Submitted by:
ITERIS

DESTINATION INNOVATION PROJECT
SAFE CORRIDOR ENHANCEMENTS (SCorE)
WORK ZONE ACCIDENT REDUCTION DEPLOYMENT (WZARD)
Final Report

Submitted to:
Minnesota Department of Transportation (MnDOT)

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GLOSSARY OF ACRONYMS

AVL – Automatic Vehicle Location
CITE – Corridor Enhanced Technical Enforcement
CMS – Changeable Message Sign
DIP – Destination Innovation Project
DMS – Dynamic Message Sign
GPS – Global Positioning System
IRIS – Intelligent Roadway Information System
ITS – Intelligent Transportation Systems
MDSS – Maintenance Decision Support System
MET – Meridian Environmental Technologies
MnDOT – Minnesota Department of Transportation
OTST – Office of Traffic Safety and Technology
RTMC – Regional Transportation Management Center
RWIS – Road Weather Information Systems
SCorE – Safe Corridor Enhancements
TOCC – Traffic Operations Communication Center
WZARD – Work Zone Accident Reduction Deployment
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EXECUTIVE SUMMARY

The SCorE WZARD Phase 2 project originated as a Destination Innovation Program project under the Minnesota Department of Transportation’s internal E-Jam effort. The vision for this project was developed by project stakeholders in response to MnDOT’s strategic directions of safety and mobility. The primary goal of the SCorE WZARD project is to help avoid car-plow collisions or crashes due to evasive maneuvers in the vicinity of plows.

One of the primary goals of this project is to put into place the infrastructure necessary to improve safety for snow/ice and other work zone operations. Other goals and objectives include reducing incidents by providing the traveling public with real-time information about corridor traffic operations between Rogers and St. Cloud, Minnesota. The goals and objectives for the SCorE WZARD project can be grouped into three main areas:

Traffic Incident Management
- Improve I-94 corridor safety during work zone operations
- Improve safety for traffic incidents and/or traffic enforcement activities
- Reduce the occurrence of snow plow/vehicle crashes
- Reduce the occurrence of secondary incidents

Transportation System Efficiency
- Improve traffic safety and mobility
- Improve travel times along the I-94 corridor
- Reduce I-94 corridor congestion
- Manage recurrent peak period congestion, including weekend seasonal traffic
- Reduce vehicle emissions

Public Communications/Traveler Information
- Provide real-time traveler information along the I-94 corridor
- Provide travelers with advance warning of maintenance operations upstream
- Provide CCTV images to RTMC, District 3 Operations and State Patrol

The SCorE WZARD project followed a systems engineering design process and as part of this project, the following deliverables were created:
- Concept of Operations Report
- System Requirements
- System Design Report
- Operations and Maintenance Manual
The Concept of Operations report identified the stakeholders involved in the SCorE WZARD project, as well as identifying user-oriented operational scenarios and design alternatives. The concept of operations documented five different design alternatives that were developed through team discussions.

The System Requirements identified the needs of the stakeholders and documented the requirements that the WZARD system needed to meet. These requirements were created using the user-oriented operational scenarios identified in the Concept of Operations.

The Systems Design report documented the system components and how they would work within the WZARD software. The System Design document also identified unique computations and features that the WZARD system would utilize including the logic tree needed to decide the different messages that may be displayed and the use of “geofences”, or virtual zones, that were used to identify the proximity of a District 3 maintenance vehicle to a changeable message sign.

Finally, the Operations and Maintenance Manual was created to identify responsible parties for any issues or changes that need to be made to the WZARD system.

The final product produced by the Iteris/Meridian Environmental Technologies team was the WZARD system. The WZARD system is an automated system that uses real-time information from the following MnDOT sources:

- District 3 Maintenance Vehicles
- Maintenance Decision Support System (MDSS)
- Road Weather Information System (RWIS)
- Intelligent Roadway Information System (IRIS)

WZARD uses the information from these sources to determine when a message needs to be posted on a changeable message sign and what type of message needs to be displayed. The WZARD system considers the following parameters to determine the necessary action:

- Location
- Speed
- Directional Bearing
- Weather Information
- Maintenance Vehicle Equipment Status

The MnDOT WZARD system was deployed on I-94 EB between TH 101 in Rogers and TH 15 in St. Cloud in January 2012. Acceptance testing was performed until May 2012. The WZARD system is expected to be permanently operational along the I-94 corridor.
1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

The Safe Corridor Enhancements (SCorE) Work Zone Accident Reduction Deployment (WZARD) Phase 2 project is one of three coordinated Destination Innovation projects along I-94 between TH 101 in Rogers and TH 15 in St. Cloud that focus upon improving safety in the corridor. The first project is the SCorE Backbone Extension project, which will extend fiber optic communications and data links along the corridor. The second project is the SCorE Corridor Enhancements via Technical Enforcement (or CITE) project. The CITE project will include the deployment of stationary roadside mounted license plate readers (LPRs) along the corridor to read license plate numbers of passing vehicles. The focus of the CITE project is to enhance the ability of law enforcement to take action upon vehicles driven by individuals with revoked, suspended or cancelled drivers’ licenses.

The third and final Destination Innovation project, WZARD Phase 2, focuses upon the integration of dynamic systems to improve the delivery of real-time road advisory/warning information to I-94 travelers. Systems engineering documentation was developed in Phase 2 to support the design of an integrated system with MnDOT maintenance vehicles and other corridor operators to provide real-time advisory traffic information through field equipment and the SCorE backbone fiber optic network. The fully-deployed system is intended to provide communications linkages to and among various devices installed along the project corridor (shown in Figure 1), including Changeable Message Signs (CMS), CCTV cameras and other detection devices. The CMS used to display WZARD messages related to snow plow presence in the corridor and their installed field locations are listed in Table 1.

This report describes the project’s system engineering process used to develop and design the SCorE WZARD system for a pilot deployment during the 2011-2012 winter season. Results from the pilot deployment can be found within the appendices of this document.
Project Limits: I-94 from TH101 in Rogers to TH15 south of St. Cloud

FIGURE 1: WZARD PROJECT CORRIDOR
TABLE 1: CMS IN WZARD CORRIDOR

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<tr>
<th>Sign</th>
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1.2 Vision

The SCoRE WZARD Phase 2 project originated as a Destination Innovation Program project under the Minnesota Department of Transportation’s internal E-Jam effort. The vision for this project was developed by project stakeholders in response to MnDOT’s strategic directions of safety and mobility. The primary goal of the SCoRE WZARD project is to help avoid car-plow collisions or crashes due to evasive maneuvers in the vicinity of plows. The congestion management and incident management portions of the project address the Department’s strategic direction for mobility.

The primary benefit from the safety applications which result from all three Destination Innovation projects will be a reduction in crashes, which carry a high cost to society. The primary benefit of the mobility portions of the Destination Innovation projects will be congestion reduction and the ability to delay the need to add additional lanes for capacity on this particular segment of I-94.

This project advances MnDOT’s strategic directions of safety and mobility using innovative technologies and existing infrastructure and systems.

1.3 Goals and Objectives

One of the primary goals of this project is to put into place the infrastructure necessary to improve safety for snow/ice and other work zone operations. Other goals and objectives include reducing incidents by providing the traveling public with real-time information about corridor traffic operations between Rogers and St. Cloud, Minnesota. The goals and objectives for the SCoRE WZARD project can be grouped into three main areas:
Traffic Incident Management
- Improve I-94 corridor safety during work zone operations
- Improve safety for traffic incidents and/or traffic enforcement activities
- Reduce the occurrence of snow plow/vehicle crashes
- Reduce the occurrence of secondary incidents

Transportation System Efficiency
- Improve traffic safety and mobility
- Improve travel times along the I-94 corridor
- Reduce I-94 corridor congestion
- Manage recurrent peak period congestion, including weekend seasonal traffic
- Reduce vehicle emissions

Public Communications/Traveler Information
- Provide real-time traveler information along the I-94 corridor
- Provide travelers with advance warning of maintenance operations upstream
- Provide CCTV images to RTMC, District 3 Operations and State Patrol

1.4 PROJECT PARTNERS
The Project partners for the SCorE WZARD project include the following:

- Minnesota Department of Transportation – Office of Traffic, Safety and Technology (OTST)
- Minnesota Department of Transportation – District 3
- Iteris, Inc.
- Meridian Environmental Technologies (MET)
- State Patrol

Iteris, in the role of prime consultant, developed the SCorE WZARD system design and was responsible for system deployment and evaluation activities. Meridian was responsible for the design of the WZARD software and the integration of the software utilizing MnDOT’s Maintenance Decision Support System (MDSS). MnDOT District 3 Maintenance and Traffic Engineering divisions provided in-kind support with field staff and the use of the District’s AVL equipped maintenance vehicle fleet as necessary for testing during the pilot deployment phase. The Minnesota Department of Public Safety (DPS) and the Minnesota State Highway Patrol assisted in review of the WZARD system design and during the pilot deployment phase through the monitoring of the system’s operations at the District 3 Traffic Operations Communication Center (TOCC). The Minnesota Department of Transportation Office of Traffic, Safety and Technology (OTST) sponsored the project and provided overall project oversight.
2.0 SCORE WZARD SYSTEM DESIGN

2.1 WZARD CONCEPT OF OPERATIONS

2.1.1 TRAFFIC MANAGEMENT INFRASTRUCTURE

Automated Traffic Management System (ATMS)

IRIS
The MnDOT Regional Transportation Management Center (RTMC) operates Intelligent Roadway Information System (IRIS) as its primary traffic management control system. IRIS operates in a client server environment, with the primary server housed in the computer room at the RTMC. Clients are operated at computer consoles within the RTMC control room and can be used remotely with wide area networking or Internet connection between the client and server. This system requires a secure, high-speed connection (i.e., MnDOT fiber optic) or security appliance for Internet access. The IRIS system was developed internally by MnDOT staff and because this is an agency product no additional software license is needed to operate or expand its current use.

IRIS has been expanded to support traffic management/traveler information activities in Duluth, St. Cloud and Rochester. TMC/TOCC operators in all of these locations have been trained in the use of IRIS. The St. Cloud deployment operates as a ‘satellite’ installment of IRIS, running off of the primary IRIS system installed at the RTMC in Roseville. Rochester and Duluth each operate server instances of IRIS. IRIS software is currently used to manage ITS field devices and record planned and unplanned events along the corridor. Currently operators interface through IRIS to post messages to the CMS along this corridor based on field reports of road conditions. The IRIS interface with CMS allows the operator to build a message from a stored library of messages. An IRIS operator can choose the message content for each line of the CMS. No “free form” messages are placed through IRIS without the consent and advance approval of TMC Supervisors. Operators must perform these and many other tasks along the I-94 corridor and many other corridors throughout the district. A significant burden would be placed on the operator to attempt to obtain the location of a slow-moving maintenance vehicle and then place the appropriate message to the CMS and then monitor the plow position in order to blank the message of the CMS all while tracking the maintenance vehicle to the next downstream CMS. Logically, an automated process to place a relevant message between the maintenance vehicle and the CMS is warranted and would not place unrealistic responsibilities on the IRIS operator.

The core functions of the IRIS system include:

- Controlling Changeable Message Signs (CMS) by allowing operators to view current messages and activate messages as needed from the TMC control software;
• Receiving and recording live motion video feeds from closed circuit television cameras
  IRIS is capable of controlling cameras by sending pan/tilt/zoom commands to the
  cameras, but most operators prefer use of the keyboard and joystick connected to the
  video switcher;
• Maintaining communications with the over 2000 loop detectors on the roadways to
  collect, process, archive and make the traffic flow data available as needed;
• Controlling ramp meters through a combination of automated and manual control
  depending upon observations and reactions to real-time traffic conditions.

Additional capabilities include:
• Incident logging
• Control of the Intelligent Lane Control signs and the Variable speed advisories.
• Maintenance capabilities to assist in troubleshooting issues.

Dynamic Message Sign Control
The IRIS system performs two key functions with regard to Changeable Message Signs (CMS):
• Allowing a CMS user interface;
• Performing all communication aspects needed to communicate with and control signs.

User Interface.
The IRIS system allows operators to graphically view all locations of CMS signs in the field as
well as a list view. Operators may select from an existing CMS message library to build three-
line messages to be displayed on the signs. A security feature allows operators to only select
from pre-formed messages and only allows approved system administrators to type other
messages into the system. The user interface allows operators to click on any sign and view the
current status of the sign as well as the current message displayed. Abducted Child (Amber
Alert) capabilities are also supported on the IRIS CMS control utilizing the ability to deploy sign
plans in which any number of signs can display various messages either manually or at pre-
programmed times. Only a limited number of supervisors or administrators are authorized to
post messages of this type to the CMS.

Sign Control
The IRIS system performs communications and control processes with CMS signs using NTCIP
standards. A limited number of lane control signs are still controlled using outputs from 170
controllers. The communications system controller relays commands in order to post messages
on to the signs, and is also capable of querying CMS to determine displayed message status and
to obtain status reports on sign functionality.

Closed Circuit Television Camera (CCTV)
The IRIS system operating at the District 3/St. Cloud site performs two key functions with CCTV
cameras:
- Allow operators to take control of pan/tilt/zoom for all cameras in the District 3 system;
- Allow display and relay of full motion video switching displays for District 3 cameras.

IRIS operators may control cameras using ‘joystick’ controls connected to the video switcher to pan/tilt/zoom (PTZ) the cameras. The IRIS system allows for motion video to be displayed on screens within the District 3 Traffic Operations Center and the RTMC. Users may select which cameras are displayed on which monitors. The IRIS system video switch allows other systems/agencies to have access to the full motion video as needed.

**Traffic Operations Systems**

**Computer Aided Dispatch (CAD)**
The State Patrol District 3 TMC Dispatchers use TriTech’s VisiNet Command CAD system to perform a variety of key functions, including:
- Verification of incident locations and identification of correct response agencies;
- Interface with 911 answering equipment for mapping purposes;
- Routing of calls for service to the correct dispatcher;
- Recommendations for appropriate field unit responses;
- Monitoring and tracking of field unit status and location;
- Documentation of incident and response unit activity and provision of timestamps for all activity-service calls;
- Transferring of appropriate incident data into departmental records management systems for further usage;
- Interface with agency records management systems (RMS) in order to immediately share data between CAD and RMS without need for redundant data entry;
- Efficient management of response resources to properly document staff and agency actions.

This system is integrated with other regional agencies and emergency response providers in order to allow for efficient and timely responses among a number of agencies to ensure that streamlining of actions occurs for each incident response.
MnDOT 511
MnDOT 511 is currently used to manage Advanced Traveler Information Systems (ATIS) statewide. Road conditions are entered into the system for interstates and state highways by State Patrol staff. Posted information moves automatically to the MnDOT 511 website (www.mn511.org) and phone system hosted by Castle Rock Consultants. Construction/maintenance entries entered directly into the MnDOT 511 automatically populate the 511 system. For roadway incidents or crashes, manual intervention by TOCC or TMC operators is required to record incident verification information from State Patrol or other emergency responders.

Maintenance Systems

Maintenance Decision Support Systems (MDSS)
Meridian currently provides MnDOT with statewide weather forecasting support and Maintenance Decision Support System (MDSS) operations. This includes District 3 and specifically I-94 from just north of Rogers to St. Cloud. Users of MDSS are able to get snow plow route specific information including pavement conditions, weather information, and even snow plow data specific to the routes. Meridian works directly with MnDOT’s third party vendor of AVL/MDC technologies, AmeriTrak, to ingest and interpret data collected within the snow plows. This data can include location (i.e. latitude and longitude), lane position (driving vs. passing), truck speed and direction, plow status, weather and road conditions, and type/application rate of deicing chemical. MnDOT is not using lane position features at the present time in part to avoid the need for snow plow and truck operators to enter data manually into the system (current GPS technology cannot pinpoint exact vehicle location). This data is integrated throughout the state for trucks equipped AVL/GPS, including the portion of the I-94 corridor where the WZARD system and this project are to be located.

Other Systems

TIGER
The TIGER (Traveler Information Guidance and Emergency Routing) system was initiated in 2003 by MnDOT. The project area included I-94, Highway 10 and State Highway 55 between the Twin Cities and St. Cloud, MN. The TIGER project was designed to address changes in traffic congestion along the local roadways by deploying additional portable and permanent systems including CCTV, dynamic message signs and traffic detection devices. These systems have been integrated into the traffic operations of both the St. Cloud Transportation Operations and Communications Center (TOCC) and the Regional Traffic Management Center (RTMC) in the Twin Cities metropolitan area. Devices installed as part of this project are monitored and controlled from either of the two operations centers with minor coordination from the RTMC. The TIGER System has resulted in an integrated, coordinated traffic management approach that has been shared among several partners on the local and regional level.
Existing and Planned Communications Infrastructure

Fourteen (14) Changeable Message Signs (CMS), sensors and 17 CCTV cameras are to be installed along I-94 under the 2011-2012 Destination Innovation Safe Corridor Enhancements project. The placement of the CCTV locations is key, as the CCTV will be used to monitor traffic conditions along the corridor and also can be used to verify automated messages posted to the CMS. In addition, CCTV cameras can be used to monitor I-94 corridor CMS and confirm message placement and removal. These roadside devices will be connected via fiber optic cable to the District 3 Traffic Operations Center and also to the Regional Traffic Management Center (RTMC) in Roseville. Currently the RTMC is connected to District 3 Dispatch via a secure client connection (workstation) located at the District 3 TOCC.

Approximately 20-30 AVL systems are currently installed in maintenance vehicles operated by District 3/St. Cloud. Vehicle location, direction of travel and speed are currently reported automatically through the AVL system and are able to be tracked. The AVL system currently installed in District 3 maintenance vehicles communicates through the MDSS system server located at Meridian via a wireless leased third party service (AT & T, Verizon, Sprint, etc).

2.1.2 OPERATIONAL DESCRIPTION

2.1.2.1 OPERATIONAL CHARACTERISTICS

Eastbound traffic on this freeway is transitioning from a rural, driving environment to an urban, higher volume environment. This corridor typically operates with higher rates of speed and at higher vehicle volumes in the segment between St. Cloud and the Twin Cities as compared to typical rural interstates. During occasions when slower moving or stopped vehicles are present for activities such as winter maintenance, mowing, oversize vehicle loads, law enforcement activity or non-recurrent congestion, drivers may unexpectedly encounter slower vehicles, which can cause or trigger unsafe maneuvers in an attempt to avoid crashes. In recent years several incidents involving car/plow crashes and/or near misses with State Patrol vehicles have been reported.

District 3 snow plow and maintenance operators describe this corridor as having an unusually high number of aggressive drivers or drivers who overdrive road conditions. This description is based on personal accounts of snow plow operators who have been passed on the shoulder or have been hit from behind while plowing in the left lane of I-94. In addition, District 3 maintenance staff have expressed concerns about personal safety as they perform basic maintenance duties such as repairing cabled guard-rail and other maintenance responsibilities along the project corridor.

The focus of the SCorE WZARD project is to determine whether an automated system can be developed without plow operator intervention to alert motorists upstream of slow-moving
maintenance vehicles performing snow and ice operations ahead of them. Maintenance vehicles typically move at a pace generally between 25-30 miles an hour on the highway with posted speeds of 60-70 mph, while performing snow and ice operations, including plowing and sanding. Beyond the interaction between slow-moving maintenance vehicles and other highway users traveling at higher speeds, winter weather conditions during snow and ice operations also contribute to the potential for increased incidents. The challenge of the SCorE WZARD project is to determine whether the automated posting of messages on roadside CMS in the project corridor will provide meaningful information to highway users traveling at higher speeds upstream.

2.1.2.2 System Integration with Current and Planned Transportation Networks

The WZARD project coordinates operation of existing and potential new components to provide a unique operational capability. The details of the integration are dependent upon the design alternative selected, but several common features of integration are anticipated. The items presented as alternatives on an interim basis may be used for an indefinite duration, depending on project performance and ability, to implement alternatives considered as the desirable end state.

1. The WZARD project is expected to use positions and velocity of the snow plows determined by using existing devices and services currently in use by District 3 maintenance vehicles. The AVL data are expected to be communicated to IRIS. On an interim basis, the proximity of the snow plows to the sign and the proper display of messages may be determined using proximity radio systems (e.g., Dedicated Short Range Communications (DSCR), Bluetooth, Zigbee or WiFi), with AVL data used to validate the accuracy of the sign display by manual review.

2. The WZARD project is expected to use the IRIS system to monitor and control the sign display, with the proper display of messages determined by using algorithms developed for this project and implemented in IRIS. The algorithms will determine when to display the message and may determine which message to display and whether snow plow alert messages or other scheduled messages are of a higher priority to display. Depending on the design alternative and possibly on an interim basis, control of message display may be performed upon proximity radio detection, with reporting of sign operation taking place using IRIS or independent control software.

3. Management of the signs used along the corridor is expected to take place at the existing dispatch location at the District 3 TOCC in St. Cloud using existing systems, with monitoring access available to any facility having IRIS capability. Depending on design alternative and possibly on an interim basis, activity may be monitored or managed using independent systems.
4. The WZARD project is expected to utilize the new CMS being deployed along the I-94 corridor. On an interim basis, portable CMS may be used to augment the deployed CMS if the deployment experiences significant delay or has significant gaps in available signage.

5. The WZARD system is expected to communicate with the new CMS using fiber infrastructure currently being deployed along I-94. On an interim basis, MnDOT-owned wireless infrastructure, commercial wireless service or leased wired line service may be used if the fiber deployment experiences significant delay or has significant gaps in available communication.

2.1.2.3 Agency Interaction

A meeting was held on March 16, 2011 at MnDOT District 3 Headquarters in St. Cloud to present and discuss the scenarios with stakeholders of the project. Stakeholders expressed the importance of automated messages for the “Snowplow Ahead” warning system. District 3 maintenance staff also requested that any system design include a feature that would allow for the message to be displayed on a CMS before the plow driver actually passed the sign, in order for the snow plow operator to visually verify that the message was posted. This desired system requirement was added into the project’s final requirements. Other attributes requested by project participants include the consideration of vehicle speed and direction when determining message display timing and the ability to accommodate snow plows that may be moving on and off of mainline while servicing ramps. The stakeholders also mentioned that mechanisms are needed with the system to take messages off the boards if the truck turns around to service the other side of I94. Group participants also mentioned that there are times when a snowplow may be used in the morning to combat freezing rain and then be used in the afternoon for guardrail repair and requested that appropriate messages for both types of work need to be considered in the system’s design. Stakeholders suggested that the use of the snow plow during guardrail repair operations could be considered an incident and that it might make sense to handle this case under incident response protocols that currently exists.

The group expressed a need for a list of message priority and hierarchy due to multiple users of the CMS. Message priority will need to be considered in the system design for the WZARD project. Incident management currently involves incident responders working with dispatch to display emergency messages on the CMS. Law enforcement, EMS, fire departments and tow services could all use the system described within the Concept of Operations during incident response, but there was agreement within the group that the current system of incident management works well for most of these situations.

Dispatchers expressed a desire for an interface that displays truck location in the corridor and messages to be prompted by the system. There was some discussion about trying to roll warning messages back to previous CMS based on traffic queuing. While this is a desirable function of the system being designed, it was determined to be beyond the WZARD project scope. Construction and other seasonal maintenance issues were discussed and should be
considered during design. While there are multiple stakeholders and users of the system, the stakeholders indicated at the meeting that the prime focus for this system design should focus on notification of snowplows in the corridor.

Maintenance of the system was discussed with the stakeholders. The general consensus was that the system had two likely maintainers, either Central Office ITS technicians (ESS) that report to the MnDOT Office of Traffic, Safety and Technology, or technical repair and maintenance staff from the RTMC (Metro District) or from District 3/St. Cloud. The potential for system failures was also discussed. Although not discussed directly with stakeholders, maintenance of components located outside of the corridor may also be performed by contract staff. The decisions on maintenance responsibility depend on the components selected during system design and will require revisiting of the topic prior to commencement of operation. The desire of the stakeholders was to have no message displayed if a system failure was detected. There was also a desire to be able to override a system message if the system failure was detected by dispatch.

2.1.2.4 Operational Needs
This section summarizes the operational needs that were identified through the stakeholder meetings and refined during discussion of the user oriented operational scenarios. These elements summarize what MnDOT and other stakeholders identified as what would be required to be put into place in order to improve safety for snow/ice and other work zone operations. The identified stakeholder needs are listed below.

1. The system must reliably display messages indicating the presence of snow plows actively being used for winter maintenance.
2. The system must verify the location and identity of snow plows prior to activating messages.
3. System must be able to operate in an automated manner to warn of a snow plow in the corridor.
4. The system must have reliable reporting of the messages currently displayed on each CMS.
5. The system must record snow plow location and CMS message display for reporting and analysis.
6. The system must have override capabilities for higher priority messages.
   a. If a higher priority message is already placed on the CMS, the new system will not override the higher priority message.
7. The system must include message removal if the snow plow leaves the project corridor areas.
8. Message hierarchy and priority must be defined and referenced for this system.
9. System must provide for verification of CMS display by the snowplow driver.
10. System must accommodate a snow plow that is used in snow/ice operations and potentially other activities that requires the vehicle to activate warning/hazard lights.
11. System should show location of the snow plow and have message specific appropriate icons on a map for dispatch.

Desirable features:

1. System design should include options for construction and maintenance work in the corridor – unplanned work, or operators that are moving in and out of traveling lane.

2.1.2.5 High-Level System Functional Requirements
The following is a list of high-level system functional requirements that were developed through project stakeholder meetings for the SCorE WZARD system. Please note that the reference to the WZARD system should be interpreted as “all components working together to meet these requirements”.

3.1.1. The WZARD system shall operate in a corridor along I-94 from Rogers to St. Cloud.
3.1.2. The WZARD system shall initiate display of predetermined messages on select CMS in the corridor without operator intervention to indicate the presence of snow and ice operations along the corridor.
3.1.3. Display of WZARD messages shall be activated based on location of designated, properly equipped vehicles with equipment operating properly.
3.1.4. Identification of equipped vehicles with authorization to initiate display of WZARD messages shall be configurable within the WZARD system.
3.1.5. The WZARD system shall initiate a display that is timed to cause the sign message to become visible a configurable time prior to the vehicle passing the sign (suggested time - 15 seconds).
3.1.6. The WZARD system shall be configurable to cause termination of the WZARD message based on either time or distance since the vehicle passed the corresponding CMS. (Note: This requirement along with the following requirement mandates the use of regional position determination, e.g. GPS/AVL).
3.1.7. The WZARD system shall be able to terminate display of the WZARD message once the vehicle is at a configurable distance beyond the sign or leaves the corridor. (Note: This requirement along with the preceding requirement mandates the use of regional position determination, e.g. GPS/AVL).
3.1.8. The WZARD system shall be able to terminate display of the WZARD message once the vehicle is a configurable time beyond the sign.
3.1.9. The CMS used by the WZARD system will report activation of messages by the WZARD system to the IRIS software operating at the Minneapolis RTMC.
3.1.10. The CMS used by the WZARD system will report displayed messages to the IRIS software operating at the Minneapolis RTMC.

3.1.11. Operators will be able to modify the displayed message.

3.1.12. Operators will be able to terminate display of WZARD messages.

3.1.13. Operators will be able to post messages on the CMS that can be overwritten by WZARD messages.

3.1.14. Operators will be able to post messages on the CMS that are not overwritten by WZARD messages.

3.1.15. The WZARD system shall log all sign messages requested to be activated or terminated by IRIS.

3.1.16. CMS display of messages upon equipped vehicle passage shall be able to be enabled remotely for each CMS designated as part of the WZARD system.

3.1.17. CMS display of messages upon equipped vehicle passage shall be able to be disabled remotely for each CMS designated as part of the WZARD system.

3.1.18. The WZARD system shall reject attempts by vehicles without properly functioning equipment and authorization to display WZARD messages.

3.1.19. The WZARD system shall log attempts by vehicles without properly functioning equipment and authorization to display WZARD messages.

3.1.20. Configuration of all components of the WZARD system shall require verification of proper authorization.

3.1.21. Attempts to configure components of the WZARD system without verification of proper authorization shall be logged.

2.1.3 **User-Oriented Operational Scenarios**

2.1.3.1 **User Oriented Operational Scenarios**
A Concept of Operations developed through detailed discussions with project stakeholders is an important tool.

The following operational scenarios were discussed with project stakeholders in order to better understand a potential WZARD system interface with existing MnDOT systems. The scenarios were intended to determine stakeholder responsibilities, describe how the system might operate under actual conditions, the environment in which the system might operate within (political, physical, operational and support), and the processes that the system can support.
2.1.3.2 SYSTEM USERS
The following system users were identified for the SCorE WZARD project:

- Maintenance Worker
- Highway Contractor
- Maintenance Supervisor
- TMC/RMTC/TOCC Operator
- TMC/RMTC/TOCC Supervisor
- Law Enforcement (Peace Officer)
- Other Emergency Services
- 911 Dispatcher
- Other Operators in the Corridor (Tow Truck Operator – Wide Load Movement)
- Traveling Public

2.1.3.3 USER SCENARIOS
The scenarios below describe expected circumstances that would be encountered by specific user groups. The scenarios are not intended to be all inclusive descriptions of an event, but rather to provide enough detail to discuss issues and considerations that must be made in the development of the final design of the system. Agency policies, constraints and other systems were considered when reviewing the scenarios.

DISTRICT 3 MAINTENANCE VEHICLE
It is necessary that the sign messages be automated because the snow plow operator should not have an additional task to perform which may distract from his ability to safely operate the snow plow. Dispatchers are also unavailable to manually monitor the snow and ice operations or to display the appropriate messages at the correct locations and times. It is also necessary to display accurate information to the motorist for the signs to gain and maintain credibility.

Scenario 1A

- District 3 snow plows use this system during winter snow and ice operations to provide dynamic warning to motorists in an attempt to reduce the potential of a plow/vehicle conflict on I-94.

- As a snow plow approaches a CMS installed along the I-94 corridor, a warning message will be automatically displayed on the sign. The snow plow operator will read and verify that the proper message has been displayed.
As the snow plow passes the sign, leaves the freeway or stops snow and ice operations and proceeds along the corridor at a normal rate of safe operating speed, the message on the CMS will be automatically removed from the sign.

**Actors:**
- Snow plow that reports its position
- Computer/Automation that displays and removes CMS message
- D3 and/or maintenance staff that monitors CMS message display

**Scenario 1B**

- District 3 snow plows performing snow and ice operations on I-94 during winter events will enter a pre-determined sign activation zone for every sign on eastbound I-94 between CSAH 15 and Highway 101 in Maple Grove.

- As the plow or plows enter a specific sign activation zone, a winter operations advisory message is automatically displayed on the CMS that indicates a maintenance vehicle is performing maintenance activities nearby.

- This message remains posted on the CMS until the snow plow or plows leaves the pre-determined sign activation zone, after which it is automatically dropped from the CMS.

**Actors:**
- Snow plow that automatically reports its position
- Software that determines where the field boundaries are for automatically posting a message to a specific CMS on the project corridor
- Computer/Automation that displays and removes CMS message

**DISTRICT 3 STATE PATROL DISPATCH OPERATIONS**

**Scenario 2A**

- District 3 snow plows are performing snow and ice operations along the I-94 eastbound corridor.

- District 3 snow plows automatically post a message to CMS located along the I-94 corridor as they near each sign. The snow plow driver reads the message and verifies that the message is accurate as the plow passes each sign.

- District 3 State Patrol Operators/Dispatchers at the TOCC in St. Cloud attend to their normal duties while the snow plows are in operation along I-94 but are able to verify the geographic location of each plow performing these functions by using a web-based link.
that opens up to a map-based application which displays the snow plow or plows’ positions a work station computer located within the St. Cloud District 3 TOCC.

**Actors:**
- District 3 maintenance supervisory/field staff involved in snow/ice maintenance activities
- District 3 maintenance vehicle performing maintenance activities
- District 3 TOCC operators that monitor snow plow locations along the project corridor as necessary

**Scenario 2B**

- District 3 maintenance trucks equipped with AVL/GPS are performing planned maintenance activities (i.e., pothole patching, guardrail repair, etc.) along eastbound I-94.

- District 3 State Patrol Operators/Dispatchers at the TOCC in St. Cloud determine which CMS along the project corridor to activate and post a generic maintenance advisory message to warn travelers that a maintenance vehicle is ahead. The TOCC Dispatcher/Operator verifies the correct message has been posted to the current CMS location(s) by viewing the message on the sign through CCTV near the sign or by having maintenance field staff verify the posted message as they approach the CMS.

- District 3 Operators/Dispatchers set up a CAD event in the system and requested automatic notification of the sign message expiration after a set amount of time. After this time has passed the Operator/Dispatcher contacts maintenance staff to determine whether the sign message should remain or be removed from the CMS. Maintenance staff advise the Operator/Dispatcher whether or not to remove the sign or to their current location on the corridor.

**Actors:**
- District 3 maintenance supervisory/field staff alerting District 3 TOCC operators of activities
- District 3 maintenance vehicle performing maintenance activities
- District 3 TOCC operators that manually post, verify and take-down CMS messages along the project corridor
METRO DISTRICT REGIONAL TRAFFIC MANAGEMENT CENTER (RTMC) OPERATIONS

Scenario 3A

- District 3/St. Cloud is conducting snow and ice operations along eastbound I-94, using AVL/GPS-equipped vehicles to automatically post advisory messages to corridor CMS as activities occur.

- RTMC Operators/Dispatchers in Metro District are able to view and verify the geographic location of the District 3 snow plows as necessary by using a web-based link that opens up to a map-based application which displays the snow plow or plows’ positions at a work station computer located within the RTMC.

Actors:
- District 3 maintenance vehicle performing maintenance activities
- RTMC operators able to view geographic location of District 3 AVL/GPS-equipped snow plows.

Scenario 3B

- District 3/St. Cloud maintenance is conducting routine maintenance activities (i.e., pot hole filling or striping) along eastbound I-94.

- District 3 State Patrol Operators/Dispatchers at the TOCC in St. Cloud determine which CMS along the project corridor to activate and post a generic maintenance advisory message to warn travelers that a maintenance vehicle is ahead. The TOCC Dispatcher/Operator verifies the correct message has been posted to the current CMS location(s) by viewing the message on the sign through CCTV near the sign or by having maintenance field staff verify the posted message as they approach the CMS. District 3 Operators/Dispatchers set up a timed CAD event in the system and verify status of operations with maintenance staff when the event timer is triggered.

- RTMC Operators/Dispatchers in the Metro District are able to view and verify the geographic location of the District 3 vehicles as necessary by using a web-based link that opens up to a map-based application which displays vehicle positions on a work station computer located within the RTMC.

Actors:
- District 3 maintenance vehicle performing maintenance activities
- District 3 TOCC operators that manually post, verify and take down CMS messages along the project corridor
RTMC Metro District operators able to view geographic location of District 3 AVL/GPS-equipped vehicles.

Scenario 3C

- On a Sunday night at 1 am a multiple-vehicle accident occurs along eastbound I-94 in the project corridor.
- District 3 State Patrol Operators/Dispatchers at the TOCC in St. Cloud have turned over operations to the RTMC in Metro District for the evening shift.
- RTMC Operators/Dispatchers in the Metro District are able to view and verify the geographic location of the incident through CCTV on the corridor. RMTC Operators/Dispatchers manually post advisory messages on appropriate CMS on the corridor.
- As the accident is cleared by State Patrol, RTMC Operators/Dispatchers in the Metro District verify accident clearance by State Patrol and manually take down the posted messages on the CMS.

Actors:
- State Patrol that reports incident to RTMC Metro District Dispatch staff and authorizes posting and clearance of CMS message
- Metro District RTMC operators that manually post, verify and take down CMS messages along the project corridor during hours when District 3 Operators/Dispatchers are off duty

LAW ENFORCEMENT

Scenario 4A

- State Patrol is working a traffic incident where a semi-truck has just overturned in the project corridor along eastbound I-94. The Patrol alerts the St. Cloud/District 3 TOCC dispatch staff that an incident has occurred.
- St. Cloud District 3 State Patrol Operators/Dispatchers view the incident through CCTV near the incident site and post an incident advisory message for display on the appropriate CMS.
• St. Cloud District 3 State Patrol Operators/Dispatchers utilize CCTV to track incident clearance progress. State Patrol advises operators/dispatchers to remove the message once incident has been cleared and is no longer active.

Actors:
• State Patrol that reports incident to St. Cloud/D3 Dispatch staff and authorizes posting and clearance of CMS message
• MnDOT St. Cloud/D3 staff that display and remove CMS message after incident is cleared

TRAVELING PUBLIC

Scenario 5A
• Traveler is traveling along eastbound I-94 at a high rate of speed and passes CMS which displays a warning that maintenance activity is occurring ahead.

Actors:
• Snow plow that reports its position
• Computer/Automation that displays and removes CMS message
• Auto driver

FAILURE AND MAINTENANCE SCENARIOS

• Any of the scenarios above - if sensors, CMS or other malfunction, how does RTMC or District 3 know?

• Who maintains the system? Would more than one group maintain? If so, who has what responsibility?

2.1.4 SYSTEM OVERVIEW AND CONCEPT
The WZARD system’s proposed conceptual design includes technology located both in the field and within the TOCC/RTMC. Each element of the conceptual design is explained further below.

