Research Report
Agreement T2695, Task 73
ITS Evaluation Framework Phase 2

ITS EVALUATION FRAMEWORK – PHASE 2

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Prepared for
Washington State Transportation Commission
Department of Transportation
and in cooperation with
U.S. Department of Transportation
Federal Highway Administration

May 2007

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
WA-RD 672.1		

4. TITLE AND SUBTITLE	5. REPORT DATE
ITS EVALUATION FRAMEWORK—PHASE 2	May 2007
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Pete Briglia, Jaime M. Kopf, Mark E. Hallenbeck	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. WORK UNIT NO.
Washington State Transportation Center (TRAC) University of Washington, Box 354802 University District Building; 1107 NE 45th Street, Suite 535 Seattle, Washington 98105-4631	11. CONTRACT GRANT NO. Agreement T2695 Task 73
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
Research Office Washington State Department of Transportation Transportation Building, MS 47372 Olympia, Washington 98504-7372 14 Doug Brodin, Project Manager, 360-705-7972	Final Research Report 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

This study was conducted in cooperation with the University of Washington and the US Department of Transportation

16. ABSTRACT

This report documents the results of applying a previously developed, standardized approach for evaluating advanced traveler information systems (ATIS) projects to a much more diverse group of 16 intelligent transportation systems (ITS) projects. The evaluation approach used structured interviews to investigate technical, management and organizational lessons learned. The approach appeared to work well with this diverse group of projects.

This report also includes the individual evaluation reports for the 16 ITS projects that were evaluated. Each report includes a discussion on background information, project description, ITS architecture and standards, system usage and benefits and institutional and technical issues.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
Evaluation, intelligent transportation systems, ITS, lessons learned	

19. SECURITY CLASSIF. (OF THIS REPORT)	20. SECURITY CLASSIF. (OF THIS PAGE)	21. NO. OF PAGES	22. PRICE
None	None		

DISCLAIMER

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CONTENTS

FIGURES

TABLES

EXECUTIVE SUMMARY

This is Phase 2 of a project for the Washington State Department of Transportation (WSDOT) that started in 2004 with the objective of developing an evaluation methodology and testing it on a group of five advanced traveler information systems (ATIS) projects. This phase applied the evaluation methodology to a diverse group of 16 intelligent transportation systems (ITS) projects that covered everything from ITS planning to safety improvements. They were deployed by five of WSDOT's six regions, WSDOT Headquarters, and two local agencies.

The evaluation approach used a structured interview script that addressed the following topics: project background, system features, system operations, system usefulness, public response, project management, and lessons learned. The interviews were able to elicit the information needed to meet the evaluation requirements. Minor modifications to the script to account for specific project components or attributes were usually required. The process was relatively quick and efficient. Most interviews were completed in less than one hour, and the interviews were conducted by telephone so no travel time was necessary.

In addition to an evaluation of the methodology, individual evaluations on the 16 projects are included in this report. They include background and project description information on each project, as well as detailed discussions of technical and institutional issues. The lessons learned fell into the following six categories: maintenance; rural development; project management; staff, training and support; customer response; and planning and system data. The majority of the lessons learned fell into the area of project management. The reason for this was that these projects were not funded by the normal WSDOT transportation planning and programming process. Therefore, funding and project management staff were usually not adequate to prevent budget overruns and delays.

Many of these projects were implemented in the rural areas of the state. In contrast to the urban areas of Washington, where ITS projects have been implemented for many years, these projects were often the first to be implemented by WSDOT's rural

Region offices. Unfamiliar communications equipment, computer hardware and software, and purchasing and procurement procedures all contributed to project delays.

On a positive note, subjective measures of customer response were favorable.

The report includes a discussion of the application of the statewide ITS architecture and ITS standards. Although most of these projects were started before the development of the statewide ITS architecture (the project to develop the architecture is one of the evaluated projects), these projects were based on the principles of data sharing and coordinated operations promoted by the architecture. These projects also precede the development of most of the national ITS standards. NTCIP compliant field devices were specified where available, and xml was used in the development of some Web pages.

ITS EVALUATION FRAMEWORK – PHASE 2

1: INTRODUCTION

This is Phase 2 of a project for the Washington State Department of Transportation (WSDOT) that started in 2004 with the objective of developing an evaluation methodology and testing it on a group of five advanced traveler information systems (ATIS) projects funded in FY 1999-2000. After the development and application of the evaluation methodology (*ATIS Evaluation Framework*, WA-RD 606.1, May 2005, published by the WSDOT), a review of remaining WSDOT intelligent transportation system (ITS) projects found 19 that had been funded between FY 1998-2002 that were still in need of evaluation. Discussions with WSDOT project managers indicated that only ten of these were completed and ready for evaluation. Six projects not included in the original review were added to those ten, for a total of 16 projects to be evaluated in this phase.

These projects were a diverse collection that covered everything from ITS planning to communications to safety-related projects. From the review, it appeared likely that all of them could be evaluated by using the same methodology developed in the framework project with minimal modification. The application of the methodology to these Phase 2 projects would enable it to be refined and generalized to encompass other types of projects.

1.1: The Federal Requirements

Evaluations of federally funded ITS projects are required as part of partnership agreements between the U.S. Department of Transportation (USDOT) and local agencies receiving the funds. Each agency agrees to produce a local evaluation report funded from project resources. The report must include two major parts: 1) a general, overall assessment of the project and 2) two or more specific evaluation products/activities. In addition, the report must contain an executive summary.

The general overall assessment of the project must include a discussion of "the major benefits anticipated from achieving project goals." It should also address key aspects of the project such as

- system and subsystem performance
- resolution of institutional issues, especially those associated with contracting procedures, liability, privacy, regulation, and intellectual property
- implications of achieving consistency with the National ITS Architecture
- consumer acceptance
- life-cycle costs.

In addition to the general overall assessment component of the local evaluation report, two or more of the following evaluation products/activities must be undertaken:

- Evaluate the institutional issues associated with achieving cooperation among public sector agencies and document how they were overcome. This is suitable for evaluation of architectural products.
- Provide a brief lessons learned report on the technical and institutional issues encountered in integrating ITS components.
- Provide an evaluation report on the lessons learned in employing innovative financing or procurement and/or public-private partnering techniques.
- Produce a lessons learned report on the experiences, challenges, and approaches used in achieving consistency with the National ITS Architecture and regional architecture and/or implementation of ITS standards. This is suitable for evaluation of architectural projects. Where regional ITS architectures are developed, the USDOT reserves the right to share them with other locations as examples of good practice.
- Produce a case study on the planning process used to achieve integration into an approved plan and program developed under an area-wide (statewide and/or metropolitan) planning process that also complies with applicable state air quality implementation plans. This is suitable for evaluation of architectural projects.
- Provide the appropriate metropolitan planning process with data generated by ITS technologies and services, and provide a report on plans or intentions for archiving or using the data.

1.2: The Projects to Be Evaluated

This report collects and summarizes the individual evaluation reports for 16 ITS projects deployed by the WSDOT and two other agencies, Yakima County and the City of Bellingham. As mentioned previously, the projects were evaluated by using a methodology that was developed in the Phase 1 evaluation of five traveler information projects. For data collection, that methodology relies on structured interviews based on a script designed to address a range of project development issues. (A copy is included in Appendix A.) The interviews were conducted by telephone between September 2006 and March 2007. The participants were primarily project management and design staff from the relevant agency's traffic engineering department.

Each individual evaluation report includes the required "general overall assessment," which addresses the key aspects of the project. In addition, two evaluation products/activities (out of a possible six) were chosen:

- Evaluate the institutional issues associated with achieving cooperation among public sector agencies and document how they were overcome. This is suitable for evaluation of architectural products.
- Provide a brief lessons learned report on the technical and institutional issues encountered in integrating ITS components.

One other product/activity was selected for one project:

- Provide the appropriate metropolitan planning process with data generated by ITS technologies and services, and provide a report on plans or intentions for archiving or using the data.

2: REPORT ORGANIZATION

The report contains three main sections: an Evaluation Summary, Individual Evaluation Reports, and Appendices.

The Evaluation Summary discusses the application of the framework methodology to the 16 projects. It includes a table that lists the 16 projects included in this evaluation and one that summarizes the lessons learned from each project. It also compares the overall lessons learned with those from the earlier ATIS project evaluation and discusses the use of the framework methodology to evaluate this diverse group of projects. A discussion of the use of the statewide ITS architecture and any ITS standards is included.

The Individual Evaluation Reports provide the "general overall assessment" and the specific evaluation products or activities specified by the FHWA agreement for each of the 16 projects.

Appendix A contains a typical script that was the starting point for the interview scripts that were modified to fit each project. Appendix B includes individual "lesson write-ups" for each of the projects. These were prepared by following a format supplied by the ITS Joint Program Office (JPO) to simplify their inclusion in a database maintained by the JPO.

3: EVALUATION SUMMARY

3.1 Application of Framework Methodology

Table 1 lists the projects included in this evaluation, and Figure 1 shows the approximate locations of the projects. In contrast to the previous local evaluation report, which evaluated five WSDOT traveler information projects, this group of projects is a diverse collection. They range from the development of a statewide ITS architecture to corridor projects to spot safety improvements. They were deployed by five of WSDOT's six regions, WSDOT Headquarters, and two local agencies. They can be grouped under the following application areas:

- Arterial Management Systems
- Freeway Management Systems
- Incident Management Systems
- Traveler Information
- Information Management
- Crash Prevention and Safety
- Road Weather Management
- Commercial Vehicle Operations.

