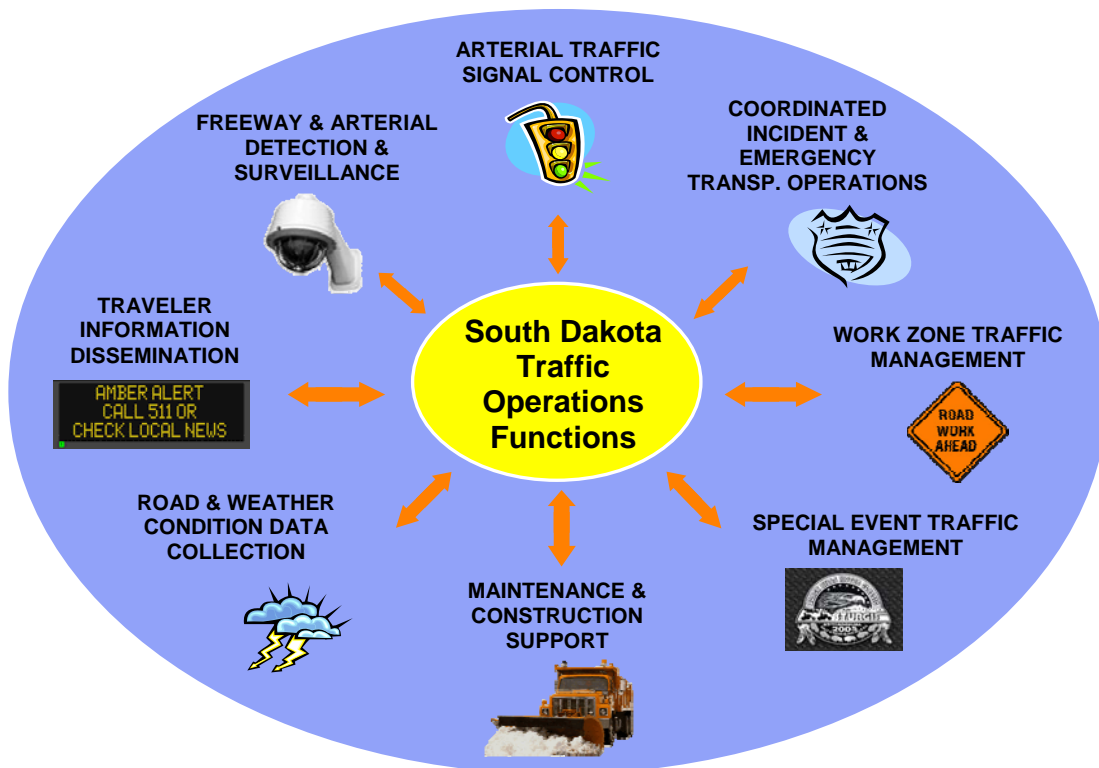


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Office of Research



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SD2005-04-F



Traffic Operations Center Concepts for South Dakota

Study SD2005-04
Final Report

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June 2006

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GLOSSARY OF ACRONYMS

ATMS	Advanced Traffic Management System
AVL	Automatic Vehicle Location
BIT	Bureau of Information and Telecommunications
C2C	Center-to-Center
C2F	Center-to-Field
CAD	Computer-Aided Dispatch
CCTV	Closed Circuit Television
CM	Configuration Management
CMAQ	Congestion Mitigation and Air Quality Program
CCB	Configuration Control Board
COTS	Commercial-Off-The-Shelf
CVO	Commercial Vehicle Operations
D/B	Design-Build
DCI	Division of Criminal Investigation
DMS	Dynamic Message Signs
DPS	Department of Public Safety
EOC	Emergency Operation Center
ESF	Emergency Support Function
ESS	Environmental Sensor Stations
FHWA	Federal Highway Administration
FTE	Full-Time Equivalent
GIS	Geographic Information System
GPS	Global Positioning System
HAR	Highway Advisory Radio
HOV	High Occupancy Vehicle
ICS	Incident Command System
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IP	Internet Protocol
ITE	Institute of Transportation Engineers
IMP	Incident Management Plan
IMS	Incident Management System
ITS	Intelligent Transportation System
JOM	Joint Operations Management
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MDSS	Maintenance Decision Support System
MET	Meridian Environmental Technology, Inc.
MOU	Memorandum of Understanding
MUTCD	Manual of Uniform Traffic Control Devices

NHS	National Highway System
NIMS	National Incident Management System
NLETS	National Law Enforcement Telecommunication System
NTCIP	National Transportation Communication for ITS Protocol
PSAP	Public Service Access Point
QC/QA	Quality Control/Quality Assurance
RCRS	Road Condition Reporting System
RFI	Request for Information
RFID	Radio Frequency Identification
RFP	Request for Proposal
RTOC	Regional Transportation Operation Center
RWIS	Road Weather Information System
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SAN	Storage Area Network
SDDOT	South Dakota Department of Transportation
SDDPS	South Dakota Department of Public Safety
STP	Surface Transportation Program
TMC	Traffic Management Center
TMS	Traffic Monitoring Station
TOC	Traffic Operation Center
UDOT	Utah Department of Transportation
UPS	Uninterruptible Power Supply
VMS	Variable Message Signs

1.0 EXECUTIVE SUMMARY

1.1 PROBLEM DESCRIPTION

In May of 2005, the South Dakota Department of Transportation (SDDOT) undertook a research project to help define traffic operations needs, functions, projects, programs and procedures applicable to South Dakota. The central question posed by this research was, “What is the most effective and economical means of managing traffic and emergency operations in South Dakota?” A corollary to this question involves the need for, and form of, a traffic operations center for the South Dakota Department of Transportation and its partners.

When most people think about traffic operations, they usually think about the need to manage traffic congestion. However, traffic operations are not related entirely to traffic congestion management. In a broader sense, traffic operations include:

- The ability to make better use of the existing transportation infrastructure – efficient management of resources
- Being prepared for growth and unforeseen situations – effective planning
- Improved response to traffic incidents, events and emergencies – action
- Applying proven traffic management tools and methods – technology
- Cooperation among agencies – partnerships and integration

This document identifies South Dakota’s traffic operations needs within this context and presents a set of recommendations for improved traffic operations throughout the state.

1.2 RESEARCH OBJECTIVES

The South Dakota Department of Transportation (SDDOT) identified the following research objectives for this project:

- Identify functionality needed to support traffic operations within South Dakota and in coordination with bordering states.
- Assess traffic operations functions, systems, and processes currently employed or planned by state and local agencies in South Dakota.
- Develop a strategic deployment plan – including descriptions of capabilities, identification of needed resources and infrastructure support, and estimates of costs and benefits – for establishing and maintaining traffic operations control functionality appropriate to South Dakota’s needs.

During the course of this project, the research team identified an additional objective to define a traffic operations center concept that is appropriate for South Dakota.

1.3 GENERAL APPROACH

In order to meet these objectives, the following research methodology was employed:

- A literature review was conducted to investigate Traffic Operations Center (TOC) concepts, TOC functions, and current or planned projects specific to South Dakota. The Federal Highway Administration Office of Operations was a valuable resource for many of the related topics. The TMC Pooled-fund Study and ITE TMC websites were also searched for relevant information. Various DOT web sites were visited to find operational concept materials.
- TOC and ITS managers in other states were surveyed to obtain information about their traffic operations programs. A survey instrument was developed and utilized to gather this information.
- A series of regional workshops was conducted in South Dakota to obtain information from stakeholders regarding traffic operations needs, functions, and preferences. Workshops were held in Sioux Falls, Rapid City and Pierre during July 2005. These workshops allowed the research team to engage stakeholders from different regions of the state in identifying traffic operations issues and opportunities for improvement.
- The experience and professional expertise of the research team was utilized to perform the analyses and to develop the strategic deployment plan.

The information gathered during the research effort was compiled and documented in a technical memorandum entitled, “A Review of Traffic Operation Concepts for South Dakota.” Traffic operations needs, functions, capabilities, and priorities were identified and presented in that technical memorandum. Alternative TOC concepts to address these needs and to carry out proposed functions also were presented. A follow-up workshop was held with key stakeholders to present the results of the first workshop series and a recommended TOC concept approach.

One month after the follow-up workshop was conducted in Pierre, a fierce snowstorm, causing travel restrictions and widespread power failures, struck South Dakota. As a result of this storm, a temporary statewide Emergency Operations Center (EOC) was activated in the Governor’s conference room (the newly constructed EOC was not ready) and remained in active mode for two weeks as recovery efforts took place. The SDDOT played a significant emergency response role in clearing state and local roads, providing road condition information to other response agencies and to the general public, assisting with search and rescue operations, providing equipment and personnel as needed, and assisting in the distribution of power generation equipment to areas without power.

This storm and the activation of the statewide EOC created the impetus for more in-depth evaluation of the links between traffic operations and emergency operations. Consequently, the research effort was expanded to include a series of interviews with key state government personnel who were involved in the EOC activation in order to identify lessons learned and to help define more thoroughly how traffic operations and emergency operations might be integrated.

This document is intended to present the key findings and recommended actions to be taken by the SDDOT to improve traffic operations in South Dakota. The document includes a definition of the recommended TOC concept, which will help SDDOT meet its mission of providing traffic operations capabilities that satisfy the diverse mobility, highway safety, and emergency management needs of South Dakota. Traffic operations strategies, deployment projects, and operational procedures also are presented as part of a phased strategic deployment plan for traffic operations in South Dakota. Seven key recommendations are offered to support future traffic operations functions and needs.

1.4 KEY FINDINGS

One of the key findings of this research is that SDDOT and its partner agencies have been proactive in dealing with traffic and emergency operations issues. SDDOT is a national leader in the collection of road condition data and in the provision of traveler information services, such as 511 and the SafeTravelUSA.com website. SDDOT also is the lead agency on a pooled fund study for the development of a Maintenance Decision Support System (MDSS), primarily aimed at improving the efficiency and effectiveness of winter maintenance operations.

SDDOT also has been actively deploying field devices to support traffic operations capabilities throughout the state. Dynamic message signs (DMS) have been installed along I-90 and I-29 near cities and key interchanges. Environmental sensor stations (ESS) are located throughout the state to collect localized road and weather conditions. Closed circuit television (CCTV) cameras have been deployed at strategic locations, and more are planned as part of an ESS upgrade program. Closed loop traffic signal control systems and emergency vehicle traffic signal preemption systems are common in most urban areas.

Few places in South Dakota experience traffic congestion on a recurring basis. Sioux Falls and Rapid City have pockets of heavy traffic during peak travel times, but most traffic problems are “event-driven.” Events may include traffic incidents, highway work zones, severe weather, fires, floods, or special events, such as the annual Sturgis Motorcycle Rally. Generally, such events call for collaborative efforts between SDDOT and other state or local agencies. A common theme derived from stakeholder workshops involved the need for greater cooperation and coordination, not only among different agencies, but also among SDDOT regions and offices involved in traffic and emergency operations.

SDDOT has strong relationships with other departments of state government, including the South Dakota Department of Public Safety (SDDPS), which includes the South Dakota Highway Patrol and the South Dakota Office of Emergency Management. The relationship between SDDOT and SDDPS appears to have been strengthened during the course of this research project. While the stakeholder workshops effectively brought key decision-makers from these two organizations together to discuss traffic and emergency management issues, the benefits of partnering became even more apparent during the winter storm in late November of 2005, when SDDOT and SDDPS worked together during this widespread emergency.

Given that traffic problems are event-driven, it was not surprising to find that road and weather conditions were identified as the primary concern of traffic operations stakeholders throughout South Dakota. This was universal across all regions of the state. It was also not surprising to find regional differences in traffic operations needs. For example, in the Sioux Falls and Rapid City areas, traffic signal control, special events, work zones and traffic incident management were given greater importance than they were in the central part of the state. In the Rapid City and Pierre regions, communications capabilities, especially to remote locations, were a primary concern. Stakeholders at the Pierre workshop, many of which were state government employees, presented more of a statewide perspective, especially related to centralized services for emergency operations, traffic operations planning and policy development, information technology administration, and traveler information dissemination.

Despite regional differences exhibited by stakeholders, some common themes emerged to help guide the development of the traffic operations strategies contained in this report. Those themes included the need for:

- More timely and accurate traffic and travel condition information
- Better coordination among agencies, especially regarding emergency operations
- Greater interregional coordination of traffic operations activities
- Better communications coverage throughout the state
- Improved and more uniform traffic operations policies and procedures
- Better planning for traffic operations
- An integrated set of tools and methods for traffic operations
- Dedicated funding for traffic operations and Intelligent Transportation Systems (ITS)

These key findings enabled the research team to identify traffic operations functions, strategies and an appropriate TOC concept for South Dakota.

1.5 CONCLUSIONS

The primary conclusions derived from this study include:

1. Eight primary traffic operations functions were defined based on the traffic operations needs identified by stakeholders. These eight functions, shown in Figure 1, would provide the basis for an integrated traffic operations program in South Dakota.
2. A distributed hybrid TOC concept was defined to meet statewide traffic operations needs and to perform the functions identified in Figure 1. The vision for this distributed hybrid TOC concept, summarized in Figure 2, includes the following primary elements:
 - a. A statewide TOC in Pierre. The Pierre TOC would have statewide purview, but would also meet regional traffic operations needs. The Pierre TOC is envisioned to be collocated with State Radio Dispatch at the statewide EOC to provide a critical link between traffic and emergency operations. The Pierre TOC would be operated on a 24/7/365 basis.
 - b. Regional TOCs in Sioux Falls and Rapid City. These regional TOCs would provide redundancy for the statewide TOC while also meeting regional traffic operations needs.
 - c. Virtual TOC capabilities to facilitate remote access to TOC functions for other SDDOT offices and partner facilities.
 - d. Broadband communications connecting the TOCs for data exchange and redundancy. Since the regional TOCs are not expected to be operated on a 24/7/365 basis, a high-speed broadband communications link with the Pierre TOC would facilitate regional operations after normal working hours while also enabling redundancy in case of catastrophic failure at one of the TOCs.
 - e. All three TOCs would operate the same standard software and hardware systems for interoperability and ease of maintenance. While all of the TOCs will operate the same advanced traffic management system (ATMS) software, the functions performed at each TOC may vary.
3. A phased deployment plan was developed for traffic operations improvements. The plan is summarized in Table 1. Specific actions and projects were identified in order to meet traffic operations needs and to implement the functions prescribed by traffic operations stakeholders

in South Dakota. The outcome is a set of early or high priority actions, short-term projects, mid-term projects and long term projects. Each project includes an estimated cost for deployment. The total ten-year program costs are estimated at \$1.1 to \$2.6 million.

4. An implementation approach with the following components should be employed to manage the traffic operations program:
 - a. Utilization of the systems engineering process for each project.
 - b. A phased approach with projects of one year or less in duration.
 - c. SDDOT should employ a full-time system manager to oversee the deployment program.

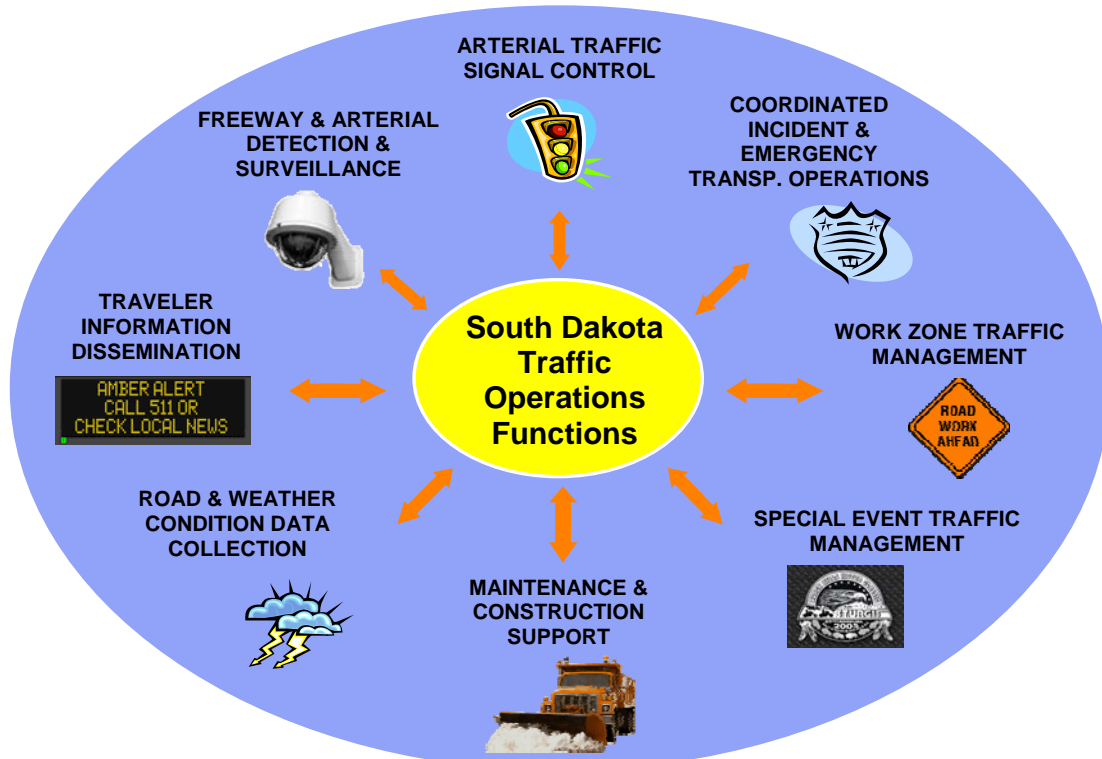


Figure 1 – ITS Functions in South Dakota

5. Many low-cost, yet highly effective procedures were identified to improve traffic operations capabilities as soon as possible. Some of these procedures are already being implemented:
 - a. More clearly define statewide ATMS device operational guidelines and procedures (DMS, CCTV, HAR, etc.)
 - b. Clearly define ATMS device control and RCRS user rights and privileges
 - c. Refine procedures and standards for RCRS data entry
 - d. Establish an ATMS training program and provide training on a continual basis
 - e. Involve SDDPS more fully in traffic planning
 - f. Provide regular incident management training and exercises for SDDOT personnel in cooperation with SDDPS personnel
 - g. Conduct operations training for regional and area office staff
 - h. Provide NIMS and ICS training to key SDDOT staff and establish layers of authority for resource allocation to improve “bench depth” during emergencies

Table 1 - Phased Implementation Projects

Implementation Project	Estimated Cost
Early Action Projects (within 1st Year)	
Develop TOC Concept of Operations	\$25,000 - \$35,000
Develop Statewide Network Communication Requirements and Design	\$25,000 - \$30,000
Develop South Dakota TOC/ATMS Software Requirements and Evaluation	\$40,000
Develop Requirements and Implement Interim Pierre TOC System and Facility	\$40,000
Develop Interim Guidelines for Operational Use of Existing ATMS Devices	\$20,000 - \$25,000
SUBTOTAL	\$150,000 - \$170,000
Near-Term Projects (1-2 years)	
Design and Implement Expanded Statewide/Regional Pierre TOC	\$80,000
Implement ATMS Communications	
Procure and implement TOC ATMS Hybrid Software	\$120,000 - \$350,000
Develop Statewide Traffic Operations Plan, Operational Guidelines and Procedures	\$80,000 - \$100,000
Enhance RCRS to Include Incident Information and Integrate with ATMS Software	\$50,000
Develop Incident Diversion and Special Event Plans	\$25,000 - \$100,000
Implement Asset Tracking and ITS Inventory Management System	\$50,000 - \$500,000
Establish Virtual TOC Capabilities	\$25,000 - \$100,000
SUBTOTAL	\$430,000 - \$1,280,000
Mid-term Projects (3-5 years)	
Develop System and Facility Design Requirements for Regional TOCs in Sioux Falls and Rapid City	\$15,000 - \$25,000
Implement Regional TOCs in Sioux Falls and Rapid City	\$120,000 - \$300,000
Integrate MDSS into TOC Operations	\$200,000 - \$500,000
Develop Requirements For and Implement a Computer Aided Dispatch System	\$165,000 - \$215,000
SUBTOTAL	\$500,000 - \$1,040,000
Long-Term Projects (6-10 years)	
Integrate State Radio CAD at Pierre with TOC ATMS / RCRS	\$30,000 - \$50,000
Develop Intertie Between the Sioux Fall and Rapid City 911 Centers and Regional TOCS and Integrate 911 Center CAD Systems with TOC ATMS/IMS	\$40,000 - \$60,000
SUBTOTAL	\$70,000 - \$110,000
TOTAL COSTS	\$1,150K - \$2,600K

- i. Educate SDDOT staff on Emergency Support Functions (ESFs) included in the Statewide Emergency Operations Plan
- j. Establish an SDDOT chain of command for EOC activation
- k. Update the SDDOT contact list for after-hours support
- l. Involve SDDOT’s region and area engineers in emergency management organizations at the local and county levels for coordination during local and regional emergencies
- m. Provide more frequent and accurate weather forecasts at the EOC
- n. Manage the expectations of motorists for timely, accurate road and travel condition information through public information campaigns

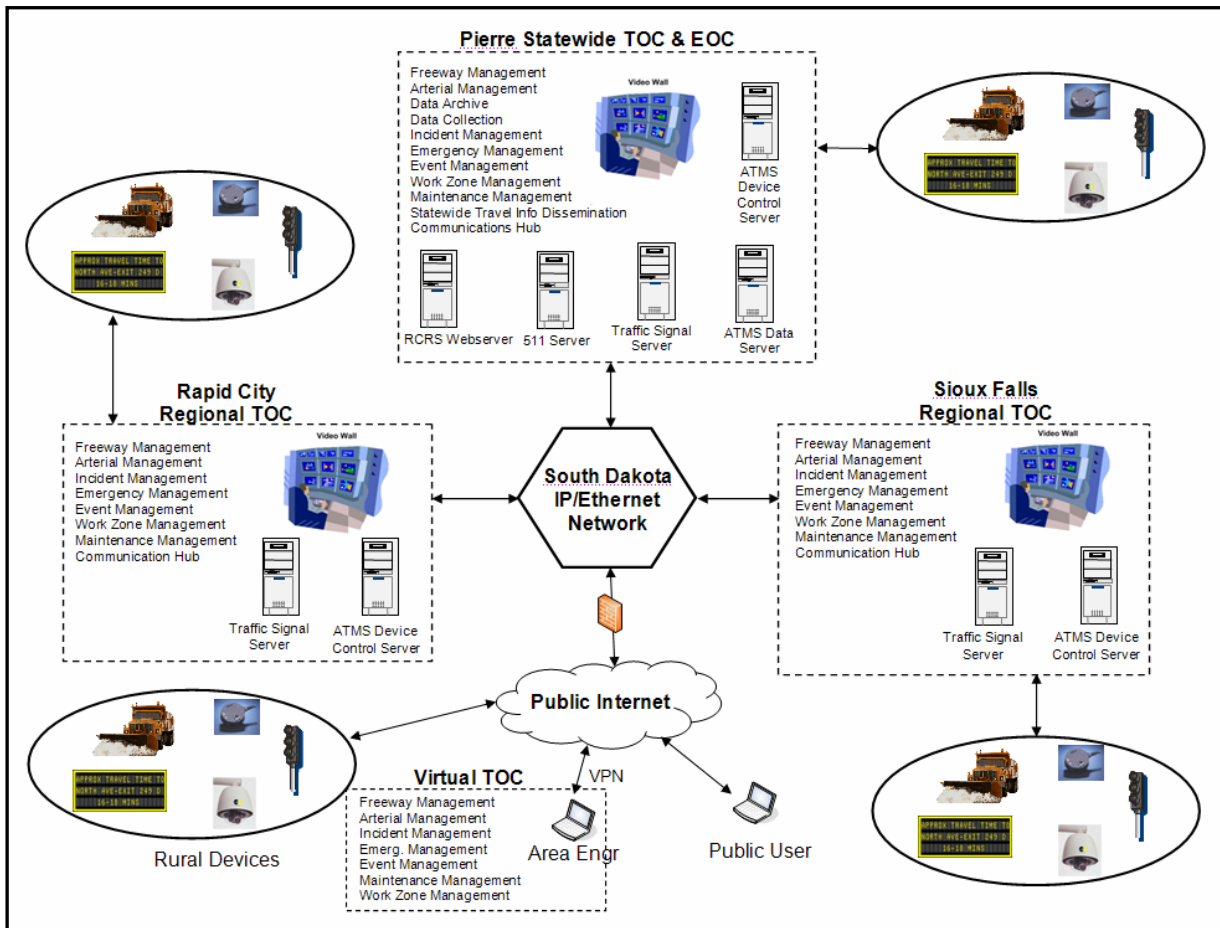


Figure 2 - Proposed South Dakota TOC Concept

Combined, these traffic operations improvements provide a solution that:

- Is practical and economical
- Leverages existing systems
- Includes critical links to emergency management
- Is consistent with federal transportation policies and guidance, and, most importantly,
- Is specific to the traffic operations needs of South Dakota.

The benefits that may be realized by SDDOT from this program include:

- More accurate, timely, and comprehensive information for decision-makers and motorists
- Improved relations with the public
 - Ability to serve more people and provide more services
 - Ability to manage expectations
- Improved efficiency and effectiveness of operations
 - Organizational enhancement
 - Well trained staff
 - Support system capabilities
 - Plans and procedures in place
- Enhanced operational partnerships

- Other departments
- Other agencies
- Other states
- Greater support for funding to support traffic operations

The TOC concept, operational strategies, actions, and projects described in this document present a road map for SDDOT to meet traffic operations needs for the next decade.

1.6 KEY RECOMMENDATIONS

Based on the findings and conclusions of this study, the researchers recommend:

- 1. Establish an Organizational Framework to Facilitate Traffic Operations.** Establishing an organizational framework to facilitate traffic operations is a key factor for successful deployment, operations and maintenance of traffic operations capabilities in most states. Therefore, the researchers recommend the following:
 - a. Create an Office of Traffic Operations
 - b. Establish a multidisciplinary ITS Steering Committee, including the following subcommittees:
 - i. Incident/Emergency Management Subcommittee
 - ii. Special Event Traffic Subcommittee
 - iii. Traffic Signal Subcommittee
 - c. Develop organizational policies and procedures
 - d. Develop statewide standards and practices for traffic operations

- 2. Formalize and Enhance Traffic Operations Plans and Procedures.** A formal plan for traffic operations and clearly defined guidelines and operational procedures will help to ensure consistency in traffic operations practices and will enable a more effective traffic operations response to events. Some of the key actions required include:
 - a. Develop a statewide traffic operations plan with ties to emergency management
 - b. Clearly define operational guidelines and procedures for ITS devices
 - c. Refine procedures for RCRS use, data entry, and content
 - d. Establish a regular training program for traffic and incident/emergency management
 - e. Establish a public information campaign to manage motorist expectations

- 3. Establish a Traffic Operations Presence in the Statewide EOC Prior to the 2006/2007 Winter.** The opportunity to collocate with State Radio in their new dispatch center has been presented. Establishing a presence in the dispatch center prior to next winter will allow SDDOT to further strengthen their partnership with SDDPS, while also preparing for possible events of similar magnitude next year. The individual actions needed include:
 - a. Collocate TOC with State Radio Dispatch in Pierre
 - b. Define operational needs, including:
 - i. Staffing
 - ii. Hours / after-hours support
 - iii. Equipment (Server, Workstations, Monitors)
 - c. Define preliminary functions and capabilities (RCRS, DMS, CCTV, RWIS)

- 4. Implement Permanent Traffic Operations Centers in Pierre, Sioux Falls, and Rapid City.** Establishing initial functionality at the State Radio Dispatch Center in Pierre is a step toward implementing a fully functioning TOC with statewide oversight in Pierre. The deployment of regional centers in Sioux Falls and Rapid City would be phased in to provide traffic operations functionality specific to those areas, while also offering system redundancy. Steps to be taken include:

 - a. Procure a statewide ATMS software license
 - b. Expand the preliminary capabilities of the Pierre TOC for full statewide and regional functionality
 - c. Implement regional TOCs in Sioux Falls and Rapid City

- 5. Expand SDDOT's ITS Capabilities.** Expansion of ITS capabilities would be on two levels – geographically to cover remote locations and functionally by adding new features on an incremental basis as needs arise and as resources dictate. One of the first steps would be to establish virtual TOC capabilities for SDDOT field offices and partner facilities. Other possible capabilities include:

 - a. Establish virtual TOC capabilities for remote offices and partner facilities
 - b. Address statewide ITS device deployment needs
 - c. Enhance communications capabilities to remote locations
 - d. Provide linkages to other states
 - e. Provide additional functionality beyond core capabilities
 - i. 911 CAD / TOC interface
 - ii. Asset Tracking and Inventory Management

- 6. Utilize Proven Tools and Methodologies for ITS Design, Deployment and Operations.** The design, deployment and operation of high technology applications require a systematic approach that helps to manage changes over time. Changes in technology, operating environment, system configuration, and functions need to be managed, and the following tools are available for that purpose:

 - a. Systems engineering approach for project development
 - b. Statewide ITS Architecture
 - c. ITS Standards
 - d. Configuration management
 - e. Asset management

- 7. Allocate Annual Funding for ITS Deployment, Operations and Maintenance.** ITS and traffic operations generally fall outside of traditional transportation project development and funding processes. They also involve ongoing activities and processes that are non-traditional in nature. Often, traffic operations projects and programs compete with more traditional projects for scarce resources. Successful traffic operations programs do the following:

 - a. Mainstream ITS deployment and operations into normal project development and programming processes
 - b. Seek additional federal funding for ITS deployment and operations
 - c. Establish annual capital and operating budgets for ITS

2.0 PROBLEM DESCRIPTION

Many public agencies are facing a common problem – a growing need to emphasize management and operations of their transportation networks. ITS provides some of the tools that these agencies have at their disposal to facilitate improved traffic operations and highway safety, yet the effective utilization of these tools requires planning, coordination, technical and procedural integration, and, in most cases, unprecedented inter-agency cooperation.

