North/West Passage Transportation Pooled Fund Study

Phase I

Project 1.9

Lessons Learned Comparing Road Condition Reporting Systems

Final Report

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1. Introduction

This document is the product of Project 1.9 conducted as part of Phase-1 of the North/West (N/W) Passage Corridor work plan. The N/W Passage corridor promotes seamless traveler information along the I-90 and I-94 corridors from Wisconsin to Washington state by emphasizing the coordination and integration of advanced traveler information systems across state lines. Given the region's long and sometimes severe winter weather, traveler information is critical for ensuring the safety of the traveling public, especially interstate travelers and commercial vehicle drivers.

Background

Several states along the I-90 and I-94 corridors have early on recognized the significant benefits of Intelligent Transportation Systems (ITS) applications to road and weather information delivery. Therefore, these states made modest to moderate investments in weather sensors, traveler information hotlines (and later 511), Dynamic Message Signs (DMS), and more recently; automated roadway/bridge treatment systems. In fact, the roots of 511 could be traced back to a system that was deployed in North Dakota and South Dakota in the late 1990s (#SAFE). Weather was the main focus of these early efforts. Further, given the sporadic availability of ITS infrastructure, these efforts were not always integrated into statewide systems that cover a wide range of traveler information. In addition, there still remain some issues regarding the consistency and compatibility of traveler information across state borders. The need to integrate these systems became apparent as their potential for delivering useful, and often critical, traveler information was better recognized.

Statewide road/weather condition reporting systems provide the means to collect, process, share, and deliver a variety of information in real-time or close to real-time basis. Several vendors developed and marketed early and proprietary road/weather condition reporting systems. One of the first of the state systems was developed under the ITS operational test/model deployment initiatives in Arizona in the mid 1990s. The system initially named Trailmaster, computerized data collection and reporting along major roadways in Arizona. Later the system was renamed as the Highway Condition Reporting System (HCRS). Soon after that, several states initiated a pool fund study to customize the Arizona HCRS to their respective needs. Over the years, other similar systems were developed, including AASHTO's Condition Acquisition and Reporting System (CARS).

While some states did approach the development of statewide condition reporting systems as part of pooled fund studies, there was no single national standard for these systems. Although the ITS Architecture provides a platform for planning these systems, the actual designs were often influenced by the availability of ITS infrastructure (especially communications) in each state. Therefore, vendor-specific (and to some extent, state specific) approaches could best characterize the early development of these systems. This resulted in little or no ability to seamlessly exchange information among different states along the same corridor.

New federal legislation (SAFETEA-LU) has been passed (August 2005) with the stated goal "to provide the nationwide capability to monitor, in real-time, the traffic and travel conditions of our nation's major highways and to widely share that information to improve the security of the surface transportation system, address congestion problems, support improved response to weather events, and facilitate national and regional traveler information." (2) SAFETEA-LU includes provisions that address the development and coordination of real-time system management information through better information exchange formats. This really underlines the importance of multi-state coordination and the increased benefits of having a nation-wide system of condition reporting systems.

Clearly, the N/W Passage Corridor is a significant step in the direction of realizing that national vision. The details of these provisions are discussed in more detail under Section 4 of this report.

Project Purpose/Objective

The initial purpose of this project was to develop a lessons learned document based on deployment experiences of statewide condition reporting systems in North Dakota and one in Wisconsin. The North Dakota Department of Transportation (NDDOT) was exploring the possible deployment of Meridian's statewide condition reporting system (later named IRIS for Incident Reporting Information System) to further expand current traveler information capabilities and support of North Dakota's 511 system. Similarly, the Wisconsin DOT (WisDOT) was in the initial planning stage of its 511 system with a vision that includes partnering with the Wisconsin State Patrol for operating the underlying statewide condition reporting system which would support 511. Therefore, WisDOT wanted to demonstrate data entry requirements to the Wisconsin State Patrol for any condition reporting system, using the CARS as an example. The Advanced Traffic Analysis Center (ATAC) at North Dakota State University was to follow the deployment of the two systems and develop a lessons learned document accordingly. In addition to the two case studies, ATAC planned to develop brief information on other existing statewide condition reporting systems, including their institutional arrangements, general data requirements, resources, etc.

After the start of the project, the NDDOT decided not to proceed with plans to deploy Meridian's statewide condition reporting system in North Dakota. This development greatly reduced ATAC's ability to study North Dakota's deployment as a case study. ATAC staff did, however, participate with demonstrations held for the NDDOT on the Meridian system.

In Wisconsin, plans for a limited CARS deployment were proceeding well. However, CARS itself was undergoing a major update in order to meet new NTCIP protocols. Therefore, the new version of CARS differs from the old version, especially in terms of compatibility with other systems. Nonetheless, some initial data were collected on Wisconsin's experience with CARS limited deployment.

After consulting with the project advisory panel, the following revised scope was developed for this project:
1. Provide a description of new federal requirements for (real-time) statewide information systems
2. Provide general descriptions of CARS, IRIS, and Arizona's HCRS
3. Document Wisconsin's CARS limited deployment
4. Review of South Dakota Department of Transportation's (SDDOT) limited Meridian condition reporting system deployment and study on improved road condition reporting
5. Provide a current listing of state traveler information sources and contact information

Report Organization

The remainder of this report is organized as follows:

Section 2 - Condition Reporting Systems: provides an overview on statewide condition reporting systems, including general components of statewide information systems and brief descriptions of HCRS, CARS, and IRIS.

Section 3 - Lessons Learned: summarizes results from Wisconsin's DOT limited deployment of CARS to illustrate data entry requirements, as well as findings from a South Dakota DOT's study of statewide condition reporting systems and an Arizona DOT study on ITS data integration.

Section 4 - New Federal Requirements: briefly discusses recent provisions on real-time system management information contained in the SAFETEA-LU transportation legislation.

Section 5 - Conclusions: provides a brief summary of findings.

2. Condition Reporting Systems

Information is often referred to as the “I” in ITS. Since the beginning of the ITS program, there has been great emphasis on collecting information relevant to system operations, processing that information, and distributing it. Recipients of this information include a variety of transportation system users, as well as agencies responsible for operating the system and responding to incidents or emergencies.

Traveler information can take a variety of formats and coverage depending on the application and the area (i.e., metropolitan vs. rural or statewide). For statewide and rural applications, these functions are generally included under the Pre-trip Travel Information and En-route Driver Information user services. Pre-trip information is typically provided through a web page or telephone interface. En-route information could be provided through cellular or regular telephone, DMS, Highway Advisory Radio, and Kiosks.

This section provides a general discussion of statewide road condition reporting systems and provides some examples. It discusses the general components of a statewide condition reporting system. It also outlines the features of three existing condition reporting systems, HCRS, CARS, and IRIS.

General Components

Regardless of the method used to deliver the information, the foundation of travel information user services is a system which collects and processes information. Therefore, a road condition reporting system must at least have a method for collecting data from the field, processing the data into deliverable or value-added information, and finally either directly or through an interface with a delivery system, distribute this information to various users.

The scope and complexity of these components largely depend on the application and the location. For large metropolitan areas or corridors with heavy traffic volumes, there is more saturation of sensors, especially video. The availability of broadband communications is not an issue. Information, including road weather conditions, is distributed to a diverse group of users that may include private sector value-added information service providers. Figure 1 provides an illustration of this type of system. An Information Service Provider (ISP) in Figure 1 handles most of value-added traveler information functions.

On the other hand, rural and statewide applications involve less saturation of sensors and they must work with less communications coverage and bandwidth. The focus in these systems emphasizes major incidents, due to weather or traffic crashes, as well as construction activity and other restrictions. Figure 2 shows an illustration of a predominantly weather information system.

