMS will operate a 511 telephone system delivering a corridor perspective to travelers. This corridor perspective will present the expected conditions along optional routes and modes throughout the corridor, parking availability, transit status reports, and a summary of current events.
- The ICMS will operate an Internet website disseminating travel time information for optional routes and modes, provide information on incidents throughout the corridor, allow visitors to view camera images, and view current speeds along each route.
- The ICMS will operate trigger push systems to notify travelers when critical conditions exist or when thresholds have been crossed. The push communication will be used to alert travelers while they still have options for route or modal shifts.
- The ICMS will operate DMS signs and provide the means for operators in selected agencies to post messages to these signs. In addition, the ICMS will automatically post travel time messages to all DMS signs in the corridor.
- The ICMS will operate on-board wireless Internet services on transit buses traveling the corridor to both allow travelers to access travel information websites and to serve as an incentive to ride transit (and work productively en-route).
- The ICMS will disseminate travel information to the travelers leaving the downtown area through dissemination in parking garages, stadiums, and covered walkways.

Traffic Management and Operational Improvements

Finally, the ICMS will perform and support traffic management and operations throughout the corridor, the operational concept is as follows:

- The ICMS will operate ramp meters based on current demand conditions.
- The ICMS will operate coordinated signalized intersections along the Hwy 55 and Hwy 7 routes allowing traffic to flow progressively even across the jurisdictional boundaries that exist on both corridors.
- The ICMS will support the operation of incident plans and allow operators to manually select to download special timing plans to intersection controllers to support incident conditions.
- The ICMS will operate transit signal priority for those interchanges where buses must navigate one or more signalized intersections between park-and-ride facilities and the freeway.
- The ICMS will support a unified payment system for the Mn/PASS HOT lanes, the Third Avenue parking garages, and the transit buses. This unified payment system will allow ICM operators to develop and execute payment incentives to draw more travelers to transit options.

- The ICMS will operate power back-up systems at intersections that are key to the corridor movement of traffic.
-

4.5.4 Mn/DOT's View

Mn/DOT's involvement in the I-394 ICM will be through the RTMC,the Metro District's Arterial Signal Operations Group, the Bicycle and Pedestrian Group, and the office of investment management.

The Mn/DOT RTMC provides freeway operations to the corridor, operating the DMS signs, ramp meters and populating information (manually and automatically) into the information clearinghouse. A number of system reports will arrive at the RTMC and be ingested into the information clearinghouse. These include incident reports from the three primary emergency dispatchers, transit travel times, and parking information from lots and park-and-ride facilities. The RTMC will be the focal point for verifying and adding value to the information clearinghouse. With camera image displays from key locations throughout the corridor and full-time staffing from early morning until late evening, the RTMC will serve as the central control point for corridor response. The RTMC operators will be responsible for posting messages on the DMS signs located on arterials and freeways throughout the corridor. The RTMC will also be responsible for any manual changes to the reversible lanes (for example changing direction of lanes in response to major events). Finally, the RTMC will operate traveler information dissemination systems displaying and pushing key information to travelers.

The Mn/DOT Arterials Signal Operations group will support the RTMC in situations where events either occur along the major arterials (Hwy 55 and Hwy 7) or will impact the volumes of traffic along these highways. When appropriate, the signals group will download special timing plans at select intersections to assist in clearing queues and moving traffic more efficiently.

4.5.5 Transit Agencies' View

Metro Transit is the largest transit provider in the corridor and will benefit from a real-time data exchange with the information clearinghouse populating their transit control center AVL dispatch system with incidents and events. Operators within the control center will consider incident information when deciding to alter bus paths or take other management actions to maintain on-time bus schedules. Metro Transit will operate park-and-ride parking availability monitoring systems and publish real-time information about parking availability as well as transit travel times and delay for the information clearinghouse to circulate to travelers and other stakeholders. Additionally, SouthWest Metro Transit dispatchers will understand which freeways have closures on the shoulder, and route buses around these closures to maintain consistent travel times. Advantages such as transit signal priority systems, freeway shoulder access, and HOT lane access will both keep buses on schedule and provide incentive for travelers to select transit options.

4.5.6 Hennepin County's View

Hennepin County's Traffic and ITS Division will benefit from access to a graphical display of information describing conditions and events that currently are described only by vast amounts of data. This summary view and flagging of operational problems will allow staff members to quickly respond to trouble signal controllers or other operational breakdowns. Operations staff members will also view camera images to assist in determining the need for signal timing changes.

4.5.7 City of Minneapolis' View

The City of Minneapolis traffic operations group will benefit from ICM initiatives that update power backup and communications to signal controllers, providing for more reliable operations. In addition, communications to key controllers will allow for flush timing plan changes to be implemented in real-time in response to incidents in order to maintain efficient travel along the corridor.

4.5.8 Law Enforcement / Emergency Responses' View

When the I-394 vision is achieved, the three 911 dispatch centers responsible for dispatching the great majority of events in the corridor will benefit from strategies that will relay notifications of incidents in real-time to the information clearinghouse, and therefore be circulated to the appropriate stakeholder/responder. Dispatch centers will experience less calls from private information service providers as these providers will have full access to incident reports through the information clearinghouse. The information clearinghouse will share these incident reports with the RTMC, transit agencies, city and county traffic management teams allowing traffic management and travel information strategies to be implemented.

4.6 Alignment with Regional ITS Architecture

A Regional ITS Architecture was established in December 2001. Through the ICM Task Force Committee, a draft ICMS concept was developed which built upon the Market Packages of the National ITS Architecture that related to the proposed ICMS Approach Strategies. A high-level comparison of the Regional ITS Architecture and the ICMS concept provides the following findings:

- The system inventory of the Regional ITS Architecture was updated for the ICMS due to the lapse of time since it was developed.

- The following Market Packages have been identified for the ICMS, but were not included in the Regional ITS Architecture:

    - APTS-8 Transit Traveler Information –

This market package provides transit users at transit stops and on-board transit vehicles with ready access to transit information. It was included to address Approach Strategies:

- B-4 Transit Hub Connection Protection
- C-6 Promote Shifts between Transit Facilities with En-Route Information

- ATMS-10 Transit Traveler Information –

  This market package provides toll operators with the ability to collect tolls electronically and detect and process violations. This package is relevant today with the deployment of MnPASS managed lanes along I-394, which did not exist when the Regional ITS Architecture was developed. It was included to address Approach Strategy:

  - B-3 Multimodal Electronic Payment

- EM-4 Roadway Service Patrols –

  This market package supports roadway service patrol vehicles that monitor roads and aid motorists to minimize disruption to the traffic stream. This package is relevant due to the desire to collect information and incident response activities from the FIRST (Freeway Incident Response Safety Team) trucks program. It was included to address Approach Strategy:

  - A-7 Incident Reporting / Asset Management System

- EM-9 Evacuation and Reentry Management –

  This market package supports evacuation of the general public from a disaster area and manages subsequent reentry to the disaster area. This package is relevant for the Evacuation Operational Scenario. It was included to address Approach Strategy:

  - A-7 Incident Reporting / Asset Management System
  - B-5 Incident Response Teams, Service Patrols, Training
  - All Approach C Strategies – Accommodate/Promote Cross-Network Route & Modal Shifts
  - All Approach D Strategies – Manage Capacity-Demand Relationship Within Corridor

- MC-1 Maintenance and Construction Vehicle and Equipment Tracking –

  This market package will track the location of maintenance and construction vehicles and other equipment to ascertain the progress of their activities. This market package did not exist in the National ITS

Architecture at the time of the Regional ITS Architecture development. It was included to address Approach Strategy:

- A-4 Information Sharing Clearinghouse / IEN
- A-7 Incident Reporting / Asset Management System

- MC-3 Road Weather Data Collection

  This market package collects current road and weather conditions using data collected from environmental sensors deployed on and about the roadway. This market package did not exist in the National ITS Architecture at the time of the Regional ITS Architecture development. It was included to address Approach Strategy:

  - A-4 Information Sharing Clearinghouse / IEN
  - A-7 Incident Reporting / Asset Management System

- MC-4 Weather Information Processing and Distribution –

  This market package processes and distributes the environmental information collected from the Road Weather Data Collection market package. This market package did not exist in the National ITS Architecture at the time of the Regional ITS Architecture development. It was included to address Approach Strategy:

  - A-4 Information Sharing Clearinghouse / IEN
  - A-7 Incident Reporting / Asset Management System

- MC-6 Winter Maintenance –

  This market package supports winter road maintenance including snow plow operations, and other snow and ice control activities. This market package did not exist in the National ITS Architecture at the time of the Regional ITS Architecture development. It was included to address Approach Strategy:

  - A-4 Information Sharing Clearinghouse / IEN
  - A-7 Incident Reporting / Asset Management System
  - B-5 Incident Response Teams, Service Patrols, Training

- MC-7 Roadway Maintenance and Construction –

  This market package supports numerous services for scheduled and unscheduled maintenance and construction on a roadway system or right-of-way. This market package did not exist in the National ITS Architecture at the time of the Regional ITS Architecture development. It was included to address Approach Strategy:

- A-4 Information Sharing Clearinghouse / IEN
- A-7 Incident Reporting / Asset Management System
- D-10 Coordinate Scheduled Maintenance and Construction

- MC-8 Work Zone Management –

  This market package directs activity in work zones, controlling traffic through portable dynamic message signs and informing other groups of activity (e.g., ISP, traffic management, other maintenance and construction centers) for better coordination management. This market package did not exist in the National ITS Architecture at the time of the Regional ITS Architecture development. It was included to address Approach Strategy:

  - A-4 Information Sharing Clearinghouse / IEN
  - A-7 Incident Reporting / Asset Management System
  - D-10 Coordinate Scheduled Maintenance and Construction

- MC-10 Maintenance and Construction Activity Coordination –

  This market package supports the dissemination of maintenance and construction activity to centers that can utilize it as part of their operations, or to the Information Service Providers who can provide the information to travelers. This market package did not exist in the National ITS Architecture at the time of the Regional ITS Architecture development. It was included to address Approach Strategy:

  - A-4 Information Sharing Clearinghouse / IEN
  - D-10 Coordinate Scheduled Maintenance and Construction

- The proposed ICMS includes an Information Sharing Clearinghouse market package, to address the Approach A Strategies – Information Sharing / Distribution. This is similar to Market Package AD 2 – ITS Data Warehouse, but rather than an archived data management system, the ICMS requires the sharing and distribution of real-time information. The Information Sharing Clearinghouse also may include archived data management features.

- The proposed ICMS includes a Corridor Traffic Control market package in place of the Regional Traffic Control market package in the Regional ITS Architecture (it is actually a subset of the regional system), to address Approach Strategies:

  - B-6 Coordinated Arterial Traffic Signals & Ramp Meters
  - B-7 Coordinated Arterial Traffic Signals & Rail Transit Crossings
  - C-1 Modify Arterial Signal Timing
  - C-2 Modify Ramp Metering Rates
  - C-3 Modify Transit Priority Parameters
  - C-4 Promote Route Shifts with Field Devices
  - C-5 Promote Modal Shifts with Field Devices

- D-1 Lane Use Control
- D-2 Convert Lanes to Transit or Emergency Only
- D-6 Open Shoulders, HOV & HOT Lanes
- D-7 Modify HOV Restrictions
- D-8 Restrict Ramp Access
- D-9 Convert Regular Lanes to "Truck Only"
- D-11 Variable Speed Limits
- D-12 Modify Toll / HOT Pricing
- D-15 Variable Truck Restrictions
- D-16 Restrict / Re-route Commercial Traffic

These appear to be the only significant conflicts between the ICMS concept and the Regional ITS Architecture, otherwise there is consistency. Upon final approval of the ICMS concept, it is expected that the ICMS stakeholders will propose to the Regional ITS Architecture Committee that the current Regional ITS Architecture be modified to include the ICMS concept. Furthermore, specific ITS standards will also be identified for the ICMS to be used throughout the region.

4.7 Implementation Issues

The history of ITS deployments in the Twin Cities dates back to the 1970's when ramp meters were first introduced. Over the past 20 years, the Minnesota Guidestar Program has served as a strong support organization, coordinating and planning the ITS implementations statewide. The partnerships that have been built within the Minnesota Guidestar Program have led to wide assortment of operational ITS systems that now support the many networks within the I-394 Corridor. While these partnerships have led to longstanding relationships, agreements, and cooperation among all levels of public agencies, the ICM initiative has verified that the operational integration among the networks can be significantly improved.

The implementation of both the near and long term ICM applications identified in this process will face many issues. The stakeholder groups (Steering Committee and Working Group) have identified many of these issues in meetings and outreach workshops. Table 4.6 identifies the technical, operational, and institutional issues that will be overcome with the help of the many partnerships and relationships that have formed over the years.

Table 4.6 ICM Issues Facing the Corridor

Technical Issues	Operational Issues	Institutional Issues
• Individually owned systems (e.g. transit, 911 centers, city, county and DOT) will all need to exchange data using common ITS standards • In addition to common data exchange standards, interoperable reporting	• Development of incident reporting plan (to support manual and automated incident reporting) is needed (e.g. defining what is reported for which locations, and what information may not be shared)	• Definition of roles and responsibilities • Funding each stakeholders' ICM specific activities • Policies for data sharing and privacy issues • Policies and procedures to support dependencies upon

Technical Issues	Operational Issues	Institutional Issues
procedures 'semantics' for describing events is critical • Hennepin County and Minneapolis 911 call centers are implementing new CAD system in the next 12 months • The City of Minneapolis is considering creating a communications center north of the city that will house 911 dispatch and other communications functions • Many City of Minneapolis traffic controllers are outdated and lack communication capabilities • Arterial street travel times are not currently computed • Firewall and security issues with integrating systems • Maintenance and operations needs of new devices and systems is a concern of stakeholders • Detailed locations of DMS and CCTV deployments need to be determined • SW Transit and Plymouth Metrolink do not have same CAD/AVL functionality that Metro Transit does	• Need to determine who can monitor the emergency management talk group and what procedures exist to be in the group • Updates to operational parameters of signal controllers, ramp meters, and transit schedules may be needed • Policy towards transit priority use needs to be agreed among stakeholders (e.g. what conditions merit priority) • Need for a common approach towards whether to 'instruct' travelers to alter trips or to 'inform' them of conditions • Need for approach to respond to incidents at all peak periods • Need for an approach for who posts messages to DMS signs during all hours of the peak periods • City and County staff are not currently staffed in the operations centers during the evening rush hour • Need for an approach for who maintains and supports in-field DMS, CCTV and other ICM related devices • Parking and park-and-ride lots are owned by various agencies. Ownership and maintenance of equipment at each facility will likely vary	stakeholder agencies (i.e. commitments from agencies to the longevity of ICM) • System procurement approach • System maintenance approach • Inter-agency agreements documenting the roles and responsibilities • Compatibility of ICM equipment with current equipment operated by each stakeholder • The Minnesota Twins Stadium relocation is currently planned for the East end of the corridor, considerable planning is currently underway • There is a city-wide study 'Access Minneapolis' that is exploring city development topics • Mn/DOT is conducting a transit advantages study for the I-394 Corridor, which must be considered

The ***technical implementation issues*** represent a combination of technical detail needed about the ICM deployments (e.g. the distribution and exact locations of additional surveillance cameras and message signs), issues regarding the interaction of systems, and issues related to the current status of systems and assets. These technical details will be addressed at the later requirements and design stages of the systems engineering process. Another example of a technical implementation issue is the need for travel time estimates for arterial street routes and transit travel that can adequately be used as comparisons against the available travel times along I-394. This issue is currently being addressed in that Metro Transit has systems capable of generating schedule adherence and route delay factors in real-time. Also, there are a number of funded research projects in Minnesota addressing arterial street travel time calculations. Therefore, these technical issues are

expected to be resolved during the requirements and design portions of the systems engineering approach. Minnesota has a history of success using ITS standards for integration. The existing use of standards reduces the issues surrounding integration of systems. However, one technical implementation issue is the issue of 'semantics' or specifically the fact that the standards for message exchanges allow for many choices of phrases to be used to describe the same event. The ICM stakeholders will seek to define definitive event descriptions within the requirements phase of this project. The most serious technical issue facing the I-394 ICM integration is the need for upgraded technologies in controllers and communications to controllers. While the primary parallel routes are mostly updated and capable of supporting the needed network-wide control, there are a number of controllers on the secondary and tertiary networks that could contribute more to integrated management if they supported state of the practice technologies.

Several ***operational issues*** must be addressed prior to ICM implementation throughout the I-394 Corridor. The majority of these issues surround the need for ICM centric operational procedures that can be agreed among all agencies. Many of these procedures have been discussed in the Concept of Operations development and agreed and documented as roles of stakeholders. However, prior to implementation, these roles will be formalized into an operations plan during system design. One key aspect of the ICM is the reporting of available parking at transit park-and-ride facilities. Technically, this is not an issue, however from an operations perspective, the park-and-ride facilities are owned by a collection of agencies and the operations/ownership of the equipment and communications to report capacity in real time will require operational agreements to be developed in the design phase. An operational issue that has been addressed in the Concept of Operations is the fact that the City and County traffic operations centers are not fully staffed during the extent of the peak periods. The definition of roles has addressed this through a sharing of operational responsibilities, and this topic will further be addressed in the requirements phase of the project.