While this problem may be widespread, the traffic operations needs in South Dakota are unique. South Dakota is characterized by a blend of small, yet vibrant metropolitan areas, vast and somewhat isolated rural areas, and sizable seasonal variations in traffic and road conditions. Interstate highways 29 and 90 carry traffic whose origins and destinations often extend beyond the state’s boundaries. Highway construction and maintenance activities on these Interstate routes often have far-reaching impacts on traffic conditions. Weather conditions, especially in winter, can dramatically impact travel and the safety of motorists, as evidenced by the blizzard that occurred in late November of 2005.

SDDOT has focused on the deployment of systems to detect, monitor and disseminate information about road conditions, weather, work zones, special events and incidents. A statewide 511 Traveler Information Service, the SafeTravelUSA.com website and a system of dynamic message signs, strategically placed along South Dakota’s interstate highways, are supported by SDDOT’s Road Condition Reporting System (RCRS). Partnerships with the public safety community, local government, other departments of state government and the media have been established to support the vision of a statewide, integrated ITS. The critical next step is to proactively integrate these elements into an effective, statewide traffic and transportation emergency operations program.

The central question posed by this research project is, “What is the most effective and economical means of managing traffic and emergency operations in South Dakota, given current and anticipated conditions and the respective roles of responsible public agencies?” A corollary to this question involves the need for, and form of, a traffic operations center to manage these operations.

When most people think about traffic operations, they usually think about the need to manage traffic congestion. However, traffic operations are not related entirely to traffic congestion management. In a broader sense, traffic operations include:

- The ability to make better use of the existing transportation infrastructure. The efficient management of resources, including not only transportation infrastructure, but also equipment, materials, and staffing, is vitally important for optimizing the use of public funds.
- Being prepared for growth and unforeseen situations. Effective traffic operations require planning, not only to anticipate unforeseen situations, but also to cover daily operational needs.
- Improved response to traffic incidents, events and emergencies. Traffic operations are about taking action. Unlike traditional transportation projects, traffic operations are ongoing and require continuous monitoring and management.
- Applying proven traffic management tools and methods. Traffic operations involve the use of technology to monitor road and traffic conditions, to assist with decision-making, and to take the actions required to optimize the use of the transportation network.
- Cooperation among agencies. More than anything else, traffic operations are a cooperative effort that requires partnerships and integration among a broad array of stakeholders.

This document identifies South Dakota’s traffic operations needs within this context and presents a set of recommendations for improved traffic operations throughout the state.

3.0 STUDY OBJECTIVES

The South Dakota Department of Transportation identified the following research objectives for this project:

- Identify functionality needed to support traffic operations within South Dakota and in coordination with bordering states.
- Assess traffic operations functions, systems, and processes currently employed or planned by state and local agencies in South Dakota.
- Develop a strategic deployment plan – including descriptions of capabilities, identification of needed resources and infrastructure support, and estimates of costs and benefits – for establishing and maintaining traffic operations control functionality appropriate to South Dakota’s needs.

In order to meet these objectives, the research team engaged traffic and emergency operations stakeholders throughout South Dakota to help define traffic operations functions and a traffic operations center concept that is practical and economical, that builds upon current systems, and that includes links with emergency management.

The tasks undertaken by the research team to meet these objectives are described below.

4.0 TASK DESCRIPTIONS

The phases that comprised the recommended research design and associated tasks required to accomplish related objectives follow:

TASK 1: MEET WITH TECHNICAL PANEL

Meet with the project's technical panel to review project scope and work plan.

The Iteris research team met with the Project Technical Panel on May 19, 2005 to define the preliminary scope of the research project and to present a work plan for the successful completion of the research. After a presentation to the Technical Panel, meetings were conducted with individual stakeholders, including the State Highway Patrol, the City of Sioux Falls Traffic Engineer, the Federal Highway Administration, and various personnel from SDDOT. These meetings were used to collect data for subsequent tasks and to establish relationships with key stakeholders in the process.

TASK 2: ATTEND NATIONAL HIGHWAY INSTITUTE'S HIGHWAY INCIDENT MANAGEMENT COURSE

Attend the National Highway Institute's Highway Incident Management workshop scheduled for presentation in South Dakota on May 9-13, 2005 to become familiar with the status of traffic operations in the state.

The Iteris research team attended the National Highway Institute (NHI) Incident Management workshop held on May 9-13, 2005 in Sioux Falls. The workshop was helpful in establishing a baseline for the status of traffic operations in South Dakota. The workshop presented an opportunity for the research team to interact with incident managers and traffic operations stakeholders. Discussions were held with many of the workshop participants to gain a fuller understanding of their roles and responsibilities, and the current state of incident management in South Dakota.

TASK 3: DEVELOP STAKEHOLDER WORKSHOP MATERIALS

Prepare, and submit to project's technical panel for approval, materials suitable for use at stakeholder meetings, describing traffic operations concepts and methods.

The Iteris research team prepared materials for use at stakeholder workshops. The materials included:

- Meeting notices and invitations
- Meeting agendas
- Interactive presentation materials
- Graphical presentations of TOC concepts

This task involved the design of the workshop format, and data collection processes and instruments. The format of the workshops called for a morning session to educate the stakeholders on traffic operations concepts and an afternoon session for break-out groups to discuss a variety of critical issues

related to traffic operations in South Dakota. The workshop materials were submitted to SDDOT in advance for approval of all content and format.

TASK 4: STAKEHOLDER WORKSHOPS

Conduct meetings with public and private stakeholders in and adjacent to South Dakota to identify current and emerging traffic operations needs and potential benefits and to assess current processes, capabilities, problems, limitations, or duplication.

The Iteris research team, in cooperation with SDDOT, conducted three regional stakeholder workshops in Sioux Falls, Rapid City and Pierre during July of 2005. Stakeholders from a broad array of concerned organizations, including the Highway Patrol, local police, emergency management personnel, local traffic engineers, tribal leaders, SDDOT staff, county highway personnel, and members of other departments of state government, attended the workshops. ITS engineers from Minnesota, Nebraska, Iowa, and North Dakota attended the workshop in Sioux Falls to discuss interstate issues related to traffic operations.

The workshops were very useful in defining the key traffic operations issues facing state and local officials. The workshop results were compiled and presented to SDDOT in a technical memorandum. Many of the results are summarized later in this document. The findings from the workshops were part of the source data used to develop study conclusions and recommendations for improvements as defined in this report.

TASK 5: REVIEW OF OTHER JURISDICTIONS OPERATIONAL EXPERIENCES

Review other jurisdictions' traffic operations experience, plans, problems, and solutions applicable to South Dakota.

The Iteris research team conducted a literature review and telephone surveys to evaluate traffic operations programs in other states throughout the country. The effort focused on those states with similar attributes to South Dakota – primarily a northern tier state, largely rural in nature, with variable and often severe weather conditions. The states selected for this research face similar traffic operations challenges as those faced in South Dakota.

The results of the literature review and phone surveys were used to refine traffic operations center concepts presented to the stakeholders during workshops in July 2005. The findings were reported in a technical memorandum that also included the workshop results.

TASK 6: TECHNICAL MEMORANDUM #1 - DEVELOP CANDIDATE TRAFFIC OPERATION CONCEPTS

Submit to the project's technical panel a technical memorandum that summarizes the findings of Tasks 4 and 5 and suggests candidate traffic operations concepts that could be effectively applied throughout the state of South Dakota.

The Iteris research team prepared a technical memorandum that captured the results of the literature review, phone surveys, and regional traffic operations workshops. Eight primary traffic operations

functions for South Dakota were defined in the technical memorandum. In addition, three traffic operations center concepts were identified for further consideration by SDDOT.

TASK 7: STAKEHOLDER FEEDBACK

Conduct meetings with public and private stakeholders and with the project's technical panel to obtain feedback on the traffic operations concepts developed in Task 7.

A second stakeholder workshop was conducted in Pierre in October of 2005 to present the findings of the research effort, as summarized in the first technical memorandum, and to identify stakeholder preferences for a TOC concept. A presentation of traffic operations functions and alternative TOC concepts was given to the stakeholders. Through discussion and specifically designed survey forms, the research team was able to capture sufficient feedback to refine the traffic operations functions and to identify a single, preferred TOC concept. A detailed definition of this concept was developed and submitted to the Technical Panel for their review and feedback.

TASK 8: INTERVIEWS WITH STATE PERSONNEL INVOLVED IN EMERGENCY OPERATIONS

Conduct interviews with state government employees and executives involved in the activation of the Emergency Operations Center during the blizzard of November 2005. This task was added to help define the inter-agency operational needs during large-scale emergencies.

On the weekend following Thanksgiving in 2005, a fierce snow storm paralyzed much of eastern South Dakota, forcing the activation of the statewide EOC. SDDOT was an active participant in emergency operations during and after the storm. The EOC was activated for a total of two weeks to deal with critical life-safety and health issues, power failures, and transportation issues. This event brought to light the need for greater coordination among state agencies, especially SDDOT and SDDPS. It also demonstrated the strengths and weaknesses of current procedures, facilities and infrastructure related to traffic and emergency management. Consequently, a task was added to the research project to interview participants in the EOC activation to identify these strengths and weaknesses, and to integrate the findings into the strategic traffic operations deployment plan.

TASK 9: TECHNICAL MEMORANDUM #2 - TRAFFIC OPERATIONS DEPLOYMENT PLAN

Based on feedback from stakeholders and the project's technical panel, prepare a comprehensive traffic operations deployment plan recommending: technology; institutional roles, responsibilities, and agreements; resource needs and costs; and, links to state emergency management.

The Iteris research team prepared a technical memorandum that included detailed descriptions of the critical traffic operations functions for South Dakota, including links with emergency management. The memorandum included a detailed definition of the preferred TOC concept and a phased deployment plan for traffic operations improvements to support the traffic operations functions. Preliminary operational concepts were proposed for managing traffic operations in South Dakota. Changes in operational procedures were recommended to improve current practice. The traffic

operations projects were phased over a ten-year period and cost estimates were prepared for each project.

The technical memorandum was submitted to the Technical Panel for review and feedback. Comments were received and were to be incorporated into the Final Report.

TASK 10: FINAL REPORT PREPARATION

Prepare a final report and executive summary of the research methodology, findings, conclusions, and recommendations.

The Iteris research team prepared this final report as a summary of the research methodology employed on this project, the principal findings of the research, the conclusions drawn from the findings and the key recommendations for improved traffic operations in South Dakota.

TASK 11: EXECUTIVE PRESENTATION TO RESEARCH REVIEW BOARD

Make an executive presentation to the SDDOT Research Review Board at the conclusion of the project.

In March of 2006, the Iteris research team made an executive presentation to the SDDOT Research Review Board to present the findings, conclusions and key recommendations of this research. The remainder of this report is dedicated to those topics.

5.0 FINDINGS

Research findings were based on the following four elements:

- A literature review was conducted to investigate Traffic Operations Center (TOC) concepts, TOC functions, and current or planned projects specific to South Dakota.
- TOC and ITS managers in other states were surveyed to obtain information about their traffic operations programs.
- A series of regional workshops were conducted in South Dakota to obtain information from stakeholders regarding traffic operations needs, functions, and preferences. Workshops were held in Sioux Falls, Rapid City and Pierre during July 2005. A follow-up workshop was held in October 2005 to present the results of the first set of workshops and to obtain further input for the definition of an appropriate TOC concept. These workshops allowed the research team to engage stakeholders from different regions of the state in identifying traffic operations issues and opportunities for improvement.
- The experience and professional expertise of the research team was utilized to perform the analyses and to develop a strategic deployment plan.

The information gathered during the research effort was compiled and documented in two technical memoranda. The first entitled, “A Review of Traffic Operation Concepts for South Dakota,” identified traffic operations needs, functions, capabilities, and priorities. Alternative TOC concepts to address these needs and to carry out proposed functions also were presented.

A second technical memorandum, entitled, “South Dakota TOC Strategic Deployment Plan,” was submitted. This document:

1. Identified specific traffic operations functions for South Dakota
2. Defined a traffic operations concept to carry out those functions, and
3. Presented a phased deployment plan for the implementation of traffic operations projects and procedures.

This second memorandum provided an evaluation of the links between traffic and emergency operations in the aftermath of the blizzard that occurred in late November and early December of 2005.

The key findings from this research project are presented below, starting with an overview of current ITS infrastructure in South Dakota.

5.1 OVERVIEW OF ITS IN SOUTH DAKOTA

Historically, SDDOT and its partner agencies have been proactive in dealing with traffic and emergency operations issues. SDDOT is a national leader in the collection of road condition data and in the provision of traveler information services, such as 511 and the SafeTravelUSA.com website. SDDOT also is the lead agency on a pooled fund study for the development of a Maintenance Decision Support System, primarily aimed at improving the efficiency and effectiveness of winter maintenance operations.

SDDOT also has been actively deploying field devices to support traffic operations capabilities throughout the state. Dynamic message signs have been installed along I-90 and I-29 near cities and key interchanges. Environmental sensor stations are located throughout the state to collect localized road and weather conditions. Closed circuit television cameras have been deployed at strategic locations, and more are planned as part of an ESS upgrade program. Closed loop traffic signal control systems and emergency vehicle traffic signal preemption systems are common in most urban areas.

The following sections describe the ITS environment in South Dakota and establish a baseline for the deployment of additional ITS infrastructure and traffic operations policies and procedures.

5.1.1. Regional Description

South Dakota, nicknamed the Mount Rushmore State, is home to Custer State Park, Badlands National Park and Mount Rushmore National Memorial. About 3 million people visit Mount Rushmore every year. During the winter, South Dakota is a destination for snowmobilers with 1650 miles of trails statewide and during the summer, the Sturgis Motorcycle rally draws in hundreds of thousand motorcycle enthusiasts. The largest estimated attendance of this event drew more than 600,000 people for the 60th anniversary in 2000.

South Dakota is bounded by six states, including the States of North Dakota, Minnesota, Iowa, Nebraska, Wyoming and Montana. Interstate 90 is the major east-west route, which traverses between Wisconsin and Seattle, Washington, and Interstate 29 is the major north-south route, which traverses between Kansas City, Kansas and Winnipeg, Canada. These routes cross in the City of Sioux Falls. Altogether, South Dakota has 83,609 miles of highway, roads and streets, of which 679 miles are interstate. SDDOT is responsible for 7,857 miles of the roadway, which carry nearly 70% of vehicles miles traveled.

The landform is relatively moderate in elevation. The Black Hills contain the highest elevations east of the Rocky Mountains, with the highest point, Harney Peak at 7,242 feet. The total land area is 75,885 miles.

5.1.2. Population and Growth

Population of the state is relatively dispersed with 9.9 persons per square mile (2000 Census). For comparison, Minnesota and Nebraska have approximately 62 persons and 22 persons per square mile, respectively.

The following are population figures for the state from the US Census Bureau. Sioux Falls comprises 18 percent of the overall state population. The rest of the population is dispersed throughout the state as shown in Figure 3.

- Statewide Population, 2004 Estimate: 770,883
- Statewide Population, 2000 Estimate: 754,844

- Population, percent change, April 1, 2000 to July 1, 2004 2.1%
- Population, percent change, 1990 to 2000 8.5%

Table 2 provides a list of the most populated cities in South Dakota. Only one city, Sioux Falls, has a population in excess of 100,000. Figure 3 displays the geographic dispersion of the state's population on a county-by-county basis. As shown, the bulk of the state's population resides in the eastern one-third of the state and in the Black Hills area.

Table 2 - Top Ten Populated Cities in South Dakota (2004 Estimates)

#	City	Population
1	Sioux Falls	136,695
2	Rapid City	61,459
3	Aberdeen	24,196
4	Watertown	20,207
5	Brookings	18,705
6	Mitchell	14,887
7	Pierre	13,983
8	Yankton	13,491
9	Huron	11,198
10	Vermillion	9,975

Source: U.S. Census Bureau/Population Estimates/Cities & Towns

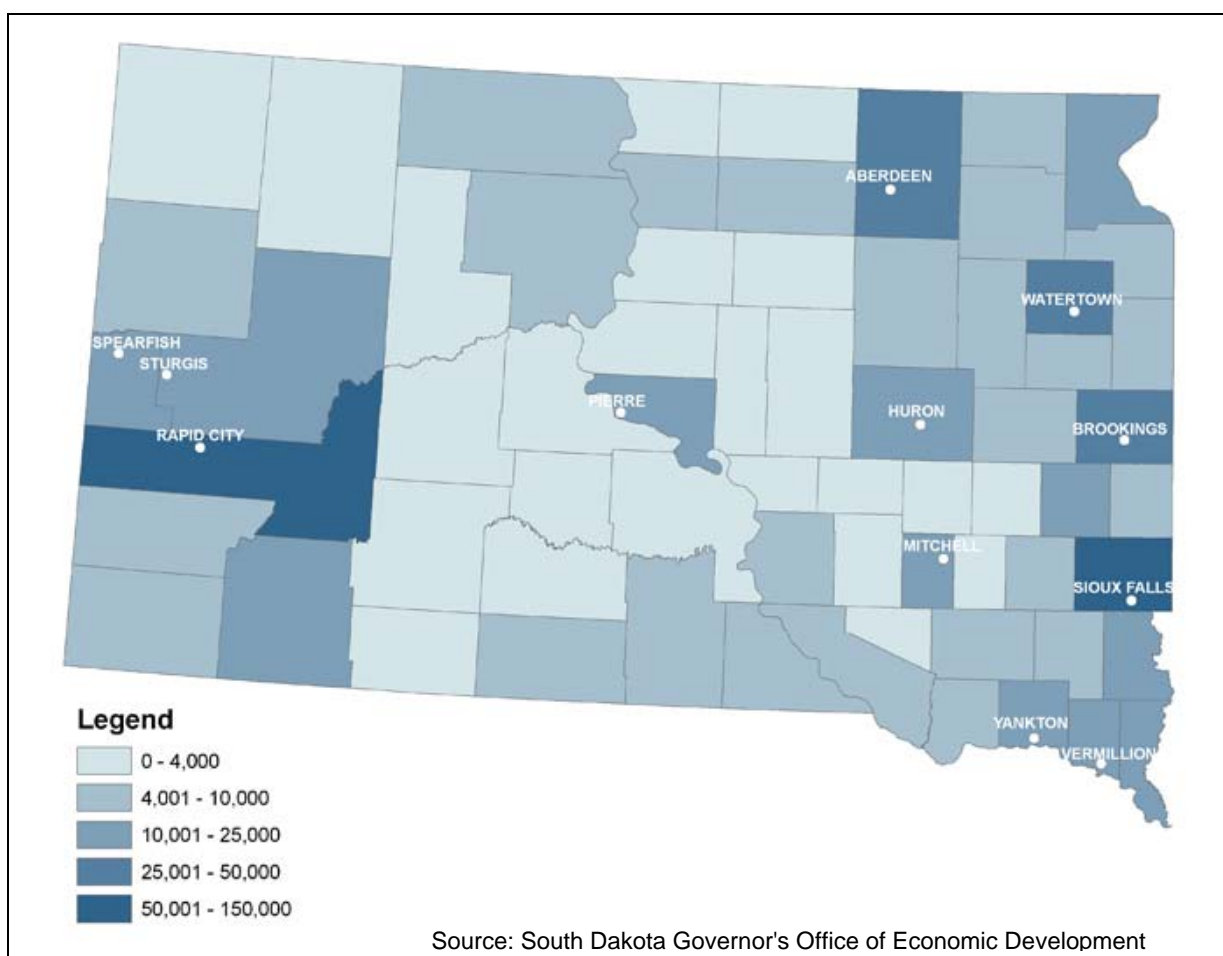


Figure 3 - South Dakota Population Map

5.1.3. Existing ITS Deployments

South Dakota has been aggressively deploying ITS and was one of the first states to deploy a statewide traveler information 511 phone system. A statewide rural ITS Deployment Plan was developed in 1999 (Study SD1999-11) and a Statewide Rural ITS Architecture (Study SD2002-03) was completed in 2003. The focus early on was toward commercial vehicle deployments and integration with these components should be recognized to ensure interoperability and compatibility. A relatively large RWIS infrastructure has been deployed, although many sites are nearing 15 years in age. Consequently, many of these sites are in need of upgrade to current technology standards and communications. A project has been initiated to upgrade the RWIS infrastructure. Additionally, a significant number of DMS were installed, both in 2001 and 2005 as shown in Figure 4. A complete list of ITS devices currently deployed is included in Table 3.

Consideration of the current ITS environment within South Dakota is necessary for establishing a baseline for building a statewide infrastructure and for developing a strategy for future ITS deployment. The deployment of ITS components will require consistency with the systems already in place and provide opportunities for integration.

Some notable ITS improvements and initiatives include:

- ITS / CVO Business Plan
- Rural ITS Deployment Plan
- Statewide Rural ITS Architecture Study
- Road Condition Reporting System (RCRS)
- 511 Telephone System
- Deployment of Dynamic Message Signs and CCTV cameras
- Kiosks at Rest Areas
- Rapid City ITS Master Plan for Integration Activities
- Sioux Falls ITS Strategy and ITS Activities

Table 3 - List of Currently Deployed ITS Devices (2006)

RWIS	DMS	CCTV	HAR	Closed Loop Traffic Signal Control Systems	WIM
36	30	2	0	Rapid City Sioux Falls Pierre Brookings	14

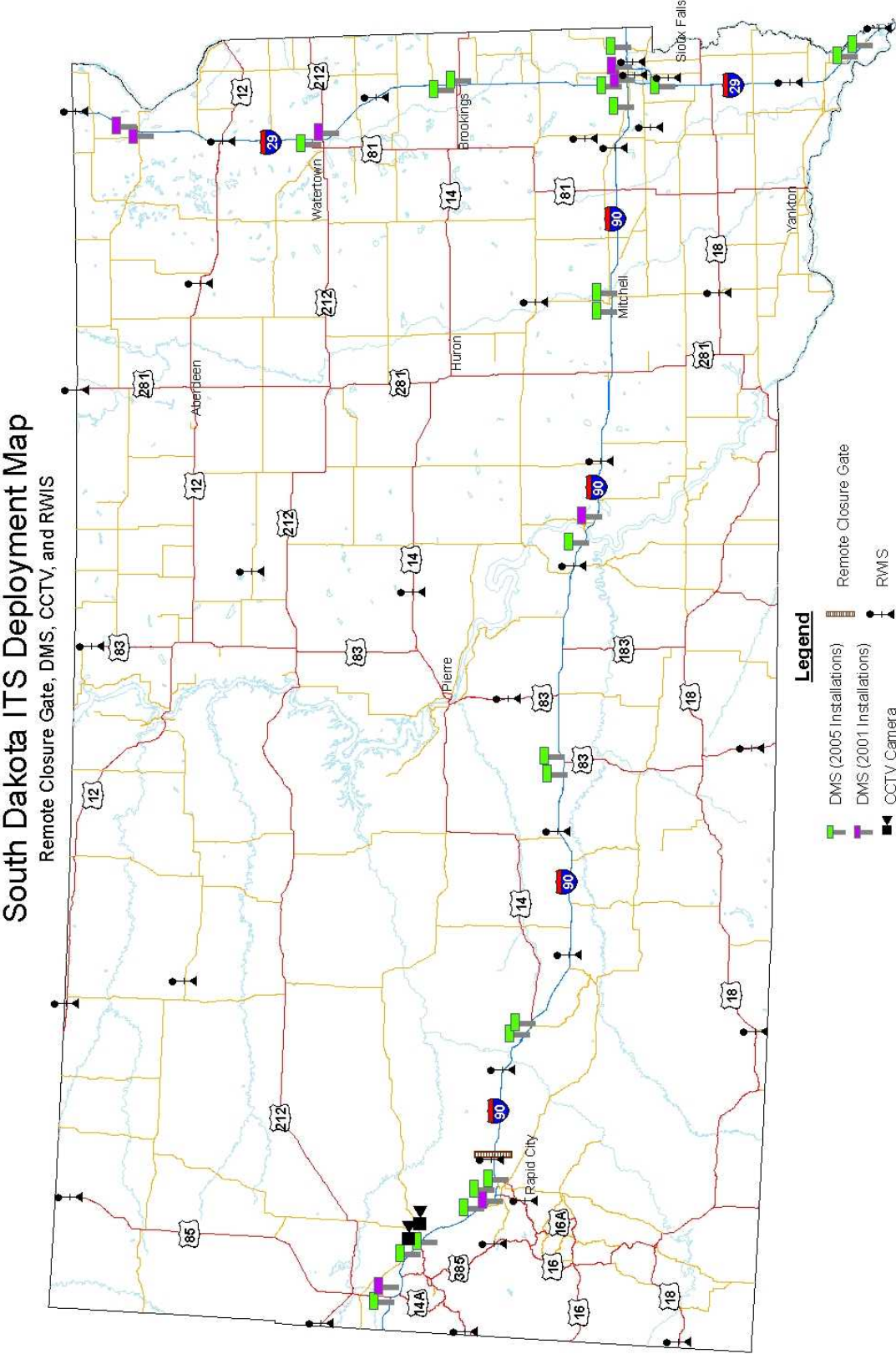


Figure 4 - ITS Deployments in South Dakota (2006)

South Dakota Deployment Map
Kiosks

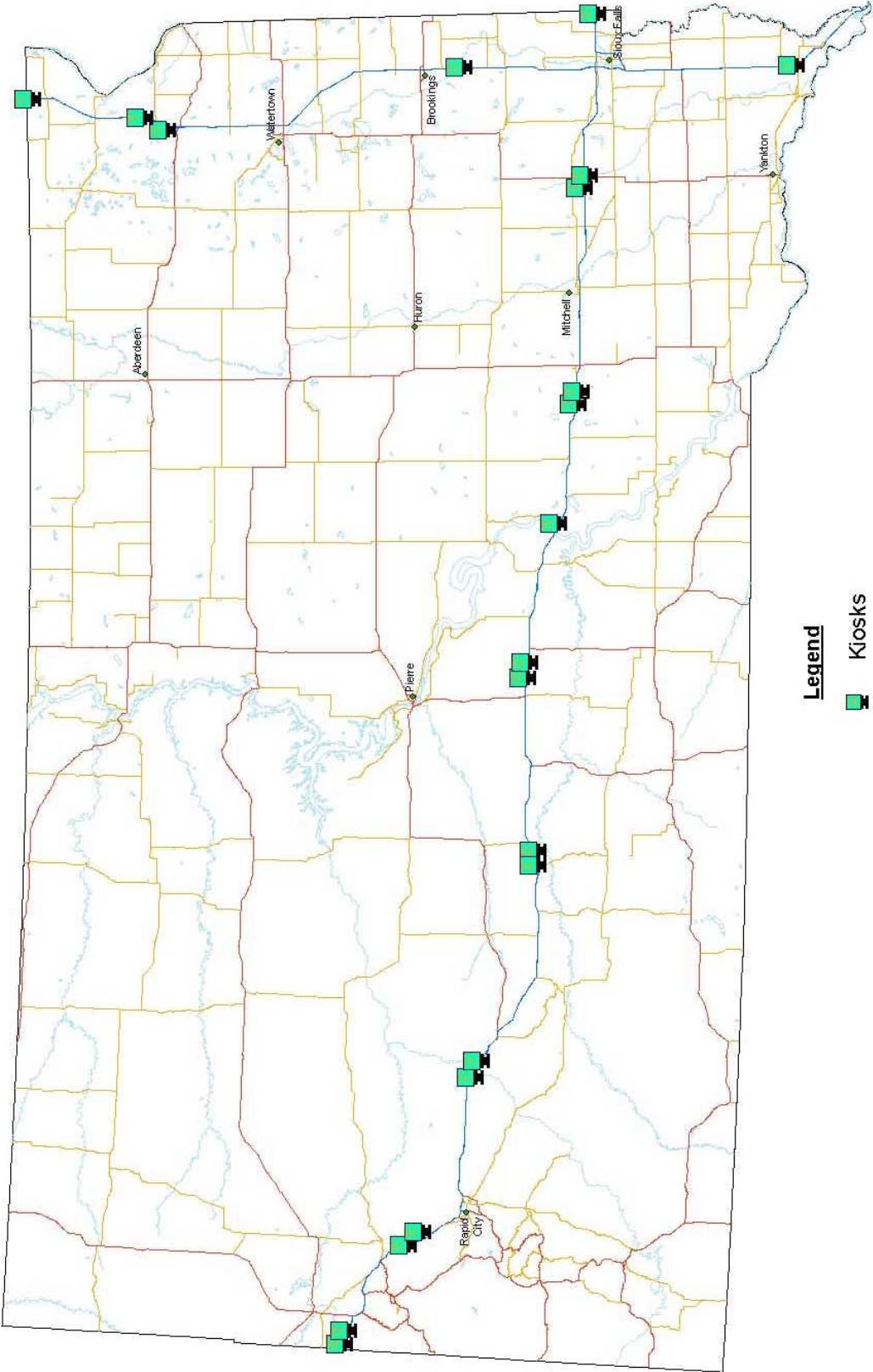


Figure 5 - ITS Deployments in South Dakota, Kiosks (2006)

5.2 LITERATURE SEARCH AND PHONE SURVEY RESULTS

Literature related to South Dakota’s traffic operations needs and functions was reviewed and summarized. The research team also reviewed applicable literature related to TOC concepts and functions in other states. A phone survey also was conducted to identify TOC deployment approaches used in other states. These other deployments were categorized for presentation purposes and to give a concise “thumbnail” view of TOC concepts. In all, six general categories were used. Each is described below, with a discussion of how the deployment concept may be relevant to South Dakota. The phone survey instrument and data were included in Technical Memorandum #1.

