Minnesota Guidestar Program: Deployment Assessment

Prepared for: **Minnesota Department of Transportation**

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Introduction

This Minnesota Guidestar Program: Deployment Assessment was created by the Minnesota Department of Transportation (Mn/DOT), in cooperation with other transportation stakeholders. The intent was to assess current programs and future opportunities for deployment of Intelligent Transportation System (ITS) projects in Minnesota that focus on safety and mobility. The assessment document is divided into two sections. Section 1 provides a "Background and Building a Foundation for Success". Section 2 builds on Section 1 by providing information on "Future ITS Deployments in Minnesota".

This assessment focuses on safety and mobility as the most important ITS applications in Minnesota and reflects Minnesota's short, medium, and long-term needs and operational objectives.

The overriding goal of this project was to develop an assessment in sufficient detail that Mn/DOT can use the assessment to help establish priorities and secure funding for ITS deployment projects that improve safety and mobility in Minnesota. Toward that goal, *Chapter 9* identifies two ITS program initiatives, the Minnesota Guidestar Mobility Initiative and the Minnesota Guidestar Safety Initiative.

Funding and deployment of these ITS projects represents a recognition of the need and value of ITS plus Minnesota's commitment to the future.

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Table of Contents

List of Tables

List of Figures

List of Appendices

Executive Summary

> Overall this assessment is not just about technology and projects, it also provides a framework for building a program that addresses safety and mobility needs using ITS.

The Minnesota Guidestar Program: Deployment Assessment was created to assess the potential for deployment of Intelligent Transportation System (ITS) projects in Minnesota that focus on transportation safety and mobility. The goal was to develop an assessment in sufficient detail that the Minnesota Department of Transportation (Mn/DOT) could use it to help secure funding for the selected ITS safety and mobility projects. Section 1 of the assessment reviews how Minnesota's background in ITS programs serves as a foundation for future success. Section 2 provides an assessment of future ITS deployment opportunities in Minnesota, including a list of potential projects to meet the short, medium, and long-term needs and operational objectives of Minnesota.

SECTION 1: BACKGROUND AND BUILDING A FOUNDATION FOR SUCCESS

Minnesota is a national leader in the development of ITS programs due to early recognition of the value and need for ITS technology. Minnesota's Guidestar program, the University of Minnesota (U of M) Center for Transportation Studies, and the U of M ITS Institute have been involved in establishing ITS programs, concepts, and research in Minnesota, as well as through cooperative programs with other stakeholders. Mn/DOT staff has worked with the Federal Highway Administration (FHWA) in developing advanced ITS programs, including the National Mayday Readiness Initiative, Vehicle Infrastructure Integration (VII), Cooperative Intersection Crash Avoidance Systems (CICAS), and the National Surface Transportation Weather Observing and Forecasting System (Clarus).

Minnesota's ITS programs and ITS deployments exist to address serious problems of highway safety and mobility. Users of Minnesota's transportation systems expect the systems to be safe and to meet their mobility needs. It is anticipated that further ITS project deployments can play a major role in reducing the number of deaths each year on Minnesota roads towards a goal of zero deaths.

In the early years of the Guidestar program, major program funding was through congressional earmarks. Congressional earmarks worked well for early studies, research planning, and operational tests. As the possibilities for ITS were fully realized, a more stable and reliable funding program, that incorporated ITS into the regular ongoing transportation programs, was necessary for long-term planning. The Safe, Accountable, Flexible, Efficient, Transportation Equity Act-Legacy for Users (SAFETEA-LU) program, passed by the United States Congress in 2005, sets the stage for incorporating ITS into the Minnesota Statewide Transportation Improvement Plan (STIP) on an equal basis with all other transportation projects. Funding for ITS will now be incorporated with, or compete with, all other transportation projects for priority and funding. The Minnesota Guidestar Program Deployment Assessment will be a major vehicle for identifying, prioritizing, and incorporating critical ITS projects into the Minnesota STIP in order that they can be funded with other transportation projects.

Beginning with the Guidestar program in the late 1980s, a continuing series of studies, plans, and research efforts have focused on defining and providing a vision of ITS in the future. In many cases, Minnesota efforts pushed the ITS envelope and have helped set the stage for utilizing and incorporating ITS in the state and national transportation infrastructure. In the past year, two very significant documents have been published that provide strategic advice and direction for ITS deployment in Minnesota. The first document, "The Guidestar Board of Director's Statewide ITS Strategic Plan 2006: An Action Plan for ITS Development and Deployment" (ITS Strategic Plan 2006) was published in June 2006. The second was the Minnesota ITS Safety Plan (ITS Safety Plan) officially distributed on October 31, 2006. This Minnesota Guidestar Program Deployment Assessment supports these plans and takes the next step by assessing and identifying a series of ITS programs and projects for the short, medium, and long-term needs and objectives of Minnesota.

With its early involvement in ITS, and the significant history of successful planning, testing and implementation of ITS technology, Minnesota is poised to continue as a national leader in deployment of ITS for the safety and mobility of its citizens.

SECTION 2: FUTURE ITS DEPLOYMENTS IN MINNESOTA

A critical step in developing the deployment assessment was the gathering of information, ideas, and data from stakeholders and the experts who will be responsible for implementing the ITS technology projects selected. Many of the stakeholders and experts have been involved in developing current Minnesota Guidestar projects and other ITS programs. To gather input from as many stakeholders and experts as possible, six Minnesota stakeholder workshops were conducted, key Minnesota and Non-Minnesota program leaders were interviewed, and relevant national and international ITS deployment initiatives were assessed.

From these sources, the ITS Strategic Plan 2006, and the ITS Safety Plan, over one hundred deployment **ELEMENTS** (suggestions, initiatives, technology uses, and ideas) addressing specific safety and mobility needs in Minnesota were identified. These elements were also matched with needs identified in the Mn/DOT District 2, 3A, 4 and 8 Scoping Studies, Highway Safety Operations Plan, FHWA Initiatives, SAFETEA-LU, and other documents. Key stakeholders, at various times, reviewed the elements to ensure they align well with the stakeholders' specific needs and priorities.

The elements collected were then used to define thirteen general broad based **PROGRAM STRATEGIES** for deployment in 2½, 5 and 10-year time periods. Each program strategy may include several different and potentially overlapping elements. To evaluate the program strategies a set of selection and prioritization criteria was developed. The selection criteria used was based upon strategic and programmatic objectives identified in other program related documents, such as the ITS Strategic Plan 2006, as well as related factors.

To implement the Program Strategies fourteen **PROJECTS** were identified. Each project selected incorporates several of the most applicable and highly valued Program Strategies that meet the overall program goal of safety and mobility. Based on input provided by the ITS Deployment Assessment Team, project descriptions were developed including project objectives,

cost estimates including operations and maintenance costs, performance measures, along with potential institutional issues.

The following listing contains the Minnesota Guidestar Program: Deployment Assessment Projects that were selected. These projects are designed to stand alone, to complement, to be incorporated with, and/or to be concurrently developed as part of ongoing scheduled transportation construction projects. When necessary to better define the path to full deployment, innovative development projects or operational tests that advance the state of knowledge are included. This listing of projects does not indicate a ranking by priority; they are numbered as a means of identification.

Minnesota Guidestar Program: Deployment Assessment Projects

Project 1:	Implement dynamic lane control and variable speed limit signs
Project 2:	Implement Hard or High Occupancy Toll (HOT) shoulder concept
Project 3:	Complete Regional Traffic Management Center (RTMC) traffic management instrumentation
Project 4:	Expand RTMC traffic management systems to arterials
Project 5:	Expand RTMC travel time display locations
Project 6:	Implement contraflow lanes
Project 7:	Convert existing High Occupancy Vehicle (HOV) lanes to HOT lanes utilizing MnPASS
Project 8:	Deploy integrated corridor management
Project 9:	Expand first responder and law enforcement systems
Project 10:	Implement Automatic Vehicle Location (AVL) technology
Project 11:	Expand interconnection between the RTMC and the Transportation Operations and Communications Centers (TOCCs)
Project 12:	Implement collision warning systems at rural highway intersections
Project 13:	Deploy automated enforcement
Project 14:	Develop a test bed for Vehicle Infrastructure Integration (VII)

Funding: Since project development and funding process for ITS has fundamentally changed under the federal SAFETEA-LU legislation this assessment becomes the first step in recognizing and utilizing the STIP planning process for ITS deployments. Safety and mobility are important public issues and the projects proposed by this assessment are important to the citizens of Minnesota. However, statewide Minnesota has many critical transportation needs and there is never enough funding to fully meet these needs. The assessment looked at two major options for funding ITS safety and mobility projects.

Option 1. Program and fund the safety and mobility projects as major, total recognizable, statewide safety and mobility program initiatives. This option develops one major program initiative for safety projects (MINNESOTA GUIDESTAR SAFETY INITIATIVE) funded at $50,275,000, and one major program initiative for mobility projects (MINNESOTA GUIDESTAR MOBILITY INITIATIVE) funded at $88,225,000. Since this option has the advantage of national name and commitment recognition it has the potential to attract major funding at the national level. It could also more effectively compete with other major national programs for funding. The disadvantage is that the overall cost can limit the potential for programming and funding through the STIP process.

One-page handouts have been developed to provide a quick reference and overview of the safety and mobility project initiatives (option 1) developed by the assessment and are in included in *Chapter 9* of this document. They are titled: **MINNESOTA GUIDESTAR MOBILITY INITIATIVE** and **MINNESOTA GUIDESTAR SAFETY INITIATIVE**

Option 2. Program and fund the individual safety and mobility projects through the standard Mn/DOT STIP programming process. This option has the advantage of projects being processed individually and of being incorporated into the mainstream STIP with other transportation projects as they are developed. The disadvantage is that the individual projects compete with construction projects and could be lost to competing funding. As a result of the integrated funding process innovative corridor or system-wide ITS projects may never be developed.

It is important to note that this assessment recognizes two funding options and that these options should move forward concurrently.

Common Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ABS	Antilock Brake System
APTS	Advanced Public Transportation Management
ARMER	Allied Radio Matrix for Emergency Response
ARTIC	Advanced Rural Transportation Information Coordination
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management Systems
ATSS	Advanced Transportation Safety Systems
ATP	Area Transportation Partnerships
AUSCI	Adaptive Urban Signal Control and Integration
AVL	Automated Vehicle Location
B/C	Benefit/Cost
CAD	Computer Aided Dispatch
CARS	Condition Acquisition and Reporting System
CCTV	Closed Circuit Television
CHSP	Comprehensive Highway Safety Plan
CICAS	Cooperative Intersection Crash Avoidance Systems
Clarus	National Surface Transportation Weather Observing and Forecasting System
CVISN	Commercial Vehicle Information Systems and Networks
CVO	Commercial Vehicle Operations
COMMS	Communications Infrastructure
DARTS	Duluth Area Resources and Transportation for Seniors
DMS	Dynamic Message Signs
DPS	Minnesota Department of Public Safety
DSRC	Dedicated Short Range Radio Communication
Elements	Suggestions, initiatives, technology uses and ideas from many sources that could address specific safety and mobility needs in Minnesota
EM	Emergency Management
EIS	Environmental Impact Study
ESC	Electronic Stability Control
EVP	Emergency Vehicle Preemption
FHWA	Federal Highway Administration
FIRST	Freeway Incident Response Safety Team
Four E's	Engineering, Education, Enforcement, Emergency medical systems
FTE	Full Time Equivalent
GAINS	Guidestar Advanced In-Vehicle Navigation Systems
GDAAP	Guidestar Deployment Assessment Action Plan
Hard Shoulder	Un-priced Shoulder Use
HOT	High Occupancy Toll (Priced Shoulder Use)
HOV	High Occupancy Vehicle
HRI	Highway/Rail Intersections
HSOP	Highway Systems Operations Plan – For maintenance
HS	Homeland Security

Common Acronyms

ICTM	Integrated Corridor Traffic Management
IBEC	International Benefits, Evaluation, and Costs
ISTEA	Intermodal Surface Transportation Efficiency Act
ITS	Intelligent Transportation Systems
ITS Safety Plan	Minnesota ITS Safety Plan
ITS Strategic Plan 2006	Minnesota Guidestar Board of Director's Statewide ITS Strategic Plan 2006: An Action Plan for ITS Development and Deployment
IVI	Intelligent Vehicle Initiative
MDSS	Maintenance Decision Support System
MC	Maintenance and Construction Management
MDCs	Mobile Data Computers
Mn/DOT	Minnesota Department of Transportation
MPO	Metropolitan Planning Organization
MSP	Minnesota State Patrol
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NIT	Non-Intrusive Technologies
OTSO	Minnesota Department of Transportation Office of Traffic, Security, and Operations
PNITDS	Portable Non-Intrusive Traffic Detection System
PPP	Public Private Partnerships
PSS	Public Safety Systems
Program Strategies	General broad based strategies for deployment of the Elements collected in 2½, 5, and 10 year time frames
Projects	Projects proposed for implementation as part of this Deployment Assessment. A project may include several program strategies
RTMC	Regional Traffic Management Center
RWIS	Road Weather Information Systems
RDC	9-Regional Development Commissions
RDS	Radio Data Systems
SAFETEA-LU	Safe, Accountable, Flexible, Efficient, Transportation Equity Act-Legacy for Users
SOV	Single Occupancy Vehicle
SHSP	Strategic Highway Safety Plan
SHVSP	Statewide Heavy Vehicle Safety Plan or Program
STIP	Statewide Transportation Improvement Plan
TC&W	Twin Cities and Western Railroad
TIGER	Traveler Information, Guidance and Evacuation Routing
TEA 21	Transportation Equity Act for the 21st Century
TIP	Transportation Improvement Plan or Program
TOCC	Transportation Operations and Communications Centers
TZD	Toward Zero Deaths
USDOT	United States Department of Transportation
U of M	University of Minnesota
VII	Vehicle Infrastructure Integration

SECTION 1: BACKGROUND AND BUILDING A FOUNDATION FOR SUCCESS

1 Background, Purpose, and Goals

Minnesota is a national leader in the development of Intelligent Transportation System (ITS) programs due to early recognition of the value and need for ITS technology. Minnesota's Guidestar program, the University of Minnesota (U of M) Center for Transportation Studies, and the U of M ITS Institute have been involved in establishing ITS programs, concepts, and research in Minnesota, as well as through cooperative programs with other stakeholders. Minnesota Department of Transportation (Mn/DOT) staff has worked with the Federal Highway Administration (FHWA) in developing advanced ITS programs, including the National Mayday Readiness Initiative, Vehicle Infrastructure Integration (VII), Cooperative Intersection Crash Avoidance Systems (CICAS), and the National Surface Transportation Weather Observing and Forecasting System (Clarus). All of these program efforts and initiatives are aimed at improving transportation safety, improving mobility, and enhancing productivity. (Additional detail is provided in *Sub-chapter 3.2: Relevant National ITS Deployment Initiatives*).

Moving beyond research, Mn/DOT has deployed ITS technology in a number of successful projects including Transportation Operations and Communication Centers (TOCC), Road Weather Information Systems (RWIS), 511-telephone and internet traveler information, and the Traveler Information Guidance and Evacuation Routing (TIGER) project. (Additional detail on these projects and programs is provided in *Sub-chapter 3.3: Minnesota ITS Deployments*.) Projects using ITS technology have now become accepted and used as additional tools to help increase transportation safety and mobility in Minnesota. Mn/DOT sees a strong benefit to the citizens of Minnesota with the additional deployment of ITS safety and mobility projects as rapidly as possible.

At the national level, funding for the U. S. Department of Transportation (USDOT), as part of Safe, Accountable, Flexible, Efficient, Transportation Equity Act-Legacy for Users (SAFETEA-LU), has placed additional emphasis and focus on improving transportation safety and mobility nationwide. Minnesota is well positioned to move forward with programs and projects that can utilize federal and other funding for the deployment of ITS technology. This Guidestar Program Deployment Assessment serves as a starting point for the next stage of ITS deployment in Minnesota in accordance with this assessment's purpose and goal.

Purpose

To perform a program assessment for deployment of ITS projects in Minnesota that focuses on transportation safety and mobility. The plan will reflect Minnesota's short, medium, and long-term needs and operational objectives while identifying and illustrating how the needs and goals align with the objectives of the USDOT and other potential partners.

Goal

The goal of this plan is to develop an assessment in sufficient detail that Mn/DOT can use this assessment to help secure funding for ITS deployment projects that improve safety and mobility in Minnesota.

2 Minnesota Guidestar ITS Strategic Plan 2006/ITS Safety Plan

In the past year, two very significant documents have been published that provide strategic advice and direction for ITS deployment in Minnesota. The first document was "The Minnesota Guidestar Board of Director's Statewide ITS Strategic Plan 2006: An Action Plan for ITS Development and Deployment" (ITS Strategic Plan 2006) published in June 2006. The second was the "Minnesota ITS Safety Plan" (ITS Safety Plan) officially distributed on October 31, 2006.

2.1 Minnesota Guidestar Strategic Plan

The ITS Strategic Plan 2006 is the Guidestar's Board of Directors guide for the development and deployment of an integrated statewide ITS program. The plan is intended to be used by the Board of Directors, as well as by the vast community of ITS providers and stakeholders, to promote the development, deployment, and use of ITS statewide. Cooperation of all groups involved with ITS, transportation planning, design, funding, and implementation will help realize the full potential that this plan provides for Minnesota. The ITS Strategic Plan 2006:

1. Provides a historical overview of the Minnesota Guidestar program and key projects that have been deployed since the 1997 Strategic Plan was adopted;

2. States the Board's mission and its vision and goals for ITS;

3. Explores impediments to ITS deployment and issues that need to be addressed;

4. Identifies a deployment program framework, as well as research, development, and deployment strategies;

5. Develops an Action Plan showing short, medium and long-term research, operational tests and deployment projects for use by Mn/DOT and other agencies, institutions, cities, and counties as a roadmap for where future ITS investments will be made.

The ITS Strategic Plan 2006 is an update of ITS Strategic Plan 2000 and the Statewide ITS Development and Deployment Plan (2002). The foundation for the current update was a Board of Directors' retreat conducted in spring 2006. The retreat offered a forum for the Board to discuss and develop the future direction for ITS in Minnesota.

Development of the ITS Strategic Plan 2006 incorporates information from a variety of sources, including:

- The Statewide ITS Strategic Plan 2000
- The 2002 Statewide ITS Development and Deployment Plan
- Current and anticipated Minnesota Guidestar initiatives and program activities

- The 2006 retreat attended by the Minnesota Guidestar Board of Directors and staff
- Continued input from the Minnesota Guidestar Board of Directors, other key stakeholders, the Executive Committee, and Minnesota Guidestar's Outreach and Implementation Teams

Both the ITS Strategic Plan 2006 and this deployment assessment recognize Minnesota as a long-time leader in the development and deployment of ITS solutions. Currently, several major USDOT sponsored ITS initiatives identified in the ITS Strategic Plan 2006 for Minnesota are being developed to save lives, prevent injuries, and relieve congestion on U.S. roadways. Through past work on ITS, Minnesota has gained the expertise to continue as a national leader in ITS deployment. This assessment will facilitate the development and deployment of ITS projects, which reflect the needs and operational objectives identified in the ITS Strategic Plan 2006.

2.2 Minnesota ITS Safety Plan

The Minnesota ITS Safety Plan is a companion document to the Minnesota Comprehensive Highway Safety Plan (CHSP), the Minnesota Statewide Heavy Vehicle Safety Plan (SHVSP), and the Toward Zero Deaths (TZD) program. All three plans and the TZD program have a common goal (reducing fatal and life changing injuries), share a common ancestry, and had a similar development process (based on outreach to safety partners). Additionally, each plan presents a comprehensive approach and set of strategies for addressing identified safety needs in their designated areas.

The purpose of the ITS Safety Plan was to develop ITS strategies and initiatives that reduce the number of vehicle traffic fatalities and serious injuries on Minnesota roadways. The ITS safety planning and development efforts resulted in identifying six ITS Critical Strategies supported by 22 ITS Safety Initiatives. The selected initiatives advance the six ITS Critical Strategies, which are proactive in their approach to reducing the number of fatalities on Minnesota roadways. The ITS Safety Plan supports safety programs and provides a plan for the implementation of ITS safety strategies and initiatives for Mn/DOT and other stakeholders.

Mn/DOT is in the process of revising the Minnesota CHSP. The revised document will incorporate the ITS Safety Plan and SHVSP. This unifying plan will be known as the Minnesota Strategic Highway Safety Plan (SHSP).

Additional information on the Minnesota ITS Safety Plan can be found at:
http://www.dot.state.mn.us/guidestar/itsprojects.html

Note: The goal of the CHSP was to reduce the number of fatalities to fewer than 500 by 2008 from a level of 650 in 2004. This goal was reached in 2006.

3 Significant ITS Programs and Deployments

Users of Minnesota's transportation systems expect the systems to be safe and to meet their mobility needs. Minnesota's ITS programs and ITS deployments exist to address serious problems of highway safety and mobility. Further, ITS project deployments can play a major role in saving the lives of many of the 500 people killed each year on Minnesota roads. Over the years, Minnesota and other organizations have developed significant ITS programs and deployed ITS technology applications.

3.1 Relevant International ITS Deployment Initiatives

For years, other countries have had the political will and public support to deploy certain ITS technologies that improve mobility and increase safety on their roads and streets. This includes ITS technologies that the United States has been reluctant to deploy. In reviewing these international programs, we find significant use of electronic enforcement. The use of red light running cameras has found widespread acceptance, as has electronic speed enforcement. In France, electronic speed enforcement has been deployed throughout the country and has been credited in reducing crashes by 29.1%, injuries by 31.8%, and fatalities by 35.4% in the first four years. On the German Autobahn, variable speed limits with lane controls have reduced injury crashes 20% to 29%. The Netherlands has been a leader in developing and promoting ITS to reduce crashes and increase mobility since the early 1990s. They have dramatically reduced traffic fatalities by 34.7% between 1996 and 2005. In part due to extensive use of ITS technologies to control speed, manage lanes, and provide electronic enforcement to ensure compliance.

The use of red light running cameras has found widespread acceptance, as has electronic speed enforcement. In France, electronic speed enforcement has been deployed throughout the country and has been credited in reducing crashes by 29.1%, injuries by 31.8%, and fatalities by 35.4% in the first four years.

To increase capacity during peak periods, the Netherlands, Germany, Great Britain, and others have deployed "enhanced shoulder" or "hard shoulders" programs. For clarification purposes, Mn/DOT will use the term "hard shoulders" as un-priced shoulder use and "High Occupancy Toll (HOT) shoulders" as priced shoulder use. "Hard shoulders" and "HOT shoulders" refer to converting existing shoulders into active traffic lanes. In Germany, the use of hard shoulders during peak periods on their motorways has reduced the number of crashes by 23% to 30%.

In addition, several European countries have been using dynamic lane control signals to manage lanes, including the use of variable speed limits, to smooth traffic and provide for aggressive incident and construction management/control systems. Radio Data Systems (RDS) have been used in Europe for many years to provide real-time traffic information to the motoring public while en-route.

Sweden and Norway have been strategic partners with Minnesota for several years. Both these countries and many others have adopted policies that are focused at reducing

fatalities on their highways (Minnesota has also adopted a TZD Program with a goal of reducing fatalities to fewer than 500 by 2008). To move toward their goal of eliminating fatalities and serious injuries, international countries have enacted legislation, such as zero tolerance for drunk driving (over 0.02% blood alcohol level), as well as ITS programs including electronic red light running and speed enforcement. Internationally, many countries have come to the realization that to reach the goal of zero deaths on our highways, it is absolutely essential to deploy ITS technologies.

Sweden realized that traditional safety models attempt to strike a balance between safety and mobility. More recent models, however, such as "Vision Zero" in Sweden and "Sustainable Safety" in the Netherlands, view safety as the prevailing consideration.

These models argue that the road-transport system can only be safe when the road infrastructure is designed and operates in a way that explicitly recognizes both human tolerance to violent forces and normal human error so that death and serious injuries can be prevented. Effectively, this means reducing travel speed and providing road infrastructure that is forgiving of human error.

There are various types of ITS available along main roads in Sweden that offer support during a journey. There are also a large number of sensors along the roads that collect traffic data. Along roads, mainly on approaches to main cities, there are signs that provide information about possible crashes or if there is a risk for queuing. Some signs are used to direct and control traffic if this is necessary. There are Dynamic Message Signs (DMSs) along the roads that show road surface and air temperature. Trials are also in progress for systems that warn motorists if wildlife is approaching the road.

Variable speed signs that change the highest permitted speed limit depending on the condition of the road, the number of cars on the road, visibility, etc. are being tested at several locations in Sweden. The trial is in part to show that the motivation to maintain speed limits increases when speed limits are based on prevailing conditions. The use of automatic speed surveillance has proven to be a good method to reduce speeds, increase road safety, and reduce environmental impact. In Sweden, seven of ten motorists approve of the system.

In Sweden they are testing DMS that provide motorists with a wide range of road condition information. The trial is in part to show that the motivation to maintain speed limits increases when speed limits are based on prevailing conditions.

At the ITS World Congress held in London, UK from October 8 to 12, 2006, representatives from Minnesota had a chance to gather first-hand information relative to international programs. On Sunday, October 8, the International Benefits, Evaluation, and Costs (IBEC) working group presented a one-day workshop (presentations from IBEC can be viewed at: *www.ibec-its.org/presentations.html*). The workshop promoted an international cost and benefit "tour" focused on a set of transportation issues that are pivotally important to mobility and safety:

- Urban mobility and access in large cities

- Automated enforcement systems
- Intelligent parking systems
- Understanding ITS benefits and costs

As part of the 2006 ITS World Congress, there were numerous technical sessions that addressed many of the programs being researched, tested, and deployed throughout the world. In addition, the exhibition provided an excellent opportunity to talk to international government organization representatives and ITS vendors to get a real feel for what is happening on the world scene. There was also an opportunity to talk to representatives from the FHWA, American Association of State Highway and Transportation Officials (AASHTO), and several industry leaders about the proposed program in Minnesota. **In all cases, the response was very favorable.**

The bottom line is that there are numerous ITS technologies being deployed throughout the world that are having dramatic impacts on mobility and safety. Minnesota has been making great progress and is committed to congestion relief and to saving lives and reducing serious injury on our transportation system. However, an examination of international deployments reveals that there are many programs and technologies that could help Minnesota reach its goal. Technologies for speed and red light running enforcement have been proven internationally that they can and do save lives and reduce serious injuries. Programs, such as "hard or HOT shoulders", have proven that they are a safe and effective means of improving overall capacity and reducing congestion. Utilization of dynamic lane management, including variable speed limits, has proven to help ease congestion and improve safety on European roads. In the case of providing capacity improvements and reducing fatalities and serious injuries, it is evident that there is the desire to make it happen, but it comes down to finding the money to make it happen and, in some cases, getting legislative authorization.

3.2 Relevant National ITS Deployment Initiatives

At the national level, FHWA has been active in developing ITS programs. In 2005, the USDOT Joint Program Office issued nine ITS Program Initiatives with Minnesota being a major partner in moving several of these initiatives forward at the state level. As an example, Mn/DOT has been awarded a $6 million contract to develop an autonomous-infrastructure system that will address rural intersection collision avoidance. The ITS Institute at the University of Minnesota is a major partner in this effort. Another example relates to a recent application by Mn/DOT to secure funding as part of the Integrated Corridor Management Initiative targeting the I-394, TH 7, and TH 55 corridor. Minnesota is also one of ten states that are active participants at the national level relative to the VII initiative.

The following information was taken directly from USDOT's Joint Program Office website and provides details on the nine federal ITS initiatives.

US DOT ITS Program Initiatives *(www.its.dot.gov/newinit_index.html)*

The nine major initiatives reflect an ongoing recognition of the potential of ITS technologies to significantly enhance the operation of America's transportation systems. In order to maximize that potential, the ITS Management Council, which is comprised of senior leadership of USDOT, conducted a multi-year review of the ITS program to determine its future direction and focus. As part of this review, the Council adopted a list of criteria it used to evaluate possible major initiatives. The criteria included an emphasis on identifiable outcomes, performance schedules, private sector partnerships, and return on investment. Upon completion of the review, the Council chose nine major initiatives to comprise the centerpiece of the ITS program. These major initiatives were announced at the 2004 ITS America Annual Meeting.

Now into its second decade, USDOT's ITS program is well positioned to build on the accomplishments generated by previous research and operational tests. The Management Council's major initiatives are an important step in the continuing evolution of the ITS program and will contribute to strengthening the role of ITS in transportation safety, mobility, and productivity.

Each of these ITS technology-based initiatives presents an opportunity to dramatically improve transportation safety and mobility in America. In each, there is a clearly defined federal role, as well as involvement and partnership with others in the public and private sectors.

National Surface Transportation Weather Observing and Forecasting System – Clarus

Weather products today generally are insufficient for transportation operations. While weather observations are plentiful, they are not often integrated to form a coherent picture. The activities of the Nationwide Surface Transportation Weather Observing and Forecasting System – Clarus initiative will develop and demonstrate an integrated surface transportation weather observing, forecasting and data management system, and establish a partnership to create a Nationwide Surface Transportation Weather Observing and Forecasting System.

Cooperative Intersection Collision Avoidance Systems

In 2003, more than 9,000 Americans died and roughly 1.5 million Americans were injured in intersection related crashes. Intersection collision avoidance systems can help save lives by preventing

these crashes. Through the Cooperative Intersection Collision Avoidance Systems initiative, USDOT is working in partnership with the automotive manufacturers and State and local departments of transportation to pursue an optimized combination of autonomous-vehicle, autonomous-infrastructure and cooperative communication systems that potentially address the full set of intersection crash problems.