Many potential ***institutional issues*** have been eliminated because of the long standing working relationships among the ICM stakeholders. The corridor stakeholders have identified the need for effective contracting and procurement processes that will allow cross-cutting systems to be deployed in several or all of the ICM partner agencies during the deployment phase. The decision of the I-394 Corridor stakeholders to not form a new entity for ICM, but rather to mainstream ICM into their existing agencies and modify the roles of existing groups to operate ICM will help mobilize ICM quickly and will ensure the ongoing success of ICM at minimal costs.

4.8 I-394 ICM Concept Institutional Framework

4.8.1 ICM Leadership and Program Management

As the ICM systems engineering process transitions from the requirements development to the design and deployment portions, the ICM management and leadership will

transition to a more defined and operational focus. This section outlines the plans for ICM leadership and management. Beyond the conceptual planning, requirements definition, and modeling process, the ICM Team members recognize not only the need for ongoing program management, but also some distinctions in the need for this management as opposed to the management provided during the current ConOps and requirement definition processes. The I-394 ICM strategies will be operated, managed, and maintained by a collection of local partners operating throughout the corridor. In general, individual agencies will lead the development, deployment, operations, and maintenance of key technical systems. Procurement and project management will be the responsibility of the individual agencies responsible for each deployment. Nonetheless, the corridor perspective of ICM can only be achieved if all participating agencies are united together and if each agency can rely on the other agencies to deliver what they have committed to perform.

In summary, three key roles are envisioned for the management of the ICM program:

- Program leadership (Overall management, commitment monitoring, stakeholder liaisons);
- Management of the ICM Concept (monitoring and assessing performance measures, maintaining the 'corridor perspective); and
- Day to day operations and maintenance of ICM strategies at the local level.

Program Leadership - ICM Program Manager Role
Mn/DOT will continue to provide an overall ICM Program Manager, and this individual will be a manager within the RTMC. This designation will ensure that the program is always managed by an individual working daily in freeway and arterial operations, and with a vested interest in the success of ICM. The ICM Program Manager (working with staff members and support contractors) will be responsible for managing the commitments of member agencies and ensuring that commitments for deployment are delivered on-time, or that other agencies are informed of delays as soon as possible, and contingency plans arranged.

Management of the ICM Concept - ICM Management Team
As the ICM deployment advances and transitions into operations, the ICM Management Team will be expanded to include one member from each agency with an active role in ICM management. The intent of the ICM Management Team will be to ensure that each agency performs the duties that they have committed to during the ConOps development process (at the ICM workshop, each activity for operations and maintenance were discussed and a lead agency was identified). The ICM Management Team will meet regularly with an ongoing agenda item to review current ICM procedures, performance measures, and assess any needs for changes.

The ICM Working Group will not exist as it currently does, but rather as needed project-specific working groups will form. Each working group will report to the ICM Management Team and ultimately to the ICM Program Manager. The ICM Steering Committee will exist and continue to play their current role until such time as the role of the committee can be migrated into an existing operations based committee structure.

The ICM Management Team will perform the regular performance reviews and commitment monitoring, and it is hoped that the steering and direction of ICM will find a home within the operational setup of the Metropolitan area.

4.8.2 Institutional Cooperation for Daily Operations and Maintenance

Institutional, Technical, and Operational Integration
The I-394 ICM initiative will initially require institutional integration of the partner agencies and individual staff and management personnel within each organization to establish the needed relationships, agreements, and internal staffing plans to operate the ICM strategies. Technical integration will involve the design, development and implementation of the specific technologies to support the ICM strategies in compliance with the regional ITS architecture and with the geographic coverage and technical capabilities to meet the aggressive objectives of ICM. Finally operational integration will fuse the individual operational activities of corridor partners to operate the systems as one overall system, recognizing the existing funding and organizational structure limitations facing each stakeholder agency.

Corridor-wide information assembly
The RTMC, housing a combination of Mn/DOT Freeway Operations, Maintenance Dispatch and State Patrol Dispatch, will play a central role in the corridor management. The RTMC currently operates all freeway control and 511 information dissemination over phone and Internet. The RTMC currently operates a condition reporting system and traffic management software system. Either of these may be expanded or incorporated somehow into the ultimate development of the information clearinghouse described in this Concept of Operations (to be determined in the requirements and design phases). To this extent, the RTMC will house the information clearinghouse (regardless of the approach taken to development). The information clearinghouse will be populated with critical information from the transit, parking, emergency response, arterial and freeway management systems. While the RTMC will not specifically operate all of these individual systems, it will ingest the data from these systems and perform the fusion of data required to create the holistic travel information view for the corridor.

De-centralized system operations and information sharing
In order to realize the vision of the I-394 ICM initiative, there will be several systems (hardware and software) developed and operated by partnering agencies throughout the corridor. The data and/or information generated by these systems will be assembled centrally in the RTMC information clearinghouse using established ITS standards and Internet protocols for data exchange. Therefore, a center to center data exchange system resembling a ‘spoke and hub’ routing scenario will be used where systems operated locally will all transfer data to the RTMC. The RTMC will assemble, normalize, process and circulate the data (and resulting information) to all partners and information service providers.

The following bullets summarize the institutional roles of each partner agency in the overall ICM vision. Please note that these roles present concepts for operations and final

commitments from partner agencies would require adequate funding and staffing allocations.

Metro Transit, Southwest Transit, Minnesota Valley Transit, and Plymouth Transit

- Operate on-vehicle monitoring systems, monitoring passengers and vehicle position;
- Perform vehicle to center data communications of key data with the Metro Transit Control Center;
- Operate park-and-ride space availability monitoring systems, relay data to RTMC information clearinghouse;
- Monitor and calculate transit schedule adherence and generate event reports of routes reporting significant delays;
- Perform center to center data communications to relay transit schedule adherence and delay information, and parking reports to RTMC information clearinghouse;
- Ingest and accept data and information from RTMC information clearinghouse about incidents (reported initially through state, county, and city EMS CAD systems), insert reports into TCC AVL/CAD system for dispatcher support; and
- Operate transit priority on-vehicle devices, interfacing with field devices.

Hennepin County Traffic Operations Center:

- Monitor information clearinghouse display of system status (display of information based on voluminous data);
- Manage traffic signal timings in real-time when appropriate;
- Publish advanced notice of roadwork or event information for ingest by RTMC into information clearinghouse;
- Establish battery backup at intersections key to the corridor movement.

Hennepin County Emergency Dispatch Center:

- Transmit information on incidents and closures along arterial streets within the corridor (initially using voice/manual communications and later through automated communications) to the RTMC information clearinghouse.

City of Minneapolis Traffic Operations Center:

- Monitor information clearinghouse display of system status (display of information based on voluminous data);
- Manage traffic signal timings at key intersections when appropriate;
- Publish advanced notice of roadwork or event information for ingest by RTMC into information clearinghouse;
- Establish battery backup at intersections key to the corridor movement.

City of Minneapolis Emergency Dispatch Center:

- Transmit information on incidents and closures along arterial streets within the corridor (initially using voice/manual communications and later through automated communications) to the RTMC information clearinghouse.

Minnesota State Patrol:

- Transmit information on incidents and closures along freeways streets within the corridor to the RTMC information clearinghouse using the CAD/TMC interface currently being developed.

Mn/DOT RTMC:

- Operate freeway management system for DMS, CCTV, ramp meter control;
- Operate arterial traffic signal real-time modifications for Hwy 55 and Hwy 7;
- Operate central information clearinghouse;
- Post real-time and advance warning messages on DMS signs throughout the corridor to maintain consistent signs that convey a 'holistic' corridor approach towards travel information;
- Populate the central information clearinghouse by:
    - Ingesting park-and-ride availability information from Metro Transit operated systems;
    - Ingesting transit schedule adherence information from Metro Transit Control Center;
    - Ingesting arterial travel time reports from Arterial operations group;
    - Ingesting signal status reports from arterial signal systems operated by Mn/DOT, Hennepin County, City of Minneapolis;
    - Ingesting incident reports from dispatch CAD systems at MSP, Hennepin County, and City of Minneapolis (automated data exchange), in the near-term operators will manually receive reports of incidents on 800Mhz talk group;
    - Fusing, assembling and distributing the information to ICM stakeholders, private information service providers, and other agencies as needed.

