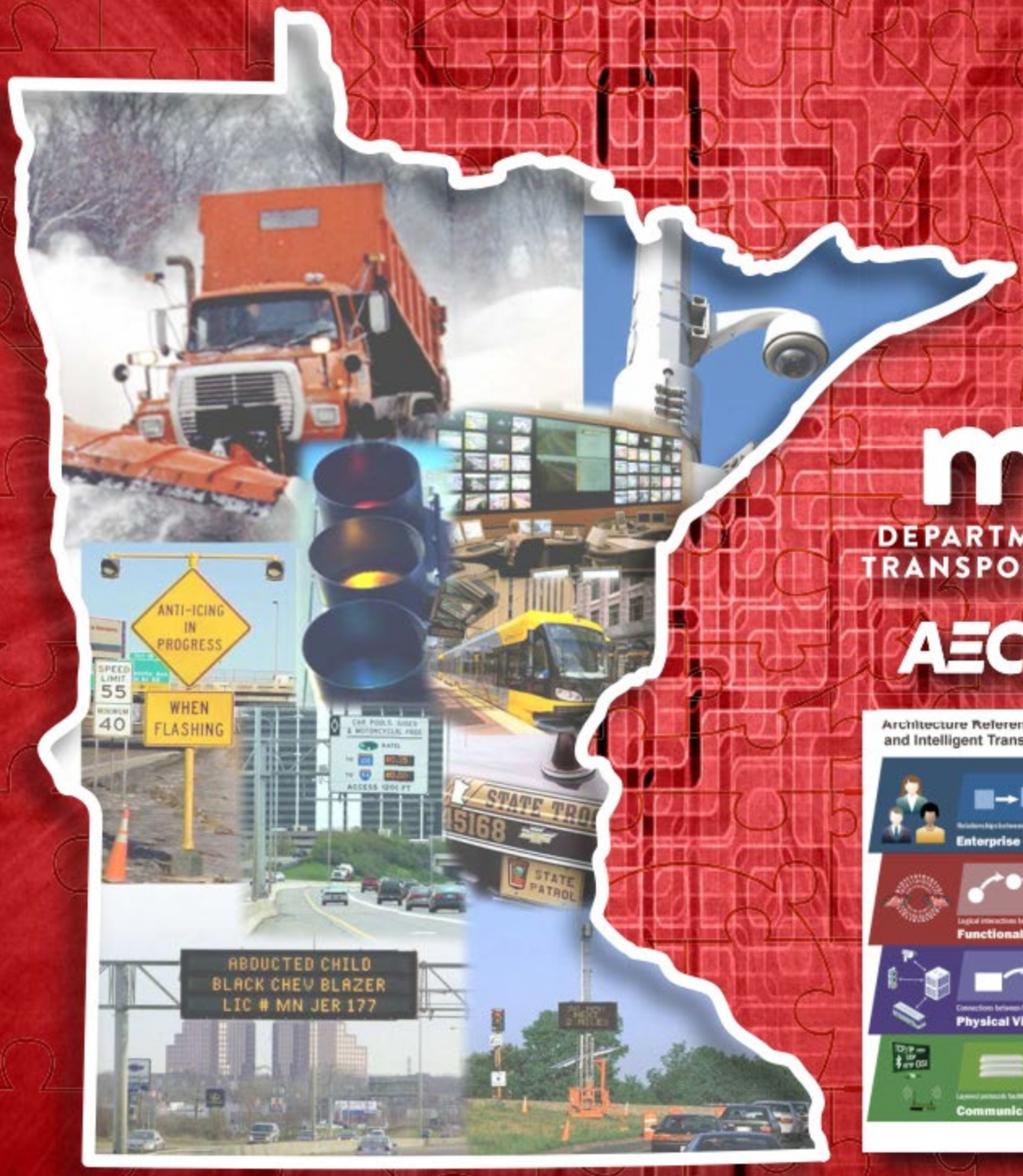
Minnesota Statewide Regional ITS Architecture

Version 2018

Volume 3:
Traffic Management Service Package Area



DEPARTMENT OF TRANSPORTATION

AECOM

Minnesota Statewide Regional ITS Architecture
Version 2018

Volume 3: Traffic Management Service Package Area

Prepared by

AECOM

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ACRONYMS

AMBER	America's Missing: Broadcast Emergency Response
ARC-IT	Architecture Reference for Cooperative and Intelligent Transportation
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
ATR	Automated Traffic Recorder
ATSPM	Automated Traffic Signal Performance Measure
AVL	Automatic Vehicle Location
CAD	Computer Aided Dispatch
CARS	Condition Acquisition and Reporting System
CICAS	Cooperative Intersection Collision Avoidance System
CTS	Center for Transportation Studies (University of Minnesota)
CVO	Commercial Vehicle Operations
DM	Data Management
DMS	Dynamic Message Sign
DOT	Department of Transportation
EOC	Emergency Operations Center
EVP	Emergency Vehicle Preemption
FHWA	Federal Highway Administration
FIRST	Freeway Incident Response Safety Team
FTA	Federal Transit Administration
GIS	Geographic Information System
HAR	Highway Advisory Radio
HOT	High-Occupancy Toll
HOV	High-Occupancy Vehicle
HRI	Highway-Rail intersection
ICM	Integrated Corridor Management
ICS	Incident Command Structure
IEEE	Institute of Electrical and Electronics Engineers
IRIS	Intelligent Roadway Information System
ITS	Intelligent Transportation Systems
IWZ	Intelligent Work Zone
LED	Light Emitting Diode
LOS	Level of Service
MC	Maintenance and Construction
MCM	Maintenance and Construction Management
MDT	Mobile Data Terminal
MnDOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
MSP	Minnesota State Patrol
MTO	Minnesota Traffic Observatory
NIMS	National Incident Management System
ODS	Office of Decision Support (MnDOT)
OIM	Office of Investment Management (MnDOT)
PeMS	Performance Measurement System
PM	Parking Management
PS	Public Safety
PSAP	Public Safety Answering Point
PT	Public Transportation
RAD-IT	Regional Architecture Development for Intelligent Transportation

RTMC	Regional Transportation Management Center
RWIS	Road Weather Information System
SOV	Single Occupancy Vehicle
SPaT	Signal Phase and Timing
ST	Sustainable Travel
SU	Support
TDA	Office of Transportation Data & Analysis (MnDOT)
TI	Traveler Information
TM	Traffic Management
TMC	Transportation/Traffic Management Center
SRCC	Southern Regional Communication Center
VMT	Vehicle-Miles Traveled
VS	Vehicle Safety
VSL	Variable Speed Limit
WX	Weather

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1. Introduction

1.1 Statewide Regional ITS Architecture Update

The Minnesota Statewide Regional Intelligent Transportation Systems (ITS) Architecture Version 2018 is an update of the previous version that was developed in 2014. It conforms with the National ITS Architecture (the Architecture Reference for Cooperative and Intelligent Transportation, or ARC-IT, Version 8.2) 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 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.

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

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

The Minnesota Statewide Regional ITS Architecture promotes deployment and integration of ITS systems and services that are compatible and interoperable with other ITS systems and services across jurisdictional boundaries. It facilitates coordination, cooperation, and information and resource sharing among State and local agencies. It guides systematic deployment and integration of regional ITS to improve the safety, efficiency, dependability, and cost effectiveness of the transportation system in Minnesota.

The Minnesota Statewide Regional ITS Architecture is organized as follows:

- **Overview:** The Overview document identifies the purpose/need, a general description of the region, development objectives, and performance measures for the Minnesota Statewide Regional ITS Architecture.

- **Implementation Volume – ITS Initiatives and Project Concepts for Implementation:** This volume serves as long-range guidance to systematically and cost-effectively implement the ITS initiatives and project concepts for the next 15 to 20 years in Minnesota based on funding availability. It lists specific ITS needs that are further prioritized into ITS initiatives and project concepts. It also provides the corresponding details for each initiative or project concept which include project concept descriptions, agency involved, champion, implementation timeframe, technology readiness, dependencies, benefits, service packages, estimated costs, and agreements needed.

- **Volumes 1 thru 12 – Development and Documentation of Service Package Areas:** Each volume is specific to the corresponding Service Package Area and includes: a description of the Service Package Area, ITS development objectives, a summary of

needs and services, and a detailed description of needs and services (consisting of the operational concept, inventory, specific service packages to address needs and services, interconnects and architecture flows, and research and development needs).

- **Volume 13 – RAD-IT Outputs of the Regional ITS Architecture:** Volume 13 consists of a report generated by the Regional Architecture Development for Intelligent Transportation (RAD-IT) software, formerly known as Turbo Architecture, for the Minnesota Statewide Regional ITS Architecture.

The purpose for developing Volumes 1 through 12 was to identify and prioritize stakeholder needs; gather information on existing infrastructure, components and technology; and define stakeholder roles and responsibilities in planning, deploying, operating and maintaining existing and future ITS systems.

Data collection activities were conducted early in the study process and focused on two primary tasks:

1. The assemblage of an inventory of existing and planned transportation infrastructure and, facilities and services.
2. The assessment of statewide needs and opportunities for further deployment of ITS.

Previously published transportation plans were the main source of data about characteristics of the existing transportation system, planned improvements, transportation system needs and goals. Strategic and long-range planning studies, ITS deployment and safety plans, transit studies and transportation planning and policy documents were reviewed.

1.2 Volume 3 – Traffic Management Service Package Area

Traffic Management (TM) Service Package Area includes the gathering of traffic monitoring information related to traveler movements and other conditions that may affect mobility and, using that monitoring information, to manage the overall performance of transportation systems, particularly safety, travel time, and travel time reliability.

Development of Volume 3 – TM Service Package Area entailed the Project Consultant working closely with MnDOT and stakeholders to identify and prioritize stakeholder needs; gather information on existing and future ITS infrastructure, components and technology; and define the stakeholders' roles and responsibilities in planning, deploying, operating and maintaining existing and future ITS systems.

Volume 3 summarizes the findings of data collection and analysis activities conducted to support development of the TM Service Package Area. Volume 3 is organized with the following sections:

- ***Section 1: Introduction*** provides a brief project overview and the purpose of this volume.
- ***Section 2: Identification of Existing Traffic Management Systems*** provides a brief overview of statewide TM deployments with a detailed listing of existing and planned systems in *Appendix A*.
- ***Section 3: Development Objectives*** provides an overview of the Minnesota ITS Development Objectives specific to TM. These objectives are used to identify needs and gaps, which will then be used to identify services to address those needs.

- ***Section 4: Identification of TM Needs and Services.*** Based on the ITS Development Objectives, needs were identified and prioritized by the stakeholders. Services were identified to address those prioritized needs.
- ***Section 5: Detail of TM Needs and Services*** describes, for each identified Need/Service, the following information:
    - **Operational Concept** - who is currently using the service and how they are using it. Users include both managers of a system and other users, like the traveling public, who use an end service.
    - **Existing Capabilities** - what systems are currently in place that are used to provide this service and who operates these services.
    - **Gaps and Planned Enhancements** - enhancements that can be made to better provide the service and address needs, who will use these enhancements, and what they will be used for. These enhancements can include expanding systems to geographic areas that currently do not have access to the service, enhancing an existing service to provide greater functionality or use by more groups, or implementing a new system to address a gap.
    - **Roles and Responsibilities** - what roles stakeholders need to fulfill to make the service operate successfully throughout a system's lifecycle (planning, design, implementation, operations, and maintenance).
    - **Interconnects** - the communications linkages between subsystems or stakeholders to provide the service.
    - **Data Archive Needs** - what data is generated for the service that should be archived, who is responsible for archiving, and any special needs or requirements for such archiving.
    - **Associated Service Packages** - other Service Packages that the service falls under. This includes both Service Packages within the Service Package Area and those in other Service Package Areas.
- ***Section 6: TM Research and Development Needs*** describes general research that can be performed to help implement the identified services.

2. Identification of Existing Traffic Management Systems

TM system deployments are located throughout Minnesota and have aided highway and transit operations to gather and provide traveler movements that affect mobility. Using that available information has improved the overall performance of the Minnesota's transportation systems, particularly in safety, travel time, and travel time reliability.

Traffic management systems can be used to affect traffic on either expressways or arterials. In a large metropolitan area, operators at the traffic management center (TMC) can monitor expressway conditions using traffic sensors. TMC operators can use video monitoring cameras to determine the cause of delay or unusual traffic flow and use appropriate countermeasures to respond. If congestion is caused by demand exceeding capacity, the TMC can use HOV/HOT lanes, lane control signals, ramp meters and DMS to help alleviate the congestion. If the congestion is caused by an incident, the TMC can alert roadways service patrol or emergency responders. Traffic management can also be used on arterials to make travel safer and more efficient. Cameral images and detector data from arterials can be monitored at a local TMC. Traffic signals along arterial corridors can be coordinated to help improve traffic flow and parking management systems can direct vehicles to available parking spots.

Traffic management can also be used in non-urban areas. TMCs in these areas can provide an integrated regional communication and transportation operations network serving rural and the smaller urban areas. The TMC can monitor roadways using video monitoring cameras and communicate with emergency responders and maintenance fleets to respond to incidents or inclement weather. Automated roadway gates can be used to close roads if driving conditions are unsafe. Roadside DMS can be used at planned special events or recreational travel generators to guide traffic and provide estimated travel times.

An inventory of existing and planned TM ITS systems (e.g. centers, devices and infrastructure) in Minnesota is described in *Appendix A*. This inventory summarizes a list of existing and programmed ITS systems in the state, their general description, associated stakeholder that are involved with their operations and management, and their current deployment. The systems described in *Appendix A* are Minnesota-specific implementations of subsystems from ARC-IT.

3. 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 various challenges. These strategies involve capital improvements as well as operational improvements. TM ITS solutions involve services that improve the overall performance of transportation systems, including safety, travel time, and travel time reliability.

TM involves the gathering of traffic monitoring information related to traveler movements and other conditions that may affect mobility and, using that monitoring information, to manage the overall performance of transportation systems, particularly safety, travel time, and travel time reliability. The goal of TM is to improve transportation systems operations through the use of advanced monitoring, communication systems, control systems and system integration between multiple jurisdictions. The Minnesota ITS Development Objectives in Table 1, specific to TM, are steps to determine and/or measure whether or not TM goals are being achieved. A complete list of Minnesota ITS Development Objectives is included in *Appendix B*.

Table 1. TM Specific Minnesota ITS Development Objectives

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

A-1 Reduce crash frequency

- 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-1-08 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
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-2-09 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
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-2-30 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

- 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

- 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

B-2 Increase average vehicle passenger occupancy and facility throughput

- 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-2-18 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-2-22 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

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
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
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
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)
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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
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-2 Improve travel time reliability
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
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
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-3-02 Reduce single occupancy vehicle trips through travel demand management strategies (e.g., employer or residential rideshare)
C-3-09 Increase the percent of the transportation system in which travel conditions can be detected remotely via video monitoring cameras, speed detectors, etc.

C-4 Reduce stress caused by transportation
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
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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-2 Safeguard the motoring public from homeland security and/or Hazmat incidents
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 video monitoring cameras, speed detectors, etc.
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D-2-03 Increase the number of travelers routed around Hazmat incidents
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

E. Support Regional Economic Productivity and Development

E-1 Reduce travel time for freight, transit and businesses
B-1-14 Reduce the variability of travel time on specified routes during peak and off-peak periods
C-2-09 Increase the miles of bus-only shoulder lanes in the metro area
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-3 Improve travel time reliability for freight, transit and businesses
B-1-14 Reduce the variability of travel time on specified routes during peak and off-peak periods
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
C-3-09 Increase the percent of the transportation system in which travel conditions can be detected remotely via video monitoring cameras, speed detectors, etc.
C-3-10 Increase the percent of transportation facilities whose owners share their traveler information with other agencies in the region
E-1-08 Decrease the annual average travel time index for selected freight-significant highways

E-4 Increase agency efficiency
C-2-09 Increase the miles of bus-only shoulder lanes in the metro area
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E-4-04 Increase the rate at which equipment is utilized
E-4-05 Increase the percentage of fleet/equipment within its lifecycle

E-5 Reduce vehicle operating costs
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F. Preserve the Transportation System

F-1 Safeguard existing infrastructure
C-3-09 Increase the percent of the transportation system in which travel conditions can be detected remotely via video monitoring cameras, speed detectors, etc.
D-1-06 Increase the percent of major and minor arterials are equipped with and operating with video monitoring cameras

G. Enhance the Integration and Connectivity of the Transportation System

G-1 Aid in transportation infrastructure and operations planning
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
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G-2 Reduce need for new facilities

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

H. Reduce Environmental Impacts

H-1 Reduce emissions/energy impacts and use associated with congestion

- 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
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- 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

H-2 Reduce negative impacts of the transportation system on communities
A-2-44 Reduce number of traffic law violations
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-2-22 Reduce trips per year in region through carpools/vanpools
H-2-01 Increase the average vehicle passenger occupancy rate in HOV lanes

4. Needs and Services

Stakeholder outreach has been a key component for updating the Minnesota Statewide Regional ITS Architecture. A stakeholder survey was conducted in 2017 to capture the following changes since the last update of the Architecture in 2014:

- Additional ITS needs and services have been identified and added
- New technologies have come on-line
- New technologies have replaced out-of-date technology.

