Minnesota Statewide Regional ITS Architecture

Version 2018

Volume 1:
Data Management Service Package Area

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DEPARTMENT OF
TRANSPORTATION

AECOM

Architecture Reference for Cooperative
and Intelligent Transportation (ARC-IT)

Relationships between Organizations
Enterprise View

Logical interactions between Functions
Functional View

Connections between Physical Objects
Physical View

Layered protocols facilitating data exchange between Physical Objects
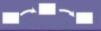**Communications View**

Minnesota Statewide Regional ITS Architecture
Version 2018

Volume 1: Data Management Service Package Area

Prepared by

AECOM

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ACRONYMS

AFR	Automated Field Reporting
ARC-IT	Architecture Reference for Cooperative and Intelligent Transportation
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
ATR	Automated Traffic Recorder
CAD	Computer Aided Dispatch
CARS	Condition Acquisition and Reporting System
CTS	Center for Transportation Studies (University of Minnesota)
CVO	Commercial Vehicle Operations
DM	Data Management
DMS	Dynamic Message Sign
DOT	Department of Transportation
DPS	Department of Public Safety
DVR	Digital Video Recorder or Digital Video Recording
EMS	Emergency Medical Services
EMSRB	Emergency Medical Services Regulatory Board
EOC	Emergency Operations Center
FAST Act	Fixing America's Surface Transportation Act
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FTA	Federal Transit Administration
GIS	Geographic Information System
HOV	High-Occupancy Vehicle
ICS	Incident Command Structure
IEEE	Institute of Electrical and Electronics Engineers
ITS	Intelligent Transportation Systems
LOS	Level of Service
LPR	License Plate Reader
MC	Maintenance and Construction
MCIS	Motor Carrier Information System
MDC	Mobile Data Computer
MnDOT	Minnesota Department of Transportation
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)
PD	Police Department
PeMS	Performance Measurement System
PM	Parking Management
PRISM	Performance and Registration information Systems Management
PS	Public Safety
PT	Public Transportation
RAD-IT	Regional Architecture Development for Intelligent Transportation
RMS	Records Management System
RTMC	Regional Transportation Management Center
RWIS	Road Weather Information System
SAFER	Safety and Fitness Electronic Records
SRCC	Southern Regional Communication Center

ST	Sustainable Travel
SU	Support
TDA	Office of Transportation Data & Analysis (MnDOT)
TDRL	Transportation Data Research Laboratory (University of Minnesota)
TI	Traveler Information
TM	Traffic Management
TraCS	Traffic and Criminal Software
U of M	University of Minnesota
UMD	University of Minnesota-Duluth
UTSDF	Unified Transportation Sensor Data Format
VMT	Vehicle-Miles Traveled
VS	Vehicle Safety
VWS	Virtual Weigh Station
WIM	Weigh-in-Motion
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 help affected agencies and stakeholders 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 in the study process and focused on two primary tasks:

- The assemblage of an inventory of existing and planned transportation infrastructure and, facilities and services.
- 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 1 – Data Management Service Package Area

Data Management (DM) Service Package Area provides crucial linkages between the sources of real-time ITS data and archived data users, other archives, and managers or operators of the systems. At its most basic level, a DM system is an information management system that collects, processes, and documents or stores real-time ITS data for use by a broad cross section of users. A DM system provides an ITS historical data archive for all relevant ITS data and incorporates the planning, safety, operations, and research communities into ITS. It provides the data collection, manipulation, and dissemination functions of these groups, as they relate to data generated by ITS. When operations data are integrated into a DM system, they offer a valuable tool that supports a variety of purposes, such as developing operational strategies, performance monitoring, planning for operations, long-term planning, and policy and investment decision-making.

Development of Volume 1 – DM 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 1 summarizes the findings of data collection and analysis activities conducted to support development of the DM Service Package Area. Volume 1 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 Data Management Systems** provides a brief overview of statewide DM system 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 DM. 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 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 DM Needs and Services** describes, for each identified Need/Service, the following information:
  o **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.
  o **Existing Capabilities** - what systems are currently in place that are used to provide this service and who operates these services.
  o **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.
  o **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).
  o **Interconnects** - the communications linkages between subsystems or stakeholders to provide the service.
  o **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.
  o **Associated Service Packages** - other Service Packages that the service falls under. This includes both Service Packages within the Service Package Bundle and those in other Service Package Bundles.
➢ **Section 6: DM Research and Development Needs** describes general research that can be performed to help implement the identified services.