Electronic Freight Management

Freight volumes by 2020 are forecasted to increase by 70% from 1998 totals, and freight volumes through primary gateway ports could more than double. Improvements in speed, accuracy, and visibility of information transfer in a freight exchange could reap large rewards for America's economic vitality. The Electronic Freight Management Initiative will assist in making these improvements through the development of a common electronic freight management.

Emergency Transportation Operations

Typically, there is at least a 72-hour forewarning of a hurricane evacuation. There is time to take appropriate advance measures. However, there are major transportation challenges when incidents arise suddenly. The Emergency Transportation Operations initiative is designed to support these types of incidents. The outcome of this initiative will be the tools, techniques, demonstrated benefits, technical guidance, and standards necessary for state and local agencies and their private sector partners to effectively manage "no notice" evacuations.

Integrated Corridor Management Systems

The efforts to date to reduce surface transportation congestion have focused on optimization of individual networks. Corridors offer an opportunity to operate and optimize the entire system as opposed to the individual networks. Through the Integrated Corridor Management Systems initiative, USDOT will provide guidance to assist agencies in implementing Integrated Corridor Operations, create supporting analysis tools, approaches, and technical standards, and demonstrate the value of Integrated Corridor Management.

Integrated Vehicle-Based Safety Systems

An integrated countermeasure system could prevent over 48% of rear-end, run-off-road, and lane change crashes. Through the Integrated Vehicle-Based Safety Systems initiative, USDOT is

seeking to establish a partnership with the automotive, commercial vehicle, and transit vehicle industries to accelerate the introduction of integrated vehicle-based safety systems into the nation's vehicle fleet.

Mobility Services for All Americans

Inefficiencies, limited resources, and a lack of coordination make delivery of human services transportation challenging. To meet these challenges, new capabilities and opportunities are being created in both the transportation and health and human services communities through the use of emerging technologies and innovative services. The Mobility Services for All Americans initiative will build upon several past and current USDOT-led activities to increase mobility and accessibility for the transportation disadvantaged and the general public, and achieve more efficient use of federal transportation funding resources through technology integration and service coordination.

Next Generation of 9-1-1

The nation's current 9-1-1 system is designed around telephone technology and cannot handle the text, data, images, and video that are increasingly common in personal communications and critical to future transportation safety and mobility advances. The Next Generation 9-1-1 (NG 9-1-1) initiative will establish the foundation for public emergency communications services in a wireless mobile society.

Vehicle Infrastructure Integration (VII)

The 21,000 of the 43,000 deaths annually on America's highways are caused by roadway departure and intersection related incidents. Building on work previously done in the Intelligent Vehicle Initiative (IVI), the VII initiative will work toward deployment of advanced vehicle-vehicle and vehicle-infrastructure communications that could keep vehicles from leaving the road and enhance their safe movement through intersections.

3.3 Minnesota ITS Deployments

This Sub-chapter provides an overview of current metropolitan and rural ITS deployments throughout the state of Minnesota. The information primarily focuses on projects that were or are included under the Minnesota ITS program and Minnesota Guidestar's ITS program. It has been categorized as follows:

- **Statewide ITS Deployments**: ITS projects and initiatives that could be applied to both metropolitan and rural settings of Minnesota.
- **Metropolitan ITS Deployments**: ITS projects and initiatives that are deployed in the metropolitan areas of Minnesota.
- **Outstate/Rural ITS Deployments**: ITS projects and initiatives that are deployed in outstate urban and rural areas of Minnesota.

Statewide ITS Deployments

511 Telephone Information Service

Minnesota launched its 511 service statewide in July 2002. Callers can obtain the following information for all state maintained roadways: road conditions, construction, incidents, and urban area congestion among other information. Minnesota continues to improve the quality and format of traffic information provided through this service.

511mn.org - Minnesota Traveler Information on the Internet

Mn/DOT also maintains a web site for traveler information related to construction, road/weather conditions, incidents, congestion, and over dimension vehicle restrictions at *http://www.511mn.org*. The site was launched along with 511 in July 2002 through a statewide promotional campaign. The service will continually be enhanced based on customer feedback. A link to the website is also provided Mn/DOT's web page.

Condition Acquisition and Reporting System (CARS)

Launched in 2000, CARS is used by Minnesota and 11 other states. In Minnesota, more than 350 Mn/DOT and State Patrol users enter information on road conditions, construction, incidents, special events, and over dimension vehicle restrictions each day. CARS also manages automated data entry for congestion in the Twin Cities metropolitan area based on information from a network of loop detectors and it provides traveler information for use in the display of road conditions on cable access television.

Commercial Vehicle Information Systems and Networks (CVISN)

A March 2002 report for USDOT and FHWA lists Minnesota as one of seven states selected as pilot sites for the CVISN deployment effort. The project will enhance commercial vehicle operations (CVO) in Minnesota by creating open electronic data interchange standards and interfaces. It will provide safety information distribution at the roadside, electronic application for credentials, electronic clearinghouses for payment of registration and fuel taxes, and the electronic clearance of trucks at fixed and mobile enforcement sites.

Minnesota ITS Standards Migration Project

This project will develop a path for Minnesota's ITS activities to follow in order to migrate towards statewide use of ITS standards. This project consists of four stages –

migration planning (completed in 2003), equipment test and evaluation, deployment plan and training, and a final report.

Metropolitan ITS Deployments

MnPASS I-394 High Occupancy Toll (HOT) Lane

I-394 HOT Lane opened to the public and solo drivers in May 2005. The purpose is to open up traffic lanes once reserved for public transit and carpools to solo drivers for a toll, collected electronically, that varies throughout the day based on the demand for use by solo drivers.

Metro Transit Park and Ride/Bus Stop Security System

The purpose of this 2000 operational test was to evaluate the usefulness of an audio/visual security system at the Metro Transit Park-and-Ride lot location (County Road C and TH 61).

Non-Intrusive Technologies (NIT)

A test of non-intrusive technologies was conducted in 2000 to provide traffic data collection practitioners with useful information on the performance of various non-intrusive traffic detection, counting, speed measuring, and classification technologies. The test was performed in a variety of traffic and climatic conditions to test the full range of capabilities of each device and technology.

Phase II was carried out in 2002, in which extensive field tests of non-intrusive technologies for use in a variety of applications was conducted, and standardized evaluation and reporting procedures were developed. The project examined the traffic data collection capabilities of each device, the application to ITS, and traffic control purposes.

Outstate/Rural ITS Deployments

Transportation and Operations Communications Centers (TOCC)

Mn/DOT and the Minnesota State Patrol (MSP) are implementing a network of nine TOCCs. The purpose of these centers is to establish an integrated statewide communication and transportation operations network serving rural and smaller urban areas outside the Twin Cities metro area. Currently, there are three communications centers providing 24-hour, 7-day service in Duluth, Rochester, and Virginia, Minnesota, with facility and equipment upgrades occurring in other locations.

Intelligent Vehicle Initiative (IVI) Projects

Three IVI projects in Minnesota demonstrated improvements in emergency and maintenance vehicles driver visibility in low visibility conditions from 1999 to 2003. The projects were tested on Highways 7, 19, and 101 in rural areas of the state. Various IVI

technologies were used to improve the operations of emergency and maintenance vehicles.

Low-Cost Active Warning for Low-Volume Highway/Rail Intersections

Mn/DOT, in cooperation with the Twin Cities and Western Railroad (TC&W) installed the envisioned low-cost active warning system at 27 low-volume Highway/Rail Intersections (HRI) in 2002. Located on the TC&W corridor between the Twin Cities and South Dakota located in the following counties: Carver, McLeod, and Renville. Mn/DOT conducted an independent evaluation of the warning systems to determine their safety performance, operational performance, cost, reliability, and maintenance implications.

Phase I: I-90 and I-94 Gate Closure Operation Evaluation

In 2002, a freeway gate closure system that can automatically raise and lower the existing FHWA approved gates was tested. The purpose of the gate closure operation project was to install permanent gates along the two corridors of I-90 to guide traffic off the interstate and prohibit access during threatening situations. It can also activate the advanced warning signs to control the traffic at the interchange of I-90 and US 71 in Jackson, Minnesota.

Portable Non-Intrusive Traffic Detection System (PNITDS)

The purpose of this project was to provide data collection practitioners with a cost-effective design of a PNITDS and an independent assessment of a variety of detection technologies. The project prepared a detailed design specification for a portable system and conducted field tests with a variety of sensors.

Duluth Area Resources and Transportation for Seniors (DARTS): Transit Technology Tests

DARTS has been the test site for an FHWA field operational test designed to measure the benefits of advanced technologies on the paratransit environment. Computer assisted scheduling dispatch, using Trapeze Quo Vadis software along with Mobile Data Terminals and Automatic Vehicle Location (AVL) devices were installed in the fall of 1998. With this ITS technology, DARTS will more effectively interface with the fixed route systems operated by Metro Transit and Minnesota Valley Transit Authority and will develop additional capacity by becoming more efficient.

Truck Priority Project

The goals and objectives of this project are to improve the operation of heavy commercial and freight trucks passing through traffic signal controlled intersections on rural high-speed highways. Truck priority has been tested on Highway 169 in Belle Plaine, Minnesota.

Travel Information Guidance and Evacuation Routing (TIGER)

The project is a Mn/DOT initiative to deploy ITS infrastructure along the I-94, US 10, and State Highway 55 corridor between the Twin Cities and St. Cloud. A variety of ITS infrastructure has been deployed, including DMSs and modular surveillance systems consisting of detectors, cameras, and wireless communication equipment. The project also includes an upgrade to the MnROAD lane control system for the I-94 test section near Albertville.

TOCC Scoping Studies

Mn/DOT has already implemented several ITS projects throughout the state and in Districts 2, 3A, 4, and 8. To further reduce traffic fatalities and improve the efficiency of the transportation system, Mn/DOT commissioned ITS scoping studies to explore new ITS solutions for Districts 2, 3A, 4, and 8. The studies were intended to identify the region's transportation needs and recommend viable ITS solutions that are relevant and effective for rural areas.

Districts 2, 3A, 4, and 8 ATMS TOCC Contract

At the completion of the TOCC scoping studies, Mn/DOT determined that the next step to move the scoping studies forward was to deploy selected projects that have an impact in saving travelers time, lives, and money in Mn/DOT Districts 2, 3A, 4, and 8. The projects selected by Mn/DOT include:

- Improving traveler information in the districts by increasing the number of portable DMS in Districts 2, 3A, 4, and 8. Increasing the number of permanent DMS in Districts 3A and 4, as well as sending travel related forecasts to schools, transit agencies, and county agencies in District 2.
- Addressing emergency response, intersection safety, and arterial operations needs by deploying Emergency Vehicle Preemption (EVP) systems in Districts 3A, 4, and 8 and traffic signal enhancements in District 2.
- Addressing highway safety by acquiring portable speed detection and advisory units in Districts 4 and 8, installing a bus stop warning system in District 8, and installing detection systems and Closed Circuit Television (CCTV) surveillance cameras in District 3A. Signal control communication in District 3A is also being developed or upgraded.
- Improving transit operations in District 8 through an upgrade of the current Computer Aided Dispatch (CAD) system.
- Implementing an AVL system to better manage the fleet of maintenance vehicles in District 2.

Previous projects that Minnesota Guidestar has completed include the following. Additional information on each project can be found at:
http://www.dot.state.mn.us/guidestar/itsprojects.html

- Activation of I-394 Lab for ITS Operational Testing

- Advanced Parking Information Systems
- ARTIC: Advanced Rural Transportation Information Coordination
- AUSCI: Adaptive Urban Signal Control and Integration (Phase I and II)
- Automatic Passenger Counting in High Occupancy Vehicle (HOV) Lanes
- Bicycle/Pedestrian Detection
- Blue Earth County Coordinate-based Local Addressing System
- Cambridge Telework Center
- CVO: Commercial Vehicle Operations Process Re-engineering
- DIVERT: Moving Downtown Traffic Around Incidents
- GAINS: Guidestar Advanced In-vehicle Navigation Systems
- Genesis
- ICTM - Integrated Corridor Traffic Management
- In-vehicle Signing at Highway/Railroad Grade Crossings
- In-vehicle Signing at Highway/Railroad Crossings Targets School Bus Safety
- Magnetic Lateral Indication System for Vehicles, a.k.a. "Smart Tape"
- Mayday Plus
- Measurement of Driver Reaction to Advanced Warning Flashers
- Midwest Mainstreaming 96
- Midwest One Stop
- Minnesota Statewide ITS Architecture
- Orion
- Pedestrian Control at Intersections (Phase 4)
- Polaris
- Road Weather Information System (RWIS)
- SAIL - Safety with Automatic Intelligent Locator
- Scenic Byways Advanced Traveler Information Systems (ATIS) Kiosk
- Smart Work Zone
- Snowplow IVI - Highway 19
- Travlink
- Trilogy
- University of Minnesota Transit Way

3.4 Minnesota Supportable Infrastructure

The core of ITS is the application of data processing and data communication to increase the safety and efficiency of the surface transportation. An ITS infrastructure can be defined as those fundamental communication frameworks developed to facilitate and accomplish ITS data transmissions across geographical and jurisdictional boundaries. ITS communication systems encompass wireless radio voice and data systems, copper and fiber optic cabling, and wireless optical data transmission systems. A robust and reliable ITS infrastructure provides a solid foundation for any ITS deployment, implementation, and operation.

In the past 10 years, Mn/DOT has been developing statewide communication networks for ITS applications along Minnesota interstate highways and major state highway corridors. The networks, both wireless and wired connectivity, establish an information infrastructure backbone allowing for the integration of ITS components with Mn/DOT

Regional Traffic Management Center (RTMC), as well as district TOCCs. Major developments and system descriptions are listed below.

Analog to Digital Microwave Conversion

In 2002, Mn/DOT began the conversion of analog microwave radio equipment to digital equipment. The existing analog microwave backbone system was implemented over 20 years ago. The radio system is used to provide voice and/or data communications between the various users of the system. There are typically a large number of mobile/portable radio system users and one or more fixed locations within the system that provide dispatch services to the users. Dispatch services assist in coordinating the response of law enforcement, emergency medical services, and other responders to all levels of an incident.

The conversion of analog microwave radio equipment to digital equipment has an anticipated completion date of late FY 2009. The remaining tasks include upgrading the current system to digital technology and changing to the 6 GHz band. The upgraded system supports the operational applications, such as Mobile Data Computers (MDCs), RWIS, and other ITS systems that use a digital format for communications. The present analog system cannot support existing or future projects that use a digital format.

Allied Radio Matrix for Emergency Response (ARMER)

The goal of the ARMER program is to implement and operate a statewide shared radio system that will serve state agencies and be available, on a voluntary basis, to all units of government and first responders in Minnesota. The plan for implementation provides for a phased statewide development of the radio system infrastructure. This plan calls for six phases as listed below.

- Phase 1 – Basic communication backbone and interoperability infrastructure in the seven county metro areas along with Chisago and Isanti Counties, completed in December 2002, which included local enhancements to Carver County, Minneapolis, and portions of Hennepin County.
- Phase 2 – Additional local enhancements to Phase I backbone
- Phase 3 – St. Cloud and Rochester State Patrol districts
- Phase 4 – Brainerd and Duluth State Patrol districts
- Phase 5 – Marshall, Mankato, and Detroit Lakes State Patrol districts
- Phase 6 – Thief River Falls State Patrol district

Currently, the project has completed Phase 1 and Phase 2 and is focusing on Phase 3. Additional project details on each project phase can be found at: http://www.armer.state.mn.us/ArmerDispArt.asp?aid=89

Regional Transportation Management Center (RTMC)

The primary purpose of Mn/DOT's RTMC is to integrate Mn/DOT's Metro District Maintenance Dispatch and Mn/DOT's Office of Traffic, Security, and Operations

(OTSO) with the Minnesota Department of Public Safety's (DPS) State Patrol Dispatch into a unified communications center. The RTMC provides the communications and computer infrastructure necessary for coordinated transportation management on metro freeways during normal commuting periods, as well as during special events and major incidents.

Each year, freeway volumes in the Twin Cities grow by about 4 percent. The goal of the RTMC is to provide motorists with a faster and safer trip on metro-area freeways by using cutting-edge technology, progressive programs, and real time information delivery systems.

The backbone of the RTMC is a state-of-the-art operations center where State Patrol Dispatch, Maintenance Dispatch, and Traffic Operations work together to provide motorists with a faster and safer trip on metro area freeways.

The RTMC staff confirms traffic incidents with 320 closed-circuit TV (CCTV) cameras posted along 260 miles of metro-area freeway. Information on incident location and resulting traffic backups are relayed to travelers via traffic radio, traffic TV, various Internet sites, and a telephone service. The RTMC provides traffic information to local radio and television traffic reporters as well. Travelers are also alerted to traffic problems via 85 DMS placed throughout the freeway system.

RTMC staff also use the cameras to verify that ramp meters are responding to real-time traffic conditions. The RTMC's 4,000 loop detectors (traffic sensors) give computers the information needed to determine ramp meter timing. Loop detectors also measure traffic speeds, which are displayed on a map available to the public on traffic TV and various Internet sites.

RTMC components include:

- Traffic Surveillance via CCTV and Loop Detectors
- Ramp Meters
- Dynamic Message Signs
- Lane Control Signals
- Traveler Information Program
- MnPASS
- HOV System
- Incident Management Program
- FIRST (Freeway Incident Response Safety Team) Program
- Research and Development

It is anticipated that Mn/DOT will have instrumented the complete I-694/I-494 freeway ring around the Twin Cities metro freeway system by spring of 2007.

Transportation Operation and Communication Centers (TOCCs)

Mn/DOT and the MSP have implemented a network of nine TOCCs and established an integrated statewide communication and transportation operations network serving rural

and the smaller urban areas outside the Twin Cities metro area. Each TOCC acts as a regional center for 24-hour incident and emergency response, multi-agency dispatching and fleet management, interagency communications, collection and dissemination of road conditions, and closures and traffic management. They can also potentially be used for integrated transit operations. TOCCs are geographically distributed around Minnesota with Virginia, Baxter, and Thief River Falls in the north; Detroit Lakes, St. Cloud, and Duluth in the center part of the state; and Marshall, Mankato, and Rochester located in the south. The TOCCs enhanced voice and data communications to improve Mn/DOT and MSP operational effectiveness and to improve the overall safety and efficiency of the transportation system in Minnesota. The new facilities include new radio consoles, new workstations, new uninterrupted power supplies, and a new digital radio and telephone recorders.

Road Weather Information System (RWIS)

Mn/DOT's RWIS includes 96 environmental sensor sites and over 50 airport sites in a statewide network. The environmental sensor sites, located adjacent to highways, are designed to measure environmental conditions and road pavement surface conditions. The airport sites do not generally measure pavement surface conditions. This data is then communicated to the RWIS central site where it is verified, processed, formatted and made available to road maintenance personnel, law enforcement, the public over 511 and to vendors who provide value added services.

In addition to the sensor sites, Mn/DOT has collected typical temperature profiles along its roadways and can use these profiles and RWIS information to predict bridge freezing, and other potential road condition problems before they occur. Maintenance forces can then proactively address these problems to keep Minnesota roads safer.

To provide maintenance with additional road condition data the environmental sensor stations are now being equipped with pan tilt cameras. Mn/DOT is currently working on incorporating RWIS into a statewide Maintenance Decision Support System (MDSS) so that maintenance forces can most effectively and efficiently react to changes in road conditions.

3.5 Auto Industry Safety and Mobility Advances

This assessment focuses on the transportation infrastructure side, but it is important to recognize the contributions and advances in safety and mobility being adopted by vehicle manufacturers. Seat belts, airbags, side airbags, bumper changes, safety glass, and many other passive safety systems are now standard features on all vehicles. These features have had a dramatic effect on reducing traffic deaths and serious injuries.

Major advances in active safety and mobility technology applications are becoming more common, even required on vehicles. Examples are Antilock Brake Systems (ABS) and adaptive cruise control.

A recent example is introduction of Electronic Stability Control (ESC) on vehicles to assist drivers in avoiding crashes. Beginning in 2012, all new vehicles must have anti-rollover technology and, according to Nicole Nason, Administrator of the National Highway Traffic Safety Administration (NHTSA), "no other safety technology since the seat belt holds as much promise to save as many lives and prevent as many injuries as ESC".

The use of ITS technologies in vehicles is now being recognized and widely distributed by major publications. An article in the December 2006 Popular Mechanics magazine titled, "Is your car smarter than you?" provides some answers and questions. According to the article, the reaction time for a human is 750 milliseconds, while the reaction time for a vehicle is 10 to 20 milliseconds. Following is an excerpt from the article:

Popular Mechanics Magazine – December 2006

"There is little question that the rise of computerized controls has made cars safer. A 2004 NHTSA study showed that ESC reduced all single-vehicle crashes by 34 percent and single-vehicle SUV crashes by 59 percent. A 2006 University of Michigan study found that ESC could reduce the odds of fatal rollovers in SUV's by 73 percent and in cars by 40 percent."

"As ESC becomes more sophisticated, the driver may not even realize it's working. This type of systems integration allows manufacturers to build smarter cars. Electric steering systems get information from the ESC to help avoid an accident. And electronic dampers can minimize body roll for increased stability…. ESC is one part of an expanding active safety envelope."

4 Current Program Assessment

Successful programs incorporate three key elements:

- Planning
- Program Champions
- Funding

In Minnesota, the planning and project champions are already in-place and involved in ITS. The third element, funding and the funding process for ITS, has now been established by SAFETEA-LU. This chapter provides an assessment of the current ITS program's key elements of planning, project champions, and funding.

ITS Technology Projects and Planning

> ITS in Minnesota has been studied, researched, planned, operationally tested, and early projects deployed. Now the time has come for major ITS deployments to be implemented so that the citizens of Minnesota can fully realize the potential mobility and life saving safety benefits that ITS can provide.

Minnesota, through its Guidestar program and many other related ITS transportation planning and development programs, has developed a significant foundation of experience for the success of future ITS projects. This foundation of expertise and experience is particularly important as Minnesota moves forward with future ITS projects that focus on improved mobility and safety. While it is relatively easy to simply propose ideas for new ITS projects, it is much harder to actually carry the ideas forward and see them through to deployment and beneficial use by transportation users.

By 2005, Minnesota had taken on more than 170 ITS initiatives and completed more than 110. A number of these projects were highlighted in *Chapter 3*. Of particular importance are the Polaris Statewide Architecture, Orion Model Deployment, TOCC, CARS for 511, Highway/Rail Intersection, RTMC, district ITS deployments, and the TIGER project. Details of these and many more Minnesota ITS projects are available online at: *www.dot.state.mn.us/guidestar/*

To accomplish this success, Minnesota has developed a number of planning and programming concepts that work together to maximize the benefits of every ITS dollar spent in Minnesota. Mn/DOT, and Guidestar from its inception, focuses not only on technological applications, but also on including stakeholders from both private and public sectors and academia, in the development process. Today, other states have used these partnership models as part of their development of successful ITS initiatives.

Beginning with the Guidestar program in the late 1980s, a continuing series of studies, plans, and research efforts have been focused on defining and providing a vision of ITS in the future. In many cases, Minnesota efforts pushed the ITS envelope and have helped set the stage for utilizing and incorporating ITS in the transportation infrastructure nationwide. The major current focus of these programs is on traveler mobility and safety.

Program Champions and Program Support

The successful implementation of new technology such as ITS, that affects the public so directly, requires significant support from program champions, potential stakeholders, the transportation community, and from the public. While visionary program champions can see the potential benefits of a new technology, they tend to be in the minority. Mn/DOT has an abundance of program champions and has supported them in their project objectives; however, better coordination with the program champions will aid in fully utilizing their strengths. Current staff levels do not adequately address project development needs and demands.

Since a successful transportation ITS program requires a broad range of support from all relevant parties the Guidestar program has worked hard to be inclusive of all stakeholders including: private industry, researchers, transportation officials, and public organizations. This group effort is recognized in Guidestar's 34-member Board of Directors representing most of the transportation community stakeholders. Through its Board of Directors, the Guidestar program has built a strong support community that has been, and continues to be, involved in selecting and developing ITS programs and projects for Minnesota. The ITS Strategic Plan 2006, described in *Chapter 2*, is the culmination of their current planning efforts. This well, thought out action plan provides a planning base for decision-making and deployment of ITS technology in Minnesota.

Program Funding is discussed in *Sub-chapter 4.2*.

4.1 How the Current Programs Fit/Work Together

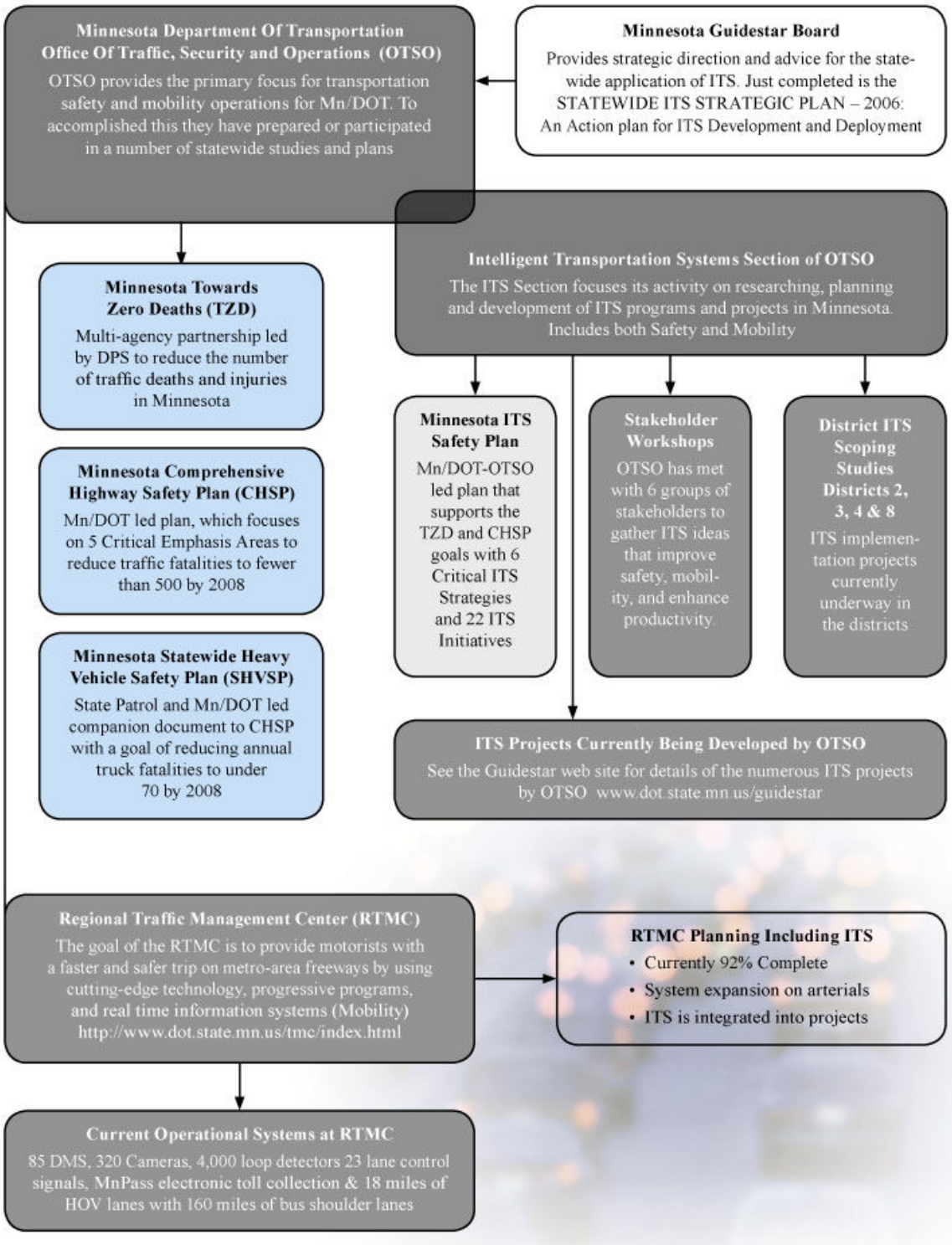
This sub-chapter provides a quick review on the current Minnesota ITS programs and how they fit and work together to provide a foundation for successful deployment of the next generation of ITS projects in Minnesota. Within Mn/DOT, OTSO is responsible for the development of ITS programs and projects, supported by many additional organizations including the Guidestar program. Currently, OTSO has placed a major emphasis on preliminary planning for ITS safety and mobility projects allowing for seamless incorporation into the mainstream Statewide Transportation Improvement Plan (STIP) process. To accomplish smooth integration of ITS projects, a number of "foundation" programs, processes, and documents have been developed.

Early in the ITS project development process, OTSO recognized the need for improving safety and has supported development of Minnesota's TZD program. TZD is a multi-agency partnership lead by the DPS to reduce the number of traffic deaths and injuries in Minnesota.

Minnesota's CHSP was developed to be a framework within which road safety programs would be evaluated and selected based on their ability to reduce the number of fatal and serious injury crashes in Minnesota. Minnesota's CHSP has been nationally recognized and used by other states as an example to follow. To support the CHSP, the SHVSP, and the ITS Safety Plan have been completed as a companion documents.

