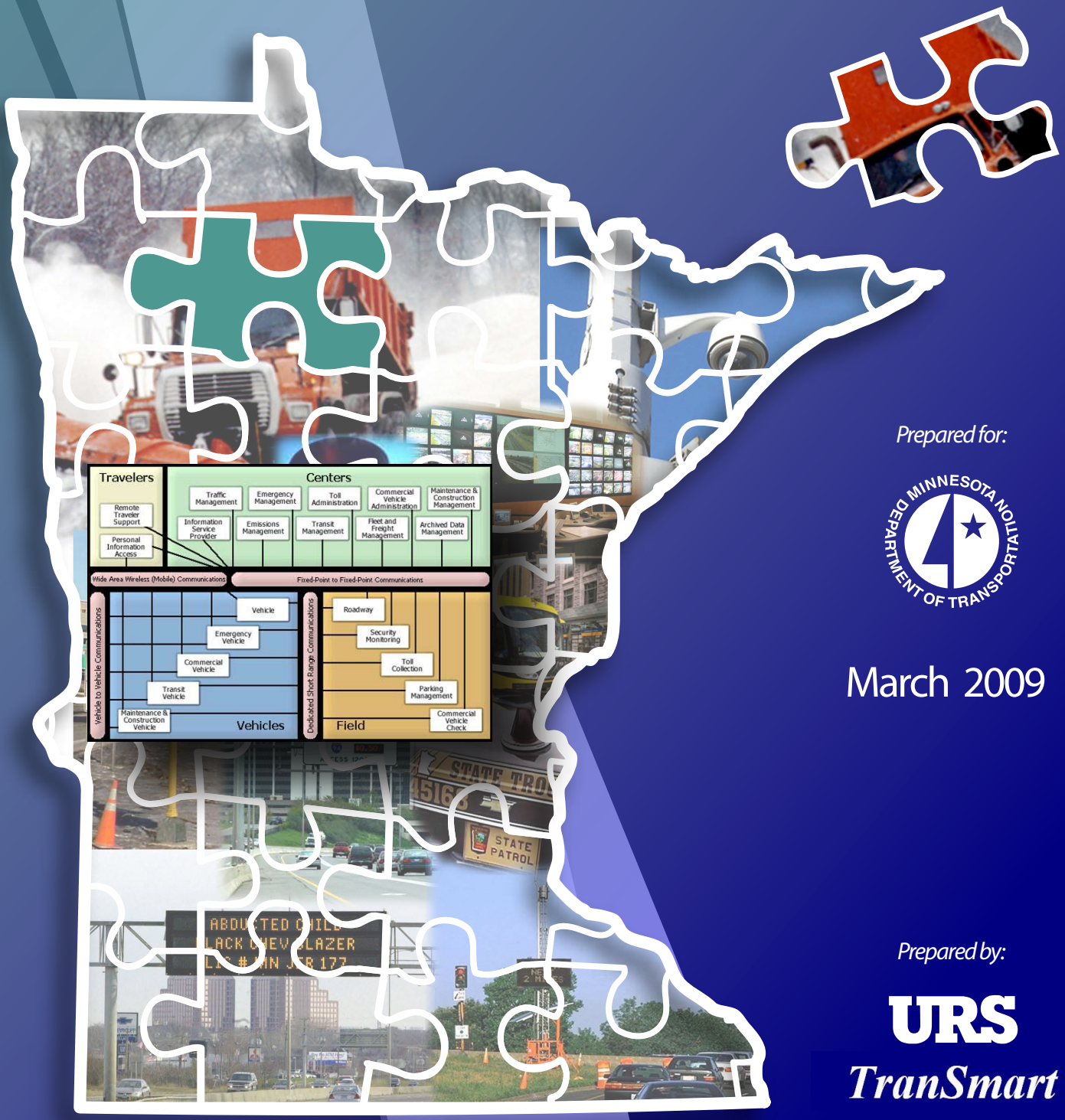
Minnesota Statewide Regional ITS Architecture

Version 2009

Volume 1: Overview



Prepared for:

MINNESOTA DEPARTMENT OF TRANSPORTATION

March 2009

Prepared by:

URS

TranSmart

Minnesota Statewide Regional ITS Architecture
Version 2009

Volume 1: Overview

Prepared by

URS Corporation

In association with

TranSmart Technologies, Inc.

March 2009

TABLE OF CONTENTS

1. Introduction and Overview 1

1.1 Project Background and Purpose 1

1.2 ITS Planning and Architecture Development Process.....1

1.3 Overview of Minnesota Statewide Regional ITS Architecture.....2

1.4 Volume 1 Organization 3

2. Minnesota ITS Goals and Objectives 4

2.1 Minnesota Transportation Vision, Policies and Strategies.....4

2.2 Minnesota ITS Development Objectives 6

3. Stakeholders.....9

4. Performance Measures.....11

5. Mainstreaming ITS into Planning and Programming 15

List of Figures

Figure 5-1. Recommended Minnesota Guidestar ITS Mainstream Process 16

List of Tables

Table 2-1. Mapping of Minnesota ITS Development Objectives and Minnesota Statewide Transportation Policies and Strategies.....10

Table 4-1. ITS Development Objectives and Performance Measures Supported by Current Data 11

Table 4-2. ITS Development Objectives and Additional Performance Measures.....15

Page Left Blank Intentionally

1. Introduction and Overview

1.1 Project Background and Purpose

The state of Minnesota is updating and documenting the Minnesota Statewide Regional Intelligent Transportation Systems (ITS) Architecture based on the National ITS Architecture. The purpose of this effort is to 1) reflect the current state of ITS planning and deployments; 2) provide a high-level planning for enhancing the state transportation systems using ITS technologies; and 3) meet the requirements of Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) for receiving Federal funds.

