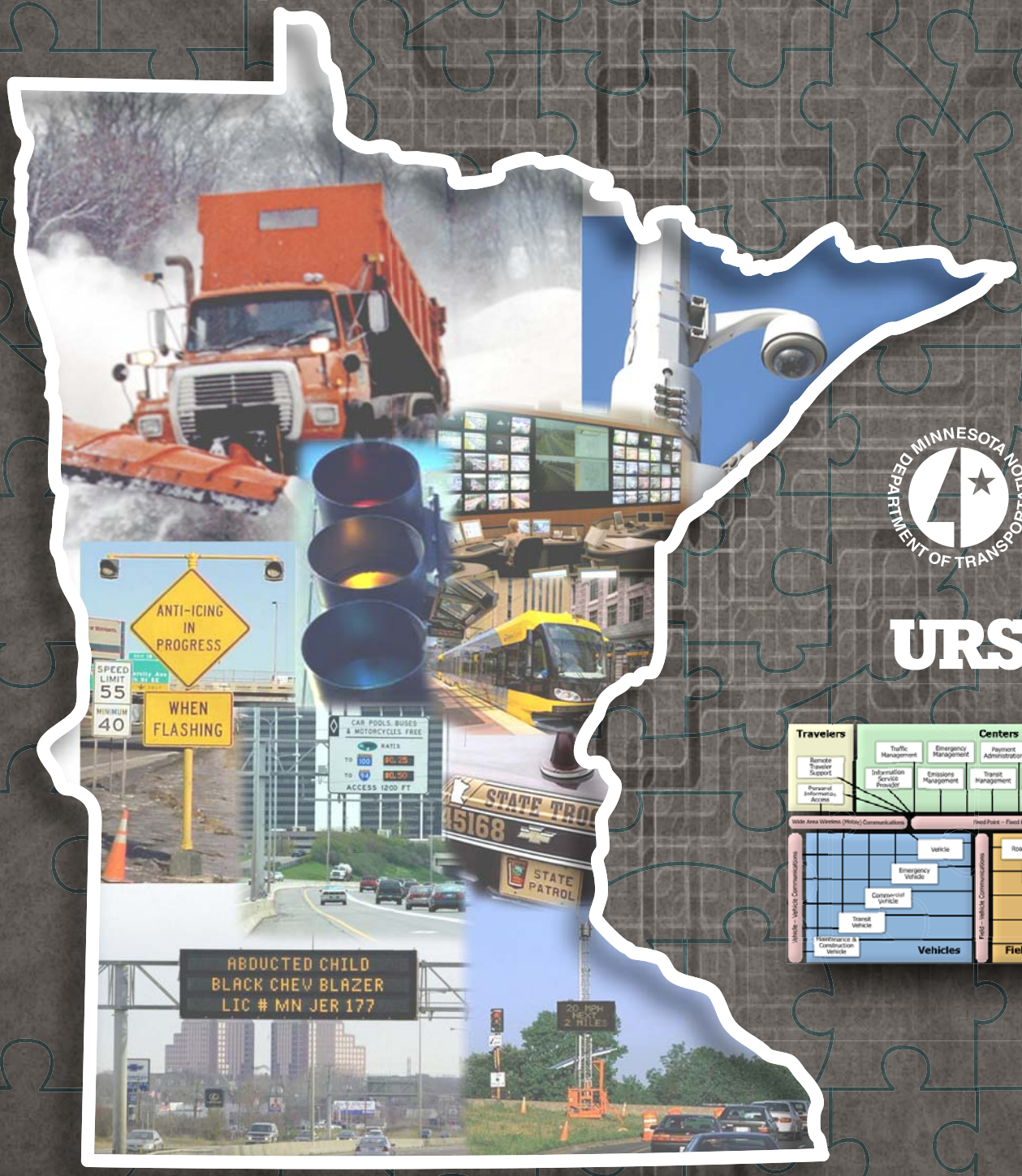
Minnesota Statewide Regional ITS Architecture

Version 2014

Overview Volume



MINNESOTA DEPARTMENT OF TRANSPORTATION

URS

Minnesota Statewide Regional ITS Architecture
Version 2014

Overview Volume

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1. Introduction

1.1 Project Background and Purpose

The Minnesota Statewide Regional Intelligent Transportation Systems (ITS) Architecture Version 2014 is an update of the previous version that was developed in 2009. The purpose of this update is to: 1) foster integration of the deployment of regional ITS systems; 2) facilitate stakeholder coordination in ITS planning, deployment and operations; 3) reflect the current state of ITS planning and deployment; 4) provide a high-level planning for enhancing the state transportation systems using current and future ITS technologies; and 5) conform with the National ITS Architecture and the Federal Highway Administration (FHWA) Final Rule 940 and Federal Transit Administration (FTA) Final Policy on ITS Architecture and Standards.

The Final Rule and the Final Policy provide policies and procedures for implementing Section 5206(e) of the Transportation Equity Act for the 21st Century (TEA–21), pertaining to conformance with the National ITS Architecture and Standards. The Final Rule and the Final Policy ensure that ITS projects carried out using funds from the Highway Trust Fund including the Mass Transit Account conform to the National ITS Architecture and applicable ITS standards.

Regional ITS architectures help guide the planning, implementation, and integration of ITS components and systems. The National ITS Architecture is a tool to guide the development of regional ITS architectures. It is a common framework that guides agencies in establishing ITS interoperability and helps them choose the most appropriate strategies for processing transportation information, implementing and integrating ITS components and systems, and improving operations. 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 in Minnesota.

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, reliability, and security. During the development of the Minnesota Statewide Regional ITS Architecture, agencies that own and operate transportation systems collaboratively consider current and future needs to ensure that the current systems, projects and processes are compatible with future ITS projects in Minnesota. The collaboration and information sharing among transportation stakeholders helps illustrate integration options and gain consensus on systematic and cost-effective implementation of ITS technologies and systems.

The Minnesota Statewide Regional ITS Architecture is a living document and will evolve as needs, technology, stakeholders, and funding streams change.

1.2 Overview of Minnesota Statewide Regional ITS Architecture

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

- **Overview Volume** provides a summary overview of the 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 1 through 8 – Service Package Bundles** provide detailed documentation of the following National ITS Architecture Service Package Bundles:

  - Volume 1 – Archived Data Management Systems (ADMS)
  - 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)
  - Volume 8 – Advanced Vehicle Safety Systems (AVSS)

  Each Service Package Bundle document is divided into five sections which provide a sequential process to identify needs and services for the bundle:
  - *Section 1 – Introduction:* Provides a brief project overview and the purpose of the 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 Service Package Bundle.
  - *Section 3 – Minnesota ITS Development Objectives:* Provides an overview of the Minnesota ITS Development Objectives specific to the Service Package Bundle.
  - *Section 4 – Identification of Needs and Services*: *S*ummarizes the results of a series of stakeholder workshops conducted in 2013 to obtain feedback on ITS needs and gaps, which were then used to identify services to address those needs. 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 Service Package Bundle Needs and Services*: Describes each identified Need/Service with the following information:
    - Concept of Operations
    - Existing Capabilities
    - Gaps and Planned Enhancements
    - Roles and Responsibilities
    - Interconnects
    - Data Archive Needs
    - Associated Service Packages
  - *Section 6 – Research and Development Needs:* Describes research that can be performed to help implement the identified services.

- **Volume 9 – ITS Initiatives and Project Concepts for Implementation** 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.

- **Volume 10 – Turbo Architecture Outputs of the Regional ITS Architecture** consists of a report for the Minnesota Statewide Regional ITS Architecture that is generated from the Turbo Architecture software.

1.3 Overview Volume Organization

The Overview Volume provides the background and purpose of the Minnesota Statewide 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. This volume is organized with the following sections:

- ***Section 1: Introduction and Overview*** provides a brief overview of the project background and purpose and defines the regional boundaries.
- ***Section 2: ITS Planning and Architecture Development Process*** describes the architecture requirements and ITS planning and architecture development process.
- ***Section 3: Stakeholder Involvement*** describes the stakeholder involvement process and summarizes stakeholder involvement activities.
- ***Section 4: Minnesota ITS Goals and Objectives*** outlines the Minnesota ITS Development Objectives and summarizes their relationships with the statewide transportation vision, guiding principles and objectives.
- ***Section 5: 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 6: 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. ITS Planning and Architecture Development Process

2.1 Coordination with Transportation Planning Process

ITS planning is an integral part of the overall transportation planning. The process for Minnesota ITS planning and Statewide Regional ITS Architecture update begins with coordination with the Minnesota transportation planning process. MnDOT initiated a Minnesota GO visioning process to create a 50-year vision that aims to better align the transportation system with what Minnesota residents expect for their quality of life, economy and natural environment. The effort is based on an understanding that transportation is a means to other ends, not an end in itself. It also recognizes that infrastructure is only one of many elements necessary to achieving a high quality of life, a competitive economy and a healthy environment. Minnesota GO started with the vision, but extends to an entire family of plans that provide direction for different modes of transportation (highways, transit, rail, bikes, pedestrians, freight, aviation).

Building upon the Minnesota GO, MnDOT updated the 20-year Statewide Multimodal Transportation Plan (SMTP) in 2012. The SMTP serves as the framework plan for MnDOT's family of plans, or the system investment plans. The SMTP articulates policies, strategies and performance measures necessary to support the vision over the next two decades. This multimodal plan establishes overarching guidance and priorities for making state transportation decisions across all modes, from roadways, to railroads, to bikeways, and beyond.