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 2014 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 July 2017 and April 2018, 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. Stakeholders reviewed the ITS functional/informational needs as well as discussed the research and technology development needs. Subsequently, the highest priority needs that would benefit the traveling public were identified.

Table 2 displays the Specific Functional/Informational Needs/Services as potential solutions and enhancements. Priority is indicated in the Priority Points column, with each point representing one vote from responders through the stakeholder survey. The ITS Development Objectives and ITS Architecture Service Packages corresponding with the potential solutions are also listed in Table 2. The potential solutions and enhancements identified in Table 2 will provide the required service(s) to fill the gaps summarized in *Appendix C*. This appendix will take the TM Needs and associated TM Solutions and define what and how the system will be used, who will use it and who is responsible for planning, design, implementation, operation and maintenance of the system.

Table 2. TM Needs and Potential Solutions

Notes:

[a] *Priority point scoring system: 0 point for "no need"; 1 point for "low"; 2 points for "low to moderate"; 3 points for "moderate"; 4 points for "moderate to high"; and 5 points for "high".*

[b] *Discussions on needs/solutions fall under other service package areas can be found in corresponding Service Package Area documents.*

[c] *Priority point is calculated based on limited votes (3 or less).*

ID	Need/Potential Solution	Priority Point[a]	ITS Development Objective	ARC-IT Reference[b]
ATMS01	Provide efficient signal timing	4.38	B-1-01, B-1-03, B-1-04, B-1-06, B-1-07, B-1-08, B-1-09, B-1-10, B-1-11, B-1-12, B-1-13, C-2-01, C-2-02	TM03, TM07
ATMS02	Implement red-light running technology	3.00	A-1-05, A-1-10, A-2-05, A-2-11, A-2-26, A-2-32	TM03, VS01, VS13
ATMS03	Use archived data for traffic management strategy development and long range planning	2.75	G-1-01, G-1-02, G-1-03	TM09, DM01, DM02
ATMS04	Provide cameras at locations with high incidents and areas of high importance for incident identification and verification	3.08	B-1-15, B-1-17, B-1-18, C-1-09, D-1-06	TM01, TM08
ATMS05	Provide incident and congestion information to travelers	2.75	A-1-04, A-1-19, A-2-04, A-2-25, B-1-01, B-1-02, B-1-03, B-1-09, B-1-10, B-1-11, B-1-12, B-1-13, B-1-14, C-1-01, C-2-01, C-2-02	TM06, TI01, TI02
ATMS06	Provide speed enforcement at high risk locations to improve safety	3.46	A-1-12, A-2-13, A-2-34, A-2-43, C-4-01	TM17
ATMS07	Provide lane and shoulder control	1.13	B-1-01. B-1-02, B-1-04, B-1-05	TM22
ATMS08	Provide enhanced manual or automated speed enforcement to improve safety	3.57	A-1-12, A-2-13, A-2-34, A-2-43, C-4-01	TM17, MC06
ATMS09	Share video, data, and other information with PSAPs	2.25	B-1-15, B-1-16, B-1-17, B-1-18, B-4-01, C-3-11	TM01, TM08, PS01
ATMS10	Utilize variable speed limits	1.50	A-1-01, A-1-03, A-1-04, A-1-12, A-1-17, A-2-01, A-2-03, A-2-04, A-2-13, A-2-18, A-2-22, A-2-24, A-2-25, A-2-34, A-2-39	TM20, TM21
ATMS11	Operate reversible lanes	1.38	B-1-01, B-1-02, B-1-04, B-1-05, B-1-09, B-1-10, B-1-11, B-1-12, B-1-13, B-1-14, B-2-11, B-2-19, B-2-22, B-2-23, B-2-24, B-2-25, C-2-01, C-2-02	TM16

ID	Need/Potential Solution	Priority Point[a]	ITS Development Objective	ARC-IT Reference[b]
ATMS12	Reduce clearance time for primary crashes	2.38	B-1-17, B-1-18	TM08, PS01, PS02, PS03
ATMS13	Provide incident information to emergency management agencies	2.63	B-1-16, B-1-17, B-1-18, C-1-01	TM08
ATMS14	Monitor operation and performance of traffic signals	4.00	B-1-01, B-1-03, B-1-04, B-1-06, B-1-07, B-1-08, B-1-09, B-1-10, B-1-11, B-1-12, B-1-13, C-2-01, C-2-02	TM03
ATMS15	Provide operating speed/travel time information to travelers	3.07	B-1-01, B-1-02, B-1-03, B-1-05, B-1-06, B-1-07, B-1-09, B-1-10, B-1-11, B-1-12, B-1-13, B-1-14, C-1-01, C-3-11, C-3-12, C-3-13, C-3-15	TM01, TM06, TI01
ATMS16	Identify alternate routes	2.38	B-1-01, B-1-02, B-1-03, B-1-05, B-1-06, B-1-07, B-1-09, B-1-10, B-1-11, B-1-12, B-3-01, B-3-02, B-3-03, B-3-04, B-3-05, B-4-01	TM08, TM09, PS13, PS14
ATMS17	Provide travel information on special events	2.82	B-1-01, B-1-02, B-1-03, B-1-05, B-1-06, B-1-07, B-1-09, B-1-10, B-1-11, B-1-12, B-1-13, B-1-14, C-3-11, C-3-12, C-3-13, C-3-15	TM06, TI01
ATMS18	Provide dynamic speed feedback to drivers and enforcement agencies	2.77	A-1-12, A-2-13, A-2-34, A-2-43, C-4-01	TM17, MC06
ATMS19	Operate in-pavement dynamic lane markings	1.38	B-1-02, B-1-10, B-1-11, B-1-12, B-1-13, B-1-14, B-2-23, B-2-24, B-2-25	TM22
ATMS20	Operate dynamic shoulders	1.38	B-1-01, B-1-02, B-1-04, B-1-05, B-1-09, B-1-10, B-1-11, B-1-12, B-1-13, B-1-14, B-2-11, B-2-19, B-2-22, B-2-23, B-2-24, B-2-25, C-2-01, C-2-02	ST06, TM10, TM22
ATMS21	Provide information on parking availability	1.75	C-4-04, C-4-05, C-4-07	PM01, PM02, PM04
ATMS22	Provide a system-coordinated response for incidents	3.54	B-1-15, B-1-16, B-1-17, B-1-18, B-4-01, C-1-01, C-1-02, C-1-03, C-1-04, C-1-05, C-1-06, C-1-07, C-1-08, C-1-09	TM08

ID	Need/Potential Solution	Priority Point[a]	ITS Development Objective	ARC-IT Reference[b]
ATMS23	Operate ramp meters	2.25	A-1-08, A-2-09, A-2-30, B-1-01, B-1-02, B-1-04, B-1-05, B-1-06, B-1-07, B-1-08, B-1-09, B-1-10, B-1-11, B-1-12, B-1-13, B-1-14, B-2-23, B-2-24, B-2-25, C-2-01, C-2-02	TM05
ATMS24	Operate freeway/expressway/arterial DMS	3.13	A-1-03, A-1-04, A-2-03, A-2-04, A-2-24, A-2-25, A-3-01, A-3-02, A-3-03, B-1-01, B-1-02, B-1-10, B-1-11, B-3-01, B-3-02, B-3-03, B-3-04,	TM06
ATMS25	Operate video monitoring cameras	4.00	B-1-14, B-1-16, B-1-17, B-1-18, C-3-09, D-1-02, D-1-05, D-1-06	TM01
ATMS26	Operate and enforce MnPASS lanes	1.67	B-1-01, B-1-02, B-1-04, B-1-05, B-1-09, B-1-10, B-1-11, B-1-12, B-1-13, B-1-14, B-2-11, B-2-19, B-2-22, B-2-23, B-2-24, B-2-25	ST06, TM10, TM16, TM22
ATMS27	Provide HOV bypass lanes at ramp meter locations	1.92	B-2-01, B-2-02, B-2-19, B-2-20, B-2-22	ST06
ATMS28	Provide railroad flashing light signals and gates	3.64	A-1-09, A-2-10, A-2-31	TM13, TM14
ATMS29	Provide automated/remote control gate systems	2.28	A-1-03, A-2-03, A-2-24	TM19
ATMS30	Provide simple and integrated electronic payment systems	1.25	B-2-16, C-4-03, C-4-06	TM10, PM03, PT04, PT18
ATMS31	Monitor and collect air quality data	2.38	H-1-01, H-1-02, H-1-03, H-1-04, H-1-05, H-1-06, H-1-07	ST01
ATMS32	Provide curve speed warnings	2.00	A-1-17, A-2-18, A-2-39	TM17, VS05
ATMS33	Provide intersection collision avoidance systems	2.85	A-1-01, A-1-08, A-1-10, A-1-11, A-1-16, A-2-01, A-2-09, A-2-11, A-2-12, A-2-17, A-2-22, A-2-30, A-2-32, A-2-33, A-2-38	VS06, VS13
ATMS34	Provide roadway flood warnings	2.29	A-1-03, A-1-17, A-2-03, A-2-18, A-2-24, A-2-39	TM12, MC09, WX03
ATMS35	Provide vehicle overheight detection/warning systems	2.56	A-1-06, A-1-17, A-2-06, A-2-18, A-2-27, A-2-39	TM12, PS09, VS11

ID	Need/Potential Solution	Priority Point[a]	ITS Development Objective	ARC-IT Reference[b]
ATMS36	Implement Integrated Corridor Management (ICM) strategies	2.63	B-1-01, B-1-02, B-1-03, B-1-04, B-1-05, B-1-06, B-1-07, B-1-08, B-1-09, B-1-10, B-1-11, B-1-12, B-1-13, B-1-14, B-2-23, B-2-24, B-2-25, C-3-02, C-3-03, C-3-04, C-3-05, C-3-08, H-2-01	TM01, TM03, TM05, TM07, TM09, TM10, TM16, SU03, ST06
ATMS37	Provide safe signal phase transition	3.43	A-1-05, A-1-10, A-2-05, A-2-11, A-2-26, A-2-32	TM03, TM12
ATMS38	Provide health monitoring of rail crossings	2.43	A-1-09, A-2-10, A-2-31	TM13, TM14
ATMS39	Monitor queue length at ramps, incident scenes, and work zones	2.63	A-1-04, A-2-04, A-2-25, A-3-01, A-3-02, A-3-03, B-1-17, B-1-18, B-3-01, B-3-02, B-3-03, B-3-04	TM05, TM12, MC06
ATMS40	Enhance enforcement in work zones	3.70	A-3-01, A-3-02, A-3-03, A-3-04	TM17, MC06
ATMS41	Improve incident investigation capabilities	2.45	B-1-17, B-1-18, C-1-01, C-1-09	TM08
ATMS42	Use roadside data collectors to determine locations with frequent occurrence of speeding	2.25	A-1-01, A-1-02, A-1-12, A-2-43, A-2-44, G-1-01, G-1-02, G-1-03	TM01, TM17, DM01, DM02
ATMS43	Notify travelers of snowplow operations and cleanup using DMS	2.91	A-1-03, A-2-03, A-2-24, C-3-15	TM06, MC04
ATMS44	Provide incident detection systems	2.25	A-1-19, B-1-15, C-1-01, C-1-09	TM08
ATMS45	Provide road closure information for far away closures	2.14	B-3-01, B-3-02, C-3-15	TM06, TM19, TI01
ATMS46	Provide systems for large area disaster management	3.00	C-3-09, C-3-10, D-1-02, D-1-06, D-1-07, D-1-08, D-1-09, D-2-03, D-2-04, D-2-05, D-2-06	TM06, PS10, PS11, PS12, PS14
ATMS47	Study the potential use of ramp meters in larger urban areas outside the Metro	5.00[c]	A-1-08, A-2-09, A-2-30, B-1-01, B-1-04, B-1-05, B-1-06, B-1-07, B-1-08, B-1-09, B-1-10, B-1-11, B-1-12, B-1-13, B-1-14, B-2-23, B-2-24, B-2-25, C-2-01, C-2-02	TM05
ATMS48	Increase enforcement/presence of enforcement	5.00[c]	A-2-43, A-2-44, C-1-09, C-3-09, D-1-01, D-1-02, D-1-04, D-1-05, D-1-06, D-1-07, D-1-08, D-1-09, E-2-03, F-1-02	TM17, TM22, ST06

ID	Need/Potential Solution	Priority Point[a]	ITS Development Objective	ARC-IT Reference[b]
ATMS49	Crack down on distracted driving	5.00[c]	A-1-01, A-1-02, A-1-14, A-2-01, A-2-02, A-2-15, A-2-36, A-2-44	TM17
ATMS50	Keep drivers off the roads during winter storms	5.00[c]	A-1-03, A-2-03, A-2-24, C-3-09, C-3-10, C-3-13, C-3-15,	TM19, TI01, TI02
ATMS51	Collect and manage traffic signal performance measures	4.00[c]	E-4-01, G-1-01, G-1-02, G-1-03	TM01, TM02, DM02
ATMS52	Implement modern signal counters	4.00[c]	B-2-23, B-2-24, B-2-25, B-1-03	TM01, TM02, TM03, TM04
ATMS53	Improve signal communication	4.00[c]	A-1-05, A-1-10, A-2-05, A-2-11, A-2-26, A-2-32, B-1-01, B-1-03, B-1-04, B-1-06, B-1-07, B-1-08, B-1-09, B-1-10, B-1-11, B-1-12, B-1-13, B-1-14, B-2-15, C-1-10, C-3-08, E-1-01, E-1-02, G-1-01, G-1-02	TM03
ATMS54	Import of WAZE and other crowd sourced data to mine for incidents	5.00[c]	G-1-01, G-1-03	TM08, SU03
MCM20	Snow plow priority at traffic signals and ramp meters	5.00[c]	E-4-04, E-4-05, G-1-06, H-1-05, H-1-06, H-1-07	TM04, SU01, SU02

5. Detail of TM Needs and Services

A detailed description of each TM Needs and Services for Minnesota is found in *Appendix C. Appendix C* contains a table listing the services sorted by Service Package and details for the service. The details described in the table include:

- **Operational Concept:** Describes who is currently using the service and how they are using it. Users of the service include both managers and operators of a system and other users who may be impacted and/or benefit from such a service, such as other agencies and the traveling public.
- **Existing Capabilities:** Describes what systems are currently in place that are used to provide this service and who operates these systems and provides such services.
- **Gaps and Planned Enhancements:** Summarizes enhancements that can be made to better provide the service and address needs, who will use these enhancements, and what they will be used for. These enhancements include expanding current systems to geographic areas that presently do not have access to the service, enhancing an existing service to fill identified gaps or use by more groups, or implementing a new system to address a need.
- **Roles and Responsibilities:** Describes the roles and responsibility of involving stakeholders to make the service operate successfully throughout a system's lifecycle (planning, design, implementation, operations, and maintenance).
- **Interconnects:** Presents the communications linkages between subsystems or stakeholders to provide the service.
- **Data Archive Needs:** Summarizes what data is generated for the service that should be archived, who is responsible for archiving, and any special needs or requirements for such archiving.
- **Associated Service Packages:** Describes other Service Package(s) required to deliver the desired service. This includes both Service Packages within the ATMS Service Package Area and those in other Service Package Areas.