5.2.1. CENTRALIZED TOC CONCEPT

Description

The centralized model emphasizes the economies achieved in co-locating as many functions as possible in a single facility. This model originated in the first urban traffic management centers that were designed to serve a limited geographic area and featured centralized control systems that addressed a specific management function. Some of the earliest examples of this approach are the mainframe-driven centralized signal systems.

The implementation of a Centralized Management approach typically meant that a “star” topology was used to connect to roadside devices (signal controllers, CCTV cameras, etc.). This topology allowed the “head end” equipment to be located in a single location and was therefore serviceable in a cost-effective manner.

In modern centralized TOCs, a variety of functions are physically combined into the facility, maximizing the exchange of information between groups. A conceptual diagram showing the overlap of differing management groups is shown below. Where the domains of the functions overlap, efficiencies may be gained through personnel, infrastructure, and information sharing.

Due to their size and complexity, centralized TOCs usually are housed in dedicated, purpose-designed facilities. Often the facility will feature a control-room style operations center meant to house dispatching, incident management, maintenance, and traveler information personnel together. Individual consoles for operators and video wall display systems allow many people to use the same real-time information for a variety of tasks.

In states with larger areas, substantial long-haul, high-bandwidth communications networks are usually needed to allow a facility that may be hundreds of miles from a roadside device to adequately manage data. Figure 6 shows some of the functional overlaps common in Statewide or centralized TOCs.

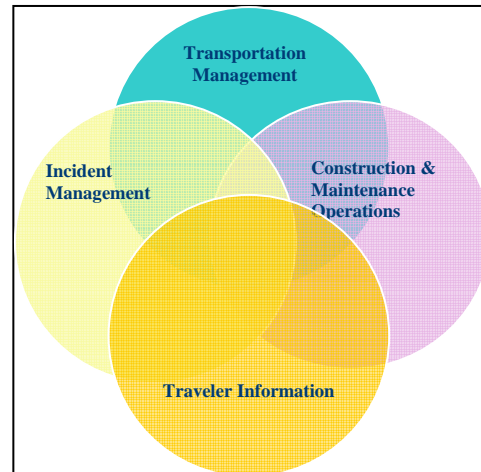


Figure 6 - Functional Overlap in Statewide TOCs

Example States

Utah has adopted a centralized, statewide model for its TOC deployment. With over half of its population living in the three counties surrounding the Salt Lake City area, most traffic management issues are found in this area. Additionally, the 2002 Olympic Games were located in Salt Lake City, creating the need for a variety of traffic management services.

The Utah TOC incorporates the UDOT Traffic Management Division, traffic engineers for the region, meteorologists, public safety dispatchers and private broadcast entities, ATMS deployment technicians and network support staff. The central TOC is also connected to City and County level management and emergency response entities. The centralized approach allows for statewide policy making, standards and architectural enforcement. The statewide center also provides 24/7 coverage while the regional TOCs provide coverage during normal business hours. Figure 7 is a graphical depiction of the Utah DOT TOC model.

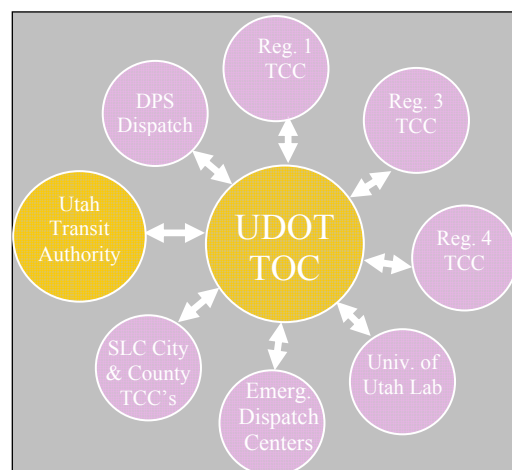


Figure 7 - Utah Connected Management Entities

Relevance for South Dakota

The primary advantage of a centralized concept for South Dakota is the cost savings and efficiency gains to be had through centralization of equipment and expertise. Specialized skill sets, while perhaps too expensive to maintain at the district level, may be in enough demand to warrant having them in a

centralized system. The collocation of equipment also reduces the need for stores of spare parts and may allow for less system downtime as a result. Fewer personnel should also be needed to operate a centralized system, resulting in a direct cost savings.

South Dakota has already applied this model for the collection and dissemination of road and weather condition information through the Road Condition Reporting System (RCRS) and the SDDOT statewide 511 system. Road and weather conditions are reported by field personnel using two-way communications, such as telephones and two-way radios. The data is entered into RCRS by authorized personnel at SDDOT. The RCRS, which is managed by Meridian Environmental Technology (MET) from its North Dakota data center, was recently enhanced to incorporate “event” data, such as traffic incidents, special event congestion data, and work zones. The RCRS is the basis for the statewide 511 system, which also is managed by MET. This centralized concept for the collection and dissemination of traveler information must be at the core of the TOC concept recommended for South Dakota, but not all TOC functions would be facilitated through the centralized concept.

The large area to be covered and lack of concentration of the population in the State make a centralized approach less attractive for other functions such as traffic signal management, special event traffic management, work zone traffic management, and other more localized traffic management needs. The long distances between roadside devices and the central facility will make adequate communications difficult to achieve. The lack of familiarity of TOC personnel with local conditions throughout the state may also make operation of a central facility problematic.

5.2.2. DISTRIBUTED TOC CONCEPT

Description

States with multiple urban areas large enough to have substantial traffic management problems, but too small to warrant the expenditure of constructing large centralized management centers face the problem of providing adequate services to the public and accomplishing that with limited resources. The resulting solution is the Distributed Management concept. This approach uses emerging high-speed data communications networks to tie together multiple entities while looking for opportunities to combine operations at the local or regional level. Since the geographic scope and functions of the TOC are limited, the personnel (and the space needed to house them) can be reduced compared to a centralized concept. Further, the staff will generally be located in the region they manage and be familiar with it, leading to a higher quality of service. A schematic of a distributed system is shown in Figure 8.

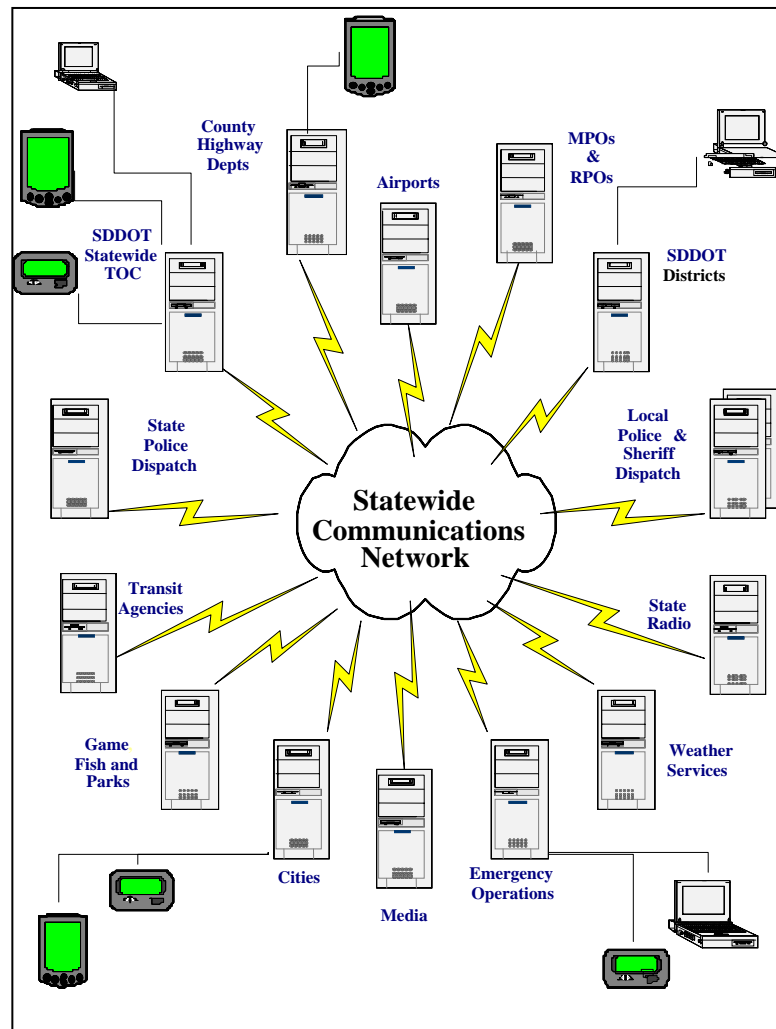


Figure 8 - Distributed TOC Concept Diagram

Example States

Minnesota has been operating TOCs using the distributed model since 2000. Under the Minnesota Guidestar Transportation Operations and Communications Center (TOCC) Deployment Plan, a total of nine regional centers will be established, using a common physical design and software platform (see Figure 9). Developing a Statewide plan for the TOCC deployment has allowed for a uniform division of responsibilities between departments collocated within the center. Planning for the TOCCs at the State level has also allowed for resolution of jurisdictional differences between the departments. For example, in Minnesota, the boundaries of the State Patrol districts and Mn/DOT maintenance districts are very different, and an accommodation had to be made for a single dispatcher to address both needs.

Relevance for South Dakota

South Dakota is structured into separate, non-overlapping regions for the Department of Transportation and Highway Patrol much as Minnesota is. The ability to tailor the individual regional TOCs is highly attractive, given the diversity of needs throughout the state. Distributed TOCs can also be deployed in a phased approach, similar to the approach Nebraska Department of Roads has taken, to allow traffic management services to be deployed to the highest priority areas first in a cost-effective manner.

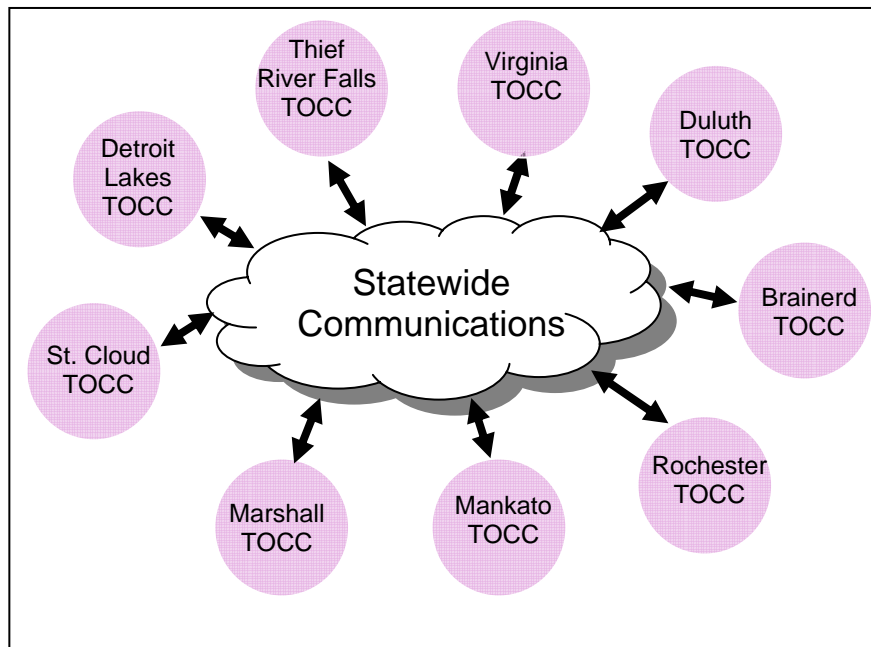


Figure 9 - Minnesota TOCC System

The TOCs will still require dedicated space and facilities to be constructed. Typically this will not require a new building, but the space will need to be remodeled to allow for efficient communication between the system operators. In most cases, a substantial amount of training and transition time will be needed by dispatchers and other personnel. The greatest ease of transition will probably be accomplished through a statewide planning process; however this may require substantial changes to operating procedures at some of the regions to accommodate shared responsibilities, etc.

5.2.3. VIRTUAL TOC CONCEPT

Description

The Virtual TOC concept takes the idea of distributed management and control one step further by eliminating the collocated facility entirely and replacing it with individual user interfaces that may be located anywhere on the network. The approach has only recently become feasible through the development of low-cost, high-speed networking technologies. With speeds of one gigabit per second now readily available, the distribution of control applications and digital video surveillance is now practical.

Typically, systems such as these will involve a workstation-type management application that may connect to a data server or directly to a roadside device. Because of the number of potential users of the system, access and security must be carefully planned and managed. Various levels of access to system functions and geographic restrictions can allow users to access only those elements relevant to them and then only to perform certain functions.

The availability of high speed communication data networks is a key to the utility of this model. If this infrastructure is in place, substantial cost savings over other TOC models can be realized through elimination of dedicated TOC space. By distributing functions, the system maintains a high degree of flexibility for allowing additional users and locations to be incorporated into the system.

Virtual or remote access to systems also provide the ability for TOC managers to become immediately and integrally involved in TOC functions during emergency and other time-critical events, while away from the TOC. TOC managers or operators are often called upon during non-business hours to operate systems, such as issuing an Amber Alerts, resetting servers, or modifying traffic signal timing to support incident and event management activities. Having remote access through a secured and reliable network provides efficient and timely response.

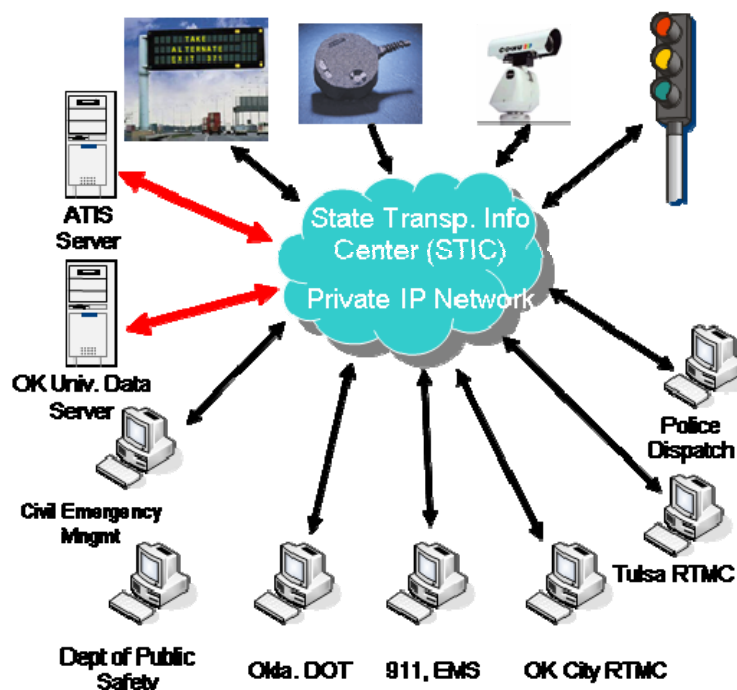


Figure 10 - Oklahoma's Virtual TOC Model

Example States

Oklahoma has adopted a virtual model using a statewide private network as shown in Figure 10. Oklahoma DOT partnered with the University of Oklahoma to develop a low-cost control architecture for their ITS Deployment. The cost to staff and construct a large, centralized TMC was cost prohibitive, thus a virtual, distributed control approach was taken to eliminate the need to develop large scale traffic management centers. An "statewide ITS Console" was developed which provides complete device control functionality from any location throughout the state and can be operated simultaneously. This results in a virtual TMC, where operators, transportation managers, emergency managers can remain geographically distributed in their current facilities. A total of 31 of these ITS consoles had been deployed as of July 2005 (Huck, Havlicek, Sluss & Stevenson, 2005).

This approach has been successful in Oklahoma due to a relatively large fiber network of approximately 940 miles that has been acquired through public-public and public-private partnerships. As this is a relatively new deployment (2005), some of the functions for traveler information and traffic management, such as incident management and construction support have not yet been fully developed.

Relevance for South Dakota

The virtual TOC concept offers several advantages for states such as South Dakota, including:

- Ease of deployment
- Low equipment costs
- Ease of expansion for users and devices
- Accommodation of remote users

The RCRS and 511 concept deployed and operational in South Dakota is an example of a virtual function typically found in TOCs. While it is practical to apply the virtual model for traveler information input, it may be impractical for other typical TOC functions, such as traffic signal control, full motion video exchange, incident management, etc.

Also, as mentioned above, this approach requires reliable, secured high-speed data communications to function properly. A careful analysis of existing data networks, their capacity and feasibility for expansion will be required to determine on what scale the virtual TOC approach can be used in South Dakota.

5.2.4. JOINT OPERATIONS CENTER CONCEPT

Description

Joint Operations Management (JOM) is an outgrowth of the TOC concepts listed above. JOM goes beyond transportation operations to include a variety of other disciplines that are related or concerned with, but not directly a part of, transportation management. These may include emergency operations for natural disasters, hazardous materials management, 911 dispatch, and public transit management. In general, a TOC can be created without JOM, but JOM cannot be implemented without a TOC.

JOM represents a policy and operations system more than a technological one. The synergies of shared facilities for the concerned disciplines must be carefully considered and the implications of collocating those entities evaluated. Clear delineation of responsibilities and parameters for data sharing must be formulated prior to the creation of a JOM system.

Example States

Several states have implemented JOM. See the examples of Minnesota and Utah in the Distributed and Centralized descriptions above.

Relevance for South Dakota

JOM offers a range of advantages for TOC deployments. Combining of staff allows for schedules that expand the hours of operation for services that would otherwise only be available during business hours. The real-time information sharing and coordination of services can substantially improve the safety of motorists whenever incidents affect travel through up-to-date and accurate traveler information. Coordination of maintenance and emergency response can minimize the impact of both incidents and maintenance activities on traffic.

JOM will allow South Dakota to leverage its investment in the deployment and operation of a TOC to gain the maximum possible benefit. Discussion has been taking place about implementing JOM in conjunction with the new statewide emergency operations center (EOC) in Pierre. The new facility would be the focal point for emergency operations, State Radio, and the Department of Criminal

Investigation. The collocation of traffic operations with these other functions would provide cost savings to the public through resource sharing arrangements and synergistic benefits from collaboration among diverse agencies (Wong, 2004).

5.2.5. MOBILE OR PORTABLE TOC CONCEPT

Description

The mobile and portable TOC concepts are an evolution of the distributed and virtual concepts for TOC deployments. Building upon the “anything anywhere” philosophy of the virtual model, mobile and portable TOCs leverage recent developments in high-speed wireless communications to extend workstation functionality to portable facilities or vehicles traveling in their operating area.

This approach may allow access to all or some of the TOC’s functions – for example a mobile workstation may be allowed to access DMS (message sign) status, but not to change the message displayed. Nearly any TOC function can be enabled on a mobile platform, with the restriction that adequate communications must be available.

Communications can be provided through the construction of private networks or through leasing service from private providers. Each approach has tradeoffs that affect their attractiveness. Building a private network eliminates most recurring charges, but can be very expensive to cover large areas. The initial investment for leased services is much lower, but users are now subject to varying network load conditions, the goals and objectives of the private provider, and recurring charges that can be substantial over a period of years.

Example States

The State of Indiana has deployed mobile operations capabilities to 17 of its Hoosier Helper vehicles that operate in the Indianapolis area and along the Borman Expressway in Northwest Indiana. Using a custom-built HTML (web) interface the vehicles can operate message signs and highway advisory radio systems using an on-board notebook computer and after the operators answer a set of questions (location of incident, number of lanes blocked, expected duration of incident, etc.) related to the incident.

To minimize the bandwidth requirements, the interface (shown in Figure 11) is by necessity simple. INDOT uses a combination of leased data services and private 802.11 hotspots to connect the mobile workstations with central data servers.

Many states, including South Dakota, have deployed portable traffic management systems during special events or for work zone traffic control. The trailer used by SDDOT during the Sturgis Motorcycle Rally is an example of a portable traffic management center, with capabilities to control and monitor ITS field devices, such as CCTV cameras and DMS.

Relevance for South Dakota

Due to the large geographic area of South Dakota, a statewide deployment of mobile operations platforms may be impractical without substantial investments in communications infrastructure.

However, in locations such as the Rapid City area, where large events require special traffic management procedures, a portable system has proven to be of great value to both transportation and

emergency response personnel. The enhancement of this portable system may be beneficial as the number of portable and permanent field devices grows in the region.

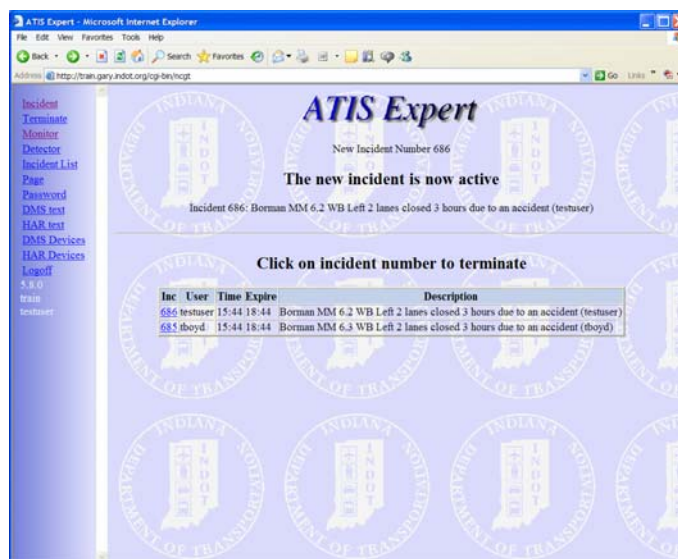


Figure 11 - INDOT Mobile TOC Interface

The use of portable traffic management systems to control traffic during highway construction or during regional emergencies also could be useful to SDDOT. An inventory of portable changeable message signs with dial-up communications should be considered in each SDDOT district.

5.2.6. HYBRID TOC CONCEPT

Description

Any of the above “pure” concepts can be combined to result in a solution that best fits the needs of the State. For example, a common hybrid concept involves creation of a large scale TOC in a metropolitan area that serves as a statewide or central TOC where operational policies and procedures and technology roadmaps for the State are established. Smaller, regional TOCs are then constructed as necessary, with their design and coordination influenced by the central TOC. This arrangement is shown in Figure 12.

Other combinations are, of course, possible. A centralized center with data management responsibilities and remote workstations forming a virtual TOC is one possibility.

Example States

Nebraska has embraced a hybrid model that combines elements of the distributed and virtual models with a centralized statewide TOC approach. In this approach, each of the regional, distributed TOCs connect to the roadside devices and perform dispatch functions. The distributed TOCs then connect to each other to form a virtual TOC.

This approach maximizes the ability to share data while minimizing the need for wide area communications infrastructure, since only each TOC must be connected with a high-speed link, and not every user location.

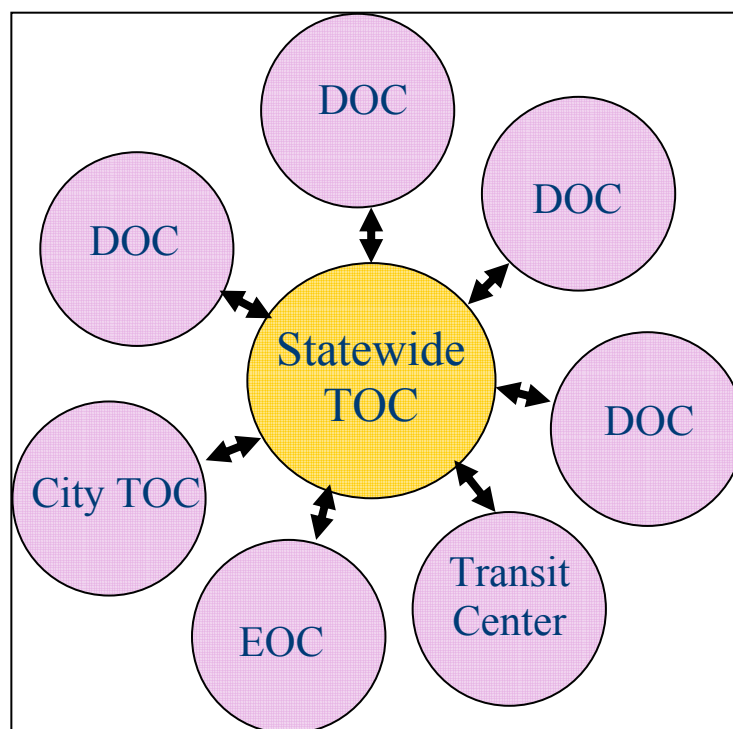


Figure 12- Hybrid Statewide/Distributed Model

Certain TOC functions of a statewide nature, such as the provision of statewide traveler information services, reside only at the Statewide Operations Center (SOC) in Omaha. However, the SOC is tied to all District TOCs over the statewide communications network.