The Minnesota Statewide Regional ITS Architecture geographically covers the entire state of Minnesota, encompassing local, regional and state transportation agencies and transportation stakeholders. It represents a shared vision of how each agency's systems work together by sharing information and resources to enhance transportation safety, efficiency, capacity, mobility, and security. The information exchange among the many transportation stakeholders helps illustrate various integration options, gain consensus on cost-effective ITS technologies and systems to be considered prior to investing in the design, development, and deployment of ITS.

The Minnesota Statewide Regional ITS Architecture is a living document and will evolve as needs, technology, stakeholders, and funding streams change. The National ITS Architecture is a resource to the Minnesota Statewide Regional ITS Architecture, providing framework for planning, defining and integrating ITS.

1.2 ITS Planning and Architecture Development Process

The ITS planning and architecture development process provides a means for Minnesota state, regional and local agencies, and other involved transportation entities with a framework for planning, defining, and integrating the ITS systems in Minnesota.

- The *ITS planning development* process identifies and defines specific ITS projects planned to be implemented statewide and needed enhancements to existing ITS systems. The ITS planning process further defines the necessary information that will facilitate and prioritize the funding resources for future ITS deployments and enhancements statewide.
- *ITS architecture development* describes the process of identifying needs and steps for developing project architectures that are consistent with the statewide architecture and is in conformance with the National ITS Architecture. The purpose of updating the statewide architecture is to illustrate and document regional integration to allow planning and deployment of ITS systems to occur in an organized and coordinated process.

The process for ITS planning and updating the Minnesota Statewide Regional ITS Architecture follows the process recommended by the FHWA[1]. A more detailed discussion of the process can be found in Volume 9 – Minnesota Statewide Regional ITS Architecture Implementation Projects. The updated Minnesota Statewide Regional ITS Architecture was developed following

[1] Regional ITS Architecture Guidance Document, Version 2.0, FHWA, July 6, 2006.

the systems engineering approach[2] and the requirements set forth in FHWA Final Rule 940[3]. Final Rule 940 requires that all ITS projects funded with highway trust funds be developed based on a systems engineering analysis. Systems engineering is a phrase used to describe the cyclical process of planning, designing, implementing, testing, operation, and maintenance of an ITS system or project throughout its useful life. The systems engineering process begins with the development and implementation of an ITS architecture and continues by outlining the steps and level of detail of each phase of project deployment, from high-level tasks such as establishing the Concept of Operations to very detailed component design, installation, and testing. The purpose of the systems engineering process is to ensure that a well-planned foundation is in place and then to affirm the requirements of an ITS system. A more detailed discussion on Final Rule 940 and systems engineering process is included in Volume 9.

The key to the ITS planning and architecture process is to identify stakeholder needs, identify ITS projects to address those needs, and define project sequencing. The project definition outlines the project concepts and the associated details including project title, stakeholder, project scope, costs, benefits and the marketing packages defined in the Regional ITS Architecture. The project sequencing provides an approximate timeframe in which an ITS project may be implemented based on the understanding of the projects, project dependencies of the project, as well as other existing or planned ITS systems.

1.3 Overview of Minnesota Statewide Regional ITS Architecture

The Minnesota Statewide Regional ITS Architecture is organized into to nine volumes as summarized below:

- **Volume 1 – Overview** provides a summary overview of the overall Minnesota Statewide Regional ITS Architecture. This volume identifies the purpose/need, a general description of the region, development objectives, and performance measures for the Minnesota Statewide Regional ITS Architecture.

- **Volumes 2 through 7 – Market Package Bundles** provide detailed documentation of the following National ITS Architecture Market Package Bundles:

    - Volume 2 – Advanced Traveler Information Systems (ATIS)
    - Volume 3 – Advanced Traffic Management Systems (ATMS)
    - Volume 4 – Advanced Public Transportation Systems (APTS)
    - Volume 5 – Commercial Vehicle Operations (CVO)
    - Volume 6 – Emergency Management (EM)
    - Volume 7 – Maintenance and Construction Management (MCM)

    Each Market Package Bundle document is divided into five sections which provide a sequential process to identify needs and services for the bundle:
    - *Section 1 – Overview:* Provides a brief project overview and the purpose of this document.
    - *Section 2 - Identification of Existing Systems:* Provides a brief overview as well as a detailed listing of the existing and planned systems related to the Market Package Bundle.

[2] Resources for Systems Engineering can be found at http://www.ops.fhwa.dot.gov/int_its_deployment/sys_eng.htm
[3] FHWA Final Rule 940 is available at http://ops.fhwa.dot.gov/its_arch_imp/docs/20010108.pdf.

- *Section 3 - Development Objectives:* Provides an overview of the Minnesota ITS Development Objectives specific to the Market Package Bundle. This section summarizes the results of a stakeholder workshop conducted in 2006 to obtain feedback on the Minnesota ITS Deployment Objectives. These objectives were used to identify needs and gaps, which were then used to identify services to address those needs.
- *Section 4 - Identification of Needs and Services*: Based on the ITS Development Objectives, needs were identified and prioritized by the stakeholders. Services were identified to address those prioritized needs.
- *Section 5 - Detail of Market Package Bundle Needs and Services*: Describes, for each identified Need/Service, the following information:
  - Concept of Operations
  - Existing Capabilities
  - Gaps and Planned Enhancements
  - Roles and Responsibilities
  - Interconnects
  - Archive Needs
  - Associated Market Packages
- *Section 6 – Research and Development Needs:* Describes research that can be performed to help implement the identified services.

- **Volume 8 – Regional ITS Architecture** consists of the hard copies of the Turbo Architecture outputs and the corresponding electronic files.