6. TM Research and Development Needs

In order to fill gaps and meet the needs for technology advancement in TM services, some research must be performed to test solutions and gain a greater understanding of what can effectively address identified needs. Research and Technology development needs and opportunities for TM are as follows:

<u>Freeway/Expressway Management and Operations</u>

- Explore ICM strategies and evaluate their effectiveness
- Develop and evaluate more effective queue detection systems for traffic back up
- Explore technologies for monitoring traffic and travel conditions in rural areas
- Improve automated congestion and incident detection and alerts
- Test cost-effective monitoring systems for remote/rural areas
- Develop automated vehicle passenger occupancy detection system as assistance in counting vehicle passenger occupancy
- Continue refining ramp metering algorithms
- Improve vehicle detection technologies
- Test HOT/parking payment integration

- Test vehicle to infrastructure communications
- Improve individual data communications to MnDOT
- Use data from connected vehicles to estimate traffic performance measures
- Determine the impact that automated vehicles will have on traffic flow

Arterial Management and Operations

- Develop and test methods to measure travel times on arterials
- Test real-time arterial performance monitoring system
- Investigate methods and technologies for improving traffic signal operations
- Test effective engineering and enforcement countermeasures for red-light running
- Develop traffic management plans as well as evacuation plans for new event venues and traffic generators
- Improve automated video detection and alerts
- Develop automated incident warning systems for intersections
- Test use of transit vehicles as traffic probes

Traffic Safety

- Test intersection collision avoidance systems
- Develop pedestrian and bicycle warning systems
- Study traffic conditions conducive to crashes
- Test curve warning systems
- Test lane departure systems
- Test traffic calming/driver warning system
- Develop low-cost rural highway-railroad intersection warning systems
- Develop new systems/refine developed systems to warn drivers of animals crossing roadways in rural areas
- Enhance work zone safety both inside and outside the zone
- Research and develop guidelines for improving pedestrian crossing safety at unsignalized intersections
- Investigate local street intersection treatments to reduce bike stops

Incidents/Emergency Response

- Improve incident identification and notification
- Explore methods to improve emergency vehicle response routing
- Improve emergency vehicle preemption systems

Information Dissemination

- Test real-time travel condition information dissemination to mobile devices
- Test use of symbols and colors on DMS

Traffic Diversions

- Develop methods to produce comparative travel times between multiple routes
- Develop dynamic automated alternate route identification system

Traffic Operations and Management Planning

- Develop planning and operations models that incorporate non-ideal conditions such as lane closures and emergencies

Appendix A: Existing/Planned TM Elements

System	Service Package	Description	Stakeholder	Status
911 Dispatch Center	TM08	This element represents the dispatch centers that receives 911 calls and dispatch the appropriate sheriff, police, fire and EMS for traffic incidents. Some centers are equipped with computer aided dispatch (CAD) systems. Dispatch centers coordinate traffic incident responses and exchange mutual aid and incident information with agencies as necessary.	Minnesota State Patrol, Local Agencies	Existing
Advance Warning Flasher Roadside Equipment	TM03, TM12	Advance Warning Flasher Roadside Equipment is located upstream from traffic signal roadside equipment on high-speed approaches to warn drivers of changes in signal phases from green to red.	MnDOT	Existing
Animal Crossing Warning Roadside Equipment	TM12	This represents roadside equipment that includes laser/light emitters along the roadway, along with a series of static deer warning signs with light flashers. When an animal breaks the beam, the flashers on the three signs nearest the deer are activated, providing additional warning to motorists. Equipment is installed near Camden State Park in MnDOT District 8 along TH 23.	MnDOT	Existing
Automated Traffic Recorder Roadside Equipment	TM01	This element represents roadside equipment that collects data on traffic patterns and volumes. Data is communicated back to the Automated Traffic Recorder (ATR) central systems reside in TMCs (i.e. RTMC, SRCC, and local TMCs). Data is also collected, processed, and archived by TMCs.	MnDOT, Local Agencies	Existing
Video Monitoring Roadside Equipment	TM01, TM08	This element represents video monitoring cameras deployed along the roadside by various agencies and municipalities throughout Minnesota. Cameras are controlled and monitored by TMCs.	MnDOT, Local Agencies	Existing

System	Service Package	Description	Stakeholder	Status
CV Roadside Equipment	TM04, SU01, SU02, SU08, ST08, VS13	This element represents the Connected Vehicle (CV) roadside devices that are used to send messages to, and receive messages from, nearby vehicles using Dedicated Short Range Communications (DSRC) or other alternative wireless communications technologies. Communications with adjacent field equipment and back office centers that monitor and control the RSE are also supported. This device operates from a fixed position and may be permanently deployed or a portable device that is located temporarily in the vicinity of a traffic incident, road construction, or a special event. It includes a processor, data storage, and communications capabilities that support secure communications with passing vehicles, other field equipment, and centers.	MnDOT	Planned
Dynamic Message Sign Roadside Equipment	TM06	This element represents portable and permanent Dynamic Message Signs (DMS) operated throughout the state used to convey driver information on special events, maintenance and construction activity, travel time, incident management, AMBER alerts, and transportation and national emergencies.	MnDOT, Local Agencies	Existing
Emergency Vehicle Equipment	TM08	This element represents vehicle equipment on emergency vehicles that communicates with 911 centers (e.g. AVL, MDT, voice/video/data communications, transponder/transmitter for signal pre-emption). Agencies operating emergency vehicles include Minnesota State Patrol, and various counties and cities throughout Minnesota.	Minnesota State Patrol, Local Agencies	Existing
Highway Advisory Radio Roadside Equipment	TM06	This element represents roadside equipment that facilitates the operation of Highway Advisory Radio (HAR) throughout Minnesota. HAR is controlled by MnDOT District Offices throughout the state.	MnDOT	Existing
Lane Control Roadside Equipment	TM22	This element represents roadside equipment that warns drivers with electronic displays about the open or closed status of traffic lanes along the roadway.	MnDOT	Existing

System	Service Package	Description	Stakeholder	Status
Lane/Ramp Access Control Roadside Equipment	TM16, TM19	This represents an automated gate closure system located on I-90 in Jackson, MN that is activated during severe weather events and other severe incidents requiring freeway closures for winter roadway maintenance and snow plowing. The system includes automated gates, video monitoring cameras that monitor each direction of travel at the intersection, and automated signs that warn drivers that the road ahead is closed. All components of the system are monitored and controlled by the MnDOT District 7B Office in Windom, MN.	MnDOT	Existing
Lift Bridge Traffic Control Central System	TM18	This represents the central control system that manages Lift Bridge Traffic Control Roadside Equipment in Stillwater.	MnDOT	Existing
Lift Bridge Traffic Control Roadside Equipment	TM18	This represents roadside equipment controlled by an operator at the Lift Bridge Traffic Control Central System in Stillwater.	MnDOT	Existing
Local TMCs	TM01, TM03, TM06, TM07, TM08	This element represents local centers that facilitate traffic management on a roadway network from a central location that provides roadway monitoring, signal system control, remote equipment control, and communications with field personnel and other agencies.	Local Agencies	Existing
Minneapolis TMC	TM01, TM03, TM06, TM07, TM08	The City of Minneapolis operates a Traffic Management Center that provides traffic-responsive and time-of-day operation and an extensive selection of on-line database operations. City of Minneapolis plans to upgrade signal controllers throughout the City, implement an adaptive signal timing plan generation algorithm for the existing traffic control system in Minneapolis, and allow for video sharing between key stakeholders.	City of Minneapolis	Existing

System	Service Package	Description	Stakeholder	Status
Minnesota Conditions Acquisition and Reporting System (CARS)	TM06	This system represents a central source of roadway event information for both the management and dissemination of traffic-related information to the traveling public. The system is maintained by the MnDOT Office of Maintenance and data is input throughout MnDOT at District Offices. Minnesota State Patrol users also enter information to CARS on road conditions, construction, incidents, special events, and over dimension vehicle restrictions each day. CARS also manages automated data entry for congestion in the Twin Cities metro area based on information from Automated Traffic Recorder Roadside Equipment and it provides traveler information for use in the display of road conditions on cable access television. In MnDOT District 7, data entry occurs via web-enabled cellular telephones with approximately 75 users, primarily snow plow operators. Similar deployment is planned for MnDOT District 6.	MnDOT Office of Maintenance	Existing
MnPASS Roadside Equipment	TM10, TM22	Roadside equipment includes variable message signs to display toll amounts that vary by time of day and/or levels of traffic congestion on toll facility and flashing roadside beacons to indicate that proper toll amounts have been paid for use of the HOT (High-Occupancy Toll) Lane facility. Equipment also includes ramp access controls to prevent drivers from entering the HOT Lane facility. MnPASS is designed to improve roadway efficiency by increasing person and vehicle-carrying capabilities in the MnPASS lanes. HOT lane tolls are priced dynamically based on the level of demand for the HOT lanes.	MnDOT	Existing
MnPASS Service Center	TM10	This element represents the center that performs administrative functions relating to MnPASS operations.	MnDOT	Existing
MnPASS Vehicle Equipment	TM10	This element represents the transponder that supports automated payment of tolls along MnPASS Lanes.	Travelers	Existing

System	Service Package	Description	Stakeholder	Status
Neighboring State Traffic Management Centers	TM07, TM08	This element represents traffic management centers located outside the state of Minnesota that plan to coordinate traffic control and information in border areas. This includes the North Dakota DOT Traffic Operations Center, the North Dakota DOT Maintenance Office, the Fargo Traffic Operations Center, the Wisconsin DOT Traffic Operations Center in Superior, and the Iowa DOT.	Neighboring States	Existing
Neighboring State Traffic Management Centers Roadside Equipment	TM01, TM06, TM08	This element represents roadside equipment whose control plans to be shared between Minnesota Traffic Management Centers and Neighboring State Traffic Management Centers. This includes signal system roadside equipment in Fargo, ND and additional roadside equipment operated by the North Dakota and Wisconsin DOT's.	Neighboring States	Existing
Queue Detection Roadside Equipment	TM05, TM12	This element represents roadside equipment that detects lengthy queues of traffic upstream of metered ramps, incident locations, and work zones.	MnDOT	Planned
Railroad Active Warning Roadside Equipment	TM13	This element represents roadside equipment that alerts motorists of railroad crossings at at-grade intersections. Gates are activated and de-activated as trains are detected approaching and clearing the intersection.	MnDOT	Existing
Ramp Meter Roadside Equipment	TM05	This element represents the system of ramp meters used by the RTMC to increase freeway volumes, trip reliability, and freeway speeds, while decreasing travel time and crashes. Ramp meters have the potential to operate during the morning and evening peak traffic periods. Timing and operation of ramp meters is controlled by Intelligent Roadway Information System (IRIS).	MnDOT	Existing
Red Light Monitoring/ Enforcement Roadside Equipment	TM17	This element represents portable or permanent photo/video monitoring systems located at intersections with high crash rates. Purpose is to inform and educate the traveling public of the dangers of running red lights. Planned for MnDOT District 6.	MnDOT	Planned

System	Service Package	Description	Stakeholder	Status
Research Lab Network Monitoring Roadside Equipment	TM01	This element represents the network of video detectors providing space- and time-continuous coverage of the I-35W/I-94 Commons freeway area in Minneapolis (the Beholder system). Portable monitoring stations deployed on the roofs of several high-rise buildings overlooking the freeway transmit data back to the MTO via a high-speed IEEE 802.16 wireless network.	U of M CTS ITS Institute	Existing
Research Lab New Monitoring Control System	TM01	This represents the Minnesota Traffic Observatory (MTO) – a transportation laboratory that gathers data on freeway traffic flows through a fully independent network of video detectors providing space- and time-continuous coverage of the I-35W/I-94 Commons freeway area in Minneapolis. Portable monitoring stations deployed on the roofs of several high-rise buildings overlooking the freeway transmit data back to the MTO via a high-speed IEEE 802.16 wireless network. MnDOT supplies eight switchable compressed / streamed Internet video feeds to the MTO. Researchers have the ability to switch between any of the MnDOT video cameras monitoring the metropolitan freeway network.	U of M CTS ITS Institute	Existing
Roadway Flooding Warning Roadside Equipment	TM12	This element represents roadside equipment on TH 59 and TH 60 near Worthington that automatically detects a rise in water level and issues an alert based on commands from the Mankato Signal Center in District 7. It also represents planned roadside equipment in Mower County that would alert the Mower County dispatch center and trigger advanced warning signs (static signs with flashing beacons) to alert approaching vehicles. The proposed equipment includes sensors in the field which report to a central receiver/decoder located which would likely be located at the Mower County dispatch center. The system would also include communication and utilities at both the flood-warning sensor and the static warning signs with flashing beacons.	Local Agencies	Existing

System	Service Package	Description	Stakeholder	Status
RTMC	TM01, TM02, TM03, TM04, TM05, TM06, TM07, TM08, TM16, TM19, TM20, TM22	MnDOT RTMC is located in the Waters Edge Building in Roseville. The RTMC is where State Patrol, MnDOT Maintenance, and MnDOT Freeway Operations work together to quickly detect, respond to and remove incidents off of the freeway systems. The RTMC is responsible for managing traffic on the Twin Cities metro freeways with the use of ramp meters, variable message signs, lane control signals and loop detectors. Additional RTMC components include the HOV system, MnPASS, and airborne monitoring systems. The RTMC monitors traffic conditions, assists in incident management and provides traveler information. Traffic Operations staff also continually perform systems analysis of field equipment, the ramp meter algorithm and Operations Center equipment. They also analyze and research traffic flow trends, new technologies and other issues that affect congestion.	MnDOT	Existing
Speed Monitoring/ Enforcement Roadside Equipment	TM17	This system will provide photo enforcement for speeding at locations where there is a history of crashes with excessive speed as a contributing factor or in work zones.	Minnesota State Patrol	Planned
SRCC	TM01, TM03, TM05, TM06, TM08, TM19	MnDOT Southern Regional Communication Center (SRCC) is a regional center in the Rochester area for 24-hour incident and emergency response, multi-agency dispatching and fleet management, interagency communications, and collection and dissemination of road conditions.	MnDOT	Existing
Traffic Detector Roadside Equipment	TM01, TM12	This element represents roadside equipment that collects data on traffic volumes, speeds and occupancy. Data is communicated back to central systems reside in TMCs (i.e. RTMC, SRCC and local TMCs). Data is also collected, processed, and archived by TMCs.	MnDOT, Local Agencies	Existing

System	Service Package	Description	Stakeholder	Status
Traffic Signal Roadside Equipment	TM03, TM04	This element represents traffic signals in Minnesota that are controlled by traffic management centers - RTMC, SRCC, Minneapolis TMC, and Local TMCs. This element supports surface street control and arterial traffic management. It represents traffic signal systems ranging from fixed-schedule control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests.	MnDOT, Local Agencies	Existing
Variable Speed Limit Roadside Equipment	TM20	This element represents Variable Speed Limit (VSL) systems that will provide real-time information on appropriate speed for current conditions based on traffic flow, traffic speed, weather and other inputs and integration with law enforcement. Can be used to manage traffic under a number of variable conditions. MnDOT will select a corridor for deployment of VSL system in conjunction with a dynamic lane control system based on traffic data analysis.	MnDOT	Existing

Appendix B: Minnesota ITS Development Objectives

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

DM:	Data Management	VS:	Vehicle Safety
PT:	Public Transportation	CVO:	Commercial Vehicle Operations
TI:	Traveler Information	PS:	Public Safety
TM:	Traffic Management	MC:	Maintenance and Construction
PM:	Parking Management	WX:	Weather
SU:	Support	ST:	Sustainable Travel

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

A-1 Reduce crash frequency *(TI, TM, PT, CVO, PS, MC, VS & WX)*

- 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 *(TI, TM, PT, CVO, PS, MC, VS & WX)*

- 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
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 *(TI, TM, PS, MC & VS)*
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 *(TI, TM, MC & VS)*
B-1-01 Reduce the percentage of facility miles (highway, arterial, rail, etc.) experiencing recurring congestion during peak periods
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

B-2 Increase average vehicle passenger occupancy and facility throughput *(TM, PT & ST)*
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 *(TI, TM, PS, MC & VS)*
- 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
- 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 *(TI, TM, PT, CVO, PS & VS)*
- 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 *(TI, TM, PT, PS & VS)*
- B-1-01 Reduce the percentage of facility miles (highway, arterial, rail, etc.) experiencing recurring congestion during peak periods
- 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
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 *(TI, TM, PT & VS)*
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 *(TI, TM, PT & ST)*
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

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 video monitoring cameras, 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 *(TI, TM, PT, PM, PS, MC & VS)*
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 peak periods
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
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 *(PT & PS)*

C-3-09 Increase the percent of the transportation system in which travel conditions can be detected remotely via video monitoring cameras, 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 video monitoring 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 video monitoring cameras
D-1-07 Increase the number of critical sites with security monitoring
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 *(TI, TM, PT, CVO, PS, MC & VS)*

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 video monitoring cameras, 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 video monitoring 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 video monitoring cameras
D-1-07 Increase the number of critical sites with security monitoring
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
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 *(TI, TM, PT, CVO & VS)*

- 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 *(TI & 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 *(TM, PT, CVO & VS)*

- 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
- C-3-09 Increase the percent of the transportation system in which travel conditions can be detected remotely via video monitoring cameras, 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 *(DM, TM, PT, CVO, PS, MC & SU)*
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 *(TM, PT, CVO & VS)*
B-1-01 Reduce the percentage of facility miles (highway, arterial, rail, etc.) experiencing recurring congestion during peak periods
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

