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South Dakota Rural Intelligent Transportation Systems (ITS) Deployment Plan

**Study SD1999-11
Final Report**

Prepared by

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16. Abstract <p>This report proposes the South Dakota Rural ITS program. It is the deployment plan to guide the SDDOT in implementing intelligent transportation systems (ITS) in an effort to improve traveler information, mobility and safety. The South Dakota Rural ITS Deployment Plan describes the traveling public and transportation agencies needs, current ITS environment, strategic direction for the South Dakota Rural ITS Program, and detailed descriptions of recommended projects for deployment. A separately published Executive Summary is also available.</p> <p>The South Dakota Rural ITS Deployment Plan was developed by Castle Rock Consultants in close collaboration with the project Technical Panel.</p>			
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Executive Summary

The implementation of intelligent transportation systems (ITS), as more states are realizing, is facilitated with a planned and strategic approach for deployment. Notwithstanding, the South Dakota Department of Transportation through several preliminary projects involving ITS recognizes this value. This report proposes the South Dakota Rural ITS Deployment Plan. The development of this plan was undertaken to achieve several objectives, which are:

- To describe the current rural ITS environment in South Dakota;
- To develop a strategic direction for ITS activities in South Dakota;
- To propose a coordinated program of rural ITS projects that address the needs of transportation users and those of government and public agencies;
- To define an organization and management framework for accomplishing the ITS projects; and
- To develop materials that will effectively communicate findings to representatives of state government and other public agencies in South Dakota.

General Approach

The approach to developing the ITS Deployment Plan was facilitated by the Technical Panel, which provided oversight and review of all the products generated throughout this process. The approach was based on effectively addressing the needs of agencies with transportation-related interests and the traveling public alike. Great consideration of needs, issues, and opportunities to improve safety and rural transit were underlying themes throughout the project. The following was the approach used to develop the ITS Deployment Plan:

- **Performing a user needs assessment (also requiring the identification of primary stakeholders).** An extensive process was undertaken to ensure that the needs and issues captured were representative of South Dakota. Eight focus groups were convened across South Dakota. Four were with transportation agencies, and four with the traveling public. These focus groups were held in Sioux Falls, Aberdeen, Pierre, and Rapid City. Furthermore, a telephone survey was conducted to support the findings of the focus groups. A review of the SDDOT published accident statistic summaries provided even more insight into the challenges of travel on South Dakota roads.
- **Understanding and documenting the current ITS environment in South Dakota.** This was an important step in establishing a better sense of the SDDOT's involvement and current experience with ITS. Review of ITS initiatives and an inventory of the South

Dakota communications infrastructure were performed. Communications are the backbone of ITS, and the inventory provided a realistic snap shot of the availability of such media across the state. While very remote areas of the state have fewer options, the current availability of communications options across the state will facilitate the deployment of ITS. Furthermore, South Dakota has great interest in providing fiber optics communications across the state.

- **Establishing a strategic direction for the South Dakota Rural ITS program.** While the development of the ITS Deployment Plan is a critical step towards achieving an ITS infrastructure, the plan alone is not sufficient for leading an ITS program. Vision and mission statements along with goals and objectives were developed. Suggested key components within the ITS program; organizational structure; and an operational model were proposed. These were critical inputs to the strategic direction for the rural ITS program.
- **Recommending projects for deployment.** The culmination of the ITS Deployment Plan was the identification of projects. Once preliminary projects were identified, these were presented to the Technical Panel for review as well as shared with the attendees from the original transportation agency focus groups. Attendees were invited back for an outreach session in their respective regions for updates on the progress of the ITS Deployment Plan. This provided an opportunity to present project concepts and obtain feedback for potential champions of ITS deployment. Additionally, a set of priority projects were identified by the Technical Panel and Region Engineers for near term deployment (within the first years of the ITS program.)

Establishing a Strategic Direction for the South Dakota Rural ITS Program

The **vision** developed for the South Dakota Rural ITS program is as follows:

The South Dakota Department of Transportation in cooperation with other public agencies and private agencies will build an integrated, rural Intelligent Transportation Systems (ITS) program. This program will seek to enhance the safety and mobility of the traveling public on South Dakota's roads and stimulate the economic vitality of the state through the application of technologies.

The supporting **mission** developed for the South Dakota Rural ITS program is as follows:

To incrementally achieve the vision of an integrated rural ITS program through planned implementation of technologies, consistent with the South Dakota Rural ITS Deployment Plan.

The goals and objectives established for the South Dakota ITS program are as follows:

- Goal 1:** Improve the safety and efficiency of highway travel through the application of ITS.
- **Objective 1.1:** Develop an integrated and strategic deployment process for rural ITS activities that consider the long term for addressing the transportation needs of South Dakota.
 - **Objective 1.2:** Identify and implement specific, high-priority deployments that will provide visible and immediate results.
 - **Objective 1.3:** Focus on deployments that will reduce rural accident rates and improve rural transit services.
 - **Objective 1.4:** Provide thorough, comprehensive and frequently updated travel and advisory information to the general public.
- Goal 2:** Ensure compatibility and consistency with the direction of national ITS initiatives.
- **Objective 2.1:** Utilize federal guidelines in strategic planning and deployment processes.
 - **Objective 2.2:** Coordinate ITS deployments with existing compliant initiatives within South Dakota.
 - **Objective 2.3:** Coordinate ITS deployments with existing compliant initiatives with neighboring states.
- Goal 3:** Encourage public interagency cooperation and participation of private industry in the process of deploying ITS within South Dakota.
- **Objective 3.1:** Ensure consistency with the state's ITS / CVO program.
 - **Objective 3.2:** Integrate ITS into community planning and regional and state transportation planning efforts.
 - **Objective 3.3:** Foster relationships to leverage resources and expertise of agencies and the private sector within South Dakota.
 - **Objective 3.4:** Educate private industry and businesses of the benefits of ITS to assist in the stimulation of local economies and increasing the competitiveness of South Dakota's private sector against that of other states.

Goal 4: Successfully secure funding for the deployment, operations and maintenance of identified ITS components.

- **Objective 4.1:** Ensure consistency with national objectives to position the state for federal funding.
- **Objective 4.2:** Identify a variety of traditional and non-traditional sources of funding.
- **Objective 4.3:** Encourage public / public and public / private partnerships to diversify funding sources.

Goal 5: Educate the general public, public agencies and government officials of the potential for ITS in South Dakota.

- **Objective 5.1:** Coordinate education and outreach efforts with existing public information programs.
- **Objective 5.2:** Utilize federally sponsored workshops to increase education and outreach opportunities.

ITS Direction

The direction for the South Dakota is to move towards scalable, interoperable ITS deployments that will ultimately help to achieve the vision of an integrated, rural, ITS program. This direction will seek to deploy ITS projects in a planned and logical manner which will ultimately ready ITS for mainstreaming activities. The strategy employed to accomplish this will build on the momentum created with the development of the rural ITS deployment plan. The deployment plan developed will act as the guide for implementation of an integrated, statewide ITS infrastructure. The development of a basic organization structure will provide insight into overall program management and oversight. Additionally, several considerations that are beyond the scope of the deployment plan need to be included in this strategy. These are developing a project implementation process and developing a statewide ITS architecture.

Organizational Structure

Basic ITS program components that were identified include public agency needs assessment; traveler needs assessment; research and development; operational test; statewide deployment; regional deployment; and local area deployment. Integral to furthering ITS deployment and acceptance is creating an organization structure that will house these components and lead the

program from concept to realization. The proposed ITS program organizational structure would consist of two primary entities: the Steering Committee and the Office of Research.

The Steering Committee would be charged with providing the strategic direction for the ITS program. The logical choice for the Steering Committee would be the Rural ITS Deployment Plan Technical Panel, already representative of a good cross section of potential ITS stakeholders and transportation agencies across South Dakota. The responsibilities of the Steering Committee may include:

- Ensuring updates to the program vision, goals, and objectives;
- Providing general oversight for implementation of the deployment plan;
- Providing general oversight of the program budget; and
- Developing consensus among stakeholder organizations.

Currently, the Office of Research oversees research-related activities including ITS initiatives. The current functions of the Office of Research naturally positions itself as the primary entity within the ITS program **in the interim**. The Office of Research would manage the day-to-day activities of the ITS program such functions as providing staff support, providing expertise and advice to local agencies, and funding administration, project management, liaison with local, state and federal agencies, and education and promotion. The Office of Research would act as the coordinating body between the Steering Committee and ITS implementers. An additional responsibility may include supporting requests for proposals and solicitations from contractors and consultants.

The South Dakota Rural ITS Program has great potential for evolving into a separate “Office” within the SDDOT. As mentioned earlier, in the interim, the Office of Research would play a predominate role. However, once the rural ITS program has been established, the organization structure will need to be re-evaluated and a dedicated staff of full-time individuals may be required to oversee the program. A suggested framework is depicted in Figure 1.

The Steering Committee could evolve in the ITS Board. The ITS Board would function in the same capacity as outlined above. The Office of Rural Intelligent Transportation Systems would be created with the lead role of ITS Coordinator / Director.

The ITS Coordinator / Director would be charged with overseeing the overall ITS program; remain abreast regional and national ITS developments; liaison with Regions to understand their needs, provide support, and facilitate individual regional ITS projects; provide outreach throughout the state to state and local agencies; provide high-level support solicitations and

request for proposals for project consultants, vendors or partners; and liaison with other state agencies, ITS programs and academic institutions.

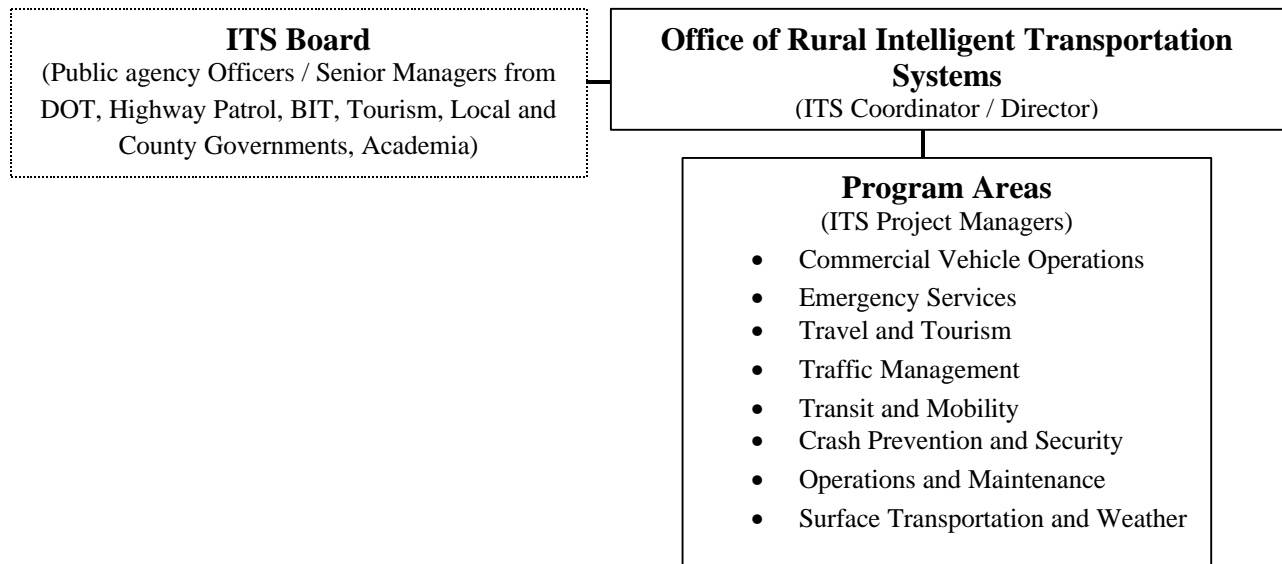


Figure 1 - Recommended Office of Intelligent Transportation Systems Framework

Furthermore, the Office of Rural Intelligent Transportation Systems would support the following program areas, where individual ITS Project Managers would be in charge of ITS deployments and project development:

- Commercial Vehicle Operations;
- Emergency Services;
- Travel and Tourism;
- Traffic Management;
- Transit and Mobility;
- Crash Prevention and Security;
- Operations and Maintenance; and
- Surface Transportation and Weather.

ITS Project Managers would have the responsibility of developing individual project definitions; coordinating and managing projects; identifying local project partners and project team members; and outreach, education, and promotional activities. Moreover, ITS Project Managers would oversee the essential day-to-day activities.

Approach for Developing Project Implementation and Evaluation Process

The purpose of the South Dakota Rural ITS Deployment Plan is to develop an approach to the implementation of technologies. One of the next suggested steps after the deployment plan is accepted and approved is to develop a project implementation process that will attempt to prioritize and facilitate deployment of future ITS endeavors within South Dakota. Considerations for generating a deployment process may entail:

- **Defining overall performance and evaluation goals for projects.** The success and outcome of an ITS implementation may be more easily measured when compared with established performance criteria at the outset of a project.
- **Identifying realistic and available funding sources.** A better handle on available funding sources can assist in painting a realistic picture of the magnitude of the ITS program. This may be a necessary criterion considered in prioritizing projects.
- **Identifying geographic appropriateness for site selection.** ITS may be very site-specific in nature. For example, the application of a train detection and alert system would be of most benefit on highway-railroad intersections historically experiencing high vehicle-train collisions.
- **Identifying lead agencies and potential project champions.** Oftentimes, the most appropriate project lead may not be the DOT. While the DOT plays a large role in ITS, it is not the only stakeholder. Greater buy-in to ITS concepts can be accomplished with involvement of stakeholder agencies.
- **Promotion and outreach of ITS projects.** As a fairly new and emerging sector in the transportation discipline, ITS concepts and benefits need to be shared with stakeholders and the traveling public. This is key in widespread acceptance.

Significant Findings

The approach undertaken led to the development of the South Dakota Rural ITS Deployment Plan, most significantly the identification of projects for further consideration. In search of applicable projects, emphasis was put on:

- **Projects that benefit a number of stakeholder agencies.** ITS is certainly an area where a great number of agencies from various disciplines can benefit from shared resources and leveraged opportunities. Many of the projects identified consider the advantages of multi-jurisdictional endeavors.
- **Projects that have been proven in other areas.** The opportunity to take advantage of the research and experiences of other projects was fully seized. Nonetheless, projects

that were “operational test” in nature were also identified to provide South Dakota the opportunity for innovation.

- **Projects that are typically cost-effective.** While ITS can be perceived as cutting-edge, the most logical choices were methods of attaining the same results, but requiring less allocation of resources. An emphasis was placed on solutions that would prove the best use of resources.
- **Projects that emphasize safety and rural transit initiatives.** Safety and rural transit are prominent concerns of the SDDOT. South Dakota is a geographically large, sparsely populated state. These factors alone pose challenges to the lack of options for multiple modes of travel between towns, which typically could consist of hundreds of miles, and the safety of rural travelers that spend greater lengths of time on the roadway than urban counterparts. Projects were identified that would help to address these areas of concern.

The end result was 29 recommended ITS projects for deployment. Of these, eight were identified as priority projects to be deployed in the near term. The remainder of the projects selected were recommended for deployment in the medium- and long-term. The medium-term is defined as projects expected to be deployed between the four to seven-year time frame. The long-term is defined as those projects deployed beyond the seven-year time frame. These projects satisfy the needs and issues identified by the end users, the strategic direction of the rural ITS program, and the work that is being undertaken at the national level. Following is a table that summarizes the recommended projects, indicates the needs category addressed by the ITS application, costs, and suggested deployment area.

Figure 2 - Recommended Projects by Suggested Deployment Regions

Need Category	Recommended Projects	Cost	Suggested Deployment Area
Traveler Information	Traveler Information Promotion Promote the current resources of information provided by the SDDOT including, but not limited to, ATWIS, the SDDOT traveler information Web page, and #SAFE programs.	Total direct costs estimated at \$10,000 for reproduction of flyers, reproduction of posters, radio / television spots, and travel to media locations. The SDDOT should also consider allocating \$10,000 to hire a marketing firm to assist in developing a marketing strategy and \$5,000 to evaluate the results of the traveler information promotion effort. Total project cost is \$25,000.	Statewide
Traveler Information, Mobility	Road Condition Via CCTV Installation of cameras on the roadway for viewing current road conditions and traffic condition, for example.	Total Equipment costs for recommended deployment of six cameras: \$30,000. Camera setups including: cabling, camera server and other electronic equipment costs are reported at \$1,800 per setup. Housing units with heaters are extra (\$130 / unit). Other miscellaneous costs include wiring, mounting brackets and additional camera lenses if needed. These capital costs do not include the costs for installing a pole, and should be added for locations without existing poles.	Six camera deployments are recommended. Rapid City in conjunction with the Ellsworth RWIS station; in Rapid City in conjunction with the Sheridan Lake Road RWIS station; Pierre at the Vivian RWIS station, Sioux Falls along I-90 near Montrose RWIS station; Belvidere near Belvidere RWIS station; the Northeast portion of the state in conjunction with the Summit RWIS station.
Traveler Information, Mobility	Expansion of ATWIS This project consists of expanding the ATWIS efforts already underway. Five subprojects are proposed including: 1. providing land-line access to the cellular-based system; 2. implementing an interactive voice recognition system; 3. providing Internet enhancements; 4. consolidating weather information numbers; and 5. improving road condition information.	1. Land-line access = \$10,500 2. Interactive voice recognition = \$30,000 3. Internet enhancements = \$40,000 4. Consolidate weather information numbers = 80 hours staff time 5. Improved road condition information = \$20,000 to \$75,000	Statewide
Safety, Mobility	Automatic Anti-Icing System Use of a spray system that is automatically activated by a computerized control system in anticipation of frost or icy road conditions. The automatic anti-icing system will detect or predict ice formation and treat the roadway before it becomes a hazard to drivers. Sites prone to icy conditions include bridge decks and shady spots. The system consists of embedded pavement sensors, a processor to determine when conditions require anti-icing, and spray nozzles for anti-icing agents.	Total equipment costs for recommended deployment of two anti-icing units: \$50,000. For bridges spanning 500 feet or less with four lanes or less, a self-contained, ready-to-roll-out system costs approximately \$19,300. This system includes 10 spray nozzles that will provide coverage to the driving lanes only (shoulders will receive run-off), piping, chemical tank, and sensors. This system is not expandable, and requires the use of clear chemical agents such as magnesium chloride. Salt brine solutions will not work. Please note that larger systems (including 1000 gallon tank, supply pump structure, precipitation sensor, installation supervision, training, 15 spray nozzles, and piping) cost approximately \$63,300.	Watertown Hill City

Figure 2 - Recommended Projects by Suggested Deployment Regions

Need Category	Recommended Projects	Cost	Suggested Deployment Area
Traveler Information, Safety, Mobility	Remote-Controlled Snow Gate Closure System This proposed system allows for snow gates to be remotely closed, offering increased safety for DOT or highway patrol personnel. The system can potentially be integrated with highway advisory radio, dynamic message signs, or closings can be posted on the integrated traveler information Web site to alert drivers of road closures.	Suggested project cost is \$50,000 for the design, deployment, test and evaluation of 3 remote-controlled gates. Traditional snow gates cost approximately \$3,600 for equipment and installation. Remote-controlled units cost approximately \$6000 (including gate, closure mechanism, and 1-year maintenance agreement.).	<ul style="list-style-type: none"> • Rapid City at an exit near camera and DMS deployments at MRM 65.2 and MRM 61.4, respectively. • Two gate deployments at exits near Sisseton in conjunction with planned DMS deployments at MRM 234.263 and MRM 228.985.
Traveler Information	Integrated Traveler Information System Enhancement of the current traveler information available. A “one-stop shop” for integrated traveler information to include camera images, information for other modes of transportation (such as transit and airport information), real-time road condition / traffic condition information, mileage calculator, rest areas, and links to tourism information, for example.	Total cost for the development of the Web site is \$100,000. The total equipment costs for deployment of six cameras is \$30,000. Please refer to Road Condition via CCTV project write-up for technical details. Other costs include: Web site planning (20 person days) - \$10,000; Coding and graphics development (30 person days) - \$20,000, Information gathering (60 person days) - \$40,000	Statewide
Safety	Rural Addressing and GIS The SDDOT has performed most of the fieldwork required in collecting GIS and rural addressing data. This project proposes to fund the effort necessary to complete the link between the GIS and rural addressing data. This would provide a statewide database of information that can be used by various state and local agencies to improve emergency service response, for land use planning, and for property data management, for example.	While the SDDOT has already purchased equipment for rural addressing, setting up a database to link GIS and rural addressing data and finishing the geo-coding effort may be a time consuming endeavor. The estimated project cost is \$100,000 to contract for database development for counties within South Dakota.	Statewide
Traveler Information, Mobility	Expansion of Dynamic Message Signs Expansion of the dynamic message sign network scheduled for deployment in 2001. The expansion will provide greater coverage and opportunities for travelers en route to receive information regarding weather, road conditions, closures, and construction information, for example.	This project description recommends the expansion of this effort. The project suggestion is for allocating \$600,000 for the expansion of the permanent sign network to include 3 more installations. The cost of equipment procurement and installation is \$100,000 for the sign, and an additional \$100,000 per installation. Mobile message signs can be purchased for approximately \$30,000 each. Total project cost is \$660,000.	Three additional permanent DMS deployments and procurement of two mobile units are recommended. <ul style="list-style-type: none"> • I-90 east of US 83. • I-90 eastbound approaching Rapid City. • I-29 northbound near Beresford for travelers heading towards Sioux Falls from Sioux City and Iowa.
Traveler Information	Statewide 5-1-1 Traveler Information Number This project proposes the designation of a dedicated 3-digit number (5-1-1) for traveler information, similar to the allocation of 9-1-1 for emergency response. Federal legislation was passed in the summer of 2000 to allow states the authority to pursue this initiative.	Initial estimates for jurisdictions to investigate and begin the process of converting an existing traveler information number to 5-1-1 is approximately \$50,000.	Statewide

Figure 2 - Recommended Projects by Suggested Deployment Regions

Need Category	Recommended Projects	Cost	Suggested Deployment Area
Traveler Information, Safety, Mobility	Portable Traffic Management System The development of a multi-purpose, self-contained trailer combining various technologies such as: variable message signs, portable traffic signal, weather sensors, radar speed detection, video surveillance, wireless communications, highway advisory radio and floodlights. The system can be used for special event management, incident management, natural disaster management and traffic data collection.	Design of the system including hardware and software requirements, and standard operational protocols may cost \$100,000 for the initial contract work.	Mobile
Safety	Automatic Vehicle Location for Agency Vehicles This project seeks to use automatic vehicle location (AVL) technology for improved dispatching, scheduling, operations, and efficiency of Highway Patrol, DOT maintenance services, and transit. The suggested project is an investigation into the limited deployment, test and evaluation of 15 AVL units.	The project suggestion is for funding a fleet of approximately 15 fleet vehicles. The project cost is approximately \$300,000. Typical AVL costs include \$6200 per vehicle for a GPS-based location system, \$2300 per vehicle for computer aided dispatching capabilities, and \$2400 per vehicle for digital communications or \$3500 per vehicle for trunked communications.	Pierre
Traveler Information, Safety, Mobility	Highway Advisory Radio (HAR) HAR systems use recorded information on traffic conditions and tourist-related activities to reach users in a limited geographical area over AM and FM frequency; new recordings are made when conditions change sufficiently. Some systems provide the capability to remotely switch between alternative messages.	Project recommendation is for \$30,000 to fund and implement a mobile HAR system. Very basic systems may be purchased for as little as \$8,000. Commercial systems run approximately \$25,000 for equipment and installation.	Mobile
Traveler Information, Mobility	Multi-Jurisdictional Transit Coordination This project proposes to provide such information as routes, schedules, pick-up drop-off time estimates, type of service provided (e.g., fixed or demand response), coverage area of service, hours of operation, cost, and assistance in planning trips across multiple towns. The information can be provided through an interactive voice response (IVR), dial-up telephone system and/or on the Internet. The Internet site could potentially be incorporated into the integrated traveler information system, or be a stand-alone system.	The suggested project funding is \$100,000 for the design and coordination of transit and multi-modal services around the state. Information provided to users is anticipated via Internet and a 1-800 or local telephone number.	Statewide
Traveler Information, Safety, Mobility	Infrastructure Inventory and Condition Monitoring System This involves the development of a centralized condition reporting system. The system allows DOT personnel to manually input and report critical roadway situations (for example, real-time road construction updates, incident, advisories, road condition information) via an Internet based system for up-to-the-minute access by other DOT personnel and travelers.	Initial capital costs are \$100,000 for deployment. Similar initiatives require internal database (e.g., Oracle, SQL) support that can operate on an existing computer. Staff and travelers can access the system using Internet browsers that can be downloaded and upgraded for free.	Statewide
Traveler Information, Mobility	Rural Traffic Operations and Communications System This project proposes to establish an integrated traffic operations and communications center initially serving a selected small urban area of South Dakota. The center would assist in gathering and disseminating transportation information, incorporating multiple agencies operations and stimulating mutual cooperation.	Most capital costs in the design of an integrated, electronic traffic operations and communications system occur with software development. Depending on the types of uses for the system, software development for the computer system may cost as much as \$500,000. Hardware with installation may be as much as \$1.5 to \$2 million depending on the size of the district being equipped, the types of implementations requested. The proposed total cost is \$3,000,000 to equip a small urban area and its surrounding rural neighbors.	Sioux Falls

Figure 2 - Recommended Projects by Suggested Deployment Regions

Need Category	Recommended Projects	Cost	Suggested Deployment Area
Safety	Highway Railroad Intersection Safety This project consists of implementing a community-friendly warning horn system to alert vehicles at train crossings of on-coming train traffic. The system requires the deployment of two stationary horns mounted at the crossing. Each horn directs its sound at the roadway. The horn is activated using the same track signal circuitry as the gate arms and bells located at the crossing. A strobe light informs the locomotive engineer that the system is working.	Automated train horns cost approximately \$20,000 apiece. However, at least one community has had to forestall their installation due to the prohibitive cost of upgrading the train track wiring system. The upgraded technology, known as “constant warning technology” can reportedly cost up to \$250,000 if not already in place.	Aberdeen
Safety	Intersection Collision Countermeasure This project involves the use of embedded traffic sensors to detect on-coming traffic at uncontrolled rural intersections. The sensors are integrated with flashing warning signs to warn drivers to proceed with caution.	Project funding is suggested at \$96,000 for the design, procurement of a sign, and installation.	Pierre
Safety, Mobility	Multi-Jurisdictional Emergency Services Coordination This project recommends the use of a centralized dispatching database to improve the emergency response services within a county or multiple jurisdictions by providing incident data and other information to emergency vehicles (such as fire trucks and ambulances) arriving at the scene of a crash.	Project funding is suggested at \$100,000 for the detailed design and implementation of a shared emergency responder database.	Aberdeen
Safety	Hand-held Devices for Reporting Accident Data This project proposes the use of hand-held devices (e.g., Palm Pilot, Visor) for communicating important on-site crash information to emergency dispatchers, and automating data collection.	Project funding is suggested for \$25,000 for the procurement of ten units and the design and integration of the interface. Hand-held devices range in price from \$150 (2MB of memory) to \$250 - \$450 (8MB of memory) per unit. Wireless cellular modem compatible with hand-held devices cost approximately \$370 per unit. Some modems have the option for global positioning system functionality. This type of system is most appropriate for emergency centers that are already equipped with some type of internal local area network.	Sioux Falls
Safety	Roadway Geometrics Alert System This project suggests coupling radar technologies with flashing warning signs to alert drivers of geometric hazards such as dangerous curves or blind intersections.	Project funding suggestion is \$30,000 for site selection, design, and the purchase of three units for test and evaluation. Flashing beacons cost approximately \$3,500 each. For the radar system, \$3,800 covers the cost of one transmitter, solar pack and installation.	Sioux Falls
Safety	Emergency Warning System This project proposes the use of solar-powered flashers to give drivers early warning of flooded routes, or other warning situations. A real-world example of this technology is the implementation of the Early Flood Warning System deployed in the City of Scottsdale, AZ.	Solar powered flashers used in Phoenix, Arizona cost \$1500 per unit. However, they will eventually pay for themselves in energy savings. A pager-activated system can be controlled from any computer, with pagers costing as little as \$30 per month. The project funding is estimated to be \$20,000 for the procurement, site survey, design, installation, testing and evaluation of six solar-powered flashers.	Aberdeen
Traveler Information, Safety, Mobility	Information Exchange Network This project is intended to facilitate the communications and information sharing among member agencies. This shared information supports coordinated transportation management and traveler information on a regional and corridor-wide basis. The I-95 corridor along the East Coast is a good example of such an effort.	Capital costs are low to zero and consist mainly of staff labor dedicated to getting the IEN up and running. Suggestion is to allocate \$50,000 for investment in one or several ITS pooled-fund study.	Statewide

Figure 2 - Recommended Projects by Suggested Deployment Regions

Need Category	Recommended Projects	Cost	Suggested Deployment Area
Traveler Information, Safety, Mobility	Broadcast Traveler Information This project investigates the use of an AM sub-carrier as a reliable, low-cost medium for transmitting traffic messages over wide geographic areas.	\$50,000 for the investigation, test and implementation of broadcast traveler information technologies.	Rapid City
Traveler Information, Safety, Mobility	Portable ITS and Traveler Information Technologies in Work Zones This project proposes the use of highway advisory radio, changeable message signs, and video for real-time work zone information dissemination and traffic management.	Project suggestion is \$100,000 for developing and testing one mobile unit. Initial low costs systems can later add advanced components. HAR costs approximately \$20,000 per unit including training. CMS technology can be purchased for approximately \$16,000 to \$18,000 per unit. The total cost of the project in Iowa (which combined HAR, CMS and the detection system) was \$100,000. The CMS units were already owned by the DOT. There is an option to lease or buy equipment.	Mobile
Safety	Breathalyzer Ignition Interlock System This project suggests the support of devices to prevent ignition of a vehicle when the alcohol level in a breath sample is above the threshold percent concentration. Support for similar programs can be found in 32 states.	There is no cost to the DOT. Support of the concept if seen as a viable drunk driving deterrent for repeat offenders.	Statewide
Traveler Information, Mobility	CAD / AVL / MDT for Rural Transit This project proposes the deployment of computer aided dispatching, automatic vehicle location and mobile data terminals for improved transit operations and service.	\$300,000 to deploy and test a fleet of 15 vehicles equipped with AVL and MDTs, and CAD capabilities.	Sioux Falls
Safety, Mobility	On-board Snow Plow Driver Assistance This project examines the use of magnetic tape and nails for maintenance vehicle guidance, specifically in low-visibility conditions.	\$600,000 for the operational test and demonstration of lateral / longitudinal guidance of snow plows within South Dakota. An alternative is to participate in the pooled-fund study, being led by CALTRANS, to study ITS applications in highway maintenance vehicles.	Aberdeen
Safety	Mayday Infrastructure This project looks at the use of in-vehicle global positioning systems (GPS) combined with cellular / satellite communications for transmission of automatic crash notification to public safety emergency response centers.	\$2,000,000 for the design and development of an interface between commercial Mayday devices and emergency response centers, and the procurement of four workstations.	Rapid City
Traveler Information, Mobility	Web-Enabled Transit Route Planning / Smart Pass This project proposes the use of a Web site for planning transit (e.g., route selection, determining use of numerous agencies to get from point A to B, automatic fare calculator, electronic fare payment) and other modes of travel. The use of a "smart pass" allows travelers to use multiple types of transportation across various jurisdictions.	\$100,000 for the development of a transit planner Web site and implementation of electronic fare readers in 10 to 15 vehicles. Electronic fare readers cost approximately \$2800 to \$9500 per vehicle.	Sioux Falls or Rapid City

The following are recommended projects, project cost estimate, and recommended deployment time frames further detailed in the South Dakota Rural ITS Deployment Plan:

Recommended Near-Term Deployment Timeline

The following is the suggested phased cost table, cost summary, and schedule timeline for deploying the highest priority ITS projects in South Dakota. Projects selected emphasize the leveraging of current ITS initiatives, improving traveler information, and addressing safety

issues. Projects selected in Year 2001 leverages current initiatives and address the traveler information issues that were discussed in the focus groups. Projects selected for Year 2002 further focuses on leveraging current initiatives, seeking to enhance and integrate traveler information, and again looks at improving safety. Projects selected for Year 2003 seek to further enhance traveler information and addresses the issue of emergency response.

Figure 3 - Near-Term Project Costs

Near Term (0-3 years) Projects	Cost			
	2001	2002	2003	Total
1. Traveler Information Promotion	\$25,000			
2. Road Condition via CCTV	\$50,000			
3. Expansion of ATWIS	\$155,500			
<i>Land-line access</i>	\$10,500			
<i>Interactive voice recognition</i>	\$30,000			
<i>Internet enhancements</i>	\$40,000			
<i>Consolidate weather information numbers</i>	80 hours staff time			
<i>Improved road condition information</i>	\$75,000			
4. Automated Anti-Icing System		\$50,000		
5. Remote-Controlled Snow Gate Closure System		\$50,000		
6. Integrated Traveler Information		\$100,000		
7. Rural Addressing / GIS			\$100,000	
8. Expansion of Dynamic Message Signs			\$660,000	
Total	\$230,500	\$200,000	\$760,000	\$1,195,500

Figure 4 - Near-Term Cost Summary

Recommended Projects	Cost
Traveler Information Promotion	Total direct costs estimated at \$10,000 for reproduction of flyers, reproduction of posters, radio / television spots, and travel to media locations. The SDDOT should also consider allocating \$10,000 to hire a marketing firm to assist in developing a marketing strategy and \$5,000 to evaluate the results of the traveler information promotion effort. Total project cost is \$25,000.
Road Condition Via CCTV	Camera setups including: cabling, camera server and other electronic equipment costs are reported at \$1,800 per setup. Housing units with heaters are extra (\$130 / unit). Other miscellaneous costs include wiring, mounting brackets and additional camera lenses if needed. These capital costs do not include the costs for installing a pole, and should be added for locations without existing poles. Total Equipment costs for recommended deployment of six cameras: \$30,000
Expansion of ATWIS	<ol style="list-style-type: none"> 1. Land-line access = \$10,500 2. Interactive voice recognition = \$30,000 3. Internet enhancements = \$40,000 4. Consolidate weather information numbers = 80 hours staff time 5. Improved road condition information = \$20,000 to \$75,000
Automatic Anti-Icing System	Total equipment costs for recommended deployment of two anti-icing units: \$50,000. For bridges spanning 500 feet or less with four lanes or less, a self-contained, ready-to-roll-out system costs approximately \$19,300. This system includes 10 spray nozzles that will provide coverage to the driving lanes only (shoulders will receive run-off), piping, chemical tank, and sensors. This system is not expandable, and requires the use of clear chemical agents such as magnesium chloride. Salt brine solutions will not work. Please note that larger systems (including 1000 gallon tank, supply pump structure, precipitation sensor, installation supervision, training, 15 spray nozzles, and piping) cost approximately \$63,300.
Remote-Controlled Snow Gate Closure System	Suggested project cost is \$50,000 for the design, deployment, test and evaluation of 3 remote-controlled gates. Traditional snow gates cost approximately \$3,600 for equipment and installation. Remote-controlled units cost approximately \$6000 (including gate, closure mechanism, and 1-year maintenance agreement).
Integrated Traveler Information System	Total cost for the development of the Web site is \$100,000. The total equipment costs for deployment of six cameras is \$30,000. Please refer to Road Condition via CCTV project write-up for technical details. Web site planning (20 person days) - \$10,000 Coding and graphics development (30 person days) - \$20,000 Information gathering (60 person days) - \$40,000
Rural Addressing and GIS	While the SDDOT has already purchased equipment for rural addressing, setting up a database to link GIS and rural addressing data and finishing the geo-coding effort may be a time consuming endeavor. The estimated project cost is \$100,000 to contract for database development for counties within South Dakota.

Figure 4 - Near-Term Cost Summary

Recommended Projects	Cost
Expansion of Dynamic Message Signs	Total project cost is \$660,000. The project suggestion is for allocating \$600,000 for the expansion of the permanent sign network to include 3 more installations. The cost of equipment procurement and installation is \$100,000 for the sign, and an additional \$100,000 per installation. Mobile message signs can be purchased for approximately \$30,000 each.

The following figure provides an illustration of the expected near-term deployments around South Dakota. Please note that the illustration includes the eight planned DMS deployments that already have been programmed by the SDDOT and will which will be undertaken in 2001.

Figure 5 - Illustration of Near-Term Deployments Statewide

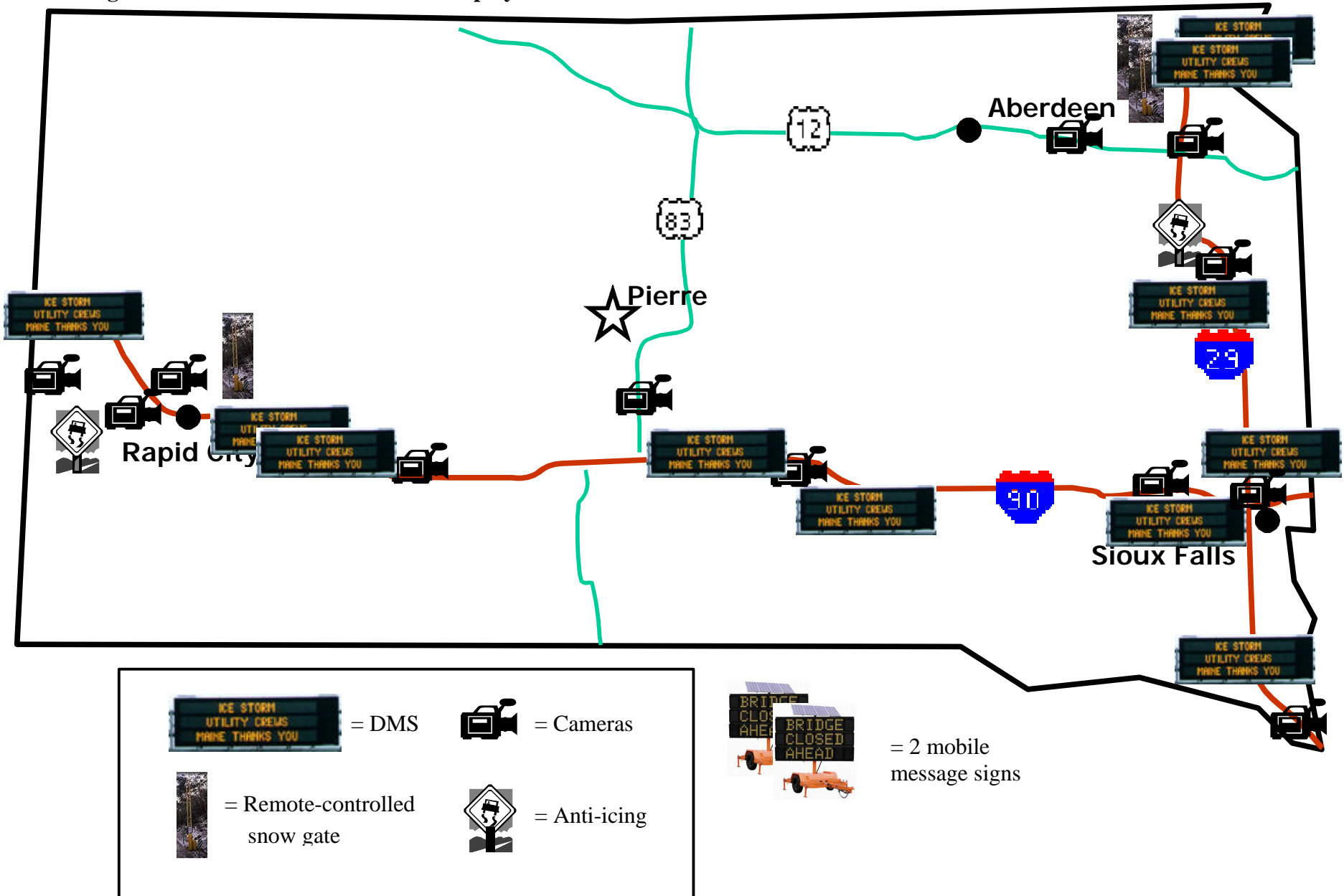


Figure 6 - Near Term Project Deployment Timeline

Projects	2001	2002	2003	2004
1. Traveler Information Promotion				
2. Road Condition Information via CCTV				
3. Expansion of ATWIS				
4. Automated Anti-/De-icing System				
5. Remote Controlled Snow Gate Closure				
6. Integrated Traveler Information System				
7. Rural Addressing / GIS				
8. Expansion of Dynamic Message Signs				

Recommended Medium- to Long-Term Timelines

The following is the suggested phased cost tables and schedule timelines for deploying the medium- and long-term ITS projects in South Dakota. Projects selected for medium-term deployment continue to address safety, traveler information and improved operations and efficiency. Some of these projects are more research in nature and may not be as readily deployable as near-term projects.

Figure 7 - Medium-Term Project Costs

Medium-Term Projects	Cost				
	2004	2005	2006	2007	Total
1. Statewide 5-1-1 Traveler Information Number	\$50,000				
2. Portable Traffic Management System	\$100,000				
3. Automatic Vehicle Location for Agency Vehicles	\$300,000				
4. Highway Advisory Radio (HAR)	\$30,000				
5. Multi-Jurisdictional Transit Coordination		\$100,000			
6. Infrastructure Inventory and Condition Monitoring System		\$100,000			
7. Rural Traffic Operations and Communications System		\$3,000,000			
8. Highway Railroad Intersection Safety		\$30,000			
9. Intersection Collision Countermeasure			\$96,000		
10. Multi-Jurisdictional Emergency Services Coordination			\$100,000		
11. Hand-held Devices for Reporting Accident Data			\$25,000		
12. Roadway Geometrics Alert System			\$30,000		
13. Emergency Warning System				\$20,000	
14. Information Exchange Network				\$50,000	
15. Broadcast Traveler Information				\$50,000	
16. Portable ITS and Traveler Information Technologies in Work Zones				\$100,000	
17. Breathalyzer Ignition Interlock System				N/A	
Medium-Term (4-7 years) Total	\$480,000	\$3,230,000	\$251,000	\$220,000	\$4,181,000

Projects selected for long-term projects are “visionary” in nature, and may require more in-depth research and advances in technologies before realization. These projects are most appropriate once the South Dakota Rural ITS Program has been in place for a number of years.

Figure 8 - Long-Term Project Costs

Long-Term Projects	Cost		
	2008	2009	Total
1. CAD / AVL / MDT for Rural Transit	\$300,000		
2. On-board Snow Plow Driver Assistance	\$600,000		
3. Mayday Infrastructure	\$2,000,000		
4. Web-Enabled Transit Route Planning / Smart Pass		\$100,000	
Long-Term (>7 years) Total	\$2,900,000	\$100,000	\$3,000,000

Figure 9 - Medium- and Long-Term Cost Summary

Recommended Projects	Cost
Statewide 5-1-1 Traveler Information Number	Initial estimates for jurisdictions to investigate and begin the process of converting an existing traveler information number to 5-1-1 is \$50,000.
Portable Traffic Management System	Design of the system including hardware and software requirements, and standard operational protocols may cost \$100,000 for contract work.
Automatic Vehicle Location for Agency Vehicles	The project suggestion is for funding a fleet of approximately 15 fleet vehicles. The project cost is approximately \$300,000. Typical AVL costs include \$6200 per vehicle for a GPS-based location system, \$2300 per vehicle for computer aided dispatching capabilities, and \$2400 per vehicle for digital communications or \$3500 per vehicle for trunked communications.
Highway Advisory Radio (HAR)	Project recommendation is for \$30,000 to fund and implement a mobile HAR system. Very basic systems may be purchased for as little as \$8,000. Commercial systems run approximately \$25,000 for equipment and installation.
Multi-Jurisdictional Transit Coordination	The suggested project funding is \$100,000 for the design and coordination of transit and multi-modal services around the state. Information provided to users is anticipated via Internet and a 1-800 or local telephone number.
Infrastructure Inventory and Condition Monitoring System	Initial capital costs are \$100,000 for deployment. Similar initiatives require internal database (e.g., Oracle, SQL) support that can operate on an existing computer. Staff and travelers can access the system using Internet browsers that can be downloaded and upgraded for free.
Rural Traffic Operations and Communications System	Most capital costs in the design of an integrated, electronic traffic operations and communications system occur with software development. Depending on the types of uses for the system, software development for the computer system may cost as much as \$500,000. Hardware with installation may be as much as \$1.5 to \$2 million depending on the size of the district being equipped, the types of implementations requested. The proposed total cost is \$3,000,000 to equip a small urban area and its surrounding rural neighbors.
Highway Railroad Intersection Safety	Automated train horns cost approximately \$20,000 apiece. However, at least one community has had to forestall their installation due to the prohibitive cost of upgrading the train track wiring system. The upgraded technology, known as “constant warning technology” can reportedly cost up to \$250,000 if not already in place.
Intersection Collision Countermeasure	Project funding is suggested at \$96,000 for the design, procurement of a sign, and installation.
Multi-Jurisdictional Emergency Services Coordination	Project funding is suggested at \$100,000 for the detailed design and implementation of a shared emergency responder database.

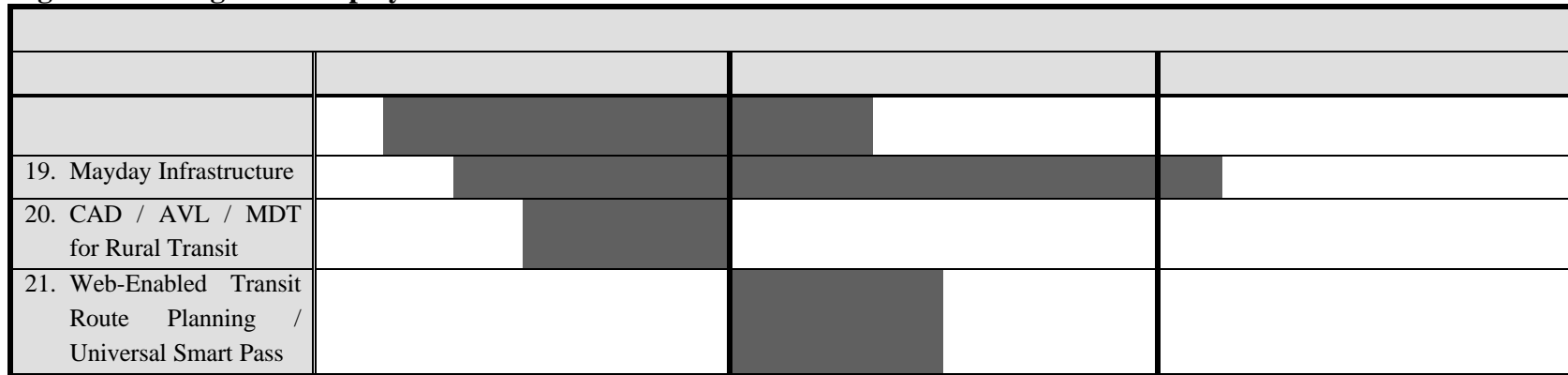
Figure 9 - Medium- and Long-Term Cost Summary

Recommended Projects	Cost
Hand-held Devices for Reporting Accident Data	Project funding is suggested for \$25,000 for the procurement of ten units and the design and integration of the interface. Hand-held devices range in price from \$150 (2MB of memory) to \$250 - \$450 (8MB of memory) per unit. Wireless cellular modem compatible with hand-held devices cost approximately \$370 per unit. Some modems have the option for global positioning system functionality. This type of system is most appropriate for emergency centers that are already equipped with some type of internal local area network.
Roadway Geometrics Alert System	Project funding suggestion is \$30,000 for site selection, design, and the purchase of three units for test and evaluation. Flashing beacons cost approximately \$3,500 each. For the radar system, \$3,800 covers the cost of one transmitter, solar pack and installation.
Emergency Warning System	Solar powered flashers used in Phoenix, Arizona cost \$1500 per unit. However, they will eventually pay for themselves in energy savings. A pager-activated system can be controlled from any computer, with pagers costing as little as \$30 per month. The project funding is estimated to be \$20,000 for the procurement, site survey, design, installation, testing and evaluation of six solar-powered flashers.
Information Exchange Network	Capital costs are low to zero and consist mainly of staff labor dedicated to getting the IEN up and running. Suggestion is to allocate \$50,000 for investment in one or several ITS pooled-fund study.
Broadcast Traveler Information	\$50,000 for the investigation, test and implementation of broadcast traveler information technologies.
Portable ITS and Traveler Information Technologies in Work Zones	Project suggestion is \$100,000 for developing and testing one mobile unit. Initial low costs systems can later add advanced components. HAR costs approximately \$20,000 per unit including training. CMS technology can be purchased for approximately \$16,000 to \$18,000 per unit. The total cost of the project in Iowa (which combined HAR, CMS and the detection system) was \$100,000. The CMS units were already owned by the DOT. There is an option to lease or buy equipment.
Breathalyzer Ignition Interlock System	There is no cost to the DOT. Support of the concept if seen as a viable drunk driving deterrent for repeat offenders.
CAD / AVL / MDT for Rural Transit	\$300,000 to deploy and test a fleet of 15 vehicles equipped with AVL and MDTs, and CAD capabilities.
On-board Snow Plow Driver Assistance	\$600,000 for the operational test and demonstration of lateral / longitudinal guidance of snow plows within South Dakota. An alternative is to participate in the pooled-fund study, led by CALTRANS, to study ITS applications in maintenance vehicles.
Mayday Infrastructure	\$2,000,000 for the design and development of an interface between commercial Mayday devices and emergency response centers, and the procurement of four workstations.
Web-Enabled Transit Route Planning / Smart Pass	\$100,000 for the development of a transit planner Web site and implementation of electronic fare readers in 10 to 15 vehicles. Electronic fare readers cost approximately \$2800 to \$9500 per vehicle.