2.   Identification of Existing Data Management Systems

A DM system offers a valuable tool and enables the use of system-enhanced archived transportation operations-related data for transportation applications such as developing operational strategies, system performance monitoring, planning for operations, long-term planning, as well as policy and investment decision-making. ITS technologies offer efficient and cost-effective solutions for transportation data collection through automation and advanced data management. Vehicle sensing and detection technology for collecting traffic volume and speed data reduces the needs for labor-intensive manual data collection methods. Other data collected from ITS, such as travel time and road weather conditions, enable a new level of decision support capability.

ITS collects a significant amount of data that support real-time control strategies such as ramp metering, incident management, traffic signal control, and traveler information services. These types of data can also be extremely valuable for many other purposes if they are saved and made accessible. Furthermore, the detailed nature of ITS-generated data allows for more accurate analyses and makes many applications possible in a cost-effective way. Data integration and fusion across modes and applications enable an information synergy, which increases the value of the separate data sources.

DM system deployments are located throughout Minnesota and have aided roadway 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. An inventory of existing and planned DM systems 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. DM solutions involve services that improve the overall information and data management functions. They have direct influences on improving performance of transportation systems, including safety, travel time, and travel time reliability.

A DM system provides crucial linkages between the sources of real-time ITS data and archived data users, other archives, and managers or operators of the system. It provides an ITS historical data archive for all relevant ITS data and incorporates the planning, safety, operations, and research communities into ITS. A DM system offers a valuable tool that supports a variety of purposes, such as developing operational strategies, performance monitoring and reporting, planning for operations, long-term planning, as well as policy and investment decision-making. The goal of DM systems is to improve transportation systems data management and integration through the use of advanced data collection techniques, information management, communication systems, and system integration between multiple jurisdictions. The Minnesota ITS Development Objectives in Table 3-1, specific to DM, are steps to determine and/or measure whether or not DM goals are being achieved. A complete list of Minnesota ITS Development Objectives is included in *Appendix B*.

Table 1. DM Specific Minnesota ITS Development Objectives

E. Support Regional Economic Productivity and Development

    <u>E-4   Increase agency efficiency</u>

B-2-15	Improve average on-time performance for specified transit routes/facilities
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-4-05	Increase the percentage of fleet/equipment within its lifecycle

G. Enhance the Integration and Connectivity of the Transportation System

    <u>G-1   Aid in transportation infrastructure and operations planning</u>

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

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 2018 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 4-1 will provide the

required service(s) to fill the gaps summarized in *Appendix C*. This appendix will take the DM Needs and associated 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. DM 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 bundles can be found in corresponding Service Package Bundle 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]
ATMS03	Use archived data for traffic management strategy development and long range planning	3.20	G-1-01, G-1-02, G-1-03	DM01, DM02, TM09
ATMS42	Use roadside data collectors to determine locations with frequent occurrence of speeding	2.44	A-1-01, A-1-02, A-1-12, A-2-43, A-2-44, G-1-01, G-1-02, G-1-03	DM01, DM02, TM01, TM17
ATMS51	Collect and manage traffic signal performance measures	4.00[c]	E-4-01, G-1-01, G-1-02, G-1-03	DM02, TM01, TM02
APTS09	Measure historical transit route performance	3.86	B-2-05, B-2-06, B-2-07, B-2-08, B-2-09, B-2-10, G-1-01, G-1-02, G-1-03	DM01, DM02, PT01
APTS24	Metro Transit Police records integration with other PD's	3.00[c]	B-1-16, G-1-01, G-1-02, G-1-03	DM01
APTS26	Additional GIS systems integration	3.00[c]	G-1-01, G-1-02, G-1-03	DM01, PT02, PT03
APTS31	Improve access to real-time and historical transit data and improve quality of data	4.33[c]	E-4-01, G-1-01, G-1-02, G-1-03	DM01, DM02
APTS32	Create connections with other public agencies and third parties to share real-time and historical transit data both ways	2.67[c]	C-3-10, G-1-01, G-1-02	DM01, DM02, SU03
CVFO03	Target enforcement at locations with history of violations	3.00	F-1-01, F-1-02	DM01, DM02, CVO03, CVO07, CVO08
CVFO04	Target enforcement on carriers, vehicles and drivers with history of violations and poor safety records	4.00	E-2-02, E-2-04, F-1-01, F-1-02	DM01, DM02, CVO04, CVO07, CVO08
CVFO19	Improve quality and accessibility of commercial vehicle-related crash data	3.00	A-1-01, A-1-02, A-1-06, A-1-07, G-1-01, G-1-02, G-1-03	DM01