Table 1. Projects Evaluated in This Report

	Project Name	Agency	FFY	Federal Aid No.
1.	Statewide ITS Architecture and Communications Plan	WSDOT — HQs	2002	ITS-2002(042)
2.	Highway Performance Monitoring	WSDOT — HQs	2002	ITS-2002(019)
3.	Traveler Information System Expansion	WSDOT — NWR	2002	ITS-2002(037)
4.	SR 821 Yakima Corridor Safety Improvements	WSDOT — SCR	1998	ITS-9853(001)
5.	Yakima County Adverse Weather Operations (three projects)	Yakima County	2002 2003 2004	ITS-2002(019) ITS-2003(054) ITS-2004(054)
6.	Tacoma Interagency Communications Coordination	WSDOT — OR	2002	ITS-2002(031)
7.	Port of Tacoma Trucker Notification System	WSDOT — OR	2002	ITS-2002(039)
8.	South Puget Sound Operational Improvements	WSDOT — OR	2002	ITS-2002(030)
9.	Spokane Regional Data Warehouse	WSDOT — ER	2003	ITS-2003(026)
10.	US 2 Stevens Pass Variable Speed Limit	WSDOT — NCR	2003	ITS-2003(062)
11.	I-90 Wind Warning System	WSDOT — NCR	2003	ITS-2003(039)
12.	Whatcom Regional ITS Fiber Optic Integration	City of Bellingham	2001	ITS-2001(027)
13.	Spokane Regional Transportation, Construction and Weather Website	WSDOT-ER	2002	ITS-2002(018)
14.	Alpowa Summit Winter Traveler Information System	WSDOT – SCR	2002	ITS-2002(032)

HQ = WSDOT Headquarters
NWR = WSDOT Northwest Region
SCR = WSDOT South Central Region
OR = WSDOT Olympic Region
ER = WSDOT Eastern Region
NCR = WSDOT North Central Region

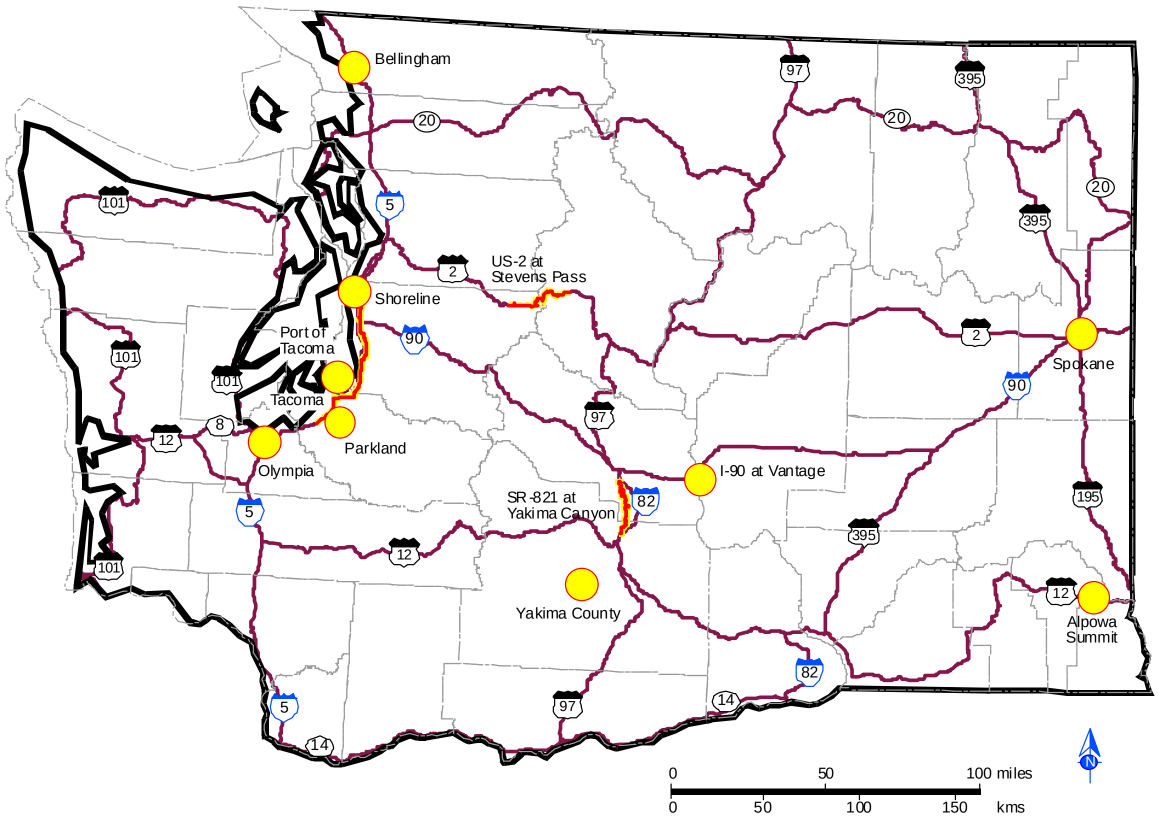

Figure 1. Project Locations

The framework methodology, developed by the Washington State Transportation Center (TRAC) in a previous ITS evaluation project was effectively applied to this group of 16 projects. The structured interviews used a script that addressed the following seven topics:

- project background
- system features
- system operations
- system usefulness
- public response
- project management
- lessons learned.

The structured interview process and the script were able to elicit the information needed to meet the evaluation requirements. Minor modifications to the script to account for specific project components or attributes were usually required. The process was relatively quick and efficient. Most interviews were completed in less than one hour, and interviews were conducted by telephone so no travel time was necessary. Interviewees were provided with the script in advance so that they had the opportunity to provide written responses or participate in the interview. Two project managers preferred to reply with written responses, and brief, follow-up discussions were conducted to clarify minor points.

3.2 Lessons Learned Summary

The individual evaluation reports include background and project description information for each project, as well as detailed discussions of the technical and institutional issues. Table 2 summarizes the lessons learned from each project. The projects are grouped by the application areas mentioned previously. The evaluation framework developed in the previous evaluation used five categories of lessons learned:

- Maintenance
- Rural Deployment
- Project Management
- Staff, Training and Support
- Customer Response.

The diversity of the Phase 2 projects and accompanying lessons learned required the addition of two categories: Planning and System Data.

It is probably not surprising that the majority of lessons learned and, therefore, the majority of technical and institutional issues, fall into the area of Project Management. The reason is that the normal WSDOT transportation planning and programming process was not followed to obtain the funding for these projects. Rather, all of these projects were funded from ITS earmark funds appropriated by Congress. In fact, WSDOT does not have a dedicated source of funding for ITS projects of this type, so without an ITS earmark appropriation, these projects would not have been implemented. As a result, cost estimates are often guesses, and in most cases the projects are not assigned to a design office or a construction office for those phases of deployment. Instead, this work is usually done by traffic engineering personnel assigned to a region or headquarters traffic operations office. It is usually added to their existing workload, and no personnel are solely assigned to manage these projects. Consequently, project funding is usually just barely adequate, and projects are frequently delayed.

While ITS have been implemented in the urban areas of Washington for many years, some of these Phase 2 projects were the first ITS projects implemented in rural areas of the state. This often involved dealing with unfamiliar communications equipment, computer hardware, and software. Project managers also often had to deal with unfamiliar environmental, historic preservation, purchasing, and procurement regulations. Frequently the projects involved working with new partners who were unfamiliar with the way that transportation projects are implemented. Getting electrical power and communications capability supplied to the sites of some rural projects required ingenuity and expense. These issues had not changed much from the first evaluation.

It is probably not realistic to expect much change in the lessons learned between the previous evaluation and this one. As long as projects continue to be funded by ITS earmarks, with all of their attendant uncertainties, the same problems remain likely to occur.

On a positive note, Customer Response was another area in which there was little change from the previous evaluation. Subjective measures of customer response were favorable, and interviewees indicated that the public generally demands more and better quality traveler information.

Table 2. Lessons Learned

LESSONS LEARNED	Architecture and Comm Plan	Highway Performance Monitoring	Traveler Info System Expansion	Yakima Canyon	Yakima County	Tacoma Interagency	Port of Tacoma	South Puget Sound Operations	Spokane Data Warehouse	Stevens Pass	Vantage	Whatcom Fiber	Spokane Regional Website	Alpowa Summit
PLANNING														
Time and resources should be devoted to "housekeeping," i.e., developing an ITS architecture, ITS plans, communications plans, and ITS implementation plan.	X													
Statewide ITS architecture eases the burden of regulations on agencies with fewer resources.	X													
Local working relationships can be utilized to gather and disseminate information.	X				X								X	
Sometimes the best option to solve complex problems is to create a committee or task force to implement changes and conduct further, more detailed studies.	X													
MAINTENANCE														
Maintenance group participation contributes to successful implementation.				X							X			
ATIS information enables maintenance organizations to perform their tasks more efficiently and effectively.					X									X
RURAL DEVELOPMENT														
Rural ATIS applications often involve remote locations that can result in additional deployment and maintenance needs.					X					X				X
ATIS information facilitates enhanced rural maintenance and emergency capabilities.				X	X									X
System reliability is important for any information system that provides crucial safety information.					X					X				X
Antiquated communications systems in rural areas can cause connectivity issues.														X