Several modal system investment plans have recently been updated or are currently undergoing updates. Many of those plans have implications to the Minnesota Statewide Regional ITS Architecture, including:

- State Highway Investment Plan (MnSHIP)
- Greater Minnesota Transit Investment Plan
- Statewide Freight System Plan
- Statewide Freight and Passenger Rail Plan
- State Aviation System Plan

Additional plans and studies that provide inputs to ITS planning and architecture development include:

- Highway System Operations Plan
- Strategic Highway Safety Plan (SHSP)
- Statewide Transportation Improvement Program (STIP)

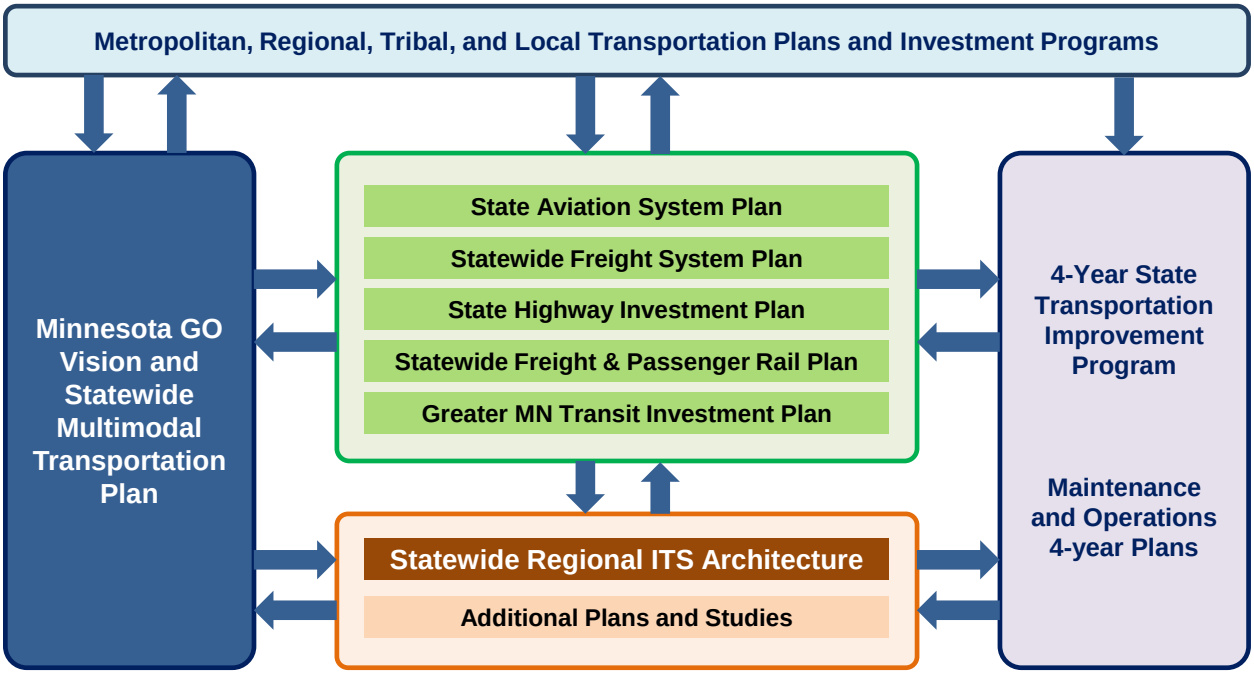

Figure 2-1. Transportation Planning Process Coordination

Coordination and collaboration with the development of MnDOT Family of Plans and other relevant plans was performed throughout the effort for updating the Minnesota Statewide Regional ITS Architecture. Relevant information from various, relevant planning documents were reviewed and included in the updated Architecture to ensure the Architecture is consistent with the visions, goals, objectives, focus areas, investment strategies, and relevant information that are identified in those plans.

In addition, MnDOT worked closely with participating stakeholders in this architecture development and update effort to identify, evaluate, select and prioritize ITS initiatives. Based on the previously identified needs and services, stakeholders identified and prioritized, in each of the service package bundles, a list of initiatives and project concepts to address those needs and services. ITS initiative selection included a detailed review of those needs and service details, keying in on operational concepts and gaps and/or planned enhancements to establish the list of initiatives. Additional safety related initiatives with ITS components were identified through coordination and collaboration with the 2014 Minnesota SHSP Update effort. Those ITS safety initiatives along with other ITS initiatives identified through the stakeholder outreach process are detailed in Volume 9 – ITS Initiatives and Project Concepts for Implementation.

Other key references for this architecture update effort are the series of publication from the United States Department of Transportation (USDOT) Planning for Operations initiative. Those documents provide technical guidance and offer great insight and useful information to guide the architecture development by incorporating ITS goals, S.M.A.R.T. (specific, measureable, agreed, realistic, and time-bound) objectives, performance measures and strategies to achieve the objectives. The Minnesota Statewide Regional ITS Architecture follows those guidance documents to refine the Minnesota ITS Development Objectives along with performance measures, performance targets and strategies to achieve these objectives.

2.2 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 updated Minnesota Statewide Regional ITS Architecture was developed following the systems engineering approach[1] and the requirements set forth in FHWA Final Rule 940[2]. Final Rule 940 requires that all ITS projects funded with highway trust funds be developed based on a

[1] Resources for Systems Engineering can be found at http://www.ops.fhwa.dot.gov/int_its_deployment/sys_eng.htm

[2] FHWA Final Rule 940 is available at http://ops.fhwa.dot.gov/its_arch_imp/docs/20010108.pdf.

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.

ITS architecture development describes the process of identifying needs and steps for developing project architectures that are consistent with the Minnesota Statewide Regional ITS Architecture and is in conformance with the National ITS Architecture. Specifically, descriptions will include ITS elements, associated service packages, functional requirements interface and informational flows. ITS standards that are applicable to systems and architecture flows will be defined in the architecture system, including identifying the status and maturity of applicable standards.

The purpose of updating the ITS architecture is to illustrate and document regional integration to allow planning and deployment of ITS systems to occur in an organized and coordinated process. In the case of Minnesota Statewide Regional ITS Architecture there are multiple transportation agencies and jurisdictions with overlapping geographies. These transportation agencies and jurisdictions have similar transportation issues (i.e. mobility, safety, traveler information, information sharing, etc.). The Minnesota Statewide Regional ITS Architecture Update provides ITS solutions to address cross-jurisdictional issues in an economic manner, utilizing public funds in a responsible manner.

To better understand the process of ITS architecture development, Figure 2-2 depicts a process recommended by the FHWA[3]. A more detailed description of the five step process as it relates to the Minnesota Statewide Regional ITS Architecture Update can be found in Appendix A.

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 service packages defined in the Statewide 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.

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

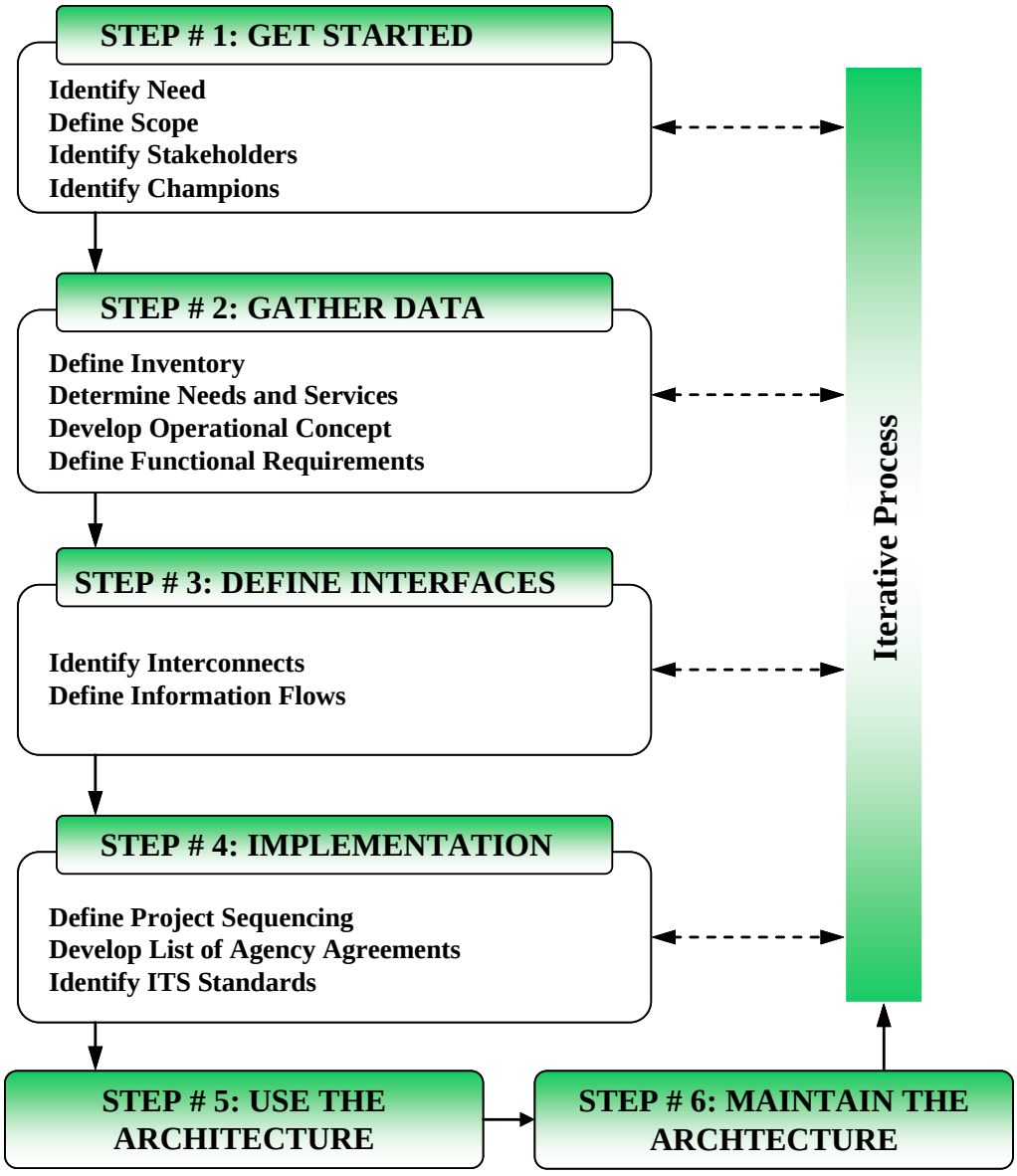

Figure 2-2. ITS Architecture Development Process

3. Stakeholder Involvement

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 Statewide Regional ITS Architecture Update effort. Between 2006 and 2008, MnDOT conducted a series of workshops with stakeholders from throughout Minnesota focusing on ITS services related to traveler information, traffic management, transit,

commercial vehicle operations, emergency management, and maintenance and construction management. 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
- Data Archive Needs
- Associated Service 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 service 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.

Because additional ITS needs and services have been identified and added since 2009, new technologies have come on-line, and new technologies have replaced out-of-date technology, a stakeholder survey was conducted in early 2013. The survey asked each survey participant to review and provide priority ranking to each of the ITS functional/informational needs as well as research and technology development needs that were identified previously in the 2009 Minnesota Statewide Regional ITS Architecture. Survey participants were also asked to identify additional needs and provide information on the status of current projects/initiatives and plans for future projects/initiatives.

Between March and May 2013, a series of stakeholder workshops were conducted. The purpose of those workshops was to obtain feedback on the Minnesota ITS Goals and Objectives, discuss the results of the stakeholder survey, and gather additional feedback on needs and priority rankings. Based on those goals and objectives, stakeholders reviewed the functional/informational needs and research and technology development needs and participated in discussion to identify the highest priority needs that would benefit the traveling public.

4. Minnesota ITS Goals and Objectives

4.1 Minnesota Transportation Vision, Guiding Principles and Objectives

The 50-year vision for transportation establish in the Minnesota GO is to maximize the health of people, the environment and our economy through Minnesota's multimodal transportation system. The system:

- Connects Minnesota's primary assets—the people, natural resources and businesses within the state—to each other and to markets and resources outside the state and country;
- Provides safe, convenient, efficient and effective movement of people and goods; and
- Is flexible and nimble enough to adapt to changes in society, technology, the environment and the economy.