Figure 1 on the following page was developed to provide an overview of how the various Minnesota plans and programs work together. At first glance, the Minnesota programs seem to overlap and duplicate one another. However, taken as a whole, the programs are mutually supportive and provide the foundation for success necessary to achieve the ITS deployment program goals in reducing the number of fatalities and serious injury crashes in Minnesota.

Figure 1 – ITS Planning Organization Relationships

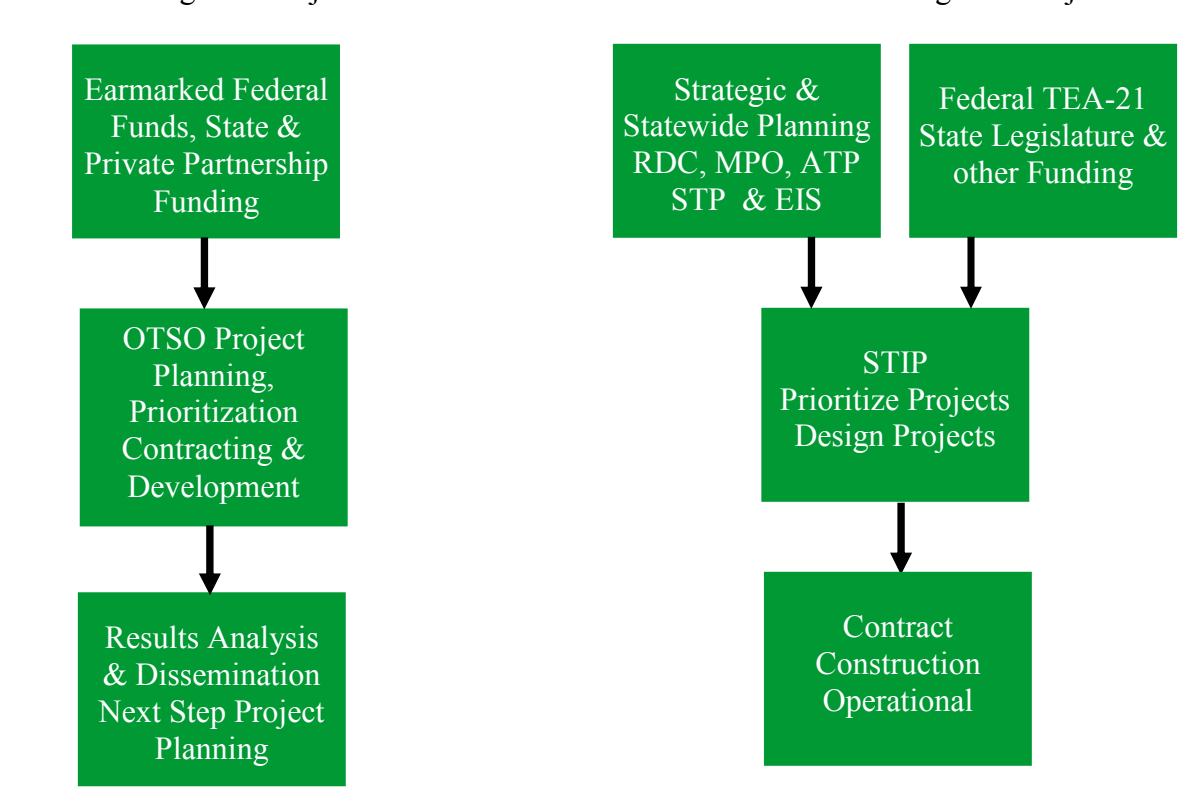


4.2 ITS Programs and Funding

Statewide transportation planning in Minnesota is provided by Mn/DOT in conjunction with local governments, community and business interest groups, and District Area Transportation Partnerships (ATP). The result of these coordinated efforts is the publication of the STIP. The STIP is a comprehensive three-year schedule of planned transportation projects in Minnesota. These projects are for state trunk highways, local roads and bridges, rail crossing projects, transit capital, and operating assistance. STIP program budgets for the years 2006, 2007, and 2008 represent an investment of over $3.6 billion in federal, state, and local funds. Each project in the STIP includes its anticipated cost and the proposed funding source for the project.

In the early years of the Guidestar program, major funding was through congressional earmarks. Congressional earmarks worked well for early studies, research planning, and operational tests. As the possibilities for ITS were fully realized, a more stable and reliable funding program, which incorporated ITS into the regular ongoing transportation programs, was necessary for long-term planning in Minnesota and other states. SAFETEA-LU, passed by Congress in 2005, sets the stage for incorporating ITS into the Minnesota STIP on an equal basis with all other transportation projects. Funding for ITS is now incorporated with, or competes with, all other construction projects for priority and funding. This Minnesota Guidestar: Deployment Assessment will be a major vehicle for identifying, prioritizing, and incorporating critical ITS projects into the Minnesota STIP in order that they can be funded along with other transportation projects. Further discussion on the funding for proposed projects is in *Chapter 8* of this assessment. Figure 2 illustrates the differences in project development and funding processes for Guidestar earmark programs/projects and STIP mainstream programs/projects.

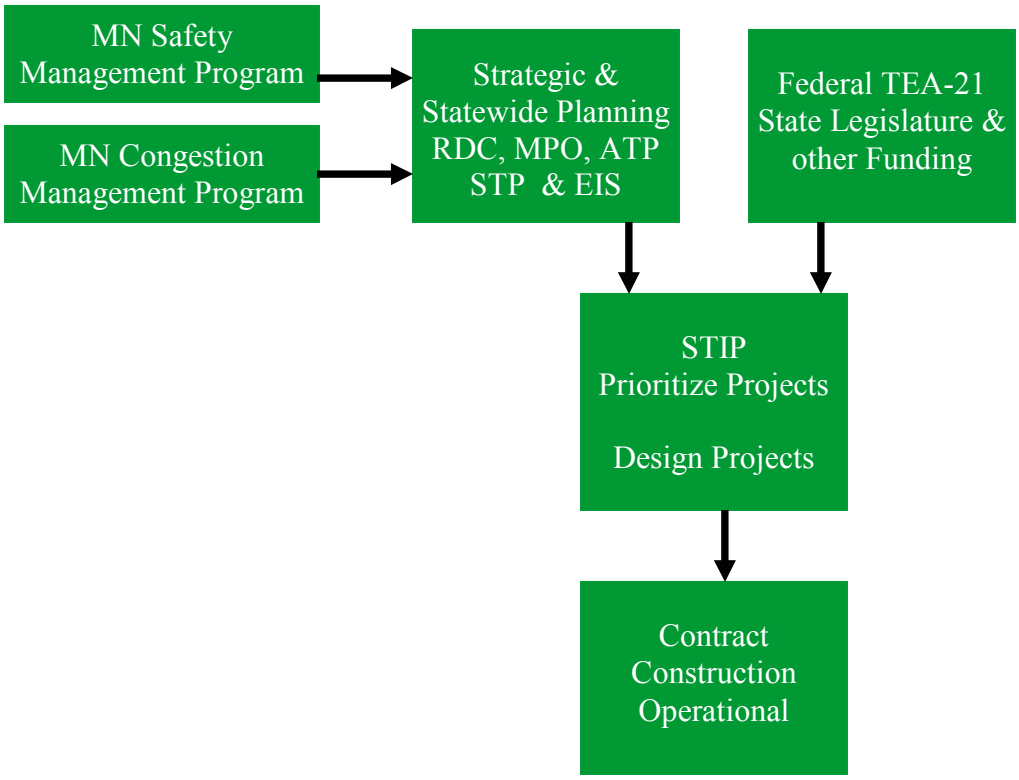
Figure 2 – Guidestar Project Development vs. Mainstream Highway Overview



This Guidestar funding/development process has encouraged ITS projects to be more cutting edge and experimental in their program development. This process has also required that the results and performance of the project be carefully analyzed and disseminated on a national level so that future projects could build on the successes of the original project.

Migrating ITS programs and projects from the Guidestar funding/deployment process to the mainstream STIP program planning process will require careful review and assessment of many of Minnesota's ITS programs. This assessment is part of the process that will help set the new directions for ITS in Minnesota. To assist and reinforce the need and process of migrating from the current ITS programming process to the STIP program process, Mn/DOT has developed an ITS mainstreaming process. Figure 3 provides an overview of the ITS mainstreaming process at Mn/DOT.

Figure 3 – ITS Mainstreaming Process Overview



Projects developed by the RTMC, non-ITS, and related transportation projects that focus on mobility and safety have, for the most part, been developed and funded through the mainstream STIP process. SAFETEA-LU places additional emphasis on safety projects as core FHWA projects. This core emphasis could help fund and move these projects forward through the mainstream process.

The overarching goal of this deployment assessment document is to develop an assessment in sufficient detail that can assist Mn/DOT in securing funding for ITS deployment projects to improve mobility and safety in Minnesota. As Minnesota moves forward with ITS programs, the funding and deployment of the ITS projects represent a recognition of the need and value of ITS and Minnesota's commitment to future transportation system demands.

4.3 Foundation for Success

Minnesota Guidestar

The Minnesota Guidestar program is a nationally and internationally recognized ITS program that is widely used as a model by other states. *Sub-chapter 2.1* discussed the ITS Strategic Plan 2006 developed by Minnesota Guidestar as an important precursor to this assessment. Guidestar has provided a foundation for success and as a result of the Minnesota Guidestar program, ITS and ITS principles have become important elements

in mobility and safety programs at Mn/DOT and within the Minnesota transportation community.

Originally developed as a stand-alone program, the Guidestar program now functions as an advisory board for OTSO in relation to ITS technology. Projects conceived by the Guidestar program are now included as key elements in OTSO mobility and safety planning and programs. This incorporation of ITS into OTSO programs has moved the ITS programs from stand-alone Guidestar program projects into the mainstream planning process at Mn/DOT.

Responsibility to develop an ITS program and projects is and will continue to be the responsibility of OTSO, with the support from many additional organizations, primarily Guidestar. Currently, OTSO is placing major emphasis on preliminary planning for ITS mobility and safety projects to fully incorporate them into the mainstream process. Incorporating ITS into the mainstream process allows ITS to become a full partner in other Mn/DOT programs including communications, maintenance, and most importantly planning, design, and construction. Although not the driving force for most projects, ITS technology will be used and recognized as an important element in the projects.

How does this incorporation of ITS into the mainstream process affect Guidestar and ITS planning? The ITS Strategic Plan – 2006 provides an excellent assessment of current and future Minnesota ITS activities (see *Chapter 3*).

In the relatively short history of ITS in Minnesota and the United States, ITS has been treated as a stand-alone set of technology-based enhancements to mostly pre-existing transportation systems and processes. The Minnesota Guidestar Board and many others now believe that many elements of ITS should be mainstreamed into the overall transportation planning and implementation process. As a result, most ITS applications will no longer be seen as standalone projects or systems. Instead they will be considered intrinsic elements of more traditional transportation projects and systems whose effectiveness can be greatly improved by ITS.

The change in course poses some challenges for ITS. First, it enters a more competitive arena where it has to find its place among broader transportation applications. Second, since statewide project selection and funding are currently done through the Transportation Improvement Plan (TIP) and STIP processes, both involving ATPs with Metropolitan Planning Organizations (MPOs), cities, and counties, ITS will have to compete with multiple jurisdictions for limited funds. Third, the concept of ITS is not universally understood by the public, policymakers, and even by all elements within transportation agencies. As a result, mainstreaming of ITS will require increasing education and dissemination efforts on all fronts. Finally, as large-scale, statewide deployments become more common, it is anticipated the private sector will play an increasing role in ITS promotion and education efforts, and in the development of products and services.

Across Mn/DOT, and with other transportation stakeholders, many of the ITS principles and elements are just beginning to be fully introduced as they move from research to

usable products and the marketplace. The difference between ITS technology and usable products is beginning to shape into useful technology applications that improve mobility and safety.

Guidestar programs and projects need to be fully integrated into the mainstream programs to allow for complete achievement of ITS goals. Evidence of the integration is particularly true where many Mn/DOT staff have had experience working on ITS technology programs and are comfortable with its capabilities. Minnesota now has a large reserve of people and organizations that are not only familiar with ITS, but who have participated in its ongoing development.

Public Private Partnerships (PPPs)

Early in ITS development, Mn/DOT recognized ITS deployments required cooperation between public agencies and private industry. As a result, legislation that encouraged the Commissioner of Transportation to develop public and private partnerships for the development of technology was approved. Since that legislative approval, Mn/DOT has worked hard to include private industry as a partner in ITS projects. Private industry has been included on the Guidestar Board, in Guidestar program planning, in research, and in project implantation and study. PPPs have become an important element in Minnesota ITS development process.

The concept of developing PPPs in Minnesota has been modeled by other states and FHWA as an important element in their ITS programs. The July/August 2006 issue of Public Roads features an article titled "Bridging the Financial Gap With PPPs, which states:

> *As State highway funding becomes more constrained and as the need for highly efficient surface transportation systems continues to grow, many transportation professionals believe the role of the private sector will increase. Transportation officials across the Nation are seeking ways to capture the efficiencies and value that the private sector can provide. As USDOT officials said in their comprehensive 2004 survey on the PPP landscape, Report to Congress on Public-Private Partnerships. USDOT "is committed to providing a greater role for the private sector in transportation services and infrastructure investment to supplement Federal, State and local spending for capital investment in our nation's infrastructure. Coupling private capital and private initiatives with public transportation efforts produces more and better facilities for the traveling public.*

Private industry will continue to be involved in future Minnesota ITS projects and is a valuable partner in the success of Minnesota ITS programs. The public-private partnerships require that all parties realize that the long-term goal of the private partner is a return on their investment. The need to make a profit will influence their perception of the level of their involvement in an initiative. With Minnesota's successful background in

the development of PPPs, Minnesota has an opportunity to become a key state in the cooperative implementation of ITS with its industry partners.

Minnesota has developed the managerial, technical, and partnership skills, along with a history of successes necessary to move aggressively forward in deploying ITS technology for its citizens.

As a result of Minnesota's past ITS planning and program development efforts, Minnesota has developed a solid foundation of managerial, technical, and partnership skills, along with a history of successes necessary to move aggressively forward in deploying ITS technology for its citizens. Minnesota is not just developing technology projects, but a program that addresses safety and mobility needs using technology.

The challenge now is to move projects forward utilizing the STIP planning and program processes and incorporating ITS projects into the STIP process for funding. That process has started with a series of planning efforts particularly focused on bringing all transportation stakeholders to begin developing the ITS programs of the future for Minnesota. The process continues by reaching out to stakeholders to include their input from the beginning of the project through its post-implementation evaluation.

5 Stakeholder Outreach

A critical step in this deployment assessment was the gathering of information, ideas, and data from stakeholders and experts who will be responsible for implementing selected ITS projects. Many stakeholders and experts have been involved in developing current Minnesota Guidestar projects and other ITS programs. As projects are selected for implementation, additional stakeholders, program managers, and staff will become involved. The success of future ITS programs depends on the effective incorporation of constructive criticism from all stakeholders as early as possible in the program development. To gather input from as many stakeholders and experts as possible, stakeholder workshops were conducted and key program leaders were interviewed as described in the following subsections. Relevant national and international ITS deployment initiatives were also assessed as described in *Sub-chapters 3.1 and 3.2* of this assessment.

5.1 Stakeholder Workshops

Stakeholder Workshop Meeting Summaries

Between May and August 2006, Mn/DOT conducted a series of workshops with stakeholders from FHWA, Mn/DOT Districts, the Minnesota State Patrol (MSP), Metro Transit, Hennepin County, and the Cities of Minneapolis and St. Paul. Stakeholder groups focused on the following categories:

1. Advanced Public Transportation Management (APTS)
2. Advanced Traveler Information Systems (ATIS)
3. Advanced Traffic Management Systems (ATMS)
4. Commercial Vehicle Operations (CVO)
5. Emergency Management (EM)
6. Maintenance and Construction Management (MC)

The purpose of the workshops was to obtain feedback on "Minnesota ITS Development Objectives" (see Table 1) that will enhance transportation through the safe and efficient movement of people, goods, and information, with greater mobility, fuel efficiency, less pollution, and increased operating efficiency in Minnesota. The information exchanged among the six groups helped illustrate various integration options and gained consensus on ITS systems to be considered prior to investing in the design and development of ITS. Information obtained from the six stakeholder meetings was used as part of the input for developing this deployment assessment.

Based on the Minnesota ITS Development Objectives, each of the six stakeholder groups were provided functional/informational needs for their particular group. Stakeholder attendees also provided additional issues and/or informational needs. Each of the stakeholder attendees participated in a voting exercise in which each attendee was given five dots (each dot was worth 1 point) to vote on functional/informational needs they believed would benefit the traveling public. The results of the voting exercises are found in Table 2 through Table 7.

Table 1 – Minnesota ITS Development Objectives

General Purpose**: Create a system that enhances transportation through the safe and efficient movement of people, goods, and information, with greater mobility and fuel efficiency, less pollution, and increased operating efficiency in Minnesota.**

A. Improve the safety of the State's transportation system

- Reduce crash frequency (ATMS, ATIS, APTS, CVO, EM, AVSS & MC)
- Reduce fatalities and life changing injuries (ATMS, ATIS, CVO, EM & AVSS)
- Safeguard the motoring public from homeland security and/or Hazmat incidents (ALL)
- Reduce crashes in work zones (ATMS, ATIS & MC)

B. Increase operational efficiency and capacity of the transportation system

- Reduce overall delay associated with congestion (ATMS & ATIS)
- Increase average vehicle occupancy and lane carrying capacity (ATMS, APTS & EM)
- Reduce number of stops (ATMS & ATIS)
- Reduce clearance time for incidents (ATMS, CVO, EM & AVSS)
- Reduce delays due to work zones (ATMS, ATIS & MC)
- Reduce infrastructure and vehicle operating costs (ATMS, APTS, CVO & AVSS)
- Reduce traffic delays during evacuation from homeland security and Hazmat incidents (ALL)
- Enhance efficiency at borders (ATMS, CVO, EM & AVSS)

C. Enhance mobility, security, convenience, and comfort for the transportation system user

- Reduce congestion and incident-related delay for travelers (ATMS, ATIS & APTS)
- Improve travel time reliability (ATMS)
- Increase choice of travel modes (APTS)
- Enhance traveler security (APTS & EM)
- Reduce stress caused by transportation (ATMS, APTS, EM & MC)

D. Enhance the present and future economic productivity of individuals, organizations, and the economy as a whole

- Reduce travel time for freight, transit and businesses (ATMS, ATIS, APTS & CVO)
- Improve the efficiency of freight movement, permitting and credentials process (ATIS & CVO)
- Improve travel time reliability for freight, transit and businesses (ATMS, APTS & CVO)
- Increase agency efficiency (APTS, AD & MC)
- Safeguard existing infrastructure (CVO, EM & MC)
- Aid in transportation infrastructure and operations planning (ALL)

E. Reduce energy consumption, environmental impacts and costs of transportation

- Reduce emissions/energy impacts and use associated with congestion (ATMS, ATIS & CVO)
- Reduce need for new facilities (CVO)
- Reduce negative impacts of the transportation system on communities (APTS, ATIS, AVSS, EM & MC)

AD: Archived Data Management
APTS: Advanced Public Transportation Management
ATIS: Advanced Traveler Information Systems
ATMS: Advanced Traffic Management Systems
AVSS: Advanced Vehicle Safety Systems
CVO: Commercial Vehicle Operations
EM: Emergency Management
MC Maintenance and Construction Management

Table 2 – APTS Voting Results

Informational Needs	
Points	**Functional/Informational Needs**
8	Provide real-time transit vehicle arrival
8	Provide transit route and schedule information
6	Provide simple fare payment systems
5	Coordinate time transfers between route segments, providers and modes
5	Track fleet and personnel operations
4	Provide surveillance and enforcement on transit vehicles and transit facilities
3	Reduce the impact of route buses merging
3	Reduce boarding time
2	Measure historical route performance
2	Provide on-board automated enunciators
2	Provide information to the ADA community
2	Optimize garage operations
1	Provide surveillance and monitoring to warn of potentially hazardous situations on transit vehicles and transit facilities
1	Provide park and ride vehicle security

Table 3 – ATIS Voting Results

Informational Needs	
Points	**Functional/Informational Needs**
8	Incidents – Impacts on freeways and minor arterials
7	Congestion levels
5	Road weather information
5	Alternate routes and detours
5	Roadway construction and maintenance
4	Travel time, operating, and actual speeds on affected freeways
4	Education/public affairs
2	EM Incidents/Evacuation – Impact of freeways and minor arterials
1	Special events – planned
1	Parking availability
1	Road Weight Restrictions – Spring
1	CVO permit restrictions

Table 4 – ATMS Voting Results

Informational Needs	
Points	**Functional/Informational Needs**
11	Provide efficient traffic signal timing
8	Analyze archived data for traffic strategy development and long range planning
7	Provide surveillance to identify and verify incidents
6	Provide speed enforcement
6	Utilize variable speed limits
6	Provide lane control
5	Provide congestion information to all travelers
5	Operate reversible lanes
3	Provide information on incidents that are causing backups to all travelers who want to travel on affected freeways and minor arterials
2	Provide dynamic feedback to drivers
2	Provide information on special events
2	Provide operating or actual speed information on the affected freeways and arterials
1	Provide safe signal phase transition
1	Divert traffic from areas with restricted traffic flow due emergency incidents/evacuation
1	Provide information on parking availability

Table 5 – Emergency Management Voting Results

Informational Needs	
Points	**Informational Needs**
5	Share video surveillance
3	CAD enhancement
3	Provide system-coordinated response
3	Provide automated enforcement
2	Provide dynamic routing of emergency vehicles
2	Provide enhanced mayday services
2	Provide surveillance to enable EM to monitor and respond according to potential hazardous situations
1	Provide automated gates
1	Provide surveillance to monitor transportation infrastructure to preclude an incident, and control access during and after an incident or mitigate the impact of an incident.

Table 6 – Maintenance and Construction Voting Results

Informational Needs	
Points	**Functional/Informational Needs**
9	Track fleet, materials, and personnel operations
6	Provide roadway construction and maintenance information to all travelers who wanted to travel on the affected road segment
5	Coordinate construction and maintenance project schedules (e.g. geographically)
3	Warn work crews or errant vehicles
2	Provide automated monitoring of road weather conditions
2	Provide trucks entering/exit system
2	Provide queue detection and advisory to warn traffic of a stopped queue
2	Provide automated gate closure
1	Provide roadway automated treatment
1	Provide maintenance decision support
1	Provide dynamic late merge systems
1	Target replacement and repair of infrastructure (e.g. signs, pavement, pavement markings)

Table 7 – CVO Ranking Results

Informational Needs	
Ranking*	**Functional/Informational Needs**
1	Weight enforcement
2	Incident management
3	Electronic processing (CVISN)
4	Providing information to roadside from CVO databases to enforcement personnel
5	Safety response

**The attendees at the workshop decided to rank the needs instead of using the point system.*

Each of the stakeholder groups identified, per functional/informational needs, existing ITS systems and identified their corresponding gaps and opportunities for enhancements.

5.2 Key Program Leader Interviews

In order to solicit input on the deployment assessment, interviews were conducted with key transportation agencies in Minnesota and other states. Fifteen15 interview candidates were selected based on the organization or program they represent. Following is a list of agencies that were able to participate in the interviews.

- Mn/DOT OTSO
- Mn/DOT RTMC
- Mn/DOT – State Aid
- Minnesota State Patrol
- FHWA
- U of M – ITS Institute

- Mn/DOT – District 3
- Mn/DOT – Metro
- St. Cloud Transit
- Metro Transit
- Kansas DOT
- California DOT (CalTrans)
- Florida DOT
- Michigan DOT
- Virginia DOT

Two different questionnaires were developed, one for Minnesota agencies and one for non-Minnesota agencies. The Minnesota questions focused on gathering input related to ITS needs in the areas of mobility and safety, specific project concepts, and funding strategies. The non-Minnesota interview questions focused on soliciting input on identifying other ITS deployment plans, specific project ideas, successful or less successful implementations, and funding.

Minnesota respondents focused on providing a list of transportation needs relating to mobility and safety, which can be addressed through ITS, as well as identifying program areas that are ready for a large ITS investment. Respondents also provided a list of ITS technology applications for deployment in Minnesota. Interviewees commented on how ITS projects by local governments fit into the overall Minnesota ITS program as well as provided input on funding strategies for operations and maintenance and incorporating local ITS projects.

One of the important themes that came out of the interviews was the importance of the continued partnership between Mn/DOT and local governments. Seamless integration of traffic management and planning operations between Mn/DOT and local governments is contingent on the growth and development of existing partnerships. A key component of the partnerships is the identification of effective funding strategies for both proposed ITS projects, as well as the operation and maintenance of all existing and future ITS components.

The non-Minnesota interview respondents suggested project ideas to implement including specific project examples of successful implementations within their agency as well challenging implementations. Respondents also noted how ITS projects are funded within their agency.

Many of the non-Minnesota agencies interviewed indicated that they do not have a deployment plan specifically, but do have a document that guides the staged deployment of ITS systems in their state. Some projects pursued are from these plans, but may not follow the plan exactly if DOT administration changes the project direction, thus making the given ITS project not applicable. Projects that were identified by stakeholders interviewed supported the improvement of real-time information sharing between government agencies, transit companies, and the public. Other state's funding mechanisms for ITS projects ranged from funds specially targeted to ITS projects to

funds from operation and maintenance budgets. The pursuit of federal funds for ITS projects was also a common theme in the interviews.

Appendix A includes detailed information gathered from the interviews.

6 Guidestar Program Deployment Assessment Elements and Strategies

To complete this chapter and the next chapter of the assessment the following terms/definitions are used:

Elements: Minnesota Guidestar Program Deployment elements are suggestions, initiatives, technology uses, and ideas collected from many sources, which could address specific safety, and mobility needs in Minnesota. The elements were developed into a list format and are included as *Appendix B*.

Program Strategies: The elements collected, in the list, were then used to define a number of general broad based Program Strategies for deployment in 2½, 5 and 10-year time periods. A program strategy may include many different and potentially overlapping elements.

Projects: Fourteen projects utilizing multiple program strategies have been identified in Chapter 7. Project descriptions provide additional details including project objectives, project cost estimates, operations and maintenance costs, performance measures, along with potential institutional issues.

6.1 Deployment Assessment Elements & Performance Measures

The Minnesota Guidestar Program Deployment Assessment Elements, which are identified in *Appendix B*, were derived from existing program plans such as the ITS Safety Plan and ITS Strategic Plan 2006, as well as key stakeholder workshops and interviews. These elements were also matched with needs identified in the district scoping studies, Highway Safety Operations Plan, FHWA initiatives, SAFETEA-LU and other documents. Key stakeholders have, at various times, reviewed the elements to ensure they align well with the stakeholders' specific needs and priorities. It should be noted that many of the elements were identified numerous times, using slightly different text names, in these various documents and workshops.

To further define and sort the elements, shown in *Appendix B*, they were categorized in the following ITS functional areas:

- Communications Infrastructure (COMMS)
- Advanced Traveler Information Systems (ATIS)
- Advanced Public Transportation Systems (APTS)
- Advanced Transportation Management Systems (ATMS)
- Advanced Transportation Safety Systems (ATSS)
- Emergency Management and Public Safety Systems (EMS/PSS)
- Homeland Security (HS)
- Commercial Vehicle Operations (CVO)
- Vehicle Infrastructure Integration (VII)

Performance measures (referred to as "objectives" in the ITS Strategic Plan 2006) for evaluating elements, program strategies and projects are based primarily on the perceived outcome and benefits. An example might be the deployment of contraflow lanes during peak periods with an outcome of increased capacity during that peak period. The benefit would be reduced congestion and shorter commute times. Some performance measures lend themselves to very accurate quantitative measurement such as increased capacity while others are more subjective such as customer satisfaction.

There are three types of performance measures; input measures, output measures and outcome measures. There are also maturity measures of performance measures; developmental measures, emerging measures and mature measures. When developing the performance measures for any given project there are four different levels that need to be taken into consideration; system or regional level, corridor level, sub-area or sub-system level, and/or project specific or fleet level. Finally, there are three performance objectives; safety, congestion/mobility and operational efficiency.

At some point performance measures need to be established for any given project given the criteria noted above. Performance measures could relate to increase mobility such as reducing congestion, reduce overall delays, improve reliability and improve system performance. They could also relate to improved safety such as reduce number of fatal and serious injury crashes or more specifically reduce intersection collisions, reduce lane departure crashes or reduce secondary crashes.

Performance measures for any given project should be clearly stated prior to deployment. As deployment occurs, results should be monitored and compared against the established measures. In addition, baseline conditions for projects and programs must be defined before deployment so that before-and-after comparisons can be made. Another way to measure overall progress would be to benchmark against peer cities, regions and states. Finally, project and program migration and mainstreaming targets for mature applications should be developed. Mainstreaming targets for mature applications should be established in the context of local, regional and state transportation plans, and an annual review of targets should be conducted.

Additional discussion of the importance and application of performance measures is presented in Appendix C.

6.2 Corridor-based Approach and Selection Criteria for Program Strategies

Using a corridor-based approach, including both urban and rural corridors, a series of general program strategies were developed to be initiated during the next 2½, 5, and 10-year timeframes. For purposes of this assessment, a corridor is defined as a primary freeway, parallel arterials and primary highways, local roads and other parallel transportation modes such as rail and transit.

Selection and development of the program strategies, from the list of elements, required defining a set of criteria to be used in order to evaluate and prioritize them. For example, the ITS Strategic Plan 2006 identified a set of strategic criteria for ITS in Minnesota.