ID	Need/Potential Solution	Priority Point[a]	ITS Development Objective	ARC-IT Reference[b]
PSFT12	Implement automated field reporting system	4.00	B-1-15, B-1-16, B-1-17, B-1-18, D-1-04	DM01
PSFT13	Provide real-time digital video recordings (DVR)	3.00	B-1-15, B-1-16, B-1-17, B-1-18	DM01, PS01, PS02, PS06
SUP02	Managing and sharing transportation data	5.00[c]	C-3-10, G-1-01, G-1-02, G-1-03	DM01, SU03

5. Detail of DM Needs and Services

A detailed description of each DM 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 DM Service Package Bundle and those in other Service Package Bundles.

6.   DM Research and Development Needs

In order to fill gaps and meet the needs for technology advancement in DM 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 DM are as follows:

Traffic Management (TM)
- Develop improved ways to access and search archived data
- Test new data gathering and archiving techniques
- Use data from connected vehicles to estimate traffic performance measures

Traveler Information (TI)
- Investigate methods and processes to improve data latency, quality and consistency
- Improve percentage and accuracy of incidents captured in CARS on statewide basis

Public Transportation (PT)
- Enhance archived data search tools

Maintenance and Construction (MC)
- Develop a generalized life-cycle costing model that can be used for estimating the optimum life of various MnDOT assets
- Test GIS database for infrastructure inventory, status, and maintenance history and schedule

Commercial Vehicle Operations (CVO)
- Measure historical commercial vehicle shipment performance and automated clearances at weigh stations to determine how competitive Minnesota is with other states

Public Safety (PS)
- Develop surveillance video search tools and archiving standards

Appendix A: Existing/Planned DM Elements

System	Service Package	Description	Stakeholder	Status
Conditions Acquisition and Reporting System (CARS)	DM01, TM06, TI01, TI02, SU03, CVO01, PS10, PS14, WX02, MC04, MC06	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
Media Information Release System	DM01, TI01	This system has been created to keep the media and the public more up to date in case of serious and fatal accidents that happen within the state of Minnesota. This system contains only those accidents in which the Minnesota State Patrol is the primary reporting law enforcement agency. Records displayed here are as current as the last time State Patrol Personnel edited data. However due to extenuating circumstances such as heavy-accident periods like ice and snow storms, data entry may get back-logged and may not be up to the minute.	Minnesota State Patrol	Existing
Minnesota Emergency Responder Database	DM01	This element represents an online database to route on-the-scene incident data, road condition, or other data through a single dispatch center or system for processing. The project area would include the seven-county metro area and 10 out-state counties.	Minnesota EMSRB	Planned

System	Service Package	Description	Stakeholder	Status
Minnesota State Patrol Databases	DM01	Minnesota State Patrol databases contain information on crash and dispatching. An Automated Field Reporting (AFR) System is planned to interface with the Records Management System (RMS). With the implementation of the AFR System, four documents that are currently manually filled out and submitted by the Troopers will be electronically transferred from Troopers' laptop computers (called Mobile Data Computers or MDC's) to a central repository.	Minnesota State Patrol	Existing
Research Lab Network Surveillance Archive	DM01	This represents the data archive maintained by the Minnesota Traffic Observatory (MTO). The archive stores data on freeway traffic flows through a fully independent network of video detectors covering 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.	U of M CTS ITS Institute	Existing
Research Lab New Surveillance Control System	DM01, 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
Traffic Data and Video Archive	DM01, DM02	This element represents the database in which Automated Traffic Recorder (ATR) data is stored. The ATR data is compiled from several sources into a single accessible database managed by the MnDOT Office of Transportation Data Analysis to answer data requests and provide reports to others. This element also represents the database in which traffic monitoring video is stored.	MnDOT	Existing