LESSONS LEARNED	Architecture and Comm Plan	Highway Performance Monitoring	Traveler Info System Expansion	Yakima Canyon	Yakima County	Tacoma Interagency	Port of Tacoma	South Puget Sound Operations	Spokane Data Warehouse	Stevens Pass	Vantage	Whatcom Fiber	Spokane Regional Website	Alpowa Summit
PROJECT MANAGEMENT														
A dedicated project manager should be provided for any complex project to keep the project on schedule and within budget.				X										
Adequate resources should be devoted to accomplish a project. Delays will occur if existing operations staff have to take on work that they will do as time permits.				X										X
Flexibility of the project scope allows for changes if initial plans prove infeasible.	X		X	X										
It is useful to install the maximum amount of conduit and fiber that the budget will allow to enable other agencies to access the data or the addition of devices in the future.			X			X								
The installation of fiber optic communications systems results in improvements in all aspects of communications: increased bandwidth, reduced operating and maintenance costs, and improved picture and data quality.			X			X	X					X		
ITS installed prior to major roadway construction can be used to mitigate construction impacts, but roadway designers and construction personnel must use caution to avoid damaging the fiber.			X											
ITS projects and standard capital improvement projects may have the same objectives. Planners and designers need to be aware of the agency's capital construction program to avoid duplication of efforts.							X							
The vendor selection process can affect scheduling, implementation, and support.					X			X	X	X	X			

LESSONS LEARNED	Architecture and Comm Plan	Highway Performance Monitoring	Traveler Info System Expansion	Yakima Canyon	Yakima County	Tacoma Interagency	Port of Tacoma	South Puget Sound Operations	Spokane Data Warehouse	Stevens Pass	Vantage	Whatcom Fiber	Spokane Regional Website	Alpowa Summit
The use of products with proven performance and reliability records can help ensure the completion of a project on time and within budget.								X	X					
The project proposal should include language allowing the hiring of qualified contractors with special skills specific to ITS.						X								
The perspectives of system operators should be considered during project development.		X		X					X		X			
Leveraging shared resources can produce benefits in a more cost-effective manner.	X			X	X	X	X	X	X			X	X	
Although shared resources can produce cost-benefits, sometimes it is difficult to get equal treatment when one partner controls the resource.					X									
For multi-agency projects, it is important to clearly define the roles and responsibilities of each agency and make sure all parties are working toward the same objectives.				X		X			X			X	X	
Matching one partner’s needs to another partner’s complementary capabilities can enhance cost effectiveness.	X							X				X		
Many potential partners are often available to provide expertise, data, and funding to expand and improve a project.				X	X	X	X	X				X	X	
Assembling a system of off-the-shelf components requires time to research the products and a clear definition of how the system should perform.					X						X			
Project managers should review similar projects by other agencies for valuable lessons.					X									
Obtaining permits from agencies concerned with resource conservation or historic preservation can affect project schedule.										X				
Contacts with the private sector can provide additional resources.										X				

LESSONS LEARNED	Architecture and Comm Plan	Highway Performance Monitoring	Traveler Info System Expansion	Yakima Canyon	Yakima County	Tacoma Interagency	Port of Tacoma	South Puget Sound Operations	Spokane Data Warehouse	Stevens Pass	Vantage	Whatcom Fiber	Spokane Regional Website	Alpowa Summit
STAFF, TRAINING, AND SUPPORT														
Vendor accessibility can affect system operations.									X		X			
Agency staff who lack experience in ITS, communications systems design, or any other type of non-traditional transportation project may have difficulty with procurement and installation.				X										
CUSTOMER RESPONSE														
While feedback was not extensive, there was a sense that travelers were using the new information and were supportive of its availability.			X	X		X	X	X		X	X	X	X	X
Camera views provide valuable information to travelers and agency staff alike.			X			X	X	X				X	X	
There was general DOT and other agency staff support for additional ATIS devices and data archives.		X				X	X	X	X					
SYSTEM DATA														
Mechanisms must exist to allow users to easily determine what data are available and to provide access to those data at a useful level of detail.		X							X				X	
Data collected for real-time management should be aggregated, filtered, and summarized into more widely used performance metrics.		X							X					
The exchange of data between TMCs, and with other local agencies, can result in better coordination of incidents, more interaction because device control is shared, and seamless travel information.			X		X	X	X	X				X	X	
Getting data archive systems populated with data is often a difficult task.		X							X				X	

LESSONS LEARNED	Architecture and Comm Plan	Highway Performance Monitoring	Traveler Info System Expansion	Yakima Canyon	Yakima County	Tacoma Interagency	Port of Tacoma	South Puget Sound Operations	Spokane Data Warehouse	Stevens Pass	Vantage	Whatcom Fiber	Spokane Regional Website	Alpowa Summit
Conducting focus group or usability testing on a web site can make it more user-friendly and appealing for non-technical users.													X	

3.3: Application of ITS Architecture and Standards

One of the projects included in this evaluation developed a statewide ITS architecture. The conceptual development of most of the projects included in this report occurred before the completion of Washington's ITS architecture. Several regional or county-wide ITS architectures existed before the statewide architecture, which was developed primarily to prevent the rural areas of the state in WSDOT's North Central and South Central regions from having to create their own. A more comprehensive discussion of this is included in the first individual evaluation report (Section 4.1)

However, the project descriptions clearly show that these Phase 2 projects were based on the principles of data sharing and coordinated operations promoted by the architecture, particularly with respect to the sharing of information between WSDOT and the Washington State Patrol. Several projects involved the installation of fiber optic cable to enable the sharing of data with transportation and non-transportation agencies. Enabling the sharing of video images from closed-circuit television (CCTV) cameras was a frequent goal, and the "consumers" of this video are fire departments, ports, law enforcement agencies, TV and radio stations, and the public via websites.

To demonstrate that the projects discussed in this report conform to the Washington State ITS architecture, the appropriate market packages from the 2006 state ITS architecture are listed for each project. Market packages provide a deployment-oriented way of describing the national ITS architecture. A market package is essentially a grouping of the physical ITS elements that are needed to provide a particular ITS service. For example, the Regional Traffic Control market package provides the service of regional traffic control. It includes the ITS equipment necessary for analyzing, controlling, and optimizing area-wide traffic flow. These capabilities allow control of a network signal system to be integrated with control of freeway devices, with the goal of providing the capability for real-time traffic adaptive control. The market package also specifies a data flow that indicates that traffic control and information will be coordinated with other traffic management systems. In summary, market packages are the sum of the equipment, data flows, and procedures necessary to make an ITS project function as desired. Listing the appropriate market packages for each project is probably the most concise way of showing where the project infrastructure and data flows fit into the framework provided by the architecture.

These projects also precede the development of most national ITS standards. NTCIP-compliant variable message signs were specified for several of these projects. RWIS installations also utilized the NTCIP standards, and during the time span covered by these projects, WSDOT was one of the first in the nation to demonstrate that RWIS data from equipment and software from two vendors could be merged into a single database. On some of the more recent projects, xml was used in the development of Web pages.

4: INDIVIDUAL EVALUATION REPORTS

4.1: ITS Earmark Project: Statewide ITS Architecture and Communications Plan, Federal Aid No. ITS-2002(042)

Background

The Transportation Equity Act for the 21st Century (TEA-21) requires that all ITS projects using federal funding must “conform” to the National ITS Architecture and ITS technical standards. The implementation of this is found in Federal Highway Administration (FHWA) Rule and Federal Transit Administration (FTA) Policy, which took effect on April 8, 2001. A key requirement of the new federal ITS regulations is the development of a statewide ITS architecture. A statewide ITS architecture is defined as a framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects.

Regional ITS architectures existed for the following area when this project was started:

- The greater Seattle metropolitan area, consisting of King, Kitsap, Pierce and Snohomish counties. The Puget Sound Regional Council (PSRC), the metropolitan planning organization (MPO) for this area, led the effort to develop the architecture.
- Spokane County. The Spokane Regional Transportation Council, the MPO for this area, led the effort.
- Clark County, which includes Vancouver, Washington. This effort was led by the region’s MPO, the Southwest Washington Regional Transportation Council.
- Thurston County, which includes the Olympia area. Thurston County abuts Pierce’s County’s southern border and includes the southern Puget Sound shoreline, which is not covered by the PSRC’s planning efforts. This effort was led by the region’s MPO, the Thurston Regional Planning Council.
- Whatcom County, which is the county that abuts Canada’s southern border in British Columbia. This effort was led by the region’s MPO, the Whatcom Council of Governments.

While these urban area ITS architectures provided guidance for the majority of Washington State's ITS projects and expenditures, ITS deployments were also being planned for vast, rural areas of the state not covered by these architectures. Systems to be deployed included weigh-in-motion sensors installed where trucks carrying farm products access state highways, road/weather information stations on highways in areas where bad weather often creates hazardous travel conditions, and traveler information delivery systems such as highway advisory radio (HAR) or variable message signs (VMS). These needed to be covered by an ITS architecture in order to be eligible to use federal funds.

These ITS applications also required substantial communications infrastructure to connect field devices to control centers and to interconnect control centers. In addition, the extensive rural deployments mentioned above required innovative and often expensive communications systems to make them function. WSDOT attempted to partner with a private communications company in a shared resources project that would have provided the private company with access to WSDOT highway right-of-way in return for statewide fiber optics communications capability. However, because of changed conditions in the telecommunications industry, the project was terminated. This development made it apparent that WSDOT needed to reexamine its ITS communications needs and prepare a comprehensive communications plan that could meet those needs.

Project Description

To accomplish these objectives, WSDOT hired a consultant to develop a statewide ITS architecture and regional ITS architectures for WSDOT's North Central and South Central regions. The consultant was also asked to develop a Statewide Communications Plan to meet WSDOT future needs for wire line communications. The scope of work (SOW) for the project included the following ITS architecture tasks:

- Review existing ITS architecture reports.
- Conduct workshops with regions and local agencies.
- Develop regional ITS architectures.
- Develop a statewide operational concept.
- Develop statewide ITS architecture diagrams.
- Prepare draft and final reports.