Conversely, project oriented objectives relate to the more practical aspects – cost/benefit ratios and operating costs – of executing individual projects.

Selection and prioritization criteria used are based upon strategic and programmatic objectives identified in other program related documents such as the ITS Strategic Plan *2006*, and related factors. For each criterion, a weighted value scale was established. Values were assigned to each "program strategy" based on research, whenever possible, and professional opinion. Weighted values for each of the criteria were also assigned based on their potential for impacting the success of the program strategy. As such, some criteria are weighted higher than others to reflect the perceived importance of those criteria.

- System-Based: Is this strategy statewide or network oriented in nature? For example, deployment of the TOCCs has been a statewide initiative designed to support system operation throughout Minnesota. A value of 0 or 5 was assigned to this criterion. 0 = Not System-Based; 5 = System-Based
- Corridor-Based: Does this represent a strategy that is focused on a particular corridor or set of related corridors that may function as a regional network? For example, I-394, Highway 55, and Highway 7 were recently identified as a corridor for the Integrated Corridor Management project. With I-394 as the primary corridor, the other two parallel routes serve as alternates for managing congestion and other operational needs. A value of 0 or 5 was assigned to this criterion. 0 = Not Corridor-Based; 5 = Corridor-Based
- Proven Technology/Innovation: Does this strategy incorporate particular technologies or applications that have been successfully deployed in the past in Minnesota, the United States or anywhere in the World? For example, variable speed limits have been used extensively in Europe for managing congestion and have also been used in Washington State as a management tool with great success. Does this strategy represent an innovative approach or application of proven technologies? A value of 0 or 5 was assigned to this criterion because of the desire to balance the use of proven technology for permanent deployments with the desire to try new innovative approaches that may yield even greater benefits. If unproven technologies or applications are to be applied then it should be initially applied on a small scale as an operational test before being considered for system-wide deployment. 0 = Unproven; 5 = Proven
- Benefit/Cost Ratio: This criterion compares the potential value of benefits to the deployment costs based on the design, engineering, software/hardware and evaluation costs associated with a strategy. It does not include operating or maintenance costs. A value of 0, 5, or 10 was assigned to this criterion. 0 = Low; 5 = Medium; 10 = High
- Net Operational Cost/Revenues: This criterion is based on estimated five-year operations and maintenance costs and the potential revenue generating possibilities. A value of 0 represents high cost or 5 which represents a moderate cost or 10 which represents a low cost was assigned to this criteria because of the greater challenge associated with modifying existing operating budgets and/or staffing levels to manage operations and maintenance activities after deployments are complete. Considering the possibility of revenue generation of a strategy

(project) a relatively high operating cost (score of "0") would be offset by revenues resulting in lower net cost and a higher score (score of "5" if operating costs are offset to moderate or score of "10" if revenue offsets operating costs are low). 0 = High; 5 = Medium; 10 = Low

- Safety Impact: Whenever possible, safety oriented strategies should identify the type and estimated number of crashes that they could potentially prevent or lessen the severity of. This criterion should then reflect that potential. A value of 0, 5, or 10 was assigned to this criterion because of its significance as both a strategic and programmatic objectives, which is evidenced in Minnesota's Comprehensive Highway Safety Plan and the goal to reduce road fatalities to less than 500 by 2008. 0 = Low; 5 = Medium; 10 = High
- Mobility Impact: This criterion reflects the potential impact on congestion, access and travel time reliability and overall mobility. A value of 0, 5, or 10 was also assigned to this criterion because of its significance as both a strategic and programmatic objective. 0 = Low; 5 = Medium; 10 = High
- Institutional Support: Is there broad based support from the key institutional stakeholders who would be impacted by the strategy? A value of 0, 3, or 5 was used for this criteria because prior experience with lack of institution support has demonstrated significant challenge, or in some cases failure. 0 = Direct opposition; 3 = Neutrality; 5 = Complete Support; or Not Applicable
- Public Support: Is there obvious public opposition to a strategy? For example, electronic enforcement is commonly viewed as an invasion of privacy (i.e., Big Brother). A value of 0, 3, or 5 was chosen for this criterion. 0 = Direct opposition; 3 = Neutrality; 5 = Complete Support; or Not Applicable

The scores given to the selection criteria for each program strategy are then totaled to give an overall value to the program strategy. The value has been used, in combination with other influences, to define a general timeframe for placement in the 10-year work plan.

Concerning the issue of Legal Authority, if current Minnesota law/technical standards do not allow Mn/DOT to pursue a strategy (i.e., electronic enforcement) as part of a project then the specific strategy should be considered a "No-Go" until such time as the law can be modified to allow the application. However, any potential project, minus the infringing strategy, should still be eligible for consideration based on the overall merit. If Minnesota law/technical standards change such as to allow the strategy it may be included for consideration in any potential project.

6.3 Deployment Program Strategies

Table 8 lists the Guidestar Program Deployment Program Strategies that were defined using the elements collected in *Appendix B*. They are purposely broad-based and general in scope. All of the strategies include a number of elements that are used to achieve the major objectives they define. They are in a general listing categorized for deployment in 2½, 5 and 10 years. The list also includes the value developed from the criteria weighted value scale assigned to each strategy. *Sub-chapters 6.3.1 (2½ -Year Strategies), 6.3.2 (5-Year Strategies), and 6.3.3 (10-Year Strategies)* summarize the total scores awarded each

program strategy. For the criteria that scored less than the maximum an indication of the rational for not awarding the maximum score is also presented.

Table 8 – Program Strategy/Selection – Criteria

Reference Number	Program Strategy	Strategy Description	Deployment 2.5, 5, 10 years	System Based 0=Not System Based 5 = System Based	Corridor Based 0=Not Corridor Based 5 = Corridor Based	Technology/Innovation 0=Unproven 5 = Proven	Benefit/Cost Ratio 0=Low 5=Medium 10=High	Operational Cost 0=High 5=Medium 10=Low	Safety Impact 0=Low 5=Medium 10=High	Mobility Impact 0=Low 5=Medium 10=High	Institutional Support 0=Direct Opposition 3=Neutrality 5=Complete Support N/A	Public Support 0=Direct Opposition 3=Neutrality 5=Complete Support N/A	TOTAL POINTS (Maximum 65 points)
1	"Hard or HOT Shoulders" to maximize use of available pavement during peak periods	The strategy of converting shoulder lanes to active traffic lanes has been successfully used in Europe. By definition, a hard or HOT shoulder lane is an enhanced shoulder equipped with various congestion management tools that can accommodate traffic on an interim basis in order to maximize capacity on existing roadways. A significant portion of the cost of deployment of this strategy would be in strengthening the actual pavement and in modifying the infrastructure. The ITS component involves traffic management and lane control. If utilized as HOV or even HOT lanes there is a very positive impact on transit.	2.5	5	5	5	10	10	5	10	5	5	**60**
2	Expansion of RTMC coverage area to 100% of metro freeways	Currently the RTMC covers approximately 92% of the in the Metro area. The goal is to have 100% coverage in the Metro area. The RTMC provides the communications and computer infrastructure necessary for coordinated transportation management during normal commuting periods, as well as during special events and major incidents.	2.5	5	5	5	10	5	10	10	5	5	**60**
3	Contraflow lanes to take advantage of unused capacity	When a major freeway or major arterial (minimum 3 lanes in each direction) has a high differential traffic flow during peak periods, this strategy focuses on utilizing the unused capacity by installing "zipper" lanes to go to a 2/4 lane situation alternating between the morning and afternoon peak periods. The "added" lane can be designated for general traffic, HOV, or even HOT use.	2.5	5	5	5	10	5	10	10	5	5	**60**
4	Implement dynamic pricing including HOT lanes	This strategy involves developing new lanes that allow any vehicle the opportunity to pay a fee to use the lanes and/or converting existing HOV lanes such as I-35W south of the Crosstown to Lakeville (HOT lanes) that allow Single Occupancy Vehicle (SOV) the opportunity to pay a fee to use the lane while HOV, transit and motorcycles use the lane for no fee. The fee varies (dynamic) depending on time of day and traffic conditions. This is an extension of the current MnPASS (I-394) program in Minnesota. Revenue generated from dynamic pricing offsets the operation costs of the system.	2.5	5	5	5	10	10	10	10	5	0	**60**
5	Improve traveler information dissemination systems and signage	This strategy focuses on the continuing improvements to provide real-time traveler information via various dissemination systems and signage. VII, satellite radio, HAR, DMS, RDS, in-vehicle signage, 511 and other technologies are potential means of providing that real-time information to the traveler.	2.5	5	5	5	5	0	5	5	5	5	**40**

Reference Number	Program Strategy	Strategy Description	Deployment 2.5, 5, 10 years	System Based 0=Not System Based 5 = System Based	Corridor Based 0=Not Corridor Based 5 = Corridor Based	Technology/Innovation 0=Unproven 5 = Proven	Benefit/Cost Ratio 0=Low 5=Medium 10=High	Operational Cost 0=High 5=Medium 10=Low	Safety Impact 0=Low 5=Medium 10=High	Mobility Impact 0=Low 5=Medium 10=High	Institutional Support 0=Direct Opposition 3=Neutrality 5=Complete Support N/A	Public Support 0=Direct Opposition 3=Neutrality 5=Complete Support N/A	TOTAL POINTS (Maximum 65 points)
6	Expand winter maintenance operations to improve safety	This strategy focuses on the application of technologies that provide for better data in maintenance vehicles, AVL, heads-up displays and implementation of SAIL II.	2.5	5	5	5	10	5	10	10	3	3	**56**
7	Dynamic lane control signals to manage lanes including the use of variable speed limits to smooth traffic and provide for aggressive incident and construction management/control systems	The use of dynamic lane control with variable speed limits has been successfully used in Europe for many years. This is another strategy that can be used to enhance dynamic traffic management during non-recurring traffic incidences, peak period congestion and work zone protection. Current Minnesota law is questionable as to whether variable speed limits are enforceable or advisory.	2.5	5	0	5	5	10	10	10	5	5	**55**
8	Incorporate state system arterials as well as local streets and transit into integrated corridor management	This strategy focuses on developing seamless corridor management that includes existing freeways programs plus state system arterials as well as local street and roads and provides greater opportunities for transit. This strategy has an urban mobility impact as it relates to the RTMC but also a rural area application potentially involving the outstate TOCCs. This strategy includes integration and coordination of the traffic signal systems.	5	5	5	5	5	5	5	10	0	5	**45**
9	Expand first responder and law enforcement systems	The ITS Safety Plan identified 6 Critical Strategies and 22 initiatives. Critical Strategy #2 focuses on 3 of those initiatives, namely: 1. Coordination of emergency responder databases 2. Ability for law enforcement to access data from onboard vehicle computers (currently not allowed under Minnesota law) and 3. Provide a uniform, real-time automated crash notification system (extension of Mayday).	5	5	5	5	10	0	10	5	5	5	**50**
10	Implement the next generation Traffic Operations and Communications Centers (TOCC) to include local governments	Minnesota has successfully deployed TOCCs statewide. This strategy focuses on the "next generation" and involves expanding the TOCC-concept to include local government agencies. The intent is to provide a seamless system that includes local roads and local transit providers as well as Mn/DOT and the Minnesota State Patrol.	5	5	5	5	5	5	5	5	0	3	**38**
11	Use intersection collision warning systems	The strategy is focused specifically to reduce the number of traffic crashes occurring at rural highway/highway and rural highway/rail intersections. A project recently completed in Minnesota successfully demonstrated an infrastructure-based technology to reduce the number of highway/rail intersection crashes. This technology is currently being developed by the private sector. Currently underway is the Comprehensive Intersection Collision Avoidance System (CICAS) project that is developing infrastructure-based technology to reduce crashes at highway/highway intersections.	5	5	0	5	5	5	10	0	5	5	**40**

Reference Number	Program Strategy	Strategy Description	Deployment 2.5, 5, 10 years	System Based 0=Not System Based 5 = System Based	Corridor Based 0=Not Corridor Based 5 = Corridor Based	Technology/Innovation 0=Unproven 5 = Proven	Benefit/Cost Ratio 0=Low 5=Medium 10=High	Operational Cost 0=High 5=Medium 10=Low	Safety Impact 0=Low 5=Medium 10=High	Mobility Impact 0=Low 5=Medium 10=High	Institutional Support 0=Direct Opposition 3=Neutrality 5=Complete Support N/A	Public Support 0=Direct Opposition 3=Neutrality 5=Complete Support N/A	TOTAL POINTS (Maximum 65 points)
12	Electronic enforcement including red light running, electronic speed enforcement to prevent crashes and ensure toll lane compliance	Minnesota currently does not allow the use of electronic enforcement for red light running cameras, speed enforcement or toll lane violations. If Minnesota would allow electronic enforcement there would be an immediate positive impact on mobility and safety.	10	5	5	5	10	5	10	5	5	0	**50**
13	Implement VII to expand data collection infrastructure on rural highway system	This strategy focuses on the potential deployment of a national VII system. VII provides the framework for advanced vehicle safety systems developed under IVI. VII provides for vehicle-to-vehicle, vehicle-to-roadside and roadside-to-vehicle communications. VII offers the ability to collect infrastructure condition data directly for passing vehicles.	10	5	5	0	5	0	5	5	5	3	**33**

6.3.1 2½-Year Strategies – Scores and Rationale

1. "Hard or HOT Shoulders" to maximize use of available pavement during peak periods

   - Total score of 60 out of 65 potential points. Developing "Hard or HOT shoulder" lanes as either general use or HOV or HOT would have a positive impact on transit.
   - Scored "5" or "Medium" relative to Safety Impact since there has been some question as to how it will actually impact safety.

2. Expansion of RTMC coverage area to 100% of metro freeways

   - Total score of 60 out of 65 potential points.
   - Scored "5" or "Medium" relative to Operational Costs since there is a significant ongoing operations cost associated with expansion of coverage.

3. Contraflow lanes to take advantage of unused capacity

   - Total score of 60 out of 65 potential points. Developing the "added" lanes as either HOV or HOT would have a positive impact on transit.
   - Scored "5" or "Medium" relative to Operational Costs since there is a significant ongoing operations cost associated with moving the barriers on a daily basis. However, if the lanes were developed as HOT lanes the revenue generated by the tolls would offset the cost of operation.

4. Implement dynamic pricing including HOT lanes

   - Total score of 60 out of 65 potential points.
   - Scored "10" relative to Operational Costs" since the addition of a revenue stream from tolls offset the actual cost of operations.
   - Scored "0" relative to Public Support since it is anticipated that there may be some public opposition.

5. Improve traveler information dissemination systems and signage

   - Total score of 40 out of 65 potential points.
   - Scored "5" or "Medium" relative to Benefit/Cost since it is very difficult to actually define the benefits in dollar and cent terms.
   - Scored "0" or "High" relative to Operational Costs.
   - Scored "5" or "Medium" relative to Safety Impact since there has been some question as to how it will actually impact safety.
   - Scored "5" or "Medium" relative to Mobility Impact since there has been some question as to how it will actually impact mobility.

6. Expand winter maintenance operations to improve safety

- Total score of 56 out of 65 potential points.
- Scored "5" or "Medium" relative to Operational Costs since there is a significant ongoing operations cost associated with deployment of winter maintenance technologies.
- The Institutional Support and Public Support criterion were scored "3" or "Neutral". Relative to Institutional Support there seems to be reluctance to incorporate this strategy at the District and local levels and relative to Public Support there is no evidence of either support or opposition.

7. Dynamic lane control signals to manage lanes including the use of variable speed limits to smooth traffic and provide for aggressive incident and construction management/control systems

   - Total score of 55 out of 65 potential points.
   - Scored "0" relative to corridor-based strategy since it will only be considered at certain designated roadways and not for corridor-wide deployment. In reality, however, any increase in capacity on a freeway or major arterial can take the pressure off of other roads in the corridor.
   - Scored "5" or "Medium" relative to Benefit/Cost since there has not been sufficient data to reliably determine a true B/C. Anecdotal evidence seems to point to a high B/C ratio.

6.3.2 5-Year Strategies – Scores and Rationale

8. Incorporate local streets and transit into integrated corridor management

   - Total score of 45 out of 65 potential points.
   - Scored "5" or "Medium" relative to Benefit/Cost since there has not been sufficient data to reliably determine a true B/C. Anecdotal evidence seems to point to a high B/C ratio.
   - Scored "5" or "Medium" relative to Operational Costs since there is a significant ongoing operations cost associated with the integration of local streets and transit integrated corridor management.
   - Scored "5" or "Medium" relative to Safety Impact since there has been some question as to how it will actually impact safety.
   - Scored "0" or "Direct Opposition" relative to Institutional Support. There has always been reluctance from local agencies to relax control of their systems.

9. Expand first responder and law enforcement systems

   - Total score of 50 out of 65 potential points.
   - Scored "5" or "Medium" relative to Mobility Impact since there has been some question as to how it will actually impact mobility.
   - Scored "0" or "High" relative to Operational Costs.

10. Implement the next generation Traffic Operations and Communications Centers (TOCC) to include local governments

    - Total score of 38 out of 65 potential points.
    - Scored "5" or "Medium" relative to Benefit/Cost since there has not been sufficient data to reliably determine a true B/C. Anecdotal evidence seems to point to a high B/C ratio.
    - Scored "5" or "Medium" relative to Operational Costs since there is a significant ongoing operations cost associated with deployment of winter maintenance technologies.
    - Scored "5" or "Medium" relative to Safety Impact since there has been some question as to how it will actually impact safety.
    - Scored "5" or "Medium" relative to Mobility Impact since there has been some question as to how it will actually impact mobility.
    - Scored "0" or "Direct Opposition" relative to Institutional Support. There has always been a reluctance from local agencies relax control of their systems.
    - Scored a "3" or "Neutral" relative to Public Support since there is no evidence of either support or opposition.

11. Use intersection collision warning systems

    - Total score of 40 out of 65 potential points.
    - Scored "0" relative to corridor-based strategy since it will only be considered at isolated critical intersections and not for widespread deployment.
    - Scored "5" or "Medium" relative to Benefit/Cost since there has not been sufficient data to reliably determine a true B/C. Intersection crashes are significant events however, the chances of occurrence at any given intersection are fairly rare indicating that there would need to be fairly large deployment to realize any appreciable benefits.
    - Scored "5" or "Medium" relative to Operational Costs since there is a significant ongoing operations cost associated with deployment of any infrastructure-based technology in the field.
    - Scored "0" or "Low" relative to Mobility Impact since there has been some question as to how it will actually impact mobility.

6.3.3 10-Year Strategies – Scores and Rationale

12. Electronic enforcement including red light running, electronic speed enforcement to prevent crashes and ensure toll lane compliance

    - Total score of 50 out of 65 potential points. This strategy could have an immediate impact on safety and mobility; however, since there is a prohibition in Minnesota relative to the use of electronic enforcement this strategy has been placed in the 10-year timeframe.

- Scored “5” or “Medium” relative to Operational Costs since there is a significant ongoing operations cost associated with deployment of any infrastructure-based technology in the field.
- Scored “5” or “Medium” relative to Mobility Impact since there has been some question as to how it will actually impact mobility.
- Scored “0” relative to Public Support since it is anticipated that there may be some public opposition.

13. Implement Vehicle Infrastructure Integration (VII) to expand data collection infrastructure on rural highway system

    - Total score of 33 out of 65 potential points. Since the current VII program calls for a major decision by the end of 2008 and, pending a “go” decision, deployment will begin in 2011 or later, therefore, this strategy has been placed in the 10-year timeframe.
    - Scored “0” for Technology/Innovation since this the proposed technology (DSRC) is still somewhat unproven at this point and is still in the “research” stage.
    - Scored “5” or “Medium” relative to Benefit/Cost since there has not been sufficient data to reliably determine a true B/C.
    - Scored “0” or “High” relative to Operational Costs since there is a significant ongoing operations cost associated with deployment of this major infrastructure-based technology in the field.
    - Scored “5” or “Medium” relative to Safety Impact since there has been some question as to how it will actually impact safety.
    - Scored “5” or “Medium” relative to Mobility Impact since there has been some question as to how it will actually impact mobility.
    - Scored a “3” or “Neutral” relative to Public Support since there is no evidence of either support or opposition.

7 Guidestar Program: Deployment Assessment Projects

The following Guidestar Program: Deployment Assessment Projects have been selected to incorporate and implement the fifteen identified Program Strategies. Each project selected incorporates several of the most applicable and highly valued Program Strategies that meet the overall program goal of safety and mobility. Based on the input provided by the ITS Deployment Team, preliminary descriptions and example locations were developed for the following ITS projects:

Project 1: Implement dynamic lane control and variable speed limit signs

Project 2: Implement Hard or High Occupancy Toll (HOT) shoulder concept

Project 3: Complete Regional Traffic Management Center (RTMC) traffic management instrumentation

Project 4: Expand RTMC traffic management systems to arterials

Project 5: Expand RTMC travel time display locations

Project 6: Implement contraflow lanes

Project 7: Convert existing High Occupancy Vehicle (HOV) lanes to HOT lanes utilizing MnPASS

Project 8: Deploy integrated corridor management

Project 9: Expand first responder and law enforcement systems

Project 10: Implement Automatic Vehicle Location (AVL) technology

Project 11: Expand interconnection between the RTMC and the Transportation Operations and Communications Centers (TOCC)

Project 12: Implement collision warning systems at rural highway intersections

Project 13: Deploy automated enforcement

Project 14: Develop test bed for Vehicle Infrastructure Integration (VII)

It should be noted that the selected projects are designed to standalone, to complement, to be incorporated with, and/or to be concurrently developed as part of ongoing scheduled transportation construction projects. When necessary to better define the path to full deployment, innovative development projects or operational tests that advance the state of knowledge are included. The listing of projects above does not indicate a ranking by priority, but the projects are numbered as a means of identification.

Each project is further identified and described in additional detail using the following fields:

Example Location – An example location was selected for each project to assist in future programming and planning. The locations selected are examples and will be adjusted as the project moves forward in development.

Program Strategies – This field lists the most highly valued Program Strategies from Table 8 to incorporate within the project. Each project is supported by a number of strategies that improve safety and mobility in Minnesota.

Project Champion(s)/Lead(s) – Each project requires a champion(s) to bring together the stakeholders and to lead the project through the appropriate steps to implementation. The selected project champions have agreed to their role and they may select additional personnel to further promote project development.

Project Purpose/Objective – The overall purpose and objective of each project is further defined in this field.

Safety or Mobility – Safety and mobility tend to go hand in hand, but for the purposes of this assessment and funding, a primary category was selected to represent each project.

Participants and Stakeholders – Organizations and agencies who have shown an interest in, or who would likely participate in development of the project.

Institutional/Public Support Issues – This field identifies the issues that will need to be addressed as part of the development of the project. In some cases if current Minnesota law/technical standards do not allow Mn/DOT to pursue all parts of a project, then only that specific part not appropriate should be considered a "No-Go" until such time as the law is modified to allow all parts of the application. The balance of the project should proceed on its overall merit.

Duration/Timing – This field provides a proposed schedule for the implementation of the project and related projects. It could include a relationship to ongoing projects, and/or construction projects. The schedules shown are preliminary, to start the planning process, and will be adjusted as the projects move forward.

Deployment Cost Estimate – Preliminary rough cost estimates to start the planning process are identified in this field. Where appropriate, the basis for the estimate, for example $$$$ per lane mile, is included.

5-Year Operations and Maintenance Cost Estimate – Estimated costs for maintaining the project over five years is noted in this field. Where appropriate, the basis for the estimate is shown. These costs are in addition to the deployment cost estimates.

Mn/DOT Full-time Employee Cost Estimate – Full Time Equivalent (FTE) estimate of additional staffing requirements to set up and manage development of the project from initiation through implementation is indicated in this field. Program delivery provides an estimate of additional staffing requirements for software development and interconnectivity with existing systems.

Evaluation Cost Estimate – This field identifies the cost for the project evaluation, if required.

Performance Measures – The measures used to effectively determine the impact of the project and that could be used in project evaluation and determining future deployments are suggested in this field.

Note: A summary of the cost estimates from each project is included in Table 9 after the project descriptions.

Project Title	**Project 1: Implement dynamic lane control and variable speed limit signs**
Example Location	▪ I-94 between downtown Minneapolis and St. Paul ▪ I-35W from downtown Minneapolis south to I-494
Program Strategies	▪ Program Strategy 5 – Improve traveler information dissemination systems and signage ▪ Program Strategy 7 – Dynamic lane controls to manage lanes including the use of variable speed limits to smooth traffic and provide for aggressive incident and construction management/control systems
Project Champion(s)/Lead(s)	Bernie Arseneau, Mn/DOT State Traffic Engineer
Project Purpose/Objective	This project focuses on using dynamic lane control with variable speed limit signs. Variable speed limit systems provide real-time information on the appropriate speed for current conditions based on traffic flow, traffic speed, weather, and other inputs and integration with law enforcement. The use of dynamic lane control with variable speed limits has been successfully used in Europe for many years. This is another strategy that can be used to enhance dynamic traffic management during non-recurring traffic incidences, peak period congestion, and work zone protection. Careful examination of traffic data will assist Mn/DOT in guiding the final selection of applying dynamic lane control and variable speed limit signs along a corridor. It is important that the corridor chosen includes camera coverage in order to evaluate and document results of the project, as well as identify modifications that are needed throughout the project.
Safety or Mobility	Mobility
Participants and Stakeholders	Mn/DOT and Minnesota State Patrol
Institutional /Public Support Issues	Current Minnesota law is questionable as to whether variable speed limits are enforceable or advisory. Public education is a necessary key to explain how drivers should react to the variable speed limits and dynamic lane control.
Duration/Timing	Implement Program Strategies 5 and 7 within 2½ years
Deployment Cost Estimate	$8,000,000 ($500,000 per mile - example locations total approximately 16 miles)
5-Year Operations and Maintenance Cost Estimate	$500,000

Project Title	**Project 1: Implement dynamic lane control and variable speed limit signs**
Mn/DOT Full-time Employee Cost Estimate	$180,000 (2 FTE for program delivery)
Evaluation Cost Estimate	$600,000
Performance Measures	▪ Number of times system is activated ▪ Reduction in crashes relating to ambient conditions

Project Title	**Project 2: Implement hard or High Occupancy Toll (HOT) shoulder concept**
Example Location	West side of the Twin Cities metro area on I-494 between I-394 and I-94 as an HOT facility (MnPASS)
Program Strategies	▪ Program Strategy 1 – "Hard or HOT shoulders" to maximize use of available pavement during peak periods ▪ Program Strategy 4 – Implement HOT lanes with dynamic pricing ▪ Program Strategy 5 – Improve traveler information dissemination systems and signage ▪ Program Strategy 7 – Deploy dynamic lane controls to manage lanes including the use of variable speed limits to smooth traffic and provide for aggressive incident and construction management/control systems ▪ Program Strategy 12 – Implement electronic enforcement including red light running, electronic speed enforcement to prevent crashes, and ensure toll lane compliance
Project Champion(s)/Lead(s)	Khani Sahebjam, Metro Division Engineer and Bernie Arseneau, Mn/DOT State Traffic Engineer
Project Purpose/Objective	The objective of this project is to convert the existing shoulders on I-494, between I-394 and I-94, into active traffic lanes. A dynamic shoulder lane is an enhanced shoulder equipped with various congestion management tools that can accommodate traffic on an interim basis in order to maximize capacity on existing roadways. Implementation of hard or HOT shoulders improves the utilization of existing highway investments, provides more immediate congestion relief for a corridor not currently programmed for capacity improvements, provides travel time reliability and relieves congestion. HOT lanes provide a dedicated transit lane allowing bus users free access that currently does not exist. This project will also give solo drivers a commuting choice, to stay in the general-purpose lane, or pay for an "express service that save them time. Dynamic shoulders have been constructed internationally in Germany, Netherlands, and Great Britain, as well as nationally in Boston, Seattle, and Los Angeles. This pilot project would be used to evaluate various traffic management tools, such as variable speed limit signs, lane control signals, dynamic pricing, and Advanced Traveler Information System (ATIS), as well as improvement in transit reliability. In addition to traffic management tools, major items in creating hard or HOT shoulders include shoulder reconstruction, drainage control, and noise walls.

Project Title	**Project 2: Implement hard or High Occupancy Toll (HOT) shoulder concept**
Safety or Mobility	Mobility
Participants and Stakeholders	Mn/DOT, Met Council/Metro Transit, communities within the corridor, FHWA, and local transit agencies.
Institutional /Public Support Issues	Public outreach, education, and buy-in through means such as the media to build and maintain acceptance and awareness are keys to successfully implementing hard or HOT shoulders.
Duration/Timing	Implement Program Strategies 1, 4, 5, and 7 within 2½ years, and Program Strategy 12 within 10 years (strategies 7 and 12 are dependent on clarification of regulations and passage of enabling legislation, once these obstacles to implement are removed these strategies can be implemented).
Deployment Cost Estimate	$25,500,000 ($3,000,000/centerline mile -example location is 8.5 miles)
5-Year Operations and Maintenance Cost Estimate	$500,000
Mn/DOT Full-time Employee Cost Estimate	$225,000 (1½ FTE for program management plus 1 FTE for program delivery)
Evaluation Cost Estimate	$200,000
Performance Measures	Reduction in peak-period congestion due to demand/capacity imbalances. Improvement of the operational efficiency of transportation systems for all modes.