Relevance for South Dakota

Most TOC deployments will include some level of hybridization of the deployment concepts. The proper balance of centralization/distribution/virtualization is the key to meeting the functional needs of South Dakota while controlling costs and which is affordable.

5.3 SOUTH DAKOTA TOC CONCEPTS REGIONAL WORKSHOP RESULTS

The most important element of the South Dakota TOC concept research involved stakeholder workshops conducted in the cities of Sioux Falls, Rapid City and Pierre. The objective of conducting three regional workshops was to obtain the unique flavor of traffic operations needs in these distinct regions of the state.

The workshop goal was to obtain input from transportation stakeholders that will assist the consultant team and the project technical panel in defining traffic operations center concepts suitable for the State of South Dakota.

Workshop objectives included:

- Define current traffic operations processes and functions
- Capture details of current plans and projects which may impact traffic operations concepts
- Identify regional differences in traffic operations needs and functions
- Obtain inputs from regional stakeholders on traffic operations center concepts applicable to their region and the state
- Identify new traffic operations projects and programs to address regional traffic operations needs

5.3.1. WORKSHOP APPROACH

The workshops were divided into two sessions – a general session in the morning and break-out sessions in the afternoon. The morning session focused on general information about the project and about traffic operations center concepts deployed in other states. Considerable discussion took place regarding the current traffic operations environment in the state. The experiences of other states were used to present alternative approaches for traffic operations.

The afternoon session started with a summary of the morning session and a discussion on the different conceptual models which are commonly deployed in other areas. The afternoon also included break-out sessions among workshop participants. The break-out sessions were intended to provide meaningful, focused discussion about traffic operations center concepts specifically addressing the traffic operations challenges in the region. Three break-out sessions were conducted to address traffic operations issues associated with such topics as weather related traffic and road conditions, highway construction work zone traffic management, special event traffic management, traffic incident management, recurring traffic congestion management, maintenance support systems, and cross-cutting issues such as traveler information, communications, resource sharing, and inter-jurisdictional cooperation. Each of the three break-out groups addressed a mix of traffic operations issues, some of which overlapped with those assigned to other groups. Table 4 identifies the issues addressed during the break-out sessions.

Each break-out group identified a leader to facilitate discussion within the group. A scribe was assigned to record the discussion and stakeholder responses in a template that was provided.

Table 4 - Break-out Group Topics

Break Out Group 1 Issues	Break Out Group 2 Issues	Break Out Group 3 Issues
Weather and Road Conditions	Weather and Road Conditions	Work Zone Traffic Management
Work Zone Traffic Management	Special Event Traffic Management	Special Event Traffic Management
Traffic Incident Management	Traffic Incident Management	Recurring Congestion Management
Recurring Congestion Management	Maintenance Support and Management	Maintenance Support and Management
Traveler Information	Communications	Resource Sharing and Inter-Jurisdictional Cooperation

5.3.2. SUMMARY OF WORKSHOP RESULTS

The workshop results correspond with the workshop objectives listed above. A list of questions was prepared to guide the discussion of current traffic operations functions, projects, programs, and plans in each region. The questions included:

- What traffic operations functions do you currently perform?
- What projects and plans are in place to improve traffic operations in your region?
- What would you consider the top traffic operations needs in your region?
- What are the traffic operations goals within your region?

In addition to these general questions, the break-out sessions revealed regional preferences with regard to traffic operations issues, opportunities and actions. The results of the break-out sessions are included below.

Sioux Falls Workshop

Much of the discussion in Sioux Falls concerned issues related to traffic signal control, incident management, traveler information dissemination and interstate coordination of traffic operations. This was due in part to the roles of the participating stakeholders, including city traffic engineering, highway patrol officers, towing companies, and ITS engineers from adjacent states.

The top issues identified by stakeholders in Sioux Falls included:

- Incident Management (Procedures, communication, training and technology)
- Road and Weather Conditions (MDSS)
- Work Zone Traffic Management

The common themes included:

- Communications (Interagency, Public, Outreach/Training)
- Uniformity of Process and Technology
- Working Together

Current functions performed include:

- Traffic signal operations, including emergency vehicle preemption in Sioux Falls, Yankton and Mitchell
- Traffic counting, especially for traffic signal timing purposes
- Red-light running system in Sioux Falls
- Regional 911 and coordinated public safety dispatch
- Towing and HazMat team dispatching through Metro Dispatch and State Radio
- Traveler information via DMS, SDDOT web site, 511 and media through RCRS
- Fixed route transit automatic vehicle location (AVL) and computer-aided dispatch in Sioux Falls

Projects and plans to improve traffic operations include:

- Improved incident management training for first responders and troopers
- Traffic signal timing improvements, especially on freeway ramps during inclement weather conditions
- Planned use of queue detection on ramps to detect traffic backing up onto mainline of freeway (i.e., I-229 at Benson)
- Implementation of more automatic de-icing systems

- DMS coordination in the Tri-State area (Nebraska, Iowa and South Dakota) near Sioux City
- Northwest Passage Pooled Fund Project for coordination of traveler information across state boundaries
- Deployment of AVL in SDDOT maintenance vehicles for Maintenance Decision Support Systems (MDSS)
- Possible expansion of automated gate closure systems along I-90 and I-29 (currently in use at one interchange near Rapid City and along interstate highways in Nebraska)
- The Nebraska Department of Roads is expanding their alternate route map to include routes within South Dakota
- SDDOT has a wireless communications study underway

The top traffic operations needs in the region include:

- Greater public information and awareness
- Automatic equipment malfunction notification
- Better management of traffic congestion caused by events, incidents and construction
- Development of a regional contact list for traffic and incident management
- Consistency of procedures and shared control of resources
- Improved winter maintenance operations

Regional traffic operations goals include:

- Inter-agency training - what to expect from each agency and understanding of each agency's procedures.
- Training on use of ITS devices.
- Cross-state communication

Rapid City Workshop

Interestingly, while the focus of the morning discussion in Rapid City concerned issues primarily related to incident and emergency management and special event traffic management, the more focused afternoon break-out sessions concentrated more on road and weather conditions. Participants ranged from SDDOT engineering staff to county level emergency management personnel.

The top issues identified in Rapid City included:

- Weather and Road Conditions (by two break-out groups)
- Interagency Coordination

The common themes included:

- The need for additional funding
- Communications
- Coordination / Cooperation
- Better Traveler Information
- Training / Human Resources

Current functions performed include:

- Coordinated incident and emergency management
 - The South Dakota State Highway Patrol has an “extremely close working relationship” with SDDOT
 - The Highway Patrol identifies high crash areas and saturate them with officers
 - The Highway Patrol works with SDDOT for improved signing
 - In high fire areas, the Highway Patrol works with SDDOT to deploy Portable DMS and assists with evacuations
 - Highway Patrol works in coordination with Forest Service on Incident Management Plans (IMP)
 - Fire departments contact SDDOT to call out maintenance crews during winter surface condition problems
 - Fire departments also contact Highway Patrol who will contact DOT to respond for incidents
 - Each fire incident has an information officer assigned
 - County Emergency Management Organizations get involved as needed, especially during winter weather emergencies
 - Prepared Disaster Response Plans
- Special Event Traffic Management
 - The Sturgis Motorcycle Rally is the premiere event, but the fireworks at Mt. Rushmore also create traffic concerns
 - Difficult to manage traffic given the limited highway capacity
 - SDDOT has taken the philosophy to do what it takes to keep the traffic moving and keep traffic from backing up onto the I-90 mainline
 - As gridlock occurs, small incidents back up traffic for miles
 - EMO perspective – a lot of time is spent in workshops to discuss how to move emergency vehicles in and around the incidents
 - Common radio/communication system is available, but may not be utilized by all event staff and agencies
 - Do a lot of “what ifs” and contingency planning
- Traffic Signal Control – Rapid City has 3 closed loop traffic signal systems (Main Street, Saint Joe Street, and Deadwood Ave.)

Projects and plans to improve traffic operations include:

- Modified geometrics, improved signal timing and installed ITS devices at Exits 30 and 32 along I-90
- Utilizing a portable, temporary TOC for this year’s Sturgis Rally
- In process of constructing new communication towers (Sturgis Area and Perkins County)
- SDDOT using top 40’ of the new Sturgis tower to communicate with ITS devices due to line-of-sight restrictions
- Other communities are now planning events to draw some of the traffic away
- Working on more standardized approach to ensure facilities and campgrounds have proper emergency evacuation plans

The top traffic operations needs in the region include:

- Improved Special Event Management (Sturgis)
- Improved Incident Management (Fire, etc.)
- Proactive management of traffic signals
- Improved dissemination of road, incident, and winter weather information to the public.
- Following up on public complaints

Regional traffic operations goals include:

- Implementation of a more unified, inter-jurisdictional approach for emergency management
- Disseminate more reliable and timely information to the public
- Improved incident management
- Improve cellular coverage to provide communication for rural traffic management and incident response
- Deploy an integrated traffic operations center
- Allow virtual access to traffic management systems for other agencies

Pierre Workshop

The focus of the Pierre workshop discussion involved incident and management, especially from an institutional standpoint.

The top issues in Pierre included:

- Traveler Information
- Road and Weather Conditions
- Resource Sharing

The common themes included:

- Need for better data (timely and more accurate)
- Need for better traveler information
- Communications coverage, especially in rural areas
- Communications among agencies for data sharing
- Need for better planning, especially related to incidents and emergencies

Current functions performed include:

- Coordinated incident and emergency management
 - Many incidents involve broken down or abandoned vehicles
 - Coordinated crash investigation between Highway Patrol and Local law enforcement
 - Local law enforcement (Pierre PD) handles regional 911 system (multiple counties/communities)
 - Towing dispatched through 911 system and State Radio
 - State Radio notified of incident to provide information to SDDOT as needed
 - Close working relationship between law enforcement (Highway Patrol and local) due to relatively small number of staff

- Most situations/incidents do not require formal “unified command” structure
- Federal level is pushing for more formal command structure, but the current system is more localized
- County emergency management personnel deal with localized emergencies
- If larger incidents involving multiple agencies occur, then State Emergency Management plays a larger role assisting/coordinating resources
- Emergency exercises conducted with local public safety personnel
- Fires and spills involve other agencies, such as the Department of Agriculture and Forest Service
- Amber Alert
 - State Radio issues Amber Alerts
 - SDDOT is at the end of the Amber Alert process
- Winter Storm Management
 - Interagency coordination is common
 - Maintenance crews generally have ample warning of winter storms
 - Dissemination of information is an important element
 - Interstate highway closures are rare and only considered when the interstates are impassable
- Work Zone Traffic Management
 - Typically traffic moves steadily through work zones
 - Special attention is paid to work zone traffic management during Sturgis Rally time
- Arterial traffic management
 - Access control is important
 - Need for a centralized traffic control system to manage flow of traffic
 - Need for traffic signal upgrades
 - Construction along Sioux Avenue will coordinate traffic signals and access management

Projects and plans to improve traffic operations include:

1. Deployment of a closed loop traffic signal system along Sioux Avenue
2. State Radio dispatch going to new DCI building
3. New State Emergency Operations Center is under construction in the DCI building

The top traffic operations needs in the region include:

- Improved cell phone coverage and ability to locate caller
- Ability to monitor road and traffic conditions on the Internet
- Improved incident management capabilities
- 24/7 coverage with regard to data collection, processing and information dissemination
- Improved information/reporting of 511 system
- Improved data collection capabilities, including additional RWIS, to provide better information
- Integration of the state EOC with a new TOC for better coordination of traffic and emergency management

5.3.3. BREAK-OUT SESSION SUMMARY

Table 5 summarizes the outcome of the break-out sessions from all three workshops. The responses are ranked according to the number of responses given. As noted, the top issue related to traffic operations is the management of road and weather conditions. Participants also recognized that traffic operations needs are event driven and require a high degree of interagency cooperation to be effective.

Improved communications capabilities, whether it was among agencies or with the public, were considered to be the top opportunity for improvement in traffic operations. Closely tied to communications capabilities was the recognized need for improved traveler information and data collection capabilities.

Actions identified by the stakeholders involved improvements in communications capabilities and coverage, increasing content for and promoting the statewide 511 system, providing a more uniform approach for DMS operations, establishing interagency plans for management incidents and emergencies, providing training on new procedures and technologies, installing more devices to collect road and traffic condition data, monitoring such conditions 24/7, seeking more funding and opportunities for resource sharing, and improving maintenance management.

A hybrid approach was the overwhelming preference regarding TOC concepts, although no consensus was reached with regard to the form of the hybrid approach. Generally, it was recognized by the stakeholders that the hybrid model provided the greatest flexibility for TOC design. It supports both centralized and distributed functions. Statewide and localized traffic management needs can be accommodated through such an approach. The hybrid model supports interagency coordination, through distributed control and information, but also supports a centralized model for statewide data collection, warehousing and dissemination. Stakeholders perceived that this model is relevant for a primarily rural state.

These key findings enabled the research team to identify traffic operations functions, strategies and an appropriate TOC concept for South Dakota.

Table 5 - Workshop Summary

Top Issues	
Road and Weather Conditions (4)	
Resource Sharing and Interagency Cooperation (2)	
Incident Management, Work Zones, and Traveler Information (1 each, tie)	
Opportunities for Improvement	
Improved communications (interagency, with public, or coverage)	15
Improved traveler information dissemination	9
Improved data collection (accuracy, timeliness, etc.)	6
Improved traffic and maintenance operations	5
Improved safety and incident/event management	5
Improved traffic operations policies and procedures; human resources	5
Actions	
Communications: additional infrastructure and better coverage; uniform mechanisms, including radio frequencies and protocols; improve interagency communications through ITS standard interfaces	
Information Dissemination: add incident, event, RWIS and work zone information to 511 and website; promote 511 and website better; provide a more uniform and consistent approach for traveler information, especially for DMS messages; establish public education program	
Public Safety: develop interagency emergency management plans; involve public safety in traffic planning; provide regular incident management training and exercises	
Planning: use ITS architecture to ensure sound planning; hold regular coordination meetings among agencies involved in traffic management and operations; research and deploy new ITS devices to improve operations	
Data Collection: install more devices to collect accurate data; monitor conditions 24/7; timestamp the data	
Training: provide training in new technologies and procedures	
Funding: Identify and obtain additional funding for ITS; make better resource allocation decisions, including resource sharing among agencies (e.g., DCI, State Radio and DOT)	
Maintenance: improve maintenance management and uniformity	
Preferred TOC Concept	
<p>The Hybrid Model was selected by eight of the nine break-out sessions conducted during the three regional workshops. The diversity of the state requires a flexible solution. Some traffic management solutions require a centralized approach, whereas others are more localized. The hybrid model supports interagency coordination, through distributed control and information, but also supports a centralized model for statewide data collection, warehousing and dissemination. Stakeholders perceive that this model is more relevant for a primarily rural state. Stakeholders also perceive that traffic operations needs are event and weather-driven, sporadic and localized. This supports a hybrid approach with possible shared control and information among agencies. The hybrid approach supports the implementation of regional TOCs in urban centers such as Sioux Falls and Rapid City, where traffic signal operations are important and where special events are commonplace, but also can support rural TOCs. The hybrid approach also supports portable traffic management systems which can be accessed remotely for special event traffic management, such as that required for the Sturgis Motorcycle Rally. Additionally, the hybrid approach supports concepts such as the Road Condition Reporting System (RCRS), the Maintenance Decision Support System (MDSS), and statewide 511 services, which are centralized and web-based.</p>	

6.0 CONCLUSIONS

Several conclusions were drawn from the findings of this study. They fall into the following general categories, which are discussed more fully in this section:

- Traffic operations needs and recommended functions
- A statewide TOC concept that addresses the functional needs
- A phased deployment plan for traffic operations improvements
- A recommended implementation approach
- Procedural changes to improve traffic operations

First is the discussion of traffic operations needs and functions.

6.1 TRAFFIC OPERATIONS NEEDS AND FUNCTIONS

As discussed previously, the purpose of this project is to identify the most effective and economical means of managing traffic and emergency operations in South Dakota. During the workshops conducted throughout the state, some common themes emerged to help guide the traffic operations strategies contained in this report. Those themes included the need for:

- More timely and accurate traffic and travel condition information
- Better coordination among agencies and offices
- Better communications coverage throughout the state
- Improved and more uniform traffic operations procedures
- Better planning for traffic operations

It was clear that traffic operations stakeholders throughout the state recognized the need for improvements in traffic operations capabilities and they expressed a commitment to facilitating those improvements.

The stakeholders also presented some overriding principles to help guide the process for improving traffic operations capabilities. These principles include:

- The solution must be practical and economical.
- The solution must integrate with and leverage existing systems.
- The solution must include links to emergency management.
- The solution must identify links to adjacent states.
- The solution must be specific to the needs of South Dakota.
- The solution must be consistent with Federal transportation policies and guidance.

During the course of this research project, the new federal transportation act – Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) – was enacted. This law authorizes the establishment of “a real-time system management information program to provide, in all States, the capability to monitor, in real-time, the traffic and travel conditions of the major highways of the United States and to share that information to improve the security of the surface transportation system, to address congestion problems, to support improved response to

weather events and surface transportation incidents, and to facilitate national and regional highway traveler information.”

Federal guidance on how the new transportation bill will be executed has not been released. However, many of the goals outlined in the new federal transportation authorization act are consistent with the traffic operations needs and objectives for South Dakota. These goals have become part of the basis of this strategic deployment plan.

Given the parameters outlined above, the ultimate TOC solution recommended for South Dakota includes the following:

- Integration with legacy systems, such as the Road Condition Reporting System and statewide 511 system
- Maximum leverage of current statewide communications infrastructure and capabilities
- Consideration of metropolitan traffic operations functions and needs, particularly in the Sioux Falls and Rapid City areas, but also in smaller urban areas
- Consideration of special event traffic management needs associated with the Sturgis Motorcycle Rally, the Mt. Rushmore July 4th fireworks display, and other large special events
- Continued focus on winter road and weather conditions as the primary issue for traffic operations
- Coordinated approach for the sharing of road and traffic condition information across state boundaries
- Formalized partnerships between SDDOT and other departments and agencies, including the Department of Criminal Investigation, State Radio Dispatch, the Highway Patrol, local public safety departments, and emergency management organizations at the state and local level, for the purpose of sharing resources and information for improved traffic and emergency management.

To accomplish these objectives, the stakeholders favor a hybrid model for TOC deployment. The stakeholders emphasized that a hybrid approach is flexible and can be designed to meet the diversity of traffic operations needs in South Dakota.

Based upon the stakeholder workshop results, discussions with SDDOT personnel, and interviews with key personnel from other state government agencies, the following traffic operations functions form the basis for the recommended TOC concept for the South Dakota. These functions, along with possible supporting technologies, are shown in Figure 13 and described more fully below.

6.1.1. ROAD AND WEATHER CONDITION DATA COLLECTION

The collection of road and weather condition data is one of the key functions performed by SDDOT and local transportation agencies, including public safety agencies. Road and weather conditions have a dramatic impact on travel within South Dakota. Stakeholders from throughout South Dakota identified road weather conditions as one of the key issues they must deal with on a daily basis.

Winter weather conditions are especially critical, as evidenced by the blizzard in late November of 2005, but summer conditions, including flooding, rain storms, fires and tornados, can also impact traffic. Weather events are often regional in scope and rarely impact the entire state. However, because such events are dynamic and move from one region to another, it is important that climatic and road

surface condition data be available on a uniform, statewide basis for maintenance operations and traveler information. Stakeholders indicated that the state needs to apply more resources to preventative maintenance and repair of the existing Road-Weather Information Systems (RWIS) since many of the existing weather stations are currently not reporting data and need to be repaired and upgraded.

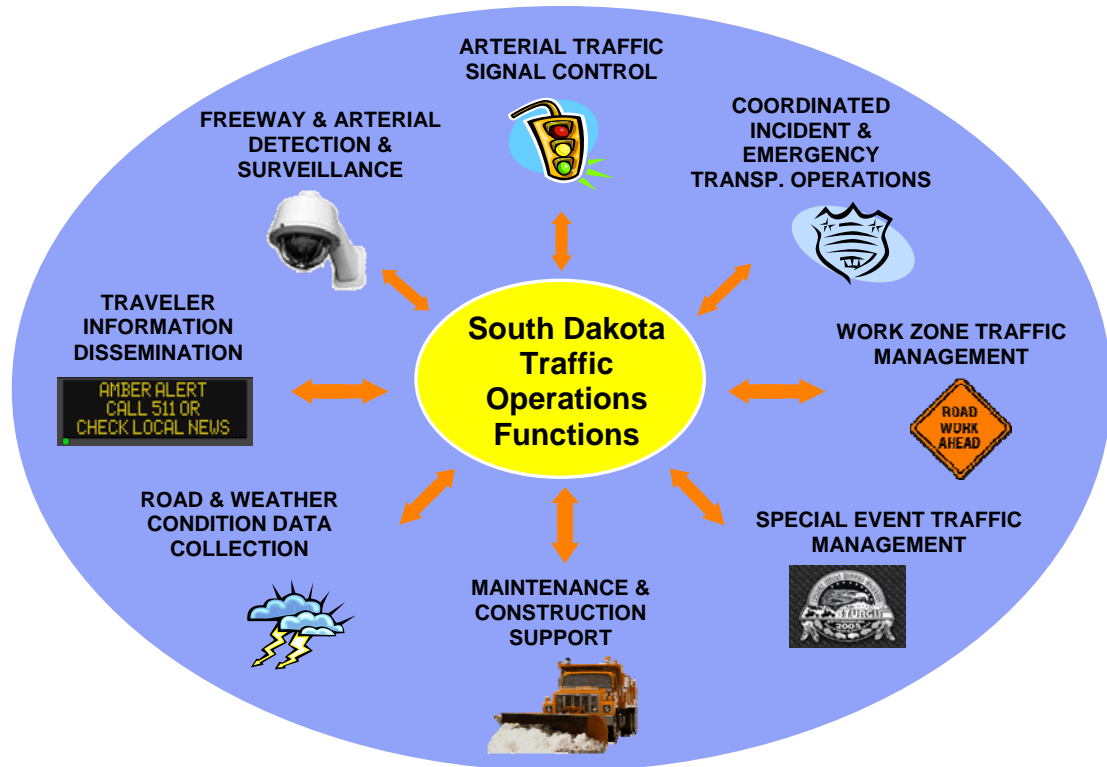


Figure 13 - ITS Functions Recommended for Inclusion in the South Dakota TOC Concept

SDDOT has been a pioneer in the collection and dissemination of road and weather condition information. The data are collected from a variety of sources including field personnel, RWIS stations, and weather forecasting services. Road surface condition data and highway construction data are entered into the RCRS manually by SDDOT field personnel. Weather forecasting data are provided to SDDOT by MET, who poll RWIS sites to obtain localized weather data. The road surface condition data in RCRS and the weather data collected by Meridian Environmental Technology are linked for dissemination through the statewide 511 system and the SafeTravelUSA.com website, but these data are maintained in separate databases.

During the statewide EOC activation in late November and early December of 2005, the SafeTravelUSA.com website was continuously monitored in the EOC. The accuracy of the information presented was very good, although rare, short-term anomalies occurred where the information was suspect. Weather forecasting information was available twice daily from the National Weather Service within the EOC. More frequent forecasts were provided to SDDOT field offices, where the information was used for local and regional operations support. Most EOC response personnel felt that the current level of weather forecasting information and the frequency of the forecasts were adequate. However, upon further discussion, most of the interviewees noted that the

availability of more frequent and accurate forecasts at the EOC would have been useful in making resource allocation decisions during the storm, especially between regions or among SDDOT field offices.

Respondents generally felt that video images would be useful for verifying or monitoring localized weather conditions at the EOC, although most believed that such images would be more useful for traffic incident verification and security purposes. During the November 2005 snowstorm, widespread power failures would have limited the utility of closed circuit TV (CCTV) cameras. Nevertheless, the installation of CCTV cameras at RWIS sites is planned, and SDDOT operations personnel have access to surveillance video images at Interstate highway rest areas.

The strong relationship between SDDOT and the Highway Patrol was evident in all of the regional workshops and during the subsequent interview sessions. This relationship can pave the way for additional collaboration in collecting, entering, monitoring and managing weather road condition and weather information. Sharing the rest area video is one way, but another way involves changes in current procedures for managing the RCRS. In later 2005, the RCRS was enhanced to allow entry of event data. Providing access to the RCRS to the Highway Patrol and to State Radio Dispatch, so they too may enter weather and incident data, would help to improve the timeliness and possible accuracy of the data, while also establishing a mechanism for after-hours support for the RCRS, 511, DMS, and the SafeTravelUSA.com website.

In the future, SDDOT would like to obtain road surface condition data and other relevant weather-related data from sensors located on maintenance vehicles. Implemented along with automatic vehicle location (AVL), weather sensors on maintenance vehicles could provide information needed to support construction and maintenance decisions. A project was approved in the Spring of 2006 to design a mobile data collection system for SDDOT maintenance vehicles.

The importance of accurate and timely weather information is critical for traffic and emergency operations in South Dakota. As mentioned above, SDDOT approved two projects expected to result in improved road - weather data collection and maintenance operations. Those projects include:

- The development of a standard configuration for the upgrade and enhancement of the SDDOT's 36 RWIS/ESS sites, including the addition of CCTV cameras.
- A study to design the installation of AVL and weather sensors on SDDOT maintenance vehicles, which would act as mobile data collectors.

Other possible improvements include:

- Development of a routine maintenance and upgrade program for RWIS sites to ensure their continued availability and reliability.
- Integration of real-time RWIS data with RCRS after the RWIS upgrade is completed and a routine maintenance program is implemented.
- Continued training and education of operations staff to make RCRS updates a priority; possibly include in performance plan goals.
- Partnering with the Highway Patrol and State Radio for RCRS data entry after normal SDDOT working hours.

- Enhancement of RCRS as the primary source of data for traveler information services, including not only 511 and the SafeTravelUSA.com website, but also DMS and Highway Advisory Radio (HAR).

6.1.2. CONSTRUCTION AND MAINTENANCE SUPPORT

Construction and maintenance support systems are becoming increasingly available to improve decision making and operational efficiency. Additionally, TOCs can support construction and maintenance operations through such things as the dissemination of traveler information regarding work zones, closures, alternate routes, and associated delays.

Just as SDDOT has been a leader in road and weather condition monitoring, they are also a leader in the development of a Maintenance Decision Support System (MDSS). In fact, South Dakota is the lead state in a pooled fund study of MDSS. The intent of these systems is to provide decision support tools and processes to improve the efficiency and effectiveness of maintenance and construction operations. For example, MDSS would provide recommendations for the timing and treatment of road surface conditions based on medium-term weather forecast data, current road surface condition data, knowledge of the chemistry/physics of the current road surface and resources available.

Such decision support systems are valuable in both the summer and the winter. For example, weather forecasts are an important factor in many construction activities and summer maintenance activities, including road paving and surface repairs. A construction decision support system (CDSS) was proposed by several of the stakeholders; however, there are no efforts or plans underway to develop such a system. CDSS functionality could be added to MDSS in the future, if required and selected for development.

Maintenance and construction support was considered to be an important SDDOT function by the stakeholder community. Many of the possible improvements listed under the Road and Weather Condition Data Collection function would provide improved inputs into the MDSS. By 2007, it is projected that the MDSS software will be mature and scalable enough for states to deploy.

6.1.3. TRAFFIC DETECTION AND SURVEILLANCE

Traffic detection and surveillance systems provide the basis for many traffic and incident management functions, traffic signal control, traveler information services, weather monitoring, emergency management, and transportation planning activities. However, extensive statewide deployment of vehicle detection and highway surveillance systems is not cost or technologically feasible at this time. Instead, the deployment of such technologies should be considered for critical spot locations, where traffic problems are a recurring problem. Examples of this which have already occurred are the deployment of CCTV cameras at the I-229/Benson interchange in Sioux Falls and at Exits 30 and 32 along I-90 in the Sturgis area. CCTV camera images should be available on the SDDOT web site and at the statewide and regional EOC's. Camera control should be available to operations personnel in the region from a TOC and from remote workstations.