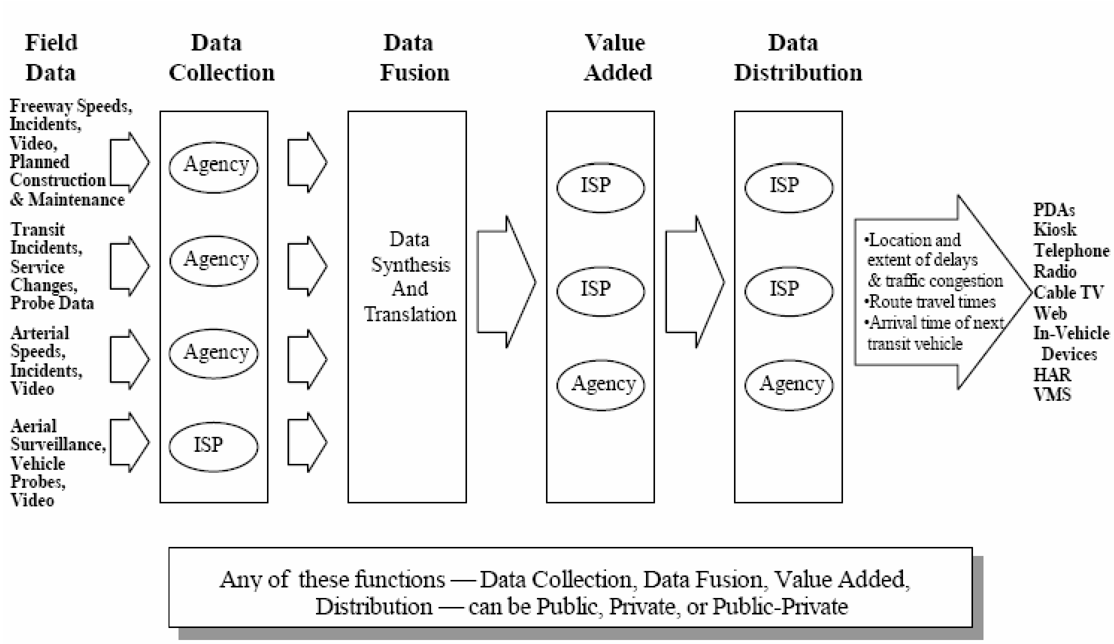

Figure 1 Typical Components of a Travel Information System (1)

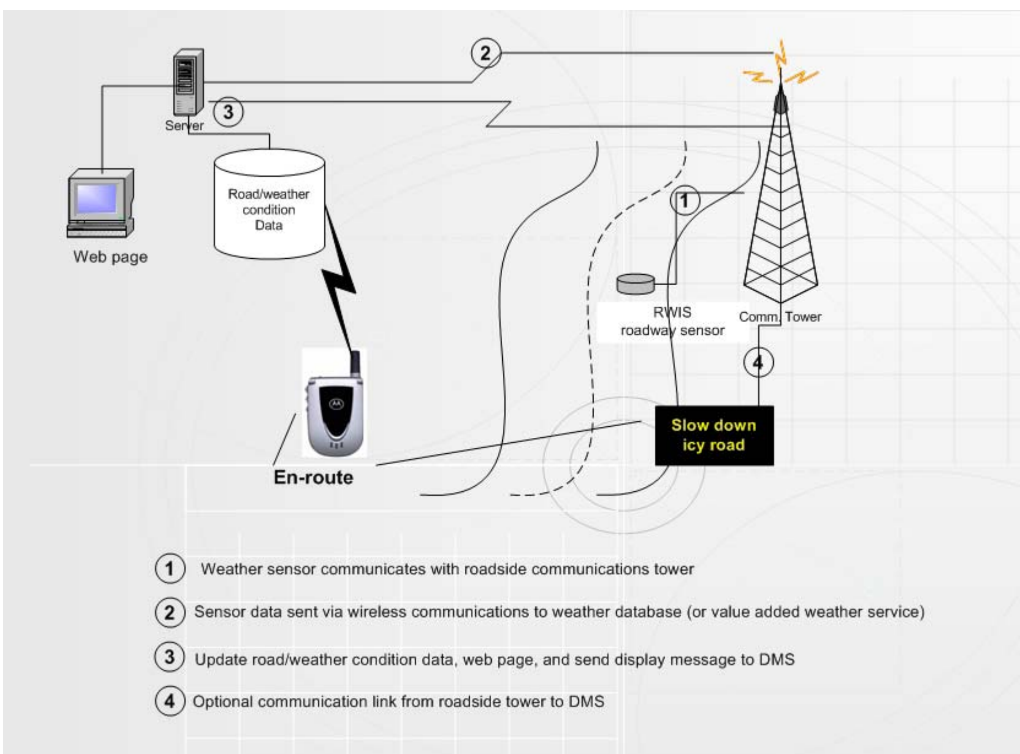

Figure 2 Typical Weather-based Travel Information System

Data Collection

Collecting road condition data provides the foundation for any travel information system, including road condition reporting systems. These condition data may include the operational characteristics of the roadway (traffic), surface conditions and environmental conditions, and incidents. A variety of devices and sensors depending on data types may be used to collect, store, and/or transmit field data. In addition to field sensors, there are other mechanisms to obtain information about the system operations, such as driver cellular calls to 911, DOT crew reports, etc.

Manual data entry is common among various states for entering collected data and other information for processing. However, several current efforts are targeting the automation of these functions to reduce staff requirements, improve accuracy, and most importantly enhance the timeliness of information.

Examples of data collection methods include:

1. Traffic
    a. Loops
    b. Video
    c. Radar
    d. Media
2. Weather
    a. RWIS
    b. Video
    c. Law enforcement
    d. Maintenance personnel
3. Incidents
    a. Law enforcement
    b. Travelers
    c. Video
    d. Homeland security sensors (i.e., HAZMAT detection)

Data Processing

After road and weather condition data are collected in the field, they are transmitted to a processing system. Processing refers to converting raw data and field reports into a usable format to support system operational decisions and to provide information to system users. Depending on the application and the system design, processing may be done automatically at pre-determined frequencies (i.e., update traffic speeds every 30 seconds) or as triggered by certain events or sensor readings (i.e., temperature readings from a RWIS). The National ITS Architecture provides the tools to define various user interfaces and the associated processing required to support their information needs.

Processing may take place on-site in the field without operator or central system intervention to support operations of roadway systems (i.e., RWIS data supports bridge automated anti-icing treatment system and a DMS to warn drivers of icy conditions). A more common arrangement is for field data to be sent to a central database for condition data. Generally, these data exchange formats are covered by established ITS standards, namely National Transportation Communications for ITS Protocol (NTCIP). The condition database may reside at a state agency responsible for operating the system or a private company under contract to operate and support the system.

Information Distribution

After road and weather condition data has been processed, information is distributed to travelers as well as other centers or systems. A variety of methods may be used to deliver information to pertinent users, including 511, web pages, HAR, and DMS. 511 is increasingly becoming a major conduit for delivering information to the travelers and it serves as both a pre-trip and as an en-route traveler information service. However, 511 systems have not been fully implemented in all states. Figure 3 shows a status map of 511 system deployment. All but three of the N/W Passage states have fully operational 511 systems. These systems are generally owned and sponsored by state agencies.