E-6 Enhance efficiency at borders *(TI & 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 *(TM, CVO, PS & MC)*

- C-3-09 Increase the percent of the transportation system in which travel conditions can be detected remotely via video monitoring cameras, speed detectors, etc.
- D-1-06 Increase the percent of major and minor arterials are equipped with and operating with video monitoring cameras
- D-1-07 Increase the number of critical sites with security monitoring
- 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 *(TM, CVO, MC & VS)*

- B-1-01 Reduce the percentage of facility miles (highway, arterial, rail, etc.) experiencing recurring congestion during peak periods
- 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
- 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 *(ST, TI, TM, CVO & VS)*

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

H-2 Reduce negative impacts of the transportation system on communities *(TM, PT, PS, ST & MC)*

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 passenger occupancy rate in HOV lanes
H-2-02 Increase the amount of environmentally friendly de-icing material used

Appendix C: Needs and Services Detail

Service Package TM01-Infrastructure-Based Traffic Surveillance

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S04	Provide cameras at locations with high incidents and areas of high importance for incident identification and verification to improve operations	• MnDOT, local agencies, emergency management agencies, law enforcement agencies, and educational and research institutions use video monitoring cameras to detect, verify, and assist response to incidents. • Traveler information providers use video cameras to verify and report on incidents. • The general public views the videos to assess traffic conditions affecting their trip.	• MnDOT video monitoring system covering major roads and arterials and is accessible to MnDOT, MSP, some cities, Metro Transit, TV stations, traveler information providers, and as snapshots to the general public. • St. Paul and Minneapolis operate video monitoring systems accessible to the Cities. • Several PSAP's receive streaming video over the internet.	• Provide additional camera coverage for sections of I-35 in MnDOT District 6. • Provide video monitoring of rural high incident roadways and areas of high importance. • Provide video from local agencies to the RTMC/SRCC. • Share video among transportation management and emergency management agencies. • Provide live motion video to the public over the Internet.	• Each agency is responsible to plan, design, construct, operate, and maintain its own video monitoring system. • RTMC is responsible to coordinate the identification of locations and sharing of video among agencies in the metro area. • MnDOT districts are responsible to coordinate the identification of locations and sharing of video among agencies in greater Minnesota.	• Each video monitoring system includes interconnects from the roadside equipment to the center for video and camera control. • The RTMC video monitoring system includes interconnects with some cities, Metro Transit, TV stations, and traveler information providers.	• Live video should be "buffered" (i.e. temporarily retained) for a period of time to allow saving video of interest after the fact. • Video should not be routinely, permanently saved due to data practices considerations as well as storage requirements. • Video of interest should be permanently saved and cataloged to provide training and post incident analysis.	• TM08

ATM S09	Share video data, and other information with PSAPs	• MnDOT and local agencies transmit video of incidents along with other related traffic and incident information to emergency response dispatchers. • Emergency response agencies use images and other information to assess response and resource needs. • Emergency response agencies use images to monitor response and recovery progress and activities.	• MnDOT RTMC and SRCC operate a video monitoring system accessible to MnDOT, the state patrol, and some cities. • Several cities operate video monitoring systems • Other existing capabilities are listed under ATMS04.	• Provide videos from RTMC and SRCC to local emergency responders. • Provide videos from cities to RTMC to share with State Patrol. • Share video among transportation management and emergency management agencies. • Provide data from MDT's on law enforcement vehicles to dispatch offices. • Provide data from in-vehicle devices to traffic and emergency management centers. • Resolve bandwidth limitations and share streaming videos from RTMC to emergency responders. • Share videos among local emergency responders.	• Each agency is responsible to plan, design, construct, operate, and maintain its own video monitoring system. • RTMC is responsible to coordinate the sharing of video among agencies in the metro area. • SRCC is responsible to coordinate the sharing of video among agencies in the Rochester area. • Local emergency response agencies are responsible for coordinating with MnDOT and local agencies for providing video images to in-vehicle devices.	• This service includes interconnects between roadside equipment and RTMC/SRCC/ TMCs for video and camera control. • This service also includes interconnects between RTMC/SRCC/ TMCs and incident/ emergency response centers.	• Archiving will be performed by the agency operating the video monitoring cameras and has the same needs as listed under service ATMS04.	• TM08 • PS01

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S15	Provide estimated travel time information to travelers	• MnDOT and local agencies gather data on vehicle speeds on roadways and posts it on the Internet. • MnDOT and local agencies provide travel speeds/ travel times to external information service providers (e.g. radio and TV stations, private Internet service providers, etc.) • MnDOT and local agencies post operating speed/ travel time information on DMS. • Travelers use the information to make travel decisions.	• The RTMC gathers speed and volume data to calculate travel times on the freeways in the Twin Cities metro area. Travel time information is provided to the motorists via DMS, 511 website, and radio.	• Expand provision of travel time/ operating speed information in the Twin Cities area and the greater Minnesota. • Investigate opportunities and conditions for posting operating speed (vs. travel time).	• MnDOT is responsible to plan, design, construct, operate and maintain loop detectors and DMS on interstate and trunk highways. • Local agencies are responsible to plan, design, construct, operate and maintain the detection systems and travel information systems on their roadways.	• Loop detector systems include interconnects from the roadside equipment to the center. • DMS systems include interconnects from center to roadside equipment for DMS operation.	• Historic speed information will be archived for planning and operational analysis.	• TM06 • TI01

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S25	Operate video monitoring cameras	• MnDOT and local agencies operate video monitoring cameras on freeways and arterials to monitor traffic and identify and verify incidents. • The general public uses video images to assess traffic conditions affecting their trip. • Parking structure operators will use video monitoring cameras for ramp operations	• MnDOT RTMC operates a video monitoring system accessible to MnDOT, the state patrol, some cities, Metro Transit, TV Stations, traveler information providers, and as snapshots to the general public. • The cities of St. Paul and Minneapolis operate video monitoring systems. • Third Avenue Distributor (TAD) parking garages operate video monitoring system.	• Provide additional camera coverage for sections of I-35 in MnDOT District 6. • Provide video from local agencies to the RTMC. • Provide live motion video to the public over the Internet. • Upgrade legacy cameras. • Share video among transportation management and emergency management agencies.	• Each agency is responsible to plan, design, construct, operate, and maintain its own video monitoring system. • Partnership formation can result in shared design, construction, operation, and maintenance of the video monitoring system.	• Each video monitoring system includes interconnects from the roadside equipment to the RTMC/local TMC for video and camera control. • The RTMC video monitoring system includes interconnects with some cities, Metro Transit, TV stations, and traveler information providers.	• Live video should be "buffered" (i.e. temporarily retained) for a period of time to allow saving video of interest after the fact. • Video should not be routinely permanently saved due to data practices considerations as well as storage requirements. • Video of interest should be permanently saved and cataloged for training, post incident briefing, and tort cases.	

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S36	Implement Integrated Corridor Management (ICM) strategies	• Transportation agencies would coordinate transportation management and transit operations on their systems to optimize overall traffic flow in a corridor by accessing underused capacity. • The public would use this service to determine which route and/or mode they use for their trips.	• RTMC and Minneapolis TMC operate transportation management systems on their roadways. • Transit authorities operate their own transit systems.	• MnDOT and ICM Project Partners applied for federal funds to implement its ICM strategies on the I-394 corridor. • Effectiveness of strategies will be modeled. • Communications links and policies between partners will be enhanced. • One agency managing regional traffic operations and principal arterial operations in multiple jurisdictions in the region.	• RTMC and the City of Minneapolis are responsible to plan, design, construct, operate, and maintain their transportation management systems. • Metro Transit is responsible to plan, design, construct, operate, and maintain their transit system • RTMC, Hennepin County TMC, Minneapolis TMC, and Metro Transit will be responsible for collecting and archiving network-specific data.	• An ICM system includes interconnects between roadside equipment and the RTMC and Minneapolis TMC. • An ICM system also includes interconnects between transit centers and transit vehicles. • An ICM system in the Twin Cities includes interconnects between the RTMC, Minneapolis TMC, and Metro Transit centers.	• Data on network and roadway/ bus route performance from use of ICM strategies should be archived for evaluation and analysis.	• TM03 • TM05 • TM07 • TM09 • TM10 • TM16 • SU03 • ST06

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S42	Use roadside data collectors to determine locations with frequent occurrence of speeding	• MnDOT and local agencies deploy speed detectors at locations to collect historic data. • MSP and local agencies use historic speed data to determine locations to target speeding enforcement.	• MnDOT uses roadside speed detectors to collect speed information. Data is available in PeMS for analysis and performance reporting.	• MnDOT and local agencies will record and analyze speed data to determine locations with a high incident of speeding and provide this information to MSP and local enforcement. • MnDOT and local agencies will use portable detection capability to track speeds in rural areas with high crash history.	• MnDOT and local agencies are responsible to plan, design, and construct, speed data gathering systems and to analyze the data. • MSP and enforcement agencies are responsible to deploy speed enforcement measures at identified locations.	• This service includes interconnects between roadside speed data collection equipment and central processing systems.	• This service requires archiving of speed data for analysis of locations with high incidents of speeding.	• TM17 • DM01 • DM02
ATM S51	Collect and manage traffic signal performance measures	• MnDOT utilizes traffic data from new and existing sources to develop a set of Automated Traffic Signal Performance Measures as required by FAST Act.	• MnDOT and local agencies monitor traffic signal operations and update timing plans as appropriate.	• Use automated monitoring system to aid in improving operations and in collecting data for use in creating Automated Traffic Signal Performance Measures. • Implement connected vehicle technologies to assist in data collection and performance measures.	• MnDOT and local agencies are responsible to plan, design, implement, operate, and maintain traffic signal monitoring and data collection systems.	• Traffic signal monitoring and data collection includes interconnects between roadside equipment and TMCs.	• Archived data can be used for analyze traffic signal performance.	• TM02 • DM02

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S52	Implement modern signal counters	• MnDOT and local agencies deploy advanced technology at signalized intersections to perform vehicle counts.	• MnDOT and local agencies use traffic counting devices at signalized intersections and mid-block locations to collect traffic volumes.	• Deploy advanced traffic data collection systems to gather traffic counts at signalized intersections. • Implement connected vehicle technologies to obtain higher resolution traffic data and improve operations and safety.	• Each agency is responsible to plan, design, construct, operate and maintain own traffic signal systems, including detection and counters.	• This service includes interconnects between traffic signal roadside equipment and the RTMC/local TMCs.	• Traffic data collected should be archived for performance monitoring, evaluation and reporting.	• TM02 • TM03 • TM04

Service Package TM02-Vehicle-Based Traffic Surveillance

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S51	Collect and manage traffic signal performance measures	See information under TM01.						
ATM S52	Implement modern signal counters	See information under TM01.						

Service Package TM03-Traffic Signal Control

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S01	Provide efficient signal timing	• MnDOT and local agencies analyze signal operations and implement efficient signal timing strategies and plans. • MnDOT and local agencies use signal coordination at consecutive signalized intersections to improve traffic flow along major arterial corridors. • MnDOT and local agencies evaluate signal coordination and improve operations. • Drivers experience fewer stops and less delay due to improved signal timing operations.	• MnDOT and local agencies operate coordinated signal systems which facilitate traffic flow through consecutive traffic signals along major arterial roads and highways. • MnDOT and local agencies also performs arterial traffic modeling.	• Utilize bus and/or truck traffic signal priority to reduce traffic congestion. • Implement coordinated signal timing plans cross jurisdictional boundaries. • Use modeling systems to annually evaluate efficiency of coordinated traffic signal systems. • One agency managing traffic operations and principal arterial operations in multiple jurisdictions in the region • Ability to access signal phase and timing information of adjacent systems and coordinate with other agencies. • Implement connected vehicle technologies to improve signal operations.	• MnDOT and local agencies are responsible to plan, design, implement, operate, maintain, monitor, and update the efficiency of signal timing plans.	• Signal systems include interconnects between roadside equipment and TMCs. • Coordinated traffic signal systems also include interconnects between roadside equipment and roadside equipment. • Some traffic signal roadside equipment includes interconnects between Advanced Warning Flashers to alert drivers of changing traffic signals.	• Traffic signal timing changes and intersection performance data should be archived for evaluation and reporting.	• TM07

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S02	Implement red-light running technology	• Local law enforcement agencies use systems to automatically detect red light violators at signalized intersections and manage photographic evidence of violations in real-time.	• MnDOT and local agencies are currently testing a collision prevention system that automatically detects red-light violators. Data is then used to develop engineering and enforcement (but not automated citations) counter measures to reduce violations.	• Automated red-light running enforcement is not permissible under current statute. Legislation must be passed to authorize it. • Deploy system at signalized intersections with highest crash and near miss rates around Minnesota.	• Local law enforcement agencies and other local agencies are responsible to plan, design, construct, operate, and maintain their own red-light running systems.	• Red-light running systems include interconnect between roadside detection equipment and roadside traffic signal systems. • Each red-light running system includes interconnects from roadside equipment to the law enforcement agency.	• Violation data including vehicle detection, time, date, and violation will be archived for performance measures and/or citation use.	• VS01 • VS13
ATM S14	Monitor operation and performance of traffic signals	• MnDOT and local agencies use detectors, video monitoring cameras and signal control software to monitoring signal timing operations and performance.	• MnDOT and local agencies monitor traffic signal operations and update timing plans as appropriate.	• Implement additional traffic signal monitoring systems and centralized traffic signal control systems to major corridors and networks. • Use automated monitoring system (Automated Traffic Signal Performance Measures or ATSPMs) to aid in improving operations.	• MnDOT and local agencies are responsible to plan, design, implement, operate, and maintain traffic signal monitoring devices and software.	• Traffic signal monitoring includes interconnects between roadside equipment and TMCs.	• Traffic signal timing changes and intersection performance data should be archived for evaluation and reporting.	

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S36	Implement Integrated Corridor Management (ICM) strategies	See information under TM01.						
ATM S37	Provide safe signal phase transition	• MnDOT and local agency investigate and implement safe signal phase transition (i.e. sufficient yellow and all-red signal phases) at intersections with high crash rates to reduce crashes. • Drivers use this enhancement to safely complete vehicle maneuvers.	• Some cities are varying signal transition phases at key intersections. • Signal phase transitions have not changed in many locations in years. • St. Cloud has a queue detection system to warn drivers about upcoming queues delayed at signals.	• Implement safe signal transition phase at signalized intersections with a high rate of incidents throughout the state.	• MnDOT and local agencies are responsible to plan, design, implement, and operate timing plans at signalized intersections.	• Traffic signals are either self-contained roadside units or include interconnects between roadside equipment and TMCs.	• None	• TM12
ATM S52	Implement modern signal counters	See information under TM01.						

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S53	Improve signal communication	• MnDOT and local agencies install fiber optic cable and other communications to communicate with traffic signal controllers and perform control and monitoring remotely. • MnDOT and local agencies install traffic signal interconnects to enable more efficient signal coordination and operations. • Drivers experience fewer stops and less delay due to improved signal timing operations.	• MnDOT and local agencies use a variety of communications methods (fiber, copper, wireless, etc.) to connect traffic signals to central traffic signal control systems and to interconnect traffic signals.	• Replace obsolete technology and replace it with modern technology that meets the current needs. • Install additional communications links to interconnect additional traffic signals.	• MnDOT and local agencies are responsible to plan, design, implement, operate, maintain traffic signal systems, including communications.	• Signal systems include interconnects between roadside equipment and TMCs. • Coordinated traffic signal systems also include interconnects between roadside equipment and roadside equipment. • Some traffic signal roadside equipment includes interconnects between Advanced Warning Flashers to alert drivers of changing traffic signals.	• Traffic signal timing changes and intersection performance data should be archived for evaluation and reporting.	

Service Package TM04-Connected Vehicle Traffic Signal System

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S52	Implement modern signal counters	See information under TM01.						
MCM 20	Snow plow priority at traffic signals and ramp meters	• MnDOT uses connected vehicle technology to enable snow plows to receive priority at traffic signals and ramp meters.	• As part of the Connected Corridor Program, MnDOT is currently in the planning stage to implement connected vehicle technology for snow plow signal priority.	• Implement the Connected Corridor system to enable snow plows to request and receive priority at signalized intersections and ramp meters.	• MnDOT is responsible to plan, design, construct, operate and maintain the snow plow signal priority system.	• This service includes interconnects between connected vehicle roadside equipment and snow plow on-board equipment.	• Data collected through the system should be archived for research and operational analysis.	• SU01 • SU02

Service Package TM05-Traffic Metering

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S23	Operate ramp meters	• MnDOT RTMC operates ramp meters to regulate traffic flow, mitigate freeway congestion, and improve safety. • RTMC adjusts metering rates and strategies based on mainline conditions and ramp demands. • MnDOT SRCC will operate ramp meters in the Rochester area.	• Over 400 ramp meters are deployed on many on ramps in the Twin Cities.	• Add more ramp meters to metro area on ramps to improve traffic flow and safety. • Continually reevaluate and refine ramp metering algorithm. • Ramp meters on I-35 in Duluth to be used as a construction mitigation tool.	• RTMC is responsible for the planning, design, construction, operations, and maintenance of its ramp meters.	• Ramp metering systems include interconnects between roadside equipment (detectors, meters, and warning flashers) and the RTMC.	• None.	
ATM S36	Implement Integrated Corridor Management (ICM) strategies	See information under TM01.						