The Minnesota GO further identifies the following principles to guide future policy and investment decisions for all forms of transportation throughout the state.

- **Leverage public investments to achieve multiple purposes:** The transportation system should support other public purposes, such as environmental stewardship, economic competitiveness, public health and energy independence.
- **Ensure accessibility:** The transportation system must be accessible and safe for users of all abilities and incomes. The system must provide access to key resources and amenities throughout communities.
- **Build to a maintainable scale:** Consider and minimize long-term obligations–don't overbuild. The scale of the system should reflect and respect the surrounding physical and social context of the facility. The transportation system should affordably contribute to the overall quality of life and prosperity of the state.
- **Ensure regional connections:** Key regional centers need to be connected to each other through multiple modes of transportation.
- **Integrate safety:** Systematically and holistically improve safety for all forms of transportation. Be proactive, innovative and strategic in creating safe options.
- **Emphasize reliable and predictable options:** The reliability of the system and predictability of travel time are frequently as important or more important than speed. Prioritize multiple multimodal options over reliance on a single option.
- **Strategically fix the system:** Some parts of the system may need to be reduced while other parts are enhanced or expanded to meet changing demand. Strategically maintain and upgrade critical existing infrastructure.
- **Use partnerships:** Coordinate across sectors and jurisdictions to make transportation projects and services more efficient.

The Minnesota SMTP focuses on activities over a 20-year horizon. The SMTP, which was updated in 2012, outlines objectives and strategies that will guide Minnesota toward the 50-year Vision over the next two decades. The objectives articulated in the SMTP are:

- **Accountability, Transparency, and Communication:** Make transportation system decisions through processes that are open and supported by data and analysis; provide for and support coordination, collaboration, and innovation; and ensure efficient and effective use of resources.

- **Traveler Safety:** Safeguard travelers, transportation facilities, and services. Apply proven strategies to reduce fatalities and serious injuries for all travel modes.
- **Transportation in Context:** Make fiscal responsible decisions that respect and complement the natural, cultural, and social context and integrate lane uses and transportation systems to leverage public and private investments.
- **Critical Connections:** Identify global, national, statewide, regional, and local transportation connections essential for Minnesotan's prosperity and quality of life; develop and invest in lower cost, high benefit strategies as a first course of action to maintain and improve these connections; and consider new connections.
- **Asset Management:** Strategically maintain and operate transportation assets; rely on system data, partners' needs, and public expectations to inform decisions; put technology and innovation to work to improve efficiency and performance; and recognize that the system should change over time.
- **System Security:** Reduce system vulnerability and ensure system redundancy to meet essential travel needs during emergencies.

The Minnesota GO Vision and Guiding Principles with the objectives and strategies set out in the Minnesota SMTP provide a framework for all transportation partners to work together to develop, maintain, and operate Minnesota's multimodal transportation system more efficiently and effectively. They also provide the policy direction for MnDOT' s system investment plans. The Minnesota GO Vision, Guiding Principles, and SMTP Objectives provide a firm platform for the transportation needs identified in the Minnesota ITS Development Objectives in the next section.

4.2 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 (MnDOT), 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. These objectives were further refined in 2013-2014 to better align with the Minnesota's ITS needs and be more consistent with the National ITS Architecture. The Minnesota ITS Development Objectives are listed in Table 4-1.

Table 4-1. Minnesota ITS Development Objectives

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

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

- A-1-01 Reduce number of vehicle crashes
- A-1-02 Reduce number of vehicle crashes per VMT
- A-1-03 Reduce number of crashes due to road weather conditions
- A-1-04 Reduce number of crashes due to unexpected congestion
- A-1-05 Reduce number of crashes due to red-light running
- A-1-06 Reduce number of crashes involving large trucks and buses
- A-1-07 Reduce number of crashes due to commercial vehicle safety violations
- A-1-08 Reduce number of crashes due to inappropriate lane departure, crossing and merging
- A-1-09 Reduce number of crashes at railroad crossings
- A-1-10 Reduce number of crashes at signalized intersections
- A-1-11 Reduce number of crashes at un-signalized intersections
- A-1-12 Reduce number of crashes due to excessive speeding
- A-1-13 Reduce number of crashes related to driving while intoxicated
- A-1-14 Reduce number of crashes related to driver inattention and distraction
- A-1-15 Reduce number of crashes involving pedestrians and non-motorized vehicles
- A-1-16 Reduce number of crashes at intersections due to inappropriate crossing
- A-1-17 Reduce number of crashes due to roadway/geometric restrictions
- A-1-18 Reduce number of crashes involving younger drivers (under 21)
- A-1-19 Reduce number of all secondary crashes

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

- A-2-01 Reduce number of roadway fatalities
- A-2-02 Reduce number of roadway fatalities per VMT
- A-2-03 Reduce number of fatalities due to road weather conditions
- A-2-04 Reduce number of fatalities due to unexpected congestion
- A-2-05 Reduce number of fatalities due to red-light running
- A-2-06 Reduce number of fatalities involving large trucks and buses
- A-2-07 Reduce number of fatalities due to commercial vehicle safety violations
- A-2-08 Reduce number of transit fatalities
- A-2-09 Reduce number of fatalities due to inappropriate lane departure, crossing and merging
- A-2-10 Reduce number of fatalities at railroad crossings
- A-2-11 Reduce number of fatalities at signalized intersections
- A-2-12 Reduce number of fatalities at un-signalized intersections
- A-2-13 Reduce number of fatalities due to excessive speeding
- A-2-14 Reduce number of fatalities related to driving while intoxicated
- A-2-15 Reduce number of fatalities related to driver inattention and distraction
- A-2-16 Reduce number of fatalities involving pedestrians and non-motorized vehicles
- A-2-17 Reduce number of fatalities at intersections due to inappropriate crossing
- A-2-18 Reduce number of fatalities due to roadway/geometric restrictions
- A-2-19 Reduce number of fatalities involving younger drivers (under 21)
- A-2-20 Reduce number of fatalities involving unbelted vehicle occupants
- A-2-21 Reduce number of hazardous materials transportation incidents involving fatalities
- A-2-22 Reduce number of roadway injuries

Table 4-1. (Continued)

A-2-23 Reduce number of roadway injuries per VMT
A-2-24 Reduce number of injuries due to road weather conditions
A-2-25 Reduce number of injuries due to unexpected congestion
A-2-26 Reduce number of injuries due to red-light running
A-2-27 Reduce number of injuries involving large trucks and buses
A-2-28 Reduce number of injuries due to commercial vehicle safety violations
A-2-29 Reduce number of transit injuries
A-2-30 Reduce number of injuries due to inappropriate lane departure, crossing and merging
A-2-31 Reduce number of injuries at railroad crossings
A-2-32 Reduce number of injuries at signalized intersections
A-2-33 Reduce number of injuries at un-signalized intersections
A-2-34 Reduce number of injuries due to excessive speeding
A-2-35 Reduce number of injuries related to driving while intoxicated
A-2-36 Reduce number of injuries related to driver inattention and distraction
A-2-37 Reduce number of injuries involving pedestrians and non-motorized vehicles
A-2-38 Reduce number of injuries at intersections due to inappropriate crossing
A-2-39 Reduce number of injuries due to roadway/geometric restrictions
A-2-40 Reduce number of injuries involving younger drivers (under 21)
A-2-41 Reduce number of injuries involving unbelted vehicle occupants
A-2-42 Reduce number of hazardous materials transportation incidents involving injuries
A-2-43 Reduce number of speed violations
A-2-44 Reduce number of traffic law violations

A-3 Reduce crashes in work zones *(ATIS, ATMS, EM, MCM & AVSS)*
A-3-01 Reduce number of crashes in work zones
A-3-02 Reduce number of fatalities in work zones
A-3-03 Reduce number of motorist injuries in work zones
A-3-04 Reduce number of workers injured by vehicles in work zones

B. Increase Operational Efficiency and Reliability of the Transportation System

B-1 Reduce overall delay associated with congestion *(ATIS, ATMS, MCM & AVSS)*
B-1-01 Reduce the percentage of facility miles (highway, arterial, rail, etc.) experiencing recurring congestion during the peak period
B-1-02 Reduce the percentage of Twin Cities freeway miles congested in weekday peak periods
B-1-03 Reduce the share of major intersections operating at LOS F
B-1-04 Maintain the rate of growth in facility miles experiencing recurring congestion as less than the population growth rate (or employment growth rate)
B-1-05 Reduce the daily hours of recurring congestion on major freeways
B-1-06 Reduce the number of hours per day that the top 20 most congested roadways experience recurring congestion
B-1-07 Reduce the regional average travel time index
B-1-08 Annual rate of change in regional average commute travel time will not exceed regional rate of population growth
B-1-09 Improve average travel time during peak periods
B-1-10 Reduce hours of delay per capita
B-1-11 Reduce hours of delay per driver

Table 4-1. (Continued)

- B-1-12 Reduce the average of the 90th (or 95th) percentile travel times for (a group of specific travel routes or trips in the region)
- B-1-13 Reduce the 90th (or 95th) percentile travel times for each route selected
- B-1-14 Reduce the variability of travel time on specified routes during peak and off-peak periods
- B-1-15 Reduce mean incident notification time
- B-1-16 Reduce mean time for needed responders to arrive on-scene after notification
- B-1-17 Reduce mean incident clearance time per incident
- B-1-18 Reduce mean incident clearance time for Twin Cities urban freeway incidents

B-2 Increase average vehicle occupancy and facility throughput *(ATMS & APTS)*

- B-2-01 Increase annual transit ridership
- B-2-02 Increase annual express bus ridership
- B-2-03 Increase annual light rail ridership
- B-2-04 Increase annual commuter rail ridership
- B-2-05 Maintain agency pre-defined performance targets for rides per hour of transit service
- B-2-06 Maintain transit passengers per capita rate for service types
- B-2-07 Maintain the cost efficiency of the statewide public transit network
- B-2-08 Maintain the service effectiveness of the statewide public transit network in terms of passengers/service hour and passengers/mile
- B-2-09 Maintain the cost effectiveness of the statewide public transit network in terms of cost per service hour, cost per passenger trip, and revenue recovery percentage
- B-2-10 Maintain the availability of the statewide public transit network in terms of hours (span) of service and frequency
- B-2-11 Reduce per capita single occupancy vehicle commute trip rate
- B-2-12 Increase the percentage of major employers actively participating in transportation demand management programs
- B-2-13 Reduce commuter vehicle miles traveled (VMT) per regional job
- B-2-14 Create a transportation access guide, which provides concise directions to reach destinations by alternative modes (transit, walking, bike, etc.)
- B-2-15 Improve average on-time performance for specified transit routes/facilities
- B-2-16 Increase use of automated fare collection system per year
- B-2-17 Increase the percent of transfers performed with automated fare cards
- B-2-18 Increase the miles of bus-only shoulder lanes in the metro area
- B-2-19 Increase the number of carpools
- B-2-20 Increase use of vanpools
- B-2-21 Provide carpool/vanpool matching and ridesharing information services
- B-2-22 Reduce trips per year in region through carpools/vanpools
- B-2-23 Increase vehicle throughput on specified routes
- B-2-24 Increase AM/PM peak hour vehicle throughput on specified routes
- B-2-25 Increase AM/PM peak hour person throughput on specified routes