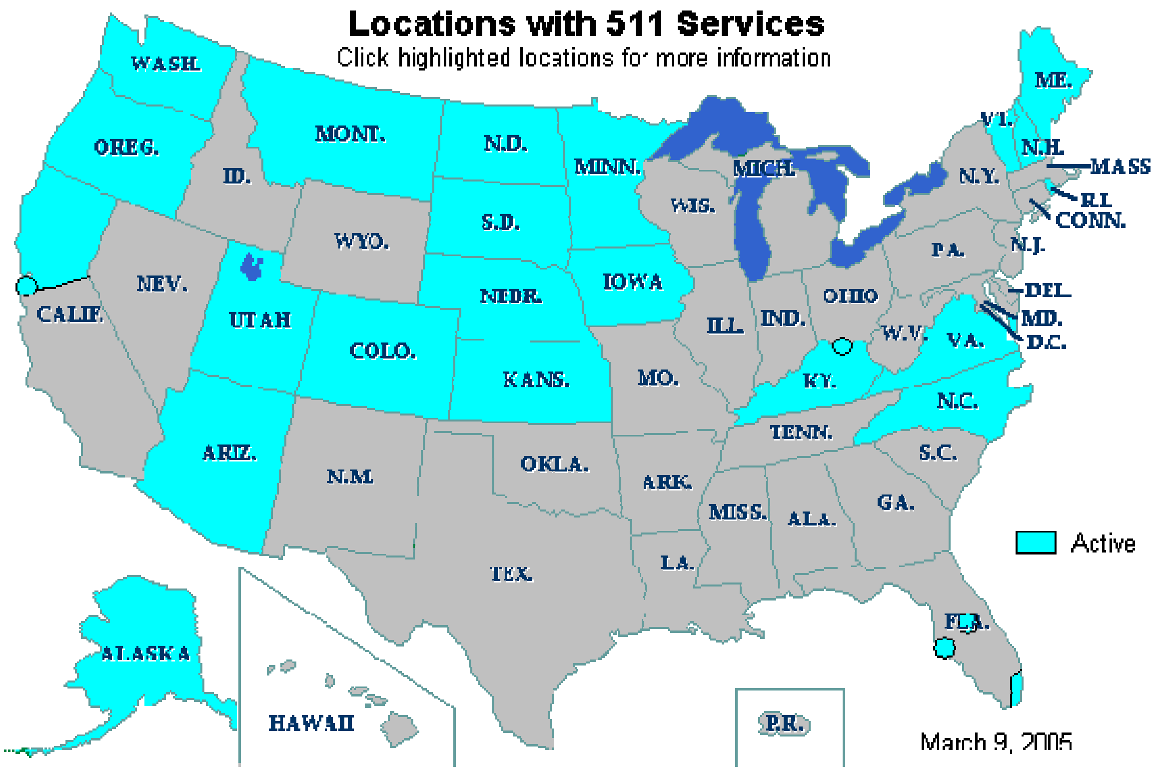

Figure 3 Status of 511 Systems Deployment (Source FHWA)

In addition to the state-sponsored systems, private vendors often provide value-added and tailored traveler information in select markets. They combine road and weather condition information with video, media announcements, advertisements, and other services to specific users and the general public.

Communications

The successful deployment of any travel information system depends on the availability of reliable communication links capable of carrying the required data at the desired frequency. Communications play a major role in influencing statewide condition reporting systems, influencing types of data, data formats, transmission frequency, accuracy, timeliness, and of course deployment and operating costs of these systems. As more data collection and transmission functions are automated and additional data (i.e., video) are added, the need for faster and more reliable communications becomes even more critical. It should also be mentioned that especially for statewide applications, there usually is a mix of communications technologies that are utilized to support desired functions.

Summary
The concept of road condition reporting systems is fairly straightforward, i.e., collect data, process data, and distribute information. However, the proper implementation of these systems is not a trivial task. There are numerous institutional, financial, technological, and technical issues that must be addressed. Given the diversity of sources of data and information and the desire to share information and access among agencies, the development of public-public and public-private partnerships is critical for success. Financial factors influence the ability of the system to cover desired locations and functions. For example, the number of sensors and the type of communications used are greatly influenced by cost considerations. Among the top technological issues are the ability of automating data collection and processing for various field devices and systems and the collection of data from vehicle probes. States can greatly enhance their condition data if they can tap into data from numerous public and private fleets as well as personal vehicles. Finally, technical issues including standardization in order to ensure interoperability and seamless inter-jurisdictional consistency are critical. National ITS Standards (i.e., NTCIP) provide the mechanisms for ensuring such interoperability, while preserving enough flexibility for states to implement systems that meet their unique needs.

To illustrate the impacts of these issues, Figure 4 and Figure 5 show two examples depicting travel information systems in North Dakota and Minnesota. These figures present a schematic illustration of data collection, processing, and distribution in the two states relative to existing systems and users. It should be mentioned that although the two systems look different, both states were successful in integrating their traveler information in order to provide travelers on both sides of the border with relevant road and weather information. This integration was largely possible because of the willingness among the state DOTs and following ITS Standards for data exchange formats.

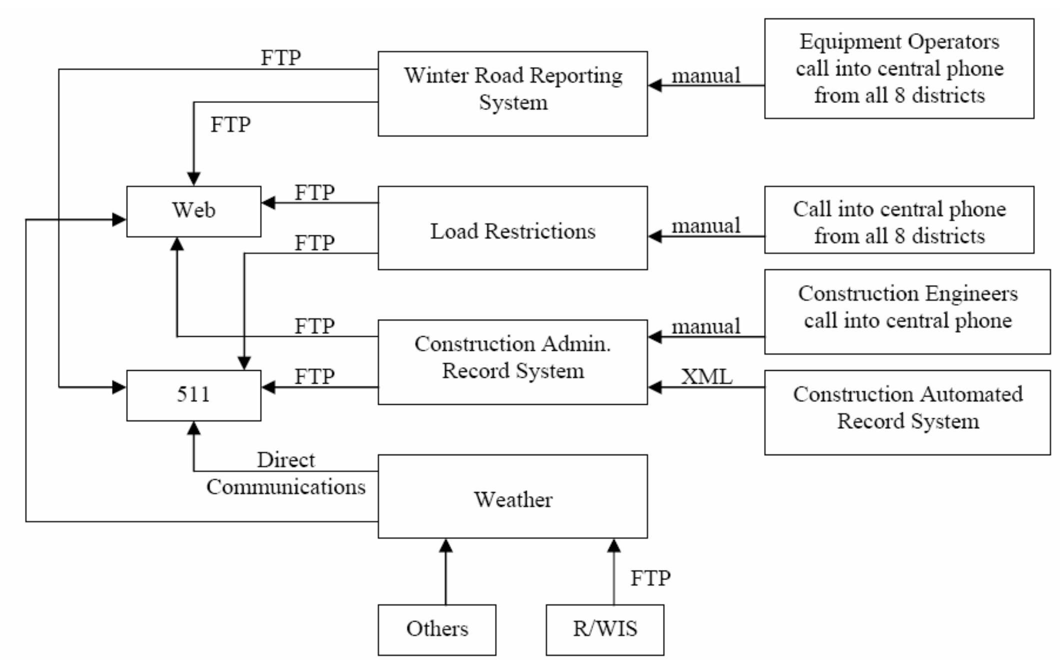

Figure 4 NDDOT Travel Information System (Source: N/W Passage)