2.1.4.1 CHANGEABLE MESSAGE SIGN (CMS) TECHNOLOGY
The dynamic message signs installed as part of the SCorE project are manufactured by Ledstar, Inc. and 13 of the installed signs measure 3 feet by 14 feet and are full color matrix Type 9C side-post mount CMS. Another larger full color matrix sign has been mounted on an overpass along I-94 eastbound at Barton Avenue. The signs were installed during the spring and summer of 2011 along the eastbound lane of I-94 as part of the SCorE Phase 2 project.
This CMS sign controller provides the ability for CMS signage to auto post and also terminate messages. Technical specifications for the LedStar CMS signage and controller can be found in the appendices of this document.

### 2.1.4.2 HARDWARE, LOCATIONS AND INSTALLATION NEEDS

The hardware required for the WZARD project is a combination of existing hardware, hardware currently being deployed to be jointly used by the WZARD project and other MnDOT projects, and possibly hardware to be deployed strictly for use by the WZARD project. The existing hardware includes the AVL equipment located on the snow plows in District 3 and the servers related to the RTMC. The hardware to be jointly used by the WZARD project and other MnDOT systems include the fiber infrastructure with related electronics to be installed along I-94 and the CMS. These pieces of hardware are to be located between the Cities of Rogers and St. Cloud on I-94. The fiber optic cables will be installed throughout the corridor along I-94 during the 2012 construction season and the CMS have been installed throughout the corridor at an interval of one to three miles along I-94 in the 2011 construction season.

For some of the design alternatives, hardware that could be installed solely for the WZARD project included proximity wireless communications to initiate pre-stored message display by establishing a contact closure. The contact closure would occur upon establishment of a communication channel between transmitter and receiver. The receiver would be installed near the CMS with a connection to the CMS controller. A compatible transmitter would be installed in each snow plow to be used along the corridor to initiate message display. To assure that the messages are displayed only when a snow plow is traversing the corridor in the direction served by the related CMS, the receiver would be required to determine the direction of travel of the transmitter. Direction of travel could be performed in a number of ways, including having both the transmitter and receiver connect to an antenna that covers less than a 180 degree arc with limited coverage above the horizontal.

### 2.1.4.3 POWER

Power for CMS and communication equipment installed along the roadside is to be accessed directly from connections to the existing utility provider along the corridor. Since this corridor is located near developed areas, the utility grid is expected to be available with high reliability and with few constraints on field device location. A local outage of communication electronics power can disable display or reporting for CMS at other places along the corridor. A backup power deployment is feasible to provide power sources such as a UPS with a pair of batteries that could operate in a power outage of up to 24 hours. Backup power sources for CMS displays typically require significantly greater size and may not be feasible for the project deployment.

Power for onboard equipment will be obtained from the vehicle electrical system. Most onboard devices can be configured to operate either continuously with limited draw on battery power, only while the vehicle is operated, or to continue operation for a limited time following
vehicle shutdown. In the case of the display of messages related to moving snow plows, the preferred configuration is for the onboard devices to operate only while the vehicle is operating.

2.1.4.4 COMMUNICATIONS
Communication options along the corridor are available from both private and commercial sources for both wired and wireless media. The primary communication method between fixed sources is anticipated to be newly deployed fiber infrastructure owned by MnDOT. The fiber infrastructure will be connected to existing fiber infrastructure owned by MnDOT in the Twin Cities area to give connectivity to facilities throughout the region as well as facilities throughout the state connected to the wide area network provided for MnDOT. While many devices located along I-94 will be connected to the new fiber, devices not located along the new linear infrastructure will continue to be serviced by either MnDOT-owned wireless communications or by commercial data plans such as EVDO. The retention of wireless access is particularly attractive along alternate routes such as TH10. Older wired technology such as T-1 and Frame Relay are alternatives for consideration when high reliability is warranted, although the installation and service costs from such technologies make justification of their use problematic.

A variety of wireless options are available for mobile sources. The winter maintenance vehicles in the area are equipped with AVL devices using GPS satellites for position determination and EVDO wireless data connections for position reporting. If full integration with IRIS is selected, this may be the only wireless communication necessary for mobile sources. If a proximity device is used, other wireless technologies will be considered including dedicated short range communications (DSRC), Bluetooth and Zigbee. The primary use of the proximity wireless technologies is to initiate a contact closure that can be used by a CMS controller to activate a pre-stored message. The available technologies, in particular DSRC, may also be used to pass ancillary data to a related application.

2.1.4.5 SYSTEM INTEGRATION
The design alternative using IRIS to control the message display provides the most flexible implementation of the WZARD project, and will be examined as the desired alternative for system integration. This design alternative requires no new hardware to be installed. It will take reported position and velocity data from the currently deployed AVL system using AmeriTrak hardware and services. CMS are to be both controlled and monitored by IRIS, an existing system. IRIS would be the major component required to be enhanced, and operations using IRIS would be required to be modified to fully use the new capability.

IRIS enhancements relate to the acquisition of AVL data, the determination that CMS display is appropriate on a specific sign, and reporting on sign display contents. The acquisition of AVL data can be implemented in a number of standards-based manners to acquire data in near real
time from the snow plow. As currently implemented, the AVL data are transmitted on a periodic basis from the AmeriTrak device on the truck via a wireless data service to an Internet location. While position and velocity are mandatory to be included in the data stream, additional information that would improve the ability of the system to operate properly include the blade positions, spreader usage and warning light usage. The acquisition of the AVL data from the website would be a new capability. The constraints on data collection would be latency consistent with the easy visibility of a vehicle in poor weather conditions. For comparison, a vehicle moving at 30 miles per hour will travel about 200 yards in 15 seconds, a quarter mile in 30 seconds, a half mile in one minute, and a mile in two minutes.

A more substantial additional capability would involve the determination to display a snow plow alert message on a specific corridor CMS. New logic and calculations would need to be developed that determine when to light the proper message. Such logic would require high reliability to essentially never display a message with inaccurate information. Owing to the frequent changes to the desirability of displaying a snow plow alert message on a CMS, it is desirable for this placement to be routinely accomplished without user interaction, although with the capability to terminate display of the messages both on a specific sign and for all signs. Considerations for determining to display a message include location of the snow plow, the speed that the snow plow is traveling, the direction of the snow plow, the state of the snow plow equipment, the state of the plow warning lights, the surrounding weather conditions, and relative priority of other messages commanded for display on the CMS. The development of this capability includes the development of the algorithmic logic, the implementation of the logic into the IRIS software, the testing of the implemented logic both in a laboratory setting and on roadway signs.

The final enhancement to IRIS software would be in the reporting of CMS usage. For a capability such as this to be reliably monitored, a real-time display of all signs along the corridor would be required along with reporting frequency similar to the AVL reporting period. The real-time display should include information about the source of the message being displayed. An alert that this capability has been initiated should also be considered.

2.1.4.6 USER INTERFACE
The primary locations for user interaction with the system elements will be at the District 3 State Patrol dispatch center and in the winter maintenance vehicle. The desired mode of operation at the dispatch center will be that of supervisory control. For a majority of the time, the signs will be available for routine operations using IRIS or a remote ATMS package. During a time when the signs are being used for snow plow alert messages, the operator screen will reflect the updated messages being displayed. For meaningful supervisory operation by the State Patrol dispatchers, the message being displayed will have to be verified by the system with a frequency of several times per minute and constantly displayed.
In situations where the dispatch center staff determines that the CMS display should be used for purposes other than snow plow alert messages, the user interface must provide the ability to replace the snow plow alert message with other messages or blank the sign. Such situations would include when a message is determined to be of higher priority than a snow plow alert message or when the dispatch staff attempt to determine whether or not the snow plow alert messages are being displayed properly. Depending on the design alternative chosen, this override control may be provided by IRIS or a remote ATMS package.

For safety reasons, the winter maintenance vehicle will not have an interface for operational interaction with the system. Access by using a laptop computer or screen and keyboard will be provided for maintenance and evaluation purposes. By activating the snowplow alert message prior to the passage of the plow by the CMS, the maintenance vehicle operator will have the ability to view message to verify that it is displayed, legible and appropriate.

### 2.1.4.7 Expected Ongoing Cost Estimate

The costs to be incurred by the project will vary based on the design alternative selected. Many components of this system are to be shared with other ongoing operations and the ongoing costs attributed to this project are subject to revision, based on both the design ultimately realized and MnDOT policy related to accounting. It is emphasized that the estimates below are intended to provide a range for expected costs.

For the design alternative using a short-range contact closure, no additional service costs would be required. The implementation of the contact closure would require hardware at each CMS and a corresponding transmitter on each corridor maintenance vehicle. No control logic would be required and limited reporting enhancements would be required to IRIS. Estimated ongoing costs include $1500 hardware maintenance on the contact closure devices in the CMS and $900 hardware maintenance costs for the related contact closure transmitters required in the vehicles. There would be some expected software maintenance costs estimated at $3,750. Operational labor is estimated as $16,000 for a total annual cost of $22,150.

For the design alternative using a third party service to request message display via IRIS, no additional service costs would be required as existing communication pathways would be used. No additional hardware would be required. New calculation logic would be required to determine requested message display based on AVL data accessed from the existing AVL service. These cost assumptions are based on a MnDOT contracted development of calculation logic, with a resulting software maintenance cost of $7,500 annually. Operational labor is estimated as $16,000, for a total annual cost of $23,500 annually. Additional assumptions include use of an existing server with an existing Internet connection to provide CMS message display requests to IRIS.

For the design alternative using a third party service to issue additional message requests to the CMS controller, an alternative communication path to the CMS would be required, implying
additional hardware costs for acquisition plus ongoing communication service costs. New
calculation logic would be required to determine desired message display based on AVL data
accessed from the existing AVL service. This design alternative would also require logic to
communicate with the NTCIP-based CMS controllers, which is available in the commercial
marketplace. These cost assumptions are based on a service plan to supply calculation logic
and sign control from a commercial vendor, with a resulting cost estimated at $78,000. The
additional communication hardware maintenance is estimated as $1,500 and communication
service as $3,100. Operational labor is estimated as $16,000, for a total annual cost of $98,600
annually.

2.1.5 Design Alternatives

2.1.5.1 Design Alternatives
The implementation of the new capability builds on infrastructure that now exists and
infrastructure currently under development in the project corridor. The primary field elements
to be used included the CMS along the corridor, existing AVL installed on District 3 snowplows,
and the existing assets of the Minneapolis RTMC. During the WZARD project, five (5)
alternative concepts were developed to accommodate for the design of the new capability:
- IRIS Control Using AVL Data
- Contact Closure Display with IRIS Control
- Contact Closure Display with Remote Control
- Remote Reporting with IRIS Control
- Connected Vehicle implementation of Dedicated Short Range Communication.

Each of the design alternatives leveraged existing assets and required additional or enhanced
components to complete the implementation.

IRIS Control Using AVL Data
The first concept uses existing AVL capability to report snow plow positions to the IRIS software
at the RTMC, which then controls sign message display. A depiction of the elements of this
concept is shown in Figure 2. Implementation of this concept would use AVL capability based
on GPS position determination and communication of positions determined on the snowplow
using cellular telephone infrastructure. The position solutions would be available for access by
IRIS using Internet techniques such as a real-time XML feed. Based on the reported positions,
IRIS would use algorithms to determine when a snowplow is operating near an available CMS in
a manner where CMS message display is desirable. When determined to be desirable, IRIS
would initiate the display of one of several predetermined messages, monitoring the CMS for
proper message display and returning the CMS to display of the preexisting message(s) once
the snowplow was no longer in the immediate vicinity of the sign.
This concept offers the excellent support of CMS operations, providing significant flexibility in operation using existing components or capability of expansion in the number of components. The use of AVL data allows for initiation of the desired message based on arrival of the snowplow near the sign. Distance prior to arrival to display the message may be adjusted through configurable parameters. Likewise, termination of the message may be adjusted by configurable parameters to be based on a time since snowplow passage or location of the snowplow once past the CMS. Control of the sign by IRIS allows for flexibility to adjust the CMS message in real time, improved coordination with prioritization of messages for snowplow warnings along with other CMS message display, and security in verification of proper snowplow identification using the AVL services. The primary disadvantage of this option is the software work required to implement the capabilities. All of the new capability rests with enhancements to IRIS, including collection of AVL data in real time, determination of when to display messages, and enhanced monitoring of sign display.

**Contact Closure Display – IRIS Reporting**

The second concept uses the capability of the CMS controller to display a pre-stored message upon detection of a contact closure. A depiction of the elements of this concept is shown in **Figure 3**. Under this concept, a snowplow would be equipped with a short-range communication technology such as Bluetooth. When a Bluetooth device with proper identification on a snowplow comes within communication range of the corresponding device,
mounted at the site of the CMS controller, the Bluetooth reader would initiate a contact closure. The CMS would then interrupt ongoing message display to display the message related to snowplow passage. Once the snowplow message had been displayed for a predetermined time, the CMS would return to the prior message display. As with other concepts, IRIS software at the RTMC would be used to monitor CMS message display.

**FIGURE 3: CONTACT CLOSURE DISPLAY - IRIS REPORTING**

This concept offers more limited control of sign display while being less software intensive in development. Implementation of this concept requires installation of hardware to initiate the contact closure on the snowplows to be used to initiate sign display along with compatible hardware at the site of the sign controller. Assuring proper configuration of the contact closure hardware is expected to be a manual process requiring entry of authorized hardware identification information into the contact closure hardware. The project team is aware of several devices that offer wireless contact closure capabilities along with developmental items that allow identification of Bluetooth or similar short range devices. The required expansion to IRIS software would be limited to enhanced monitoring of sign display.

**Contact Closure Display - Remote Reporting**
The third concept is similar to the second with the reporting aspect handled independently of IRIS using a remote or web-based service. A depiction of the elements of this concept is shown below in Figure 4. Unlike other concepts, IRIS software at the RTMC would not be used to monitor CMS message display. To avoid conflict in control of CMS, the corridor CMS would be controlled by the remote service and unavailable to the D3 workstation under IRIS.
The primary advantage of this concept over the IRIS reporting is the ability to completely implement without modification to IRIS. Remote services can be adjusted without impact to integrated implementations such as RTMC operation under IRIS.

**FIGURE 4: CONTACT CLOSURE DISPLAY - REMOTE REPORTING**

The fourth concept combines aspects of remote reporting with IRIS control. Under this concept, a remote application determines the proper message and timing of the snow plow alert message and then requests that IRIS displays the message under the existing priority scheme and operational setting of District 3. A depiction of this concept is shown in **Figure 5**. The AVL data are accessed using existing or easily established pathways. The request for message text display is an existing concept within IRIS. The primary advantages of this concept are the flexibility in operational control provided by AVL/MDSS data and the ability to limit implementation effort on the part of IRIS using established concepts. While this concept removes development effort from the IRIS staff, it presents the need for a limited development effort by an outside developer. Possible developers of this application include the AVL vendor, the MDSS vendor, or independent web service providers with ITS domain knowledge.
The fifth concept uses elements of connected vehicle technology to enable secure control and reporting of CMS message display related to snowplow passage. The communication between the snowplow and sign controller would be enabled by the presence of roadside equipment and onboard equipment capable of using the Dedicated Short Range Communication (DSRC) standards in the 5.9 GHz bandwidth. A depiction of this concept is shown in Figure 6. Such technology is currently available on off-the-shelf products. Communication would include reporting of sign operation and possibly coordination of sign messages using IRIS.
The use of connected vehicle concepts has advantages in security and leveraging ongoing research. The use of the connected vehicle core provides security processes to ease configuration of use by authorized vehicles while inhibiting the ability of erroneous or malicious users to control sign display. The ongoing research has the potential to offer a broad array of hardware and data services economically and supported by standards. For example, MDSS data could be transmitted to road weather forecasters over a shared communication infrastructure.
2.2 **WZARD SYSTEM REQUIREMENTS**

The SCorE WZARD final system design was based upon the following requirements.

**Environment Requirements**

3.1.1. The WZARD system shall operate in a corridor along I-94 from Rogers to St. Cloud.

3.1.2. The WZARD system shall operate on a combination of servers hosted by MnDOT at the Regional Traffic Management Center (RTMC) and/or servers available through the public Internet.

3.1.3. Control of the CMS along the corridor will routinely be provided by the Intelligent Roadway Information System (IRIS).

3.1.4. The control of the CMS for WZARD messages can be performed either by IRIS or in coordination with IRIS.

3.1.5. Operational control of the WZARD system will be performed at District 3 dispatch in St. Cloud.

**Functional Requirements**

3.2.1. The WZARD system shall initiate display of predetermined messages on select CMS in the corridor without operator intervention to indicate the presence of snow and ice operations along the corridor.

1. The CMS included in the project shall include:
   1. MP 171.71
   2. MP 174.49
   3. MP 176.85
   4. MP 180.25
   5. MP 183.45
   6. MP 185.66
   7. MP 186.4
   8. MP 188.45
   9. MP 190.71
  10. MP 192.37
  11. MP 194.73
  12. MP 198.2
  13. MP 200.1
  14. MP 202.95
3.2.2. The WZARD system shall calculate message initiation and termination times based on vehicle positions reported by the AmeriTrak AVL system currently in operation.

3.2.3. The WZARD system shall store data regarding the CMS being used, including:
   1. Sign identification
   2. Sign location
   3. Number of lines available for message display
   4. Number of characters per line available for message display
   5. Sign Manufacturer and Model Number

3.2.4. Identification of equipped vehicles with authorization to initiate display of WZARD messages shall be configurable within the WZARD system.

3.2.5. The WZARD system shall store data regarding the maintenance vehicles being used, including:
   1. Vehicle identification
   2. Vehicle equipment status
   3. Inclusion of vehicle in dynamic operation.
   4. AVL Manufacturer and Model Number

3.2.6. Display of WZARD messages shall be activated based on location, speed, and direction of designated, properly-equipped vehicles with equipment operating properly.
   1. The location to activate messages shall include an area within a configurable distance (nominally 50 feet) of the traveled way and shoulder of I-94 from a configurable distance before passage of the CMS (nominally 1500 feet) to a configurable distance beyond the CMS (nominally two miles or to the next sign), resulting in a typical display time of between four and five minutes.
   2. The range of speeds to activate messages shall include a lower limit (nominally 10 mph) to indicate that the vehicle is on a mobile assignment to an upper limit (nominally 45 mph) to indicate that the vehicle is an obstruction to traffic flow.
   3. The direction to activate messages shall include a cone within a configurable angle (nominally 5 degrees) of the direction of the roadway.
   4. The vehicle must maintain reported location, speed, and direction within the range causing display for two consecutive AVL reports to initiate display.

3.2.7. The WZARD system shall initiate display timed to cause the sign message to become visible a configurable time prior to the vehicle passing the sign (suggested time 15 seconds).
3.2.8. The WZARD system shall be configurable to cause termination of the WZARD message based on either time or distance since the vehicle passed the corresponding CMS.

3.2.9. The WZARD system shall be able to terminate display of the WZARD message once the vehicle is a configurable distance beyond the sign or leaves the route.
   1. The vehicle must maintain reported location, speed or direction outside the range causing display for two consecutive AVL reports to cause removal of an existing display.

3.2.10. The WZARD system shall be able to terminate display of the WZARD message once a configurable amount of time (nominally 5 minutes) has passed since the snow plow passed the sign.

3.2.11. Operators of the IRIS system shall be able to terminate display of WZARD messages.

3.2.12. Operators of the IRIS system shall be able to post messages on the CMS that can be overwritten by WZARD messages.

3.2.13. Operators of the IRIS system shall be able to post messages on the CMS that are not able to be overwritten by WZARD messages.

3.2.14. Operators of the IRIS system shall be able to remotely disable display of WZARD messages on all CMS with a single action.

3.2.15. Operators of the IRIS system shall be able to remotely disable display of the WZARD messages on individual CMS with a single action.

3.2.16. The WZARD system shall be able to select messages for display from a predefined set of potential messages.

3.2.17. The WZARD system shall use default fonts pre-stored in the CMS appropriate for freeway message display.

3.2.18. The WZARD system shall be able to select messages for display on typical configurations of CMS including:
   1. Full size overhead or roadside signs capable of displaying three lines with 20 characters on each line
   2. Smaller roadside signs capable of displaying two lines with 12 characters on each line
   3. Portable signs capable of displaying three lines with 8 characters on each line

3.2.19. For full size, three-line signs, the messages to be displayed include:
   1. A one-phase message showing:
      “SNOW PLOW”
      “AHEAD”
      “USE CAUTION”
2. A one-phase message showing:
   “MAINTENANCE”
   “VEHICLE AHEAD”
   “USE CAUTION”
   when active snow plowing is not confirmed for the corridor.

3.2.20. For smaller, two-line signs, the messages to be displayed include
   1. A two-phase message showing:
      “SNOW PLOW”
      “AHEAD”
      on one phase, and
      “USE”
      “CAUTION”
      on the second phase when active snow plowing is confirmed for the corridor.

   2. A two-phase message showing:
      “MAINTENANCE”
      “VEH AHEAD”
      on one phase, and
      “USE”
      “CAUTION”
      on the second phase when active snow plowing is not confirmed for the corridor.

3.2.21. For portable, three-line signs, the messages to be displayed include:
   1. A two-phase message showing:
      “SNOW”
      “PLOW”
      “AHEAD”
      on one phase, and
      “USE”
      “CAUTION”
      on the second phase when active snow plowing is confirmed for the corridor.

   2. A two-phase message showing:
      “MAINT”
      “VEHICLE”
      “AHEAD”
      on one phase, and
      “USE”
      “CAUTION”
on the second phase when active snow plowing is not confirmed for the corridor.

3.2.22. The WZARD system shall utilize verifying information to adjust display of messages for the entire corridor using:
1. Active treatment information
2. Weather information
3. Vehicle movement information
4. Calendar

3.2.23. The CMS used by the WZARD system shall report activation of messages to the IRIS software operating at the Minneapolis RTMC.

3.2.24. The WZARD system shall log all AVL data accessed for use in message display termination for performance analysis.

3.2.25. The CMS used by the WZARD system shall report displayed messages to the IRIS software operating at the Minneapolis RTMC.

3.2.26. The WZARD system shall log all sign messages requested to be activated or terminated by IRIS.

3.2.27. The WZARD system shall log the reason for removal of a displayed message such as loss of communication, location outside of geofence, heading outside of geofence, speed outside of range or confirming parameter change.

3.2.28. The WZARD system shall log and timestamp all AVL data accessed along with the related messages to be displayed (if any) and reasons for not displaying a message.

3.2.29. The performance of the system will be able to be monitored from the RTMC, by the developing organization, through Internet access, or from a combination of these locations.

3.2.30. The WZARD system shall implement a monitoring display with the following information displayed on a single screen:
1. Icons representing the location of each CMS capable of displaying a WZARD message (static)
2. The operational status of each CMS into states of at least disabled, operating with no messages displayed, and operating with messages requested (dynamic)
3. The text of the message currently displayed on CMS (dynamic)
4. The text of the message requested by the WZARD logic (dynamic)
5. The location of maintenance vehicles with operating AVL systems (dynamic)
6. An indication of the operational status of the WZARD logic into states of at least disabled, operating with no messages requested, and operating with messages requested (dynamic)
7. A corridor map of sufficient detail to identify the location of field elements (static)

3.2.31. The WZARD system shall be able to restrict access to the performance monitoring information.

3.2.32. One or more of the following techniques shall be implemented to restrict access:
   1. Username/Password authentication
   2. Virtual Private Network (VPN) connection
   3. IP address filtering

Performance Requirements

3.3.1. The CMS shall be updated based on vehicle positions within a maximum period (nominally 30 seconds) of position determination.

3.3.2. WZARD messages shall be displayed for a minimum period (nominally 30 seconds) unless manually overridden.

3.3.3. WZARD messages shall be removed within a maximum period (nominally five minutes) of loss of communication with the CMS or components of the WZARD system.

3.3.4. WZARD messages shall be removed within a maximum period (nominally 30 seconds) of determination that the message should no longer be displayed.

3.3.5. WZARD messages shall be displayed 95% of the time that actual maintenance vehicle locations would mandate display unless manually overridden.

3.3.6. WZARD messages shall be removed within a maximum period (nominally one minute) of failure of the control logic.

3.3.7. The accuracy of the reported vehicle position will be within 10 meters at the time of position determination.

3.3.8. The monitoring display will be updated on a configurable frequency (nominally once per minute) with information on vehicle position and sign display not more than a maximum period since realization (nominally two minutes).

Administrative Requirements

3.4.1. RTMC/TOCC operators of the WZARD system shall be able to modify the displayed message.

3.4.2. The WZARD system shall reject attempts by vehicles without properly functioning equipment and authorization to display WZARD messages.

3.4.3. The WZARD system shall log attempts by vehicles without properly functioning equipment and authorization to display WZARD messages.

3.4.4. RTMC/TOCC operators of the WZARD system shall be able to remotely disable display of WZARD messages on all CMS with a single action.
3.4.5. Configuration of all components of the WZARD system shall require verification of proper authorization.
   1. Authorization for MnDOT staff shall utilize existing credentials.

3.4.6. Attempts to configure components of the WZARD system without verification of proper authorization shall be logged.

CAD Integration Requirements

3.5.1. The WZARD system shall make information available to interfacing systems including:
   1. Requested messages
   2. System status information

3.5.2. The State Patrol Computer-Aided Dispatch (CAD) shall incorporate WZARD-related data into the CAD geographic display.

3.5.3. The State Patrol CAD shall collect WZARD-related data from the following locations:
   1. MnDOT vehicle position from the AVL vendor Internet portal or MnDOT Internet portal

2.3 Final WZARD Selected System Design

This section describes the final working design chosen for the WZARD system. The rationale for selection of this design over other considered alternatives centered on the quality of available message display, the ability to implement a pilot system for operation during the 2011/2012 winter maintenance season and anticipated project costs.

The selected design uses AVL data reported to a server location to determine the timing of message display. This approach was chosen over a class of techniques that would determine proximity of the snow plow to a corridor CMS using a short-range communication signal such as ZigBee, Wi-Fi, Bluetooth or DSRC devices. The advantages of the AVL approach include knowledge of vehicle movement once past the CMS and processing capabilities of servers to adjust message content based on external factors.

The use of CMS for display of WZARD messages in the corridor requires sharing of the field resource with routine freeway management operation under the control of IRIS servers located at the MnDOT Regional Traffic Management Center (RTMC). The selected design eliminates IRIS modifications and limits IRIS configuration revisions. This approach was chosen over alternatives that incorporated some or all of the logic into IRIS, which requires coordination with ongoing enhancements and efforts of staff knowledgeable about the internal workings of IRIS. This coordination and potential contracting effort required schedule and budget resources not available for the WZARD pilot system implementation.
The use of existing components located remotely from the CMS and each other requires communication resources, which can most efficiently be provided by Internet access and MnDOT-owned fiber. The selected design leverages existing server and communication usage. This approach was selected over approaches requiring new communication paths and new server locations primarily as a way to reduce recurring costs, but secondarily as a way to reduce implementation cost and improve system reliability.

2.3.1 SYSTEM CONTEXT

The system context section of this report presents the WZARD system under development and identifies the connections between that system and external entities, with the relationships between the external entities not depicted. At the most basic level, this context identifies the interfaces to be implemented and reflects very limited variation among design alternatives. For the WZARD system pilot implementation, the working design limited the interfaces to four external entities--the AmeriTrak server to retrieve AVL data, the MDSS server to retrieve weather data, the IRIS server to exchange message display information and a web browser to monitor system performance. While the WZARD system interacts with field devices including CMS, AVL-equipped snow plows and weather sensors, the interaction is indirect, and managed by existing systems that will be used in an unmodified manner. The context diagram for the WZARD pilot implementation is shown in Figure 7.

![FIGURE 7: WZARD PILOT IMPLEMENTATION CONTEXT](image-url)
2.3.2 WZARD SYSTEM COMPONENTS

The final WZARD system design used elements operating from a variety of locations to accomplish the functions required to display relevant messages on CMS in the I-94 corridor between the Twin Cities and St. Cloud. For completeness, the subsequent design description shows some of the field elements connected to the systems interfacing with the WZARD system. The final WZARD system design is shown in Figure 8.

![Figure 8: Final WZARD System Design](image)

The WZARD logic was implemented in a new custom application developed by Meridian Environmental Technologies (MET) specifically for this project. The logic resides in a new process hosted in the server farm located at the MET facility in Grand Forks, ND using existing internal networking facilities and existing Internet connections. This facility is designed to host Maintenance Decision Support System (MDSS) servers, which entails reliable operation in the face of inclement weather, power outages, and communications outages.
The remainder of the system operates using existing services of existing systems without modification. Communication with the existing systems is either performed on the local network for information which already exists at MET facilities or via internet connections.

The WZARD logic accesses weather related information synthesized by the MDSS processes and available locally on the MET network using database access tools. According to current plans and at completion of this pilot project in May 2012, roadway temperature and presence of precipitation are the only items that are intended to be taken from the MDSS results. This data, along with validity and timing information, will be accessed when needed by the WZARD logic and will reflect the best knowledge at that time.

AmeriTrak servers provide truck position and velocity data along with vehicle equipment status information. AmeriTrak provides automated vehicle location (AVL) services to each snow plow included in the pilot implementation. Position and velocity data at a reported time are determined onboard each truck using a Global Positioning System (GPS) receiver integrated into the onboard component of the AVL system. The onboard component also collects information from sensors on the truck and interacts with a touch screen visible to the truck driver and located in the cab of the vehicle. According to current plans, spreader activation, strobe light operation and report timing are the only items that will be taken from the AVL stream in addition to the GPS data. The GPS and AVL data will be transmitted from the onboard AVL component to the AmeriTrak servers using cellular data services via the Internet with a 15 second period. To limit new development, all elements from the AVL stream will be stored locally on the MET servers by existing MDSS processes and accessed through database tools using WZARD logic.

The MnDOT Intelligent Roadway Information System (IRIS) provides the interface to the CMS used by the WZARD system. The WZARD logic provides an XML feed to be accessed on a periodic basis by the IRIS servers (typically ranging every 15 to 30 seconds) at a static Internet location. The XML feed includes an identifier for the requested sign and the requested text to display. Existing logic in IRIS accepts an incoming display request, determines if the request can be displayed on the sign, and transmits the message, if appropriate. WZARD logic will retrieve information on the message currently displayed on the corridor CMS. The CMS message content information is currently available and stored in the IRIS dictionary and will be used without change as of May 2012.

Monitoring of WZARD operations is provided in real time by a single screen available for display on a web browser. For routine operations, the location of the web browser is a workstation located in the St. Cloud Traffic Operations and Communication Center, jointly operated by MnDOT and the Minnesota State Patrol. Acceptable web browsers include the recent versions of Microsoft Internet Explorer, Google Chrome, Apple Safari, and Mozilla Firefox.
2.3.3 Developmental Items
The entirety of the custom logic for the WZARD pilot implementation was developed and operated by MET at their Grand Forks, ND facility. The custom logic consists of acquisition of data for decision making, logic to determine when to display a WZARD message and which message to display on which CMS, monitoring display generation in html format and performance logging. Since the logic will operate on a process in the existing server farm with sufficient processing and communication resources to host the logic, no other developmental items are planned for this project. Meridian has granted the Minnesota Department of Transportation with a free, lifetime license for the use of the WZARD system software installed along the existing WZARD project corridor in 2012. While MnDOT is able to use the WZARD software which has been developed on the project corridor at no additional cost or fee in the future, the WZARD software is operational only due to the relationship and limited dependencies upon which it operates as part of Meridian’s MDSS infrastructure. The WZARD software developed for the project corridor is unable to operate independently from Meridian’s MDSS system unless further modifications beyond this project are developed are in the future.

2.3.4 Unique Computations
The unique computations used in the WZARD system include decision-making logic and calculations to support the decision making. The decision-making logic is shown via Nassi-Schneiderman diagrams in Figure 9 and Figure 10.
The main loop of logic is executed without termination. Each iteration of the loop begins with receipt of updated AVL reports. During the WZARD pilot deployment, this event occurred approximately every 15 seconds. The result of the loop will either be a revision to the current information related to each CMS and a request to display a different message or just a revision to the current information.

The answer to the question “Is a truck in the geofence?” requires the examination of each active vehicle in the corridor for inclusion in the calculation of messages for the CMS. A geofence is defined as “a polygon encompassing the CMS and nearby roadway” and includes a range of allowed headings corresponding the direction of travel able to view the CMS. If a situation arises where two or more vehicles are within a specific geofence, WZARD system calculations will be performed separately for the information related to each vehicle, with the resulting messages being prioritized as maintenance vehicle message, snow plow message, or a blank message.

The answer to the questions “Is a message displayed?”, “Is a maintenance vehicle message displayed?”, and “Is a snow plow message displayed?” results from examination of the requested message for display on the CMS under consideration and is state internal to the WZARD logic process.

The answer to the question “Is vehicle a moving traffic impediment or are the strobe lights on?” is determined by examining data obtained from the AVL stream. Strobe light operation is an element of the data stream and a “yes” should be returned as the answer when the most recent AVL indicates that the strobe lights are active and the most recent report is “current”. “Current” is defined by parameter and will initially take the value of 60 seconds. If the strobe lights are in operation, the vehicle operator has decided that the operation is potentially hazardous and WZARD logic will alert other drivers to that hazard regardless of the speed of the vehicle or the likelihood of the driver overtaking the maintenance vehicle if subsequent criteria are met. Whether or not the vehicle is a moving traffic impedance is determined by comparison of the reported speed to a maximum and minimum speed. If the reported speed is between those values, a “yes” is returned. If the vehicle is above the maximum threshold, it will not be a potential hazard; in a typical winter weather event scenario this would occur when a snow plow relocates prior to beginning maintenance operations. If the vehicle is below a minimum threshold, it will be part of a stationary or slow-moving work detail with CMS messaging and safety procedures handled through existing WZARD standards. In both of these cases, the WZARD logic will not request sign display. WZARD logic will request display of a WZARD message when the speed is between the thresholds and subsequent criteria are also met.
The question of “Has enough time passed?” is unique to the situation where the question is asked. For display of a blank message to be requested based on no truck being within the geofence (“Has enough time passed (1)”) and for display of a blank message to be requested based on a truck being within the geofence, but moving outside of speed parameters and without strobe lights operating (“Has enough time passed (2)”), the time between the last requested non-blank message display time and the current time has to exceed the display termination parameter time and the duration of display has to exceed the minimum display time parameter. For a maintenance vehicle message to be requested for display (“Has enough time passed (3)”) and for a snow plow message to be requested for display (“Has enough time passed (4)”), the time between the first maintenance vehicle request and the current time has to exceed the display initiation threshold and the duration of display has to exceed the minimum display time parameter.

The question of “Can a snow message be confirmed” is addressed using a number of parameters to determine whether or not the maintenance vehicle is being used as a snow plow. If use of the vehicle as a snow plow is not highly likely, the more generic message indicating the presence of a maintenance vehicle is selected for display. The logic in Figure 10 is used to decide the answer to this question.

![FIGURE 10: MESSAGE SELECTION LOGIC](image-url)
A snow message cannot be confirmed if the calendar time is not within the winter maintenance season, defined by parameter start and end times. The suggested start time for the winter maintenance season is November 15 and the suggested end time is April 15. The calendar time is obtained from the server hosting the WZARD process. A snow message cannot be confirmed if the reported pavement temperature is above a parameter temperature, suggested to have an initial value of 35 degrees Fahrenheit. The pavement temperature is obtained from the MDSS database. If the calendar is within the winter maintenance season and the pavement temperature is below the threshold, a snow plow message can be confirmed if either precipitation has been reported or the spreader is currently operating or has recently been operating. The determination of recent spreader operation is compared to a parameter value with a suggested initial value of 60 seconds. Spreader operation is obtained from the AVL data stream. If both values are not reported or operating (precipitation is not reported and the spreader is not operating), a snow plow message cannot be confirmed.

2.4 Design Alternatives Considered

During concept of operations and requirements development, a number of implementation alternatives were considered based on differing technologies and integration schemes. The design alternative presented in Section 3 represents the design alternative considered most advantageous for a pilot implementation in the I-94 corridor Northwest of Minneapolis for the 2011/2012 winter maintenance season. This was the final WZARD design tested during winter weather conditions during January through March of 2012.

The alternative presented below offers potential for desirable system implementation in locations with different legacy environment, cost approaches and implementation philosophy. The concept represents the state of the design in that alternative when further development of that concept was abandoned for this project. As such, the level of detail represented in the concept and the terminology used are in some cases inconsistent and no attempt has been made to correct design errors found in the alternative.

2.4.1 Proximity Detection

The initial concept for determination of when to display a message was the establishment of a communication path between a snow plow and the specific CMS under consideration using a short-range communication technology to perform a contact closure. Using existing capabilities of the Ledstar CMS controller, the contact closure would be detected by the controller to cause display of a predefined message. This concept is attractive from the standpoint of being able to use existing technology with few interfaces to initiate the snow plow message. The drawbacks to this approach include the need for additional equipment both on each CMS and on each snow plow, the lack of ability to remotely disable system operation, the lack of ability to adjust display based on movement of the snow plow following passage of the CMS, and the inability of reporting system operation to adequately report functioning without modification to IRIS. The
concept is shown in Figure 3 using Bluetooth as the short-range communication technology and incorporating reporting changes into IRIS.