Figure 10 - Medium-Term Deployment Timeline

Projects Recommended for Medium Term (4-7 years) Deployment				
Projects	2004	2005	2006	2007
5-1-1 for Traveler Information				
Portable Traffic Management System				
Automatic Vehicle Location for Agency Vehicles				
Highway Advisory Radio				
Infrastructure Inventory/Condition Monitoring System				
Multi-Jurisdictional Transit Coordination				
Rural Traffic Operations and Communications Center				
Highway Railroad Intersection Safety				
Intersection Collision Countermeasure				
Multi-Jurisdictional Emergency Services Coordination				
Hand-held Devices for Reporting Accident Data				
Information Exchange Network				
Emergency Warning System				
Roadway Geometrics Alert System				
Portable ITS and Traveler Information Technologies in Work Zones				
Broadcast Traveler Information				
Breathalyzer Ignition Interlock Program				

Figure 11 - Long-Term Deployment Timeline



Recommendations

The following are a set of recommendations that have resulted from the South Dakota Rural ITS Deployment Plan initiative. It has been submitted to the SDDOT Research Review Board for further consideration:

1. **It is recommended that the SDDOT should endorse the vision, mission, goals, and objectives of the South Dakota Rural ITS Deployment Plan.** The work undertaken in developing the plan helped to establish the current ITS environment and to further shed insight into the future direction of ITS in South Dakota. As a result, it was determined that the South Dakota rural ITS program should operate under some guiding principles which can be accomplished by using the plan as the basic foundation.
2. **It is recommended that the near-term projects be implemented.** While all projects within the plan are recommended for deployment within a specified timeline and detailed descriptions are provided, the SDDOT should implement a logical process that will further prioritize and facilitate the implementation of medium- and long-term endeavors. In many cases, projects may not begin as early and also extend for longer schedules than originally anticipated. The dynamic nature of funding and technology costs makes it difficult to attach hard figures to projects. The development of the plan will assist the SDDOT in programming realistic funding for ITS in future years according to priorities and the selection process developed. The approach for developing a project implementation process may consist of:
 - Defining overall performance and evaluation goals for projects;
 - Identifying realistic and available funding sources;
 - Identifying geographic appropriateness for site selection;
 - Identifying lead agencies and potential project champions; and
 - promoting and providing outreach of ITS projects.
3. **The SDDOT should implement an organizational structure that will oversee the deployment and integration of individual ITS components in pursuit of an integrated, rural ITS program.** In the interim, it is recommended that the organizational structure consist of a Steering Committee and the SDDOT Office of Research. It is recommended this Steering Committee consist of the members of the Technical Panel for the South Dakota Rural ITS Deployment Plan. The SDDOT Office of Research would provide program oversight and direct the day-to-day activities of the ITS program. The Steering Committee would be charged with providing the strategic

direction for the ITS program. Part of this responsibility is to revisit the deployment plan to ensure that the founding principles are current, and that deployments still are in line with the direction of the South Dakota rural ITS program. A more detailed description of these functions can be found in Chapter 5.4 of the South Dakota Rural ITS Deployment Plan.

The SDDOT has pursued ITS initiatives even before the development of the South Dakota Rural ITS Deployment Plan. The initiatives currently in place provide a good starting point for further deployments. As more and more projects are developed, the SDDOT needs to be assured that the projects implemented are in the appropriate direction of the ITS program. Establishing an organizational structure will help to accomplish this.

4. **It is recommended that the SDDOT develop a statewide ITS architecture that would include CVO initiatives.** By doing so, the SDDOT will further position itself for more federal funding of ITS initiatives. The development of a statewide architecture is a significant process that will ensure adherence to federal guidelines. The development of a statewide ITS architecture has been facilitated by several accomplishments within the deployment plan. Each recommended project describes the equipment required in terms of the National ITS Architecture. That is, for each project, the process in which individual equipment components interact is described in terms of the relationship between critical ITS subsystems. A graphical representation of the South Dakota ITS architecture concept was also provided. This overview will allow the SDDOT to share their vision of ITS across the state in an easy to understand manner with stakeholders. Additionally, the relationship between projects and national market packages were referenced in the event that the SDDOT pursue architecture development by way of using market packages.
5. **It is recommended that the SDDOT consider staying abreast of national ITS initiatives, particularly standards activities.** The success of other states' ITS programs have been achieved through innovation, support, and keeping in touch with national initiatives. A good example is with the Minnesota Department of Transportation's Guidestar program. Minnesota's modest roots began from the implementation of ramp meters 30 years ago to one of the nation's leading ITS programs. Mn/DOT and Guidestar play an active role at the national level by chairing ITS committees and involvement in standards development activities. It is recommended that SDDOT increase its' visibility and involvement in regional activities. This can be accomplished by joining regional ITS programs such as ITS Midwest (member states include Iowa, Missouri, Kansas, and Nebraska) or Enterprise (a pooled-study initiative that encourages the advancement of

ITS through cooperative research). At the national level, the SDDOT can take part in ITS committees and standards development activities. A good activity to follow at the national level is the Advanced Rural Transportation Systems committee which focuses on the deployment of ITS to address the needs of rural America.

1. INTRODUCTION

In recent years, technological advances have given transportation professionals a new set of tools to assist in providing a safe and effective transportation system. These Intelligent Transportation Systems (ITS) now offer very practical, proven, cost effective solutions to many of the needs of travelers and transportation professionals. In 1994, the Minnesota Rural ITS Scoping Study was the first initiative that employed face to face meetings with rural travelers and transportation professionals to understand their needs and the role ITS can play to address these needs. Through this and other rural ITS planning efforts, it became apparent that ITS has the potential to impact many aspects of rural transportation, including: tourism, commercial vehicles, safety, efficiency, mobility, and economic development.

At this time, ITS technologies are yet to become mainstreamed into most states' transportation budgets, and often are viewed as being competitors to construction, maintenance or operations budgets. For this reason, many states are treating this as a transition period by phasing in the use of ITS by first testing individual components that will eventually be linked together as a seamless system. During these transition periods, it is important that states develop and follow a strategic plan of action to ensure that eventual deployments are interoperable and collectively address the needs of travelers and transportation professionals.

Defining the Transition

In order to prepare for statewide ITS deployment, it is important that the South Dakota ITS planning process document the needs of travelers and transportation professionals around the state. This will ensure that all ITS decisions are needs based, and will allow recommended projects to be prioritized according to end user input. It will also be as important to identify and bring together stakeholders to form an executive steering committee. An executive steering committee will help to build consensus around a statewide plan, engaging all those agencies / individuals in the planning process that need to be involved.

Planning the Transition

South Dakota already has an ITS Commercial Vehicle business plan. In addition, a number of ITS initiatives are either underway or being deployed across the state. As a result, the planning initiative must consider existing projects (including state, local and regional transportation plans) and set a course for scalable deployment by defining schedules, budgets and funding opportunities. Also, in order to ensure that South Dakota's ITS components are interoperable with other states, and support upward compatibility, it is important to plan deployment within the framework of the National ITS Architecture and accompanying ITS standards. In addition to

this, many neighboring states to South Dakota have completed ITS plans and are well underway towards statewide ITS deployment. With states like Montana, Wyoming, Nebraska, Minnesota and North Dakota surrounding it, South Dakota holds the potential to build upon many individual states' ITS components and offer South Dakota travelers benefits while traveling within the upper Midwest region.

Funding the Transition

While the vision is for ITS to eventually offer cost effective solutions to many transportation problems, many states have been reluctant to devote large amounts of funding towards ITS initiatives until the benefits are proven. Presently, ITS is eligible for all categories of Federal aid. Therefore, one clear objective is to move to a scenario where ITS technologies are mainstreamed into the overall transportation system and funding process. Nonetheless, during this transition period, the FHWA (Federal Highway Administration) has allocated funding to allow states to test ITS technologies under real-world operating environments. These dedicated ITS funds have already been designated by Congress for each year of TEA-21 (the Transportation Equity Act for the 21st Century). States that receive these designated funds during appropriations must have an approved ITS plan that is compliant with the National ITS Architecture. In addition, innovative funding sources are available for multi-state programs, and serve as a means for encouraging regional approaches and interstate integration.

Realizing the Broad Vision

The South Dakota Department of Transportation (SDDOT) is interested in developing a statewide ITS plan, with particular emphasis on:

- ensuring that the specific needs of South Dakota travelers and transportation professionals are met;
- incorporating current ITS initiatives - including the CVO (Commercial Vehicle Operations) business plan and impending CVISN (Commercial Vehicle Information Systems and Networks) deployment;
- adhering to the National ITS Architecture to ensure open compatibility and interoperability, as well as to meet Federal requirements;
- benefiting from partnerships with neighboring states in that great economies of scale may be enjoyed, and to benefit from designated Federal Highway funding that is only available to joint state initiatives; and
- defining a plan of action that will provide a blueprint for the next several years of ITS deployment in South Dakota.

These aspects have been incorporated into this initiative that will deliver a plan that is not read and placed on a shelf, but rather a plan that serves as a living document throughout the next several years as ITS expands within South Dakota.

2. PROJECT OVERVIEW

2.1 Project Objectives

The following describes the objectives of the South Dakota Rural ITS Deployment plan:

To describe the current rural ITS environment in South Dakota.

The current rural ITS environment within South Dakota was an important consideration throughout the project for a couple of reasons. It assisted in assessing the best means for deploying and supporting ITS applications within the state, building upon existing technologies. Secondly, it helped to establish a better picture of the advancement and direction of ITS within South Dakota.

To develop a strategic direction for ITS activities in South Dakota.

The deployment plan developed during this project served as the strategic guide for the future of ITS in South Dakota, not only those activities specifically identified. The plan provides specific recommendations for applications with immediate benefits, and was designed to be flexible enough to understand that the needs in South Dakota, and the technologies available, constantly change. The plan provides the state with a blueprint for future ITS expansion. It gives transportation professionals the tools they need to be able to identify opportunities, evaluate the potential for future ITS applications, and create realistic deployment and management plans that are integrated and coordinated with the state, regional and national ITS programs.

To propose a coordinated program of rural ITS projects that address the needs of transportation users and those of government and public agencies.

The workshops and interviews conducted helped to better understand the needs of South Dakota's ITS stakeholders, and by involving a wide range of participants it ensured that the complete range of potential ITS users were represented in South Dakota's strategic plan. The stakeholder interactions were designed specifically so that the needs of different groups, such as transportation professionals, travelers and commercial vehicle operations, do not directly compete with each other for priority in the ITS planning process. Instead, each stakeholder was encouraged to identify the needs and perceived solutions that are specific to them. While the needs of the stakeholders may be different, some applications identified addressed many of them. All needs were considered and the resulting ITS activities identified reflect the solutions that most effectively address the broadest range of transportation needs.

To define an organization and management framework for accomplishing the ITS projects.

ITS applications often operate with the cooperation of many divisions within a transportation agency as well as other public and private organizations. Frequently, they cannot be deployed, operated and maintained by a single entity, and they do not fit easily into a single division. ITS can be incorporated into a DOT's operations without having to revise the organizational structure or the overall responsibilities of its many divisions, or its working relationships with other organizations. Instead, ITS is best deployed through a cooperative effort that does not challenge the institutional authority of individuals or groups. Working with the specific structure of the SDDOT, a framework was created that results in project guidance from the organizations most capable of ensuring success, and that is agreed upon by all involved in the projects.

To develop materials that will effectively communicate findings to representatives of state government and other public agencies in South Dakota.

The understanding and technical knowledge of ITS varies for different individuals, as does its importance. It is recognized that some stakeholder groups, such as executive decision-makers are more interested in the potential results of ITS than the technical details, while other groups, such as system implementers, need specific details. Throughout this project, technical memorandums and presentations were developed to supply information at the level required by the audience, from high-level decision-makers to technical staff.

2.2 Research Plan

The following sections outline the primary tasks undertaken within this initiative:

Task 1. Perform a Literature Search on Rural ITS Initiatives in States Similar to South Dakota

The first step in developing the South Dakota Rural ITS Deployment Plan was to review rural ITS initiatives in other states, as well as ongoing programs within South Dakota. This task assisted in establishing background information on the current efforts of statewide ITS deployment initiatives in other states; and providing an inventory of initiatives across South Dakota (both at the state and local level). The review of documents included:

- ITS/CVO business plans;
- CVISN initiatives;

- Variable Message Sign Deployment Plans;
- The Sioux Falls ITS Plan; and
- Other statewide, regional, county, and local master plans with significant transportation components in South Dakota.

The results of this task were reported in Technical Memorandum 1 and were distributed to Technical Panel members for review.

Task 2. Meet with the Project's Technical Panel to Review the Work Plan and Begin Establishing a Strategic Direction for South Dakota's Rural ITS Program.

The first steps of establishing a strategic overview of the South Dakota rural ITS program are to develop guiding vision, mission, goals and objectives. The results of the strategic overview discussion at the kick-off meeting (held on March 7, 2000) fed into the effort to establish basic program principles. Additionally, as a precursor to developing the South Dakota Rural ITS Deployment Plan, South Dakota developed the South Dakota ITS / CVO Business Plan. Numerous ITS-related projects that focused on commercial vehicle operations were identified, and several were deployed. The vision, mission, goals and objectives drafted for the Technical Panel review strongly considered the work of the ITS / CVO Business Plan as well as the primary points of discussion at the kick-off meeting. This vision, mission, goals and objectives developed were intended to be flexible allowing for modifications and additions as the South Dakota Rural ITS Program evolves. The program vision, mission, goals and objectives were documented in Technical Memorandum 2, and submitted to the Technical Panel for review.

Task 3. Identify Rural Transportation Users and Other Stakeholders and Submit a List to the Technical Panel for Review.

The kick-off meeting also provided the opportunity to review the work plan, discuss the details of the anticipated tasks, discuss strategic overview of the South Dakota rural ITS program, and to identify rural transportation users and other stakeholders. Technical Panel members assisted in identifying rural transportation users and stakeholders. The list was refined and submitted to the Technical Panel for review. This final list recommended individuals for participating in the focus group study. Those identified were thought to be the primary stakeholders with great interest in ITS and the related activities.

- Task 4. Using Focus Groups and Interviews with Rural Transportation Users and Public Agencies, Collect Data from Stakeholders to Identify Problems, Institutional Barriers, Needs and Opportunities for Rural ITS in South Dakota.

The needs assessment portion of the project consisted of a two step process: convening focus groups with transportation agencies and the general public, and performing telephone interviews with the traveling public. The focus groups assisted in determining and understanding the primary issues, challenges and needs of South Dakota; and the telephone surveys helped to understand the magnitude of each issue in order to understand which ITS applications are appropriate for deployment.

Step One: Focus Groups

Within step one, eight focus groups were conducted at key locations around the state. These primary locations included Rapid City, Pierre, Aberdeen, and Sioux Falls. Four of the focus groups involved members of the traveling public (both rural and urban) and four involved transportation professionals and other agencies affected by transportation-related concerns outside of the transportation industry (e.g., health care and law enforcement professionals). The intent of the focus groups was to document and establish the principal challenges facing attendees, and to begin to introduce the concepts of ITS and observe the reactions.

All focus groups were held at a neutral setting (primarily, hotels) during the week of April 3. A professional moderator facilitated the traveling public focus groups. All sessions were videotaped, audio taped, and transcribed. Technical Panel members had the opportunity to attend the focus groups and view the sessions in a separate room through a television monitor. The results of the focus groups were documented in Technical Memorandum 3 and submitted to the Technical Panel for review.

Once the development of the ITS Plan reached a critical milestone (the project identification phase), four separate outreach meetings were held in Rapid City, Pierre, Aberdeen, and Sioux Falls. The intent of these outreach sessions included:

- *Sharing the results of the user needs assessment activities with the transportation professionals in each area.* A brief presentation was provided on: the results of the traveling public focus groups, the results of the traveling public telephone surveys, and the results of the transportation professional focus groups.
- *Gathering additional input from the transportation professionals to supplement the information gathered in the earlier meetings.* The meeting attendees had the opportunity

to express additional needs / issues beyond those that were documented in the earlier meetings. This also allowed members to react to the summary given of the earlier meetings.

- *Presenting the current status of the project with particular emphasis on the projects being developed as part of the planning process.* The project had reached a critical milestone before re-convening the original focus group participants. At this point in the project, enough data was gathered to develop and propose preliminary project concepts sufficiently to present them (at a high level) and answer specific questions.
- *Seeking the attendees' feedback on the projects being presented.* Attendees were offered the opportunity to react and provide input on the preliminary list of projects.

Step Two: Telephone Surveys

Based on the feedback received within the qualitative analysis, a limited telephone survey of residents within South Dakota was conducted. The survey that was developed incorporated the results of the focus group sessions. To properly represent the needs of travelers, an independent market research group performed the telephone survey. The main purpose of the telephone survey is to further support the findings of the focus groups performed with the general public. The results supported the findings of the focus groups and further assisted in determining an ITS program that will prioritize and focus on the real, documented needs and issues representative of South Dakota travelers. The results of the telephone survey were documented in Technical Memorandum 4 and submitted to the Technical Panel for review.

Task 5. Through Interviews and Reviews of Other States' and Regions' Rural ITS Plans and South Dakota Traffic Safety Records, Identify and Evaluate Strategies, Best Practices, and Program Components Applicable to South Dakota

The primary goal of this task was to identify and evaluate strategies, best practices and program components applicable to South Dakota. The process undertaken within this task consisted of the following steps:

- Identifying strategies and best practices based on a review and summary of approaches followed within other states and the national Advanced Rural Transportation Systems (ARTS) strategic and program plans; and
- Identifying program components applicable to South Dakota based on a combination of the first step and three sources of information: the 1998 South Dakota Vehicle Traffic Accident Summary, results of the focus groups, and the results of the telephone surveys performed in Task 4.

The first step ensured an integrated approach for developing South Dakota's ITS program that considered the framework provided by the efforts of other states and the work performed at the national level. The ARTS strategic plan defines rural America as communities or areas with less than 50,000 residents. The entire state of South Dakota excluding the Sioux Falls and Rapid City regions fit this description. The nature of South Dakota being a rural state more than warranted the development of an ITS program that strongly considers the transportation needs and challenges of the rural environment. This rural strategic plan not only considers the rural towns in South Dakota, but also the needs of the small urban areas as well. The second step allowed for identifying ITS program components that specifically is derived from the needs of South Dakota. The results of this task were documented in Technical Memorandum 6 and submitted to the Technical Panel for review.

Task 6. Conduct a General Assessment of Current and Future Communications Infrastructure Necessary to Support Rural ITS Deployment in South Dakota.

The deployment of intelligent transportation systems (ITS) is greatly assisted by the communication media available in the field. While these communications options are numerous in urban areas, the lack of options in rural areas proves challenging for the deployment of technologies in these settings. An important step in determining which applications can be deployed successfully in the field was to inventory the communications media currently available in South Dakota. This inventory assisted in determining which ITS technologies are appropriate for the state of South Dakota, in addition to site specific applications.

The communications inventory was based on first reviewing the types of media used in other states for ITS. A list of these communications media was compiled and further investigated for applicability and availability within the state of South Dakota. The results of the inventory were accomplished through an Internet search and speaking with local private providers. The findings of the communications assessment were documented in Technical Memorandum 6 and submitted to the Technical Panel for review.

Task 7. Prepare and Present to the Project's Technical Panel a Technical Memorandum that Documents South Dakota's Current ITS Program and Proposes a Strategic Direction for the State's Future Rural ITS Program.

As the project moved towards the final stages of identifying projects for the deployment plan, the direction of the South Dakota Rural ITS Program was addressed. A vision, mission, goals and objectives were created early on. The current ITS environment within South Dakota had been

documented. The needs and issues of travelers and transportation professionals were identified. Every precursor task was integral not only to the development of the ITS deployment plan itself, but also to shaping the strategic direction for the rural ITS program. This task consisted of evaluating and developing a strategy for ITS implementation within South Dakota and looking at other considerations that will lead to a successful rural ITS program. The proposed strategy was documented in Technical Memorandum 7 and submitted to the Technical Panel for review.

Task 8. Upon the Technical Panel's Approval of Task 7, Define and Prioritize Current and Future Projects to Develop, Test and Deploy Specific Rural ITS Products and Services. Definitions Should Address Goals and Objectives, Desired Outcomes, Project Locations, Technical Approaches, Organizational and Management Approaches, Roles and Responsibilities, Schedules and Milestones, Benefits and Costs, Staffing, and Potential Funding Sources.

The heart of the South Dakota Rural ITS Deployment Plan is a subset of recommended projects. The purpose of this task was to define specific projects for development, testing and deployment of specific rural ITS products and services. The projects identified were based on the findings of all preceding tasks in addition to the activities that are ongoing at the national and regional level. Each project description included:

- ITS program objectives satisfied and desired outcomes;
- Project locations, technical approaches;
- Equipment required and communications requirements;
- Steps to deployment, organizational management, schedules and milestones;
- Capital costs, O&M costs, and benefits/cost;
- Roles, responsibilities, and staffing;
- Potential funding sources; and
- Application examples, web sites, and references.

Additionally, the projects identified were mapped out to complementary goals and objectives of the ITS program, and the identified transportation challenges and needs identified in Task 3. Projects were also identified within a deployment time frame consisting of short-, medium-, or long-range. A graphical representation of South Dakota's statewide ITS architecture concept was also developed. Full project descriptions can be found in Chapter 6.1 of this plan.

Task 9. Prepare a Final Report Including Methodology, Findings, Conclusions and Recommendations. The Final Report is to be the South Dakota Rural ITS Plan.

The purpose of this task was to develop the deployment plan including documenting the methodology, findings, conclusions and recommendations resulting from the execution of all tasks. The result of this task was the South Dakota Rural ITS Deployment Plan. The draft plan was submitted to the Technical Panel in September 2000 for review. Upon review, the Technical Panel provided recommendations for revisions. The plan was accepted after revisions were incorporated.

Task 10. Prepare and Make Executive Presentations to the SDDOT Research Review Board and to Representatives of Stakeholder Organizations at the Conclusion of the Project. (Presentation Materials will be retained by SDDOT for Subsequent Presentations to Other Groups.)

The purpose of this task was to present the final accepted South Dakota Rural ITS Deployment Plan to the SDDOT Research Review Board and to representatives of other stakeholder organizations at the conclusion of the project. Presentations were made to the Technical Panel in October 2000 and SDDOT Research Review Board in November 2000.

3. TRAVELER AND AGENCY TRANSPORTATION NEEDS

A series of focus groups (eight in total) with both the traveling public and transportation professionals participating were conducted to ascertain specific transportation-related needs, issues and concerns. Focus groups were conducted in Rapid City, Aberdeen, Pierre and Sioux Falls. These focus groups were video taped, audio taped and transcribed. The detailed results were captured in Technical Memorandum 3.

3.1 Overview of Focus Groups

The primary interest of the focus groups was to explore the attitudes of in-state public agencies on transportation issues related to their line of work. Information from the public agency focus groups was provided on the following:

- Services or information the agency uses or provides; how their services or information could be improved;
- The most important types of traveler information that should be provided and methods on how it should be disseminated;
- The most important safety issues and ideas on how safety could be improved on the current transportation system;
- The most important mobility issues and how mobility can be improved; and
- Funding opportunities for either technological or design improvements to the transportation system.

In addition to the perceptions of public agencies, the focus groups explored the general public's attitude on the following:

- Transportation habits;
- Attitudes regarding the design and maintenance of local streets and state and federal highways;
- Awareness, attitudes, and usage toward public transportation, both in town and rural;
- Opinions on various travel concerns, and how those might be remedied; and
- Information sources used for traffic, road, and weather conditions.

The following were the primary **traveler information** concerns, issues and needs identified by public agency focus group attendees:

- Respondents recognized problems with providing pavement condition and weather information to travelers.
- Respondents expressed the need for traveler information to be provided before and during the trip.
- Respondents felt the need for a more dynamic method of accessing and posting traveler information than current methods.
- Respondents noted the lack of a statewide communications infrastructure for accessing and posting traveler information.
- Respondents noted the need for improved traveler information dissemination.
- Respondents mentioned the need for improved sharing and integration of traveler information among agencies within South Dakota.
- Respondents recognized the need for quick, easy access to imperative information provided to the general public during emergencies such as inclement weather.
- Respondents agreed that traveler information projects such as these should primarily be funded publicly – by local/state/federal government funding through the DOT.
- Based on the rankings, respondents noted that weather, visibility and road conditions due to weather were the top traveler information concerns due to the wide expanse of the state.

The following were the primary transportation-related **safety** concerns, issues and needs identified by public agency focus group attendees:

- Respondents were highly concerned with drunk driving, and noted it as a primary safety issue.
- Respondents felt that the use of cellular phones while driving was a primary culprit of inattentive driving.
- Respondents were concerned with slow emergency response times in rural areas.
- Respondents were concerned with drivers' disregard of speed limits.
- Respondents were concerned with roadway visibility.
- Respondents were concerned with accidents due to collisions with other objects besides another automobile.
- Respondents noted concern with slow moving vehicles in the traffic mix.
- Respondents recognized problems with train crossings in counties and cities.
- Respondents felt that some kind of government funding could be used for safety improvements and funding.

The following were the primary transportation-related **mobility** concerns, issues and needs identified by public agency focus group attendees:

- Respondents mentioned the lack of public transportation options within cities.
- Respondents recognized an even greater disparity in the known public transportation options for citizens to travel between towns.
- Respondents expressed the need for improving signs for popular attractions to improve mobility around tourist areas.
- Respondents felt the lack of critical mass to sustain a statewide transit system.
- Respondents recognized state funding as a potential source for funding mobility improvements (as far as the infrastructure was concerned.)
- Respondents noted the need for enhancing the coordination of services between transit and transportation providers.

The following are the primary findings, issues and concerns expressed by **general public** focus group attendees:

- Respondents were very dependent on their personal transportation, which in most cases was a car, but also included pick-up trucks, motor cycles, bicycles and minivans.
- Respondents in each town had suggestions for roads or intersections that needed repair or redesign.
- Very few respondents felt terribly inconvenienced by work zones, saying that at worst it meant a temporary slow down, but rarely involved complete road closures.
- Respondents in all focus groups expressed concern about being stranded in a rural area and long emergency response time.
- Of most concern were habits of other drivers, such as speeders, inattentive driving (often due to cellular phones) and drunk drivers.
- Solutions to some of the “other driver” issues often mentioned was the need for more law enforcement and a belief that there should be a greater sense of personal responsibility among drivers.
- Driver education was an issue mentioned in all public focus groups.
- Respondents expressed concern with the same roads seeming to need constant patching and repair work.
- Most respondents were aware of limited public transportation options that existed in their towns, but most of the respondents did not use public transportation.
- Respondents mentioned road and weather conditions as a major impediment to driving.
- Respondents want the State to take more responsibility with traveler information.
- When asked to discuss which “intelligent” information sources they would be most likely to use, the special radio station and changeable message signs were very popular choices.

3.2 Overview of Telephone Survey Results

A subsequent task involved performing 100 telephone interviews. The telephone survey further supported the findings of the focus groups performed with the traveling public. The detailed findings of the telephone surveys were captured in Technical Memorandum 4. The following are the results of the 100 telephone surveys.

- Half of those interviewed were from towns with a population over 5,000 and the other half were from towns with a population under 5,000.
- Over 75 percent of all trips are for traveling to and from work, or for personal / family errands or outings. Those traveling for farm or agriculture related trips were from the towns with a population under 5,000.
- Overwhelmingly (92 percent), respondents typically combine trips for multiple purposes.
- The majority of respondents drive alone. Of those that do share rides, the majority of these were from towns with a population less than 5,000.
- Respondents from towns with a population less than 5,000 tended to average more miles on the road than those from towns with a population of over 5,000. Forty four percent of respondents from towns with a population less than 5,000 drove more than 200 miles per week compared to 24 percent from towns with a population greater than 5,000.
- The majority of respondents from towns with a population over 5,000 drove mostly on "local city streets" whereas respondents from towns of population under 5,000 drove mostly on "county or township roads" or "state highways."
- The majority of residents indicated the most need for "weather conditions" information before travel on roads and highways within South Dakota. Almost as equally important was information pertaining to "safety problems due to icy bridges, flooding, storms, hazardous spills, etc." Overall, females tended to rate items of higher importance than did male respondents.
- Technologies perceived as most likely to be used by respondents were "a special radio channel to listen for weather and travel-related information," and "a special number to call from a regular phone or cellular phone for weather and road condition information."
- Very few (5 percent) of the respondents ever use public transportation. The most common reasons cited were that the "service is not available" or "have a car" so there would be no need for public transportation.
- The most popular reasons for not using local bus service included: "service not available", "have a car / no need", and "live close to where I go / walk."
- A greater number (11 percent) use vanpools, however, a large percentage of respondents have never or do not typically use this type of public transportation. Again, the most common reason was that they "have a car" or the "service is not available."

- All but one respondent has never or does not use a private shuttle service. Again, respondents primary reasons for not using such a service were the "service not available" and "have a car / no need."
- Seven respondents use a taxi service at least once a month. Five of these respondents live in a town of population greater than 5,000. The majority of respondents never use a taxi service. The most common reasons were the "service not available" and "have a car."
- Fifty-one percent of all respondents travel by airplane at least once a year, regardless of income level. Approximately the same amount of these respondents that travel by air reside in towns greater and less than 5,000. The most common reasons for not traveling by airplane is "don't go on trips / too expensive to fly."
- Twenty-seven percent of respondents "would not use" public transportation. Twenty-five percent could not think of anything to improve the current system to make it more attractive to potential users. The most common improvement suggested by respondents (21 percent) was to make public transportation more available. One of the most common reasons mentioned (for not using public transportation) was the lack of service.
- The majority of respondents felt that all of their transportation needs are met.
- All but one respondent felt that state funds, federal funds, user fees, county funds, city funds, sales taxes, and property taxes should be used for changes in transportation services.
- Sixty percent of the respondents were under age 50.
- All but three respondents possessed a current driver's license. Age was not a factor in those who did not possess a driver's license.
- More respondents from towns of a population greater than 5,000 work outside the home.
- Of those who work outside of their home, the majority (55 percent) travels less than 5 miles one-way to work.
- The majority of respondents (73 percent) are currently working.
- All but four respondents owned a vehicle. Population size and age were not factors.
- Ethnic background was not a factor in the telephone survey.
- Income was not a factor in the telephone survey.

3.3 Review of 1997-1999 South Dakota Motor Vehicle Traffic Accident Summary

The implementation of ITS can potentially help to increase safety on the roadway in a number of ways. For example, message signs can alert drivers to adverse conditions on the roadway ahead to warn them to proceed with caution. The use of automatic anti- / de-icing systems can assist maintenance personnel in proactively treating identified problem stretches of roadway in anticipation of icy or frosty conditions. Still, another example is the implementation of remote-

controlled snow gates. Maintenance personnel could decrease the risk of injury or bodily harm by being able to remotely lower gate arms. Sections of the roadway could be plowed more quickly and efficiently allowing for safer passage.

Furthermore, crashes on rural roads have fatal implications. The "golden hour", the amount of time required to administer trauma care to crash victims, is critical to survival. With five percent of crashes on rural roads taking more than 30 minutes to notify an emergency response agency, this eats away at precious time that can be used for treatment of crash related injuries. Investigation into Mayday systems has altered the way transportation professionals are addressing safety and security for the traveling public, particularly in the rural setting. Mayday systems typically consist of a means of automatically or manually requesting emergency assistance through the use of cellular and satellite location and communication technologies installed in vehicles. A direct link is maintained between vehicles and emergency response centers. In the event of a crash, location and imperative emergency critical data is transmitted from the vehicle to responders.

Another source for determining the needs of South Dakota was traffic accident data. The South Dakota Motor Vehicle Traffic Accident Summary for 1997, 1998, and 1999 provided an account of the type, location, and the primary causes of traffic related accidents. Through the review of these documents, it was found that some accident types listed in these reports were also mentioned during the focus group meetings.

3.3.1 Accidents by Highway Type

The average number of accidents reported for 1997, 1998, and 1999 was 20,218. Of these accidents, on average approximately 138 were fatal. More densely populated areas suggest a higher accident count in urban areas. Fifty-four percent (54.4%) of accidents occurred in urban areas compared with 45.6% in rural areas. The comparison of urban to rural accidents by fatalities and injuries is very stark. Eighty-five percent (85%) of injury accidents occur in the rural setting. Even though less than one percent of **all** accidents in the rural environment were fatal, it is still important to note that 61 % of all fatal¹ crashes occur in the rural environment.

On average for 1997 through 1999, there were approximately 2,211 rural fatal and injury accidents throughout the state. Ten counties had more than two percent of these accidents consistently from 1997 to 1999. Of these, Pennington, Minnehaha, Lincoln, Meade, and Lawrence counties account for one-third of the total rural fatal and injury accidents. These five

¹ Statistics obtained from the U.S. DOT

counties are also the most populated and have approximately 24% of total vehicle miles traveled (VMT) in South Dakota and contain or surround important, urban centers.

3.3.2 Contributing Circumstances

In the focus groups, three primary causes were highlighted as causes of accidents: unsafe driver behavior, poor weather and road conditions and other obstacles. According to both the focus group meetings and the summary accident data from 1997-1999, drinking and driving stands out as an unsafe driver behavior in fatal accidents. Out of 214 fatalities due to unsafe driver behavior, 25.2% of those were due to drunken driving, but this accounted for only 4.5% of total accidents. Other driver behaviors that were emphasized in focus groups that are consistent with the summary included exceeding the speed limit (20.6% of total fatalities, 3.1% of total accidents) and driving on the wrong side of the road (13.2% of fatalities, 1.4% of total accidents). Failure to yield to other vehicles is not a major cause of fatalities, but a major cause of injuries and property damage only accidents. Over twelve percent (12.7%) of all injury accidents due to unsafe driver behavior was due to this.

3.3.3 Roadway Surface Conditions

Weather and road conditions have a small impact on total accidents in 1997, 1998, and 1999. Most accidents involving fatalities, injuries or property damage occurred during dry conditions. However, imperfect roadway surface conditions were indeed a factor in 30% of these accidents. The primary culprits contributing to the most accidents outside of dry roadway were wet, icy or snowy conditions. The public agency focus groups revealed that “road conditions due to weather” were among the top traveler information concerns. Overall, public agency focus group participants ranked the concern 3.94 on a 4-point scale.

3.3.4 First Harmful Event

The accident summary noted that obstacles in the roadway might include such objects as another moving vehicle, fixed objects, or animals. On average, half of all accidents in South Dakota from 1997 to 1999 were the result of collisions with moving vehicles. A significant statistic that should be highlighted is vehicle-animal collisions, which accounted for, on average, 20.5% of all accidents. However, there were not a significant number of fatalities or injuries compared to the amount of property damage only incidents.

3.4 Relationship between Needs and ITS Applications

The findings of both the focus groups and telephones assisted the researchers in determining an initial set of appropriate technologies that would address the determined transportation issues and concerns. Based on these, the needs were mapped against relevant ITS applications presented to the Technical Panel. Figures 3-1 to 3-3 outlines the above stated relationship between the initial project list and needs. *It should be noted that the input of the Technical Panel assisted in refining, prioritizing, and adding to the initial project list. The projects listed in the tables do not reflect the final selection of projects. The final project list differs slightly from the ones presented in the tables. These final project descriptions can be found in further detail in Chapter 6 of this report.*

Figure 3-1. Prominent Traveler Information Issues by Preliminary Technology Selection

Rural ITS Tracks	Technology	Traveler Information Issues								
		Provide pavement and weather information to travelers	Provide traveler info before and during trip	More dynamic method of accessing and posting traveler information	Need for statewide communications infrastructure for posting and accessing traveler information	Need for improved traveler information dissemination	Need for improved sharing and integration of traveler information among agencies	Need for quick, easy access to imperative information provided to the general public during emergencies such as inclement weather	Need for construction zone information	Need for traveler service location information
Emergency Services	Mayday Systems									
	AVL for Highway Patrol									
	Hand-Held Accident Investigation Devices									
	Rural Addressing and GIS									
	Multi-Jurisdictional Coordination Of Emergency Response									
Tourism / Travel	Integrated Traveler Information System	*	*	*	*	*		*	*	*
	Broadcast Traveler Information	*	*	*		*		*	*	*
	5-1-1 for Traveler Information	*	*	*	*	*		*	*	*
	Dynamic Message Signs (DMS)	*	*	*		*		*	*	
	Road Condition via CCTV	*	*	*		*		*	*	
Traffic Management	Workzone Safety System			*		*			*	
	Portable Traffic Management Systems			*		*				
	Interagency Coordination		*	*		*	*		*	
Rural Transit / Mobility	CAD / AVL / MDT									
	GIS / GPS / AVL									
	Web-Enabled Transit Route Planning / Universal Smart Pass		*	*		*	*			
Crash Prevention and Safety	Animal-Collision Warning Systems									
	Roadway Geometrics Alert System									
	Speed Warning Systems									
	Intersection Collision Countermeasure System									
	Highway-Railroad Intersection Warning System									
	Automatic Gate Closure System									
	Longitudinal / Lateral Sensing Technologies									
	Breathalyzer Ignition Interlock System									
Operations / Maintenance	Infrastructure Inventory and Condition Monitoring System	*	*	*	*	*	*	*	*	
	Automatic Anti-Icing									
	Vehicle Location / Status System									
	Information Exchange Network	*	*				*	*	*	
	RWIS	*	*	*	*	*	*	*		
Weather	Integrated Weather Monitoring / Prediction	*	*	*	*	*	*	*		
	Emergency Warning Systems		*	*		*		*		

Figure 3-2. Prominent Safety Issues vs. Preliminary Technology Selection

Rural ITS Tracks	Technology	Safety Issues												
		Drunk driving	Inattentive driving	Slow emergency response times in rural areas	Disregard to speed limits	Roadway visibility	Animal-vehicle collisions	Slow moving vehicles in the traffic mix	Problem with highway-railroad intersections	Highway construction and workzones	Dangerous road geometrics	Road conditions such as ice and snow	Reckless, speeding, inattentive and sleepy drivers	Travelers being able to get assistance if their cars break down
Emergency Services	Mayday Systems			*										*
	AVL for Highway Patrol			*										*
	Hand-Held Accident Investigation Devices			*										*
	Rural Addressing and GIS			*										*
	Multi-Jurisdictional Coordination Of Emergency Response			*										*
Tourism and Travel	Integrated Traveler Information System									*				*
	Broadcast Traveler Information									*				
	5-1-1 for Traveler Information									*				*
	Dynamic Message Signs (DMS)		*							*				*
	Road Condition via CCTV													
Traffic Management	Workzone Safety System		*		*					*				
	Portable Traffic Management Systems		*					*						
	Interagency Coordination							*		*				
Rural Transit and Mobility	CAD / AVL / MDT													
	GIS / GPS / AVL													
	Web-Enabled Transit Route Planning / Universal Smart Pass													
Crash Prevention and Safety	Animal-Collision Warning Systems		*				*						*	
	Roadway Geometrics Alert System		*		*						*		*	
	Speed Warning Systems		*		*						*		*	
	Intersection Collision Countermeasure System		*								*		*	
	Highway-Railroad Intersection Warning System		*						*				*	
	Automatic Gate Closure System		*									*	*	
	Longitudinal / Lateral Sensing Technologies		*										*	
	Breathalyzer Ignition Interlock System	*												
Operations and Maintenance	Infrastructure Inventory and Condition Monitoring System					*						*		
	Automatic Anti-Icing											*		
	Vehicle Location / Status System							*				*		
	Information Exchange Network							*		*				
	RWIS					*						*		
Weather	Integrated Weather Monitoring / Prediction					*						*		
	Emergency Warning Systems					*						*		

Figure 3-3. Prominent Mobility Issues vs. Preliminary Technology Selection

Rural ITS Tracks	Technology	Mobility Issues						
		Need for improving signs for popular attractions	Lack of public transportation options within cities	Lack of public transportation between cities	Lack of critical mass to sustain a statewide transit system	Congestion and delays	Better road signs and directions	Better road closure, advisory and weather information
Emergency Services	Mayday Systems							
	AVL for Highway Patrol							
	Hand-Held Accident Investigation Devices							
	Rural Addressing and GIS							
	Multi-Jurisdictional Coordination Of Emergency Response					*		
Tourism and Travel	Integrated Traveler Information System	*				*	*	*
	Broadcast Traveler Information	*				*	*	*
	5-1-1 for Traveler Information	*				*	*	*
	Dynamic Message Signs (DMS)	*				*	*	*
	Road Condition via CCTV	*						*
Traffic Management	Workzone Safety System					*		*
	Portable Traffic Management Systems					*		*
	Interagency Coordination					*		*
Rural Transit and Mobility	CAD / AVL / MDT		*	*	*			
	GIS / GPS / AVL		*	*	*			
	Web-Enabled Transit Route Planning / Universal Smart Pass		*	*	*			
Crash Prevention and Safety	Animal-Collision Warning Systems							
	Roadway Geometrics Alert System							
	Speed Warning Systems							
	Intersection Collision Countermeasure System							
	Highway-Railroad Intersection Warning System							
	Automatic Gate Closure System							*
	Longitudinal / Lateral Sensing Technologies							
Operations and Maintenance	Breathalyzer Ignition Interlock System							
	Infrastructure Inventory and Condition Monitoring System							*
	Automatic Anti-Icing							
	Vehicle Location / Status System							
	Information Exchange Network							*
Weather	RWIS							*
	Integrated Weather Monitoring / Prediction							*
	Emergency Warning Systems							*

4. CURRENT ITS ENVIRONMENT

4.1 Current ITS Initiatives

South Dakota currently is involved in several ITS related initiatives. South Dakota has been involved in the Advanced Traveler and Weather Information System (ATWIS) project spearheaded by the University of North Dakota Regional Weather Information Center over the last few years. This project is a multi-state initiative that aims to improve advanced traveler information system inputs by including more detailed meteorological analysis and forecasting. This information can be accessed using cellular telephone (#SAFE), or via the Internet. Another ground breaking ITS initiative is South Dakota's commitment to the implementation of dynamic message signs along Interstate 90 and Interstate 29. The aim is to improve traveler information along these two corridors. Furthermore, closed-loop signal systems and signal preemption deployments can be found in the Sioux Falls, Rapid City, and Brookings area. The deployments have fallen within two primary areas, inter-modal transportation and intelligent traffic control system. There is great interest in pursuing widespread deployment of technologies, and this will be captured in the development of the Sioux Falls ITS Deployment Plan in the near future.

The majority of ITS-related initiatives, however, relate to commercial vehicle operations (CVO). CVO was originally promulgated by the U.S. DOT as one of the critical program areas for rural ITS. However, the national Advanced Rural Transportation Systems Committee has recently redefined these critical program areas. These are now referred to as rural infrastructure systems categories. CVO is no longer recognized as a standalone component of rural ITS. Nonetheless, CVO applications are ITS applications designed to improve safety, increase efficiency and reduce transportation costs. These CVO efforts provide an important introduction and foundation for any future ITS deployments. Integration with these components is important to interoperability and ensuring that as many agencies as possible benefit from these applications.

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 where ITS will go in the future. The deployment of ITS components will require consistency with the systems already in place and provide opportunities for integration. The following sections provide an overview of South Dakota's current ITS initiatives. These include:

- Advanced Traveler and Weather Information System project;
- Interstate Dynamic Message Signs;
- City of Sioux Falls ITS Activities;
- ITS / CVO Business Plan;

- Documentation of South Dakota's ITS / CVO Data Architecture;
- Midwest States "One-Stop" Electronic Purchase of Credentials;
- Automated Routing and Permitting; and
- Roadside Data Transfer.

Figure 4-1. Advanced Traveler and Weather Information System (ATWIS)

Title: Advanced Traveler and Weather Information System **Geographic Area:** North and South Dakota

Lead Agency: South Dakota Department of Transportation, Dave Huft, 605/ 773-3358

Project Time Period: Operational Testing began Oct. 1996 and is funded through fiscal year 2001.

Project Cost: \$6,363,000

Funding Source: North Dakota DOT, SDDOT, FHWA, private partnerships.

Project Scope: On-line and telephone access to winter road conditions, weather information, road construction maps, water problems on State Highways, trucker information and travel tip.

Project Goals: To evaluate and demonstrate how current technologies in meso-scale meteorological analysis and forecasting can be effectively used to produce precise spatial and temporal weather information that can be integrated into an ATIS for safer and more efficient operations.

Project Objectives:

- Continue development/integration of site-specific nowcasting/forecasting weather information into a decision support software environment.
- Develop/implement information distribution procedures to the traveler.
- Demonstrate the feasibility of the system to support the needs of the traveler.
- Estimation of the marketability and user acceptance of the provided weather information.

Future Plans: Project is on-going.

Integration Plans: Program is currently providing access to pre-trip and en-route weather and road condition information to users via the Internet and cellular telephones.

Actual or Expected Benefits:

- Providing pre-trip and en-route travel-related information to travelers.
- Improved access to real-time and forecast weather conditions.

Contribution to ARTS Goals / Objectives: Project is consistent with ARTS goals and objectives relating to: mobility and convenience, efficiency, and economic vitality and productivity.

Rural ITS Infrastructure System Category: The most relevant category is:

- Surface transportation weather.

Comments: On-line traveler information can be accessed by visiting the following Web site: <http://www.rwic.und.nodak.edu/Research/atwis/>

Figure 4-2. Interstate Dynamic Message Signs

Title: Interstate Dynamic Message Signs	Geographic Area: South Dakota
Lead Agency: South Dakota Department of Transportation; Dan Martell, Traffic Design Engineer, 605/ 773-4434	Project Time Period: Project is scheduled for deployment in 2001.
Project Cost: \$1,000,000	Funding Source: SDDOT
Project Scope: To deploy dynamic message signs on South Dakota's interstates along I-90 / I-29.	
Project Goals: To provide travelers with weather related information such as icy conditions or closure of highway due to weather conditions.	
Future Plans: If the signs are well received from the general public, then the hope would be to install additional dynamic signs.	
Integration Plans: To deploy 6-8 dynamic message signs along I-90 and I-29.	
Actual or Expected Benefits: Increase the safety of travelers on roads during inclement weather.	
Contribution to ARTS Goals / Objectives: Project is consistent with ARTS goals and objectives relating to: <ul style="list-style-type: none">• Safety and security.• Mobility and convenience.	
Rural ITS Infrastructure System Category: The use of dynamic message signs to improve the weather information to travelers is consistent with the Rural ITS Infrastructure System category pertaining to: <ul style="list-style-type: none">• Travel and tourism	
Comments: There is a need to identify mechanisms for coordination of the message signs across DOT regions.	

Figure 4-3. Sioux Falls ITS Activities

Title: City of Sioux Falls ITS Activities	Geographic Area: Sioux Falls MPO
Lead Agency: City of Sioux Falls Kevin Smith, Assistant Director of Public Works	Project Time Period: Pre-Deployment Plan is complete. Deployment of ITS applications in the near future.
Project Cost: Not available	Funding Source: City of Sioux Falls, South Dakota Department of Transportation, potential federal funding after completion of ITS deployment plan.
Project Scope: The City of Sioux Falls is looking to implement ITS as traffic and transportation management solutions.	
Project Goals: To develop an integrated approach to deploying ITS and to obtain federal funding for ITS projects	
Future Plans: Funding mechanisms should be in place for deployment of ITS components upon completion of the ITS Deployment Plan	
Integration Plans: ITS deployments will be integrated with Sioux Falls closed loop traffic signals and other technologies. Example technologies that are of interest to the City of Sioux Falls include motion detector for turn signals, traffic monitors, and small-scale traffic management center.	
Actual or Expected Benefits: <ul style="list-style-type: none">• Alleviate and to better manage traffic-related problems with the use of ITS.• Improve the efficiency of traffic management.	
Comments: The City of Sioux Falls is underway is Phase I of their ITS Deployment Plan. The plan is required for eligibility of federal funding.	

Figure 4-4. ITS / CVO Business Plan

Title: ITS / CVO Business Plan	Geographic Area: Entire state of South Dakota
Lead Agency: South Dakota Department of Transportation Dave Huft, 605/ 773-3358	Project Time Period: 1 year. Completed January 1998.
Project Cost: \$55,000	Funding Source: SDDOT and federal funding
Project Scope: <ul style="list-style-type: none"> • Describe the current CVO environment. • Develop a strategic direction for ITS / CVO activities. • Propose a coordinated program of ITS / CVO projects that address state and motor carriers needs and goals. • Define an organization and management framework for accomplishing the ITS / CVO projects. • Develop materials that communicated the findings of the Business Plan to government officials and the motor carrier industry and secure support for the ITS / CVO program and its component projects. 	
Project Goals: <ul style="list-style-type: none"> • Improve the safety and efficiency of CVO. • Increase the efficiency of the state CVO regulatory processes. • Safely utilize the capacity of the state's transportation system while preserving its integrity. • Provide better service to the industry. 	
Project Objectives: <ul style="list-style-type: none"> • Focus inspection and enforcement activities on high-risk carriers. • Educate motor carriers about safe and responsible operations. • Educate the traveling public about sharing roads with commercial vehicles. • Streamline deskside procedures. • Automate credentialing procedures. • Network systems to ensure the effective exchange of critical information among government agencies and industry. • Increase the ability to comply with existing regulations. • Optimize safe and efficient movement throughout the state. • Increase industry involvement through public and private partnerships. • Provide timely weather, construction, and regulatory information. 	
Actual or Expected Benefits: Successful attainment of goals would provide the benefits of: improved safety and efficiency of CVO, increased efficiency of the state CVO regulatory processes, and providing a better service to industry.	

Figure 4-4. ITS / CVO Business Plan

Future Plans: Within the business plan, twelve projects were recommended plan for deployment, including:

- Proactive information dissemination
- CVO database architecture
- Automated routing and permitting
- Roadside data transfer
- Two-dimensional (2-D) barcoding
- Automated inspection, citation, and accident reporting
- Linking registration to safety performance
- Information helpline
- Automatic vehicle identification (AVI)
- Safety data access
- Electronic credentialing
- Weigh-in-motion

Integration Plans: A number of projects have been implemented as suggested in the business plan including:

- CVO database architecture
- Roadside data transfer

An automated routing and permitting project is in the works pending resolution of institutional issues.

Contribution to ARTS Goals / Objectives: Project is consistent with ARTS goals and objectives relating to:

- efficiency
- economic vitality and productivity

Rural ITS Infrastructure System Category: Not designated within the rural ITS infrastructure systems categories. Nonetheless, the focus on rural needs and conditions will be interoperable with extensions of metropolitan ITS, and will be seamless for travelers and commercial vehicles as identified in the ARTS strategic plan.