- **Volume 9 - Regional ITS Architecture Implementation Projects** describes processes for developing an ITS program and projects, identifies a list of future ITS projects, and develops concept and details for each project. The project detail includes a project description, dependencies, time frame, project champion and any agency agreements required. Volume 9 serves as long-range guidance to help affected agencies and stakeholders systematically and cost-effectively implement ITS projects for the next 15 to 20 years in Minnesota based on funding availability. Volume 9 also identifies an approach for mainstreaming ITS into the Minnesota Transportation Investment Process, which is the SAFETEA-LU required transportation planning and project development process and recommends the sequence and strategy for future project implementation.

1.4 Volume 1 Organization

Volume 1 provides the background and purpose of the Minnesota ITS Planning and Regional ITS Architecture Update effort. It summarizes the boundaries of the architecture, the ITS planning and architecture development process, and stakeholder involvement. It also outlines the Minnesota ITS Development Objectives and corresponding performance measures. Volume 1 is organized with the following sections:

- ***Section 1: Introduction and Overview*** provides a brief overview of the project background and purpose, defines the regional boundaries, and describes the ITS planning and architecture process.
- ***Section 2: Minnesota ITS Goals and Objectives*** outlines the Minnesota ITS Development Objectives and summarizes their relationships with the statewide transportation vision, policies and strategies.
- ***Section 3: Stakeholders*** provides a list of stakeholders involved, describes the stakeholder involvement process, and summarizes stakeholder involvement activities.

- ***Section 4: Performance Measures*** summarizes the role of performance measures in ITS planning, project development and implementation; identifies the performance measures; and describes the relationships between performance measures and Minnesota ITS Development Objectives.
- ***Section 5: Mainstreaming ITS into Planning and Programming*** provides an overview of statewide transportation planning and programming process; identifies challenges and considerations for mainstreaming ITS; and recommends a process to incorporate ITS projects into the Statewide Transportation Plan (STP) and State Transportation Improvement Program (STIP).

2. Minnesota ITS Goals and Objectives

2.1 Minnesota Transportation Vision, Policies and Strategies

The "Vision" identified by statewide stakeholders for the 2009-2028 Minnesota Statewide Transportation Plan[4] (20-year plan) is as follows:

"A safe, efficient and sustainable transportation system"

The process of moving toward the Vision is to recognize the challenges and opportunities involved in this long term process. The following key principles frame the plan approach and are reflected in the policies and strategies:

1. Continued performance-based planning
2. Articulate a more multi-modal jurisdictional approach to transportation
3. Build on existing plans
4. Concurrently update the 20-year State Highway Investment Plan
5. Emphasize importance of partnerships
6. Commit to innovation
7. Seek cost-effective and context-appropriate solutions
8. Maintain a flexible and opportunistic approach

The 20-year plan presents policies, strategies, and performance measures into 10 policy areas. The following outlines those policies and associated strategies:

Policy 1 – Traveler Safety

1A – TZD and "The Four Es"
1B – System-wide, Cost Effective Safety Enhancements
1C – Local Road Safety
1D – Air and Rail Safety

Policy 2 – Infrastructure Preservation

2A – State Highway Bridge Conditions
2B – State Highway Pavement Conditions
2C – Other State Highway Infrastructure
2D – Other State Transportation Infrastructure

[4] Minnesota Statewide Transportation Plan (Draft), January 2009. Final plan adoption is anticipated in spring 2009.

Policy 3 – Maintenance and Security

3A – Bridge Inspection, Follow-up, and Preventative Maintenance
3B – Level of Highway Maintenance
3C – Efficiencies Across all Jurisdictions
3D – Maintenance of Other Modes

Policy 4 – National and Global Connections

4A – Public Roles in Rail and Water
4B – Partnership in Highway, Rail, and Water Transport
4C – Minnesota Air Transport
4D – Performance Measures

Policy 5 – Statewide Connections

5A – The IRC System
5B – Supplemental Truck Routes
5C – Intercity Bus Service
5D – Intercity Passenger Rail Services
5E – Greater Minnesota Air Service

Policy 6 – Twin Cities Mobility

6A – Approach to Twin Cities Mobility
6B – Innovative Solutions
6C – Strategic Capacity Improvements
6D – Metro Transit Plan
6E – Freight Movements

Policy 7 – Greater Minnesota Metropolitan and Regional Mobility

7A – Regional Planning
7B – Planning the Roadway System
7C – Planning the Transit System
7D – Bicycle and Pedestrian Systems
7E – Freight Systems

Policy 8 – Community Development and Transportation

8A – Metropolitan, Regional, or Corridor Planning for Transportation
8B – Land Use Planning
8C – Street and Development Design
8D – Networks for Timely communication

Policy 9 – Energy and the Environment

9A – Environmental Stewardship in Project Development
9B – Emissions and Energy Consumption

Policy 10 – Accountability and Transparency

10A – Strengthen Performance Tracking and Reporting
10B – Implement New Scope, Cost, and Schedule Controls
10C – Strengthen Stakeholder Involvement
10D – Communicate Needs and Proposed Approach

This 20-year plan's vision, guiding principles, policies and strategies provide a firm platform for the transportation needs identified in the Minnesota ITS Development Objectives.