Project Title	**Project 3: Complete RTMC traffic management instrumentation**
Location	I-35E and I-35W from north of the I-35 split south to I-694
Program Strategies	▪ Program Strategy 2 – Expand RTMC coverage area to 100% of metro freeways ▪ Program Strategy 5 – Improve traveler information dissemination systems and signage
Project Champion(s)/Lead(s)	Jim Kranig, Mn/DOT Assistant State Traffic Engineer – RTMC Director
Project Purpose/Objective	The Regional Transportation Management Center (RTMC) integrates Mn/DOT's Metro District Maintenance Dispatch and Office of Traffic, Security, and Operations with the Minnesota Department of Public Safety's State Patrol Dispatch into a unified communications center. The integration provides the communications and computer infrastructure necessary for coordinated transportation management on metro freeways during normal commuting periods, as well as during special events and major incidents. Additional information on the RTMC can be found in *Sub-chapter 3.4 – Minnesota Supportable Infrastructure*. Currently, Mn/DOT is working on completing the instrumentation of the I-494/I-694 freeway ring on the Twin Cities metro freeway system with an anticipated completion date of spring 2007. The next step is to instrument I-35E and I-35W from the I-35 split down to just north of I-694. Completion of the RTMC coverage of the metro freeways will provide additional real-time information to drivers via DMS, cameras, and 511 traveler information (phone and internet).
Safety or Mobility	Mobility
Participants and Stakeholders	Mn/DOT, Minnesota State Patrol, KBEM, local agencies, and information service providers (i.e., Traffic.com)
Institutional /Public Support Issues	None anticipated
Duration/Timing	Implement Program Strategies 2 and 5 within 2½ years.
Deployment Cost Estimate	$3,910,000 ($170,000 / centerline mile – example location is 23 miles)
5-Year Operations and Maintenance Cost Estimate	$300,000
Mn/DOT Full-time Employee Cost Estimate	$405,000 (3 FTE for program management plus 1½ FTE for program delivery)
Evaluation Cost	Not applicable

Project Title	**Project 3: Complete RTMC traffic management instrumentation**
Estimate	
Performance Measures	▪ Number of devices installed ▪ Number of additional miles covered ▪ Number of new devices operational at a given time

Project Title	**Project 4: Expand RTMC traffic management systems to arterials**
Example Location	Phase 1: TH 55 (I-94 to I-494) Phase 2: TH 65 (I-694 to Crosstown Blvd.)
Program Strategies	▪ Program Strategy 2 – Expand RTMC coverage area to 100% of metro arterials and major arterials ▪ Program Strategy 5 – Improve traveler information dissemination systems and signage
Project Champion(s)/Lead(s)	Steve Misgen, Mn/DOT Metro District Signal Operations Engineer
Project Purpose/Objective	This project will install various surveillance and traveler information signs to the signalized arterial network. This project serves a number of functions including Homeland Security, Transportation Management. Phase 1 will add surveillance, variable message signs and fiber optic communications along TH 55 in the west metro from I-494 to I-94. This will add to the existing surveillance on TH 55 and add to the redundancy of the existing fiber optic system. Phase 2 will add surveillance, variable message signs and fiber optic communications along TH 65 from I-694 north to Crosstown Blvd. The fiber optic communications will add redundancy to the existing fiber system in the area.
Safety or Mobility	Mobility
Participants and Stakeholders	Mn/DOT
Institutional /Public Support Issues	There may be staffing limitations and availability of space on the RTMC switch that would need to be addressed.
Duration/Timing	Implement Program Strategies 2 and 5 within 2½ years.
Deployment Cost Estimate	Phase 1: $775,000 Phase 2: $1,100,000
5-Year Operations and Maintenance Cost Estimate	Phase 1: $170,000 Phase 2: $200,000
Mn/DOT Full-time Employee Cost Estimate	$225,000 (2½ FTE ½ software/programming, 1 integration, 1 design/construction inspection)
Evaluation Cost Estimate	Not applicable
Performance Measures	▪ Number of devices installed ▪ Number of miles covered ▪ Number of new devices operational at a given time

Project Title	**Project 5: Expand RTMC travel time display locations**
Example Location	25 point-to-point freeway locations
Program Strategies	▪ Program Strategy 2 – Expand RTMC coverage area to 100% of metro freeways ▪ Program Strategy 5 – Improve traveler information dissemination systems and signage
Project Champion(s)/Lead(s)	Jim Kranig, Mn/DOT Assistant State Traffic Engineer – RTMC Director and Bernie Arseneau, Mn/DOT State Traffic Engineer
Project Purpose/Objective	The Regional Transportation Management Center (RTMC) integrates Mn/DOT's Metro District Maintenance Dispatch and Office of Traffic, Security, and Operations with the Minnesota Department of Public Safety's State Patrol Dispatch into a unified communications center. The integration provides the communications and computer infrastructure necessary for coordinated transportation management on metro freeways during normal commuting periods, as well as during special events and major incidents. Additional information on the RTMC can be found in *Sub-chapter 3.4 – Minnesota Supportable Infrastructure*. Mn/DOT currently displays data at multiple locations to identify freeway travel times. In order to expand coverage, Mn/DOT will research and prioritize the top 25 locations for expansion of the displaying freeway travel times. As part of identifying locations, Mn/DOT will consider those locations where travel times can be placed on DMS. The information will also be displayed within Mn/DOT's 511 traveler information system. This project supports Mn/DOT's development of mobility measures by providing data to measure duration and extent of congestion as well as travel time reliability.
Safety or Mobility	Mobility
Participants and Stakeholders	Mn/DOT, Minnesota State Patrol, KBEM, local agencies, and information service providers (i.e., Traffic.com)
Institutional /Public Support Issues	None anticipated
Duration/Timing	Implement Program Strategies 2 and 5 within 2½ years
Deployment Cost Estimate	$2,100,000 ($84,000 per location - 25 locations)
5-Year Operations and Maintenance Cost Estimate	$50,000 added electricity cost

Project Title	**Project 5: Expand RTMC travel time display locations**
Mn/DOT Full-time Employee Cost Estimate	$45,000 (½ FTE for program management)
Evaluation Cost Estimate	Not required
Performance Measures	▪ Number of devices installed ▪ Number of additional miles covered ▪ Number of new devices operational at a given time

Project Title	**Project 6: Implement contraflow lanes**
Example Location	I-94 starting north of TH 101 interchange and just south of the Fish Lake interchange (I-94/I-494/I-694)
Program Strategies	▪ Program Strategy 3 – Use Contraflow lanes to take advantage of unused capacity ▪ Program Strategy 4 – Implement HOT lanes with dynamic pricing ▪ Program Strategy 5 – Improve traveler information dissemination systems and signage ▪ Program Strategy 7 – Incorporate dynamic lane controls to manage lanes, including the use of variable speed limits to smooth traffic and provide for aggressive incident and construction management/control systems ▪ Program Strategy 12 – Implement electronic enforcement including red light running, electronic speed enforcement to prevent crashes and ensure toll lane compliance
Project Champion(s)/Lead(s)	Khani Sahebjam, Metro Division Engineer and Bernie Arseneau, Mn/DOT State Traffic Engineer
Project Purpose/Objective	This 7.5-mile portion of the I-94 corridor has a high differential traffic flow during peak periods. In order to focus on utilizing the unused capacity, this project will install "zipper" lanes to go from a 3/3 to a 2/4 lane configuration during the morning peak period. By allocating more capacity to the direction of traffic needing more throughput, Mn/DOT can efficiently use the existing roadway and delay additional lane construction until funding is available, at which time the zipper lane(s) infrastructure and operating equipment can be removed and reused at a new location. The "added" lane can be designated for general traffic, HOV, or even HOT use. Contraflow lanes could also be implemented along select metro arterials. Contraflow has generally been used throughout the country during evacuation or emergency situations, such as hurricanes, or during special event circumstances, such as a Super Bowl. During these events, law enforcement officials are needed to manually direct or block traffic to create a lane reversal. The proposed project would not need law enforcement to enact the contraflow lane. Contraflow bus lanes are also utilized throughout the country, as well as in Europe. This model is a good representation of how transit benefits from contraflow lanes, whether the lanes operate as general use, HOV, or HOT lanes.

Project Title	**Project 6: Implement contraflow lanes**
	As part of this project, Mn/DOT would focus on developing and deploying signage, as well as traffic control devices. Transit could benefit from the contraflow lanes during peak periods, since the lane could be designated for HOV.
Safety or Mobility	Mobility
Participants and Stakeholders	Mn/DOT, Metro Transit, Met Council, FHWA, and local governments
Institutional /Public Support Issues	In order for safe operation, the public will have to be educated as to what to expect as they enter these contraflow lanes. Public acceptance and comfort with this strategy will be important to the overall project success.
Duration/Timing	Implement Program Strategies 3, 4, 5, and 7 within 2½ years and Program Strategy 12 within 10 years
Deployment Cost Estimate	$15,500,000; transfer machine (1) $1,000,000; medium crossover, signing (static and dynamic) - $4,000,000; $1,400,000/mile - 7.5 miles of moveable barrier (Cost is for general use or HOV and does not include HOT deployment)
5-Year Operations and Maintenance Cost Estimate	$850,000
Mn/DOT Full-time Employee Cost Estimate	$135,000 (½ FTE for program management plus 1 FTE for program delivery)
Evaluation Cost Estimate	$300,000
Performance Measures	Reduction in the peak period congestion due to demand/capacity imbalances. Improvement of the operational efficiency of transportation systems for all modes.

Project Title	**Project 7: Convert existing HOV lanes to HOT lanes utilizing MnPASS**
Example Location	I-35W from the Crosstown to TH13
Program Strategies	▪ Program Strategy 4 – Implement dynamic pricing including HOT lanes ▪ Program Strategy 5 – Improve traveler information dissemination systems and signage ▪ Program Strategy 7 – Deploy dynamic lane controls to manage lanes including the use of variable speed limits to smooth traffic and provide for aggressive incident and construction management/control systems ▪ Program Strategy 12 – Implement electronic enforcement including red light running, electronic speed enforcement to prevent crashes and ensure toll lane compliance
Project Champion(s)/Lead(s)	Khani Sahebjam, Metro Division Engineer and Bernie Arseneau, Mn/DOT State Traffic Engineer
Project Purpose/Objective	This project focuses on implementing dynamic pricing on the underutilized HOV lanes along I-35W by converting them to MnPASS HOT lanes for the purpose of reducing recurring congestion. This project would incorporate the lessons learned from the MnPASS deployment on I-394. MnPASS is a Mn/DOT program that provides a way to move traffic in metropolitan areas while making better use of existing roadways. MnPASS also gives solo drivers a commuting choice, stay in the general purpose lanes or pay for an "express" service that will save them time. The purpose of the MnPASS express lanes is to get people to and from their destinations faster, and a fee is charged for this service. When the MnPASS express lanes become too congested, meaning traffic is moving below 50 mph, the fee to enter the MnPASS express lanes increases. This increase is an attempt to slow the number of cars entering the lane, and thereby maintain the speed above 50 mph for the vehicles already in the lane. If the MnPASS express lanes were not priced in this dynamic fashion, the lanes would not continue to be an "express" option for motorists. Through various technologies such as signage, computer software, and in-vehicle equipment, this project will convert the existing I-35W HOV lanes to HOT. This project will also address enforcement issues, costs, and hours of operation. It is important to note that HOV and HOT lanes will continue allowing carpoolers and bus users to free access and priority use.

Project Title	**Project 7: Convert existing HOV lanes to HOT lanes utilizing MnPASS**
Safety or Mobility	Mobility
Participants and Stakeholders	Mn/DOT, Metro Transit, Local Transit Providers, Local Government
Institutional /Public Support Issues	The State of Minnesota currently has legislations that allows Mn/DOT to enter into infrastructure agreements with the private sector. Minnesota also has authority under the federal Value Pricing Program to convert HOV to HOT lanes, and to implement optional fee-based lanes on new interstate capacity. However, public education and outreach will be necessary to inform drivers of the lane change. Marketing research will also be an important component of this project.
Duration/Timing	Implement Program Strategies 4, 5, and 7 within 2½ years and Program Strategy 12 within 10 years.
Deployment Cost Estimate	$12,000,000 (8 miles at $1,500,000 per centerline mile)
5-Year Operations and Maintenance Cost Estimate	$5,000,000 ($1,000,000 /year for administration, enforcement, and maintenance)
Mn/DOT Full-time Employee Cost Estimate	$225,000 (1½ FTE for program management plus 1 FTE for program delivery)
Evaluation Cost Estimate	$250,000
Performance Measures	▪ Maintaining 50 MPH speed in HOT lane 95% of time (required) ▪ Number of single occupancy vehicles utilizing the HOT lane ▪ Reduction in congestion in general purpose lanes of roadway

Project Title	**Project 8: Deploy integrated corridor management**
Example Location	I-394 Corridor (encompassing TH 55 on the north side and TH 7 on the south side of I-394)
Program Strategies	▪ Program Strategy 2 – Expand RTMC coverage area to 100% of metro freeways ▪ Program Strategy 5 – Improve traveler information dissemination systems and signage ▪ Program Strategy 7 – Deploy dynamic lane controls to manage lanes including the use of variable speed limits to smooth traffic and provide for aggressive incident and construction management/control systems ▪ Program Strategy 8 – Incorporate local streets and transit into integrated corridor management ▪ Program Strategy 12 – Implement electronic enforcement including red light running, electronic speed enforcement to prevent crashes and ensure toll lane compliance
Project Champion(S)/Lead(S)	Brian Kary, Mn/DOT Freeway Operations Engineer
Project Purpose/Objective	The goal of this project is to reduce both recurring and non-recurring traffic congestion in the I-394 corridor through coordination between multiple transportation networks. By effectively utilizing technologies, strategies, and institutional cooperation, traffic in the corridor can be spread through different transportation networks in the corridor area to effectively use the available capacity in the area. There are already a number of network and corridor management strategies in place in the corridor and this project will integrate these capabilities and the operations of the different facilities and agencies in a more effective manner to decrease congestion. This specific ICM projects is part of a broader national ICM program, which has three stages: ▪ Stage 1: Pioneer sites, where a site-specific concept of operations will be developed, along with requirements documentation and data collection to address congestion and other transportation issues in a corridor ▪ Stage 2: Pioneer analysis, modeling, and simulation (AMS) sites, where data will be modeled and analyzed to determine which solutions are most effective and which pioneer sites will be selected for stage three ▪ Stage 3: Pioneer demonstration sites, where sites will conduct a demonstration project and assist in the evaluation

Project Title	**Project 8: Deploy integrated corridor management**
	of the demonstration Currently, Mn/DOT was one of eight Pioneer Sites chosen to start Stage 1.
Safety Or Mobility	Mobility
Participants And Stakeholders	Mn/DOT, Hennepin County, the City of Minneapolis, FHWA and Metro Transit
Institutional /Public Support Issues	Stakeholder buy-in is key to successfully implementing the integrated corridor management project.
Duration/Timing	Stage 1: Submit Draft Concept of Operations – March 20, 2007 Submit Final Concept of Operations – June 4, 2007 Submit Requirements Document – December 10, 2007 Stage 2: Pioneer AMS Sites Selected – early 2008 Stage 3: Pioneer Demonstration Sites Selected – early 2009
Deployment Cost Estimate	$7,220,000 (Strategies and technologies to be deployed are yet to be determined by the concept of operations. Up to four of the original Pioneer Sites will be selected for Stage 3 with a total of $7,000,000 divided up between the sites.)
5-Year Operations And Maintenance Cost Estimate	$625,000 (Strategies and technologies to be deployed are yet to be determined by the concept of operations)
Mn/DOT Full-time Employee Cost Estimate	$585,000 (6½ FTE are needed to set up and manage the project from the beginning stages to implementation)
Evaluation Cost Estimate	$550,000
Performance Measures	Reduction in the peak-period congestion due to a balance in traffic demands throughout the system. Improvement of operational efficiency for all modes of transportation particularly during incidents or special events.

Project Title	**Project 9: Expand first responder and law enforcement systems**
Example Location	Twin Cities Metro Area plus ten outstate counties
Program Strategies	▪ Program Strategy 9 – Expand first responder and law enforcement systems
Project Champion(s)/Lead(s)	Michele Tuchner, State Patrol and Mary Hedges, Emergency Medical Services Regulatory Board (EMSRB)
Project Purpose/Objective	Coordinate emergency responder databases (State Patrol, Local Law Enforcement, EMS, fire department, etc) to allow: ▪ Coordination of emergency responder databases (such as an online database to route on-the-scene incident data, road condition, or other data through a single dispatch center or system for processing). ▪ Law enforcement to access data from onboard vehicle computers ▪ Development of a uniform, real-time automated crash notification system (such as an extension of the Mayday system) Such coordination would allow the seamless sharing of consistent information on crash and victim details to facilitate better response and care. A single dispatch center would act on the information request by dispatching the proper emergency personnel to a traffic incident. Road and weather conditions data may also be uploaded to a central source and disseminated via various means from the center. Improved incident clearance will allow for better traffic flow/mobility. This project could be a further evolution of the Minnesota State Ambulance Report System (MNSTAR). A web-based, statewide data system that went online April 1, 2003. MNSTAR gives Minnesota's 256 agencies the flexibility to collect their own data. Additional research is needed to identify if similar activities are being implemented in other parts of the country. Conversations are needed that will lead to a better understanding of the authority of the EMSRB and Minnesota Department of Health in coordinating this initiative.
Safety or Mobility	Safety
Participants and Stakeholders	State Patrol, EMSRB, local law enforcement community, Minnesota DPS, Minnesota Traffic Safety, and Minnesota DVS
Institutional /Public	There may be data privacy implications regarding the transfer of

Project Title	**Project 9: Expand first responder and law enforcement systems**
Support Issues	personal or health related information for victims as governed by the Health Insurance Portability and Accountability Act of 1996 (HIPAA). The Minnesota Department of Health has previously encountered legislative issues regarding the accessibility of personal records. Participating agencies will need to modify the format they currently maintain data so that it can be used by a common system. Getting buy in from stakeholders is a very important part of this project.
Duration/Timing	Implement Program Strategy 9 within 5 years.
Deployment Cost Estimate	$8,500,000 ($500,000/county database – 7 county Metro area plus 10 outstate counties)
5-Year Operations and Maintenance Cost Estimate	$500,000
Mn/DOT Full-time Employee Cost Estimate	$45,000 (½ FTE Mn/DOT employee is needed to set up and manage this project from the beginning stages to implementation, as well as provide integration support. This project would be led by the State Patrol and the EMSRB with support from Mn/DOT.)
Evaluation Cost Estimate	$750,000
Performance Measures	▪ Number of databases coordinated ▪ Number of onboard computer terminals with access to database

Project Title	**Project 10: Implement AVL technology**
Example Location	900 Mn/DOT vehicles statewide
Program Strategies	▪ Program Strategy 6 – Expand winter maintenance operations to improve safety
Project Champion(s)/Lead(s)	Steve Lund, Mn/DOT Director of Office of Maintenance
Project Purpose/Objective	Clearing lanes as quickly as possible will provide safer traveling conditions for vehicles and reduce the number of crashes during winter weather events. This project would install AVL technology in maintenance vehicles in order to fully maximize available resources during snowfall and icy conditions. Fleet management systems at a regional control center allow maintenance managers to better deploy and manage their fleet. AVL technology will also improve traffic flow by reducing the number of crashes that would otherwise occur. Crashes are a major source of congestion. This project can be coordinated with Mn/DOT's involvement in the Maintenance Decision Support System (MDSS), which is a project to develop a prototype predictive tool using a variety of weather and maintenance inputs to recommend most effective treatment and timing. This project can also be coordinated with RWIS. Mn/DOT has implemented AVL technology within different districts throughout the state. This project would focus on integrating the different AVL systems between districts, as well as deploy AVL on 900 vehicles statewide. Standards will need to be developed to ensure consistency between districts.
Safety or Mobility	Safety
Participants and Stakeholders	Mn/DOT
Institutional /Public Support Issues	This project will need to be accepted by the maintenance vehicle operators and management.
Duration/Timing	Implement Program Strategy 6 within 2½ years
Deployment Cost Estimate	$2,430,000 ($2,400/vehicle – example location includes 900 vehicles; $270,000 for hardware and software at operations headquarters)
5-Year Operations and Maintenance Cost Estimate	$500,000

Project Title	**Project 10: Implement AVL technology**
Mn/DOT Full-time Employee Cost Estimate	$180,000 (1½ FTE for program management (office of maintenance) plus ½ FTE for program delivery)
Evaluation Cost Estimate	$150,000
Performance Measures	▪ Improvements in plowing or maintenance time ▪ Reduction in crashes due to adverse weather conditions

Project Title	**Project 11: Expand interconnection between the RTMC and the TOCCs**
Example Location	RTMC in the Twin Cities and the nine TOCCs
Program Strategies	▪ Program Strategy 5 – Improve traveler information dissemination systems and signage ▪ Program Strategy 8 – Incorporate local streets and transit into integrated corridor management ▪ Program Strategy 9 – Expand first responder and law enforcement systems ▪ Program Strategy 10 – Implement the next generation TOCC to include local governments
Project Champion(s)/Lead(s)	Andy Terry, Mn/DOT Electronic Communications; Bernie Arseneau, Mn/DOT State Traffic Engineer
Project Purpose/Objective	A high-bandwidth connection between the RTMC in the Twin Cities and the TOCC in St. Cloud has allowed a high degree of inter-operation and sharing of responsibilities in the corridor. In addition, both centers combine traffic management, emergency response dispatch, and maintenance fleet management into a unified, co-located operations center. Strong interconnectivity between RTMC and TOCCs will provide 24/7 coverage and also aid in homeland security operations and event response, as well as alleviate the need for traffic management staff during off-peak hours at out-state centers. This project focuses on identifying and improving the interconnection of the RTMC with the eight other TOCCs throughout Minnesota, as well as with the TOCCs and local agencies. Interconnecting the traffic management centers will increase coordination of traveler information between districts, jurisdictions, and local agencies, as well as coordination of emergency response information.
Safety or Mobility	Safety
Participants and Stakeholders	Mn/DOT RTMC, Mn/DOT TOCCs, Mn/DOT OEMC, and Minnesota State Patrol
Institutional /Public Support Issues	DPS support could be needed for all services.
Duration/Timing	Implement Program Strategy 5 within 2½ years and Strategies 8, 9, and 10 within 5 years.
Deployment Cost Estimate	$8,100,000 for program completion
5-Year Operations and Maintenance Cost Estimate	$1,500,000

Project Title	**Project 11: Expand interconnection between the RTMC and the TOCCs**
Mn/DOT Full-time Employee Cost Estimate	$90,000 (1 FTE for program delivery)
Evaluation Cost Estimate	$100,000
Performance Measures	Coordination of traveler information and emergency response between jurisdictions

Project Title	**Project 12: Implement collision warning systems at rural highway intersections**
Example Location	200 rural highway intersections
Program Strategies	▪ Program Strategy 5 – Improve traveler information dissemination systems and signage ▪ Program Strategy 11 – Use intersection collision warning systems
Project Champion(s)/Lead(s)	Ginny Crowson, Mn/DOT ITS Project Manager
Project Purpose/Objective	This project is focused specifically on reducing the number of traffic crashes occurring at rural highway and rural highway/rail intersections. The system provides drivers on the rural roadways with information indicating when entry into the intersection is unsafe. A project recently completed in Minnesota (Low-Cost Active Warning for Low-Volume Highway/Rail Intersections, see Sub-*Sub-chapter 3.3* for additional project details) successfully demonstrated the potential of an infrastructure/train-based technology to reduce the number of highway/rail intersection crashes. This technology is currently being further developed by the private sector. Another project currently underway is the Cooperative Intersection Collision Avoidance System (CICAS) that is an infrastructure-based technology to reduce crashes at highway intersections.
Safety or Mobility	Safety
Participants and Stakeholders	Mn/DOT, University of Minnesota, USDOT, city transportation agencies, county transportation agencies, and private companies.
Institutional /Public Support Issues	There are human factor implications. A careful design is necessary to avoid driver confusion from the additional feedback from the system. Deployment and operating costs are further issues that will need to be addressed as the system equipment involves detection, power, and communication.
Duration/Timing	Implement Program Strategy 5 within 2 ½ years and Program Strategy 11 within 5 years.
Deployment Cost Estimate	$5,000,000 ($25,000/intersection - 200 locations)
5-Year Operations and Maintenance Cost Estimate	$1,000,000

Project Title	**Project 12: Implement collision warning systems at rural highway intersections**
Mn/DOT Full-time Employee Cost Estimate	$180,000 (2 FTE for program management)
Evaluation Cost Estimate	$180,000
Performance Measures	Reduction in crashes at rural highway intersections

Project Title	**Project 13: Deploy automated enforcement**
Example Location	64 rural or work zone locations
Program Strategies	▪ Program Strategy 12 – Electronic enforcement including red light running, electronic speed enforcement to prevent crashes and ensure toll lane compliance
Project Champion(s)/Lead(s)	Michele Tuchner, Minnesota State Patrol
Project Purpose/Objective	Photo enforcement for speeding can be deployed at rural or work zone locations where there is a history of crashes with excessive speed as a contributing factor. This project focuses on exploring existing legal restrictions and determining how to address them in a way that allows for a limited deployment of automated enforcement of speed violations.
Safety or Mobility	Safety
Participants and Stakeholders	Mn/DOT, law enforcement community, judicial system, and Minnesota Department of Public Safety-Traffic Safety.
Institutional /Public Support Issues	There are legal restrictions on the issuance of citations when an officer is not physically present to witness the violation. Some of the public has been resistant to this approach to enforcing traffic violations under the auspices of privacy and accuracy of the technology.
Duration/Timing	Implement Program Strategy 12 within 10 years.
Deployment Cost Estimate	$3,200,00 (50,000 per site -Project has 64 sites)
5-Year Operations and Maintenance Cost Estimate	$200,000
Mn/DOT Full-time Employee Cost Estimate	No additional need
Evaluation Cost Estimate	$150,000
Performance Measures	▪ Number of speeding citations issued ▪ Number of time system is activated ▪ Decrease in crashes, especially in work zones

Project Title	**Project 14: Develop a test bed for VII**
Example Location	▪ I-94 between St. Cloud and Maple Grove, Minnesota ▪ TH 7 between the Twin Cities and Hutchinson, Minnesota
Program Strategies	▪ Program Strategy 5 – Improve traveler information dissemination systems and signage ▪ Program Strategy 6 – Expand winter maintenance operations to improve safety ▪ Program Strategy 13 – Implement VII to expand data collection infrastructure on rural highway system
Project Champion(s)/Lead(s)	Rick Arnebeck, Mn/DOT Division Director
Project Purpose/Objective	With the high capacity of the network in the area, Minnesota is pursuing the implementation of a VII test bed on I-94. DSRC provides high speed low-latency communications for local safety applications, including in-vehicle signing. Personal devices, such as mobile phone, can also be used for network applications such as location specific traveler information. This project would focus on deploying the VII infrastructure along I-94 corridor as a pilot project. The initial pilot project would be in-vehicle signing and traveler information.
Safety or Mobility	Safety
Participants and Stakeholders	Mn/DOT, auto manufacturers, cell phone providers, and Minnesota State Patrol
Institutional /Public Support Issues	Not applicable
Duration/Timing	Implement Program Strategy 5 and 6 within 2½ years and Strategy 13 within 10 years.
Deployment Cost Estimate	$16,000,000 (including roadside units, in-vehicle units, and communications infrastructure)
5-Year Operations and Maintenance Cost Estimate	$500,000
Mn/DOT Full-time Employee Cost Estimate	$270,000 (1 FTE for project management plus 2 FTE for program delivery)
Evaluation Cost Estimate	$750,000
Performance Measures	Decrease in crashes

Table 9 – Mobility and Safety Initiatives Deployment Cost Estimate Summary

Project Number	Project Title	Safety	Mobility	Unit	Unit Cost	Number of Units	Project Cost	5 Year Operations & Maint. Cost	Evaluation Cost	MN/DOT FTE ($90,000/ FTE)	Total Dplmt, Ops & Eval Costs
Guidestar Program MOBILITY Initiative											
1	Implement dynamic lane control and VSL signs		X	Mile	$500,000	16	$8,000,000	$500,000	$600,000	$180,000	**$9,280,000**
2	Implement Hard or HOT Shoulder Concept		X	Mile	$3,000,000	8.5	$25,500,000	$500,000	$200,000	$225,000	**$26,425,000**
3	Complete RTMC traffic mgmt instrumentation		X	Mile	$170,000	23	$3,910,000	$300,000	N/a	$405,000	**$4,615,000**
4	Expand RTMC traffic management systems to arterials Phase 1		X	Phase	$775,000	1	$775,000	$170,000	N/A	$225,000	**$1,170,000**
	Phase 2			Phase	$1,100,000	1	$1,100,000	$200,000	N/A		**$1,300,000**
5	Expand RTMC travel time display locations		X	Location	$84,000	25	$2,100,000	$50,000	N/A	$45,000	**$2,195,000**
6	Implement contraflow lanes		X	Mile	$1,400,000	7.5	$10,500,000	$750,000	$300,000	$135,000	**$11,685,000**
	Transfer machine			Machine	$1,000,000	1	$1,000,000	Included	N/A	N/A	**$1,000,000**
	Median crossover - signing			Location	$2,000,000	2	$4,000,000	$100,000	N/A	N/A	**$4,100,000**
7	Convert existing HOV lanes to HOT lanes utilizing MnPass		X	Mile	$1,500,000	8	$12,000,000	$5,000,000	$250,000	$225,000	**$17,475,000**
8	Deploy integrated corridor management		X	site	$84,000	10	$840,000	$75,000	$200,000	$90,000	**$1,205,000**
	Strategy 7			Mile	$500,000	9	$4,500,000	$ 350,000	$150,000	$180,000	**$5,180,000**
	Strategy 8			Location	$800,000	1	$800,000	$100,000	$100,000	$180,000	**$1,180,000**
	Strategy 12			site	$54,000	20	$1,080,000	$100,000	$100,000	$135,000	**$1,415,000**
TOTAL for MOBILITY Initiative							**$76,105,000**	**$8,195,000**	**$1,900,000**	**$2,025,000**	**$88,225,000**
Guidestar Program SAFETY Initiative											
9	Expand first responder and law enforcement systems	X		County	$500,000	17	$8,500,000	$500,000	$750,000	$45,000	**$9,795,000**
10	Implement AVL Technology	X		Vehicle	$2,700	900	$2,430,000	$500,000	$150,000	$180,000	**$3,260,000**
11	Expand interconnection between the RTMC and the TOCC's	X		Statewide	$900,000	9	$8,100,000	$1,500,000	$100,000	$90,000	**$9,790,000**
12	Implement collision warning systems at rural highway intersections	X		Location	$ 25,000	200	$5,000,000	$1,000,000	$180,000	$180,000	**$6,360,000**
13	Deploy automated enforcement	X		site	$ 50,000	64	$3,200,000	$200,000	$150,000	N/A	**$3,550,000**
14	Develop test bed for VII	X		Test Bed	$2,000,000	1	$16,000,000	$500,000	$750,000	$270,000	**$17,520,000**
TOTAL for SAFETY Initiative							**$42,230,000**	**$4,200,000**	**$2,080,000**	**$765,000**	**$50,275,000**
TOTAL MOBILITY and SAFETY Deployment Cost Estimate							**$119,335,000**	**$12,395,000**	**$3,980,000**	**$2,790,000**	**$138,500,000**

8 Funding Potential and Guidestar Deployment Assessment Action Plan

When it comes to Minnesota transportation investments, Mn/DOT follows an iterative process that integrates state and local priorities in solving transportation problems and for achieving long range objectives. This process is defined in the STIP Section II. Three primary sources or opportunities for funding the ITS transportation projects defined in this deployment assessment are state funding, federal funding, and PPPs. As appropriate, additional sources of funding, including transit and local funding, will be required to complete the projects.