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S39	Monitor queue length at ramps, incident scenes and work zones	• MnDOT RTMC monitors traffic backups on ramps and adjusts ramp meter timing. • RTMC, SRCC, MnDOT maintenance and local agencies monitor backups approaching work zones and activate counter measures. • RTMC, SRCC, and local agencies monitor backups caused by incidents.	• The RTMC uses video monitoring cameras and queue detectors to monitor queues on some ramps. • Queue monitoring has been used in some construction projects and has been incorporated into the dynamic late merge system. • RTMC and SRCC use video monitoring cameras to monitor queues approaching work zones and incidents.	• Implement queue detection at more ramp locations with meters. • Improve queue detection technology. • Implement queue detection systems at work zones. • Video monitoring capability is being added to TH 13 arterial for monitoring of corridor.	• MnDOT and local agencies are responsible to plan, design, construct, operate, and maintain their own queue detection and monitoring systems. • MnDOT Construction & Maintenance is responsible to plan, design, deploy, operate, and maintain their portable detection system for work zones.	• Queue monitoring systems include interconnects between the roadside detection/ monitoring equipment and TMCs. • Detection/monitoring systems for work zones include interconnects between roadside detection/monitoring equipment and permanent or portable traffic management systems as well as between roadside detection/monitoring equipment and portable roadside DMS/HAR.	• Queue detection data should be routinely saved for use in performance measures and future traffic management planning.	• TM12 • MC06

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S47	Study the potential use of ramp meters in larger urban areas outside the Metro	• MnDOT studies the feasibility of implement ramp meters in large urban areas outside the Metro area. • MnDOT RTMC/SRCC operates ramp meters to regulate traffic flow, mitigate freeway congestion, and improve safety. • RTMC/SRCC adjusts metering rates and strategies based on mainline conditions and ramp demands.	• Ramp meters are currently installed and operational in the Twin Cities area.	• Investigate feasibility and as appropriate implement ramp meters at locations in large urban areas outside of the Twin Cities area.	• MnDOT is responsible for the planning, design, construction, operations, and maintenance of its ramp meters.	• Ramp metering systems include interconnects between roadside equipment (detectors, meters, and warning flashers) and the RTMC/SRCC.	• None.	

Service Package TM06-Traffic Information Dissemination

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S05	Provide real-time incident and congestion information to travelers	• MnDOT and local agencies provide travelers with real-time congestion information via DMS, HAR, and 511, websites, social media, mobile apps, etc. • MnDOT and local agencies provide information on incidents to travelers via multiple media to alert them of congestion and closures caused by incidents. • Travelers use information to make travel decisions based on travel times and routes.	• RTMC provides congestion, incident, and travel time information in the Twin Cities metro area via the 511 system, DMS, and KBEM radio system. • MnDOT 511 system provides incident and congestion information statewide. • Local agencies also provide real-time congestion information to travelers via DMS and websites.	• Provide congestion information for recreational/ seasonal traffic generators in greater Minnesota. • Complete instrumentation of metro area freeways to provide congestion information. • Provide congestion monitoring for key expressways and arterials in the metro area.	• RTMC is responsible to plan, design, construct, operate, and maintain its congestion monitoring and information dissemination systems in the metro area. • SRCC is responsible to plan, design, construct, operate, and maintain its congestion monitoring and information dissemination systems in the Rochester area. • Local agencies and transit service providers are responsible to plan, design, construct, operate and maintain their systems.	• This service includes interconnects between roadside detection equipment and TMCs. • It also includes interconnects between roadside DMS and HAR equipment to TMCs. • Interconnects between TMCs and 511 system are also needed.	• Historic congestion information will be archived for planning and operational analysis.	• TI01 • TI02

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S15	Provide estimated travel time information to travelers	See information under TM01.						

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S17	Provide travel information on special events	• MnDOT and local agencies gather information from special events organizers. • MnDOT and local agencies coordinate with event organizers and other agencies on event management plans. • MnDOT and local agencies provide information on an event's traffic impacts to the public via the internet, media, DMS, HAR, and 511 system. • Private information providers distribute special event information to the public. • The public uses special event information to make travel decisions.	• MnDOT and local agencies use DMS, HAR, 511 system, internet and the media to provide event, travel, and parking information to travelers.	• Provide real-time or near real-time information regarding travel routes, traffic conditions, parking directions and availability, and transit options. • Develop special event traffic management plans for new event venues as needed.	• MnDOT and local agencies are responsible for the planning, design, construction, operations, and maintenance of their system for information dissemination. • MnDOT, local agencies, law enforcement, and event organizers are responsible for event and traffic management planning and coordination. They are also responsible for providing information to the media and the public.	• This service includes interconnects between TMCs and roadside equipment (DMS and HAR). • This service also includes interconnects between TMCs, and travel information systems (511, web sites). • It also includes interconnects between event organizers and TMCs.	• None	• TI01

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S24	Operate freeway/ expressway/ arterial DMS	• MnDOT and other agencies (i.e. law enforcement) use DMS to provide congestion, travel time, road weather conditions, maintenance and construction, incident, safety, security, and emergency information to travelers. • Travelers use information on DMS to make travel decisions.	• MnDOT Metro has over 85 DMS, and more are deployed in other districts. • Many local agencies have DMS on arterials to provide traveler information. • Operations of DMS are capable of being shared between agencies. • Hennepin County uses DMS for a queue detection situation. • Portable/ temporary DMS have been integrated into comprehensive systems.	• Expand DMS deployment. Deploy additional DMS at key decision points throughout Minnesota. • Improve cross-jurisdictional operations (i.e. among MnDOT districts, between MnDOT and local agencies, and between states).	• MnDOT RTMC, SRCC, and other state agencies (i.e. State Patrol, Maintenance, etc.) are responsible for the planning, design, construction, operations, and maintenance of DMS systems on freeways/ expressways. • Local agencies are responsible for their systems.	• DMS systems include interconnects between roadside DMS equipment and TMCs and other agencies controlling DMS operation.	• None	

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S43	Notify travelers of snowplow operations and cleanup using DMS	• MnDOT and local agencies track snowplow locations and activities and use DMS to provide snowplow location notices and snow cleanup maintenance information to travelers. • Travelers observe information on DMS and take precaution as approaching and passing snowplows in operation.	• Many snowplows are equipped with AVL to assist maintenance and traffic management staff to track snowplow locations. • MnDOT Metro has over 85 DMS, and more are deployed in other districts. • Operations of DMS are capable of being shared between agencies.	• Expand AVL capability to additional MnDOT and local agencies' snowplow and maintenance vehicles. • Expand DMS deployment. Deploy additional DMS at key decision points throughout Minnesota.	• Each agency is responsible for the planning, design, construction, operations, and maintenance of their DMS and AVL systems.	• DMS systems include interconnects between roadside DMS equipment and TMCs and other agencies controlling DMS operation. • This service also includes interconnects between in-vehicle equipment and maintenance dispatch centers. • Interconnects are also needed between maintenance dispatch centers and TMCs.	• None	• MC04

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S45	Provide road closure information for far away closures	• MnDOT and local agencies provide information on road closures to drivers via DMS and HAR far in advances of the closures. • MnDOT and local agencies also provide road closure information to the public via the internet, media, and the 511 system. • The public uses the information to find alternate routes.	• MnDOT and local agencies use DMS, HAR, 511 system, internet and the media to provide road closure information to travelers.	• Provide road closure information far in advance of the closures, prior to key decision points for alternate routes. • Provide information on alternate routes and real-time or near real-time information regarding traffic conditions and expected delays on alternate routes.	• MnDOT and local agencies are responsible for the planning, design, construction, operations, and maintenance of their system for information dissemination. • MnDOT and local agencies are responsible for road closures and alternate route planning and coordination. They are also responsible for providing information to the media and the public.	• This service includes interconnects between TMCs and roadside equipment (DMS and HAR). • This service also includes interconnects between TMCs, and travel information systems (511, web sites).	• None	• TM19 • TI01

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S46	Provide systems for large area disaster management	• MnDOT, local transportation agencies, and emergency management agencies use these systems to detect and monitor disasters, provide notifications to other agencies and disseminate disaster and evacuation information to the public. • MnDOT, local agencies and emergency management agencies also use the systems to manage disaster response and recovery activities. These system are also used to manage evacuation from a disaster area and subsequently reentry to the area.	• DPS operates the SEOC and provides disaster information to transportation agencies, public safety agencies, and media. • MnDOT provides information to public via traveler information systems including 511, DMS, and advisory radio (HAR, LPFM, KBEM, etc.). • MnDOT provides web-based camera feeds as available for other agencies and the public. • Local agencies disseminate information via web sites, DMS, and other communication channels (such as cable TV).	• Enhance evacuation/ reentry simulations to provide better information. • Develop systems to recommend alternate routes based on real-time information and historic travel information. • MnDOT plans to provide information through In-vehicle capabilities (VII) in future. • Gap in center-to-center and/or information sharing.	• Agency in charge of disaster management will work with DPS and MnDOT will determine evacuation and reentry information and using traveler information systems (including DMS, HAR, 511, web sites, and media) to distribute the information to travelers.	• This service includes interconnects between centers (SEOC, County EOCs, the RTMC, and SRCC) and, traveler information systems roadside equipment, media, and private traveler information providers.	• Evacuation/ reentry information will be archived for post-event debriefings, training, and event analysis. • Stakeholders would want detector, cameras, etc. data for post-event de-briefing and management.	• PS10 • PS11 • PS12 • PS14

Service Packages TM07-Regional Traffic Management

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S01	Provide efficient signal timing	See information under TM03.						
ATM S36	Implement Integrated Corridor Management (ICM) strategies	See information under TM01.						

Service Packages TM08-Traffic Incident Management System

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S04	Provide cameras at locations with high incidents for incident identification and verification	See information under TM01.						
ATM S09	Share video, data and other information with PSAPs	See information under TM01.						

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S12	Reduce clearance time for primary crashes	• MnDOT, MSP, local agencies and other response agencies use ITS and communications to assist in coordination and information sharing for incident response and clearance, and for restoring traffic to normal flow.	• Several ITS technologies and applications are currently used in incident response – video monitoring cameras, FIRST responders, CAD, EVP, DMS, detection, and communication between transportation agencies and responders. • Several PSAP's currently receive streaming video over the internet.	• Share video among transportation management and emergency management agencies. • Provide live motion video to the public over the Internet. • Incorporate State Patrol's CAD-to-CAD capability with CAD systems for local agencies. • Provide additional interagency training for incident management.	• Transportation agencies are responsible to coordinate with emergency management agencies with information, data, and video sharing. • Emergency management agencies are responsible for CAD system integration.	• This service includes interconnects between roadside equipment and TMCs/ emergency management agencies. • This service also includes interconnects between TMCs and emergency management agencies. • Interconnects are also needed between emergency management agencies.	• CAD messages will be archived for future analysis, training, and tort claims issues. • General system data needs to be archived to indicate how the system worked and responded to the incident.	• PS01 • PS02 • PS03

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S13	Provide incident information to emergency management agencies	• MnDOT and local agencies detect incidents through ITS devices, or observations of TMC operators or field personnel. • MnDOT and local agencies share incident information with appropriate emergency management agencies. • Emergency management agencies verify and assess incidents and execute response plans accordingly. • MnDOT, State Patrol, and local agencies analyze and determine the impact of incidents on travel.	• MnDOT shares incident information with State Patrol.	• Integrate State Patrol and MnDOT Maintenance CAD with CARS to input more incidents. • Integrate CAD systems among local agencies. • Enhance local agencies' abilities to provide incident information on local routes to emergency management agencies. • Automate incident updates between MnDOT and affected jurisdictions.	• Each agency is responsible for the planning, design, construction, operations, and maintenance of its system for information sharing. • MnDOT and State Patrol are responsible for the planning, design, deployment, operations, and maintenance of the interface and integration between CAD systems and CARS. • Local agencies are responsible to plan, design, implement, operate and maintain integrated CAD systems.	• This service includes interconnects between 911 dispatch centers/ incident response agencies and TMCs. • It also includes interconnects between TMCs, MCM centers, incident management centers, and the CARS central system for incident information input. • It also includes interconnects between TMCs and roadside equipment.	• Incident information will be archived for future review and training. • Need for archiving incident information extends to local roads.	

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S16	Identify alternate routes	• MnDOT and local agencies work together to identify alternate routes for various scenarios. • MnDOT and local agencies detour traffic to alternate routes when a roadway is closed, congested, or has reduced capacity due to incidents, emergencies, evacuations, or planned events.	• MnDOT Districts have identified alternate routes for limited scenarios based on location and incomplete sets of performance information. • Evacuation routes and traffic management plans have been identified and evaluated in the Twin Cities metro area. • Message of “Use Alternate Routes” is presented on DMS during incidents, allowing drivers to determine the routes themselves.	• Develop and update a database incorporating roadway capacity, restrictions, construction information, and additional information to be used in recommending alternate routes. • Develop a system to automatically identify alternate routes based on various factors input by operators.	• MnDOT and local agencies are responsible to plan, design, develop, and maintain the alternate route identification system. • Responsibilities will vary based upon the route classification (i.e. state or local roads).	• Alternate route identification system includes interconnects between alternate route database and TMCs and MCM centers.	• None.	• TM09 • PS13 • PS14

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S22	Provide a system-coordinated response for incidents and emergencies	• Transportation and public safety agencies use ITS and communications to coordinate response to an incident or emergency. • Transportation and public safety agencies communicate with each other and share information and resources.	• Transportation agencies currently communicate with emergency response agencies when an incident occurs on the transportation system. • MnDOT and the State Patrol dispatchers are collocated at the RTMC and SRCC. • Agencies have adopted the NIMS structure for incident response.	• Incorporate State Patrol's CAD-to-CAD capability with CAD systems for local agencies. • There will be an expansion of the use of the ARMER statewide shared radio system. • There is currently not enough interagency training.	• Transportation and public safety agencies are responsible to plan, design, construct, operate, integrate, and maintain their communications and CAD systems. • Agencies should coordinate with each other to establish common communications channels for effective communications during incidents and emergencies.	• This service will include interconnects between TMCs, 911 dispatch centers and emergency operations centers. • This service will also include interconnects between centers and vehicles; and between centers and roadside equipment for incident verification and monitoring.	• CAD messages will be archived for future analysis, training, and tort claims issues. • General system data needs to be archived to indicate how the system worked and responded to the incident.	

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S41	Improve incident investigation capabilities	• Make total stations and/or photogrammetry equipment available to all agencies investigating accidents. • State Patrol troopers and local public safety personnel close an incident scene for as long as it takes to collect and review evidence of a crash scene.	• MSP and local agencies use robotic total stations and/or photogrammetry equipment to quickly and thoroughly record an incident site for 3-dimensional re-creation later, allowing an incident scene to be opened in less time and increase the safety of public safety personnel and motoring public.	• Make robotic total stations and/or photogrammetry available to public safety agencies for incident investigation, crash scene reconstruction and documentation. • Systems are not distributed to all that could use them. • Use drones for crash scene reconstruction and documentation.	• Agencies are responsible for procuring and maintaining their own equipment and training staff.	• None. Total stations and photogrammetry equipment are self-contained systems made of cameras used to gather images and computers to process them and develop recreations.	• High resolution images and 3-dimensional simulations of incident scenes will need to be stored with incident files.	