2.2 Minnesota ITS Development Objectives

Transportation needs identify the transportation problems that can be solved by ITS services. They also represent a link to transportation planning efforts that define the strategies and solutions to address problems and challenges. These strategies involve capital improvements as well as operational improvements. In 2006, stakeholders from FHWA, Minnesota Department of Transportation (Mn/DOT), Minnesota State Patrol (MSP), Metro Transit, and local transportation, transit and public safety agencies discusses and provided feedback on the "Minnesota ITS Development Objectives." The goal of the Minnesota ITS Development Objectives is to enhance transportation through the safe and efficient movement of people, goods, and information, with greater mobility, fuel efficiency, less pollution and increased operating efficiency statewide. The Minnesota ITS Development Objectives are listed below:

A. Improve the Safety of the State's Transportation System

A-1. Reduce crash frequency (*ATMS, ATIS, APTS, CVO, EM, MCM & AVSS*[5])

- O-1 Reduce crashes due to road weather conditions
- O-2 Reduce crashes due to unexpected congestion
- O-3 Reduce secondary crashes
- O-4 Reduce incident clearance time
- O-5 Reduce crashes due to red-light running
- O-6 Reduce crashes due to unsafe drivers, vehicles and cargo on the transportation system
- O-7 Reduce lane departure crashes
- O-8 Reduce crashes due to roadway/geometric restrictions
- O-9 Reduce crashes at railroad crossings
- O-10 Reduce crashes at intersections
- O-11 Reduce speed differential
- O-12 Reduce crashes due to driver errors and limitations
- O-13 Reduce crashes involving pedestrians or non-motorized vehicles
- O-14 Reduce violation of traffic laws

A-2. Reduce fatalities and life changing injuries (*ATMS, ATIS, CVO, EM, MCM & AVSS*)

- O-5 Reduce crashes due to red-light running
- O-9 Reduce crashes at railroad crossings
- O-10 Reduce crashes at intersections
- O-11 Reduce speed differential
- O-15 Reduce emergency/incident response time
- O-16 Enhance emergency/incident response effectiveness
- O-17 Safeguard public safety personnel while they are at roadway incidents and emergencies
- O-18 Reduce speed violations

A-3. Safeguard the motoring public from homeland security and/or Hazmat incidents (*ALL*)

- O-15 Reduce emergency/incident response time
- O-19 Reduce security risks to transit passengers and transit vehicle operators
- O-20 Reduce security risks to motorists and travelers
- O-21 Reduce security risks to transportation infrastructure

[5] AVSS - Advanced Vehicle Safety Systems

O-22 Reduce exposure due to Hazmat & homeland security incidents
O-23 Enhance tracking and monitoring of sensitive Hazmat shipments

A-4. Reduce crashes in work zones (*ATMS, ATIS, EM & MCM*)
O-4 Reduce incident clearance time
O-11 Reduce speed differential
O-24 Reduce congestion and delay
O-25 Enhance safety of workers

B. Increase Operational Efficiency and Capacity of the Transportation System

B-1. Reduce overall delay associated with congestion *(ATMS, ATIS & MCM)*
O-4 Reduce incident clearance time
O-15 Reduce emergency/incident response time
O-16 Enhance emergency/incident response effectiveness
O-24 Reduce congestion and delay
O-26 Maintain smooth traffic flow
O-27 Reduce incident detection and verification time

B-2. Increase average vehicle occupancy and facility throughput *(ATMS & APTS)*
O-28 Increase transit ridership
O-29 Enhance transit operations efficiency
O-30 Increase carpoolers
O-31 Increase throughput of roadways

B-3. Reduce delays due to work zones *(ATMS, ATIS, EM & MCM)*
O-4 Reduce incident clearance time
O-24 Reduce congestion and delay
O-26 Maintain smooth traffic flow

B-4. Reduce traffic delays during evacuation from homeland security and Hazmat incidents *(ALL)*
O-24 Reduce congestion and delay

B-5. Enhance efficiency at borders *(ATMS, CVO, EM & AVSS)*
O-32 Reduce delays at border crossings
O-33 Keep travelers informed of travel conditions

C. Enhance Mobility, Security, Convenience, and Comfort for the Transportation System User

C-1. Reduce congestion and incident-related delay for travelers *(ATMS, ATIS & APTS)*
O-4 Reduce incident clearance time
O-15 Reduce emergency/incident response time
O-16 Enhance emergency/incident response effectiveness
O-24 Reduce congestion and delay
O-26 Maintain smooth traffic flow
O-27 Reduce incident detection and verification time
O-34 Enhance parking facility services and management

C-2. Improve travel time reliability *(ATMS)*
O-24 Reduce congestion and delay
O-26 Maintain smooth traffic flow

C-3. Increase choice of travel modes *(APTS & ATMS)*
O-33 Keep travelers informed of travel conditions
O-35 Inform travelers of travel mode options

C-4. Enhance traveler security *(APTS & EM)*
O-19 Reduce security risks to transit passengers and transit vehicle operators
O-20 Reduce security risks to motorists and travelers

O-21 Reduce security risks to transportation infrastructure

C-5. Reduce stress caused by transportation *(ATMS, ATIS, APTS, EM & MCM)*

O-3 Reduce secondary crashes
O-11 Reduce speed differential
O-14 Reduce violation of traffic laws
O-18 Reduce speed violations
O-24 Reduce congestion and delay
O-29 Enhance transit operations efficiency
O-33 Keep travelers informed of travel conditions
O-34 Enhance parking facility services and management
O-35 Inform traveler of travel mode options

D. Enhance the Present and Future Economic Productivity of Individuals, Organizations and the Economy as a Whole

D-1. Reduce travel time for freight, transit and businesses *(ATMS, ATIS, APTS & CVO)*

O-24 Reduce congestion and delay
O-26 Maintain smooth traffic flow
O-29 Enhance transit operations efficiency
O-33 Keep travelers informed of travel conditions

D-2. Improve the efficiency of freight movement, permitting and credentials process *(ATIS & CVO)*

O-33 Keep travelers informed of travel conditions
O-36 Enhance asset and resource management
O-37 Enhance credential process automation
O-38 Reduce freight movement delays due to inspection

D-3. Improve travel time reliability for freight, transit and businesses *(ATMS, APTS & CVO)*

O-26 Maintain smooth traffic flow
O-29 Enhance transit operations efficiency
O-33 Keep travelers informed of travel conditions
O-38 Reduce freight movement delays due to inspection