Comments: The ITS / CVO business plan can be viewed, downloaded and printed by visiting the following Web site:

<http://www.state.sd.us/dot/Research1/projects/index.cfm?Fuseaction=ViewProjectDetail&PN=SD1997-10&Type=Topic>

Figure 4-5. ITS / CVO Data Architecture

Title: Documentation of South Dakota's ITS / CVO Data Architecture	Geographic Area: South Dakota
Lead Agency: South Dakota DOT Hal Rumpca, 605/ 773-3852	Project Time Period: 7 months Completed September, 1999
Project Cost: \$75,000	Funding Source: SDDOT and federal funding
Project Scope: To document the current ITS/CVO data architecture for the state of South Dakota in terms of CVO business areas, processes, data flow linkages, and the systems used by each agency for each process.	
Project Goals: To produce a high level functional design that depicts current CVO regulatory data flows and business practices.	
Project Objectives: To develop data and process models to describe and document the current business areas and processes for agencies involved with the regulation of motor carriers operating in South Dakota.	
Actual or Expected Benefits: Increased efficiency and cost-effective administrative processes through sharing of information by various agencies	
Future Plans: Additional research will be needed to identify improvements to current business practices and processes and to design an architecture to support the proposed improvements.	
Integration Plans: This project was identified as a priority within the South Dakota ITS/ CVO Business Plan. The results of the plan are to identify compatibility and interoperability of South Dakota's current CVO-related technology deployments.	
Contribution to ARTS Goals / Objectives: Project is consistent with ARTS goals and objectives relating to: <ul style="list-style-type: none"> • Efficiency • Economic vitality and productivity 	
Rural ITS Infrastructure System Category: Not designated within the rural ITS infrastructure systems categories. Nonetheless, the focus on rural needs and conditions, will be interoperable with extensions of metropolitan ITS, and will be seamless for travelers and commercial vehicles as identified in the ARTS strategic plan.	
Comments: The ITS / CVO Data Architecture document can be viewed, downloaded and printed by visiting the following Web site: http://www.state.sd.us/dot/Research1/projects/index.cfm?Fuseaction=ViewProjectDetail&PN=SD1999-07&Type=Topic	

Figure 4-6. CVO Safety Information Exchange

Title: Safety Information Exchange	Geographic Area: South Dakota
Lead Agency: South Dakota Highway Patrol's Motor Carrier Enforcement Division, Captain Myron Rau	Project Time Period: Total estimated project timeline is end of Q4, 2000 to Q4 2002. The following is the estimated timeline for individual components: <ul style="list-style-type: none"> • Commercial Accident Report: Q1, 2001 to Q4, 2001 • PRISM: Q4,2000 to Q3, 2002 • Motor Carrier Safety Profile: Carrier Q2,2001 to Q4, 2002
Project Cost: \$700,000	Funding Source: SDDOT/CVISN
Project Scope: The Safety Information Exchange project is comprised of three subset components: Commercial Accident Reporting, Performance and Registration Information Systems Management programs (PRISM), and Motor Carrier Safety Profile. South Dakota's initiatives to improve motor carrier safety will establish CVISN Level 1 capabilities for exchange of information between roadside, desk-side, and national CVISN core information systems.	
Project Goals: Commercial Accident Reporting will improve the number, reliability, and accuracy of commercial vehicle accident reports. PRISM will tie vehicle registration to motor carriers' safety performance. Motor Carrier Safety Profile will allow carriers to view their own safety performance information. Furthermore, other goals include: <ul style="list-style-type: none"> • Installing and operating the ASPEN motor vehicle inspection system (or equivalent) at all major inspection sites • Connecting to the national Safety and Fitness Electronic Records (SAFER) system to provide exchange of interstate carrier and vehicle snapshots among states • Deploying a Commercial Vehicle Information Exchange Window (CVIEW) or equivalent system for exchange of intrastate snapshots of motor carrier information within the state and connect to SAFER for exchange of interstate snapshots 	

Figure 4-6. CVO Safety Information Exchange

Project Objectives:

- Unified Accident Reporting will combine state and local accident information and modify the state database to handle this information. Automated Accident Reporting will enable South Dakota Highway Patrol to enter accident information directly into mobile computers.
- PRISM will provide uniform registration of motor vehicles, make vehicle registration dependent on demonstrated safety performance, and improve safety performance of high-risk carriers.
- Motor Carrier Safety Profile allows carriers to view via an Internet browser their history of accidents, inspections, and citations.

Actual or Expected Benefits: Nearly one third of all accidents go unreported due to paperwork not being completed and an inability to search data between the local and state level, Commercial Accident Reporting will reduce that number. PRISM increases the focus on vehicle safety performance and will identify high-risk carriers. Having the Motor Carrier Safety Profile available via the internet will allow carriers to review their safety performance history and look for ways to improve it.

Future Plans: The Commercial Accident Reporting software will ultimately be developed to export commercial vehicle accident information to Motor Carrier Management Information System (MCMIS) and allow reporting of citations. South Dakota will enter into a formal agreement with the U.S. DOT regarding their participation in PRISM. Motor Carrier Safety Profile plans to include vehicle registration and fuel tax status.

Integration Plans: Commercial Accident Reporting will begin with a feasibility and requirements study, followed by software development by the Bureau of Information and Telecommunications and consultant developers. The PRISM component entails developing a state implementation plan. As soon as safety performance information can be organized in a central location, South Dakota will provide a Web site to view the information.

Contribution to ARTS Goals / Objectives: The Project is consistent with ARTS goals and objectives relating to:

- Efficiency
- Economic vitality and productivity
- Safety and Security

Rural ITS Infrastructure System Category: Not designated within the rural ITS infrastructure systems categories. The focus on rural needs and conditions, will be interoperable with extensions of metropolitan ITS, and will be seamless for travelers and commercial vehicles as identified in the ARTS strategic plan.

Comments: Automating reporting systems and unifying the state database will reduce duplication of paperwork and increase efficiency. PRISM allows punitive measures to be taken against those carriers with sub standard safety ratings. The Motor Carrier Safety Profile will increase communication and awareness of safety performance.

Figure 4-7. CVO Credentials Administration

Title: Credentials Administration	Geographic Area: South Dakota
Lead Agency: Director of the South Dakota Department of Revenue's Motor Vehicle Division, Debra Hillmer	Project Time Period: Total estimated project is Q3 1999 to the end of Q4 2002. The following is the estimated timeline for the project sub-components: <ul style="list-style-type: none"> • IRP/IFTA Supplements: Q3, 1999 to Q4, 2002 • Automated Permitting System: Q2, 2001 to Q4, 2002 • USDOT # for Interstate Carriers: Q2 to Q3, 2001 • Motor Carrier Web site: Q3, 2000 to Q4 2002
Project Cost: \$650,000	Funding Source: SDDOT/CVISN
Project Scope: The Credentials Administration project includes the IRP/IFTA Initial/Renewal/Supplements, Automated Permitting System, U.S. DOT number for Intrastate Carriers, and Motor Carrier Web Site components.	
Project Goals: To establish the needed CVISN Level 1 capabilities in South Dakota. Using the U.S. DOT number will allow information to be shared with all CVISN components in South Dakota. The Web site will provide a central location that links to other state agencies.	
Project Objectives: <ul style="list-style-type: none"> • Automate processing (i.e., carrier application, state application processing, credential issuance, fuel tax filing) of at least International Registration Plan (IRP) and International Fuel Tax Agreement (IFTA) credentials; be ready to extend to other credentials (such as intrastate credentials, titles, oversize/overweight (OS/OW) permits, carrier registration, and hazardous materials permits) • Connect to IRP Clearinghouse • Connect to IFTA Clearinghouse • Handle at least 10% of transaction volume electronically; be ready to bring on more carriers as they subscribe, and be ready to extend to branch offices where applicable 	
Actual or Expected Benefits: <ul style="list-style-type: none"> • To complete credentials service and connect to IRP/IFTA clearinghouses. • Gain the ability to share data with other states. • Increase the amount of information available on the Internet. 	
Future Plans: The plan is to have a system in place that will become an agency standard.	

Figure 4-7. CVO Credentials Administration

Integration Plans: The CVISN Systems Architect will oversee the integration of the Credentials Administration Project. The Department purchased and installed R. L. Polk's IFTA system in 1999, and has initiated purchase of Polk's IRP system in 2000. The DOT's Office of Research Services will initiate development and commercial acquisition of the Automatic Permitting System during the spring of 2001. Procedures will be developed to assign U.S. DOT numbers to interstate and intrastate carriers.

Contribution to ARTS Goals / Objectives: Project is consistent with ARTS goals and objectives relating to:

- Efficiency
- Economic vitality and productivity

Rural ITS Infrastructure System Category: Not designated within the rural ITS infrastructure systems categories. The focus on rural needs and conditions, will be interoperable with extensions of metropolitan ITS, and will be seamless for travelers and commercial vehicles as identified in the ARTS strategic plan.

Comments: Once in place, this will be a powerful tool for the state. Information can be shared between state or national agencies. This will streamline the process significantly.

Figure 4-8. Electronic Screening

Title: Electronic Screening	Geographic Area: South Dakota
Lead Agency: South Dakota Highway Patrol's Motor Carrier Enforcement Division, Captain Myron Rau	Project Time Period: Total estimated project timeline is Q1, 2000 to Q4, 2002. The following are timelines for the subset components: <ul style="list-style-type: none"> • E-Screening Enrollment begin Q3, 2002; • Jefferson Port of Entry Q1, 2000 to Q4, 2002.
Project Cost: \$2,500,000	Funding Source: SDDOT/CVISN
Project Scope: The Electronic Screening project is comprised of E-Screening Enrollment and Jefferson Port of Entry components.	
Project Goals: <ul style="list-style-type: none"> • Deploy at a minimum of one fixed or mobile inspection site • Be ready to replicate at other sites 	
Project Objectives: <ul style="list-style-type: none"> • Focus inspections and enforcement activities on high risk carriers. • Optimize safe and efficient movement through the state. • Provide better service to the trucking industry. 	
Actual or Expected Benefits: The E-Screening Enrollment will reduce traffic into weigh stations. The Jefferson Port of Entry will enable enforcement personnel to focus on high-risk carriers and at the same time reduce queue lengths and delays. Jefferson Port of Entry will reduce truck queues, which can back up into the mainline Interstate.	
Future Plans: The McCook Port of Entry will be relocated north to Jefferson, South Dakota. The Jefferson Port of Entry will be constructed in 2002. South Dakota will decide whether to operate its own electronic screening system or to enroll in a commercially operated system.	
Integration Plans: The SDDOT will contract to build the Jefferson Port of Entry, with completion planned by the end of 2002. When construction is completed E-Screening will be placed at that location.	
Contribution to ARTS Goals / Objectives: Project is consistent with ARTS goals and objectives relating to: <ul style="list-style-type: none"> • Efficiency • Economic vitality and productivity • Mobility and Convenience 	

Figure 4-8. Electronic Screening

Rural ITS Infrastructure System Category: Not designated within the rural ITS infrastructure systems categories. The focus on rural needs and conditions, will be interoperable with extensions of metropolitan ITS, and will be seamless for travelers and commercial vehicles as identified in the ARTS strategic plan.

Comments: The combination of a new port of entry and E-Screening capabilities will reduce heavy congestion and long delays of motor carriers.

Figure 4-9. Commercial Vehicle Information Exchange Window

Title: Commercial Vehicle Information Exchange Window		Geographic Area: South Dakota
Lead Agency: Bureau of Information & Telecommunications, Ron Knecht		Project Time Period: Total estimated project timeline is Q3, 2000 to Q4, 2001. The following are timelines for the subset components: <ul style="list-style-type: none"> • Requirement Study: Q3 to Q4, 2001 • Roadside Data Transfer: Q3, 2000 to Q4, 2002 • Communication with SD Systems: Q2, 2001 to Q3, 2003 • Repository for Snapshots: Q4, 2001 to Q4, 2002 • Access to National Core System: Q4, 2001 to Q4, 2002
Project Cost: \$350,000		Funding Source: SDDOT/CVISN
Project Scope: The Commercial Vehicle Information Window project is made up of several smaller components including; Requirement Study, Roadside Data Transfer, Communication with SD Systems, Repository for Snapshots, and Access to National Core Systems.		
Project Goals: Commercial Vehicle Information Exchange Window will transfer information among various state information systems and between state systems and national CVISN Core Infrastructure systems.		
Project Objectives: <ul style="list-style-type: none"> • The Requirement Study will determine the functional requirements for the project. • Roadside Data Transfer will establish communication to both fixed and mobile sites. • Communications with SD Systems plans to integrate communication from state commercial vehicle information systems • A database will be created to house the Repository for Snapshots. • Access to National Core Systems will allow South Dakota to transfer information to CVISN Core Infrastructure Systems. 		
Actual or Expected Benefits: Use of this software will enhance the communication between state and federal agencies regulating commercial vehicle operations.		

Figure 4-9. Commercial Vehicle Information Exchange Window

Future Plans: South Dakota will have the opportunity to transfer information through the CV Information Exchange Window to various agencies. These would include International Registration Program (IRP) Clearinghouse, International Fuel Tax Agreement (IFTA) Clearinghouse, Commercial Drivers License Information System (CDLIS), Motor Carrier Management Information System (MCMIS), National Law Enforcement Telecommunications System (NLETS), and the Safety and Fitness Electronic Records (SAFER) system.

Integration Plans: The CVISN Systems Architect will oversee System Engineering & Integration for the Safety Information Exchange Project.

Contribution to ARTS Goals / Objectives: Project is consistent with ARTS goals and objectives relating to:

- Efficiency
- Economic vitality and productivity

Rural ITS Infrastructure System Category: Not designated within the rural ITS infrastructure systems categories. The focus on rural needs and conditions, will be interoperable with extensions of metropolitan ITS, and will be seamless for travelers and commercial vehicles as identified in the ARTS strategic plan.

Comments: The Commercial Vehicle Information Exchange Window project will allow for the electronic transfer of information between various agencies. This will reduce the paperwork, time, and money involved in disseminating reports and other data.

Figure 4-10. Midwest States "One-Stop" Electronic Purchase of Credentials

Title: Midwest States "One-Stop" Electronic Purchase of Credentials	Geographic Area: South Dakota and other Midwest States
Lead Agency: South Dakota Department of Transportation, Dave Huft, 605/ 773-3358	Project Time Period: Operational Testing was completed February 1998.
Project Cost: \$7,874,856 (total cost of project including contribution from all participating states and FHWA funding)	Funding Source: SDDOT, and federal funding (\$4,525,937), IL, MN, WI, SD, MO, KS, NE departments of transportation
Project Scope: The scope of the operational test was to examine the feasibility of providing an electronic means for motor carriers and state agencies to conduct the business of commercial vehicle credentialing, permitting, and fuel tax administration. <i>Please note that the SDDOT played a small role in the project, essentially just donating its time.</i>	
Project Goals: To demonstrate one-stop administration capabilities for registration, fuel-tax registration and reporting, operating authority, and over-dimensional permitting.	
Project Objectives: <ul style="list-style-type: none"> • Design and test a simple, easily deployable, forward and backward compatible one-stop electronic system for the purchase of motor carrier credentials and permits, and the filing of quarterly tax reports. • Evaluate the improvements in both state and motor carrier productivity offered by streamlining the processes using the one-stop system. 	
Actual or Expected Benefits: <ul style="list-style-type: none"> • Improved efficiency of processing motor carrier credentials and permits. 	
Future Plans: The Midwest Electronic One-Stop Shopping Operational Test, which included seven states and ran through mid-1997, was developed to give motor carriers the capability of obtaining credentials from multiple states through electronic application to their base state. Although this capability was tested in some of the states, it was not tested in South Dakota as none of the pilot carriers submitted applications through the test system.	
Integration Plans: The implementation of this technology is on track with integration of ITS / CVO technology components.	
Contribution to ARTS Goals / Objectives: Project is consistent with ARTS goals and objectives relating to: <ul style="list-style-type: none"> • Efficiency. • Economic vitality and productivity. 	

Figure 4-10. Midwest States "One-Stop" Electronic Purchase of Credentials

Rural ITS Infrastructure System Category: Not designated within the rural ITS infrastructure systems categories. Nonetheless, the focus on rural needs and conditions will be interoperable with extensions of metropolitan ITS, and will be seamless for travelers and commercial vehicles as identified in the ARTS strategic plan.

Comments: A copy of the final report can obtained by contacting the Center for Transportation Research and Education at Iowa State University at 515/ 294-8103, or visiting <http://www.ctre.iastate.edu/index.html>

Figure 4-11. Automated Routing and Permitting

Title: Automated Routing and Permitting	Geographic Area: South Dakota
Lead Agency: South Dakota Department of Transportation Dave Huft, 605/ 773-3358	Project Time Period: Estimated at 30 months.
Project Cost: \$650,000	Funding Source: SDDOT
Project Scope: To determine functional software and hardware for an automated routing and permitting of overweight and oversize vehicles.	
Project Goals: To implement an automated system for routing and permitting oversize and overweight vehicles.	
Project Objectives: <ul style="list-style-type: none">• To improve the routing of oversize and overweight vehicles• Enable optional electronic permit applications by motor carriers• Automate recording of permit information	
Actual or Expected Benefits: Calculated benefit to cost ratio as documented in the ITS / CVO Business plan of 1.58.	
Future Plans: RFP's will be posted in the first half of 2001.	
Integration Plans: This project was identified as a priority deployment in the South Dakota ITS / CVO Business Plan. The implementation of this technology is on track with integration of ITS / CVO technology components.	
Contribution to ARTS Goals / Objectives: Project is consistent with ARTS goals and objectives relating to: <ul style="list-style-type: none">• Efficiency• Economic vitality and productivity	
Rural ITS Infrastructure System Category: Not designated within the rural ITS infrastructure systems categories. The focus on rural needs and conditions, will be interoperable with extensions of metropolitan ITS, and will be seamless for travelers and commercial vehicles as identified in the ARTS strategic plan.	
Comments: Issues relating to compatibility with state / national architecture are being resolved before the start the of project.	

Figure 4-12. Roadside Data Transfer

Title: Roadside Data Transfer	Geographic Area: South Dakota
Lead Agency: South Dakota Highway Patrol	Project Time Period: 21 months. Project was completed October 1999.
Project Cost: \$93,000	Funding Source: MCSAP (Motor Carrier Safety Assistance Program) funds (\$74,400) and SDDOT (\$18,600)
Project Scope: To deploy computers, cell phones, and modems to facilitate the transmission of roadside inspections and data using wireless communications.	
Project Goals: To develop a means of transferring data from the roadside to desk-top systems in the office environment.	
Project Objectives: <ul style="list-style-type: none"> • Improve the efficiency of the enforcement of regulations • Provide more timely data to users 	
Actual or Expected Benefits: <ul style="list-style-type: none"> • Provide fast and reliable data exchange between roadside and in-office systems • Improve upload time of safety information 	
Future Plans: Not available.	
Integration Plans: This project was identified as one of a number of projects for deployment in the South Dakota ITS / CVO Business Plan.	
Contribution to ARTS Goals / Objectives: Project is consistent with ARTS goals and objectives relating to: <ul style="list-style-type: none"> • Efficiency. • Economic vitality and productivity. 	
Rural ITS Infrastructure System Category: Not designated within the rural ITS infrastructure systems categories. Nonetheless, the focus on rural needs and conditions, will be interoperable with extensions of metropolitan ITS, and will be seamless for travelers and commercial vehicles as identified in the ARTS strategic plan.	

4.2 South Dakota Communications Infrastructure

The deployment of intelligent transportation systems (ITS) is greatly assisted by the communication media available in the field. While these communications options are numerous in urban areas, the lack of options in rural areas may prove challenging for the deployment of technologies in these settings. An important step in determining which applications can be deployed successfully in the field is to inventory the communications media currently available in South Dakota. This inventory will assist in determining which ITS technologies are appropriate for the state of South Dakota, in addition to site-specific applications.

The following is the communications inventory for South Dakota. Please note that neither the authors nor the SDDOT endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to reporting the findings within this technical memorandum. The following communications media are further detailed in the following sections: Landline Telephone, Cellular Telephone, AM / FM Radio, Internet, Wireless local area network (LAN), Fiber Optic, Satellite, PCS, and Cable TV/Modem.

A brief discussion on future communications media is provided following the inventory. These include high-speed circuit switched data technology (HSCSD), packet-switched data technologies, and the third generation of digital cellular technologies.

4.2.1 Current Communications Media

The following sections outline the current communications media available within the state of South Dakota. It should be noted that this information is accurate to the best of the authors' knowledge, based upon information gathered from local communications companies, and cannot be guaranteed. For each medium, a brief description as well as cost information is provided. Figure 4-11 at the end of this section provides a summary of each medium as well.

Conventional Land-Line Telephone Service

Approximately 60 separate telephone companies currently serve South Dakota². Basic telephone service for a single line carrying voice transmission, or data transmission up to 53 kilobits per second (kbps), costs \$10 to \$40 per month for service within the service region of each phone company. Additionally, some calls within the same service boundary but to different exchanges are considered long distance. The estimated cost of in-state long distance is \$0.11/minute.

² Public Utilities Commission of South Dakota, Report on Telecommunication Company Operations, June 2000

Conventional landline service is available throughout the state, and, in most cases, the most available and inexpensive means for data and voice exchange. Regular high-speed modems (56 kbps) may be purchased for less than \$100, and telephone equipment ranges from \$10 to \$150 for a single phone to several thousand dollars for a complete telephone exchange system.

Although telephones are the most popular means of communications in the state, there are still a number of people without basic telephone service, especially on Native American reservations. The Public Utilities Commission (PUC) claims that only 47% of people on Reservations and 76% of people in rural households earning less than \$5000/year has basic telephone service³. In stark comparison, ninety-four percent (94%) of all people in the United States have some kind of basic telephone service. Federal Communications Commission order number FCC 00-208 *“adopts measures to promote the telecommunications subscribership and infrastructure deployment within American Indian tribal communities.”*

Cellular Telephone Service

As of June 2000, twenty-one wireless companies were providing service in South Dakota⁴. Verizon Wireless and Cellular One provide voice cellular service. Verizon provides the majority of the service to the state. Cellular systems exist in two primary types, analog and digital. The major difference is in how the audio signals are transmitted between the phone and base station. Analog and digital refer to this transmission mechanism. Digital cellular typically consists of CDMA (code division multiple access) and is characterized by high capacity and small cell radius, employing spread-spectrum technology and a special coding scheme. Current CDMA standards provide ISDN rates up to 64 kbps on the existing 1.25 MHz channel. The next evolution will enable 144 kbps packet data transfer in a mobile environment, support all channel sizes (5 MHz, 10 MHz, etc.), provide circuit and packet data rates up to 2 Mbps, and incorporate advanced multimedia capabilities. Figure 4-9 provides an illustrative coverage map of the service provided by Commnet.

Analog cellular can be used for data computing, however, less successfully than its digital counterpart. Analog cellular system has the widest coverage of any type of cellular system, and is often the only wireless data option in rural areas. Wide ranges of cellular plans are available, starting at \$20 per month with 40 minutes of airtime. Each additional minute beyond the basic plan is \$0.35/min. Cellular telephones cost anywhere from \$50 to \$400, and cellular modems

³ FCC report, “Promoting Deployment and Subscribership in Unserved and Underserved Areas, Including Tribal and Insular Areas”, June 2000, available for viewing at <http://www.state.sd.us/puc/fcc00208.pdf>

⁴ Public Utilities Commission of South Dakota, Report on Telecommunication Company Operations, June 2000

cost about \$250 each, with a data transfer rate of 9.6 kbps – noticeably lower than a conventional landline. Analog phones may be provided free with a service agreement.

Cellular service representatives maintain that cellular service in South Dakota is fairly extensive. However, experience suggests that the actual coverage may diverge from coverage maps provided by cellular service companies. Nonetheless, cellular coverage extends from the major metropolitan areas into some of the smaller rural communities. There is also partial coverage that extends from Minnesota into the northeast part of the state, although it is only for “quick calls” (basically emergency service).

Cellular coverage on Native American Reservations is poor due to the lack of towers and infrastructure needed to provide cellular coverage. All interstate highways have some range of coverage, while parts of the northwest quarter of the state do not have cellular coverage. However, a subsidiary of Verizon, called Rural Cellular Corporation, provides extensive roaming service over this area of the state. Additionally, areas west of the Missouri River (West River) are poorly covered where tourism is prevalent. Similarly, service in the West River region is also limited as a result of the rolling terrain.

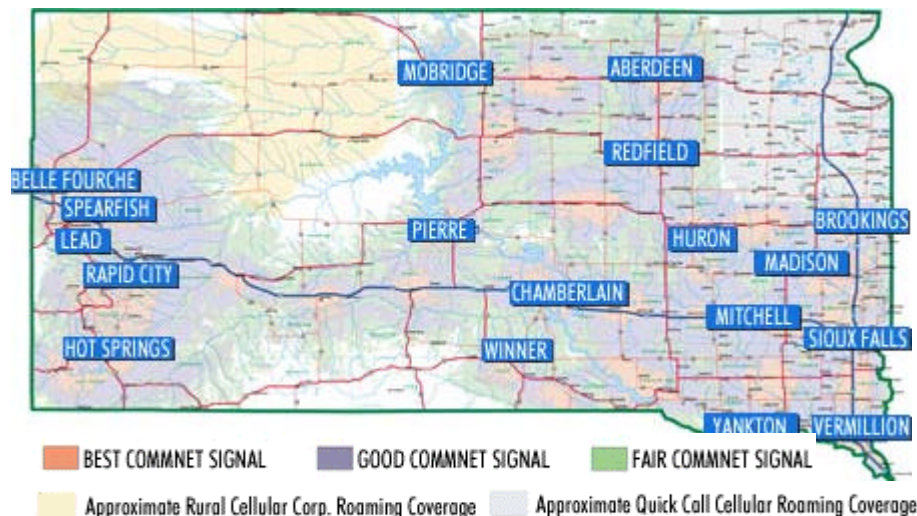


Figure 4-13. South Dakota cellular coverage provided by Commnet

Cellular signals, if strong and unobstructed, are a reliable means for voice communication and low-volume data-transfer. Signals can be used in remote areas where installing a landline may not be as economical, for example, to operate a variable message sign.

Personal Communications Service (PCS). Personal communications service (PCS) refers primarily to a group of three digital cellular phones: GSM 1900, CDMA IS-95, and TDMA IS-136. Data-enabled cellular phones are capable of connecting to laptops and can act as a wireless modem. This allows for such applications as Internet browsing, agency LAN/database access,

fax, short messaging service (the ability to send and receive messages of about 150 characters directly to the phone or to the attached computer), and email.

PCS is available in limited access in South Dakota. Currently, Sprint is working on expanding its network into South Dakota. Coverage primarily is provided mainly along I-29 in the east part of the state from Sioux Falls to Watertown.

AM / FM Radio

Data dissemination via AM/FM sub-carrier frequencies is available in South Dakota. Depending on the transmission protocol, data transmission rates for digital transmission of data can range from 12 kbps at 57 kHz (kilohertz) to 6200 bps at 76kHz. Other proprietary sub-carrier data transfer protocols have speeds of up to 32 kbps. The advantage of developing AM sub-carriers is that AM radio has much more range at lower power than FM frequencies, and are more suited to rural areas. Therefore, FM frequencies are more suitable for metropolitan areas since a higher population is covered by a limited radio frequency. An example of the type of service offered includes paging services using AM sub-carrier frequencies. Primarily, these services are directed toward truckers on the road in rural areas. The service covers most stretches of interstate highway in South Dakota and the surrounding areas of Pierre, Rapid City, Sioux Falls, Aberdeen and Watertown. AM station owners will usually lease out the sub-carrier for a usage or monthly fee.

Receivers and demodulators cost approximately \$300 in order to receive and translate the data message. Pagers using the AM sub-carriers range from \$30 to \$200 from vendors that sell the technology. Making the technology successful requires the participation of radio stations and companies willing to develop the frequencies for use. Hardware required at the broadcast site costs approximately \$25,000 per installation for FM installation and \$10,000 for AM installation. Commercial interests developing the protocols may also build their own network of towers to broadcast over those frequencies.

Broadband Internet Access

Currently, there are approximately 458,000 telephone company customers statewide. Of these, 303,000 have access to broadband service, but only 8,000 have actually subscribed, indicating a great potential for growth. South Dakota has a variety of ways to access the Internet with a range of reliabilities and data transfer rates. These include:

- Dialup access – up to 53 kbps
- Integrated Digital Services Networks (ISDN) – offered at 64 or 128kbps.

- Digital Subscriber Line (DSL) – offered at 192, 256, 384 or 512 kbps
- Cable Modem – usually offered at 256 or 512 kbps
- T-1 – up to 1,540 kbps
- Frame Relay—up to 1.544 Mbps
- Asynchronous Transfer Mode (ATM) 1.5-155 Mbps

Dialup Access. A variety of in-state and out-of-state Internet Service Providers (ISPs) exist in South Dakota. Lower rates are becoming more available. For example, South Dakota Network, Inc. is striving to provide affordable Internet access in South Dakota by charging modest monthly rates and eliminating long distance charges. Statewide Internet service is provided out of Sioux Falls by using a T-1 line routed from Minneapolis, Minnesota. Through a statewide partnership between SoDak Net and local telephone companies, users can dial in to modems in Sioux Falls from anywhere in the state without being charged long distance fees. Internet service from SoDak Net ranges from \$10 to \$30 per month, with a small fee that local telephone companies charge for long-distance access to the modems in Sioux Falls. SoDak currently provides dialup services in 130 rural communities and is increasing its customer base at 20% per month. A 56 kbps modem for dialup access may range from \$50 to \$150. It is also common for local telephone companies in South Dakota to provide dialup service to the Internet. Again, a range of monthly fees and services apply, but they are comparable to SoDak Net. Some ISP's may charge a setup fee as well.

Integrated Services Digital Network (ISDN). Generally, this service is available only in urban centers with a population greater than 100,000. However, Qwest offers ISDN service in any territory where telephone service is offered. ISDN operates over regular, copper, landline telephone wires and rapid signal degradation occurs about three to four miles from the central service location. As a result the infrastructure cost for ISDN service is prohibitive for smaller companies serving less populated areas.

Local telephone companies generally own the infrastructure that operates ISDN. Any number of ISP's may provide the Internet service through ISDN. Start up fees may vary. Initial setup is \$50 to \$70, which includes the ISDN modem and IP address setup. Monthly service fees range from \$30 to \$50, depending on the speed of the service. If the user wishes to set up a local area network (LAN) with an ISDN connection, then additional equipment, such as a network router, hub and Ethernet cards for the computers are needed. Routers start at around \$150, and simple network starter kits with 5-port hubs, wiring, and network cards may cost \$80-\$200 depending on the speed of the networking components.

Digital Subscriber Line (DSL). Like ISDN, DSL also operates over normal copper telephone lines, only at higher capacity. Most of the same principles of ISDN apply to DSL. Thirty plus South Dakota communities will have DSL access by the end of 2000. Also, DSL operates at higher data rates depending on the distance from the central office. DSL has different data rates, from 128 kbps up to 7 Megabits over local telephone lines. Initial start-up costs for DSL range from \$100 to \$350, depending on whether or not the DSL will be used over a LAN. Start-up fees include installation, DSL modem and Internet protocol (IP) addresses assignments. Monthly residential rates vary from \$20 to \$60 per month. Small business rates start at \$30 per month for 256 kbps service, which includes better technical support in case of outages.

Cable Modem. Local telephone service providers may also offer Cable TV, which is capable of providing Internet service as well. Usually, the Cable TV service provider owns the infrastructure for which it provides Internet and TV service. The backbone of Cable Internet is a fiber optic network built by the company that offers the cable or Internet service. Cable Modem is available on a sporadic basis throughout South Dakota, but is becoming more popular as trunk fiber optic networks build out. Cable Modem offers line speeds from 256 kbps to 512 kbps. Cable Modem is available, for example in the Black Hills Region for a \$200 setup fee, which includes the cable modem and installation. Internet service ranges from \$20 to \$75 per month depending on the capacity and the ISP.

T-1 Lines. Generally, T-1 lines are used as a pipeline for Internet Service Providers to provide Internet service to their customers through other means, similar to those mentioned previously. For example, SoDak Net has T-1 service from Minneapolis, Minnesota. The South Dakota DOT uses dedicated T-1 lines to transmit data to each district through Pierre. The ISP or dedicated user of the T-1 line also owns and installs the lines. For general Internet use, T-1 lines may cost \$500 to \$3000 per month for speeds up to 1,500 kbps. Installation and initial startup costs are very expensive, depending on the application.

Wireless LAN

A wireless local area network, or wireless LAN, is very similar to a normal EtherNet wireline network that can transfer data at high-speed (1.5 megabits per second or greater). The only difference is that the data is transferred over airwaves instead of network cable. Wireless LAN can operate using infrared light, microwaves, or other radio waves capable of transferring data at high speeds. Similar to normal wired networks, a wireless network may be built to any scale – from office networks between personal computers to statewide networks utilizing radiowave towers for data transmission. Some ISPs provide wireless Internet service over short distances (from a 10- to 30-mile radius from the ISP) using microwave technology.

The advantages of using a wireless network are inherent – the ability to transfer data over a network without having to invest in a network of wires or fiber optics to transfer the data. In-vehicle data terminals for police, fire or ambulance may utilize a wireless LAN for direct transfer of field data to in-house databases, for example. Wireless LANs may also be useful on a municipal basis assisting in networking traffic management components or emergency services.

There may be reliability issues associated with this type of technology. Reliability is dependent on the obstruction of radio waves, the distance from the transponder source, the direction with respect to the transponder source and quality of equipment. Obstructions include walls, hills, buildings, other radio waves or any other type of media that may cause interference with high-speed data transfer. For example, this system may not be feasible in the West River regions of South Dakota where the hills may obstruct the signals. Distance and direction are also important considerations. A high-speed data transfer network over microwaves may be only good for 15 to 30 miles between transponders and receivers. Also, data transfer over microwaves and infrared are directed, narrow-bandwidth waves. The receiver must be directly pointed at the transmitter to receive the highest data transfer rate. Finally, the equipment for the fast transfer of data is still in the experimental stages and the market has yet to develop a reliable mobile receiver that can receive the microwave transmissions from any direction. Additionally, as a result of error-correction overhead built into the equipment to verify wireless data transfers, wireless transfer rates can be as low as ISDN. Currently, these systems are useful for stationary installations within a short distance to the transponder.

Several ISP's in Sioux Falls offers wireless Internet services via microwave transmitter. Installation costs \$200 for residential service and \$600 for commercial service. Monthly costs range from \$45 to \$500 per month depending on the speed of the service, number of IP addresses assigned and other features of the packages. The range of their service covers Minnehaha, Turner, Lincoln, Moody, Lake, Yankton, Clay, and Brookings counties and limited areas of northwest Iowa and southwest Minnesota.

Fiber Optic

South Dakota is known nationally for the aggressive expansion of its fiber optic infrastructure. Fiber optic conduits expand from Rapid City to Sioux Falls and connect with Minnesota, Nebraska and Wyoming. Parts of the network even serve parts of North Dakota. Figure 2 below shows a map of the fiber optic pipelines within the state. South Dakota Networks LLC is the corporation responsible for maintaining the fiber optic infrastructure throughout the state. They are also responsible for linking all schools and colleges within South Dakota to the fiber optic gateway. Qwest operates an additional fiber optic network that includes three self-healing rings, which means there is no down time if a connection is broken.

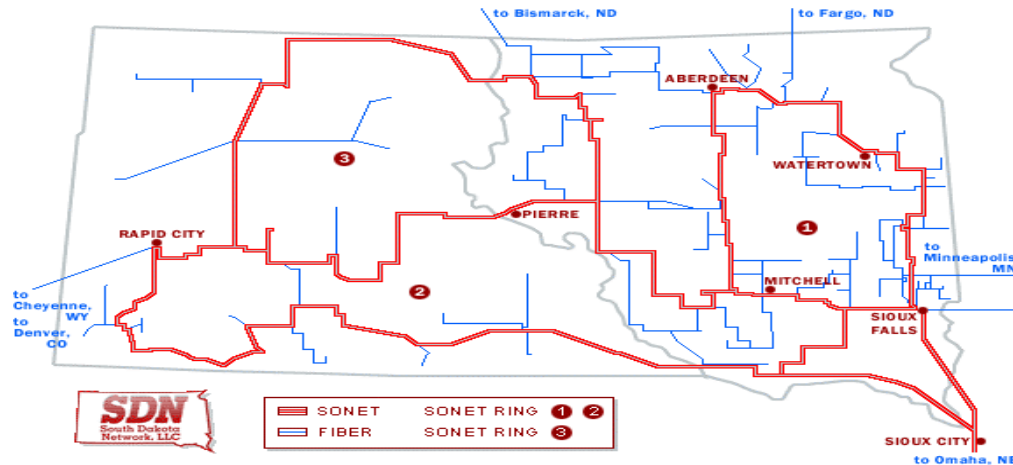


Figure 4-14. South Dakota Fiber Network Provided by SDN

An example of fiber optic (DS3 fiber optics with ISDN gateways) use for telecommunications is the Southeast Interactive Long Distance Learning Project in South Dakota. This project links together twelve school (K-12) sites, the University of South Dakota, and Children's Care Hospital and School. In ITS, fiber optic networks are useful for the transmission of large amount of road conditions, traffic and other traveler information data among a wide-area network with a central hub. State DOT's typically use fiber optic to connect their own wide-area network among each district.

Fiber optic networks cost thousands to millions of dollars to install. Fiber optic lines have such a high capacity for data that they are used mostly in wide-area networks, and built as a separate network. This network has switching facilities available that translate the data over existing copper or T-1 lines.

Satellite

Satellite communications are available on a statewide basis throughout South Dakota. Satellites may offer a high-speed, one-way, mobile data communication solution to remote regions of the state. Also, satellites may be useful for locating objects, such as stranded vehicles and nearby emergency vehicles for efficient dispatch.

Satellite usage is becoming commercially widespread, with new digital satellite systems used on an individual basis for entertainment and data transfer purposes.

Global Positioning Systems (GPS). GPS uses satellite triangulation to pinpoint the exact location of a user on the earth's surface. Consisting of 24 satellites in 6 orbital planes, there may be at least five satellites (called NAVSTARs) in view of any area of the planet at any one time. To

triangulate positions, the satellites send out a one-way signal that broadcasts a timing signal to the receiver. The receiver then calculates the amount of time it takes for the signal to reach the receiver. Knowing the velocity of the radio waves (estimated by the speed of light), a distance to the satellite is calculated. The actual position of the receiver is calculated using triangulation, which requires the signals from three to five satellites. Usually, basic triangulated GPS calculations are accurate within 10 meters.

The United States Armed Forces have the ability to reduce the resolution of GPS, in order to prevent hostile users from taking advantage of the system. Known as Selective Availability (SA), it decreases the accuracy of the system to within 100 meters. However, President Clinton in a May 2000 executive directive decided to “discontinue SA in an on-going effort to make GPS more responsive to civil and commercial users worldwide.” Other inaccuracies in the system are caused by the fact that the radio signals from space travel through the atmosphere and the velocity of the wave may be slower than the assumed speed of light. Also, inaccuracies with internal satellite clocks and internal receiver errors also have an effect on the accuracy of the system.

There are a variety of methods available to correct for errors, which can increase accuracy to within one to two meters of the true location. This is known as differential GPS (DGPS). One method is to use an error correction algorithm. For example, the Colorado Mayday system can pinpoint an incident to accuracy within two to three meters using measurements from three GPS satellites with their correction algorithm. Another method is the use of AM/FM subcarrier installations to transmit a correction to the satellite error. By having a stationary point with a known location, the installation measures the timing error in the signal from the satellite. The installation then broadcasts a data stream that may be received by special equipment, which are used in conjunction with the basic GPS receiver. The Coast Guard provides these error correction signals on the 285 to 315 kHz frequencies.

GPS signals are available worldwide. Portable GPS receivers can be purchased at most electronics stores for as low as \$100 to convert the signals into useful coordinates. State of the art commercial-grade equipment with error correction receivers or algorithms may cost thousands of dollars and require permanent installation.

Digital Satellite Service (DSS). DSS is a service provided mostly by private companies with an interest in television or Internet communications. DSS systems usually include a satellite dish approximately one foot in diameter and some type of decoding device. For television service, a decoder box with a digital access card is needed to decode the digital signal into picture and sound. For data transmission, a special modem and an extra telephone landline is needed to

download data from a satellite up-link. If the user desires both services, one DSS dish may be used for both operations.

DSS services are relatively inexpensive, with initial installation costs ranging from \$190 to \$350, depending on which services (data, TV or both) the user requests. Customers can request the service from a local retail outlet or directly from the DSS provider. Monthly services start at \$50 per month with commercial packages at slightly higher costs depending on needs. Download rates for DSS can reach 400 kbps reliably, however, uploading is only available via an extra telephone line. The extra telephone line for the data service is used to upload Web page requests to the ISP, which prompts the satellite uplink to download the data to the customer's computer. Data can be uploaded, but only through the extra phone line, which is usually a normal landline capable of 53 kilobits per second. Theoretically, DSS service may be received from any location in the state. Data service using DSS is also feasible if a phone line is available. The equipment can either be purchased from an electronics store or ordered over the phone.

Cable TV

Cable TV is provided in part by local companies that also provide other communication services such as telephone and Internet access. Service to Cable TV providers is usually provided via satellite up-link to network satellites. Cable companies, via a fiber optic backbone, can also provide Cable Modem access to the Internet.

Sioux Falls, Rapid City, Aberdeen and Pierre all use public access television for posting transportation-related events, such as construction or road conditions. Public access channels are provided as part of the basic cable service. Initial installation and activation can run anywhere from \$50 to \$100 for residential. Commercial or educational installations may be billed per connection and can run from \$20 to \$40 per connection. Basic Cable TV service is available statewide and costs \$20 to \$30 per month without special "pay channels." Public access is usually available on a cable system as a public service. Information is posted usually as a public service during weather events. Public access television stations also rent out editing suites for television programs.

K-Band and Other Traffic Radar

K-band radar is typically used by public safety to detect speeding motorists. However, its application in ITS has been proven around the country to assist in detecting and alerting drivers of objects in the roadway. K-band typically operates on $24.150 \text{ GHz} \pm 100\text{MHz}$ frequency.

Typical data transmission is approximately 100 bps. These transmitters can be installed along the roadway and can broadcast up to 1.5 miles. A reliable transmitter may be purchased for under \$2,000. Radar has a wide beam combined with a range of three-fourths of a mile or more.

Similar to radar is Lidar (LIght Detection and Ranging). One application of Laser or LIDAR is for use in speed measurement. LIDAR does not actually measure speed, but calculates it by dividing the distance by the time of the light pulses of the laser ($S=D/T$ of light pulses). The range of LIDAR is typically within 1200 feet. The range of LIDAR is degraded when used in rain and fog, or behind glass. LIDAR units typically cost approximately \$4,000 to \$5,000 each.

Figure 4-15. Summary of Communications Media

Communication Medium	Data Transfer Rate	Implementation Cost	Usage Fees	Availability	Infrastructure Ownership
Land-line Telephone	Up to 53 kbps. Two-way communication.	\$40 for phone line installation	\$10-\$40/month depending on service	Statewide through local and national phone companies	42 local phone companies both municipal and private
Cellular Telephone	Up to 28.8kbps. Two-way communication.	\$50 to \$300 for a Cellular Phone or wireless transponder	Depends on Cellular plan. Plans start at \$20/month, which includes 40 airtime minutes.	Analog service provided statewide. Digital service in Sioux Falls and Rapid City	Verizon Wireless provides Statewide coverage through Airtouch and Commnet
PCS	9.6 kbps. Two-way communication	Phones or transmitters range from \$50 to \$400	Packages start with 180 minutes at \$30 per month, and increase based upon the amount of airtime.	Along a section of I-29 from Sioux Falls to Watertown.	Sprint PCS is currently the only company that offers PCS in South Dakota.
AM / FM Radio	<p>Ranges with the type of protocol and the subcarrier frequency. Public protocols range from 100bps to 9600bps data rates. Some proprietary protocols can reach 32kbps net data transfer rate (with error correction overhead).</p> <p>Usually one-way communication.</p>	Existing radio stations are usually outfitted with a subcarrier upgrade cost: \$25,000	<p>Public data transmission protocols are available for free use.</p> <p>Proprietary sub-carrier usage starts at \$15/month for paging services in local areas, which includes 100 free messages and alerts per month.</p>	<p>Coverage is dependent on the directed use of the subcarrier. For example, the Coast Guard may setup a GPS error-correction installation.</p> <p>CUE paging services, with their proprietary protocols, covers portions of the Interstate Highways throughout the state.</p>	Usually local radio stations with subcarrier retrofits. The companies lease the frequencies from the radio stations. The FCC is the one that licenses the frequencies.
Internet	<p>Can range from phone line speed (53kbps) to T-1 speed or higher (1,500kbps).</p> <p>One-way or two-way communication.</p>	The faster the connection, the higher the cost of installation due to availability. Installation of DSL may cost \$300 for equipment to connect a Local Area Network to the Internet.	As reliability and speed increase and availability decreases, cost per month increases. Dialup access, which is the slowest and least reliable ranges	Statewide through local phone companies and fiber optic networks.	Public and private ownership by assorted companies and municipalities – Usually phone companies and internet service providers (ISPs)

Figure 4-15. Summary of Communications Media

Communication Medium	Data Transfer Rate	Implementation Cost	Usage Fees	Availability	Infrastructure Ownership
		Comparatively, dialup providers may charge up to \$50 for one-time setup.	From \$10 to \$30 per month whereas a T-1 line (constant connection to the internet and low availability) costs at least \$500 per month to maintain.		
T-1	Up to 1,500 kbps. Two-way communication.	Very expensive to install. \$10,000 to \$30,000 to get a line from an Internet hub. Cost can be reduced by using frame relay or ATM.	\$500 to \$3000 per month depending on speeds up to 1,500kbps	T-1 is available on demand throughout the state. Establishments, such as ISP's or government entities may invest in a T-1 pipeline.	ISPs and public/private ventures.
ISDN	Up to 128 kbps. Two-way communication.	Initial Setup varies from \$50 - \$70	Service Ranges from \$30 to \$50/month.	The availability is dependent on the service provider. Not all service providers offer ISDN, due to land-line length.	Qwest and some smaller telephone companies provide the service.
DSL	Up to 384 kbps. Two-way communication.	\$100 to \$300 depending on type of use whether single computer or network.	Qwest offers the service from \$20 to \$60 per month depending on transfer rate.	Currently, only within a 3 mile radius of an equipped central office.	Multiple companies provide DSL based on location.
Wireless LAN	From 450 kbps to 4 meg/sec. Two-way communication via microwave or infrared.	Installation Costs: Residential: \$200 Business: \$600 or none with contract \$150 for multiple IP modem	\$45/month for 128 to 256 kbps residential. \$75 to \$500 per month for business ranging in speed from 64 kbps to T1 speeds	Only available within a 15-mile radius of Sioux Falls for commercial internet service. However, a transponder and receiver setup may be feasible and convenient in remote areas for short-distance data transfer.	Offered through private companies... expanded from an Internet pipeline.
Fiber Optic	Fiber is capable of providing speed in	Black Hills Fibercom recently invested \$48	Fiber optic costs vary depending on the	Statewide network established. Some private	Fiber Optic Cooperatives, private

Figure 4-15. Summary of Communications Media

Communication Medium	Data Transfer Rate	Implementation Cost	Usage Fees	Availability	Infrastructure Ownership
	excess of T-1.	million in an expansion of their fiber optic network around the Rapid City Area.	bandwidth required.	companies have their own networks as well.	companies and public/private ventures.
Satellite	One-way or two-way communication. Up to 400kbps for DSS systems (12-inch dish) download. Because of the nature of it, phone lines for upload speeds.	GPS units range from \$100 “over-the-counter” to thousands for state-of-the-art equipment. Satellite setups for TV or data transfer can cost \$180 to \$350 for installation and setup.	Unlimited Residential service \$50/month Business rates may vary depending on packages needed. Military GPS signal is free when detected by GPS transponder.	Available statewide. Only need to purchase a receiver. Special equipment is needed for more precise location than what basic GPS may provide.	Department of defense and private communication enterprises.
Cable TV/Modem	Up to 256kbps two-way.	\$100 to \$200 for installation	\$25 to \$100 per month for unlimited access.	Available in densely populated areas of the state.	Private telephone and cable providers
K-band and other radar	One-way, less than 1 kbps	Radar transmitters cost less than \$2000. \$4000 to \$5000 for LIDAR.	None.	Site specific and mobile applications along the roadside. Currently used by public safety for speed measurements.	This technology is infrastructure dependent. Units are owned by whomever purchases them.

4.2.2 Future Communications Media

The widespread use and increasing popularity of cellular technologies are rapidly advancing the mobile, wireless communications. Advances are leveraging the current analog and digital systems and pushing the capabilities of wireless data transfer. Such technologies being further developed include: High Speed Circuit Switched Data Technology (HSCSD); packet-switched data technologies such as GPRS; and the third generation of digital cellular technologies.

HSCSD will extend data transfer rates to 14.4 kbps from 9.6 kbps for single channels. Multiple channels will extend data rates to 28.8 kbps. The development of GPRS will allow for occupancy of channels only when data is transmitted, rather than continuously such as being performed today. This allows for channels to be immediately available for other data users after the transmission. It is anticipated that HSCSD and GPRS systems will be available at the end of 2000.

The first generation of cellular technologies is analog and the second is digital cellular. The third generation of cellular technology will allow for much higher data transmission speeds, perhaps ranging from 144 Kbps up to 2 Mbps. An example of usage of third generation cellular includes wireless multimedia applications such as video conferencing. It is anticipated that third generation systems will start to be deployed beginning in 2002.

5. STRATEGIC DIRECTION FOR SOUTH DAKOTA ITS PROGRAM

This chapter provides the strategic overview for the South Dakota ITS program, including ITS program vision, mission, goals and objectives; ITS program components; organization structure; and operational model.

5.1 ITS Program Vision and Mission

The **vision** developed for the South Dakota Rural ITS program is as follows:

The South Dakota Department of Transportation in cooperation with other public agencies and private agencies will build an integrated, rural Intelligent Transportation Systems (ITS) program. This program will seek to enhance the safety and mobility of the traveling public on South Dakota's roads and stimulate the economic vitality of the state through the application of technologies.