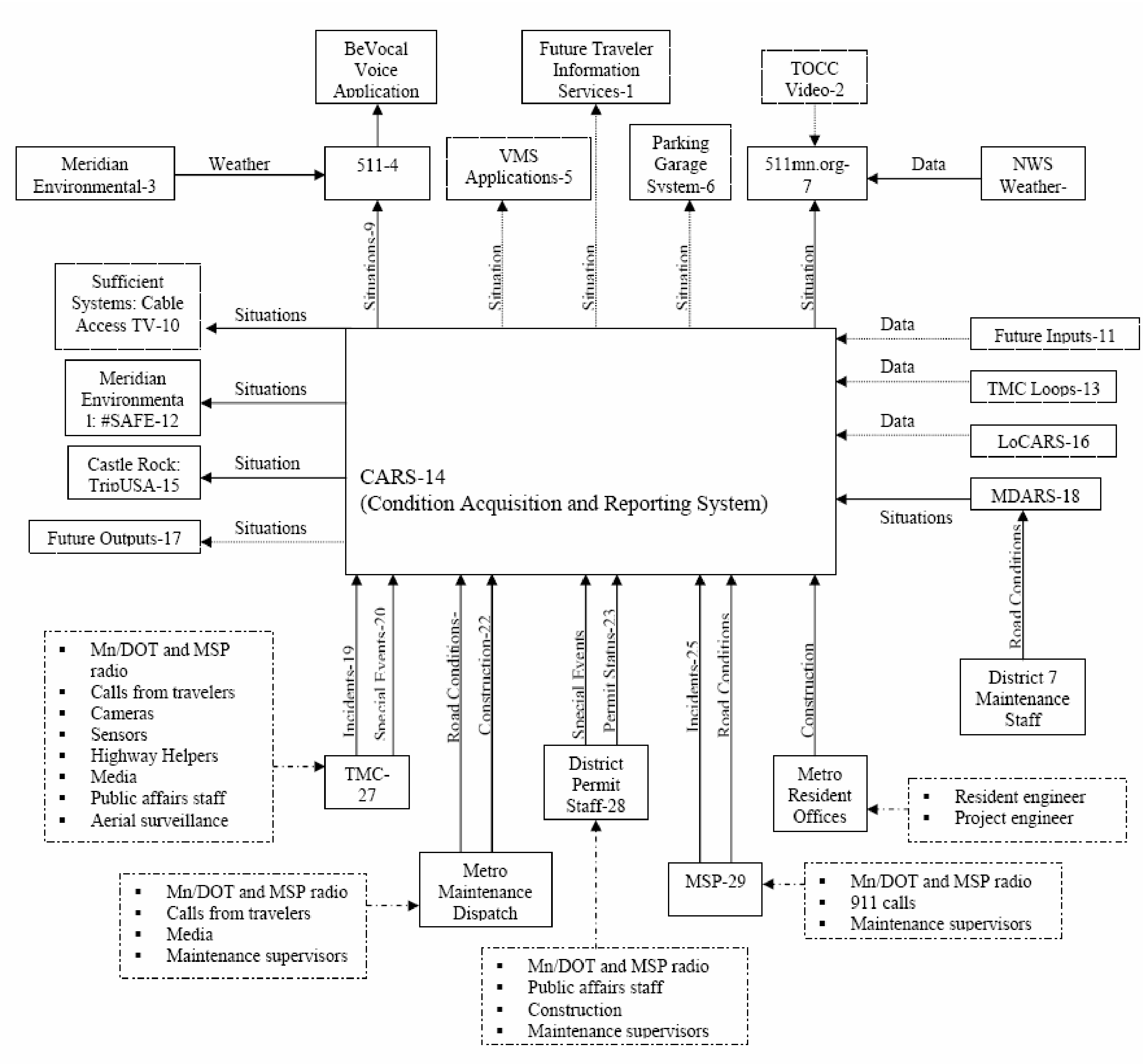

Figure 5 Minnesota DOT Travel Information System (Source: N/W Passage)

Existing Systems

The Highway Condition Reporting System (HCRS) developed in Arizona was among the first statewide condition reporting systems. Soon after that, several states initiated a pool fund study to customize the Arizona HCRS to their respective needs. Over the years, other similar systems were developed, including AASHTO's Condition Acquisition and Reporting System (CARS). A third system was recently developed by Meridian Environmental Technologies under the name Integrated Road Information System (IRIS).

The section provides a brief description of each system. It should be noted that documentation on system components and design was hard to find. Therefore, the researchers relied on documents as well as interviews to develop this information. As such, the level of detail under each system's description varies depending on available information.

HCRS

HCRS is a statewide data fusion system that Arizona Department of Transportation (ADOT) developed in the mid-1990s principally as a means of coordinating the construction and maintenance activities among various ADOT jurisdictions statewide (4). Originally, HCRS stood for Highway Closure and Restriction System and later became Highway Condition Reporting System. The AZDOT realized soon after the HCRS was developed that there was great value in providing this information to the traveling public. Therefore, a web page and an information hot line (prior to 511) were established to provide travelers with access to the system.

HCRS has three main components: data collection, data processing, and data dissemination. The system serves as the central data store for the collection and dissemination of information (3). HCRS is widely and frequently used by ADOT staff. Data is manually entered into HCRS at ADOT offices statewide over the Internet. Currently, information from key fields in the HCRS form are automatically converted to synthesized speech messages by means of a text-to-speech process and made available through the 511system See Figure 6 and Figure 7 for more information on system components.

System Inputs

The HCRS uses traffic and weather information from a network of road/weather information sensors, still-frame video cameras, and construction and maintenance crews and patrols. Information is entered into HCRS via the Internet from HCRS workstations located at ADOT facilities statewide, including in each of the nine ADOT District Offices and field offices within each District (4). Other agencies can also enter information into HCRS, including local traffic agencies and the Arizona Department of Public Safety. As part of the I-40 Traveler and Tourism Information System deployment, other emergency and tourist organizations and private event promoters could enter information in the system.

HCRS data are entered using an Internet-based interface on an electronic on-screen event form. Event data include various event attributes, such as location, type, etc. The system stores the data using International Traveler Information Interchange Standard "category" and "description" information. Recent upgrades to the system enhanced the location field entry by introducing a graphical user interface which allows users to click on mileposts from a map to enter the location (5).

User Interfaces (System Outputs)

The two main outlets for travelers to access information from the HCRS are the Internet and Arizona's 511. The ADOT statewide web site provides real-time roadway condition information. Using a state road map, users can click on a specific route and receive a list of current roadway incident and construction information. Figure 8 shows a sample screen shot of the ADOT web site.