B-3 Reduce delays due to work zones *(ATIS, ATMS, EM, MCM & AVSS)*

- B-3-01 Reduce total vehicle hours of delay by time period (peak, off-peak) caused by work zones
- B-3-02 Reduce the percentage of vehicles traveling through work zones that are queued

Table 4-1. (Continued)

B-3-03 Reduce the average and maximum length of queues, when present,

B-3-04 Reduce the average time duration (in minutes) of queue length greater than some threshold (e.g., 0.5 mile)

B-3-05 Reduce the variability of travel time in work zones during peak and off-peak periods

B-4 Reduce traffic delays during evacuation from homeland security and Hazmat incidents *(ATIS, ATMS, APTS, CVO, EM, MCM & AVSS)*

B-4-01 Reduce vehicle hours of delay per capita during evacuation from homeland security and Hazmat incidents

C. Enhance Mobility, Convenience, and Comfort for Transportation System Users

C-1 Reduce congestion and incident-related delay for travelers *(ATIS, ATMS, APTS, EM & AVSS)*

B-1-01 Reduce the percentage of facility miles (highway, arterial, rail, etc.) experiencing recurring congestion during the peak period

B-1-02 Reduce the percentage of Twin Cities freeway miles congested in weekday peak periods

B-1-03 Reduce the share of major intersections operating at LOS F

B-1-04 Maintain the rate of growth in facility miles experiencing recurring congestion as less than the population growth rate (or employment growth rate)

B-1-05 Reduce the daily hours of recurring congestion on major freeways

B-1-06 Reduce the number of hours per day that the top 20 most congested roadways experience recurring congestion

B-1-07 Reduce the regional average travel time index

B-1-08 Annual rate of change in regional average commute travel time will not exceed regional rate of population growth

B-1-09 Improve average travel time during peak periods

B-1-10 Reduce hours of delay per capita

B-1-11 Reduce hours of delay per driver

B-1-12 Reduce the average of the 90th (or 95th) percentile travel times for (a group of specific travel routes or trips in the region)

B-1-13 Reduce the 90th (or 95th) percentile travel times for each route selected

B-1-14 Reduce the variability of travel time on specified routes during peak and off-peak periods

B-1-15 Reduce mean incident notification time

B-1-16 Reduce mean time for needed responders to arrive on-scene after notification

B-1-17 Reduce mean incident clearance time per incident

B-1-18 Reduce mean incident clearance time for Twin Cities urban freeway incidents

C-1-01 Reduce the vehicle hours of total delay associated with traffic incidents during peak and off-peak periods

C-1-02 Increase percentage of incident management agencies in the region that participate in a multi-modal information exchange network

C-1-03 Increase percentage of incident management agencies in the region that use interoperable voice communications

C-1-04 Increase percentage of incident management agencies in the region that participate in a regional coordinated incident response team

Table 4-1. (Continued)

- C-1-05 Increase the number of corridors in the region covered by regional coordinated incident response teams
- C-1-06 Maintain a percentage of transportation operating agencies have a plan in place for a representative to be at the local or State Emergency Operations Center (EOC) to coordinate strategic activities and response planning for transportation during emergencies
- C-1-07 Conduct joint training exercises among operators and emergency responders in the region
- C-1-08 Maintain a percentage of staff in region with incident management responsibilities who have completed the National Incident Management System (NIMS) Training and a percentage of transportation responders in the region are familiar with the incident command structure (ICS)
- C-1-09 Increase number of regional road miles covered by ITS-related assets (e.g., roadside cameras, dynamic message signs, vehicle speed detectors) in use for incident detection/response
- C-1-10 Increase number of traffic signals equipped with emergency vehicle preemption

C-2 Improve travel time reliability *(ATIS, ATMS, APTS & AVSS)*

- B-1-07 Reduce the regional average travel time index
- B-1-12 Reduce the average of the 90th (or 95th) percentile travel times for (a group of specific travel routes or trips in the region)
- B-1-14 Reduce the variability of travel time on specified routes during peak and off-peak periods
- B-2-15 Improve average on-time performance for specified transit routes/facilities
- B-2-16 Increase use of automated fare collection system per year
- B-2-17 Increase the percent of transfers performed with automated fare cards
- C-2-01 Decrease the average buffer index for multiple routes or trips
- C-2-02 Reduce the average planning time index for specific routes in region
- C-2-03 Increase the miles of bus-only shoulder lanes in the metro area

C-3 Increase choice of travel modes *(ATIS, ATMS & APTS)*

- B-2-01 Increase annual transit ridership
- B-2-11 Reduce per capita single occupancy vehicle commute trip rate
- B-2-12 Increase the percentage of major employers actively participating in transportation demand management programs
- B-2-13 Reduce commuter vehicle miles traveled (VMT) per regional job
- B-2-14 Create a transportation access guide, which provides concise directions to reach destinations by alternative modes (transit, walking, bike, etc.)
- C-3-01 Increase active (bicycle/pedestrian) mode share
- C-3-02 Reduce single occupancy vehicle trips through travel demand management strategies (e.g., employer or residential rideshare)
- C-3-03 Increase the percent of alternative (non-single occupancy vehicle) mode share in transit station communities (or other areas)
- C-3-04 Increase transit mode share
- C-3-05 Increase transit mode share during peak periods
- C-3-06 Increase average transit load factor
- C-3-07 Increase passenger miles traveled per capita on transit

Table 4-1. (Continued)

- C-3-08 Reduce the travel time differential between transit and auto during peak periods per year
- C-3-09 Increase the percent of the transportation system in which travel conditions can be detected remotely via CCTV, speed detectors, etc.
- C-3-10 Increase the percent of transportation facilities whose owners share their traveler information with other agencies in the region
- C-3-11 Increase number of 511 calls per year
- C-3-12 Increase number of visitors to traveler information website per year
- C-3-13 Increase number of users of notifications for traveler information (e.g., e-mail, text message)
- C-3-14 Increase the number of transit routes with information being provided by ATIS
- C-3-15 Increase the number of specifically tailored traveler information messages provided
- C-3-16 Increase annual transit ridership reported by urbanized area transit providers
- C-3-17 Increase annual transit ridership reported by rural area transit providers

C-4 Reduce stress caused by transportation *(ATIS, ATMS, APTS, EM, MCM & AVSS)*

- A-2-43 Reduce number of speed violations
- A-2-44 Reduce number of traffic law violations
- B-1-01 Reduce the percentage of facility miles (highway, arterial, rail, etc.) experiencing recurring congestion during the peak period
- B-1-02 Reduce the percentage of Twin Cities freeway miles congested in weekday peak periods
- B-1-03 Reduce the share of major intersections operating at LOS F
- B-1-04 Maintain the rate of growth in facility miles experiencing recurring congestion as less than the population growth rate (or employment growth rate)
- B-1-05 Reduce the daily hours of recurring congestion on major freeways
- B-1-06 Reduce the number of hours per day that the top 20 most congested roadways experience recurring congestion
- B-1-07 Reduce the regional average travel time index
- B-1-08 Annual rate of change in regional average commute travel time will not exceed regional rate of population growth
- B-1-09 Improve average travel time during peak periods
- B-1-10 Reduce hours of delay per capita
- B-1-11 Reduce hours of delay per driver
- B-1-12 Reduce the average of the 90th (or 95th) percentile travel times for (a group of specific travel routes or trips in the region)
- B-1-13 Reduce the 90th (or 95th) percentile travel times for each route selected
- B-1-14 Reduce the variability of travel time on specified routes during peak and off-peak periods
- B-1-15 Reduce mean incident notification time
- B-1-16 Reduce mean time for needed responders to arrive on-scene after notification
- C-3-11 Increase number of 511 calls per year
- C-3-12 Increase number of visitors to traveler information website per year
- C-3-13 Increase number of users of notifications for traveler information (e.g., e-mail, text message)
- C-3-14 Increase the number of transit routes with information being provided by ATIS
- C-3-15 Increase the number of specifically tailored traveler information messages provided

Table 4-1. (Continued)

C-4-01 Reduce the speed differential between lanes of traffic on multi-lane highways
C-4-02 Increase the number of users aware of park-and-ride lots in their region
C-4-03 Increase the number parking facilities with electronic fee collection
C-4-04 Increase the number of parking facilities with automated occupancy counting and space management
C-4-05 Increase the number of parking facilities with advanced parking information to customers
C-4-06 Increase the number of parking facilities with coordinated electronic payment systems
C-4-07 Increase the number of parking facilities with coordinated availability information

D. Improve the Security of the Transportation System

D-1 Enhance traveler security *(APTS & EM)*

C-3-09 Increase the percent of the transportation system in which travel conditions can be detected remotely via CCTV, speed detectors, etc.
D-1-01 Reduce on an annual basis the number of complaints per 1,000 boarding passengers
D-1-02 Increase the number of closed circuit television (CCTV) cameras installed on platforms, park-n-ride lots, vehicles, and other transit facilities
D-1-03 Increase customer service and personal safety ratings
D-1-04 Reduce the number of reported personal safety incidents
D-1-05 Decrease the number of security incidents on roadways
D-1-06 Increase the percent of major and minor arterials are equipped with and operating with closed circuit television (CCTV) cameras
D-1-07 Increase the number of critical sites with security surveillance
D-1-08 Reduce the number of security incidents on transportation infrastructure
D-1-09 Increase the number of critical sites with hardened security enhancements

D-2 Safeguard the motoring public from homeland security and/or Hazmat incidents *(ATIS, ATMS, APTS, CVO, EM, MCM & AVSS)*

B-1-16 Reduce mean time for needed responders to arrive on-scene after notification
C-3-09 Increase the percent of the transportation system in which travel conditions can be detected remotely via CCTV, speed detectors, etc.
D-1-01 Reduce on an annual basis the number of complaints per 1,000 boarding passengers
D-1-02 Increase the number of closed circuit television (CCTV) cameras installed on platforms, park-n-ride lots, vehicles, and other transit facilities
D-1-03 Increase customer service and personal safety ratings
D-1-04 Reduce the number of reported personal safety incidents
D-1-05 Decrease the number of security incidents on roadways
D-1-06 Increase the percent of major and minor arterials are equipped with and operating with closed circuit television (CCTV) cameras
D-1-07 Increase the number of critical sites with security surveillance
D-1-08 Reduce the number of security incidents on transportation infrastructure
D-1-09 Increase the number of critical sites with hardened security enhancements
D-2-01 Reduce the number of Hazmat incidents
D-2-02 Reduce the number of homeland security incidents
D-2-03 Increase the number of travelers routed around Hazmat incidents