The following Communications Plan tasks were listed in the SOW:

- Review previous work.
- Identify and interview stakeholders.
- Determine WSDOT enterprise communication requirements.
- Determine center-to-center communications requirements.
- Determine center-to-field communications requirements.
- Inventory existing communications infrastructure.
- Assess potential technologies.
- Develop and evaluate alternative concepts.
- Conduct stakeholder workshop.
- Prepare draft and final reports.

System Benefits and Usage

The WSDOT project manager indicated that all of the items specified in the SOW were completed. The project manager said that both the Statewide ITS Architecture and the Communications Plan were useful. WSDOT created an Implementation Task Force to implement the recommendations in the final report.

Institutional and Technical Issues

The following, primarily institutional, issues arose during the course of this project:

- While it often isn't possible to follow a well defined, sequential process when building a statewide or regional ITS program, eventually time and resources should be devoted to "housekeeping," i.e., developing an ITS architecture, ITS plan, communications plan, and ITS implementation plan. This helps to determine whether the program is "on course" or corrections are necessary.
- Take a flexible approach to developing ITS architectures. MPOs led efforts to develop ITS architectures in Washington State's urban areas in order to comply with the federal requirements. These agencies are responsible for transportation planning and certifying compliance with federal regulations. In the rural areas of the state, where ITS deployments are less extensive and are

primarily deployed on major (state) roadways, it was necessary for WSDOT to lead the ITS architecture effort.

- Look for ways to ease the burden of regulations on agencies with fewer resources. Having a statewide ITS architecture in place saved the cities, counties, and regional transportation planning organizations (RTPOs) from Washington State's rural areas from having to delay their ITS projects until many, individual ITS architecture efforts had been completed. Incidentally, there was no funding source for these local efforts, so it would have been necessary to use scarce project funds to develop such architectures.
- Utilize local working relationships when trying to gather and disseminate information. Coordinate with stakeholders early and often. WSDOT's regional offices were asked to host the ITS architecture meetings and decide which local agencies to invite. The regions used their local contacts to ensure a good turnout at the stakeholder meetings. These stakeholder meetings were a good opportunity to gather information on ITS deployments planned by the rural counties and smaller cities in the regions and a good opportunity to do some ITS outreach. Many agency personnel had little knowledge of the national ITS program and the state's extensive ITS program.
- Sometimes the best option is to create a committee or task force to study things some more. Improving WSDOT statewide communications and solving all of the existing problems was a big task. It was made bigger by a change in the scope of work that expanded the study to include all of WSDOT enterprise communications requirements rather than just ITS requirements. The result of the study was a series of recommendations that required organizational changes and a great deal of unavailable funding to implement. An implementation task force was formed to carry out the changes and conduct further, more detailed studies. Sometimes that's the best thing that can be done to start to solve complex problems.

4.2: ITS Earmark Project: Highway Performance Monitoring, Federal Aid Project No. ITS-2002(019)

Background

Before implementation of this project, the WSDOT already operated a successful Archived Data User Service (ADUS) effort. The system takes freeway operations data that are collected as part of the Seattle area freeway management effort (the FLOW system), generates an archive, and then analyzes the data in that archive to produce a large number of key performance measures used by WSDOT and other agencies. However, this system was not Web accessible and could analyze only data that came from WSDOT's Northwest Region Traffic Management Center (the Seattle area freeway system).

This project proposed expanding the scope and capabilities of this system in two ways. First, the system would be expanded to include other roadway data sources in order to expand both the geographic scope of the system and the types of measures the system could report. Second, the archive would be Web accessible so that users outside of WSDOT could access the performance measures by using the Internet.

The project would take advantage of several other WSDOT projects that were under way at the time. It would construct a database system that would allow diverse data to be collected at a central location, convert those data into a set of consistent, usable statistics, provide a mechanism for analyzing and reporting facility performance statistics from those data sources, and provide access to those summary measures via the Internet.

An additional goal of the project was to demonstrate the concept of ITS archives linked through geographic information systems (GIS). It was designed to show how data archives from disparate sources could be built and connected in an easily accessible, easily used manner, so that data from those archives could be readily found and used by transportation agency staff from around the state.

Project Description

The project created three, Internet accessible, ITS-related databases and linked those databases through the spatial identifiers stored in WSDOT's GIS. The following databases were created:

- CVISN truck tag database, which computes truck travel times between CVISN tag reader locations
- Average Car Occupancy database, which tabulates multiple years of vehicle occupancy counts from WSDOT's Puget Sound area HOV lane system
- Summary FLOW database, which contains summary statistics from WSDOT's Seattle area freeway management system.

Summary statistics that could be useful to a range of WSDOT staff were developed from each of these databases. All three databases are accessible through an on-line, map-based interface based on WSDOT's maps and linear reference system. The URL is http://trac29.trac.washington.edu/trac/mapserver

Architecture and Standards

The following ITS architecture market packages are represented in this project:

- Traffic Forecast and Demand Management (ATMS 09)
- ITS Date Mart (AD1)
- ITS Data Warehouse (AD2)
- ITS Virtual Data Warehouse (AD3).

While this project was under way, a metadata ("data about data," or a general description of the data stored within an archive) standard was being balloted by the ASTM Archived Data User Services (ADUS) Committee. The intent of the metadata standard is to help transportation agencies understand the types of metadata they should provide for ITS data archives so that more uses can be made of these data resources, and those uses will be less costly to implement.

The current prototype versions of the ITS data archives developed by this project lack robust metadata, although recent additions to one archive interface help this database more closely resemble the level of metadata recommended for ITS archives.

The software developed under this project was developed by following Open Source principals. All of the software (source code and executable code) as placed in the public domain so that it can be used elsewhere. The intent is to spur the implementation of ADUS and reduce the cost of ADUS development.

System Usage and Benefits

The Statewide Archive is being used on a daily basis. All three initial ITS archives have operated in a stable manner for over a year.

Institutional and Technical Issues

This project was designed to remedy two major shortcomings of most data archives. Its success derived from keeping the following two items in mind:

1) The primary goal of every archive should be to support the traffic management decisions that the ITS supplying the data are intended to improve. The data collected for real-time management are often very fine-grained. To derive meaningful performance statistics, they must be aggregated, filtered, and summarized into more widely used performance metrics. Continued storage of performance metrics can then grow over time, allowing the analysis of archived data to describe
    - trends that are occurring in system performance
    - the impacts of system management policies
    - the success or failure of specific treatments applied to make the transportation system function more efficiently.
2) Mechanisms must exist to allow users to easily determine what data are available and to provide access to those data at a useful level of detail.
    - Realize that the usability of the database program often determines how useful the database is. As databases, and the programs that allow users to manipulate them, become easier to use, fewer requests for data are received because users are able to retrieve the data themselves.

4.3: ITS Earmark Project: Traveler Information System Expansion, Federal Aid No. ITS-2002(037)

Background

WSDOT currently operates two traffic management centers (TMCs) in the Puget Sound area: one in the Seattle area (Shoreline) and one approximately 30 miles south of Seattle in the Tacoma area (Parkland). The TMCs are also in two WSDOT administrative regions: the Seattle TMC is in the Northwest Region, and the Tacoma

TMC is in the Olympic Region. Because of this, the ITS deployments in the area between Seattle and Tacoma were not well aligned. This is primarily a result of the methods used to deploy ITS, which usually involve including the installation work in conventional roadway projects. Because the roadway projects are not programmed with ITS system coverage in mind, gaps in ITS device coverage often occur. Many commute trips cross the boundary between the regions (the King-Pierce County line is the boundary), and there is a need for traveler information in this area. There is also a need for devices to help both regions cooperatively monitor and manage major incidents in this area.

Project Description

The goal of this project was to connect the two WSDOT regions and provide a seamless advanced traveler information system (ATIS) for the area between Seattle and Tacoma. The project extended the fiber optic communications backbone and added freeway management system devices (vehicle detection, ramp meters, and surveillance cameras) to cover a 3-mile gap in the southern part of the Northwest Region. The Olympic Region used other funding to extend its fiber system 3 miles to the north so that they both reached the county line, where they were connected. Figure 2 shows the locations of the two TMCs and the approximate route of the fiber.

Architecture and Standards

This project clearly demonstrates the kind of data sharing and system connections that the National ITS Architecture effort has tried to promote.

The following ITS architecture market packages are represented in this project:

- Network Surveillance (ATMS 01)
- Traffic Information Dissemination (ATMS 06)
- Regional Traffic Control (ATMS 07)
- Traffic Incident Management Systems (ATMS 08).

NTCIP standards were used in the project. Xml was used for Web applications.