System	Service Package	Description	Stakeholder	Status
Transit Data Archives	DM01, DM02	Transit data archives will store automated data generated by metro area transit providers, as well as local transit providers. It is planned to upgrade existing or install new scheduling software systems as determined by transit agencies. The automated archiving system will provide the capability to automate real time, interactive and/or batch scheduling functions and increase the efficiency of service. The basic program features will include vehicle management, driver management, trip reservations, automated scheduling and routing, coordination, dispatching, reporting, geo-coding, and mapping.	Metro Area Transit Providers	Planned
Transportation Information System (TIS)	DM01	MnDOT Office of Transportation Data Analysis (TDA) is responsible for the collection, creation, storage, maintenance, and dissemination of transportation-related data to the general public through various means. Interconnects with MnDOT RTMC and SRCC, RWIS Central Server, and CARS. Archive coordination exists with the RTMC, SRCC, and RWIS.	MnDOT TDA	Existing
UMD Transportation Data Research Laboratory (TDRL)	DM01, DM02	Transportation Data Research Laboratory (TDRL) server located at the University of Minnesota-Duluth (UMD) campus downloads data from the MnDOT RWIS Central Server. The TDRL server daily archives this RWIS data using the Unified Transportation Sensor Data Format (UTSDF) and makes them available to the public through Internet. This archived historic data is presently only available through TDRL.	University of Minnesota Duluth	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 Packages DM01 – ITS Data Warehouse

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 better manage and plan resources and 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 Monitoring 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.	• DM02 • TM09

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.	• DM02 • TM01 • TM17
APTS 09	Measure historical transit route performance	• Transit agencies measure and analyze route performance to identify areas to enhance service and improve operations.	• Many metro area and local transit agencies already track route performance and use in analysis of transit operations.	• Refine data analysis tools to evaluate route performance based on archived data. • Refine tools to manage archived transit performance data.	• Transit agencies are responsible to gather, manage, archive, and analyze route performance for their system.	• This service includes interconnects between in-vehicle equipment and transit management centers. • Interconnects between transit management centers and transit data archives.	• Key measures of route performance have already been archived for future analysis and comparison.	• DM02 • PT01

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
APTS 24	Metro Transit Police records integration with other PD's	• Local public safety agencies and Metro Transit Police integrate their records for better data sharing and coordination in incident/ emergency responses.	• Metro Transit Police currently have a separate, non-integrated police record system. • Coordination between Metro Transit Police and local PD's is conducted by calling each other during an incident.	• Define standards for data record integration. • Integrate Metro Transit Police system with that of other PD's in the metro area.	• Metro Transit Police and local public safety agencies are responsible to develop common standards and integrate and maintain their systems.	• Data integration includes interconnects between Metro Transit Police and other PD's.	• None for data/ record integration. Separate systems already have archiving guidelines and storage protocols for police records.	
APTS 26	Additional GIS systems integration	• Transit police and transit agencies use GIS systems for collecting incident data and performing incident investigation.	• Transit agencies use GIS for operations and management. • Transit police uses GIS to an extent for incident data collection.	• Integrate transit agencies GIS systems with city/ county law enforcement systems for enhanced data collection and investigation capabilities.	• Transit agencies are responsible to coordinate with law enforcement agencies and to plan, procure, integrate, operate and maintain their systems.	• None.	• Transit service data and incident data are already archived.	• PT02 • PT03

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
APTS 31	Improve access to real-time and historical transit data and improve quality of data	• Transit agencies use database and tools to store real-time and historical transit data. • Transit agencies use tools to verify and improve data quality. • Non-operations transit personnel is provided with improved access to retrieve real-time and historical data. • Transit agencies uses real-time and historical data for performance monitoring, planning, analysis and research.	• Transit data is typically stored in transit agencies' operation systems and is challenging to retrieve or extract the data for non-operations uses.	• Develop new or enhance existing tools to improve access to operations data. • Develop tools and methods to improve transit data quality.	• Transit agencies are responsible to plan, design, deploy, integrate, operate and maintain transit databases to data access tools.	• This service includes interconnects between transit databases, transit management centers, and other transit personnel.	• None.	• DM02