CCTV images may also be used to help determine the severity of localized weather conditions. It is now feasible to obtain digital video images through wireless communications from CCTV cameras located at remote RWIS sites. Such cameras may be stationary or have pan-tilt-zoom (PTZ) capabilities, depending on the communications capabilities and needs at the particular RWIS site. This

function was discussed in the previous Road and Weather Condition Data Collection Section and is being considered as part of a phased deployment approach for upgrading RWIS sites.

Most of the surveillance conducted by SDDOT is for road surface conditions, and these data are collected manually by SDDOT field personnel. Road condition and construction data are entered manually into the RCRS by authorized personnel with remote access to the system. Currently, field personnel from the SDDOT construction and maintenance divisions enter a majority of the data into the RCRS, including maintenance work, construction information and road surface conditions.

Recently, the RCRS and the 511 Traveler Information System were modified to accept and report information about road closures, special events, traffic congestion, emergencies and other disruptions to normal traffic flow. A data entry screen, which resembles the “Construction” data entry screen, is available to authorized personnel for the entry of “event” data. This modification is being tested at this time. However, it is possible that the Highway Patrol and local police departments may be given authorization to add incident information directly into RCRS in the future. Procedures for the entry of such data into RCRS are needed to ensure accurate and timely information.

Portable surveillance systems may also be used for special events, such as the Sturgis Motorcycle Rally. These devices can be set up and moved with relative ease. Many run on solar power, and wireless communications to the devices allow real-time monitoring and control.

Traffic detection is a primary source of data for congestion information and traffic signal control. Some urban corridors in South Dakota may benefit from traffic detection. At this time, closed loop traffic signal control systems are operational in both the Sioux Falls and Rapid City metropolitan areas, and along major arterial corridors in smaller urban areas, such as Pierre. Most of these systems run on time-of-day plans. However, the control equipment is capable of operating traffic-responsive control if traffic detection is operational.

Possible improvements to support this function include:

- CCTV camera installations at critical interchanges along the Interstate Highway System
- CCTV camera installation at RWIS stations (project is underway)
- Process changes for monitoring, collecting and entering road condition data, traffic incident data, and event data

6.1.4. INCIDENT AND EMERGENCY TRANSPORTATION OPERATIONS

Traffic incidents and emergency situations were key concerns among the traffic operations stakeholders in South Dakota. Traffic operations concerns are event-driven, and these types of events, though rare, can have significant impact on travel conditions throughout the state.

Incident Management

Incident management is defined as the systematic, planned and coordinated use of human, institutional, mechanical and technical resources to reduce the duration and impact of incidents, and improve the safety of motorists, crash victims, and incident responders. Traveler delay is a direct consequence of incidents, but the most serious problem is timely response to the incident scene. The risk of secondary crashes is also a major concern. Incident management typically involves detection,

verification, response and clearance in addition to motorist information, traffic and site management. These activities warrant the involvement of multiple agencies, including:

- SDDOT
- The South Dakota Highway Patrol
- Local Police and Fire
- Emergency Medical Services
- The Forest Service
- Game, Fish and Parks
- Various County and City Traffic Departments
- 911 Dispatch Centers
- HazMat Response agencies
- Towing and recovery services
- State and County Level Emergency Management Organizations
- Media organizations

Incident management is one of the key functions to be performed at a TOC. Activities would include the detection and verification of incidents, the activation of incident response activities, the notification of agencies and the media, and traveler information dissemination. While these functions are important, it is equally important to have a set of incident management policies and procedures in place for coordination among responding agencies. SDDOT may also consider the establishment of a statewide Incident Management Committee to establish formal plans and procedures for incident management.

One of the most profound changes in traffic operations has come about with the proliferation of cellular phones. Cellular phone calls to 911 dispatch centers are now the most common means of detecting traffic incidents or other conditions that may impact traffic conditions. The integration of 911 computer aided dispatch (CAD) systems with data collection systems, such as RCRS, may be automated for the transfer of incident data. Currently, State Radio Dispatch does not employ a CAD system, but are evaluating several CAD systems and intend to procure and deploy a system possibly by the end of the 2006 calendar year. The use of CAD varies among 911 centers throughout the state. The New World CAD System seems to be the prevalent system used, according to State Radio Dispatch.

The linkage between the 911 dispatch centers and SDDOT, whether through collocation in a TOC/EOC, by automated data transfer or by other means of communications, is critical for prompt and proper incident detection and response. Automating the data transfer function to reduce data entry requirements for incidents and other events should be considered for future implementation. However, procedural changes will also be required. The establishment of a communications link and procedural changes to enter, protect and transfer incident information should be considered as part of the TOC concept for South Dakota.

A step in this direction has been taken recently by SDDOT. The RCRS has been enhanced to accept incident and special event data from authorized users. At this time, a formal process has not been established for granting user privileges or for partnering with the public safety community. However, as access to the RCRS is offered to other agencies in the future, it will be important to establish rules and procedures for data entry and to protect the privacy of certain data.

Transportation Emergency Management

SDDOT also plays a key role in emergency management. The statewide Emergency Operations Plan includes an Emergency Support Function (ESF) specifically related to transportation. The Transportation ESF outlines the policies, concept of operations and specific actions required of SDDOT during an EOC activation. SDDOT's primary responsibilities cover assessment, clearance, recovery, restoration, and the safety and security of the state's transportation infrastructure. SDDOT also is required to support the movement of state resources during emergencies.

These responsibilities require that SDDOT have the capability to adequately assess the emergency, identify resource requirements and deploy the resources required as efficiently as possible. Centralized tracking of resources on a statewide basis is required. Finally, tremendous coordination, not only between SDDOT headquarters and field offices, but also between SDDOT and other support agencies is mandatory.

The link between traffic operations and emergency operations was given added focus during and after the November 2005 snowstorm. It was apparent during this emergency that the SDDOT played a critical role in the emergency response. It was also apparent that improvements are needed in the following areas:

- National Incident Management System (NIMS) and Incident Command Structure (ICS) training for SDDOT personnel. One of the after-action recommendations resulting from the EOC activation is that key SDDOT personnel receive this training during 2006. This will add depth to the personnel resources required for emergency response. This is recommended for all state government agencies involved in EOC activations.
- Familiarity with the South Dakota Emergency Operations Plan and Emergency Support Functions. Very few SDDOT personnel are familiar with these documents, which are based on ICS principles and used during all EOC activations. This was common among the various departments of state government represented at the EOC during the activation.
- Resource tracking systems and procedures. Key personnel at the EOC felt that they were able to manage resources well during the storm, but that it was often difficult to move resources efficiently to areas where the need was greatest. A uniform procedure and system for tracking resources would facilitate better resource management during emergencies.
- Coordination of resources at the sub-state level. Generally, coordination between the SDDOT and local governments is good. However, in some cases during the blizzard, it was felt that local resources were not fully tapped to support the emergency. This occurred primarily between different counties or regions. Regional or statewide oversight, including resources tracking at this level, may be needed during widespread emergencies.
- Off-system support mechanisms and resources. Key SDDOT personnel felt that their resources and emergency response capabilities were adequate for the state highway system. However, SDDOT also responded to off-system needs. This stressed the SDDOT's resources to the limit. In addition, due to statewide priorities, SDDOT responded to off-system roads as quickly as possible, but could not satisfy all needs immediately. Improvements may be required at the local and county levels to ensure that local resources are fully utilized, but also for resources sharing among local governments during widespread emergencies. Resource tracking, at the state level, and coordination with contractors or neighboring states also may be needed.

- Statewide traffic and incident management plans. During the interview with SDDOT executives, it was noted that SDDOT does not have a statewide traffic operations plan similar to the statewide emergency operations plan. The statewide traffic operations plan would be a compilation of policies and procedures for effective traffic operations, incident management plans and diversion routes, interagency agreements, resource inventory, and contact lists. It should incorporate the Emergency Support Functions where SDDOT plays a role.
- Technologies to support both traffic and emergency management.
 - CCTV coverage of key locations, including RWIS sites, and the availability of video at the EOC would be beneficial. The availability of CCTV images from SDDOT CCTV cameras in the EOC could facilitate the verification of conditions and emergency response decisions.
 - Integration of State Radio dispatch incident data and RCRS would improve the value of the information to the public over 511 and the SafeTravelUSA.com website. This integration should be automated to eliminate duplicate entry of the data into both systems. This may require State Radio dispatch to deploy a computer aided dispatch (CAD) system at the new dispatch center. An alternative would be for State Radio Dispatch to be given authorization and training to enter data into the RCRS, especially after normal working hours. This would require a memorandum of understanding between SDDOT and the SDDPS.
 - The SafeTravelUSA.com website and the South Dakota 511 system should be enhanced to include traffic conditions, traffic incident information, and special event information in addition to the road surface condition information, weather information and work zone information currently available. RCRS currently has these capabilities, but procedures to update RCRS with this information have not been fully implemented.
 - TOCs should be established in Pierre, Rapid City and Sioux Falls to support traffic and emergency/incident management. These TOCs should be equipped with a common suite of Advanced Traffic Management System (ATMS) software to allow CCTV control and monitoring; traffic signal control (including emergency vehicle preemption); DMS control; incident management functions for detection, verification, notification, and response; road and weather condition monitoring; MDSS capabilities; asset management and tracking; special event traffic plan execution; and work zone traffic management, including the control of portable traffic management devices.
 - External interfaces should be established between each TOC and:
 - The other regional TOCs over existing DS3 communications links. This will allow the exchange of data and video while also offering redundant capabilities among the centers.
 - SDDOT Regional and Area Offices via the current SDDOT communications network or through other remote access means.
 - Local and county level EOC's to facilitate the integration of traffic and emergency operations at the local level.
 - Local, county and State Radio dispatch centers for the exchange of incident data and video images.
 - RCRS should be integrated with the ATMS software.
 - An ATMS workstation should be located in the State Radio dispatch center and in the EOC.

The coordination requirements of emergency management and the opportunities for sharing resources between the SDDOT and other departments of state government support the collocation of the Pierre TOC with the new statewide EOC. Collocation is currently under consideration by SDDOT and SDDPS executives. Space within the State Radio Dispatch Center at the Pierre Statewide EOC has been reserved for a small TOC.

6.1.5. SPECIAL EVENT TRAFFIC MANAGEMENT

Special event traffic management has become more important in recent years as the number of events increases along with their size and duration. In South Dakota, numerous events take place that impact regional and sometimes even statewide traffic conditions. For example, the traffic impacts of the Sturgis Motorcycle Rally are felt throughout the state as hundreds of thousands of visitors converge on the Black Hills from all parts of the country.

Special event traffic management integrates traffic management, traveler information, parking management, and public transportation management into a comprehensive special event plan for managing traffic. Other important elements involved in special event planning include public information, coordination with event organizers and area businesses (including private parking providers), and media relations.

The objectives of special event traffic management include:

- Facilitate safe and efficient travel to and from the event
- Use excess system capacity if available
- Maximize the efficiency of parking operations
- Accommodate pedestrians
- Automate traffic management tasks
- Disseminate useful traveler information
- Maximize safety and security
- Minimize impact on neighbors

Spot improvements have been made to improve traffic management in the Sturgis area, and traffic management has become a major part of the planning activities for the Sturgis Rally. A portable traffic management system is now used to monitor traffic conditions at certain locations, such as Exits 30 and 32 along I-90, and to provide traveler information on both permanent and portable DMS in the region.

Even with these improvements, more can be done to improve traffic operations for the Sturgis Rally and other events. The mobile command center currently in use cannot accommodate the variety of stakeholders involved in the management of the event. A permanent TOC, which can be used on a daily basis for traffic management, could be used as a command center and “situation” room during such events.

Traveler information is provided via DMS along I-90 and portable DMS along secondary routes. The statewide 511 system is now capable of accommodating information related to the event. The use of the internet for pre-trip traveler information also is encouraged, with the possibility of having a web page devoted to traffic conditions in the Black Hills.

Traditional broadcast media, such as radio and television, are not considered part of the intelligent transportation system, but nonetheless, they play an important role in the overall effort to deliver timely traffic information to the public. The media should be actively involved in event planning. Media announcements of upcoming events, routes to the events, parking and shuttle services, and times of the events can help to minimize the traffic impacts in the immediate area of the event.

Travel demand management techniques also are an important part of special event traffic management. During the TOC workshops, it was noted that shuttle services are available during the Sturgis Rally. In addition to such services, other events are being offered throughout the area to disperse traffic over the road network or over time. These are effective techniques for managing traffic related to the events.

It's important to note that one of the most effective ways to mitigate traffic impacts associates with special events is to develop a plan and execute it properly. Often, event organizers are given too much responsibility for traffic management and control functions during special events. When this is the case, traffic management is not usually treated with the priority it requires. Special event planning should be a collaborative effort, and SDDOT must ensure that they are highly involved in both the development and execution of the traffic management plans.

6.1.6. WORK ZONE TRAFFIC MANAGEMENT

The participants in the TOC workshops identified work zone traffic management as another important function performed by SDDOT. It was recognized that road construction activities on I-29 and I-90 can impact traffic throughout a region due to the limited number and capacity of detour routes. In some instances, it was noted that construction activities are suspended on a regional basis during the period before, during and after the Sturgis Motorcycle Rally. On other occasions, work zone traffic management isn't as critical a need due to relatively low traffic volumes.

At the present time, SDDOT requires contractors to provide public information on major projects or on smaller projects that may have a significant impact on traffic. Usually, the contractors will use the media to relate such information. SDDOT area offices also provide information on construction projects within their jurisdictions to local newspapers. In either case, the information provided to the public is seldom real-time in nature.

Nevertheless, many ITS technologies are available to ensure work zone safety and to provide real-time information about road work and closures to travelers. The deployment of permanent DMS along I-29 and I-90 is an example of such a technique. Portable DMS and portable detection and surveillance systems also are available to provide motorists with advance warning of traffic slow-downs at work zones.

6.1.7. TRAFFIC SIGNAL CONTROL AND MANAGEMENT

Arterial traffic management capabilities should be an important element of any regional traffic management system. Traffic signal control improvements generally provide the greatest payoff for reducing congestion levels and travel times on surface streets when compared with any other methods. In addition to reducing travel time, these improvements also reduce stops, fuel consumption, and emissions.

Improvements can be made in a number of ways, including traffic signal timing optimization, traffic-responsive signal control, integration with a freeway management system and preemption for emergency vehicles.

Traffic signal optimization includes the timing of traffic signals to provide traffic signal coordination within corridors. It also includes the optimization of traffic signal phase splits (i.e., red, yellow, and green) at each intersection to allocate “green time” to the approaches which need it the most. Traffic engineers attempt to find the right balance between coordination and phase splits when they optimize traffic signal timing.

Quite often, due to limited resources, transportation agencies retime traffic signals on a five to ten year cycle. The final research report entitled, “Improved Traffic Signal Maintenance and Management (SD2003-01),” included a recommendation to perform annual traffic signal maintenance inspections, which would include a review of traffic signal timing. As a result of the annual review, SDDOT could request municipalities to make adjustments to the traffic signal timings.

In Sioux Falls, the jurisdiction of all state roads has been transferred to the city. Even before this transfer took place, the city was authorized to adjust signal timing without SDDOT approval. The city maintains 216 traffic signals, which are optimized on a three year cycle. The City of Sioux Falls also operates seven MARC closed loop traffic signal systems and plans to upgrade to an Eagle ACTRA centralized traffic signal control system in the next five years.

As mentioned above, the installation of detection equipment at selected intersections provides the opportunity for traffic-responsive control of traffic signals. In such cases, the signal timing will adjust to the flow and density of traffic on the network or within a corridor. Most modern traffic signal control equipment can accommodate such a strategy. For example, the migration to ACTRA in Sioux Falls will facilitate real-time, traffic-responsive traffic signal control on an area-wide basis.

Centralized traffic signal control also facilitates traffic signal maintenance. System health monitoring and reporting are features of most centralized traffic signal control systems. Also, such systems contain the ability to make traffic signal timing changes remotely or from the office. This can be useful during inclement weather or special events. For example, during winter weather events, minimum green times, yellow times, and all-red times could be extended to allow for increased time to clear intersections.

Even with more frequent optimization, revised procedures, and upgraded technology, greater attention and resources should be applied to traffic signal timing throughout the state. This activity provides some of the biggest payoffs to the drivers in terms of travel delay reductions, reduced stops and fuel consumption.

Attention should also be given to integrating arterial management and freeway management. In San Antonio, Texas, integrating arterial, freeway and incident management led to a 20 percent reduction in travel delay during major incidents. Information obtained from surveillance on the freeway, ramp area, and arterials can be used to adjust traffic signal timing and or accommodate additional traffic diverted from the freeway. Action sets or procedures can be predefined to address traffic congestion caused by incidents on the freeways and principal arterials. These procedures can include activation of incident timing plans on the arterials, activation of HAR messages, and programming DMS messages (SAIC, 2000).

Emergency vehicle preemption systems are used in Sioux Falls, Rapid City, Pierre, Mitchell and Sturgis. These systems can provide improved response times by emergency response and law enforcement vehicles. Even during normal, recurring congestion, emergency vehicles can have trouble navigating through traffic. Preemption systems will enable quicker response to, and clearance of, traffic incidents and reduce congestion associated with the incident. Installation of an emergency vehicle preemption system can also reduce conflicts and driver confusion, but will create some interruption of normal traffic signal progression, which requires several traffic signal cycles to return to normal operation.

Although cities can use different types of preemption systems, it is recommended that a single agency be responsible for scheduling, coordinating and funding system maintenance. A memorandum of understanding may be necessary between the agencies to establish a clear method of reporting system problems, service call procedures, access to controller cabinets, service log requirements, and any other necessary site-specific coordination issues and communication protocol to ensure timely repair and system adjustments (Louisell, 2006).

6.1.8. TRAVELER INFORMATION DISSEMINATION

Traveler Information facilitates efficient travel by providing necessary information relating to the roadway and traffic conditions, incidents, multi-modal opportunities, and weather. The RCRS is a tremendous source of traveler information for the state of South Dakota. It is not only the basis for the statewide 511 traveler information system, but the RCRS automatically generates and issues reports to police agencies throughout the state over the National Law Enforcement Telecommunication System (NLETS).

As mentioned above, recent enhancements to the RCRS will provide the opportunity to disseminate “event” information over 511, and plans call for an interface between the RCRS and the SDDOT network of DMS’s. In addition to road surface condition data, the RCRS has recently been enhanced to provide, via authorized staff inputs, incident, emergencies and special events information. This information is disseminated through the www.SafeTravelUSA.com web site. Weather information is provided separately to the SafeTravelUSA web site and the 511 phone system from MET data feeds. This web site currently provides weather forecasts for specific roadway segments in a six-state area (i.e., South Dakota, North Dakota, Montana, Minnesota, Nebraska and Kansas). These enhancements will improve SDDOT’s capabilities for disseminating traveler information in a consistent, uniform manner, even across state borders.

SDDOT has deployed thirty DMS’s along Interstate highways throughout the state. By doing so, SDDOT has elevated the expectations of motorists for timely, accurate road and travel condition information. Policies for DMS operations are not clearly articulated. Consequently, one area that may need improvement involves the procedures for placing messages on the DMS’s. Twenty-two SDDOT personnel, including region and area operations engineers, have authority to place messages on the signs and have the ability to control DMS in other regions. Improved coordination between jurisdictions, including adjacent states such as Iowa, would also improve message consistency and provide advance warning of downstream events or conditions.

Another procedural improvement involves the entry or removal of DMS messages and RCRS information after normal working hours. Generally, the Highway Patrol or State Radio Dispatch will contact SDDOT personnel on their call list to place a critical message on the DMS’s or to enter similar

data into the RCRS for dissemination over 511 or the Internet. This practice has been working, but it has been problematic on rare occasions. Sometimes, State Radio Dispatch may not be able to reach SDDOT personnel at the top of the call list, necessitating multiple calls. Consequently, it may take considerable time for the information to be communicated to SDDOT personnel, entered into the systems and disseminated to the public.

After the November 2005 blizzard, a procedure was established to update RCRS four times per day to ensure freshness and accuracy. The frequency of RCRS updates in the future is likely to vary and will depend on the severity and volatility of road conditions and events. The update process should be described in the proposed operation guidelines. Additional updates could be provided by authorizing the Highway Patrol and State Radio Dispatch to enter data into RCRS and to have RCRS be the primary source of data for DMS messages. The collocation of the Pierre TOC with the State Radio Dispatch Center may facilitate such an arrangement, but will depend on inter-agency agreement.

The coordination of traveler information with adjacent states is another concern, especially because of the volume of interstate traffic on I-90 and I-29. Ideally, SDDOT could share road and traffic condition data with adjacent states, and that information would be disseminated to travelers over an array of media including DMS, 511, rest area kiosks and traveler information websites. Such data sharing is already taking place to a large degree with the states of Minnesota, Nebraska, Montana, and North Dakota, which offer compatible systems for data sharing. At this time, Wyoming and Iowa operate incompatible systems that do not allow data sharing. However, efforts are underway to overcome these incompatibilities.

The Northwest Passage pooled fund project presents an opportunity to enhance data sharing among adjacent states in the I-90 and I-94 corridors from Wisconsin to Washington State. When this project is completed, road-weather condition information and traveler information services will be provided seamlessly to travelers as they cross state borders along these corridors.

6.2 OVERVIEW OF SOUTH DAKOTA PREFERRED TOC CONCEPT

Stakeholder meetings were held in July and October of 2005 to obtain stakeholder input on functional and operational requirements, including recommendations on TOC operational concepts that participants felt would be the most effective and economical means of managing traffic and emergency operations in South Dakota. A hybrid approach was the overwhelming stakeholder preference among TOC concepts. Although no consensus was reached with regard to the exact form of the hybrid approach, the stakeholders identified the primary components of the hybrid approach as having both a physical TOC (or multiple centers) and virtual TOC capabilities. The rationale for selecting the Hybrid TOC concept was that it:

- Provides the greatest flexibility to SDDOT and partner agencies
- Supports interagency coordination, distributed control, and centralized data collection and dissemination
- Can accommodate both statewide and regional traffic operations needs
- Recognizes that most traffic operations needs are event or weather driven, sporadic and localized

The stakeholders agreed with the recommendation that a Distributed-Hybrid TOC is the most appropriate concept for South Dakota. This section is intended to describe the Distributed-Hybrid TOC concept by reviewing high-level requirements and defining the elements of that concept.

6.2.1. TOC HIGH-LEVEL OPERATIONS REQUIREMENTS

The high level requirements for the South Dakota TOC concept are dependent upon the traffic and emergency operations functions to be performed, the statewide and regional ITS architectures, the institutional structure for such operations, current and anticipated roles and responsibilities for operations, partnerships and data sharing requirements, staffing and resources needed, continuing maintenance and operational requirements, legacy systems and stakeholder preferences.

The TOC is intended to be a central component of the South Dakota transportation management system and the means for managing traffic, incidents, events, emergencies, maintenance and construction operations, and the collection and dissemination of real-time traffic and weather data. The TOC is identified in the South Dakota ITS Rural Architecture as the home of the “Center Subsystems” and also performs the functions of an “ITS Data Mart” and “ITS Data Warehouse”. It impacts many other market packages and user services.

The TOC will function as the key technical and institutional hub bringing various agencies together to focus on optimizing the performance of the transportation system and emergency transportation operations. Interaction and cooperation can be greatly enhanced when different disciplines and agencies within South Dakota are collocated at the TOC. Collocation will likely result in a more consistent and unified response during events, small or large, unplanned or planned.

The following high-level requirements for the South Dakota Traffic Operations Centers were identified. The implementation of a TOC should:

- Support both statewide and local operational and administrative functions (arterial management, freeway management, traveler information, incident and emergency management, work zone traffic management, event management, maintenance and construction management);
- Support the collection and dissemination of information regarding winter road and weather conditions;
- Accommodate centralized traffic and emergency operations policies and standards;
- Provide for centralized statewide travel information;
- Connect with other SDDOT offices via a common communication/network system, with regional TOCs acting as communications hubs;
- Provide common software and hardware for ease of device control, data sharing, configuration management, integration, and maintenance;
- Allow remote access and support virtual TOC capabilities;
- Interface with 911 dispatch centers in each region;
- Provide centralized data archiving;
- Allow integration and data exchange with partner agencies;
- Utilize existing facilities and space for TOCs;
- Maximize use of ITS standards;
- Be consistent with the statewide and regional ITS architectures, which provide a shared vision of how each agency’s systems will work together in the future, sharing information and resources to provide a safer, more efficient, and more effective transportation system for travelers in the region;
- Accommodate a coordinated approach for the sharing of road and traffic condition information across state boundaries

- Integrate with the Road Condition Reporting System (RCRS) and current centralized information dissemination services.

6.2.2. TOC CONCEPT DEFINITION

For South Dakota, one pure TOC operational concept, such as a centralized statewide operation center, does not meet all of the identified requirements. South Dakota has many diverse operational needs, which include both urban and rural incident management, statewide and local traveler information dissemination, arterial management in larger urbanized areas, large event management (Sturgis Rally), and winter maintenance operations as a result of severe weather conditions. The relatively large area, population distribution and rural nature of the State make a centralized approach less attractive for functions such as traffic signal management, special event traffic management, work zone traffic management, and other more localized traffic management needs. The long distances between roadside devices and a central facility would make adequate communications difficult to achieve and costly. The lack of familiarity of TOC personnel with local conditions throughout the state may also make operation of a single, central facility problematic.

Consequently, it is recommended that the traffic operations concept for South Dakota not be accomplished from a single, centralized TOC, but be accomplished through a combination of integrated, regional traffic operations centers situated in key areas of the state to allow operational management and control at the regional level, governed by state policy and use of a common software system, hardware platforms and communication network. This distributed, peer-to-peer concept also will provide redundant operations capabilities from other locations.

It is recommended that a Statewide TOC be established in Pierre that provides statewide and regional responsibilities, and that Regional TOCs (RTOCs) be established in Rapid City and Sioux Falls to perform regional traffic operations responsibilities. A breakdown of statewide and regional functions is shown in Table 6. In addition, it is recommended that South Dakota implement a virtual TOC concept that will enable other SDDOT offices and authorized field personnel appropriate and approved access to manage incidents, operations and events at the local level.

Table 6 - Regional TOC Functional Responsibilities

Location	Operations						Operation Functions							Device Control			
	Statewide	Regional	24/7 Operations	Data Warehouse	Communications Hub	Remote Access	Freeway Management	Road Condition Reporting	Arterial Management	Special Event Management	Regional Work Zone Mngmt	Incident Management	Traveler Information	DMS	CCTV	HAR	Traffic Signal Control
Pierre	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rapid City		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sioux Falls		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Pierre – Statewide TOC with Statewide and Regional Responsibilities

A Statewide TOC in Pierre is recommended for several reasons:

- 1) It is centrally located within the State.
- 2) The TOC can be collocated with the statewide EOC to provide interagency coordination and resource sharing opportunities during major planned and unplanned events or emergencies.
- 3) Pierre is the location of SDDOT administrative headquarters.
- 4) Pierre is the headquarters for other collaborating state agencies.
- 5) Pierre is the central hub for State Radio Dispatch.
- 6) Pierre is the hub for the SDDOT communications network, with connectivity to Region, Area, and local SDDOT facilities throughout the state.
- 7) The resources of SDDOT headquarters can support use of the statewide TOC as a test bed for new functions and technologies in the future.

Pierre TOC partners would include:

- South Dakota Department of Transportation;
- South Dakota Department of Public Safety;
 - South Dakota Highway Patrol;
 - South Dakota Office of Emergency Management;
 - State Radio Dispatch;
 - Division of Criminal Investigation (DCI);
 - Motor Carriers;
- Bureau of Information and Telecommunications (BIT);
- City of Pierre.