D-4. Increase agency efficiency *(ATMS, APTS, AD[6], CVO, EM & MCM)*

O-29 Enhance transit operations efficiency
O-36 Enhance asset and resource management
O-39 Enhance garage operations efficiency

D-5. Safeguard existing infrastructure *(CVO, EM & MCM)*

O-21 Reduce security risks to transportation infrastructure
O-36 Enhance asset and resource management
O-40 Reduce commercial vehicle size and weight violations

D-6. Aid in transportation infrastructure and operations planning *(ALL)*

O-36 Enhance asset and resource management
O-41 Enhance planning with better data
O-42 Enhance investment decision making

D-7. Reduce vehicle operating costs *(ATMS, APTS, CVO & AVSS)*

O-24 Reduce congestion and delay
O-26 Maintain smooth traffic flow

E. Reduce Energy Consumption, Environmental Impacts and Costs of Transportation

E-1. Reduce emissions/energy impacts and use associated with congestion *(ATMS, ATIS & CVO)*

[6] AD - Archived Data Management

O-24 Reduce congestion and delay
O-33 Keep travelers informed of travel conditions
O-43 Enhance compliance of air quality standards

E-2. Reduce need for new facilities *(ATMS,CVO & MCM)*
O-31 Increase throughput of roadways
O-36 Enhance asset and resource management
O-37 Enhance credential process automation

E-3. Reduce negative impacts of the transportation system on communities *(APTS, ATMS, EM & MCM)*
O-14 Reduce violation of traffic laws
O-28 Increase transit ridership
O-30 Increase carpoolers
O-44 Reduce environmental impacts of de-icing material use

It is essential that overarching policies from statewide, regional and local plans provide guidance and directions to ITS planning by establishing transportation needs and priorities. As such, ITS solutions and improvements can be planned and incorporated to address those needs and priorities. The basis for all Mn/DOT transportation planning documents is the Mn/DOT Strategic Plan. This high-level plan defines Mn/DOT's principles and outlines strategies to satisfy its vision and mission. The 20-Year Statewide Transportation Plan further clarifies these strategies and lays out policies to implement the Strategic Directions identified in the Strategic Plan. The Minnesota ITS Development Objectives, based on these policies and strategies, further establish a set of specific objectives that can be achieved through implementing ITS. Table 2-1 depicts relationships between the Minnesota ITS Development Objectives and the policies and strategies established in the Minnesota Statewide Transportation Plan.

3. Stakeholders

Stakeholders are commonly considered to be those who own or operate ITS systems in the region as well as those who have an interest in regional transportation issues. As stakeholders provide crucial input regarding the region's transportation investment and ITS deployments, stakeholder participation and coordination is critical to the success of the ITS planning and architecture development. The Minnesota Statewide Regional ITS Architecture includes a wide range of stakeholders. Stakeholder outreach has been a key component even prior to the beginning of the Minnesota ITS Planning and Regional Architecture Update effort. Between 2006 and 2008, Mn/DOT conducted a series of workshops with stakeholders from throughout Minnesota focusing on the six Market Package Bundles. Throughout the stakeholder involvement process, feedback has been received based on review of ITS functional and informational needs to determine ITS needs and priorities. In the spring of 2008, a series of stakeholder workshops were conducted to further refine ITS needs and services, and to develop concept of operations for each identified need and service that includes details of the following:

- Needs/Services
- Operational Concepts
- Existing Capabilities
- Gaps/Planned Enhancements
- Roles/Responsibilities
- Interconnects

Table 2-1. Mapping of Minnesota ITS Development Objectives and Minnesota Statewide Transportation Policies and Strategies