The supporting **mission** developed for the South Dakota Rural ITS program is as follows:

To incrementally achieve the vision of an integrated rural ITS program through planned implementation of technologies, consistent with the South Dakota Rural ITS Deployment Plan.

5.2 ITS Program Goals and Objectives

The goals and objectives established for the South Dakota ITS program are as follows:

- Goal 1:** Improve the safety and efficiency of highway travel through the application of ITS.
- **Objective 1.1:** Develop an integrated and strategic deployment process for rural ITS activities that consider the long term for addressing the transportation needs of South Dakota.
 - **Objective 1.2:** Identify and implement specific, high-priority deployments that will provide visible and immediate results.
 - **Objective 1.3:** Focus on deployments that will reduce rural accident rates and improve rural transit services.

- **Objective 1.4:** Provide thorough, comprehensive and frequently updated travel and advisory information to the general public.

Goal 2: Ensure compatibility and consistency with the direction of national ITS initiatives.

- **Objective 2.1:** Utilize federal guidelines in strategic planning and deployment processes.
- **Objective 2.2:** Coordinate ITS deployments with existing compliant initiatives within South Dakota.
- **Objective 2.3:** Coordinate ITS deployments with existing compliant initiatives with neighboring states.

Goal 3: Encourage public interagency cooperation and participation of private industry in the process of deploying ITS within South Dakota.

- **Objective 3.1:** Ensure consistency with the state's ITS / CVO program.
- **Objective 3.2:** Integrate ITS into community planning and regional and state transportation planning efforts.
- **Objective 3.3:** Foster relationships to leverage resources and expertise of agencies and the private sector within South Dakota.
- **Objective 3.4:** Educate private industry and businesses of the benefits of ITS to assist in the stimulation of local economies and increasing the competitiveness of South Dakota's private sector against that of other states.

Goal 4: Successfully secure funding for the deployment, operations and maintenance of identified ITS components.

- **Objective 4.1:** Ensure consistency with national objectives to position the state for federal funding.
- **Objective 4.2:** Identify a variety of traditional and non-traditional sources of funding.
- **Objective 4.3:** Encourage public / public and public / private partnerships to diversify funding sources.

Goal 5: Educate the general public, public agencies and government officials of the potential for ITS in South Dakota.

- **Objective 5.1:** Coordinate education and outreach efforts with existing public information programs.
- **Objective 5.2:** Utilize federally sponsored workshops to increase education and outreach opportunities.

5.3 Meeting South Dakota's ITS Program Goals and Objectives

The use of mapping matrices is the most successful technique in demonstrating the relationship between the recommended projects and ITS program elements. A previous matrix showed the relationship between the national rural ITS program to the issues identified through the needs assessments activities. The following matrix (Figure 5.1) will show the relationship between the recommended projects and the South Dakota ITS program goals and objectives. Furthermore, a mapping of recommended projects by suggested locations is provided in Figure 6.10.

Figure 5-1. Recommended Projects vs. Goals and Objectives

Recommended Projects		Goal 1				Goal 2			Goal 3				Goal 4			Goal 5	
		Objectives															
		1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2
1.	Traveler Information Promotion	*	*	*	*										*	*	
2.	Road Condition Via CCTV			*	*		*		*	*	*	*	*	*	*		
3.	Expansion of ATWIS	*			*	*	*	*		*	*	*		*	*		
4.	Integrated Traveler Information System	*			*		*	*	*	*	*	*	*	*	*		
5.	Automatic Anti-Icing System		*	*			*	*	*				*				
6.	Expansion of Dynamic Signs		*	*	*	*	*	*		*		*					
7.	Remote-Controlled Snow Gate Closure System		*	*			*	*	*						*		
8.	Rural Addressing and GIS			*		*	*	*	*	*	*			*		*	
9.	Statewide 5-1-1 Traveler Information Number				*			*		*		*		*	*		
10.	Portable Traffic Management System		*	*				*		*		*					
11.	Automatic Vehicle Location for Agency Vehicles		*	*			*	*	*		*	*					
12.	Highway Advisory Radio		*		*												
13.	Multi-Jurisdictional Transit Coordination	*		*	*	*		*	*	*	*	*	*	*	*		
14.	Infrastructure Inventory and Condition Monitoring System	*			*			*	*	*		*		*	*		
15.	Rural Traffic Operations and Communications System	*				*		*	*	*		*					
16.	Highway Railroad Intersection Safety		*	*				*		*	*	*		*	*		
17.	Intersection Collision Countermeasure			*				*						*	*		
18.	Multi-Jurisdictional Emergency Services Coordination	*		*				*	*	*		*		*			
19.	Hand-held Devices for Reporting Accident Data		*					*					*	*			
20.	Roadway Geometrics Alert System		*	*				*							*		
21.	Emergency Warning System		*	*				*							*		
22.	Information Exchange Network	*				*	*	*	*	*		*	*	*		*	
23.	Broadcast Traveler Information				*			*			*	*		*	*		
24.	Portable ITS and Traveler Information Technologies in Work Zones		*		*			*				*			*	*	
25.	Breathalyzer Ignition Interlock System		*	*				*					*	*	*		
26.	CAD / AVL / MDT for Rural Transit			*	*	*	*	*	*	*	*	*		*		*	
27.	On-board Snow Plow Driver Assistance					*		*				*		*		*	
28.	Mayday Infrastructure	*		*		*		*		*		*	*	*	*	*	
29.	Web-Enabled Transit Route Planning / Smart Pass	*		*	*			*	*	*	*	*	*	*	*		

5.4 ITS Program Components

ITS deployment is typically a three-phased process consisting of: needs assessment; concept development; and deployment. Similarly, establishing ITS program components that will facilitate the deployment of ITS will fall along these lines. Figure 5-2 provides a general overview of the anticipated program components that could apply to South Dakota. It is envisioned that the South Dakota ITS program consist of three primary component groups stated above. These main component groups are based on the three-phased process for deploying ITS found in Technical Memorandum 5 of this report.

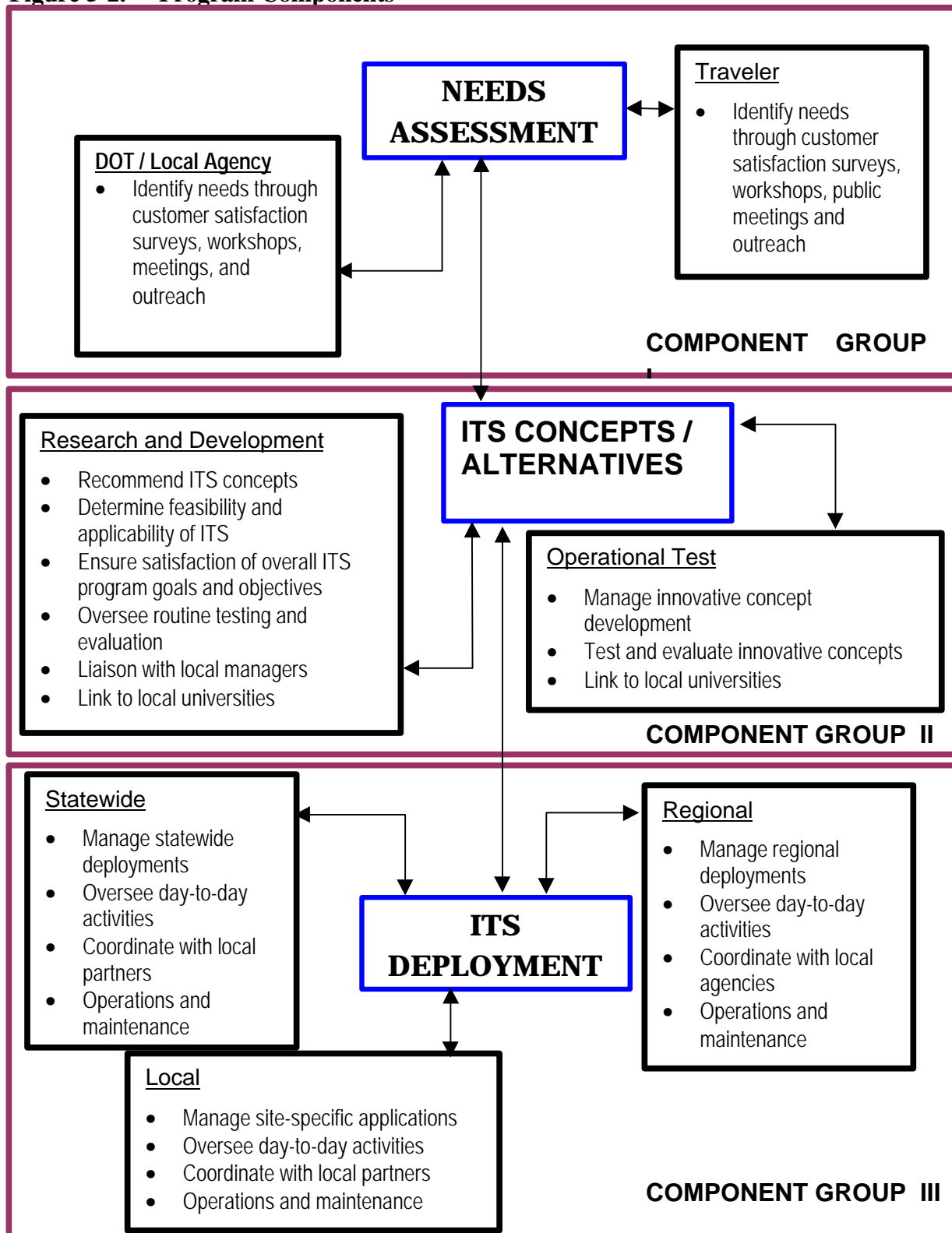
5.4.1 Program Group I - Needs Assessment

Within the needs assessment group resides two basic components: DOT / local agency and travelers. The primary role of this Group is to ensure that the transportation-related needs of travelers and transportation agencies are met. Traveler needs may be assessed using a variety of mechanisms, many of which have been employed by the South Dakota DOT. For example, traveler needs may be obtained using market research studies, public outreach meetings, and surveys. Similar endeavors can be undertaken to obtain transportation agency needs.

5.4.2 Program Group II - ITS Concepts and Alternatives

The function of the ITS Concepts and Alternatives Group is to evaluate the needs derived from the needs assessment group and determine whether ITS is a viable solution. Two primary components reside within this category: Research and Development and Operational Test. The Research and Development component handles ITS developments that have been proven in other real-world examples and will provide expertise and input into tailoring technologies for South Dakota. Correspondingly, the Operational Test component will oversee the development, testing and evaluation of “innovative” technologies, those that have limited real-world applications. Both components will have an imperative link to local universities. Other functions within this group include determining the feasibility and applicability of ITS and ensuring satisfaction of overall ITS program goals and objectives. Additionally, the local managers will look to these components for expertise and advice.

Figure 5-2. Program Components



Under this component group, specific development tracks can be designated that correspond to the various categories of needs. Based on the needs assessment performed thus far for the

development of the South Dakota Rural ITS Deployment Plan, several recurring categories of needs have been identified. These relate to traveler information, safety and mobility and can be directly traced back to national efforts. The rural ITS development tracks to address rural needs (as promulgated by the U.S. DOT) include:

- Emergency services, tourism, and travel;
- Traffic management, rural transit and mobility;
- Crash prevention, security, and operations and maintenance; and
- Surface transportation and weather.

The mapping of needs versus the rural ITS development tracks is shown in Table 5-3.

5.4.3 Program Group III - ITS Deployment

ITS deployment within South Dakota will ultimately occur on a statewide, region-wide, or site-specific scale. Correspondingly, this Group is divided into three components: statewide, regional, and local. Component functions include managing deployments at each respective level and overseeing day-to-day activities. Critical to these components is a dedicated project champion that will ensure the smooth deployment of technologies and open the flow of communication with local partners. Along with the deployment of technologies, operations and maintenance requirements will need to be considered. Operating and maintaining ITS will be a critical function within this component.

5.4.4 Summary of Components

The above sections recommend the consideration of seven program components within the South Dakota ITS Program (public agency needs assessment, traveler needs assessment, research and development, operational test, statewide deployment, regional deployment, and local area deployment). The definition of how these program components exist may vary during the different stages of the ITS program. For example, following completion of the ITS Deployment Plan, the majority of activity may focus on the statewide and local area deployment components, with efforts directed at deploying and operating some "early winner" projects that have been proven elsewhere. After this initial period of deploying early winners, efforts may shift towards focusing on the operational test components in order to attempt to deploy some less proven technologies. Similarly, at some point in the future, the needs assessment components may increase in activity in order to understand how users needs have changed over time, or through the deployment of new technologies. These examples are cited as illustrative examples to demonstrate that all seven components need not be active at all times. However the structure of how each component interacts with the others still remains in place.

The definition of what a component physically comprises will be at the discretion of SDDOT. For example, the research and development component may be a committee comprising members of local universities and DOT members that meets either regularly or when necessary to discuss needed research activities. Other components may consist of either individuals or groups of individuals assigned to work with one or more components. No definitive structure of each component is provided here, as these are expected to change throughout the life of the South Dakota ITS Program.

Rural ITS Development Tracks	Traveler Information Issues								Safety Issues								Mobility Issues			
	Better road closure, advisory and weather information																			
	Better road signs and directions		*	*	*															
	Congestion and delays	*	*																	
	Lack of critical mass to sustain a statewide transit system				*															
	Lack of public transportation between cities				*															
	Lack of public transportation options within cities				*															
	Need for improving signs for popular attractions		*																	
	Travelers being able to get assistance if their cars break down	*	*																	
	Reckless, speeding, inattentive and sleepy drivers												*							
	Road conditions such as ice and snow											*	*							
	Dangerous road geometrics										*	*								*
	Highway construction and workzones			*	*						*	*								
	Problem with highway-railroad intersections									*	*									
	Slow moving vehicles in the traffic mix			*							*	*								
	Animal-vehicle collisions								*		*									
	Roadway visibility										*	*								*
	Disregard to speed limits			*						*	*									
	Slow emergency response times in rural areas	*																		
	Inattentive driving		*	*					*	*		*								
	Drunk driving						*				*									
	Need for traveler service location information		*																	
	Need for construction zone information		*	*	*															
	Need for quick, easy access to imperative information provided to the general public during emergencies such as inclement weather	*	*												*	*			*	*
	Need for improved sharing and integration of traveler info among agencies	*		*	*										*	*			*	*
	Need for improved traveler information dissemination	*	*	*	*										*	*			*	*
	Need for statewide communications infrastructure for posting and accessing traveler info		*												*	*			*	*
	More dynamic method of accessing and posting traveler info		*	*	*										*	*			*	*
	Provide traveler info before and during trip		*	*	*										*	*			*	*
	Provide pavement and weather information to travelers		*												*				*	
Emergency Services																				
Tourism and Travel		*		*																
Traffic Management		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Rural Transit and Mobility			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Crash Prevention and Safety									*	*	*	*	*	*	*	*	*	*	*	*
Operations and Maintenance		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Surface Transportation and Weather		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Figure 5-3. South Dakota Needs and Issues by National Program Areas

5.5 Organization Structure

The direction for the South Dakota is to move towards scalable, interoperable ITS deployments that will ultimately help to achieve the vision of an integrated, rural, ITS program. This direction will seek to deploy ITS projects in a planned and logical manner which will ultimately ready ITS for mainstreaming activities. The strategy employed to accomplish this will build on the momentum created with the development of the rural ITS deployment plan. The deployment plan developed will act as the guide for implementation of an integrated, statewide ITS infrastructure. The development of a basic organization structure will provide insight into overall program management and oversight. Additionally, several considerations that are beyond the scope of the deployment plan need to be included in this strategy. These are developing a project implementation process and developing a statewide ITS architecture.

5.5.1 Organizational Structure

Basic ITS program components that were identified include public agency needs assessment; traveler needs assessment; research and development; operational test; statewide deployment; regional deployment; and local area deployment. Integral to furthering ITS deployment and acceptance is creating an organization structure that will house these components and lead the program from concept to realization. The proposed ITS program organizational structure would consist of two primary entities: the Steering Committee and the Office of Research.

The Steering Committee would be charged with providing the strategic direction for the ITS program. The logical choice for the Steering Committee would be the Rural ITS Deployment Plan Technical Panel, already representative of a good cross section of potential ITS stakeholders and transportation agencies across South Dakota. The responsibilities of the Steering Committee may include:

- Ensuring updates to the program vision, goals, and objectives;
- Providing general oversight for implementation of the deployment plan;
- Providing general oversight of the program budget; and
- Developing consensus among stakeholder organizations.

Currently, the Office of Research oversees research-related activities including ITS initiatives. The current functions of the Office of Research naturally positions itself as the primary entity within the ITS program **in the interim**. The Office of Research would manage the day-to-day activities of the ITS program such functions as providing staff support, providing expertise and advice to local agencies, and funding administration, project management, liaison with local,

state and federal agencies, and education and promotion. The Office of Research would act as the coordinating body between the Steering Committee and ITS implementers. An additional responsibility may include supporting requests for proposals and solicitations from contractors and consultants.

The South Dakota Rural ITS Program has great potential for evolving into a separate “Office” within the SDDOT. As mentioned earlier, in the interim, the Office of Research would play a predominate role. However, once the rural ITS program has been established, the organization structure will need to be re-evaluated and a dedicated staff of full-time individuals may be required to oversee the program. A suggested framework is depicted in Figure 5-4.

The Steering Committee could evolve within the ITS Board. The ITS Board would function in the same capacity as outlined above. The Office of Rural Intelligent Transportation Systems would be created with the lead role of ITS Coordinator / Director.

The ITS Coordinator / Director would be charged with overseeing the overall ITS program; remain abreast of regional and national ITS developments; liaison with Regions to understand their needs, provide support, and facilitate individual regional ITS projects; provide outreach throughout the state to state and local agencies; provide high-level support solicitations and request for proposals for project consultants, vendors or partners; and liaison with other state agencies, ITS programs and academic institutions.

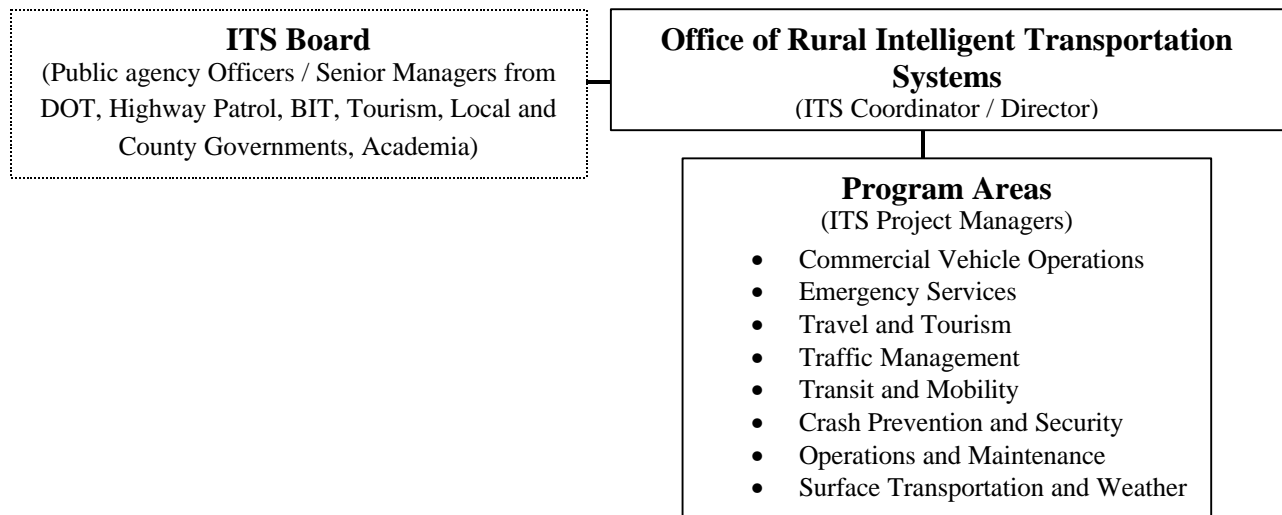


Figure 5-4. Recommended Office of Intelligent Transportation Systems Framework

Furthermore, the Office of Rural Intelligent Transportation Systems would support the following program areas, where individual ITS Project Managers would be in charge of ITS deployments and project development:

- Commercial Vehicle Operations;
- Emergency Services;
- Travel and Tourism;
- Traffic Management;
- Transit and Mobility;
- Crash Prevention and Security;
- Operations and Maintenance; and
- Surface Transportation and Weather.

ITS Project Managers would have the responsibility of developing individual project definitions; coordinating and managing projects; identifying local project partners and project team members; and outreach, education, and promotional activities. Moreover, ITS Project Managers would oversee the essential day-to-day activities.

5.5.2 Approach for Developing Project Implementation and Evaluation Process

The purpose of the South Dakota Rural ITS Deployment Plan is to develop an approach to the implementation of technologies. One of the next suggested steps after the deployment plan is accepted and approved is to develop a project implementation process that will attempt to prioritize and facilitate deployment of future ITS endeavors within South Dakota. Considerations for generating a deployment process may entail:

- *Defining overall performance and evaluation goals for projects.* The success and outcome of an ITS implementation may be more easily measured when compared with established performance criteria at the outset of a project.
- *Identifying realistic and available funding sources.* A better handle on available funding sources can assist in painting a realistic picture of the magnitude of the ITS program. This may be a necessary criterion considered in prioritizing projects.
- *Identifying geographic appropriateness for site selection.* ITS may be very site-specific in nature. For example, the application of a train detection and alert system would be of most benefit on highway-railroad intersections historically experiencing high vehicle-train collisions.
- *Identifying lead agencies and potential project champions.* Oftentimes, the most appropriate project lead may not be the DOT. While the DOT plays a large role in ITS, it is not the only stakeholder. Greater buy-in to ITS concepts can be accomplished with involvement of stakeholder agencies.

- *Promotion and outreach of ITS projects.* As a fairly new and emerging sector in the transportation discipline, ITS concepts and benefits need to be shared with stakeholders and the traveling public. This is key in widespread acceptance.

5.5.3 Approach for Developing the Statewide Architecture

The development of a statewide architecture is a significant process that will ensure adherence to federal guidelines. As it is defined, “*the National ITS Architecture provides a common framework for planning, defining, and integrating intelligent transportation systems. It is a mature product that reflects the contributions of a broad cross-section of the ITS community.*”¹ The development of a statewide architecture will assist in facilitating the deployment of ITS in an integrated manner. In summary, the architecture helps to define:

- *Functions that are required for ITS components.*⁵ For example, road weather information systems (RWIS) gather pavement temperature information or in-vehicle Mayday devices detect an automobile collision.
- *Physical entities (referred to as subsystems within the National ITS Architecture) where these functions reside.*⁵ For example, the road weather information systems reside along the roadside. Mayday devices typically reside within the vehicle. The roadside and vehicle are considered subsystems. Other subsystems include Center subsystems (e.g., traffic or emergency management centers) and Traveler subsystems (e.g., remote traveler support such as kiosks and personal information access such as telephones).
- *Data flows that connect these functions and physical subsystems together into an integrated system.*⁵ For example, a data flow between the RWIS Roadway subsystem and Operations and Maintenance subsystem is environmental conditions (e.g., pavement temperature, precipitation accumulation, etc.). A data flow between a Mayday device vehicle subsystem and an Emergency Management center subsystem is emergency notification.

The development of a statewide ITS Architecture involves several steps. South Dakota should first assess at the statewide level the existing and future (planned) ITS functions for South Dakota, pulling in those elements that are relevant to South Dakota. Secondly, regional functions can be evaluated in the same manner and separate Regional Architectures can be developed. It is recommended that the Turbo Architecture (available by visiting the ITS National Architecture Web site) software be used to assist the agency in pulling together the data

⁵ National ITS Architecture Web site: <http://www.iteris.com/itsarch/>

required for documentation of the state and regional architectures. The following are the recommended steps for developing the statewide and regional architectures:

- Engage stakeholders (e.g., counties, cities, emergency management, tourism, etc.) for consensus;
- Map existing ITS elements to Architecture entities as defined nationally;
- Select market packages to address current and programmed future services;
- Customize market packages to South Dakota;
- Create Architecture flow diagrams;
- Map Architecture flows to standards; and
- Develop final report and database.

5.6 Operational Model

As the South Dakota ITS program advances over the next few years it will likely transition from a program where most ITS activities are led by the state to one in which many cities, counties and private vendors use products that are ITS. Also, as the program advances, funding for ITS will transition from largely Federal and State research dollars to mainstream funding and operations money. The following sections recommend some overall guidelines for allowing the South Dakota ITS program to evolve and adapt with the expected changes.

5.6.1 Central Versus Local Deployment of ITS

In the early years of deploying ITS, many projects will be organized, funded and managed by the SDDOT Office of Research. Nonetheless, SDDOT may want to consider taking steps to activate local champions of ITS so that they may eventually lead projects and solicit local funds. This can be accomplished by outreach to local champions and encouraging local leadership in projects. As a start, local champions should be identified in various regions, perhaps beginning with the cities targeted for the focus groups. The relationships established through the focus groups, and the outreach effort already put forth with the development of the ITS deployment plan is a good starting point for furthering relationships. While it may be necessary to identify individuals from local and regional transportation agencies, champions within other stakeholder agencies are also key. These stakeholder agencies, include, but should not be limited to: tourism, emergency management, local police, local fire, planning organizations, and tribal agencies.

5.6.2 Standards

The ultimate vision for ITS nationwide is that all systems be deployed with common standards to promote complete interchangeability and interaction. Nonetheless, while standards are still developing, and in order to allow early winner low cost projects to advance, it is inevitable that deployments will occur without standards in the early days. SDDOT may want to consider a long-range standards migration plan that would assist in the migration of current and future ITS systems and other transportation devices to standards. A variety of organizations are leading standards efforts such as American Association of State Highway and Transportation Officials (AASHTO), Institute of Electrical and Electronics Engineers (IEEE), and the Society of Automotive Engineers (SAE). As South Dakota's program evolves, active participation in standards development activities could greatly benefit the ITS program. As an example, as standards emerge, they need to be tested in a real-world environment. Federal funding is oftentimes provided to candidate test beds. Remaining abreast of standards development activities will strategically position the SDDOT for funding. Other opportunities to increase familiarity include participating in federally sponsored workshops. An example of steps to consider, include:

- *Determine which standards will be adhered to and when.* The National ITS Architecture (<http://www.iteris.com/itsarch>) web site provides some insight and direction into ITS related standards. Other resources, include: ITS Standards Web site (<http://www.its.dot.gov/standards/standard.htm>); American National Standards Institute (ANSI) Web site (<http://www.ansi.org>); and Institute of Transportation Engineers (ITE) Web site: (<http://www.ite.org>).
- *Determine a plan for how to phase to the scheduled standards.* As an example, the Minnesota Department of Transportation has convened a number of standards workshops intended to facilitate standards migration. The workshops consist of bringing in experts from across the nation to provide insight on real-world use of standards, educating attendees on local and national standards initiatives, and a brainstorming session for planning towards standards migration.
- *Solicit federal funds to help with the transition.* At the national level, the federal government is preparing for the active solicitation for test sites. Real-world test sites are of highest priority. The intent is to determine 10 test beds nationwide for the testing of over 50 developed standards.

6. ITS PROGRAM SUMMARY

The South Dakota rural ITS deployment plan will show how the ITS strategy developed can meet the transportation objectives of the SDDOT and other stakeholders, and will detail the individual current and future projects and integration tasks to be undertaken to accomplish these objectives. This chapter details the recommended ITS projects for deployment in South Dakota, and include the timeframes and cost estimates for scoped potential deployments. In addition to illustrating the recommended projects by timeframe, they will also be segmented by geographic region.

To provide consistency with the work already undertaken in ITS, cost information provided for projects will follow the structure outlined within South Dakota's ITS / CVO Business Plan. ITS costs are difficult to quantify due to reliance on technologies. As technologies evolve, costs fluctuate drastically and are never a constant. The following is the cost scale for projects:

- **Low** - Projects that are considered low-cost will range between zero to \$25,000.
- **Moderate** - Projects that are considered moderate-cost will range between \$26,000 to \$200,000.
- **High** - Projects considered high-cost will be over \$200,000.

Moreover, benefits are even more difficult to quantify, and national efforts to quantify benefits are slow in emerging. For purposes of the project descriptions, rather than quantifying benefits, benefits are attached a qualitative measure. Qualitative measure definitions ensure that benefits are assessed evenly. The following provides an overview of the definitions low, moderate and high benefits:

- **Low** - Little or no benefit for improved traveler information, mobility or safety. Furthermore, these projects provide benefits visible only to one or a few agencies, and will not benefit every traveler.
- **Moderate** - Greater enhancements to traveler information, mobility and safety. Implementation of these projects will benefit multiple jurisdictions and impact a greater number of travelers.
- **High** - Major improvements to traveler information, mobility or safety. Also, these projects provide widespread benefit to the largest number of agencies and travelers.

6.1 Recommended Projects for Near-Term Deployment

The following are the **eight** candidate projects recommended for deployment within the first three calendar years of establishing the ITS program within South Dakota. These projects have been selected as priority projects based on discussions with the Technical Panel and Region Engineers.

1. Traveler Information Promotion
2. Road Condition Via CCTV
3. Expansion of ATWIS
4. Automatic Anti-/De-icing System
5. Remote-Controlled Snow Gate Closure System
6. Integrated Traveler Information System
7. Rural Addressing and GIS
8. Expansion of Dynamic Signs

The ITS projects chosen for near term deployment (within the first three years) of the South Dakota ITS program were chosen using prioritization guidelines. These guidelines basically consider aspects of a project that would position it for early deployment over others. These priority categories (in no particular order) were discussed at a Technical Panel meeting, and include:

- Technical readiness. The capability of an agency (e.g., DOT, local / county agencies, transit, etc.) to deploy and support technology. This could relate to existing telecommunications infrastructure, or staff for example.
- Transferability. Ability for technologies to be used and easily deployed in other areas of the state.
- Benefits versus needs. Examining how the project will address the needs identified by the traveling public and transportation professionals. For example, does the technology address the traveler information needs expressed by the traveling public? Does it help to address the lack of mobility options for travelers? Does it address the need for improved and detailed information?
- Cost. The fiscal considerations required for funding the proposed project. Is this cost-effective, or worth the investment?
- Availability of champions. The personnel (at the state, county or local level) available to see a project from start to finish.

- Ability to leverage existing systems and resources. Projects that will build on efforts / results of existing systems or projects within the DOT or stakeholder agencies. This may prevent duplication of work that may already have been performed.
- Ease of deployment. Proposed projects that have been proven in other areas (e.g., other states, cities, and counties) and ready for implementation without a great amount of further research. Components of the system are “commercial, off-the-shelf” technologies that will facilitate the implementation process.
- Geographic equity. Proposed projects, when ultimately deployed, will ultimately benefit the widest range of end users and areas across the state. Also, this may include addressing the needs of all areas.

Further, the Technical Panel and Region Engineers provided input regarding those projects they felt were higher priority among the entire list of recommended projects. As a result of the discussion with the Technical Panel and Region Engineers, these projects were selected for near term deployment.

6.1.1 Traveler Information Promotion

South Dakota needs specific to this technology:

In the qualitative focus group discussions:

- Public agency representatives ranked the importance of weather and visibility information as 3.87 on a scale of 1-4, and road condition information as 3.94 on a scale of 1-4;
- Attendees indicated that radio was the most common mechanism for obtaining updated travel related information while on the road;
- Attendees expressed concern that the information provided over radio is typically not specific enough for local areas;
- Attendees expressed frustration over the lack of continuity from one weather report to the next when traveling through multiple areas;
- Travelers expressed a need for pre-trip travel information and indicated that they felt the Internet could be the most effective means for accomplishing this; and
- Emergency responders attending the focus groups indicated that during inclement weather, many travelers call them for information on current conditions and tie up the phone lines and staff time responding to such requests.

In the quantitative telephone survey:

- Participants ranked the importance of weather conditions a mean value of 4.25 on a scale of 1-5; and
- the two technologies identified as most likely to be used to access traveler information were a special radio channel for weather and road condition information, and a dedicated telephone number from a cellular or land-line telephone to access weather and road information.

Applicability towards the needs: Participants have indicated the need for traveler weather and road condition information, and specifically requested Internet, telephone, and a radio channel for access to the information. Currently South Dakota DOT operates an Internet site with current and forecasted weather and road condition information specific to regions around the state. In addition, the South Dakota #Safe cellular phone system allows travelers to dial-in and receive weather information tailored to their trip. This service directly applies to the requests for consistent weather reports over different regions, and the request for locally specific information. Therefore, without deploying any additional technologies or modifying current systems, many of

the needs expressed in the study can be addressed by promoting existing systems, and expanding the number of travelers who are aware of these existing systems.

Participants of the telephone survey expressed desire for a specialized weather radio channel. In order to address this request, it is recommended that the NOAA weather radios be included in the promotion of the traveler information systems. While NOAA weather radios need to be purchased specifically for weather announcements, the costs are typically \$10-\$20 and they do continually broadcast localized weather reports.

Desired Outcomes: To promote the current information resources provided by the SDDOT including, but not limited to, ATWIS, the SDDOT traveler information web page (<http://www.state.sd.us/dot/travinfo.cfm>), #SAFE program, and NOAA weather radio.

Project Locations: Promotion is recommended statewide, however emphasis should be placed in areas that will reach the highest numbers of users. Several key audiences should be reached with this promotion outreach:

- *media outlets* such as television, radio stations, and newspapers;
- *repositories of public notices* such as libraries, schools, and major employers;
- *local government agencies* such as city and county agencies;
- *major tourist attractions* such as parks, campgrounds and the Black Hills attractions; and
- *end users* such as travelers who live in or pass through South Dakota.

Recommended approach: As part of the promotion of traveler services, it is recommended that South Dakota DOT consider selecting an Internet URL listing for the traveler information page that is easily promoted and remembered by target audiences. Candidate URLs may include “sdconditions.com”, “sdinfo.com”, or “dakotaconditions.com”.

The following are recommended approaches for performing outreach to each target audience:

Media outlets -

1. Prepare a set of brief summaries of the available services.
2. Identify some anecdotal descriptions of success stories of uses of the system.
3. Using DOT established procedures, share the summaries with as many local media as possible (e.g. press releases, press conferences, interviews).

Public notices -

1. Prepare one-page flyers announcing available services and how to access them.
2. Establish a list of organizations that may be willing to post public notices (considering local libraries, schools, employers, DMV buildings).
3. Mail flyers to the identified organizations together with a cover letter introducing the purpose behind the effort.

Local Governments

1. Prepare a memorandum explaining the needs outlined in this description, and explaining the extent to which current free systems address these needs.
2. Prepare a letter to local government agencies requesting that they use established local communications methods to promote these services to local residents. This will ensure that methods familiar to locals are used for outreach, and will allow local government agencies to tap into local contacts and resources.
3. Conduct limited follow-up telephone calls with local representatives to understand progress.

Tourist Attractions

1. Prepare a one-page memorandum explaining the availability of the services to educate employees of tourist attractions on how to respond when traveler ask questions about the weather (encouraging employees to note the availability of these services and referring travelers to wall mounted posters.
2. Prepare poster quality displays containing key information on each service, and distribute these to key tourist attractions.

End Users

1. South Dakota DOT already has deployed large numbers of signs announcing the #Safe cellular phone system, these actions should continue.
2. Continue site promotion of the Internet site with Internet search engines.

Staff time for promotion activities:

Development of contact lists and plan for mailing schedule: 5 person days
Preparation of two memos, one flyer and three technical briefs: 10 person days
Preparation of poster announcing services: 5 person days
Radio / television announcements: 5 person days
Conduct mailings: 15 person days
Prepare press releases: 5 person days
Travel to and meet with selected media locations: 15 days

Costs for recommended approach: Low - Total direct costs estimated at \$10,000 for reproduction of flyers, reproduction of posters, radio / television spots, and travel to media locations. The SDDOT should also consider allocating \$10,000 to hire a marketing firm to assist in developing a marketing strategy and \$5,000 to evaluate the results of the traveler information promotion effort. Total project cost is \$25,000.

Schedules and Milestones: Promotional activities should be performed for the duration of a year, allowing for the monitoring of increased activity and usage of SDDOT provided traveler information solutions.

Equipment Required: Not applicable.

Communications Requirements: Not applicable.

Organizational Management: An option for the promotional campaign is to work with a professional marketing services firm in order to identify the best means of outreach to the general public. Alternatively, if SDDOT public outreach resources are available, the entire project could be conducted internally.

Benefits / Cost: High - Promoting current traveler information resources greatly benefit both transportation agencies and end users alike. The following are the likely benefits of the promotional campaign:

- Benefits to Transportation Agencies:
 - Improve use of current traveler information sources.
 - Gain better understanding of traveler information areas in need of improvement.
 - Leverage current resources.
 - Improved outreach in meeting traveler information needs.

- Benefits to Traveler:
 - More outreach from transportation agencies.
 - Improved awareness of traveler information resources.
 - Improved trips with increased and better traveler information.

Roles and Responsibilities: The SDDOT would most likely take the lead in the traveler information promotional campaign.

Staffing: The campaign would most likely require the part-time assistance of the public information representative for the SDDOT and meeting between selected ITS representatives to discuss goals, objectives, and plan for performing marketing campaign.

Potential Funding Sources: SDDOT funds would most likely be used to spearhead the project.

6.1.2 Road Condition Information via Closed Circuit Television (CCTV)

South Dakota needs specific to this technology:

In the qualitative focus group discussions:

- Travelers expressed a need for pre-trip travel information and indicated that they felt the Internet could be the most effective means for accomplishing this;
- Public agency representatives ranked the importance of weather and visibility information as 3.87 on a scale of 1-4, and road condition information as 3.94 on a scale of 1-4;
- Attendees in the Rapid City meeting expressed the need for traffic information during the summer tourist season;

In the quantitative telephone survey:

- Participants ranked the importance of weather conditions a mean value of 4.25 on a scale of 1-5; and
- Participants ranked the likelihood of using the Internet for pre-trip traveler information a mean value of 2.63 on a scale of 1-5.



Applicability towards the needs: The needs definition clearly identifies weather information as the most desired type of information for travelers around the state of South Dakota. CCTV images on the Internet will allow visual confirmation of the conditions as reported by other systems such as the ATWIS system or radio/TV reports. In addition to reaching pre-trip travelers directly, CCTV camera images can be accessed by radio stations and traveler service businesses (such as hotels) in order to

verbally relay information to travelers while en-route. It is also important to note that camera images are useful as a visual verification to weather conditions that have been reported or forecasted. Therefore, camera images should not be viewed as a replacement to the type of information provided by the ATWIS system or the RWIS stations in the field.

There was some desire for traffic information, particularly in the Rapid City area. If placed strategically, cameras could serve as effective weather monitors in the winter and traffic monitors in the tourist seasons.

Shortcomings of the technology: In the telephone survey, participants did not rank the likelihood of using the Internet for traveler information very highly, causing some question of the amount of use this technology will receive. Nonetheless, other states experiences have shown that camera images on the Internet are by far the most viewed pages of traveler information sites. In order to address this issue, a phased deployment is described below in order to avoid large scale deployment without sufficient use.

Another possible shortcoming is that Internet dissemination only addresses a percentage of the population who may have access to the Internet in their homes or work, or both. In order to ensure that this technology carries benefits to potentially every South Dakota traveler, there is a recommended coordination with the Traveler Information Promotion project to ensure that media providers are informed of the camera images. This could allow television stations to display images during newscasts or radio reporters to describe the images.

Project Locations: Six camera deployments are recommended. *The following locations are suggested camera sites, however a site survey will need to be conducted to verify the applicability of each site with site requirements defined below. Each of the sites below has been recommended in conjunction with an existing RWIS station, in order to share utilities:*

- Rapid City: to support travelers heading to the west portion of the state along I-90 for both winter weather conditions as well as summer traffic and weather information. Recommended deployment in conjunction with the Ellsworth RWIS station – I-90 at M.P. 65.2;
- Within Rapid City: to support local weather information requests and also to provide views of local traffic situations during tourist seasons. Recommended deployment in conjunction with the Sheridan Lake Road RWIS station.
- Pierre: to offer a visual representation of the central portion of the state, and to offer destination information for the many travelers heading to Pierre. Recommended deployment at the Vivian RWIS station on U.S. 83 at M.P. 101.9;
- Sioux Falls: to support travelers heading to the East portion of the state along I-90. Recommended site is the Montrose RWIS station on I-90 at M.P. 376; and
- Belvidere: to offer a mid-state visual report on conditions along I-90. Recommended site is the Belvidere RWIS station on I-90 at M.P. 172.5.

- The Northeast portion of the state: to support travelers along I-29 as well as traffic to and from Minnesota accessing Pierre. Recommended deployment in conjunction with the Summit RWIS station on I-29 at M.P. 206.8.

Recommended approach: The recommended approach is to mount a camera in a heated enclosure high enough to provide a good roadway image (recommended 30 feet above the ground). Connect the camera to a camera server that will take snapshot images from the video at preset intervals, dial out to the Internet and post the images in a desired FTP location. These camera images can then be displayed on the South Dakota DOT Internet site with small modifications to accommodate the images. The FTP transfer would be recommended that the images be transferred to the most appropriate DOT computer server to facilitate file access for display on traveler information Internet sites.

As noted above, a phased deployment of the cameras could allow for a test of the level of acceptance and use of these systems. Therefore, it is suggested that the first four locations be equipped with cameras initially, and the remaining two deployments occur based upon feedback of users.

Equipment Costs: Moderate - Camera setups, including: cabling, camera server and other electronic equipment costs are reported at \$1,800 per setup. Housing units with heaters are extra (\$130 / unit). Other miscellaneous costs include wiring, mounting brackets and additional camera lenses if needed. These capital costs do not include the costs for installing a pole, and should be added for locations without existing poles.

Total Equipment costs for recommended deployment of six cameras: \$30,000

Staff time for deployment:

Site coordination and management of installation: 30 person days

Equipment installation and configuring: 60 person days

Internet programming: 10 person days

O&M Costs: Operations of the camera entail establishing Internet accounts for specific camera sites (\$15-\$20 per month), and a phone line for dialing out and transferring the images. Ongoing costs include maintaining the cameras and equipment, which will typically consist of cleaning the camera lens and troubleshooting repairs. Estimated 2 hours of staff time per month per camera, totaling 12 hours per month for routine maintenance.

Communications: Standard telephone line communications are recommended. Commercial-off-the-shelf camera servers can be purchased to facilitate the connection between the camera and the telephone line.

Status of Technology: This technology is proven and very low risk for deployment. All technologies recommended are available off-the-shelf. The following list suggests the types of technologies available for this technology. Specific vendor names and models are identified to illustrate the types of products that could be used (and for substantiating the price estimate), this list does not serve as a product endorsement, nor should it influence the standard SDDOT procurement process:

1. Camera (Panasonic WV-CP 454)
2. Camera lens (Panasonic WVLA-18)
3. Camera Sunshield (Pelco SS 2512)
4. Power Supply
5. Heated enclosure (Pelco enclosure EH3512-2)
6. Mounting bracket
7. Camera Server (Realcam 5000 – reference <http://www.internetimaging.com>)
8. Camera Server housing
9. On/Off timer for periodic reset of Camera Server (Radio Shack model 61-1060)
10. Coaxial cable (roughly 30 feet per camera)
11. 2 BNC connectors and one BNC-to-RCA adapter
12. 22 gauge wire for 24 volts power supply (roughly 30 feet per camera)

Steps to Deployment: The following are the suggested steps toward deployment:

Step 1: Conduct site surveys of each suggested location to determine if they are feasible locations and install poles at selected sites if necessary. In order to install a camera at a height of 30 feet, 35 foot high poles are recommended. Sites must also have a dedicated phone line, a 110VAC power supply, and a box to house the camera server. Time expected for this task is one month to allow for schedule coordination with local representatives for each site.

Step 2: Arrange any needed phone lines (if not already installed), a local Internet Service Provider (ISP) offering dial-up service, and procure the camera, camera housing, and camera server. Five days of effort over the course of one month (allowing time for equipment purchases).

Step 3: Program each camera server and camera in house prior to moving them to the site to ensure they function. Two weeks of activities.

Step 4: Deploy the cameras, set the cameras for the best viewing image and verify all connections work. One month of activities.

Step 5: Develop Internet pages to house the camera images and explain the location and direction of view. Two weeks of activities.

Schedules and Milestones:

	Month 1	Month 2	Month 3	Month 4
<i>Step 1</i>				
<i>Step 2</i>				
<i>Step 3</i>				
<i>Step 4</i>				
<i>Step 5</i>				

Benefits / Cost: High - Deployment of CCTV cameras are fairly easy compared with other ITS endeavors. Images can be shared with public agencies as well as the media.

- Closed circuit TV images provide visual and real-time imaging of roadway conditions – therefore meeting the expectations of having real-time accurate traveler information.
- Camera data may be collected and analyzed at a later date for purposes of planning if needed.
- Images are versatile and can be transmitted to any point on demand.

Potential Funding Sources: DOT, federal and local funding.

Application Examples: Oregon DOT installation of 70 cameras on the interstate for viewing road conditions. CCTV systems are fairly mainstream and can be found in most major metropolitan area.

Web Sites: <http://www.odot.state.or.us/its/ITSDocs/WEBCAMTECHBRIEF22800%20V2.pdf>

6.1.3 Expansion of the Advanced Traveler and Weather Information System (ATWIS)

South Dakota needs specific to this technology:

In the qualitative focus group discussions:

- Public agency representatives ranked the importance of weather and visibility information as 3.87 on a scale of 1-4, and road condition information as 3.94 on a scale of 1-4;
- Travelers expressed a need for pre-trip travel information and indicated that they felt the Internet could be the most effective means for accomplishing this; and
- Attendees in the Rapid City meeting expressed the need for traffic information during the summer tourist season.

In the quantitative telephone survey:

- Participants ranked the importance of weather conditions a mean value of 4.25 on a scale of 1-5;
- The majority of South Dakota residents indicated the most need for "weather conditions" information before travel on roads and highways within South Dakota. Almost as equally important was information pertaining to "safety problems due to icy bridges, flooding, storms, hazardous spills, etc."; and
- Technologies perceived most likely to be used by respondents were "a special radio channel to listen for weather and travel-related information," and "a special number to call from a regular phone or cellular phone for weather and road condition information."

Applicability towards the needs: The needs definition clearly identifies weather information as the most desired type of information for travelers around the state of South Dakota. This project recommendation recognizes that the Advanced Traveler Weather Information System (ATWIS) project currently operates one of the most sophisticated weather forecasting and reporting systems specifically tailored to transportation information, and recommends enhancements to the system to further address the specific needs expressed during this study. More specifically, recommended enhancements will attempt to address:

- the request for pre-trip availability of information;
- the indication that the Internet is an effective means for delivering pre-trip information;
- the specific requests for "safety problems related to icy bridges, flooding, storms..."

Recommended Enhancements: Suggested enhancements to the ATWIS system in the near term include:

1. System modifications to allow land-line telephone access to the ATWIS phone system. This will address the need for pre-trip travel information, and open access to the ATWIS system beyond those with cellular phones and the Internet to everyone with access to a land-line telephone.
2. System modifications to support voice recognition. This will allow travelers to speak into the system to indicate location and direction rather than punching numbers in the phone keypad, and should reduce driving hazards.
3. System modifications to the ATWIS Internet access pages to make information availability more user-friendly to all users of the Internet. This will address the request for pre-trip information and the interest in the Internet.
4. Research and hold discussions regarding the consolidation of the weather information numbers in Aberdeen, Rapid City, Sioux Falls and Pierre together with the ATWIS system. This research should explore options for a business model for sustaining the ATWIS telephone lines that considers such things as funding sources and ongoing operations contracts.
5. The development of agreed steps that would eventually link information on roadway conditions (i.e., have roads been plowed or treated, are roads open or closed, and the general “driveability” of roads) to the ATWIS system, and initial implementation of such a system in limited form. This will address the need for safety information about the roadway.

Project Locations: Statewide

Technical Approaches and Schedule for Deployment: The approach to the five options presented above are:

Action #1 Land-line access:

1. A policy decision must be reached regarding whether SDDOT wishes to provide land-line telephone access via a statewide toll free number, local access numbers in each area of the state, or via one statewide number that will be a toll call for some and local for others. Together with this decision should be discussions regarding allowing sponsorship advertisements on the telephone system. As an example of how critical this decision is, in Washington State an interactive weather phone line for the Snoqualmie Pass was created in 1991. With toll-free access, the system grew to support roughly 1 million calls per winter in 1995. After 1995, the legislature asked for reduced operations costs and a

toll number replaced the toll free number. The number of calls that winter reduced drastically to 300,000 calls. In 1997, a private sponsor (Recreational Equipment International) provided \$40,000 of sponsorship funding (roughly 40% of the total costs) and allowed the state to again offer toll free access. Usage of the toll free number jumped back to 1.6 million calls that year.

2. As a short-term recommendation, it is suggested that one land-line toll number be established and pointed towards the ATWIS phone system and announced to travelers. Preliminary reactions by the travelers and usage could provide valuable insight to the policy decisions regarding future direction on the business model.
3. Estimated deployment time to arrange for one land-line number, arrange routing of that number, test the functionality and prepare announcements of the number are estimated to take 80 hours of staff time over a one month period. In the event that local numbers are desired to be rolled over to one central number, considerable additional time is required to coordinate with the estimated 30 local phone carriers and establish the relationships. This process is estimated at roughly six months.
4. Ongoing operations of the “one-number” toll-free system would be estimated at the amount of long distance charges incurred. Depending upon negotiations, a “per minute” rate of five to seven cents per minute could be expected. If a toll line were installed, ongoing operations would be minimal (excluding current costs for operations of the ATWIS weather portion of the phone system). An initial \$10,500 could be allocated for the projection of 150,000 calls for the first year. In the first year of system deployment, ATWIS received a total of 55,000 transactions, and a cumulative total of 180,000 transactions up until August 2000.⁶

Action #2 Voice Recognition:

1. The ATWIS system currently has a proven method for entering location and direction of travel using the telephone touch pad. It is recommended that this same method be developed into a voice recognition system allowing the traveler to speak the information.
2. Meridian Environmental Technologies has estimated that this enhancement can be performed for approximately \$20,000, and that the modification is straight forward and a low risk effort.