2.5 WZARD SYSTEM COMPONENTS

2.5.1 SYSTEM HARDWARE
The hardware installed for the SCorE WZARD system deployed along I-94 EB consisted of the following components:

- Fourteen (14) Ledstar changeable message signs
- Fourteen (14) Ledstar CMS controllers
- Fourteen (14) Verizon cellular modems
- Fiber optic cable (future)

2.5.2 SOFTWARE
The WZARD system software is hosted on MET servers in Grand Forks, ND. The system runs in the background, grabbing data from AVL/GPS and MDSS. WZARD uses a logic tree to determine if a maintenance vehicle warrants a message on a CMS sign and the type of message that should be displayed.

The use of geofences, or virtual zones, was created as part of the WZARD software to detect AVL/GPS equipped vehicles. Each CMS along I-94 EB utilizes a geofence which allows the WZARD system to identify the need for a message based on the following parameters:

- Location
- Speed
- Directional Bearing
- Weather Information
- Maintenance Vehicle Equipment Status

Depending on the data provided from all of the sources, the WZARD system is able to determine what message needs to be placed on the CMS. Figure 11 illustrates how the geofence is used to trigger a message.
2.5.3 **User Interface**

WZARD does not currently have a system interface that is available to MnDOT. This was a decision that was made at the request of District 3 TOCC operators of the systems who did not desire to have to monitor an additional screen or interface during inclement weather operations. Future expansion of the WZARD system may require the creation of an interface which may be integrated into IRIS or the State Patrol’s Computer Aided Dispatch (CAD) system.

2.6 **Communications System**

The fiber optic cable was not installed prior to the operational test because of scheduling difficulties unrelated to the WZARD project. A decision was made by the project committee to use cellular modem communication devices as a temporary means of communication to WZARD signs along I-94 during the operational test in order to keep the project on schedule. The cellular modem devices will be removed by MnDOT as fiber optic cable lines are permanently installed along the WZARD corridor.

2.6.1.1 **Wireless Modem Communications**

At this time, communications between IRIS and the signs is performed through the use of wireless modems, using Verizon Wireless service. The current model installed and used is the Sierra Wireless AirLink GX400. A list of CMS controller and wireless modem Internet Protocol (IP) information can be found in Table 2.

2.6.1.2 **Fiber Optic Communications**

Future communications on the I-94 corridor will be performed through the use of fiber optic cable lines. Fiber optic cable is scheduled for installation in the WZARD corridor during Spring 2012.
### TABLE 2: I-94 CORRIDOR WIRELESS COMMUNICATION INFORMATION

<table>
<thead>
<tr>
<th>Plan Name or InPlace Location</th>
<th>Sign Name</th>
<th>Sign Location Description</th>
<th>Mile Post</th>
<th>Lat</th>
<th>Long</th>
<th>Setup Completed</th>
<th>Sign and Manufacture</th>
<th>Sign Size</th>
<th>Serial Controller</th>
<th>Controller Static IP</th>
<th>Controller Drop</th>
<th>GX400 Address</th>
<th>IP</th>
<th>ESN</th>
<th>GX400 S/N</th>
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<td>A-1</td>
<td>VT4E23</td>
<td>I-94 E of Co Rd 87</td>
<td>171.5</td>
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<td>174.49</td>
<td>42° 26.727' N</td>
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<td>A-3</td>
<td>VT4E23A</td>
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<td>A-4</td>
<td>VT4E25B</td>
<td>I-94 E of TH24 near Clearwater</td>
<td>180.25</td>
<td>42° 25.978' N</td>
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<td>A-5</td>
<td>VT4E25C</td>
<td>I-94 @ Co Rd 8 Haury</td>
<td>183.8</td>
<td>42° 22.665' N</td>
<td>93° 58.427' W</td>
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<td>185.7</td>
<td>42° 21.355' N</td>
<td>93° 55.917' W</td>
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<td>Barton Ave EB</td>
<td>VT4E25E</td>
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<td>42° 21.178' N</td>
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<td>A-7</td>
<td>VT4E22F</td>
<td>I-94 @ Auto-A-Vue</td>
<td>188.45</td>
<td>42° 21.458' N</td>
<td>93° 52.798' W</td>
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<td>A-8</td>
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<td>I-94 W of Hw 87 near Monticello</td>
<td>190.7</td>
<td>42° 19.297' N</td>
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<td>42° 18.322' N</td>
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<td>A-11</td>
<td>VT4E28</td>
<td>Middle of MN/ROAD</td>
<td>198.05</td>
<td>42° 15.871' N</td>
<td>93° 43.001' W</td>
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<td>A-12</td>
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<td>200.1</td>
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</table>
3.0 SYSTEM HARDWARE/SOFTWARE OPERATIONAL AND MAINTENANCE COSTS

The hardware and software supply and installation costs of the WZARD system deployed along I-94 EB between St. Cloud and Rogers are comprised of the following:

**TABLE 3: SCORÉ WZARD PROJECT HARDWARE/SOFTWARE COSTS**

<table>
<thead>
<tr>
<th>Hardware/Software Type</th>
<th>Unit Cost</th>
<th>Number of Units</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>WZARD Software Development (MET)</td>
<td>$8,300</td>
<td>1</td>
<td>$8,300</td>
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<tr>
<td>Geofence Development (MET)</td>
<td>$830</td>
<td>14</td>
<td>$11,620</td>
</tr>
<tr>
<td>*Wireless Communications (temporary modems)</td>
<td>$760</td>
<td>14</td>
<td>$10,000</td>
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<tr>
<td>*Wireless Communications (temporary service)</td>
<td>$400</td>
<td>5 (months)</td>
<td>$2,000</td>
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</tbody>
</table>

* Temporary wireless equipment and services were required for pilot WZARD deployment in 2012 because fiber optic system was not yet installed along the I-94 project. These should be considered one-time only costs to MnDOT in this deployment.

**Hardware/Software Operational and Maintenance Issues**

A minimal number of WZARD operational issues were observed during the demonstration project period scheduled between January and May 2012. Both Meridian and Iteris staff monitored system performance and provided requested system upgrades as necessary during the deployment period.

During the installation and initial deployment of the WZARD system along I-94 EB, District 3 TOCC staff noticed that maintenance vehicles driving eastbound on the MnROAD facility were triggering CMS on I-94 EB. The MnROAD facility located on the WZARD corridor is a unique piece of infrastructure used for road research and testing purposes by MnDOT and partners. Because it is a test facility and the test lanes are configured in a certain manner (some are closed during various times of the year), snow plows are many times able to plow in both directions of the test facility without encountering opposing traffic. Once this issue was reported by the District 3 TOCC Supervisor, Meridian staff reduced the width of the geofence facility (the distance perpendicular to the roadway).
System Operational Costs
The WZARD system is run on a Meridian Environment Technology server in Grand Forks, ND. The program runs in the background with little to no Meridian intervention. There is no associated cost for running the WZARD program on Meridian equipment for the pilot deployment on I-94 EB between St. Cloud and Rogers. Future expansion of the system may require additional operational costs if expansion is considered beyond the current project deployment boundaries. If necessary, future costs for additional WZARD system deployments will be determined between Meridian Environmental Technologies and MnDOT.

Wireless service was provided by Verizon Wireless as a temporary solution to provide communications to all fourteen CMS in the field. Additional operational costs were assumed on a temporary basis by MnDOT to provide wireless communications to the signs during the WZARD operational test period between January and May 2012. Fiber optic cable will be installed sometime during the Spring or in Summer 2012 for fixed communications in the field. At that point the temporary wireless communications system will no longer be required to operate the WZARD system and once the system has been transitioned from a wireless system to the fixed fiber system, the WZARD system will be continually running in the background and accessible to District 3 and the RTMC users.

4.0 PROJECT SUMMARY/NEXT STEPS
The SCorE WZARD project was initiated by MnDOT as part of their 2010-2011 Destination Innovation Program. The vision for this project was developed by project stakeholders in response to MnDOT’s strategic directions of safety and mobility. The primary goal of the SCorE WZARD project is to help avoid car-plow collisions or crashes due to evasive maneuvers in the vicinity of plows. The congestion management and incident management portions of the project address the Department’s strategic direction for mobility.

One of the primary goals of this project is to put into place the infrastructure necessary to improve safety for snow/ice and other work zone operations. Other goals and objectives include reducing incidents by providing the traveling public with real-time information about corridor traffic operations along I-94 eastbound between Rogers and St. Cloud, Minnesota. The goals and objectives for the SCorE WZARD project can be grouped into three main areas:

Traffic Incident Management
- Improve I-94 corridor safety during work zone operations
- Improve safety for traffic incidents and/or traffic enforcement activities
- Reduce the occurrence of snow plow/vehicle crashes
- Reduce the occurrence of secondary incidents

Transportation System Efficiency
- Improve traffic safety and mobility
- Improve travel times along the I-94 corridor
- Reduce I-94 corridor congestion
- Manage recurrent peak period congestion, including weekend seasonal traffic
- Reduce vehicle emissions

**Public Communications/Traveler Information**
- Provide real-time traveler information along the I-94 corridor
- Provide travelers with advance warning of maintenance operations upstream
- Provide CCTV images to RTMC, District 3 Operations and State Patrol

The SCorE WZARD project was defined by the needs of project stakeholders. The team identified a need for an automated system that would warn motorists of slow moving maintenance vehicles on the project corridor. The team developed a program that utilized “geofences”, or virtual boundaries, to identify an AVL equipped maintenance vehicle that is within close proximity to changeable message signs along the project corridor. The program is able to identify vehicle location, speed and equipment status (i.e., spreader control) to determine whether an AVL equipped maintenance vehicle is performing maintenance operations.

**Issues for Further Consideration – Next Steps**
The project has provided MnDOT and the Department of Public Safety with a valuable tool that helps to increase safety for field staff without creating additional effort by TOCC staff. The geofence system can be easily expanded across the state for a relatively small cost to MnDOT. Areas that the team has identified as possible routes where the system could be expanded include:

- Twin Cities Metro area
- I-35 between Cloquet and Duluth
- I-94 WB between the Twin Cities Metro and St. Cloud
- US-52 in Rochester
- I-35 between the Twin Cities Metro and the Iowa border
- I-94 between St. Cloud and Moorhead??
- US-169 between the Twin Cities Metro and Mankato

Geofencing could be used to enhance other areas of transportation utilizing AVL/GPS technology including:

- Maintenance fleets
- Transit fleets
- Work zones
- Heavy truck operations
In regard to future applications and uses of the WZARD system, the following concepts should be considered for future WZARD system enhancement or expansion?

- Does it make sense to expand the WZARD system to create a statewide system?
- Does the WZARD system increase safety to maintenance vehicle operators and the traveling public?
- How can the “geofence” idea be used in future projects to increase safety and/or efficiency?
- Should the WZARD system be expanded to include State Patrol and/or other emergency vehicles equipped with AVL/GPS?
## ATTACHMENT A
Mn/DOT 2011 Destination Innovation Project SCoRE WZARD
SYSTEM REQUIREMENTS

<table>
<thead>
<tr>
<th>DOCUMENT/ TRACKING</th>
<th>REQUIREMENT</th>
<th>REQUIREMENT TEXT</th>
<th>Methodology</th>
<th>Test Date</th>
<th>Sign A-L MP 171.71</th>
<th>Comments</th>
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<tbody>
<tr>
<td></td>
<td>Environmental Requirements</td>
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<td></td>
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<td></td>
<td>System Requirements/ Con Ops</td>
<td>3.1.1</td>
<td>The device shall operate in a corridor along I-94 from Rogers to St. Cloud.</td>
<td>Visual Inspection</td>
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<tr>
<td></td>
<td>System Requirements</td>
<td>3.1.2</td>
<td>The WZARD system shall operate on a combination of servers hosted by Mn/DOT at the Regional Traffic Management Center (RTMC) and/or servers available through the public Internet.</td>
<td></td>
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<td>3.1.3</td>
<td>Control of the DMS along the corridor will routinely be provided by the Intelligent Roadway Information System (IRIS).</td>
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<td>System Requirements</td>
<td>3.1.4</td>
<td>The control of the DMS for WZARD messages can be performed either by IRIS or in coordination with IRIS.</td>
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<td>Operational control of the WZARD system will be performed at District 3 dispatch in St. Cloud.</td>
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<td>Functional Requirements</td>
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<td>System Requirements/ Con Ops</td>
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<td>The WZARD system shall initiate display of predetermined messages on select DMS in the corridor without operator intervention to indicate the presence of snow and ice operations along the corridor. The DMS included in the project shall include:</td>
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<td>3.2.2</td>
<td>The WZARD system shall calculate message initiation and termination times based on vehicle positions reported by the Ameritak AVL system currently in operation.</td>
<td>☒ Pass ☐ Fail</td>
<td>3/29/12 Steve Toughill/Dan Rowe</td>
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<td>3.2.3</td>
<td>The WZARD system shall store data regarding the DMS being used, including:</td>
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<td>3/29/12 Steve Toughill/Dan Rowe</td>
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<td>1. Sign Identification</td>
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<td>3.2.3.3</td>
<td>3. Number of lines available for message display</td>
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<td>Variance #1</td>
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<td>3.2.3.4</td>
<td>4. Number of characters per line available for message display</td>
<td>☐ Pass ☐ Fail</td>
<td>Variance #2</td>
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<td>3.2.3.5</td>
<td>5. Sign Manufacturer and Model Number</td>
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<td>Variance #3</td>
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<td>3.2.4</td>
<td>Identification of equipped vehicles with authorization to initiate display of WZARD messages shall be configurable within the WZARD system.</td>
<td>☒ Pass ☐ Fail</td>
<td>1/26/12 Kathy Gilson</td>
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<td>3.2.5</td>
<td>The WZARD system shall store data regarding the maintenance vehicles being used, including:</td>
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<td>3.2.5.2</td>
<td>2. Vehicle Equipment Status</td>
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<td></td>
<td>3.2.5.3 3. Inclusion of vehicle in dynamic operation</td>
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<td></td>
<td>3.2.5.4 4. AVL Manufacturer and Model Number</td>
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<tr>
<td>3.2.6</td>
<td>Display of WZARD messages shall be activated based on location, speed, and direction of designated, properly-equipped vehicles with equipment operating properly.</td>
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<tr>
<td>3.2.6.1</td>
<td>The location to activate messages shall include an area within a configurable distance (nominally 50 feet) of the traveled way and shoulder of I-94 from a configurable distance before passage of the DMS (nominally 700 feet) to a configurable distance beyond the DMS (nominally two miles or to the next sign), resulting in a typical display time of between four and five minutes.</td>
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<tr>
<td>3.2.6.2</td>
<td>The range of speeds to activate messages shall include a lower limit (nominally 10 mph) to indicate that the vehicle is on a mobile assignment to an upper limit (nominally 45 mph) to indicate that the vehicle is an obstruction to traffic flow.</td>
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<tr>
<td>3.2.6.3</td>
<td>The direction to activate messages shall include a cone within a configurable angle (nominally 5 degrees) of the direction of the roadway.</td>
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<tr>
<td>3.2.6.4</td>
<td>The vehicle must maintain reported location, speed, and direction within the range causing display for two consecutive AVL reports to initiate display.</td>
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<td>3.2.7</td>
<td>The WZARD system shall initiate display timed to cause the sign message to become visible a configurable time prior to the vehicle passing the sign (suggested time 15 seconds).</td>
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<tr>
<td>System Requirements/ Con Ops</td>
<td>3.2.8</td>
<td>The WIZARD system shall be configurable to cause termination of the WIZARD message based on either time or distance since the vehicle passed the corresponding DMS.</td>
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<td>3/29/12 Steve Toughill/Dan Rowe</td>
<td></td>
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</tr>
<tr>
<td>System Requirements/ Con Ops</td>
<td>3.2.9</td>
<td>The WIZARD system shall be able to terminate display of the WIZARD message once the vehicle is a configurable distance beyond the sign or leaves the route.</td>
<td></td>
<td>1/26/12 Kathy Gilson</td>
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<tr>
<td>System Requirements/ Con Ops</td>
<td>3.2.9.1</td>
<td>The vehicle must maintain reported location, speed or direction outside the range causing display for two consecutive AVL reports to cause removal of an existing display.</td>
<td></td>
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<td>Variance #7</td>
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<tr>
<td>System Requirements/ Con Ops</td>
<td>3.2.10</td>
<td>The WIZARD system shall be able to terminate display of the WIZARD message once a configurable amount of time (nominally 5 minutes) has passed since the snow plow passed the sign.</td>
<td>Pass/Fail</td>
<td>3/29/12 Steve Toughill/Dan Rowe</td>
<td></td>
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</tr>
<tr>
<td>System Requirements/ Con Ops</td>
<td>3.2.11</td>
<td>Operators of the IRIS system shall be able to terminate display of WIZARD messages.</td>
<td>Pass/Fail</td>
<td>1/26/12 Kathy Gilson</td>
<td></td>
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</tr>
<tr>
<td>System Requirements/ Con Ops</td>
<td>3.2.12</td>
<td>Operators of the IRIS system shall be able to post messages on the DMS that can be overwritten by WIZARD messages.</td>
<td>Pass/Fail</td>
<td>1/26/12 Kathy Gilson</td>
<td></td>
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</tr>
<tr>
<td>System Requirements/ Con Ops</td>
<td>3.2.13</td>
<td>Operators of the IRIS system shall be able to post messages on the DMS that are not able to be overwritten by WIZARD messages.</td>
<td>Pass/Fail</td>
<td>1/26/12 Kathy Gilson</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Requirements/ Con Ops</td>
<td>3.2.14</td>
<td>Operators of the IRIS system shall be able to remotely disable display of WIZARD messages on all DMS with a single action.</td>
<td>Pass/Fail</td>
<td></td>
<td></td>
<td>Variance #8</td>
</tr>
<tr>
<td>System Requirements/ Con Ops</td>
<td>3.2.15</td>
<td>Operators of the IRIS system shall be able to remotely disable display of the WIZARD messages on individual DMS with a single action.</td>
<td>Pass/Fail</td>
<td></td>
<td></td>
<td>Variance #9</td>
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<tr>
<td>System Requirements</td>
<td>3.2.16</td>
<td>The WIZARD system shall be able to select messages for display from a predefined set of potential messages.</td>
<td>Pass/Fail</td>
<td>1/26/12 Kathy Gilson</td>
<td></td>
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<tr>
<td>System Requirements</td>
<td>3.2.17</td>
<td>The WIZARD system shall use default fonts prestored in the DMS appropriate for freeway message display.</td>
<td>Pass/Fail</td>
<td>1/26/12 Kathy Gilson</td>
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<td>Methodology</td>
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<td>3.2.18</td>
<td>The WIZARD system shall be able to select messages for display on typical configurations of DMS including:</td>
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<tr>
<td>3.2.18.1</td>
<td>Full size overhead or roadside signs capable of displaying three lines with 20 characters on each line</td>
<td>Pass □ Fail</td>
<td>1/26/12 Kathy Gilson</td>
<td></td>
<td></td>
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<tr>
<td>3.2.18.2</td>
<td>Smaller roadside signs capable of displaying two lines with 12 characters on each line</td>
<td>Pass □ Fail</td>
<td>1/26/12 Kathy Gilson</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3.2.18.3</td>
<td>Portable signs capable of displaying three lines with 8 characters on each line</td>
<td>Pass □ Fail</td>
<td>8/14/11 Tom Dumont</td>
<td></td>
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<tr>
<td>3.2.19</td>
<td>For full size, three-line signs, the messages to be displayed include:</td>
<td></td>
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<tr>
<td>3.2.19.1</td>
<td>A one-phase message showing:</td>
<td>Pass □ Fail</td>
<td>1/26/12 Kathy Gilson</td>
<td></td>
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<tr>
<td></td>
<td>&quot;SNOW PLOW&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;AHEAD&quot;</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>&quot;USE CAUTION&quot;</td>
<td></td>
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<td></td>
<td>when active snow plowing is confirmed for the corridor.</td>
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<tr>
<td>3.2.19.2</td>
<td>A one-phase message showing:</td>
<td>Pass □ Fail</td>
<td>4/30/2012 Kathy Gilson</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;MAINTENANCE&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;VEHICLE AHEAD&quot;</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>&quot;USE CAUTION&quot;</td>
<td></td>
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<td>when active snow plowing is not confirmed for the corridor.</td>
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<td>3.2.20</td>
<td>For smaller, two-line signs, the messages to be displayed include:</td>
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<tr>
<td>3.2.20.1</td>
<td>A two-phase message showing:</td>
<td>Pass □ Fail</td>
<td>1/26/12 Kathy Gilson</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>&quot;SNOW PLOW&quot;</td>
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<tr>
<td></td>
<td>&quot;AHEAD&quot;</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>&quot;USE&quot;</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>&quot;CAUTION&quot;</td>
<td></td>
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<td></td>
<td>on the second phase when active snow plowing is confirmed for the corridor.</td>
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<tr>
<td>3.2.20.2</td>
<td>A two-phase message showing:</td>
<td>Pass □ Fail</td>
<td>4/30/2012 Kathy Gilson</td>
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<tr>
<td></td>
<td>&quot;MAINTENANCE&quot;</td>
<td></td>
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<tr>
<td></td>
<td>&quot;VEH AHEAD&quot;</td>
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<tr>
<td></td>
<td>on one phase, and</td>
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<td>Comments</td>
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</tbody>
</table>
| 3.2.20.1        | “USE”  
“CAUTION” on the second phase when active snow plowing is not confirmed for the corridor.                                                                                                                      |             |           |                   |                   |
| 3.2.21          | For portable, three-line signs, the messages to be displayed include:                                                                                                                                              |             |           |                   |                   |
| 3.2.21.1        | A two-phase message showing:  
“SNOW”  
“PLOW”  
“AHEAD”  
“USE”  
“CAUTION” on the second phase when active snow plowing is confirmed for the corridor.                                                                 |             |           |                   |                   |
| 3.2.21.2        | A two-phase message showing:  
“MAINT”  
“VEHICLE”  
“AHEAD”  
“USE”  
“CAUTION” on the second phase when active snow plowing is confirmed for the corridor.                                                                 |             |           |                   |                   |
<p>| 3.2.22          | The WZARD system shall utilize verifying information to adjust display of messages for the entire corridor using:                                                                                                 |             |           |                   |                   |
| 3.2.22.1        | Active treatment information                                                                                                                                                                                        | ☒ Pass ☐ Fail | 3/29/12 Steve Toughill/Dan Rowe |
| 3.2.22.2        | Weather information                                                                                                                                                                                              | ☒ Pass ☐ Fail | 3/29/12 Steve Toughill/Dan Rowe |
| 3.2.22.3        | Vehicle movement information                                                                                                                                                                                        | ☒ Pass ☐ Fail | 3/29/12 Steve Toughill/Dan Rowe |
| 3.2.22.4        | Calendar                                                                                                                                                                                                          | ☐ Pass ☐ Fail | Varience #10    |
| 3.2.23          | The DMS used by the WZARD system will report activation of messages by the WZARD system to the IRIS software operating at the Minneapolis RTMC.                                                                 | ☒ Pass ☐ Fail | 4/20/2012 Dan Rowe |</p>
<table>
<thead>
<tr>
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<th>Sign</th>
<th>Comments</th>
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<tr>
<td>System Requirements</td>
<td>3.2.24</td>
<td>The WZARD system shall log all AVL data accessed for use in message display termination for performance analysis.</td>
<td></td>
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<td>4/20/2012 Dan Rowe</td>
</tr>
<tr>
<td>System Requirements/Con Ops</td>
<td>3.2.25</td>
<td>The DMS used by the WZARD system will report displayed messages to the IRIS software operating at the Minneapolis RTMC.</td>
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<td>4/20/2012 Dan Rowe</td>
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<tr>
<td>System Requirements/Con Ops</td>
<td>3.2.26</td>
<td>The WZARD system shall log all sign message display activations and terminations.</td>
<td></td>
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<td></td>
<td>3/29/12 Steve Toughill/Dan Rowe</td>
</tr>
<tr>
<td>System Requirements</td>
<td>3.2.27</td>
<td>The WZARD system shall log the reason for removal of a displayed message such as loss of communication, location outside of geofence, heading outside of geofence, speed outside of range, or confirming parameter change.</td>
<td></td>
<td></td>
<td></td>
<td>4/20/2012 Dan Rowe</td>
</tr>
<tr>
<td>System Requirements</td>
<td>3.2.28</td>
<td>The WZARD system shall log and timestamp all AVL data accessed along with the related messages to be displayed (if any) and reasons for not displaying a message.</td>
<td></td>
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<td>3/29/12 Steve Toughill/Dan Rowe</td>
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<tr>
<td>System Requirements</td>
<td>3.2.29</td>
<td>The performance of the system will be able to be monitored from the RTMC, by the developing organization, through internet access, or from a combination of these locations.</td>
<td></td>
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<td>4/20/2012 Dan Rowe</td>
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<tr>
<td>System Requirements</td>
<td>3.2.30</td>
<td>The WZARD system shall implement a monitoring display with the following information displayed on a single screen:</td>
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<tr>
<td></td>
<td>3.2.30.1</td>
<td>Icons representing the location of each DMS capable of displaying a WZARD message (static)</td>
<td></td>
<td></td>
<td></td>
<td>Pass Fail</td>
</tr>
<tr>
<td></td>
<td>3.2.30.2</td>
<td>The operational status of each DMS into states of at least disabled, operating with no messages displayed, and operating with messages requested (dynamic)</td>
<td></td>
<td></td>
<td></td>
<td>Pass Fail</td>
</tr>
<tr>
<td></td>
<td>3.2.30.3</td>
<td>The text of the message currently displayed on DMS (dynamic)</td>
<td></td>
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<td>Pass Fail</td>
</tr>
<tr>
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<td>3.2.30.4</td>
<td>The text of the message requested by the WZARD logic (dynamic)</td>
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<td>Pass Fail</td>
</tr>
<tr>
<td></td>
<td>3.2.30.5</td>
<td>The location of maintenance vehicles with operating AVL systems (dynamic)</td>
<td></td>
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<td>Pass Fail</td>
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<tr>
<td>3.2.30.6</td>
<td>An indication of the operational status of the WZARD logic into states of at least disabled, operating with no messages requested, and operating with messages requested (dynamic)</td>
<td></td>
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<tr>
<td>3.2.30.7</td>
<td>A corridor map of sufficient detail to identify the location of field elements (static)</td>
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<tr>
<td>3.2.31</td>
<td>The WZARD system shall be able to restrict access to the performance monitoring information.</td>
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<tr>
<td>3.2.32</td>
<td>One or more of the following techniques shall be implemented to restrict access:</td>
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<tr>
<td>3.2.32.1</td>
<td>Username/Password authentication</td>
<td></td>
<td></td>
<td></td>
<td>Variance #12</td>
<td></td>
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<td>3.2.32.2</td>
<td>Virtual Private Network (VPN) connection</td>
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<td></td>
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<td>Variance #13</td>
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<tr>
<td>3.2.32.3</td>
<td>IP address filtering</td>
<td></td>
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<tr>
<td>3.3.1</td>
<td>The DMS shall be updated based on vehicle positions within a maximum period (nominally 30 seconds) of position determination.</td>
<td></td>
<td></td>
<td></td>
<td>Variance #14</td>
<td></td>
</tr>
<tr>
<td>3.3.2</td>
<td>WZARD messages shall be displayed for a minimum period (nominally 30 seconds) unless manually overridden.</td>
<td>☒ Pass ☐ Fail</td>
<td>5/17/2012 Dan Rowe</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3.3.3</td>
<td>WZARD messages shall be removed within a maximum period (nominally five minutes) of loss of communication with the DMS or components of the WZARD system.</td>
<td>☒ Pass ☐ Fail</td>
<td>5/17/2012 Dan Rowe</td>
<td></td>
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<tr>
<td>3.3.4</td>
<td>WZARD messages shall be removed within a maximum period (nominally 30 seconds) of determination that the message should no longer be displayed.</td>
<td>☒ Pass ☐ Fail</td>
<td>5/17/2012 Dan Rowe</td>
<td></td>
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<tr>
<td>3.3.5</td>
<td>WZARD messages shall be displayed 95% of the time that actual maintenance vehicle locations would mandate display unless manually overridden.</td>
<td>☒ Pass ☐ Fail</td>
<td>5/17/2012 Dan Rowe</td>
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<tr>
<td>3.3.6</td>
<td>WZARD messages shall be removed within a maximum period (nominally one minute) of failure of the control logic.</td>
<td>☒ Pass ☐ Fail</td>
<td>5/17/2012 Dan Rowe</td>
<td></td>
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<tr>
<td>System Requirements</td>
<td>3.3.7</td>
<td>The accuracy of the reported vehicle position will be within 10 meters at the time of position determination.</td>
<td>☒ Pass ☐ Fail</td>
<td>3/29/12 Steve Toughill/Dan Rowe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Requirements</td>
<td>3.3.8</td>
<td>The monitoring display will be updated on a configurable frequency (nominally once per minute) with information on vehicle position and sign display not more than a maximum period since realization (nominally two minutes)</td>
<td>☐ Pass ☐ Fail</td>
<td>1/26/12 Kathy Gilson</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administrative Requirements</td>
<td>3.4.1</td>
<td>Operators of the WZARD system shall be able to modify the displayed message.</td>
<td>☐ Pass ☐ Fail</td>
<td>1/26/12 Kathy Gilson</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Requirements/ Con Ops</td>
<td>3.4.2</td>
<td>The WZARD system shall reject attempts by vehicles without properly functioning equipment and authorization to display WZARD messages.</td>
<td>☐ Pass ☐ Fail</td>
<td>3/29/12 Steve Toughill/Dan Rowe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Requirements/ Con Ops</td>
<td>3.4.3</td>
<td>The WZARD system shall log attempts by vehicles without properly functioning equipment and authorization to display WZARD messages.</td>
<td>☐ Pass ☐ Fail</td>
<td>Variance #15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Requirements</td>
<td>3.4.4</td>
<td>Operators of the WZARD system shall be able to remotely disable display of WZARD messages on all DMS with a single action.</td>
<td>☐ Pass ☐ Fail</td>
<td>Variance #16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Requirements/ Con Ops</td>
<td>3.4.5</td>
<td>Configuration of all components of the WZARD system shall require verification of proper authorization.</td>
<td>☐ Pass ☐ Fail</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>System Requirements/ Con Ops</td>
<td>3.4.5.1</td>
<td>Authorization for Mn/DOT staff shall utilize existing credentials.</td>
<td>☐ Pass ☐ Fail</td>
<td>Variance #17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Requirements/ Con Ops</td>
<td>3.4.6</td>
<td>Attempts to configure components of the WZARD system without verification of proper authorization shall be logged.</td>
<td>☐ Pass ☐ Fail</td>
<td>Variance #18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAD Integration Requirements</td>
<td>3.5.1</td>
<td>The WZARD system shall make information available to interfacing systems including:</td>
<td>☐ Pass ☐ Fail</td>
<td>Variance #19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Requirements</td>
<td>3.5.1.1</td>
<td>Requested messages</td>
<td>☐ Pass ☐ Fail</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>SYSTEM REQUIREMENTS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>---------------------</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DOCUMENT TRACKING</strong></td>
<td><strong>REQUIREMENT</strong></td>
<td><strong>REQUIREMENT TEXT</strong></td>
<td><strong>Methodology</strong></td>
<td><strong>Test Date</strong></td>
<td><strong>Sign A-1</strong></td>
<td><strong>Comments</strong></td>
</tr>
<tr>
<td><strong>System Requirements</strong></td>
<td>3.5.1.2</td>
<td>System status information</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System Requirements</strong></td>
<td>3.5.2</td>
<td>The State Patrol Computer-Aided Dispatch (CAD) shall incorporate WZARD-related data into the CAD geographic display.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System Requirements</strong></td>
<td>3.5.3</td>
<td>The State Patrol CAD shall collect WZARD-related data from the following locations:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System Requirements</strong></td>
<td>3.5.3.1</td>
<td>Mn/DOT vehicle position from the AVL vendor Internet portal or Mn/DOT Internet portal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System Requirements</strong></td>
<td>3.5.3.2</td>
<td>Mn/DOT sign content from the Mn/DOT Internet portal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
MnDOT SCorE WZARD Acceptance Test
Variance Report Form

Variance #1

Variance Date: 4/19/2012
Variance Time: 2:45 PM
Project Representative: Lisa Raduenz
MnDOT Representative: Jon Jackels/Dan Rowe

Equipment Involved: WZARD System
Test Section: WZARD Message Requirements
Requirement #: 3.2.3.3

Variance Severity: Low

Variance System (Circle one and provide more detail below):

DMS  MDSS  WZARD System  OPERATIONS  COMMUNICATIONS

Variance Description:

IRIS only allows pre-approved messages to be requested from the WZARD system. If a message were requested from WZARD that was not in the IRIS library, the message would not be posted to the CMS. For this reason, it was determined that WZARD logs do not need to display the number of lines available for message display.

Variance Resolution:

Requirement 3.2.3.3 will be removed from the system requirements.

Resolution By: Lisa Raduenz
Resolution Date: 6/6/12

Confirmation: [Signature]
MnDOT Representative: [Signature]
IRIS only allows pre-approved messages to be requested from the WZARD system. If a message were requested from WZARD that was not in the IRIS library, the message would not be posted to the CMS. For this reason, it was determined that WZARD logs do not need to display the number of characters per line available for message display.

Requirement 3.2.3.4 will be removed from the system requirements.
MnDOT SCorE WZARD Acceptance Test
Variance Report Form

Variance #3

Variance Date: 4/19/2012  
Variance Time: 2:50 PM  
Project Representative: Lisa Raduenz  
MnDOT Representative: Jon Jackels/Dan Rowe

Equipment Involved: WZARD System  
Test Section: WZARD Message Requirements  
Variance Severity: Low  
Requirement #: 3.2.3.5

Variance System (Circle one and provide more detail below):

<table>
<thead>
<tr>
<th>DMS</th>
<th>MDSS</th>
<th>WZARD System</th>
<th>OPERATIONS</th>
<th>COMMUNICATIONS</th>
</tr>
</thead>
</table>

Variance Description:

Steve Toughill and Dan Rowe agreed that this requirement was not necessary because this information is documented elsewhere. It would bring no added value to the WZARD system to know the Sign Manufacturer and Model Number.

Variance Resolution:

Requirement 3.2.3.5 will be removed from the system requirements.

Resolution By:  
Resolution Date: 6/18/12

Confirmation: 
MnDOT Representative:  
Signature:
MnDOT SCorE WZARD Acceptance Test
Variance Report Form

Variance #4

Variance Date: 4/19/2012  
Project Representative: Lisa Raduenz

Variance Time: 2:55 PM  
MnDOT Representative: Jon Jackels/Dan Rowe

Equipment Involved: WZARD System  
Test Section: WZARD System Requirements

Variance Severity: Low  
Requirement #: 3.2.5.4

Variance System (Circle one and provide more detail below):

DMS  MDSS  WZARD System  OPERATIONS  COMMUNICATIONS

Variance Description:

Steve Toughill believes that this information is not needed in the WZARD logs. It is documented elsewhere. It brings no added value to the WZARD system.

Variance Resolution:

Requirement 3.2.5.4 will be removed from the system requirements.

Resolution By:  
Resolution Date 6/18/12

Confirmation:  
MnDOT Representative:
From Meeting Notes from 8-10-11: Ostermeier noted that consecutive points within a geofenced area could be used as a check for vehicles that may be a few miles per hour under the speed limit or if an errant bearing reading occurred in the system. He proposed that two consecutive point readings could be used to confirm the sign's activation status. This method was discussed by the group and there was general agreement that while this method could be used, the system design will proceed with using one point reading to activate the DMS, however the capability of using two consecutive points within a geofenced area will be included in the system design, per Ostermeier.
The WZARD system was created to be a configurable distance away from the sign, not a configurable time. This was discussed and agreed upon by the team.

Requirement 3.2.7 will be removed from the system requirements.
MnDOT SCorE WZARD Acceptance Test
Variance Report Form

Variance #7

<table>
<thead>
<tr>
<th>Variance Date:</th>
<th>4/27/2012</th>
<th>Project Representative: Lisa Raduenz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance Time:</td>
<td>2:55 PM</td>
<td>MnDOT Representative: Jon Jackels/Dan Rowe</td>
</tr>
<tr>
<td>Equipment Involved:</td>
<td>WZARD System</td>
<td>Test Section: WZARD System Requirements</td>
</tr>
<tr>
<td>Variance Severity:</td>
<td>Low</td>
<td>Requirement #: 3.2.9.1</td>
</tr>
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</table>

Variance System (Circle one and provide more detail below):

<table>
<thead>
<tr>
<th>DMS</th>
<th>MDSS</th>
<th>WZARD System</th>
<th>OPERATIONS</th>
<th>COMMUNICATIONS</th>
</tr>
</thead>
</table>

Variance Description:

From Meeting Notes from 8-10-11: Ostermeier noted that consecutive points within a geofenced area could be used as a check for vehicles that may be a few miles per hour under the speed limit or if an errant bearing reading occurred in the system. He proposed that two consecutive point readings could be used to confirm the sign's activation status. This method was discussed by the group and there was general agreement that while this method could be used, the system design will proceed with using one point reading to activate the DMS, however the capability of using two consecutive points within a geofenced area will be included in the system design, per Ostermeier.

Variance Resolution:

Requirement 3.2.9.1 will be removed from the system requirements.