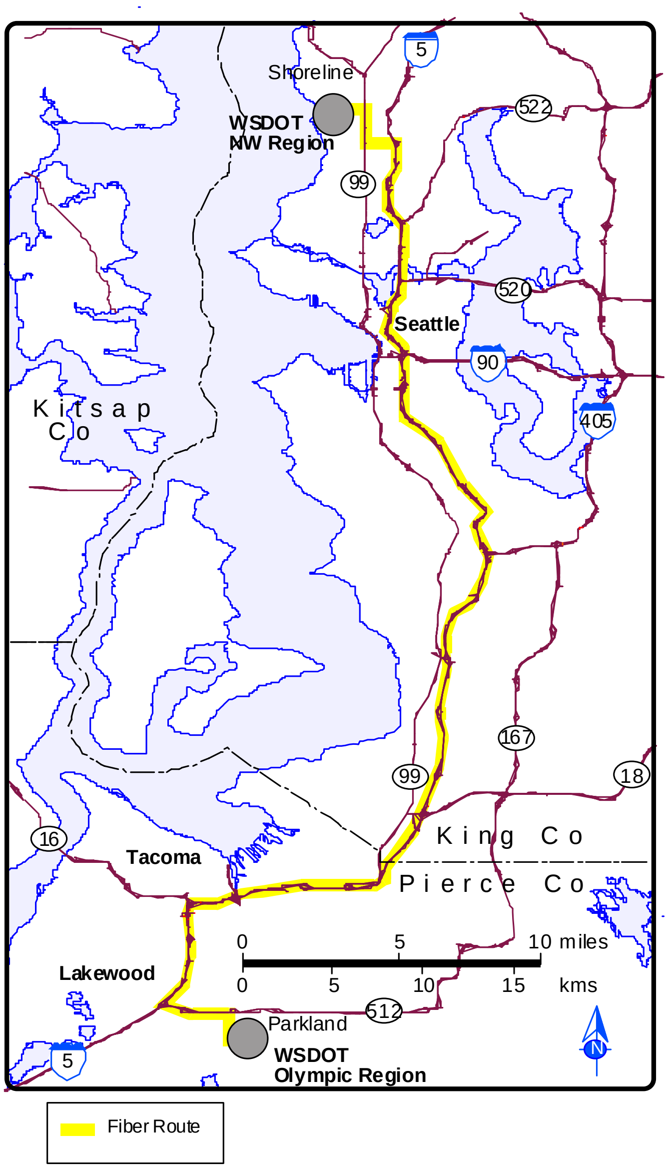

Figure 2. Traveler Information System Expansion

System Usage and Benefits

The following operations were integrated with this project:

- The two TMCs have direct access to each other's CCTV cameras and highway advisory radio systems. This has been helpful in managing incidents that have occurred in one region and affected traffic in the other.

- The interconnection allows direct monitoring of the status of each TMC's systems and quick information exchange during the management of incidents.
- Travel information is now seamless between the regions. The existing gap in CCTV camera coverage has been filled. Loop detector data from the two regions can now be combined to provide travel times for cross-region trips. The major TV stations that show video images from the Northwest Region's system can now also show video from the Olympic Region's Tacoma area cameras.

Comments of the interviewees suggest that everyone is satisfied with the results of this project. Both WSDOT regions, other agencies involved in incident management, the media, and the public have all received benefits from this project.

Institutional and Technical Issues

The only problems experienced by the project managers concerned the installation of the fiber optic communications system. The Olympic Region received complaints that additional fiber should have been installed for future use.

Some lessons regarding fiber installation are as follows:

- The engineers assumed that the contractor would install the fiber conduit by plowing it into the ground rather than trenching and covering it. The specifications were written to allow either method to be used, and the winning bidder chose the trenching method. (The winning contractor had recently had a bad experience with the plowing method.) The interviewees recommended writing specifications that were independent of the construction method because there is no way for them to predict which method will cost the least. Overall costs to provide a finished product need to be considered. One method may have cheaper conduit installation costs and more expensive costs to pull the fiber, resulting in a higher overall cost.
- The timing of an ITS installation may be crucial. This project was completed just prior to a major roadway construction project. The additional devices and the integration of the two TMCs helped with traffic management through the construction zone. As-built plans showing the location of the fiber conduit

were used by the roadway construction contractor to avoid damage to the fiber.

4.4: ITS Earmark Project: SR 821 Yakima Corridor Communications Safety Project, Federal Aid No. ITS-9853(001)

Background

SR 821 is a 25-mile long stretch of rural, two-lane, state highway that winds through a scenic canyon cut by the Yakima River in Central Washington, east of the Cascade Mountains. The roadway was selected as one of the first Highway Safety Corridor project locations in the state because of its accident history. Highway Safety Corridor projects involve a multi-agency approach to applying the "3 Es"—Education, Enforcement and Engineering—to implement low-cost traffic operations solutions to safety problems.

A unique feature of the SR 821 corridor was the lack of communications infrastructure in the canyon. Land-line phone service was available for the first 1 mile on the north end of the corridor and for 5 miles on the south end. Only two establishments existed within the central part of the corridor, and only one of those had land-line phone service that was provided by phone lines coming over the canyon rim. When accidents or emergencies occurred (either highway accidents or recreational accidents involving use of the river), people were unable to call for help without driving to either end of the corridor. The drive to find a telephone would use up most of the injured person's "Golden Hour" (the first hour after a victim's injury during which, if he or she receives assistance, chances of survival are greatly increased). The few canyon residents (one with telephone service and one without) also complained about late night requests from possible accident victims to use their phones. In addition, first responder emergency crews were unable to communicate with each other or their dispatchers while in the canyon, and WSDOT experienced dead spots in its communications.

The Highway Safety Corridor project recommended the installation of motorist aid call boxes every ¼ mile for 20 miles of the corridor. The agencies that would be responsible for responding to the calls and maintaining the call boxes were concerned about false alarms and vandalism. Another consideration was the slowly, but steadily, improving commercial cellular phone coverage in the corridor.

Project Description

The goal of this project was to improve safety in the SR 821 corridor by improving communications. The project installed two, full-matrix variable message signs on I-82, which connects to SR 821 at either end, to enable traffic to be diverted to or from SR 821 depending on conditions. Six solar-powered, cellular motorist aid call boxes were also installed. Two of these are roadside mounted, and the other four are located in pullouts or recreation sites. The four call boxes in the recreation sites are off of the main road, so signs indicating the call boxes are posted on the roadside ½ mile in advance. A new building and a 100-foot high tower were installed on Manastash Ridge to improve WSDOT and WSP communications and to provide communications for Kitt Com first responders (Kittitas County fire and sheriff). A new tower was also installed on Mt. Baldy to eliminate dead spots in WSDOT's 800 MHz radio coverage and to improve microwave communications with the WSP. Funding was also provided to develop a WSDOT Traffic Management Center at Union Gap (near Yakima) to manage the corridor devices and coordinate incident response in this area. This included radio equipment to enable South Central Region's radio dispatch to take over operation of North Central Region's radio dispatch outside of normal working hours in the summer (when the North Central Region is not staffed 24/7). Figure 3 shows the project location.

Architecture and Standards

This project clearly demonstrates the kind of data sharing and system connections that the National ITS Architecture effort has tried to promote. The following ITS architecture market packages are represented in this project:

- Traffic Information Dissemination (ATMS 06)
- Emergency Call-Taking and Dispatch (EM 01)
- Mayday and Alarm Support (EM 03).

NTCIP 1201 and 1203 were used for the project.

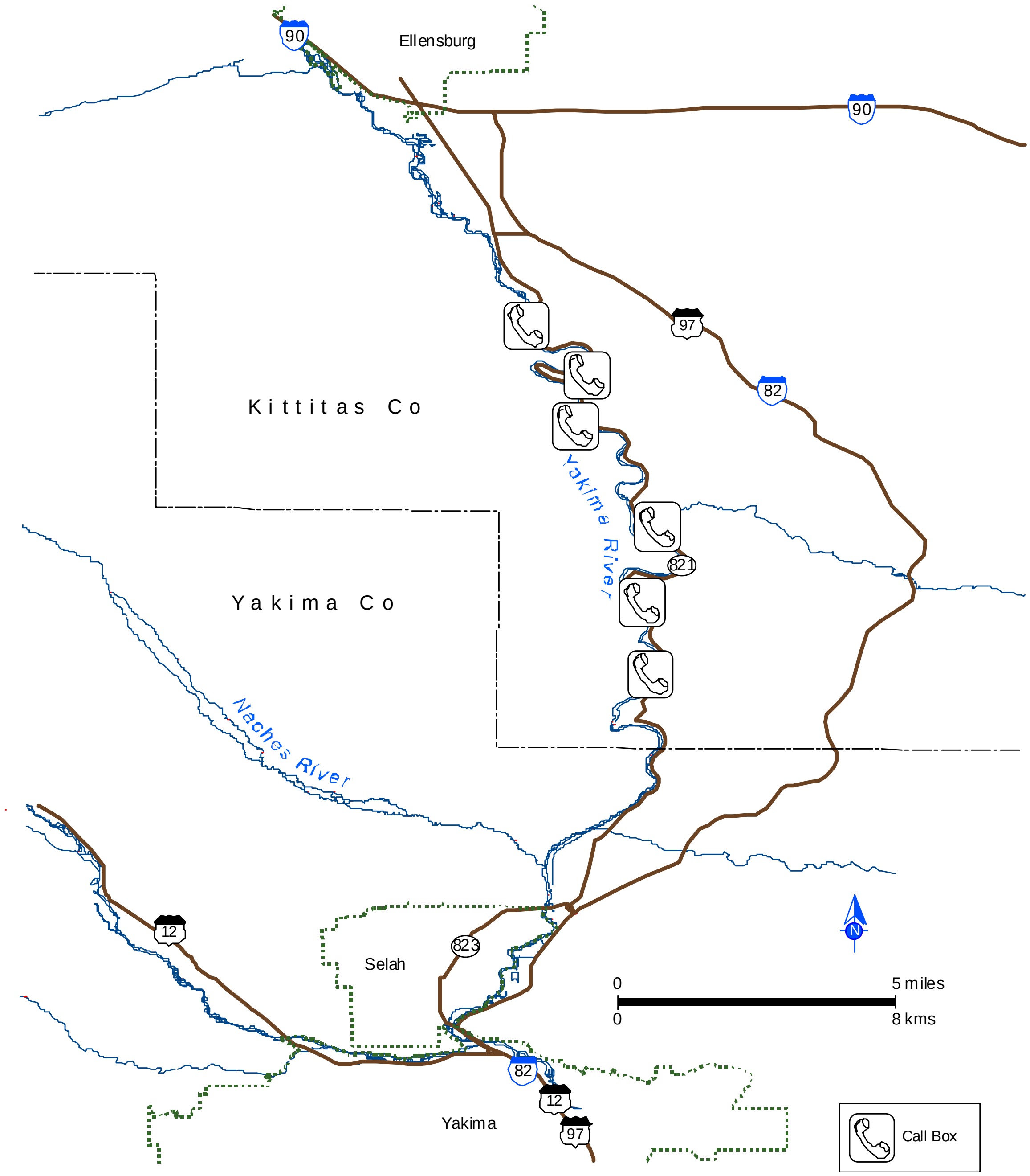

Figure 3: SR 821 Yakima Corridor Communications Safety Project

System Usage and Benefits

Some of the users are satisfied with the system. The project reduced the number of complaints from WSDOT Maintenance about 800 MHz radio dead spots.