Minnesota ITS Development Objectives		Minnesota Statewide Transportation Policies and Strategies																																									
		Policy 1. Traveler Safety				Policy 2. Infrastructure Preservation				Policy 3. Maintenance and Security					Policy 4. National and Global Connections				Policy 5. Statewide Connections					Policy 6. Twin Cities Mobility					Policy 7. Greater Minnesota Metropolitan and Regional Mobility					Policy 8. Community Development and Transportation				Policy 9. Energy & the En-vironment		Policy 10. Accountability and Transparency			
		1A. TZD and "The Four Es"	1B. System-wide, Cost-Effective Safety Enhancements	1C. Local Road Safety	1D. Air and Rail Safety	2A. State Highway Bridge Conditions	2B. State Highway Pavement Conditions	2C. Other State Highway Infrastructure	2D. Other Transportation Infrastructure	3A. Bridge Inspection, Follow-Up, and Preventative Maintenance	3B. Level of Highway Maintenance	3C. Efficiencies Across All Jurisdictions	3D. Maintenance of Other Modes	3E. Security	4A. Public Roles in Rail and Water Transport	4B. Partnership in Highway, Rail, and Water Transport	4C. Minnesota Air Transport	4D. Performance Measures	5A. The IRC System	5B. Supplemental Truck Routes	5C. Intercity Bus Services	5D. Intercity Passenger Rail Services	5E. Greater Minnesota Air Service	6A. Approach to Twin Cities Mobility	6B. Innovative Solutions	6C. Strategic Capacity Improvements	6D. Metro Transit Plan	6E. Freight Movements	7A. Regional Planning	7B. Planning the Roadway System	7C. Planning the Transit System	7D. Bicycle and Pedestrian Systems	7E. Freight Systems	8A. Metropolitan, Regional, or Corridor Planning for Transportation	8B. Land Use Planning	8C. Street and Development Design	8D. Networks for Timely Communication	9A. Environmental Stewardship in Project Development	9B. Emissions and Energy Consumption	10A. Strengthen Performance Tracking and Reporting	10B. Implement New Scope, Cost, and Schedule Controls	10C. Strengthen Stakeholder Involvement	10D. Communicate Needs and Proposed Approach
O-1	Reduce crashes due to road weather conditions	x	x	x																																							
O-2	Reduce crashes due to unexpected congestion	x	x	x																																							
O-3	Reduce secondary crashes	x	x	x																																							
O-4	Reduce incident clearance time	x	x	x																					x																		
O-5	Reduce crashes due to red-light running	x	x	x	x																																						
O-6	Reduce crashes due to unsafe drivers, vehicles and cargo on the transportation system	x	x	x	x															x																							
O-7	Reduce lane departure crashes	x	x	x																																							
O-8	Reduce crashes due to roadway/geometric restrictions	x	x	x	x																																						
O-9	Reduce crashes at railroad crossings	x	x	x	x																																						
O-10	Reduce crashes at intersections	x	x	x	x																																						
O-11	Reduce speed differential	x	x	x																																							
O-12	Reduce crashes due to driver errors and limitations	x	x	x	x																																						
O-13	Reduce crashes involving pedestrians or non-motorized vehicles	x	x	x	x																											x											
O-14	Reduce violation of traffic laws	x	x	x	x																																						
O-15	Reduce emergency/incident response time	x	x	x	x									x											x																		
O-16	Enhance emergency/incident response effectiveness	x	x	x	x									x											x																		
O-17	Safeguard public safety personnel while they are at roadway incidents and emergencies	x	x	x	x																																						
O-18	Reduce speed violations	x	x	x																																							
O-19	Reduce security risks to transit passengers and transit vehicle operators													x																													
O-20	Reduce security risks to motorists and travelers													x																													
O-21	Reduce security risks to transportation infrastructure													x																													
O-22	Reduce exposure due to Hazmat & homeland security incidents				x									x																													
O-23	Enhance tracking and monitoring of sensitive Hazmat shipments				x									x																													
O-24	Reduce congestion and delay																		x	x				x	x	x	x	x	x	x			x						x				
O-25	Enhance safety of workers	x	x	x	x																																						
O-26	Maintain smooth traffic flow											x							x	x				x	x	x		x	x	x			x						x				
O-27	Reduce incident detection and verification time											x		x											x																		
O-28	Increase transit ridership																				x	x		x	x	x	x				x								x				
O-29	Enhance transit operations efficiency											x									x			x	x		x				x								x				
O-30	Increase carpoolers																				x			x	x	x					x								x				
O-31	Increase throughput of roadways																		x		x			x	x	x				x													
O-32	Reduce delays at border crossings													x		x																							x				
O-33	Keep travelers informed of travel conditions																								x			x		x			x										
O-34	Enhance parking facility services and management																		x					x	x					x	x												
O-35	Inform travelers of travel mode options																				x	x	x	x	x		x			x	x												
O-36	Enhance asset and resource management					x	x	x	x	x	x	x	x	x											x					x	x							x	x	x	x		
O-37	Enhance credential process automation															x																	x										
O-38	Reduce freight movement delays due to inspection															x																	x										
O-39	Enhance garage operations efficiency											x	x												x																		
O-40	Reduce commercial vehicle size and weight violations																																x										
O-41	Enhance planning with better data					x	x	x	x	x	x	x	x	x				x	x					x		x	x		x	x	x		x	x	x	x				x			
O-42	Enhance investment decision making					x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x
O-43	Enhance compliance of air quality standards				x																																	x	x				
O-44	Reduce environmental impacts of de-icing material use																																					x					

- Archive Needs
- Associated Market Packages

In November 2008, stakeholders were again invited to attend an open house workshop. The workshop was broken into two sessions. The first session provided the stakeholders an overview of Volume 9. The second session broke the stakeholders into six groups for each of the six market package bundles. Facilitators guided the stakeholders through a list of potential ITS projects that were identified during this planning process, verify project validity, and discuss implementation timeline and strategies.

4. Performance Measures

Performance measures are used to assess how successful a project is in meeting defined goals and objectives. They use quantifiable data, either quantitative or qualitative in nature, to answer specific questions about the intended effect of the project. Measures should be simple, understandable, logical, repeatable, and tell how well goals and objectives are being met. They should be unambiguously defined and ideally show a trend.

Performance measures can be used to determine whether an approach or technology is having its intended effect and to detect and correct problems. They can also be used to communicate progress toward goals to key stakeholders and can be considered when making decisions to allocate resources and set policy.

Data availability is essential to support performance monitoring, evaluation and reporting. Based on currently available data, Table 4-1 identifies a list of performance measures that can be used to assist with measuring how well projects are meeting the Minnesota ITS Development Objectives. It should be noted that data to support some performance measures may require processing and transformation (e.g. data mining, stipulations, aggregation, segregation, imputation, etc.) to get the data into a readily accessible format for use in performance monitoring and evaluation.

Table 4-1. ITS Development Objectives and Performance Measures Supported by Current Data

O-1 Reduce crashes due to road weather conditions
M1 - Number of crashes and fatalities related to weather conditions
O-2 Reduce crashes due to unexpected congestion
M2 - Number of crashes and fatalities related to unexpected congestion
O-3 Reduce secondary crashes
M3 - Number of secondary crashes
O-5 Reduce crashes due to red-light running
M5 - Number of crashes and fatalities related to red-light running
O-6 Reduce crashes due to unsafe drivers, vehicles and cargo on the transportation system
M6 - Number of crashes and fatalities due to commercial vehicle safety violations
O-7 Reduce lane departure crashes
M7 - Number of crashes and fatalities related to inappropriate lane departure, crossing or merging

Table 4-1. (Continued)