Sub-chapter 8.7 presents the Guidestar Deployment Assessment Action Plan (GDAAP), which provides the basis for beginning the funding discussions/applications and for moving forward with detailed planning, design, and ultimately construction and operations for the projects.

As described in *Chapter 4*, the project development and funding process for ITS has fundamentally changed under recently adopted federal SAFETEA-LU legislation. In the past, most ITS innovative project ideas have been funded through separate Guidestar earmarked funds that did not follow the overall STIP planning process. This difference was important because ITS projects were innovative and needed special attention, while STIP projects are more mainstream and the technology was well established. In the future, ITS projects will be moved into the mainstream funding process and scheduling using the STIP planning process. So this GDAAP becomes the first step in recognizing and utilizing the STIP planning process for ITS deployments.

Safety and mobility are important public issues, and the projects proposed by this assessment are important to the citizens of Minnesota. However, Minnesota has many critical transportation needs statewide, and there is never enough funding to fully meet these needs. This GDAAP looks at two major options for funding ITS safety and mobility projects.

Option 1 – Program and fund the identified major safety and mobility projects as a total recognizable statewide safety and mobility program packages. This option develops one major program for safety projects and one major program for mobility projects. This option has the advantage of national name and commitment recognition and the potential to attract major funding at the national level (think big and mighty forces will come to your aid). It could also more effectively compete with other major national programs for funding. The disadvantage is that the overall cost can limit the potential for programming and funding through the STIP process.

Option 2 – Program and fund the individual safety/mobility projects through the standard Mn/DOT STIP programming process. This option has the advantage of projects being processed individually and of being incorporated into the mainstream with other transportation projects as they are developed. The disadvantage is that the individual projects will compete with construction projects and could be lost to competing funding. As a result of the integrated funding process innovative corridor or system-wide ITS projects may never be developed.

8.1 Funding Opportunities

Funding Opportunities for Option 1 – Major program package funding requires special links to national FHWA discretionary and special program funds. These funds and additional unidentified funding sources or opportunities may be available as Minnesota advertises its major push for deployment of ITS technologies to directly improve safety and mobility. These funding opportunities are generally outside of the traditional funding sources for projects and include the following identified opportunities as starters:

- Nine federal initiatives
- Safety funding within SAFETEA-LU
- Developing some of the projects using public private partnership opportunities
- FHWA special projects, request for proposal, and notices announced in the federal registrar

Funding Opportunities for Option 2 – Development of safety and mobility projects through the standard STIP programming process follow the standard funding process. Each project's funding will be developed in detail through the project planning process. Since the projects include multiple program strategies and involvement with many stakeholders, only general overall funding requirements and opportunities can be identified at this time.

Projects in the STIP are generally developed by Mn/DOT districts with about 25% of the projects developed by RDC and counties. *Sub-chapter 4.2* of this assessment includes a discussion of how planning and funding for ITS has moved from congressional earmark funding to become part of the mainstream funding process. To address this Mn/DOT has developed an ITS planning/funding migration strategy that includes development of this deployment assessment and deployment action plan.

The following funding opportunities list is only general to establish that funding opportunities are available for both Option 1 and 2. As projects or programs evolve, each funding opportunity requires a dedicated effort to apply them. Most projects will require the identification of a funding source, justification, and documentation. Identification of a funding source for each project or program will be a challenge because of the many different, often overlapping programs available, and the varying requirements for each of them. Funding opportunities are continually changing as new federal and state programs are announced. Many funding sources must be balanced against other needs. For example, whether it is more important for a pavement overlay for a deteriorating section of road or to deploy an ITS DMS.

8.1.1 State Transportation Funds

State funds both for matching FHWA funds and for funding critically needed projects that do not meet FHWA criteria are available, but are always subject to actions by the Minnesota Legislature.

8.1.2 Minnesota Guidestar

Many projects in the Guidestar program are funded by previous ITS earmarks, ITS state matching funds, and regular federal highway funding. Guidestar generally does not fund ITS implementation projects. The Guidestar program focuses mainly on innovative ideas and programs to develop demonstration projects and studies, as well as deployments that are statewide in nature

8.1.3 FHWA Funding

Federal funding is and will remain a key part of any funding program. SAFETEA-LU provides additional opportunities and challenges to obtaining FHWA funding for any project. In the 2005 SAFETEA-LU authorization, safety and mobility projects were elevated to core program status. These core programs represent 63% of the total FHWA funding. Several SAFETEA-LU categories bear special mention and attention as potential funding sources. These include:

- The national Strategy to Reduce Congestion on America's Transportation Network, announced by U.S. Secretary of Transportation, Norman Mineta, in May of 2006. Among other things, it calls for more widespread deployment of new technologies and practices that end traffic congestion and designates and funds new "corridors of the future".
- Opportunities exist within the nine FHWA ITS initiatives including VII, Integrated Corridor, Clarus, and Cooperative Intersection Collision Avoidance Systems.
- SAFETEA-LU funding for integration of ITS planning projects into the normal STIP planning process, so that ITS becomes another element in the STIP planning process. This will require development of ITS specifications to make it easier to prepare ITS proposals.

Project Amendments and Addendums Embedded in Traditional Construction Projects

Often it is possible to imbed all or part of an ITS project into the scope of a planned transportation construction project or an ongoing project. This allows for early implementation of many of the safety initiatives without waiting for statewide or federal funding programs to develop.

8.1.4 Earmark Funding

On the federal level, earmarked ITS funding for projects is expected to be significantly limited. On the state level, earmarks are unlikely at this time, but the value of lives saved is always a convincing argument for special funding. Funds remaining from previous earmarks are available until expended or retracted by the USDOT.

Public Private Partnerships (PPPs)

Minnesota has a rich history of developing public-private partnerships for ITS technology programs. Several of these partnerships have provided an opportunity to work with vehicle manufacturers for joint development and deployment of ITS safety technologies. These PPPs require that all parties realize that the long-term goal of the private partner is to create a return on their investment. The need to make a profit will influence their perception of the need for their involvement in an initiative.

The July/August 2006 issue of Public Roads magazine features an article on "Bridging the Financial Gap With PPPs". In the article, PPPs are described as a contractual agreement formed between public and private sector partners that allow more private sector participation than is traditional. Privately designed, financed, developed, and operated toll roads are an example.

Homeland Security, Public Safety, and Other Special Funding Opportunities

As part of the programs for public safety and homeland security, various organizations sometimes have transportation safety related funding opportunities available.

Research Funding

The ITS Institute at the University of Minnesota received increased funding in SAFTEA-LU that can fund ITS research projects.

As we move ITS projects into the STIP project proposal and selection process, we need to consider how that process affects innovative ITS projects. The STIP, while deliberately designed to incorporate all stakeholders and bring local involvement into the process of selecting transportation projects, is a process that in many situations does not encourage innovation or ITS deployment. STIP projects, particularly safety-oriented projects, are often reactive to a recognized specific problem like an intersection or rail crossing or a deteriorating pavement condition. The STIP works to resolve that specific problem, but is not designed to take an overall view at how technology could be used to improve the whole corridor or statewide situation.

8.2 Leveraging Existing Programs

Project amendments and addendums embedded in traditional construction projects are a method of utilizing existing programs for implementing ITS technology. However, if we really want to leverage existing programs, Minnesota needs to include ITS technologies at the conceptual planning and early design stages of the project. That way, ITS can be fully integrated, not just added on to the project. Since ITS has generally been viewed as “Guidestar projects”, this will require that planners and designers become more aware of, and willing to utilize ITS as an acceptable method to improve safety and mobility.

The RTMC provides an excellent example of this technique in action. RTMC projects were originally developed as standalone projects, and their needs were often overlooked when road or bridge construction projects were initiated. However, over the years, the

need and value of the RTMC has been proven, and today, most transportation project planners/designers approach the RTMC to incorporated their ITS ideas into the early stages of project development.

A training and education process to acquaint and involve planners and designers with ITS technologies and to encourage their use could help speed up the process. One method to develop more ITS interest and experts would be to increase the availability of mobility assignments in the ITS program.

8.3 Impact on Improving Safety and Mobility

Former Secretary of Transportation, Norman Y. Mineta, has it right when he says, "improving safety is our highest transportation priority". And the application and use of ITS technology is key to reducing fatalities on our roads.

> **"Improving safety is our highest transportation priority"**
> – Norman Y. Mineta, Secretary of Transportation, December 10, 2003

It should be self-evident that safety is the most important consideration in developing transportation projects. It would be wonderful if cost was not a factor when improving safety, yet there are never enough funds to meet every safety need, as well as other needs. So, it becomes necessary to balance the various needs.

In Minnesota, the CHSP was developed to identify opportunities to reduce highway crashes and deaths on Minnesota's roads. A companion document, the ITS Safety Plan, developed six ITS critical strategies and 22 ITS safety initiatives for Minnesota to focus its efforts. An effectiveness spreadsheet was then developed to assess the factors that could help determine the potential of each initiative to reduce crashes, save lives, and minimize injury severity in a way that demonstrates a positive benefit/cost ratio. These plans were key to the development of this Guidestar Deployment Assessment.

8.4 Research Strategy

ITS-related research has been a strong component of Minnesota's ITS program since the ITS Institute at the University of Minnesota was established by an act of Congress in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. The actual program got off the ground in January 1993 and has been growing steadily since that time. Congressional funding was continued under the Transportation Equity Act for the 21st Century (TEA 21) and again under SAFETEA-LU.

The ITS Strategic Plan 2006 established a goal to promote research relating to the development of new, innovative ITS technologies. This goal states that a key feature of Minnesota Guidestar has been the close working relationship with the University of Minnesota and public and private entities. Opportunities to expand these joint activities are enhanced by continuing reauthorization of the ITS Institute. These are opportunities to leverage these basic funds by competing for federal ITS initiatives, such as the Mn/DOT and ITS Institute partnership in 2005 to attract the CICAS for rural

intersections program. There is also an opportunity for private sector partnerships with the ITS Institute that can allow testing of technologies and other joint activities, helping the ITS Institute satisfy its federal match requirements. Joint activities with the public and private sectors can also provide ITS experience for students, as future members of the transportation work force. A starting point for promoting research partnerships is to periodically update the Guidestar board members on research ideas and initiatives, and engaging them in discussions to explore potential partnerships for developing new ITS technologies and innovations. These partnerships open the way for discussing ways to convert research results into technology applications and applications into deployments.

8.5 Keys to Success

Communication with citizens, legislators, stakeholders, FHWA, other states, ITS organizations, and within Mn/DOT is the primary key to success. For these are the people who will see the need and value of the ITS safety and mobility projects and who will make the funding commitments to implement the projects. To communicate the safety and mobility message effectively with these various groups requires appropriate presentation materials, speakers, a committed Mn/DOT staff, and adequate preparation.

The CHSP, ITS Safety Plan, and Guidestar Statewide ITS Strategic Plan 2006 help provide the background and stakeholder commitment necessary for ITS safety and mobility projects to move forward.

8.6 Legislative Approach

In recent years, there has been less transportation funding available at the federal, state, and local levels. While safe and efficient transportation is still a priority for government at all levels, the trend towards greater accountability and lower taxes results in fewer resources to spend on transportation. In this environment of static funding, agencies must carefully choose what projects they pursue with an eye toward activities that derive the most benefit from the available resources. It does not appear that this outlook will change significantly in the near future, so agencies need to be very selective when determining projects for deployment, enhancement, and/or operation.

Federal funding often requires states to provide matching funds to access the federal funding source. State agencies or legislatures may not be able or willing to provide the matching funds so an agency may not be able to access existing federal funds that are earmarked for a particular agency or initiative. The best way to address this is to make the decision-makers aware of the importance and benefits of the project. Benefits of projects should be presented in a clear and concise manner so they are easy to understand and make a positive impact. As mentioned above, effective communication with decision-makers is a key to success.

While a state will have to find the resources for a match, its investment is leveraged significantly with federal funds. Agencies should also be aware of different types of resources that can be used as matching funds, such as operations staffing hours, previously deployed systems, or equipment that can be included as “in-kind” match.

8.7 Guidestar Deployment Assessment Action Plan – GDAAP

If Minnesota is to move forward with a significant ITS safety and mobility action plan, then a whole series of action activities come into play. Shown below are a series of anticipated action activities for the action plan. They are appropriate for either the major program option or the standard STIP programming option. These activities will not necessarily be taken in the order listed because many steps can be completed simultaneously.

- In-house approval and backing
- Develop "champions"
- Begin discussions with FHWA on funding and programming
- Coordinate with stakeholders and other planning organizations
- Announce the plan
- Early stages proceed with both Options 1 and 2
- Search for opportunities to add on to existing contracts
- Incorporate ongoing design and funded projects
- Begin the process of incorporating into the STIP
- Develop a plan for requesting legislative approval for those items requiring it
- Move forward with project planning either Options 1 or 2, whichever is appropriate at the time.
- Design, construction, operations, and maintenance
- Assessment of the safety and mobility results/benefits

The Minnesota challenge (federal, state, county, local agencies and stakeholders) will be to develop the initiatives contained in the Minnesota Guidestar Mobility Initiative and the Minnesota Guidestar Safety Initiative into projects and programs that can be funded and implemented. A sometimes bigger challenge is to actively seek and utilize funding opportunities when they become available.

9 Summary

This Minnesota Guidestar Program Deployment Assessment was created by the Minnesota Department of Transportation (Mn/DOT), and other transportation stakeholders, as a program assessment and work plan for deployment of Intelligent Transportation System (ITS) projects in Minnesota. Building on a firm foundation of the past success for Minnesota's ITS programs, and driven by the need to improve safety and mobility, the assessment provides an opportunity to move ITS programs and projects into the mainstream. Overall, this plan reflects Minnesota's short, medium and long-term needs and operational objectives for ITS programs and projects.

The overriding goal of the second section of the assessment is to develop an assessment and work plan in sufficient detail that Mn/DOT can use it to help secure funding for ITS deployment projects that improve safety and mobility. *Chapter 7* presented a series of ITS projects and *Chapter 8* presented an outline for funding and a Guidestar Deployment Assessment Action Plan for project and program implementation. It is important to note that the action plan provides two options and that these options should move forward concurrently:

Option 1 is to develop the projects into major programs for mobility and safety. These programs consisting of a number of projects could then be presented not as individual projects but as major Minnesota ITS programs. To implement this option the assessment process categorized projects into major programs for safety and mobility. These multi-project programs are titled the Minnesota Guidestar Mobility Initiative and the Minnesota Guidestar Safety Initiative.

With the two program initiatives identified materials were then developed to describe each proposed program. A program fact sheet is included at the end of this section for the ITS Safety Initiative and for the ITS Mobility Initiative. Each of these fact sheets are designed as stand alone programs and each serves as a talking paper for its program focus. Each fact sheet contains a listing of selected projects from *Chapter 7*. All of the identified projects in *Chapter 7* are found in either the safety initiative or the mobility initiative programs.

Option 2 is to program and fund the identified major safety/mobility projects through the standard Mn/DOT STIP program process. To implement this option Mn/DOT needs to program the selected projects in the STIP following standard programming procedures. The project listings provided in the assessment provide the starting point for listing these projects in the STIP.

Overall program costs and projects for either Option 1 or Option 2 are the same. A cost summary is provided for the safety and mobility initiative after each one-page fact sheets.

As a final side note, early in the assessment it was recognized that Minnesota had already started or completed many ITS safety and mobility projects following the STIP process and or with earmarked funding. This is particularly true of ITS mobility projects completed by the RTMC. For example a project titled *Deploy "Corridors of the Future"* (*TIGER,* located on I-94 from North Dakota/Minnesota Border to the Wisconsin/Minnesota border) is not included since Minnesota has already moved forward and applied for federal funding as part of the North/West Passage partnership program.

With this Guidestar Program: Deployment Assessment complete the next challenge is to begin actively pursing the identified projects and initiatives. This active pursuit of life saving and mobility improving ITS projects begins with supporting project champions, legislative action, STIP programming, funding, development, and finally deployment.

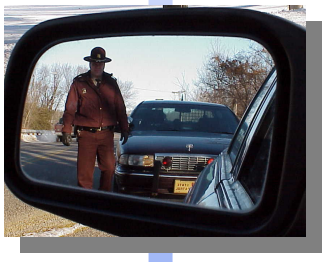
One-page handouts on the safety and mobility initiatives developed as part of this assessment are included on the following pages along with cost estimates for each project. This assessment document and the two program initiatives brings Minnesota one step forward in improving safety and mobility. Serving as an assessment for future ITS deployments it can be a valuable tool and roadmap in helping Mn/DOT improve safety and mobility.

Minnesota Guidestar Safety Initiative

Minnesota Guidestar

www.dot.state.mn.us/guidestar

Mn/DOT Contact
Rick Arnebeck,
Division Director
651.296.1615



PURPOSE

The Minnesota Guidestar Safety Initiative will deploy Intelligent Transportation Systems (ITS) technologies throughout Minnesota to make roads safer and improve mobility. The initiative calls for development of a rural safety network to reduce crash-related fatalities and serious injuries and may be characterized as follows.

- Builds on impressive infrastructure already in place
- Emphasizes innovative yet proven technology
- Takes a system-wide approach that encompasses local roads
- Starts to implement elements of the "ITS Safety Plan"
- Moves "Toward Zero Deaths" (TZD) to reality
- Presents a model for other states

STRATEGIES

Minnesota will reduce crash-related fatalities and serious injuries through the safety initiative using these key strategies throughout the state.

- Expand data collection infrastructure on highway system
- Improve traveler information dissemination systems and signage
- Expand first responder and law enforcement systems
- Implement Vehicle Infrastructure Integration (VII)
- Implement the next generation Traffic Operations and Communications Centers (TOCC) to include local governments
- Expand winter maintenance operations to improve safety
- Use intersection collision warning systems as well as red light running and electronic speed enforcement to prevent crashes

EXAMPLE PROJECTS

The safety initiative will produce dramatic results as the key safety initiatives are implement. The following proactive safety project, each incorporating one or more strategies, have been identified for early deployment.

- First responder and law enforcement systems
- Implement Automated Vehicle Location (AVL) technology
- Expand interconnection between the RTMC and TOCC's
- Implement collision warning systems at rural highway intersections
- Deploy automated enforcement
- Develop test bed for VII

FUNDING

- $50,275,000 for this safety initiative

Safety Initiative Project Cost Estimate Summary

Project Number	Project Title	Safety	Mobility	Unit	Unit Cost	Number of Units	Project Cost	5 Year Operations & Maint. Cost	Evaluation Cost	MN/DOT FTE ($90,000/ FTE)	Total Dplmt, Ops & Eval Costs
Guidestar Program SAFETY Initiative											
9	Expand first responder and law enforcement systems	X		County	$500,000	17	$8,500,000	$500,000	$750,000	$45,000	**$9,795,000**
10	Implement AVL Technology	X		Vehicle	$2,700	900	$2,430,000	$500,000	$150,000	$180,000	**$3,260,000**
11	Expand interconnection between the RTMC and the TOCC's	X		Statewide	$900,000	9	$8,100,000	$1,500,000	$100,000	$90,000	**$9,790,000**
12	Implement collision warning systems at rural highway intersections	X		Location	$ 25,000	200	$5,000,000	$1,000,000	$180,000	$180,000	**$6,360,000**
13	Deploy automated enforcement	X		site	$ 50,000	64	$3,200,000	$200,000	$150,000	N/A	**$3,550,000**
14	Develop test bed for VII	X		Test Bed	$2,000,000	1	$16,000,000	$500,000	$750,000	$270,000	**$17,520,000**
TOTAL for Safety Initiative							**$42,230,000**	**$4,200,000**	**$2,080,000**	**$765,000**	**$50,275,000**

Minnesota Guidestar Mobility Initiative

Minnesota Guidestar

www.dot.state.mn.us/guidestar

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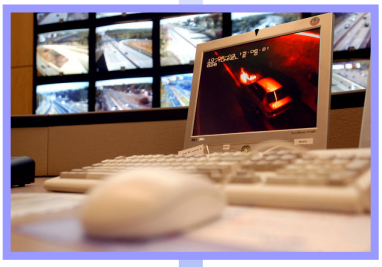

PURPOSE

The Minnesota Guidestar Mobility Initiative will deploy Intelligent Transportation Systems (ITS) technologies throughout Minnesota to reduce congestion and make roads safer. The initiative calls for deployment of tools to improve mobility and may be characterized as follows.

- Builds on impressive infrastructure already in place
- Emphasizes innovative yet proven technology
- Takes a system-wide approach that encompasses local roads
- Presents a model for other states
- Begins the transition to the "Next Generation Interstate"

STRATEGIES

Minnesota will implement active, aggressive transportation management through the mobility initiative using the following key strategies in the state's urban areas.

- "Hard or HOT Shoulders" to maximize use of available pavement
- Expansion of RTMC coverage area to 100% of metro freeways
- Variable speed limits to smooth traffic
- Lane control signals to manage lanes
- Incorporating local streets and transit into integrated corridor management
- Contra-flow lanes to take advantage of unused capacity
- Electronic enforcement to optimize compliance
- Aggressive incident and construction management/control systems
- HOT lanes with dynamic pricing

EXAMPLE PROJECTS

To implement these key mobility strategies the following proactive project have been identified. Each of these projects will incorporate one or more of the strategies with a focus on producing results.

- Implement dynamic lane control and variable speed limits
- Implement Hard or HOT Shoulder concept
- Complete RTMC traffic management instrumentation
- Expand TRMC traffic management systems to arterials
- Expand RTMC travel time display locations
- Implement contraflow lanes
- Convert existing HOV lanes to HOT lanes utilizing MnPASS
- Deploy integrated corridor traffic management

FUNDING

- $88,225,000 Million for this mobility initiative

Mobility Initiative Project Cost Estimate Summary

Project Number	Project Title	Safety	Mobility	Unit	Unit Cost	Number of Units	Project Cost	5 Year Operations & Maint. Cost	Evaluation Cost	MN/DOT FTE ($90,000/ FTE)	Total Dplmt, Ops & Eval Costs
Guidestar Program MOBILITY Initiative											
1	Implement dynamic lane control and variable speed limit signs		X	Mile	$500,000	16	$8,000,000	$500,000	$600,000	$180,000	**$9,280,000**
2	Implement Hard or HOT Shoulder Concept		X	Mile	$3,000,000	8.5	$25,500,000	$500,000	$200,000	$225,000	**$26,425,000**
3	Complete RTMC traffic management instrumentation		X	Mile	$170,000	23	$3,910,000	$300,000	N/a	$405,000	**$4,615,000**
4	Expand RTMC traffic management systems to arterials - Phase 1		X	Phase	$775,000	1	$775,000	$170,000	N/A	$225,000	**$1,170,000**
	Phase 2			Phase	$1,100,000	1	$1,100,000	$200,000	N/A		**$1,300,000**
5	Expand RTMC travel time display locations		X	Location	$84,000	25	$2,100,000	$50,000	N/A	$45,000	**$2,195,000**
6	Implement contraflow lanes		X	Mile	$1,400,000	7.5	$10,500,000	$750,000	$300,000	$135,000	**$11,685,000**
	Transfer machine			Machine	$1,000,000	1	$1,000,000	Included	N/A	N/A	**$1,000,000**
	Median crossover - signing			Location	$2,000,000	2	$4,000,000	$100,000	N/A	N/A	**$4,100,000**
7	Convert existing HOV lanes to HOT lanes Utilizing MnPass		X	Mile	$1,500,000	8	$12,000,000	$5,000,000	$250,000	$225,000	**$17,475,000**
8	Deploy integrated corridor management		X	site	$84,000	10	$840,000	$75,000	$200,000	$90,000	**$1,205,000**
	Strategy 7			Mile	$500,000	9	$4,500,000	$ 350,000	$150,000	$180,000	**$5,180,000**
	Strategy 8			Location	$800,000	1	$800,000	$100,000	$100,000	$180,000	**$1,180,000**
	Strategy 12			site	$54,000	20	$1,080,000	$100,000	$100,000	$135,000	**$1,415,000**
TOTAL for Mobility Initiative							**$76,105,000**	**$8,195,000**	**$1,900,000**	**$2,025,000**	**$88,225,000**

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2. *Minnesota Statewide Heavy Vehicle Safety Plan.* Minnesota Department of Public Safety and Minnesota Department of Transportation, St. Paul, Minnesota, June 30, 2005.

3. *Statewide ITS Strategic Plan 2006: An Action Plan for ITS Development and Deployment*, Minnesota Guidestar Board of Directors and Minnesota Department of Transportation OTSO, June 30, 2006.

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5. *AASHTO Strategic Highway Safety Plan: A Plan to Substantially Reduce Vehicle-Related Fatalities and Injuries on the Nation's Highways*, American Association of State Highway and Transportation Officials, Washington, D.C., 1998.

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9. *Intelligent Transportation Society of America* website, http://www.itsa.org

10. *Popular Science Magazine*, May, 2006 article, "What's New Auto Tech" describing autonomous vehicle

11. *Public Roads*, July/August 2006 article, "Bridging the Financial Gap with PPPs"

12. District 2 ITS Scoping Study, April 2004

13. District 3A ITS Scoping Study, March 2004

14. District 4 ITS Scoping Study, April 1004

15. District 8 ITS Scoping Study, March 2004

Appendix A
Stakeholder Interview Highlights

Stakeholder Interview Highlights

In order to solicit input on this deployment assessment, interviews were conducted with key transportation agencies in Minnesota and other states. Fifteen15 interview candidates were targeted based on the organization or program they represent. Following is a list of agencies that were able to participate in the interviews.

- Mn/DOT OTSO
- Mn/DOT RTMC
- Mn/DOT – State Aid
- Minnesota State Patrol
- FHWA
- U of M – ITS Institute
- Mn/DOT – District 3
- Mn/DOT – Metro
- St. Cloud Transit
- Metro Transit
- Kansas DOT
- California DOT (CalTrans)
- Florida DOT
- Michigan DOT
- Virginia DOT

Two different questionnaires were developed, one for Minnesota agencies and one for non-Minnesota agencies. The Minnesota questions focused on gathering input related to ITS needs in the areas of mobility and safety, specific project concepts, and funding strategies. The non-Minnesota interview questions focused on soliciting input on identifying other ITS deployment plans, specific project ideas, successful or less successful implementations, and funding.

Following is summary of information gathered from the interviews split into two sections, Minnesota Stakeholder Interview Highlights and Other State's Interview Highlights.

Minnesota Stakeholder Interview Highlights

Needs

Transportation needs relating to mobility and safety, which can be addressed through ITS:

- Expand real-time information to be seamless as drivers travel through rural areas, urban surface transportation systems, and the freeway system, as well as bordering states. A seamless real-time information system will allow driver options to determine the best routes and better utilize the entire transportation system.
- Share real-time information between agencies such as Mn/DOT and Metro Transit
- Expand ITS applications to assist managing congestion in urban areas
- Enhance interagency communications to assist in incident management, emergency routing and response, and system overflow
- Increase local government ITS involvement in rural areas
- Identify incentives for customers to choose transit
- Be aware of the focus and projects other agencies are working on in order to identify integration opportunities. Integration is hard to accomplish when each agency is accomplishing projects separately.
- Increase ITS education by involving every stakeholder that may be impacted at the beginning of an ITS project.
- Integrate transit scheduling technology between neighboring agencies to increase capacity
- Clear incidents and complete traffic stops faster to improve safety
- Technology integrated into seat belts would ensure greater compliance and improved safety
- Reduced collisions at intersections
- Improved mobility and address bottlenecks through better use of traffic shoulders
- Ability to enforce automatically (lane restrictions, intersections, speed)
- ITS projects should improve reliability, mobility, safety, and credibility.