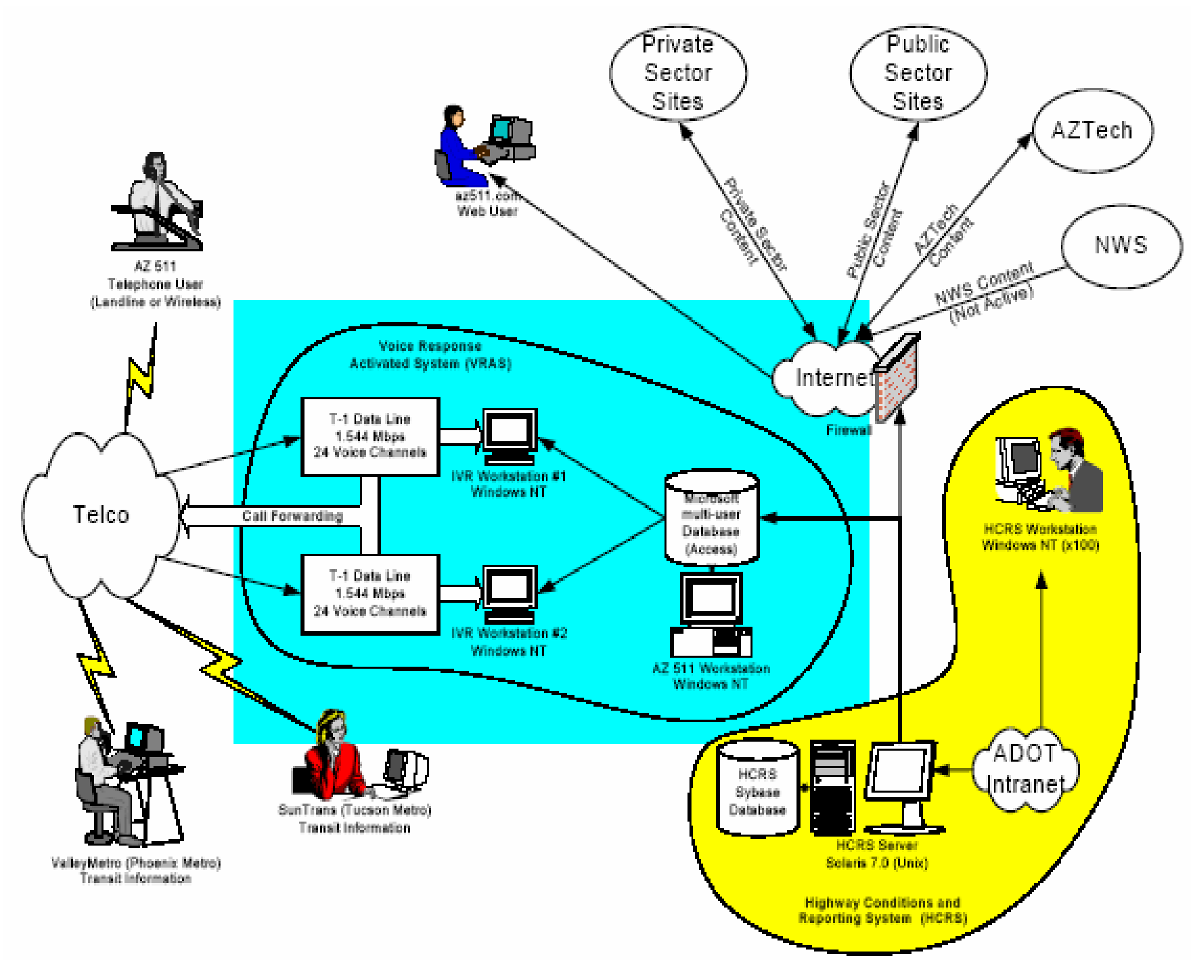

Figure 6 Relationship of HCRS to Arizona's 511 (4)

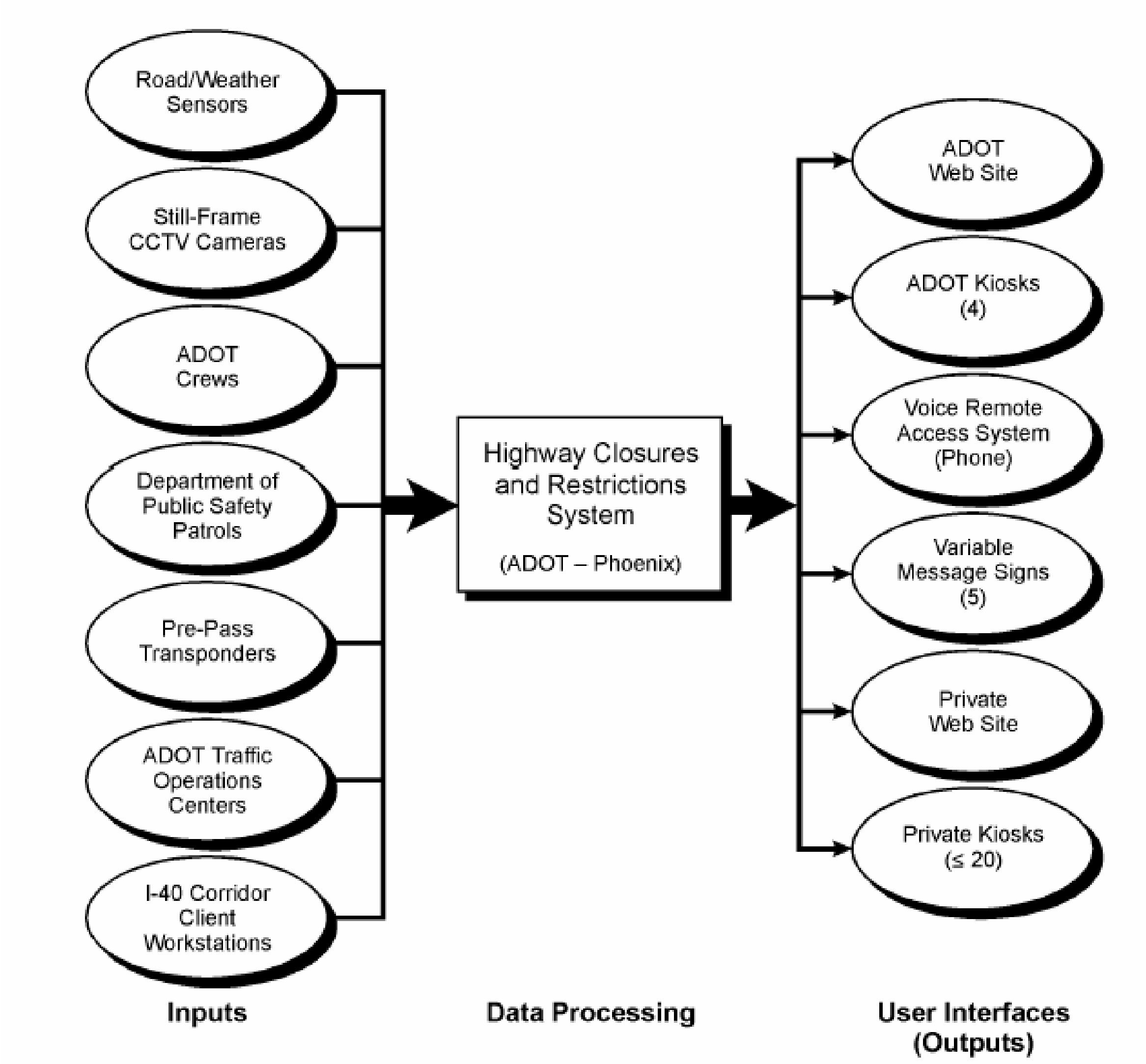

Figure 7 HCRS Components Overview as part of the I-40 ITIS (3)