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S44	Provide incident detection systems	• MnDOT and local agencies use incident detection systems to detect and verify incidents. • MnDOT and local agencies notify law enforcement and emergency responders of roadway incidents.	• Transportation agencies and emergency responders currently receive incident reports and notifications through citizens (via 911 calls) and agency staff (field observations). • Transportation agencies also use video monitoring cameras to manually detect and verify incidents.	• Research, develop and test automated incident detection systems. • Current incident detection systems tend to report a large amount of fault detection.	• Private sectors and academia will research, develop, test and improve the systems. • Agencies are responsible for planning, procuring, operating and maintaining the systems.	• This service includes interconnects between roadside equipment for incident detection and TMCs. • This service also includes interconnects between TMCs and 911 dispatch centers.	• Incident information will be logged and archived. • General system data needs to be archived to indicate the accuracy and effectiveness of the system.	
ATM S54	Import of WAZE and other crowd sourced data to mine for incidents	• MnDOT imports and integrates traffic incident data from WAZE and other crowd sourced data with data reported by MSP and MnDOT • MnDOT develops and uses tools to verify and validate incident data from WAZE and other crowd sourced database. • MnDOT uses the valid and fused data mine for traffic incidents.	• MnDOT currently uses third party speed and travel time data to supplement MnDOT detector data for generating traffic flow/congestion maps. • MnDOT uses incident reports from MSP along with detectors and video monitoring cameras for incident detection and verification.	• Investigate and develop filtering techniques for assessing incident reports and alert notifications from WAZE and other crowd sourced data. • Develop and improve techniques to mine for incidents using WAZE and crowd sourced data.	• MnDOT is responsible to work with WAZE and other crowd sourced data providers to establish partnerships. • MnDOT is responsible to plan, develop, implement, operate, and maintain a data mining system for incident detection and verification.	• This service includes interconnects between MnDOT RTMC/SRCC and private third party data providers; and interconnects between MnDOT RTMC/SRCC and MSP.	• Verified incidents should be archived.	• SU03

Service Packages TM09-Integrated Decision Support and Demand Management

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S03	Use archived data for traffic management strategy development and long range planning	• MnDOT OIM, ODS, and local agencies (i.e. Metropolitan Council) utilize collected traffic data to determine effective strategies and actions (i.e. project development) to address transportation challenges.	• MnDOT and local agencies currently collect traffic volume, crash, and other traffic event data for planning use. • MnDOT RTMC uses PeMS (Performance Monitoring System) to obtain and analyze performance measures. • MnDOT uses traffic signal location data for origin-destination studies.	• Develop an automated system for data archiving. • Develop a user-friendly system to quickly find and process archived data. • Develop planning and operations models that incorporate non-ideal conditions, such as lane closures or emergencies. • Incorporate data into Metro GIS mapping efforts. • PeMS (Performance Measurement System) can be used in analyzing mobility measures with respect to operations and MAP-21.	• MnDOT TDA and RTMC are responsible to plan, design, construct, operate, integrate, and maintain data archive systems. • Local agencies are responsible to plan, design, construct, operate, and maintain their own data archives.	• This service includes interconnects between TMCs and Data Archives; and between Data Archives and archive data users. • This service also includes interconnects between MnDOT (state) level data and city/county (local) level data.	• This service is dependent on archived data from other services. Statewide data formatting and archiving standards are necessary for this service to be used for all planning and traffic management purposes.	• DM01 • DM02
ATM S16	Identify alternate routes	See information under TM08.						

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S36	Implement Integrated Corridor Management (ICM) strategies	See information under TM01.						

Service Packages TM10-Electronic Toll Collection

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S20	Operate dynamic shoulders	• MnDOT operates dynamic shoulders to allow single occupancy vehicles (SOV) to use shoulders in order to reduce overall congestion and divert traffic from other lanes during traffic incidents. • Transit, HOV, and motorcycles can use the lanes free of charge. SOV drivers can enter the lanes for a fee based on the level of congestion. • Tolls for SOV are collected electronically using MnPASS transponders. • Toll rates are displayed via dynamic message signs prior to access points. • MSP and local law enforcement agencies monitor lane users and enforce compliance.	• There are currently no priced dynamic shoulder lanes in Minnesota. They are planned to be deployed on I-35W in Minneapolis between 46th Street and downtown. • Bus-only shoulders are utilized throughout the metro area for transit vehicles.	• Priced and un-priced dynamic shoulder lanes are planned for I-35W in Minneapolis between 46th Street and downtown. • Pricing algorithm will be further refined. • Electronic overhead lane control signs will be used to operate the shoulder lanes.	• MnDOT is responsible to plan, design, implement, operate, and maintain the dynamic shoulders in the metro area. • MSP and local law enforcement agencies are responsible to enforce appropriate usage of lanes.	• Dynamic shoulder systems include interconnects between vehicles and roadside equipment for toll collection. • Systems also include interconnects between roadside toll equipment and the toll collection center for account monitoring. • Systems also include interconnects between roadside detection, lane control equipment, DMS, and the RTMC. • Systems include interconnects between toll collection center and the RTMC.	• MnPASS data including volume, speed, revenue, and violations should be archived. This data will be used for performance monitoring and reporting. • MnPASS user account transactions should also be archived for back-office account management.	• TM22 • ST06

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S26	Operate and enforce MnPASS lanes	• MnDOT RTMC operates the dynamically priced MnPASS lanes to allow SOV to use the facility to reduce overall congestion. • Transit, HOV, and motorcycles use the lanes free of charge. SOV drivers can enter the lanes for a fee based on the level of congestion. • Tolls for SOVs are collected electronically using MnPASS transponders. • Toll rates are displayed via overhead electronic signs prior to access points. • MSP and local law enforcement agencies monitor lane users and enforce compliance.	• MnPASS lanes are currently operational on I-394, I-35E and I-35W in the Twin Cities Metro Area. • Priced dynamic shoulder lanes, similar to the I-394 MnPASS, have been implemented on I-35W from 46th Street to downtown Minneapolis, as well as on I-94 between Minneapolis and St. Paul. • Minnesota State Patrol (MSP) is primarily being utilized as enforcement on MnPASS lanes.	• Implement additional MnPASS lanes in the Metro area. • Develop an automated vehicle passenger occupancy detection system to assist enforcement. • Integration of MnPASS with other toll systems (part of MAP-21 legislation).	• MnDOT will plan, design, implement, operate, and maintain MnPASS lanes in the Twin Cities metro area. • MSP and local law enforcement agencies are responsible to enforce appropriate usage of lanes.	• MnPASS systems include interconnects between vehicles and roadside equipment for toll collection. • Systems also include interconnects between roadside toll equipment and the toll collection center for account monitoring. • Systems also include interconnects between roadside detection, lane control equipment, DMS, and the RTMC. • Systems include interconnects between toll collection center and the RTMC.	• MnPASS data including volume, speed, revenue, and violations is archived. This data is used for performance monitoring and reporting. MnPASS user account transactions should also be archived for back-office account management.	• TM16 • TM22 • ST06

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S30	Provide simple and integrated electronic payment systems	• Parking garage operators, toll operators, and transit operators integrate their payment systems into a single electronic payment system. • Travelers use a single payment card/device to pay parking, toll, and transit fare electronically.	• MnPASS is currently used on I-394 for pay tolls. • City of Minneapolis parking ramps use a separate automated payment system.	• Integrate MnPASS with City of Minneapolis parking payment systems. • Integrate various payment systems for transit, parking, and MnPASS to a single system. • Integration of MnPASS with other toll systems (part of MAP-21 legislation).	• MnDOT, City of Minneapolis, parking operators and transit operators are responsible to coordinate and integrate MnPASS into the parking fee payment systems.	• Electronic payment systems include interconnects between in-vehicle transponders and roadside readers. • Systems also include interconnects between roadside equipment and parking management systems. • Interconnects between parking management systems and the MnPASS customer center are also needed.	• Account transactions and parking utilization data should also be archived for back-office account management.	• PM03 • PT04 • PT18
ATM S36	Implement Integrated Corridor Management (ICM) strategies	See information under TM01.						

Service Package TM11-Road Use Charging

MnDOT has conducted studies and technology tests with respect to road user fee. However, no needs or services under this service package were identified by stakeholders.

Service Package TM12-Dynamic Roadway Warning

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S34	Provide roadway flood warnings	• MnDOT and local agencies use these systems to detect potential and actual flooding affecting roadways, alert state and local enforcement, and provide warnings to travelers and information on alternate routes through various means (DMS, HAR, 511). • Drivers use these systems to avoid flooded roadways and reroute to their destination.	• Flood warning systems are planned in Austin. • Hazardous roadway warnings are an application of Intelligent Work Zones (IWZ) Systems.	• Deploy flood warning systems at locations with a history of flooding. • Develop automated data entry into 511 system.	• Each agency is responsible for the planning, design, construction, operations, and maintenance of its flood warning systems.	• Flood warning systems include interconnects between roadside detection equipment and roadside signs. • Systems also include interconnects between roadside equipment and TMCs, MCM centers, law enforcement, and emergency management.	• Need for archiving system activation logs.	• MC09 • WX03

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S35	Provide vehicle overheight detection/ warning systems	• MnDOT and local agencies use these systems to detect overheight vehicles, alert overheight vehicle drivers, and provide alternate route instructions. • Drivers of overheight vehicles follow instructions and take an alternate route.	• An overheight detection/warning system has been tested in MnDOT District 1B. • Other systems are operational in few places within the state.	• Deploy overheight detection/warning systems at locations with low height clearance bridge overpasses and tunnels. • Target deployment at locations experienced overheight incidents.	• Each agency is responsible for the planning, design, construction, operations, and maintenance of its overheight warning systems.	• This service includes interconnects between roadside detection equipment and roadside signage equipment. • It also includes interconnects between roadside equipment and TMCs and MCM centers. • It also includes interconnects between roadside equipment and in vehicle equipment for overheight vehicles.	• None.	• PS09 • VS11
ATM S37	Provide safe signal phase transition	See information under TM03.						
ATM S39	Monitor queue length at ramps, incident scenes and work zones	See information under TM05.						

Service Package TM13-Standard Railroad Grade Crossing

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S28	Provide railroad flashing light signals and gates	• MnDOT and railroad companies use this system to warn drivers of trains approaching crossing. • Drivers use this system to determine when they should wait for trains to cross. • This system connects with railroad companies.	• Many rural railroad crossings currently have passive warning systems as static signs. • Some railroad crossings already have active warning systems.	• Deploy active flashing light signals and gates at highway/ railroad intersections that have high risk factors. • Develop low-cost active warning systems for low-volume crossings and remote/rural areas.	• MnDOT and railroad companies are responsible to plan, design, and construct the active railroad crossing warning systems. • Railroad companies are responsible to design, construct and maintain the active railroad crossing warning systems. • Coordination is needed between MnDOT/local agencies and railroad companies in planning and design phases of the proposed systems with an interconnection feature in terms of ITS.	• Active railroad crossing warning systems include interconnects between wayside detection equipment and roadside warning equipment. • It also includes interconnects between roadside equipment and rail operators and MCM centers.	• Crossing equipment failure data will be archived for future safety and maintenance analysis.	• TM14

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S38	Provide health monitoring of rail crossings	• MnDOT Office of Freight and CVO will use this system to detect faults in the highway-rail intersection (HRI) equipment and send repair crews to perform maintenance. • Local traffic agencies and railroad companies will perform the health monitoring of rail crossings.	• Limited railroad crossings are currently equipped with health monitoring systems.	• Install HRI monitoring equipment at additional key crossings to transmit equipment failure data to HRI signal maintenance center.	• Local agencies or railroad companies are responsible to plan, design, construct, and maintain the railroad crossing health monitoring systems.	• Railroad crossing health monitoring system includes interconnects between roadside crossing equipment and MCM centers.	• Crossing equipment failure data will be logged and archived for future safety and maintenance analysis.	• TM14

Service Package TM14-Advanced Railroad Grade Crossing

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S28	Provide railroad flashing light signals and gates	See information under TM13.						
ATM S38	Provide health monitoring of rail crossings	See information under TM13.						

Service Package TM15-Railroad Operations Coordination

While there are significant railroad operations in Minnesota, no needs or services under this service package were identified by stakeholders.

Service Packages TM16-Reversible Lane Management

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S11	Operate reversible lanes	• MnDOT controls reversible lanes to maximize traffic throughout and mitigate congestion. • MnDOT uses video monitoring cameras to monitor reversible lane operations. • MnDOT sends field personnel to verify safe conditions prior to switching direction of traffic for reversible lanes.	• MnDOT currently operates reversible lanes on I-394 MnPASS HOT lanes in the metro area.	• MnDOT is considering implementing a reversible/contra-flow system at several locations in the metro area. • MnDOT may also consider moveable barriers as a means of implementing reversible lanes.	• MnDOT and/or local agencies are responsible to plan, design, construct, operate, and maintain the reversible lanes and associated systems.	• Reversible lane systems could include interconnects between roadside equipment (gates, signs, and monitoring equipment) and the RTMC.	• Will need to archive gate open and close events.	
ATM S26	Operate and enforce MnPASS lanes	See information under TM10.						
ATM S36	Implement Integrated Corridor Management (ICM) strategies	See information under TM01.						

Service Package TM17-Speed Warning and Enforcement

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S06	Provide speed enforcement at high risk locations to improve safety	• State Patrol and local agencies use automated speed monitoring and enforcement to reduce crashes at high risk locations.	• MnDOT and local agencies use dynamic speed feedback signs to inform drivers of their current speeds compared to the posted speed limits. • Law enforcement also enforces speeds in work zones where possible	• Automated speed enforcement is not permissible under current statute. Legislation must be passed to authorize it. • With legislation authorized, deploy system at locations where speed violations occur most often.	• Each agency is responsible to plan, design, construct, operate, and maintain its own automated speed enforcement systems.	• Speed enforcement systems include interconnects between roadway detection equipment and in-vehicle equipment in the enforcement vehicles. • The systems may also include interconnects between roadside detection equipment and roadside dynamic feedback/speed warning equipment.	• Speed enforcement data should be archived to study the potential effects of automated enforcement on speed limit compliance.	

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S08	Provide enhanced manual or automated speed enforcement to improve safety	• State Patrol and local agencies perform speed enforcement at locations experiencing frequent speeding as a deterrent to improve travel safety • State Patrol and local agencies use automated speed monitoring and enforcement to reduce crashes • Drivers comply with speed limits and travel with safe speeds.	• State Patrol and local enforcement agencies patrol roadways regularly to enforce and enhance speed compliance. • Target speed enforcement at locations with frequent speeding and/or high incidents due to speeding. • Provide extraordinary enforcement to increase presence at work zones.	• Increase automated speed enforcement is not permissible under current statute. Legislation must be passed to authorize it. • Conduct operational tests and move toward full legislative approval. • Perform automated speed enforcement in work zones when possible. • MnDOT is conducting a pilot project of enhanced speed compliance for work zones.	• State patrol and local agencies are responsible for performing speed enforcement.	• Speed enforcement does not include any interconnects. • Automated speed enforcement systems include interconnects between roadway detection equipment and in-vehicle equipment in the enforcement vehicles.	• Speeding and enforcement data should be archived.	• MC06

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S18	Provide dynamic speed feedback to drivers and enforcement agencies	• MnDOT and local agencies use dynamic speed feedback to alert drivers of their speeds. • MnDOT Construction and Maintenance and local agencies advise drivers on the speed to safely travel through a work zone. • Drivers view the speed information and make adjustment as appropriate.	• MnDOT and local agencies use dynamic feedback systems. • Speed Advisory Information is an application of the Intelligent Work Zone (IWZ) systems. • MnDOT uses these systems for maintenance and construction activities.	• Deploy dynamic advisory speed systems at more work zones to provide smooth traffic flow through work zones. • Deploy dynamic advisory speed systems at more permanent non-work zone locations.	• Each agency is responsible to plan, design, construct, operate, and maintain their own dynamic speed feedback systems. • Private contractors are also responsible for operating dynamic advisory speed systems in work zones.	• This service includes interconnects between roadway detection equipment and roadway signing equipment. • This service also includes interconnects between roadside signing equipment and remote server for system control.	• Speed feedback activation data should be archived for future analysis to determine how well the systems work. • Data collection options include local storage and real-time communica-tion.	• MC06
ATM S32	Provide curve speed warnings	• MnDOT and local agencies use this system to alert drivers to safe driving speeds for curves to reduce crashes. • Drivers use this system to determine safe driving speed.	• MnDOT has used this system on some curves. • Static signs are often used to recommend speeds for drivers. • Demonstration on I-694/I-94/I-494 is underway to provide truck drivers a warning to slow down.	• Deploy speed warning systems at curves with recurring adverse roadway conditions and/or high crash rates.	• Each agency is responsible to plan, design, construct, operate, and maintain its own curve speed warning systems.	• Speed warning systems include interconnects between roadway detection equipment and roadway sign equipment.	• None.	• VS05

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S40	Enhance enforcement in work zones	• MnDOT and local agencies use speed monitoring equipment to assist enforcement agencies with detecting speed violations in work zone. • MnDOT, State Patrol, and local agencies use automated speed enforcement as a deterrent to improve travel safety in work zones.	• MnDOT uses dynamic speed feedback signs to inform drivers of their current speeds compared to the posted speed limits. • State Patrol and local agencies perform manual enforcement in work zones.	• Increase manual enforcement in work zones and gradually move toward automated enforcement through operational tests and enabling legislation. • Automated speed enforcement is not permissible under current statute. Legislation must be passed to authorize it. • MnDOT is conducting a pilot project of enhanced speed compliance for work zones.	• State patrol and local agencies are responsible to perform enforcement in work zones. • Each agency is responsible to plan, design, construct, operate, and maintain their automated speed enforcement systems.	• Speed enforcement systems may include interconnects between roadway detection equipment, centers, and in-vehicle equipment.	• Speed enforcement data should be archived to study the potential effects of automated enforcement on speed limit compliance.	• MC06
ATM S42	Use roadside data collectors to determine locations with frequent occurrence of speeding	See information under TM01.						