4.9 Performance Measures and Targets

4.9.1 Performance Measure Definitions

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, with the understanding that as the systems engineering process continues into the requirements definition and design stages, the preliminary performance measures will need to be re-evaluated. The preliminary performance measures, mapped against the goals and objectives of the I-394 Corridor are described in Table 4.7.

Table 4.7 I-394 ICM Preliminary Performance Measures

GOAL	OBJECTIVE	NEEDS RELATED TO OBJECTIVE	PERFORMANCE MEASURE
Mobility & Reliability	**Reduce the variation in travel times**	- Need for incident detection and notification - Need for efficient movement of vehicles throughout the corridor - Need for corridor wide status monitoring - 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. Maximum travel times experienced by travelers throughout the corridor Range of travel times (and variability) experienced by travelers Percentage of 'late' bus routes throughout the corridor.
	Maintain options for travelers'	- Need to monitor status of devices and systems - Need for a comprehensive view of all available capacity and demand throughout the corridor	Average parking availability per facility and time of day Comparisons of transit, HOV/HOT lanes, Freeways, and arterial route performance Percentage of corridor (routes and modes) reported on in real-time

GOAL	OBJECTIVE	NEEDS RELATED TO OBJECTIVE	PERFORMANCE MEASURE
			(travel times, 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	- Need for transit advantages - Need for transit incentives	Percentage of drivers altering route or mode based on traveler information 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 - Need for overall view of conditions along all routes and modes - Need for dissemination of corridor-wide traveler information	Number of events where viable alternates are delivered to travelers (either via. phone, web or push) Number of callers receiving alternate route/mode information 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 Number of times alternate plans are implemented, and the real-world results. Response/ clearance times for major events.

GOAL	OBJECTIVE	NEEDS RELATED TO OBJECTIVE	PERFORMANCE MEASURE
Holistic Traveler Infor-mation delivery	**Travelers are aware of their modal and route options**	- Need for overall view of conditions along all routes and modes - Need to assemble and disseminate park-and-ride availability - 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 - Need for access to information en-route	Travelers' feedback after incidents and events.

4.9.2 Target Definitions

In addition to defining the measures that will help assess the impacts of the ICM strategies on the I-394 Corridor, the project team felt it was important to identify preliminary targets for some of the performance measures that most lend themselves to quantitative measurements. The Buffer Index is one of the most critical performance measures, since overall reliability of travel (and minimizing the impacts of incidents on travel times) is a primary objective of the I-394 ICM project. In order to identify a performance measure success threshold for the Buffer Index, the project team examined the travel times along I-394 to ascertain the median, minimum, and maximum (95 percentile) travel times.

The following table (Table 4.8) defines a set of preliminary targets for impacts and performance of the ICM strategies on the I-394 Corridor.

Table 4.8 Preliminary Targets for Measuring Performance Measures

Performance Measure	Performance Measure Success Threshold
Buffer Index – The amount of time travelers must allow to ensure they are on-time 95% of the time	20% of total travel time

Maximum travel times experienced by travelers throughout the corridor	20% spread from average travel time to maximum travel time
Range of travel times (and variability) experienced by travelers	20% of total travel time
Percentage of 'late' bus routes throughout the corridor	95% of buses arrive within 20% of travel times
Response/ clearance times for major events	Percentage of events with clearance time greater than 30 minutes

5. Operational Scenarios

In order to demonstrate the detailed roles of corridor stakeholders involved in the I-394 Integrated Corridor Management (ICM) initiative, this document presents a series of scenarios to illustrate the impacts of full ICM implementation. The scenarios depict a variety of minor and major incidents at various locations throughout the corridor. The scenarios 'paint a picture' of the activities to be performed by each stakeholder, the ICM strategies employed, and the likely impacts that would be experienced by travelers.

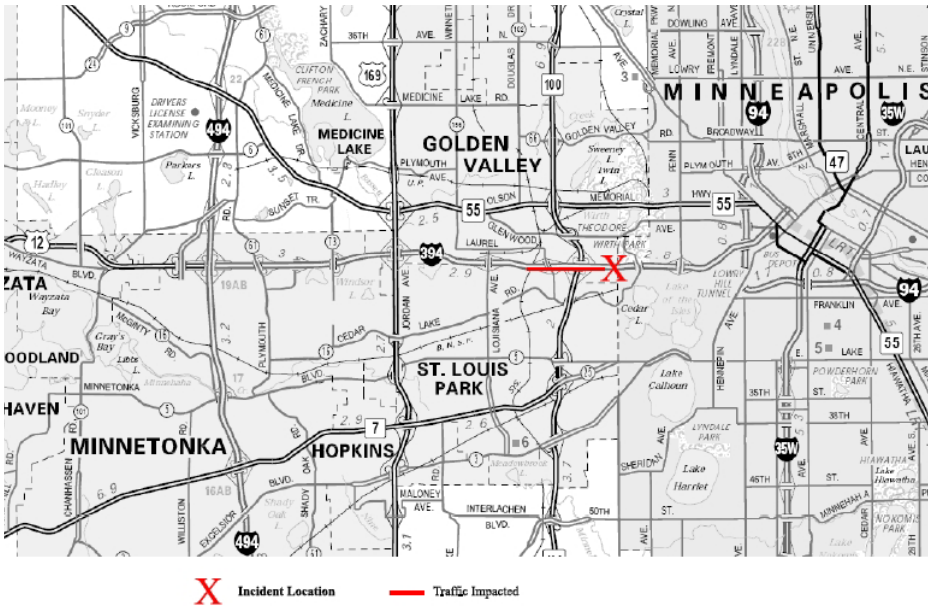
The first ten scenarios each describe a different type (and location) of incident. Scenario #11 presents a daily operational scenario, describing likely activities during the typical recurring congestion conditions.

Following the summary of each scenario, a series of bullet points outline the operational activities and reactions.

Scenario #1: Major Traffic Incident

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.

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 I-394 ICMS receives an event report from the State Patrol CAD system describing the location and impacts to traffic. Within seconds, representatives from the ICM stakeholder agencies have seen an icon at their dispatch or work console alerting them to the event and view CCTV images to understand the event.

- 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.

- The ICMS automatically notifies the Mn/DOT Arterial Signals group 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.

- The ICMS notifies the City of Minneapolis traffic group, and the 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.

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

- At the Metro Transit Control Center, the AVL/CAD system has received the information push from the ICM Information Clearinghouse 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 HOV bypass at the on-ramps has helped Metro Transit vehicles remain as close to schedule as possible.

- The Metro Transit system automatically updates the ICMS with a report of the transit travel times and arrival/departure information, as well as the available parking spaces at the park-and-ride lots.

- The ICMS enhancements to the already existing traveler information systems operated by Mn/DOT and Metro Transit inform transit riders of updated arrival/departure information using 'next departure signs' at bus stops, park-and-ride facilities and transit stations, as well as the 511 phone system and Internet pages.

- SouthWest Transit has received a push notification of the incident and notice of 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 ICMS enhancements to the existing 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,
  - 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.

  The ICM traveler information system has also notified a number of commuters who work for companies that participate in a telecommuting/commute delay program. These commuters (as well as their employers) are informed of this incident and the expected delays and clearance time. As a result, a small number of commuters work at home for the first hour of the day, then commute in after the event has cleared.

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 incidents created in the information clearinghouse were set to expire after 2 hours, however were canceled early by RTMC staff when notified that the scene was cleared. Finally, the information clearinghouse presents the cleared event notification to the City and County and all signal timings are returned 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.

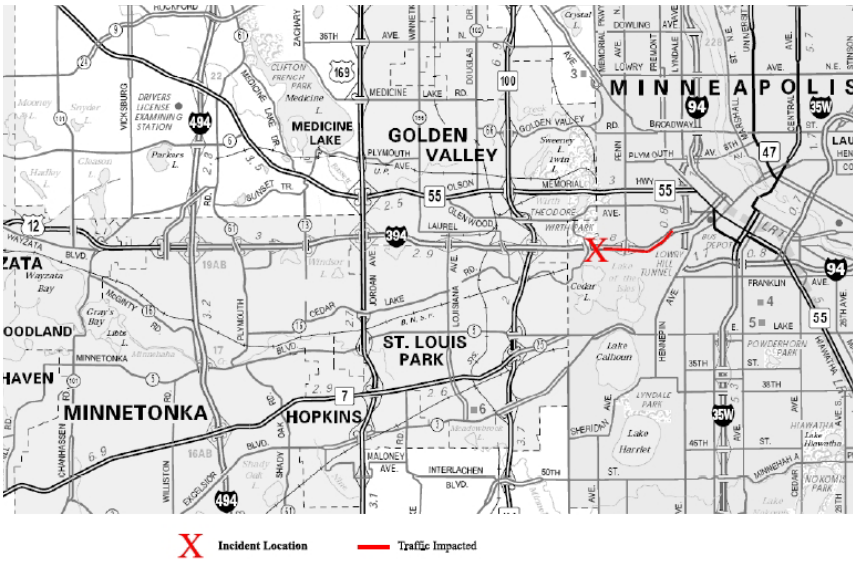
2. Scenario Impacts on Corridor Goals and Objectives

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.