Sioux Falls and Rapid City – Regional TOCs

Regional TOCs in Sioux Falls and Rapid City are recommended for several reasons:

- 1) They would provide traffic operations capabilities and coverage over the western and eastern portions of the state;
- 2) Sioux Falls and Rapid City are the two largest population centers in the State;
- 3) Regional traffic management is needed for rapidly growing urbanized areas;
- 4) Regional knowledge and resources are required to manage events on a more localized level;
- 5) The RTOCs would provide backup capability to support statewide and other regional TOCs;
- 6) The RTOCs would meet local traffic signal operations needs.

The RTOC concept calls for the collocation of SDDOT personnel with traffic management personnel from the municipalities for arterial traffic management and integrated corridor management. In Sioux Falls, the collocation of the Highway Patrol within the TOC also is recommended, especially since they currently occupy a shared facility with SDDOT. Collocation with the State Radio Dispatch Center in Rapid City may be possible to leverage the synergy generated by such collocation, especially during incidents, major events and emergencies. This possibility was presented by SDDPS and should be explored as the Rapid City TOC concept is developed.

Virtual TOC Capabilities

Virtual TOC capabilities need to be developed to provide SDDOT field personnel and partner agencies the ability to remotely control devices, disseminate traveler information (via DMS or HAR, for example), monitor events and input incident and event data via remote client.

Virtual TOC ITS device control capabilities would include:

- Statewide ITS devices control to provide backup and redundant facilities when the Pierre center or other regional TOCs are inaccessible;
- DMS sign control and monitoring. DMS control software should provide capability to group signs into logical groups or zones for global messages or regional sign messaging;
- CCTV camera control and reduced video viewing capabilities, based on the communication available to the remote site;
- HAR control and monitoring;
- RWIS monitoring;
- Integrated access to RCRS for remote data entry;
- Traffic signal monitoring;
- Multi-tiered system of user levels and privileges.

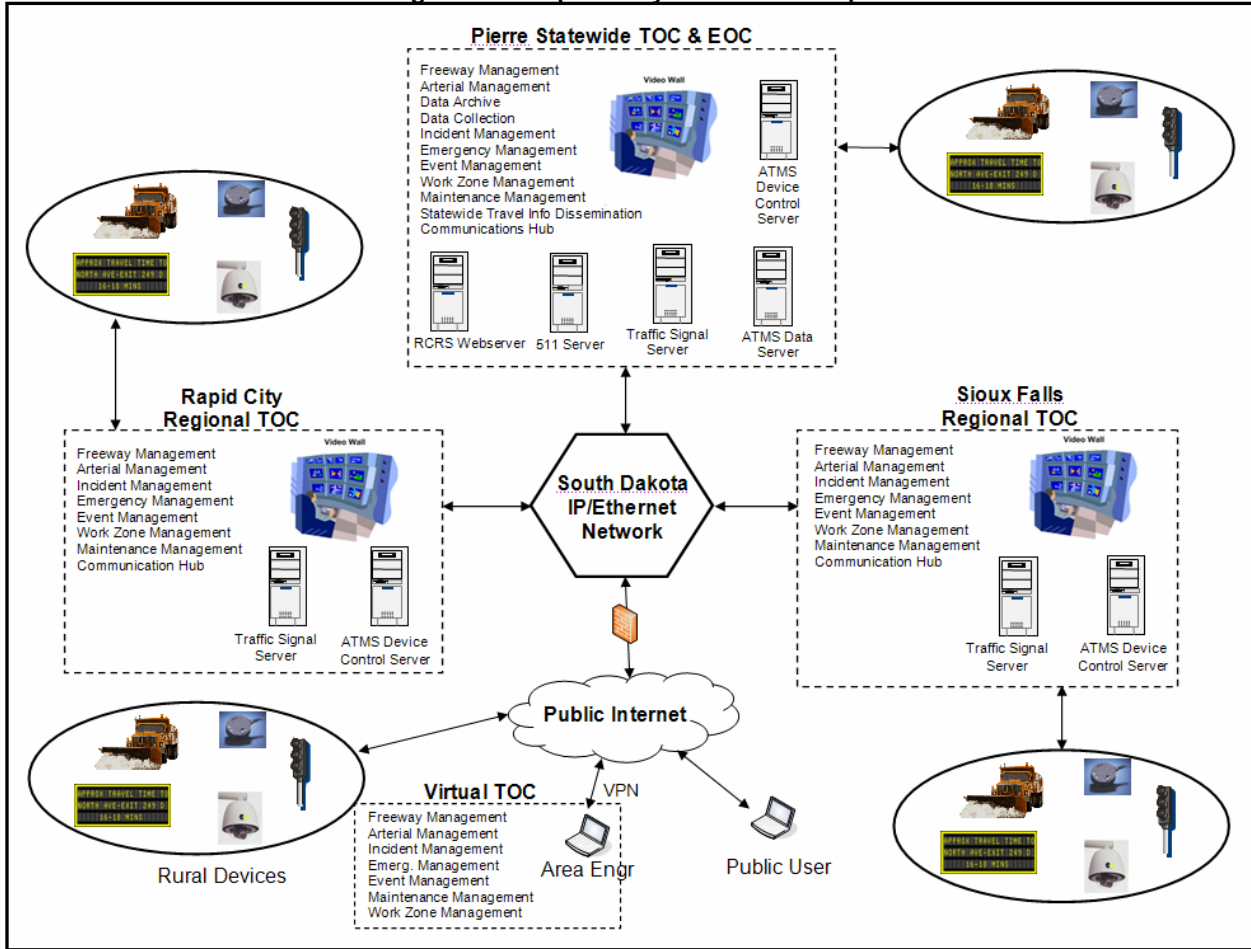
Figure 14 provides an overview of the TOC concept recommended for South Dakota. The concept presented in this diagram is a representation of the ultimate system for implementation in the state. This system would be developed in phases over time, based on priority traffic and emergency operations needs. As depicted in the diagram, the three TOCs would act as peers in a statewide network. Each TOC would have similar functionality. However, the statewide TOC in Pierre would have additional functions related to statewide emergency management, data collection, data archiving, traveler information, statewide communications management, system administration, and statewide traffic operations policy development.

6.3 TOC IMPLEMENTATION PROJECTS

Specific actions and projects were identified in order to meet traffic operations goals and to implement the functions prescribed by ITS stakeholders in South Dakota. The outcome is a set of recommendations for improving current operational procedures, early or high priority actions, short-term projects, mid-term and long term projects. It is difficult to predict technological and institutional issues beyond 10 years and anything beyond that is impractical. However, some immediate actions can be taken that will be beneficial and set the stage for TOC deployment. A 10 year horizon should provide sufficient strategic direction; however, most of the projects are recommended to be accomplished within five (5) years depending on funding availability. The duration of these projects is based on experience from other TOC software development and implementation projects.

The implementation approach, immediate action recommendations and implementation projects are described in the following sections.

Figure 14 - Proposed Hybrid TOC Concept



6.3.1. IMPLEMENTATION APPROACH

It is recommended that South Dakota follow several required and important considerations which will help to ensure successful, efficient completion of the projects and meet desired objectives. The three items are System Engineering Analysis, Configuration Management and use of a System Manager.

System Engineering Analysis

SDDOT should subscribe to the systems engineering approach for the continued development and enhancement of ITS and traffic operations capabilities to ensure that systems meet end-user needs, improve reliability and increase the chance of system development being on time and within budget.. The evolutionary development of ITS and traffic operations capabilities in South Dakota requires the management of planning, design and implementation over a long period of time. Continuity is important for managing change and traceability through the program life-cycle. Additionally FHWA rule/FTA policy requires that all ITS projects funded with highway trust funds shall be based on a systems engineering analysis (23 CFR Section 940.11(a)). The analysis should be on a scale commensurate with the project scope.

To meet this objective, the systems engineering process is utilized to reduce the inherent risk in deploying leading-edge systems and minimize changes to the detailed design once it has been completed. As an example, the concept of operations will identify the overall operational features of

the system, followed by development of the system requirements and detailed design, and implementation. This goal is accomplished by ensuring that all relevant concerns have been included in the overall design process and at the right time.

The systems proposed as part of this project are multidisciplinary in nature and include requirements and interface management, configuration control, design validation, integration and testing (including product verification). The system engineering process will allow SDDOT to confirm that the system meets the intent and requirements for the project and provides traceability throughout the project timeline.

The concept of operations is the critical first step in the development of traffic management capabilities and operational practice. Each individual component or project can then be designed, implemented and operated within the context of the concept of operations.

The primary objectives of the system engineering process are (Mitretek, 2002):

- To provide modern, state-of-the-art, project management requirements for the design, procurement, construction, integration, testing, and maintenance of technical systems;
- To limit and reduce the proliferation of management documentation and to implement relevant aspects of applicable standards;
- Identify relevant directives and references;
- To provide evidence that control over the design, procurement, installation, integration, testing, inspection and support will be performed;
- To provide emphasis on a disciplined integrated systems development approach;
- To provide South Dakota with the concepts of systems engineering management and techniques.

Configuration Management

Configuration management is a set of procedures, forms, resources and data necessary to provide an effective, efficient development process that meets the needs of all programs.

A mature and disciplined configuration management process is needed from the beginning of the deployment to establish the documentation, requirements, naming conventions, requirements traceability and change-control practices. A configuration management plan should be developed early on and would apply to all projects including software, hardware, communications network, documentation and commercial-off-the-shelf (COTS) materials.

Procure Services of a System Manager

It is recommended that SDDOT procure the services of a System Manager to assist them during the system engineering process. The System Manager would be an extension of SDDOT staff to facilitate system development and ensure engineering discipline over multiple program phases. A system manager will relieve SDDOT of considerable effort to manage and oversee system development. This process is consistent with evolutionary system development and is consistent with Task Order type contracts. Consequently, a major benefit of such a process is the effective management of change over time. Most of the implementation projects described below could be set up on a task order basis to fit budgetary constraints and program phasing.

The costs associated with procuring system manager services depend on the tasks assigned to the system manager. The master agreement should be set up with a maximum contract value and a well-defined contract term. One or two well-defined tasks should be included in the master agreement to initiate the process and to establish momentum. Each task should be defined through a work plan (scope, schedule, budget, staffing plan, QC/QA plan) or equivalent and authorized by SDDOT prior to beginning work. It is recommended that the value of the master agreement be established at a minimum of \$250,000 for the first two years to cover most of the planning, design and implementation oversight activities for the first two phases of the program (i.e., Early Action projects and the Near Term projects). The system manager contract costs are included in the costs for the implementation projects and are not additional costs to SDDOT.

The recommended projects are described in detail below. A summary table with the recommended phasing of the projects also is included. First, however, is a list of procedural changes that can be taken immediately to improve traffic and emergency operations while also requiring very little investment.

6.3.2. OPERATIONAL PROCEDURES ENHANCEMENTS

Many low-cost, yet highly effective procedures can be established to improve traffic operations immediately. These procedural changes are recommended in the near term, some of which are in progress and/or planned:

- More clearly define statewide ATMS device operational guidelines and procedures (DMS, CCTV, HAR, etc.)
- Establish standards for RCRS data entry to reduce regional variability
- Clearly define ATMS and RCRS user rights and privileges
- Refine and enforce procedures for RCRS data entry
- Establish an MOU with State Radio for RCRS entry of road condition and incident data after normal working hours
- Establish an ATMS training program and provide training on a continual basis
- Involve the SDDPS more fully in traffic planning
- Provide regular incident management training and exercises for SDDOT personnel in cooperation with DPS personnel
- Conduct operations training for regional and area office staff
- Provide NIMS and ICS training to key SDDOT staff and establish layers of authority for resource allocation to improve “bench depth” during emergencies
- Educate SDDOT staff on ESFs included in the Statewide Emergency Operations Plan
- Establish an SDDOT chain of command for EOC activation
- Update the SDDOT contact list for after-hours support
- Involve the DOT’s region and area engineers in emergency management organizations at the local and county levels for coordination during local and regional emergencies
- Provide more frequent and accurate weather forecasts at the EOC
- Consider the establishment of a statewide Incident Management Committee to establish formal plans and procedures for incident management
- Manage the expectations of motorists for timely, accurate road and travel condition information through public information campaigns
- Clarify policies for DMS operations and establish procedures for updating messages after normal working hours

6.3.3. IMPLEMENTATION PROJECTS

Table 7 outlines the TOC deployment projects by deployment phase.

Table 7 - Recommended TOC Deployment Projects

Early Action Projects (with 1 st Year)	
AT-01	Develop TOC Concept of Operations
AT-02	Develop Statewide ATMS Communication Network Requirements and Design
AT-03	Develop South Dakota TOC/ATMS Software Requirements and Evaluation
AT-04	Develop Requirements and Implement Interim Pierre TOC System and Facility
OP-01	Develop Interim Guidelines for Operational Use of Existing ATMS Devices
Near-Term Projects (1-2 years)	
AT-05	Design and Implement Expanded Statewide Pierre TOC
AT-06	Implement ATMS Communications
AT-07	Procure and implement TOC ATMS Hybrid Software
OP-02	Develop Statewide Traffic Operations Plan, Operational Guidelines and Procedures
AT-08	Enhance Advanced Traveler Information System to include Incident Information and Integrate with ATMS Software
OP-03	Develop Incident Diversion and Special Event Plans
AT-09	Implement Asset Tracking and ITS Inventory Management System
AT-10	Enhance Virtual TOC Capabilities
Mid-term Projects (3-5 years)	
AT-11	Develop System and Facility Design Requirements for Regional TOCs in Sioux Falls/ Rapid City
AT-12	Implement Regional TOCs in Sioux Falls and Rapid City
OP-04	Integrate MDSS into TOC Operations
AT-13	Develop Requirements For and Implement a Computer Aided Dispatch System
Long-Term Projects (6-10 years)	
OP-05	Integrate State Radio CAD at Pierre with TOC ATMS -IMS
AT-14	Develop Intertie Between the Sioux Falls and Rapid City 911 Centers and Regional TOCS and Integrate 911 Center CAD Systems with TOC ATMS / IMS

The total duration of the program is expected to be ten years. Detailed descriptions of the projects shown in Table 7 are included. The projects are separated into two categories, ATMS (AT) and Operational (OP). ATMS projects are more implementation in nature where the operational projects are more procedural in nature.

6.3.4. EARLY ACTION PROJECTS

AT-01 Develop TOC Concept of Operations

Description: A Statewide TOC Concept of Operations should be initiated as an early action project to guide the development of detailed functional requirements, design, deployment, operations and maintenance of the TOC and ITS systems. This is a starting point for defining requirements. A concept of operation should be a high-level description of what the major capabilities of the traffic operation center should be and would likely contain the following elements:

- Goals and Boundaries of the system
- High-level description of the major capabilities of the Traffic Operation Centers in South Dakota
- Organizational relationships - how data are shared between agencies

- User-oriented operational description
- Organizational responsibilities
- Hours of operation
- Operational challenges
- Operations and Maintenance considerations
- Operational scenarios

Implementation Considerations:

- 1) Assign this as the first task order under a system manager contract. Project costs would be covered under the system manager contract.

Timing & Duration Factors: Estimated Project Length – 7 months)

- Procure consultant
- Establish Concept of Operations interdisciplinary team
- Perform project (Data Gathering, Reports, QC, Preliminary Findings, Comment Period, etc)
- Meet with Technical Panel
- Publish results

Benefits & Costs:

This initial task is critical for setting the stage for system development and ongoing operations. Much of the content of the concept of operations has been established through the current project. Further refinement of the concept of operations should cost between \$25,000 and \$35,000.

AT-02 Develop Statewide ATMS Communication Network Requirements and Design

Description: A robust communication design will be required to ensure interoperability and timely distribution of data that will allow the state to carry out its mission and meet strategic goals. The communication requirements should take into account the operational practice, center-to-center requirements, affordability of available communication, reliability and redundancy. The requirements should take into consideration the exchange or trading of excess or spare communication infrastructure for bandwidth on other networks. This project can only be effectively carried out after a concept of operations is completed.

Implementation Considerations:

- 1) Assign this task to the system manager
- 2) Require a system engineering approach
- 3) Develop an interagency, interdisciplinary working or advisory group and include agencies such as BIT, SDDPS, SDDOT and possibly some industry experts on telecommunications
- 4) The communication design should be strategic in nature to assess technology trends

Timing & Duration Factors: Project Estimated Length – 9 months

- Start after Concept of Operations is either completed or nearly completed
- Procure consultant, use system manager or perform in-house
- Establish interdisciplinary communications team
- Project Tasks (investigate current technology trends, available communication, cost-benefit analyses, etc.)
- Meet with Technical Panel
- Publish results

Benefits & Costs:

The statewide communication network will maximize the network performance and improve the communication efficiency among the involved state agencies in both information exchange and electronic data transmission. Developing the system requirements is essential to the final design and is beneficial to trace any changes in the design phase. The goals and objectives identified in the requirements will not only ensure that the final design best meets the stakeholders' needs but also avoids any conflicting goals and objectives among the stakeholders. The detailed requirements will document the functional needs and identify as many key issues as possible, whether technical or institutional, to help stakeholders fully understand system operations. In addition, the statewide communication design will strive to maximize network maintainability and reliability and minimize the costs for system deployment. A typical system engineering approach will be used to develop the requirements which will ensure consistency between the detailed requirements and the high-level requirements established in the Concept of Operations document.

The costs involved in this effort will be associated with several major tasks: collecting inputs from the stakeholders, performing inventory for existing statewide communication systems in cooperation with BIT, and identifying the administration and agreements needs. A cost for these efforts will range between \$25,000 and \$30,000.

AT-03 Develop South Dakota TOC/ATMS Hybrid Software Requirements and Evaluation

Description: An integrated statewide TOC software system should provide significant cost savings and ensure interoperability and center-to-center communications on a statewide basis. The software could be a commercial off-the-shelf (COTS) package, new custom software or modification of existing software available elsewhere, which address the operational characteristics, defined through the Concept of Operations.

An integrated TOC/ATMS software system that has the full suite of capabilities to perform many of the identified functions is ideal. The ATMS software should have the following capabilities:

- Freeway management, including ATMS device control
- Arterial management
- Interface to RCRS for road condition reporting and traveler information dissemination
- Special event management
- Regional Work Zone Management
- Incident management
- RWIS monitoring and management

- NTCIP Center to Center (C2C) Communications and center to field (C2F) communications support
- Scalability - modular configuration on a mainstream platform
- Multi-user, multi-priority level access support
- Virtual operation capabilities and requirements support

Implementation Considerations:

- 1) Assign this task to the system manager
- 2) Develop high-level requirements
- 3) Issue RFI to known TOC/ATMS software providers to provide description of system capabilities, address maintainability, system documentation, configuration management, etc.
- 4) Map South Dakota TOC high-level and functional requirements to available software
- 5) Evaluate software systems and make a recommendation

Timing & Duration Factors: Estimated Project Length – 7 months

- This project should only be undertaken after Concept of Operations is completed to ensure that the ultimate product meets the defined need and requirements.
- A review of available software and functionality can be reviewed during the project for ideas and to assist in the establishment of ATMS Software requirements.

Benefits & Costs:

The requirements will clearly identify the user needs and deployment issues for the integrated statewide TOC/ATMS software system. Through this project, system requirements will be defined and commercially available software candidates will be compared to determine the best software for a final implementation. The requirements will maintain the consistency between the software and stakeholders' expectations for testing, upgrades and operations. An evaluation will provide a full assessment on software capabilities against the system requirements. The evaluation results will not only verify the capabilities that meet the system requirements but also identify those capabilities that need to be modified or added, which will ensure that the selected software meets all the requirements. The integrated software suite will minimize system operational and maintenance cost, and increase system integrity, reliability and flexibility.

The effort to develop system requirements will include the identification of user inputs and expectations for the integrated TOC/ATMS software system. The collected information will be reviewed and confirmed so that a final agreement on system requirements will be reached. A full evaluation will be conducted by the system manager and proper administration will be provided as needed. The cost for developing the requirements and conducting the evaluation is estimated approximately \$40,000.

AT- 04 Develop Requirements and Implement Interim Pierre TOC System and Facility

Description: This project is proposed to define the specific operational characteristics for the initial Pierre TOC to be collocated with the State Radio Dispatch Center (e.g., space requirements, communication requirements, staffing, hours of operations, etc.) A need exists to establish some

preliminary requirements and move into the current EOC facility while the welcome and space are still available. SDDOT has the invitation to move in and share the available technological and physical resources.

The TOC facility may consist of one or two workstations with access to CCTV cameras, DMS and RCRS entry. Collocation with State Radio Dispatch at the EOC should strengthen the relationship between SDDOT and agencies involved in emergency management. This project is intended to be implemented quickly while requirements for long-term capabilities and operations are being determined.

Implementation Considerations:

- 1) Assign this task to the system manager
- 2) Develop requirements (space, communications, staffing, equipment, etc.)
- 3) Present and obtain administration approval
- 4) Develop interagency agreement
- 5) Obtain funding
- 6) Develop implementation plan
- 7) Procure necessary furnishings and equipment for interim TOC
- 8) Install and integrate equipment

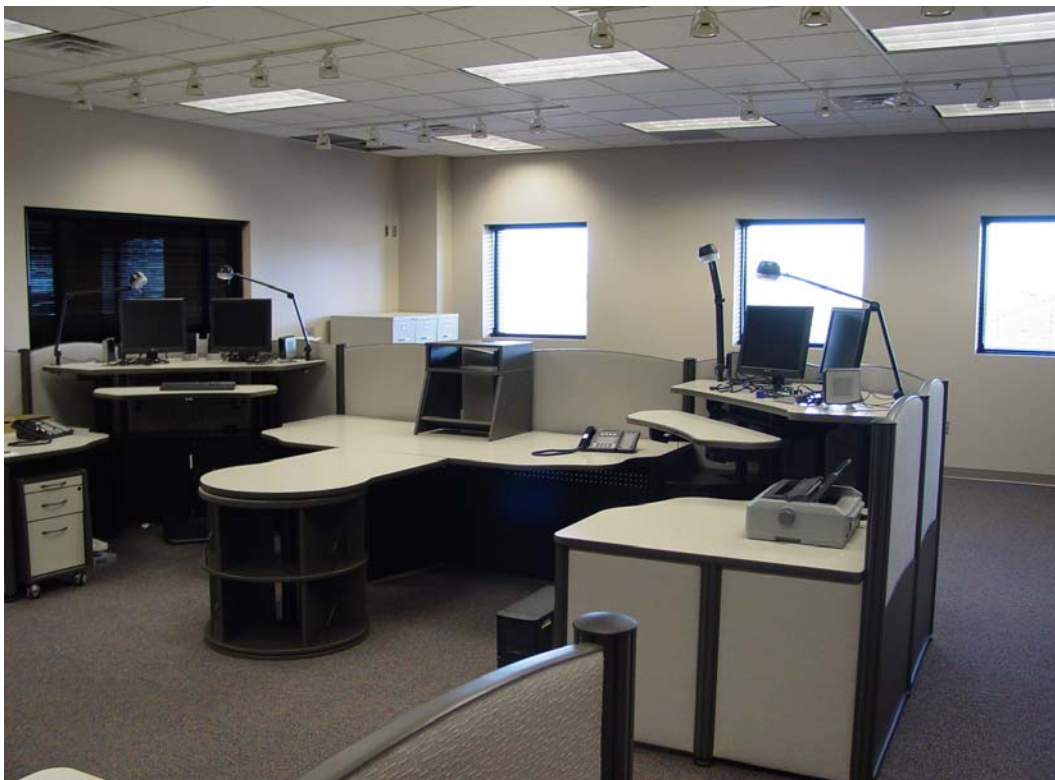


Figure 15 - Location of Proposed TOC in the State Radio Dispatch Center in Pierre

Timing & Duration Factors: Estimated Project Length – 4 months

- This project should begin as soon as possible to secure location that is committed and to have working and initial TOC operational by Fall 2006.
- The project length is estimated based on time needed to establish MOU with SDDPS, procure necessary hardware, setup equipment and configure software.
- Additional staffing may be required to fulfill requirements for 24/7 operations. At this time the staffing requirement is estimated at 4.5 to 5 full-time operations personnel.
- Staff will likely need to spend some time working with the consultant to assist in developing the Interim Guidelines for Operational Use of Existing ATMS Devices (Project OP-01)

Benefits & Costs:

Developing requirements for a TOC in Pierre will allow stakeholders to further develop partnerships early in the project. The requirements generated by the stakeholders will serve as a starting point for the establishment of permanent statewide TOC in Pierre and for the expansion of the TOC concept to new TOCs in Sioux Falls and Rapid City.

The implementation of the interim TOC in Pierre will establish an early visible success for the project. This success will create momentum and energize the stakeholders as the project moves forward. This project will be accomplished with minimal capital expenditure as the TOC will maximize efficient use of existing facilities and resources. The implementation of the Pierre TOC will also help to identify potential deployment problems as resources begin to be pulled together to operate out of a central location.

Development of requirements for and implementation of the interim TOC in Pierre should cost about \$40,000.

OP-01 Develop Interim Guidelines for Operational Use of Existing ATMS Devices

Description: Operational guidelines and procedures are needed for the operation and use of currently deployed ATMS devices, such as CCTV cameras and Dynamic Message Signs. In particular, DMS guidelines are needed to provide accurate, clear, consistent and useful messages to the public in order to maintain public confidence and agency effectiveness and credibility. Guidelines and procedures will include documentation of thresholds for when to activate DMS, which type of message has priority, the number of frames allowed for various traffic conditions (speeds), time of message display for 2+ frame messages, standards for allowable messages, i.e. will “Buckle up for Safety” type messages be used, use of “Amber Alert” vs. “Child Abduction” messages, etc. There are several useful studies and references on use of portable and permanent DMS, particularly from the Texas Transportation Institute. In addition, procedures could be useful for the operation and maintenance of other devices, such as CCTV cameras, RWIS and traffic detectors. An Operational Guideline ensures that devices are properly used for the intended purpose and that an operational protocol is clear.

Implementation Considerations:

- 1) Perform expanded literature search for this specific purpose
- 2) Contact other TOCs and obtain copies of their guidelines and operational procedures

Timing & Duration Factors: Estimated Project Length – 4 months

- This project should begin as soon as possible to have some interim operating guidelines for staff working at the Pierre TOC.
- Estimated project length includes literature and peer review of other agency guidelines.
- The estimated length of the project could be reduced depending on the anticipated complexity and thoroughness of the document.

Benefits & Costs:

This project will result in many benefits to both the public sector stakeholders and the traveling public. The main agency stakeholder benefits result from consistency in operations of dynamic message signs and cameras. Operators who are given clear direction and training on the use of these devices will be more comfortable with using the technology. The public will ultimately benefit as clear, concise, understandable and consistent DMS messages are used to inform travelers.

As stakeholder partnering increases and new agencies within South Dakota begin operating these devices, clear guidelines and procedures will help to enhance relationships between agencies and avoid conflicts. Coordination of operations with adjacent states will also be easier to implement.

Establishment of guidelines for the use of CCTV cameras will identify camera viewing and control priorities between agencies/regions and will help prevent inappropriate use of cameras. Video storing and sharing guidelines between SDDOT, other public agency stakeholders, and the media defined in this document will establish clear expectations and foster good relations between these partners.

The costs associated with this project would mostly be through the tasks performed by the consultant to conduct literature searches, review of other agency guidelines, and TOCs' operational procedures and is expected to cost between \$20,000 – \$25,000. Workshops with SDDOT and other stakeholders to reach consensus would also require public agency staff time.

6.3.5. NEAR TERM PROJECTS (1-2 YEARS)

AT-05 Design and Implement Expanded Statewide Pierre TOC

Description: After the establishment of an initial TOC in Pierre, the TOC requirements should be readdressed, using a system engineering approach to expand the role of the Pierre TOC as defined in the South Dakota TOC concept documents and concept of operations. Additional functionality will be added and the permanent facility will be implemented within the State Radio Dispatch Center.