Table 4-1. (Continued)

D-2-04 Increase the number of travelers routed around homeland security incidents
D-2-05 Reduce the Hazmat incident response time
D-2-06 Reduce the homeland security incident response time
D-2-07 Increase the number of Hazmat shipments tracked in real-time

E. Support Regional Economic Productivity and Development

E-1 Reduce travel time for freight, transit and businesses *(ATIS, ATMS, APTS, CVO & AVSS)*
B-1-14 Reduce the variability of travel time on specified routes during peak and off-peak periods
B-2-15 Improve average on-time performance for specified transit routes/facilities
B-2-16 Increase use of automated fare collection system per year
B-2-17 Increase the percent of transfers performed with automated fare cards
C-2-09 Increase the miles of bus-only shoulder lanes in the metro area
C-3-08 Reduce the travel time differential between transit and auto during peak periods per year
E-1-01 Maintain a travel time differential between transit and auto during peak periods
E-1-02 Improve average transit travel time compared to auto in major corridors
E-1-03 Decrease the annual average travel time index for selected freight-significant highways
E-1-04 Decrease point-to-point travel times on selected freight-significant highways
E-1-05 Decrease hours of delay per 1,000 vehicle miles traveled on selected freight-significant highways

E-2 Improve the efficiency of freight movement, permitting and credentials process *(ATIS & CVO)*
E-2-01 Increase the percent (or number) of commercial vehicles tracked by trucking companies
E-2-02 Increase the percent (or number) of freight shipment tracked
E-2-03 Increase the percent of agencies involved in CVO inspection, administration, enforcement, and emergency management in the region with interoperable communications
E-2-04 Increase the use of electronic credentialing at weigh stations and border crossings
E-2-05 Increase the number of automated permits/credentials issued
E-2-06 Reduce the frequency of delays per month at intermodal facilities
E-2-07 Reduce the average duration of delays per month at intermodal facilities

E-3 Improve travel time reliability for freight, transit and businesses *(ATMS, APTS, CVO & AVSS)*
B-1-14 Reduce the variability of travel time on specified routes during peak and off-peak periods
B-2-15 Improve average on-time performance for specified transit routes/facilities
B-2-16 Increase use of automated fare collection system per year
B-2-17 Increase the percent of transfers performed with automated fare cards
C-1-06 Increase percentage of incident management agencies in the region that participate in a multi-modal information exchange network
C-2-09 Increase the miles of bus-only shoulder lanes in the metro area

Table 4-1. (Continued)

- C-3-09 Increase the percent of the transportation system in which travel conditions can be detected remotely via CCTV, speed detectors, etc.
- C-3-10 Increase the percent of transportation facilities whose owners share their traveler information with other agencies in the region
- C-3-13 Increase number of users of notifications for traveler information (e.g., e-mail, text message)
- E-1-08 Decrease the annual average travel time index for selected freight-significant highways
- E-2-04 Increase the use of electronic credentialing at weigh stations and border crossings
- E-3-01 Reduce average crossing times at international borders

E-4 Increase agency efficiency *(ADMS, ATMS, APTS, CVO, EM & MCM)*

- B-2-15 Improve average on-time performance for specified transit routes/facilities
- B-2-16 Increase use of automated fare collection system per year
- B-2-17 Increase the percent of transfers performed with automated fare cards
- C-2-09 Increase the miles of bus-only shoulder lanes in the metro area
- E-2-01 Increase the percent (or number) of commercial vehicles tracked by trucking companies
- E-2-03 Increase the percent of agencies involved in CVO inspection, administration, enforcement, and emergency management in the region with interoperable communications
- E-4-01 Increase the number of ITS-related assets tracked
- E-4-02 Reduce the number of pavement miles damaged by commercial vehicles
- E-4-03 Increase the rate of on-time completion of construction projects
- E-4-04 Increase the rate at which equipment is utilized
- E-4-05 Increase the percentage of fleet/equipment within its lifecycle
- E-4-06 Increase the number of fleet vehicles with maintenance diagnostic equipment
- E-4-07 Increase the number of vehicles operating under CAD

E-5 Reduce vehicle operating costs *(ATMS, APTS, CVO & AVSS)*

- B-1-01 Reduce the percentage of facility miles (highway, arterial, rail, etc.) experiencing recurring congestion during the peak period
- B-1-02 Reduce the percentage of Twin Cities freeway miles congested in weekday peak periods
- B-1-03 Reduce the share of major intersections operating at LOS F
- B-1-04 Maintain the rate of growth in facility miles experiencing recurring congestion as less than the population growth rate (or employment growth rate)
- B-1-05 Reduce the daily hours of recurring congestion on major freeways
- B-1-06 Reduce the number of hours per day that the top 20 most congested roadways experience recurring congestion
- B-1-07 Reduce the regional average travel time index
- B-1-08 Annual rate of change in regional average commute travel time will not exceed regional rate of population growth
- B-1-09 Improve average travel time during peak periods
- B-1-10 Reduce hours of delay per capita
- B-1-11 Reduce hours of delay per driver
- B-1-12 Reduce the average of the 90th (or 95th) percentile travel times for (a group of specific travel routes or trips in the region)

Table 4-1. (Continued)

B-1-13 Reduce the 90th (or 95th) percentile travel times for each route selected
B-1-14 Reduce the variability of travel time on specified routes during peak and off-peak periods

E-6 Enhance efficiency at borders *(ATIS & CVO)*
E-2-04 Increase the use of electronic credentialing at weigh stations and border crossings
E-3-11 Reduce average crossing times at international borders

F. Preserve the Transportation System

F-1 Safeguard existing infrastructure *(ATMS, CVO, EM & MCM)*
C-3-09 Increase the percent of the transportation system in which travel conditions can be detected remotely via CCTV, speed detectors, etc.
D-1-06 Increase the percent of major and minor arterials are equipped with and operating with closed circuit television (CCTV) cameras
D-1-07 Increase the number of critical sites with security surveillance
D-1-08 Reduce the number of security incidents on transportation infrastructure
D-1-09 Increase the number of critical sites with hardened security enhancements
E-2-03 Increase the percent of agencies involved in CVO inspection, administration, enforcement, and emergency management in the region with interoperable communications
E-4-03 Increase the rate of on-time completion of construction projects
F-1-01 Decrease the number of pavement miles damaged by commercial vehicles
F-1-02 Decrease the number of size and weight violations

G. Enhance the Integration and Connectivity of the Transportation System

G-1 Aid in transportation infrastructure and operations planning *(ALL)*
G-1-01 Increase the amount of data gathered from ITS enhancements used in infrastructure and operations planning
G-1-02 Increase the number of planning activities using data from ITS systems
G-1-03 Increase the number of years of data in database that is easily searchable and extractable
G-1-04 Reduce project schedule deviation
G-1-05 Reduce project cost deviation
G-1-06 Reduce operations cost deviation
G-1-07 Reduce administrative support rate (as part of overall project budget)

G-2 Reduce need for new facilities *(ATMS, CVO, MCM & AVSS)*
B-1-01 Reduce the percentage of facility miles (highway, arterial, rail, etc.) experiencing recurring congestion during the peak period
B-1-02 Reduce the percentage of Twin Cities freeway miles congested in weekday peak periods
B-1-03 Reduce the share of major intersections operating at LOS F
B-1-04 Maintain the rate of growth in facility miles experiencing recurring congestion as less than the population growth rate (or employment growth rate)
B-1-05 Reduce the daily hours of recurring congestion on major freeways
B-1-06 Reduce the number of hours per day that the top 20 most congested roadways experience recurring congestion
B-1-07 Reduce the regional average travel time index

Table 4-1. (Continued)

B-1-08 Annual rate of change in regional average commute travel time will not exceed regional rate of population growth
B-1-09 Improve average travel time during peak periods
B-1-10 Reduce hours of delay per capita
B-1-11 Reduce hours of delay per driver
B-1-12 Reduce the average of the 90th (or 95th) percentile travel times for (a group of specific travel routes or trips in the region)
B-1-13 Reduce the 90th (or 95th) percentile travel times for each route selected
B-1-14 Reduce the variability of travel time on specified routes during peak and off-peak periods
E-2-04 Increase the use of electronic credentialing at weigh stations and border crossings
E-2-05 Increase the number of automated permits/credentials issued
E-3-11 Reduce average crossing times at international borders

H. Reduce Environmental Impacts

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

B-1-01 Reduce the percentage of facility miles (highway, arterial, rail, etc.) experiencing recurring congestion during the peak period
B-1-02 Reduce the percentage of Twin Cities freeway miles congested in weekday peak periods
B-1-03 Reduce the share of major intersections operating at LOS F
B-1-04 Maintain the rate of growth in facility miles experiencing recurring congestion as less than the population growth rate (or employment growth rate)
B-1-05 Reduce the daily hours of recurring congestion on major freeways
B-1-06 Reduce the number of hours per day that the top 20 most congested roadways experience recurring congestion
B-1-07 Reduce the regional average travel time index
B-1-08 Annual rate of change in regional average commute travel time will not exceed regional rate of population growth
B-1-09 Improve average travel time during peak periods
B-1-10 Reduce hours of delay per capita
B-1-11 Reduce hours of delay per driver
B-1-12 Reduce the average of the 90th (or 95th) percentile travel times for (a group of specific travel routes or trips in the region)
B-1-13 Reduce the 90th (or 95th) percentile travel times for each route selected
B-1-14 Reduce the variability of travel time on specified routes during peak and off-peak periods
H-1-01 Reduce excess fuel consumed due to congestion
H-1-02 Reduce total fuel consumed per capita for transportation
H-1-03 Reduce vehicle miles traveled per capita
H-1-04 Reduce MnDOT fleet gasoline use
H-1-05 Reduce MnDOT fleet diesel use
H-1-06 Reduce the amount of all emissions in the atmosphere
H-1-07 Reduce the amount of carbon dioxide emissions measured

Table 4-1. (Continued)

H-2 Reduce negative impacts of the transportation system on communities *(ATMS, APTS, EM & MCM)*

- A-2-44 Reduce number of traffic law violations
- B-2-01 Increase annual transit ridership
- B-2-12 Increase the percentage of major employers actively participating in transportation demand management programs
- B-2-13 Reduce commuter vehicle miles traveled (VMT) per regional job
- B-2-14 Create a transportation access guide, which provides concise directions to reach destinations by alternative modes (transit, walking, bike, etc.)
- B-2-19 Increase the number of carpools
- B-2-20 Increase use of vanpools
- B-2-21 Provide carpool/vanpool matching and ridesharing information services
- B-2-22 Reduce trips per year in region through carpools/vanpools
- H-2-01 Increase the average vehicle occupancy rate in HOV lanes
- H-2-02 Increase the amount of environmentally friendly de-icing material used

It is essential that the 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 MnDOT transportation planning documents is the Minnesota GO. This high-level plan defines MnDOT's vision for transportation and guiding principles and outlines strategies to satisfy its vision and mission. The 20-Year SMTP further clarifies these strategies and lays out actions to implement the strategies. The Minnesota ITS Development Objectives, based on these vision, guiding principles, objectives and strategies, further establish a set of specific objectives that can be achieved through implementing ITS. Tables 4-2 and 4-3 depict the relationships between the Minnesota ITS Development Objectives and the Minnesota GO Guiding Principles and SMTP Objectives.