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S48	Increase enforcement / presence of enforcement	• State Patrol and local enforcement agencies increase their presence and visibility on the road to the general public.	• MnDOT and local agencies use dynamic speed feedback signs to inform drivers of their current speeds compared to the posted speed limits. • MSP and local enforcement agencies enforce traffic law violations on the road, including work zones and MnPASS lanes.	• Increase manual enforcement and gradually move toward automated enforcement through operational tests and enabling legislation. • Automated speed enforcement is not permissible under current statute. Legislation must be passed to authorize it.	• State patrol and local agencies are responsible to perform enforcement on the road. • Each agency is responsible to plan, design, construct, operate, and maintain their automated enforcement systems.	• Automated enforcement systems include interconnects between roadway detection equipment and in-vehicle equipment in the enforcement vehicles.	• Enforcement/ violation data should be archived to study the potential effects of automated enforcement.	• TM22 • ST06
ATM S49	Crack down on distracted driving	• State Patrol and local agencies increase enforcement on distracted driving.	• MSP and local enforcement agencies visually monitor distracted drivers and perform enforcement.	• Test technology to detect distracted drivers.	• Each agency is responsible to procure, operate, and maintain systems for distracted driving detection	• Systems may include interconnects between roadway detection equipment and in-vehicle equipment in State Patrol vehicles	• Distracted driving data should be archived to study when it is being detected most frequently.	

Service Packages TM18-Drawbridge Management

While there are drawbridge operations in Minnesota, no needs or services under this service package were identified by stakeholders.

Service Package TM19-Roadway Closure Management

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S29	Provide automated/ remote control gate systems	• MnDOT remotely operate gates to close roadways or ramps due to unsafe driving conditions. • MnDOT or local agencies operate gate systems for reversible lanes. • RTMC and SRCC operators visually verify the safe activation of gate systems. • Systems also allow special transit access at transit/BRT stations	• An automated gate closure system is deployed on I-90 at Jackson.	• Provide additional systems at rural locations experiencing unsafe driving conditions. • Provide video monitoring cameras to assist verifying safe operation of the gate closure system.	• MnDOT is responsible to plan, design, construct, operate, and maintain the automated gate closure system in their jurisdictions.	• Automated/ remote control gate closure systems include interconnects between roadside equipment (gates and cameras) and TMCs. • The systems may also include interconnects between TMCs and roadside DMS equipment.	• Will need to archive gate open and close events.	
ATM S45	Provide road closure information for far away closures	See information under TM06.						

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S50	Keep drivers off the roads during winter storms	• Transportation agencies provide road weather conditions information to the public via 511, websites, social media, and media outlets to discourage travel in inclement weather. • MnDOT uses automated gate/ roadway closure systems to remotely close roadways or ramps due to unsafe driving conditions. • RTMC and SRCC operators visually verify the safe activation of roadway closure systems.	• MnDOT and local agencies disseminate road condition reports via 511, websites, mobile apps, and social media to the public. • MnDOT, MSP and local agencies work closely with media to provide updated road weather conditions to the public. • An automated gate closure system is deployed on I-90 at Jackson.	• Continue educational campaign discouraging unnecessary travel during inclement weather. • Provide additional systems at rural locations experiencing unsafe driving conditions. • Provide video monitoring cameras to assist verifying safe operation of the gate closure system.	• MnDOT RTMC and SRCC are responsible to plan, design, construct, operate, and maintain the automated gate closure system. • MnDOT and local agencies are responsible to provide road conditions information and advisory to the public.	• Automated/ remote control gate closure systems include interconnects between roadside equipment (gates and cameras) and TMCs. • The systems may also include interconnects between TMCs and roadside DMS equipment.	• Will need to archive gate open and close events.	• TI01 • TI02

Service Package TM20-Variable Speed Limits

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S10	Utilize variable speed limits	• MnDOT Districts, RTMC and SRCC provide safe travel speed information to drivers based on road weather conditions, congestion, incidents, work zones, or other factors. • Drivers adjust driving speeds based on posted speed limits.	• Test sites for variable speed limits are being conducted in the Metro area. • Lane control signals on I-35W and I-94 in the metro area provide variable speed advisory.	• Variable speed limits can be deployed at locations with high occurrences of crashes caused by visibility, road weather conditions, or fluctuations in traffic speeds.	• MnDOT Districts and RTMC will plan, design, implement, operate, and maintain systems.	• Variable speed limit systems include interconnects between TMCs and roadside equipment.	• Need to archive the variable speeds that are utilized and when speed limits are modified.	• TM21

Service Package TM21-Speed Harmonization

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S10	Utilize variable speed limits	See information under TM20.						

Service Package TM22-Dynamic Lane Management and Shoulder Use

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S07	Provide lane and shoulder control	• MnDOT operates dynamic lane control signals to alert drivers of lane open/closure. • Drivers react to lane control signals by moving into an open lane or out of a closed lane.	• MnDOT operates dynamic lane control signals on I-35W, I-94, and on eastbound and westbound traffic heading into the Lowry Hill tunnel and other tunnels statewide. • MnROAD facility operates dynamic lane control signals for vehicles along I-94 roadway test bed.	• Additional locations will include I-35E north of St. Paul and I-494 in the west metro.	• MnDOT and MnPASS are responsible to plan, design, implement, operate, and maintain lane and shoulder control system.	• Lane control systems include interconnects between roadside equipment and the RTMC.	• Need to investigate and determine the need for archiving the operation logs and status of the lane and shoulder control system.	

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S19	Operate in-pavement dynamic lane markings	• MnDOT RTMC uses this service to remotely direct traffic into other lanes or onto shoulders. • Drivers follow the lane markings to safely travel through problem areas. • MnROAD facility is used for re-routing of traffic along I-94.	• In-pavement LEDs have been tested at MnROAD.	• Deploy in-pavement dynamic lane markings on congested roadway segments in the Twin Cities metro area. • Enhance opening and closing of lanes with in-pavement dynamic lane markings.	• MnDOT RTMC is responsible to plan, design, implement, operate, and maintain the in-pavement dynamic lane markings in the metro area. • MnDOT Districts are responsible to plan, design, implement, operate, and maintain the in-pavement dynamic lane markings in greater Minnesota. • MnDOT is responsible to plan, design, implement, operate, and maintain the in-pavement dynamic lane markings for MnROAD.	• In-pavement dynamic lane markings include interconnects between pavement marking roadside equipment and TMCs.	• Will need to archive when in-pavement dynamic lane marking are utilized and the status of their operation.	
ATM S20	Operate dynamic shoulders	See information under TM10.						
ATM S26	Operate and enforce MnPASS lanes	See information under TM10.						

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S48	Increase enforcement/ presence of enforcement	See information under TM17.						

Service Package TM23-Border Management Systems

No needs or services under this service package were identified by stakeholders.

Service Package ST01-Emissions Monitoring[1]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S31	Monitor and collect air quality data	• Federal, state, and local agencies collect air quality data in selected areas to measure emissions and air pollution levels. • MnDOT Environmental Services and the Minnesota Pollution Control Agency (MPCA) use data to monitor and analyze air quality in the Twin Cities metro area. • MnDOT informs travelers of ozone and air quality information. • Travelers use air quality information to make travel and modal choices.	• Air quality sensors are installed on I-394 and the Lowry Tunnel in Minneapolis.	• Install additional air quality sensors at strategic locations. • Refine air quality analysis algorithms • Develop future strategies to reduce greenhouse gases.	• Federal, state (i.e. MnDOT), and local agencies are responsible to plan, design, construct, and maintain the air quality monitoring system. • MnDOT Planning is responsible for analysis of data for long term planning purposes.	• Air quality monitoring systems include interconnects from roadside equipment to the RTMC.	• Monitoring center should archive air quality data for future environmental study and analysis.	

[1] See Volume 12 – Sustainable Travel Service Package Area for the description of ST01 – Emission Monitoring.

Service Package ST06-HOV/HOT Lane Management[2]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S20	Operate dynamic shoulders	See information under TM10.						
ATM S26	Operate and enforce MnPASS lanes	See information under TM10.						
ATM S27	Provide HOV bypass lanes at ramp meter locations	• MnDOT provides HOV bypass at ramp metering locations to encourage carpooling and use of transit by allowing preferred access. • HOVs and transit vehicles use this service to bypass vehicle queues at on-ramp locations. • MSP and local law enforcement agencies enforce HOV requirements.	• Some metro area ramp meters currently have HOV bypass lanes.	• Construct HOV bypasses at additional metered ramp locations when requested by transit agencies • Develop automated vehicle passenger occupancy verification system for effective enforcement.	• MnDOT is responsible for the planning, design, construction, operations, and maintenance of HOV bypasses. • MSP and local law enforcement agencies are responsible to enforce occupancy compliance.	• Interconnect from HOV bypass ramp detection systems to RTMC. • Passenger occupancy verification systems include interconnects between roadside detection equipment and in-vehicle enforcement alert equipment.	• Passenger occupancy verification enforcement will be archived for performance measures analysis and citation use. • Vehicle detection data also needs to be archived.	
ATM S36	Implement Integrated Corridor Management (ICM) strategies	See information under TM01.						

[2] See Volume 12 – Sustainable Travel Service Package Area for the description of ST06 – HOV/HOT Lane Management.

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S48	Increase enforcement/presence of enforcement	See information under TM17.						

Service Package PM01-Parking Space Management[3]

[3] See Volume 9 – Parking Management Service Package Area for the description of PM01 – Parking Space Management.

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S21	Provide information on parking availability	• Parking operators use parking management systems to obtain parking availability and provide the information to the public via DMS at or near ramp entrances as well as via websites and mobile apps. • Parking operators share parking availability with transportation management agencies. • Drivers use availability information to make parking decisions. • Parking operators share availability information with other parking operators in the area for coordination and facilitation of regional parking management strategies.	• City of St. Paul has an advanced parking management system in downtown St. Paul. • University of Minnesota and Metropolitan Airports Commission operate parking management systems to monitor parking and distribute parking information to the public. • Minneapolis has an advanced parking management system for its ABC ramps. • Metro Transit has parking information systems at park-and-ride lots. • Truck parking availability systems are installed in the state.	• Upgrade the St. Paul parking management system, in particular the communications components. • Provide regional parking management systems to support coordination between parking facilities.	• Parking facility operators are responsible for coordination in planning, designing, constructing, and maintaining their parking management system. • Local agencies are responsible for coordinating with private parking ramp operators and encouraging regional information sharing and coordination.	• The parking management systems include interconnects between roadside equipment near the parking ramps and the parking operator. • Systems also include interconnects between parking operators and TMCs; and between parking operations in the same area.	• None	• PM02 • PM04

Service Package PM02-Smart Park and Ride System[4]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S21	Provide information on parking availability	See information under PM01.						

Service Package PM03-Parking Electronic Payment[5]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S30	Provide simple and integrated electronic payment systems	See information under TM10.						

Service Packages PM04-Regional Parking Management[6]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S21	Provide information on parking availability	See information under PM01.						

[4] See Volume 9 – Parking Management Service Package Area for the description of PM02 – Smart Park and Ride System.
[5] See Volume 9 – Parking Management Service Package Area for the description of PM03 – Parking Electronic Payment.
[6] See Volume 9 – Parking Management Service Package Area for the description of PM04 – Regional Parking Management.

Service Packages TI01-Broadcast Traveler Information[7]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S05	Provide incident and congestion information to travelers	See information under TM06.						
ATM S15	Provide operating speed/travel time information to travelers	See information under TM01.						
ATM S17	Provide travel information on special events	See information under TM06.						
ATM S45	Provide road closure information for far away closures	See information under TM06.						
ATM S50	Keep drivers off the roads during winter storms	See information under TM19.						

[7] See Volume 2 – Traveler Information Service Package Area for the description of TI01 – Broadcast Traveler Information.

Service Packages TI02-Personalized Traveler Information[8]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S05	Provide incident and congestion information to travelers	See information under TM06.						
ATM S50	Keep drivers off the roads during winter storms	See information under TM19.						

Service Packages DM01-ITS Data Warehouse[9]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S03	Use archived data for traffic management strategy development and long range planning	See information under TM09.						

[8] See Volume 2 – Traveler Information Service Package Area for the description of TI02 – Personalized Traveler Information.
[9] See Volume 1 – Data Management Service Package Area for the description of DM01 – ITS Data Warehouse.

Service Packages DM02-Performance Monitoring[10]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S03	Use archived data for traffic management strategy development and long range planning	See information under TM09.						
ATM S51	Collect and manage traffic signal performance measures	See information under TM01.						

Service Packages SU01-Connected Vehicle System Monitoring and Management[11]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
MCM 20	Snow plow priority at traffic signals and ramp meters	See information under TM04.						

Service Packages SU02-Core Authorization[12]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
MCM 20	Snow plow priority at traffic signals and ramp meters	See information under TM04.						

[10] See Volume 1 – Data Management Service Package Area for the description of DM02 – Performance Monitoring.
[11] See Volume 11 – Support Service Package Area for the description of SU01 – Connected Vehicle System Monitoring and Management.
[12] See Volume 11 – Support Service Package Area for the description of SU02 – Core Authorization.

Service Packages SU03-Data Distribution[13]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S36	Implement Integrated Corridor Management (ICM) strategies	See information under TM01.						
ATM S54	Import of WAZE and other crowd sourced data to mine for incidents	See information under TM08.						

Service Packages VS01-Autonomous Vehicle Safety Systems[14]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S02	Implement red-light running technology	See information under TM03.						

Service Package VS05-Curve Speed Warning[15]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S32	Provide curve speed warning	See information under TM17.						

[13] See Volume 11 – Support Service Package Area for the description of SU03 – Data Distribution.
[14] See Volume 8 – Vehicle Safety Service Package Area for the description of VS01 – Autonomous Vehicle Safety Systems.
[15] See Volume 8 – Vehicle Safety Service Package Area for the description of VS05 – Curve Speed Warning.

Service Package VS06-Stop Sign Gap Assist[16]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S33	Provide intersection collision avoidance systems	• MnDOT/Local Agencies use this service to alert drivers of unsafe gaps to avoid collisions at intersections. • Drivers use this service to take appropriate action to avoid collisions.	• MnDOT/Local Agencies are participating in FHWA's Cooperative Intersection Collision Avoidance System (CICAS) initiative.	• Test and deploy intersection warning systems at rural and suburban intersections. • Research, develop and test intersection collision avoidance systems. • Incorporate wireless communications and solar power capability to the intersection collision avoidance systems.	• MnDOT/Local Agencies are responsible to develop, test, deploy, operate, and maintain intersection warning systems. • FHWA in conjunction with state DOTs, automobile manufactures, and research institutes are responsible for developing and testing intersection collision avoidance systems.	• Intersection warning systems include interconnects between roadside detection equipment and roadside warning systems. • Intersection collision avoidance systems include interconnects between roadside equipment and in-vehicle equipment.	• Activation and performance data will be archived for future analysis.	• VS13

[16] See Volume 8 – Vehicle Safety Service Package Area for the description of VS06 – Stop Sign Cap Assist.

Service Packages VS11-Oversize Vehicle Warning[17]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S35	Provide vehicle overheight detection/ warning systems	See information under TM12.						

Service Packages VS13-Intersection Safety Warning and Collision Avoidance[18]

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
ATM S02	Implement red-light running technology	See information under TM03.						
ATM S33	Provide intersection collision avoidance systems	See information under VS06.						

[17] See Volume 8 – Vehicle Safety Service Package Area for the description of VS11 – Oversize Vehicle Warning.
[18] See Volume 8 – Vehicle Safety Service Package Area for the description of VS13 – Intersection Safety Warning and Collision Avoidance.

Appendix D: Traffic Management Service Packages and Descriptions

The descriptions of Traffic Management (TM) service packages are taken directly from the ARC-IT version 8.2.