⁶ Osborne Jr., Leon; Owens, Mark. “Evaluation of the Operations and Demonstration Test of Short-Range Weather Forecasting Decision Support within an Advanced Rural Traveler Information System”. October 2000.

3. It is also recommended that an additional \$10,000 be devoted towards a limited period in which Meridian monitors the system to determine the extent to which individual accents or phrase selections make access a challenge. This funding estimate was based upon allowing limited observations over a one-month period, together with time for presenting results and any recommendations for further enhancements to the recognition software to SDDOT for further consideration.
4. A **three-month implementation** and testing period is recommended for this implementation.

Action #3 Internet enhancements:

1. It is recommended that the Internet site used to display the ATWIS information be modified for easier interpretation by the general travelers. Examples of suggested enhancements include:
 - The ability to select key roads in addition to areas for display of information;
 - The ability to select long distance routes (i.e., I-90 from Minnesota to Montana) and view information for the entire route;
 - Graphical displays of icons or other easily recognized weather descriptions; and
 - The ability to view areas of the map while textural information is displayed. Eliminating confusion between linking from a map to an all text display.
2. Specific details of the Internet modifications are not included as it is recognized that the ATWIS system is a collection of multiple states and agencies. Therefore, it is suggested that these recommendations be considered by the group together with the input of other users, and with the knowledge of what information is available and most desirable to disseminate to the travelers (best understood by the ATWIS group and Meridian) to reach final decisions on deployment.
3. Based upon experiences in Minnesota, estimated Internet enhancements to display weather information from the ATWIS system are roughly estimated at \$40,000 to allow for four person-months of Internet coding.

Action #4 Consolidation of weather numbers:

1. Consolidating the four regional weather numbers and the ATWIS number into one general number would have several benefits, namely: less confusion on what number to call, less operations expense to maintain and promote one number, and lack of discrepancies between numbers. However, the decision must be reached and agreed that

all parties involved desire consolidation. Therefore, the first recommended step is to convene the key players in the ATWIS system and the four individual weather numbers to discuss benefits/drawbacks to consolidation. Any history regarding individual numbers that is a barrier to consolidation needs to be understood. Also, these discussions should explore any features of the local weather phone systems that should be carried through towards the consolidation.

2. If it is agreed that consolidation proceed, the recommended approach would be to combine activities with recommended action #1 to implement land-line access to the ATWIS system to reach decision on toll vs. toll free numbers and to coordinate the technical switchover of the phone lines.
3. Assuming consolidation occurs and the common system is the enhanced ATWIS system, it is recommended that the current numbers be forwarded to the new ATWIS number for an agreed period. Beyond that, the consolidated number can be marketed in conjunction with the Traveler Information Promotion project.
4. Based upon the results of the consolidation of weather telephone numbers, it is also recommended that an internal study be devoted to determining the business model preferred by SDDOT for ongoing operations of the weather information telephone numbers. More specifically, the following questions should be addressed:
 - Does SDDOT wish to continue ATWIS phone service operations as currently conducted or would a South Dakota specific service be preferred in which the telephone access could be operated by the DOT with weather served by the ATWIS program and Meridian?
 - Does SDDOT wish to recover some or all of the costs in the form of sponsorship or advertisement, and is this allowed by the legislature?
 - Does SDDOT wish to offer the service as a toll-free service to travelers or would toll charges be acceptable?
 - Does SDDOT wish to allow competing information service providers disseminate the common information, or is it preferred that one dissemination point be continued?
5. The estimated costs of consolidation include 80 hours of staff time over a six-month period for those critical staff to discuss and reach consensus on an approach. Outside costs for equipment and telephone charges are estimated to include the long distance charges for forwarding of the telephone calls.

Action #5 Improved road condition information:

The following activities are recommended to implement a reporting system for state and local agencies to report on roadway conditions.

1. Define for the state of South Dakota the phrases “Driving Conditions Good”, “Driving Conditions Fair”, “Driving Conditions Poor”, and “Hazardous Driving Conditions”. These phrases are part of the agreed ITE-AASHTO traffic management data dictionary (TMDD) for event descriptions. These phrases, combined with supporting phrases on current conditions (i.e., weather, snow removal progress, incidents in the area) are intended to convey a sense of the level of safety for driving along the road. As an example, district data entries by the State of Minnesota convey one of these phrases together with supporting information when describing current conditions.
2. Develop an Internet based data entry tool that would enable SDDOT (and possibly local agencies performing maintenance of local roads) to enter one of the above phrases together with other standardized phrases from the TMDD list to describe conditions in either the area or on specific roads. For example, an area-wide description system could allow data entry in accordance with the regions on the ATWIS Internet map at: http://www.state.sd.us/dot/travinfo_weather_forecast.cfm
For one region, the display could show conditions as:
Interstates: Driving Conditions Good, Snow removal completed
Major Highways: Driving conditions Fair, Snow removal in progress
Secondary routes: Driving conditions poor
For road specific routes, information could be at the level of:
I-90 from Rapid City to Montana Border, Driving conditions Poor, Blizzard conditions.
3. It is recommended that this Internet data entry tool be developed and used by regions around the state for one winter season without expectations of data directly disseminated to the traveling public. During this winter season, it will become apparent how current the information providers are likely to keep information, and if data entry is a significant inconvenience to these staff. Internal DOT and ATWIS staff can monitor the information and determine its usefulness to the traveling public, and reach decisions on whether or not full scale use should continue.
4. The development of the Internet entry tool will vary in cost depending upon the level of detail desired. Because there are many questions about the acceptance of such a system, it is recommended that minimal funding be spent to deploy and test the system. It is

estimated that \$20,000 could fund a statewide “regional” based data entry tool, and that \$75,000 could fund a statewide data entry tool allowing route and county specific condition reporting. Time for development of the regional entry tool is estimated at three months, while the route specific entry deployment schedule is six months.

Equipment Required: Telephone routing equipment will be required for the above options to allow consolidation of phone lines and forwarding of calls. However, this equipment will be very similar (if not the same) to the equipment currently used to operate the ATWIS system.

Communications Requirements: Standard phone lines and phone connections will be used for the communications. For those enhancements involving the Internet, existing DOT Internet connections will be suitable for communications.

Schedules and Milestones:

	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
Land-line access												
Interactive voice recognition												
Internet Enhancements												
Consolidation of weather numbers												
Improved road condition information												

Benefits / Cost: High - This project has great potential for streamlining operations and maintenance by providing a clearinghouse (one-stop shop) for weather information.

- Improved weather information for operations such as snow removal, anti-icing activities, and paving operations.
- Centralized repository and distribution point for weather information.
- Platform independent system provides greater access to information.
- Real-time access to weather information pre-trip and en-route.
- Improved local weather information for towns and cities.
- Consistent resource for statewide information.

Roles and Responsibilities: It is recommended that the current ATWIS structure continue. This effectively brings together the public sector states, the research through University of North Dakota, and private involvement through Meridian.

Staffing: This technology is primarily privately operated. The DOT is purchasing the information as a service. Therefore, there is little staffing required to operate and maintain the system. A foreseeable requirement is the need to adequately train staff in using the information for improved decision-making regarding the maintenance of roadways. Training is required initially and on a continual basis.

Potential Funding Sources: SDDOT

Application Examples: ATWIS (Dave Huft, SDDOT (605) 773-3358)

Web Sites: <http://www.state.sd.us/dot/travinfo.cfm>

6.1.4 Automatic Anti-Icing Capabilities

South Dakota needs specific to this technology:

In the qualitative focus group discussions:

- Travelers mentioned road and weather conditions as major impediments to driving;
- In the focus groups, three primary causes were highlighted as causes of accidents: unsafe driver behavior, poor weather and road conditions and other obstacles.

In the quantitative telephone survey:

- The majority of those surveyed identified information regarding “safety problems due to icy bridges, flooding, storms, hazardous spills, etc.” high;
- Public agency representatives ranked the importance of weather and visibility information as 3.87 on a scale of 1-4, and road condition information as 3.94 on a scale of 1-4;
- Safety issues concerning road conditions such as ice and snow rated highest by focus group attendees (3.65 on a 4-point scale); and
- Travelers rated weather / visibility and related safety problems 3.19 on a scale of 1-4.

In the review of South Dakota safety records:

- The primary culprits contributing to the most accidents outside of dry roadway were wet, icy or snowy conditions.

Applicability towards the needs: The needs definition clearly identifies road conditions as a driving safety concern. The implementation of fixed anti-icing systems on known problem areas would greatly assist maintenance personnel in automatically pre-treating these surfaces in anticipation of frosty conditions. The primary purpose of this project is to enhance the safety of travelers through the early detection and response to roadway icing at strategic locations.

Project Locations: Two anti-icing deployments are recommended. *The following locations are suggested deployment sites, however a site survey will need to be conducted to verify the applicability of each site with site requirements defined below. Each of the sites below has been recommended based on maintenance engineers suggestion:*

- Watertown Truck Route Project P0020(68)394, PCEMS 4792, Codington County
- Bridge east of Hill City on US 16 at MRM 42.64

Recommended approach: The recommended approach is to install pavement sensors in the roadway to detect icing, snow or frost conditions. Once the pavement sensors detect such conditions, it will trigger nozzles (imbedded into the pavement and connected by piping to a storage tank) to spray anti-icing agents onto the roadway.

Equipment Costs: Moderate – For bridges spanning 500 feet or less with four lanes or less, a self-contained, ready-to-roll-out system costs approximately \$19,300. This system includes 10 spray nozzles that will provide coverage to the driving lanes only (shoulders will receive run-off), piping, chemical tank, and sensors. This system is not expandable, and requires the use of clear chemical agents such as magnesium chloride. Salt brine solutions will not work. Please note that larger systems (including 1000 gallon tank, supply pump structure, precipitation sensor, installation supervision, training, 15 spray nozzles, and piping) cost approximately \$63,300.

Total equipment costs for recommended deployment of two anti-icing units: \$50,000

Staff time for deployment:

Site coordination and management of installation: 5 person days

Equipment installation and configuring: 5 person days

O&M Costs: Maintenance of equipment is moderate. Replacement of nozzle heads is under \$1,000. Anti-icing agent costs approximately \$60 per application.

Communications: Standard telephone-line if remote-controlled capabilities are desired. 120 / 240 volt power source.

Status of Technology: This technology is proven and very low risk for deployment. All technologies recommended are available off-the-shelf. The following list suggests the types of technologies available for this technology. Specific vendor names and models are identified to illustrate the types of products that could be used (and for substantiating the price estimate), this list does not serve as a product endorsement, nor should it influence the standard SDDOT procurement process:

- Spray nozzles (Odin)
- Precipitation sensors (Odin)
- Piping (Odin)
- Chemical tank (Odin, or any other agriculture tank)
- 120 / 240 volt power source

Steps to Deployment: Following are suggested steps to facilitate deployment:

Step 1: Specify the equipment needed. *1 week.*

Step 2: Develop guidelines for determining when the automated system should be overridden. *1 month.*

Step 3: Procure and test equipment at limited sites. *1 month.*

Step 4: Develop a deployment plan for installation at other locations based on experiences and lessons learned during testing. *3 months.*

Step 5: Maintain and monitor effectiveness of technology. *Ongoing.*

Schedules and Milestones:

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
<i>Step 1</i>						
<i>Step 2</i>						
<i>Step 3</i>						
<i>Step 4</i>						
<i>Step 5</i>						ONGOING

Benefits / Cost: High - Benefits are as follows:

- Maintenance and operations will save money on ice abatement efforts for overpasses.
- Anti-icing chemicals are applied on demand and without maintenance vehicles having to travel through treacherous conditions to apply de-icing chemicals to problem areas.
- Greater safety for travelers in areas where the system is used.

Potential Funding Sources: SDDOT.

Application Examples: Virginia anti-icing project, Minnesota Mississippi River Bridge anti-icing project.

Web Sites: <http://matrix.vtrc.virginia.edu/DATA/NOVA766/>, <http://www.odin.com>, <http://www.dot.state.mn.us/metro/news/000201deicer.html>

References: 1. NYSDOT Strategic Plan for Intelligent Transportation Systems in Rural and Small Urban Areas.

6.1.5 Remote Controlled Snow Gate Closure System

South Dakota needs specific to this technology:

In the qualitative focus group discussions:

- Respondents recognized adverse road conditions as their highest safety concern.
- Respondents were concerned with roadway visibility.
- Traveler information relating to weather, visibility and road conditions due to weather were among top concerns.

In the quantitative telephone survey:

- Safety issues concerning road conditions such as ice and snow rated highest by focus group attendees (3.65 on a 4-point scale);
- The majority of those surveyed identified information regarding “safety problems due to icy bridges, flooding, storms, hazardous spills, etc.” as high;
- Public agency representatives ranked the importance of weather and visibility information as 3.87 on a scale of 1-4, and road condition information as 3.94 on a scale of 1-4; and
- Travelers rated weather / visibility and related safety problems 3.19 on a scale of 1-4.

In the review of South Dakota safety records:

- The primary culprits contributing to the most accidents outside of dry roadway were wet, icy or snowy conditions.



Applicability Towards the Needs: The needs definition recognizes the safety implications of winter travel in adverse conditions in addition to acting as a preventive measure to deter motorists from traveling in advised “do not travel” conditions. Road closure gates currently used by the South Dakota Department of Transportation are comprised of a gate that is hinged to a post. Deployment of the gate requires SDDOT personnel to manually swing the free end of the gate out across the roadway. Snow and ice buildups on the roadway and on and around the gate can make gate operation difficult. Poor visibility and slippery conditions, which typically accompany the need for road closure, can make this deployment dangerous to SDDOT or public

safety personnel. A change in the road closure gate design along with automation of the closure mechanism may reduce the labor and danger associated with deployment of road closure gates. The South Dakota School of Mines and Technology conducted a study to determine how usable remote-controlled snow gates would be. Having remote-controlled gates would reduce the number of workers sent out into the field and reduce the time spent on site closing the gate. Additionally, while public safety personnel may need to patrol closed sections of the roadway despite the remote-controlled nature of the system, this will allow them to do so from the safety of their vehicle or off-road.

Shortcomings of the Technology: This technology requires integration with other technology and information dissemination activities in order to work effectively. Gate closures need to be well communicated with the general public and local agencies.

Project Locations: Three remote-controlled gate closure systems are recommended. *The following locations are suggested project sites, however a site survey will need to be conducted to verify the applicability of each site with site requirements defined below. Each of the sites below has been recommended in conjunction with an existing RWIS station, intended CCTV deployment or DMS deployment, in order to allow for visual verification of conditions for pre-trip travelers and advanced warning of road closures for travelers en-route:*

- Rapid City at an exit near camera and DMS deployments at MRM 65.2 and MRM 61.4, respectively.
- Two gate deployments at exits near Sisseton in conjunction with planned DMS deployments at MRM 234.263 and MRM 228.985.

The deployment of remote-controlled snow gates near CCTV deployments will further provide visual verification of conditions warranting road closures. Alternatively, remote-controlled gates deployed in succession of dynamic message signs provide travelers en-route advanced warning of conditions ahead. Furthermore, additional information obtained from RWIS sites near the deployment will assist in further validating closure decisions.

Recommended Approach: The recommended approach is to install remote-controlled gate arms in place of the current manual system to evaluate the impact on safety and usage during adverse winter weather conditions.

Equipment Costs: Moderate – Traditional snow gates cost approximately \$3,600 for equipment and installation. Remote-controlled units cost approximately \$6000 (including gate, closure mechanism, and 1-year maintenance agreement).

Suggested project cost is \$50,000 for the design, deployment, test and evaluation of 3 remote-controlled gates.

Staff Time for Deployment: Site coordination and management of installation: 30 person days
Equipment installation and configuring: 20 person days
Staff Training: 5 person days

O&M Costs: These costs will consist of maintaining gates and remote control units. Estimated time is 1 hour of staff time per month per gate. Likely maintenance will be to repair damage caused by vandalism or by routine operations.

Communications Requirements: Short-range wireless remote control units.

Status of Technology: This technology is proven and very low risk for deployment. All technologies recommended are available off-the-shelf. The following list suggests the types of technologies available for this project. *Specific vendor names and models are identified to illustrate the types of products that could be used (and for substantiating the price estimate), this list does not serve as a product endorsement, nor should it influence the standard SDDOT procurement process.* Gates purchased should have the following features:

- Heater;
- Key-switch and radio control (to close the gate using a short-range remote control device);
- 32-ft. aluminum/fiberglass arm with low voltage flashing lights;
- Linear actuator or hydraulic driven; and
- Passes government crash test standards.

South Dakota School of Mines and Technology researchers specifically recommended a gate manufactured by Hy-Security Gate Operators, Inc.

Steps to Deployment: The following are the suggested steps toward deployment:

Step 1: Review reports on snow gates in general and remote-controlled gates prepared by Minnesota DOT and South Dakota School of Mines and Technology researchers. *1 month.*

Step 2: Perform site survey to verify applicability of selected locations for snow gates. *1 month.*

Step 3: Compile specifications, deployment, and operations plan for the snow gate installation and maintenance. Ensure that deployment plan is in conjunction with recommendations in these reports. Develop a public information plan to inform the public of road closures. *2 months.*

Step 4: Install gates and monitor effectiveness of technology and operations. Modify as necessary. *3 months.*

Schedules and Milestones:

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
<i>Step 1</i>						
<i>Step 2</i>						
<i>Step 3</i>						
<i>Step 4</i>						

Benefits / Cost: High – High benefits to travelers in adverse weather conditions.

- Reduces staff time required to physically close gates.
- Reduces the need to physically enter the roadway while swinging closure gates.
- Increases safety of DOT and Highway Patrol personnel.
- Clear and consistent communication of road closures.
- Deployments near CCTV's will allow pre-trip travelers to visually verify road conditions.
- Deployments near dynamic message signs provide travelers en-route with advanced warning of road closures.

Potential Funding Sources: Federal and State DOT funding.

Application Examples: Wyoming Teton Pass. Bob Rice, Winter Alpine Engineering (801) 585-7787 brice@wasatch.com, Rand Decker, University of Utah (801) 581-3403.

Web Sites: Hy-Security Gate Systems: <http://www.hysecurity.com>
School of Mines and Technology report: <http://www.state.sd.us/dot/pe/research/projects/SD00-11final.pdf>

6.1.6 Integrated Traveler Information System

South Dakota needs specific to this technology:

In the qualitative focus group discussions:

- Attendees expressed the need for a more dynamic method of accessing and posting traveler information to accommodate, for example, up-to-the-minute changes in construction activity and weather. The Internet was mentioned (by public agencies) as the most effective means for information dissemination.
- Respondents noted the lack of a statewide communications infrastructure for accessing and posting traveler information.
- Respondents noted the need for improved traveler information dissemination. It was suggested that part of the problem is the lack of technology or computers to store information.
- Travelers expressed a need for pre-trip travel information and indicated that they felt the Internet could be the most effective means for accomplishing this.
- Public agency representatives ranked the importance of weather and visibility information as 3.87 on a scale of 1-4, and road condition information as 3.94 on a scale of 1-4.
- Attendees in the Rapid City meeting expressed the need for traffic information during the summer tourist season.

In the quantitative telephone survey:

- Participants ranked the likelihood of using the Internet for pre-trip traveler information a mean value of 2.63 on a scale of 1-5.



Applicability towards the needs: The needs definition clearly identifies the need for dynamic methods of disseminating and accessing changes in traveler information such as construction activity, road closures, and weather.

Shortcomings of the technology: In the telephone survey, participants did not rank the likelihood of using the Internet for traveler

information as very high, causing some question of the amount of use this technology will receive. Nonetheless, the Internet is the most flexible mechanism for providing up-to-the minute traveler information. Web sites can provide a greater amount of detailed than more conventional methods such as the use of a 1-800 number and distribution of print materials.

In order to address this issue, it is suggested that the deployment of an Integrated Traveler Information Web site be used in conjunction with current 1-800 numbers and coordinated with the South Dakota Department of Tourism. Furthermore, traveler information centers can act as distribution points for the dissemination and sharing of information provided through the Integrated Traveler Information Web site with their customers. Updated maps provided by the Integrated Traveler Information Web site could be printed out on an as-needed basis by tourism personnel and provided to travelers.

Project Locations: The suggested project calls for the enhancement of current traveler information provided on the South Dakota Department of Transportation Web site. This project is intended to act as a repository for information and allow users to access information statewide.

Recommended approach: It is recommended that the Web site incorporate road camera images, up-to-the minute road construction and road closure details, transit options and schedule information, airport information, and links to local city and county information, as a minimum.

Camera images. The Web site should incorporate camera images deployed as a part of the Road Condition via CCTV project. Furthermore, this project intends to expand on the network of cameras deployed. It is recommended that 6 additional cameras be included as a part of this project. These images allow users to view up-to-the-minute visual verification of specific segments of roadway. These images could be viewed before a trip, or along the route at rest stop kiosks that provide Internet connectivity. Additional deployment sites are suggested for:

- Sioux Falls on I-229 at Benson Road (Exit 9).
- North Sioux City on I-29 at MRM 6.1 near current RWIS deployment.
- I-29 at MRM 157.6 near Brandt RWIS deployment.
- US 12 at MRM 219.5 near Andover RWIS deployment.
- I-90 at MRM 251.1 near Reliance RWIS deployment.
- US-85 at MRM 0.0 near Western Black Hills RWIS deployment.

Again, these sites are suggested in correspondence with RWIS stations in order to share current power systems.

Road construction information. Focus group attendees stated the need for up-to-minute construction information. The road construction information provided as a part of the traveler information Web site is a good foundation. However, users suggest that current construction information could be expanded to include details such as traffic lanes and direction of travel affected, anticipated speed limit through construction zone, anticipated hours or days of work, and expected detours (if applicable) that would further enhance the information already provided. To further illustrate, the information could be posted in the following manner on the Web site:

Activity:	Grading and re-surfacing
Location:	Interstate I-90, Exit 55 (West Rapid City) to Exit 60 (SD 79)
Affected Lanes:	Intermittent alternating lane closures
Construction Hours:	Monday through Friday 8 am to 5 pm
Advisory Speed Limit:	45 mph
Project Duration:	April 2001 to July 2001
Last Update:	12/01/00 4:00 p.m.

Alternate Modes of Travel. While the majority of the traveling public within South Dakota relies on personal vehicles for transportation, there is a need for better information regarding access to transit options available within and between local jurisdictions. The integrated traveler information Web site could also act as a repository for information regarding alternative modes of travel including city buses, van pools, taxis, privately-operated buses (e.g., Greyhound, Casino buses, etc.), and air travel. The SDDOT Web site does provide airport information such as scheduled airline service connections (<http://www.state.sd.us/dot/Aeronautics/sch-air.htm>), however, it is not accessible from the current DOT traveler information Web page. For the traveler, a link provided from the Integrated Traveler Information Web site to the airport directory should provide easier access to flight travel information. Other enhancements that should be considered include provide a listing of car rental agencies (along with contact information) available at the airports or other modes of transportation that could be arranged within the destination city.

The City of Sioux Falls (http://www.sioux-falls.org/transit_routes/index.htm) provides good transit schedule information on the City's Web site, allowing users the ability to view and print out transit schedules and route information. This is an excellent prototype for transit information on the Integrated Traveler Information Web site. This type of information is useful to travelers not only on a city-to-city basis, but on a statewide level as well. The Integrated Traveler Information system should include local and regional transit schedules, routes and hours of operation information as a minimum. Please note that this should not be limited to city buses, the inclusion of van pools, taxis, and other modes of travel should be considered.

Costs for recommended approach: Moderate - Total Equipment costs for recommended deployment of six cameras is \$30,000. *Please refer to Road Condition via CCTV project write-up for technical details.*

Web site planning (20 person days) - \$10,000

Coding and graphics development (30 person days) - \$20,000

Information gathering (60 person days) - \$40,000

Total cost for the development of the Web site is \$100,000.

Equipment Costs: Camera deployment cost is estimated at \$1,800 per camera, \$130 for heating unit.

Staff time for deployment:

Camera Installation

Site coordination and management of installation: 30 person days

Equipment installation and configuring: 60 person days

Internet programming: 10 person days

Web Site Development

Web site coordination, planning and information gathering: 90 person days

Internet programming: 30 person days

O&M Costs: Maintenance required for the Web site includes: posting scheduled updates, yearly domain name renewal, checking links, and keeping contact information up to date.

Communications: Standard telephone line communications are recommended for camera deployments. The Web site should reside on a server that has high-speed Internet access (e.g., ISDN, T-1 or DSL) in order to potentially handle large volumes of page requests. The SDDOT current capabilities should be sufficient for handling the implementation of the Integrated Traveler Information Web site.

Status of Technology: This technology is proven and very low risk for deployment. *Please refer to the Road Condition via CCTV write-up for details on the camera technology.* The following list suggests the types of technologies available for the Web site development for compatibility with current state of South Dakota Web site capabilities:

- Cold Fusion server for queries.

- Adobe Acrobat to allow for printable versions of maps, schedules, and other stand alone information sheets.
- HTML programming for the Web page development.
- Use of Real Networks for audio & video.

Steps to Deployment: The following are the suggested steps toward deployment:

Step 1: Assemble web site committee, consisting of information systems staff and representatives from DOT, transit, and tourism, to commiserate on the specifications and design for the web site. 1 month.

Step 2: Determine what types and sources of traveler information should be included for enhancements. Determine whether Web site enhancements should be performed in-house (e.g., using the South Dakota Bureau of Information and Telecommunications), or advertised for bid. 2 months.

Step 3: (***Please note that this step is only required if the request for proposal (RFP) method is chosen.***) Assemble RFP, solicit and choose Integrated Web Site developer. 2 months.

Step 4: Develop and launch beta version of the system. Encourage public feedback via email. 6 months.

Step 5: Monitor effectiveness of information sources and dissemination. Modify if necessary. Ongoing.

Schedules and Milestones:

	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
<i>Step 1</i>												
<i>Step 2</i>												
<i>Step 3</i>												
<i>Step 4</i>												
<i>Step 5</i>											ONGOING	

Benefits / Cost: High – The deployment of an Integrated Traveler Information Web site provides the best mechanism for sharing a host of information with other agencies and the traveling public.

- Provides traveling public with “one-stop” information source for construction, delays, road conditions, directions, alternative modes of travel and local amenities. This type of information is required for decision making.
- Allows for quick and easy up-to-the-minute posting of traveler information. Real-time traffic cameras are highly credible.
- Flexible technology is easily adaptable to rural and urban areas.
- Provides a statewide infrastructure for accessing and providing traveler information.
- Information is dynamic and frequently updated.
- Information is available before and during a trip.

Potential Funding Sources: DOT, federal and local funding.

Application Examples: Oregon State’s TripCheck developed by the Oregon State Department of Transportation.

Web Sites: <http://www.tripcheck.com>, <http://tripusa.com>

6.1.7 Rural Addressing and Geographic Information Systems (GIS)

South Dakota Needs Specific to this Technology:

In the qualitative focus group discussions:

- Public agencies were concerned with slow emergency response times in rural areas;
- Travelers expressed concern about being stranded in a rural area and long emergency response times; and
- Public safety personnel from Rapid City noted numerous calls for assistance from lost travelers.

In the quantitative surveys:

- Concern for stranded motorists and long emergency response times ranked 3.11 on a 4-point scale; and
- The need for better road signs and directions ranked 3.31 on a 4-point scale.



Applicability Towards the Needs: The needs definition recognizes the need for improved signing and rural addressing for improved emergency response and mobility. This rural addressing project uses GIS to improve emergency services and improve the ability to locate rural locations. At the conclusion of the project, all rural residents should have an easily referenced street address, and rural route addresses should be phased out.

Project Locations: The SDDOT has performed much of the foundation for a rural addressing database. As such, a statewide system would be most applicable.

Recommended Approach: Residents in the rural areas often do not have consistent reliable road addresses. Many rural areas use a postal route and box number for an "address" but the route and box numbers do not adequately describe *where* a house is. There are also many homes in the rural areas that do not have any type of address at all. This becomes a life-threatening issue when emergency response personnel cannot find the victim in need. In response to these problems, a countywide rural addressing system may be implemented, first in one test county, and then expanded. The intention is to fill the void where rural addresses do not currently exist, fix the problems where the numbers are out of sequence or on the wrong side of the road, and

preserve the addresses that are good. Part of this process is to create an inventory of the existing addresses and residences. This is performed using Global Positioning System (GPS) technology, which uses satellites to derive coordinate locations of roadways and address points. A state or county Geographic Information Systems (GIS) department conducts a survey, which is mapping the roads, access points and structure locations, along with address information and road names where available. The map inventory will be the basis for the new addressing system and will be used by 9-1-1, fire and ambulance response to more quickly and accurately locate a residence. Proposed method of assigning addresses to properties is as follows:

- Sequential street numbers assigned to rural roads, forming a “grid” system covering the entire county.
- New addresses consist of a 5-digit house number and a 3-digit street number, such as “10589 481st Avenue.”
- North-South roads are identified as “Avenues,” and East-West roads are identified as “Streets.”
- Roads that meander, run diagonally, or curve back on themselves have alphabetic names assigned in alphabetical order from West to East.
- Dead-end roads are identified as “Lanes.”
- Houses on the Northerly and Westerly sides of roads get even numbers, houses on the Southerly and Easterly sides of roads get odd numbers.

Costs for Recommended Approach: Moderate - While the SDDOT has already purchased equipment for rural addressing, setting up a database to link GIS and rural addressing data and finishing the geo-coding effort may be a time consuming endeavor. The estimated project cost is \$100,000 to contract for database development for counties within South Dakota.

Staff Time for Deployment:

Database design: 40 person days

Link GIS and rural addressing database: 180 person days

O&M Costs: GIS software may require upgrading, and costs are also expected for updating data.

Communications Requirements: SDDOT GIS data released for use by other public agencies could potentially be accessed via the Internet.

Status of Technology: The SDDOT currently owns a GIS computer system, which allows for creating a database of addresses and address updating software that link to the county E-9-1-1

system and assessor rolls. The address update software is also linked to the official database of roads. It has been recognized that the SDDOT Office of Data Inventory under contract has driven all counties in South Dakota with GPS equipment with each of the five planning districts in the state. GPS data recorded all counties include issuing data tags to display farm buildings, structures and intersections. The following counties are still being processed:

- | | | | |
|-------------|-----------|------------|---------------|
| - Roberts | - Spink | - Mellette | - Charles Mix |
| - Marshall | - Beadle | - Todd | - Douglas |
| - Codington | - Corson | - Tripp | - Turner |
| - Brown | - Ziebach | - Gregory | - Minnehaha |
| - Custer | - Davison | | |

The actual step of cross-referencing the latitude and longitude data with traditional local addresses has not been done. Some counties will perform this work themselves in the future, other counties will not. SDDOT will perform the work for counties who do not have rural addressing capabilities.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Determine extent of rural address performed. Investigate measures to share and make available the data to government institutions across South Dakota. *2 months.*

Step 2: Identify database software to store GIS / rural addressing. *3 months.*

Step 3: Develop database design, structure and fields. *4 months.*

Step 4: Link GIS and rural addressing database (e.g., build address database, assign geocodes, link new addresses to assessor rolls, create new mailing lists, etc.). *6 months.*

Step 5: Inform local and county governments of GIS / rural addressing database. *1 month.*

Schedules and Milestones: The following is the suggested schedule reflecting steps to deployment:

	Months													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<i>Step 1</i>														
<i>Step 2</i>														
<i>Step 3</i>														
<i>Step 4</i>														
<i>Step 5</i>														

Benefits / Cost: High – Improved emergency response to rural emergencies saves lives.

- Benefits to Emergency Responders:
 - Greater ability to provide rapid assistance
 - Overall improved emergency response efficiency
- Benefits to Residents:
 - Convenience of having a standard street address
 - Peace of mind, knowing they can be found in an emergency
 - Feeling of community that comes from all streets and dwellings having addresses and being accounted for.
- Benefits to other government agencies:
 - Use of GIS / rural addressing for land use planning.
 - Save money by leveraging effort of GIS / rural addressing endeavor.
 - Agencies can use data for property data management.

Potential Funding Sources: DOT and local government funding. Local hospitals and emergency response agencies may be motivated to contribute.

Application Examples: RJ Zimmer, Lewis & Clark County GIS, (406) 447-8367; Al Forsberg, Blue Earth County Public Works Director, (612) 625-3281, Alan.Forsberg@co.Blue-Earth.mn.us

Web Sites: <http://www.co.lewis-clark.mt.us/gis/ra-home.htm>,
<http://www.globalpositions.com/ruraladr.htm>, <http://www.co.blue-earth.mn.us/rural/index.php3>

6.1.8 Expansion of Dynamic Message Signs (DMS)

South Dakota needs specific to this technology:

In the qualitative focus group discussions:

- Travelers rated the use of dynamic message signs along the highway for advisory and weather information as the highest among a list of potential technologies;
- Focus group participants expressed the need for traveler related information to be provided before and during their trip;
- Public agency representatives ranked the importance of weather and visibility information as 3.87 on a scale of 1-4; and

In the quantitative telephone survey:

- Participants ranked the importance of weather conditions a mean value of 4.25 on a scale of 1-5;

Applicability towards the needs: The needs definition clearly identifies weather information as the most desired type of information for travelers around the state of South Dakota. While the DOT has programmed the implementation of eight message signs along I-90 and I-29, the expansion of the system would allow greater geographic coverage and reach a larger number of people. Mobile units can be used for situations such as construction zones or planned events.

Shortcomings of the technology: While drivers do not require specialized devices to receive messages, DMS are most beneficial to drivers en-route on that specified segment of the roadway.

Project Locations: The deployment of the first set of dynamic message signs within South Dakota is planned for 8 locations as follows:

- I-29 north of Sisseton at MRM 234.263 for southbound traffic
- I-29 south of Sisseton at MRM 228.985 for northbound traffic
- I-229 south of Watertown at MRM 176.120 for northbound traffic
- I-90 at Sioux Falls at MRM 83.427 for northbound traffic
- I-90 at Sioux Falls at MRM 397.317 for westbound traffic
- I-90 east of Chamberlain at MRM 268.1 for westbound traffic
- I-90 at Spearfish at MRM 11.15 for eastbound traffic
- I-90 at Rapid City at MRM 61.14 for eastbound traffic

Three additional permanent DMS deployments and procurement of **two** mobile units are recommended. *The following locations are suggested for the permanent DMS sites, however a site survey will need to be conducted to verify the applicability of each site with site requirements defined below:*

- I-90 east of US 83 for drivers heading towards the eastern part of South Dakota.
- I-90 eastbound approaching Rapid City for information to travelers heading into Rapid City and the Black Hills. This may also benefit the large influx of visitors during the Sturgis Motorcycle rally.
- I-29 northbound near Beresford for travelers heading towards Sioux Falls from Sioux City and Iowa.

Recommended Approach: Lighted digital electronic signs are used to display traveler advisories for any type of event, such as construction activity, traffic congestion, accidents or hazardous situations. The signs may post work zone advisories, such as speed limits or detours. Use of mobile installations is primarily for construction zones, hazardous situations, special events or for situations that last for a brief period of time. Permanent installations are more prevalent on higher traffic volume roads, where traffic management is a concern. These may post congestion warnings, advise of an upcoming incident or construction activity, or impending weather conditions. However, permanently installed message signs in rural areas may be used for the same purposes as in urban areas. The message the signs display may be operated via cellular modem, normal land-line telephone or by fiber optic connection.

Mobile message signs provide a supplement to permanent installations. Colorado DOT installed a variable message sign connected to a speed detection device that warns drivers of their speed through a dangerous curve on I-70. Other applications could include using VMS as part of a traffic management system for directing traffic during large events. It is recognized that the SD DOT has undertaken an initiative to deploy 6-8 dynamic message signs along I-90 and I-29. This project suggests the expansion of such a system to include the deployment of three additional permanent signs and procurement of two mobile signs.

Equipment Costs: High - The SD DOT has programmed \$1 million (state and federal funding) for the deployment of initial eight permanent installations message signs. This project description recommends the expansion of this effort. The project suggestion is for allocating \$600,000 for the expansion of the permanent sign network to include 3 more installations. The cost of equipment procurement and installation is \$100,000 for the sign, and an additional \$100,000 per installation. Mobile message signs can be purchased for approximately \$30,000 each. Total project cost is \$660,000.

O&M Costs: Mobile message units are either solar or battery powered. Remote control units are used to program signs. Permanent units will typically require a hard-wired power supply for operation. Average power consumption is approximately 15% of maximum, with 120/240 VAC single-phase power.

Communications: Most signs can interface with land-line, cellular, fiber and radio.

Status of Technology: This technology is proven and very low risk for deployment. The components recommended are available off-the-shelf. The following list suggests the types of technologies available for this technology. Specific vendor names and models are identified to illustrate the types of products that could be used (and for substantiating the price estimate), this list does not serve as a product endorsement, nor should it influence the standard SDDOT procurement process. Furthermore, a more detailed specification and design process will be required before actual deployment:

- NTCIP compliant signs that have LED (light-emitting diode) display modules that compose alphanumeric or graphic messages.
- A single-board computer installed as part of the sign and operates the sign.
- Allow for remote control via internal modem.
- Application software that allows for creating and editing message signs, security password, scheduling, and allows for control of multiple signs within a network.
- Electronics mounted in a rugged-environmental box mounted in virtually any location within 1000 feet (305 meters) of computer.
- Controller communicates with the computer via a single, RS-232 cable for distances up to 50 feet (15.3 meters).
- Sign housings designed to withstand a 100 mph wind load.

Steps to Deployment: The following are the suggested steps for deployment:

Step 1: Monitor the results of the first installment of message signs. Verify and perform site inspection on additional locations for fixed deployments statewide. Identify control methods and protocol for control. Specify the equipment needed, including the size and control method of the message signs and any additional components needed for activation. Identify any potential issues.

Step 2: Define a protocol for determining or composing messages and determine allowable personnel for programming the messages. Identify any other stakeholder groups that could benefit from the message signs system, such as emergency service providers.

Step 3: Procure, deploy, and test equipment for a specified duration, collect data and generate feedback.

Step 4: Develop a deployment and operations plan for installation of equipment at other locations based on experiences and lessons learned in *Step 3*.

Step 5: Monitor effectiveness of technology. Modify and adjust as necessary.

Schedules and Milestones: The following is a suggested deployment schedule for message signs:

	Month									
	1	2	3	4	5	6	7	8	9	10
<i>Step 1</i>										
<i>Step 2</i>										
<i>Step 3</i>										
<i>Step 4</i>										
<i>Step 5</i>									ONGOING	

Benefits / Cost: High - Initial capital costs may be great, however, message signs will benefit all travelers. Since message signs are a roadside implementation, it does not require in-vehicle devices for access to information.

- Benefits to DOT:
 - Real-time traffic warnings and traveler advisories bring more profile and credibility to the department.
 - Technology is mobile and can be used statewide.
 - Improved traffic management and safety, especially in construction zones.
- Benefits to Traveler:
 - Real-time, en-route traveler information that reduces frustration. Message signs may post possible detour routes around an incident, construction zone or special event in the area.
 - No need to have in-vehicle devices for reading the messages posted.
 - Increased safety due to known traveler advisories and speed limits.

Roles and Responsibilities: These systems can be controlled on site or from remote sources. The DOT will have to determine the roles of specific staff to operate and maintain the system.

Staffing: Minimal staffing is required. Reprogramming of message signs may be done from the field via cellular phone or laptop. Minimal time is needed to change the message.

Potential Funding Sources: DOT funding and federal grants for ITS deployments.

Application Examples: Indiana DOT (Dan Shamo, ITS Program Manager, 317 232-5523); and Dane County Wisconsin (John Norwell, Dane County, 608 266-4011).

Web Sites: <http://www.dot.state.wi.us/dtd/hdist2/monitor.html>
<http://www.vhb.com/i595.htm>
<http://www.dot.state.mn.us/guidestar/divert.html>

6.2 Recommended Near-Term Deployment Timeline

The following is the suggested phased cost table, cost summary, and schedule timeline for deploying the highest priority ITS projects in South Dakota. Projects selected emphasize the leveraging of current ITS initiatives, improving traveler information, and addressing safety issues. Projects selected in Year 2001 leverages current initiatives and address the traveler information issues that were discussed in the focus groups. Projects selected for Year 2002 further focuses on leveraging current initiatives, seeking to enhance and integrate traveler information, and again looks at improving safety. Projects selected for Year 2003 seek to further enhance traveler information and addresses the issue of emergency response.

Figure 6-1. Near-Term Project Costs

Near Term (0-3 years) Projects	Cost			Total
	2001	2002	2003	
1. Traveler Information Promotion	\$25,000			
2. Road Condition via CCTV	\$50,000			
3. Expansion of ATWIS	\$155,500			
<i>Land-line access</i>	<i>\$10,500</i>			
<i>Interactive voice recognition</i>	<i>\$30,000</i>			
<i>Internet enhancements</i>	<i>\$40,000</i>			
<i>Consolidate weather information numbers</i>	<i>80 hours staff time</i>			
<i>Improved road condition information</i>	<i>\$75,000</i>			
4. Automated Anti-Icing System		\$50,000		
5. Remote-Controlled Snow Gate Closure System		\$50,000		
6. Integrated Traveler Information		\$100,000		
7. Rural Addressing / GIS			\$100,000	
8. Expansion of Dynamic Message Signs			\$660,000	
Total	\$230,500	\$200,000	\$760,000	\$1,195,500

Figure 6-2. Near-Term Cost Summary

Recommended Projects	Cost
Traveler Information Promotion	Total direct costs estimated at \$10,000 for reproduction of flyers, reproduction of posters, radio / television spots, and travel to media locations. The SDDOT should also consider allocating \$10,000 to hire a marketing firm to assist in developing a marketing strategy and \$5,000 to evaluate the results of the traveler information promotion effort. Total project cost is \$25,000.
Road Condition Via CCTV	Camera setups including: cabling, camera server and other electronic equipment costs are reported at \$1,800 per setup. Housing units with heaters are extra (\$130 / unit). Other miscellaneous costs include wiring, mounting brackets and additional camera lenses if needed. These capital costs do not include the costs for installing a pole, and should be added for locations without existing poles. Total Equipment costs for recommended deployment of six cameras: \$30,000
Expansion of ATWIS	6. Land-line access = \$10,500 7. Interactive voice recognition = \$30,000 8. Internet enhancements = \$40,000 9. Consolidate weather information numbers = 80 hours staff time 10. Improved road condition information = \$20,000 to \$75,000
Automatic Anti-Icing System	Total equipment costs for recommended deployment of two anti-icing units: \$50,000. For bridges spanning 500 feet or less with four lanes or less, a self-contained, ready-to-roll-out system costs approximately \$19,300. This system includes 10 spray nozzles that will provide coverage to the driving lanes only (shoulders will receive run-off), piping, chemical tank, and sensors. This system is not expandable, and requires the use of clear chemical agents such as magnesium chloride. Salt brine solutions will not work. Please note that larger systems (including 1000 gallon tank, supply pump structure, precipitation sensor, installation supervision, training, 15 spray nozzles, and piping) cost approximately \$63,300.
Remote-Controlled Snow Gate Closure System	Suggested project cost is \$50,000 for the design, deployment, test and evaluation of 3 remote-controlled gates. Traditional snow gates cost approximately \$3,600 for equipment and installation. Remote-controlled units cost approximately \$6000 (including gate, closure mechanism, and 1-year maintenance agreement).
Integrated Traveler Information System	Total cost for the development of the Web site is \$100,000. The total equipment costs for deployment of six cameras is \$30,000. Please refer to Road Condition via CCTV project write-up for technical details. Web site planning (20 person days) - \$10,000 Coding and graphics development (30 person days) - \$20,000 Information gathering (60 person days) - \$40,000
Rural Addressing and GIS	While the SDDOT has already purchased equipment for rural addressing, setting up a database to link GIS and rural addressing data and finishing the geo-coding effort may be a time consuming endeavor. The estimated project cost is \$100,000 to contract for database development for counties within South Dakota.

Recommended Projects	Cost
Expansion of Dynamic Message Signs	Total project cost is \$660,000. The project suggestion is for allocating \$600,000 for the expansion of the permanent sign network to include 3 more installations. The cost of equipment procurement and installation is \$100,000 for the sign, and an additional \$100,000 per installation. Mobile message signs can be purchased for approximately \$30,000 each.

The following figure provides a illustration of the expected near-term deployments around South Dakota. Please note that the illustration includes the eight planned DMS deployments that already have been programmed by the SDDOT and which will be undertaken in 2001.

Figure 6-3. Illustration of Near-Term Deployments Statewide

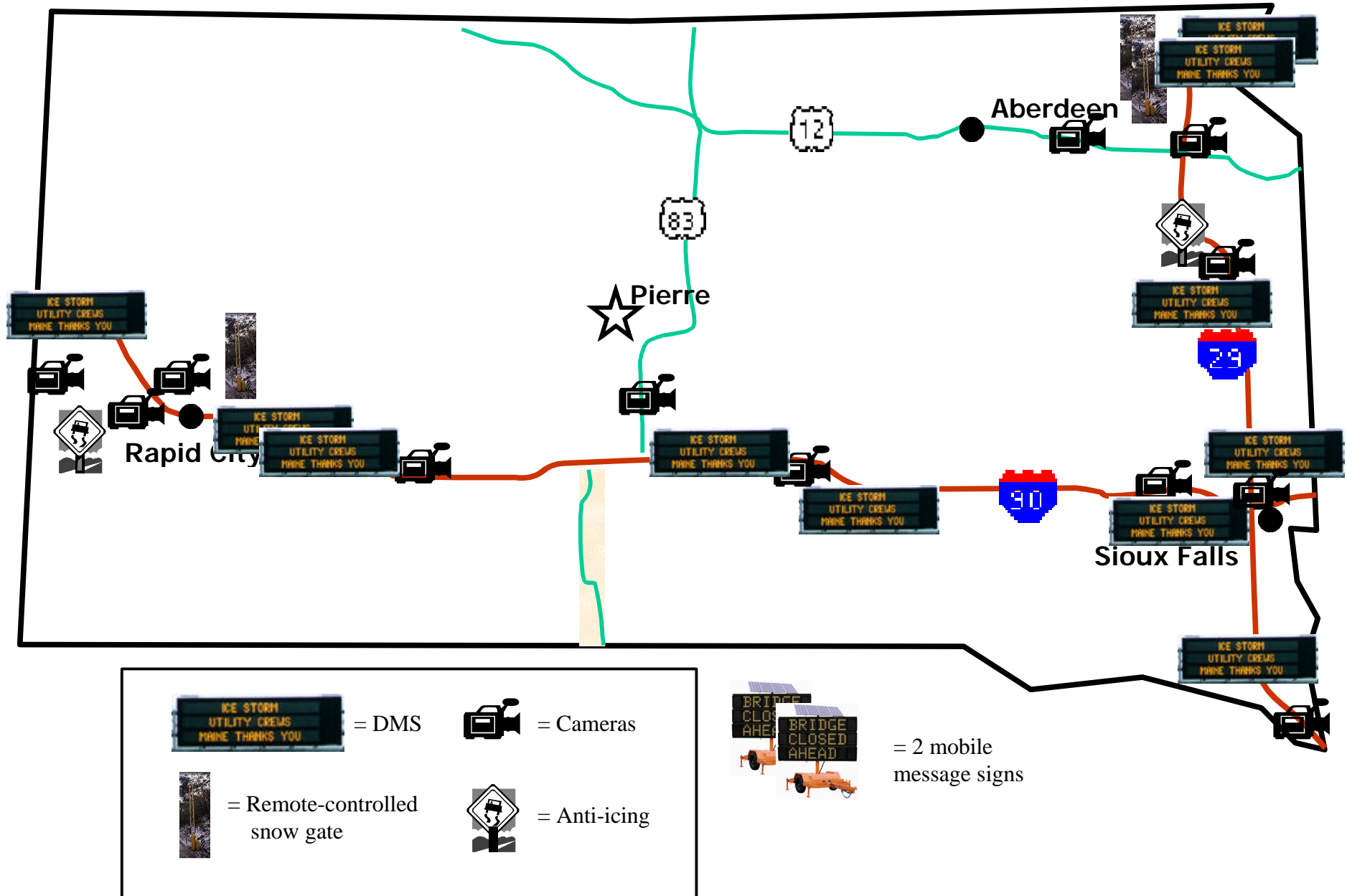


Figure 6-4. Near Term Project Deployment Timeline

Projects	2001	2002	2003	2004
Traveler Information Promotion				
Road Condition Information via CCTV				
Expansion of ATWIS				
Automated Anti-/De-icing System				
Remote Controlled Snow Gate Closure				
Integrated Traveler Information System				
Rural Addressing / GIS				
Expansion of Dynamic Message Signs				

6.3 Recommended Projects for Medium- to Long-Term Deployment

The following are the 21 candidate projects recommended for medium- to long-term deployment. The medium-term is defined as four to seven years, and long-term is eight years and beyond the start of South Dakota's rural ITS program. The appropriate timeframes were recommended based on both a duration for the activity and its' priority.

1. 5-1-1 for Traveler Information
2. Portable Traffic Management System
3. Automatic Vehicle Location for Agency Vehicles
4. Highway Advisory Radio
5. Infrastructure Inventory and Condition Monitoring System
6. Multi-Jurisdictional Transit Coordination
7. Rural Traffic Operations and Communications System
8. Highway Railroad Intersection Safety
9. Intersection Collision Countermeasure
10. Multi-Jurisdictional Emergency Services Coordination
11. Hand-held Devices for Reporting Accident Data
12. Roadway Geometrics Alert System
13. Emergency Warning System
14. Information Exchange Network
15. Broadcast Traveler Information
16. Portable ITS and Traveler Information Technologies in Work Zones
17. Breathalyzer Ignition Interlock System
18. Computer Aided Dispatching (CAD) / Automatic Vehicle Location (AVL) / Mobile Dispatch Terminals (MDT) for Rural Transit
19. On-board Snow Plow Driver Assistance
20. Mayday Infrastructure
21. Web-Enabled Transit Route Planning / Universal Smart Pass

6.3.1 5-1-1 for Traveler Information

Objectives: 4, 7, 8, 10, 12, 14, 15



Desired Outcomes: Real-time traveler information, including weather and road conditions, construction activity, facilities available and other special events notification. It is anticipated that travelers will use this number more often since it is easier to remember than normal 7 or 10-digit traveler information lines.