Table 4-2. Minnesota ITS Development Objectives Support Minnesota GO Guiding Principles

	Minnesota GO Guiding Principles							
Minnesota ITS Development Objectives	**Leverage public investments to achieve multiple purposes**	**Ensure accessibility**	**Build to a maintainable scale**	**Ensure regional connections**	**Integrate safety**	**Emphasize reliable and predictable options**	**Strategically fix the system**	**Use partnerships**
A. Improve the Safety of the State's Transportation System					●			●
B. Increase Operational Efficiency and Reliability of the Transportation System						●		●
C. Enhance Mobility, Convenience, and Comfort for Transportation System Users	●	●		●		●		●
D. Improve the Security of the Transportation System	●				●	●		
E. Support Regional Economic Productivity and Development	●			●		●		
F. Preserve the Transportation System			●				●	
G. Enhance the Integration and Connectivity of the Transportation System				●				●
H. Reduce Environmental Impacts	●							

Table 4-3. Mapping of ITS Development Objectives to Statewide Multimodal Transportation Plan (SMTP) Objectives

	SMTP Objectives					
Minnesota ITS Development Objectives	**Accountability, Transparency, and Communication**	**Traveler Safety**	**Transportation in Context**	**Critical Connections**	**Asset Management**	**System Security**
A. Improve the Safety of the State's Transportation System	●	●				
B. Increase Operational Efficiency and Reliability of the Transportation System	●				●	
C. Enhance Mobility, Convenience, and Comfort for Transportation System Users	●		●	●	●	●
D. Improve the Security of the Transportation System		●	●			●
E. Support Regional Economic Productivity and Development			●	●		
F. Preserve the Transportation System					●	
G. Enhance the Integration and Connectivity of the Transportation System	●			●		
H. Reduce Environmental Impacts			●			

5. 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 5-1 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 5-1. Performance Measures Supported by Current Data

- Number of crashes related to road weather conditions
- Number of fatalities related to road weather conditions
- Number of injuries related to road weather conditions
- Number of vehicle crashes in Minnesota
- Number of vehicle crashes per VMT
- Number of roadway fatalities in Minnesota (***MnDOT Performance Target: <350 by 2014***)
- Number of roadway fatalities per VMT
- Number of roadway injuries in Minnesota (***MnDOT Performance Target: <850 by 2014***)
- Number of roadway injuries per VMT
- Number of crashes related to unexpected congestion
- Number of fatalities related to unexpected congestion
- Number of transit fatalities
- Number of fatalities related to excessive speeding
- Number of injuries related to unexpected congestion
- Number of crashes related to red-light running
- Number of fatalities related to red-light running
- Number of injuries related to red-light running
- Number of crashes involving large trucks and buses
- Number of crashes due to commercial vehicle safety violations
- Number of crashes related to excessive speeding
- Number of crashes related to driving while intoxicated
- Number of crashes related to driver inattention and distraction
- Number of fatalities involving large trucks and buses
- Number of fatalities due to commercial vehicle safety violations
- Number of fatalities related to driving while intoxicated

Table 5-1. (Continued)

- Number of fatalities related to driver inattention and distraction
- Number of fatalities involving unbelted vehicle occupant
- Number of hazardous materials transportation incidents involving fatalities
- Number of injuries involving large trucks and buses
- Number of injuries due to commercial vehicle safety violations
- Number of transit injuries
- Number of injuries related to excessive speeding
- Number of injuries related to driving while intoxicated
- Number of injuries related to driver inattention and distraction
- Number of injuries involving unbelted vehicle occupant
- Number of hazardous materials transportation incidents involving injuries
- Number of crashes in work zones
- Number of fatalities in work zones
- Number of motorist injuries in work zones
- Number of crashes related to inappropriate lane departure, crossing, or merging
- Number of fatalities related to inappropriate lane departure, crossing, or merging
- Number of injuries related to inappropriate lane departure, crossing, or merging
- Number of crashes related to roadway/geometric restrictions
- Number of fatalities related to roadway/geometric restrictions
- Number of injuries related to roadway/geometric restrictions
- Number of crashes at railroad crossings
- Number of fatalities at railroad crossings
- Number of injuries at railroad crossings
- Number of crashes at signalized intersections
- Number of crashes at un-signalized intersections
- Number of fatalities at signalized intersections
- Number of fatalities at un-signalized intersections
- Number of injuries at signalized intersections
- Number of injuries at un-signalized intersections
- Speed differential between lanes of traffic on multi-lane highways
- Number of crashes at intersections due to inappropriate crossing
- Number of fatalities at intersections due to inappropriate crossing
- Number of injuries at intersections due to inappropriate crossing
- Number of crashes involving younger drivers (under 21)
- Number of fatalities involving younger drivers (under 21)
- Number of injuries involving younger drivers (under 21)
- Number of crashes involving pedestrians and non-motorized vehicles
- Number of fatalities involving pedestrians and non-motorized vehicles
- Number of injuries involving pedestrians and non-motorized vehicles
- Number of traffic law violations
- Number of traffic signals equipped with emergency vehicle preemption
- Mean incident notification time
- Mean incident response time
- Mean incident clearance time
- Mean incident clearance time for Twin Cities urban freeway incidents (***MnDOT Performance Target: 35 minutes or less***)

Table 5-1. (Continued)

- Hazmat incident response time
- Homeland security incident response time
- Percentage of incident management agencies in region participating in multi-modal information exchange network
- Number of agencies in the region with interoperable voice communications
- Number of participating agencies in a regional coordinated incident response team
- Number of TIM corridors in the region covered by regional coordinated incident response teams
- Percent of transportation operating agencies that have a plan in place for a representative to be at the local (city or county) EOC or State EOC to coordinate strategic activities and response planning for transportation during emergencies
- Number of joint training exercises conducted among operators and emergency responders
- Percent of staff having completed NIMS training and percent of transportation responders familiar with ICS
- Number of speed violations
- Transit user complaint rate
- Number of CCTV cameras on platforms, park-n-ride lots, vehicles, and other transit facilities
- Number of reported personal safety incidents
- Number of security incidents on roadways
- Percent of major and minor arterials equipped and operating with closed circuit television (CCTV) cameras
- Number of critical sites with security surveillance
- Number of security incidents on transportation infrastructure
- Number of critical sites with hardened security enhancements
- Number of Hazmat incidents
- Number of homeland security incidents
- Percent of Twin Cities freeway miles congested (below 45 mph) in weekday peak periods - 5 AM to 10 AM and 2 PM to 7 PM
- Percent of intersections operating at LOS F or V/C > 1.0 and population growth rate
- Rate of increase in facility miles operating at LOS F or V/C > 1.0
- Travel time index
- Average travel time during peak periods (minutes)
- 95th or 90th percentile travel times for selected routes
- Variance of travel time on specified routes during peak and off-peak periods
- Vehicle hours of delay associated with traffic incidents in peak and off-peak periods
- Buffer index or buffer time
- Planning time index
- Travel time index on selected freight-significant highways
- Point-to-point travel times on selected freight-significant highways
- Hours of delay per 1,000 vehicle miles on selected freight-significant highways
- Total fuel consumed per capita for transportation (***MN performance target: decrease to 2.92 billion gallons by 2015***. Source: 2007 Minnesota Next Generation Energy Act.)
- Minnesota vehicle miles traveled
- Number of workers injured by vehicles in work zones
- Average commute trip travel time (minutes)
- Average border crossing time for freight at international borders per year

Table 5-1. (Continued)

- Number of regional roadway miles covered by ITS-related assets in use for incident detection
- Annual transit ridership across the state (***Metropolitan Council performance target for Twin Cities: double 2003 ridership by 2030***)
- Annual express bus ridership
- Annual light rail ridership
- Annual commuter rail ridership
- Transit rider per hour of transit service by transit system
- Transit passengers per capita rate
- Percent of all peak-period trips made by transit
- Number of riders on transit units per trip
- Number of transit passenger miles traveled per capita
- Annual transit ridership across the state
- Ridership reported by urbanized area transit providers
- Ridership reported by rural area transit providers
- Transit Cost efficiency (cost/mile and miles/vehicle)
- Transit Service effectiveness (passengers/service hour and passengers/mile)
- Transit Cost effectiveness (cost/service hour, cost/passenger trip, and revenue recovery percentage)
- Transit Availability (hours (span) of service and frequency)
- On-time performance of transit
- Percent of fares collected using automated fare collection
- Percent of total transfers performed with automated fare cards
- Miles of bus-only shoulder lanes available for transit use in the metro area
- Transit to auto travel time differential for a given period on a given portion of the system
- Number of trips in region
- Availability of carpool/vanpool matching and ridesharing information services
- Vehicle volume and persons per hour per lane
- Vehicle throughput on specified routes
- AM/PM peak hour vehicle throughput on specified routes
- AM/PM peak hour person throughput on specified routes
- Percent of the transportation system in which travel conditions can be detected remotely via CCTV, speed detectors, etc.
- Percent of transportation facilities whose owners share their traveler information with other agencies in the region
- Number of 511 calls per year
- Number of visitors to traveler information website per year
- Number of users of notifications for traveler information (e.g., e-mail, text message) per year
- Number of specifically tailored traveler information messages provided
- Percent of construction projects completed on-time according to established schedule
- Number of fleet vehicles with maintenance diagnostic equipment
- Number of vehicles operating under CAD
- Percent of weigh stations use electronic credentialing
- Number of automated permits/credentials issued
- Number of enforcement personnel assigned to enforcing truck weight limit violations
- Number of size and weight violations

Table 5-1. (Continued)

- Years of data in database that is easily searchable and extractable
- Measurements of emissions within the state of Minnesota (***MN target: Reduce greenhouse gas by 15% by 2015, 30% by 2025, and 90% by 2050 compared with 2005.*** *Source: 2007 Minnesota Next Generation Energy Act*)
- Carbon dioxide emissions
- Project schedule deviation
- Project cost deviation
- Operations cost deviation
- MnDOT fleet gasoline use
- MnDOT fleet diesel use
- 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 5-2. 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 5-2. Additional Performance Measures for Future Consideration