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.

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 I-394 ICMS receives an event report from the State Patrol CAD system describing the location and impacts to traffic. Within seconds, the RTMC operators have seen an icon at their dispatch console alerting them to the event and 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 control software 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.

- 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.

- Operators within the ABC garages are automatically pushed an alert of the westbound crash and impending delays from the ICM integrated traveler information system. 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. Similarly, a static sign reading 'Tune radios to 870 AM when flashing' is next to a flashing alert light. Travelers who tune to this station hear an HAR broadcast from within the structure broadcasting an automatically generated announcement of the event and travel times along alternate routes (no manual intervention to create the audio message).

- The ICMS has automatically pushed a message to the City of Minneapolis operator on-call during the evening commute. The operator is able to access the information clearinghouse from home and, once familiar with the situation, alters the signal timings on several local roads to accommodate the expected influx of traffic as commuters attempt to reach Highway 55 and Highway 7 as quickly as possible.

- The Mn/DOT Arterial Signals group is automatically alerted to the event, and the signals group 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 AVL/CAD system has received the information push from the ICMS 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 has received a push notification of the incident and 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.

- Plymouth Transit agency is 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 incidents created in the information clearinghouse were set to expire after 1 hour and expired without intervention. Finally, the information clearinghouse presents the cleared event notification to the City and County and all signal timings are returned 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.

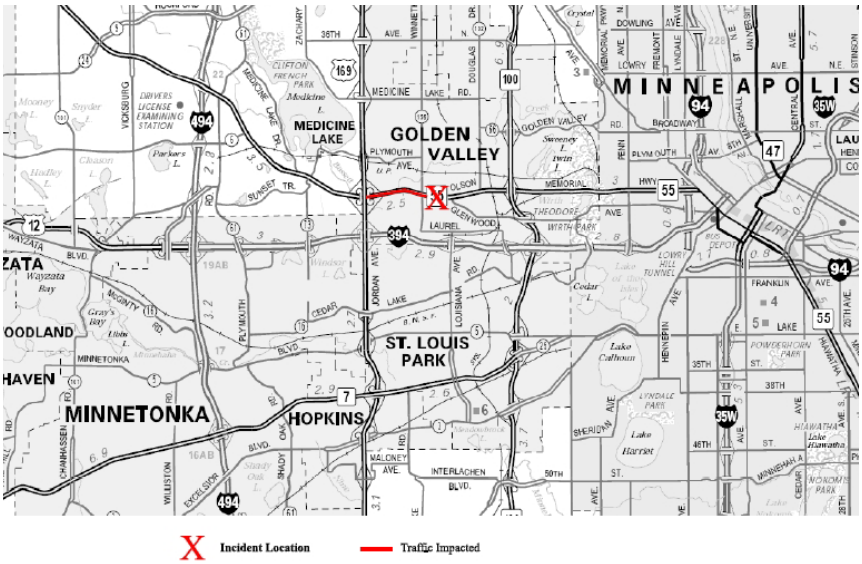
2. Scenario Impacts on Corridor Goals and Objectives

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.

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.

Scenario 3 Illustration



A passenger in a vehicle upstream is stopped behind the crash and phones 911 to report the event within minutes of 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 I-394 ICMS receives an event report from the Hennepin County CAD system describing the geo-located location and impacts to traffic. Within seconds, 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 maintenance dispatch has been alerted by the ICM Information Clearinghouse 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 Mn/DOT arterial signals group is automatically notified by the ICMS and the signals group downloads flush plans to Highway 55 east of the crash site to prepare to clear the queue that has formed.

- 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 AVL/CAD system has received the information push from the ICM Information Clearinghouse 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.

- SouthWest Transit has received a push notification of the incident. In viewing the event and impacts, they shift all the inbound buses to use Highway 100 to access the Crosstown Highway (Hwy 62).

- 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 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.

  The 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. Finally, the information clearinghouse presents the cleared event notification and all DMS signs are returned 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.

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.

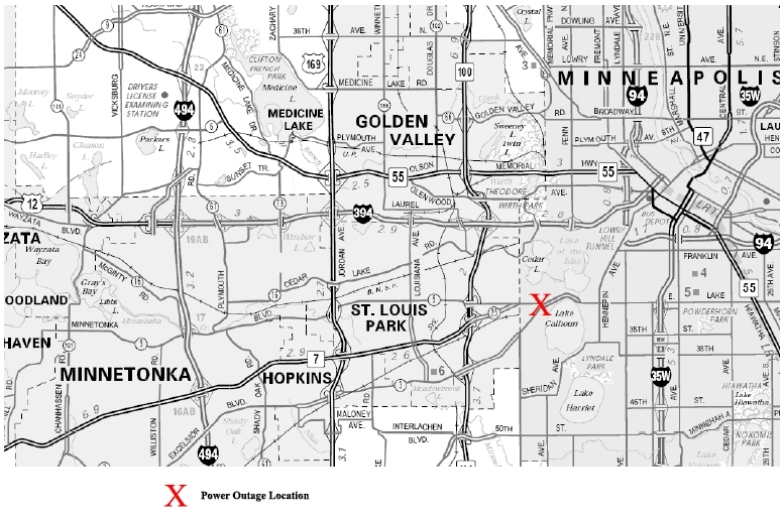
2. Scenario Impacts on Corridor Goals and Objectives

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.

Scenario #4: Infrastructure Reliability Incident

A utility hit causes two traffic signals on Hwy 7 east of Hwy 100 in the City of Minneapolis to lose power at 7:00am with power restoration not expected for two hours.

Scenario 4 Illustration



- The recently upgraded signal controllers utilizing light emitting diodes (LED) operated by the City of Minneapolis include battery backup. The reduced power requirements allow for 2 hours of full operation and an additional 2 hours of flashing red lights.

- The City of Minneapolis traffic management center is alerted to the power outage by the traffic control system, and the operators immediately create an entry in the ICMS. The timing of the event is such that the power will likely be restored within the timeframe that normal operations will continue, and most certainly before the flashing red time expires. Also, the rush hour will be ending in approximately 90 minutes, therefore the incident is not a high priority; however the city police are notified and asked to survey the scene in the event further problems are observed.

- The RTMC dispatchers are alerted by the ICMS. However, because the infrastructure will likely handle the situation, no immediate actions are taken other than to observe the event.

Scenario #4 Recap:

1. Scenario Management and Leadership

This scenario presents a situation where ICM installed systems self-operate to maintain normal conditions. No human response was required.

2. Scenario Impacts on Corridor Goals and Objectives

As a result of the standardized ICM upgrades to key infrastructure, an event that has traditionally been a major problem for morning commutes (i.e. a power outage that these intersections at the eastern-most end of the ICM corridor typically backs up the entire corridor) has not caused any operational problems for commuters.

Scenario #5: 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.

Scenario 5 Illustration

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

- Almost instantaneously, the Transit Control Center AVL/CAD system automatically transfers an incident report to the ICMS relaying information on the event (location and expected impacts). Within seconds, representatives from each ICM stakeholder 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 SouthWest Transit CAD system is populated with an alert of the stalled vehicle by the ICMS. 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 Metro Transit incident response team clears the vehicle onto the available shoulder and within 30 minutes the on-ramp is reopened.

Scenario #5 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.

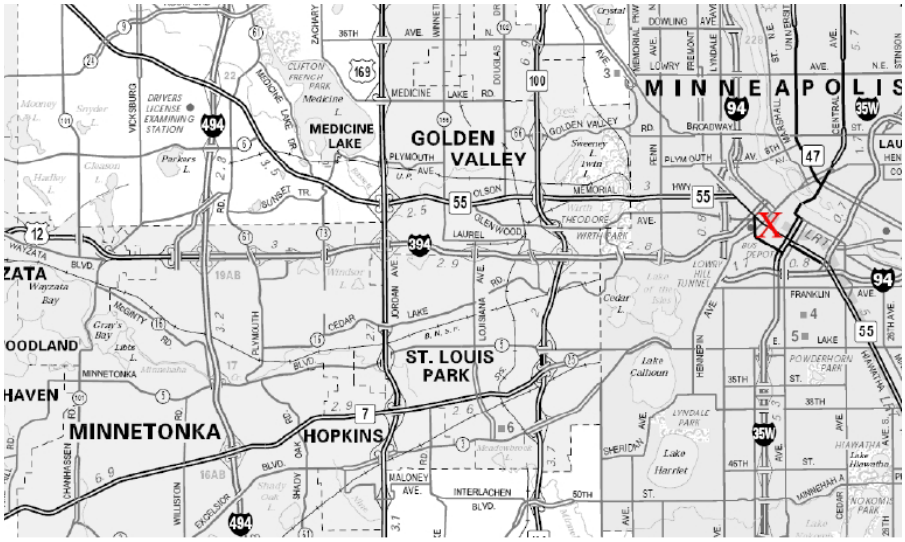
2. Scenario Impacts on Corridor Goals and Objectives

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.