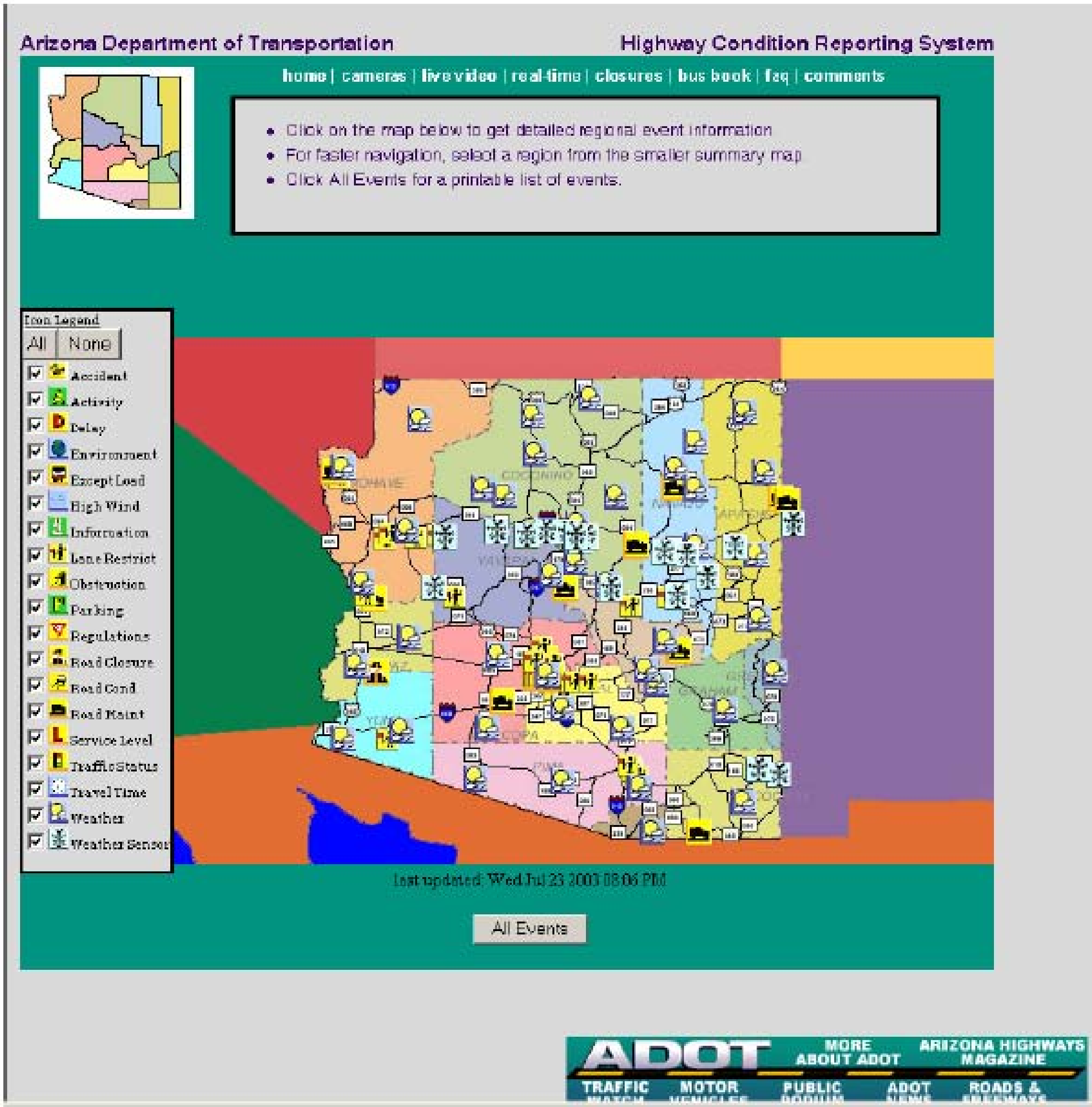

Figure 8 Arizona Traveler Information Web Site Using HCRS Information (4)

CARS

The Condition Acquisition and Reporting System (CARS) was developed as part of a FHWA Pooled Fund Study to customize Arizona's HCRS and turn it into a commercial product. Currently, CARS is non-proprietary and is owned by a consortium of states, including the ten states of Alaska, Iowa, Kentucky, Maine, Minnesota, Missouri, New Hampshire, New Mexico, Vermont, and Washington (6). These states also drive the ongoing improvement and extension of the CARS system based on their needs and budgets.

Authorized users can enter, view and disseminate critical road, travel, weather, and traffic information. CARS users access the system from any location using a standard web browser. This allows users to enter any condition reports or view reports entered by any other users around the state. The system provides for different user groups with different access levels and each user is assigned a login and password. The access/security levels may all be customized by system administrators of the state (7).

In order to keep CARS an open system that can be flexible enough to meet member state needs while being able to interface with other ITS applications, it closely follows national ITS standards. CARS uses Center to Center standards to send or receive incident data. It also uses the national ERM model to transmit and receive data via XML, allowing it to be integrated with other databases and information systems.

System Inputs

CARS data entry is performed manually through a web-based interface. This interface greatly enhanced the system's ability to receive data from as many authorized individuals as possible. Events and situations are formulated according to the National Traffic Management Data Dictionary (TMDD). Users may choose phrases already built intp the system to expedite the data entry process and minimize errors (6). Event data entered into the system include: construction, accidents, traffic, special events, and road weather conditions. The system allows automation of data collection from some ITS devices to reduce data entry costs and time.

Information Display/Graphical Interface

CARS provides several options for displaying system information to travelers and system users. A graphical display using a standard web browser provides a map with zoom options to view a situation's detailed information and location. Additionally, a text-based display is also available. Figures 9 and 10 show examples of the two displays.

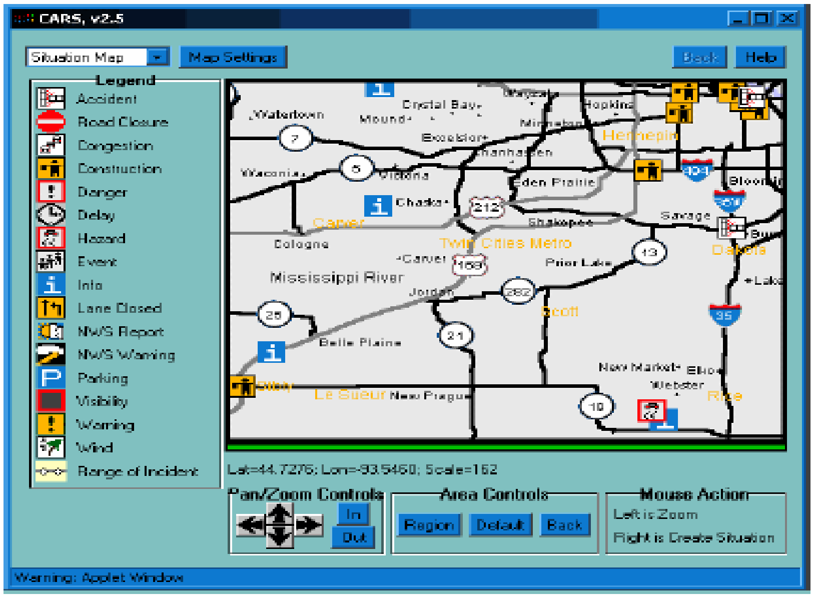

Figure 9 CARS Graphical Situation Display (Source: (6))

Figure 10 CARS Text-Based Display (Source: (6))

IRIS

The Integrated Road Information System (IRIS) was developed by Meridian Environmental Technologies. Meridian has done pioneer work by developing traveler information systems (#SAFE) in the states of North Dakota, Minnesota, and South Dakota in the late 1990s. The development of IRIS came as a product of a study conducted for the SDDOT in 2001 (8). In that study, a review of existing road reporting systems relative to SDDOT requirements revealed the need for a new system. IRIS was therefore developed as an open-design client-server system based on SQL.

The system consists of two major components, winter road conditions and construction information. Information may be entered and accessed from various locations within the state. Based on the organizational structure of the agency, the state may be divided into smaller units. For example, in South Dakota, the state is divided into Regions, Areas, and Shops.

System Inputs

Data entry to the system is accomplished through a graphical user interface for assigning conditions. Winter road condition data include selected highways, conditions, and duration. Construction data include: highway: designate the highway (and direction), restrictions (list of restrictions is configurable and could contain items such as road condition, routing, no passing, width height and weight limitations), and duration (start time and end time for the construction event (9).

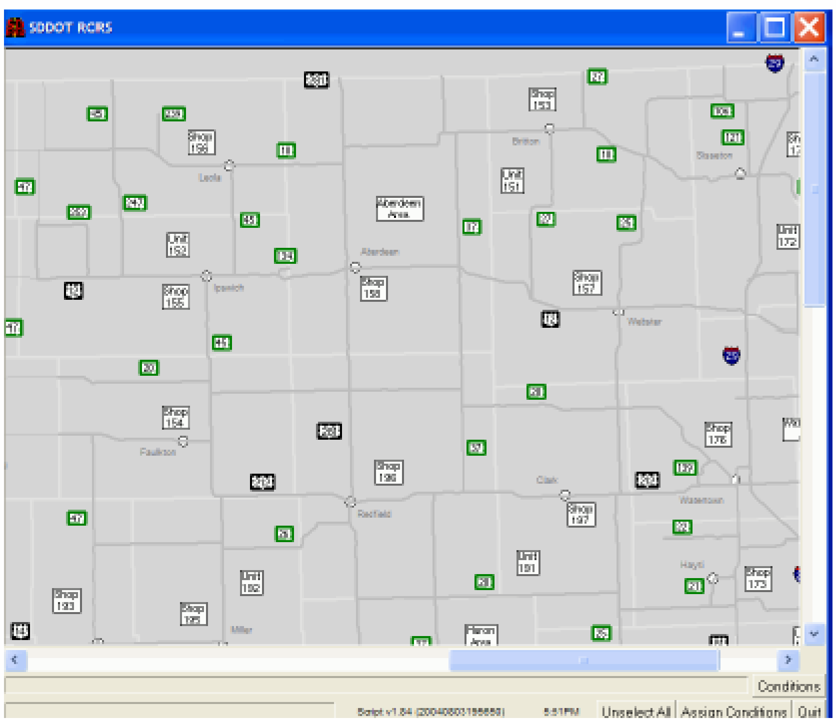

Figure 11 IRIS Graphical Data Entry Interface (8)

The system authenticates the users through a login screen that requires a username and a password. The system allows for a configurable number of user levels, each user level will have different functionality and areas of the system that are available to them. Generally, all users from different levels can view the information, however changing and editing the information requires the user to be authorized (9). IRIS currently handles only manual data input. No data is collected automatically from other systems (such as RWIS).