Considerations include:

- Determine staffing needs and requirements
- Refine hours of service defined in the interim concept of operations
- Determine maintenance needs
- Define security needs and requirements

Implementation Considerations:

- 1) Assign this task to the system manager
- 2) Expand preliminary concepts to incorporate full functionality and permanent facilities
- 3) Obtain budgetary approval and funding
- 4) Update interagency agreement, if needed
- 5) Develop procurement documents
- 6) Oversee installation and integration
- 7) Require acceptance testing of new requirements

Timing & Duration Factors: Estimated Project Length – 6 months

- Requirements Development
- Procurement Process
- Revise interagency agreement

Benefits & Costs:

By concentrating operations in one place through implementing a statewide/regional TOC in Pierre, SDDOT will be able to more efficiently manage the statewide transportation system. The TOC will provide South Dakota with faster incident response, decreasing congestion impacts and reducing the duration of incidents as well as chances of secondary incidents. Dissemination of information to the public will be timelier and will allow travelers to make informed travel decisions which leads to a safer and more efficient transportation system. The center will also improve the flow of information between agencies such as SDDOT Maintenance, SDDOT Traffic, and Highway Patrol. In future stages of the project, the TOC in Pierre will serve as a model for design and implementation of TOCs in Sioux Falls and Rapid City.

Construction of the TOC may involve additional physical space alterations and the purchase of operator equipment and workstations. Once constructed, staffing needs should be re-addressed to provide 24/7 operations. The capital cost to implement a statewide/regional TOC in Pierre should cost less than \$80,000.

AT-06 Implement ATMS Communication Design

Description: This is the follow-on implementation of the planning and design from Project AT-02. It is proposed that much of the communication implementation will occur as a component of various ITS initiatives and projects; however, it is likely that a stand-a-lone project will be needed to procure and implement a dedicated, secured ATMS network, either at the Pierre TOC facility or another location.

Implementation Considerations:

- 1) Complete AT-02 - Develop Statewide ATMS Communication Network Requirements and Design first.
- 2) Partner with BIT on communication implementation to ensure compatibility and consistency with State Communication Standards, Policies and Requirements.
- 3) Consider building as much of the ATMS communication network as possible as part of individual projects.
- 4) Consider a procurement for statewide or regional contractor for 1-3 year terms to establish contract pricing for various communication elements (conduit, fiber-optics, cabling, junction boxes, etc.) and to reduce learning curve.

Timing & Duration Factors: Estimated Project Length – 12 months

- Initial efforts dedicated to establishment of dedicated/secured network in parallel with initial Pierre TOC.
- Communication implementation will be ongoing as part of other TOC and traffic operations deployment projects.

Benefits & Costs:

Costs cannot be determined at this time with performing a thorough needs assessment, concept of operations, and communications design. However, communications tend to be one of the largest cost items for deployment and ongoing operations and maintenance.

AT-07 Procure and Implement TOC ATMS Hybrid Software

Description: The process includes hiring a software solution provider and integrator after software requirements are developed and candidate software systems are identified.

Implementation Considerations:

- 1) Use system manager to develop software evaluation procedures and to identify candidate software systems
- 2) Use system manager to develop RFP for software system and software integrator
- 3) Use system manager to develop software acceptance test procedures and to run system acceptance tests

Timing & Duration Factors: Estimated Project Length – 15 months

- Software development project usually take longer than anticipated.
- Begin project after Project AT-03 Develop TOC/ATMS Software Requirements and Design is completed
- The project length is estimated based on time needed to develop procurement contract, procurement process, contract award, develop software requirements schedule, configuration management board, software development, software testing/acceptance, software documentation, training and establishment of MOU with partner agencies receiving the software.

Benefits & Costs:

Procuring and implementing TOC/ATMS hybrid software will allow system operation to be simplified, making it easier to use. The integrated software implementation will provide flexibility in staffing, minimize training efforts, and improve operation efficiency. By integrating TOC/ATMS, statewide awareness of the system will be increased. The acceptance test will evaluate all system functions, identify the limitations that the system may carry, and generate recommendations for future upgrades. The evaluation will ensure the software procurement and system implementation meet system requirements as well as stakeholders' expectations. The integrated software will not only minimize system operational and maintenance efforts but also increase system efficiency and reliability.

Costs required for this effort are dependant on five major steps: selecting a common software system, developing an RFP and identifying the software integrator, deploying the system, developing acceptance test plans, and conducting the acceptance test. The costs for selecting an integrated ATMS software package will vary based on the availability and compatibility of the selected software suites compared to the TOC/ATMS requirements. System deployment and evaluation costs will rely on the complexity of system integration. To the degree possible, commercial-off-the-shelf ATMS software should be procured. Many off-the-shelf solutions are currently available. However, most TOCs have some unique requirements that require custom software development. For example, the integration of RCRS with the new ATMS may require the need for a custom interface to facilitate traveler information services. Core functionality should be available for in a price range of \$20,000 to \$50,000. Customization costs will depend on requirements, but could cost as much as \$100,000 to \$200,000. Integration and testing costs would depend on the amount of custom work to be completed, but should be less than \$100,000.

OP-02 Develop Statewide Traffic Operations Plan, Operational Guidelines and Procedures

Description The statewide traffic operations plan is intended to be a comprehensive plan, containing operational procedures, training plans, a TOC Operations Manual based on the concept of operations, and other documents. The plan can be developed by component and should be developed so that it can easily be maintained and updated.

The statewide traffic operations plan and procedures manual would include incident management plans, contacts, resource inventory, polices and procedures, links to the emergency operations plan, and emergency notification reporting procedures for highway-related incidents.

The previously developed interim guidelines for operational use of existing ATMS devices can be refined and incorporated. The components of this project include:

- 1) Statewide Operations Plan.
 - Incident Management Plan
 - SDDOT Emergency Management Function and relation to State Emergency Operations Plan
 - Emergency Notification Procedures
 - Roles and Responsibilities

- 2) Staff Training Plan
- 3) TOC Operational Manual, which may contain the following elements:
 - Emergency and other Contact Numbers
 - Daily Operation Procedures
 - Control System Operation Procedures
 - Maintenance Procedures
 - System Operations Logs
 - Operational Concepts
 - Control Center Description /System Field Devices
 - System Documentation
- 4) Emergency Transportation Operations Plan

Implementation Considerations:

- 1) This can be completed by the system manager in cooperation with SDDOT personnel
- 2) A workshop format can be used to define procedures more precisely and to develop documentation
 - 1) Contact other DOT and operations centers and obtain example plans
 - 2) Prioritize development of deliverables
 - 3) Create a development plan for each of the Statewide Operation Plan components (scope, budget, schedule)

Timing & Duration Factors: Estimated Project Length –6 months

- This project should begin as soon as possible to secure location that is committed and to have working and initial TOC operational by Fall 2006.
- The project length is estimated based on time needed to perform literature search, develop draft guidelines, hold workshop, review, technical panel review and publishing.

Benefits & Costs:

Developing operational plans, guidelines and procedures will benefit not only the system operators but the general public as well. The operators will benefit through an improved understanding of their roles and responsibilities facilitating quick and consistent response. A plan will also ensure that all parties are trained uniformly so that conflict can be avoided when responding. Not only will it help in the operations aspect, but the process will help build the relationship between the agencies.

When operations run smoothly because the involved agencies have shared understanding of roles and responsibilities, incidents are responded to quickly and secondary accidents and congestion related to incidents are minimized. The public sees consistent messaging and response and ultimately builds trust in the system.

The costs associated with developing statewide traffic operations plans, operational guidelines and procedures depend on the scope of the effort. Developing the plan should cost between \$80,000-\$120,000 with a clearly defined scope of work.

AT-08 - Enhance Traveler Information System to Include Incident Information and Integrate with ATMS Software

Description: Enhance or develop traveler information system to provide timely incident information for incorporation into the RCRS or 511 systems.

Implementation Considerations:

- 1) Utilize System Engineering approach to develop requirements with consideration for e-mail, handheld PDA alerting, incident display via traveler information website and 511 system dissemination.
- 2) Consider using focus groups to ensure incident information meets their needs (e.g. does the public accept description of delay as minimum, moderate or major). Use of focus groups can help developers understand how the public is interpreting the data, set priorities of future enhancements, ascertain improvements which can be made to improve the data quality and usefulness or eliminate data items that are not used.

Timing & Duration Factors: Estimated Project Length – 12 months

- Procure focus group facilitator and hold focus groups to review ATIS and obtain feedback on existing system
- Develop requirements for enhancements
- Perform development project, including ATMS software integration development, testing acceptance and documentation

Benefits & Costs:

Incorporation of incident and event information into RCRS will provide several important benefits to the traveler. In cases of major crashes, the traveler will be able to alter their trip to avoid the incident or if they are already approaching the site, advanced warning will allow them to pass through the area safely, avoiding secondary crashes. More comprehensive information available on the 511 system will also lead to increased use. Direct integration of databases to allow a “single-entry” system of data also minimizes the staff effort needed to keep the data up to date and keep data consistent and accurate.

Proper implementation of this feature will begin with creation of a requirements document to guide the software and procedures development. Development and deployment of software tools to allow incident management would then follow. Requirements creation will cost roughly \$10,000 and system enhancement an additional \$40,000.

OP-03 Develop Incident Diversion and Special Event Plans

Description: As TOC implementation becomes more mature, attention can be given to developing incident diversion and special event plans. Typically, robust freeway management software will provide the capabilities to define “action sets” which are proposed actions to be taken, procedures to be followed and devices to be utilized for incident management and special events or incidents that occur at various locations with the transportation network. For example, an accident that closed eastbound I-90 in Rapid City would require use of a different set of DMS, possibly signal adjustments on arterial than other locations within the City. A list of available DMS with predefined DMS

messages, list of traffic signals requiring timing adjustment, and HAR messages can be predetermined for incidents that occur at various locations in the transportation system.

Special event plans should also be developed and integrated into the TOC software. It is recommended that simple checklists and contact notification charts also be developed for quick reference. Some of this has already been accomplished, especially related to the Sturgis Motorcycle Rally. In 2005, SDDOT utilized a portable traffic management system during the event. The portable system had capabilities to manage devices (permanent and temporary) and contact appropriate event managers. Refinement of event plans should become an annual routine as part of the “after event analysis”.

Implementation Considerations:

- 1) This can be assigned to the system manager on a task order basis, or assign someone within SDDOT with specific responsibility to define incident diversion and special event plans
- 2) Contact other TOCs for recommendations
- 3) Utilize the ATMS software provider to develop action set development procedures

Timing & Duration Factors: Estimated Project Length – 9 months

- This project should begin after the deployment of ATMS software is implemented to ensure that the incident and diversion plans are consistent with the available system functionality.
- Incident and special event plans should be carefully coordinated with other transportation partners.

Benefits & Costs:

Congestion resulting from incident queues often causes secondary crashes. Effective incident management and diversion can significantly reduce these secondary crashes as well as traveler delays. As emergency response and traffic management agencies work together to implement incident/special event diversion plans, the improved agency coordination results in an organized alternate route for travelers to follow. This coordinated diversion of traffic reduces delays and increases safety. Also, by diverting traffic from the congested roadway, emergency response agencies (and the victims of the crash) realize faster emergency response times and a shorter duration to clear and recover from the incident.

Another qualitative benefit of providing good incident/special event plans comes from reduced “road rage”, since travelers are kept better informed via the signing and traffic management activities along the diversion route.

Successful programs involve multiple emergency response agencies where each responder has an alternate route response guide depicting the predetermined diversion route location of DMS and other ITS devices, location of traffic control officers, etc. These programs have evolved so that operators utilize e-guides (electronic response guides) on their workstations that walk them through the steps and responsibilities of each agency/jurisdiction during a traffic diversion.

The costs of implementing incident diversion and special event plans can vary depending on the type of special event, location of the incident, available alternate routes and the number of agencies

involved with the coordinated response. Costs range from \$25,000 - \$100,000, depending on these factors.

AT-09 Implement an Asset Tracking and ITS Inventory Management System

Description: There are two components for this project, asset tracking and inventory management system. Personnel involved in the November 2005 EOC activation described the need for an asset tracking system to be able to monitor the movement, deployment and utilization of assets, primarily DOT equipment and resources. Although local managers had an understanding of asset deployments and locations, emergency and executive managers did not have an efficient method to track these resources.

Additionally, an asset or inventory management component of the system will allow managers to maintain an updated inventory of ITS devices, spare parts, maintenance equipment, track work orders, warranty expirations, and equipment maintenance or replacement cycles. Often a GIS based system, using barcodes and feature inventory containing all of the major ITS components are used for this purpose. Many municipalities have used similar systems to manage their streets/traffic inventory, track service requests, manage work orders, and provide custom reporting. South Dakota has considered merging with the Traffic Signal Management system, which is a GIS based inventory management system that provides capabilities to store inventory information, geographical locations, maintenance history and other pertinent data.

Typically asset management systems use a GIS-based system with bar-code scanning. Asset tracking systems use GPS or Radio Frequency ID (RFID) tracking techniques to monitor equipment utilization and locations. An AVL system could be implemented to serve this purpose, which is also a requirement for the MDSS system. The commercial vehicle industry has used GPS tracking systems to monitor high-security, high risk and hazardous material loads. Shippers have also utilized RFID tags to track location and integrity of individual trailers or cargo containers. Use of RFID requires use of RFID readers at strategic locations to identify the data encoded in the RFID tag's integrated circuit and the data is passed to a host computer for processing. RFID technology could potentially be used to track equipment as they arrive or depart maintenance yards and at other strategic locations to provide location of equipment over time.

This proposed Asset Tracking and Management System should be managed from the TOC in close coordination with the EOC to support the Emergency Managers and Traffic Managers in mobilizing equipment to where it is most needed during significant emergencies.

Implementation Considerations:

- 1) Implement Inventory Management System as early as possible to avoid having to backtrack, locate and inventory equipment in the field and research the warranty information. It's easier to inventory equipment and input the equipment properties and warranty information before it's deployed.
- 2) Use the system manager to evaluate alternative solutions.
- 3) The system manager could develop an RFP for procurement and integration of the required system.
- 4) The system manager could oversee installation and integration of the system.

Timing & Duration Factors: Estimated Project Length – 12 months

- Requires development of system
- Evaluate alternative system; possibly invite vendors in for demonstrations
- Development procurement package and advertise
- Evaluate alternatives, select and award
- Install, perform necessary enhancements, and provide training
- Establish budget for operating system, populate data and manage

Benefits & Costs:

Asset tracking has been shown to have great benefits in the retail and shipping industries. Implementation of such a system in South Dakota will allow managers at all levels access to current information regarding asset status, location and condition. Armed with this information, use of assets will be maximized and asset availability increased through better repair and replacement management. Inventory “shrinkage” through asset misplacement or theft will also be reduced through better tracking and monitoring.

Defining the system requirements for asset management is a key to successful implementation, so this will be the first task completed. Following requirements documentation, an RFP will be prepared and issued, leading to the procurement and deployment of the asset management system. Costs for such a system can vary widely based on the level and type of tracking desired and the mechanisms used to gather and process data. Construction of a simple database and populating it with inventory data can be expected to cost on the order of \$50,000.

AVL systems for vehicle tracking vary greatly range in price, with centralized software and on-board equipment needed. Partnerships with other agencies, such as the Highway Patrol, for procurement and management of an AVL system would reduce the procurement and long-term maintenance costs for each individual agency. A more complete system using a large number of RFID tags, sophisticated mobile data collection units and an “enterprise grade” database back end could cost as much as \$500,000.

AT-10 Enhance Virtual TOC Capabilities

Description: Many of the virtual capabilities will have been outlined in the original TOC Concept of Operations project. These capabilities will likely have to be revisited with technology changes that have occurred since the original concept was defined. Also, many of the virtual capabilities may have already been implemented with the TOC/ATMS software deployment Project AT-07 or available through Citrix Servers via a broadband connection.

Implementation Considerations:

- 1) Reevaluate and redefine Virtual TOC capabilities
- 2) Develop requirements for Virtual TOC capabilities using Systems Engineering Approach
- 3) Establish cost and obtain necessary budgetary approvals and funding
- 4) Develop contract scope of work

- 5) Establish contract with TOC ATMS software provider to perform the required software enhancements.

Timing & Duration Factors: Estimated Project Length – 12 months, including training

- SDDOT staff have indicated interest in early deployment of this capability. Therefore, it has been assigned near-term project status.
- It is recommended that the ATMS software be fully implemented in the physical TOCs (at least the Pierre TOC) to ensure the environment to support virtual TOC capabilities, logging capabilities, and data acquisition servers are implemented.
- It is also advised that the operational guidelines be developed and are adopted to ensure consistent use and application of ITS.
- Training should also be provided for the remote area engineers and operations staff using the virtual capabilities.

Benefits & Costs:

Reviewing the original software capabilities will allow the state to accommodate advances in technology and potentially increase the effectiveness of the statewide management of the system. Using the system engineering approach to create and redefine requirements ensures confidence that the system will be flexible and have the ability to incorporate new technology while minimizing costs.

The cost for establishing Virtual TOC capabilities should be about \$25,000. An estimated maximum contract amount should be \$100,000.

6.3.6. MID-TERM PROJECTS (3-5 YEARS)

AT-11 Develop System and Facility Design Requirements for Regional TOCs in Sioux Falls and Rapid City

Description: The implementation of Regional TOCs in both Sioux Falls and Rapid City has been recommended as part of the TOC Concept Definition Study to work in cooperation with the recommended Statewide TOC in Pierre and to manage regional traffic operations in their respective regions. The Regional TOC requirements should reflect the intended concept of operations, local culture and multi-agency coordination requirements.

Requirements for facility design should be developed utilizing a systems engineering approach and the previously developed State TOC Concept of Operations. However, SDDOT might consider alternative options to design and deploy regional TOCs. The method to deploy the TOC should be chosen first, which would affect the way in which the requirements are defined. For instance, SDDOT may choose a non-traditional method, such as the Design-Build method. The requirements would then be developed based on performance specifications and outcomes. The traditional design-bid-build approach is also acceptable and may offer some savings by have one consultant develop the requirements and design for both TOCs and then hire separate, local contractors to build, install equipment and perform the acceptance testing.

Implementation Considerations:

- 1) Use System Manager to undertake this task
- 2) Obtain agency approval and funding
- 3) Create a multi-disciplinary team to guide the development of requirements and decisions
- 4) Include the requirements for Statewide TOC/ATMS software implementation and integration
- 5) Consider combining the requirements and design development together for both RTOCs

Timing & Duration Factors: Estimated Project Length – 7 months

- Establish multi-discipline Team
- Draft requirements and review
- Finalize requirements

Benefits & Costs:

Developing precise system and facility design requirements will ensure a quality system design. The system requirements will clearly identify goals and objectives to avoid conflicts and will ensure that the design meets stakeholders' expectations and project needs. Eventual implementation of Regional TOCs in both Sioux Falls and Rapid City will maximize the interoperability between these two systems with other state systems. The requirements will be developed based on the Concept of Operation which will keep the new deployments consistent with the existing TOC systems. This consistency will allow the future implementations to re-use the existing TOC technologies which will minimize deployment costs. Using the system engineering process to develop system requirements will ensure that all system needs are covered or addressed. It will also help prevent any conflicting user requirements and maintain traceability for any changes during the design phase.

The costs needed to develop system and facility design requirements for the regional TOCs are dependent on two correlated tasks, reviewing project sites and developing detailed requirements. It is essential to conduct site surveys to review candidate TOC sites. The site surveys will provide the first hand information that will facilitate developing the requirements. Technical meetings will be conducted to address any critical issues. Final requirements will be developed by taking into account all the recommendations proposed by the stakeholders. Requirements from the Pierre TOC will provide a starting point for the two other regional TOCs. The cost will range from \$15,000 to \$25,000.

AT-12 Implement Regional TOCs in Sioux Falls and Rapid City

Description: This project is the implementation of the previous project. The implementation schedule will likely be based on available funding and approvals.

Implementation Considerations:

- 1) Use system manager for oversight of TOC implementation
- 2) Create Regional TOC Advisory Taskforces to provide guidance during implementation activities
- 3) Carefully consider QC/QA requirements and implementation
- 4) Focus on acceptance testing

Timing & Duration Factors: Estimated Project Length – 18 months

- Certain TOC functionality can be implemented early on, but the entire process from concept, design, integration, acceptance and testing will take an estimated 18 months.
- Develop RFP for ITS System Designer /Integrators.
- Concept planning and design are required.
- Develop PS&E package.
- Integration and testing are required.

Benefits & Costs:

The implementation of regional TOCs in Sioux Falls and Rapid City will improve statewide systems integration in South Dakota. The integration will allow traffic information to flow among state agencies and improve statewide traffic management efficiency and safety. Consistency between TOCs provides flexibility in system operation, maintenance and staffing. Such consistency minimizes the cost of maintaining the system. The regional TOC deployments will be highly visible to the public, which will help maintain the momentum to incorporate more advanced technologies in improving safety, mobility, and efficiency in existing infrastructure.

It is essential to identify an optimal location for the implementation. This effort includes determining physical space alteration and investigating the existing equipment and software to minimize costs. It is important to develop a Deployment Plan to guide the implementation and develop an Acceptance Plan to ensure the quality of the system implementation. Both plans will be reviewed and discussed by the stakeholders to ensure the proper procedures and schedules. This effort will also include potential staffing changes. The cost estimates are dependent on the availability of the location and complexity of the system. By considering the above factors, typical costs will range from \$60,000 to \$150,000 per site.

OP-04 Integrate MDSS into TOC Operations

Description: South Dakota is the lead state in a multi-state pooled-fund study along with seven states to research and develop a Maintenance Decision Support System (MDSS). The current deployment schedule is for states to deploy MDSS in 2007, according to information supplied during the October 2005 Stakeholder Review meetings (Huft 2005).

The goal of the MDSS project is to develop a prototype maintenance decision support system that:

- Utilizes existing road and weather data sources,
- Augments data sources to improve data accuracy, to improve decision-making,
- Integrates and fuses environmental and road condition data and presents in an easy to understand format,
- Processes data to provide time and location-specific weather forecasts with emphasis on the 1 to 48-hour horizon
- Predicts road conditions utilizing forecast weather and candidate maintenance treatments;
- Provides a decision support tool, which provides recommendations on road maintenance courses of action

The implementation and integration of MDSS into the traffic operations realm requires a transformation in traditional traffic operations thinking that focuses more attention on road condition and treatments to improve travel conditions. It is recognized that in order to do this, some budgetary resources need to be applied to this effort, in R&D, staffing and infrastructure. The deployment of MDSS and integration into traffic operation center will require:

- More extensive deployment and testing
- Improved RWIS environment
- Validation of weather and road condition prediction capabilities
- In-vehicle instrumentation
- Improved physical models
- Integration with DOT information systems (Equipment, Scheduling, Traveler Information, etc.)

Implementation Considerations:

- 1) Evaluate and develop requirements for MDSS inclusion into traffic operation procedures
- 2) Ensure MDSS operations and procedures are included in the State Operations Plan
- 3) Upgrade the RWIS infrastructure

Timing & Duration Factors: Estimated Project Length – 12 months, including training

- This project can occur in shorter time-frame, but its speed of implementation is not as critical as some of the other projects.
- Some operational procedures will need to be developed and included in the State Operations Plan for TOC operators to utilize MDSS capabilities and information in operational decision making.
- Some training will be required for operations staff to become familiar with MDSS.

Benefits & Costs:

A key goal and benefit of the ultimate MDSS is more timely, efficient and effective application of maintenance resources (time, materials, snow/ice removal equipment, etc.) to provide a safer transportation system. Maintenance supervisors will utilize the MDSS system to make better decisions on when to call in snowplow operators, which chemicals to apply, which application methods to utilize, optimum mixture of chemical/sand ratios and where to focus maintenance operations. The end result to the public of these improved maintenance operations is safer roadways, better traveler information, a more reliable system and overall cost savings. More efficient application of deicing/anti-icing chemicals will save the SDDOT money and will reduce the negative effects of chemicals on the environment.

The cost to implement and to eventually integrate the MDSS into SDDOT operations are made up of several system needs such as augmentation of RWIS and weather source data, maintenance fleet instrumentation and AVL tracking system, geospatial meteorological data modeling, data integration, data processing and formatting, staff training and integration with existing DOT systems. System costs could range from \$200,000 to \$500,000.

AT-13 Develop Requirements for and implement a Computer Aided Dispatch System

Description: SDDOT should consider furnishing the Computer Aided Dispatch (CAD) software to State Radio, if SDDPS does not complete their acquisition of a CAD system. This will help create a foundation for cooperation and enable SDDOT to be involved in the requirements development and design with the future purpose of integrating CAD with the traffic incident management system, and ultimately providing incident information to the public through established processes such as the 511 system.

Computer Aided Dispatch Systems provide some of the following capabilities (Computer-Aided Dispatch Software Resources Web Page)

- Records Maintenance - tracks and records call and dispatcher inputs;
- Search/Query – Databases search and query capabilities to obtain critical records information (license plate search, name search, warrants, etc.);
- Manage Resources - system can display list or recommended units to be sent on any given call, per officer specialty, call nature and location;
- Customizable Call Priority – ensures rapid response to urgent situations.

The System Engineering Approach should be utilized to guide the development of requirements and design. The requirements should include the capability to transfer transportation related incident data to the TOC ATMS incident management and traveler information systems. An interagency agreement likely will be needed to address maintenance responsibility, ownership, sharing of incident data, and acquisition/implementation issues.

Implementation Considerations:

- 1) Use the system manager to develop requirements and to assist with procurement
- 2) Consider issuing RFI to assess the available CAD systems and capabilities
- 3) Ensure that resulting CAD system is based on mainstream technologies and data can be transferred to the TOC incident management and traveler information systems using nationally adopted standards, such as IEEE 1512® family of transportation emergency communication standards.

Timing & Duration Factors: Estimated Project Length – 12 months

- SDDOT should wait until it appears that SDDPS does not follow through with their CAD acquisition.
- Interagency agreement will need to be drafted, reviewed and executed fully.
- CAD system procurement
- Installation and Customization
- Training

Benefits & Costs:

Including State Radio in the development of the requirements for the Computer Aided Dispatch system will allow for system requirements to be defined meeting both State Radio and the SDDOT needs. Having one system provides for more timely and accurate shared information which allows for more effective response and management of the transportation system. By including transfer data as a requirement into the TOC incident management system, the system will present the public with valuable information to use to make travel decisions. With more consistent incident information being presented to the traveling public through the 511 system, a decrease in congestion and secondary incidents can be realized.

The costs associated with the requirement definition are approximately \$15,000 and implementation of a Computer Aided Dispatch system should vary between \$150,000 to \$200,000 depending on functionality and licensing agreements. The details will have to be worked out during the requirements definition. *NOTE: Implementing CAD statewide could cost several million dollars.*

6.3.7. LONG TERM PROJECTS (6-10 YEARS)

OP-05 Integrate State Radio CAD at Pierre with TOC ATMS-Incident Management System (IMS)

Description: It is recommended that SDDOT partner with State Radio and SDDPS to share information between the State Radio CAD System (implemented in Project AT-13 or other) and the established TOC ATMS-Incident Management System (IMS). The ultimate goal would be to seamlessly transfer transportation and emergency related incident data between both systems, using national established IEEE 1512 standards. State Radio dispatches for South Dakota Highway Patrol in three separate districts, statewide. This would be an excellent source of statewide incident related data that have an impact on traffic operations and which could be disseminated to the public to keep them informed and allow drivers to make informed travel decisions.

Much of the dispatch or 911 information comes first to State Radio and would be entered into their dispatch system. The data can then be filtered and transferred to the State DOT TOC ATMS Incident Management System, where operators can enhance the data (add number of lanes, length of delay, incident impact level, etc.) for issuance through the traveler information components (511, DMS, etc.) of the system.