Resolution By:                      Resolution Date 6/13/12

Confirmation: Lisa Raduenz           MnDOT Representative Dave[illegible]
MnDOT SCorE WZARD Acceptance Test
Variance Report Form

Variance #8

<table>
<thead>
<tr>
<th>Variance Date:</th>
<th>4/19/2012</th>
<th>Project Representative: Lisa Raduenz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance Time:</td>
<td>3:00 PM</td>
<td>MnDOT Representative: Jon Jackels/Dan Rowe</td>
</tr>
<tr>
<td>Equipment Involved:</td>
<td>WZARD System</td>
<td>Test Section: WZARD System Requirements</td>
</tr>
<tr>
<td>Variance Severity:</td>
<td>Low</td>
<td>Requirement #: 3.2.14</td>
</tr>
</tbody>
</table>

Variance System (Circle one and provide more detail below):

<table>
<thead>
<tr>
<th>DMS</th>
<th>MDSS</th>
<th>WZARD System</th>
<th>OPERATIONS</th>
<th>COMMUNICATIONS</th>
</tr>
</thead>
</table>

Variance Description:

Due to a change in IRIS, this is no longer possible. Kathy Gilson does not believe this to be an issue. She can manually change the signs easily, if needed.

Variance Resolution:

Requirement 3.2.14 will be removed from the system requirements.

Resolution By: [Signature]
Resolution Date: 6/18/12

Confirmation: [Signature]  MnDOT Representative [Signature]
**MnDOT SCorE WIZARD Acceptance Test**  
**Variance Report Form**

**Variance #9**

<table>
<thead>
<tr>
<th>Variance Date:</th>
<th>4/19/2012</th>
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</thead>
<tbody>
<tr>
<td>Variance Time:</td>
<td>3:05 PM</td>
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<tr>
<td>Equipment Involved:</td>
<td>WIZARD System</td>
</tr>
<tr>
<td>Variance Severity:</td>
<td>Low</td>
</tr>
<tr>
<td>MnDOT Representative:</td>
<td>Jon Jackels/Dan Rowe</td>
</tr>
<tr>
<td>Test Section:</td>
<td>WIZARD System Requirements</td>
</tr>
<tr>
<td>Requirement #:</td>
<td>3.2.15</td>
</tr>
</tbody>
</table>

**Variance System (Circle one and provide more detail below):**

<table>
<thead>
<tr>
<th>DMS</th>
<th>MDSS</th>
<th>WIZARD System</th>
<th>OPERATIONS</th>
<th>COMMUNICATIONS</th>
</tr>
</thead>
</table>

**Variance Description:**

Kathy Gilson noted that she does not think this requirement is necessary. If she sees a WIZARD message that is not working properly, she can manually blank the message in IRIS.

**Variance Resolution:**

Requirement 3.2.15 will be removed from the system requirements.

**Resolution By:**

Resolution Date: 6/19/12

Confirmation: Lisa Raduenz

MnDOT Representative: Jon Jackels/Dan Rowe
MnDOT SCorE WZARD Acceptance Test
Variance Report Form

Variance #10

Variance Date: 4/19/2012  Project Representative: Lisa Raduenz
Variance Time: 3:10 PM  MnDOT Representative: Jon Jackels/Dan Rowe
Equipment Involved: WZARD System  Test Section: WZARD System Requirements
Variance Severity: Low  Requirement #: 3.2.22.4

Variance System (Circle one and provide more detail below):

<table>
<thead>
<tr>
<th>DMS</th>
<th>MDSS</th>
<th>WZARD System</th>
<th>OPERATIONS</th>
<th>COMMUNICATIONS</th>
</tr>
</thead>
</table>

Variance Description:

Steve Toughill noted that the way the system logic is set up, the WZARD system no longer needs to distinguish the summer months from the winter months. If one of the system logic fails, it automatically defaults to "MAINTENANCE VEHICLE AHEAD, USE CAUTION".

Variance Resolution:

Requirement 3.2.22.4 will be removed from the system requirements.

Resolution By:  

Resolution Date: 6/19/17

Confirmation:  

MnDOT Representative:
MnDOT SCorE WZARD Acceptance Test
Variance Report Form

Variance #11

<table>
<thead>
<tr>
<th>Variance Date:</th>
<th>4/19/2012</th>
<th>Project Representative: Lisa Raduenz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance Time:</td>
<td>2:55 PM</td>
<td>MnDOT Representative: Jon Jackels/Dan Rowe</td>
</tr>
</tbody>
</table>

Equipment Involved: WZARD System
Test Section: WZARD System Requirements

Variance Severity: Low
Requirement #: 3.2.30.1-7

Variance System (Circle one and provide more detail below):

<table>
<thead>
<tr>
<th>DMS</th>
<th>MDSS</th>
<th>WZARD System</th>
<th>OPERATIONS</th>
<th>COMMUNICATIONS</th>
</tr>
</thead>
</table>

Variance Description:

The team agreed that the WZARD system will not be using a separate interface to control/view operations of WZARD. An interface may be created for future applications of this system.

Variance Resolution:

Requirement 3.2.30.1-7 will be removed from the system requirements.

Resolution By: Lisa Raduenz
Resolution Date: 6/18/12

Confirmation: MnDOT Representative
The team agreed that the WZARD system will not be using a separate interface to control/view operations of WZARD. An interface may be created for future applications of this system. Since there will be no interface, this requirement is not needed.

Requirement 3.2.31 will be removed from the system requirements.
MnDOT SCorE WZARD Acceptance Test  
Variance Report Form  
Variance #13

<table>
<thead>
<tr>
<th>Variance Date:</th>
<th>4/19/2012</th>
<th>Project Representative: Lisa Raduenz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance Time:</td>
<td>3:10 PM</td>
<td>MnDOT Representative: Jon Jackels/Dan Rowe</td>
</tr>
<tr>
<td>Equipment Involved:</td>
<td>WZARD System</td>
<td>Test Section: WZARD System Requirements</td>
</tr>
<tr>
<td>Variance Severity:</td>
<td>Low</td>
<td>Requirement #: 3.2.32.1-3</td>
</tr>
</tbody>
</table>

Variance System (Circle one and provide more detail below):

| DMS | MDSS | WZARD System | OPERATIONS | COMMUNICATIONS |

Variance Description:

The WZARD system is not an interface. It is an executable file that is stored and operated on Meridian servers.

Variance Resolution:

Requirement 3.2.32.1-3 will be removed from the system requirements.

Resolution By:  
Confirmation:  
MnDOT Representative:  
Resolution Date: 6/8/12
MnDOT SCorE WZARD Acceptance Test
Variance Report Form

Variance #14

<table>
<thead>
<tr>
<th>Variance Date:</th>
<th>5/17/2012</th>
<th>Project Representative: Lisa Raduenz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance Time:</td>
<td>3:35 PM</td>
<td>MnDOT Representative: Jon Jackels/Dan Rowe</td>
</tr>
<tr>
<td>Equipment involved:</td>
<td>WZARD System</td>
<td>Test Section: WZARD System Requirements</td>
</tr>
<tr>
<td>Variance Severity:</td>
<td>Low</td>
<td>Requirement #: 3.3.1</td>
</tr>
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</table>

Variance System (Circle one and provide more detail below):

<table>
<thead>
<tr>
<th>DMS</th>
<th>MDSS</th>
<th>WZARD System</th>
<th>OPERATIONS</th>
<th>COMMUNICATIONS</th>
</tr>
</thead>
</table>

Variance Description:

Due to a the IRIS poll cycle of 30 seconds, the WZARD system is unable to meet the 30 second nominal time to post a message to the DMS. The original design of the WZARD system was to push data through IRIS, but the RTMC staff workload was too high and this was unable to be accomplished.

Variance Resolution:

Requirement 3.3.1 will be revised to say "(nominally 60 seconds)" and the phrase "(nominally 30 seconds)" will be removed.

Resolution By:

Resolution Date 6/13/12

Confirmation: Lisa Raduenz
MnDOT Representative: [Signature]
Daniel Rowe
**MnDOT SCorE WZARD Acceptance Test**  
**Variance Report Form**  

**Variance #15**  

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td><strong>Variance Date:</strong></td>
<td>4/19/2012</td>
</tr>
<tr>
<td><strong>Variance Time:</strong></td>
<td>3:20 PM</td>
</tr>
<tr>
<td><strong>Project Representative:</strong></td>
<td>Lisa Raduenz</td>
</tr>
<tr>
<td><strong>MnDOT Representative:</strong></td>
<td>Jon Jackels/Dan Rowe</td>
</tr>
<tr>
<td><strong>Equipment Involved:</strong></td>
<td>WZARD System</td>
</tr>
<tr>
<td><strong>Test Section:</strong></td>
<td>WZARD System Requirements</td>
</tr>
<tr>
<td><strong>Variance Severity:</strong></td>
<td>Low</td>
</tr>
<tr>
<td><strong>Requirement #:</strong></td>
<td>3.4.3</td>
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**Variance System (Circle one and provide more detail below):**

<table>
<thead>
<tr>
<th>System</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMS</td>
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<td>MDSS</td>
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<td>WZARD System</td>
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</tr>
<tr>
<td>OPERATIONS</td>
<td></td>
</tr>
<tr>
<td>COMMUNICATIONS</td>
<td></td>
</tr>
</tbody>
</table>

**Variance Description:**

The WZARD system uses an inclusive or exclusive list to determine what MnDOT AVL equipped vehicles are capable of triggering a WZARD message. The WZARD system was designed to completely drop any request from an unauthorized vehicle. It is not stored.

**Variance Resolution:**

Requirement 3.4.3 will be removed from the system requirements.

**Resolution By:**

**Confirmation:**

**Resolution Date:** 6/18/12
MnDOT SCorE WZARD Acceptance Test
Variance Report Form

Variance #16

Variance Date: 4/19/2012  
Project Representative: Lisa Raduenz

Variance Time: 3:20 PM  
MnDOT Representative: Jon Jackels/Dan Rowe

Equipment involved: WZARD System  
Test Section: WZARD System Requirements

Variance Severity: Low  
Requirement #: 3.4.4

Variance System (Circle one and provide more detail below):

<table>
<thead>
<tr>
<th>DMS</th>
<th>MDSS</th>
<th>WZARD System</th>
<th>OPERATIONS</th>
<th>COMMUNICATIONS</th>
</tr>
</thead>
</table>

Variance Description:

Due to a change in IRIS, this is no longer possible. Kathy Gilson does not believe this to be an issue. She can manually change the signs easily, if needed. See variance for requirement 3.2.14.

Variance Resolution:

Requirement 3.4.4 will be removed from the system requirements.

Resolution By: [Signature]  
Resolution Date: 6/18/12  
Confirmation: [Signature] MnDOT Representative
The WZARD system is not an interface. It is an executable file that is stored and operated on Meridian servers. MnDOT staff will not have direct access to configure components of the Meridian system.

Requirement 3.4.5.1 will be removed from the system requirements.
MnDOT SCorE WIZARD Acceptance Test
Variance Report Form

Variance #18

Variance Date: 4/19/2012  Project Representative: Lisa Raduenz
Variance Time: 3:20 PM  MnDOT Representative: Jon Jackels/Dan Rowe
Equipment Involved: WIZARD System  Test Section: WIZARD System Requirements
Variance Severity: Low  Requirement #: 3.4.6

Variance System (Circle one and provide more detail below):

<table>
<thead>
<tr>
<th>DMS</th>
<th>MDSS</th>
<th>WIZARD System</th>
<th>OPERATIONS</th>
<th>COMMUNICATIONS</th>
</tr>
</thead>
</table>

Variance Description:

The WIZARD system is not an interface. It is an executable file that is stored and operated on Meridian servers. MnDOT staff will not have direct access to configure components of the Meridian system.

Variance Resolution:

Requirement 3.4.6 will be removed from the system requirements.

Resolution By:  Resolution Date 6/18/12
Confirmation:  MnDOT Representative
The team agreed that the WIZARD system will not be using a separate interface to control/view operations of WIZARD. An interface may be created for future applications of this system. Since there will be no interface, this requirement is not needed.

Requirement 3.5.1.1-2 will be removed from the system requirements.
MnDOT SCoRE WZARD Acceptance Test
Variance Report Form

Variance #20

<table>
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<tr>
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<th>1/30/2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Rep.:</td>
<td>Lisa Raduenz</td>
</tr>
<tr>
<td>MnDOT Rep.:</td>
<td>Jon Jackels/Dan Rowe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variance Time:</th>
<th>3:20 PM</th>
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<tbody>
<tr>
<td>Test Section:</td>
<td>WZARD System Requirements</td>
</tr>
<tr>
<td>Requirement #:</td>
<td>3.5.2</td>
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Variance System (Circle one and provide more detail below):

<table>
<thead>
<tr>
<th>DMS</th>
<th>MDSS</th>
<th>WZARD System</th>
<th>OPERATIONS</th>
<th>COMMUNICATIONS</th>
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</table>

Variance Description:

The WZARD system will not be incorporated to the State patrol CAD system.

Variance Resolution:

Requirement 3.5.2 will be removed from the system requirements.

Resolution By: 

Resolution Date: 6/8/12

Confirmation: 

MnDOT Representative: 

[Signature]

[Signature]
MnDOT SCorE WIZARD Acceptance Test
Variance Report Form

Variance #21

Variance Date: 1/30/2012  Project Representative: Lisa Raduenz
Variance Time: 3:20 PM  MnDOT Representative: Jon Jackels/Dan Rowe
Equipment Involved: WIZARD System  Test Section: WIZARD System Requirements
Variance Severity: Low  Requirement #: 3.5.3.1-2

Variance System (Circle one and provide more detail below):

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<tr>
<th></th>
<th>DMS</th>
<th>MDSS</th>
<th>WIZARD System</th>
<th>OPERATIONS</th>
<th>COMMUNICATIONS</th>
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Variance Description:

The WIZARD system will not be incorporated to the State patrol CAD system.

Variance Resolution:

Requirement 3.5.3.1-2 will be removed from the system requirements.

Resolution By: [Signature]
Resolution Date: 6/3/12
Confirmation: [Signature]
A project kickoff meeting was held on Wednesday, February 16, 2011 from 10 a.m. to 3 p.m. at District 3B Headquarters in St Cloud. A list of meeting attendees is attached to the meeting minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **SCorE Phase 2 Project Background:**

   - Jon Jackels, SCorE WZRD Project Manager, provided the group with a summary of the project background. He said that the Destination Innovation Project was a result of internal agency suggestions from District 3B staff for innovative strategies aimed at improving snow and ice operations on the I-94 corridor between Rogers and St. Cloud. The corridor currently has between 40,000-80,000 ADT and a fiber backbone along the corridor will be installed and lit by the end of October 2011 as part of another related Destination Innovation effort. The Minnesota State Patrol is now working on another related project—CITE—which will install roadside stationary license plate readers at several locations along the same section of roadway to capture license plate information from passing vehicles. The focus of all of these Destination Innovation projects is on safety along this particular stretch of corridor, and all three projects give Mn/DOT another tool for managing traffic operations on the corridor.

Dan Anderson and Randy Reznicek of Mn/DOT District 3B discussed the concerns of Mn/DOT truck and snowplow operators regarding safety along the I-94 corridor. Reznicek said that some truck drivers are very nervous because they are seeing drivers at high speeds frequently passing trucks and maintenance vehicles on the right, with several instances of vehicles running off the road. State Patrol officers have had many near misses along this stretch of the corridor while trying to assist disabled motorists. The use of full color matrix signs offers a flexible, adaptive approach to a problem where high rates of speed are the real issue, according to Anderson, as they are able to display regulatory signage. He said the State Patrol (which posts advisory messages on the CMS along the corridor) also displays advisory speed limit messages not just for snow/ice operations or for snowplows but also for secondary incidents due to vehicles passing around snowplows and causing incidents on the corridor.

During Phase I it was determined that the eastbound segment of I-94 from St. Cloud/Greater Minnesota to Maple Grove/Twin Cities outskirts was the worst from a traffic perspective, as motorists tended to travel at higher speeds upon entering the outskirts of the metro area. During the evaluation phase of the project, both the eastbound and westbound segments of the corridor will be evaluated to review differences in performance once technology is in place and operational.
At this point in the meeting, Jackels introduced the Iteris team. Iteris staff briefly discussed team member backgrounds and made introductions, and stated that they felt the project was a traditional system engineering approach and project, and that it was a good opportunity to identify stakeholders for the project in order to get started as soon as possible given a short project timeframe.

2. **Overview of Phase 1 System Design**

- Terry Haukom and Scott Coozenney of the Mn/DOT Regional Traffic Management Center (RTMC) provided an overview of the Destination Innovation project’s Phase 1 system design. Haukom discussed a number of project stakeholders that should provide feedback to the consultant team in the development of the Concept of Operations and System Requirements for the Phase 2 project including:
  - Department of Public Safety/State Patrol
  - Traffic Operations
  - Maintenance
  - Regional Traffic Management Center (RTMC)
  - Private Towing Operators (through State Patrol)
  - County/City Law Enforcement
  - Emergency Responders (911/Fire)

Haukom said that the St. Cloud Traffic Management Center has an ‘umbilical’ relationship with the RTMC in the Metro District as St. Cloud can run clients from the RTMC server. He said that once the TOCCs are consolidated sometime in the future, the potential will exist in controlling St. Cloud CMS from Rochester. He also discussed other things related to the current and planned system, including that all of the new CMS to be installed on the eastbound segment of the I-94 corridor will be NTCIP Version 2 (able to upload or download graphics) and a gig Ethernet network will be installed for communications. Garbe asked about the current AVL system and specifically about how operators of Mn/DOT trucks currently enter data, including lane position. Anderson responded that there is a goal to have a lot of automation in the snow plow so operators can focus as much as possible on the task at hand. He said while the plows have the capability of using plow up/plow down features, they are not currently using the feature at this time. Dumont suggested that feedback be obtained from snow plow operators to find out what they think about how the current system operates.

Garbe discussed the Concept of Operations and asked the group to discuss the impacts of the system evaluation on traffic and traffic operations (i.e., does someone have to push a button to operate the system, and, if so, from where?). Dumont said that snow plows are used primarily about four months a year and that the I-94 corridor is closed down an average of five times per year due to tanker accidents
and other incidents. He said Maintenance staff do a lot of other functions along I-94 where safety is an issue year-round, including patching of cable guardrails and roadside maintenance, and cars are still running off the road, even in good weather months.

Discussion resumed about potential stakeholders for the project. Many were noted, including:
- DPS/ State Patrol
- Local Police Departments
- Local Fire Departments
- City/County Public Safety Officers
- District 3 IT Staff (Steve Toughill)
- District 3 Maintenance Staff (Randy Reznicek and Mike Kiley)
- Central Maintenance Staff (Mark Loxtercamp and Jakin Koll)
- Towing Industry (multiple vendors through State Patrol)
- Regional Traffic Management Center (RTMC) (Brian Kary/Terry Haukom)
- District 3 Traffic Operations (Tom Dumont)
- Mn/DOT Online Community (Karla Rains)
- DPS Access Points
- FHWA
- Mn/Road
- Minnesota Trucking Association (MTA)

Haukom said that District 3B was the lead agency in terms of directing the project and its outcomes and that RTMC would support whatever the District wanted or needed to get the project completed. Dumont talked about the importance of understanding operational and maintenance “tails” (costs) for the deployment of the system as well as costs for electricity and/or power, which could be substantial given the potential for a high number of additional devices installed along the corridor with monthly costs. Haukom said that the addition of more cameras along the corridor could affect RTMC Operators and that signs can handle priority messages. Dumont said that this would be important to address in the ConOps, citing an example of how an older message stating that a snow plow was going by it would have to allow for the retriggering of a newer message or priority message.

The Department of Public Safety (DPS) is now running the entire TIGER system at this time but DPS is not able to dictate the priority level of messages along the corridor, according to Dumont. Priority message levels are set by Mn/DOT Traffic Operations in District 3B. Haukom said that the Twin Cities is using video archiving software called “Milestone” where counties can now get streaming video (runs through a connection with Office of Enterprise Technology-OET, not internet) and that perhaps looking at PSAPs
in this area as stakeholders might be a good idea. He suggested contacting the State Patrol because they would know based on the number of transferred calls they receive (only take cellular and 911 calls, Stearns County handles the rest of the other calls in area). Haukom said that whatever is done in the corridor cannot be location dependent. He suggested talking with truckers in the area (one idea is Speedy Delivery) or with the Minnesota Trucking Association. Haukom stressed looking at the project from the standpoint of how creative it can be designed and deployed without having to get new procurements of hardware or software but instead using existing signage, power and infrastructure.

Coozenney provided a map of the corridor which detailed the location of existing and future devices as well as fiber optic information. At Opportunity Drive in St. Cloud, the State fiber conduit leaves the freeway and wanders east, according to Coozenney. OET may partner with Mn/DOT to bring the conduit and fiber up to County Road 15. Mn/DOT is working with power companies for spacing and to make sure that in-place signage will match points as needed. On east end of corridor there is 1.5 mile spacing for cameras and detection, and from Monticello to Highway 101 it is 1 mile spacing because visual verification is important in that stretch of roadway. Coozenney said that cameras are really important for both Mn/DOT and DPS for verification. He said that the current detection systems now in place (Wavetronics) on the east side of the corridor will be uninstalled from Monticello east and reinstalled on the west segment this year and that the east segment will use Wavetronics HD units in order to better monitor the recurring congestion along the eastbound segment from Monticello to the Twin Cities limits. Travel time messages are important in this portion of the corridor and will need to be updated, and the legacy systems on the TIGER corridor along Highway 10 will remain in place.

The schedule for Phase 1 includes a contracting letting date scheduled for May 2011 and a June 2011 award with a project completion date at the end of October 2011. LedStar signs are already on order and will be available to the contractor as soon as the bid is awarded. There are vaults at all locations (1.5 mile spacing or so) and 334 MP cabinets with power surge suppression or pole cabinets on a fiber optic pole with pigtails to it (one is installed at the RTMC in Roseville on a pole near the front door). All sign locations will have a 334 cabinet with Velmont tip-pole designs. Vaults in front of rest areas are already installed. Local detection units (CCTV in 334 cabinets) include field-hardened Ethernet CISCO 3000 or 3010 rack or dim-rail mounted. 90% field plans were provided to Iteris staff in order to assist in the development of system requirements.

Dumont spoke about CMS message content for the signage, indicating that travel time information would be provided at two or three locations on both overhead and side-mount CMS between Monticello and Highway 101. Coozenney said that there is no solar or wind power being done along the corridor and that gator patch mounts are being used and armored for rodent protection. He stressed that field
personnel on the project should not be touching armor while in the field because of the danger of electric shock.

At this point in the project, the group broke for lunch, which was provided in the room.

- **Tour of District 3B AVL/GPS Equipped Snowplows** – A brief tour was provided after lunch for meeting attendees to inspect and review District 3B fleet vehicles (snowplows) already equipped with AVL/GPS systems.

- **Next Steps** – Discussion occurred among group members about adding other stakeholders to the project technical advisory committee. Iteris team members outlined the project schedule and the next project tasks. The project Concept of Operations will be drafted and submitted to the TAC by the end of March 2011, and draft System Requirements will be submitted in concert with the beginning System Design task (by mid-April 2011). Final System Design is to be completed by the end of May 2011.

- **Next Project Meeting** – The next meeting of the SCorE WZRD project is scheduled for Wednesday, March 16, 2011 from 12:30 to 3 pm at District 3B Headquarters in St. Cloud. Iteris staff will send out meeting minutes and a meeting agenda in advance of the next meeting date.
# Mn/DOT Safe Corridor Enhancements Phase 2 Meeting

**Mn/DOT Project No. 97532WO1**

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A project meeting was held on Wednesday, March 16, 2011 from 12:30 p.m. to 3 p.m. at District 3B Headquarters in St Cloud. A list of meeting attendees is attached to the meeting minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **Review Meeting Minutes from February 2011 Meeting**
   Lisa Raduenz of Iteris passed out meeting minutes from the February 16, 2011 meeting to all meeting attendees.

2. **Updated Project Stakeholder Contact List**
   Lisa Raduenz passed out an updated project stakeholder contact list to all meeting attendees.

3. **User Survey and Survey Responder List**
   A copy of the survey that was developed by Iteris staff to engage I-94 corridor stakeholders in responding to information to be used for the project Concept of Operations was provided to all meeting attendees, along with a list of each organization and person that was contacted by Iteris to return the survey. Survey respondents were asked to return the survey electronically or via fax to Iteris by Monday, March 14. Raduenz said that there were a total of 14 respondents that had returned survey information prior to the meeting and said that Iteris staff would continue to seek stakeholder input from those on the list until the final draft of the project’s Concept of Operations has been completed. Iteris staff also passed out a summary sheet of survey responses by responder. Raduenz mentioned that early responses from responding organizations seem to indicate that the issue of procurement of hardware specifically designated to meet the technology needs of this project might be of concern to local units of government and public service organizations according to what responses have been returned to this point. Jackels said that the District 3 State Patrol contact for the survey should be Mark Sprengler or Lieutenant Kitzmueller and asked that someone familiar with the project from District 3 Patrol be consulted on the survey (Iteris will identify the appropriate person at State Patrol with the assistance of Kathy Gilson).

4. **Project Architecture Conformance**
   Steve Garbe of Iteris distributed a project architecture conformance memorandum that described the overall project architecture and its conformance with federal requirements and the Statewide Regional ITS Architecture. He described the I-94 SCorE WZARD project as “doing well in terms of conformance” and said the intent of the document was to compare project documentation to rules and to provide Mn/DOT with a document that displays adherence to federal and regional goals for ITS projects and the regional architecture.

5. **Project Architecture Alternatives**
   Dwight Shank of Iteris presented a document entitled “Project Architecture Alternatives” which presented three concepts or alternatives for the SCorE WZARD project architecture, describing them as “three ways in which components could interact with each other” on the project:
- **IRIS Control Alternative** – This concept is based on the regional communications system now in place, which is a cellular infrastructure. The diagram provided by Shank displayed a corridor vehicle linked via internet to the Regional Traffic Management Center (RTMC) through servers with a St. Cloud-based work station where a person situated in St. Cloud would determine when to turn on or light a CMS along I-94.

- **Local Alternative** (Bluetooth) – This concept consists of a corridor vehicle providing a signal when in proximity to a Bluetooth reader, which in turn sends a detection signal to the DMS. This would result in basically an auto-generated message to the St. Cloud TMC or TOCC via the RTMC in Roseville with St. Cloud-based work station verification, as shown on the concept drawing.

- **TPFKAI Alternative** – The third and final concept Shank presented was TPFKAI, or, as he referred to it, “The project formerly known as IntelliDrive” (ConnectedVehicle is current name). Shank described this alternative as a beacon-based option using roadside equipment to verify operations with a St. Cloud-based operator. He indicated that it would be up to a St. Cloud system member to make the decision on whether or not to light the sign.

Garbe asked the group what was reasonable as a solution for a VII type of scenario (i.e., TPFKAI scenario as presented). Jakin Koll said that snow plow operators and other maintenance drivers had too much to do at the present time while operating equipment, and stated that the first architecture concept presented seemed to work well as Mn/DOT staff had enough to do while operating vehicles during maintenance activities. Randy Reznicek concurred and stated that there is already funding invested now in the operations of the fleet and that it made sense to stick to a simpler process in order to get the system up and started sooner rather than later, with adjustments that could be made in the future after the system was fully operational. Jackels stated that he wanted the group to consider the third scenario and not necessarily throw it out but rather identify the risks of getting it done instead, perhaps in two phases and keep “options open”. Shank remarked that the TPFKAI alternative could be implemented using 3G/4G wireless service and not just dedicated short range communications (DSRC). Based on this discussion among group members, the IRIS alternative was selected by the group for further development as part of the project’s Concept of Operations.


Iteris staff distributed a handout that included project goals and Use Cases/Scenarios for discussion purposes. Garbe briefly reviewed the project goals listed on the first two pages of the handout with the group. Jackels and Dumont clarified that the reduction of I-94 corridor congestion was relevant not only to weekday AM and PM peak hour traffic but also to weekend recreational traffic that peaks on
Friday afternoons on the westbound lanes and Sunday afternoons on the eastbound lanes of I-94 in the project corridor. Garbe asked group members to review project goals and to send any other comments to Iteris staff by the end of the following week (by Friday, March 25, 2011).

The rest of the meeting was devoted to a detailed discussion of the possible Use Cases/Scenarios for the WZARD project. Iteris staff presented a handout which included a number of detailed scenarios for consideration by the group:

**Scenario 1 – Basic Snow Plow Operation interaction with DMS on Corridor**

Under this scenario, a snow plow passes DMS on the corridor and without human verification or intervention a warning is displayed on the DMS within 30 seconds of vehicle passage, indicating that the snow plow is ahead but no lane indication is made. Five minutes after the snowplow has passed the message is dropped from the DMS. Coozennoy asked why thirty seconds was the length of delay used in the scenario, and stated he did not see an issue with instant turn-on of the CMS. Reznicek said that the sign would not necessarily be seen by cars following the snow plow because of the snow cloud. Koll said that the sign could be populated 15 seconds before the truck came upon the sign and that it was better to put a message on the sign sooner rather than later. Jackels asked the group if the intent was to have the snow plow operator verify that a message was posted on the CMS as the operator passed the sign. Group members responded affirmatively. Koll said a generic message should be posted to the sign in this case such as “SNOW PLOW IN AREA”. He suggested that the message be posted 15 seconds before the plow reached the sign in order to alert drivers and to get operator verification of the message. Dumont said this would be an issue for those vehicles traveling ahead of the plow on the highway. Reznicek said that a plow in the left lane of I-94 travels at a speed of 25-30 mph and Jackels stated that this was really a discussion about vehicle speed. Koll stated that the only time that an issue may exist in this area was if the hazard lights on the vehicle were used, because Mn/DOT would prefer to have the message posted when hazard lights on the plow were on. Jackels calculated that 15 seconds would allow the snow plow driver to be “3 signs away” and asked what the driver would be doing for speed. Koll said the MDSS system used by Mn/DOT can tell speed of the plow and the data would already be available in the MDSS system. Shank responded that there would be an advantage of using 3G/4G service and GPS/AVL for that reason but indicated that the group wouldn’t want to worry about speed because the system would already be aware of where the snow plow actually was. More discussion occurred about drivers who use ramps and passovers near the signs and how CMS would be activated based on when ramps and passovers are used during the plowing process. Dumont asked how the system would need to be activated based on these activities. Koll stated that point of direction in which the plow was traveling would be important. Coozennoy suggested tying direction to the next sign as it becomes tripped by plow proximity. Kiley stated that the plow would take the next ramp after a sign would be tripped. Koll said that operators at the TMC would know the plow would be in-between signage and still doing maintenance work. Jackels
suggested that the next sign trips downstream after snow plow leaves the first sign. He said that if the driver left the road to take a ramp the sign would go off. He suggested that if the driver re-enter the road, the next sign would then go on, stating that GPS/AVL would be the key concept for this scenario and that the emphasis would be on vehicle position rather than on the amount of time needed to keep a sign turned on or shut off. Shank stated that if there happened to be two maintenance vehicles in the vicinity, the system would still want to have the nearby sign lit. Garbe suggested that the key component for this particular scenario was whether or not there should be human intervention in the system. Gilson said that there was no time available for Patrol staff or operators at the TMC to do this work, particularly in a busy winter weather operation. Toughill said that messaging priority would also be an issue and stated that whatever message had been previously posted on the sign prior to the activation by the vehicle would have to return to the sign after the vehicle passed.

Scenario 1B - Lane Position of Snow Plow Reported. Gilson said that the State Patrol is currently working on a similar system known as “CAD to Cars” and wondered how this would be different from that initiative. She suggested that the consultants talk with Brian Kary of the RTMC or TK (formerly of the RTMC) to find out more about this statewide project and system. Gilson also stated that trooper verification is required when an incident is first noted in the CAD system. Tony McClellan of Meridian asked if any intervention should be required at the RTMC for this verification process. Coozenoy said that the RTMC was different as it maintains a 24/7 operation schedule while different staffing levels exist at the District 3 office and on weekends there is usually an on-call person only to support maintenance operations. Garbe said it was important to determine whose responsibility it would be for an incident that occurred after normal hours at District 3. Dumont stated that it would be the responsibility of the State Patrol to verify incidents or problems and stated that it would be important to have a fully automated system for verification for that purpose. Toughill said it would depend upon how busy things are regarding whether or not verification could occur and that while verification will show up in IRIS cameras may not be able to view all the signs. Reznicek said that consolidation of the TOCC to Rochester may be an issue. Gilson said there would be fewer operators if consolidation of the TOCC occurs. Dumont said that Scenario 1 should be fully automated unless someone wants to get rid of a message set. Shank said that monitoring activities could possibly be done via surveillance from an IRIS work station.

Scenario 1C – Snow Plow Lane Positioning with Message Display and Removal Automation. Garbe asked if the operator should get an audible alarm if message was still on CMS. Gilson stated that most operators will turn the alarm volume down because it becomes a matter of priority levels. She stated that when operators are usually needed the most that’s the time when they are usually least available, particularly in winter weather operations. McClellan said that the consultant team wanted to make sure that the scenarios under development were meeting the needs of the TMC. Gilson asked the group if that meant that there would be an IRIS type of map that would track snow plows on it. She
said that if this were the case it would be of great benefit to operators because it would really improve their ability to track plows. Garbe suggested an icon that would change colors on the map in order to notify operators that when they have the time they could see if a message that was currently displayed on CMS should still be posted. Gilson responded that she could see this type of information if a message had been posted on a sign for a long period of time, such as if the icon was yellow meaning active or active in automation. She said differentiation would be important. Koll said that the MDSS software could be set up as a “View Only” account for State Patrol operators, as it shows where the plows are and troopers really like that feature. Shank stated that an IRIS enhancement for the project might not be out of scope. McClellan said that the State Patrol and Mn/DOT already have an agreement in place on sharing information on where snow plows are as part of the MDSS software. Reznicek said that this is already being done and it is a big help. Garbe asked about the need for understanding vehicle lane position. Koll stated that the current GPS system would not be able to tell lane position of the vehicle because it is based on sending centerline information. He said that the lane position information is not important. Shank said that if the group really wanted to know about lane positioning the Iteris team would be glad to discuss that option. He stated that lane position would also drive message content for snow plow operations but that incident management will be manual information. Koll said that in the future lane position could be entered via touch screen but that regular maintenance activities that are scheduled can be entered manually as is currently done. Kiley said that some maintenance activities might have to be entered in manually more than once in the same day, such as a cable guardrail that would have to be repaired because of incidents in the field with a variety of weather conditions in the same period of time.

Scenario 1D - Snow Plow Operating as Part of an Incident Message Communications System. Garbe asked the group to decide if this was a frequent problem, because if so, automation should be high in value. Group members determined that this is a less frequent activity and one where the manual notification process and procedures should work fine as they currently operate. Garbe asked the group if they are using CB Wizard in Minnesota as Wisconsin does. The group said that they are not using that system in Minnesota but are aware of it.

Scenario 2A – Public Traveling Without Lane Position Reported. Garbe stated that this scenario corresponded to Scenarios 1A, 1B and 1C but that the group had already determined that lane position was not relevant so Scenario 2B would be eliminated from consideration. He asked the group if they were interested in other message content, such as the speed of the snow plow. Koll said that this was not a good idea as the speed of the plow could change rapidly. Garbe asked the group if they desired an interface with sidefire microwave units to determine average traffic flow speeds for travel time display on the CMS. He used the example “Travel Time to Monticello – 6 minutes” and also asked about post advisory messages such as “Congestion Ahead” or “Average Speed Ahead”. Coozenoy said that because the spacing to Monticello is one mile apart and a mile and a half after that it would be
pretty tough to be accurate with these types of messages. Jackels responded that this may be true for the travel time or incidents parts of the project but not necessarily true for the snow plow part of the project. Garbe asked Coozenoy if he or someone else could provide the LedStar sign specifications for the consultants to look at the message autopopulation information.

**Scenario 3A – Law Enforcement Escorting Wide/Heavy Load on I-94 Corridor.** Shank asked the group if this was an important activity to consider. Group members felt that they did not really see a high incidence of this scenario occurring on the I-94 corridor, as most wide/heavy loads traveled during off hours and off of the interstate system. Garbe asked the group if it was planning to take a different approach about posting more messages along the corridor rather than less messages for advisory purposes. Dumont said that Mn/DOT looks at this type of scenario as more of a construction-related activity along the corridor (i.e., bituminous truck causing queues) and said that heavy trucks generally look for an open lane along I-94 as they move through the corridor. He said that with dynamic movements such as this that can cause backing up or queues the best thing to do would be to keep the process automated. Garbe asked Dumont if he had a defined process for the Traffic Management Plan on queueing. Dumont responded yes and said that field devices could become part of the TMP summary. McClellan commented that the devices could detect speed of slow-moving vehicles and determine the queue length behind the vehicle. Koll said that the concept shouldn’t be ignored and should be considered down the road, but for now the process should be kept simple. Jackels responded that with the level of congestion along the corridor 1 to 1½ mile spacing there would not be immediate information but the system could provide an advance warning of congestion when hitting the first detector based on speed and could roll message back upstream in an automated way. Shank asked where that activity might fall within the scope of this project. Jackels commented about looking at a scenario where the operator would be sent information that congestion or queueing is building, such as an alert. Garbe responded that most ATMS software will provide an alert. He provided an example – Sensor A could report average speed of 40 mph and Sensor C is reporting 65 mph speed and said that an algorithm would be needed. Dumont added an operator could get this information if speeds dropped below a certain level on the corridor. Gilson said that this feature was already available in IRIS at the RTMC, not in St. Cloud, and that is displayed as a color-coded system. Dumont said a system could have an algorithm that was built upon the concept of when the speed differential is greater than X level, messages would be posted to the signs. Garbe asked if a VISSIM or CORSIM model of the corridor has been created or suggested that perhaps this might be something a University graduate student could do for modeling purposes. Shank asked if lanes were open, would there be automated messages. Gilson said that on Sunday afternoons there are usually backups during the spring/summer/fall months but usually no crashes or incidents that happen. Garbe asked about travel time messages as the basis of why this scenario had been originally created. Dumont said that regular commuters across the corridor know their travel times, it is infrequent travelers that do not. Jackels said that travel times would be an enhancement to the WZARD project. He said there would be
a need to capture this idea so as not to lose it but it would not be part of the current project phase. Dumont added that taking a message off rather than putting one up might be an issue – such as “Reduced Speeds” or “Stopped Traffic” and asked whether the message could be terminated automatically.