System Architecture

The system has a central database which can reside at either Meridian or the agency itself. Meridian uses a server with a pulling function where data are pulled from the system every minute. A pushing system is being considered where the data will be transferred to the server only when there is a change in conditions that warrants the transfer. Communication between the clients and the server (database) is done over the internet and some proprietary interface between the client and server. Meridian indicated that bandwidth is not an issue since data are usually only several kilobytes that need to be transferred at a given time and indicated that the system can be run over a dialup modem. Figure 12 shows a general logical architecture of IRIS as it was envisioned for the SDDOT.

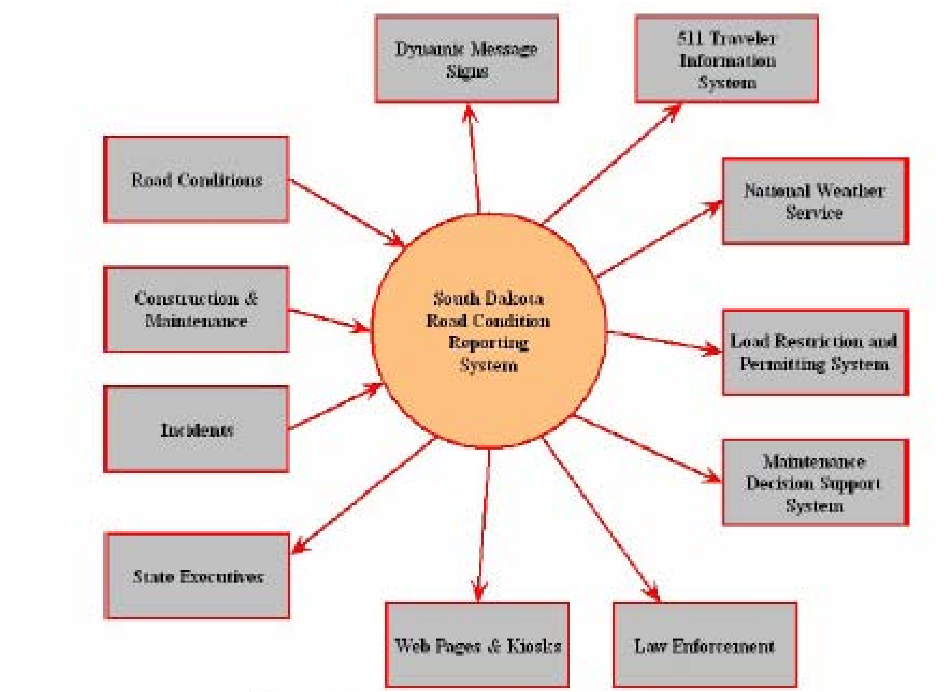

Figure 12 IRIS Logical Architecture (8)

3. Lessons Learned

This section provides more detailed information based on Wisconsin's limited deployment of CARS to illustrate data entry requirements, and information obtained from South Dakota DOT 's deployment of IRIS, as well as an Arizona DOT study on ITS data integration. Unfortunately, the IRIS deployment in North Dakota was postponed due to funding issues and uncertainty with the new transportation bill. The NDDOT indicated a desire to wait for federal requirements impacting incident reporting systems before embarking on IRIS's deployment (10). Therefore, information about IRIS is supplemented from a SDDOT study which resulted in the development of the system.

The methodology for obtaining information about both systems relied on a questionnaire developed by the ATAC research team that addressed several deployment aspects. Areas covered in the questionnaire included:

1. System components
    a. User interface:
    b. Functionality:
    c. Output
2. Data collection, entry, and storage
3. System requirements
    a. Technical
    b. Organizational/agency/financial

Figure 13 shows the full questionnaire.

CARS Limited Deployment in Wisconsin

The Project 1.2 of the N/W Passage aimed at testing the CARS system in Wisconsin through a limited deployment. The trial was intended to demonstrate the system's requirements, especially staff requirements for data entry to the Wisconsin DOT (WisDOT) and the Wisconsin State Patrol (WSP). It was envisioned that incident/event data entry into CARS would be handled by WSP (11).

Using the CARS for this demonstration was for illustration purposes, i.e., the intent was to give State Patrol dispatchers an idea of the level of effort that would be required to enter events into any condition reporting system. It was also hoped that the WSP would see the value of a centralized system to handle all incident and road condition information. The demonstration took place along the I-94 corridor near the Minnesota/Wisconsin border at Osseo, Wisconsin.

Questions for Road Condition Reporting Systems
The purpose of these questions is to capture a snapshot of a road condition reporting system. Such information as a description of the general functionality the system provides, a description of the user interface, and system requirements both technical and organizational.

1. The system
   a. User interface:
      i. User Authentication
      ii. Does the system provide for different user groups with different access levels?
      iii. If the system allows different user groups, how many of them?
      iv. Is the number of user groups built into the system or controlled by the end user?
      v. Are the levels of access (the functionally each user group can access) built into the system for the different user groups or customizable by the end user?
   b. Functionality:
      i. Components
         1. Does the system provide for weather/winter road conditions?
         2. What weather conditions are supported? Are they customizable for each agency?
         3. Does the system provide construction information?
         4. Traffic incidents information?
         5. Security information?
      ii. How are road segments identified? Mile posts? Other?
   c. Output
      i. How will the output be provided to the system users?
      ii. How will the output be presented to the traveling public?
      iii. Interfaces with other systems? (511, web, other condition reporting systems)
2. Data
   a. What equipment/methods are used to enter data into the system?
      i. Are Police departments and Highway Patrol mobile data systems supported? Or is communication done through dispatch?
      ii. Does the system support PDA type devices?
   b. Who handles data entry?
   c. Does the system have a mechanism to support getting data from motorists?
   d. Where are the data housed?
      i. Central database?
         1. controlled by agency/ controlled by vendor?
      ii. Distributed database?
      iii. How are entries for the same event handled?
3. Requirements
   a. Technical
      i. What are the communication requirements of the system?
         1. Client/server architecture
         2. Bandwidth requirements
      ii. What are the computing requirements of the system?
         1. CPU speed/Computer memory?
         2. Is the system PC based or other devices are supported?
         3. PDA/Cell phones/Law enforcement mobile data systems?
      iii. What is required before deployment of the system in terms of infrastructure of existing systems or data
   b. Organizational/Agency
      i. What is required in terms of organizational requirement of the agency deploying the system
         1. lead agency
         2. agreements
         3. access
         4. funding
         5. staffing
         6. maintenance/operation

Figure 13 Questionnaire

Mn/DOT staff along with Castle Rock Consulting provided training to WSP dispatchers on the use of CARS, including event data entry, viewing, and editing. A prototype of the CARS system was configured and deployed for the demonstration including all roads in Wisconsin. However, the test activity focused on the Eau Claire region. The trial began on November 15, 2004 and finished on December 15, 2004. During the test period, WSP dispatchers were able to test the system by entering winter driving conditions, snowfall, crashes and other relevant events (11). The system use was monitored during the one-month period, including staff resource requirements, ease of use, and perceived value. System users were able to see CARS output as it would appear to the travelers; however, there was no live broadcast of information during the trial.

The results of the limited deployment were extremely positive, especially in alleviating concerns about data entry resource requirements. The team made the following observations at the conclusion of the trial (11):

1. Manual data entry would not be a burden for WSP dispatchers
2. WSP operators liked the idea of centralizing data entry and information distribution to other agencies that need access to view the data (rather than sending data to several particular agencies)
3. WSP operators felt the system was easy and quick to use
4. The WSP noted that uptime of the system and the availability of 24 hour support was an important criteria to be considered if and when WisDOT/WSP pursue full deployment

SDDOT Study

The SDDOT study on improving road condition reporting systems was not initially part of this project scope (8). However, it was felt that the study's final report provided some valuable insights that could apply to any state and fit well with the lesson-learned theme of this project.