Project Locations: Statewide

Technical Approaches: According to FCC order 00-256, the United States Department of Transportation (USDOT) petitioned for assignment of a nationwide N11 number for use by state and local governments to deliver traveler information. Most state and local government provide this via a traveler information hotline with a designated phone number. However, these systems are underutilized because travelers have difficulty either remembering or ascertaining these numbers to access the information, especially as they travel across jurisdictions. Therefore, the FCC has assigned 5-1-1 as the national access code for traveler information. The USDOT believes that using a three-digit number, such as 5-1-1 and 9-1-1, is easier to remember and more convenient to use across jurisdictional boundaries. Hence, with the increased use of the traveler information hotline, the USDOT believes that the establishment of 5-1-1 will reinforce its goals with providing traveler information, such as reducing congestion, increasing safety and lowering fuel consumption.¹

5-1-1 works in the same way that 9-1-1 does in that the code is dialed and the call is automatically routed to an information service provider via the telephone company. Depending on the jurisdiction and the local exchange carrier, partnerships may be formed between phone companies and information service providers to route 5-1-1 calls to the desired location.

Equipment required: Based on the national ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Center Subsystem: The type and amount of information provided will vary from locality to locality. Information for traveler information hotlines is usually provided from a central location, which could be in a city office or maintenance facility associated with the locality. The dissemination ranges from manually recorded to fully automated. Automated arrangements may

use a personal computer to compile a variety of travel information (i.e. road and weather conditions, rest facilities, construction information) from dispersed sources within the region. The system is connected to the local telephone company providing 5-1-1 service. The phone call is then routed through the phone company or wireless provider in the region to the information provider.

Roadway Subsystem: Road conditions monitoring can range from emergency personnel observation to a fully connected traffic operations and communications system. State troopers may report road conditions to central dispatch. Weather information may be provided by remote weather stations near the highway. Traffic management centers with closed circuit television monitoring and in-pavement loop detection may provide road condition and congestion information. Other roadside implementations that could be tied into the system include data from environmental sensing and road weather information stations.

Traveler Subsystem: Information is accessible via land-line telephone primarily. Depending on contracts with wireless network providers, cellular customers may also use 5-1-1 service from their mobile phone.

Communications Requirements: A land-line connection to a traveler information provider from a phone company is needed. Travelers only need a land-line telephone in the area to use the traveler information provided for the area. Wireless providers, if they have a contract with telephone companies for routing purposes, will also provide 5-1-1 service.

Steps to Deployment: The following are suggested steps to facilitate deployment:

Step 1: Research other N11 (E-9-1-1) systems in place and established routing protocols. Determine the type of information to be provided by the 5-1-1 number and the sources for input into system.

Step 2: Inventory communications infrastructure and associated institutional barriers associated with access via land-line and cellular. For example, identify local exchange carriers in the area to see which regions they serve.

Step 3: Determine the capacity needed to accept 5-1-1 requests at both the telephone and information service providers. Identify any additional stakeholders in the system.

Step 4: Obtain and test the equipment on a small scale. Test equipment for routing 5-1-1 calls to the information service provider. Obtain feedback from use of the system.

Step 5: Develop a full-scale deployment plan for a statewide deployment. Incorporate the lessons learned from *Step 4*.

Step 6: Monitor and evaluate. Modify as necessary.

Organizational Management: The biggest challenge to implementation is matching up jurisdictional and telephone company boundaries. For example, one telephone company could serve two different regions that need to have separate traveler information resources. Partnerships and agreements between the telephone companies and the information providers should be established so 5-1-1 calls are directed to the desired provider. One solution offers travelers the option to select certain regions for further information at the beginning of the call.

Schedules and Milestones: The assignment of the 5-1-1 code for traveler information by the FCC occurred in July 2000. There are no full-scale deployments to emulate. However, a test of using an N-1-1 dialing code versus a 7-digit telephone number in the Cincinnati and Northern Kentucky area has been conducted. When Ohio residents dialed 333-3333 to reach traveler information services and Kentucky residents dialed 2-1-1 to reach the same service, the Kentucky Transportation Cabinet reported 72 percent more calls were made to the abbreviated dialing code than to 333-3333.¹

	Month														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
<i>Step 1</i>															
<i>Step 2</i>															
<i>Step 3</i>															
<i>Step 4</i>															
<i>Step 5</i>															
<i>Step 6</i>															<i>Ongoing</i>

Capital Costs: Moderate to High - Initial estimates for jurisdictions to investigate and begin the process of converting an existing traveler information number to 5-1-1 is approximately \$50,000. However, this estimate can increase drastically depending on the types of interactive features provided by the system; and the amount of effort involved to implement agreements with telephone companies.

O&M Costs: Most of the costs associated with maintaining this system are associated with keeping the traveler information current. Real-time travel information will obviously require more maintenance than travel information that is updated once daily. According to the partnership, the phone companies may be able to lease or borrow government resources in exchange for the 5-1-1 service.

Benefits / Cost: High - This abbreviated one-number service is beneficial to both travelers and information service providers:

- Traveler information systems originally under-utilized due to travelers having problems remembering telephone numbers will be utilized to their full potential. Surveys conclude that travelers would like to have that traveler information, but have problems getting to it.
- Better information to travelers thereby saving time and money, and decreasing congestion on mainline routes.
- Increased safety on rural roads since travelers will know what the road conditions will be like ahead of them.
- Seamless access to traveler information across jurisdictional boundaries.

Roles and Responsibilities: The information service provider should be responsible for heading up the effort to partner with telephone companies for implementation of this system. Telephone and wireless companies have the responsibility of providing good service for routing 5-1-1 phone calls to the information service provider.

Staffing: Minimal staffing is needed. Normal staff operations to maintain switching equipment is all that is needed to reroute 5-1-1 calls. Staff operations maintaining the traveler information at the information service provider should not change either.

Potential Funding Sources: Federal funding for the conversion program will begin in FY 2000. Funding (up to \$50,000) is subject to funding availability. The anticipated amount of funding available in each FY is up to \$2 million with a program total of up to \$5 million. Funding can be used for system design; conversion support including software modifications and necessary hardware changes; and system and acceptance testing. A 20 % match by non-federally derived funds is required.

Application Examples: Ohio/Kentucky 211 Traveler Information Experiment

Web Sites: <http://www.itsa.org/traveler.html>, <http://www.its.dot.gov/511/511.htm>

References: 1. FCC Order #00-256. "Assignment of 5-1-1 for Traveler Information."

6.3.2 Portable Traffic Management Systems (PTMS)

Objectives: 2, 3, 7, 8, 10, 12

Desired Outcomes: Deployment of a mobile package of traffic management tools that may be used in both planned and unplanned event situations.

Project Locations: The use of portable traffic management systems is site-specific, however, several units can be developed and shared among districts, counties, and local agencies. Portable monitoring units can be used in any location where real-time traffic monitoring is required. An example is during planned events such as the Sturgis Motorcycle Rally and for unplanned events such as flooding or other disasters. Planned mobile deployments may be geared toward rural areas that only require traffic management functions during seasonal events.

Technical Approaches: In rural locations, where resources are constrained, there is value in developing a multi-purpose, mobile traffic management system that can support a broad range of applications. The intent is to provide a full complement of core-equipment components for traffic management in a single mobile package, which can be towed by a light truck. The package can be used for typical rural transportation activities, including:

- Special event management;
- Incident management;
- Natural disaster management; and
- Traffic data collection.

The trailers should be designed to be self-contained and require minimal setup and staffing. Because the system is a complete self-contained package, districts or regions may pool resources to purchase several systems for use among regions as needed. Examples of components for the portable traffic management system may include a combination of the following:

- A variable message sign;
- A portable traffic signal;
- Weather sensors;
- Radar speed detection;
- Video surveillance;
- Wireless communications;
- Floodlights;
- Power source; and

- Highway advisory radio.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within each subsystem it can be found:

Center Subsystem: The mobile package itself acts as a center for traffic management. The system is mobile, but data may be monitored from a remote source such as a district office or traffic management center. Traffic data may also be monitored on-site as well.

Roadside Subsystem: These are the visible components of the system that may include: variable message sign; portable traffic signal; weather sensors; radar speed detection; video surveillance; wireless communications; floodlights; power source; and highway advisory radio. This mobile system can be controlled remotely, or on site. Communications is typically via wireless communications.

Vehicle Subsystem: Travelers can receive traffic conditions and travel advisories via AM radio.

Traveler Subsystem: If the camera installations are opted for deployment, these images can be relayed to travelers via various media such as the Internet and television.

Communications Requirements: The mobile traffic management centers will most likely rely on wireless communications connection to communicate between the station and the remote maintenance source. Recorded messages for the HAR device may be stored at the remote facility and transmitted to the mobile TMC on demand.

Steps to Deployment: The following are some suggested steps regarding deployment:

Step 1: Evaluate areas in South Dakota that have high seasonal traffic and incident rates. For example, popular travel destinations such as Mount Rushmore, the Black Hills and the Badlands could be potential candidates. Other events such as the bicentennial celebration of the Lewis and Clark trail could benefit from use of such a system for traffic control.

Step 2: Explore options for equipping these mobile units. Determine from research and past experiences the combination of ITS tools most suitable and useful for South Dakota.

Step 3: Develop partnership agreements with agencies willing to pool resources.

Step 4: Develop specifications and design for the portable traffic management system.

Step 5: Retain vendor to develop system.

Step 6: Test and implement system. A good milestone is to aim for complete implementation for use during the Sturgis Motorcycle Rally in late summer.

Organizational Management: The operations and maintenance of the portable traffic management system should fall to traffic operations within the DOT. However, if shared resources are used to retain equipment, primary considerations include how the units will be lent out, and one body should be responsible for keeping track of the units as they are borrowed. The DOT may have to be the single organization to determine how the units will be distributed among regions. Situations and planned events for when the system should be used may be determined by consensus of the purchasers. The regions can authorize and assign maintenance personnel to operate individual units. Great consideration of “wants” versus “needs” will help to manage costs.

Schedules and Milestones: The following is a suggested schedule for the development and deployment of the portable traffic management system:

	Month													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<i>Step 1</i>														
<i>Step 2</i>														
<i>Step 3</i>														
<i>Step 4</i>														
<i>Step 5</i>														
<i>Step 6</i>														

Capital Costs: Moderate to High - Design of the system including hardware and software requirements, and standard operational protocols may cost \$100,000 for the initial contract work. Purchase of additional mobile units themselves may cost around \$50,000 each. Training for each unit may cost around \$1,500, depending on regional experience with ITS initiatives. Design of a system may be more cost-effective than what is mentioned above. New York State DOT is currently experimenting with a system like this, and variations in design may be minimal to apply to rural South Dakota.

O&M Costs: Costs include troubleshooting of the equipment and normal maintenance to make sure the equipment works properly in the future. Upgrade of equipment is another consideration.

Benefits / Cost: Moderate. The mobile nature of this deployment will allow for many agencies to share costs but also to reap the benefits of using this system. Examples of benefits include:

- Mobile nature of system allows for great flexibility of use.

- Systems may be sufficient for addressing the traffic control needs of rural states that experience traffic due to tourism and special events.
- Leveraging of resources is increased allowing multiple agencies use of system.
- Potential “plug and play” capabilities of the system furthers the ITS vision of interoperability between components.

Roles and Responsibilities: The SDDOT may need to take the lead in system development and procurement and act as the coordinating body between agencies. A process for using of the system will need to be developed. Some considerations include determining whether the DOT will operate the system even though it is being used for a non-DOT event. Consensus on distribution and use of the system is key.

Staffing: The nature of these systems is that it is used on an as-needed basis. The use of the system will require staff for set up and operation of the system. Posted messages and HAR recordings would need to be changed as needed.

Potential Funding Sources: Shared funding between SDDOT and local municipalities desiring use of equipment. In the example of New York State DOT, federal funding was received for the development and deployment of the portable traffic management system.

Application Examples: Minnesota DOT, New York State DOT.

References: *NYSDOT Strategic Deployment Plan of ITS for Region 2.*

6.3.3 Automatic Vehicle Location for Agency Vehicles

Objectives: 2, 3, 5, 6, 7, 8, 12, 14

Desired Outcomes: Utilize automatic vehicle location (AVL) technologies to track the location of agency vehicles (e.g., snow plows, maintenance, highway patrol, etc.) for improved operations and efficiency.



Project Locations: A good starting point would be to apply AVL at a local or regional level (such as the Pierre area) to assess usefulness of technology.

Technical Approaches: The majority of AVL technologies use the GPS (Global Positioning System) to pinpoint the location of various vehicles equipped with a GPS receiver. GPS is a free service provided by the US Government, which allows the use of a constellation of

24 satellites in orbit 10,900 miles above the earth. Vehicles with GPS receivers have their position determined by a space/time triangulation of three or more of the 24 satellites. AVL also incorporates a wireless communications system to communicate the vehicle location back to the control center. Some options for this communications link are the state's existing radio frequency system, cellular communications, cellular digital packet data (CDPD), or satellite communications.

The goal of implementing AVL on agency vehicles is to track vehicle locations to incident sites for fleet management, for special applications such as salting and snow plowing, and to provide communications, both voice and data, between agency vehicles and dispatch centers. Combined with GIS software or mapping database, and road weather information systems, this technology can ensure the most cost-effective use of resources and deploy snow plows and de-icing materials to those areas most critically in need. Trucks equipped with an AVL system will show the truck's location on a map at the central office and in each of the highway district offices. The AVL system also monitors if the trucks are spreading salt or if the salt spreader is turned off. Trucks are also equipped with infrared pavement temperature sensors. These sensors advise staff of the amount of salt needed to prevent freezing. To aid in these snow removal efforts, the district offices may also receive information from Road Weather Information System (RWIS) units that continuously relay information such as air temperature, wind direction and speed, pavement temperature, and precipitation type and amount.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Center Subsystem: A computer with a mapping layer of the area covered by the emergency response agency is used by the Emergency Response Center to track vehicles with installed GPS transponders.

Vehicle subsystem: GPS receiver and communications modules facilitate two-way communication between the vehicle's operator and center dispatchers. Along with messages and requests for assistance, center dispatchers can also receive information about miles traveled and types of chemicals spread. Communications can be accomplished using cellular or satellite communications.

Roadway subsystem: Differential GPS data correction systems provided by the Coast Guard on FM sub-carrier frequencies can be installed along the roadside for improved location accuracy. Optional RWIS sensors may be installed that transmit information on pavement and weather conditions back to the operations center to aid in decision-making.

Center subsystem: Maintenance/operations or highway patrol office or dispatch center equipped with electronic map displaying vehicle locations. Equipment is typically used to monitor location and system operations of snowplows. Vehicle location may greatly assist personnel in dispatching closest officer or maintenance vehicle to the scene of an accident.

Traveler subsystem: Potentially, this system could be tied into a Web site, providing travelers with information on which roads have been plowed and are safe to travel.

Communications Requirements: Satellite coverage by at least three NAVSTAR satellites to pinpoint a location are needed for the receiver to activate. The receiver returns the location over a wireless connection. In-vehicle mobile data terminals may be installed in patrol vehicles to assist in transmitting emergency data, or obtaining other pertinent data from centers to facilitate Highway Patrol or maintenance activities. Some options include existing radio frequency system, cellular communications, cellular digital packet data (CDPD), or satellite communications.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Identify the setting that AVL would be best suited for deployment. Examine whether the benefits outweigh the costs.

Step 2: Determine the extent of the system deployment, whether it will be municipal, region-wide or statewide.

Step 3: Examine different vendors of computer systems and GPS equipment. Also, examine software manufacturers that will provide the efficient usage of the system. Determine the amount of staff that would be needed to maintain the system and police personnel in charge of using the information. Make sure the system is easy to use for dispatchers.

Step 4: Procure and test equipment to identify its effectiveness. Test the system on a limited amount of fleet vehicles for a specified duration and obtain feedback.

Step 5: Based on feedback, develop a deployment plan suitable to the size of the fleet.

Step 6: Monitor the effectiveness of the system – for example, make sure police become more responsive to the needs of people in rural areas.

Organizational Management: Protocol considerations include: determining procedure for locating vehicles and those responsible for gathering the information. For example, will police dispatchers be responsible for locating the vehicle using this system, or will specialized personnel use the system? How will the current system be maintained – a person newly trained in using GPS/GIS or will a person who already maintains a computer system be trained to maintain it?

Schedules and Milestones: While this technology has been proven and vendors are readily available, implementation of an AVL system is a large-scale project that can take several years. The following is a suggested schedule to test AVL equipped snowplows or highway patrol vehicles:

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
<i>Step 1</i>						
<i>Step 2</i>						
<i>Step 3</i>						
<i>Step 4</i>						
<i>Step 5</i>						
<i>Step 6</i>						(ONGOING)

Capital Costs: High - Total budgets for AVL systems range from \$1 million to \$2 million depending on how many vehicles are planned as a part of the system. The project suggestion is for funding a fleet of approximately 15 fleet vehicles. The project cost is approximately \$300,000. Typical AVL costs include \$6200 per vehicle for a GPS-based location system, \$2300 per vehicle for computer aided dispatching capabilities, and \$2400 per vehicle for digital communications or \$3500 per vehicle for trunked communications.

O&M Costs: Costs include consideration of computer maintenance for all fleet vehicles and software upgrades. Troubleshooting of the system may also be included in maintaining the system for future use. Hardware upgrades may also be a deciding factor and will most likely be capital intensive. Other costs include staff training.

Benefits / Cost: Moderate - In a rural setting, an AVL system for any type of fleet would be beneficial. However, the potential high operating and capital costs may not be feasible for smaller townships. Sharing of resources and operating costs would allow smaller townships and cities to benefit from this type of technology. Additionally, AVL installations in all fleet vehicles can be quite costly. Adverse reaction to monitoring of snowplow activities may be expressed by staff.

- Benefits to DOT:
 - Better removal of snow from the roadway resulting in faster incident response and reduction in delays.
 - Improved operations at exact locations of snowplows may be known.
 - Ability to monitor agency vehicles in real-time.
 - Optimize the dispatching of agency vehicles.
 - Favorable public perception of DOT.
 - Instant location of police vehicles for dispatching trooper units nearest incident scene.
 - Location information provided also increases safety for patrol officers.
 - System can help to identify locations that experience frequent patrol stops or incidents.
 - Location of incidents for other emergency personnel to respond, but only if a patrol vehicle has responded.
 - System is capable of other functionality such as logging maintenance work performed on fleet vehicles and other operations statistics.
- Benefits to Traveler:
 - Reduction in travel time delays and increased supply of traffic information.
 - Improved safety on roadways during inclement weather.

Roles and Responsibilities: Public safety agencies will be responsible for maintaining and operating the system, unless these resources are currently shared with other agencies. For example, in some states, Highway Patrol will assist in dispatching maintenance vehicles for the DOT during non-office hours.

Staffing: Dispatchers need to be capable of operating the system on a GIS layer to locate police vehicles. Training will be required to familiarize dispatchers with using the system. It is anticipated that the system operations can be integrated into current protocols and procedures. Implementing an AVL system may require at least one full-time agency person dedicated to the project as the system is designed and integrated. Other staff will assist with procuring and installing the equipment, and training other personnel. Eventually, this system can be integrated into current dispatching procedures and may not require additional staff for system operations.

Potential Funding Sources: Federal public safety grants, state DOT and local funding.

Application Examples: Kansas State Patrol, Bay Area Freeway Service Patrol Communications / Vehicle Tracking System (Jaime C. Maldonado, Metropolitan Transportation Commission, (510) 464-7899), Minnesota DOT: Dick Maddern, (218) 749-7793 ext. 3804, richard.maddern@dot.state.mn.us; Orbital GPS systems: Chris Body (443) 259-7328, cbody@oscsystems.com

References: 1. *NYS DOT ITS Toolbox for Rural and Small Urban Areas*.
2. *Traffic Technology International*, August/September 1997, Page 14.
3. *Automated Vehicle Location System Pilot Project*, Virginia Department of Transportation Northern Virginia District, December 1997.
4. <http://www.fhwa.dot.gov/tfhrc/safety/pubs/its/generalits/heartland.pdf> ,
5. <http://www.mtc.ca.gov/projects/fsp/fspcomm.htm>
6. News release on Kentucky AVL project: <http://www.kytc.state.ky.us/News/snow.htm>;
7. Orbital Systems transportation and maintenance page:
<http://www.orbital.com/TMS/TransportationMaintenance/index.html>
8. New York State Rural ITS Toolbox

6.3.4 Highway Advisory Radio (HAR)

Objectives: 2,4

Desired Outcomes: The ability to disseminate traveler information, including emergency notices and work-zone information, through HAR. This technology also addresses the need for either a regional or statewide HAR or dedicated highway advisory frequency. The information that may be disseminated includes:

- Special event and parking;
- Road closures and detours;
- Inclement weather conditions; and
- Alternative routes in known congested areas.

Project Locations: Construction zones and roadways that become especially hazardous in inclement weather. HAR may be deployed statewide in these areas of special need. This project recommendation is for a mobile HAR unit that can be tested and evaluated in construction zones.

Technical Approaches: HAR systems use recorded information on traffic conditions and tourist-related activities to reach users in a limited geographical area over AM and FM frequency; new recordings are made when conditions change sufficiently. Some systems provide the capability to remotely switch between alternative messages. These systems are best deployed to meet the needs of users in tourist or work-zone areas where the information provided is more predictable and requires less interface on behalf of the operating agency. Information signs alerting users to the service should provide for identifying whether the service is operational. As with VMS, users can become desensitized to the medium if information is not kept up to date or incorrect information is broadcast. HAR systems can be deployed in the near-term to meet the needs for work-zone and tourist-related information. In the medium-term, enhanced HAR systems are possible that link together several successive HAR towers in order to deliver a continuous message to travelers as they traverse through the ranges of several HAR towers. The primary advantage of HAR is that it reaches travelers using a device they already have in their vehicle: the radio. Most HAR stations broadcast at 10 watts or less, meaning their effective range is no more than a few miles. HAR can be on both AM and FM stations set aside for information, such as 87.9 FM or 530 AM.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Vehicle subsystem: AM/FM radio for receiving recorded messages.

Center subsystem: Short-range radio broadcast station to transmit messages.

Roadway Subsystem: Static signs with flashing lights to alert drivers to tune into a certain frequency to obtain traffic information. Portable CMS are typically LED-display, solar charged and programmable. Legibility distances are approximately one thousand feet (1000'). Signs may be equipped for remote operation.

Communications Requirements: HAR can typically be programmed via cellular or telephone.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Identify those areas along the roadway that are in need of traveler information.

Step 2: Determine what type of information needs to be disseminated in each area.

Step 3: Research the possibility of a public/private partnership. A commercial station may be willing to allow the DOT use of airtime for a fee.

Step 4: Install equipment and evaluate.

Organizational Management: Some institutional issues involve personnel capable of controlling HAR and establishing standard messages to transmit within construction zones.

Schedules and Milestones: The following is the suggested schedule for the deployment of highway advisory radio:

	Month								
	1	2	3	4	5	6	7	8	9
<i>Step 1</i>									
<i>Step 2</i>									
<i>Step 3</i>									
<i>Step 4</i>									
<i>Step 5</i>									
<i>Step 7</i>									

Capital Costs: Moderate – Commercial systems run approximately \$25,000 for equipment and installation. This includes a transmitter enclosed in a pad mounted signal cabinet, antenna (antenna cost varies with range), flashing advisory lights that are solar-powered and remote-controlled, and software that may be used to monitor the system. Very basic systems may be

purchased for as little as \$8,000. Project recommendation is for \$30,000 to fund and implement a mobile HAR system.

O&M Costs: Operations and maintenance is minimal once units are in place.

Benefits / Cost: Potentially high, as this system addresses a variety of traveler information needs at low cost.

- **Benefits to DOT:**
 - Mobility of technologies allows use across state.
 - Economic way to address numerous needs relating to traveler information dissemination.
 - Favorable public perception of DOT.
- **Benefits to Traveler:**
 - Radios are present in most vehicle makes and models.
 - Can access all types of traveler information, including warning messages and pavement conditions.

Roles and Responsibilities: FCC approval is required for broadcasting. It should be noted also that many travelers may need more than just a flashing beacon to get them to tune in to the HAR station, and additional promotion may be required.

Staffing: The messages broadcast over the system require consistent updating.

Potential Funding Sources: DOT funding. Commercial radio stations may provide airtime and broadcast equipment in exchange for the opportunity to promote their station on freeway signs.

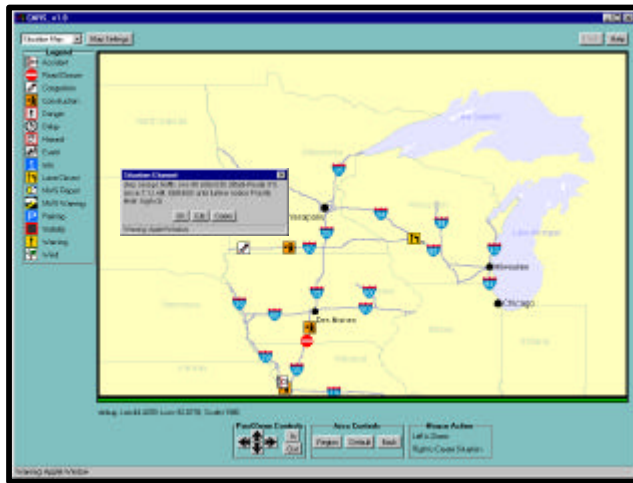
Application Examples: Dick Kane, Florida DOT; (850) 414-4590. Florida DOT contracted with a private station to provide emergency notifications as well as more routine traveler information.

Web Sites: <http://www.theradiosource.com>

6.3.5 Infrastructure Inventory and Condition Monitoring System

Objectives: 1, 4, 7, 8, 9, 10, 12, 14, 15

Desired Outcomes: Integrated system for posting and accessing information pertaining to the roadway network, information such as accidents, road closures, construction, and height and weight restrictions.



Project Locations: Statewide

Technical Approaches: The basic component of this system consists of specialized software for inputting, updating, and viewing current road and traffic conditions. Once inputted, there must be a mechanism for storage and retrieval of data, most often a database. Practitioners and

travelers must be able to view this data, preferably with visual displays. This is commonly most successful with the use of Internet-based platforms. Travelers can also access information by dialing into an automatic voice response system. Individually packaged information designated through a subscription service allows travelers to receive updated information through their pagers, email, and other computing devices.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Center subsystem: Dispatchers at a central traffic operations center will typically input new situations into the database. However, the system being used in Iowa, Minnesota, Missouri and Washington state is Internet-based, allowing for those with permitted access to enter situations using the Internet from any location. For example, a supervisor may enter a situation in the field with a laptop and Internet link via cellular communications. A database located within the DOT is required for storing road restrictions, conditions, advisories, and other related information.

Vehicle subsystem: The system permits remote access and input. In some states, Highway Patrol act as probes for current road and travel condition. While information is sent via radio or telecommunications, the system is capable of receiving data from laptops in the field.

Traveler subsystem: Travelers can access information via the Internet, dial-in telephone, cellular phone message systems, personalized e-mails and pages, and faxes. This information can also be tied to kiosks at rest stops as well.

Communications Requirements: The proposed system is Internet-based. Those accessing the system would need Internet access, at a minimum a dial-up connection. Greater system reliability would be improved with higher speed connections such as ISDN or DSL.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Evaluate various systems that are available such as the Condition Acquisition Reporting System (CARS) or the Highway Condition Reporting System (HCRS) in Arizona for leveraging opportunities.

Step 2: Document current processes for posting information to travelers and determine data inventory requirements. This may consist of building onto a current system.

Step 3: Determine system specifications and design elements. Identify potential integration issues such as potential firewall concerns and location / responsibility of database.

Step 4: Letting and award of project.

Step 5: System design and deployment.

Step 6: Test and evaluation.

Organizational Management: This deployment has potential for a great number of users within the DOT. Some operations-level considerations include: determining process for inputting situations in database, determining level of access for users (including travelers), and consistency of message formats posted. Most issues are institutional in nature.

Schedules and Milestones: These types of systems are being used in other states in a real-world setting. The following is the suggested schedule reflecting steps to deployment:

	Month														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<i>Step 1</i>															
<i>Step 2</i>															
<i>Step 3</i>															
<i>Step 4</i>															
<i>Step 5</i>															
<i>Step 6</i>															

Capital Costs: Moderate - Initial capital costs are \$100,000 for deployment. Similar initiatives require internal database (e.g., Oracle, SQL) support that can operate on an existing computer. Staff and travelers can access the system using Internet browsers that can be downloaded and upgraded for free.

O&M Costs: Annual costs are estimated at \$50,000 for technical support and upgrades provided by the vendor.

Benefits / Cost: High. This project provides an opportunity to streamline the reporting and posting of situations that occur on the roadway to travelers, departments within the DOT and external agencies. The information is not limited to traffic accidents and congestion, but can be any type notice such as travel advisory, construction updates, and travel conditions.

- Benefits to DOT:
 - Fostering better intra-and-inter-agency communication of roadway problems
 - Providing timely, valuable information to travelers
 - Central storage and posting of situations on the roadway
 - Platform independent system allows permitted users to enter situations via an Internet browser
- Benefits to Traveler:
 - Real-time access to construction and traffic / road condition information
 - Central repository for accessing advisory, construction, and weather information statewide
 - Increased options for accessing traveler information

Roles and Responsibilities: DOT participation will be required throughout the system development process. The DOT will need to determine requirements for the system and may require an extensive evaluation of current processes and protocols.

Staffing: This technology will require an estimated 10% of a staff administrator's time for maintaining the system database housed within the DOT. Additionally, staff will need to be trained on the system to ensure that situation messages are consistent in nature. In the example of the Condition Acquisition Reporting System (CARS), this system is based on the Traffic Management Data Dictionary standards ensuring greater consistency of the structure of messages.

Potential Funding Sources: DOT. As an example, funding of the Condition Acquisition and Reporting System is supported by SP&R money (as designated by similar pooled-fund studies).

Application Examples: Condition Acquisition and Reporting System (CARS) (John Whited, Iowa DOT, (515) 239-1411); Highway Restriction and Closure System (HCRS) (Phil Bleyl, Area Engineer, FHWA Arizona Division Office (602) 379-3913, Dottie Shoup, Supervisor, Traffic Operations Center, (602) 252-1951); Highway Travel Condition Reporting System (HTCRS) (Glen Hammer, Oregon DOT, (503) 986-3977).

Web Sites: <http://216.17.172.241/Version1/carsapp.htm> (For user name and access, contact John Whited), <http://www.azfms.com/HCRS/hcrs.html>, and <http://www.tripcheck.com/RoadCond/roadcondindex.htm>

6.3.6 Multi-Jurisdictional Coordination of Transit Services

Objectives: 1, 3, 4, 5, 7, 9, 10, 11, 12, 13, 14, 15

Desired Outcomes: Centralized transit information of all small urban and rural transit services available throughout the entire state of South Dakota. The information will be accessible via telephone and Internet.



Project Locations: Statewide

Technical Approaches: Most transit fleets currently in existence in rural areas are too small (e.g., number of fleet vehicles and ridership) to warrant extensive investment into ITS for further enhancing operations. However, the information provided to the transit riders could be improved with the development of a central repository for multi-modal options (e.g., buses, vanpools, taxis, airplanes, etc.) across the state. This project proposes to provide such information as routes, schedules, pick-up drop-off time estimates, type of service provided (e.g., fixed or demand response), coverage area of service, hours of operation, cost, and assistance in

planning trips across multiple towns. The information can be provided through an interactive voice response (IVR), dial-up telephone system and/or on the Internet. The Internet site could potentially be incorporated into the integrated traveler information system, or be a stand-alone system. The City of Sioux Falls currently provides transit information via the Internet and is a good model for other regional transit agencies for posting information on an on-line format.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Center subsystem: The center subsystem consists of a central hosting service for the IVR and Internet service. While the system would automatically output information to the personal access subsystem, manual input of the data may be required.

Traveler subsystem: The Web site could be designed to enable transit passengers the ability to check updated scheduling information of service areas. This site could also provide an on-line trip-planning guide, whereby users can plan trips across multiple jurisdictions. This information can also be provided by an interactive voice response telephone system.

Communications Requirements: The telephone service could be made available over land-line or cellular service. Internet service is required for any on-line platform.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Identify transit services available across the state.

Step 2: Work with local transit agencies to assemble schedule information, hours of operation, cost details, contact information, type of service provided, eligibility requirements, etc.

Step 3: Begin planning for trip planning web site.

Step 4: Identify agency to host and maintain web site, and contract for IVR implementation.

Step 5: Design and implementation of Web site and dial-in service.

Step 6: Marketing and notification of resource to the traveling public.

Organizational Management: To optimally benefit all potential users, the information mechanism must be cheap to use and easily accessible. This oftentimes translates into providing a statewide 1-800 or local call-in numbers. Other considerations include determining an agency to be in charge of maintaining up-to-date information.

Schedules and Milestones: The following is the suggested schedule for deployment:

	Month									
	1	2	3	4	5	6	7	8	9	10
<i>Step 1</i>										
<i>Step 2</i>										
<i>Step 3</i>										
<i>Step 4</i>										
<i>Step 5</i>										
<i>Step 6</i>										

Capital Costs: Moderate - The suggested project funding is \$100,000 for the design and coordination of transit and multi-modal services around the state. Information provided to users is anticipated via Internet and a 1-800 or local telephone number.

O&M Costs: Operations and maintenance costs include monthly Internet Service Provider (ISP) charges, and keeping the transit data up-to-date. Additionally, telephone charges are expected for both the 1-800 and local telephone numbers. A benefit/cost study into these two alternatives may aid in the decision of which or both options are most attractive.

Benefits / Cost: High – The creation of a transit / multi-modal repository and trip planning mechanism would greatly improve information available to the traveling public.

- Benefits to Transit Agencies:
 - Centralized repository for current information regarding travel modes.
 - Better customer service due to improved information resources.
 - Potential increase in ridership.
- Benefits to Passengers
 - Easy access to schedules, fares, routes, etc.
 - Provides users a mechanism for finding options for travel out of known service areas.
 - Implementation of web site may reduce number of customer service calls.

Roles and Responsibilities: A lead agency is required for coordination and collecting data from transit / multi-modal agencies statewide.

Staffing: Staffing is required for updating data on a periodic basis. Depending on the type of telephone system selected, some IVR systems have the option for machine-generated voice.

Potential Funding Sources: DOT, FTA, and FHWA funding.

Application Examples: None. This was a project suggested during discussion with the Technical Panel and Region Engineers.

Web Sites: http://www.sioux-falls.org/transit_routes/index.htm

6.3.7 Rural Traffic Operations and Communications Center (TOCC)

Objectives: 1, 5, 8, 9, 10, 12

Desired Outcomes: Improved transportation operations and efficiency through the application of a cost-effective traffic control / monitoring system and integrated traveler information. Travelers will benefit by having access to timely information such as road/weather conditions, events, and alternate routes. Public safety agencies are able to improve incident response with the improved road, traffic and weather condition information. Furthermore, this system can also act as a central repository for alternative modes of transportation.

Project Locations: These projects are applicable to small urban and rural areas requiring some type of traffic control and monitoring system, without the need for installation of expensive hardware. Some candidate communities include those experiencing high fluctuations in traffic due to tourism and seasonal events (e.g., Rapid City and the surrounding communities), or larger communities (e.g., Sioux Falls) within South Dakota. *The development of the Sioux Falls area ITS plan and the areas implementation of numerous ITS components would make this region a prime project location.*

Technical Approaches: Small urban areas (which could be considered about the size of Sioux Falls or Rapid City) in need of improving the safety and efficiency of travel on their road networks often do not have the resources to support dedicated urban-style traffic centers. The approach to developing a system that can be used in these areas consists of utilizing remote access and platform independent software. Technology components could include:

- Deployment of CCTV and VMS;
- Providing responsive signal control in areas that experience traffic problems;
- Improved transit dispatch through implementation of AVL and MDTs;
- Deployment of a travel information network for each specific region; and
- Software deployment to integrate all components of the system.

Equipment Required: Following are a list of components that may contribute to this concept according to the National ITS architecture.

Center Subsystem: The state DOT district offices may house centralized operations. The center point of the system is a server, which is the workhorse for the entire operation. The server combines all aspects of the area-wide network. Normal maintenance or state patrol operations may operate in the same area, but these operations are enhanced by the presence of ITS

components. Such components may include, but are not limited to: pavement condition and reporting system; CCTV for traffic surveillance cameras; computers for operating changeable message signs, signal synchronization systems, other external components, and other components of the system that may interface with travelers. Operations may also be Internet-based so that the system can be operated from anywhere in the state. For example, the system may be operated via the Internet from a dialup connection at home or a laptop computer in the field.

Vehicle Subsystem: Emergency, maintenance or transit vehicles equipped with AVL transmits location and other valuable information to center subsystems. Short-range radio or in-car laptops may interface with the system for rapid dissemination of information. For the traveler, reception of traveler data may be via AM/FM radio or cellular telephone.

Roadside Subsystem: The roadside has many different components feeding into the Center Subsystem. These components include road and weather stations, state troopers and maintenance probe vehicles, closed-circuit TV cameras, traffic-count loop detectors and other assorted data-collection mechanisms.

Traveler Subsystem: Information provided by the traveler information network can be linked to kiosks or accessed with cellular phones, land-line phones and personal computers. The system can also be set up to send out emails and messages to personal communicating devices.

Communications Requirements: A rural TOCC can integrate the normal road operations of the state patrol, maintenance and other agencies responsible for the safe operations of the road network. Therefore, it is advantageous to make the system Internet-based for fast transfer of data between different agencies and areas of the state. South Dakota's already aggressive expansion of Internet pipelines and fiber optic communications will support the communications needs of the system. Communications may also include the existing infrastructure used by maintenance and emergency personnel. Use of CCTV cameras may require installation of fiber optics for increased reliability of data transfer.

Steps to Deployment:

Step 1: Establish the needs of potential deployment site.

Step 2: Generate a list of stakeholders and determine the extent the each agency's involvement. For example, this may entail emergency responders, transit authorities, local municipalities and SDDOT.

Step 3: Determine system specifications and design elements. Identify potential integration issues at various partner agencies. Determine how each component will benefit each agency.

Step 4: Advertisement of RFP and award of project.

Step 5: System design. Determine the staff needed to operate the system and train them in use of the system.

Step 6: System deployment. If rapid-rollout of the system is desired, then deployment of some systems can occur during the planning of others. Deploy the equipment, such as cameras, traveler information systems and computers to control the system. Design-build is also another possibility.

Step 7: Monitor the effectiveness of the system, evaluate the system and continuously upgrade the equipment as necessary.

Organizational Management: Since the nature of this project crosses many boundaries, there is great need for the formation of work teams consisting of public agencies and vendors. The institutional relationships between all partners must be forged. Strong leadership within partner agencies is important as well as complete buy-in from these agencies. Communication between partners is imperative to the successful implementation of this project.

Schedules and Milestones: Milestones vary widely for this type of operation. Full implementation and operation of the system can be established within 1 ½ to 2 years. Each deployment of equipment may be treated as a separate project. Below is a suggested timeframe for each ITS project to be implemented.

	Month																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
<i>Step 1</i>																			
<i>Step 2</i>																			
<i>Step 3</i>																			
<i>Step 4</i>																			
<i>Step 5</i>																			
<i>Step 6</i>																			
<i>Step 7</i>																			<i>Ongoing</i>

Capital Costs: High - Most capital costs in the design of an integrated, electronic traffic operations and communications system occur with software development. Depending on the types of uses for the system, software development for the computer system may cost as much as \$500,000. Hardware with installation may be as much as \$1.5 to \$2 million depending on the size of the district being equipped, the types of implementations requested. The proposed total cost is \$3,000,000 to equip a small urban area and its surrounding rural neighbors.

O&M Costs: Upgrading software, equipment repairs and staffing of the area to monitor the system are major costs in operating the system.

Benefits: Moderate - This project is higher cost, long-range project that once implemented will have great benefits to partners involved. A good example of such a deployment is the Duluth TOCC developed in Minnesota. Some anticipated benefits include:

- Increased emergency management coordination between state and local agencies. Better operational efficiency resulting from decreased response time and increased preparedness.
- Increased partnership opportunity between public / public and public / private.
- Increased safety, operations, and efficiency of the roadway for travelers.
- Decreased cost to the department of transportation for maintenance costs. Traffic management is more automated and resources can be deployed for incident management in a more efficient manner.
- Possibility of remote access to the system. The system can be controlled virtually from anywhere in the state with just a phone line and modem.
- Interface combines all aspects and data collection into a layer map where one can click on a road segment and retrieve many attributes of the segment.
- Data collection is centralized.

Roles and Responsibilities: The role of the public sector and emergency management is to specify according to the public good which equipment or procedures would be best for the public good. They are also responsible for staffing and maintaining the system to the benefit of the traveler. The private sector's responsibility is to design the system around the requests and to maintain flexibility in modifications to the system.

Staffing: Staff already responsible for dispatch would be trained in the use of the equipment. Support staff for the computer equipment may be needed, but that can also be provided by the vendors themselves. Staff time to relay traffic information to those in the field and to collect road conditions data is minimal.

Potential Funding Sources: Public (SDDOT and FHWA) funding may be used initially to purchase the system. Private matching contributions are also a possibility. This was the case in the development of the Duluth and St. Cloud TOCC in Minnesota.

Application Examples: Duluth and St. Cloud Transportation Operations Centers (Tom Peters Mn/DOT Office of Advanced Transportation Systems (651) 282-2469).

Web Sites: <http://www.dot.state.mn.us/guidestar/toccproj.html>

6.3.8 Highway-Railroad Intersection Safety System

Objectives: 2,3,7,8,10,11,12,14,15

Desired Outcomes: Improved quality of life for residents living near railroad tracks, improved safety at highway-rail intersections overall.



Project Locations: This project is suitable for site-specific areas where residents are concerned with the loudness and frequency of traditional train horns. According to the focus groups, Aberdeen would be a suitable deployment site.

Technical Approaches⁷: Traditionally, locomotive engineers begin sounding the train horn approximately 1/4 mile from the crossing to warn motorists and pedestrians approaching the intersection. To be heard over this distance, the train horn must be very loud. This combination of loud horns, and the length along the tracks that the horn is sounded, creates a large area adversely impacted by the horn noise. Unfortunately, in more populated area, this area likely includes many nearby residents. The automated horn system provides a similar audible warning to motorists and pedestrians by using two stationary horns mounted at the crossing. Each horn directs its sound toward the approaching roadway. The horn system is activated using the same track signal circuitry as the gate arms and bells located at the crossing. Once the horn is activated, a strobe light begins flashing to inform the locomotive engineer that the horn is working. If the strobe light is not flashing, or the locomotive engineer has a reason for concern regarding safety at the crossing, the engineer simply sounds the standard train horn.

In the Iowa study, horn volume readings were collected on a grid pattern and noise level contour maps were developed for the train horns and automated horn system. Use of the automated horn system reduced the area with noise levels greater than 80 dBA by 97 percent, from 171 acres using the train horns to less than six acres using the automated horn system. At the end of the study, it was concluded that there is no safety compromise in using automated train horns.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

⁷ Please refer to final report posted to URL on page 2.

Roadway subsystem: As described in Technical Approaches, two stationary horns are mounted at the intersection. Track circuitry, currently in place to activate gates and bells is used to activate the horns. A strobe light alerts the engineer that the system is working.

Communications Requirements: Communications between the train and the roadside is self-contained.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Determine appropriate locations for the system. Ensure that track circuitry is compatible with the system, as upgrades are expensive.

Step 2: Work with local railroad operations to form an agreement regarding outfitting the crossings with the automated horns.

Step 3: Acquire and install new equipment.

Step 4: If desired, test equipment at limited sites for a specified duration and obtain feedback from local residents.

Step 5: Monitor effectiveness of technology. Modify equipment if necessary.

Organizational Management: Protocol considerations include: how to determine the most appropriate locations for the system, and type of agreement to form with local rail companies as to system costs and liability.

Schedules and Milestones: The following is the suggested schedule reflecting steps to deployment:

	Month 1	Month 2	Month 3	Month 4	Month 5
<i>Step 1</i>					
<i>Step 2</i>					
<i>Step 3</i>					
<i>Step 4</i>					
<i>Step 5</i>					(ONGOING)

Capital Costs: Low to Moderate – Automated train horns cost approximately \$20,000 apiece. However, at least one community has had to forestall their installation due to the prohibitive cost of upgrading the train track wiring system. The upgraded technology, known as “constant warning technology” can reportedly cost up to \$250,000 if not already in place.

O&M Costs: System will require scheduled maintenance to ensure proper operations.

Benefits / Cost: Moderate - While the study in Iowa provided that the safety of the highway-railroad intersection was not compromised, there is concern that with newer model vehicles the sound-proof features will prevent adequate sound penetration.

- Low cost project that can help boost the public's perception of the DOT.
- Improves quality of life for nearby residents while maintaining or improving the safety of the intersection.

Roles and Responsibilities: Railroad engineers will need to be briefed on the new system, and encouraged to always use the manual horn if there is any doubt that the automated horn is functioning properly.

Staffing: Staff time is needed for installation and periodic maintenance of the system.

Potential Funding Sources: DOT funding, federal funding and potential contribution from railroad companies.

Application Examples: Steve Gent, P.E., (515) 239-1129 or Scott Logan, P.E., (515) 239-5275

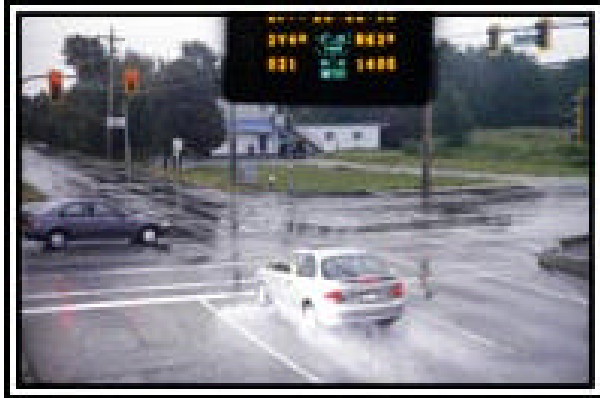
Web Sites: <http://www.dot.state.ia.us/trainhornstudy.htm>

References: Report posted to above URL.

6.3.9 Intersection Collision Countermeasure System

Objectives: 3, 8, 14, 15

Desired Outcomes: Reduction in number of collisions at unsignalized intersections.



Project Locations: Unsignalized 4-way stop intersections that experience relatively light traffic and numerous collisions. Especially appropriate for rural areas where installation of new traffic signals is not feasible. Intersections selected for this type of project should have little visual clutter nearby. The Pierre region would be a good candidate site.

Technical Approaches: A two-way intersection controlled by stop signs is outfitted with the following equipment:

- 4 passage/presence detection zones on Road A (2 in each direction).
- 4 active warning signs on Road B (2 in each direction).
- Six speed/presence detection zones on Road A (3 in each direction).
- 2 dynamic warning signs on Road B (one behind each existing stop sign) that warn of approaching traffic in either direction from Road A.

The busier of the two roads will be the road equipped with the speed/presence detectors. The system tracks all vehicles approaching and occupying the intersection. Arrivals and warnings are calculated in real time, and display warnings of traffic on the other road via the DMS signs. The warning signs are activated six seconds before the car's arrival. All data may be recorded and stored off-site. Another option is to install a stop sign with a blinking light to actively warn driver of approaching vehicles.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Center subsystem: Data recorded from the system can be saved at the city engineer's office and used to analyze the effectiveness of the system. Data is received from the roadway subsystem by way of cellular or land-line communications.

Roadway subsystem: Vehicle detectors, in this case ten sets of loops are installed, along with a signal controller with custom software, and highly visible active signs with blinking LED icons.

Communications Requirements: A simple telephone connection is necessary to transfer recorded data back to the traffic management office for analysis.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Review FHWA Collision Countermeasure Phase 1 and 2 reports, available at the web sites listed below.

Step 2: Based on criteria for site selection (low traffic volume, high collision rate, low visual clutter in area), select appropriate intersections in South Dakota.

Step 3: Procure and test equipment at limited sites for a specified duration and obtain feedback.

Step 4: Develop a deployment and operations plan for installation of equipment at other locations based on experiences and lessons learned in *Step 3*.

Step 5: Monitor effectiveness of technology. Modify equipment if necessary.

Organizational Management: While the system is designed to be self-activated, drivers need to understand the purpose of the signs. Potentially, as more signs are deployed, drivers might become desensitized and the original effectiveness of the deployment may decrease.

Schedules and Milestones: The following is the suggested schedule reflecting steps to deployment:

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
<i>Step 1</i>						
<i>Step 2</i>						
<i>Step 3</i>						
<i>Step 4</i>						
<i>Step 5</i>						ONGOING

Capital Costs: Moderate to High - In Virginia, costs for hardware were approximately \$16,000. Signs were \$12,000 and installation ran to \$52,000. The cost of consultant labor pushed the total cost of the project to \$201,000. Project funding is suggested at \$96,000.

O&M Costs: Operations and maintenance costs include power, telephone and any replacement equipment.

Benefits / Cost: Moderate - The widespread deployment of this technology may be high cost.

- Benefits to DOT:
 - Opportunity to collect extensive data on traffic patterns through intersection.
 - System can be less expensive than installation of traditional traffic signals.

While the system generally improves the safety of the intersection for drivers, there are several effects that can negatively impact safety:

- Drivers can be distracted by the novelty or incomprehension of the signs.
- Inaccurate performance may cause warning to be ignored.
- Over-reliance on signs, causing increased speed or dangerous crossings.

Roles and Responsibilities: The operational test nature of this deployment requires further investigation into system effectiveness. It is anticipated that the deployment of this system be the responsibility of the DOT.

Staffing: Staff time will be necessary for installation of the system as well as monitoring and analysis of recorded data.

Potential Funding Sources: DOT or federal funding.