Scenario #6: 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.

Scenario 6 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 automatically populated the ICMS with information on park-and-ride availability, and transit trip planning was available on the Metro Transit website.

- Many ball game attendees have phoned 511, accessed the Internet, or been pushed event reports (based on wireless identities provided when they purchased their tickets on-line) 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.

- Many of the attendees riding transit are regular Mn/PASS users that occasionally ride transit when their schedules allow. Through inter-agency payment relationships (and special event incentives), they have accrued enough credits from transit rider ship during the peak periods that their transit trips during this off-peak planned event day are free for them and their family by swiping their multi-use payment card.

- 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. These plans are implemented, and as a result travel along Hwy 55 is near normal.

- The increased congestion around the ball stadium has caused delays in the initial transit departures. As a result, the transit vehicles heading out Hwy 55 are behind schedule. Therefore, transit priority is activated and the transit buses have recovered the delays before reaching their destinations.

Scenario #6 Recap:

1. Scenario Management and Leadership

The overall ICM management during Scenario #6 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

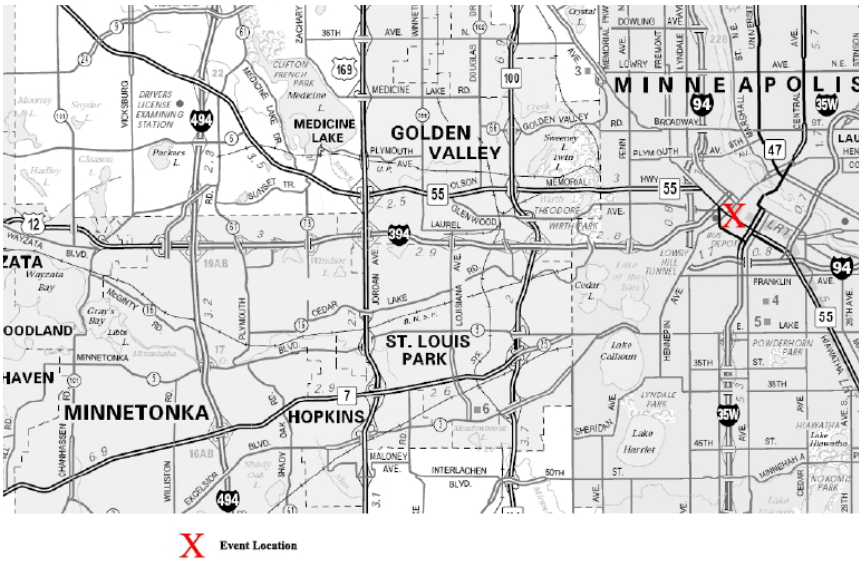
Many attendees to the ballgame are first time or seldom use transit riders, and many of those have made connections to arrive at the game. Throughout their trip home, these riders call 511 or view bus departure/arrival time signs at their stops to understand their connection points and the next departures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

Scenario #7: Major Planned Event Scenario Evening Baseball Game

A weeknight Twins game at the new stadium with an estimated 40,000 attendees is seeing most fans arriving between 5:30 and 6:45pm.

Scenario 7 Illustration



The ball game arrival pattern will overlap with the evening commute time. This will result in attendees attempting to park in facilities still occupied by commuters and a contra-flow of inbound stadium attendees competing with the outbound commuters on the highways. Roughly 20% of the attendees (8,000 individuals) to the game will enter from the western suburbs using the I-394 Corridor.

- The response to this planned event began early about mid-day of the event, when the Metro Transit Control Center automatically populated the ICMS with information on park-and-ride availability, and transit trip planning was available on the Metro Transit Website.

- Many ball game attendees have phoned 511, accessed the Internet, or been pushed event reports (based on wireless identities provided when they purchased their tickets on-line) to understand their travel and parking options for the game.

- While park-and-ride space availability was limited because the commuters would not be vacating their spaces until approximately game time, approximately 4,000 attendees (2,200 vehicles) have been informed of temporary park-and-ride facilities located at malls and church parking lots. Metro Transit is offering free shuttle service from the lots to the on-line transit stops and this increase in capacity has sustained the option of transit for many attendees. The locations of these temporary lots and capacity was available on the Internet and 511 phone system.

- Many of the attendees riding transit are regular Mn/PASS users that occasionally ride transit when their schedules allow. Through inter-agency payment relationships (and special event incentives), they have accrued enough credits from transit rider ship during the peak periods that their transit trips during this off-peak planned event day are free for them and their family by swiping their multi-use payment card.

- Approximately 4,000 attendees (2,200 vehicles) will drive in to the downtown area during the evening peak period. During this timeframe, the reversible lane is supporting outbound (westbound) traffic and the inbound lanes are typically heavy. The additional 2,200 vehicles have caused unusual congestion. Many travelers to Minneapolis on this evening have received pushed information from the ICMS about the increased congestion on I-394. Meanwhile, Hwy 55 and Hwy 7 are experiencing typical light volumes on the inbound. Therefore, many travelers who normally use I-394 (for destinations beyond the ballpark) in the evening period have diverter to alternate routes based on information received. Transit vehicles continue to operate on the shoulders in congested areas.

- Finally, as stadium attendees arrive in downtown, the RTMC system has automatically posted message signs on the DMS along I-394 informing travelers that the ABC garage 'A' is full and recommending that they follow the Exit signs for Garage 'B'.

- As the arrival patterns conclude, the attendees who have driven have followed DMS signs to available spaces. Those that have selected transit are informed of a phone number they can call for arrival and departure information and when they reach the bus stop after the game, they will also view the next departure times for their buses. They have also received verification of the latest time that the shuttle services from the on-line transit stops to the mall/church lots they parked in will depart, and therefore they feel comfortable about their path to arrive back at their vehicles.

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.

Scenario #7 Recap:

1. Scenario Management and Leadership

The overall ICM management during Scenario #7 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

The evening game was anticipated and planned for in advance with incentives for parking transit use and information about alternate parking. These strategies have reduced the number of single occupant vehicles traveling to and from the game and alleviated any parking capacity problems, as well as minimized delays due to increased inbound vehicles. As a result of these precautionary measures, no operational problems occurred and the evening peak period was uneventful. The return trip home after the game was uneventful. The Mn/DOT signals group had implemented the evening peak timing plans for Hwy 55 and Hwy 7 to handle the influx of traffic. With low volumes of general traffic at 10:00 pm (when the game ended), I-394 was able to handle the excess capacity.

Scenario #8: Evacuation Scenario

An emergency evacuation for all downtown Minneapolis has been called due to safety threats on a weekday at about 1:00pm

The ICM initiative and stakeholders were involved in the Mn/DOT evacuation planning process in 2007. As a result, the role of the I-394 Corridor ICM initiative in such evacuations has been designed into the overall metropolitan network evacuation scenario. The Minnesota State Patrol leads the evacuation command structure, and their procedures and policies have been developed around the known tools and capabilities of the I-394 ICM initiative.

- The statewide Emergency Operations Center (EOC) in St. Paul is activated and representatives from Mn/DOT, Metro Transit, State Patrol, Hennepin County and City of Minneapolis (all informed of the ICM capabilities and procedures) join others in response to the evacuation.

- The ICM stakeholder representatives at the EOC have access to the ICM Information Clearinghouse server. These representatives serve as a conduit informing others at the EOC of information shared through the ICMS and entering any critical information learned at the EOC into the ICM Information Clearinghouse.

- The ICMS is instrumental in the EOC response to the need for the evacuation, given the considerable information on what lanes are closed, what intersections are not operational, and what the congestion levels and travel times are on routes throughout the corridor.

Scenario #8 Recap:

1. Scenario Management and Leadership

The overall ICM management during Scenario #8 would be provided by the Mn/DOT RTMC Freeway Operations Team. The Emergency Operations Management Team would activate an emergency operations center and manage the evacuation. The role that ICM plays in facilitating this evacuation would be managed by the RTMC Freeway Operations Team.