Interagency cooperation is key and should be solidified in an interagency agreement. A guide to the IEEE 1512® family of standards is available that covers topics such as the need for the standards, issues related to information sharing, table top exercises, and how to incorporate the standards into existing communication systems. The guide also includes implementation guidelines and case studies on the equipment, software and policy changes agencies have made to enhance interaction among 1512 standard users.

Implementation Considerations:

- 1) Bring in partners early to discuss security concerns, data requirements and interagency agreement issues and roles.
- 2) Ensure that a champion exists from each party that can facilitate closure to issues and help streamline the agreement process.

Timing & Duration Factors: Estimated Project Length – 12 months

- The 1512 Standard should be fully reviewed for applicability.
- The agreement process will take considerable time to address privacy, security and integration issues.
- A scanning review of other similar integration projects is advised.
- This is primarily an institutional and software management process and normal software development methodologies should be applied.

Benefits & Costs:

The value of traveler information systems increases directly with the quality of information put in it. A link between the CAD system used by State Radio and the TOCs ATMS will allow for valuable incident information to be available to the public, increasing the safety of travel. This information will also be valuable to maintenance personnel who may need to do emergency maintenance (guard rail replacement, etc.) in response to incidents. Integration efforts such as this also allow for closer cooperation between agencies and will foster more efficient operations for all parties.

The processes for information sharing must be established as well as any applicable rules for data management and privacy. Once these ground rules are agreed upon the implementation mechanisms (software and communications infrastructure) can be determined and put into place. Costs for this project are hard to predict due to the uncertainty of operational aspects of the system, but should be in the \$30,000 to \$50,000 range.

AT-14 Develop Intertie Between the Sioux Falls and Rapid City 911 Centers and Regional TOCS and Integrate 911 CAD Systems with TOC ATMS / IMS

Description: This project would define the feasibility and ultimately the requirements to interconnect the Regional TOCs with 911 or PSAP centers in Sioux Falls and Rapid City. There is value and benefit to interconnect system between both entities - the PSAP centers could obtain operations data, such as video and incident information, in exchange for providing transportation and emergency information to the Regional TOCs for inclusion into the TOC ATMS incident management system. The incident information provided by the PSAP centers will improve the timeliness and reliability of incident information to be distributed through the traveler information systems and utilized in the operation of DMS.

Implementation Considerations:

- 1) Develop a feasibility report assessing the benefits and costs of interconnect
- 2) Develop interagency agreements
- 3) Obtain budgetary approvals and funding
- 4) Develop requirements and design for interconnect

Timing & Duration Factors: Estimated Project Length – 12 months

- Requires site investigation , conceptual planning and design
- An interagency MOU or cooperative agreement will need to be drafted, reviewed and executed
- Requires integration effort to install the interconnect between the two systems

Benefits & Costs:

This project offers many benefits to both emergency responders and transportation operators. PSAPs will gain access to improved tools for monitoring and managing incidents (CCTV, vehicle detection, road condition, DMS, etc.) and TOCs will have the most timely, complete information possible for making management decisions and providing traveler information. Connections between the two centers allow for sharing of data on a statewide level, which may be crucial for large-scale incidents and events.

The administrative effort of such an undertaking will be substantial, including stakeholder input for initial feasibility assessments and system requirements. Several options will be explored for cost/benefit purposes and the needed interagency agreements drafted. Following this work, a preliminary design will be created that satisfies the data practices constraints and user requirements. Development of this design and the background research needed can be expected to cost between \$40,000 and \$60,000. Deployment of the interconnection will be dependent on the requirements and constraints identified.

6.4 TOC DEPLOYMENT RESOURCE NEEDS

TOC resource needs generally include building modifications and construction, furnishings, equipment, ATMS hardware and software, and staffing. These resources and estimated costs are described below.

6.4.1. TOC DEPLOYMENT RESOURCE NEEDS

The cost estimates below are specific to the equipment and furnishings needed to complete the first TOC located in Pierre in the State Radio Dispatch Center. The following assumptions are used:

- One facility is to be completed
- No new structures are to be built
- Two “operator” workstations will be included
- Some additional data cabling will be required
- Electrical wiring and lighting are assumed to be present
- The total space available will be at least 120 square feet
- All operators will require a new computer
- The TOC will require new networking hardware
- Two large format common displays (plasma or LCD monitors) will be placed in the operations room
- Data communications to other facilities are assumed to be provided
- A common transportation management software platform will be needed

- Costs of roadside devices are not included
- Costs of any personnel relocation to the TOC are not included

Table 8 provides estimated costs for initial furnishings and cabling at the Pierre TOC. Table 9 provides a preliminary review of equipment requirements and estimated costs.

Table 8 - Pierre TOC Construction/Furnishing Summary

Item	Quantity	Unit Cost	Total
Office Chair	2	\$ 240	\$ 480
Operator Workstation / Console	2	\$ 5,000	\$ 10,000
File Cabinet	2	\$ 150	\$ 300
Category 6 Cable Drops	16	\$ 115	\$ 1,840
		Total Cost	\$12,620

Table 9 - Proposed Interim Pierre TOC Equipment

Item	Quantity	Cost per unit	Total
Network Switch	1	\$4,500	\$ 4,500
Firewall	1	\$10,000	\$ 10,000
Operator Workstation/ Computer	2	\$1,200	\$ 2,400
Server	1	\$6,000	\$ 6,000
SAN Hardware	1	\$10,000	\$ 10,000
4 Port KVM Switch and Keyboard	1	\$600	\$ 600
19" LCD Monitors (1280 X 1024)	4	\$800	\$ 3,200
42" Plasma Screen	2	\$3,400	\$ 6,800
Server Rack (36U)	1	\$1,600	\$ 1,600
APC UPS (120V, 2200 VA, 2U)	1	\$1,200	\$ 1,200
Emergency Response Radios	2	\$3,000	\$ 6,000
Contingency (20%), cabling, misc.	Lump Sum	\$10,000	\$ 10,000
ATMS Management Software	1	See Note	
		Total Cost	\$62,300
<p style="font-size: small;">Note: Many ATMS management packages are available. Some can be used for installation cost ~ \$20,000 to \$30,000. Others may be ~\$100,000-\$200,000. Customization of the software for unique requirements would be integrated for an additional cost.</p>			

Space within the State Radio Dispatch Center will be used for the TOC. This space will require only minor remodeling or improvement. Specific interior design options and the availability of salvage equipment at the State Radio Dispatch Center will influence final costs. An example of a small TOC is shown in Figure 16.

It is anticipated that similar remodeling costs will be required at the Sioux Falls and Rapid City TOCs when they are established.



Figure 16 - Example Workstation and TOC Configuration (City of Corona, California)

The equipment suite will be heavily influenced by the requirements of the already available BIT network, TOC deployment and the video display system. The estimates above are given only as a guide. For example, larger LCD or plasma displays may be required, and this will increase the implementation costs.

The equipment above would allow for an independent, self-contained network with a high-performance firewall to connect to other networks and the SDDOT Wide Area Network and provide for an independent storage area network (SAN). The estimate also includes a console-mounted radio for communication with SDDOT field personnel and emergency response personnel. It is assumed that an antenna system will be available at the EOC and was not included.

Most equipment will require some degree of installation and configuration. These costs may be absorbed by existing BIT staff or they may be contracted to outside providers. Because of this uncertainty, those costs were not included in this estimate and are defined in the TOC design and implementation requirements development process.

Similar costs will be expected for each of the regional TOCs. However, software costs are not expected to increase substantially if sufficient software licenses are obtained with the original purchase.

6.4.2. STAFFING NEEDS

Staffing and organizational structure should be an important consideration during the development of a Concept of Operations. A dedicated, focused organizational structure is needed to support ITS

infrastructure expansion, to solve complex interagency issues, and to manage the ITS functions and programs. South Dakota can take incremental steps towards this and will need to address how the Traffic Operations Office inter-relates with other operations groups and the regional offices, and how ITS projects can be implemented through the current project development procedures.

A possible organizational structure is shown in Figure 17. The bulleted list presents the responsibilities for each group, which are not necessarily tasks performed by a separate person. The number of staff is dependent on the level of responsibility and detail in which these responsibilities are carried out. Additional discussion is presented in the staffing sections below.

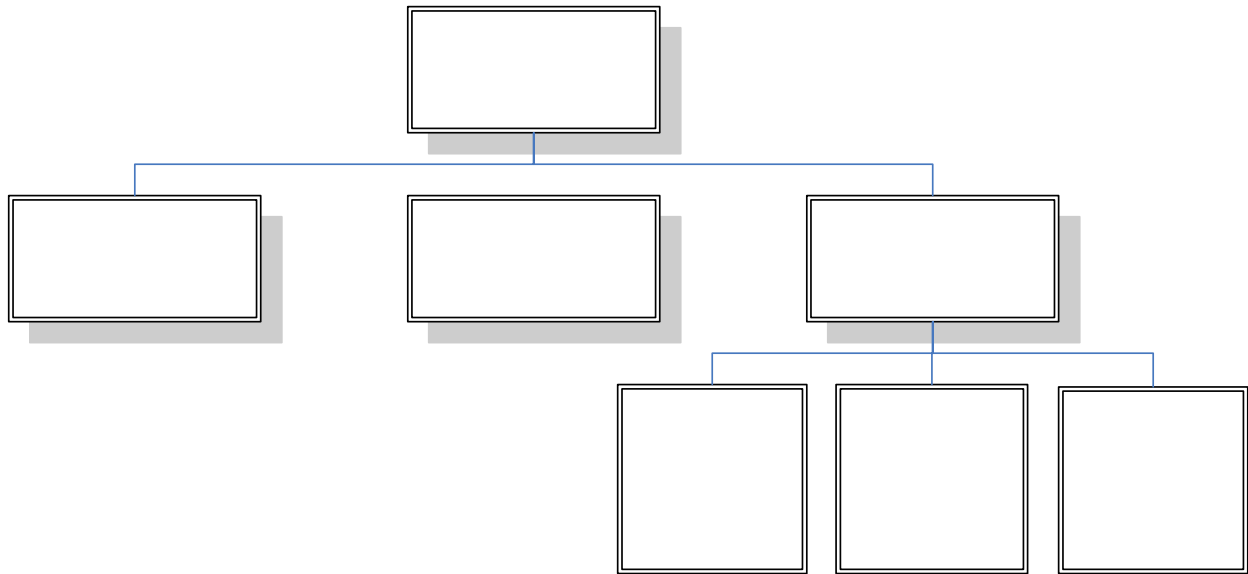


Figure 17 - Possible Traffic Operations Organizational Structure

TOC Staffing

The organizational structure of the statewide TOC and regional TOCs will influence the effectiveness of operations. The level and accessibility of management are important components of the TOC concept of operations. Decisions at the TOC should be made by experienced professionals where the level of automation is low, where significant liability issues exist and where accountability is required. Often a TOC operations room manager is placed nearby in an adjoining office to provide easy access to control room personnel when supervisory intervention is required (FHWA, TMC Concept of Operation, Implementation Guide, 1999).

Most traffic operations decisions will be handled on a routine basis by operations personnel assigned to the TOC. The Pierre TOC is expected to be operated on a 24/7/365 basis. This will require approximately 4.5 to 5 full-time equivalent (FTE) personnel. TOC personnel would likely report to the manager of the Office of Traffic Operations. Additional depth of TOC resources may be needed during emergencies and special events, and SDDOT may find it necessary to add management staffing and resources over time to accommodate growing needs.

The primary consideration for TOC staffing is the number of ITS functions that are to be carried out. Other factors that influence staffing and workload include the hours of operation, the level of automation provided, the number of control room responsibilities assigned, staff responsibilities

beyond the TOC, and the organizational structure. For example, the number of staff required is dependent on the level in which the staff is involved in monitoring video, dispatching work crews or response vehicles, interactions with State Radio dispatch, interaction with the public, work order reception/processing, updating traveler information (DMS, RCRS entry, etc.), and incident documentation (media contact logs, DMS message logs, etc.) (FHWA, TMC Concept of Operation, Implementation Guide, 1999).

Hours of operations, staffing during special events, the number of incidents, and maintenance considerations will also influence the workload and staffing levels. Serious consideration should be given to cross-training of operations room staff, who then can perform all of the required functions whenever other staff is unavailable.

Managers from both SDDPS and SDDOT have discussed the possibility of sharing staff during periods of heavy workload. Potentially, the TOC staff could be cross-trained to assist State Radio dispatch during low TOC activity and when public safety activity is high. These procedural details will still need to be worked out and likely agreed to in an interagency agreement.

6.4.3. MAINTENANCE NEEDS

Maintenance needs are often overlooked or inadequate attention is given to this area. SDDOT should devote sufficient attention to this area in the Concept of Operations to ensure that the system is operating properly and that the mission of the TOC is accomplished. Reliability and redundancy should also be considered, planned for and incorporated into the system to the degree that is affordable. For instance, an uninterruptible, power/battery backup is usually specified and utilized for key TOC systems and networks. The Statewide EOC and State Radio Dispatch Center in Pierre have backup power generation. However, this does not negate the need for a UPS for TOC systems.

Field Maintenance

Maintenance of ITS field devices is key for successful operations. Currently, SDDOT contracts for DMS maintenance. A similar contractual mechanism can be used for RWIS and other devices, or SDDOT can allocate staff to perform this work themselves. Either way, technical staff with sufficient expertise in troubleshooting, deploying and testing equipment is needed. A preventive maintenance program should be developed to provide routine maintenance services for all field devices and communications.

Staff also is needed to develop, manage and maintain a maintenance configuration management process, which usually includes an asset or inventory management system and work-order system. The work order system capabilities can often be incorporated into the asset management system. However, it is essential to setup the configuration management system early in the deployment process to track communication channels, fiber-optic location and allocation, device serial numbers, warranty information, etc. Adequate resources are needed to establish and then maintain the system. Traffic operators should be trained to identify problem equipment and ATMS software problems, fill-out the work-order system properly, and assist with acceptance of the devices after they are repaired or replaced. Without a configuration management process, the maintenance of highly technical equipment will become difficult and inefficient. Obtaining spare equipment, warranty repairs or upgrading equipment will also become difficult.

ITS maintenance requires specific tools and equipment. The equipment needed is dependent on the types of field devices to be maintained and the responsibility for maintenance. For example, the maintenance of a fiber optic communications network may require expensive splicing and laser testing equipment. CCTV cameras or traffic signal maintenance may require expensive boom trucks. Often ITS maintenance crews are also responsible for system acceptance, inspection, testing and turn-ons for contractor deployed equipment. A robust maintenance system and team, whether in-house or outsourced, should be equipped with some of the following tools of the trade.

Equipment:

- High-lift 75 ft Boom Truck
- Standard 45 ft Boom Truck
- $\frac{3}{4}$ Ton Trucks with Utility Beds
- Utility Locating Devices
- Electronic Diagnostic Equipment
- Lab and Bench Test Area

Materials:

- Extra step-up/down transformers
- Spare electronics and traffic signal cabinets
- Junction box lids
- Stock replacement wire (#4, #6, #12, etc.)
- Spare and replacement devices, CCTV cameras, DMS power supplies, RWIS sensors, communication modem and switches, ground rods, solar panels (a industry standard is to purchase 10% of deployed devices each year as replacements and spares)
- Preventative maintenance materials (DMS air filters, spare LEDs, spare lenses, etc.)

Software Maintenance and Administration:

- Software debugging
- System configuration management
- Modifications to improve performance
- Testing and implementation of operating system, and network upgrades and patches
- Computer hardware maintenance and management of computer/system contracts
- Develop of system enhancement requirements
- Development of device protocols and interfaces as new devices are added
- System administration (add new users, apply and upgrade security)
- Backup storage and administration
- Computer and operator training

6.4.4. TOC OPERATIONAL NEEDS

The final operational needs should be identified in the TOC Concept of Operations and refined during the requirements development for each individual TOC facility. Some of the capabilities may already be present if TOC is collocated with another agency such as that proposed in Pierre. The administration and support sections typically have the following responsibilities:

- Security system management
- Facility maintenance
- Emergency maintenance
- Plant care
- Janitorial services
- Emergency action team and evacuation training
- Telephone system management and maintenance
- Office supplies restocking and inventory
- Printing supplies and maintenance
- Cellular phone issuance and contracts
- Payrolls, accounts receivables and payables
- Annual budgeting, coordination and monitoring
- Performance monitoring
- Staff training

It is expected that many of these responsibilities will be absorbed by current EOC facilities management staff. However, SDDOT may need to take these into consideration in their plans for the regional TOCs.

Consideration should be given to nonstandard operations, which are usually separated into three distinct categories: special events, emergency operations and operations with partial capabilities. The Concept of Operations should deal with the planning and process to deal with each circumstance. Additionally, the TOC Operations Plan should address these circumstances. For instance, a plan is needed on how to operate the TOC when personnel, such as TOC operators, are unable to get to the TOC facility. The plan should also address how the TOC can be operated during partial or complete system failure.

6.4.5. FUNDING STRATEGIES

Identification of an ongoing source of funding is critical for the deployment of the projects identified in this plan and for continuing traffic operations. SDDOT received a congressional earmark under SAFETEA-LU which will provide the initial infusion of funds needed to get this program off the ground. However, an ongoing funding source will be required for continuing implementation and operations.

The use of NHS, STP and CMAQ funding for ITS must be part of the strategy. This strategic deployment plan calls for the expenditure of approximately \$1.1 million to \$2.6 million for deployment and operations improvements over the next ten years. SDDOT can expect to spend another 10 to 15 percent of the implementation costs annually for maintenance and operations. A portion of these costs should be covered from current highway program funds.

Another strategy is to seek annual earmarks to cover these costs. Each year, Congress appropriates funds for High Priority Projects or authorizes earmarks under other sections of SAFETEA-LU. Earmark requests are usually made early in the appropriations process, in January or February. The 50/50 match requirements of the ITS Deployment Program have been eliminated and a more favorable 80/20 federal/local match is now the norm.

Other state revenue sources, such as the state fuel tax, can be used for continuing maintenance and operations, along with federal funding. This source of funding is the most commonly used source for current SDDOT traffic and maintenance operations. Continued use of these funds for ongoing traffic operations is recommended.

The combination of current earmark funding, traditional federal, state highway funds and annual transportation appropriations provides an effective funding strategy for implementation and ongoing operations.

6.5 IMPLEMENTATION COSTS AND SCHEDULE

Traffic Operations Centers comprise a variety of technology implementations and communications methods as well physical spaces and equipment. The TOC must not only provide the tools to manage a transportation system but also an environment in which these tools can be used to their greatest effect. Each of these elements will have costs, both for their procurement and installation, as well as for their ongoing operation. Exact estimates of these costs cannot be made at this time. However, general inferences based on the preliminary ideas put forth in this report are summarized in Table 10.

The projects and costs are shown four phases. Operations and maintenance costs in the first year will be minimal. These costs will depend upon SDDOT's staffing plans for the TOC in Pierre. The operations and maintenance costs will increase incrementally with each phase as the Pierre TOC adds functionality and the regional TOCs in Sioux Falls and Rapid City come on line.

A high-level implementation schedule is depicted in Figure 18. The implementation schedule follows the systems engineering process, which begins with a Concept of Operations as a first step.

Table 10 - Estimated Annual Staffing and Capital Cost

#	Implementation Project	Annual Costs (FTE's)	Estimated Cost
Early Action Projects (within 1st Year)			
AT-01	Develop TOC Concept of Operations	-	\$25,000 - \$35,000
AT-02	Develop Statewide Network Communication Requirements and Design	-	\$25,000 - \$30,000
AT-03	Develop South Dakota TOC/ATMS Software Requirements and Evaluation	-	\$40,000
AT-04	Develop Requirements and Implement Initial Pierre TOC System and Facility	5	\$40,000
OP-01	Develop Interim Guidelines for Operational Use of Existing ATMS Devices	-	\$20,000 - \$25,000
SUBTOTAL		5	\$150,000 - \$170,000
Near-Term Projects (1-2 years)			
AT-05	Design and Implement Expanded Statewide/Regional Pierre TOC	1	\$80,000
AT-06	Implement ATMS Communications	-	
AT-07	Procure and implement TOC ATMS Hybrid Software	-	\$120,000 - \$350,000
OP-02	Develop Statewide Traffic Operations Plan, Operational Guidelines and Procedures	-	\$80,000 - \$100,000
AT-08	Enhance RCRS to Include Incident Information and Integrate with ATMS Software	-	\$50,000
OP-03	Develop Incident Diversion and Special Event Plans	-	\$25,000 - \$100,000
AT-09	Implement Asset Tracking and ITS Inventory Management System	1	\$50,000 - \$500,000
AT-10	Establish Virtual TOC Capabilities	-	\$25,000 - \$100,000
SUBTOTAL		2	\$430,000 - \$1,280,000
Mid-term Projects (3-5 years)			
AT-11	Develop System and Facility Design Requirements for Regional TOCs in Sioux Falls and Rapid City	-	\$15,000 - \$25,000
AT-12	Implement Regional TOCs in Sioux Falls and Rapid City	4	\$120,000 - \$300,000
OP-04	Integrate MDSS into TOC Operations	-	\$200,000 - \$500,000
AT-13	Develop Requirements For and Implement a Computer Aided Dispatch System	-	\$165,000 - \$215,000
SUBTOTAL		4	\$500,000 - \$1,040,000
Long-Term Projects (6-10 years)			
OP-05	Integrate State Radio CAD at Pierre with TOC ATMS / RCRS	-	\$30,000 - \$50,000
AT-14	Develop Intertie Between the Sioux Fall and Rapid City 911 Centers and Regional TOCS and Integrate 911 Center CAD Systems with TOC ATMS/IMS	-	\$40,000 - \$60,000
SUBTOTAL		-	\$70,000 - \$110,000
TOTAL		11	\$1,150K - \$2,600K

Figure 18 - High-Level Implementation Schedule

		Duration	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6-10			
		(Months)	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Yr 6	Yr 7	Yr 8	Yr 9
Early Action Projects (with 1st Year)																										
AT-01	Develop TOC Concept of Operations	7	█																							
AT-02	Develop Statewide Network Communication Requirements and Design	9		█	█																					
AT-03	Develop South Dakota TOC/ATMS Software Requirements and Evaluation	7			█	█																				
AT-04	Develop Requirements and Implement Initial Pierre TOC System and Facility	4				█																				
OP-01	Develop Interim Guidelines for Operational Use of Existing ATMS Devices	4			█																					
Near-Term Projects (1-2 years)																										
AT-05	Design and Implement Expanded Statewide/Regional Pierre TOC	6					█	█																		
AT-06	Implement ATMS Communications	12					█	█	█																	
AT-07	Procure and implement TOC ATMS Hybrid Software	15						█	█	█	█															
OP-02	Develop Statewide Traffic Operations Plan, Operational Guidelines and Procedures	6							█	█																
AT-08	Enhance RCRS to Include Incident Information and Integrate with ATMS Software	12							█	█	█	█														
OP-03	Develop Incident Diversion and Special Event Plans	9								█	█	█														
AT-09	Implement Asset Tracking and ITS Inventory Management System	12						█	█	█	█															
AT-10	Establish Virtual TOC Capabilities	12							█	█	█	█														
Mid-term Projects (3-5 years)																										
AT-11	Develop System and Facility Design Requirements for Regional TOCs in Sioux Falls and Rapid City	7									█	█														
AT-12	Implement Regional TOCs in Sioux Falls and Rapid City	18										█	█	█	█											
OP-04	Integrate MDSS into TOC Operations	12											█	█	█											
AT-13	Develop Requirements For and Implement a Computer Aided Dispatch System	12												█	█	█										
Long-Term Projects (6-10 years)																										
OP-05	Integrate State Radio CAD at Pierre with TOC ATMS / RCRS	18																				█	█	█		
AT-14	Develop Intertie Between the Sioux Fall and Rapid City 911 Centers and Regional TOCS	12																							█	

7.0 STRATEGIC RECOMMENDATIONS

Based on the findings and conclusions of this study, the researchers recommend the following to the South Dakota Department of Transportation:

1. Establish an Organizational Framework to Facilitate Traffic Operations.

Establishing an organizational framework to facilitate traffic operations is a key factor for successful deployment, operations and maintenance of traffic operations capabilities in most states. Therefore, the researchers recommend the following:

- a. Create an Office of Traffic Operations to focus on traffic operations functions
- b. Establish a multidisciplinary ITS Steering Committee, including the following subcommittees:
 - i. Incident/Emergency Management Subcommittee
 - ii. Special Event Traffic Subcommittee
 - iii. Traffic Signal Subcommittee
- c. Develop organizational policies and procedures to guide the work of the new organization
- d. Develop statewide standards and practices for traffic operations to ensure consistency in operations and interoperability throughout the state

2. Formalize and Enhance Traffic Operations Plans and Procedures.

A formal plan for traffic operations and clearly defined guidelines and operational procedures will help to ensure consistency in traffic operations practices and will enable a more effective traffic operations response to events. Some of the key actions required include:

- a. Develop a statewide traffic operations plan with ties to emergency management
- b. Clearly define operational guidelines and procedures for ITS devices
- c. Refine procedures for RCRS use, data entry, and content
- d. Establish a regular training program for traffic and incident/emergency management
- e. Establish a public information campaign to manage motorist expectations

3. Establish a Traffic Operations Presence in the Statewide EOC Prior to the 2006/2007 Winter.

The opportunity to collocate with State Radio in their new dispatch center in Pierre has been presented. Establishing a presence in the dispatch center prior to next winter will allow SDDOT to further strengthen their partnership with SDDPS, while also preparing for possible significant events next year. The individual actions needed include:

- a. Collocate TOC with State Radio Dispatch in Pierre
- b. Define operational needs, including:
 - i. Staffing requirements
 - ii. Hours / after-hours support
 - iii. Equipment (Server, Workstations, Monitors)
- c. Define preliminary functions and capabilities to be included in the initial deployment (e.g., RCRS, DMS, CCTV, RWIS)

4. Implement Permanent Traffic Operations Centers in Pierre, Sioux Falls, and Rapid City.

Establishing initial functionality at the State Radio Dispatch Center in Pierre is a step toward implementing a fully functioning TOC with statewide oversight in Pierre. The deployment of regional centers in Sioux Falls and Rapid City would be phased in to provide traffic operations functionality specific to those areas, while also offering system redundancy. Steps to be taken include:

- a. Procure a statewide ATMS software license
- b. Expand the preliminary capabilities of the Pierre TOC for full statewide and regional functionality
- c. Implement regional TOCs in Sioux Falls and Rapid City to provide regional traffic operations capabilities

5. Expand SDDOT's ITS Capabilities.

Expansion of ITS capabilities would be on two levels – geographically to cover remote locations and functionally by adding new features on an incremental basis as needs arise and as resources dictate. One of the first steps would be to establish virtual TOC capabilities for SDDOT field offices and partner facilities. Other possible capabilities include:

- a. Establish virtual TOC capabilities for remote offices and partner facilities
- b. Address statewide ITS device deployment needs
- c. Enhance communications capabilities to remote locations
- d. Provide linkages to other states
- e. Provide additional functionality beyond core capabilities
 - i. 911 CAD / TOC interface
 - ii. Asset Tracking and Inventory Management

6. Utilize Proven Tools and Methodologies for ITS Design, Deployment and Operations.

The design, deployment and operation of high technology applications require a systematic approach that helps to manage changes over time. Changes in technology, operating environment, system configuration, and functions need to be managed, and the following tools are available for that purpose:

- a. Systems engineering approach for project development
- b. Statewide ITS Architecture
- c. ITS Standards
- d. Configuration management
- e. Asset management

7. Allocate Annual Funding for ITS Deployment, Operations and Maintenance.

ITS and traffic operations generally fall outside of traditional transportation project development and funding processes. They also involve ongoing activities and processes that are non-traditional in nature. Often, traffic operations projects and programs compete with more traditional projects for scarce resources. Successful traffic operations programs do the following:

- a. Mainstream ITS deployment and operations into normal project development and programming processes
- b. Seek additional federal funding for ITS deployment and operations
- c. Establish annual capital and operating budgets for ITS

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