O-8 Reduce crashes due to roadway/geometric restrictions
M7 - Number of crashes and fatalities relate to inappropriate lane crossing, departure and merging
O-9 Reduce crashes at railroad crossings
M9 - Number of crashes and fatalities at railroad crossings
O-10 Reduce crashes at intersections
M5 - Number of crashes and fatalities related to red-light running
M10 - Number of crashes and fatalities at signalized intersections
M11 - Number of crashes and fatalities at unsignalized intersections
O-11 Reduce speed differential
M12 - Number of crashes and fatalities related to excessive speeding
M13 - Number of speed violations
O-12 Reduce crashes due to driver errors and limitations
M14 - Number of crashes and fatalities related to driving while intoxicated
M15 - Number of crashes and fatalities related to driver inattention and distraction
O-13 Reduce crashes involving pedestrians or non-motorized vehicles
M16 - Number of crashes and fatalities involving pedestrians and non-motorized vehicles
M17 - Number of crashes and fatalities at intersections due to inappropriate crossing
O-14 Reduce violation of traffic laws
M18 - Number of traffic law violations
O-16 Enhance emergency/incident response effectiveness
M20 - Number of assets tracked in real-time
M24 - Number of agreements between response agencies and transportation agencies
M25 - Percentage of geographic area covered by agency electronic communications
O-17 Safeguard public safety personnel while they are at roadway incidents and emergencies
M26 - Number of public safety personnel struck by vehicle at incident/emergency site
M27 - Number of public safety vehicles struck at incident/emergency site
O-18 Reduce speed violations
M13 - Number of speed violations
O-19 Reduce security risks to transit passengers and transit vehicle operators
M28 - Number of transit facilities and vehicles under security surveillance
M29 - Number of security incidents on transit vehicles
M30 - Number of security incidents at transit facilities
O-20 Reduce security risks to motorists and travelers
M31 - Number of security incidents on roadways
M32 - Number of critical sites with security surveillance
O-21 Reduce security risks to transportation infrastructure
M32 - Number of critical sites with security surveillance
M33 - Number of security incidents on transportation infrastructure
M34 - Number of critical sites with hardened security enhancements
O-22 Reduce exposure due to Hazmat & homeland security incidents
M35 - Number of Hazmat incidents
M36 - Number of homeland security incidents
M40 - Homeland security incident response time
O-23 Enhance tracking and monitoring of sensitive Hazmat shipments
M41 - Number of Hazmat shipments tracked in real-time

Table 4-1. (Continued)

O-24 Reduce congestion and delay
M42 - Travel time
M43 - Travel speeds
M44 - Travel time reliability/variability
M45 - Duration of congestion
M47 - Length of queue
M48 - Snow & ice clearance time
M49 - Average length of time between signal retiming evaluations
O-25 Enhance safety of workers
M50 - Number of crashes and fatalities in work zones
M51 - Number of workers injured by vehicles in work zones
O-26 Maintain smooth traffic flow
M52 - Speed variation for segments along corridor
O-27 Reduce incident detection and verification time
M53 - Incident verification time
O-28 Increase transit ridership
M54 - Number of transit riders
O-29 Enhance transit operations efficiency
M56 - Percentage of routes adhering to schedule
M58 - Number of transit vehicles with electronic fare payment systems
M59 - Miles of lanes offering preferential treatment to transit
O-30 Increase carpoolers
M60 - Number of high occupancy vehicles
M61 - Vehicle occupancy
O-31 Increase throughput of roadways
M61 - Vehicle occupancy
M62 - Number of vehicles through segment per hour or day
O-32 Reduce delays at border crossings
M63 - Border crossing time
O-33 Keep travelers informed of travel conditions
M64 - Number of roadway miles ATIS reports on
M65 - Number of events/incidents entered into ATIS
M66 - Number of agencies providing information to CARS/ATIS
M68 - Number of specifically tailored traveler information messages provided
O-34 Enhance parking facility services and management
M69 - Number parking facilities with electronic fee collection
M70 - Number of parking facilities with automated occupancy counting and space management
M101 - Number of parking facilities with advanced parking information to customers
M102 - Number of parking facilities with coordinated electronic payment systems
M103 - Number of parking facilities with coordinated availability information
O-35 Inform travelers of travel mode options
M68 - Number of specifically tailored traveler information messages provided
M71 - Number of ATIS users getting information on driving, carpooling, transit, other modes
M72 - Number of transit routes with information being provided by ATIS

Table 4-1. (Continued)

O-36 Enhance asset and resource management
M20 - Number of assets tracked in real-time
M25 - Percentage of geographic jurisdiction covered by agency electronic communications
M73 - Extended pavement life due to truck weight enforcement
M74 - Percentage of maintenance activities completed in required time-frame
M75 - Rate at which equipment is utilized
M76 - Percentage of fleet/equipment within lifecycle
M77 - Vehicle operating costs
O-37 Enhance credential process automation
M78 - Average length of permitting/credential process
M79 - Number of automated permits/credentials issued
O-38 Reduce freight movement delays due to inspection
M80 - Average freight inspection time
M81 - Number of freight vehicles going through automated detection
O-39 Enhance garage operations efficiency
M20 - Number of assets tracked in real-time
M74 - Percentage of maintenance activities completed in required time-frame
M82 - Number of fleet vehicles with maintenance diagnostic equipment
M83 - Number of vehicles operating under CAD
O-40 Reduce commercial vehicle size and weight violations
M84 - Number of size and weight violations
O-41 Enhance planning with better data
M85 - Amount of data gathered from ITS enhancements used in infrastructure and operations planning
M86 - Number of planning activities using data from ITS systems
M87 - Years of data in database that is easily searchable and extractable
O-42 Enhance investment decision making
M88 - Project cost deviation
M89 - Operations cost deviation
M90 - Administrative support rate (as part of overall project budget)
M91 - Project schedule deviation
M92 - Number of projects where schedule was coordinated with another project
O-43 Enhance compliance of air quality standards
M93 - Air pollutants
M94 - Carbon dioxide emissions
O-44 Reduce environmental impacts of de-icing material use
M95 - Amount of environmentally-friendly de-icing material used

Additional performance measures to support the Minnesota ITS Development Objectives were also identified, as presented in Table 4-2. These additional measures do not currently have readily available data to support performance monitoring and evaluation. However, it is recognized that these measures are good indicators for linking the Minnesota ITS Development Objectives with project or system performance. As technology advances as well as more ITS devices and data collection capabilities are deployed, additional data will likely be available in the future to support performance monitoring and evaluation. In addition, specific, individual data collection efforts, either manually or using automated data collection, may be done for

projects with limited scales to obtain data that is otherwise not available to support project-focused performance evaluation and before-after studies.