- Number of secondary crashes
- Personal safety and customer service ratings
- Number of travelers routed around Hazmat incidents
- Number of travelers routed around homeland security incidents
- Number of Hazmat shipments tracked in real-time
- Percent of lane-miles operating at LOS F or V/C > 1.0
- Hours per day at LOS F or V/C > 1.0 (or other threshold)
- Hours of delay per capita
- Hours of delay per driver
- Percent of major employers with active TDM programs
- Commuter vehicle miles traveled (VMT) per regional employee
- Number of agencies create and implement transportation access guides
- Vehicle hours of delay associated with work zones
- Percentage of vehicles experiencing queuing in work zones
- Length of average and maximum queues in work zones
- Variance of travel time in work zones
- Total vehicle hours of delay per capita during evacuation from homeland security and Hazmat incidents
- Excess fuel consumed (due to congestion) (total or per capita)
- Percent of all trips made by transit
- Single occupancy vehicle commute trips per capita
- Share of household trips by each mode of travel
- Number of employers with access to regional carpool/vanpool database
- Number parking facilities with electronic fee collection

Table 5-2. (Continued)

- Number of parking facilities with automated occupancy counting and space management
- Number of parking facilities with advanced parking information to customers
- Number of parking facilities with coordinated electronic payment systems
- Number of parking facilities with coordinated availability information
- Share of employees walking, biking, telecommuting, carpooling/vanpooling, riding transit, driving alone
- Share of trips by each mode of travel
- Percent of all trips made using alternative modes in transit station communities
- Number of transit routes with information being provided by ATIS
- Number of users aware of park-and-ride lots in their region
- Percent (or number) of commercial vehicles tracked by trucking companies
- Percent (or number) of freight shipment tracked
- Number of ITS-related assets tracked
- Rate at which fleet/equipment is utilized
- Percentage of fleet/equipment within lifecycle
- Percent of agencies involved in CVO inspection, administration, enforcement, and emergency management in the region with interoperable communications
- Frequency of delays per month at intermodal facilities
- Average duration of delays per month at intermodal facilities
- Number of pavement miles damaged by commercial vehicles (***MnDOT performance targets for state principal arterial pavement: 70% in good condition and 2% or less in poor condition; for state non-principal arterials: 65% in good condition and 3% or less in poor condition***.)
- Amount of data gathered from ITS used in infrastructure and operations planning
- Number of planning activities using data from ITS systems
- Administrative support rate (as part of overall project budget)

6. Mainstreaming ITS into Planning and Programming

Throughout the 1990s and early 2000s, major Minnesota 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 GO and Statewide Multimodal Transportation Plan, which are supported by statewide, district, regional and local plans. Figure 6-1 provides a high

level overview of the ITS mainstreaming process into the Minnesota Transportation Investment Process.

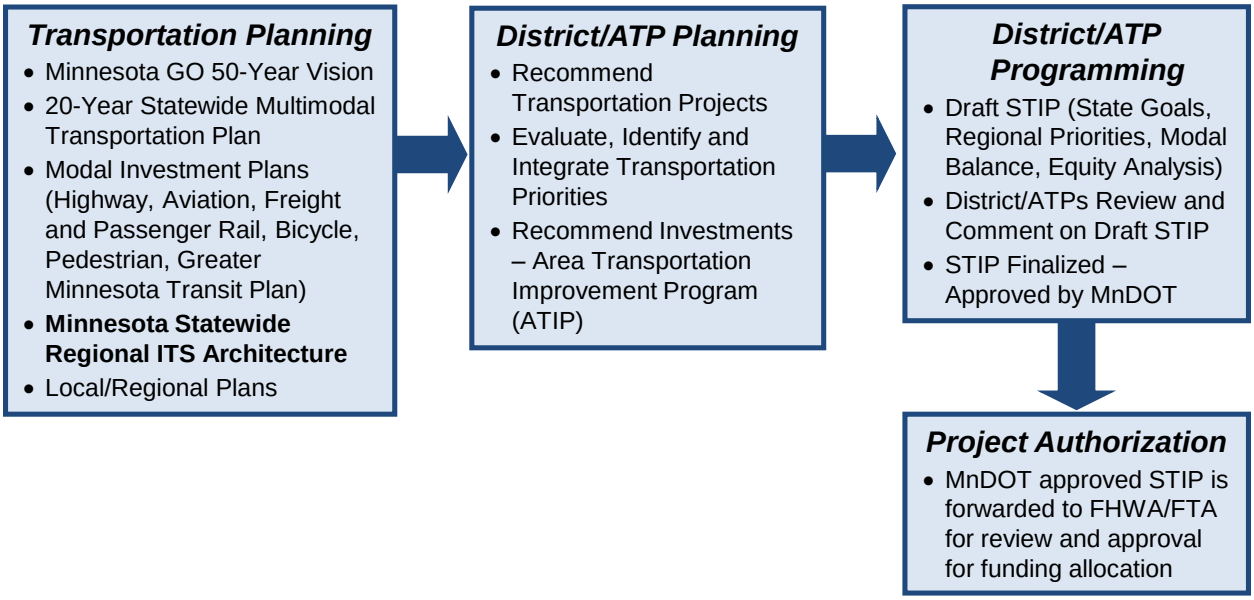

Figure 6-1. Mainstreaming ITS into Transportation Investment Process

Migrating ITS programs and projects from the Minnesota ITS 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 ITS 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.

"ITS components that operate together and as part of a system will enhance safety and mobility and reduce the possibility of costly incompatible systems in the future."

Former DOT Secretary Rodney Slater

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.

MnDOT and the FHWA Division Office are working together to develop and implement a process to improve the implementation of the FHWA Rule 940 and foster integration of the deployment of ITS systems in Minnesota. Figure 6-2 illustrates a first step in mainstreaming ITS into transportation planning and project development processes by aligning ITS specific processes with the MnDOT Highway Project Development Process (HPDP). In addition, MnDOT has developed procedures and checklists for ITS projects for conformity with the FHWA Rule 940 and ITS systems engineering requirements. The FHWA Rule 940 requirements and the conformity process are described in Section 3.2 of Volume 9 – ITS Initiatives and Project Concepts for Implementation.

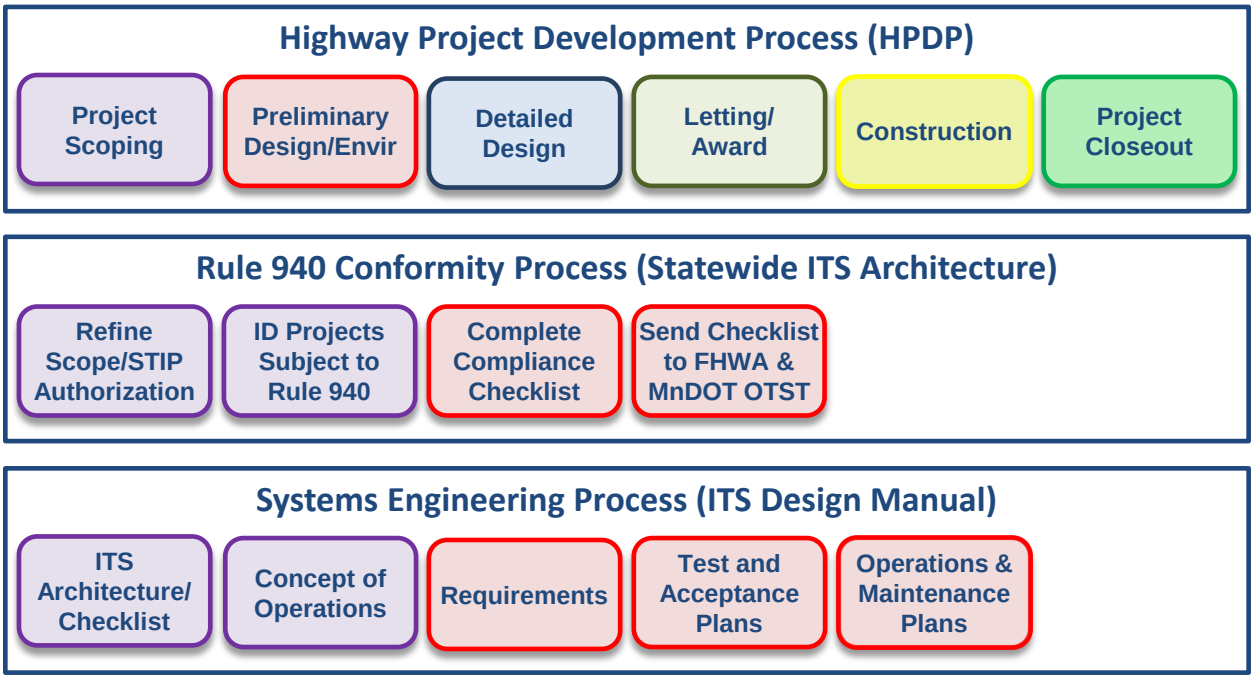

Figure 6-2. Aligning HPDP and ITS-Specific Processes

Appendix A:
Minnesota Statewide Regional ITS Architecture Development Process

Step 1: Get Started

The Minnesota Statewide Regional ITS Architecture process begins with a focus on relevant stakeholders ranging from transportation policy decision makers, to transportation planning, to project development. Based on the scope of the regions, in this case statewide, the relevant stakeholders and one or more champions are identified. Additionally, the personnel that will be involved are identified and the overall development effort is planned. The steps to getting started are:

1. **Identify Need** – Assess the need for the architecture and identify regional architecture boundaries. This step is complete. The Minnesota ITS Regional Architecture was originally developed in Minnesota in the late 1990s and subsequently was updated in 2001, 2009 and 2014. As part of the planning and ITS architecture update:
   - It is necessary to determine if ITS technologies are being implemented.
   - Determine needs and services to develop ITS projects in the region.
   - Continue to build awareness statewide of the benefits of a regional ITS architecture through outreach and education. Focus on the benefits of ITS rather than the rule/policy.

   The most important reason in developing and updating Minnesota Statewide Regional ITS Architecture is that it can help to efficiently plan for and implement more effective ITS systems. It is important to have a regional architecture that complies with a federal rule or policy. However, the ultimate goal is to develop a regional architecture that can be used statewide to guide ITS implementation, and to help ensure the statewide ITS needs are integrated with statewide transportation programs (i.e. Statewide Transportation Plan, STIP, local and regional long range transportation plans, ITS Strategic Plan and other ITS documents etc.).

2. **Define Scope –** What is the general scope of the ITS architecture?
   - Review the geographic area. What cities, counties, or other special areas need to be included that was not previously part of the regional architecture.
   - Identify the timeframe the statewide architecture will address. The Minnesota ITS Planning and Architecture Updated has identified projects to be implemented over the next 0 to 4 years (short-term), 5 to 8 years (medium-term) and over 8 years (long-term).

   Information and feedback to define the scope was actively solicited from stakeholders throughout the Minnesota Statewide Regional ITS Architecture Update.

3. **Identify Stakeholders** – This task identifies and engages relevant stakeholders that own or operate ITS systems, as well as other agencies that have an interest in regional transportation issues.
   - Provide educational materials that provide examples of successful ITS projects, benefits of ITS systems and ITS architecture.
   - Use working groups already in place to engage potential stakeholders and obtain feedback to identify new stakeholders.
   - Identify additional stakeholders from referrals by stakeholders already participating in the process.