2. Scenario Impacts on Corridor Goals and Objectives

The ICM strategies have allowed the emergency operations center to fully understand the capabilities and limitations of the I-394 Corridor. As a result, many of the arterials were used as evacuation routes in addition to the freeway. Also, the knowledge of where transit vehicles were located and the number of passengers on-board allowed for transit dispatchers to re-route many vehicles to pick up additional passengers. As a result, the evacuation process avoids lengthy congestion on some routes while other routes are

empty. Instead, a combination of many routes is used and the time of congestion is limited.

Scenario #9: Weather Incident Scenario

A unexpected snow storm is starting around 9:00am 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.

- At approximately 11:00am many businesses have decided to close early for the day and many commuters are returning home from the downtown area.

- RTMC operators activate the reversible HOT lane to be outbound earlier than normal as the peak outbound commute begins at approximately 11:00am.

- 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 Metro Transit Control Center is regularly updating the ICMS with 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.

- Representatives from the Mn/DOT arterial signals group have been activated to the RTMC and are observing the cameras with an interest on the signal progression. 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 signs, parking garage kiosks and 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 #9 Recap

1. Scenario Management and Leadership

The overall ICM management during Scenario #8 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.

Scenario #10: Major Event on a Secondary Arterial Impacting a Freeway

On a weekday evening about 5:00pm, a flatbed carrying pallets has collided with another vehicle on County Hwy 73 just after exiting from I-394. The result is a spilled load with an estimated time to clear of two hours. This incident is backing up the exit from westbound I-394 on to County Hwy 73. The County Hwy 73/I-394 interchange hosts two major park-and-ride facilities and is a major destination for outbound transit buses (as well as commuters and carpoolers) at this time.

- The crash has caused a blockage on the westbound I-394 Exit at County Hwy 73, resulting in a queue forming on to I-394. The crash is initially reported by a good samaritan calling 911. The 911 call is answered by Minnesota State Patrol. Since the event occurs on a county road, the call is transferred to Hennepin County dispatch. The dispatcher who takes the call enters the event in the CAD system and announces the event on the 800 Mhz talk channel. Immediately, the crash summary is automatically transferred to the ICMS.

- As the queue builds into the general travel lane of westbound I-394, congestion soon results. In response to this, the Mn/PASS subscribers quickly divert to the HOT lane and as the HOT traffic builds, the variable pricing soon automatically changes to a current rate of $3.50.

- At the Metro Transit Control Center, the dispatchers quickly observe that there are 5 transit vehicles (at various stages of their route) en-route to the park-and-ride facility on County Hwy 73. While these vehicles could use the shoulder or HOT lane, the queue on the exit ramp is not moving and County Hwy 73 is at a stand-still at the intersection of I-394. The transit dispatchers quickly determine the best route to reach the park-and-ride using an alternate exit and arterial streets that parallel I-394. With the benefits of transit priority and shoulder access, the transit vehicles drop the passengers at the park-and-ride with only 10 minutes of delay. The combination of the open freeway and transit priority upon exiting on arterial streets quickly allows the transit vehicles to recover their scheduled arrival/departure times.

- The duration of the incident is such that extensive delays occur on westbound I-394. Commuters exiting the ABC garage are informed of this event through kiosks and HAR radio broadcasts and most commuters select Hwy 55.

- The Mn/DOT arterial group receives an automated notification of the event and implements a planned set of timings to help flush excess demand on Hwy 55.

- The City of Minneapolis traffic control center is not staffed at this time. However, the on-call representative receives a page and, after studying the event, implements a special event timing scheme for intersections around the ABC garages to anticipate the excess traffic reaching Hwy 55.

Scenario #10 Recap:

1. Scenario Management and Leadership

The overall ICM management during Scenario #10 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

After several hours on scene, the incident is cleared. The impacts of this surface street incident on the mainline freeway have been extensive. However, with re-routed transit vehicles and diverted commuters in automobiles, the impacts have been minimized.

Scenario #11: Daily Operational Scenario (Recurring Congestion)

- A series of regular automated processes operate on a daily basis within the I-394 Corridor. These include:
    1. The Metro Transit CAD/AVL system regularly monitors bus arrival/departure information and reports transit travel times and schedule adherence on routes to the ICMS;
    2. Sensors at many of the park-and-ride facilities monitor the available parking capacity and reports capacity to the Information Clearinghouse;
    3. RTMC sensors and systems compute current travel times on I-394, Hwy 55, and Hwy 7;
    4. When transit vehicles are behind schedule and meet other criteria, transit signal priority is activated and extends the green times on approaches to signalized intersections;
    5. The locations and types of incidents, combined with observed volumes and speeds, are used to automatically calculate the most appropriate variable speed limit to be posted on I-394 to maintain safe traffic flow;
    6. Inter-agency payment processes regularly deduct money from one account per traveler (or household) when travelers use transit, park in designated lots, or use the Mn/PASS lanes;
    7. Incidents in the CAD systems of the three participating law enforcement agencies are automatically shared with the ICMS.

- Planned roadwork, maintenance and special events are manually entered into the ICMS by the responsible agencies.

- Incidents reported to city, county and state 911 dispatchers, to RTMC operators, and to transit dispatchers are entered into their respective CAD systems for automatic sharing.

- At the Metro Transit Control Center, the AVL/CAD system is used by the dispatchers to monitor the bus status and other observed incidents throughout the corridor. Transit signal priority, bus shoulder access, and use of the HOT lanes helps buses remain on schedule (wherever the limited bus on shoulder access is allowed). However, dispatchers take initiative to act whenever buses become behind schedule beyond an agreed threshold by either altering routes, or altering pickup procedures.

- SouthWest Transit receives alerts to freeway conditions throughout the corridor. They are particularly sensitive to closures on the shoulders as they prefer to send buses down corridors that have open shoulders (where travel is allowed).

- Plymouth Transit receives alerts to freeway and arterial conditions. They typically follow a set path along the corridor (joining I-394 west of County Hwy 73) however

as they have no pickups beyond the park-and-ride facility on County Hwy 73 and Hwy 55, they may continue on Hwy 55 if I-394 is congested.

- The ICMS uses push and pull tools to inform travelers of travel times on the parallel ICM commuter routes as well as transit routes. The information system informs travelers of parking availability at the park-and-rides and at the downtown garages. Some users receive push notices of varying Mn/PASS rates.

- The traveler information system supports home and work Internet use, mobile phone and text messaging tools, and DMS signs for en-route information. Pre-trip information within the corridor includes kiosks and HAR at the downtown parking garage to inform travelers before exiting the garage of conditions or recommendations for travel.

- The traffic management tools used on a daily basis include ramp meters, DMS signs, signal timing and coordination, variable speed limit signs, reversible lanes, HOT lanes and FIRST vehicles.

As a result of the ICM response procedures and cooperation among the ICM stakeholders, travelers no longer are surprised by long delays, but rather are notified of potential delays and informed of their options for avoiding these delays. As a result, the recurring congestion and small fluctuations in congestion rarely has an impact on commuters and most arrive within 3-5 minutes of their estimated arrival times.

Glossary of Acronyms

AVL	Automatic Vehicle Location
CAD	Computer Aided Dispatch
CCTV	Closed Circuit Television
CBD	Central Business District
CSAH	County State Aid Highway
DMS	Dynamic Message Signs
FIRST	Freeway Incident Response Safety Team
HAR	Highway Advisory Radio
HOV/HOT	High Occupancy Vehicles / High Occupancy Toll
Mn/PASS	The Minnesota HOT lanes operated along I-394
MTCC	Metro Transit Control Center
RTMC	Regional Transportation Management Center
ABC	A,B,C Garages (previously referred to as Third Avenue Distributor (TAD) garages - Garages are located at the terminus of the corridor
US TH	United States Trunk Highway

Appendix A: Sample Concept Developed Among ICM Stakeholders to Define a Relationship and Begin Integration of Services

I-394 Corridor – Integrated Corridor Management
Manual Information Exchange Concept

1. Overview

One goal of the Integrated Corridor Management (ICM) initiative is to establish and maintain an integrated operations approach to event and incident management. To this extent, the ICM concept will seek to minimize the unplanned spillover of traffic on to local roads (that are not designed to handle the increased demand) by managing traffic and informing travelers to utilize the most appropriate routes that are capable of safely and effectively moving the traffic.