TM01 Infrastructure-Based Traffic Surveillance
This service package includes traffic detectors, other surveillance equipment, the supporting field equipment, and Center to Field communications to transmit the collected data back to the Traffic Management Center. The derived data can be used locally such as when traffic detectors are connected directly to a signal control system or remotely (e.g., when a CCTV system sends data back to the Traffic Management Center). The data generated by this service package enables traffic managers to monitor traffic and road conditions, identify and verify incidents, detect faults in indicator operations, and collect census data for traffic strategy development and long range planning. The collected data can also be analyzed and made available to users and the Traveler Information Center physical object.

TM02 Vehicle-Based Traffic Surveillance
This service package uses probe data information obtained from vehicles in the network to support traffic operations, including incident detection and the implementation of localized operational strategies. Since traffic data is collected from vehicles, travel times and other related traffic performance measures are available. This service package includes the capability to collect data from Connected Vehicles so that "probe" data can be collected from all equipped vehicles, providing access to a large vehicle population as penetration increases. Incident detection enables transportation agencies to determine the location of potential incidents so the agencies can respond more quickly to the incident and mitigate any negative impacts to the transportation network. Vehicle data that can be used to detect potential incidents include changes in vehicle speeds indicating the disruption of traffic flow, when a vehicle's safety systems have been activated or deployed, or sudden vehicle turns or deceleration at a specific location (indicating a potential obstacle in the roadway).

TM03 Traffic Signal Control
This service package provides the central control and monitoring equipment, communication links, and the signal control equipment that support traffic control at signalized intersections. A range of traffic signal control systems are represented by this service package ranging from fixed-schedule control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests. This service package is generally an intra-jurisdictional package. Systems that achieve coordination across jurisdictions by using a common time base or other strategies that do not require real time coordination would also be represented by this package. Coordination of traffic signal systems using real-time communications is covered in the TM07-Regional Traffic Management service package. This service package is consistent with typical traffic signal control systems.

TM04 Connected Vehicle Traffic Signal System
This service package uses both vehicle location and movement information from connected vehicles as well as infrastructure measurement of non-equipped vehicles to improve the operations of traffic signal control systems. The service package utilizes the vehicle information to adjust signal timing for an intersection or group of intersections in order to improve traffic flow, including allowing platoon flow through the intersection. Other service package provide related mobility services such as Transit Signal Priority, Freight Signal Priority, Emergency Vehicle Preemption, and Pedestrian Mobility to maximize overall arterial network performance.

TM05 Traffic Metering
This service package provides central monitoring and control, communications, and field equipment that support metering of traffic. It supports the complete range of metering strategies including ramp, interchange, and mainline metering. This package incorporates the instrumentation included in the TM01 service package (traffic sensors are used to measure traffic flow and queues) to support traffic monitoring so responsive and adaptive metering strategies can be implemented. Also included is configurable field equipment to provide information to drivers approaching a meter, such as advance warning of the meter, its operational status (whether it is currently on or not, how many cars per green are allowed, etc.), lane usage at the meter (including a bypass lane for HOVs) and existing queue at the meter.

TM06 Traffic Information Dissemination
This service package provides driver information using roadway equipment such as dynamic message signs or highway advisory radio. A wide range of information can be disseminated including traffic and road conditions, closure and detour information, travel restrictions, incident information, and emergency alerts and driver advisories. This package provides information to drivers at specific equipped locations on the road network. Careful placement of the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information. This package also covers the equipment and interfaces that provide traffic information from a traffic management center to the media (for instance via a direct tie-in between a traffic management center and radio or television station computer systems), Transit Management, Emergency Management, and Transportation Information Centers. A link to the Maintenance and Construction Management Center allows real time information on road/bridge closures and restrictions due to maintenance and construction activities to be disseminated.

TM07 Regional Traffic Management
This service package provides for the sharing of information and control among traffic management centers to support regional traffic management strategies. Regional traffic management strategies that are supported include inter-jurisdictional, real-time coordinated traffic signal control systems and coordination between freeway operations and traffic signal control within a corridor. This service package advances the TM03-Traffic Signal Control and TM05-Traffic Metering service packages by adding the communications links and integrated control strategies that enable integrated, interjurisdictional traffic management. The nature of optimization and extent of information and control sharing is determined through working arrangements between jurisdictions. This package relies principally on roadside instrumentation supported by the Traffic Signal Control and Traffic Metering service packages and adds hardware, software, and fixed-point communications capabilities to implement traffic management strategies that are coordinated between allied traffic management centers. Several levels of coordination are supported from sharing of information through sharing of device control between traffic management centers.

TM08 Traffic Incident Management System
This service package manages both unexpected incidents and planned events so that the impact to the transportation network and traveler safety is minimized. The service package includes incident detection capabilities through roadside surveillance devices (e.g. CCTV) and through regional coordination with other traffic management, maintenance and construction management and emergency management centers as well as rail operations and event promoters. Information from these diverse sources is collected and correlated by this service package to detect and verify incidents and implement an appropriate response. This service

package supports traffic operations personnel in developing an appropriate response in coordination with emergency management, maintenance and construction management, and other incident response personnel to confirmed incidents. The response may include traffic control strategy modifications or resource coordination between centers. Incident response also includes presentation of information to affected travelers using the Traffic Information Dissemination service package and dissemination of incident information to travelers through the Broadcast Traveler Information or Interactive Traveler Information service packages. The roadside equipment used to detect and verify incidents also allows the operator to monitor incident status as the response unfolds. The coordination with emergency management might be through a CAD system or through other communication with emergency field personnel. The coordination can also extend to tow trucks and other allied response agencies and field service personnel.

TM09 Integrated Decision Support and Demand Management
This service package recommends courses of action to transportation operators in a corridor, downtown area, or other heavily traveled area. Recommendations are based on an assessment of current and forecast transportation network performance and environmental conditions. Multi-modal transportation operational strategies are created that consider all modes and all roads in the travel area to correct network imbalances and effectively manage available capacity. As part of the operational strategies, this service package may also recommend lane restrictions, transit, parking, and toll strategies to influence traveler route and mode choices to support active demand management programs and policies managing both traffic and the environment. Operational strategies, including demand management recommendations, are coordinated to support operational decisions by each transportation operator that are consistent with the recommended strategy. All recommended operational strategies are based on historical evaluation, real-time assessment, and forecast of the roadway network performance based on predicted travel demand patterns. This service package also collects air quality, parking availability, transit usage, and vehicle occupancy data to support operational strategies that manage and balance capacity and demand.

TM10 Electronic Toll Collection
The Electronic Toll Collection service package provides toll operators with the ability to collect tolls electronically and detect and process violations. The fees that are collected may be adjusted to implement demand management strategies. Field-Vehicle Communication between the roadway equipment and the vehicle is required as well as Fixed Point-Fixed Point interfaces between the toll collection equipment and transportation authorities and the financial infrastructure that supports fee collection. Toll violations are identified and electronically posted to vehicle owners. Standards, inter-agency coordination, and financial clearinghouse capabilities enable broad interoperability for these services.

TM11 Road Use Charging
The Road Use Charging service package supports the capability to charge fees to roadway vehicle owners for using specific roadways with potentially differential payment rates based on time-of-day, which specific roadway is used, and class of vehicle (a local policy decision by each roadway owner). These payment schemes could be forms of Vehicle Miles Traveled (VMT) or other schemes that are yet to be defined. Vehicle owners need only register with a single payment entity of their choice (a participating state, municipal, or regional DOT, an authority, or a private entity), and payments are reconciled by the entity receiving payment (and travel history) with all roadway owners that participate in the road use payment scheme, which may also include the Federal government. Vehicle owners would pay nothing for distances traveled where there are no payments required (e.g. in jurisdictions that have not implemented a

distance based payment or for roadway operators that collect payment using traditional tolls), although a Federal payment rate might cover some or all roadway operations (a Federal policy decision). Basic operation depends on the vehicle tracking its own location, and periodically reporting its travel history to the registered entity receiving payment using connected vehicle communications.

TM12 Dynamic Roadway Warning
This service package includes systems that dynamically warn drivers approaching hazards on a roadway. Such hazards include roadway weather conditions, road surface conditions, traffic conditions including queues, obstacles or animals in the roadway and any other transient event that can be sensed. These dynamic roadway warning systems can alert approaching drivers via warning signs, flashing lights, in-vehicle messages, etc. Such systems can increase the safety of a roadway by reducing the occurrence of incidents. The system can be centrally monitored and controlled by a traffic management center or it can be autonomous.

Speed warnings that consider the limitations of a given vehicle for the geometry of the roadway (e.g., rollover risk for tall vehicles) are not included in this service package but are covered by the TM17 – Speed Warning and Enforcement service package.

Roadway warning systems, especially queue warning systems are an Active Traffic Management (ATM) strategy and are typically used in conjunction with other ATM strategies (such as TM20-Variable Speed Limits and TM22-Dynamic Lane Management and Shoulder Use).

TM13 Standard Railroad Grade Crossing
This service package manages highway traffic at highway-rail intersections (HRIs) where operational requirements do not dictate more advanced features (e.g., where rail operational speeds are less than 80 miles per hour). Both passive (e.g., the crossbuck sign) and active warning systems (e.g., flashing lights and gates) are supported. (Note that passive systems exercise only the single interface between the ITS Roadway Equipment and the Driver in the physical view.) These traditional HRI warning systems may also be augmented with other standard traffic management devices. The warning systems are activated on notification of an approaching train by interfaced wayside equipment. The equipment at the HRI may also be interconnected with adjacent signalized intersections so that local control can be adapted to highway-rail intersection activities. Health monitoring of the HRI equipment and interfaces is performed; detected abnormalities are reported to both highway and railroad officials through wayside interfaces and interfaces to the Traffic Management Center.

TM14 Advanced Railroad Grade Crossing
This service package manages highway traffic at highway-rail intersections (HRIs) where operational requirements demand advanced features (e.g., where rail operational speeds are greater than 80 miles per hour). This service package includes all capabilities from the Standard Railroad Grade Crossing service package and augments these with additional safety features to mitigate the risks associated with higher rail speeds and leverage Connected Vehicle technologies. The active warning systems supported by this service package include positive barrier systems that preclude entrance into the intersection when the barriers are activated. Like the Standard package, the HRI equipment is activated on notification by wayside interface equipment which detects, or communicates with the approaching train. In this service package, the wayside equipment provides additional information about the arriving train so that the train's direction of travel, estimated time of arrival, and estimated duration of closure may be derived. This service package will alert and/or warn drivers who are approaching an at-grade railroad

crossing if they are on a crash-imminent trajectory to collide with a crossing or approaching train. This enhanced information may be conveyed to the driver prior to, or in context with, warning system activation. This service package also includes additional detection capabilities that enable it to detect an entrapped or otherwise immobilized vehicle within the HRI and provide an immediate notification to highway and railroad officials.

TM15 Railroad Operations Coordination
This service package provides an additional level of strategic coordination between freight rail operations and other transportation centers. Rail operations provides train schedules, maintenance schedules, and any other forecast events that will result in highway-rail intersection (HRI) closures. This information is used to develop forecast HRI closure times and durations that may be used in advanced traffic control strategies or to enhance the quality of traveler information.

TM16 Reversible Lane Management
This service package provides for the management of reversible lane facilities. In addition to standard surveillance capabilities, this service package includes sensory functions that detect wrong-way vehicles and other special surveillance capabilities that mitigate safety hazards associated with reversible lanes. The package includes the field equipment, physical lane access controls, and associated control electronics that manage and control these special lanes. This service package also includes the equipment used to electronically reconfigure intersections and manage right-of-way to address dynamic demand changes and special events.

TM17 Speed Warning and Enforcement
This service package monitors vehicle speeds and supports warning drivers when their speed is excessive. Also the service includes notifications to an enforcement agency to enforce the speed limit of the roadway. Speed monitoring can be made via spot speed or average speed measurements. Roadside equipment can display the speed of passing vehicles and/or suggest a safe driving speed. Environmental conditions and vehicle characteristics may be monitored and factored into the safe speed advisories that are provided to the motorist. For example, warnings can be generated recognizing the limitations of a given vehicle for the geometry of the roadway such as rollover risk for tall vehicles.

This service focuses on monitoring of vehicle speeds and enforcement of the speed limit while the variable speed limits service (covered in TM20-Variable Speed Limits service package) focuses on varying the posted speed limits to create more uniform speeds along a roadway, to promote safer driving during adverse conditions (such as fog) and/or to reduce air pollution.

TM18 Drawbridge Management
This service package supports systems that manage drawbridges at rivers and canals and other multimodal crossings (other than railroad grade crossings which are specifically covered by other service packages). The equipment managed by this service package includes control devices (e.g., gates, warning lights, dynamic message signs) at the drawbridge as well as the information systems that are used to keep travelers apprised of current and forecasted drawbridge status.

TM19 Roadway Closure Management

This service package closes roadways to vehicular traffic when driving conditions are unsafe, maintenance must be performed, and other scenarios where access to the roadway must be prohibited. The service package includes automatic or remotely controlled gates or barriers that control access to roadway segments including ramps and traffic lanes. Remote control systems allow the gates to be controlled from a central location or from a vehicle at the gate/barrier location, improving system efficiency and reducing personnel exposure to unsafe conditions during severe weather and other situations where roads must be closed. Surveillance systems allow operating personnel to visually verify the safe activation of the closure system and driver information systems (e.g., DMS) provide closure information to motorists in the vicinity of the closure. The equipment managed by this service package includes the control and monitoring systems, the field devices (e.g., gates, warning lights, DMS, CCTV cameras) at the closure location(s), and the information systems that notify other systems of a closure. This service package covers general road closure applications; specific closure systems that are used at railroad grade crossings, drawbridges, reversible lanes, etc. are covered by other Traffic Management service packages.

TM20 Variable Speed Limits

This service package sets variable speed limits along a roadway to create more uniform speeds, to promote safer driving during adverse conditions (such as fog), and/or to reduce air pollution. Also known as speed harmonization, this service monitors traffic and environmental conditions along the roadway. Based on the measured data, the system calculates and sets suitable speed limits, usually by lane. Equipment over and along the roadway displays the speed limits and additional information such as basic safety rules and current traffic information. The system can be centrally monitored and controlled by a traffic management center or it can be autonomous.

This service establishes variable speed limits and communicates the speed limits to drivers. Speed warnings and enforcement of speeds limits, including variable speed limits, is covered in the TM17-Speed Warning and Enforcement service package.

Variable speed limits are an Active Traffic Management (ATM) strategy and are typically used in conjunction with other ATM strategies (such as TM22-Dynamic Lane Management and Shoulder Use and TM23-Dynamic Roadway Warning).

TM21 Speed Harmonization

This service package determines speed recommendations based on traffic conditions and weather information and uses connected vehicle technologies to assist in harmonizing speeds to these recommendations. The speed recommendations can be regulatory (e.g. variable speed limits) or advisory. The purpose of speed harmonization is to change traffic speed on links that approach areas of traffic congestion, bottlenecks, incidents, special events, and other conditions that affect flow. Speed harmonization assists in maintaining flow, reducing unnecessary stops and starts, and maintaining consistent speeds. The service package utilizes connected vehicle V2I communication to detect the precipitating roadway or congestion conditions that might necessitate speed harmonization, to generate the appropriate response plans and speed recommendation strategies for upstream traffic, and to broadcast such recommendations to the affected vehicles. The speed recommendations can be provided in-vehicle for connected vehicles, or through roadside signage for non-connected vehicles.

TM22 Dynamic Lane Management and Shoulder Use

This service package provides for active management of travel lanes along a roadway. The package includes the field equipment, physical overhead lane signs and associated control electronics that are used to manage and control specific lanes and/or the shoulders. This equipment can be used to change the lane configuration on the roadway according to traffic demand and lane destination along a typical roadway section or on approach to or access from a border crossing, multimodal crossing or intermodal freight depot. This package can be used to allow temporary or interim use of shoulders as travel lanes. The equipment can be used to electronically reconfigure intersections and interchanges and manage right-of-way dynamically including merges. Also, lanes can be designated for use by special vehicles only, such as buses, high occupancy vehicles (HOVs), vehicles attending a special event, etc. Prohibitions or restrictions of types of vehicles from using particular lanes can be implemented.

The lane management system can be centrally monitored and controlled by a traffic management center or it can be autonomous. This service also can include automated enforcement equipment that notifies the enforcement agency of violators of the lane controls.

Dynamic lane management and shoulder use is an Active Traffic Management (ATM) strategy and is typically used in conjunction with other ATM strategies (such as TM20-Variable Speed Limits and TM12-Dynamic Roadway Warning).

TM23 Border Management Systems

This service package provides international border crossing management for passenger vehicles and other non-commercial travelers crossing the border. This service package manages traffic at the border crossing, provides technology to support expedited processing of trusted travelers, and collects and disseminates border wait times.