Table 4-2. ITS Development Objectives and Additional Performance Measures

O-8 Reduce crashes due to roadway/geometric restrictions
M8 - Number of crashes and fatalities related to roadway/geometric restrictions
O-15 Reduce emergency/incident response time
M19 - Incident response time
O-16 Enhance emergency/incident response effectiveness
M4 - Incident clearance time
M21 - Number of CAD systems coordinated
M22 - Number of TMCs connected to incident response centers
M22 - Number of TMCs connected to EOCs
M23 - Number of surveillance video images shared with PSAPs
O-22 Reduce exposure due to Hazmat & homeland security incidents
M37 - Number of travelers routed around Hazmat incidents
M38 - Number of travelers routed around homeland security incidents
M39 - Hazmat incident response time
O-27 Reduce incident detection and verification time
M19 - Incident response time
O-29 Enhance transit operations efficiency
M57 - Average boarding time

5. Mainstreaming ITS into Planning and Programming

Throughout the 1990s and early 2000s, major Minnesota Guidestar ITS funding was through congressional earmarks. Congressional earmarks worked well for previous studies, research planning, and operational tests. As the possibilities for ITS have become realized, it has become apparent that a more stable and reliable funding program, which incorporates ITS into the regular ongoing transportation programs, is necessary for long-term transportation planning in Minnesota. SAFETEA-LU, passed by Congress in 2005, set the stage for integrating ITS into the Minnesota State Transportation Investment Process on an equal basis with all other transportation projects.

The Minnesota Transportation Investment Process encompasses planning, programming and project development. This transportation investment process is driven by statewide goals and transportation directions via the Minnesota Strategic Plan and Statewide Transportation Plan, which are supported by statewide, district, regional and local plans. Figure 5-1 provides a high level over view of the ITS mainstreaming process into the Minnesota Investment Process.

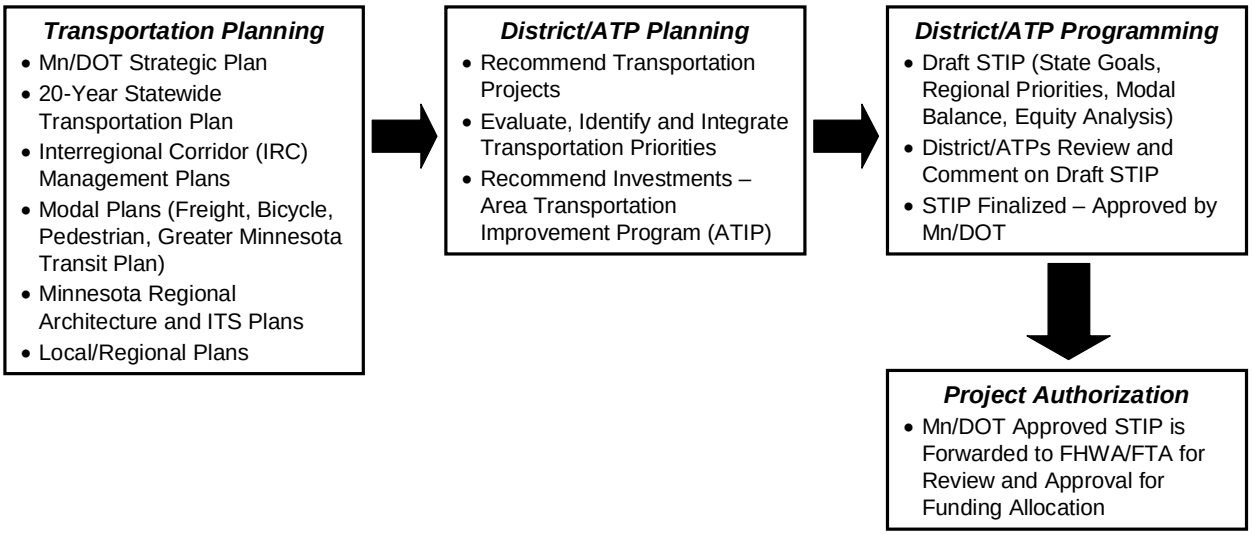


Figure 5-1. Recommended Minnesota Guidestar ITS Mainstream Process

Migrating ITS programs and projects from the Guidestar funding/deployment process to the mainstream statewide planning process requires 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. The overarching goal of mainstreaming the Minnesota Guidestar program into the Minnesota Transportation Investment Process is to secure funding for ITS deployment projects to improve safety and mobility in Minnesota. FHWA Rule 940 provides policies and procedures for implementing Section 5206(e) of the Transportation Equity Act for the 21st Century (TEA–21), Public Law 105–178, 112 Stat. 457, pertaining to conformance with the National ITS Architecture and Standards.

The rule states, in part, that the final design of all ITS projects funded with Highway Trust Funds must accommodate the interface requirements and information exchanges as specified in the regional ITS architecture. Furthermore, the rule states, after funding has been programmed for a specified ITS project, or a transportation project incorporating ITS elements, the focus is on having the ITS project follow a sound systems engineering process. The Minnesota Statewide Regional ITS Architecture is a specific application of the framework specified in the National ITS Architecture, tailored to the needs of the transportation stakeholders statewide.