Application Examples: George Beronio, Raytheon Systems Company, (703) 560-5000 ext. 4263, or Steve Beningo, FHWA, (207) 622-8350

Web Sites: Phase 1 report: http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/1w001!.htm#I62
Phase 2 report: http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/1w101!.htm#I34

References: Please review documents posted to above web sites.

6.3.10 Multi-Jurisdictional Coordination of Emergency Response

Objectives: 1, 3, 7, 8, 9, 10, 12, 14

Desired Outcomes: To share data more efficiently between police, fire, ambulance, and state agencies through the use of a centralized common, comprehensive incident reporting database.

Project Locations: Coordination of emergency response services may be addressed on the regional level – more specifically, on the county or township level. Emergency response issues were particularly noted in the Aberdeen region making this area a good candidate deployment site.

Technical Approaches: When a 9-1-1 call is placed, a Mayday system is activated or an emergency vehicle has appeared on the incident scene, on-site incident data can be relayed to a central dispatch center for action. The dispatch center acts on the request by sending the proper emergency personnel to a traffic incident. The dispatch center also acts as an information clearinghouse for police, fire, ambulance crews, and other emergency responders by disseminating information about the incident to all responders. Road conditions, especially in rural areas, are a deciding factor in response time. The dispatch center may also compile information about road and weather conditions in the area of the incident, thereby estimating the time required to get personnel on the scene. The scale of the system theoretically could be any size and coordinate emergency responders statewide. However, a more manageable system would be county-wide, with coordination of all township emergency responders connected to the county central dispatch. Township responders closest to the accident scene may be deployed.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Center Subsystem: Dispatch coordination consists of a central dispatch point where calls for help are accepted. The clearinghouse consists of 9-1-1 dispatchers which accept emergency calls from the coverage region. The townships need only some type of direct communication line with the dispatch center for coordination.

Vehicle Subsystem: Radio or in-vehicle computers could be used for communication between dispatch and emergency vehicles. Communication between emergency vehicles could be routed through dispatch.

Roadside Subsystem: Road and weather conditions from RWIS, patrol vehicles or maintenance vehicles may be routed to the dispatch center for the safety of the emergency vehicles. Patrol vehicles are also responsible for reporting incidents that have happened. Roadside cellular call boxes may be provided for emergency purposes.

Traveler Subsystem: Travelers can contact Emergency Response through cellular telephone or a Mayday system.

Communications Requirements: Emergency data is relayed either by voice or data transmission. A primary mode of transmission would be over voice radio or cellular phone. Data transmission to an in-vehicle computer could occur over cellular modem or FM subcarrier. Connections between the central dispatch and townships may be over land-line telephone, radio, or fiber optic – whichever is most economical for the area.

Steps to Deployment:

Step 1: Determine from local emergency management agencies what major problems impede the improvement of response time. Determine if information sharing is their largest problem and the impediments for communicating effectively between emergency responders.

Step 2: Develop a plan and determine equipment needed to develop this database and communication among emergency responders.

Step 3: Determine how the coordination will work – who will staff the main dispatch facility, who has access to the central database and how the staffing will work.

Step 4: Develop a procedure for responding to emergencies according to jurisdiction. For example, a question that should be agreed upon is: When emergency personnel are dispatched, should it be based on how close a unit is to the incident regardless of jurisdiction?

Step 5: Examine the current means of communication. Determine how much technology needs to be present in emergency vehicles – whether or not in-car laptop computers are needed for example. Make changes to the communications infrastructure if needed.

Step 6: Procure the equipment and install. It is suggested that experimentation start no larger than a county-wide basis.

Step 7: Conduct operational testing on a county-wide scale or smaller.

Step 8: Observe and document the testing.

Step 9: Implement in other areas if the test is acceptable. From the operational testing, determine the areas most feasible for this project.

Organizational Management: Management considerations include: determining a procedure among townships for dispatching emergency personnel; a dispatch manager should be on hand to coordinate efforts between 9-1-1 call operators and emergency dispatchers; police, fire, rescue

and ambulance services should know the severity of the incident so they can send appropriate responders to the scene – a township dispatch manager should be able to handle coordination between fire, police and ambulance services for the township. Most problems dealing with deployment have to do with institutional issues between emergency providers.

Schedules and Milestones: Most 9-1-1 systems are central dispatching points for emergency response. More data sharing among dispatchers and emergency response agencies is needed. Following is a schedule reflecting steps to deployment:

	Month																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Step 1																								
Step 2																								
Step 3																								
Step 4																								
Step 5																								
Step 6																								
Step 7																								
Step 8																								
Step 9																								<i>Ongoing</i>

Capital Costs: Moderate to High- Initial capital costs for creating a centralized database for sharing among various agencies could cost over \$100,000, not including perhaps the need to purchase new hardware (e.g., personal computers). Emergency response centers can be linked together via a wide area network. In-vehicle computers can cost \$3,400 to equip an emergency vehicle. Most issues with this application are institutional. The communication infrastructure for emergency vehicles and 9-1-1 dispatch is usually available. Project funding is suggested at \$100,000.

O&M Costs: Operations and maintenance costs are moderate. These include keeping a dispatch center staffed 24 hours per day. Software upgrades for a fully-automated computer dispatching system are also included in the costs of maintaining the system.

Benefits: Moderate – Coordination of emergency response among agencies has great potential for improving the use of resources. Agencies that could potentially benefit from any partnerships include Emergency Management agencies, such as ambulance and police, Highway Patrol and the DOT.

Benefits to DOT:

- Savings on resources or repetitious 9-1-1 dispatch centers.
- Institutional arrangement can be used on current communications infrastructure.
- Increased safety for emergency response crews.
- Database of incidents helps identify problem areas that need special attention.

Benefits to Traveler:

- Decreased response time to incidents.
- More direct medical care in a shorter amount of time.
- Confidence in traveling on rural roadways.

Roles and Responsibilities: The responsibility of the DOT should be to educate emergency response personnel on the benefits of creating a central dispatch for all emergency services in the county. DOT should take responsibility in getting the counties to coordinate with the townships. Counties and townships have the responsibility of creating their own emergency management protocols, but make sure that they agree upon the central dispatching system. Existing emergency protocols should be encased in a statewide standard for 9-1-1 service.

Staffing: The dispatch center needs to be staffed around the clock with operators to take calls. A dispatcher for each township and for the dispatch center should also be on hand. The size of the dispatch area depends on the population of the county and whether or not the population increases during the tourist season.

Potential Funding Sources: Seed money to establish, develop, and implement project can come from the Federal Highway Administration, National Highway Transportation Safety Administration, DOT and local public safety agencies..

Application Examples: Interagency Dispatch/Reporting Coordination, Dane County, Wisconsin. (Frank Sleeder, Chief of Police, City of Sun Prairie, WI; (608) 837-7336.)

Web Sites: http://inform.enterprise.prog.org/display_all_sol.cfm?&sol_id=33

References: *FHWA Simple Solutions.*

6.3.11 Hand-Held Devices for Reporting Crash Victim Data

Objectives: 2,8,13,14

Desired Outcomes: Automate the recording of medical condition information sent from field to emergency rooms. Improved efficiency through streamlined data gathering and processing methods.



Project Locations: Region-wide with potential for statewide deployment. The Sioux Falls area would be a good deployment site as a result of more wireless communications available than in other regions.

Technical Approaches: Current methods of recording accident information in the field typically rely on manual forms of data collection and transfer. The primary method for communicating the state of crash victims in the field to central operations is with voice and handwritten notes. This often warrants the need for multiple trip reports and duplication of efforts. Improvements in wireless

communications and remote computing can improve emergency response practices. The system proposed consists of using hand-held devices for recording various victim status and crash-related data that is automatically transmitted to an emergency response center. The automatic transfer of data ensures greater accuracy and allows emergency room doctors to better assist in providing triage instructions and better feedback to field professionals.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Vehicle subsystem: Patient vital statistics, illnesses, injuries, injury details and other data can be recorded on a hand-held device. The device sends this information using a wireless cellular modem via the CDPD (cellular digital packet data) network to emergency room doctors to assist in patient care.

Center subsystem: Emergency room doctors are able to review patient information automatically on a computer screen and better assist field professionals in advising patient treatment and care at the scene of an incident or en-route to emergency centers. At the emergency center, the hand-held devices would need to be able to communicate and connect to a local area network (LAN). Once the data is sent, it populates a database or patient care management system within the

emergency response center. Various emergency centers can be connected to this system further supporting the exchange of information.

Communications Requirements: Information sent from an accident site to emergency facilities is by way of cellular communications, specifically using the CDPD (cellular digital packet data) network.

Steps to Deployment: The hand-held system that is proposed consists of a combination of commercial off-the-shelf technologies. While proven, this type of system is not currently being used extensively in other areas. Nonetheless, this deployment is a candidate for an operational testing scenario. The following are the suggested steps to facilitate deployment:

Step 1: Identify potential deployment site and assemble project partners.

Step 2: Determine availability of CDPD network within the emergency response area.

Step 3: Determine data elements to be sent from the field to emergency response center.

Step 4: Develop coding for tailoring hand-held device for application.

Step 5: Test and evaluate system in the field.

Organizational Management: In this particular instance, public safety agencies would be responsible for identifying system requirements and procuring equipment. However, this technology has the potential for easy transfer to other applications and the involvement of DOT would be beneficial.

Schedules and Milestones: The following is the suggested schedule reflecting steps to deployment:

	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
<i>Step 1</i>												
<i>Step 2</i>												
<i>Step 3</i>												
<i>Step 4</i>												
<i>Step 5</i>												

Capital Costs: Low - Hand-held devices range in price from \$150 (2MB of memory) to \$250 - \$450 (8MB of memory) per unit. Wireless cellular modem compatible with hand-held devices cost approximately \$370 per unit. Some modems have the option for global positioning system functionality. This type of system is most appropriate for emergency centers that are already

equipped with some type of internal local area network. Project funding is suggested for \$25,000 for the procurement of ten units and the design and integration of the interface.

O&M Costs: Operation costs entail charges for monthly cellular telecommunications use. Agencies may already have a cellular service plan through a local provider. Other cost considerations include upgrades to software and hardware.

Benefits / Cost: High - The application (suggested within this project description) is only one use for these hand-held devices. The relative ease of developing the software interface, hand-held devices have great flexibility allowing easy transfer to other initiatives. For example, the DOT can retrofit hand-held devices to assist in field inspections of bridges or pavement maintenance. These devices can easily be programmed to log and automatically send observations from the field to a central database information regarding pavement condition such as rutting, longitudinal cracks, potholes, etc. Public safety professionals can use these devices for assisting in traffic stops allowing remote access to vehicle records databases. Other benefits include:

- Comparatively low-cost mobile computing platform.
- Adequate cellular connectivity¹.
- Quick and easy user adoption¹.
- Large improvement in ability of emergency responders¹.
- Reducing the amount of paper work required in the field.

However, the use of the system relies on the digital cellular network. Currently, digital cellular is not available widespread across South Dakota. In remote areas where this type of technology can improve the efficiency of emergency response, cellular coverage may be even sparser.

Roles and Responsibilities: This is a comparatively lower cost alternative to other mobile data platforms. While the initial procurement of hand-held devices could possibly be funded by public safety agencies, technical and software expertise within the DOT or universities could be leveraged for actual system development.

Staffing: System usage will be on an as-needed basis when emergency response teams are deployed. It is anticipated that the use of these hand-held devices will be an integrated part of emergency response and will not require a dedicated staff person to maintain the system. Nonetheless, the database required for information storage and retrieval will need to be maintained.

Potential Funding Sources: Cooperative funding between DOT and public safety agencies. The following Web site identifies funding strategies for public safety agencies:
<http://iacptechnology.org/funding.htm>.

Application Examples: Demonstration of hand-held devices for use in HAZMAT and medical emergency response performed by Penn State University - The Pennsylvania Rural Highway Trauma Program (Dave Witmer, (814)865-7453)).

Web Sites: <http://www.arl.psu.edu/areas/patrauma/thrusts.html>,
<http://www.novatelwireless.com/prodserv/publicsafety.html>

References: 1. <http://www.arl.psu.edu/areas/patrauma/thrusts.html>

6.3.12 Roadway Geometrics Alert system

Objectives: 2, 3, 8, 15

Desired Outcomes: Improved road safety by encouraging drivers to merge in advance of work zone construction, or to slow down when approaching curves.



Project Locations: Busy work zones and curves where speed and passing becomes hazardous. Focus group attendees most concerned with roadway geometrics were from Sioux Falls. Sioux Falls would be a good deployment site.

Technical Approaches: In work zones, a series of portable "DO NOT PASS" signs equipped with flashing beacons is placed at the approach to the site. Portable electronic occupancy sensors are placed in the roadway. At the outset of operations only the sign nearest to the work zone has activated beacons. When these sensors detect a certain threshold, that is, as the volume of traffic grows heavier at the approach to the construction, the beacons on the next sign upstream will also be activated, and so on. As traffic flow varies, the signs are activated or deactivated in sequence. Five signs generally comprise one lane drop smoothing system. A system specification is currently being developed. When complete, this specification will be circulated to contractors.

Along roadways with sharp curves, radar detection equipment can be installed to detect the speeds of vehicles approaching the curve. A "BEWARE OF SHARP CURVE" sign is located prior to the curve. When the radar equipment detects that a vehicle is traveling too quickly to safely negotiate the curve, beacons on the sign flash to alert the driver. This technology may also be used in work zones.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Roadway subsystem: Series of flashing signs and electronic occupancy sensors for lane drop system, radar transmitters linked to a flashing warning sign for radar system.

Traveler subsystem: Content of traveler information web sites should include information on warning systems such as these so that travelers will know what to expect when they are

encountered on the road. More general advice on the location of construction or work zones, or any lane drops needed for special events, could be provided to the drivers of vehicles via wireless data broadcast, using AM, FM, or HAR. Messages could either be provided to travelers using roadside signs or in-vehicle devices, including regular radios.

Communications Requirements: All communications are self-contained within the units. For example, the system is battery and solar operated.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Specify equipment needed and desired.

Step 2: Determine locations for fixed systems and mobile systems across South Dakota.

Step 3: Procure and test equipment at limited sites for a specified duration and obtain feedback.

Step 4: Monitor effectiveness of technology. Modify equipment if necessary.

Organizational Management: For mobile systems, a process for sharing units among agencies needs to be established.

Schedules and Milestones: Technology has been proven, deployed and currently in use in other states. The following is the suggested schedule reflecting steps to deployment:

	Month 1	Month 2	Month 3
<i>Step 1</i>			
<i>Step 2</i>			
<i>Step 3</i>			
<i>Step 4</i>			(ONGOING)

Capital Costs: Low - Flashing beacons cost approximately \$3,500 each. For the radar system, \$3,800 covers the cost of one transmitter, solar pack and installation. Project funding suggestion is \$30,000 for the purchase of three units for test and evaluation.

O&M Costs: Operations and maintenance is minimal once units are in place. Most units are solar / battery-powered.

Benefits / Cost: High – These technologies can reduce the likelihood of a speed-related accident.

- Benefits to DOT:
 - Increased safety for construction and maintenance personnel.

- Smoother traffic flow at construction sites.
- Benefits to Traveler:
 - Increased safety at the approach to, and within, workzones and other areas where the number of lanes decreases.
 - Increased safety near sharp curves.
 - Less delay due to construction and maintenance work.

Roles and Responsibilities: A potential implementation issue associated with this technology is ensuring that construction personnel are given adequate training and guidance as to the appropriate positioning of the signs in the roadway to achieve the desired results. For example, if signs are positioned too closely to the work zone, positive benefits may not be achieved. Indeed work zone safety could even be negatively affected.

Staffing: Beyond installation, little staff participation is required.

Potential Funding Sources: DOT funding.

Application Examples: Dan Shamo, ITS Program Engineer, INDOT, (317) 232-5523, Email: dshamo@indot.state.in.us

Web Sites: Speed advisory on curves project:

http://inform.enterprise.prog.org/display_all_sol.cfm?&sol_id=21

Indiana lane drop/merge: <http://www.fhwa.dot.gov////////quality/HP-IN11.htm>

6.3.13 Emergency Warning System

Objectives: 2, 3, 7, 8, 15

Desired Outcomes: Highly visible alert system to warn the traveling public of potential flooding hazards.

Project Locations: Mobile applications can be used in the rural and urban setting. Permanent installations are more suitable for higher traffic and “known” problem areas. For example, a bridge that is prone to washing out several times during a particularly rainy month. Aberdeen is an area prone to flooding and would be a good candidate deployment site.



Technical Approaches: The emergency warning system is proposed to use warning signs and flashing beacons (either remotely or automatically activated) to alert

travelers to hazards such as flooding, slippery pavement, or other temporary hazards. Flashing beacons on static signs (either mobile or fixed) can be activated remotely by pager technology. In this capacity, pagers are attached to the beacon light allowing operators to use a standard telephone to dial the pager number and activate the flashing sign. One specific recommendation for automated activation is in the event of flooding. Sensors in the field detect rising or standing water. The sensors then automatically trigger nearby warning beacons that may be attached to static “Flooded” signs that may either be fixed or mobile. The sensor should be mounted at the point where high water will impair safety. Once the water has risen above this point, the electronics module will activate the warning device supplied by the user. Commercial products are available that offer turnkey systems for delivering all aspects of this concept.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Roadway subsystem: Static warning signs equipped with solar flashers, water-sensing trigger, radio signal and receiver. Also gates, similar to those at highway-rail intersections can be used to completely block entrance to the flooded or hazardous road, as some motorists have been known to attempt crossing anyway.

Traveler subsystem: Potentially, a warning system could be tied into a Web site or HAR system, advising travelers of flooded road and other hazards.

Communications Requirements: Flood warning system requires solar power and radio communications capability, as built into the equipment.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Determine locations requiring warning systems. Determine need for detection devices if necessary. Identify any potential issues.

Step 2: Specify equipment needed and desired. A variety of vendor specific devices may be reviewed.

Step 3: Procure and test equipment at limited sites for a specified duration and obtain feedback.

Step 4: Maintain equipment as necessary.

Organizational Management: It is anticipated that the DOT will have primary control over the system. However, mobile systems can be loaned out to other agencies in the event of emergencies.

Schedules and Milestones: Technology has been proven, deployed and currently in use in other states. The following is the suggested schedule reflecting steps to deployment:

	Month 1	Month 2	Month 3	Month 4
<i>Step 1</i>				
<i>Step 2</i>				
<i>Step 3</i>				
<i>Step 4</i>				(ONGOING)

Capital Costs: Low to Moderate – Solar powered flashers used in Phoenix, Arizona cost \$1500 per unit. However, they will eventually pay for themselves in energy savings. A pager-activated system can be controlled from any computer, with pagers costing as little as \$30 per month. The project funding is estimated to be \$20,000 for the procurement, installation, testing and evaluation of six solar-powered flashers.

O&M Costs: Operations and maintenance is minimal once units are in place. Units are solar / battery-powered. Flasher signs that are connected to pagers and activated remotely will run an extra cost of around \$5 per month for pager service, however remote activation can save on labor time, since staff will not have to travel to the site.

Benefits / Cost: Moderate: Low cost system can prevent travelers from entering hazardous areas.

- Benefits to DOT:
 - A more dynamic method of posting warnings and information.
 - Flashing lights help improve roadway visibility.
 - Alerts motorists while they still have the chance to turn back.
- Benefits to Traveler:
 - Advance notice of road hazards.

Roles and Responsibilities: The DOT will need to procure and install all fixed systems. The DOT will also be responsible for loaning out mobile systems and determining the procedures for this.

Staffing: Since the system may be controlled remotely via pager, minimum staffing is required.

Potential Funding Sources: DOT funding.

Application Examples: Flashing warning beacons: Eric Snyder, Traffic Signal Supervisor, City of Scottsdale, Arizona. (480) 312-5635; Water Line: asti@asti-trans.com

Web Sites: ASTI Transportation: <http://www.asti-trans.com> An example of pagers used to remotely control flasher signs: http://inform.enterprise.prog.org/display_all_sol.cfm?&sol_id=14

6.3.14 Information Exchange Network

Objectives: 1, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16

Desired Outcomes: Improved multi-jurisdictional activities along common corridors (or with similar interests) through interagency cooperation and innovative project deployment.



Project Locations: It is suggested that the SDDOT consider involvement at the state level in an information exchange network.

Technical Approaches: An information exchange network (IEN) consists of various agencies with a stake in a particular region. The goal of IEN is to facilitate communications and information sharing among

Coalition member agencies. This shared information supports coordinated transportation management and traveler information on a regional and corridor-wide basis. Through user surveys, meetings, and interviews, components of a long-term vision for information exchange may be developed. The vision emphasizes the importance of information exchange as a process that is larger than any particular technology or function. Member agencies may each pay yearly dues, which are then used to fund member-proposed projects.

SDDOT has participated in an exchange network in the past through involvement in the Aurora Program -- a multinational pooled-fund study group working to advance RWIS technologies.

Equipment Required: N/A

Communications Requirements: N/A

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Determine potential member agencies and contacts.

Step 2: Coordinate meeting of interested parties to determine organizational structure, purpose, vision, goals and objectives.

Step 3: Invite potential member agencies, as determined in *Step 1*, to an informational meeting for the purpose of recruiting potential memberships.

Step 4: After a suitable number of member agencies are on board, begin proposing potential interests and current efforts that could be shared between members. Work to develop a clear mission and direction for the network.

Step 5: Consider hiring a managerial consultant to assist with day-to-day administration of the group.

Step 6: Continue to hold regular meetings, recruit members and monitor sponsored network communication projects.

Organizational Management: Board members will need to be elected. Champion representatives will need to be identified for each organization. As mentioned above, the group may wish to hire a consultant to tend to organizational issues.

Schedules and Milestones: The schedule for development of this sort of organization will vary considerably depending on the amount of interest among potential members.

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
<i>Step 1</i>						
<i>Step 2</i>						
<i>Step 3</i>						
<i>Step 4</i>						
<i>Step 5</i>						
<i>Step 6</i>						(ONGOING)

Capital Costs: Capital costs are low to zero, and consists mainly of staff labor dedicated to getting the IEN up and running. Suggestion is to allocate \$50,000 for investment in one or several ITS pooled-fund study.

O&M Costs: Member agencies pay dues to cover O&M costs. Examples of membership fees range from \$10,000 to \$50,000 yearly.

Benefits / Cost: High: Member agencies and travelers benefit from information sharing. A challenge to IENs is that they are typically volunteer in nature. Participants are limited by the commitments to their supporting agencies. A strong advocate to lead the IEN sufficiently addresses this concern. High turnover of representative individuals is also common.

- Benefits to Member Agencies:
 - Pooling of ideas leads to better means of disseminating traveler information.
 - Interagency communication means that information is collected at the source.

- Greater network of “expertise” from which to draw.
- Benefits to Traveler:
 - Better access to more types of traveler information.

Roles and Responsibilities: The sponsoring agency will be responsible for handling the initial organizing of the IEN.

Staffing: One staff member from each agency will be the primary contact who attends meetings and is a liaison between the agency and the IEN.

Potential Funding Sources: Federal pooled-fund money.

Application Examples: ENTERPRISE pooled-fund study: Gene Martin, Chair, (804) 786-4168; Aurora Program: Curt Pape, Chair, (651) 297-1798; I-95 Corridor Coalition: John Baniak, Executive Director, (518) 584-4826

Web Sites: ENTERPRISE: <http://www.enterprise.prog.org> Aurora: <http://www.aurora-program.org> I-95 Coalition Connection: <http://www.i95coalition.org/>

6.3.15 Broadcast Traveler Information

Objectives: 4, 7, 8, 11, 12, 14, 15

Desired Outcomes: Traveler information broadcast in rural areas where other types of communications may not be feasible.



Project Locations: Broadcasting traveler information over AM radio is practical in rural areas where there can be a shortage of local radio signals and/or cellular coverage. The Rapid City area and the large draw of tourists would benefit greatly from a test of this system.

Technical Approaches: An AM subcarrier for disseminating traveler information is determined. Optimal coding strategies are developed for placing a silent data stream on that subcarrier. For purposes of testing, a prototype in-vehicle unit capable of receiving the data stream, and the transmission equipment suitable for testing different AM modulation schemes and error correction methods are developed. Once the best approach is identified, off-air channel interference tests may be performed, leading to a limited on-air and over-the-road system test. Testing continues by moving it on-air using a low-power AM broadcast on an unused channel and conducting field tests that use an actual radio station to broadcast the transmission.

A system proposed by Mikros Engineering is being developed and claims to offer AM carrier data rates as high as 8800 bps. This system, developed with venture capital by commercial interests has a realistic chance of commercial viability.

Equipment required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Center Subsystem: Radio broadcast station for transmitting traveler information.

Roadway Subsystem: Static signs with flashing lights are located along the roadside to alert drivers to tune into a certain frequency to obtain traffic information. Portable CMS can also be used (typically LED-display, solar charged and programmable) to further post information. Legibility distances are approximately one thousand feet (1000'). Signs may be equipped for remote operation.

Vehicle Subsystem: In-vehicle AM radio units receive advisory broadcast information transmitted from the Center Subsystem.

Traveler Subsystem: Kiosks that are capable of receiving, decoding and displaying the broadcast traveler information.

Communications Requirements: AM subcarrier between the vehicle and center subsystem.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Specify equipment needed and desired. Determine broadcast power of optimal AM subcarrier.

Step 2: Determine locations for CMS and broadcast range of messages. .

Step 3: Procure and test equipment at limited sites for a specified duration and obtain feedback.

Step 4: Develop a deployment and operations plan for installation of equipment at other locations based on experiences and lessons learned in *Step 3*.

Step 5: Monitor effectiveness of technology. Modify equipment if necessary.

Organizational Management: The primary considerations are obtaining required licenses from the FCC. Additionally, a dedicated traveler information station could perhaps be set up between a public / private partnership.

Schedules and Milestones: The following is a schedule for technology implementation based on other product demonstrations:

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
<i>Step 1</i>						
<i>Step 2</i>						
<i>Step 3</i>						
<i>Step 4</i>						
<i>Step 5</i>						ONGOING

Capital Costs: Low to Moderate. Project funding suggestion is for \$50,000 to test and evaluate similar technologies.

O&M Costs: Operations and maintenance is minimal once units are in place.

Benefits / Cost: Low - Potentially high, as this system addresses a variety of traveler information needs at low cost. However, the in-vehicle systems are not yet commercially available.

- Benefits to DOT:
 - Mobility of technologies allows use across state.
 - Economic way to address numerous needs relating to traveler information dissemination.
- Benefits to Traveler:
 - AM radio is available in most vehicle makes and models.
 - The installation of kiosks makes information available both pre-trip and en-route.
 - Can access all types of traveler information, including warning messages and pavement conditions.

Roles and Responsibilities: FCC approval is required for broadcasting. It will be the DOT's responsibility for obtaining the necessary licenses.

Staffing: The messages broadcast over the system require consistent updating. This may require a Traveler Information Officer position to integrate and lead the dissemination of information not only by broadcast radio, but by the other means as suggested in other project descriptions.

Potential Funding Sources: DOT funding and local transportation agency funding. In the event of a public / private partnership, there may be private contributions.

Application Examples: John Whited, Iowa DOT. (515) 239-1411

Web Sites: <http://www.enterprise.prog.org/herald.htm>

References: Please see PDF documents posted to Web site.

6.3.16 Portable ITS and Traveler Information Technologies in Work Zone

Objectives: 2, 4, 8, 12, 15, 16

Desired Outcomes: Real-time notification to travelers of construction zone activities.

Project Locations: Mobile applications can be used in the rural and urban setting. Permanent installations are more suitable for higher traffic and “known” problem areas. For example, tourist areas that experience high traffic volumes or areas that experience rush hour delays.



Technical Approaches: The basic portable system requires coupling highway advisory radio (HAR) and changeable message sign (CMS) technologies. Advanced systems known as “smart work zones” further integrate the use of solar-powered cameras to monitor current traffic flows. Queue length detectors can be used as well. The advisory radio technology is used to

warn motorists of traffic and travel related information. A sign with lights alerts travelers to tune into a certain frequency (e.g., “TRAFFIC INFO RADIO/TUNE 530 AM”) is located one mile in advance of each HAR. Cellular modem is used to activate messages on CMS, or this can be done remotely. CMS units can be activated on-site or remotely. CMS can be used to provide motorists work zone information such as advisory speed limits or detours. Mobile video detection technologies can be solar- and battery-powered. The video system can be controlled remotely and can provide still-frames every four seconds. A system in use in Iowa has experienced some problems and needs to be fully tested before it can be used with “confidence.” Nonetheless, the technology has been well received and proved of value for future applications.

Equipment required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Center subsystem: Standard messages for the HAR system can be recorded and housed within the construction and maintenance office. Available systems can provide 4.5 to 30 minutes of record time and capacity for storing 300 messages. A set of pre-programmed messages can be determined for typical conditions experienced at work zones.

Roadway subsystem: Static HAR signs with flashing lights to alert drivers to tune into a certain frequency to obtain traffic information. Portable CMS are typically LED-display, solar charged and programmable. Legibility distances are approximately one thousand feet (1000'). Signs may be equipped for remote operation. Other options include interfacing with an optional radar

transmitter and display actual speeds for vehicles exceeding the user selectable "threshold" speed. Wireless cameras offer video detection where installation of cables is not possible or desirable. All roadway subsystems are capable of remote or on-site operation.

Vehicle subsystem: AM radio to receive advisory broadcast information.

Traveler subsystem: Potentially, this system could be tied into a Web site, providing travelers with real-time construction zone information, or a dial-in phone service to access construction zones along a designated travel route.

Communications Requirements: The HAR, CMS, and video detection can be solar / battery operated. The mobile feature requires cellular coverage in the area of deployment. Fixed stations could leverage existing land-line or fiber optics communications.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Specify equipment needed and desired. Determine broadcast power of HAR, identify size and control method of CMS, and determine number of units to be deployed. Determine need for detection devices if necessary. Identify any potential issues.

Step 2: Determine locations for fixed systems and mobile systems across South Dakota.

Step 3: Build consensus on approach for determining and composing messages, determine allowable personnel for programming messages, and identify additional stakeholders such as state patrol and local agencies.

Step 4: Procure and test equipment at limited sites for a specified duration and obtain feedback.

Step 5: Develop a deployment and operations plan for installation of equipment at other locations based on experiences and lessons learned in *Step 4*.

Step 6: Monitor effectiveness of technology. Modify equipment if necessary.

Organizational Management: Protocol considerations include: determining procedure for recording and standardizing messages, whether messages will reflect real-time conditions or remain static for the duration of the project, and who can record messages. For example, in Iowa, each HAR unit has four pre-programmed messages. Depending on the real-time traffic conditions, either the "normal", "congested" or one of two "diversion" messages will be heard. Messages can typically be activated, changed, or recorded by regular or cellular telephone.

Schedules and Milestones: Technology has been proven, deployed and currently in use in other states. The following is the suggested schedule reflecting steps to deployment:

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
<i>Step 1</i>						
<i>Step 2</i>						
<i>Step 3</i>						
<i>Step 4</i>						
<i>Step 5</i>						
<i>Step 6</i>						(ONGOING)

Capital Costs: Low to Moderate - Initial low costs systems can later add advanced components. HAR costs approximately \$20,000 per unit including training. CMS technology can be purchased for approximately \$16,000 to \$18,000 per unit. The total cost of the project in Iowa (which combined HAR, CMS and the detection system) was \$100,000. The CMS units were already owned by the DOT. There is an option to lease or buy equipment. Project suggestion is \$100,000 for developing and testing one mobile unit.

O&M Costs: Operations and maintenance is minimal once units are in place. Most units are solar / battery-powered, resulting in costs for cellular phone use to activate the system. Electricity and communications costs would vary for fixed sites depending on the technologies used.

Benefits / Cost: High - High benefits to travelers through work zones

- Benefits to DOT:
 - Real-time traffic warnings create more credibility (Iowa).
 - Mobility of technologies allows use across state.
 - Improved traffic management through the construction zones (Missouri).
 - Reduced congestion in construction zones (Indiana).
 - CMS technology can be used as speed control device in work zones, thereby increasing safety in work zones.
- Benefits to Traveler:
 - AM radio is available in most vehicle makes and models.
 - Reduced congestion in construction zones (Indiana).
 - Reduction in frustration of traveling public if delays are experienced (Missouri).

Roles and Responsibilities: These systems can be controlled on-site. The use of HAR requires prior Federal Communications Commission approval, however, vendors will typically assist DOTs in this process.

Staffing: The required staff time is minimal. The entire system can be operated by a cellular phone in the field and does not require extensive re-programming.

Potential Funding Sources: DOT funding.

Application Examples: Indiana DOT (Dan Shamo, ITS Program Manager, (317) 232-5523); Missouri DOT (Tom Ryan, Asst. Traffic Division Engineer, (573) 526-0124); and Iowa DOT (Steve Gent, P.E., Traffic Engineer, (515) 239-1129).

Web Sites: <http://www.bts.gov/ntl/DOCS/EC.html>

References: 1. *Effectiveness Of Changeable Message Signs In Controlling Vehicle Speeds In Work Zones*; Garber, Nicholas J.; Patel, Surbhi T.; August 1994.

6.3.17 Breathalyzer Ignition Interlock Device

Objectives: 2, 3, 2, 7, 13, 14, 15

Desired Outcomes: Prevent those who have been convicted of drunk driving from operating vehicles while intoxicated.



Project Locations: Localities where drunk driving is a particular problem and the recidivism rate is high.

Technical Approaches: Legal sanctions to deter drunk driving, such as license suspension, mandatory jail time, and court-ordered treatment have not consistently reduced recidivism rates. In fact, reports indicate that up to 75% of those with suspended licenses continue to drive. In response to the dismal outcome of traditional legal remedies, several states have authorized judges to use the breath analyzer ignition interlock device as an optional sanction in drunk driving cases. Ignition interlock is essentially a Breathalyzer attached to the ignition of a motor vehicle, and is designed to prevent an alcohol- or drug-impaired person from starting and driving a motor vehicle. The Court may order an ignition interlock device as a condition for obtaining restricted driving privileges.

The operator of the vehicle is required to give two tests before the device will permit the ignition of the vehicle to start up the vehicle. The first test is a deep lung sample of breath. The interlock is programmed to "fail" this test if the operator has over a .02 level of alcohol in the breath sample. If the breath sample is under a .02 level, the device will then ask for the second test. This second test is called the CBPA test. This test is a code of breaths and pauses. Each CBPA test is programmed for each device. If the operator fails either test, the device will permit up to three attempts before a lockout. If the operator does get a lockout, the device will permit another test in approximately 30 minutes. Upon passing both tests, the device will allow the operator to start the car. The Probation Division processes all paperwork needed when the Court orders an interlock to be installed, and can provide additional information and further instructions about installation and costs.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Center subsystem: Statewide database of repeat drunk driving offenders.

Roadway subsystem: Static signs or billboards warning against drinking and driving.

Vehicle subsystem: Ignition interlock device that prohibits the vehicle from starting if alcohol is detected from the driver's breath.

Communications Requirements: N/A

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Work with courts and police to determine which offenders receive the device, and how fees for the device should be worked into fines.

Step 2: Procure equipment, contract installation company.

Step 3: Monitor effectiveness of technology. Consider bringing in university group to research reducing the number of repeat offenders and monitor the device's effect.

Organizational Management: While the prosecution and prevention of drunk driving is not a traditional DOT responsibility, SDDOT accident records repeatedly cite drunk driving as a large contributor to deaths on the roadway. Safety and accident prevention are certainly within the realm of concerns for the DOT and support (this may be institutional and not financial) of these systems would not be beyond the scope of DOT efforts.

Schedules and Milestones: Technology has been proven, deployed and currently in use in other states. The following is the suggested schedule reflecting steps to deployment:

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
<i>Step 1</i>						
<i>Step 2</i>						
<i>Step 3</i>						

Capital Costs: Low– Interlock devices cost several hundred dollars apiece. However, offenders are usually charged a fee to lease the device, which leads to the device paying for itself in a very short time. A typical lease fee is around \$60 per month. Offenders are also responsible for the cost of installing the device.

O&M Costs: N/A

Benefits / Cost: Moderate – The system only works on vehicles with the equipment installed, therefore offenders could operate other vehicles.

- Benefits to DOT:
 - Discourages drunk driving.
- Benefits to Traveler:
 - Fewer drunk drivers make the roads safer for everyone.
 - Offenders foot the bill for the system.

Roles and Responsibilities: Generally, the courts will be responsible for requiring the devices be installed, and for ensuring compliance. State laws will determine the punishment for tampering with the devices.

Staffing: The required staff time is minimal. A staff member will need to work with the courts and police agencies to coordinate the procurement and introduction of the devices.

Potential Funding Sources: State funding.

Application Examples: National Commission Against Drunk Driving (NCADD): (202) 452-6004

Consumer Safety Technology, Inc., maker of Intoxalock: 1-877-777-5020

Web Sites: Consumer Safety Technology, Inc.: <http://www.cstinc.com/index.html> NCADD: <http://www.ncadd.com> Links to research on the use of technology to deter drunk driving: <http://www.ncadd.com/tsra/abstracts/technology.html>

References: 1. *Effects of Ignition Interlock Devices on DUI Recidivism: Findings from a Longitudinal Study in Hamilton County, Ohio; Crime and Delinquency*; Morse, Barbara J. and Elliott, Delbert S. Volume 38, No. 2, 1992; pp. 131-157.

6.3.18 On-Board Snow Plow Driver Assistance

Objectives: 5, 7, 8, 12, 14, 16

Desired Outcomes: Improved vehicle guidance and control that is potentially compatible with all types of vehicles but may be especially suitable for specialized deployments on snowplows.

Project Locations: Initial deployments should be in areas that are (1) Most prone to adverse winter weather (2) Most necessary to keep open during adverse weather and (3) Close to a DOT facility, so that testing may be performed. The suggested project location is Aberdeen area.



Technical Approaches⁸: Pavement-embedded magnets combined with in-vehicle sensors can provide very accurate measurements of vehicle position within a lane, absolute longitudinal location of a vehicle, and advance information about upcoming roadway characteristics, including roadway curvatures, entrances and exits, mileposts, etc. The

magnetic guidance system comprises a series of magnetic markers that serve as a roadway reference, plus vehicle-borne sensing and processing units that obtain information from the markers. Simple permanent magnets embedded in the center of a lane, about 1.2 meters apart, indicate the lane center. Alternating the magnetic polarities of the markers (north-up vs. south-up) creates a binary code that indicates roadway characteristics. One binary-coded message about roadway characteristics requires an average of 25 markers, which takes up 30 meters length of roadway. The elapsed time to read that message would be about a second for a vehicle traveling at 100 km/h (60 mph). Magnetic sensors, mounted under the front and rear bumpers of a vehicle, measure the magnetic fields on three axes. An on-board Pentium computer processes the magnetic field data to derive lateral and longitudinal position measurements and to decode the binary information. (The computer is also capable of other vehicle control functions.)

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Center subsystem: Computer monitoring equipment to track vehicle-mounted AVL systems. Communications is possible between center subsystems and vehicles.

⁸ Information gathered from Partners for Advanced Transit and Highways, University of California at Berkeley.

Roadway subsystem: Ordinary magnets serving as lane markers, placed approximately 1.2 meters apart.

Vehicle subsystem: Magnetic sensors mounted under the front and rear bumpers and an in-vehicle computer that calculates position measurements and decodes binary information.

Communications Requirements: Communications between the center subsystem and vehicle is required and can be accomplished through cellular and satellite communications.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Review all existing research on this technology, including Houston Metro’s work with automated transit buses, Minnesota and California’s work with automated snow plows and other Automated Highway System (AHS) studies.

Step 2: Select appropriate sites for deployment across South Dakota. Consider need for improved snowplowing and ability to easily access test bed. Identify potential partners.

Step 3: Develop system design and operational parameters.

Step 3: Procure, acquire or build system.

Step 4: Demonstrate and evaluate technologies.

Organizational Management: Protocol considerations include: what to do if the system fails, how to track vehicle status, how to select appropriate test sites, and how to train personnel who may be reluctant to “trust” an automated vehicle.

Schedules and Milestones: The following is the suggested schedule reflecting steps to deployment:

	Month													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<i>Step 1</i>														
<i>Step 2</i>														
<i>Step 3</i>														
<i>Step 4</i>														

Capital Costs: Moderate to High - Most markers are ceramic magnets (2.4 cm diameter, 10 cm long, 9¢ each), with neodymium magnets (2.5 cm diameter, 2.5 cm high, less than \$10 each) used for special locations where rebar is close to the surface. The cost per lane mile of installation is less than \$10,000. When the installation process is automated, this cost can be

substantially reduced. Magnetic sensors and in-vehicle equipment also need to be purchased at varying prices. Project funding is suggested at \$600,000 for the operation test and demonstration of lateral / longitudinal guidance of snow plows within South Dakota. An alternative is to participate in the pooled-fund study being led by CALTRANS, to study ITS applications in highway maintenance vehicles, primarily snow plows.

O&M Costs: If the tests are considered a success, then additional equipment will need to be purchased. Other future considerations include replacement of imbedded magnets with reconstruction and re-paving of roadway.

Benefits / Cost: Moderate - This type of system is still in the operational test phases. It will be a number of years before the automated highway system will be a widely accepted concept.

- Can reduce hazards caused by sleepy drivers/fatigued maintenance workers.
- Can reduce hazards of snowplowing during extremely poor winter driving conditions by providing advanced support to drivers.
- Cutting-edge application can be an example to other states.

Roles and Responsibilities: Since the system is not commercially available, vendors will need to be sought out for the individual components. This project requires additional research before it becomes accepted at a fully-operational level.

Staffing: Staff labor will be required for installation and testing of the system.

Potential Funding Sources: SDDOT/Federal funding.

Application Examples: Wei-Bin Zhang/Steven Shladover, PATH researchers, (510) 231-9495

Web Sites: PATH research page: <http://www.path.berkeley.edu/PATH/Research/magnets/>
Minnesota Intelligent Vehicle Initiative: <http://www.dot.state.mn.us/guidestar/>

6.3.19 Mayday Infrastructure

Objectives: 1,3,5,7,8,10,12,13,14,15,16

Desired Outcomes: Develop a communications infrastructure capable of accepting emergency calls from commercial Mayday devices resulting in faster and automatic emergency notification.



Project Locations: Rural areas of South Dakota that experience slow emergency response due to sparseness of population, with eventual expansion statewide. The suggested location is Rapid City, where emergency safety personnel noted concern with motorists with a lack of knowledge regarding their location.

Technical Approaches: Current Mayday initiatives have been undertaken on an operational test capacity. With the private vendors pushing the development of in-vehicle Mayday systems, public agencies need to consider how these calls will be handled once widespread market penetration is reached. At the national level, there are several initiatives working to standardize message sets sent from in-vehicle systems to emergency response centers. The best approach to implementation is to work with one or several Mayday device manufacturers to directly route Mayday related calls to public safety response centers. This will require (as an initial step) determining which data elements are required for emergency response and enhancing the capabilities within public call centers to receive and display Mayday data. Examples of Mayday data elements include location of crash; vehicle make, model, and color; and crash severity data. Another element of the infrastructure is linking public safety answering points together, perhaps by way of a wide area network.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Vehicle subsystem: In-vehicle devices initiate Mayday calls. These devices can be activated manually or triggered with the deployment of an air bag. Mayday data is sent to Emergency Response centers using cellular or satellite communications.

Center subsystem: Crash related data sent from the vehicle is received at the Emergency Response center. This data can be manually or automatically forwarded to other agencies involved in responding to emergencies. Additionally, there may be a link between the public

safety answering point receiving the Mayday data and the private third party responder associated with the commercial Mayday device. In some instances, this link provides a back-up mechanism for responding to calls in the event that the call between the vehicle and public safety answering point is disconnected, or for some reason the call is not successfully answered on the first attempt. Most commercial Mayday devices offer concierge services such as directions, yellow pages information, remote vehicle diagnostics, and roadside assistance. These types of requests are handled by a third party response center affiliated with the Mayday device.

Communications Requirements: The key to timely emergency notification is adequate cellular coverage. This is specifically a challenge that is fully recognized in rural areas. Satellite communications can also be used, but this scenario is not as likely since most commercial Mayday devices operate using cellular communications. The communications required between emergency response centers is more flexible and consists of a variety of land-line telephone and fiber-optic options.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Identify deployment site and potential partners.

Step 2: Evaluate and research Mayday initiatives undertaken in other states and commercial products available to the public.

Step 3: Develop specifications (e.g., message set requirements between vehicle and centers, and center to center), standards and technical approach for project.

Step 4: Letting and award of project.

Step 5: Vendor development. Delivery and installment (including acceptance testing) of equipment and training of staff.

Step 6: Test and evaluate proposed system.

Organizational Management: Some of the challenges of Mayday implementation relate to determining how Mayday calls should be handled. For example, should Mayday calls be received at a central dispatching center (e.g., Highway Patrol in Pierre) and then forwarded to appropriate response agency (e.g., state patrol, fire, local police)? Or, should Mayday call response be distributed (based on how 9-1-1 calls are routed, could be Highway Patrol or other emergency response center)? The suggested configuration for the implementation of a Mayday infrastructure would initially reside within Highway Patrol, that is all the Mayday calls would initially be answered by the Highway Patrol.

Schedules and Milestones: The following is the suggested schedule for the deployment of a Mayday infrastructure:

	Month																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Step 1																							
Step 2																							
Step 3																							
Step 4																							
Step 5																							
Step 7																							

Capital Costs: High – The development of a Mayday infrastructure will require significant effort as a result of its operational test nature. Very few operating models exist for duplication. The project cost is an estimated \$2 million.

O&M Costs: Operations and maintenance considerations include data storage and retrieval and anticipated software upgrades.

Benefits / Cost: Moderate - Initially, this implementation would only benefit those with in-vehicle Mayday devices. However, with the push for the deployment of in-vehicle devices by the private sector, the evolution of Mayday devices will be similar to that of airbags.

- Benefits to Emergency Response:
 - Ability to receive value-added crash data for improved emergency response.
 - Improved incident location information.
 - Better anticipation of severity level of incident before arriving at the scene of an incident.
- Benefits to Traveler:
 - Accurate crash location information.
 - Automatic emergency notification in the event of severe crashes.
 - Direct voice contact with emergency dispatchers.
 - Quicker emergency notification.

Roles and Responsibilities: Call routing for Mayday calls should follow current protocols for cellular 9-1-1 requests for assistance. Typically emergency response is the responsibility of Highway Patrol and other public safety answering points such as local police and fire. The DOT can act as the intermediary to bring all agencies together.

Staffing: At the operational test level, test emergency calls can be expected on a daily basis. The staffing required once a system is fully operational is expected to remain the same. The volume of incoming calls may not change from the current number of requests for assistance from cellular 9-1-1 calls, and the number of calls from Mayday systems may be few initially. However, it is anticipated that initial and continual training will be required once the system is deployed. Initial training is necessary to familiarize staff with the system and ensure that they are comfortable with using the technology. Continual training is required to ensure that staff can respond to Mayday calls despite the frequency of calls. This may require self-directed training programs that staff can access during low peak call times.

Potential Funding Sources: The USDOT ITS Public Safety Program

(<http://www.its.dot.gov/pubsafety/factsheet.htm>) is working to increase the link between public safety and transportation operations. Part of this program is to “deploy interoperable procedures and technologies for public safety and transportation operations. “ This will be the focus of the program during the next four years. The DOT funding for these types of initiatives is estimated at \$9 million over the duration of the next four years, in addition to supplemental funding expected from other federal programs and non-federal partners. A request for proposal for a Mayday-related field operational test may be expected for solicitation in the early portion of the next US DOT fiscal year.

Application Examples: Rochester, Minnesota Mayday Plus implementation; Buffalo, New York Automatic Collision Notification; Seattle, and Washington Puget Sound Help Me project.

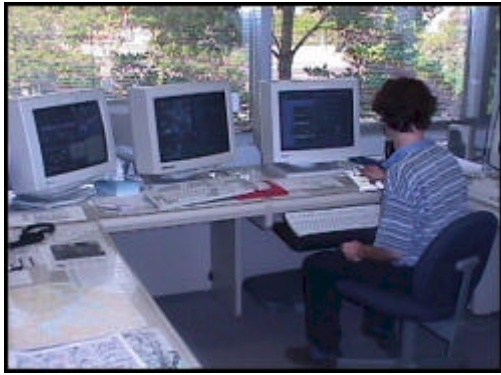
Web Sites: <http://www.dot.state.mn.us/guidestar/maydayproj.html>,
<http://enterprise.prog.org/mjm.htm>

6.3.20 Computer Aided Dispatching (CAD) / Automatic Vehicle Location (AVL) / Mobile Dispatch Terminals (MDT) for Rural Transit

Objectives: 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 16

Desired Outcomes: Combining CAD, AVL, and MDT technologies for improved transit operations and service.

Project Locations: The systems can be used anywhere transportation information is desired.



The type of mobile data system most likely to be used in the community transportation arena is one that includes demand response components or some sort of subscription service. Some Sioux Falls area transit agencies have begun investigation into AVL, thus facilitating the deployment of such technologies.

Technical Approaches: Computer aided dispatching (CAD), automatic vehicle location (AVL), and mobile dispatch terminals (MDT) are three separate technologies that work together to improve operations efficiency and provide better service to rural transit passengers. AVL using global positioning system (GPS) technology is quickly becoming the most popular way to track vehicle location. GPS uses satellite receivers to pinpoint a location. This location is then transmitted to a dispatch center via wireless communications. CAD software enables the dispatch center to coordinate all passenger service calls through one primary “hub”. After a dispatch operator receives a call from a citizen requesting service, the operator may check the status and location of available transit vehicles and then use a MDT to communicate the request to the driver.

This combination of technologies enables a variety of rural transit providers (e.g., churches, schools, daycare centers, senior-citizen centers, etc.) to streamline their operations while providing more efficient service.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Center subsystem: Central dispatching agency, which tracks all of the equipped vehicles by “polling” them—electronically requesting their position. Computers at the dispatch center are equipped with Computer Assisted Dispatching (CAD) software that enables bus status,

condition, position, schedule adherence, operator, and incident information to be displayed on-screen.