Institutional and Technical Issues

Although interviewees thought that it was essential to have dedicated project staff if a complex project was going to stay on schedule and within budget, the region was unable to provide a dedicated project manager. Such a person is most important when other agencies and public services are involved.

The following were the region's suggestions for things that it would do differently if starting the project today:

- Devote adequate resources to accomplish the project. Delays occurred because existing operations staff had to take on design and construction work that they could only accomplish as time became available.
- For multi-agency projects, clearly define the roles and responsibilities of each agency. This is especially important when working with agencies that don't usually get involved in transportation projects. Make sure all parties are working toward the same objectives.
- Anticipate problems when agency staff lack experience in ITS, communications systems design, or any other type of non-traditional transportation project. Items such as VMS procurement, radio system procurement, call box installation, and radio site property leases all presented significant problems for inexperienced staff (as well as many experienced staff).
- Having State Procurement Contracts in place for ITS equipment such as variable message signs was important in reducing project time delays and simplifying the process.
- Make sure that projects are developed with ownership at the local level by using input from those who will have to design, build, operate, and maintain the new systems.
- Flexibility of the scope is important. This project was originally scoped to put many call boxes through the corridor. When this was determined to be extremely expensive (because of communications issues) and not as important because of the increased availability of personal cell phones, the flexibility in

the Earmark to spend the money on communications for emergency service providers was very helpful.

4.5: Yakima County ITS Earmark Projects

- Yakima County Adverse Weather Operations, Federal Aid No. ITS-2002(019)
- Yakima County Adverse Weather System, Federal Aid No. ITS-2003(054)
- Yakima County Adverse Weather Monitoring System, Federal Aid No. ITS-2004(054)

Background

Yakima County, located in central Washington on the eastern slopes of the Cascade Mountains, covers 4,268 square miles and is mostly rural with an agriculture-based economy. It experiences a full range of weather and its effects. Summer can be very hot and arid, and winter can be very cold and snowy. The county's location in the foothills and the variable terrain can simultaneously produce different weather and roadway conditions at different locations in the county.

The county had no road and weather information stations (RWIS). To monitor road conditions, county road crews had to traverse the county making observations. Because of staff limitations, rapid changes in conditions were missed. Unless local residents submitted reports, isolated hazards were sometimes not observed.

The county wanted to improve its ability to keep its roadways passable in winter. It was particularly concerned about the safety of school buses using county roads during that season. In addition, Yakima County is a major agricultural producer, and it is crucial for producers to get their products to market. An important freight route is a narrow, winding road between the Cowiche/Tieton Plateau and SR 12 near Naches, which can be treacherous during winter.

There were also problems with flash floods in the spring, when snow was melting in the mountains, and in summer, when rainstorms occurred. The county had a few stream gauges but no ability to predict when floods were imminent.

Project Description

The first phase of the project installed five RWIS. The data from these RWIS were fed into the WSDOT server, which collects data from WSDOT's network of RWIS in the area. The county also contracted with a consultant to provide hydrologic modeling services for the Naches watershed in an attempt to provide warning of flash floods that could affect county roads. The next phase installed three RWIS, which gave the County a total of eight. The third phase installed an RWIS with a "first in the nation" infra-red and laser-based sensor on the road between the Cowiche/Tieton plateau and SR 12 near Naches (the Naches/Tieton Road). This sensor is tied to a VMS that will alert trucks to the need for tire chains when the road is icy. A CCTV camera on the RWIS is used to confirm that the VMS is displaying the correct message.

In addition, the county installed a server, independent from the WSDOT server, to handle the data from its RWIS installations. This was done to provide the county with a more reliable system. Figure 4 shows the approximate locations of the RWIS installations.

Architecture and Standards

The data sharing promoted by the ITS architecture inspired the county to add its RWIS data to the WSDOT RWIS server, thereby providing additional data to WSDOT and allowing the county access to the WSDOT data. The following ITS architecture market packages are represented in this project:

- Network Surveillance (ATMS 01)
- Traffic Information Dissemination (ATMS 06)
- Road Weather Data Monitoring (MC 04)
- Weather Information Processing and Distribution (MC 04)
- Winter Maintenance (MC 06)
- Early Warning System (MC 07).

NTCIP standards were specified for the RWIS procurements. This allowed some integration between the RWIS purchased in the first phase and the RWIS purchased in the next phase. The county used the state procurement contract for RWIS, which was held by SSI during the first phase and then by Visala in the next phase.

The experimental pavement sensor that was used in the last phase was not NTCIP compliant, which prevented complete integration between the two types of systems.

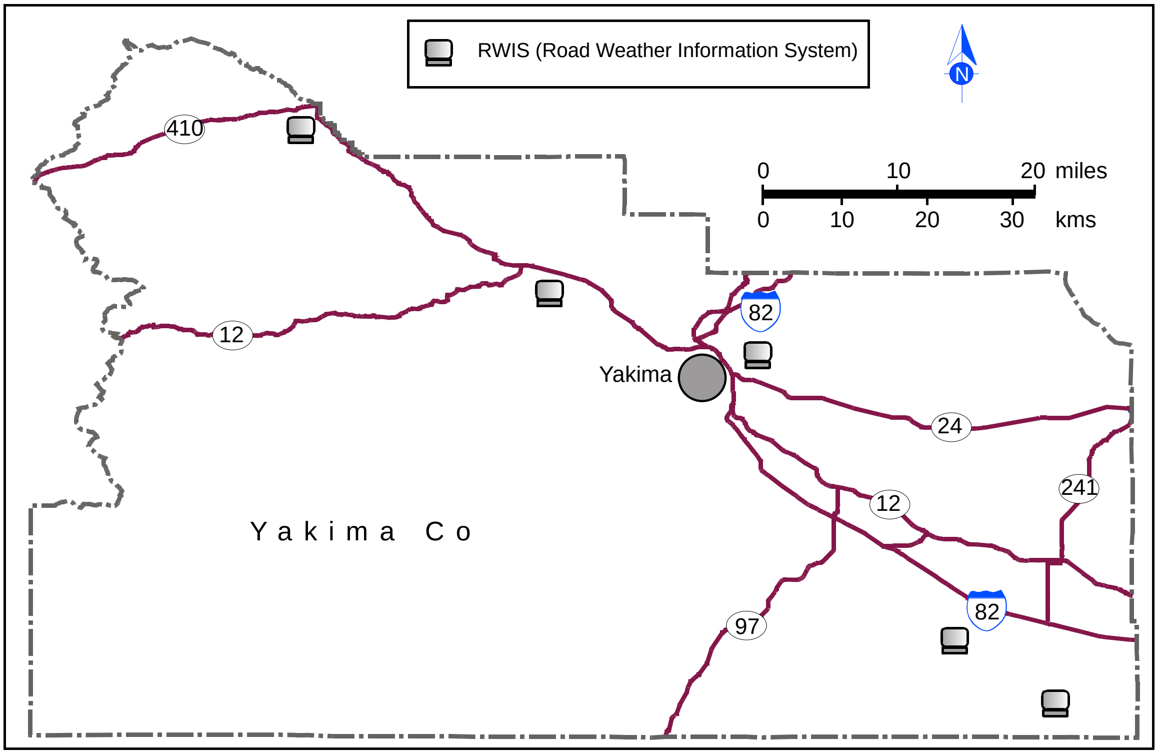

Figure 4. Yakima County Adverse Weather Operations Projects (3 Phases)

System Usage and Benefits

The RWIS data are used by County Maintenance as planned. Many others, including the school district, sheriff's office, and trucking companies, use the website to get weather information. There are many complaints if the system goes down, and there are many requests for more coverage.

Institutional and Technical Issues

The hydrologic modeling consultant's contract was not continued. This was the first time that the consultant had tried to model the east slope of the Cascade Mountains. Its model had difficulty predicting when warm weather would spill over the mountain crest and cause snow to melt. It repeatedly predicted flooding in three days, which didn't occur. The model also couldn't handle the frequent temperature inversions that occurred in the area. The weakness was the weather prediction model and not the flood prediction model. In other areas, where the weather prediction model works well, flood prediction might be feasible. The County Flood Control Zone District, a partner on this project, is still working with the consultant on other aspects of flood forecasting.

The county assembled the pavement ice warning system by using off-the-shelf components, and it was surprised at the time that was required to research equipment availability and operation. County personnel thought they should have spent more time meeting with vendors to define how the system should operate and how it would be expected to perform. They also thought that more time should have been allocated for inspection to make sure that the features worked as expected.