**Scenario 3C – Incident Needing Cleanup.** Garbe said the main point of this scenario is the law enforcement vehicle to know where incidents are at in the system and that it would require the sharing of vehicle information (location) between State Patrol and snow plow operators. Gilson stated that the troopers voice this information over the air at this time and that the TMC operators can see which trooper, what speeds and other information about how long response will take. Jackels asked if a local sheriff were to pull someone over on the right shoulder, wondering if this was a warning that could be done automatically. Koll said that it would not be good practice to post a message stating “Trooper on shoulder ahead” and that Minnesota already has a Move Over Law for maintenance and State Patrol. Toughill asked whether the Patrol would let Mn/DOT use AVL information and most of those in attendance thought probably not. Garbe said if a vehicle was 1½ miles away it would be two minutes from the incident area and perhaps this would be a good safety idea. He said if the group determined that to be the case, needed agreements would have to be in place with the State Patrol.

**Scenarios 4B and 4C – Mowing Operations along the Corridor.** Garbe presented these scenarios, saying that based on the rest of the conversation to this point, these were the last scenarios that would need to be discussed with the group and the rest could be ignored. Reznicek said that it would be good to have a warning for mowing operations and for stripers, too. He asked if AVL equipment was going to be placed in the mowing units. Gilson said that the operators take calls now about mowing by position (i.e., left inside shoulder, etc.) but that it would be nice to have a message set for this use. Garbe said that putting AVL in the mower was most likely not an option, but if there was a Bluetooth device at each sign it could display a message by mower proximity, although the exact position of the mower would not be known. Reznicek said that mowing operators can take out a hand-held radio now to notify State Patrol and do so. Jackels asked if this scenario would hold true for all maintenance activities and planned events. The range of Bluetooth devices was asked. Iteris staff responded that to their knowledge and experience, a range of about 330 feet was the maximum reading range. Jackels said that right now planned, routine maintenance events can be coordinated with Dispatch and manual messages can be placed on the CMS. Dumont asked if GPS was turned off in the summer by maintenance. Koll said that GPS was tied into hazard lights so that when hazards are on, AVL comes on. Koll suggested a generic “Maintenance Vehicle Ahead” sign that could be posted for sign trucks and stripers on the road and that they may need some level of automation similar to snow plows for the signage. Someone asked about how to distinguish Mn/DOT AVL equipment from other AVL equipment on the corridor. Shank said that there should be ESN/static and IP addresses that identify Mn/DOT equipment on the corridor so this should not be an issue. Koll said that it would be important
to make sure that reliability of message posting was not an issue, such as a sign in the middle of summer that displayed the message “Snow Plow Ahead” rather than something else. Garbe said there would be time in the next few months to figure out message content later in the project development process. A question was asked about fire trucks in the corridor responding to incidents and how State Patrol is aware of this scenario. Gilson responded that whenever 911 is contacted the State Patrol knows and that these types of incident messages are manually posted.

**Final Scenario – System Failures.** Garbe and McClellan talked about possible system failures and if they occurred, who would be responsible. Toughill said that in District 3 he would be the person who would have to deal with system failures, but not on a 24/7 basis. He said he was only called if there is an Amber Alert or Abducted Child issued and the sign that had to display the message would fail. Raduenz asked how often that scenario had occurred. He said that he had never had a failure yet for an after-hours Amber Alert message. Dumont said that if a safety problem occurred after hours the State Patrol or RTMC would handle the issue via Dispatch. For maintenance issues in District 3, this is not necessarily the case. Reznicek said that for some traffic or ESS issues, they might be handled after hours and if so, Arnie of ESS would be the person to do so. The sign maintenance point of contact is Randy Reznicek for sign maintenance protocol and for weekend failures. Garbe suggested the blanking of CMS signs in the event that signs fail for Ethernet-based systems. District 3 staff said that if signs failed on weekends there would be no call out to fix them (unless an Amber Alert were issued). Garbe asked for a clarification on this policy in the event it was a Sunday afternoon and there was recurrent congestion on the corridor and travel time messages were to be posted. The answer by District 3 staff was still the same – no.

7. **Next Steps/Next Meeting Date**

a. **Next Steps**–Iteris team members are continuing to work on developing the Draft Concept of Operations at this time due to the project’s late start date (February 22, 2011). The discussion on scenarios will allow Iteris staff to consolidate the remaining pertinent scenarios and refine the Draft Concept of Operations. They expect to have a Draft Concept of Operations for group review by the end of the week of March 21, 2011. Once this draft has been reviewed and comments are received from project stakeholders, the Final Concept of Operations will be drafted and submitted to the committee by April 4, 2011. Iteris staff will also begin working to draft System Requirements in order to stay current on the project schedule.

b. **Next Project Meeting** – The next meeting of the SCorE WZRD project is scheduled for **Wednesday, April 13, 2011 from 12:30 to 3 pm at District 3B Headquarters in St. Cloud.** Iteris staff will send out meeting minutes and a meeting agenda in advance of the next meeting date.
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A project meeting was held on Wednesday, April 13, 2011 from 12:30 p.m. to 3 p.m. at District 3B Headquarters in St Cloud. A list of meeting attendees is attached to the meeting minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **Review Meeting Minutes from March 2011 Meeting**
   Lisa Raduenz of Iteris passed out meeting minutes from the March 16, 2011 meeting to all meeting attendees.

2. **Review Draft Concept of Operations**
The Iteris team distributed a handout that summarized the SCorE WZARD system operational needs and also draft system concept alternatives described within the Draft Concept of Operations document. The Draft Concept of Operations document was also distributed electronically and in written form to meeting attendees. Dwight Shank of Iteris provided a systematic overview of the operational needs for the WZARD system as defined by system users at the March 2011 project meeting. The focus of the operational needs was on providing a reliable system for snow plows actively involved in winter maintenance activities. Additionally, the system needs to be automated so that no driver needs to manually input information into the system. Shank stated that another system need is that the plow must be able to identify location and the individual identify of the vehicle (plow). Jakin Koll of Mn/DOT District 3 asked if the hazard lights on the vehicle could also work as a signal for the system to verify vehicle operation needing warning messages. This is one possible solution that maybe incorporated into the project. Other capabilities for the system included identification of where the plow was when it passes the DMS, system override capabilities as determined by the Operations staff, and the determination of priority messages for the override system and which messages are not able to be overridden based on priority level. Koll asked if that meant travel time messages. The priority of each message would be determined by this group based on the message type and operational practice of Mn/DOT. Shank said plow drivers would be asked to verify that the message was posted on the DMS as they passed each sign according to the group discussion held at the last meeting. Preliminary review by the project team of the planned DMS for this project indicates that pixel status (lit or not lit) can be obtained from the DMS, this would allow for message confirmation within the ATMS or sign management software. Shank asked if the group had other items or requirements that needed to be addressed at this time.

Steve Toughill of District 3 asked if priority messaging would be done automatically. Shank said that it would all be done automatically without plow operator intervention. Tom Dumont of District 3 asked that a bullet on the handout include the phrase “project corridor area” rather than just “corridor”. Raduenz asked Kathy Gilson and District 3 operations staff if they felt their needs were covered in the overview provided by Shank. Gilson said yes and that her staff wants to make sure the system is as automated as possible. Jon Jackels, Mn/DOT Project
Manager, asked that a sub-bullet be added under the second bullet on page 2 of the slide presentation to reflect this.

Shank moved on to system features that are currently described as “desirable” but not necessarily required. Koll said that he would prefer that a bullet be restated to read “in snow/ice operations and potentially other activities that require vehicle to put hazard lights on”. Dumont asked about the definition of the word “accommodate” in the first bullet under the “Desirable Features” area. Shank said it was intentionally left “fuzzy” because it is yet unknown as to what this will actually mean.

Toughill said that other maintenance activities are generally planned activities, such as fixing guard rails and pothole repair, so it would be known when vehicles would be out doing those activities. Dumont asked if using the word “accommodate” meant automatically generating a message. Koll suggested such a message could read “Caution...Maintenance Vehicle Ahead” in order to make it generic in nature. Gilson said she posted a similar message earlier that day and has previously posted other messages that say “Vehicle Ahead Right Lane”. Reznicek said that Patrol and Operations/Dispatch can do these types of messages because they already know where the vehicle is located.

Shank said that the discussion was about reliably posting the message because those in the room had asked how one would know the message was correctly posted at any other times when a slow-moving vehicle was traveling along the corridor. Dumont said that striping trucks would also be doing that activity at times along I-94. Others in the room added that they could also see the same happening for weather operations and road patching activities. Shank said that weather-related events and mobile patching activities might be a little more “tricky”. Toughill said that it would depend upon the message. Shank said that with today’s weather (cloudy, no snow on ground) a snow plow message would “not fly”. Tony McClellan of Meridian suggested that perhaps the key to this issue was in the spreader control. Koll said that this would probably not be consistent enough but perhaps could be a good cross-reference. McClellan suggested that maybe another piece could be added to make it work. Koll agreed. Jackels said that he was still having a hard time understanding and needed the scenario recapped again. Dumont stated the default state of the system would be no message displayed on the sign. Gilson added that as soon as the first vehicle went by at 80 mph a call will come in to Dispatch to trigger the message to be put up on the sign. Jackels said that he thought the desirable system features might have already been built-into the system at this point. Toughill said that it might be one day in early spring with a slow-moving truck going along the corridor and it would be all about how the sign was actually worded. Koll agreed. Dumont stated that Jackels was asking what the sign would say if the vehicle was out there on the corridor doing something other than plowing. Jackels said if the vehicle is plowing snow the sign should be automated and if it is a routine maintenance effort in the corridor, then the TOCC/RTMC operator can post the
message. Dumont replied that the sign should not say “Snow Plowing Ahead” if there was no snow to plow. Koll suggested that a generic “Maintenance Vehicle Ahead” sign should be put up or nothing at all.

Dumont asked if the message could be generic, like “Maintenance Activity Ahead”. Dumont said that he would rather not put a snow plow message out in the summer. Toughill said he could ease Dumont’s mind and perhaps utilize an internal clock feature (i.e., April 15 for ending winter messages). Shank responded that it might be too much for an administrator to adjust at a certain point of the year. Reznicek asked if it is something that can be done by pushing a switch. Jackels suggested October 15 as a start date for posting snow messages and April 15 for ending the posting of snow messages to the system. Shank said the scenario he might be worried about would be where there is a sunny day in winter, the ground is bare and a winter vehicle is doing pothole repair. He suggested that there would also be maintenance information as provided through the MDSS system already in place. Koll said that sander information from AVL could determine “plowing” activity and another could be to use the sensors that detect whether the plow blade is up or down as that technology is getting better. He said that Mn/DOT is not planning to use that plow position sensors and that weather data by itself doesn’t tell the whole story. The project team agreed to continue to look at MDSS data and sensor data along with potential calendar date designations for the posting of messages.

Reznicek asked if the Patrol would still be allowed to override the system. Discussion ensued among several people in the room that focused upon the automation of the dispatch system to override the system as necessary. A number of different options were discussed among group members that will be further reviewed during the development of detailed system requirements and during the design process. Gilson asked if a separate message could be placed based on specific dates during the year, like April 15-October 15 for maintenance signs and then October 15-April 15 for winter signs with default override capabilities. Shank said yes. Gilson said that would work, but that Patrol dispatch operators would have to remember to disengage the messages, although it is done now in CAD by Patrol operators. Koll stated that the system could be designed to do this and to generate a reminder message to operators to check sign message status. Shank said one other way to do this could be when a maintenance vehicle is moving near the sign zone, capture the presence of the vehicle but don’t display any message that could be “laughable”.

Discussion continued about the list of desirable system features. Shank stated that the “icons on a map” bullet is currently listed as a “desirable” and not a mandatory requirement. Koll asked if he was talking about MDSS icons, to see where the plows are in the system and switching screens back and forth from a DOT work station but not in IRIS. Koll asked if this was to be included as part of the system. He said that if that particular feature were required, “icons on a map” would be moved from the desirable system list to the operational needs list. Gilson asked if that meant that they would see trucks on the IRIS system. Shank responded that they would not be on the IRIS system but on another screen. Dumont asked if any other things like travel time display are out of
the system. Shank responded that this system would not do travel times but rather the IRIS system does. Koll asked what travel time messages would say. Dumont said that District 3 people set up the travel time display and how prioritization of those messages gets done. Shank responded that this feature was not within the scope of the current project. Dumont asked if the capability to display travel time messages on the DMS was covered in the system requirements. Shank responded yes.

In summary, each of the needs presented in the Concept of Operations was validated. One additional need was to be added to the Concept of Operations stating that the system must have capability to allow continued display of a DMS message of higher priority than snow plow requested message display. Rewording was requested to assure that references to the project corridor along I-94 were not confused with the regional corridor including I-94 beyond the project area and TH 10. Two desirable capabilities were discussed at length related to display of messages and display of snow plow location. The discussion of messages indicated that display of messages when maintenance vehicles are moving along a corridor below the posted speed is a need regardless of whether the vehicle is actively plowing snow and emphasized that information displayed must be accurate and automated. A conclusion was not reached as to how the position data would be displayed, how to assure proper message display, degree of operational control needed at the dispatch center or the determination of criteria for automated message display. These details will be addressed in future work related to the development of detailed requirements and will be based on the availability of resources.

**Discussion on Five (5) Design Concepts**
Shank reviewed the five (5) design concepts included in the handout and within the Draft Concept of Operations document.

**Concept #1- IRIS Control Using AVL Data** – In this system design concept, snow plows report positions to IRIS using AVL, IRIS will ingest the information which has been reported by the system and will determine when to put the message up and when to take it down. This concept utilizes only existing system components but new features would require IRIS staff to develop, configure, and operate the system, according to Shank. Since pilot deployments such as this frequently require adjustments, this concept would also require the IRIS implementation and reporting to be tweaked on a frequent basis demanding additional IRIS staff resources. Shank said the main disadvantage was the input and time required by IRIS system staff. Based on a discussion Iteris staff had with Ralph Adair, it would take 6-8 weeks of lead time to get required elements into the IRIS system if this project became a high priority and he was unsure this could be done by October or November 2011 given current workloads for his group and current agency priorities. He did say that it could be done in the future when a tight timeline was not so prevalent.
Concept #2 – Contact Closure Display - IRIS Reporting - This concept includes a dedicated wireless communications device mounted on the side of the road in some fashion with a mated pair of one receiver and potential for multiple transmitters, each of which could light a sign if in close proximity to it. Once the sign was lit, IRIS would continually poll the sign and can recognize the sign in the system. Shank said the biggest advantage to this concept is that it is much less software intensive than Concept #1, but the biggest disadvantage is that there is much more limited system control and it would be difficult to determine if a snow plow had left the corridor for any reason. Shank said the hardware required is available and must be installed at each sign and on each snow plow as part of this alternative.

Someone asked how the snowplow message would be lit. Shank responded that there was a capability on the sign controller of each sign to display a prestored message upon detection of a contact closure. The messages for each sign would have to be pre-stored in the sign controller using the IRIS message library or a separate tool, which was a complexity but solvable. He also said intelligence could be put into the AVL system that may allow it to send additional data including transmission of NTCIP message control commands. Shank said his biggest concern with this alternative is about system security and that it would be a “viable alternative with some undesirable features”.

Concept #3 – Contact Closure Display – Remote Reporting - In this alternative the system would operate in a similar way to the previous concept (#2), only it would report sign display status to a third party rather than to IRIS, according to Shank. It would appear similar to the MDSS or work zone display/interface. This system would operate completely independently of IRIS and there is potentially a “small software piece of work” that would be needed from someone other than IRIS staff to make it work. Toughill asked if this meant that messages would not be put up based on the priority level of the message. Shank responded that messages would still be able to be prioritized according to the levels desired by Mn/DOT and Patrol staff. In addition to the disadvantages of Concept #2, this concept makes availability of signs for routine use by IRIS more difficult.

Concept #4 – Remote Display Request - Shank said the intent of this concept was to “interact and report to IRIS” by a separate utility requesting that IRIS display a specific message, with IRIS determining when messages should be displayed on the DMS in keeping with priorities set by operational staff in IRIS. Adair confirmed with Iteris staff that this concept was viable within the existing IRIS configuration, requiring limited development effort. Shank outlined the advantages of this system by noting that it brings IRIS control into the system but limits IRIS involvement. He said that it would require some development by contract staff to implement and the advantage there would be that they would be responsive to the project deployment schedule and project timeline for operational development and support functions. Shank explained that under Concept #4 messages would go through IRIS and would be available within the IRIS system, but that another group would have to do the software development work required to make this system operate as designed. He said that there were
ways in which to obtain AVL data and that this could be done in the near-term (before November 2011) and done in time to do system testing before system turn on. Steve Garbe of Iteris provided one example of how this was currently being done within the Twin Cities area was the Transit Customer Information System (TCIS) project undertaken by Metro Transit as part of the I-35W UPA Transit Technologies program in 2009. Garbe said there would need to be a discussion among the group about how to procure an independent system and the timing required to get under contract and this might be easier if a vendor was already working for Mn/DOT as part of another work order or project. Shank agreed, saying the time to get the independent consultant underway on the development of the system is a big issue.

**Concept #5- Connected Vehicle** – Shank said that Dedicated Short-Range Communication (DSRC) capabilities in this concept are used to get information to the roadside and that AVL data that was within range of the DSRC would work. He said there was a security advantage to this concept that was “fairly significant” and that a trust relationship already exists in the DSRC system. Shank said there is a large amount of interest and research being done in this area and a fairly broad offering of devices is available. Shank said the biggest disadvantage to this concept is that the timing is “not the greatest” for working on Connected Vehicle system because they are just now getting underway from a design standpoint and his personal opinion on whether or not this concept could be implemented in time based on the project schedule seems “remote”. Koll said that he personally would say “zero chance, even for next year”.

Koll said that Ameritrak and their geofencing system could work in a number of these concepts and that limits IRIS modifications. He asked if the group would consider this option. Shank asked Koll to describe the term “geofencing” for the group. Koll responded that it was to “put a fence around a sign, and to draw the boundaries however a person might want in order to get system activation, which would then put up or take down a sign, either making it go to a lower priority or go blank”. Shank asked Koll if geo-fencing could determine which direction the vehicle was heading. Koll said “it certainly can” and stated that Ameritrak could come demonstrate and discuss how it works. Koll stated that there was not a “whole lot extra in this concept then what is being done now”. Shank asked if Maintenance could write a work order to expand the scope of what Ameritrak was currently doing to include these features. Garbe said that a third party vendor could be contracted from the AVL or from the work zone vendors. The work zone vendors already have AVL/DMS interfaces built in to their systems that could show all plows and place them by speed and direction and there are a couple that are local that could go through and demonstrate these capabilities. Koll said it might come down to price. Garbe added that it also depended upon timing and type of contract, which would be key considerations. Koll stated that Maintenance in District 3 “had a lot on its plate already but could consider putting it in place to support other upcoming things and he wasn’t shutting the door on other possibilities”. Dumont asked if any funding beyond this contract had been identified for activities like this. Jackels said that there is some other funding available and that it appeared as if Concept #4 is the best option for consideration.
based on the group’s discussion to this point in the meeting. Toughill also said that “Concept #1 would be the ultimate system if the IRIS people can get it done but if it only requires a $10,000 fix then it would be a no-brainer” in the short term.

(At this point in the meeting group members took a 5 minute break).

When the meeting resume Koll said that he had contacted Ameritrak during the break and that they said they could do what had been discussed in this meeting over a two week period and at in the range of $10,000. McClellan of Meridian said that they could also do a similar concept through the MDSS system as it already has an interface with the AVL data. Discussion occurred about scheduling a time to bring in Ameritrak and Meridian and any other potential vendor to discuss possibilities of the system, sub-system requirements and deployment schedule. The group agreed to have vendors come for a information-gathering process meeting on Monday, May 2, 2011 at 12:30-3pm at District 3 Headquarters in St. Cloud. Raduenz said she would make contact with Ameritrak, Meridian and VerMac/JAMLogic to discuss the meeting format and the necessary time frame.

3. High Level Functional Requirements
Shank reviewed a list of high level functional requirements for the system that were included as part of the meeting handout. He indicated that once the system concept design was confirmed a more specific list of functional requirements would be developed for the group to review. For the most part there was little discussion about the list Shank presented to the group, with the exception of the following requirements (as labeled in the handout):

- **Requirement #5** – (“The WZARD system shall initiate display timed to cause the sign message to become visible a configurable time prior to the vehicle passing the sign”). Shank asked the group if they still believed that 15 seconds was realistic. The group agreed that 15 seconds worked based on sign and sight distance to the sign by the average driver along the corridor.
- **Requirement #12** – (“Operators connected to the IRIS software will be able to post messages on the DMS that can be overwritten by WZARD messages”). The group asked that this requirement be amended to include the terms “high priority” and “low priority”.
- **Requirement #15** – (“DMS display of messages upon equipped-vehicle passage shall be able to be enabled remotely for each DMS designated as part of the WZARD system”). Someone asked if this referred to the new signs only to be installed along I-94 on the eastbound lane. A brief discussion about when all signs would be moved onto the fiber network ensued. Toughill said he would double-check on when older signs would be moved to westbound side and on the fiber network. He said that the conduit was already in place in the field and the fiber would just be blown through for the upcoming installation. Koll asked when testing could occur after the fiber installation and whether or not it made sense to test in certain areas or all at once, as it
was coming in from the RTMC and the system might have to wait until everything was in place. Jackels said that testing could pretty much occur as scheduled for the project and that some testing on how the system feeds into IRIS can be done independently. Shank confirmed this by saying the sign in the front room at the RTMC could be tested to see how it lit up to determine if it worked correctly.

- **Requirement #14** – (“The WIZARD system shall log all sign message display activations and terminations”). Toughill asked if this meant that the system will keep track of which truck placed a message request. Shank responded yes, but also stated that if the system were to be implemented in two different places he wasn’t exactly sure yet how the feature would function and archive the information.

- **Requirement #17** – (“The WIZARD system shall reject attempts by vehicles without properly-functioning equipment and authorization to display WIZARD messages”). Shank asked the group if something “more dramatic” should be added for security purposes besides just logging the attempt. He asked them if they wanted an alert to be sent. Toughill said if there was some way they could be sure the AVL was working that would be helpful. Shank said the system would be able to identify whether people have proper authorization to access the system and would log this information as well. Toughill asked Shank what would be the authorization required from an operator level. Shank responded that accounts would be set up for people who need to get into the system. Toughill asked Shank if the current Mn/DOT security authentication credentials could be used (i.e., same passwords, etc.) for specific individuals. Shank said he would look into this but that the override piece of the system would come from the IRIS folks.

4. **Next Steps/Next Meeting Date**

a. **Next Steps**—Iteris team members continue to refine the Draft Concept of Operations and have asked for all comments to be provided to them by Friday, April 22, 2011. The Final Concept of Operations will be submitted to the committee once all comments have been received. Iteris staff has provided high-level draft system requirements at the April 13, 2011 meeting and will finalize system requirements by the middle of May 2011 in accordance with the project schedule.

b. **Next Project Meeting** – The next meeting of the SCorE WZRD project is scheduled for **Monday, May 2, 2011 from 12:30 to 3 pm at District 3B Headquarters in St. Cloud.** This meeting will be primarily dedicated to talking with vendors about potential system software modifications. The next regularly-scheduled progress meeting for the SCorE WZRD project will be held on **Tuesday, May 24, 2011 from 12:30 to 3 pm at District 3B Headquarters in St. Cloud.** Meeting materials will be sent to all project committee members in advance of this meeting.
Draft Concept of Operations
SCorE WZARD Phase 2

SCorE WZARD System
Operational Needs
SCorE WIZARD System
Operational Needs

- The system must reliably display messages indicating the presence of snowplows actively being used for winter maintenance.
- The system must verify the location and identity of snowplows prior to activating messages.
- System must be able to operate in an automated manner to warn of snowplows in the corridor.
- The system must have reliable reporting of the messages currently displayed on each DMS.
SCorE WIZARD System
Operational Needs (continued)

- The system must record snow plow location and DMS message display for reporting and analysis.
- The system must have override capabilities for higher priority messages.
- The system must include message removal if the snow plow leaves the corridor.
- Message hierarchy and priority must be defined and referenced for this system.
- System must provide for verification of DMS display by snow plow driver.
Desirable Features:

- System should accommodate snow plow that is used in the morning to combat snow and ice and is then used in the afternoon for guardrail repair.
- System design should include options for construction and maintenance work in the corridor – unplanned work, or operators that are moving in and out of traveling lane.
- System should show location of snow plow and have message-specific appropriate icons on a map for dispatch.
Innovation for better mobility

Draft Concept of Operations
SCorE WZARD Phase 2

SCorE WZARD System
Design Concept Alternatives
Design Concept 1
IRIS Control Using AVL Data

Innovation for better mobility
Design Concept 1
IRIS Control Using AVL Data (cont.)

Advantages
- Display controllable by location or time since passage
- Uses existing components
- Integration with other DMS usage
- Information security provided by existing AVL

Disadvantages
IRIS software updates/enhancements would be required:
- Collection of real-time AVL data necessary
- Determination of when to activate/de-activate sign
- Enhanced monitoring of sign display capability
Design Concept 2
Contact Closure Display-IRIS Reporting

IRIS Reporting

Bluetooth Reader
Vehicle Detection

Bluetooth Signal

Corridor Vehicle

DMS Controller
Display Verification

Mn/DOT Fiber Network

SNOw PLOW AHEAD USE CAUTION

Corridor DMS

Display Verification and Client/Server Data

WAN

IRIS at RTMC

Client/Server Data

IRIS W/S at St. Cloud
Design Concept 2

Contact Closure Display-IRIS Reporting (cont.)

**Advantages**

- Less software-intensive development needed  
  (limited to enhanced monitoring of sign display)

**Disadvantages**

- More limited control of sign display
- Requires additional hardware installation (to initiate snow plow contact closures for sign display)
- Manual process needed to ensure proper contact closure system configuration
Design Concept 3
Contact Closure Display - Remote Reporting

Remote Reporting

Bluetooth Reader
DMS Controller
Vehicle Detection
Display Verification

Corridor Vehicle
AVL/MDSS Data
Cell Service
Internet

Corridor DMS

Web Browser at District 3
Display Verification

DMS Web Service
Display Verification

IRIS at RTMC
IRIS W/S at St. Cloud

Mn/DOT Fiber Network

Innovation for better mobility
Design Concept 3
Contact Closure Display - Remote Reporting (cont.)

Advantages

- Implementable independent of IRIS modifications

Disadvantages

- More limited control of sign display
- Requires additional hardware installation (to initiate snow plow contact closures for sign display)
- Manual process needed to ensure proper contact closure system configuration
- Requires limited software development from outside vendor
Design Alternative 4
Remote Display Request

Remote Reporting

Corridor DMS

DMS Controller

Display Commands and Display Verification

Display Commands, Client Server Data and Display Verification

Display Request and Display Verification

Mn/DOT Fiber Network

IRIS at RTMC

IRIS W/S at St. Cloud

AVL Application Database

AVL/MDSS Data

AVL/MDSS Data

AVL/MDSS Data

AVL/MDSS Data

AVL/MDSS Data

AVL/MDSS Data

AVL/MDSS Data

Client Server Data

Corridor Vehicle

Cell Service

Web Browser at District 3

DMS Web Service

Internet

Innovation for better mobility
Design Concept 4
Remote Display Request (cont.)

Advantages

- Operational flexibility similar to Concept 1
- Limited IRIS development effort due to established concepts using existing or easily-established pathways
- Ability to modify remote services quickly
- Ability to monitor operation remote from IRIS workstation

Disadvantages

- Development required by independent group
Design Concept 5
Connected Vehicle

Innovation for better mobility
Design Concept 5
Connected Vehicle (continued)

Advantages

- Security advantages (inhibits ability of malicious users to control sign displays)
- Ability to leverage existing and future Connected Vehicle research and deployment activities
- Potential to offer broad array of economical hardware/data services in future (with supported standards)

Disadvantages

- Timing may be difficult to allow for WZARD system deployment by November 2011
SCorE WZARD System
High-Level Functional Requirements
SCorE WZARD System
High-Level Functional Requirements

1. The WZARD system shall operate in a corridor along I-94 from Rogers to St. Cloud.

2. The WZARD system shall initiate display of predetermined messages on select DMS in the corridor without operator intervention to indicate the presence of slow-moving vehicles along the corridor.

3. Display of WZARD messages shall be activated based on location of designated, properly-equipped vehicles with equipment operating properly.

4. Identification of equipped vehicles with authorization to initiate display of WZARD messages shall be configurable within the WZARD system.

5. The WZARD system shall initiate display timed to cause the sign message to become visible a configurable time prior to the vehicle passing the sign (suggested time 15 seconds).
6. The WZARD system shall be configurable to cause termination of the WZARD message based on either time or distance since the vehicle passed the corresponding DMS. (Note: This requirement along with the following requirement mandates to use of regional position determination, e.g. GPS/AVL).

7. The WZARD system shall be able to terminate display of the WZARD message once the vehicle is a configurable time beyond the sign. The WZARD system shall be able to terminate display of the WZARD message once the vehicle is a configurable distance beyond the sign. (Note: This requirement along with the preceding requirement mandates to use of regional position determination, e.g. GPS/AVL).

8. The DMS used by the WZARD system will report activation of messages by the WZARD system to the IRIS software operating at the Twin Cities RTMC.

9. The DMS used by the WZARD system will report displayed messages to the IRIS software operating at the Twin Cities RTMC.
10. Operators connected to the IRIS software will be able to modify the displayed message.

11. Operators connected to the IRIS software will be able to terminate display of WZARD messages.

12. Operators connected to the IRIS software will be able to post messages on the DMS that can be overwritten by WZARD messages.

13. Operators connected to the IRIS software will be able to post messages on the DMS that are not overwritten by WZARD messages.

14. The WZARD system shall log all sign message display activations and terminations.

15. DMS display of messages upon equipped vehicle passage shall be able to be enabled remotely for each DMS designated as part of the WZARD system.
16. DMS display of messages upon equipped vehicle passage shall be able to be disabled remotely for each DMS designated as part of the WZARD system.

17. The WZARD system shall reject attempts by vehicles without properly functioning equipment and authorization to display WZARD messages.

18. The WZARD system shall log attempts by vehicles without properly functioning equipment and authorization to display WZARD messages.

19. Configuration of all components of the WZARD system shall require verification of proper authorization.

20. Attempts to configure components of the WZARD system without verification of proper authorization shall be logged.
## April 11, 2011 Project Meeting – St. Cloud

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### Additional Contacts

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A project meeting was held on Tuesday, May 24, 2011 from 12:30 p.m. to 3 p.m. at District 3B Headquarters in St. Cloud. A list of meeting attendees is attached to the meeting minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **Draft System Requirements Discussion**

Dwight Shank began the meeting by introducing the project’s Draft System Requirements. The environmental requirements are as follows:

- Corridor runs along I-94 from Rogers to St. Cloud
- The WZRD system will operate on a combination of servers hosted by Mn/DOT at RTMC and/or a server through the public internet
- Control of DMS will be provided by IRIS
- Operation control will be performed at District 3 Dispatch in St. Cloud
- Performance will be monitored by the Regional Transportation Management Center (RTMC)

Steve Toughill said if the system was on the IRIS server that any Mn/DOT employee would be able to change messages on the signs. Shank explained that the operational control will be held by District 3, but if needed RTMC would be able to post messages.

Shank then explained the Functional Requirements. Some of the key issues that were discussed included the following:

- **Functional Requirement**: Display of WZARD messages shall be activated based on location, speed and direction by designated, properly-equipped vehicles with equipment operating properly.
  - Shank explained there is a speed range upon which the sign will become activated-- 45 mph at the high end and 10 mph on the low end. Garbe and Reznicek said that there may be a need to change the speeds. Shank said this is a database value that can be adjusted.
  - Reznicek asked how the “traveled way” was defined. Shank explained that there is a “cone of direction” which determines the direction of the vehicle. If the vehicle is not in this “cone of direction”, the sign will not be activated.
  - Reznicek asked “If there is plowing and conditions are bad, does it affect the AVL/GPS system” (interrupting the signal). McClellan stated that he did not believe there will have a problem with signal interruption by explaining that the only instance may be if a thick canopy of snow is flying over the plow and a connection might be lost. Dumont asked if the system misses one or two readings, does the sign go blank? Shank
explained that the system would not light the sign if it was not reliability located and that this was addressed in the upcoming set of requirements yet to be reviewed.

- **Functional Requirement: WIZARD system shall terminate based on time/distance.**
  - Shank explained that the time issue is remaining a functional requirement in the event that stakeholders choose to keep messages “fresh”. Toughill asked if there is a requirement to report what turns the system off (i.e. loss of communications, outside of geo fence, etc.). Shank and McClellan agreed that this reporting function should be added to the requirements. (ACTION ITEM)

- Shank explained possible message content for two-line CMS with two phases. Jackels said it was important to give the driver an action to do, and that this is a policy issue that will need to be discussed among Mn/DOT staff. Jackels questioned whether the system should show the speed of the plow ahead. Shank explained that this could be done with little change to the Concept of Operations. Toughill said that signs could be misread by the driver as an advisory speed, which could cause other problems. The general consensus was that the phrase “DRIVE WITH CAUTION” should be replaced and that further discussion should be held with Mn/DOT staff as to how this message might be worded. Examples of possible messages included Phase 1: “CAUTION SNOW PLOW AHEAD”, Phase 2: “REDUCE SPEED”. Shank said that he liked “PREPARE TO SLOW” rather than “REDUCE SPEED”. Jackels requested that this issue should be brought up to Mn/DOT’s sign committee for input. He also suggested that the group may want to use other messages as a test during the evaluation portion of the project. Shank said that the project will need a measure of performance and a measure of effectiveness for evaluation.

- The discussion moved to three line CMS with a single phase message. Typically, there is only one phase on three line signs. Dumont and Jackels agreed to take the discussion to the TEO Committee, RTMC and the CMS Manual of Practice Committee for input and review to determine what WIZARD messages should display.

After the discussion on Functional Requirements, Dumont asked about each sign’s message library. Shank explained that only two messages will be in the sign library, one for snow operations and one for other maintenance operations. Shank stated that depending on the design of the system, which is in progress, a message could be entered as a number in the message library or developed as a text string which would then be pushed through the IRIS system.

Performance Requirements were discussed and some key findings included:

- **Performance Requirement: DMS will be updated on vehicle’s position within two minutes or less. Preferred time should be around 15 to 30 seconds.**
  - The current AVL system has a two (2) minute polling rate. Shank explained that the project team is hopeful that it can get the polling rate down to 15 seconds. McClellan explained that Meridian has had discussions with AmeriTrak on the use of obtaining
data through a “socket”, which would improve the latency time. Jackels believes that two minutes is too long of time for the latency of the system. He asked that the requirement be changed to 15 to 30 second polling time period. (ACTION ITEM)

- **Performance Requirement**: WZARD message will be terminated if there is a loss of communication, minimum period of five (5) minutes has been proposed.
  - Reznick believes that five (5) minutes is a reasonable place to start and that it can be altered if needed.
- **Performance Requirement**: WZARD messages shall be displayed 95% of the time that the maintenance vehicle would mandate display.
  - Jackels commented that if the message is overridden it will not be counted as a failure.

Due to time constraints, the group decided that the Administrative Requirements section should have an in-depth review by stakeholders for full implementation of the project at a suitable time in the future but not for the pilot implementation by November 2011. It is important that this set of requirements be reviewed and carried forward for future consideration. Comments on this section can be sent to the Iteris team by June 15, 2011. (ACTION ITEM)

2. **AVL/Message Generation Capability Demonstration**

Meridian set up a demonstration of a geofence system for the group as a means of demonstrating how such a system could be easily configured in a short amount of time. McClellan explained that four zones were created for the north and southbound directions of Highway 10 from north and west of CSAH 15 in St. Cloud as part of the demonstration. A “fake” sign was created on a web interface to display information that was received by a Mn/DOT District 3 maintenance vehicle equipped with the AmeriTrak AVL system. As the truck entered the geofence zone which was created by Meridian, a message was displayed on the interface that shows information received from the truck. This information is similar to data that will be brought brought into IRIS, according to McClellan. The two minute delay (latency) was present in this demonstration. The display on the interface included the geofence segment name, whether the vehicle was in or out of the geofenced area, the date/time of the AmeriTrak system update, the date/time of the event, and the latitude/longitude, bearing and speed of the maintenance vehicle while in the geofenced area. The demonstration proved to be successful. According to Shank and McClellan, the demonstration was a good example of the effects of latency on the system.