Program areas ready for a large ITS investment:

- Expansion of the data collection infrastructure
- Expansion of the RTMC coverage to the entire freeway system in the metro area
- Developing an automated system to assist with filling-in crash reports and issuing citations
- MnPASS expansion to include HOV lane on I-35W

Project Concepts

ITS technology applications for deployment in Minnesota:

- Expansion of the 800 MHz system
- Enhance real-time traveler information using:
  - RWIS
  - Increase queue detection systems in rural areas
  - Expand detection system on TIGER

  - Increase DMS in rural areas
  - Navigation system in cars
  - Use GPS cells phones as probes on the roadway
  - Satellite radios
  - Flood detection systems at isolated locations
  - Over-height bridge warnings
  - LED pavement markings
- Expand existing technology in traffic signals, such as Ethernet devices
- Enhance real-time transit traveler information using:
  - DMS indicating the number of open parking spaces at park and ride lots
  - DMS indicating the time until the next bus/train for travelers on the freeway system
  - Signs providing directions to a park and ride lot
  - Wireless real-time information to customers through e-mail or cell phone to alert them of bus arrival/departure times and detours
- Use buses as probes to transmit data such as road condition information to the RTMC
- Enhance rural AVL systems
- Hard or HOT shoulders
- Dynamic/congestion pricing
- Expansion of the MnPASS program
- Transit Signal Priority (TSP)
- Expand Heads-Up Display for Snow Plowing
- Continue to place reflective curve signs on low volume roads
- Curve warning devices
- Integrate Metro Police incident reporting format with municipalities and the BCA
- Implement a statewide transit scheduling system through standards and specifications in order for consistency
- Upgrade transit software and identify opportunities for integration with other systems
- Enhance current transit on-board digital video system
- Place sensor around the outside of a bus to notify the driver is a pedestrian is too close
- Integrate transit payment systems to track ridership and billing
- Remote communication and monitoring of transit equipment
- Variable speed limits
- Automated speed enforcement in work zones
- Feed traffic video images into state patrol vehicles
- Lane departure warning systems
- Intersection collision warning systems
- Tie cities and counties into the TOCC system
- In-vehicle technology to prevent tailgating and alert drivers of other vehicles in proximity
- Better tools for automated field reporting and issuing citations.

Local Government

How ITS projects by local governments fit into the overall ITS program:

- Local governments need to be a partner in order to develop a seamless traffic management system

- Continuing to enhance standards would assist local agencies as they upgrade different systems and allow for additional integration opportunities as agencies pull local governments into specific projects
- Currently, local governments feel they do not fit into an ITS program because they are usually only asked to participate on a project by project basis.
- Local governments are seeing the benefits of ITS so there are good opportunities to integrate projects.
- ITS education is needed with local governments prior to starting projects.
- More local government involvement in safety than in mobility
- Eventually in using vehicle probe data to adjust traffic signal system timings

Funding Strategies

Funding for operations and maintenance:

- Include operation and maintenance costs when a project is initially funded.
- Develop annual maintenance contracts with vendors
- Include recommended operation and maintenance costs from vendors in the project cost
- Use Mn/DOT BARC funds. BARC fund money comes out of the construction budget that goes to maintenance. If BARC funds are used, it would help by not affecting the operations fund. ITS maintenance could qualify on a case by case basis using BARC funds.
- Research the cost/benefit of ITS deployment prior to starting a project to assist in requesting operation and maintenance funds
- Include operation and maintenance of ITS applications in the annual operating budget
- Identify a dedicated funding source for ITS projects
- Develop a maintenance budget within Mn/DOT ESS to support ITS components
- Each district needs flexibility in the ITS operation and maintenance budgets.
- Current planning process makes it hard to get operations and maintenance funding. Make it more open to operations and maintenance in terms of criteria and technical areas.
- Are now placing money specifically for O & M and for equipment replacement in budget

Funding for local ITS projects:

- Combining investments with local governments
- Dedicated ITS deployment source for state and federal funds going to local agencies
- Centralize administered pot of money through Mn/DOT State Aid to identify project types and ITS technology applications for deployment with local governments
- Explore outsourcing some operations and maintenance
- Needs of outstate districts to fund operations and maintenance should be formally acknowledged and funded

Other information

- Mn/DOT underestimates the counties ability to work with ITS. Once Mn/DOT completes a project, they should identify other opportunities of where this technology could be used throughout the state if the project was successful.
- Mn/DOT should develop a 1-pager directed at cities and counties on how to incorporate ITS projects.
- Identify a neutral person to pass along information learned on previous projects, so local efforts do not keep re-inventing the wheel
- Identify key staff personnel dedicated to move ITS projects forward. Currently, it seems that ITS projects are added on to a busy work load for existing staff
- Local agencies need to be involved in the ITS development process in order for them to identify integration opportunities or be made aware of technology.
- An open mind is needed to plan and design future ITS projects.
- Always ask questions of what the outcome of the project will be before it is started.
- Transit is an integral component of an ITS statewide program.
- It is important to acknowledge that tests on technology are not being done anymore. A lot of systems have been tried and proven leading to off the shelf ITS technology.
- Look beyond Mn/DOT's perspective and identify how local agencies can be involved with each new project.
- Rural agencies are concerned with mainstreaming ITS, since it would be difficult to fund an ITS portion of a project. ITS is not viewed as necessary.
- Implementation of ITS is needed to buy more time (10 to 20 years) until expensive major infrastructure programs can be implemented.
- Raise the gas tax.
- Guidestar is a great structure to push ITS.

Other State's Stakeholder Interview Highlights

Other State's Project Ideas

- Travel time generation
- Providing video images to TMCs and the public
- Use cell phones as probes to provide information such as travel times
- Vehicle Infrastructure Integration (VII)
- Integrated Corridor Management (ICM)
- Integrated Ramp Metering (coordinating ramp meters along a corridor)
- Addressing institutional issues to improve incident management
- Gathering traveler information on major arterials
- ITS architecture (focusing on rural applications)
- ATIS and RWIS
- Use WiFi and 800 MHz in lieu of Dedicated Short Range Radio Communication (DSRC)

Other State's Previous Implementations

Other State's Successful Implementations

- Deployment of regional TMCs to serve as a foundation for future ITS deployment and integration
- CAD for State Police
- Deploying ITS systems on interstates
- Privatizing some maintenance and TMC operations
- Upgrade of 800 MHz system
- Kansas statewide rural transit deployment
- Fiber optic network
- Transportation Management Center

Other State's Challenging Components of ITS Implementations

- Maintenance of loop detectors
- Upgrading traffic controllers, the focus was on hardware to the exclusion of software. When the upgraded controllers were built, the software could only perform some functions that the old software/signal controllers could.
- Earlier infrastructure and TMC development, which were not developed with a central system in mind
- Cost overruns and related lawsuits on a functionally successful project stopped ITS major deployments for a decade
- Contracting, control, staffing, and operations for a Transportation Management Center

Other State's Effective Implementation Approach

- Outsourcing small projects (though that can lead to incompatible software/systems if done by districts)
- Design-build instead of design-bid-build for deployments and major upgrades

Other State's Less effective Implementation Approach

- Trying to perform all activities in-house
- A large bureaucratic process to justify projects
- Previous design-build project caused cost overruns; will use only design-bid-build contracting with a systems manager and a systems integrator

Other State's Funding Methods

- Some states cover operations and maintenance costs under their annual budget.
- Some states have a separate division for operations and a division for maintenance. However, there is not always an office specifically for ITS. Each division has a budget based on inventory (estimated hours to operate or repair the device deployed).
- Actively pursue federal money on a competitive basis
- Inventory-based funding has been successful, though you must keep a historical record time spent on operations or maintenance to justify funding.
- Some states fund operations and maintenance through CMAQ funds.
- Contract out all maintenance, including for ITS.
- Using a state's operating budget takes away from other district activities, which could become an issue as districts are asked to cut budgets.
- Set an ITS Set-Aside program that provides ITS funding through state funds at a set amount each year.

Other Non-Minnesota ITS Comments

- Stay focused on attainable goals
- Continue to use the systems engineering approach
- Do not get sidetracked with politics.
- Look for venues to invite the legislature and show them the benefits
- Get buy-in from the highest levels of government
- Consider design-build process for deployments and major upgrades
- Develop realistic performance measures
- Consider placing ITS staff in districts as an extension of the Mn/DOT ITS office
- Maintain focus on improving the system
- Obtain buy-in for ITS projects by scheduling meetings with decision-makers to discuss the direction of ITS

- All design projects are outsourced. DOT ITS staff serves as managers and disseminates information.
- Continue to mainstream ITS
- Each year submit a request to DOT office, counties, and cities asking for interest and ideas for ITS project. A committee reviews the applications and votes on projects to be funded.
- Cooperation with other government agencies works well until a staff change occurs, and then it is starting from scratch.
- Keep projects short-term and general because there are changes in mindset after 6 years and it makes each agency re-look at the direction of ITS. Long-term projects should be for major ITS deployments.

Appendix B
ITS Elements

Appendix B – Minnesota Guidestar Program Assessment Elements

Ref #	**Element**	**Description**	**Source***	**Safety/Mobility**
Communications Infrastructure (COMMS)				
1A	Develop a Internet Based Central Communications System for Road Maintenance Data Transfer	Share road maintenance information throughout the state for traffic management purposes	Interview	Mobility
1B	Coordinate Construction and Maintenance Project Schedules	On-line statewide interagency scheduling tool or monthly coordination teleconferences	Workshops	Mobility
1C	Expand 800 MHz deployment	Improve interagency voice communication	Interview	Safety
Advanced Traveler Information Systems (ATIS)				
2A	Improve 511 Traveler Information	Improve 511 telephone user interface and develop new, more user-friendly approaches to deliver 511 traveler information to drivers in vehicles while minimizing distraction.	Guidestar Strategic Plan	Safety/Mobility
2B	Expand Point-to-Point Freeway Travel Times	Expand expected point-to-point freeway travel times at 25 additional locations in the Twin Cities metro area.	Guidestar Strategic Plan	Mobility
2C	Integrate Arterial Streets Traffic Information into ATIS	Provide comparative time for alternate routes including arterials and provide incident information on arterials	Guidestar Strategic Plan, Interview	Mobility
2D	Provide Non-Commuter Congestion Information	Provide congestion information for seasonal and recreational traffic on congested corridors.	Guidestar Strategic Plan; workshops	Mobility
2E	Disseminate Incident E-mail Alerts About Major Incidents	Disseminate e-mail alerts to employers	Guidestar Strategic Plan	Mobility
2F	Expand ATIS to include real-time en-route Traffic Information	Such as travel times, current speeds, incidents, evacuations, planned events, congestion, construction and maintenance	Interview	Mobility
2G	Enhance Road Weather Information	Include Hazardous Conditions	Workshops, Interview	Safety
2H	Expand Parking Availability Notification Systems	Dynamic signs to indicate the number of parking spots available in a lot or ramp	Workshops	Mobility

Ref #	**Element**	**Description**	**Source***	**Safety/Mobility**
2I	Provide real-time information to equipped vehicles that deliver warnings to drivers	This system could include technology to notify a driver, based on their location of the posted speed limit. Other notification could include indication of an unsafe area ahead, such as hazardous roadway locations, alignment changes, upcoming work zones, or bridge surface conditions.	ITS Safety Plan	Safety
2J	Use preemption on vehicle radios to provide real-time information	Real-time information related to road emergencies could be delivered to drivers by preempting radio broadcasts or through Radio Data Systems (RDS) messages.	ITS Safety Plan	Safety
2K	Research equipping vehicles with systems to detect driver distractions and provide warnings	A driver would receive an audible (i.e., beeping) or tactile (i.e., seat vibration) alert as a warning if distraction or unresponsiveness are detected. The University of Minnesota has previously developed technology and conducted research in this area.	ITS Safety Plan; Guidestar Strategic Plan, workshops	Safety
2L	Integrate reporting systems across state and local borders	Provide the ability for reporting systems to share information across state borders. Reporting systems are available now and integration across state borders has been explored through the North/West Passage transportation pooled fund study.	ITS Safety Plan	Safety
2M	Increase Queue Detection and DMS in Rural Areas	Identify Traveler Information Opportunities in Rural Areas	Interview	Mobility
Advanced Public Transportation Systems (APTS)				
3A	Expand Metro Area Transit Safety Technologies to Rural Transit Systems	Expand metro area transit safety technologies to rural transit systems.	Guidestar Strategic Plan	Safety
3B	Enhance GPS Assistance in Bus Lanes	Develop a second generation, high-accuracy GPS system for bus-only shoulder lane use assist.	Guidestar Strategic Plan	Mobility
3C	Enhance Transit Signal Coordination and Priority	Provide signal coordination and priority for transit at ramp meters (bypass), on major bus, LRT and BRT routes.	Guidestar Strategic Plan, Interview	Mobility
3D	Provide Real-Time Information to Transit Users	Provide real-time information to transit users through cell phones, e-mail, DMS including parking availability at P/R facilities.	Guidestar Strategic Plan, Interview	Mobility

Ref #	**Element**	**Description**	**Source***	**Safety/Mobility**
3E	Provide Traffic Information to Transit Operators	Deliver congestion/road closure information to dispatchers and bus operators.	Guidestar Strategic Plan; Interview	Mobility
3F	Enhance Next Bus Arrival Signs	Provide dynamic signs at key bus stops and park and rides displaying real-time information on next bus arrival	Workshops; Guidestar Strategic Plan, Interview	Mobility
3G	Develop Coordinated Fairbox Payments	Provide simple, consistent fare payment that works for multiple transit agencies such as proximity fare payments systems (equip buses with fare readers that only need to come close to passes to register riders)	Workshops	Mobility
3H	Equip Transit Operations and Maintenance Vehicles with AVL Systems	Equip maintenance vehicles with locating equipment to deploy them more effectively and enhance operations	Workshops	Mobility
3I	Enhance Security Cameras on Transit Vehicles	Deploy mobile CCTV surveillance for transit safety and security using digital cameras in buses/light rail vehicles combined with "panic button" activator to transmit images to dispatch center and transit security.	Workshops; Guidestar Strategic Plan	Safety
3J	Measure Transit Historic Route Performance	Analyze transit route data to identify ways to enhance route service and performance	Workshops	Mobility
3K	Equip Transit Vehicles with On-Board Automated Enunciators	Equip buses to automatically provide verbal information about stops and service messages	Workshops	Mobility
3L	Provide Transit Outreach to the ADA Community	Meetings with disabled community representatives to educate them about transit services	Workshops	Mobility
3M	Use transit vehicles as probes	To gather data such as road condition information to feed into the RTMC	Interview	Mobility
3N	Implement a statewide transit scheduling coordination	To ensure consistency (develop standards and specifications) to provide transit route/schedule information and coordinate transfers between segments, providers, and modes	Workshops, Interview	Mobility
3O	Implement pedestrian sensors on transit vehicles	Place sensors on the outside of the bus to notify the driver if a pedestrian is to close to the bus	Interview	Safety
Advanced Transportation Management Systems (ATMS)				
4A	Enhanced Connectivity Between TMCs	On I-94 (Corridor of the Future) connect the RTMC and TMC in St. Cloud to TMCs in District 4, Madison and Milwaukee	Guidestar Strategic Plan	Safety/Mobility

Ref #	**Element**	**Description**	**Source***	**Safety/Mobility**
4B	Implement Dynamic Pricing in HOV Lanes	Implement dynamic pricing on underutilized HOV lanes by converting them to high-occupancy toll (HOT) lanes for the purpose of reducing recurring congestion. Implement electronic toll collection and advance detection system to ensure premium, free-flow speeds for transit, carpools and toll-paying SOVs. Expand express bus service on the HOT lane as well as park-and-ride facilities along the corridor.	Guidestar Strategic Plan, Interview	Mobility
4C	Implement Congestion Pricing	Implement congestion pricing using dynamic pricing technology on a freeway expansion project that holds great potential for reducing recurring congestion and eliminating bottlenecks. Implement an Advantages for Transit Program with the congestion pricing project to ensure that travelers have a choice between paying the toll as drivers, reduced tolls as carpoolers and no tolls as transit passengers.	Guidestar Strategic Plan	Mobility
4D	Deploy Adaptive Traffic Signal Control on Arterials	Adaptive traffic signal controls on arterials to manage traffic and mitigate congestion during special events and at major traffic generators	Guidestar Strategic Plan	Mobility
4E	Provide Suggested Route Information on DMS	Traveler information DMS directing arriving/departing customers to less congested freeway exit/access ramps, parking locations and other way finding information.	Guidestar Strategic Plan; Workshops	Mobility
4F	Deploy Portable Traffic Management Systems at Planned Events	Portable Traffic Management Systems technology (e.g., DMS, cameras communications, variable speed signs) to control traffic during major events and to manage non-recurring congestion.	Guidestar Strategic Plan	Safety/Mobility
4G	Traffic Condition Cameras on Transit Vehicles	Deploy roof-mounted traffic surveillance cameras on buses/light rail vehicles combined with GPS to transmit surrounding arterial traffic conditions to RTMC and transit dispatch centers.	Guidestar Strategic Plan	Mobility
4H	Improve Traffic Signal Timing	Evaluate and upgrade traffic signal timings for agencies that have not reviewed them recently	Workshops	Mobility
4I	Analyze Archived Traffic Data	For Traffic Strategy Development and Planning	Workshops	Mobility
4J	Enhance Surveillance to Identify and Verify Incidents	Upgrade cameras to pan-tilt-zoom or deploy new ones at key locations	Workshops	Safety

Ref #	**Element**	**Description**	**Source***	**Safety/Mobility**
4K	Implement Reversible Lanes	Equip interstate and major arterial express lanes to be used both directions depending on time of day	Workshops	Mobility
4L	Expand TIGER Project	Expand TIGER project on I-94 from Chicago to Fargo, ND (Corridor of the Future)	Guidestar Strategic Plan	Safety/Mobility
4M	Expand work zone safety systems	Currently being done in Minnesota, safety systems could include deploying dynamic late merge systems, which consist of detection, dynamic message signing and software for automation.	ITS Safety Plan; Guidestar Strategic Plan, workshop	Safety
4N	Expand the use of dynamic message signs to provide location based, real-time information to drivers	Dynamic message signs (DMS) are being increasingly used to provide motorists with incident, construction and travel time information. This initiative would explore the use of DMS for additional real-time information and instruction.	ITS Safety Plan	Safety
4O	Research use of graphics (and text) for dynamic message sign messages	As new dynamic message signs (DMS) are deployed, graphic related messaging capabilities would be added. Alone or combined with text, graphics would show information in different formats to enhance driver understanding.	ITS Safety Plan	Safety
4P	Expand geographic coverage of the RTMC systems	The Regional Transportation Management Center (RTMC) integrates Mn/DOT's Metro District Maintenance Dispatch and Office of Traffic, Safety, Security, and Operations with the Minnesota Department of Public Safety's State Patrol Dispatch into a unified communications center. The integration provides the communications and computer infrastructure necessary for coordinated transportation management on metro freeways during normal commuting periods, as well as during special events and major incidents.	ITS Safety Plan	Safety/Mobility
4Q	Implement Dynamic Road Shoulders	Use left-hand shoulder as HOV/HOT lane during rush hours	Interview	Mobility

Ref #	**Element**	**Description**	**Source***	**Safety/Mobility**
4R	Use Cell Phones as Traffic Probes	This system would gather location information from cell phones in a corridor and extrapolate speed information from them. This would provide less expensive and more flexible way together information than installing traditional detectors.	Interview	Mobility
4S	Expand DMS Coverage	Provide greater DMS coverage in rural areas	Interview	Mobility
4T	Implement Over Height Bridge Warning Systems	Vehicle height detectors and electronic advance warning signs that warn drivers of over height vehicles that they are approaching a potential collision	Interview	Safety
4U	Queue Detection and Advisory at Work Zones	Traffic sensors and dynamic message signs to alert motorists of work zone queues	Workshops; Guidestar Strategic Plan; Interview	Safety
4V	Maintenance Decision Support	Utilize the advantages of the Internet to deliver customized surface forecasting and tracking reports.	Workshops	
4W	AVL for Maintenance & Construction Vehicles	Equip maintenance vehicles with equipment to track their location and deploy them more effectively	Workshops	Mobility
4X	Enhance Rural AVL Systems	Expand the AVL systems in rural areas.	Interview	Safety
Advanced Transportation Safety Systems (ATSS)				
5A	Implement Animal Warning Systems	Implement animal-warning systems for drivers at known animal-crossing locations in rural areas	Guidestar Strategic Plan	Safety
5B	Deploy Pedestrian Safety Systems	Deploy technologies to improve pedestrian safety at signalized and unsignalized intersection (e.g., pedestrian-crossing countdown activation)	Guidestar Strategic Plan	Safety
5C	Deploy Speed Detection and Feedback Signs on Arterials	Speed detection and feedback signs on arterials	Guidestar Strategic Plan	Safety
5D	Provide Surveillance and Countermeasures at Crash-Prone Locations	Identify most crash-prone locations in urban areas and fatality-prone locations in rural areas, and conduct high-accuracy macroscopic surveillance to determine causal factors and identify solutions	Guidestar Strategic Plan	Safety
5E	Provide Pedestrian Warning for Drivers	Pedestrian/bicycle detection technology combined with advance warning signs for drivers	Guidestar Strategic Plan	Safety
5F	Provide Dynamic Feedback to Drivers	In-vehicle warnings of Upcoming Hazards	Workshops; Interview	Safety

Ref #	**Element**	**Description**	**Source***	**Safety/Mobility**
5G	Install rural intersection warning and decision support systems	Provide drivers on the rural roadways with information indicating when entry into the intersection is safe.	ITS Safety Plan; Guidestar Strategic Plan	Safety
5H	Implement Automated Curve Driver Warning	Signs would illuminate when traffic approached to alert them of a curve ahead and post the suggested speed	Interview	Safety
5I	Implement Highway/Rail Intersection Warnings	Signs near intersection light up as train approaches to warn drivers	Interview	Safety
5J	Implement Flood Detection Systems	Deploy automated flood warning systems to alert dispatchers or traffic management staff of flooding at low-lying, high traffic roads	Interview	Safety
5K	Deploy LED Pavement Markings	Enhance MnROAD's evaluation of LED pavement markings	Interview	Safety
5L	Implement Automated Gate Closure	Remote operated gates to close exits/entrances to roadways	Workshops	Safety
5M	Enhance Driver Assistance System	Develop and evaluate smartphone-based driver assistance system to prevent crashes	Guidestar Strategic Plan	Safety/Mobility
5N	Require seatbelt ignition interlocks on new vehicles	The premise of this initiative is to expand existing seatbelt interlocks so that a driver would be unable to start a vehicle unless the seatbelt is fully engaged for everyone in the vehicle. Technology is currently available to interlock the ignition with seatbelts. Currently, most new vehicles issue an audible alarm that will continue until everyone in the front seat is buckled.	ITS Safety Plan	Safety
5O	Require blood alcohol content level ignition interlocks on vehicles driven by repeat drunk driving offenders	This strategy would require a driver's blood alcohol content level to be checked by an onboard device that is interlocked with the vehicle's ignition system. The vehicle would not start if the driver's blood alcohol content were above a preset level. There is technology currently available and several state court systems currently require some form of blood alcohol content level ignition interlock.	ITS Safety Plan; Guidestar Strategic Plan	Safety
5P	Expand graduated driver licensing	New drivers are rewarded for safe driving under graduated driver licensing programs. Currently, a limited graduated driver licensing program exists in Minnesota. However, using technology such as in-vehicle monitoring could be added to enhance the program to reward safe drivers.	ITS Safety Plan	Safety

Ref #	**Element**	**Description**	**Source***	**Safety/Mobility**
5Q	Automated Roadway Treatment	Automated anti-icing equipment to prevent ice forming on roadway	Workshops	Safety
5R	Warn Work Crews of Errant Vehicles	Automated detection and warnings of vehicles that leave lanes in work zones	Workshops	Safety
5S	Equip vehicles with technology to alert drivers of other vehicles in close proximity	In-vehicle technology to prevent tailgating and alert driver of other vehicles in proximity	Interview	
5T	Use driving simulation for teenage and mature driver education	Individuals would be asked to participate in driving simulation to see the effects of driving too fast, tailgating, reaction time, etc. This technology has been available for many years. However, political support will be needed to proceed at a state level.	ITS Safety Plan	Safety
Emergency Management and Public Safety Systems (EMS/PSS)				
6A	Enhance Interagency Communications Infrastructure	Improve coordination between Mn/DOT, DPS, local governments and other agencies to ensure a timely response to emergency situations by the nearest responder. Extend this coordination to adjacent states as well. (Includes expanded 800 MHz deployment among other technologies.)	Guidestar Strategic Plan; Workshops	Safety
6B	Develop an Operational Guide for Emergency Vehicle Strategic Deployment	Convert available crash location information into operational guide for strategic deployment of emergency vehicles.	Guidestar Strategic Plan	Safety
6C	Implement AVL for FIRST Vehicles	Implement rapid incident clearance through CAD integration and AVL on Freeway Incident Response Safety Team (FIRST) vehicles.	Guidestar Strategic Plan	Safety/Mobility
6D	Incorporate ITS Technologies in Local Emergency Management Plans	Incorporate use of traffic detectors, traffic signal preemption/priority, CCTV cameras, and other ITS technology into emergency management plans as applicable and on-going identification and dissemination of potential and actual hot-spot locations for strategic deployment of emergency vehicles	Guidestar Strategic Plan	Safety
6E	Share Video Surveillance	Share video data between traffic management and emergency management partners	Workshops; Guidestar Strategic Plan	Safety

Ref #	**Element**	**Description**	**Source***	**Safety/Mobility**
6F	Enhance/Integrate CAD	Rapid incident clearance through CAD integration	Workshops; Guidestar Strategic Plan	Safety
6G	Automated Incident Report Writing	automated roadside citation and report writing to improve clearance time	Workshops	Safety/Mobility
6H	Provide Dynamic Routing of Emergency Vehicles	Provide the best route to emergency vehicles	Workshops	Safety
6I	Provide Incident/Emergency Surveillance at Borders	Provide surveillance to enable Emergency Management to monitor and respond to potentially hazardous situations	Workshops	Safety
6J	Coordinate emergency responder databases to allow access to consistent crash information	Coordinate emergency responder databases to allow each entity to enter and access information about a crash through an online database. Such coordination would allow the seamless sharing of consistent information on crash and victim details to facilitate better response and care.	ITS Safety Plan; Guidestar Strategic Plan	Safety
6K	Allow law enforcement to retrieve data from onboard vehicle computers	Ideally, law enforcement would access this data to determine vehicle speed, deceleration, time of incident, etc. This type of information is currently available on newer model vehicles and Minnesota law enforcement is able to access the data with a warrant.	ITS Safety Plan; Guidestar ITS Strategic Plan	Safety
6L	Develop and provide a uniform, real-time automated crash notification system	This system would provide immediate notification of a crash to emergency responders and provide access to driver, passenger and vehicle information. This would reduce emergency response time and, ultimately, improve crash fatality and injury rates through faster and more targeted care. This could be viewed as a continuation of the previous Mayday projects conducted in Minnesota.	ITS Safety Plan; Workshops; Interviews	Safety
6M	Implement automated enforcement of red light running at intersections	Identify signalized intersections where there have been higher than average crash rates and deploy portable or permanent photo/surveillance systems that automatically mail citations to drivers running red lights.	ITS Safety Plan; Guidestar Strategic Plan, workshop	Safety

Ref #	**Element**	**Description**	**Source***	**Safety/Mobility**
6N	Expand quick clearance policies for incidents	Quick clearance policies have strong effects on traffic safety and minimize incident related congestion. Studies indicate that good traffic incident management lead by quick clearance actions can reduce delay nationally by 170 million hours annually.	ITS Safety Plan	Safety/Mobility
6O	Implement automated enforcement of speed violations	Photo enforcement for speeding can be deployed reactively at locations where there is a history of crashes with excessive speed as a contributing factor or in work zones.	ITS Safety Plan; Workshops	Safety
6P	Surveillance of Transportation Infrastructure	Critical infrastructure surveillance systems that include cameras, lighting, fencing, and/or motion detectors at highway or transit facilities. These systems will require adequate monitoring staff to be effective.	Workshops	Safety
6Q	Feed Traffic Video Images Into State Patrol Vehicles	To determine the best routes for responding to incidents.	Interview	Safety
Homeland Security (HS)				
7A	Expand TIGER to Include Emergency Management	Complete/expand the Traveler Information Guidance and Evacuation Routing (TIGER) project on I-94/TH 55/TH 10 to include emergency management (i.e., alternate route plan, conversion to contraflow lane operation, use of a portable Smart Work Zone technology for signing, merging, communications, speed, etc.)	Guidestar Strategic Plan	Safety
7B	Equip Transit Vehicles with Communications Links to Emergency Response Command Centers	Equip bus fleets with communication system connection to emergency response command centers to enable the driver to provide Homeland Security alerts.	Guidestar Strategic Plan	Safety
7C	Enhance Evacuation Management Plans	Ensure that emergency evacuation management plan features are in place for key evacuation routes (e.g., conversion to contraflow lane operation, ramp closures, use of portable Smart Work Zone technology for signing, merging, speed messages, communications, etc.).	Guidestar Strategic Plan	Safety
Commercial Vehicle Operations (CVO)				

Ref #	**Element**	**Description**	**Source***	**Safety/Mobility**
8A	Provide Truck Priority	Investigate providing truck priority at isolated intersections in high-speed rural roadways.	Guidestar Strategic Plan	Mobility
8B	Provide Rest Area Availability Notice to Truck Drivers	Provide advance rest area parking availability information to truck drivers through the use of DMS, 511, HAR, combined with in-pavement or non-intrusive detection technology to ascertain level of use and availability.	Guidestar Strategic Plan	Mobility
8C	Mitigate Freight Congestion at Bottlenecks	Target congestion-reduction technologies to major freight bottlenecks (e.g., urban inter-modal transfer facilities, congested facilities carrying significant heavy commercial vehicle traffic, real-time road condition, detours, and congestion-ahead information to freight vehicles).	Guidestar Strategic Plan	Mobility
8D	Enhance CVO Weight Enforcement	Upgrade existing weigh-in-motion units to variable weigh stations to help enforcement officers identify overweight trucks	Workshops	Safety
8E	Provide Automated Roadside Safety Monitoring and Reporting	Technology that can detect defective braking systems, emissions detectors that can identify dangerous chemicals, and low-level radiation screening can be used to detect contraband	Workshops	Safety
8F	Enhance CVISN	Improve the efficiency of freight movement, permitting, and credentials process	Workshops	Safety/Mobility
8G	Provide Road Weight Restriction Information	Inform truckers of weight restrictions prior to entering a road	Workshops	Safety
8H	Provide CVO Permit Restriction Information	Inform truckers of permit restrictions	Workshops	Safety
8I	Provide Roadside Enforcement Personnel with CVO Database	Data link from state CVISN and enforcement databases to state patrol vehicles	Workshops	Safety
Vehicle Infrastructure Integration (VII)				
9A	Create a VII Testbed Along I-94	Create a VII technology testbed along I-94 (Between St. Cloud and Maple Grove)	Guidestar Strategic Plan	Safety/Mobility
9B	Implement the Cooperative Intersection Collision Avoidance System	Implement the Cooperative Intersection Collision Avoidance System (CICAS)	Guidestar Strategic Plan, Interview	Safety

Ref #	**Element**	**Description**	**Source***	**Safety/Mobility**
9C	Implement improved lane departure warning system	Provide lane departure warning to drivers/vehicles through the use of magnetic, GPS and pavement markings.	ITS Safety Plan; Guidestar Strategic Plan	Safety
9D	Develop vehicle to vehicle and vehicle to infrastructure communication	This initiative encompasses the national vision for VII. VII will build on the availability of advanced vehicle safety systems developed under the Intelligent Vehicle Initiative (IVI) and on the results of related research and operational tests. It is also supported by radio spectrum at 5.9 GHz specifically allocated for digital short range communications (DSRC).	ITS Safety Plan; Guidestar Strategic Plan	Safety
9E	Implement variable speed limit signs	Variable speed limit systems provide real-time information on appropriate speed for current conditions based on traffic flow, traffic speed, weather and other inputs and integration with law enforcement.	ITS Safety Plan; Guidestar Strategic Plan, workshop, KS Interview	Safety/Mobility
9F	Enhance Heads-Up Display for Snowplows	Screen that allows snowplow drivers to see lane borders and obstacles during white-out conditions	Interview	Safety

* ITS Safety Plan = Minnesota ITS Safety Plan August 31, 2006
Guidestar Strategic Plan = Statewide Strategic Plan 2006: An Action Plan for ITS Development and Deployment
Interview = Key Minnesota and Non-Minnesota transportation interviews conducted as part of this Deployment Assessment
Workshops = Mn/DOT conducted Stakeholder Workshops

Appendix C
Performance Measures

Minnesota Department of Transportation
Office of Transportation Safety and Operations (OTSO)
ITS-Related Transportation System Performance Measures

The purpose of this analysis is to develop performance measures for evaluating the effectiveness of ITS technologies and programs for improving safety, reducing congestion and improving the operational efficiency of transportation systems.