County personnel thought that they didn't plan adequately for system reliability. This is particularly important for any information system that provides crucial information. Some RWIS were installed in rural areas with poor quality power. Poor quality power can cause the RWIS to crash, requiring maintenance personnel to make a trip to the device. The installation of an uninterruptible power supply to filter the power has improved reliability a great deal.

The county looked at the RWIS system that WSDOT had installed to learn what it wanted and what worked. For example, personnel viewed the WSDOT mountain pass cameras and realized that the view wasn't very useful at night. In order for the county's CCTV images to be useful to school officials trying to decide whether to install chains on school buses in the very early morning, a view of the road conditions was crucial, so the county included illumination wherever it installed cameras.

Sharing data servers seemed like a good way to save time and money; however, server problems during critical times would cause the WSDOT server to lose the data from the county RWIS but not the WSDOT RWIS. The county eventually purchased a server to store its own data. When agencies share equipment that drives crucial applications, it probably is good practice to have a letter of understanding or agreement that specifies the respective expectations, duties, and levels of service to be provided.

4.6: ITS Earmark Project: Tacoma Interagency Communications Coordination (Gravelly Lake to 49th St. Fiber Optic Cable Installation), Federal Aid No. ITS-2002(031)

Background

WSDOT's Olympic Region has a network of surveillance cameras and vehicle detectors along I-5 in the Tacoma area. The images and data from these devices reached the Tacoma TMC via a combination of fiber optic cable, analog and digital microwave, and telephone lines. While this system worked, there were some inherent problems. The analog microwave was subject to distortion caused by inclement weather and vegetation obscuring the microwave path. In addition, the limitations of the microwave system did not allow for expansion, nor did it allow information sharing with other agencies. The disadvantages of using telephone lines were the monthly service fees and the dependency upon an external agency. Expansion was also limited with the use of telephone lines.

Another problem with the existing communications system was that the portion of the fiber optic cable that was shared with the City of Tacoma had reached capacity. This system bottleneck prevented additional field devices from being installed and did not allow WSDOT to share all of the traffic information that it has with the City of Tacoma.

On a previous project, the Olympic Region installed a fiber optics communications system to link the field devices on I-5 at the south end of the current project to the TMC. The previous project did not, however, link all of the existing devices to the TMC, nor did it link all of the potential local agencies to the system. The result was that not all of the existing microwave and telephone communication links were replaced with fiber, and WSDOT was not able to share its traffic data with some agencies that were interested in it.

Project Description

This project provided an improved communications link for WSDOT that alleviated the problems associated with the current link. It consisted of additional fiber optic cable along I-5 and from the existing fiber along I-5 to the headquarters of Pierce Transit and WSDOT's Tacoma area maintenance facility. A new fiber link was also constructed that allowed WSDOT to remove the video images from the City of Tacoma fiber. These links allowed the Olympic Region to distribute all current traffic information (mostly from I-5 and SR 16) directly to the City of Tacoma, Pierce Transit, WSDOT Maintenance, and the Washington State Patrol.

The final part of this project installed two CCTV cameras on I-5 in the Tacoma area. Figure 5 shows the approximate route of the fiber and camera installations.

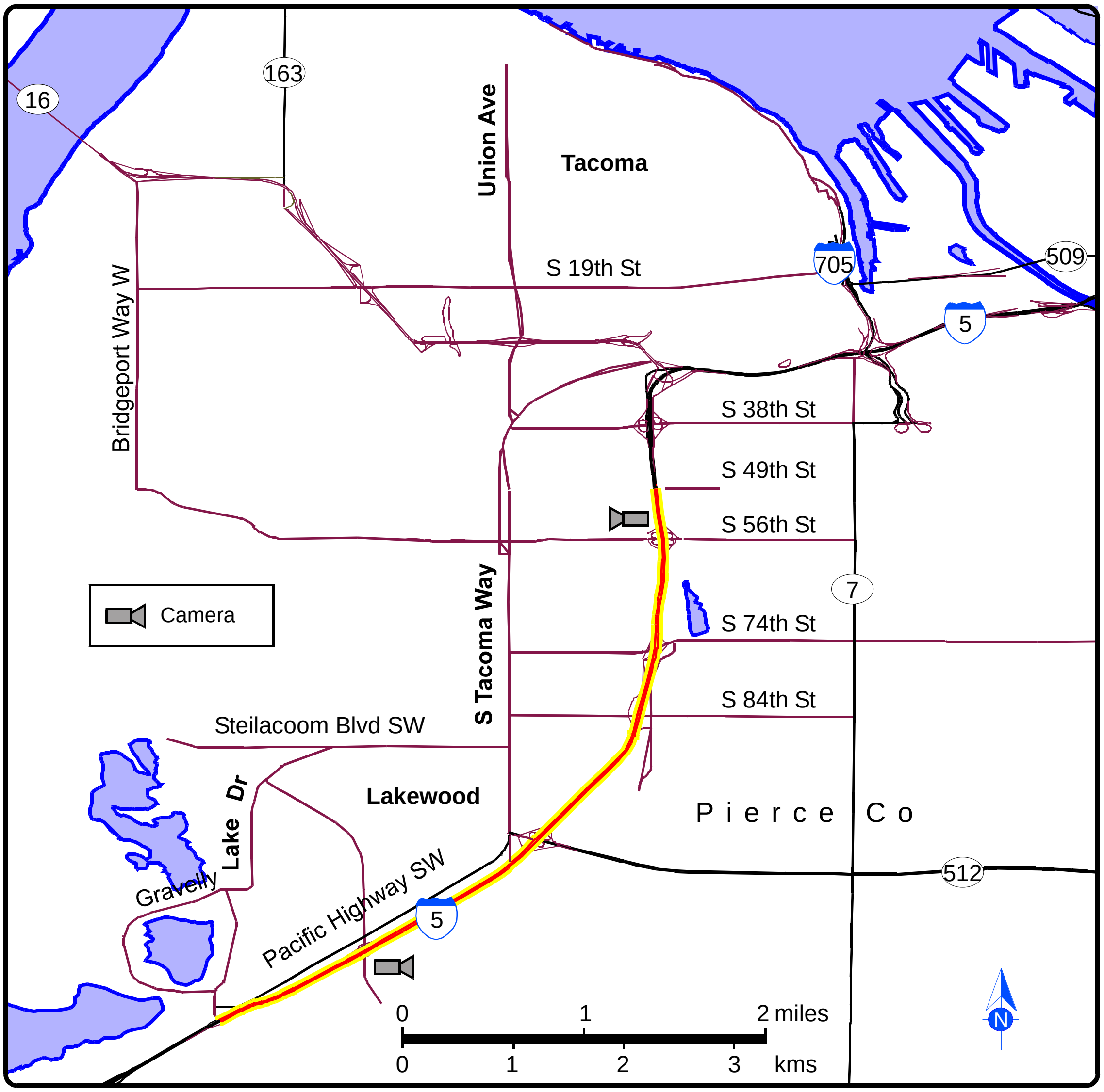

Figure 5. Tacoma Interagency Communications Coordination (Gravelly Lake to 49th St. Fiber Optic Cable Installation)

Architecture and Standards

This project demonstrates the kind of data sharing and system connections that the National ITS Architecture effort has tried to promote. The following ITS architecture market packages are represented in this project:

- Network Surveillance (ATMS 01)
- Traffic Information Dissemination (ATMS 06)
- Traffic Incident Management Systems (ATMS 08).

NTCIP standards were used for procurement of the CCTV cameras.

System Usage and Benefits

The Olympic Region TMC is no longer prevented from installing additional field devices by communications constraints. Therefore, it can manage additional roadway sections and provide improved incident response. It is able to share regional traffic information with other agencies. The Washington State Patrol, City of Tacoma, and the Tacoma Fire Department all have access to real-time video images and use them in their daily operations. The public also has access to this information via the WSDOT web site.

Institutional and Technical Issues

There were problems obtaining a contractor that was qualified to install fiber optic cable. It is not possible to get a qualified contractor if the contract documents are not properly written. On a subsequent project, language was added to the special provisions that allowed the selection of a more qualified contractor.

There are many options for communicating video and data from field devices to a TMC, but fiber optic cable appears to produce improvements in all aspects of communications: increased bandwidth, reduced operating and maintenance costs, and improved picture and data quality.

WSDOT worked with a local agency to share fiber until it could get projects funded to install its own fiber. That fiber sharing delayed this project because fiber installation was not essential to the primary mission of the other agency. However, that delay was offset by the fact that sharing the fiber saved money on interim communications costs, which eventually allowed more fiber to be installed.

At the time of this project, one agency said that it didn’t want to be connected to the fiber. WSDOT ended the fiber near that agency but put extra, coiled fiber in the junction box. At a later time the agency requested to be connected to the fiber. WSDOT is currently working to connect it, which will be relatively inexpensive thanks to foresight and the coiled fiber.

4.7: ITS Earmark Project: Port of Tacoma Trucker Notification System, Federal Aid Project No. ITS-2002(039)

Background

The Port of Tacoma is a vital part of the economy of Pierce County. To sustain the economic vitality of the port, it is critical that the transportation network into and out of the port operate as efficiently as possible.

Three freeway interchanges on I-5 provide access to the port. The most direct one for southbound traffic is the Port of Tacoma Road interchange. Approximately 300 feet from the southbound off-ramp intersection with the Port of Tacoma Road is a railroad crossing. When long trains travel through the crossing, truck traffic backs up onto the mainline of I-5, causing a safety problem. This project installed a system to monitor queues on the ramp and alert approaching trucks to use an alternative route.

WSDOT’s Olympic Region has a network of CCTV cameras and vehicle detectors along I-5 through Tacoma. The Region TMC uses these devices to monitor traffic conditions in this corridor. Some of this information is shared with local agencies and the public.