Perhaps one of the first observations from the SDDOT study is the diversity of stakeholders involved in making a decision regarding a state's choice of a condition reporting system. In addition to traditional DOT involvement, state patrol or other law enforcement agencies have an increasing role in supporting condition reporting systems. These agencies provide the much needed operational staff support which may not be available at the DOT. Another agency that could have a crucial role in a condition reporting system implementation is a state IT department. In South Dakota, the Bureau of Information and Telecommunications (SDBIT). The SDBIT had technical requirements in regards to the system design, specifically using SQL Server protocols.

Another observation from the SDDOT experience was that the value of information to travelers and system users was greatly influenced by the timeliness and accuracy of the system. These two system attributes are however impacted by the data collection/entry method. Manual data entry requires more resources and could result in significant delay in entering and displaying event information. This limitation may be addressed by automation and/or by increasing the number of data entry operators by utilizing other agency staff (i.e., law enforcement and emergency management). It should be further noted that automation does not have to be an all-or-nothing provision. There are opportunities to improve system performance by partial automation from ITS devices which could provide automated data.

Finally, the use of ITS standards once again was emphasized as a critical factor of success for the development of any condition reporting systems (and other ITS as well). The SDDOT approach proved effective by developing a criteria based on a wide representation of stakeholders, thus recognizing the unique needs/circumstances of South Dakota, and closely following national ITS standards.

Arizona ITS Data Integration

Although this project was not specific to condition reporting systems, it did address some relevant issues concerning HCRS. The Arizona Department of Transportation (ADOT) recognized the fragmentation of various traffic ITS data and therefore conducted an ITS Traffic Data Consolidation System study (5). ADOT maintains a variety of independent ITS applications to monitor and manage roadway conditions and events across the state. Data from these systems include traffic counts, weather, pavement conditions, signal timing, and DMS text, camera images.

Each of these ITS applications has its own unique user interface, security, output data format, and task initiation timetable. The first phase of this project provided access for HCRS users and website visitors to VMS sign messages, Closed Circuit Television (CCTV) roadway images, sensor data from Road Weather Information Systems (RWIS), and National Weather Service (NWS) forecasts and advisories (5).

The second phase of the project addressed improvements to HCRS's data entry interface. System users are now able to enter highway mileposts graphically, greatly simplifying field data entry and improving location accuracy. In addition, numerous redundant display layers and icons were removed or simplified (15).

Some of the issues identified from this integration project included (5):

1. Difficulty of integrating third-party data (DMS and RWIS)
2. The amount of data archived by the HCRS became an issue Therefore, a storage capacity analysis should have been done prior to system integration
3. There needs to be a process for adding new road sections and integrating these sections into the system's GIS database.
4. Inclusion of more information into the HCRS, including rural travel prediction based on road/weather conditions.

4. New Federal Requirements

The Federal Highway Administration (FHWA) and the USDOT ITS Joint Program Office (IJPO) have long been advocates of advancing travel information to reduce delay and enhance safety. Therefore, Transportation System Management and Operations Information has increasingly been the focus of the national ITS program as a new era following system construction and preservation. ITS is an integral part of this focus labeled "21st Century Operations Using 21st Century Technology." (FHWA)

Real-time information availability is viewed by FHWA and the IJPO as the foundation of system management and operations. As a result, there are several new provisions in the recently passed "Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users'' (SAFETEA–LU) to promote the development of real-time information systems to support management and operations. Most notable among these provisions is included under Subtitle B Congestion Relief in Sec. 1201 which establishes a Real-Time System Management Information Program. The purpose of this program includes three main components (2):

1. Establish, in all states, a system of basic real-time information for managing and operating the surface transportation system
2. Identify longer range real-time highway and transit monitoring needs and develop plans and strategies for meeting such need
3. Provide the capability and means to share that data with state and local governments and traveling public

This section calls for the U.S. DOT to establish data exchange formats no later than two years of the enactment of TEA LU (i.e., by August 10, 2007). These data formats will ensure that the data provided by highway and transit monitoring systems, including statewide incident reporting systems, can be readily exchanged to facilitate nationwide availability of information. However, this section does not include a specific date for states and local governments to develop new real-time system management information or incorporate data exchange formats into existing systems.

As State and local governments develop or update regional ITS architectures, they must explicitly address real-time highway and transit information needs and the systems needed to meet such needs, including addressing coverage, monitoring systems, data fusion and archiving, and methods of exchanging or sharing highway and transit information (2). Once again, there is no specific date for meeting this requirement since the deadline targeted for the Regional ITS Architecture Conformity Rule expired as of April 2005. Additionally, this rule does not have a specific requirement as to the frequency or scheduling of architecture updates.

No separate funds were allocated for developing and supporting this program. However, states may use their National Highway System (NHS), Congestion Mitigation and Air Quality Improvement (CMAQ), and Surface Transportation Program (STP) funds for these activities.

5. Conclusions

This study developed information on condition reporting systems from a variety of sources, including review of existing condition reporting systems, available documentations, and interviews with system integrators and agency staff. Below are some of the major observations and findings:

1. There is an increased focus on real-time information as part of a larger emphasis on systems operations and customer service. The traveling public's appetite for information is expected to only grow. With that there is an opportunity for delivering information in a variety of methods as more users have access to the Internet as well as other personal communication devices.

2. Any great information system relies on timely, accurate, and useable data. Our study has found that manual data entry is the general practice for current road condition reporting systems. Manual data entry greatly impacts the level of resources required for successfully operating the system as well as the value to travelers in terms of timeliness and accuracy of information. To increase the number of operators with time-critical data entry privileges, state DOTs should explore sharing the system with other agencies. This is especially true for law enforcement/emergency management agencies which generally have longer operating hours and are most familiar with incidents and other events affecting system operations.

3. There may yet be great opportunities to expand the use of road condition reporting systems to other agencies, especially law enforcement (which has time-critical data) and with local jurisdictions.

4. Integration of condition reporting systems with other existing state systems continues to be an issue. This not only influences the system's ability to widen its potential users, but also how data are exchanged, including ITS data automation.

5. Database housing, management, and maintenance must be examined prior to system implementation. There could be additional restriction if the database is housed at a state agency by its respective IT department.

6. Integration/coordination between/among neighboring states' condition reporting systems are key to ensure seamless service to the traveler. Of course this requires compatibility among the various systems and protocols for exchanging information. Related to this issue are national ITS standards and possible guidelines through the proposed federal requirements for incident reporting systems.

7. New federal requirements for developing real-time information and management systems were watched closely by the states. The final language in SAFETEA-LU requires the U.S. DOT to develop data exchange formats for these systems no later than August 2007. Additionally, areas developing or updating their regional ITS architectures must explicitly address real-time highway and transit information needs and the systems needed to meet such needs. This legislation should provide additional emphasis on multi-state and multi-agency integration and coordination.

8. North/West Passage states have not only been leaders in developing traveler information systems, but have also developed special projects designed to integrate and coordinate their information systems on a multi-state/multi-agency basis. This places them in a national lead position to implement new system standards, data entry improvements, and multi-state/multi-agency coordination projects

Conclusion

The North/West Corridor Pooled Fund Study states are well positioned to provide a positive example of how states can work together in streamlining road and weather condition data across their borders. These states recognized the value of coordination and integration long before the passage of SAFETEA-LU and its provisions for real-time system management. They have developed and implemented projects specifically focused on solving problems of data collection, data entry, and multi-state/multi-agency sharing of resources. Further, the output of the strategic plan and corridor architecture to be undertaken in Phase II of the North/West Passage should provide valuable insights to the U.S. DOT and other states.

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