Roadway subsystem: N/A

Vehicle subsystem: Transit vehicles are equipped with GPS antenna, receiver and transmitter as well as a MDT for hands-free communication with the dispatch center while driving.

Traveler subsystem: A web site that enables transit passengers to log in and see where their bus is currently located and whether it is on time. By providing an online trip-planning guide, users can plan a multi-town trip that allows transferring between transit agency jurisdictions.

Communications Requirements: Radio communications are used by the MDT and AVL systems.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Review existing AVL/CAD/MDT deployments in other states.

Step 2: Work with local transit agencies to determine a suitable location for a pilot test.

Step 3: Procure and test AVL/CAD/MDT equipment for duration of time sufficient for all staff to become comfortable with the new technology.

Step 4: Develop a deployment and operations plan for installation of equipment at other locations based on experiences and lessons learned in *Step 3*.

Step 5: Monitor effectiveness of technology. Modify equipment if necessary.

Organizational Management: Careful coordination with all local transit agencies will be necessary to ensure that the streamlining effort is indeed timesaving and leads to better service. A larger transit agency could act as the coordinating body between smaller partners.

Schedules and Milestones: Long term. This is a large-scale project that utilizes proven technology. The following is the suggested schedule reflecting steps to deployment:

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
<i>Step 1</i>						
<i>Step 2</i>						
<i>Step 3</i>						
<i>Step 4</i>						
<i>Step 5</i>						(ONGOING)

Capital Costs: Moderate to High - The capital cost of an integrated installation of AVL and other advanced public transportation system components is dependent on the size of the system, its level of sophistication, and the components to be included. The average cost of an AVL-equipped bus is approximately \$15,500. CAD centers require computer workstations and software at a cost of approximately \$5,000 apiece. Project funding is suggested at \$300,000 for equipping a fleet of 15 vehicles with automatic vehicle location and mobile dispatching terminals, and computer aided dispatching capabilities.

O&M Costs: Operations and maintenance costs mostly consist of equipment upgrades and repairs. O&M costs for GPS are approximately \$500 annually.

Benefits / Cost: High – High benefits for passengers, transit operators and dispatchers:

- Benefits to Operations:
 - Improved schedule adherence.
 - Improved transfer coordination.
 - Improved ability of dispatchers to control bus operations.
 - Facilitated on-street service adjustments.
 - Increased accuracy in schedule adherence monitoring and reporting.
 - Assisted operations during snowstorms and detours caused by accidents or roadway closings.
 - Effectively track off-route buses.
 - Effectively track paratransit vehicles and drivers.
 - Eliminated need for additional road supervisors.
 - Reduced manual data entry.
 - Improved safety from hands-free communication with dispatch.
- Benefits to Dispatchers:
 - Reduced voice radio traffic.
 - Established priority of operator calls.

- Improved communications between supervisors, dispatchers, and operators.
- Benefits to Passengers
 - Provides capability to inform passengers of predicted bus arrival times.
 - Passengers can call one phone number to reach a variety of transit services.
 - Improves rural mobility by providing coordinated service to those who may not have access to personal vehicles.

Roles and Responsibilities: If multiple agencies are involved in the deployment of this system, the location control center would have to be agreed upon by all parties. Additionally, agreements between partners need to be in place establishing operational procedures, required funding contributions, etc.

Staffing: All transit drivers and dispatch center workers will need to be thoroughly trained in how to use the new equipment and software. This training may be expedited if staff participate in the early testing of the system. The operation of a multi-jurisdictional transit system will require one full-time staff person for operation. It may be just a reallocation of current resources.

Potential Funding Sources: Federal and State DOT, FTP OTRB Accessibility Program, FY 2000 JARC Application, USDA Cooperative State Research Education and Extension Service.

Application Examples: Sweetwater County Transit Authority, Wyoming. ARTIC, Virginia, Minnesota.

Web Sites: <http://www.ctaa.org/ntrc/rtap/pubs/ib/newtech.shtml>, <http://www.tucows.com>,
<http://www.host.ots.utexas.edu/mac/main.html>,
[http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/45\\$01!.pdf](http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/45$01!.pdf)
Funding: <http://www.ctaa.org/funding>

References: 1. *Advanced Public Transportation Systems: The State of the Art Update '96*. January 1996.
2. *FTA-MA-26-7007-96-Automatic Vehicle Location Technology Adds Capabilities*, Keith Strandberg, Mass Transit, November/December 1993, pp. 28-35.
3. *Integrated Service Extends Transit Options, Reduces Paratransit Demand*," Staff, CTR August 1995, Project Action Insert.

6.3.21 Web-Enabled Transit Route Planning / Universal Smart Pass

Objectives: 1, 2, 3, 7, 8, 9, 10, 11, 12, 13, 14, 15

Desired Outcomes: A fully multi-modal web site that allows users to enter destination information and receive complete directions for their trip. Smart passes enable travelers to use one pass to board several modes of transportation such as buses and trains across various city and county boundaries.

Project Locations: A pilot program may be undertaken in either a metro or rural area. Deployment in a more populous area will have more opportunities for increased multi-modal options. The suggested deployment areas are either Rapid City or Sioux Falls.

Technical Approaches: This proposed Web site enables the public to access a variety of categories, for example, services for senior citizens and the handicapped, online bicycle maps,



the location of free park-and-ride lots, and meeting agendas. Real-time traffic reports from the Department of Transportation would also be available for congested areas. An online planning system allows users to tap into a database used by phone operators when giving route information to callers. To use the Web site's planner, transit passengers would provide streets addresses or cross streets for their starting point and destination. The

system then generates a step-by-step itinerary that takes passengers to their destination using the most convenient bus routes or even several modes such as train or shuttle bus. After reviewing the route, users may opt to view maps of the distance between transfer points. Ridesharing options are also covered by the transit-routing database. In addition to planning the best route, the system could calculate the total fare.

Equipment Required: Based on the National ITS Architecture, the following is a likely scenario of the equipment required for deployment, and within which subsystem it can be found:

Center subsystem: Databases containing route information and user preferences for rideshare. Decision support system capable of processing requests and generating recommended trips either automatically or semi-automatically by supporting operators.

Roadway subsystem: Static signs on busy freeways reminding commuters to try alternate modes and ridesharing. Other possibilities include installation of more dynamic signs that will alert the rider of an approaching bus within a designated amount of time.

Traveler subsystem: Web site providing ride sharing, route planning, traffic conditions, and special service information.

Communications Requirements: Web sites may be accessed through traditional telephone or cellular connections.

Steps to Deployment: The following are the suggested steps to facilitate deployment:

Step 1: Compile existing route databases. Plan to build any deficient databases. Form committee of web designers/developers to begin planning web site.

Step 2: Form committee of representatives from local transportation providers to begin making plans for Smart Pass.

Step 3: Perform usability testing of first version of web site to gauge public opinion.

Step 4: Modify web site according to usability feedback. Begin promoting new services to public via bus billboards, radio, etc.

Step 5: Go live with web site.

Step 6: Continue adding functionality to web site and promoting a standardized mechanism for payment.

Organizational Management: A top consideration is the amount of fare charged by various transit entities. Fare lists and options must be readily available to passengers. However, increased ridership will be experienced with consistency in fares across various municipal boundaries and (perhaps) a cost-savings for using multiple modes of travel. These opportunities must be thoroughly discussed and agreed upon by all partners. Especially important is encouraging the public to use the new service. For example, great effort needs to be put forth to easily and clearly show the benefits of using the integrated system.

Schedules and Milestones: Technology has been proven, deployed and currently in use in other states. The following is the suggested schedule reflecting steps to deployment:

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
<i>Step 1</i>						
<i>Step 2</i>						
<i>Step 3</i>						
<i>Step 4</i>						
<i>Step 5</i>						
<i>Step 6</i>						(ONGOING)

Capital Costs: Moderate to High -- Capital costs will vary depending on the scope of the project. A web site that provides only static information can cost under \$5,000. Added functionality (e.g., fare and rate calculators, ability to purchase fare cards on-line) will increase initial capital costs. Electronic fare payment costs between \$2800 to \$9500 per vehicle. The integration of a universal smart pass system will greatly increase the initial capital costs. Fare readers may need to be updated or completely replaced. This will also depend on the number of buses in the fleet and size of the service. Smaller implementations will cost under \$200,000 with larger deployments estimated at over \$200,000. Project funding is suggested at \$100,000 for the development of a transit planner web site and implementation of electronic fare readers in 10 to 15 vehicles.

O&M Costs: Ongoing costs include registration costs for the web site domain name, labor costs for updating the site and advertising.

Benefits / Cost: High – Transit agencies save money on hiring live telephone operators to assist with route planning. Travelers enjoy the convenience. Air quality can improve from fewer vehicles on the road.

- Benefits to DOT:
 - Interagency coordination improves working relationships.
 - Costs reduced by using automated route planning rather than live assistants.
 - Increased revenue from increased use of transit.
- Benefits to Traveler:
 - Having more options makes commuting less stressful.
 - Route planning is instantaneous, as compared to waiting on hold to speak with a live route assistant.

Roles and Responsibilities: As with any multi-jurisdictional endeavor, one agency will need to champion the project. Other responsibilities include determining the location of the Web site (that is, determine whether it should be housed within an agency or through a professional service) and maintenance of the Web site. For example, should maintenance be contracted or the responsibility of a partner agency?

Staffing: Once the web site is live, a staff web programmer will need to accept responsibility for periodic updates. Other staff members will absorb public relations and coordination of the smart pass system into their daily responsibilities.

Potential Funding Sources: FTA, FHWA, and DOT funding. Further funding from local municipalities.

Application Examples: Steven DeGeorge Transportation Planner/Manager, Ventura County Transportation Commission, (805) 642-1591

Web Sites: Ventura County Transportation Commission: <http://www.goventura.org/> Report on various ITS success stories: http://pti.nw.dc.us/task_forces/transportation/docs/roads/roads.pdf

References: 1. *Roads Less Traveled: Intelligent Transportation Systems for Sustainable Communities*; Public Technology, Inc.; 1998.

6.4 Recommended Medium- to Long-Term Timelines

The following is the suggested phased cost tables and schedule timelines for deploying the medium- and long-term ITS projects in South Dakota. Projects selected for medium-term deployment continue to address safety, traveler information and improved operations and efficiency. Some of these projects are more research in nature and may not be as readily deployable as near-term projects.

Figure 6-5. Medium-Term Project Costs

Medium-Term Projects	Cost				
	2004	2005	2006	2007	Total
18. Statewide 5-1-1 Traveler Information Number	\$50,000				
19. Portable Traffic Management System	\$100,000				
20. Automatic Vehicle Location for Agency Vehicles	\$300,000				
21. Highway Advisory Radio (HAR)	\$30,000				
22. Multi-Jurisdictional Transit Coordination		\$100,000			
23. Infrastructure Inventory and Condition Monitoring System		\$100,000			
24. Rural Traffic Operations and Communications System		\$3,000,000			
25. Highway Railroad Intersection Safety		\$30,000			
26. Intersection Collision Countermeasure			\$96,000		
27. Multi-Jurisdictional Emergency Services Coordination			\$100,000		
28. Hand-held Devices for Reporting Accident Data			\$25,000		
29. Roadway Geometrics Alert System			\$30,000		
30. Emergency Warning System				\$20,000	
31. Information Exchange Network				\$50,000	
32. Broadcast Traveler Information				\$50,000	
33. Portable ITS and Traveler Information Technologies in Work Zones				\$100,000	
34. Breathalyzer Ignition Interlock System				N/A	
Medium-Term (4-7 years) Total	\$480,000	\$3,230,000	\$251,000	\$220,000	\$4,181,000

Projects selected for long-term projects are “visionary” in nature, and may require more in-depth research and advances in technologies before realization. These projects are most appropriate once the South Dakota Rural ITS Program has been in place for a number of years.

Figure 6-6. Long-Term Project Costs

Long-Term Projects	Cost		
	2008	2009	Total
5. CAD / AVL / MDT for Rural Transit	\$300,000		
6. On-board Snow Plow Driver Assistance	\$600,000		
7. Mayday Infrastructure	\$2,000,000		
8. Web-Enabled Transit Route Planning / Smart Pass		\$100,000	
Long-Term (>7 years) Total	\$2,900,000	\$100,000	\$3,000,000

Figure 6-7. Medium- and Long-Term Cost Summary

Recommended Projects	Cost
Statewide 5-1-1 Traveler Information Number	Initial estimates for jurisdictions to investigate and begin the process of converting an existing traveler information number to 5-1-1 is \$50,000.
Portable Traffic Management System	Design of the system including hardware and software requirements, and standard operational protocols may cost \$100,000 for contract work.
Automatic Vehicle Location for Agency Vehicles	The project suggestion is for funding a fleet of approximately 15 fleet vehicles. The project cost is approximately \$300,000. Typical AVL costs include \$6200 per vehicle for a GPS-based location system, \$2300 per vehicle for computer aided dispatching capabilities, and \$2400 per vehicle for digital communications or \$3500 per vehicle for trunked communications.
Highway Advisory Radio (HAR)	Project recommendation is for \$30,000 to fund and implement a mobile HAR system. Very basic systems may be purchased for as little as \$8,000. Commercial systems run approximately \$25,000 for equipment and installation.
Multi-Jurisdictional Transit Coordination	The suggested project funding is \$100,000 for the design and coordination of transit and multi-modal services around the state. Information provided to users is anticipated via Internet and a 1-800 or local telephone number.
Infrastructure Inventory and Condition Monitoring System	Initial capital costs are \$100,000 for deployment. Similar initiatives require internal database (e.g., Oracle, SQL) support that can operate on an existing computer. Staff and travelers can access the system using Internet browsers that can be downloaded and upgraded for free.
Rural Traffic Operations and Communications System	Most capital costs in the design of an integrated, electronic traffic operations and communications system occur with software development. Depending on the types of uses for the system, software development for the computer system may cost as much as \$500,000. Hardware with installation may be as much as \$1.5 to \$2 million depending on the size of the district being equipped, the types of implementations requested. The proposed total cost is \$3,000,000 to equip a small urban area and its surrounding rural neighbors.
Highway Railroad Intersection Safety	Automated train horns cost approximately \$20,000 apiece. However, at least one community has had to forestall their installation due to the prohibitive cost of upgrading the train track wiring system. The upgraded technology, known as “constant warning technology” can reportedly cost up to \$250,000 if not already in place.
Intersection Collision Countermeasure	Project funding is suggested at \$96,000 for the design, procurement of a sign, and installation.
Multi-Jurisdictional Emergency Services Coordination	Project funding is suggested at \$100,000 for the detailed design and implementation of a shared emergency responder database.

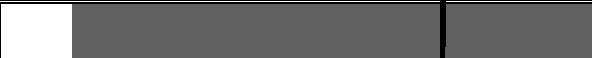
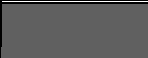




Figure 6-7. Medium- and Long-Term Cost Summary

Recommended Projects	Cost
Hand-held Devices for Reporting Accident Data	Project funding is suggested for \$25,000 for the procurement of ten units and the design and integration of the interface. Hand-held devices range in price from \$150 (2MB of memory) to \$250 - \$450 (8MB of memory) per unit. Wireless cellular modem compatible with hand-held devices cost approximately \$370 per unit. Some modems have the option for global positioning system functionality. This type of system is most appropriate for emergency centers that are already equipped with some type of internal local area network.
Roadway Geometrics Alert System	Project funding suggestion is \$30,000 for site selection, design, and the purchase of three units for test and evaluation. Flashing beacons cost approximately \$3,500 each. For the radar system, \$3,800 covers the cost of one transmitter, solar pack and installation.
Emergency Warning System	Solar powered flashers used in Phoenix, Arizona cost \$1500 per unit. However, they will eventually pay for themselves in energy savings. A pager-activated system can be controlled from any computer, with pagers costing as little as \$30 per month. The project funding is estimated to be \$20,000 for the procurement, site survey, design, installation, testing and evaluation of six solar-powered flashers.
Information Exchange Network	Capital costs are low to zero and consist mainly of staff labor dedicated to getting the IEN up and running. Suggestion is to allocate \$50,000 for investment in one or several ITS pooled-fund study.
Broadcast Traveler Information	\$50,000 for the investigation, test and implementation of broadcast traveler information technologies.
Portable ITS and Traveler Information Technologies in Work Zones	Project suggestion is \$100,000 for developing and testing one mobile unit. Initial low costs systems can later add advanced components. HAR costs approximately \$20,000 per unit including training. CMS technology can be purchased for approximately \$16,000 to \$18,000 per unit. The total cost of the project in Iowa (which combined HAR, CMS and the detection system) was \$100,000. The CMS units were already owned by the DOT. There is an option to lease or buy equipment.
Breathalyzer Ignition Interlock System	There is no cost to the DOT. Support of the concept if seen as a viable drunk driving deterrent for repeat offenders.
CAD / AVL / MDT for Rural Transit	\$300,000 to deploy and test a fleet of 15 vehicles equipped with AVL and MDTs, and CAD capabilities.
On-board Snow Plow Driver Assistance	\$600,000 for the operational test and demonstration of lateral / longitudinal guidance of snow plows within South Dakota. An alternative is to participate in the pooled-fund study, led by CALTRANS, to study ITS applications in maintenance vehicles.
Mayday Infrastructure	\$2,000,000 for the design and development of an interface between commercial Mayday devices and emergency response centers, and the procurement of four workstations.
Web-Enabled Transit Route Planning / Smart Pass	\$100,000 for the development of a transit planner Web site and implementation of electronic fare readers in 10 to 15 vehicles. Electronic fare readers cost approximately \$2800 to \$9500 per vehicle.

Figure 6-8. Medium-Term Deployment Timeline

Projects Recommended for Medium Term (4-7 years) Deployment				
Projects	2004	2005	2006	2007
5-1-1 for Traveler Information				
Portable Traffic Management System				
Automatic Vehicle Location for Agency Vehicles				
Highway Advisory Radio				
Infrastructure Inventory/Condition Monitoring System				
Multi-Jurisdictional Transit Coordination				
Rural Traffic Operations and Communications Center				
Highway Railroad Intersection Safety				
Intersection Collision Countermeasure				
Multi-Jurisdictional Emergency Services Coordination				
Hand-held Devices for Reporting Accident Data				
Information Exchange Network				
Emergency Warning System				
Roadway Geometrics Alert System				
Portable ITS and Traveler Information Technologies in Work Zones				
Broadcast Traveler Information				
Breathalyzer Ignition Interlock Program				

Figure 6-9. Long-Term Deployment Timeline

Projects Recommended for Long Term (>2008) Deployment			
Projects	2008	2009	2010
On-Board Snow Plow Driver Assistance			
Mayday Infrastructure			
CAD / AVL / MDT for Rural Transit			
Web-Enabled Transit Route Planning / Universal Smart Pass			

6.5 Recommended Projects Summary

Following is a table that summarizes the recommended projects, indicates the needs category addressed by the ITS application, costs, and suggested deployment area.

Figure 6-10. Recommended Projects by Suggested Deployment Regions

Need Category	Recommended Projects	Cost	Suggested Deployment Area
Traveler Information	Traveler Information Promotion Promote the current resources of information provided by the SDDOT including, but not limited to, ATWIS, the SDDOT traveler information Web page, and #SAFE programs.	Total direct costs estimated at \$10,000 for reproduction of flyers, reproduction of posters, radio / television spots, and travel to media locations. The SDDOT should also consider allocating \$10,000 to hire a marketing firm to assist in developing a marketing strategy and \$5,000 to evaluate the results of the traveler information promotion effort. Total project cost is \$25,000.	Statewide
Traveler Information, Mobility	Road Condition Via CCTV Installation of cameras on the roadway for viewing current road conditions and traffic condition, for example.	Total Equipment costs for recommended deployment of six cameras: \$30,000. Camera setups including: cabling, camera server and other electronic equipment costs are reported at \$1,800 per setup. Housing units with heaters are extra (\$130 / unit). Other miscellaneous costs include wiring, mounting brackets and additional camera lenses if needed. These capital costs do not include the costs for installing a pole, and should be added for locations without existing poles.	Six camera deployments are recommended. Rapid City in conjunction with the Ellsworth RWIS station; in Rapid City in conjunction with the Sheridan Lake Road RWIS station; Pierre at the Vivian RWIS station , Sioux Falls along I-90 near Montrose RWIS station; Belvidere near Belvidere RWIS station; the Northeast portion of the state in conjunction with the Summit RWIS station.
Traveler Information, Mobility	Expansion of ATWIS This project consists of expanding the ATWIS efforts already underway. Five subprojects are proposed including: <ul style="list-style-type: none"> providing land-line access to the cellular-based system; implementing an interactive voice recognition system; providing Internet enhancements; consolidating weather information numbers; and improving road condition information. 	<ul style="list-style-type: none"> Land-line access = \$10,500 Interactive voice recognition = \$30,000 Internet enhancements = \$40,000 Consolidate weather information numbers = 80 hours staff time Improved road condition information = \$20,000 to \$75,000 	Statewide
Safety, Mobility	Automatic Anti-Icing System Use of a spray system that is automatically activated by a computerized control system in anticipation of frost or icy road conditions. The automatic anti-icing system will detect or predict ice formation and treat the roadway before it becomes a hazard to drivers. Sites prone to icy conditions include bridge decks and shady spots. The system consists of embedded pavement sensors, a processor to determine when conditions require anti-icing, and spray nozzles for anti-icing agents.	Total equipment costs for recommended deployment of two anti-icing units: \$50,000. For bridges spanning 500 feet or less with four lanes or less, a self-contained, ready-to-roll-out system costs approximately \$19,300. This system includes 10 spray nozzles that will provide coverage to the driving lanes only (shoulders will receive run-off), piping, chemical tank, and sensors. This system is not expandable, and requires the use of clear chemical agents such as magnesium chloride. Salt brine solutions will not work. Please note that larger systems (including 1000 gallon tank, supply pump structure, precipitation sensor, installation supervision, training, 15 spray nozzles, and piping) cost approximately \$63,300.	Watertown Hill City

Figure 6-10. Recommended Projects by Suggested Deployment Regions

Need Category	Recommended Projects	Cost	Suggested Deployment Area
Traveler Information, Safety, Mobility	Remote-Controlled Snow Gate Closure System This proposed system allows for snow gates to be remotely closed, offering increased safety for DOT or highway patrol personnel. The system can potentially be integrated with highway advisory radio, dynamic message signs, or closings can be posted on the integrated traveler information Web site to alert drivers of road closures.	Suggested project cost is \$50,000 for the design, deployment, test and evaluation of 3 remote-controlled gates. Traditional snow gates cost approximately \$3,600 for equipment and installation. Remote-controlled units cost approximately \$6000 (including gate, closure mechanism, and 1-year maintenance agreement.).	<ul style="list-style-type: none"> • Rapid City at an exit near camera and DMS deployments at MRM 65.2 and MRM 61.4, respectively. • Two gate deployments at exits near Sisseton in conjunction with planned DMS deployments at MRM 234.263 and MRM 228.985.
Traveler Information	Integrated Traveler Information System Enhancement of the current traveler information available. A “one-stop shop” for integrated traveler information to include camera images, information for other modes of transportation (such as transit and airport information), real-time road condition / traffic condition information, mileage calculator, rest areas, and links to tourism information, for example.	Total cost for the development of the Web site is \$100,000. The total equipment costs for deployment of six cameras is \$30,000. Please refer to Road Condition via CCTV project write-up for technical details. Other costs include: Web site planning (20 person days) - \$10,000; Coding and graphics development (30 person days) - \$20,000, Information gathering (60 person days) - \$40,000	Statewide
Safety	Rural Addressing and GIS The SDDOT has performed most of the fieldwork required in collecting GIS and rural addressing data. This project proposes to fund the effort necessary to complete the link between the GIS and rural addressing data. This would provide a statewide database of information that can be used by various state and local agencies to improve emergency service response, for land use planning, and for property data management, for example.	While the SDDOT has already purchased equipment for rural addressing, setting up a database to link GIS and rural addressing data and finishing the geo-coding effort may be a time consuming endeavor. The estimated project cost is \$100,000 to contract for database development for counties within South Dakota.	Statewide
Traveler Information, Mobility	Expansion of Dynamic Message Signs Expansion of the dynamic message sign network scheduled for deployment in 2001. The expansion will provide greater coverage and opportunities for travelers en route to receive information regarding weather, road conditions, closures, and construction information, for example.	This project description recommends the expansion of this effort. The project suggestion is for allocating \$600,000 for the expansion of the permanent sign network to include 3 more installations. The cost of equipment procurement and installation is \$100,000 for the sign, and an additional \$100,000 per installation. Mobile message signs can be purchased for approximately \$30,000 each. Total project cost is \$660,000.	Three additional permanent DMS deployments and procurement of two mobile units are recommended. <ul style="list-style-type: none"> • I-90 east of US 83. • I-90 eastbound approaching Rapid City. • I-29 northbound near Beresford for travelers heading towards Sioux Falls from Sioux City and Iowa.
Traveler Information	Statewide 5-1-1 Traveler Information Number This project proposes the designation of a dedicated 3-digit number (5-1-1) for traveler information, similar to the allocation of 9-1-1 for emergency response. Federal legislation was passed in the summer of 2000 to allow states the authority to pursue this initiative.	Initial estimates for jurisdictions to investigate and begin the process of converting an existing traveler information number to 5-1-1 is approximately \$50,000.	Statewide

Figure 6-10. Recommended Projects by Suggested Deployment Regions

Need Category	Recommended Projects	Cost	Suggested Deployment Area
Traveler Information, Safety, Mobility	Portable Traffic Management System The development of a multi-purpose, self-contained trailer combining various technologies such as: variable message signs, portable traffic signal, weather sensors, radar speed detection, video surveillance, wireless communications, highway advisory radio and floodlights. The system can be used for special event management, incident management, natural disaster management and traffic data collection.	Design of the system including hardware and software requirements, and standard operational protocols may cost \$100,000 for the initial contract work.	Mobile
Safety	Automatic Vehicle Location for Agency Vehicles This project seeks to use automatic vehicle location (AVL) technology for improved dispatching, scheduling, operations, and efficiency of Highway Patrol, DOT maintenance services, and transit. The suggested project is an investigation into the limited deployment, test and evaluation of 15 AVL units.	The project suggestion is for funding a fleet of approximately 15 fleet vehicles. The project cost is approximately \$300,000. Typical AVL costs include \$6200 per vehicle for a GPS-based location system, \$2300 per vehicle for computer aided dispatching capabilities, and \$2400 per vehicle for digital communications or \$3500 per vehicle for trunked communications.	Pierre
Traveler Information, Safety, Mobility	Highway Advisory Radio (HAR) HAR systems use recorded information on traffic conditions and tourist-related activities to reach users in a limited geographical area over AM and FM frequency; new recordings are made when conditions change sufficiently. Some systems provide the capability to remotely switch between alternative messages.	Project recommendation is for \$30,000 to fund and implement a mobile HAR system. Very basic systems may be purchased for as little as \$8,000. Commercial systems run approximately \$25,000 for equipment and installation.	Mobile
Traveler Information, Mobility	Multi-Jurisdictional Transit Coordination This project proposes to provide such information as routes, schedules, pick-up drop-off time estimates, type of service provided (e.g., fixed or demand response), coverage area of service, hours of operation, cost, and assistance in planning trips across multiple towns. The information can be provided through an interactive voice response (IVR), dial-up telephone system and/or on the Internet. The Internet site could potentially be incorporated into the integrated traveler information system, or be a stand-alone system.	The suggested project funding is \$100,000 for the design and coordination of transit and multi-modal services around the state. Information provided to users is anticipated via Internet and a 1-800 or local telephone number.	Statewide
Traveler Information, Safety, Mobility	Infrastructure Inventory and Condition Monitoring System This involves the development of a centralized condition reporting system. The system allows DOT personnel to manually input and report critical roadway situations (for example, real-time road construction updates, incident, advisories, road condition information) via an Internet based system for up-to-the-minute access by other DOT personnel and travelers.	Initial capital costs are \$100,000 for deployment. Similar initiatives require internal database (e.g., Oracle, SQL) support that can operate on an existing computer. Staff and travelers can access the system using Internet browsers that can be downloaded and upgraded for free.	Statewide
Traveler Information, Mobility	Rural Traffic Operations and Communications System This project proposes to establish an integrated traffic operations and communications center initially serving a selected small urban area of South Dakota. The center would assist in gathering and disseminating transportation information, incorporating multiple agencies operations and stimulating mutual cooperation.	Most capital costs in the design of an integrated, electronic traffic operations and communications system occur with software development. Depending on the types of uses for the system, software development for the computer system may cost as much as \$500,000. Hardware with installation may be as much as \$1.5 to \$2 million depending on the size of the district being equipped, the types of implementations requested. The proposed total cost is \$3,000,000 to equip a small urban area and its surrounding rural neighbors.	Sioux Falls

Figure 6-10. Recommended Projects by Suggested Deployment Regions

Need Category	Recommended Projects	Cost	Suggested Deployment Area
Safety	Highway Railroad Intersection Safety This project consists of implementing a community-friendly warning horn system to alert vehicles at train crossings of on-coming train traffic. The system requires the deployment of two stationary horns mounted at the crossing. Each horn directs its sound at the roadway. The horn is activated using the same track signal circuitry as the gate arms and bells located at the crossing. A strobe light informs the locomotive engineer that the system is working.	Automated train horns cost approximately \$20,000 apiece. However, at least one community has had to forestall their installation due to the prohibitive cost of upgrading the train track wiring system. The upgraded technology, known as "constant warning technology" can reportedly cost up to \$250,000 if not already in place.	Aberdeen
Safety	Intersection Collision Countermeasure This project involves the use of embedded traffic sensors to detect on-coming traffic at uncontrolled rural intersections. The sensors are integrated with flashing warning signs to warn drivers to proceed with caution.	Project funding is suggested at \$96,000 for the design, procurement of a sign, and installation.	Pierre
Safety, Mobility	Multi-Jurisdictional Emergency Services Coordination This project recommends the use of a centralized dispatching database to improve the emergency response services within a county or multiple jurisdictions by providing incident data and other information to emergency vehicles (such as fire trucks and ambulances) arriving at the scene of a crash.	Project funding is suggested at \$100,000 for the detailed design and implementation of a shared emergency responder database.	Aberdeen
Safety	Hand-held Devices for Reporting Accident Data This project proposes the use of hand-held devices (e.g., Palm Pilot, Visor) for communicating important on-site crash information to emergency dispatchers, and automating data collection.	Project funding is suggested for \$25,000 for the procurement of ten units and the design and integration of the interface. Hand-held devices range in price from \$150 (2MB of memory) to \$250 - \$450 (8MB of memory) per unit. Wireless cellular modem compatible with hand-held devices cost approximately \$370 per unit. Some modems have the option for global positioning system functionality. This type of system is most appropriate for emergency centers that are already equipped with some type of internal local area network.	Sioux Falls
Safety	Roadway Geometrics Alert System This project suggests coupling radar technologies with flashing warning signs to alert drivers of geometric hazards such as dangerous curves or blind intersections.	Project funding suggestion is \$30,000 for site selection, design, and the purchase of three units for test and evaluation. Flashing beacons cost approximately \$3,500 each. For the radar system, \$3,800 covers the cost of one transmitter, solar pack and installation.	Sioux Falls
Safety	Emergency Warning System This project proposes the use of solar-powered flashers to give drivers early warning of flooded routes, or other warning situations. A real-world example of this technology is the implementation of the Early Flood Warning System deployed in the City of Scottsdale, AZ.	Solar powered flashers used in Phoenix, Arizona cost \$1500 per unit. However, they will eventually pay for themselves in energy savings. A pager-activated system can be controlled from any computer, with pagers costing as little as \$30 per month. The project funding is estimated to be \$20,000 for the procurement, site survey, design, installation, testing and evaluation of six solar-powered flashers.	Aberdeen
Traveler Information, Safety, Mobility	Information Exchange Network This project is intended to facilitate the communications and information sharing among member agencies. This shared information supports coordinated transportation management and traveler information on a regional and corridor-wide basis. The I-95 corridor along the East Coast is a good example of such an effort.	Capital costs are low to zero and consist mainly of staff labor dedicated to getting the IEN up and running. Suggestion is to allocate \$50,000 for investment in one or several ITS pooled-fund study.	Statewide

Figure 6-10. Recommended Projects by Suggested Deployment Regions

Need Category	Recommended Projects	Cost	Suggested Deployment Area
Traveler Information, Safety, Mobility	Broadcast Traveler Information This project investigates the use of an AM sub-carrier as a reliable, low-cost medium for transmitting traffic messages over wide geographic areas.	\$50,000 for the investigation, test and implementation of broadcast traveler information technologies.	Rapid City
Traveler Information, Safety, Mobility	Portable ITS and Traveler Information Technologies in Work Zones This project proposes the use of highway advisory radio, changeable message signs, and video for real-time work zone information dissemination and traffic management.	Project suggestion is \$100,000 for developing and testing one mobile unit. Initial low costs systems can later add advanced components. HAR costs approximately \$20,000 per unit including training. CMS technology can be purchased for approximately \$16,000 to \$18,000 per unit. The total cost of the project in Iowa (which combined HAR, CMS and the detection system) was \$100,000. The CMS units were already owned by the DOT. There is an option to lease or buy equipment.	Mobile
Safety	Breathalyzer Ignition Interlock System This project suggests the support of devices to prevent ignition of a vehicle when the alcohol level in a breath sample is above the threshold percent concentration. Support for similar programs can be found in 32 states.	There is no cost to the DOT. Support of the concept if seen as a viable drunk driving deterrent for repeat offenders.	Statewide
Traveler Information, Mobility	CAD / AVL / MDT for Rural Transit This project proposes the deployment of computer aided dispatching, automatic vehicle location and mobile data terminals for improved transit operations and service.	\$300,000 to deploy and test a fleet of 15 vehicles equipped with AVL and MDTs, and CAD capabilities.	Sioux Falls
Safety, Mobility	On-board Snow Plow Driver Assistance This project examines the use of magnetic tape and nails for maintenance vehicle guidance, specifically in low-visibility conditions.	\$600,000 for the operational test and demonstration of lateral / longitudinal guidance of snow plows within South Dakota. An alternative is to participate in the pooled-fund study, being led by CALTRANS, to study ITS applications in highway maintenance vehicles.	Aberdeen
Safety	Mayday Infrastructure This project looks at the use of in-vehicle global positioning systems (GPS) combined with cellular / satellite communications for transmission of automatic crash notification to public safety emergency response centers.	\$2,000,000 for the design and development of an interface between commercial Mayday devices and emergency response centers, and the procurement of four workstations.	Rapid City
Traveler Information, Mobility	Web-Enabled Transit Route Planning / Smart Pass This project proposes the use of a Web site for planning transit (e.g., route selection, determining use of numerous agencies to get from point A to B, automatic fare calculator, electronic fare payment) and other modes of travel. The use of a "smart pass" allows travelers to use multiple types of transportation across various jurisdictions.	\$100,000 for the development of a transit planner Web site and implementation of electronic fare readers in 10 to 15 vehicles. Electronic fare readers cost approximately \$2800 to \$9500 per vehicle.	Sioux Falls or Rapid City

6.6 Graphical Representation of South Dakota's Statewide ITS Architecture

Graphical representation is an important tool to:

- Engage other stakeholders;
- Assure the continuing support of executive management;
- Track ongoing deployment progress; and
- Facilitate the development of a detailed statewide architecture.

A graphical representation of recommended projects and how they interact is depicted in Figure 6.11. This graphic is preliminary statewide ITS architecture. The graphic is only intended to provide a general overview of the SDDOT's current and future ITS program. The level of detail is general, providing a template for future development of a more comprehensive architecture. To further assist the development of the future architecture, each of these recommended projects were traced to an appropriate market package, and from this the National ITS Architecture can be applied. This recommendation of projects by market package is shown in Figures 6.12 and 6.13.

Figure 6-11. Graphic Representation of South Dakota Rural ITS Architecture

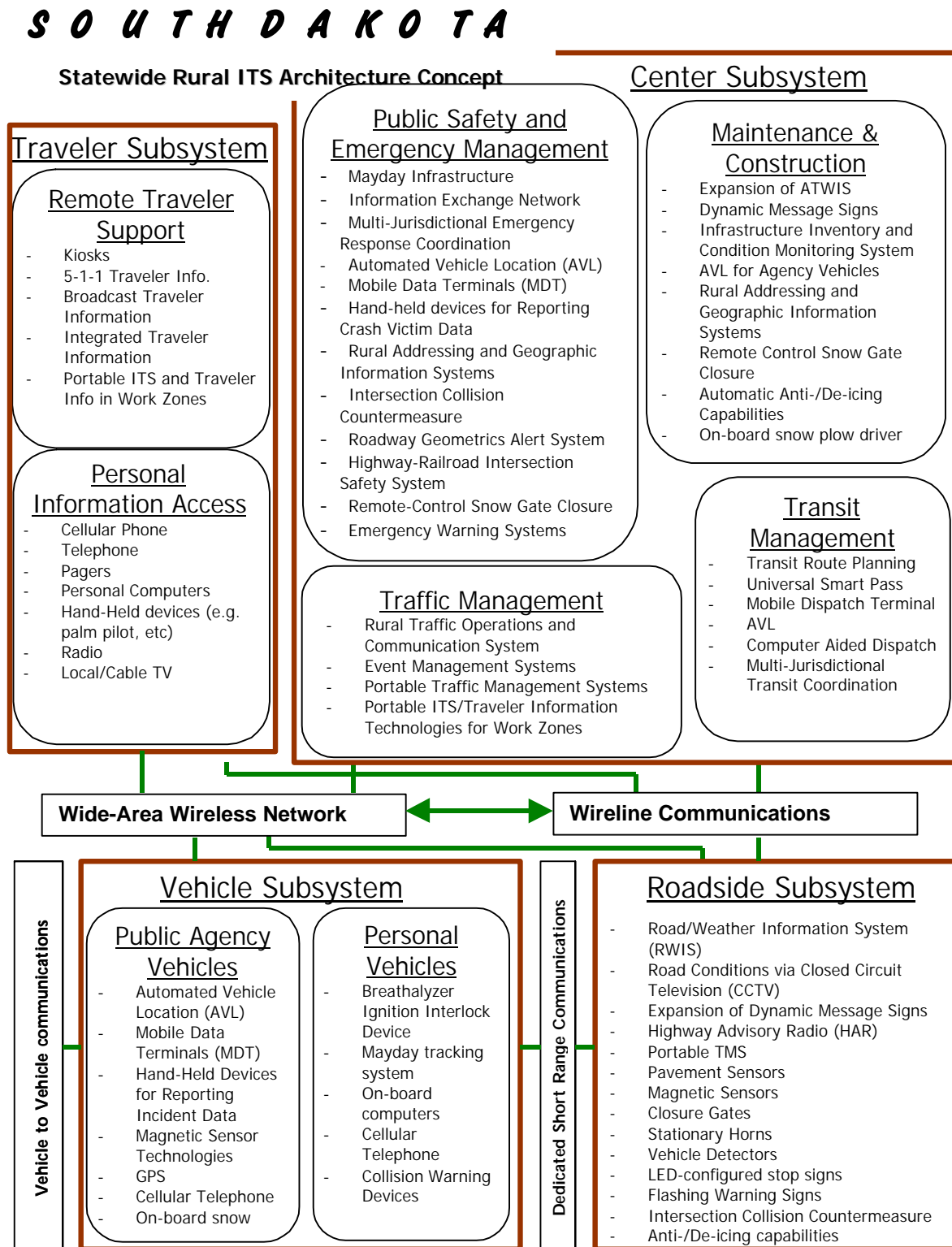


Figure 6-12. Recommended Projects by Market Packages

Market Package	Recommended Projects													
	Mayday Infrastructure	Hand-Held Devices	Rural Addressing / GIS	Multi-jurisdictional EM Coordination	Integrated Traveler Information System	Broadcast Traveler Information System	5-1-1 Traveler Information	DMS	Road Condition via CCTV	Work Zone Technologies	Highway Advisory Radio	PTMS	Rural TOCC	Multi-Jurisdictional Transit
Transit Vehicle Tracking														*
Transit Fixed-Route Operations														*
Demand Response Transit Operations														*
Transit Passenger/Fare Management														
Transit Security														
Transit Maintenance														
Multi-modal Coordination														
Transit Traveler Information					*								*	*
Broadcast Traveler Information						*		*			*			
Interactive Traveler Information					*		*							
Autonomous Route Guidance														
Dynamic Route Guidance														
ISP Based Route Guidance														
Integrated Transportation Management/Route Guidance														
Yellow Pages and Reservation														
Dynamic Ridesharing														
In Vehicle Signing														
Network Surveillance									*			*		
Probe Surveillance										*		*		
Surface Street Control											*			
Freeway Control												*	*	
HOV Lane Management														
Traffic Information Dissemination					*	*	*	*			*		*	
Regional Traffic Control													*	
Incident Management System	*	*	*	*									*	
Traffic Prediction and Demand Management											*		*	
Virtual TMC/Smart Probe Data													*	
Standard Railroad Grade Crossing														
Advanced Railroad Grade Crossing														
Railroad Operations Coordination														
Parking Facility Management														
Reversible Lane Management														
Road Weather Information System														
Vehicle Safety Monitoring														
Driver Safety Monitoring														
Longitudinal Safety Warning														
Lateral Safety Warning														
Intersection Safety Warning														
Pre-Crash Restraint Deployment														
Driver Visibility Improvement														
Advanced Vehicle Longitudinal Control														
Advanced Vehicle Lateral Control														
Intersection Collision Avoidance														
Automated Highway System														
Emergency Response	*	*	*	*										
Emergency Routing	*		*	*										
Mayday Support	*		*	*										
ITS Planning														

Figure 6-13. Recommended Projects by Market Packages continued

Market Package	Recommended Projects										
	Roadway Geometrics Alert	Intersection Collision Prevent	Highway-Railroad Intersection	Automatic Snow Gate Closure	On-Board Snow Plow Assistance	Breathalyzer Ignition Interlock	Infrastructure inventory	Automatic Anti-Icing	Automatic Vehicle Location for Agency Vehicles	Information Exchange System	Emergency Warning System
Transit Vehicle Tracking											
Transit Fixed-Route Operations											
Demand Response Transit Operations											
Transit Passenger/Fare Management											
Transit Security											
Transit Maintenance											
Multi-modal Coordination											
Transit Traveler Information											
Broadcast Traveler Information							*	*			*
Interactive Traveler Information							*				*
Autonomous Route Guidance											
Dynamic Route Guidance											
ISP Based Route Guidance											
Integrated Transportation Management/Route Guidance										*	
Yellow Pages and Reservation											
Dynamic Ridesharing											
In Vehicle Signing											
Network Surveillance											
Probe Surveillance											
Surface Street Control										*	
Freeway Control				*			*		*	*	
HOV Lane Management											
Traffic Information Dissemination							*			*	
Regional Traffic Control				*			*			*	
Incident Management System							*			*	
Traffic Prediction and Demand Management							*				
Virtual TMC/Smart Probe Data											
Standard Railroad Grade Crossing			*								
Advanced Railroad Grade Crossing											
Railroad Operations Coordination											
Parking Facility Management											
Reversible Lane Management											
Road Weather Information System				*				*			*
Vehicle Safety Monitoring	*										
Driver Safety Monitoring	*	*				*					
Longitudinal Safety Warning					*						
Lateral Safety Warning					*						
Intersection Safety Warning		*									
Pre-Crash Restraint Deployment											
Driver Visibility Improvement											
Advanced Vehicle Longitudinal Control											
Advanced Vehicle Lateral Control											
Intersection Collision Avoidance											
Automated Highway System					*						
Emergency Response											
Emergency Routing											
Mayday Support											
ITS Planning										*	

7. RECOMMENDATIONS

The following are a set of recommendations that have resulted from the South Dakota Rural ITS Deployment Plan initiative. The recommendations have been submitted to the SDDOT Research Review Board for further consideration:

1. **It is recommended that the SDDOT should endorse the vision, mission, goals, and objectives of the South Dakota Rural ITS Deployment Plan.** The work undertaken in developing the plan helped to establish the current ITS environment and to further shed insight into the future direction of ITS in South Dakota. As a result, it was determined that the South Dakota rural ITS program should operate under some guiding principles which can be accomplished by using the plan as the basic foundation.
2. **It is recommended that the near-term projects be implemented.** While all projects within the plan are recommended for deployment within a specified timeline and detailed descriptions are provided, the SDDOT should implement a logical process that will further prioritize and facilitate the implementation of medium- and long-term endeavors. In many cases, projects may not begin as early and also extend for longer schedules than originally anticipated. The dynamic nature of funding and technology costs makes it difficult to attach hard figures to projects. The development of the plan will assist the SDDOT in programming realistic funding for ITS in future years according to priorities and the selection process developed. The approach for developing a project implementation process may consist of:
 - Defining overall performance and evaluation goals for projects;
 - Identifying realistic and available funding sources;
 - Identifying geographic appropriateness for site selection;
 - Identifying lead agencies and potential project champions; and
 - Promoting and providing outreach of ITS projects.
3. **The SDDOT should implement an organizational structure that will oversee the deployment and integration of individual ITS components in pursuit of an integrated, rural ITS program.** In the interim, it is recommended that the organizational structure consist of a Steering Committee and the SDDOT Office of Research. It is recommended this Steering Committee consist of the members of the Technical Panel for the South Dakota Rural ITS Deployment Plan. The SDDOT Office of Research would provide program oversight and direct the day-to-day activities of the ITS program. The Steering Committee would be charged with providing the strategic

direction for the ITS program. Part of this responsibility is to revisit the deployment plan to ensure that the founding principles are current, and that deployments still are in line with the direction of the South Dakota rural ITS program. A more detailed description of these functions can be found in Chapter 5.4 of this plan.

The SDDOT has pursued ITS initiatives even before the development of the South Dakota Rural ITS Deployment Plan. The initiatives currently in place provide a good starting point for further deployments. As more and more projects are developed, the SDDOT needs to be assured that the projects implemented are in the appropriate direction of the ITS program. Establishing an organizational structure will help to accomplish this.

4. **It is recommended that the SDDOT develop a statewide ITS architecture that would include CVO initiatives.** By doing so, the SDDOT will further position itself for more federal funding of ITS initiatives. The development of a statewide architecture is a significant process that will ensure adherence to federal guidelines. The development of a statewide ITS architecture has been facilitated by several accomplishments within the deployment plan. Each recommended project describes the equipment required in terms of the National ITS Architecture. That is, for each project, the process in which individual equipment components interact is described in terms of the relationship between critical ITS subsystems. A graphical representation of the South Dakota ITS architecture concept was also provided. This overview will allow the SDDOT to share their vision of ITS across the state in an easy to understand manner with stakeholders. Additionally, the relationship between projects and national market packages were referenced in the event that the SDDOT pursue architecture development by way of using market packages.
5. **It is recommended that the SDDOT consider staying abreast of national ITS initiatives, particularly standards activities.** The success of other states' ITS programs have been achieved through innovation, support, and keeping in touch with national initiatives. A good example is with the Minnesota Department of Transportation's Guidestar program. Minnesota's modest roots began from the implementation of ramp meters 30 years ago to one of the nation's leading ITS programs. Mn/DOT and Guidestar play an active role at the national level by chairing ITS committees and involvement in standards development activities. It is recommended that SDDOT increase its' visibility and involvement in regional activities. This can be accomplished by joining regional ITS programs such as ITS Midwest (member states include Iowa, Missouri, Kansas, and Nebraska) or Enterprise (a pooled-study initiative that encourages the advancement of ITS through cooperative research). At the national level, the SDDOT can take part in

ITS committees and standards development activities. A good activity to follow at the national level is the Advanced Rural Transportation Systems committee which focuses on the deployment of ITS to address the needs of rural America.

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Appendix B - List of Acronyms / Definitions

1. AASHTO - American Association of State Highway and Transportation Officials
2. ANSI - American National Standards Institute
3. ARTS - Advanced Rural Transportation Systems
4. ATM - Asynchronous Transfer Mode
5. ATWIS – Advanced Traveler and Weather Information System
6. AVL – Automate Vehicle Location
7. Branson TRIP - Branson Travel and Recreational Information Program
8. CAD – Computer Aided Dispatch
9. CARS - Condition and Acquisition Reporting System
10. CCTV – Closed Circuit Television
11. CDMA - Code Division Multiple Access
12. CDPD - Cellular Digital Packet Data
13. CMS – Changeable Message Signs
14. CVISN - Commercial Vehicle Information Systems and Networks
15. CVO - Commercial Vehicle Operations
16. DGPS – Differential Global Positioning System
17. DMS – Dynamic Message Signs
18. DOT - Department of Transportation
19. DSL - Digital Subscriber Line
20. DSS – Digital Satellite Service
21. FCC – Federal Communications Commission
22. FHWA - Federal Highway Administration
23. GIS – Global Information System
24. GPS – Global Positioning System
25. HAR – Highway Advisory Radio
26. HCRS - Highway Condition Reporting System
27. HSCSD - High-speed Circuit Switched Data
28. IEEE - Institute of Electrical and Electronics Engineers
29. IEN – Information Exchange Network
30. IP - Internet Protocol
31. ISDN- Integrated Digital Services Networks
32. ISP – Internet Service Provider
33. ITE – Institute of Transportation Engineers
34. ITS - Intelligent Transportation Systems
35. LAN – Local Area Network
36. LED – Light-Emitting Diode
37. LIDAR - Light Detection and Ranging

38. Market package - deployment oriented collection of National ITS Architecture defined subsystems, equipment packages and architecture flows.
39. MCSAP - Motor Carrier Safety Assistance Program
40. MDT – Mobile Data Terminal
41. NWS – National Weather Service
42. O&M - Operations and Maintenance
43. PCS – Personal Communication System
44. PUC – Public Utilities Commission
45. RWIS – Road Weather Information System
46. SAE – Society of Automotive Engineers
47. SDO - Standards Development Organization
48. T2 - Technology Transfer
49. TEA-21 - Transportation Equity Act for the 21st Century
50. TMC – Traffic Management Center
51. TMDD - Traffic Management Data Dictionary
52. TOCC - Transportation Operations and Communications Center
53. U.S. DOT - United States Department of Transportation
54. VMS – Variable Message Signs
55. VMT - Vehicle Miles Traveled