Kiley asked if the logic of the system could include a determination of whether the spreader has recently operated vs. being in operation at the present time. Meridian agreed to look at incorporating this concept into the system’s logic. (ACTION ITEM)
3. Recap/Discussion from May 2 Vendor Demonstrations

The two vendors that attended the May 2, 2011 meeting were VerMac and Meridian Environmental who talked about possible solutions for the project. Raduenz said that the demonstration proved that a successful demonstration of a geofence system could be quickly designed and that after the previous meeting she had asked Meridian to create the system so that the group could understand how it might work. Both VerMac and Meridian can provide solutions for the system, as could AmeriTrak, which chose not to attend the May 2 demonstration because of a heavy workload. AmeriTrak and Meridian currently work together to provide MDSS systems for Mn/DOT and other states, and there is familiarity between the companies on how to bring this information together for a display on the I-94 corridor DMS. Jackels said that the current project scope ends with the design of the system and that another effort will be required to actually deploy the system and evaluate it. He is working on determining how best to accomplish this and has not yet made any final decisions. The potential of a state shut-down will change the project schedule for deployment and create a number of issues, and this will have to be weighed along with any other procurement issues that are occurring as a result of the SCoRE projects that are not part of this project’s scope (i.e., DMS procurement, fiber optic placement).

4. Next Steps/Next Meeting Date

a. Next Steps – Due to the conclusion of the state legislative session without a budget resolution, Raduenz said that the Iteris team was pushing forward in the next four weeks to design the system and do as much work as possible prior to a potential state shutdown, which would affect the project’s schedule and possible deployment. Jackels said that the installation of fiber along the corridor may be delayed, which could push back the implementation of this system even further. Dumont said that the DMS equipment installation could be pushed back to January 2012 based on what he had been hearing as of late. Iteris will do more research on the three proposed systems and create a comparative report of the three alternatives and provide to Mn/DOT before the next project meeting. (ACTION ITEM)

b. Next Project Meeting – The next meeting of the SCoRE WZARD project is scheduled for Thursday, June 16, 2011 from 12:30 to 3 p.m. at District 3B Headquarters in St. Cloud. Meeting materials will be sent to all project committee members in advance of the meeting.
## SCoRE WZARD Meeting Attendees – May 24, 2011 Project Meeting

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A project meeting was held on Thursday, June 16, 2011 from 12:30 p.m. to 3 p.m. at District 3B Headquarters in St. Cloud. A list of meeting attendees is attached to the meeting minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **Project Risk Management**
   Jon Jackels said that there should be discussion on how to mitigate the risks with this project given the potential for a state shutdown as of July 1, 2011. The following risks were identified and discussed by stakeholders at the meeting:

   a. **State Shutdown implications**
      The first risk identified is the likelihood of a state shutdown. Jackels stated that the likelihood of this happening was very high and that there is not a lot the team will be able to do to mitigate/minimize this risk. Raduenz said that the Iteris team had received a letter from the state notifying them of the shutdown.

   b. **I-94 Fiber**
      The next risk mentioned is the delivery of fiber for installation along I-94. The delivery of fiber is three or four months out at this point and the precon will not be done at this point until after July 1. The contract was just awarded, which means the contractor will not order it until after the precon, most likely September 2011 at the earliest for a possible delivery date.

      The team agreed that fiber installation is a bigger risk than the delivery of the 94 CMS at this time, since they have already been ordered and are being manufactured now. Shank described a risk mitigation strategy that could utilize temporary wireless communications at each sign. He said that a wireless provider such as Verizon or Sprint could be used at each location, with a per site installation cost of about $1000 ($700 for the Digi or other communications device +$300 for installation) and a monthly fee of approximately $30-40 per device for 3G service. The team agreed that there are benefits to putting in a temporary solution to test how the public reacts to the system and to conduct the pilot demonstration to determine whether the system works as expected. No formal agreement on this topic was reached. Jackels stressed the significance of documenting all possible concepts and the pros and cons of each system because of the unknown system design deployment at this time. Jon stated that the temporary alternative that could be chosen for this project may not be the best solution for future implementation of the system.
c. **CMS delivery**

   Jackels stated that the CMS have been ordered by MnDOT but have not yet been delivered. He said he had spoken with Ralph Adair and that everything related to the procurement of the CMS seems to be on schedule at this point.

d. **MDSS Contract Issues**

   Jackels also said that any contractual issue with the MDSS integration of the planned system design could push the project schedule back further and could possibly be a cost risk.

e. **Other**

   Jackels said that there are a couple things that haven’t yet been purchased for state supplies on the total SCoRE project but he believes funds could be moved between fiscal years without too large of an issue. He said he would check on the status of purchasing supplies and equipment.

2. **System Design Alternatives**

   Shank led the conversation on design alternatives. He stated that the project is at a 90% design level at this time and that further discussions would not change the design alternative that takes best advantage of the maintenance fleet’s AVL system.

   The first alternative discussed was the *Working Design*. Shank identified this alternative as the best path to finish and deploy the WZARD project before Winter 2011. This solution has AVL data from the maintenance vehicles in District 3 sent to MDSS servers at Meridian Environmental Technologies. The key strengths to this concept include little to no monthly costs and system implementation that could meet the current project schedule. Shank said that the display could use a Google Maps application that would provide the location of the signs and show the message each sign displays. The weakness of this alternative, according to Shank, is that in order to override a message the user or operator has to get into IRIS to access the system.

   The second alternative is referred to as the IRIS *Integration Alternative*. Shank said that the Iteris team has been in contact with Berkeley Transportation Systems, a company that could develop appropriate code for IRIS on this project. According to Shank, the biggest advantage of a system like the Integration Alternative system is that everything is done through IRIS. The risk is that this alternative can’t be developed within the current project schedule or cost. Shank said that the existing contract with Iteris does not cover the possible work that would be required under this option.
The last alternative still active was referred to as the Controller Integration Alternative. Shank said that this alternative is similar to the options provided by Ver-Mac in the vendor demonstration earlier this Spring. This system uses cell service to provide the data link to the system, which could also be used for all alternatives if fiber installation is delayed. A few of the system’s weaknesses include monthly costs for cell service provision and allowing a third-party to control the DMS system. Koll mentioned that this solution seems unrealistic in that another communication path is being introduced into the system, and that the system would not be fully utilizing the planned fiber network along I-94.

Jackels said that the IRIS Integration Alternative would be the ideal solution if the team knew for sure that this system would reduce incidents or if the project schedule was not so aggressive. After additional group discussion, it was agreed that the first alternative should be further developed. Gilson and Toughill mentioned that three computers in the dispatch center at the D3 offices are available and can be used to host the WZARD displays.

Shank offered a simple cost/benefit analysis of the three alternatives:
- Working Design – Mid-development cost, lowest monthly cost
- IRIS Integration Alternative – Highest development cost, lowest monthly cost
- Controller Integration Alternative – Lowest development cost, highest monthly cost

Koll expressed a concern regarding web browser security. Shank responded and offered two options to address the security concern:
- Open access to the public through a web browser
- Access through a web portal utilizing an existing MnDOT username/password

The team agreed strongly that access to this information should be accessed via a web portal. Shank said he would adjust the system design concept drawing based on the group’s preference and would also add this as a system requirement.

3. Revised System Requirements
Koll said that snow plow strobe lights should be in operation in order to activate the WZARD system and that this should be added to Requirement #21. Shank responded that he was not sure if this action would be of much more benefit based on the group’s discussion of how maintenance and snow plow drivers would utilize the WZARD system. The group discussed this item for several minutes and pondered the pros and cons of linking the snow plow strobe light operations to WZARD system activation. No resolution resulted from this discussion. It was agreed that this item would be discussed at a future meeting.
Koll asked how dispatchers will be notified of message display when the WZARD message is removed within one minute per system requirements. With the hectic pace and duties required during the winter season, dispatchers may not be checking the WZARD browser as often as preferred by system designers due to the time they must spend on higher priority events. Discussion was held on how to make it simpler and easier for dispatchers to periodically check the WZARD browser. Some ideas generated from the group’s discussion included the use of a color-coded message or integrating the WZARD system with the CAD system.

Shank reviewed the logic requirements necessary to display system messages and provided a logic tree handout to meeting attendees. The following examples were used to determine whether the need to post a WZARD message existed:

- Blowing/falling snow – AVL via driver input/RWIS/MDSS
- Road Temperature – AVL
- Speed, Direction, Position, Flashers – AVL
- Duration timing – Server

Koll and Kiley discussed the use of driver inputs to report blowing snow conditions. Koll mentioned that it is currently not mandatory for drivers to input road conditions into the AVL touch screen when they are in the cab of the vehicle, but it will likely become mandatory in the future. The group agreed that this would be a reliable way of reporting blowing/falling snow conditions as the driver can differentiate between dry and snowy/icy conditions. The group also agreed that this method is not 100% reliable, as approximately 20% of drivers are now reporting road conditions.

Shank explained what the display/interface of the WZARD system might look like to the dispatch operator. The following information was discussed as it would appear on a SINGLE DISPLAY:

- Snow plow location (dynamic)
- Sign location (static)
- Sign desired message
- Sign reported message
- Corridor overview map

Dumont said that he had recently attended a meeting with Gilson regarding future TOCC consolidation and that a concern had been expressed by those at the meeting that there are too many displays operators have to use at the present time to do their jobs. He said that operators now have 7-8
different displays on their computer which can become overwhelming at certain times. Dumont asked if it would be possible to integrate the WZARD system with CAD. The current CAD system provides dispatch operators with AVL information of state patrol vehicles. Gilson said that it would be ideal if this information could be integrated into the CAD program. Shank said that adding information to an existing program usually comes with a large integration cost. Dumont said that this may be something that needs to be discussed when the future integration of the TOCC consolidation is expected to occur in 2013.

Shank reviewed the discussion among group members at the last meeting in May 2011 regarding WZARD Message content. After reviewing a variety of message possibilities for the WZARD project and not sensing the group’s agreement to any of the potential messages that could be posted, Raduenz suggested that Iteris contact the MnDOT Market Research group and use their services to poll MnDOT’s online community about preferred message content for the WZARD project area. The group agreed to this idea and Raduenz said she would contact Karla Rains and/or her staff to discuss the issue.

The group’s final discussion was about the logic diagram presented by Shank. Some discussion occurred regarding the use of “spreader operations” as a means to identify weather conditions in the field. Kiley suggested that perhaps drivers could be asked a question about what they were planning to do in the field when signing into the system in the vehicle’s cab. He said they could push a button on the screen to select a choice of the activity that they were going to be doing while in the vehicle—“plowing snow” or “maintenance activities”. He felt that this might provide a good way to determine whether or not messages should be posted to DMS on the 94 corridor.

4. Next Steps/Next Meeting Date

a. Next Steps –
Due to the impending government shutdown, there was uncertainty about when the next project meeting should be held. The group has tentatively reserved Wednesday, July 20, 2011 from 12:30 to 3:00 pm for its next meeting, but this will be a placeholder only at this time and will not be verified until closer to the actual meeting date, depending upon the outcome of governor/state legislature negotiations on the state shutdown. In the meantime, Iteris and Meridian staff will continue to refine the system design until they are notified that the shutdown has occurred.
b. Next Project Meeting – The next meeting of the SCoRE WZRD Project is scheduled for Wednesday, July 20, 2011 from 12:30 to 3 p.m. at District 3B Headquarters in St. Cloud. Meeting materials will be sent to all project committee members in advance of this meeting.

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A project meeting was held on Wednesday, August 10, 2011 from 12:30 p.m. to 3 p.m. at District 3B Headquarters in St. Cloud. A list of attendees is attached to the meeting minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **Status of Field Infrastructure**
   Jackels explained that everything should be in place for the project to be deployed on schedule with the exception of the installed fiber. He stated that wireless solutions should be used as a temporary solution for sign communications as the plan is to deploy a system by November 2011. Toughill said that all of the signs should be installed by the end of October based on his conversations with SCoRE project managers. Jackels said Terry Haukom, the SCoRE project manager, is looking into wireless solutions (i.e., Sprint, Verizon, etc.) at this time. Toughill said his experience is that Sprint works well along this corridor. He also said that there is some signal interference near Monticello and Albertville due to wireless disturbances. Shank said that he would prefer to use an Internet Service Provider (ISP) because it is the ISP’s responsibility to keep the connection running.

   Jackels mentioned that the communications between IRIS and the signs is the responsibility of MnDOT and is not the responsibility of the SCoRE WZRD project team. He said that communications should be up and running by the end of October to the middle of November 2011. Garbe expressed his concern regarding delay of system testing if there is any delay in the schedule for installation of the signs. Jackels said that the test could still be completed without signs in the field by documentation through IRIS.

   Koll confirmed that all snow plows on the I-94 corridor will be equipped with AVL/GPS. The District 3 snow plows only go as far as St. Michael, not all the way down the project corridor to Rogers.

2. **System Design Document**
   Shank distributed the wireless communications design diagram to the project team. He said that the design is pretty stable at this point and that work is presently being developed for an interface with IRIS. The Draft System Design document was distributed to the group. Shank informed the group that there are gaps remaining within the document that will be filled in as the project progresses, especially in the interface area. Raduenz distributed a CSV format for a message file that the project team has created in order to interface with IRIS. The following information is included in the CSV file:
   - Sign_ID
   - Message
   - Priority
   - Data_Time
3. Geofencing Update

Ostermeier of Meridian discussed the progress made in geofencing along the project corridor boundaries. He said that rectangles/polygons were being created along I-94 as a geofence area/boundary for each sign, including on and off-ramps. He is also creating polygons for testing purposes. Raduenz asked whether on/off ramps and overpasses should be included within geofencing boundaries. Koll said that this may be a discussion that needs to include Mike Kiley and Randy Reznicek, who were not at the meeting. The group began discussing what on and off-ramp issues may result in the field during winter operations. The following scenarios were discussed:

- A snow plow on an on-ramp activating a sign upstream of the overpass.
  - Consensus: Yes, the sign should be activated.
- A snow plow on an off-ramp activating a sign upstream of the overpass.
  - Consensus: Yes, the sign should be activated.
- A snow plow located on top of the overpass.
  - Consensus: No, the sign should not be activated.
- A snow plow using/clearing a corridor crossover.
  - Consensus: This needs to be discussed further with Reznicek and Kiley. Meridian staff said that if the latitude and longitude of each crossover along the corridor were provided to them, a separate crossover polygon could be created with different parameters that would address the issue.

Raduenz asked where the geofence was drawn with respect to the westbound lanes, which are not included in the pilot demonstration. Ostermeier said that he included both westbound lanes of traffic in the geofence but placed a secondary parameter of bearing for each polygon he has drawn along the westbound segment of the project corridor. He explained that by doing this in that matter only vehicles that were traveling in the proper bearing would be able to place a message on the nearby CMS and that the accuracy issue of the AVL/GPS system would no longer be an issue (accuracy is generally within 12 feet or so of a GPS data point and not specific enough to use as a geofence boundary). A snow plow scenario was discussed by the group where the vehicle may spin out on the corridor and end up at a 180 degree bearing from the normal geofence bearing parameter. One way this was addressed in the Concept of Operations was in providing a maximum time limit of 5 minutes before the message would be blanked out or removed from the sign once the vehicle left the geofenced area, according to Shank.
Ostermeier noted that consecutive points within a geofenced area could be used as a check for vehicles that may be a few miles per hour under the speed limit or if an errant bearing reading occurred in the system. He proposed that two consecutive point readings could be used to confirm the sign’s activation status. This method was discussed by the group and there was general agreement that while this method could be used, the system design will proceed with using one point reading to activate the DMS, however the capability of using two consecutive points within a geofenced area will be included in the system design, per Ostermeier.

**User Interface**
McClellan introduced a discussion of the user interface being created for the project. He introduced three “scenarios”.

- **Basic User Interface Map** - This map allows the operator to click on a sign and it gives information on Message Request, Message Posted, Message Request Time, Message Display Time and Message Termination Time. (Easiest for developer to create)

- **Mouse Over User-Interface Map** – The operator places the cursor over a sign and a message on the screen provides the user with information on Message Requested and Message Posted (Medium Difficulty for Developer to create).

- **Actual Message Displayed Show on User Interface** – Shows signs in real time, with the message that is being displayed on the sign face at the time. (Most Difficult for Developer to create).

When asked her preference, Gilson said she liked the mouse over interface map because it would save the operator time. She said she did not like a new screen popping up. Dumont said he originally envisioned that there would be a snow plow moving on the corridor in real-time on the screen which would allow the operator to see when signs are activated. McClellan said that essentially that option was what was being discussed, but because it had to be captured on a screen shot for discussion purposes the handout was not in real time. Gilson said she ultimately preferred Option 3, with a mouse over option for more information.

Koll said that he did not see the need for implementing a new interface for District 3B dispatchers. He said that all of the information that would be needed is already contained within the IRIS or MDSS interfaces, so there would be no use for a new interface. Raduenz asked Gilson what her preference was in this area – to view the current two screens (one in IRIS which would display only sign information) and one in MDSS which would display only truck location information, or one screen which allowed the operator to view both the message/sign and the location of the nearest maintenance vehicle at the same time. After some discussion the group determined that there was no need for a separate user interface to be created that would provide both sign/message and truck location information on it for the WZARD project. Gilson and District 3B staff said that District 3B operators were familiar enough with IRIS capabilities and are in the process of learning how to use the
MDSS interface and thought a third interface, while created specifically for the WZARD project, would be too much work to monitor and review. The group decided that an interface will not be created for the WZARD project. Meridian staff said that they would still need to create an interface for debugging purposes and this would be done anyway, but they will no longer refine the interface for operator use based on the group’s discussion.

A discussion was held among the group about what kind of data would be needed in order to evaluate the system. Iteris staff said the following information was included in the System Requirements document previously developed and distributed among group members and included the following:

Vehicle Data:
Before and After Truck Info for:
- Timestamp
- Location (Lat, Long)
- Speed
- Bearing

Message Info:
- Timestamp for when message was displayed
- Sign ID
- Message Displayed

This information will be continuously stored in the WZARD system and will be available for evaluation and other purposes, according to Shank. Dumont asked if any events were going to be time-stamped in the system. Shank said that a log would be kept in the databases of what messages would be requested and what were displayed but that this information would likely exist in two different databases and would have to be cross-referenced for evaluation purposes. Toughill asked if the system would provide data on when the sign turns in, where the truck is at that point and whether the geofencing system would track latitude and longitude when the sign was activated. Meridian staff replied that the geofencing system would track speed of the vehicle, latitude and longitude, and it would be time-stamped at each reference point. Toughill also asked that the signs that were to be placed in the field for the project be numbered in order to make it easier on maintenance staff to identify the signs. Gilson suggested that the easiest way for operators to identify signs in the field was to number them based on the nearest milepost to which they were located. Raduenz said that would be something to bring up to the contractor installing the signs, as that was not the responsibility of the WZARD team. Toughill said that District 3B maintenance staff could number the signs themselves.
4. **Next Steps/Next Meeting Date**
   
a. **Next Steps** – Raduenz asked what the next steps should be at this point in the project and when the next meeting should be held. She also mentioned that Mike Kiley had sent her a note indicating that District 3B has 5 NTCIP compliant portable message boards available for testing purposes and the group discussed what would be required items for an end-to-end test of the system: An NTCIP-compliant sign or a suitable, configurable sign controller, an internet connection and AVL/GPS equipped truck. Shank and Garbe said their preference would be to conduct an end-to-end test by the end of September 2011 in order to give the project team enough time for a November deployment. Meridian staff said that they would work toward the goal of getting their components ready for a mid-September system test. The group identified Wednesday, Sept 14, 2011 as a good date to hold the end-to-end system test. Steve Toughill agreed to pre-test the NTCIP-compatible TIGER PCMS board that is stored at District 3B to ensure it is able to activate via IRIS and that it will be ready to use for the September 14th end-to-end test. Jackels said he would talk with Terry Haukom, the SCoRE Project Manager, to make sure he and Ralph Adair were available to come to the next meeting if possible.

b. **Next Project Meeting** – The next meeting of the SCoRE WZRD Project is scheduled for **Wednesday, September 14, 2011 from 11:00 a.m. to 2 p.m. at District 3B Headquarters in St. Cloud**. The objective of this meeting will be to conduct an end-to-end WZARD system test. Meeting materials will be sent to all project committee members about one week in advance of this meeting.

**Action Items:**
- Jackels to contact Haukom and Adair and invite them to next meeting for end-to-end test
- Jackels to contact Haukom and request use of a LedStar sign controller for end-to-end test
- Meridian staff to complete message string development for IRIS exchange
- Iteris staff to provide latitude/longitude information for I-94 crossovers in project corridor
- Meridian staff to complete geofencing development and include crossover information and on/off ramp information as discussed at 8/10/11 meeting
### MnDOT SCoRE WZRD Meeting Attendees

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A project meeting was held on Wednesday, September 14, 2011 from 11:00 a.m. to 2:00 p.m. at District 3B Headquarters in St. Cloud. A list of meeting attendees is attached to the meeting minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **Status of Field Infrastructure**
   Jon Jackels restated that fiber will not be in the ground this winter. Steve Toughill said that the electrical contractor is not expected to get the signs until the first week of November and the installation should be complete by the middle of November. It is expected that all the conduit and sign structures should be installed prior to the delivery of the signs. Jon Jackels confirmed that a temporary wireless solution will be used in place of the fiber communications.

   Toughill mentioned that there is not 4G coverage past Rogers, MN so the project will need to utilize 3G or 3G/4G wireless devices for communications. Jakin Koll noted that MnDOT has a contract with Verizon already in place and that the cost of their 3G services is $26 per month. Jakin also noted that MnDOT needs to decide if this cost is something that should be taken advantage of and act quickly to get it so that it can be grandfathered into Verizon’s unlimited data package at that rate.

   Arnie Michalicek noted that if Sprint is used for 3G/4G service, that there is a dead spot that interrupts communication near Monticello. However, he said, EVDO does work in that area. Toughill and Michalicek mentioned that an external antenna would be needed so that the EVDO could get a signal. Also, testing will need to be done to ensure that the EVDO and 3G service is not affected by the new electrical transmission lines along I-94.

2. **Project Schedule/Optional Tasks**
   Raduenz brought up a few key points regarding the project scope and schedule, including the need for a contract extension as the original contract is scheduled to end on September 30, 2011. Jon Jackels confirmed that the contract will need to be extended and suggested that he and Raduenz discuss this issue and other contractual issues, including tasks that were originally out of project scope, in the next week.

   **Message Content**
   Raduenz discussed her conversation with the market research consultants that work with MnDOT’s Online Community and Karla Rains/Lyn Isaacson. She met with them by phone on the previous day and talked about potential messages that may be posted on CMS for the SCoRE WZARD deployment. These potential messages had been previously discussed in WZARD committee meetings with the group but no resolution on which exact messages should be displayed was ever reached. Iteris staff
sent a request for preferred CMS messages to Tom Dumont, Randy Reznicek, Dan Anderson and Jon Jackels the previous week and each of the four agreed on the following variations:

(Single-phase sign): Either “SNOW PLOW AHEAD” or “MAINTENANCE VEHICLE AHEAD”
(Dual-phase sign): Either “SNOW PLOW AHEAD/USE CAUTION” or “MAINTENANCE VEHICLE AHEAD/USE CAUTION”. These messages will provided in a scenario to the Online community and the results will be broken down by age group. The market research firm will compose the information in a format they believe will solicit informative comments.

Tom Dumont said he believed that traffic may have trouble distinguishing between the terms MAINTENANCE VEHICLE and SNOW PLOW. He believes that the drivers may perceive a MAINTENANCE VEHICLE as a vehicle that is stopped and a SNOW PLOW as a vehicle in motion. Raduenz said she would discuss this idea with Lyn Isaacson and the market research team for the Online Community information. Dumont also said that the term “MAINTENANCE VEHICLE AHEAD” may be too long for the general public to read in a short time. It may be beneficial to shorten it to “MAINT VEHICLE AHEAD” or “MAINT VEH AHEAD” or “WORK VEH AHEAD”.

In general, the group agreed that there is a need to further explore what the best message to display on the CMS for the I-94 project, but agreed that the messages under discussion and which had been provided to the market researchers should not cause any harm and are acceptable for the time being.

Steve Toughill remarked that Wavetronix devices placed along I-94 could be used to determine how traffic reacts to the signs by looking at speed data outputs. The information placed on the signs could be tested and changed during the pilot deployment to study the variances in corridor average speed. Maintenance drivers and other DOT staff could be asked if they are seeing any different motorist behaviors on the corridor during the pilot demonstration as well. Al Kutz of the Minnesota State Patrol said that the shorter the message, the better, as far as the State Patrol was concerned.

3. End-to-End Demonstration
The end-to-end test was considered a success by team members. Shank was satisfied with the results of the tests, saying that all components had been tested individually on Tuesday and in a complete end-to-end test Wednesday. He mentioned that there is some unknown interaction between Meridian and IRIS that is causing additional lag time within the system. Shank asked Ostermeier (Meridian) to discuss this issue with Doug Lau of the RTMC to figure out how lag time can be reduced. Garbe stated that there a lot more variables in the demonstration that we did due to traffic signals and reduced speeds.
Shank said that there are two issues with the message priority:

1. The Meridian feed was not able to override Michalicek’s TEST message in IRIS.
2. Once Michalicek’s TEST message was cleared and the Meridian feed was displayed on the sign, Michalicek was unable to override the message.

Ostermeier will take the lead in contacting Lau to figure out the solution to override CMS messages according to MnDOT/IRIS guidelines and message prioritization requirements and he will request a debugging output from the demonstration held on September 14.

Someone asked if the 15 mph threshold was accurate, given how the sign blanked out during the demonstration. A discussion was held about lowering the threshold or creating a parameter under the threshold that would allow for a lower speed for one minute (4 GPS points). Garbe said that crossovers could be an issue. Dumont said that maintenance vehicle could likely be at zero mph during periods of work on the road.

Jackels asked if AVL provides a history of truck locations that could be compared against an IRIS database output on a side-by-side basis for evaluation purposes. The answer was yes, and Meridian staff also said that the Meridian MDSS log can be accessed via an internet address to get this information. Garbe said that rapidly-changing areas would not be easily seen on I-94 because plowing would happen consistently, thereby triggering the same signs to stay on for “gang” plowing-type events. Shank said the WZARD message would be up for about 5 minutes. Ostermeier said that there were some IRIS issues he noted, particularly in the overwriting area, and that he understood what was going on during the Tuesday demonstration, where the group was unable to overwrite the “TEST” message and Michalicek was not able to overwrite the “WZARD” message. Ostermeier said that IRIS needs to have the ability to overwrite the WZARD message, as it is of lower priority than other RTMC messages. Ostermeier said he has had no discussion with Lau of the RTMC about when this issue will be added into IRIS capabilities.

Toughill asked if there was one geofence that encompassed the entire corridor or if there were separate geofences created for separate directions on the project corridor. Ostermeier responded that a geofence area was created to cover both the northbound and southbound lane directions but also included direction/bearing as a directional requirement. He explained he did this in this way to ensure that one sign could still operate effectively and that 120 degrees was used for directional requirements as directed by the group.
4. Next Steps/Next Meeting Date ***(Please see end of meeting minutes for post-meeting discussion)***

a. **Next Steps** –

Jackels thanked everyone for the work that went into deployment of the test and felt it was a good demonstration of system capabilities. He said he felt confident that the system would work the way it was intended. Shank said that the next step would be to turn on the system and make sure the pathway is reliable. He asked if there was a way in which the sign could be lit and if hours were available within District 3B to observe/log the sign output. Toughill said that all of the new sign controllers to be installed along I-94 are faster than existing signs and if one modem of the type to be installed for the wireless system could be obtained they could test in his office. Discussion arose among the group about how best to obtain system components (controller and modem) for testing purposes. Ostermeier suggested that the process could be kept running and every few days logs could be reviewed to determine what has been reported on the AVL/GPS system. He said the group would just have to choose a location near to where a sign would be placed and then place a temporary sign and device and they could see how often the sign was lit. Jackels said he would talk with RTMC staff and see if they could run the system in the background. Garbe said it would be beneficial to schedule a one day test with plows running and that all geofences should be built by November 1 in order to make it happen. Jackels said that a demonstration could be watched on IRIS in a simulated fashion even if all the signs were not yet installed. The latency issues of drivers seeing signs and at what point could be finalized during the one day test. Toughill suggested moving the test along the corridor by triggering different geofences on different days. Dumont said the latency issue might reoccur when the fiber is linked up next year and that tweaking of the system would need to be done because fiber is quicker. Toughill suggested that when the IRIS interface displays the message on the sign that the sign name, the person who programmed the message and the name “WZARD” should be displayed on the sign, as is done with other test messages. He said during a real message instead of the name of the programmer the truck ID number would be displayed instead, in order to identify which truck was “turning on” the message board. Meridian staff was asked if they could program that information to be automatically stored into a log file for the system. Hershey asked about the scenario of two trucks plowing in tandem along the corridor and how the event would need to be logged. Discussion turned to the question of logging the creator truck only or whether the display should change to log all the trucks that had tripped the sign. Toughill said that only one truck number was needed. Koll said that he would like to know which truck re-triggered the sign. Toughill asked if IRIS could flip the data so that it would display both truck messages, i.e., Truck #152 in initial message and then when Truck #154 came into the field the sign would blink and then trigger the same message for five minutes and turn off when Truck #154 left the area.
Garbe suggested that at least two trucks would be needed for the one day test to look at these types of scenarios. Shank and Garbe said they would create a test simulation sheet with scenarios that would need to be tested, including the passing of two trucks, a truck pulling over in the crossover, a truck idling on an overpass, etc.

**Action Items:**

**Greg Ostermeier/Meridian:**
1. Speak to Doug Lau at MnDOT to discuss problems between IRIS and MET.
   a. The first problem is to identify what is causing the latency problem between IRIS and MET.
   b. The second problem involves message prioritization and message overriding in IRIS.
2. Finalize geofencing and parameters along I-94 corridor by November 1, 2011.
3. For District 3B ongoing test on I-94 corridor, compare AVL/GPS data with IRIS sign activation log to check accuracy*.

**Jon Jackels/MnDOT:**
1. Talk with RTMC and run the SCoRE WZRD system in the IRIS background.

**Iteris:**
1. Schedule a 1-day acceptance test for the first part of December. If signs are not in place, the controllers or IRIS can be used for the simulation.
2. Create test simulation information to document possible scenarios that may happen (i.e. two snow plows plowing in tandem).

**District 3 Personnel:**
1. Monitor and maintain TIGER temporary CMS board (if available) for the ongoing District 3 test along I-94 corridor.

**Ralph Adair/Doug Lau/RTMC:**
1. Work with Meridian staff to fix latency and message prioritization issues noted.
2. Create/adjust IRIS logic to show the truck identification number that activated the sign as the creator of the displayed message.

**b. Next Project Meeting** – The next meeting of the SCoRE WZRD Project is scheduled for **Monday, October 10, 2011 from 1:00 p.m. to 2:00 p.m. via teleconference.** A teleconference will also be held on **Monday, November 14, 2011 from 1:00 p.m. to 2 p.m. at the MnDOT District 3 Headquarters in St. Cloud. Meeting information and materials will be sent to committee**
members about a week ahead of the meeting dates. The December meeting will be scheduled in the next month and held in the field or at the St. Cloud District 3B Offices.

****Post-Meeting Discussion:****

After the meeting adjourned, Steve Toughill and Arnie Michalicek discussed the possibility of utilizing existing CMS on eastbound I-94 for testing of the WZARD system for reliability (more than one day—post-system turn-on). This could be done rather than using the portable CMS message board that was used for the pilot demonstration on 9/14/11. All or some of the existing signage along the corridor could be used along with the geofence concept prior to the installation of new signage sometime during November 2011. Toughill, Michalicek, Dumont, Raduenz, Shank, Garbe, Nieveen, Jackels and Rowe discussed this idea among the group after the official meeting adjourned. No decision was made at that time as to implementing this idea.
## MnDOT SCoRE WZRD Meeting Attendees

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<td>Jon’s New Trainee</td>
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A project meeting was held on Monday, October 10, 2011 from 1:00 p.m. to 2 p.m. via teleconference. A list of meeting attendees is attached to the meeting minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. Recap of September 14 End-to-End Demonstration/Results
In the previous meeting, an end-to-end demonstration was performed by Iteris to test the system. The team agreed that the demonstration was a success. Greg Ostermeier noted that there were some minor problems with the demonstration and explained that these are the result of the cellular connection timing out, which results in a blank sign. Greg talked with IRIS staff who said that this will not be an issue when the system is switched over to fiber optic. He also mentioned that IRIS has a 30 second refresh time, which may result in Meridian having to make minor adjustments to when the sign gets lit in the project corridor (earlier than thought in geofence zone). Jackels said that he was happy with the demo and that the project is reading to move on at this point.

Update on MnDOT Online Community Research-WZARD DMS Messages
Lisa gave a brief overview on some preliminary findings from the MnDOT Online Community Research project on DMS messages for the WZARD system. The research questions will remain on the Online Community website through the end of the current week, after which the market research firm and Karla Rains’ staff will document findings and prepare a report that should be provided by end of October. Preliminary findings after just one week of responses noted the following:

- 206 out of the 600 online community members had responded to the survey. More are expected to respond during the next week.
- Many of the participants said they liked dual phase messages because it catches the attention of the driver and because it provides more specific action-oriented information.
- 75% of the participants like the message “SNOW PLOW AHEAD USE CAUTION”

A final report will be prepared by MnDOT’s Online Community Research department and the results will be discussed between Jon Jackels and Brian Kary of the RTMC to determine the appropriate WZARD message content prior to system deployment.

2. Update on Sign Installation Status/Progress
Jon Jackels reported on the status of the sign installation. He noted that everything appears to be on schedule, with the exception of the fiber. He expects the signs to be installed in mid-November as mentioned in the last meeting.
3. Contract Amendment Status
   a. Amendment #1 Time Extension
   Raduenz said that she and Jackels had discussed a time extension on the project contract. The new contract will be extended to January 31, 2012 pending MnDOT final approval.

   b. Project Tasks-Reordering, Future Activities
   Jackels said that the optional tasks associated with the contract had been discussed among his office and District 3 personnel. Some of the findings of these discussions:
   
   - Task 5 Training: Jackels said that District 3 staff felt that training will not be needed for this project.
   - Task 6 Operation and Maintenance Plan: Jackels said that it is an important task and that the Operation and Maintenance Plan should address the following questions:
     - What is the relationship between MDSS and IRIS?
     - If geofences need to be changed or created, would another contract need to be created? Are there costs associated with this?
     - Are there additional charges to be incurred by MnDOT for the use of this system (geofence system)?
   - Task 7 Evaluation: Jackels said that this task would be needed. Lisa asked Jackels and District 3 staff to start thinking about how they want to proceed with the evaluation process. SEH will be performing most of the evaluation for the WZARD deployment, but discussions from the previous meeting stated that District 3 personnel would also be evaluating the system. Jackels agreed to think about what needs to be evaluated and who will be responsible for it. He said that the MnDOT firewall is a logical place to divide the work between SEH and District 3, meaning that MnDOT staff can gather/compare IRIS data.
   - Acceptance Testing: Jackels believes that this will be included in the contract extension. He said that this can be done using existing signs in the field and/or through the use of the TIGER PCMS board to test priority messaging.
   - Pilot Deployment Enhancement Study with Recommendations: Jon stated that this would be beneficial to MnDOT in order to know what other applications can be included in the WZARD system to increase its value.
   - Post Fiber Deployment: Jon noted that this task will not be needed because all of the infrastructure will be present and the MnDOT integrators will have no problem integrating signage with the WZARD system.
Final Report: Jon stated that this task would need to be discussed further with Raduenz and that they would be meeting the next day to do so.

Jackels, Rowe and Raduenz will be meeting to discuss the details of these tasks and further amendments to the existing Iteris contract on Tuesday, October 11 at a previously-scheduled meeting. The rest of the project team will be updated on results of the discussions either prior to or at the scheduled teleconference meeting on November 14, 2011 at 1:00-2:00 pm.

4. Next Steps/Next Meeting Date

a. Next Steps –
   Jon Jackels, Dan Rowe and Lisa Raduenz will meet to discuss the contract extension on Tuesday, October 11, 2011 at Water’s Edge.

b. Next Project Meeting – The next meeting of the SCoRE WZRD Project is scheduled for Monday, November 14, 2011 from 1 p.m. to 2 p.m. via teleconference. Meeting materials will be sent to all project committee members in advance of this meeting.
### 10/10/11 WZARD Teleconference Meeting Attendees

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<tr>
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A project meeting was held on Monday, November 11, 2011 from 1:00 p.m. to 2 p.m. via teleconference. A list of meeting attendees is attached to the meeting minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **Update on MnDOT Online Community Research-WZARD DMS Messages**
   Raduenz provided an update on the MnDOT Online Community Research that was undertaken as part of the SCoRE WZARD project. The focus of this research was to get a better understanding of how the public will react to the different messages that may be posted on the WZARD DMS signs. Some of the key findings from the market research done on this topic by MnDOT included:
   - Study participants felt that the term “snow plow” should be used on messages as opposed to “maintenance vehicle”. Participants stated that use of the term gave the motorist a better understanding (more literal interpretation) of what was ahead of them on the roadway.
   - Most of the participants preferred that the message “USE CAUTION” be included on the DMS as a second phase of the message. However, they did not feel that adding the word “EXTRA” would help to change the awareness level of the presence of snow plows on the corridor.
   - Most of the participants agreed that a dual phased DMS message would be the most useful, not because it portrayed more information, but because it brought more attention to the sign through the concept of “flashing” that occurs as message phases are initiated.