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
APTS 32	Create connections with other public agencies and third parties to share real-time and historical transit data both ways	• Transit agencies work with other transit, traffic and public safety agencies to share real-time and historical data. • Transit agencies work with third party data/ information providers to share information to improve services and customer satisfaction. • Transit agencies uses real-time and historical data for performance monitoring, planning, analysis and research.	• Information sharing among transit, traffic and public safety agencies occurs on limited basis. • MnDOT shares Metro area congestion, detour and incident information with transit providers in the Metro area. • Minneapolis and St. Paul shares roadway closures with transit providers in the Metro area.	• Coordinate with traffic and public safety agencies and third party providers to identify data sharing needs. • Develop and implement plans for establishing connects with traffic and public safety agencies and third parties to share data both ways.	• Public agencies are responsible to coordinate with each other to plan and implement two-way data sharing. • Transit agencies are responsible to coordinate with third party data providers to enable two-way data sharing.	• Interconnects between transit management centers, other transit management centers, traffic management centers, public safety agencies and third party providers.	• None.	• DM02 • SU03

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
CVF O03	Target enforcement at locations with history of violations	• Law enforcement agencies use analysis of data from WIM sites and from Virtual Weigh Stations (VWS) to determine locations with high levels of violations and use mobile enforcement to target these "hot spots"	• MnDOT currently uses both permanent and portable scales to address problem areas.	• Deploy additional VWS to provide for better identification of locations with high levels of violations. • Legislation is needed to support targeted enforcement at locations with history of violations.	• MnDOT is responsible to plan, design, operate and maintain portable and permanent scales. • Minnesota State Patrol is responsible for enforcement.	• Interconnects between in-vehicle equipment, roadside equipment and various CVO databases are required.	• None.	• DM02 • CVO03 • CVO07 • CVO08

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
CVF O04	Target enforcement on carriers, vehicles and drivers with history of violations and poor safety records	• Data from SAFER, and complaints made to MnDOT CVO and/or DPS are analyzed to determine carriers, drivers and vehicles that have a high level of violations or crashes. These problem drivers, carriers or vehicles are then targeted for future enforcement. • MnDOT uses federal FMCSA database to monitor safety data for compliance reviews.	• FMCSA PRISM identifies problem vehicles to revoke licenses. • SAFER system has company safety data, though it is possible for companies to hide their histories within the SAFER database by changing their company names. • MnDOT uses Motor Carrier Information System (MCIS) to track motor carrier credentials, operating authority, associated transactions, enforcement cases and hazardous materials incidents.	• Improve company tracking in SAFER for interstate carriers to reduce hiding of past safety issues. • Use databases for tracking intra-state carriers to reduce hiding of past safety issues.	• MnDOT is responsible to plan, design, operate and maintain CVO administrative databases. • Minnesota State Patrol is responsible for roadside enforcement.	• Interconnects are required between MnDOT CVO and various regional, state and federal CVO databases.	• Legislation on LPR data may restrict MnDOT from archiving and reporting LPR data. LPR data may be available for up to two weeks of time to allow for Minnesota State Patrol to issue citations on past violations.	• DM02 • CVO04 • CVO07 • CVO08

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
CVF O19	Improve quality and accessibility of commercial vehicle-related crash data	• MSP and other law enforcement agencies collect and enter improved and more detailed data regarding crashes involving commercial vehicles into crash databases. • Law enforcement, DPS, planning agencies use improved data to plan safety and enforcement enhancements.	• Minnesota State Patrol and other law enforcement agencies currently collect relevant information during investigations of crashes.	• Investigate the use of advanced equipment to more efficiently collect crash data while minimizing the amount of field investigation time needed.	• MnDOT and Minnesota State Patrol are responsible to operate and maintain the field equipment and central databases.	• Interconnects are required between field equipment, law enforcement, and MnDOT CVO.	• Crash data is archived for future safety studies and planning efforts.	

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
PSFT 12	Implement automated field reporting system	• MSP troopers, local law enforcement, and local fire/EMS agencies use this system to reduce the time for incident reporting and citation issuance, and increase data accuracy. • This system can also include license swipe technology that allow the use of a portable license reading device to pull up driver information in real-time without manually entering information.	• A license swipe system has been implemented. • An electronic reporting system is currently being deployed. • Electronic citation system has been implemented to reduce paperwork process of issuing citations.	• Implement an electronic reporting system that is similar to TraCS used in Iowa.	• MSP and local public safety agencies are responsible to coordinate with each other to plan, design, construct, operate and maintain the automated field reporting system.	• Automated reporting systems include interconnects between in-vehicle equipment and central reporting system. • Systems also include interconnects between handheld devices and a central reporting systems/ databases.	• This system will automate the data entry and archiving process and will not generate new data which is not already being archived.	