To continue momentum and to keep open channels of communication, schedule ongoing meetings and/or provide a consistent mechanism of communication to/from agencies responsible for the overall transportation program. Existing examples include Minnesota Guidestar, ITS MN which sponsors many activities and events related to ITS. NCITE and ITS MN have an organized ITS Technical Committee which meets every other month with various interested stakeholders to cover ITS related topics.

4. **Identify Champions** – The key to this task is to identify one or more key persons to lead the regional ITS architecture development. In the case of Minnesota's Statewide Regional ITS architecture, MnDOT with the support of Minnesota Guidestar, has championed ITS architecture development and continues to do so. However, another key objective of this task is to continue to obtain broad-based buy in and support from stakeholders. As new ITS programs and projects are identified the following are recommended characteristics of a "program or project champion":
   - Champion must be a stakeholder, so they have a vested interest.
   - If the program or project is more complex and, for example, crosses jurisdictional boundaries more on champion may be identified.
   - Have an understanding of the subject (Minnesota Statewide Regional ITS Architecture) and have familiarity of the National ITS Architecture.
   - Knowledge of local ITS systems and projects.
   - Have high level access to resources to gain support for various regional or cross jurisdictional efforts.

Step 2: Gather Data

An inventory of existing and planned ITS elements supports development of interface requirements and information exchanges with ITS elements as required in FHWA Rule 940 and FTA National ITS Architecture Policy. Minnesota has a developed an ITS inventory as required by the FHWA rule. Most recently and, as part of the Minnesota Statewide Regional ITS Architecture Update the following was completed.

1. **Define Inventory –** Review of the existing Minnesota ITS inventory, as well as locating data that may have been documented since the previous ITS architecture update.
   - Updated and collected inventory data is included in an updated ITS inventory list per FHWA requirements.
   - The existing and revised ITS inventory was reviewed with relevant stakeholders and as necessary additional collected inventory information was obtained from the stakeholders.
   - Each ITS element is documented, at a high level, by associated organization(s), status (e.g. existing or planned), and a brief description for each element in the ITS inventory.
   - Each ITS element is mapped to the National ITS Architecture subsystems and terminators and use the National ITS Architecture to help map identify gaps and identify additional inventory to fill the gaps.

2. **Determine Needs and Services –** This step identifies regional needs and ITS services that are documented in ITS strategic plan, other ITS planning and deployment documents, long-range plans and other transportation planning documents. This information is most effectively collected from key stakeholders associated and responsible for operation, maintenance and uses of the transportation system. Since

2006, at numerous stakeholder forums, MnDOT has met with and collected data from stakeholders around Minnesota to identify ITS needs and services to be planned, demonstrated and deployed into short, medium and long-rang projects. Key activities related to this task include:

- Review regional needs and ITS services that may be documented in various transportation documents.
- Collect needs from stakeholders relevant to the overall transportation system.
- Document regional needs and services.
- Identify projects based on the needs and services collected from documents and stakeholder feedback.
- Tie in associated services with each element in the in the ITS inventory.

In summary, this step requires input from stakeholders, planning studies (e.g. transportation plans, ITS deployment plans, etc.). Review of the 20-Year Statewide Transportation Plan, long-rang transportation plans, congestion management plans, safety plans etc. should be reviewed as part of this step.

3. **Develop Operational Concept –** This step identifies current and future stakeholder roles and responsibilities in the implementation and operation of regional ITS elements. As part of this step buy-in and verification of roles/responsibilities, laying the groundwork for interagency coordination, and future agency agreements is important. The overall process for this step follows:
   - Gather existing documents that identify responsibilities in multi-agency scenarios (e.g. Incident Management Plans).
   - Develop relevant operational scenarios that require cooperation among a broad array of stakeholders.
   - Set up a meeting/workshop where stakeholders can walk through prepared scenarios and identify current roles and opportunities for cooperation/integration in the future.
   - Document each stakeholder's current and future responsibilities for each scenario.
   - Key findings should be identified into the high level Operational Concept.

   In short, the Operational Concept document for the region will provide an overview how ITS services are provided and identifies the roles and responsibilities of relevant stakeholders.

4. **Define Functional Requirements –** The objective of this task is to develop a high level description of the required functionality for each ITS element in the inventory. The process includes the following:
   - Determination of the level of functional requirements specification that is appropriate for the region.
   - Identify ITS elements that require functional requirements definition.
   - Build on ITS service and operational concepts to define functional requirements, focusing on those with regional implications.
   - Use the National ITS Architecture (subsystems, market packages equipment packages and functional requirements) to support the functional requirements development.

It is important to have stakeholder participation in the functional requirements development so as to accurately define the stakeholders support of the requirements that will be put on their ITS elements.

Step 3: Define Interfaces

This step provides detailed task descriptions pertaining to "Identifying Interconnect" and "Defining Information Flows". Each task provides detailed process procedures, relevant resources and tools for guidance and a general description of associated outputs.

1. **Identify Interconnect –** This process identifies and documents the existing and associated procedure and ensures each interface agrees with the connections that are identified. This process will provide an accurate list of existing and planned interconnects to the region. The summary process is as follows:
   - Review existing connections between ITS elements.
   - Based on the inventory, needs and services, operational concept, and functional requirements, identify inventory elements that will exchange information.
   - Consider whether existing person-to-person connections may evolve into automated interfaces between ITS elements.
   - Document high level status for each connection, including existing and planned.
   - Connections should be reviewed with stakeholders to ensure there is agreement with the identified interfaces for their ITS elements.

2. **Define Information Flows –** This task involves identifying the information to be exchanged between elements and verifies stakeholders responsible for providing and using the information agree with the identified information exchanges.
   - Based on interconnected decisions made by stakeholders and the services, operational concept, functional requirements created in the previous step, define actual information content (i.e. information flows) exchanged on the interface.
   - Provide documentation of the high level status for each information flow, existing and planned.
   - Use the National ITS Architecture to identify potential information to be exchanged.
   - Identify supporting information flows that are not defined in the National ITS Architecture, but important to the region.

Step 4: Implementation

This step, utilizes the regional ITS framework to define additional projects to bridge identified gaps between the Minnesota Statewide Regional ITS Architecture and regional ITS implementation. A series of staged projects, enabling agency agreements, and supporting ITS standards will support progressive, efficient implementation of ITS in the region. The following process tasks are outlined below:

1. **Define Project Sequencing –** This task identifies and creates a sequence of projects based on regional needs and project readiness. Key activities include:
   - Gather existing project sequence information from documented implementation plans.
   - Define ITS projects for the region in terms of the regional ITS architecture including defining short term projects and locations.
   - Identify project dependencies between ITS projects based on the inventory, functional requirements, and interfaces. Identify projects that that must be implemented before other projects can begin.

- Develop an efficient project sequencing process that stakeholders agree with and takes the feasibility, benefits and dependencies into account.

As with the other steps, project sequencing should take into account stakeholder input as well as review of existing planning documents. Focus should be on short, medium and long term planning decisions.

2. **Develop List of Agency Agreements –** Review and research each agency's records to determine if there agreements in place that can or should be amended to include specific ITS operations. If an agency agreement needs to be created the following is recommended:
   - When possible, use existing standard agreements for operations, integration, funding etc.
   - Evaluate what kind of agreement is needed (e.g. handshake agreement, MOU, interagency agreements etc.) and build consensus with each of the stakeholders involved.

   Typically, agreements take time to execute so it is imperative to build consensus early with simple agreements such as MOUs while final agreements are being developed.

3. **Identify ITS Standards –** Identification of ITS standards that support interfaces in the regional ITS architecture are often not understood by stakeholders involved, and therefore educating stakeholders of ITS standards as it relates to implementation of an ITS project is important. A summary of this task process is as follows:
   - Using information flows identified in Step 3, identify relevant ITS standards for the region.
   - Assess the ITS standard maturity and develop agreements for use of interim standards when determined necessary.
   - Identify other regional and/or statewide standards that might apply.

   As previously noted, it is important to educate stakeholders on the importance of ITS standards, especially with respect to cost, risk, and interoperability issues both within the region and when connecting with other ITS architecture regions. Also, work with stakeholders to build regional commitment to consider and deploy ITS standards-conformant system interfaces.

Step 5: Use the Regional ITS Architecture

Use of the regional ITS architecture is a culmination of the previous steps and as briefly outlined below this step shows how incorporate and support ITS services in transportation planning, support programming, budgeting capital planning, and support project implementation.

1. **Support Transportation Planning –** *Fully incorporate ITS elements into the region's transportation and planning programming processes*, and support ITS projects that fully consider the integration opportunities defined in the regional ITS architecture.
   - Long Range Planning: The Minnesota Statewide Regional ITS Architecture supports long range planning efforts by promoting increased stakeholder participation and promoting system and inter-jurisdictional integration.
   - ITS Strategic Planning: Outputs of the Minnesota Statewide Regional ITS Architecture serve as the basis for ITS planning, with additional effort required to

define issues such as funding, system management and operation, and regional technology choices.
- Other Planning Activities: The Minnesota Statewide Regional ITS Architecture supports other planning activities such as congestions management, safety planning, freight planning, security planning and operations planning.

2. Support Programming/Budgeting/Capital Planning
- Transportation Improvement Programming: The Minnesota Statewide Regional ITS Architecture supports the selection of projects identified in programming/budgeting documents through its projects definition and sequencing recommendations.
- Capital Planning/Budgeting: Projects from the Minnesota Statewide Regional ITS Architecture will require agency funds to be injected into the capital planning/budget process.

3. Support Project Implementation
- The Minnesota Statewide Regional ITS Architecture supports key system engineering analysis activities.

In summary, the Minnesota Statewide Regional ITS Architecture fully incorporates ITS elements into regional, statewide, agency plans and programs/budgets. Programming documents and capital plans identify efficient sequences that reflect ITS project dependency and sequencing recommendations.

Step 6: Maintain the Regional Architecture

This step provides an overview of responsibilities and procedures to be considered as the Minnesota Statewide Regional ITS Architecture is used and maintained over time. As noted below development and implementation procedures and responsibilities need to be in place to maintain the regional ITS architecture:

- Determine who will be responsible for architecture maintenance. What group or individuals will be responsible for maintaining the architecture? Who will support the effort, and who will have oversight for the maintenance effort?
- What outputs/documents will be maintained? Will only the database be maintained or will graphic representations be maintained as well?
- Define the change management process.
  - How will changes be introduced and who will introduce the changes?
  - Who will evaluate the changes for inclusion?
  - What group will review the change recommendations and make the decisions on what changes are accepted and which are not?
- Develop an Architecture Maintenance Plan. This plan will document the process and provide a framework for the architecture maintenance activity.
- Maintain the architecture plan. Identify, analyze, approve, incorporate, and communicate changes to the ITS architecture. Refine the Maintenance Plan over time so that it continues to accurately reflect the regions architecture maintenance process.