Jackels said that this study was very useful. He said he would be meeting with Brian Kary of the RTMC and Tom Dumont the D3 Traffic Engineer on what message or messages should be provided to motorists as part of the project. He will also talk with Kary about SCorE message prioritization as it relates regular RTMC message prioritization.

2. **Update on Sign Installation Status/Progress**
   Tom Dumont and Arnie Michalicek noted that all the underground work and the l-beams are in place in the field for the WZARD signs. The signs are expected to arrive at the end of November at this point and will be installed by the contractor and integrated by MnDOT after their arrival.

Dwight Shank inquired about the availability of communication devices (modems) for the new DMS signs. Steve Toughhill said that he had given Jackels pricing information for the modems but had not heard anything back. Jackels said that he will speak to Ralph Adair at the RTMC to get the modems ordered.
3. **Contract Amendment Status**

Jackels gave the team an update on the status of the contract with Iteris. He said that a time extension has been approved for Iteris to continue their work through January 31, 2012. Jon also stated that Iteris and MnDOT are currently working on a second contract amendment that would extend the contract to May 31, 2012 and will include the following tasks:

- Systems Acceptance Testing and Evaluation
- Results Monitoring and Recommendations
- Project Final Report

Jon noted that he has spoken to Dan Anderson at District 3 and they believe that they should be able to find the funding for this amendment. Iteris has provided an estimate to Jackels for project completion through May 31, 2011.

4. **Next Steps/Next Meeting Date**

a. **Next Steps** –

Raduenz identified acceptance testing and a draft evaluation plan as the next issues for moving forward with the SCoRE WZARD project. Jackels asked what people’s thoughts were on the need to test the system before it was deployed. Shank said that he is in favor of testing early and often, especially when it is outside the eyes of the public. Toughill agreed with Shank’s comments. Everyone agreed that the system should be tested on the NTCIP-compliant TIGER board in the District 3 parking lot.

Toughill also noted that in order for a message to be posted to the DMS sign, IRIS must be able to assign a prioritization to the message being posted. Steve asked if this has been discussed with the necessary people in order to allow these messages to be posted. Jackels said that this would be a good topic to discuss with Brian Kary and Tom Dumont in their upcoming meeting. Raduenz noted that according the CMS guidelines in place at MnDOT at the present time, Work Zone Applications are given the second highest priority and would be a logical place for the SCoRE WZARD messages to apply.

Greg Ostermeier asked that if the decision tree needed to be changed as a result of the findings from the MnDOT Online Community research. Dwight said that the decision tree will remain in place, but some of the messages may change. He noted that it would not be good if the signs display “SNOW PLOW” in July when there is no snow on the ground.

Tom Dumont asked how testing would be performed for the accuracy of the geofencing. Jackels stated that the new amendment under consideration involves both 1-day and 30-day
testing that will address this issue. Dumont also asked about displaying messages for maintenance operations held in the summer. He said he thought there were certain operations that would utilize the SCoRE WZARD system to warn motorists of MnDOT vehicles. Shank said that the group had determined earlier that maintenance operations that are planned (i.e., guard rail repair) will be handled through dispatch, whereas maintenance operations that are unplanned (i.e., debris removal) will be handled through the SCoRE WZARD messaging system. The only exception to this is when MnDOT striping vehicles are operational in the corridor, because they are not equipped with AVL and therefore unable to use the WZARD system.

**Action Items:**

**Jon Jackels/MnDOT:**

1. Talk with Brian Kary at RTMC, Tom Dumont and Kathy Gilson about message content and message prioritization. Report these findings to Greg Ostermeier so that he can make the necessary changes to the SCoRE WZARD system module.
2. Check with Ralph Adair on the status of the modems for SCoRE WZRD communications.
3. Finalize the Iteris amendment and time extension contract.

**Iteris:**

2. Create System Acceptance Test documents.

**b. Next Project Meeting** – The next meeting of the SCoRE WZRD Project is scheduled for **Monday, December 12, 2011 from 1:00 p.m. to 2:00 p.m. via teleconference.** A conference call invitation and meeting materials will be sent to meeting attendees prior to the meeting via email.
MnDOT SCoRE WZRD Project – Phase 2
MnDOT Project No. 97532WO1

Project Meeting 11/14/2011

## MnDOT SCoRE WZRD Meeting Attendees

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A project meeting was held on Monday, December 12, 2011 from 1:00 p.m. to 2:00 p.m. via teleconference. A list of meeting attendees is attached to the meeting minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **WZARD Testing Results at St. Cloud TMC/D3 (performed 11/30/11)**

Dwight Shank explained that Iteris, MnDOT and District 3 State Patrol performed testing of the WZARD system on the NTCIP-compliant PCMS last month at the District 3 facility. He noted that the basic operations of the system performed as expected. The system proved to be reliable. The PCMS is still located outside the main door of the District 3B building and the sign board is visible from inside the TMC. Iteris hopes that the sign will remain in place as long as possible for continued remote testing/posting of test messages prior to installation of field components, including CMS, expected sometime in January.

2. **WZARD Message Content/Message Priority in IRIS**

During the system testing done on November 30, 2011 at the St. Cloud TMC, it was determined that the St. Cloud TMC staff were not able to post scheduled messages in IRIS. In a separate meeting among Brian Kary, Jon Jackels and Dan Rowe regarding the priority classification for WZARD messages, it was determined that WZARD messages would be considered “low priority” incident II level scheduled messages. Currently IRIS ranks these types of messages as a lower priority than that of a manually-entered message. Since St. Cloud staff in the TMC are unable to post scheduled messages in IRIS, the WZARD system will not operate exactly as designed during the pilot deployment period (through May 31, 2012) without an adjustment to IRIS to accommodate this issue. Raduenz suggested that this issue should be discussed in more detail as it relates to long-term WZARD messaging requirements and that a meeting should be held among District 3B traffic engineering staff, the St. Cloud TMC Supervisor and RTMC/IRIS staff. Iteris and Meridian would be more than willing to attend a meeting to provide additional information as necessary in order to resolve the long-term issue. Raduenz asked Rowe (in the absence of Jackels on the call) to bring this request back to Jackels as Project Manager for consideration. Rowe agreed to do so.

Greg Ostermeier also noted that the team tried to override the lowest priority (a scheduled Public Service Announcement) during the system testing on 11/30/11. Ostermeier said the WZARD system successfully replaced the lower priority message, but as the message was removed, the message was replaced by a blank sign, which was recognized by IRIS as a WZARD message. Ostermeier said that he has been in contact with Doug Lau of the RTMC and that Lau said there was an available fix for this issue. Ostermeier will ask Lau when the fix can be done.
Dwight Shank proposed that another test be done this week after the IRIS fix in order to prove that this issue has been resolved. The following items are needed to perform this test:

- The NTCIP-compatible PCMS must be operational (Kathy Gilson confirmed that the PCMS is still operational and that she was able to post a message to it during the meeting)
- Kathy Gilson must have access to post a scheduled PSA to the PCMS (she doesn’t have authority to do so at the present time)
- District 3B staff/TMC staff should verify the following after the above two conditions are met:
  - A scheduled PSA message can be posted on the PCMS
  - The WZARD message is able to replace the PSA message
  - The PSA message replaces the WZARD message when the WZARD message is removed

3. **Update on SCoRE Field Components/Sign Installation Status**
   
a. **Modems**
   
   Dan Rowe provided information on the status of the modems. He said that Ralph Adair said he would be ordering the modems in two shipments (one of 11 modems and one of 4 modems, for a total of 15 modems). Steve Toughill asked why 15 modems were being purchased for the SCoRE WZARD project. Rowe responded that there are to be a total of 15 signs (13 sidemount, 2 overhead) to be installed along the project corridor, according to Adair. Steve Toughill asked what carrier was being used for service (i.e., Verizon, Sprint, etc.). Rowe wasn’t sure, but he said he would talk to Adair about the following:
   - The status of modem purchases and when they would be available
   - The carrier that will be used for service (i.e., Verizon, Sprint, etc.)

b. **Sign Delivery/Expected Installation**
   
   Rowe also reported that he was told that the project CMS will be delivered on December 19th. They are expected to be commissioned sometime by the middle of January. Raduenz noted that this means the signs will not be operational until the end of January at the earliest, which Rowe agreed might be the case.

4. **Draft WZARD System Acceptance Test Plan**
   
   Raduenz informed the team that Iteris is currently creating the Draft Systems Acceptance Test Plan for the WZARD system. She noted that it is 95% complete at this time and is expected to be sent out to project team members by the end of this week for review and comment.
5. **Contract Amendment Status**
   a. **Amendment #1 Time Extension to 1/31/12 – Completed**
   b. **Amendment #2 Status**
      Raduenz updated the team on the status of the project’s second contract amendment. Key components of the amendment include the following:
      - The new amendment takes some of the optional tasks that were originally to be completed (Training, Evaluation) and reconfigures other tasks to be performed instead (i.e., System Acceptance Testing, Wireless Design, etc.)
      - Language related to the ownership of the intellectual property/software developed for the WZARD system. MnDOT has been granted a lifetime license to use the Iteris/Meridian WZARD software along the project corridor at no additional charge.
      - The original optional system evaluation task will not be included in the revised project scope.
      - Iteris will provide a Final Report on the project as part of the revised deliverables.

      Rowe said that he had prepared the amendment for Jackels’ review and following his approval the amendment will be sent to Ron Bisek, the MnDOT OTST Contract Manager.

6. **Next Steps/Next Meeting Date**
   a. **Next Steps** –
      The team is waiting for the modems to be purchased and for the delivery of the Changeable Message Signs (CMS). The CMS should be installed and commissioned by the middle of January, according to MnDOT. Dwight Shank and Greg Ostemeier reported that the WZARD system is currently running in IRIS and will be available to be transitioned to the newly-installed CMS along the I-94 corridor once the signs are installed. Testing will continue to be performed on the PCMS in the District 3 parking lot until the 94 signs are operational or unless the District staff need to dismantle the sign/communications for some reason.

   **Action Items:**
   **Dan Rowe:**
   1. Request access in IRIS (Adair) for Kathy Gilson to post scheduled PSA messages on PCMS board for testing.
   2. Check with Ralph Adair on when modems for SCoRE WZRD sign communications will arrive and be available for project use.
   3. Obtain approval for Amendment #2 from Jackels/Bisek.
4. Arrange a meeting among District 3 State Patrol, District 3 MnDOT staff, RTMC, MnDOT Office of Traffic Safety and Technology and (if needed) Iteris/Meridian to discuss long-term IRIS modifications for the WZARD operational system.

Iteris:
1. Finalize and send Draft System Acceptance Test documents to the team.
2. Continue testing of the system with District 3/State Patrol assistance.

b. **Next Project Meeting** – The next meeting of the SCoRE WZRD Project is scheduled for **Monday, January 9, 2012 from 1:00 p.m. to 2:00 p.m. via teleconference.** A conference call invitation and meeting materials will be sent to meeting attendees prior to the meeting via email.
MnDOT SCoRE WZRD Meeting Attendees

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The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **Update on Status of SCoRE Field Components/Sign Installation**
   Steve Toughill provided an update on the status of the field components. He reported that all the signs are installed in the field and that the sign commissioning will begin tomorrow, January 10, 2012. All signs are expected to be commissioned by the end of the week, weather permitting.

   Toughill also noted that the modems that will be used have been ordered, configured and tested on the existing installed overhead signs on I-94. Michalicek will be installing the modems while the signs are being commissioned in the coming week.

2. **Draft WZARD System Acceptance Test Plan**
   Raduenz reported that the Draft WZARD System Acceptance Test Plan is in the process of being finalized and will be sent to project members later in the day for their review. She noted that testing is expected to be performed during the week of January 23 based on availability of key individuals necessary to the process. Gilson indicated she was unavailable on January 24-25 due to other work commitments. Raduenz said they would try and work around Gilson’s availability for the testing.

   The following people will be needed to complete the acceptance testing at District 3B:
   - Lisa Raduenz, at D3 TOCC
   - Derek Nieveen, in field
   - Kathy Gilson, at D3 TOCC
   - Dan Rowe/Jon Jackels, in field
   - Dwight, Remote Support
   - Greg Ostermeier, Meridian Remote Support
   - Mike Kiley, snow plow drivers/communications in the TOCC/radio
   - Arnie Michalicek/Steve Toughill, technical support (if required)

   Dan Rowe asked the team if Gilson would need special IRIS access to be able to post PSA messages to complete the acceptance testing. Shank said it would be necessary for Gilson to be able to post scheduled messages to complete the acceptance testing process. Rowe noted that Brian Kary of the RTMC needs to travel to St. Cloud to train Kathy on how to post a scheduled message. Rowe will follow up with Kary to schedule a time prior to the acceptance test date.
Greg Ostermeier requested that sign identification numbers be provided to him so that he can input these numbers into the WZARD system.

Ostermeier also asked for clarification on the message that signs will display during the acceptance test. He noted that in earlier discussions the group agreed that the WZARD program would need to be able to identify the difference between a snow plow and a maintenance vehicle. Jackels stated that the following message should be used:

Frame 1: **SNOW PLOW AHEAD**
Frame 2: **USE CAUTION**

Jackels also noted that it would be beneficial to test the system against the design document (which includes logic for weather information and active treatment information). Ostermeier agreed that this would be beneficial and that he would create a slightly different message to document any vehicles that do not meet the logic standards (possibly the use of a period after the original message as a differentiating factor).

Shank asked Ostermeier if he had an update on the ability of the WZARD system to overwrite scheduled messages in IRIS. Ostermeier said that Doug Lau of the RTMC had identified the problem and the fix had been made. However, Ostermeier said that he is not aware whether or not the fix has been tested. Shank noted that this should be a specific test within the test plan. Rowe and Jackels agreed to talk with Adair/Lau of the RTMC to determine whether all IRIS fixes had been made to support the WZARD system acceptance test as previously requested by the project team.

Shank also said that there could be a safety issue for plow operators while testing of the signs in the field due to the fact they would be traveling at low speeds on the freeway. He asked whether D3 staff had a preference of using the road shoulder rather than a lane on the road. Mike Kiley said that he would make sure that any equipment on the road while testing had attenuators or other equipment traveling with the vehicles to protect them while traversing the 94 corridor during the field test.
3. **WZARD Message Content/Message Priority in IRIS - Meeting**
   Raduenz said that she had requested this meeting to have a formal discussion among MnDOT staff, both at the RTMC and at the District 3B/OTST level, about what message priorities should be for WZARD messages following the pilot deployment period. She said that she felt the team needs to clarify how the prioritization of WZARD messages will work through IRIS for permanent use of the WZARD system beyond May 31, 2012. Rowe noted that he has already set up a meeting time with Brian Kary on Friday, January 20, 2012 to discuss this issue.

4. **Contract Amendment Status**
   a. **Amendment #1 Time Extension to 1/31/12 – Completed**
   b. **Amendment #2 Status**
      The second amendment was received and signed by Iteris and will be delivered to Jackels/Rowe within the next few days, according to Raduenz.

5. **Next Steps/Next Meeting Date**
   a. **Next Steps** –
      Iteris will begin acceptance testing during the week of January 23, dates to be determined. Those expected to be needed for the acceptance testing process are listed in Section 2 of this document and will be contacted by Raduenz prior to a final date for the system acceptance test.

**Action Items:**

**Jon Jackels/Dan Rowe:**
1. Check with Tom Dumont to see if he is comfortable with a message warning of snow plows on 94 corridor CMS on clear, non-snow winter days.
2. Discuss system requirements/needs for Acceptance Test with RTMC staff to ensure compatibility with IRIS.
3. Review Draft Acceptance Test plan and provide comments to Iteris.

**Iteris:**
1. Distribute the Draft Acceptance Test plan to the team.
2. Schedule acceptance testing for as soon as possible or during the week of January 23, 2012.
b. **Next Project Meeting** – The next meeting of the SCoRE WZRD Project is scheduled for **Monday, February 13, 2012 from 1:00 p.m. to 2:00 p.m. via teleconference**. A conference call invitation and meeting materials will be sent to meeting attendees prior to the meeting via email.

### MnDOT SCoRE WZRD Meeting Attendees

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A project meeting was held via teleconference on Wednesday, February 8, 2011 from 2:00 p.m. to 2:30 p.m. A list of meeting attendees is attached to these minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **IRIS Message Prioritization**

Raduenz explained that the meeting was called to better understand and document how WZARD message prioritization within IRIS has been assigned by the RTMC. She said that a project acceptance test held a few weeks ago in St. Cloud on the WZARD corridor performed well but that there were still some questions about how and when WZARD messages would overwrite other messages, including scheduled messages, and there was a need to get clarification about this feature for satisfying system requirements during the pilot deployment, which ends by May 31, 2012. She also said that Gilson was unable to easily blank out a WZARD message through IRIS during the Acceptance Test process and ended up manually blanking a WZARD message instead.

Brian Kary described how message prioritization in IRIS works. The current WZARD message prioritization level is “incident low”, which is of a higher priority than a scheduled message. Kary said that scheduled messages include messages such as travel time messages and public service announcements (PSAs). WZARD messages are classified as “Incident – Low” in IRIS (“Incident – Medium” is used solely for Lane Control Signs or Dynamic Shoulder Lane signs), which is the highest scheduled message available. He also said that any message that is manually entered into IRIS by an operator will always override a WZARD message.

Kary noted that it is possible for messages such as weather messages (i.e., “Use caution during snow storms”) to be defined as a scheduled message within IRIS and a message like this would be overwritten for a WZARD message in the event of a WZARD trigger event (snow plows on road performing snow/ice operations). This would allow the WZARD message to trump a weather message. The team agreed that this was not necessary and that everything as is currently set up should work appropriately for any future snow/ice event through the pilot deployment.

Gilson said that the ability for her to blank a message leaving just a period on the sign face was sufficient enough for her and TOCC staff to fulfill the WZARD requirement of blanking a sign. The rest of the team agreed to this. System Requirement #3.2.15 will be noted as a PASS in the Acceptance Test documentation.
## MnDOT SCoRE WZRD Meeting Attendees

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A project kickoff meeting was held on Wednesday, February 16, 2011 from 10 a.m. to 3 p.m. at District 3B Headquarters in St Cloud. A list of meeting attendees is attached to the meeting minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **SCoRE Phase 2 Project Background:**

   - Jon Jackels, SCoRE WZRD Project Manager, provided the group with a summary of the project background. He said that the Destination Innovation Project was a result of internal agency suggestions from District 3B staff for innovative strategies aimed at improving snow and ice operations on the I-94 corridor between Rogers and St. Cloud. The corridor currently has between 40,000-80,000 ADT and a fiber backbone along the corridor will be installed and lit by the end of October 2011 as part of another related Destination Innovation effort. The Minnesota State Patrol is now working on another related project—CITE—which will install roadside stationary license plate readers at several locations along the same section of roadway to capture license plate information from passing vehicles. The focus of all of these Destination Innovation projects is on safety along this particular stretch of corridor, and all three projects give Mn/DOT another tool for managing traffic operations on the corridor.

   Dan Anderson and Randy Reznicek of Mn/DOT District 3B discussed the concerns of Mn/DOT truck and snowplow operators regarding safety along the I-94 corridor. Reznicek said that some truck drivers are very nervous because they are seeing drivers at high speeds frequently passing trucks and maintenance vehicles on the right, with several instances of vehicles running off the road. State Patrol officers have had many near misses along this stretch of the corridor while trying to assist disabled motorists. The use of full color matrix signs offers a flexible, adaptive approach to a problem where high rates of speed are the real issue, according to Anderson, as they are able to display regulatory signage. He said the State Patrol (which posts advisory messages on the CMS along the corridor) also displays advisory speed limit messages not just for snow/ice operations or for snowplows but also for secondary incidents due to vehicles passing around snowplows and causing incidents on the corridor.

   During Phase I it was determined that the eastbound segment of I-94 from St. Cloud/Greater Minnesota to Maple Grove/Twin Cities outskirts was the worst from a traffic perspective, as motorists tended to travel at higher speeds upon entering the outskirts of the metro area. During the evaluation phase of the project, both the eastbound and westbound segments of the corridor will be evaluated to review differences in performance once technology is in place and operational.
2. Overview of Phase I System Design

- Terry Haukom and Scott Coozenney of the Mn/DOT Regional Traffic Management Center (RTMC) provided an overview of the Destination Innovation project’s Phase 1 system design. Haukom discussed a number of project stakeholders that should provide feedback to the consultant team in the development of the Concept of Operations and System Requirements for the Phase 2 project including:
  - Department of Public Safety/State Patrol
  - Traffic Operations
  - Maintenance
  - Regional Traffic Management Center (RTMC)
  - Private Towing Operators (through State Patrol)
  - County/City Law Enforcement
  - Emergency Responders (911/Fire)

Haukom said that the St. Cloud Traffic Management Center has an ‘umbilical’ relationship with the RTMC in the Metro District as St. Cloud can run clients from the RTMC server. He said that once the TOCCs are consolidated sometime in the future, the potential will exist in controlling St. Cloud CMS from Rochester. He also discussed other things related to the current and planned system, including that all of the new CMS to be installed on the eastbound segment of the I-94 corridor will be NTCIP Version 2 (able to upload or download graphics) and a gig Ethernet network will be installed for communications. Garbe asked about the current AVL system and specifically about how operators of Mn/DOT trucks currently enter data, including lane position. Anderson responded that there is a goal to have a lot of automation in the snow plow so operators can focus as much as possible on the task at hand. He said while the plows have the capability of using plow up/plow down features, they are not currently using the feature at this time. Dumont suggested that feedback be obtained from snow plow operators to find out what they think about how the current system operates.

Garbe discussed the Concept of Operations and asked the group to discuss the impacts of the system evaluation on traffic and traffic operations (i.e., does someone have to push a button to operate the system, and, if so, from where?). Dumont said that snow plows are used primarily about four months a year and that the I-94 corridor is closed down an average of five times per year due to tanker accidents.
and other incidents. He said Maintenance staff do a lot of other functions along I-94 where safety is an issue year-round, including patching of cable guardrails and roadside maintenance, and cars are still running off the road, even in good weather months.

Discussion resumed about potential stakeholders for the project. Many were noted, including:

- DPS/State Patrol
- Local Police Departments
- Local Fire Departments
- City/County Public Safety Officers
- District 3 IT Staff (Steve Toughill)
- District 3 Maintenance Staff (Randy Reznicek and Mike Kiley)
- Central Maintenance Staff (Mark Loxtercamp and Jakin Koll)
- Towing Industry (multiple vendors through State Patrol)
- Regional Traffic Management Center (RTMC) (Brian Kary/Terry Haukom)
- District 3 Traffic Operations (Tom Dumont)
- Mn/DOT Online Community (Karla Rains)
- DPS Access Points
- FHWA
- Mn/Road
- Minnesota Trucking Association (MTA)

Haukom said that District 3B was the lead agency in terms of directing the project and its outcomes and that RTMC would support whatever the District wanted or needed to get the project completed. Dumont talked about the importance of understanding operational and maintenance “tails” (costs) for the deployment of the system as well as costs for electricity and/or power, which could be substantial given the potential for a high number of additional devices installed along the corridor with monthly costs. Haukom said that the addition of more cameras along the corridor could affect RTMC Operators and that signs can handle priority messages. Dumont said that this would be important to address in the ConOps, citing an example of how an older message stating that a snow plow was going by it would have to allow for the retriggering of a newer message or priority message.

The Department of Public Safety (DPS) is now running the entire TIGER system at this time but DPS is not able to dictate the priority level of messages along the corridor, according to Dumont. Priority message levels are set by Mn/DOT Traffic Operations in District 3B. Haukom said that the Twin Cities is using video archiving software called “Milestone” where counties can now get streaming video (runs through a connection with Office of Enterprise Technology-OET, not internet) and that perhaps looking at PSAPs...
in this area as stakeholders might be a good idea. He suggested contacting the State Patrol because they would know based on the number of transferred calls they receive (only take cellular and 911 calls, Stearns County handles the rest of the other calls in area). Haukom said that whatever is done in the corridor cannot be location dependent. He suggested talking with truckers in the area (one idea is Speedy Delivery) or with the Minnesota Trucking Association. Haukom stressed looking at the project from the standpoint of how creative it can be designed and deployed without having to get new procurements of hardware or software but instead using existing signage, power and infrastructure.

Coozenney provided a map of the corridor which detailed the location of existing and future devices as well as fiber optic information. At Opportunity Drive in St. Cloud, the State fiber conduit leaves the freeway and wanders east, according to Coozenney. OET may partner with Mn/DOT to bring the conduit and fiber up to County Road 15. Mn/DOT is working with power companies for spacing and to make sure that in-place signage will match points as needed. On east end of corridor there is 1.5 mile spacing for cameras and detection, and from Monticello to Highway 101 it is 1 mile spacing because visual verification is important in that stretch of roadway. Coozenney said that cameras are really important for both Mn/DOT and DPS for verification. He said that the current detection systems now in place (Wavetronics) on the east side of the corridor will be uninstalled from Monticello east and reinstalled on the west segment this year and that the east segment will use Wavetronics HD units in order to better monitor the recurring congestion along the eastbound segment from Monticello to the Twin Cities limits. Travel time messages are important in this portion of the corridor and will need to be updated, and the legacy systems on the TIGER corridor along Highway 10 will remain in place.

The schedule for Phase 1 includes a contracting letting date scheduled for May 2011 and a June 2011 award with a project completion date at the end of October 2011. LedStar signs are already on order and will be available to the contractor as soon as the bid is awarded. There are vaults at all locations (1.5 mile spacing or so) and 334 MP cabinets with power surge suppression or pole cabinets on a fiber optic pole with pigtails to it (one is installed at the RTMC in Roseville on a pole near the front door). All sign locations will have a 334 cabinet with Velmont tip-pole designs. Vaults in front of rest areas are already installed. Local detection units (CCTV in 334 cabinets) include field-hardened Ethernet CISCO 3000 or 3010 rack or dim-rail mounted. 90% field plans were provided to Iteris staff in order to assist in the development of system requirements.

Dumont spoke about CMS message content for the signage, indicating that travel time information would be provided at two or three locations on both overhead and side-mount CMS between Monticello and Highway 101. Coozenney said that there is no solar or wind power being done along the corridor and that gator patch mounts are being used and armored for rodent protection. He stressed that field
personnel on the project should not be touching armor while in the field because of the danger of electric shock.

At this point in the project, the group broke for lunch, which was provided in the room.

- **Tour of District 3B AVL/GPS Equipped Snowplows** – A brief tour was provided after lunch for meeting attendees to inspect and review District 3B fleet vehicles (snowplows) already equipped with AVL/GPS systems.

- **Next Steps** – Discussion occurred among group members about adding other stakeholders to the project technical advisory committee. Iteris team members outlined the project schedule and the next project tasks. The project Concept of Operations will be drafted and submitted to the TAC by the end of March 2011, and draft System Requirements will be submitted in concert with the beginning System Design task (by mid-April 2011). Final System Design is to be completed by the end of May 2011.

- **Next Project Meeting** – The next meeting of the SCorE WZRD project is scheduled for Wednesday, March 16, 2011 from 12:30 to 3 pm at District 3B Headquarters in St. Cloud. Iteris staff will send out meeting minutes and a meeting agenda in advance of the next meeting date.
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A project meeting was held on Wednesday, March 16, 2011 from 12:30 p.m. to 3 p.m. at District 3B Headquarters in St Cloud. A list of meeting attendees is attached to the meeting minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **Review Meeting Minutes from February 2011 Meeting**
   Lisa Raduenz of Iteris passed out meeting minutes from the February 16, 2011 meeting to all meeting attendees.

2. **Updated Project Stakeholder Contact List**
   Lisa Raduenz passed out an updated project stakeholder contact list to all meeting attendees.

3. **User Survey and Survey Responder List**
   A copy of the survey that was developed by Iteris staff to engage I-94 corridor stakeholders in responding to information to be used for the project Concept of Operations was provided to all meeting attendees, along with a list of each organization and person that was contacted by Iteris to return the survey. Survey respondents were asked to return the survey electronically or via fax to Iteris by Monday, March 14. Raduenz said that there were a total of 14 respondents that had returned survey information prior to the meeting and said that Iteris staff would continue to seek stakeholder input from those on the list until the final draft of the project’s Concept of Operations has been completed. Iteris staff also passed out a summary sheet of survey responses by responder. Raduenz mentioned that early responses from responding organizations seem to indicate that the issue of procurement of hardware specifically designated to meet the technology needs of this project might be of concern to local units of government and public service organizations according to what responses have been returned to this point. Jackels said that the District 3 State Patrol contact for the survey should be Mark Sprengler or Lieutenant Kitzmueller and asked that someone familiar with the project from District 3 Patrol be consulted on the survey (Iteris will identify the appropriate person at State Patrol with the assistance of Kathy Gilson).

4. **Project Architecture Conformance**
   Steve Garbe of Iteris distributed a project architecture conformance memorandum that described the overall project architecture and its conformance with federal requirements and the Statewide Regional ITS Architecture. He described the I-94 SCorE WZARD project as “doing well in terms of conformance” and said the intent of the document was to compare project documentation to rules and to provide Mn/DOT with a document that displays adherence to federal and regional goals for ITS projects and the regional architecture.

5. **Project Architecture Alternatives**
   Dwight Shank of Iteris presented a document entitled “Project Architecture Alternatives” which presented three concepts or alternatives for the SCorE WZARD project architecture, describing them as “three ways in which components could interact with each other” on the project:
- **IRIS Control Alternative** – This concept is based on the regional communications system now in place, which is a cellular infrastructure. The diagram provided by Shank displayed a corridor vehicle linked via internet to the Regional Traffic Management Center (RTMC) through servers with a St. Cloud-based work station where a person situated in St. Cloud would determine when to turn on or light a CMS along I-94.

- **Local Alternative** (Bluetooth) – This concept consists of a corridor vehicle providing a signal when in proximity to a Bluetooth reader, which in turn sends a detection signal to the DMS. This would result in basically an auto-generated message to the St. Cloud TMC or TOCC via the RTMC in Roseville with St. Cloud-based work station verification, as shown on the concept drawing.

- **TPFKAI Alternative** – The third and final concept Shank presented was TPFKAI, or, as he referred to it, “The project formerly known as IntelliDrive” (ConnectedVehicle is current name). Shank described this alternative as a beacon-based option using roadside equipment to verify operations with a St. Cloud-based operator. He indicated that it would be up to a St. Cloud system member to make the decision on whether or not to light the sign.

Garbe asked the group what was reasonable as a solution for a VII type of scenario (i.e., TPFKAI scenario as presented). Jakin Koll said that snow plow operators and other maintenance drivers had too much to do at the present time while operating equipment, and stated that the first architecture concept presented seemed to work well as Mn/DOT staff had enough to do while operating vehicles during maintenance activities. Randy Reznicek concurred and stated that there is already funding invested now in the operations of the fleet and that it made sense to stick to a simpler process in order to get the system up and started sooner rather than later, with adjustments that could be made in the future after the system was fully operational. Jackels stated that he wanted the group to consider the third scenario and not necessarily throw it out but rather identify the risks of getting it done instead, perhaps in two phases and keep “options open”. Shank remarked that the TPFKAI alternative could be implemented using 3G/4G wireless service and not just dedicated short range communications (DSRC). Based on this discussion among group members, the IRIS alternative was selected by the group for further development as part of the project’s Concept of Operations.


Iteris staff distributed a handout that included project goals and Use Cases/Scenarios for discussion purposes. Garbe briefly reviewed the project goals listed on the first two pages of the handout with the group. Jackels and Dumont clarified that the reduction of I-94 corridor congestion was relevant not only to weekday AM and PM peak hour traffic but also to weekend recreational traffic that peaks on
Friday afternoons on the westbound lanes and Sunday afternoons on the eastbound lanes of I-94 in the project corridor. Garbe asked group members to review project goals and to send any other comments to Iteris staff by the end of the following week (by Friday, March 25, 2011).

The rest of the meeting was devoted to a detailed discussion of the possible Use Cases/Scenarios for the WZARD project. Iteris staff presented a handout which included a number of detailed scenarios for consideration by the group:

Scenario 1 – Basic Snow Plow Operation interaction with DMS on Corridor
Under this scenario, a snow plow passes DMS on the corridor and without human verification or intervention a warning is displayed on the DMS within 30 seconds of vehicle passage, indicating that the snow plow is ahead but no lane indication is made. Five minutes after the snowplow has passed the message is dropped from the DMS. Coozennoy asked why thirty seconds was the length of delay used in the scenario, and stated he did not see an issue with instant turn-on of the CMS. Reznicek said that the sign would not necessarily be seen by cars following the snow plow because of the snow cloud. Koll said that the sign could be populated 15 seconds before the truck came upon the sign and that it was better to put a message on the sign sooner rather than later. Jackels asked the group if the intent was to have the snow plow operator verify that a message was posted on the CMS as the operator passed the sign. Group members responded affirmatively. Koll said a generic message should be posted to the sign in this case such as “SNOW PLOW IN AREA”. He suggested that the message be posted 15 seconds before the plow reached the sign in order to alert drivers and to get operator verification of the message. Dumont said this would be an issue for those vehicles traveling ahead of the plow on the highway. Reznicek said that a plow in the left lane of I-94 travels at a speed of 25-30 mph and Jackels stated that this was really a discussion about vehicle speed. Koll stated that the only time that an issue may exist in this area was if the hazard lights on the vehicle were used, because Mn/DOT would prefer to have the message posted when hazard lights on the plow were on. Jackels calculated that 15 seconds would allow the snow plow driver to be “3 signs away” and asked what the driver would be doing for speed. Koll said the MDSS system used by Mn/DOT can tell speed of the plow and the data would already be available in the MDSS system. Shank responded that there would be an advantage of using 3G/4G service and GPS/AVL for that reason but indicated that the group wouldn’t want to worry about speed because the system would already be aware of where the snow plow actually was. More discussion occurred about drivers who use ramps and passovers near the signs and how CMS would be activated based on when ramps and passovers are used during the plowing process. Dumont asked how the system would need to be activated based on these activities. Koll stated that point of direction in which the plow was traveling would be important. Coozennoy suggested tying direction to the next sign as it becomes tripped by plow proximity. Kiley stated that the plow would take the next ramp after a sign would be tripped. Koll said that operators at the TMC would know the plow would be in-between signage and still doing maintenance work. Jackels
suggested that the next sign trips downstream after snow plow leaves the first sign. He said that if the driver left the road to take a ramp the sign would go off. He suggested that if the driver re-enter the road, the next sign would then go on, stating that GPS/AVL would be the key concept for this scenario and that the emphasis would be on vehicle position rather than on the amount of time needed to keep a sign turned on or shut off. Shank stated that if there happened to be two maintenance vehicles in the vicinity, the system would still want to have the nearby sign lit. Garbe suggested that the key component for this particular scenario was whether or not there should be human intervention in the system. Gilson said that there was no time available for Patrol staff or operators at the TMC to do this work, particularly in a busy winter weather operation. Toughill said that messaging priority would also be an issue and stated that whatever message had been previously posted on the sign prior to the activation by the vehicle would have to return to the sign after the vehicle passed.

**Scenario 1B- Lane Position of Snow Plow Reported.** Gilson said that the State Patrol is currently working on a similar system known as “CAD to Cars” and wondered how this would be different from that initiative. She suggested that the consultants talk with Brian Kary of the RTMC or TK (formerly of the RTMC) to find out more about this statewide project and system. Gilson also stated that trooper verification is required when an incident is first noted in the CAD system. Tony McClellan of Meridian asked if any intervention should be required at the RTMC for this verification process. Coozenoy said that the RTMC was different as it maintains a 24/7 operation schedule while different staffing levels exist at the District 3 office and on weekends there is usually an on-call person only to support maintenance operations. Garbe said it was important to determine whose responsibility it would be for an incident that occurred after normal hours at District 3. Dumont stated that it would be the responsibility of the State Patrol to verify incidents or problems and stated that it would be important to have a fully automated system for verification for that purpose. Toughill said it would depend upon how busy things are regarding whether or not verification could occur and that while verification will show up in IRIS cameras may not be able to view all the signs. Reznicek said that consolidation of the TOCC to Rochester may be an issue. Gilson said there would be fewer operators if consolidation of the TOCC occurs. Dumont said that Scenario 1 should be fully automated unless someone wants to get rid of a message set. Shank said that monitoring activities could possibly be done via surveillance from an IRIS work station.