When focusing on ITS-specific performance measures, it is important to understand that is sometimes difficult to separate ITS-related effects from other factors such as design improvements occurring simultaneously. Even when only ITS technologies and program are implemented, outside factors such as changes in vehicle-miles of travel resulting from fluctuations in the economy can make it difficult to separate the role of ITS in observed outcomes.

Types of Performance Measures

As a first step in the development of ITS-related performance measures, it is important that input, output and outcome-based performance measures be defined. For example, if it is known that certain input factors or actions are related to preventing crashes and saving lives, then input measures such as "amount of dollars invested in crash- or fatality-reduction activities" or "passing mandatory seatbelt use law" can serve to measure their level of deployment and their indirect effect on safety.

Another way to measure the effectiveness of ITS implementations is to define output-based performance measures such as "level of seatbelt use" or "reduction in red-light running". Again, these are indirect safety measures that address the tools used to improve safety, but do not measure the desired outcomes directly (reduction in number of crashes and fatalities).

The best kinds of measures are outcome-based, because they directly address ultimate desired results such as "reduction in crashes and fatalities". They reflect the "outcome" resulting from implementing safety actions, making investments in safety programs, and passing safety laws, etc.

The relationship between these three types of measures can be illustrated as follows:

Input Measure	Output Measure	Outcome Measure
• Invest $100,000 per year in ignition interlock systems	• Install ignition interlock on vehicles driven by repeat DWI offenders	• Reduce fatalities associated with DWI offenses by 10% per year

Recognizing that much of the data required for developing robust outcome-based performance measures is not available at present, three levels of measures are defined (following the scheme used in the 2003 Statewide Transportation Plan, as follows:

Developmental Measures

Historic baseline data does not exist, nor have levels of desirable performance been defined previously. In this case, data would have to be collected before acceptable performance levels can be properly defined.

Emerging Measures

Historic baseline data does not exist, but informal, non policy-based levels of acceptable performance have been defined previously. In this case, interim levels of desirable performance can be defined, with the understanding that further monitoring of performance levels is needed before acceptable levels can be finalized.

Mature Measures

Historic baseline data exists and levels of desirable performance have been previously defined through national state or local plans and policies.

Once the proposed performance measures are selected, an analysis of data availability and quality is needed to establish current and historic trends. If data is available, this assessment will help determine if performance levels of acceptability exist or can be established. If data is not available, then interim levels of performance acceptability levels would be defined. Once these steps are completed, mid- and long-term targets (five year and 10-year, respectively) should be defined for each performance measure.

Scope of ITS Performance Measures

The performance measures proposed are a function of the extent or level of deployment, as follows:

1. **System or Regional Level**: Examples are metro freeway instrumentation (RTMC), and regional Transportation Operations Communications Systems (TOCCs) covering the state.

2. **Corridor Level**: Examples include the I-94 TIGER Corridor and the I-90 Gate Closure projects.

3. **Sub-area or Sub-System Level**: Examples include the downtown Minneapolis and Saint Paul signal coordination systems, and city-wide Emergency Vehicle Preemption (EVP) systems at traffic signals.

4. **Project-Specific or Fleet Level**: Applies to projects of limited scope, such as a discrete number of signals, intersections or roads in small geographic areas, or a fleet of vehicles.

Generally speaking, performance expectations in terms of absolute outcomes increase as the deployment moves from project-specific level, at one end, to system or regional level, at the other.

The proposed approach for measuring the performance of ITS-related deployments is to do it at the project-specific level for partial deployments (intersection, corridor, fleet, sub-area), and at the regional or statewide level for full or area-wide deployments.

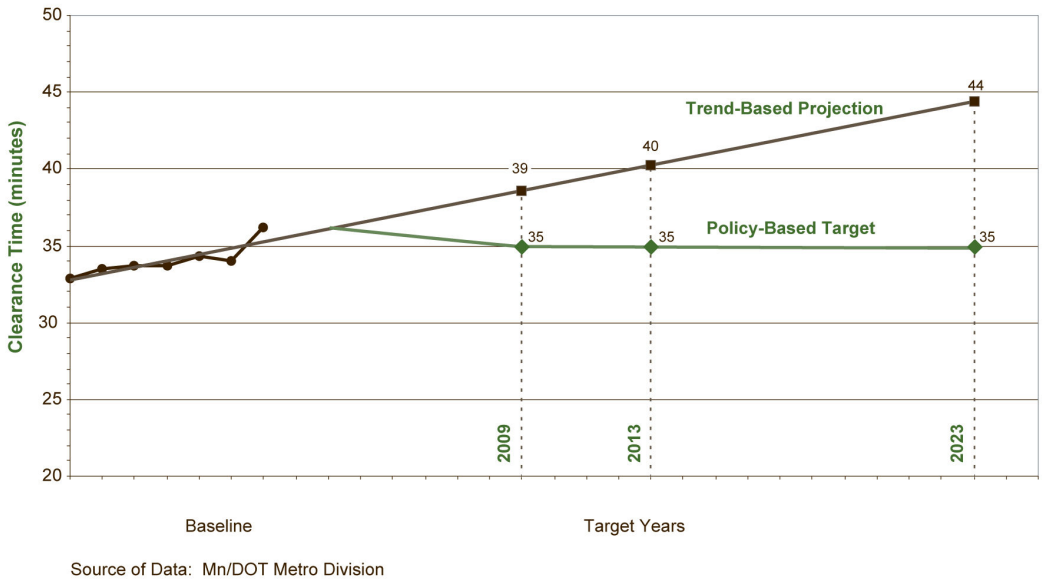
The following sections define the objectives of the ITS-related transportation system performance measures:

1. Increase Safety
2. Reduce Congestion and Improve Mobility
3. Improve Operational Efficiency

For each of these objectives, ITS strategies are described and performance measures are identified. Specific short- and long-term targets are not defined at this time, pending analysis of data availability and quality and determination of policy- or planning-driven levels of performance acceptability.

To illustrate, the attached figure shows the performance measure: Average Clearance Time for Freeway Incidents (Three-Year Moving Average), taken from the 2003 Transportation Plan. Baseline data for overall clearance time—from detection to total clearance—is used as the basis for developing trends, and policy-based targets are developed to reflect acceptable levels of performance for the short, medium and long term.

Figure 6-9: Average Clearance Time for Freeway Incidents (Three-Year Moving Average)



Source of Data: Mn/DOT Metro Division

Objective 1: Increase the Safety of Transportation Systems and Their Users Through the Use of ITS Technology

This objective derives from Mn/DOT's Policy 3—Effectively Manage the Operation of Existing Transportation Systems to Provide Maximum Service to Customers; and Policy 7—Increase the Safety and Security of Transportation Systems and their Users (2003 Statewide Transportation Plan). ITS can assist in achieving policy objectives through implementation of technologies aimed at reducing the occurrence of well-recognized causal factors for crashes and fatalities, which include:

- High speed variability
- Driving while intoxicated
- Driver distraction and inattention
- Pavement snow and ice conditions
- Length of time crashes remain on road

Crash and Fatality Prevention Strategies Using ITS Technologies

ITS technology applications can reduce or eliminate the incidence of causal factors in crashes. Relevant ITS technologies currently available include:

- Installation of aftermarket ignition interlock (triggered by breathalyzer results) on vehicles driven by repeat drunk-driving offenders. This strategy is intended to reduce or eliminate repeat offenses. Ultimately, working with the auto industry and the legislature, ignition interlock could be required on new vehicles, and activated for repeat offenders.

- Implementation of variable speed-limit signs at work zones and in areas where recurring, abrupt speed changes are likely to occur. A significant number of rear-end crashes occur because vehicles are not able to slow down in time in response to sudden speed changes. Advance variable speed limit signs help drivers respond earlier.

- Reducing the time it takes to clear snow and ice from roads is an important Mn/DOT objective. ITS technologies, such as truck-mounted pavement temperature sensors to help truck operators select sand and salt application rates, can make the process more efficient and cost-effective.

- Implementation of automated gate/signal controls at at-grade rail crossings have been shown to reduce inadvertent or inappropriate crossings.

- Legislation to allow automated enforcement of red-light-running violations at signalized intersections: Experience has shown that enforcement will reduce this form of violation, but since there are not sufficient officers to do this, automatic enforcement becomes an effective

alternative. Legislative approval will be required to implement this technology. While the expected reduction in fatalities is limited, the reduction in total crashes could be significant.

- Legislation to allow automated enforcement of speed violations, especially for speeds above a certain threshold (e.g., above the 85-percentile speed level): High-speed differentials are associated with higher crash rates and fatalities.

- Vehicle Infrastructure Integration (VII) Systems promises to improve communications between in-vehicle technology and roadside technology to assist and provide advance warning and information to drivers.

- Improved vehicle lane-guidance and front and rear proximity warning systems and/or autonomous, self-correcting systems promise to reduce many crashes.

- Rural intersection gap-warning and decision-support systems for side-street crossing and merging vehicles can substantially reduce many crashes that result in fatalities or life-threatening injuries.

- Technology aimed at detecting driver distraction, inattention, together with warning systems to alert drivers could prevent many of these types of crashes.

During- and After-Crash ITS Response Strategies

ITS technology applications can help prevent or reduce the seriousness of crashes as they occur, or in their immediate aftermath. Applicable ITS technologies include:

- Better communications between crash sites and emergency response providers will reduce response-time, which is key to saving lives, especially in rural areas where distance is a significant factor.

- Development of a uniform, real-time, automated crash-notification system for use by law enforcement and first-responders will make data processing, emergency vehicle deployment and response more efficient.

- Automated violation and crash data processing will reduce the time State Patrol and other first-responders spend at crash sites: The greater the time spent at crash sites, the greater the slowdowns (rubbernecking) and the chances for secondary crashes, and the greater the length of time that enforcement personnel are exposed to adverse conditions.

- Seatbelt interlock on new vehicles to make sure that more drivers are buckled-up: It will be necessary to overcome driver resistance to this type of active, intrusive technology, and legislative and automaker cooperation will be needed.

- Installation of automatic seatbelt- and headrest-adjustment technology in new vehicles will reduce the effects of crashes on drivers and passengers: The on-board computer detects loss

of control, tightens the seatbelts and adjusts the headrest forward to reduce the adverse effects. (Some automakers have already developed this technology, which is likely to show up in new vehicles.)

Proposed Safety-Related ITS Performance Measures for all Modes

The following safety-related performance measures generally address implementation of ITS strategies listed in the Statewide Transportation Plan (2006), the Statewide ITS Strategic Plan (2006), the Statewide ITS Safety Plan (2006) as well as selected strategies from the ITS Deployment Assessment, currently underway.

Performance Measures

Short- to Mid-Term (2-5 years)

1. Reduce crashes and fatalities related to drinking while intoxicated.

- Install ignition interlock on vehicles driven by convicted repeat drunk drivers.

2. Reduce crashes and fatalities related to excessive speeds.

- Promote legislation to allow automated photo monitoring and enforcement of excessive speeding.
- Implement variable speed limit signs in areas where abrupt speed changes are likely to occur (work zones, bottleneck areas, and substantial changes in vertical or horizontal alignment).

3. Reduce crashes and fatalities related to red-light running at signalized intersections.

- Promote legislation to allow automated photo enforcement of red-light running at intersections.

4. Reduce snow and ice clearance time using automated technology.

- Install temperature sensors on winter maintenance vehicles to more efficiently apply salt and sand.

5. Reduce incident clearance and response time.

- Reduce duration of on-site enforcement through automated violation and crash data processing.
- Improve communications between crash sites and emergency-response providers to reduce crash-clearance time.
- Develop uniform, automated crash-notification system.

6. Reduce crashes at at-grade rail crossings.

- Install signal-warning technology at high-exposure at-grade rail crossings.

Long Term (6 to 10 years)

7. Reduce crashes and fatalities related to seatbelt non-use or inappropriate use.

- Promote installation of automatic seatbelt- and headrest-adjustment technology in new vehicles.
- Promote installation of automatic seatbelt interlock.

8. Reduce crashes and fatalities related to lane departure.

- Promote development and implementation of lane-guidance and lane-departure warning technologies.

9. Reduce intersection crashes and fatalities related to inappropriate crossing and merging.

- Implement Vehicle Infrastructure Integration (VII) systems to improve communications between vehicles and roadside signals, signs and other infrastructure systems.
- Install gap-warning and decision-assistance systems at rural intersections.

10. Reduce crashes and fatalities related to driver inattention and distraction

- Implement detection and warning technology to reduce the effects of driver inattention and distraction
- Implement Vehicle Infrastructure Integration systems to improve communications between vehicles and roadside signals, signs and other infrastructure systems.

Objective 2: Reduce Congestion and Increase Mobility on Transportation Systems through the Use of ITS Technology

This objective derives from Mn/DOT's Policy 3—Effectively Manage the Operation of Existing Transportation Systems to Provide Maximum Service to Customers; Policy 5—Enhance Mobility in Interregional Transportation Corridors Linking Regional Trade Centers; and Policy 6—Enhance Mobility within Regional Trade Centers (2003 Statewide Transportation Plan). As with the safety objective, ITS can assist in achieving this objective through implementation of technologies aimed at reducing congestion and improving mobility.

It should be noted that, in many cases, strategies aimed at improving safety have the effect of reducing congestion and improving mobility. Examples include, response and clearance time for crashes—the shorter the duration of this safety-related measure, the lower the level of traffic disruption and congestion, and the lower the chances of a secondary crash occurring. A similar situation happens when reducing snow and ice clearance time, which is primarily a congestion/mobility improving activity. The longer snow and ice conditions remain, the greater the disruption to traffic flow and the chances of a crash occurring.

ITS Strategies for Reducing Congestion and Improving Mobility

- Increase capacity through use of "dynamic shoulders" to take advantage of available pavement in existing right of way. Use ITS technology to manage demand and operations.

- Incorporate arterials and highways in integrated corridor management approaches in urban areas to ensure that highways and parallel arterials are managed so as to complement each other.

- Implement contraflow-lane operations, using ITS technologies, to take advantage of imbalanced demand and unused capacity in urban freeways.

- Implement HOT lanes in urban areas using dynamic pricing to promote transit and HOV use, and to optimize use of the excess capacity by charging single-occupant vehicle drivers a fee, while maintaining premium, free-flow speeds.

- Consider implementing variable or dynamic pricing on freeway capacity-expansion projects in urban areas. Pricing has been shown to be a very effective traffic management method for reducing demand and delays and promoting mobility.

- Improve incident response time by expanding first-responder communications systems in urban and rural areas (similar to safety strategy).

- Implement next-generation Traffic Operations and Communications Centers (TOCCs) to include area local governments (counties and cities). This is a key strategy for mainstreaming ITS technologies.

- Expand winter maintenance activities to reduce snow and ice clearance time using ITS technologies (similar to safety strategy).

- Implement aggressive construction management and control systems to reduce level and duration of traffic disruptions.

Proposed Congestion- and Mobility-Related ITS Performance Measures for all Modes

The following congestion- and mobility-related performance measures generally address implementation of ITS strategies listed in the Statewide Transportation Plan (2006), the Statewide ITS Strategic Plan (2006), and selected strategies from the ITS Deployment Assessment, currently underway.

1. Reduce peak-period congestion due to demand/capacity imbalances.

Short- to Mid-Term (2-5 years)

- Increase highway capacity through use of "dynamic shoulders". Use ITS technology such as dynamic pricing to manage lane use and operations.

- Implement contraflow-lane operations, through use of ITS technologies, to take advantage of imbalanced demand and unused capacity in urban freeways.
- Implement HOT lanes in urban areas using dynamic pricing to ensure that free-flow speeds are maintained.

Long Term (6 to 10 years)

- Implement variable or dynamic pricing on freeway capacity-expansion projects in urban areas.

2. Improve mobility through better system management, integration and communications.

Short- to Mid-Term (2 to 5 years)

- Incorporate arterials and highways in integrated corridor management applications.
- Improve incident response time by expanding law-enforcement and first-responder communications systems in urban and rural areas.
- Implement aggressive construction management and control systems to reduce level and duration of traffic disruptions.

Long-Term (6 to 10 years)

- Implement next-generation Traffic Operations and Communications Centers (TOCCs) to include local governments (counties and cities) traffic operations and communications systems.

Objective 3: Improve the Operational Efficiency of Transportation Systems through the Use of ITS Technologies

This objective derives from Mn/DOT's Policy 3—Effectively Manage the Operation of Existing Transportation Systems to Provide Maximum Service to Customers; Policy 5—Enhance Mobility in Interregional Transportation Corridors Linking Regional Trade Centers; and Policy 6—Enhance Mobility within Regional Trade Centers (2003 Statewide Transportation Plan). ITS can assist in achieving this policy objective through implementation of technologies aimed at improving system operational efficiency.

ITS Strategies for Improving the Operational Efficiency of Transportation Systems

- Expand RTMC instrumentation coverage to the entire metro freeway system. Technology includes closed-circuit TVs, loop detectors, other vehicle-counting and classification technology, and monitoring systems.

- Lane-control technology is used to manage lane use in urban and rural areas. This strategy can be used to reduce lane imbalance and for advance communication of conditions ahead.

- State-of-the-art signal coordination technology for arterials and collectors that are used to access the metro freeway system can substantially improve system efficiency. Requires improved communications and coordination with local governments, and is an important strategy for mainstreaming ITS applications.

- Expand data collection technology for highway and transit systems to collect better weather and traffic condition information and to create better information for travelers.

- Improve traveler information dissemination technology and signage on the highway system to help drivers make more informed decisions about route, time and mode of travel.

- Implement electronic enforcement of traffic laws to achieve greater compliance (similar to the safety strategy).

- Implement next-generation Traffic Operations and Communications Centers (TOCCs) to include area local governments (counties and cities). This is a key strategy for mainstreaming ITS technologies.

- Expand winter maintenance activities to reduce snow and ice clearance time using ITS technologies (similar to safety strategy).

- Implement aggressive construction management and control systems to reduce level and duration of traffic disruptions.

Proposed ITS-Related Performance Measures to Improve Transportation System Operational Efficiency for all Modes

The following operational efficiency system performance measures address implementation of ITS strategies listed in the 2003 Statewide Transportation Plan, the 2006 Statewide ITS Strategic Plan, and selected strategies from the ITS Deployment Assessment, currently underway.

1. Improve the operational efficiency of transportation systems for all modes.

Short- to Mid-Term (2-5 years)

- Expand RTMC instrumentation coverage to the entire metro freeway system.
- Implement lane-control technology to manage lane use.
- Expand winter maintenance operations (similar to safety and mobility strategy).
- Implement aggressive construction management/control systems (similar to congestion/mobility strategy).

- Implement state-of-the-art signal coordination technology on arterials and collectors used to access the metro freeway system.
- Expand highway and transit system data collection technologies for use in traveler information systems.
- Improve traveler information collection and dissemination system.

Long Term (6-10 years)

- Implement next generation TOCCs to include local governments.

Relationship between ITS Performance Measures and Program Strategies (from Deployment Assessment handout)

Ref No.	Program Strategy	ITS Safety Plan Element (1)	Performance Objectives		
			Safety (3)	Congestion/ Mobility (2) (3)	Operational Efficiency (3)
1	"Dynamic Shoulders" to maximize use of available pavement **(with/dynamic pricing? As a pilot?)**			**P**	S
2	Expansion of RTMC coverage area to 100% of metro freeways		S	S	**P**
3	Variable speed limits to smooth traffic **(and avoid crashes)**	√	**P**	**P**	S
4	Lane control signals to manage lanes			**P**	**P**
5	Incorporate local streets into integrated corridor management			**P**	S
6	Contraflow lanes to take advantage of unused capacity **(freeways and arterials)**			**P**	S
7	Electronic enforcement to optimize compliance **(speed, HOV violations)**	√	**P**	S	
8a	Aggressive incident response **(automated)**	√	**P**	**P**	S
8b	Aggressive construction management/control systems			**P**	S
9	HOT lanes with dynamic pricing		S	**P**	
10	Expand data collection infrastructure on highway system **(urban/rural)**				**P**
11	Improve traveler information dissemination systems and signage			S	**P**
12	Expand first responder and law enforcement systems **(to reduce response time)**	√	**P**	S	
13	Implement Vehicle Infrastructure Integration (VII) **(in urban and rural areas)**		**P**	S	
14	Implement the next generation Traffic Operations and Communications Centers (TOCC) to include local governments **(address transit)**		S	**P**	**P**
15	Expand winter maintenance operations to improve safety **(mobility and operational efficiency)**	√	**P**	**P**	**P**
16	Use intersection collision warning systems as well as red light running	√	**P**		

(1) Safety strategies not included in program:
- Ignition interlock/DWI
- Driver-distraction warning systems
- Lane departure guidance systems
- Signal/gate control at at-grade crossings
- Seatbelt interlock
- Seatbelt/headrest automatic adjustment

(2) Congestion/Mobility strategies not included in program:
- Signal coordination
- Dynamically priced lanes
- Signal priority for transit corridors

(3) **P**: Primary objective
S: Secondary objective

Office of Transportation Safety and Operations (OTSO)

ITS-Related Transportation System Performance Measures

SUMMARY

Purpose

The purpose of this analysis is to develop performance measures for evaluating the effectiveness of ITS technologies and programs for:

- Improving Safety
- Reducing Congestion
- Improving Operational Efficiency

Types of Performance Measures

- Input Measures
- Output Measures
- Outcome Measures

Acceptable Levels of Performance

- Developmental Measures
- Emerging Measures
- Mature Measures

Scope of Performance Measures

- System or Regional Level
- Corridor Level
- Sub-area of Sub-System Level
- Project-Specific or Fleet Level

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Strategies for Improving Safety, Reducing Congestion and Improving the Operational Efficiency—Resources

- Statewide Transportation Plan (2003) Policies and Performance Level and Targets (6-, 10- and 20-year horizon)
- Statewide ITS Strategic Plan: An Action Plan for ITS Development and Deployment (2006)
- Statewide ITS Safety Plan (2006)
- ITS Deployment Assessment (2006 Draft)

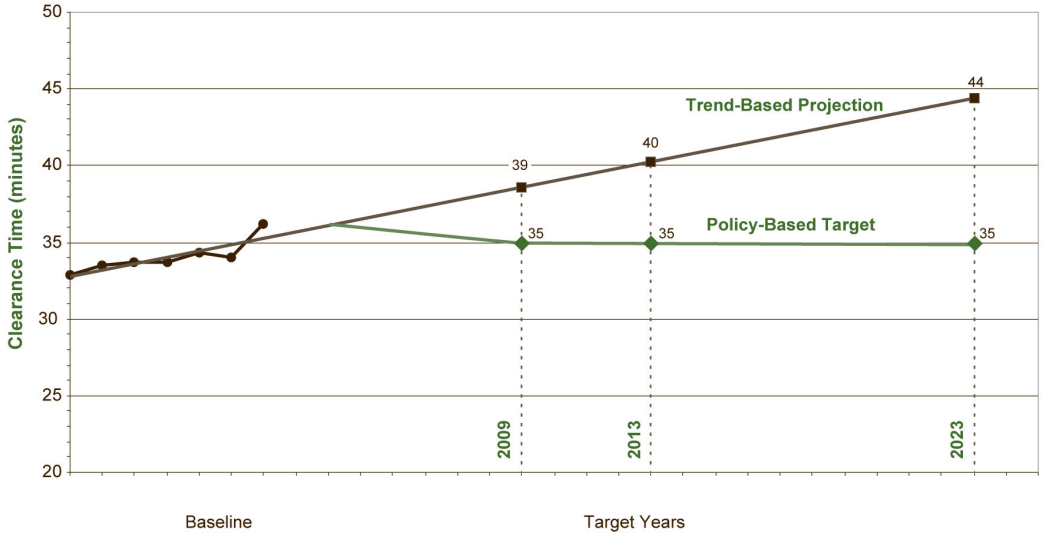
Preliminary Measures

(see Table attached)

Next Steps

- Historic Data
- Acceptable Levels of Performance
- Short- and Mid-Term Targets

Figure 6-9: Average Clearance Time for Freeway Incidents (Three-Year Moving Average)



Source of Data: Mn/DOT Metro Division

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Preliminary Measures by Type

Performance Measures	Short-, Medium- or Long-Term	Type of Measure		
		Input	Output	Outcome
A. Safety Measures				
1. Reduce crashes and fatalities related to drinking while intoxicated	S – M		√	
2. Reduce crashes and fatalities related to excessive speeds	S – M		√	
3. Reduce crashes and fatalities related to red-light running at signalized intersections	S – M		√	
4. Reduce snow and ice clearance time using automated technology	S – M		√	
5. Reduce incident clearance and response time	S – M		√	
6. Reduce crashes at at-grade rail crossings	S – M		√	
7. Reduce crashes and fatalities related to seatbelt non-use or inappropriate use	L	√		
8. Reduce crashes and fatalities related to lane departure	L	√		
9. Reduce intersection crashes and fatalities related to inappropriate crossing and merging	L	√		
10. Reduce crashes and fatalities related to driver inattention and distraction	L	√		
B. Congestion Measures				
1. Reduce peak-period congestion due to demand/capacity imbalances	S – M, L			√
2. Improve mobility through better system management, integration and communications	S – M, L		√	
C. Operational Efficiency Measures				
1. Improve the operational efficiency of transportation systems for all modes	S – M		√	

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