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
PSFT 13	Provide real-time digital video recordings (DVR)	• Emergency responder and dispatchers will use DVR to review camera images in real-time to verify events at incident sites and make decisions to better respond to an incident.	• Dispatchers have access to some camera images, but do not have the ability to play images back immediately to review conditions or events at an incident scene. • All MSP squads can record analog video at the scene.	• Integrate DVR systems into MSP dispatch centers and MnDOT RTMC and SRCC. • Integrate DVR systems into MSP vehicles with cameras to allow officers to review images.	• MnDOT RTMC is responsible to plan, design, construct, integrate, operate and maintain DVR systems for their cameras. • MSP is responsible to plan, design, construct, integrate, operate and maintain DVR systems for its fleet.	• DVR systems include interconnects between roadside camera systems and dispatch centers, emergency operations centers, and/or vehicles.	• Live video should be "buffered" for a period of time to allow saving video of interest after the fact. • Long-term archiving is covered under video monitoring camera operations services. • Law enforcement should be able to record an entire incident/ response.	• PS01 • PS02 • PS06

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
SUP02	Managing and sharing transportation data	• MnDOT, MSP, local agencies and transit agencies collect and manage data from their perspective systems to aid in real-time monitoring, situational awareness and for operational analysis and performance management. • MnDOT, MSP, local agencies and transit agencies share their data with others to facilitate transportation management and incident response and management.	• Individual agencies operate own data collection systems and manage own databases. • Sharing of real-time and historical transportation data occurs between few agencies, mainly in the Twin Cities area.	• Broaden the types of data collected and shared among agencies. • Enhance the capabilities of data management to support planning, performance monitoring, safety analysis, operational analysis, and research. • Enhance the ability to share real-time transportation data among operating agencies.	• Each agency is responsible to plan, design, construct, operate and maintain its own data collection and management system. • Agencies are responsible to coordinate and collaborate with others to establish policies and agreements and to plan, design, construct, operate and maintain systems and components to allow for data sharing.	• This service includes interconnects among participating agencies' databases.	• Data archive needs are determined by individual agency and system.	• SU03

Service Package DM02 – Performance Monitoring

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 DM01.						
ATM S42	Use roadside data collectors to determine locations with frequent occurrence of speeding	See information under DM01.						
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 devices.	• Traffic signal monitoring and data collection includes interconnects between roadside equipment and TMCs.	• Archived data can be used for analyze traffic signal performance.	• TM01 • TM02
APTS 09	Measure historical transit route performance	See information under DM01.						

ID	Need/Service	Operational Concept	Existing Capability	Gap/Planned Enhancement	Role/ Responsibility	Interconnect	Data Archive Need	Associated Service Package
APTS 31	Improve access to real-time and historical transit data and improve quality of data	See information under DM01.						
APTS 32	Create connections with other public agencies and third parties to share real-time and historical transit data both ways	See information under DM01.						
CVF O03	Target enforcement at locations with history of violations	See information under DM01.						
CVF O04	Target enforcement on carriers, vehicles and drivers with history of violations and poor safety records	See information under DM01.						

Appendix D: Data Management Service Packages and Descriptions

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

DM01 ITS Data Warehouse
This service package provides access to transportation data to support transportation planning, condition and performance monitoring, safety analysis, and research. Configurations range from focused repositories that house data collected and owned by a single agency, district, private sector provider, or research institution to broad repositories that contain multimodal, multidimensional data from varied data sources covering a broader region. Both central repositories and physical distributed ITS data repositories are supported. Requests for data that are satisfied by access to a single repository in the ITS Data Warehouse service package may be parsed by the local repository and dynamically translated to requests to other repositories that relay the data necessary to satisfy the request.

DM02 Performance Monitoring
The Performance Monitoring service package uses information collected from detectors and sensors, connected vehicles, and operational data feeds from centers to support performance monitoring and other uses of historical data including transportation planning, condition monitoring, safety analyses, and research. The information may be probe data information obtained from vehicles in the network to determine network performance measures such as speed and travel times, or it may be information collected from the vehicles and processed by the infrastructure, e.g. environmental data and infrastructure conditions monitoring data. Additional data are collected including accident data, road condition data, road closures and other operational decisions to provide context for measured transportation performance and additional safety and mobility-related measures. More complex performance measures may be derived from the collected data.