**Scenario 1C – Snow Plow Lane Positioning with Message Display and Removal Automation.** Garbe asked if the operator should get an audible alarm if message was still on CMS. Gilson stated that most operators will turn the alarm volume down because it becomes a matter of priority levels. She stated that when operators are usually needed the most that’s the time when they are usually least available, particularly in winter weather operations. McClellan said that the consultant team wanted to make sure that the scenarios under development were meeting the needs of the TMC. Gilson asked the group if that meant that there would be an IRIS type of map that would track snow plows on it. She
said that if this were the case it would be of great benefit to operators because it would really improve their ability to track plows. Garbe suggested an icon that would change colors on the map in order to notify operators that when they have the time they could see if a message that was currently displayed on CMS should still be posted. Gilson responded that she could see this type of information if a message had been posted on a sign for a long period of time, such as if the icon was yellow meaning active or active in automation. She said differentiation would be important. Koll said that the MDSS software could be set up as a “View Only” account for State Patrol operators, as it shows where the plows are and troopers really like that feature. Shank stated that an IRIS enhancement for the project might not be out of scope. McClellan said that the State Patrol and Mn/DOT already have an agreement in place on sharing information on where snow plows are as part of the MDSS software. Reznicek said that this is already being done and it is a big help. Garbe asked about the need for understanding vehicle lane position. Koll stated that the current GPS system would not be able to tell lane position of the vehicle because it is based on sending centerline information. He said that the lane position information is not important. Shank said that if the group really wanted to know about lane positioning the Iteris team would be glad to discuss that option. He stated that lane position would also drive message content for snow plow operations but that incident management will be manual information. Koll said that in the future lane position could be entered via touch screen but that regular maintenance activities that are scheduled can be entered manually as is currently done. Kiley said that some maintenance activities might have to be entered in manually more than once in the same day, such as a cable guardrail that would have to be repaired because of incidents in the field with a variety of weather conditions in the same period of time.

**Scenario 1D - Snow Plow Operating as Part of an Incident Message Communications System.** Garbe asked the group to decide if this was a frequent problem, because if so, automation should be high in value. Group members determined that this is a less frequent activity and one where the manual notification process and procedures should work fine as they currently operate. Garbe asked the group if they are using CB Wizard in Minnesota as Wisconsin does. The group said that they are not using that system in Minnesota but are aware of it.

**Scenario 2A - Public Traveling Without Lane Position Reported.** Garbe stated that this scenario corresponded to Scenarios 1A, 1B and 1C but that the group had already determined that lane position was not relevant so Scenario 2B would be eliminated from consideration. He asked the group if they were interested in other message content, such as the speed of the snow plow. Koll said that this was not a good idea as the speed of the plow could change rapidly. Garbe asked the group if they desired an interface with sidefire microwave units to determine average traffic flow speeds for travel time display on the CMS. He used the example “Travel Time to Monticello – 6 minutes” and also asked about post advisory messages such as “Congestion Ahead” or “Average Speed Ahead”. Coozenoy said that because the spacing to Monticello is one mile apart and a mile and a half after that it would be
pretty tough to be accurate with these types of messages. Jackels responded that this may be true for the travel time or incidents parts of the project but not necessarily true for the snow plow part of the project. Garbe asked Coozenoy if he or someone else could provide the LedStar sign specifications for the consultants to look at the message autopopulation information.

Scenario 3A – Law Enforcement Escorting Wide/Heavy Load on I-94 Corridor. Shank asked the group if this was an important activity to consider. Group members felt that they did not really see a high incidence of this scenario occurring on the I-94 corridor, as most wide/heavy loads traveled during off hours and off of the interstate system. Garbe asked the group if it was planning to take a different approach about posting more messages along the corridor rather than less messages for advisory purposes. Dumont said that Mn/DOT looks at this type of scenario as more of a construction-related activity along the corridor (i.e., bituminous truck causing queues) and said that heavy trucks generally look for an open lane along I-94 as they move through the corridor. He said that with dynamic movements such as this that can cause backing up or queues the best thing to do would be to keep the process automated. Garbe asked Dumont if he had a defined process for the Traffic Management Plan on queueing. Dumont responded yes and said that field devices could become part of the TMP summary. McClellan commented that the devices could detect speed of slow-moving vehicles and determine the queue length behind the vehicle. Koll said that the concept shouldn’t be ignored and should be considered down the road, but for now the process should be kept simple. Jackels responded that with the level of congestion along the corridor and 1 to 1 ½ mile spacing there would not be immediate information but the system could provide an advance warning of congestion when hitting the first detector based on speed and could roll message back upstream in an automated way. Shank asked where that activity might fall within the scope of this project. Jackels commented about looking at a scenario where the operator would be sent information that congestion or queueing is building, such as an alert. Garbe responded that most ATMS software will provide an alert. He provided an example – Sensor A could report average speed of 40 mph and Sensor C is reporting 65 mph speed and said that an algorithm would be needed. Dumont added an operator could get this information if speeds dropped below a certain level on the corridor. Gilson said that this feature was already available in IRIS at the RTMC, not in St. Cloud, and that is displayed as a color-coded system. Dumont said a system could have an algorithm that was built upon the concept of when the speed differential is greater than X level, messages would be posted to the signs. Garbe asked if a VISSIM or CORSIM model of the corridor has been created or suggested that perhaps this might be something a University graduate student could do for modeling purposes. Shank asked if lanes were open, would there be automated messages. Gilson said that on Sunday afternoons there are usually backups during the spring/summer/fall months but usually no crashes or incidents that happen. Garbe asked about travel time messages as the basis of why this scenario had been originally created. Dumont said that regular commuters across the corridor know their travel times, it is infrequent travelers that do not. Jackels said that travel times would be an enhancement to the WZARD project. He said there would be
a need to capture this idea so as not to lose it but it would not be part of the current project phase. Dumont added that taking a message off rather than putting one up might be an issue – such as “Reduced Speeds” or “Stopped Traffic” and asked whether the message could be terminated automatically.

**Scenario 3C – Incident Needing Cleanup.** Garbe said the main point of this scenario is the law enforcement vehicle to know where incidents are at in the system and that it would require the sharing of vehicle information (location) between State Patrol and snow plow operators. Gilson stated that the troopers voice this information over the air at this time and that the TMC operators can see which trooper, what speeds and other information about how long response will take. Jackels asked if a local sheriff were to pull someone over on the right shoulder, wondering if this was a warning that could be done automatically. Koll said that it would not be good practice to post a message stating “Trooper on shoulder ahead” and that Minnesota already has a Move Over Law for maintenance and State Patrol. Toughill asked whether the Patrol would let Mn/DOT use AVL information and most of those in attendance thought probably not. Garbe said if a vehicle was 1 ½ miles away it would be two minutes from the incident area and perhaps this would be a good safety idea. He said if the group determined that to be the case, needed agreements would have to be in place with the State Patrol.

**Scenarios 4B and 4C – Mowing Operations along the Corridor.** Garbe presented these scenarios, saying that based on the rest of the conversation to this point, these were the last scenarios that would need to be discussed with the group and the rest could be ignored. Reznicek said that it would be good to have a warning for mowing operations and for(stripers, too. He asked if AVL equipment was going to be placed in the mowing units. Gilson said that the operators take calls now about mowing by position (i.e., left inside shoulder, etc.) but that it would be nice to have a message set for this use. Garbe said that putting AVL in the mower was most likely not an option, but if there was a Bluetooth device at each sign it could display a message by mower proximity, although the exact position of the mower would not be known. Reznicek said that mowing operators can take out a hand-held radio now to notify State Patrol and do so. Jackels asked if this scenario would hold true for all maintenance activities and planned events. The range of Bluetooth devices was asked. Iteris staff responded that to their knowledge and experience, a range of about 330 feet was the maximum reading range. Jackels said that right now planned, routine maintenance events can be coordinated with Dispatch and manual messages can be placed on the CMS. Dumont asked if GPS was turned off in the summer by maintenance. Koll said that GPS was tied into hazard lights so that when hazards are on, AVL comes on. Koll suggested a generic “Maintenance Vehicle Ahead” sign that could be posted for sign trucks and stripers on the road and that they may need some level of automation similar to snow plows for the signage. Someone asked about how to distinguish Mn/DOT AVL equipment from other AVL equipment on the corridor. Shank said that there should be ESN/static and IP addresses that identify Mn/DOT equipment on the corridor so this should not be an issue. Koll said that it would be important.
to make sure that reliability of message posting was not an issue, such as a sign in the middle of summer that displayed the message “Snow Plow Ahead” rather than something else. Garbe said there would be time in the next few months to figure out message content later in the project development process. A question was asked about fire trucks in the corridor responding to incidents and how State Patrol is aware of this scenario. Gilson responded that whenever 911 is contacted the State Patrol knows and that these types of incident messages are manually posted.

**Final Scenario – System Failures.** Garbe and McClellan talked about possible system failures and if they occurred, who would be responsible. Toughill said that in District 3 he would be the person who would have to deal with system failures, but not on a 24/7 basis. He said he was only called if there is an Amber Alert or Abducted Child issued and the sign that had to display the message would fail. Raduenz asked how often that scenario had occurred. He said that he had never had a failure yet for an after-hours Amber Alert message. Dumont said that if a safety problem occurred after hours the State Patrol or RTMC would handle the issue via Dispatch. For maintenance issues in District 3, this is not necessarily the case. Reznicek said that for some traffic or ESS issues, they might be handled after hours and if so, Arnie of ESS would be the person to do so. The sign maintenance point of contact is Randy Reznicek for sign maintenance protocol and for weekend failures. Garbe suggested the blanking of CMS signs in the event that signs fail for Ethernet-based systems. District 3 staff said that if signs failed on weekends there would be no call out to fix them (unless an Amber Alert were issued). Garbe asked for a clarification on this policy in the event it was a Sunday afternoon and there was recurrent congestion on the corridor and travel time messages were to be posted. The answer by District 3 staff was still the same – no.

### 7. Next Steps/Next Meeting Date

a. **Next Steps**–Iteris team members are continuing to work on developing the Draft Concept of Operations at this time due to the project’s late start date (February 22, 2011). The discussion on scenarios will allow Iteris staff to consolidate the remaining pertinent scenarios and refine the Draft Concept of Operations. They expect to have a Draft Concept of Operations for group review by the end of the week of March 21, 2011. Once this draft has been reviewed and comments are received from project stakeholders, the Final Concept of Operations will be drafted and submitted to the committee by April 4, 2011. Iteris staff will also begin working to draft System Requirements in order to stay current on the project schedule.

b. **Next Project Meeting** – The next meeting of the SCorE WZRD project is scheduled for **Wednesday, April 13, 2011 from 12:30 to 3 pm at District 3B Headquarters in St. Cloud.** Iteris staff will send out meeting minutes and a meeting agenda in advance of the next meeting date.
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A project meeting was held on Monday, April 30, 2012 from 11:00 a.m. to 11:30 a.m. via teleconference. A list of meeting attendees is attached to the meeting minutes.

The meeting agenda, including results of discussions held in each topic area during the meeting, is highlighted below:

1. **Update on SCoRE System Acceptance Test**
   The Iteris team met with Dan Rowe and Steve Toughill to go through the WZARD and IRIS system logs to verify that system requirements were met on 3/29/12. The updated list of the system requirements and variance forms were sent out to Dan Rowe and Steve Toughill on Friday, April 28 for their final review. Toughill noted that there were some discrepancies in the numbering scheme of the variances. The numbering scheme will be reviewed and resent to Dan and Steve as soon as possible.

   Dan also noted that he would like to discuss the materials that were sent by Iteris staff with both Toughill and Iteris very soon.

2. **Next Steps/Next Meeting Date**
   a. **Next Steps**
      1) **Draft Operations/Maintenance Plan**
         The Draft Operations and Maintenance Plan will be sent to the project team by May 1st. Comments are due to Dan Rowe by May 15th.
      2) **Draft Final Report**
         The Draft Final Report will be sent to the project team by May 1st or as soon as possible after that date and prior to May 15. Comments are due to Dan Rowe by May 15th.
      3) **WZARD Operations**
         The WZARD system will continue to run in the background at Meridian after 5/31/12. The system is currently operational and will remain that way. Jon Jackels needs to discuss the future operational status for WZARD beyond the project with District 3B staff and others at MnDOT. The team expects that the system will continue to run after this point without operator intervention. Kathy Gilson noted that her team is not actively watching when a message has been populated by WZARD, but she has noticed the message “MAINTENANCE VEHICLE AHEAD, USE CAUTION” on the signs when she is aware of maintenance activities on the corridor.

         Dwight noted that he would be giving a presentation on SCoRE WZARD at the 2012 ITS America conference in Washington D.C. on May 21. He also noted that he has been receiving comments from several snow states on future interest of the WZARD system.
Jon agreed and stated that he is working with Jakin Koll to incorporate the WZARD system into MDSS to assist in a possible statewide deployment.

Raduenz said that there would be no additional project meetings at this point and that she wished to express her appreciation for a great project and working relationship with District 3B and OTST on the WZARD project. Final project deliverables will be sent by email to all project committee members. Jackels said that the project ended up being more than what was planned for at the beginning and that he and other MnDOT staff are considering how best to incorporate future WZARD system expansion within MDSS and throughout the state.

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APPENDIX D
DESTINATION INNOVATION PROJECT
SAFE CORRIDOR ENHANCEMENTS – PHASE 2
WORK ZONE ACCIDENT REDUCTION DEPLOYMENT
Final Operations and Maintenance Manual

Submitted to:
Minnesota Department of Transportation (MnDOT)
May 2012

19-J11-1905
## Document Version Control

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Appendices

Appendix A
1.0 INTRODUCTION

This is the Operations and Maintenance Manual for the Safe Corridor Enhancements (SCorE) Work Zone Accident Reduction Deployment (WZARD) project which was funded through the Minnesota Department of Transportation’s (MnDOT) Destination Innovation Project (DIP) in 2011.

This Operations and Maintenance Manual was prepared as a source of documentation intended to cover all the system components developed for the WZARD project.

2.0 SYSTEM OVERVIEW

2.1 GENERAL OPERATIONS OF THE SCorE WZARD SYSTEM

The SCorE WZARD Operations and Maintenance Manual has been created to document all of the WZARD system components, installation locations and high level system architecture. The Operations and Maintenance Manual provides essential information for MnDOT District 3B operations and maintenance personnel to perform the following functions related to the WZARD system:

- Troubleshoot inoperable system components
- Installation and removal of system components
- Configuration of system components
- Conduct scheduled maintenance
- Administer, monitor and report system status

2.2 SCorE WZARD CENTRAL SYSTEM CONTROL COMPONENTS

2.2.1 SCorE WZARD SOFTWARE/PROGRAM

The WZARD system software is an executable file that is permanently stored and runs on a server at Meridian Environment Technologies (MET) in Grand Forks, ND. The software combines information received from several sources of data including:

- MnDOT District 3B maintenance vehicle third-party AVL/GPS data, including:
  - Speed
  - Bearing (direction)
  - Location
  - Spreader
- Weather information from MnDOT RWIS and MDSS systems
- Calendar date information

The WZARD software utilizes user-defined zones called “geofences”. A geofence is a set of GPS defined polygons that are used to determine the presence of a maintenance vehicle within a set boundary. The WZARD software “grabs” AVL data from each AVL equipped maintenance vehicle and determines whether or not the vehicle is within the geofence’s defined boundaries. If the vehicle presence is validated, an automatic pre-stored message contained within the IRIS
system is posted to the changeable message sign (CMS) located within the geofence zone. When the AVL equipped maintenance vehicle leaves the geofence, the message is removed from the CMS located within the geofence zone.

WZARD software also relies on logic from other data sources to determine if a message should be placed on a CMS. The logic diagram in Figure 1 displays the queries used by WZARD to determine if a message should be placed on a corridor CMS and how the program utilizes the information.

![Figure 1: WZARD System Logic Diagram](image-url)

If MnDOT staff determine that the existing parameters depicted in Figure 1 need to be adjusted for any reason along the WZARD project corridor, appropriate protocol is to contact Meridian Environment Technology staff (see Section 4.1 for contact information).

The WZARD software is able to separate acceptable AVL equipped vehicles in the following ways:

- Inclusion list (lists all AVL equipped vehicles that activate the WZARD system)
- Exclusion list (lists all AVL equipped vehicles that DO NOT activate the WZARD system)

At the present time, MnDOT District 3B utilizes the inclusion list to differentiate between WZARD corridor vehicles in the fleet and those that are not included for operations along the WZARD corridor. The following District 3 vehicle identification numbers are included as of May 1, 2012:
To add a vehicle to the inclusion list, contact Steve Toughill – District 3 Office of Enterprise Technology (see Section 4.1 contact information). Steve has been designated as the responsible party in District 3 for updating the master WZARD vehicle list and for contacting Meridian Environmental Technology to make revisions to the inclusion list on the WZARD system.

2.3 SCORÉ WZARD SYSTEM COMPONENTS

2.3.1 CHANGEABLE MESSAGE SIGNS

The WZARD system is installed on fourteen (14) changeable message signs (CMS) on I-94 EB between Rogers (T.H. 101) and St. Cloud (T.H. 15), the WZARD “project corridor”. There are two types of CMS located on this corridor -- overhead CMS and side mount CMS. A list of sign locations and sign type can be found below in Table 1.
There is one overhead sign on this corridor at Barton Avenue (M.P. 186.4). The sign at Barton Ave. is a **LedStar MN1C-56X270C**. This sign is capable of displaying three lines of twenty three (23) characters each. WZARD messages should be displayed on one frame as depicted in the picture below.

![Overhead Sign](image)

The WZARD system is also installed on thirteen (13) **LedStar MN9C-28X130** side mount CMS. These signs are capable of displaying two lines of thirteen (13) characters each. WZARD messages should be displayed on two frames as depicted in the pictures below.
A cut sheet and sign design sheet for the LEDSTAR MN9C-28X130 side mount CMS can be found in Appendix A.

Although the CMS play a large role in the public display of the WZARD system, MnDOT is responsible for maintenance issues and control of the signs in the WZARD corridor. Contact Steve Toughill for maintenance or failures associated with CMS signs (see Section 4.1 contact information).

2.3.2 CHANGEABLE MESSAGE SIGN CONTROLLERS
There is one controller installed at each CMS sign location – a LedStar CTL-24. The CMS controller is used to properly operate the changeable message sign. Information regarding the LedStar CTL-24 can be found in the controller cut sheet information in Appendix A.

Contact Steve Toughill for maintenance or failures associated with CMS sign controllers (see Section 4.1 contact information).

2.3.3 COMMUNICATIONS

2.3.3.1 WIRELESS MODEM COMMUNICATIONS
At this time, temporary communications between IRIS and the signs are performed through the use of wireless modems. The current model installed and in use as of May 1, 2012 is the Sierra Wireless AirLink GX400. A list of CMS controller and wireless modem Internet Protocol (IP) information can be found in Table 2. More information for this device can be found in Appendix A.

2.3.3.2 FIBER OPTIC COMMUNICATIONS
Future WZARD communications along the I-94 corridor will be facilitated through the use of fiber optic cable. Fiber optic cable is scheduled to be installed along the I-94 project corridor during the Spring and/or Summer of 2012.
### TABLE 2: I-94 CORRIDOR WIRELESS COMMUNICATION INFORMATION

<table>
<thead>
<tr>
<th>Plan Name or InPlace Location</th>
<th>Sign Name</th>
<th>Sign Location Description</th>
<th>Mile Post</th>
<th>Lat</th>
<th>Long</th>
<th>Strip Completed</th>
<th>Sign type and Manufacturer</th>
<th>Sign Size</th>
<th>Sign Serial #</th>
<th>Controller Serial #</th>
<th>Controller Static IP</th>
<th>Controller Drop</th>
<th>GX400 IP Address</th>
<th>GX400 ESN Hex</th>
<th>GX400 S/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1 VT94E23</td>
<td>VT94E23</td>
<td>164 E of Co Rd 75 Near Brunk Road</td>
<td>171.5</td>
<td>45°28.909' N</td>
<td>94°8.588' W</td>
<td>1/15/2012</td>
<td>LedViz MSNG-26X130</td>
<td>28 x 130</td>
<td>201112175</td>
<td>2011100130</td>
<td>192.168.13.30</td>
<td>1</td>
<td>166.150.194.290</td>
<td>CA11941497110</td>
<td>60E4C71B</td>
</tr>
<tr>
<td>A-3 VT94E22A</td>
<td>VT94E22A</td>
<td>184 W of TH24 Near Clovis Ave</td>
<td>177.1</td>
<td>45°25.339' N</td>
<td>94°4.963' W</td>
<td>1/15/2012</td>
<td>LedViz MSNG-26X130</td>
<td>28 x 130</td>
<td>201112181</td>
<td>2011100192</td>
<td>192.168.13.30</td>
<td>1</td>
<td>166.150.194.222</td>
<td>CA1194139910</td>
<td>60E4C0F</td>
</tr>
<tr>
<td>A-5 VT94E27C</td>
<td>VT94E27C</td>
<td>@ Co Rd # 8 Haby</td>
<td>183.3</td>
<td>45°22.065' N</td>
<td>93°58.427' W</td>
<td>1/15/2012</td>
<td>LedViz MSNG-26X130</td>
<td>28 x 130</td>
<td>201112179</td>
<td>2011100154</td>
<td>192.168.13.30</td>
<td>1</td>
<td>166.150.194.284</td>
<td>CA1194149810</td>
<td>60E4D836</td>
</tr>
<tr>
<td>A-6 VT94E22D</td>
<td>VT94E22D</td>
<td>194 W of Barton Ave Overpass</td>
<td>185.7</td>
<td>45°21.355' N</td>
<td>93°55.917' W</td>
<td>1/15/2012</td>
<td>LedViz MSNG-26X130</td>
<td>28 x 130</td>
<td>201112172</td>
<td>2011100191</td>
<td>192.168.13.30</td>
<td>1</td>
<td>166.150.194.235</td>
<td>CA1194143910</td>
<td>60E4D81B</td>
</tr>
<tr>
<td>Barton Ave EB</td>
<td>VT94E23E</td>
<td>Barton Ave EB End of East Area</td>
<td>184.6</td>
<td>45°21.178' N</td>
<td>93°56.007' W</td>
<td>12/04/2011</td>
<td>LedViz MSNG-26X130</td>
<td>56 x 270</td>
<td>201109131</td>
<td>2011040471</td>
<td>192.168.13.30</td>
<td>1</td>
<td>166.150.194.287</td>
<td>CA1194172810</td>
<td>60E4C030</td>
</tr>
<tr>
<td>A-7 VT94E25F</td>
<td>VT94E25F</td>
<td>@ Atnea Ave</td>
<td>188.45</td>
<td>45°21.438' N</td>
<td>93°52.798' W</td>
<td>1/15/2012</td>
<td>LedViz MSNG-26X130</td>
<td>28 x 130</td>
<td>201112173</td>
<td>2011100193</td>
<td>192.168.13.30</td>
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<td>166.150.194.238</td>
<td>CA1194135180</td>
<td>60E4D8E9</td>
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<tr>
<td>A-8 VT94E26E</td>
<td>VT94E26E</td>
<td>196.7</td>
<td>190.7</td>
<td>45°19.287' N</td>
<td>93°50.984' W</td>
<td>1/15/2012</td>
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<td>28 x 130</td>
<td>201112168</td>
<td>2011100151</td>
<td>192.168.13.30</td>
<td>1</td>
<td>166.150.194.289</td>
<td>CA11941449610</td>
<td>60E4C84E</td>
</tr>
<tr>
<td>A-9 VT94E26B</td>
<td>VT94E26B</td>
<td>202.3</td>
<td>192.3</td>
<td>45°18.322' N</td>
<td>93°49.122' W</td>
<td>1/15/2012</td>
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<td>28 x 130</td>
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<td>2011100224</td>
<td>192.168.13.30</td>
<td>1</td>
<td>166.150.194.240</td>
<td>CA1194144310</td>
<td>60E4C72C</td>
</tr>
<tr>
<td>A-10 VT94E27</td>
<td>VT94E27</td>
<td>204 W of Co Rd 18 Monticello</td>
<td>194.4</td>
<td>45°17.511' N</td>
<td>93°56.471' W</td>
<td>1/15/2012</td>
<td>LedViz MSNG-26X130</td>
<td>28 x 130</td>
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<td>201105153</td>
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<td>60E4C7F2</td>
</tr>
<tr>
<td>A-11 VT94E28</td>
<td>VT94E28</td>
<td>210.2</td>
<td>198.02</td>
<td>45°15.871' N</td>
<td>93°43.001' W</td>
<td>1/15/2012</td>
<td>LedViz MSNG-26X130</td>
<td>28 x 130</td>
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<td>2011100012</td>
<td>192.168.13.30</td>
<td>1</td>
<td>166.150.194.242</td>
<td>CA11941363510</td>
<td>60E4C612</td>
</tr>
<tr>
<td>A-12 VT94E29</td>
<td>VT94E29</td>
<td>East End of MNIROAD</td>
<td>200.1</td>
<td>45°14.916' N</td>
<td>93°41.044' W</td>
<td>1/15/2012</td>
<td>LedViz MSNG-26X130</td>
<td>28 x 130</td>
<td>201112177</td>
<td>201108153</td>
<td>192.168.13.30</td>
<td>1</td>
<td>166.150.194.243</td>
<td>CA11941559810</td>
<td>60E4C811</td>
</tr>
<tr>
<td>A-13 VT94E30</td>
<td>VT94E30</td>
<td>214 E of Co Rd 37 Albertville</td>
<td>202.9</td>
<td>45°13.740' N</td>
<td>93°37.552' W</td>
<td>1/15/2012</td>
<td>LedViz MSNG-26X130</td>
<td>28 x 130</td>
<td>201112178</td>
<td>2011100153</td>
<td>192.168.13.30</td>
<td>1</td>
<td>166.150.194.244</td>
<td>CA11941404110</td>
<td>60E4D7E2</td>
</tr>
</tbody>
</table>
2.3.4 INTELLIGENT ROADWAY INFORMATION SYSTEM (IRIS)
The Mn/DOT Regional Transportation Management Center (RTMC) operates Intelligent Roadway Information System (IRIS) as its primary traffic management control system. IRIS operates in a client server environment, with the primary server housed in the computer room at the RTMC. Clients are operated at computer consoles within the RTMC control room and can be used remotely with wide area networking or Internet connection between the client and server. This system requires a secure, high-speed connection (i.e., Mn/DOT fiber optic) or security appliance for Internet access. The IRIS system was developed internally by Mn/DOT staff and because this is an agency product no additional software license is needed to operate or expand its current use, it is considered “Open Source” software.

IRIS has been expanded to support traffic management/traveler information activities in Duluth, St. Cloud and Rochester. TMC/TOCC operators in all of these locations have been trained in the use of IRIS. The St. Cloud deployment operates as a ‘satellite’ installment of IRIS, running off of the primary IRIS system installed at the RTMC in Roseville. IRIS software is currently used to manage ITS field devices and record planned and unplanned events along the corridor. Currently operators interface through IRIS to post messages to the CMS along this corridor based on field reports of road conditions. The IRIS interface with CMS allows the operator to build a message from a stored library of messages. An IRIS operator can choose the message content for each line of the CMS. No “free form” messages are placed through IRIS without the consent and advance approval of TMC Supervisors. Operators must perform these and many other tasks along the I-94 corridor and many other corridors throughout the district. A significant burden would be placed on the operator to attempt to obtain the location of a slow-moving maintenance vehicle and then place the appropriate message to the CMS and then monitor the plow position in order to blank the message of the CMS all while tracking the maintenance vehicle to the next downstream CMS. Logically, an automated process to place a relevant message between the maintenance vehicle and the CMS is warranted and would not place unrealistic responsibilities on the IRIS operator.

The core functions of the IRIS system include:

- Controlling Changeable Message Signs (CMS) by allowing operators to view current messages and activate messages as needed from the TMC control software;
- Receiving and recording live motion video feeds from closed circuit television cameras. IRIS is capable of controlling cameras by sending pan/tilt/zoom commands to the cameras, but most operators prefer use of the keyboard and joystick connected to the video switcher;
- Maintaining communications with the over 2000 loop detectors on the roadways to collect, process, archive and make the traffic flow data available as needed;
- Controlling ramp meters through a combination of automated and manual control depending upon observations and reactions to real-time traffic conditions.

Additional capabilities include:

- Incident logging
- Control of the Intelligent Lane Control signs and the Variable speed advisories.
- Maintenance capabilities to assist in troubleshooting issues.
Dynamic Message Sign Control
The IRIS system performs two key functions with regard to Changeable Message Signs (CMS):
- Allowing a CMS user interface;
- Performing all communication aspects needed to communicate with and control signs.

User Interface.
The IRIS system allows operators to graphically view all locations of CMS signs in the field as well as a list view. Operators may select from an existing CMS message library to build messages to be displayed on the signs. A security feature allows operators to only select from pre-formed messages and only allows approved system administrators to type other messages into the system. The user interface allows operators to click on any sign and view the current status of the sign as well as the current message displayed. Abducted Child (Amber Alert) capabilities are also supported on the IRIS CMS control utilizing the ability to deploy sign plans in which any number of signs can display various messages either manually or at pre-programmed times. Only a limited number of supervisors or administrators are authorized to post messages of this type to the CMS.

Sign Control
The IRIS system performs communications and control processes with CMS signs using NTCIP standards. The communications system controller relays commands in order to post messages on to the signs, and is also capable of querying CMS to determine displayed message status and to obtain status reports on sign functionality.

Message Priority
The IRIS system uses prioritization to determine which messages are more important to the traveling public. The following list describes the priority levels as defined by the IRIS system:

1. Unscheduled messages (i.e., incidents, road work)
2. Scheduled messages
   a. Incident – Medium (used for Lane Control Signs)
   b. Incident – Low
   c. Scheduled construction
   d. Travel times
   e. PSA’s

WZARD messages are defined in the IRIS system as “Incident – Low”, which is the highest level scheduled message for CMS. TOCC Operators should be aware that any message manually entered by an operator will override a WZARD message.
IRIS Interaction with WZARD
WZARD and IRIS are two separate programs that interact together to post messages to CMS. If WZARD identifies the need to post a message to a CMS, WZARD sends IRIS a request to post a message, depending on the roadway/weather conditions gathered from MDSS and AVL data. The WZARD message tells IRIS to which sign a message should be posted, the wording of the message and timestamp information. The IRIS system polls the WZARD system every 30 seconds for message requests. The IRIS system then determines if the message request will be posted based on whether or not an existing message is present in the system and at what priority level.

2.3.5 MAINTENANCE DECISION SUPPORT SYSTEM (MDSS)
Meridian currently provides MnDOT with statewide weather forecasting support and Maintenance Decision Support System (MDSS) operations. This includes District 3 and specifically I-94 from just north of Rogers to St. Cloud. Users of MDSS are able to get snow plow route specific information including pavement conditions, weather information, and even snow plow data specific to the routes. Meridian works directly with MnDOT’s third party vendor of AVL/MDC technologies, AmeriTrak, to ingest and interpret data collected within the snow plows. This data can include location (i.e., latitude and longitude), lane position (driving vs. passing), truck speed and direction, plow status, weather and road conditions, and type/application rate of deicing chemical spreading. MnDOT is not using MDSS lane position features at the present time in part to avoid the need for snow plow and truck operators to enter data manually into the system (current GPS technology cannot pinpoint exact vehicle location). This data is integrated throughout the state for trucks equipped with AVL/GPS, including the portion of the I-94 corridor where the WZARD system and this project are located.

2.3.6 AMERITRAK AVL/GPS SYSTEM
The WZARD system relies on AVL/GPS data from the snow plow to determine its location. The District 3B MnDOT fleet is equipped with AmeriTrak AVL/GPS equipment. The WZARD system is able to directly access information from the AmeriTrak equipment without any interaction through IRIS. See Appendix A for a cut sheet on the AmeriTrak equipment.

Contact AmeriTrak for maintenance or failures associated with the AVL/GPS system (see Section 4.1 contact information).
3.0 PREVENTATIVE MAINTENANCE

3.1 ROUTINE/SCHEDULED MAINTENANCE
Any updates needed to be performed to the WZARD system will be done by Meridian Environmental Technologies.

Meridian Environmental Technologies, MnDOT District 3B and RTMC staff shall be notified prior to beginning any troubleshooting or repair procedure.

System downtime should be limited.

3.2 REVISION LOG
Any updates performed to the WZARD system should be logged by all parties. Once the WZARD system has been modified, some or all of the following information shall be documented in accordance with agency policies:

- Location
- Date procedure was completed
- Name of person and/or agency performing procedure

3.3 SYSTEM LOG INFORMATION

3.3.1 WZARD SYSTEM LOGS
The WZARD system is capable of generating a variety of system logs. A list of available system logs include:

- Sign activation request and sign termination request by WZARD
- AVL/GPS data log
- AVL/GPS vehicle information (location, speed, etc.)
- Vehicle validation information

If the need is identified, there is the ability to generate additional system logs. Contact Meridian Environmental Technologies to obtain all WZARD log info, which will be kept permanently on file.

3.3.2 IRIS SYSTEM LOGS
IRIS is also capable of producing log information. The logs provided by IRIS include:

- WZARD request acceptance information
- CMS activation and termination timestamps
- CMS message information

Contact Steve Toughill to obtain all IRIS log info kept on file.
3.4 SCHEDULED DOWN TIME

The criticality of the specific failure on the system will determine the urgency for troubleshooting and/or repair activities. If possible, these activities should be scheduled in advance, ideally during non-peak periods.

Meridian Environmental Technologies, MnDOT District 3B and RTMC staff shall be notified prior to beginning any troubleshooting or repair procedure.

System downtime should be limited.

3.5 TROUBLESHOOTING

A quick reference guide for the troubleshooting section of each WZARD system component is show below:

| TABLE 3: QUICK REFERENCE GUIDE FOR SCORE WZARD TROUBLESHOOTING SECTIONS |
|-------------------------------------------------|-----------------|-----|
| Component                                      | Section         | Page |
| Changeable Message Signs                       | 2.3.1           | 6   |
| Changeable Message Sign Controllers            | 2.3.2           | 8   |
| Communications                                 | 2.3.3           | 8   |
| IRIS                                           | 2.3.4           | 10  |
| MDSS                                           | 2.3.5           | 12  |
| AmeriTrak AVL/GPS                              | 2.3.6           | 12  |

4.0 EMERGENCY CONTACTS

4.1 24-HOUR CONTACTS

| TABLE 4: ITERIS COMPANY CONTACTS FOR WZARD FAILURES |
|-------------------------------------------------|-----------------|-----------------------|
| Contact Name                                    | E-mail          | Phone Number          |
| Lisa Raduenz                                    | ljr@iteris.com  | (612) 371-9200 – office |
| (9 am – 5 pm Mon-Fri)                           |                 | (651) 399-4099 - cellular |
| Dwight Shank                                    | des2@iteris.com | (301) 562-1453 – office |
| (7 am – 4 pm Mon-Fri)                           |                 | (301) 922-1819 – cellular |
| Greg Ostermeier                                 | grego@meridian-enviro.com | (701) 792-1865 – office |
### TABLE 5: DISTRICT 3B CONTACTS FOR WZARD FAILURES

<table>
<thead>
<tr>
<th>Contact Name</th>
<th>E-mail</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steve Toughill</td>
<td><a href="mailto:steve.toughill@state.mn.us">steve.toughill@state.mn.us</a></td>
<td>(320) 223-6510</td>
</tr>
</tbody>
</table>

### TABLE 6: AMERITRAK CONTACTS FOR AVL/GPS FAILURES

<table>
<thead>
<tr>
<th>Contact Name</th>
<th>E-mail</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jeff Edelstein</td>
<td><a href="mailto:jeff@ameritrack.biz">jeff@ameritrack.biz</a></td>
<td>(612) 310-1419</td>
</tr>
</tbody>
</table>
### DMS CONTROLLER SPECIFICATIONS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model No.</td>
<td>CTL-24</td>
</tr>
<tr>
<td>Dimensions</td>
<td>19.0&quot; W x 13.5&quot; D x 3.4&quot; H (19&quot; rack mount). [483mm 343mm x 86mm]</td>
</tr>
<tr>
<td>Housing</td>
<td>Aluminum</td>
</tr>
<tr>
<td>Power</td>
<td>120 VAC, 60 W.</td>
</tr>
<tr>
<td>Weight</td>
<td>10 LB [4.5Kg]</td>
</tr>
<tr>
<td>Environmental</td>
<td>NEMA TS 4-2005</td>
</tr>
<tr>
<td>Front panel</td>
<td>Power switch, Power ON indicator, Fuse, Local/Remote switch, Keypad 4x4 alphanumeric, LCD status display.</td>
</tr>
<tr>
<td>Communication Ports</td>
<td>Remote RS232-1, Remote RS232-2, Local RS232, Ethernet 10/100, Auxiliary external input, Copper RS485 connection to DMS electronics, Fiber Optic connection to DMS electronics.</td>
</tr>
<tr>
<td>Communication protocol</td>
<td>NTCIP conformance level 1, NTCIP 1101, Simple Transportation Management Framework, NTCIP 1103, Transportation Management Protocols, NTCIP 1201, Global Object Definitions, NTCIP 1203, Object Definitions for DMS, NTCIP 2101, Subnet Profile for PMPP using RS-232, NTCIP 2102, Subnet Profile for PMPP over FSK Modems, NTCIP 2103, Subnet Profile for PPP using RS-232, NTCIP 2104, Subnet Profile for Ethernet, NTCIP 2201, Transportation Transport Profile, NTCIP 2202, Internet (TCP/IP) Transport Profile, NTCIP 2301, Application Profile for Simple Transportation Management Framework, FDOT Standard Global MIB</td>
</tr>
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