The Mn/DOT Regional Transportation Management Center (RTMC) operators currently are alerted to crashes and incidents on the freeway system through an automated (view only) terminal accessing the Minnesota State Patrol Computer Aided Dispatch (CAD) system. However, information about key primary arterials in the area is not currently accessible to RTMC operators. Therefore, Mn/DOT is hoping to establish a communication channel in order to learn (in real-time) about crashes, road closures, and other major incidents on the arterial streets throughout the I-394 Corridor. This will enable RTMC operators to post messages on the 511 phone system, public web pages, and radio broadcasts; and manage traffic through the use of Dynamic Message Signs (DMS), ramp meters and signal timings as appropriate.

2. The Concept

The long term vision is to include a strategy in the ICM initiative proposing to establish an automated link that would allow RTMC operators to receive information on major events from both the City of Minneapolis and Hennepin County's CAD system. However, this vision of automated data exchange is at least 12-24 months in to the future.

The current proposal is to make use of the Inter System radio talk group on the 800 Mhz radio system to allow the county and city dispatchers to relay notification of major events to the RTMC operators on duty.

The concept of this manual (and eventual automated) data exchange is also to promote a more unified flow of information to private sector information service providers and media outlets (e.g. Metro Networks and other TV and Radio media providers), and ideally prevent these outlets from having to contact individual 911 dispatch centers

directly. The RTMC already communicates information on incidents and events on freeways metro-wide to these private information providers using an automated data exchange. The inclusion of county and city incidents would add to the information relayed to these providers. Figures 1 and 2 (on the last page of this document) present the current flow of information and the proposed flow of information.

3. Information Exchange Definition

The following bullets define the parameters for what and when events will be communicated to the RTMC:

- ***Time Parameters***. The manual information exchange is only possible during those hours that the RTMC is staffed and operational, as follows:
  - 5:30am – 8:30pm M-F
  - 10:00am – 6:00pm Sat
  - 11:00am – 7:00pm Sun

- ***Event type parameters.*** The intent is to communicate notice of those incidents expected to last more than 15 minutes and causing a major impact on traffic flow, resulting in expected traffic delays of more than 10 minutes. These would include:
  - Road or lane closures;
  - One or more passenger (or response) vehicles blocking a lane on a major travel route.

- ***Location parameters – Hennepin County.*** The following are requested locations to consider reporting to the RTMC, when possible:
  - TH 55 (CR 19 to Minneapolis Boundary)
  - TH 7 (CR 19 to TH 100)
  - CR 101 (TH 55 to TH 7)
  - US 169 (TH 55 to TH 7)
  - TH 100 (TH 55 to TH 7)

- ***Location parameters – City of Minneapolis.*** The following are requested locations to report to the RTMC, when possible:
  - Lake Street
  - Portland Avenue
  - Hiawatha Avenue
  - Park Street
  - Lyndale Avenue
  - Hennepin Avenue

- ***Event content.*** The RTMC operators are most interested in obtaining a quick summary of the event, and are not expecting detailed information. The RTMC is happy to receive these reports in the format of established city and county procedures. The following are suggested reporting procedures, provided for examples:
  - *Brief description of incident (e.g. 'crash', 'stalled vehicle')*

- *Impact on traffic (if known) (e.g. 'stopping traffic', 'causing minor delays')*
- *Location (e.g. 'on 55 East of I-494', 'on 7 at hwy 169')*

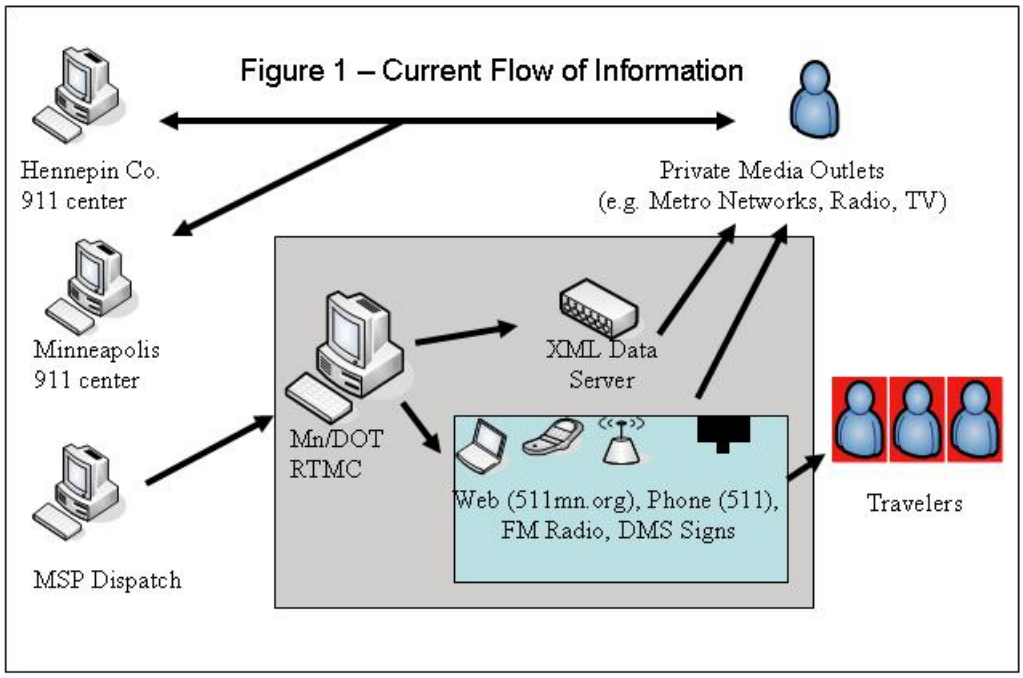


Figure 1 – Current Flow of Information
Hennepin Co.
911 center
Private Media Outlets
(e.g. Metro Networks, Radio, TV)
Minneapolis
911 center
XML Data
Server
Mn/DOT
RTMC
Web (511mn.org), Phone (511),
FM Radio, DMS Signs
Travelers
MSP Dispatch

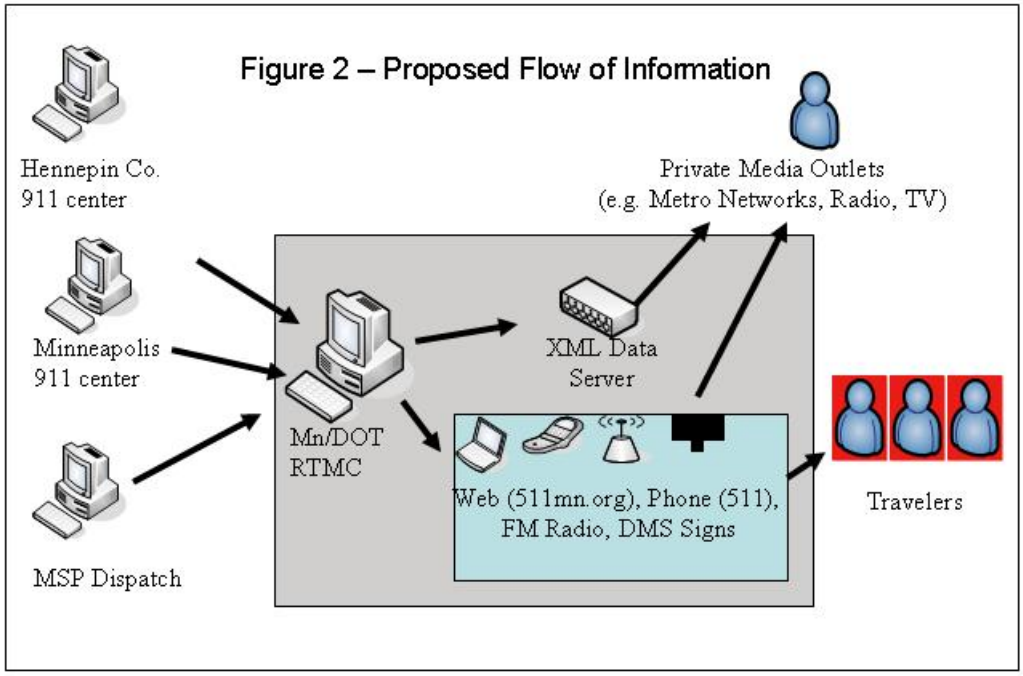


Figure 2 – Proposed Flow of Information
Hennepin Co.
911 center
Private Media Outlets
(e.g. Metro Networks, Radio, TV)
Minneapolis
911 center
XML Data
Server
Mn/DOT
RTMC
Web (511mn.org), Phone (511),
FM Radio, DMS Signs
Travelers
MSP Dispatch

Appendix B: Tabular Summary of the I-394 ICM Strategies

Appendix A contains a summary table of each recommended strategy, the local applications of each strategy, the roles of each stakeholder agency in implementing, integrating, and Operating Each Strategy, and the relationships and dependencies among each strategy application

<Appendix B is a separate MS Word Document Submitted with this Concept of Operations Document>