The existing communications network that served these devices consisted of microwave and telephone links, so it had limited capability. This network limited WSDOT’s ability to share the information with local agencies. With the installation of a fiber optics communications network, the traffic information could be disseminated directly to the City of Tacoma, the Washington State Patrol, and other local agencies.

Project Description

There were several components to this project. One was to install a queue detection system on the southbound I-5 off-ramp to the Port of Tacoma Road. When a queue is detected on the ramp, a signal is sent to a sign on I-5 in advance of the off-ramp to activate a set of flashing beacons. The sign advises truck traffic to use an alternative route when the beacons are flashing.

The other components to this project were as follows:

- An existing HAR at the Port of Tacoma Road interchange was upgraded to be compatible with the equipment used at other WSDOT HAR sites and with the control software. This improves the ability of the TMC operators to use the HAR to provide information to truckers in the vicinity.
- A CCTV was installed at the I-5/54th Street interchange, 1 mile north of the Port of Tacoma Road interchange. This enables the TMC operators to view conditions on roads leading to the port.
- Fiber optic communications cable was installed to link the existing and newly installed ITS devices near the Port of Tacoma to the existing fiber to the south of this project, thus linking the devices to the Olympic Region TMC. The existing fiber network is shared by WSDOT and the City of Tacoma; therefore, in addition to the camera images being sent to the WSDOT TMC, they are also sent to the City of Tacoma Fire Station near the port.

Architecture and Standards

This project clearly demonstrates the kind of data sharing and system connections that the National ITS Architecture effort has tried to promote. The following ITS architecture market packages are represented in this project:

- Network Surveillance (ATMS 01)
- Traffic Information Dissemination (ATMS 06).

NTCIP standards were used for the project.

System Usage and Benefits

The Port of Tacoma and trucking companies use the video images, congestion information, and HAR messages to improve freight mobility into and out of the port. The Olympic Region TMC uses the integrated ITS system to monitor and operate the freeway system more efficiently. It is also able to share area traffic information with other agencies. The Washington State Patrol, City of Tacoma, and the Tacoma Fire

Department have direct access to the real-time CCTV camera images and use them in their daily operations. The public also has access to the images to use in trip planning.

Figure 6 shows the approximate locations of the components installed on this project.

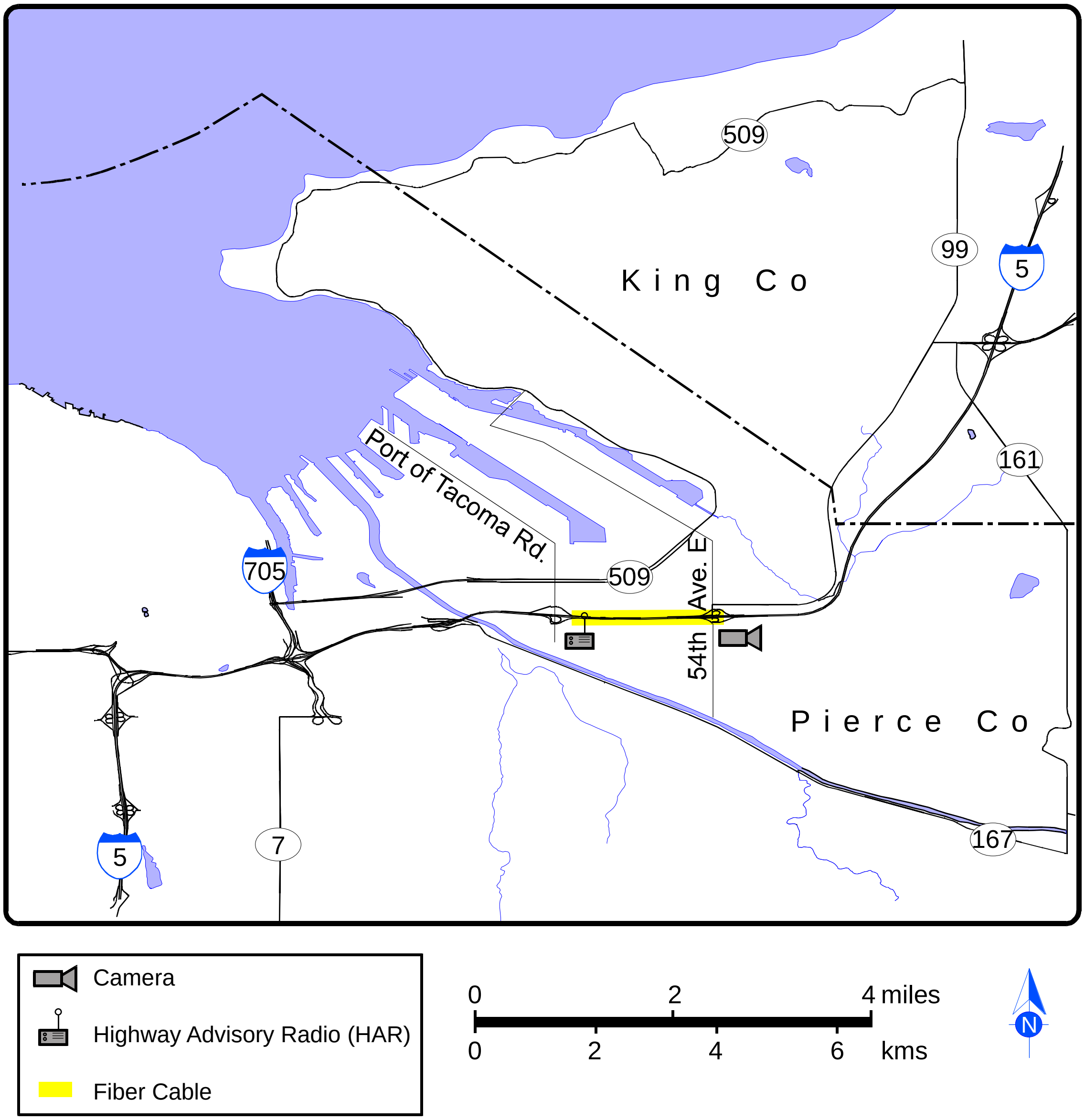

Figure 6. Port of Tacoma Trucker Notification System

Institutional and Technical Issues

Working with local agencies to install fiber in their streets was a challenge. It is usually best to install fiber in agency right-of-way by using agency personnel or contractors. When that is not possible, it may be worth the effort to deal with partners to get access to fiber. This situation is temporary until WSDOT can install fiber as part of freeway reconstruction projects. However, because that might not happen for 10 years or more, the project managers thought that the benefits to users from developing the interim system would be worth the effort.

Shortly after this project was completed, a railroad over crossing was constructed on Port of Tacoma road that eliminated traffic delays caused by trains. As a result, the sign with flashing beacons was never used. This demonstrates the need for ITS planners and designers to be aware of the agency's capital construction program and to look for ways to for the two programs to complement each other.

4.8: ITS Earmark Project: South Puget Sound Operations Improvements, Federal Aid No. ITS-2002(030)

Background

Thurston County, Washington, is at the south end of Puget Sound and is the location of the state capitol of Olympia. Thurston County and the surrounding region have experienced large population increases over the past two decades. As a result, I-5, which passes through the region, is now at or over capacity during the peak commute periods. The result is more traffic incidents, which, in turn, cause more congestion. In addition, some areas along the corridor experience icy conditions during the winter, which result in more accidents. WSDOT proposed to install components of a freeway management system along I-5 in Thurston County to improve traffic flow and to help manage incidents.

Prior to this project, WSDOT's Olympic Region had HARs on I-5 in the north and south parts of Thurston County. However, the lack of CCTV cameras and detector stations on the freeway limited its ability to use the HARs to provide traveler information, since the TMC could not confirm when traffic congestion resulting from traffic incidents was cleared, nor could it provide information on the length of the delays that motorists would experience. The lack of incident monitoring and detection devices also limited the ability of WSDOT to assist with the management of incidents in the corridor.

WSDOT also installed an RWIS station and HAR on SR 8 in response to the high rate of ice related accidents on this roadway. WSDOT worked with the Washington State Patrol and the Thurston County Fire Department to share the information provided by the RWIS site.

The major obstacle to implementing a freeway management system in Thurston County was the lack of a communications system to transmit the data to the TMC. Leased telephone lines had been used previously, but the expense of using phone lines with enough bandwidth to transmit video limited the number of cameras that could be installed. The Olympic Region needed a more cost-effective way to provide ITS communications in this corridor.

Project Description

This project installed a digital microwave system that linked the WSDOT Traffic Management Center (TMC), the Washington State Patrol in Thurston County, and the Thurston County Emergency Response Center. Thurston County is working on a project to expand its microwave communications system throughout the region to improve emergency services. WSDOT will use parts of the county's system for its link, which will allow data to be shared between the WSDOT TMC, the Washington State Patrol, and local agencies in the county. The exchange of information made possible by this communications link should improve the ability of the agencies to manage incidents and emergency response in the county.

The project also installed two CCTV cameras on I-5 in the Olympia area and installed a microwave link from the camera sites to the digital microwave system to get the images to the TMC. The CCTV cameras were installed at the Pacific Avenue interchange and SR 101 interchange. These interchanges typically experience congestion and incidents during peak commute periods.

The following agencies were involved in the project:

- Washington State Department of Transportation
- Thurston County Emergency Services
- Thurston County Communications Center (CAPCOM)
- Washington State Patrol

- Thurston Regional Planning Council (MPO for the County).

Figure 7 shows the approximate locations of the components installed for this project.

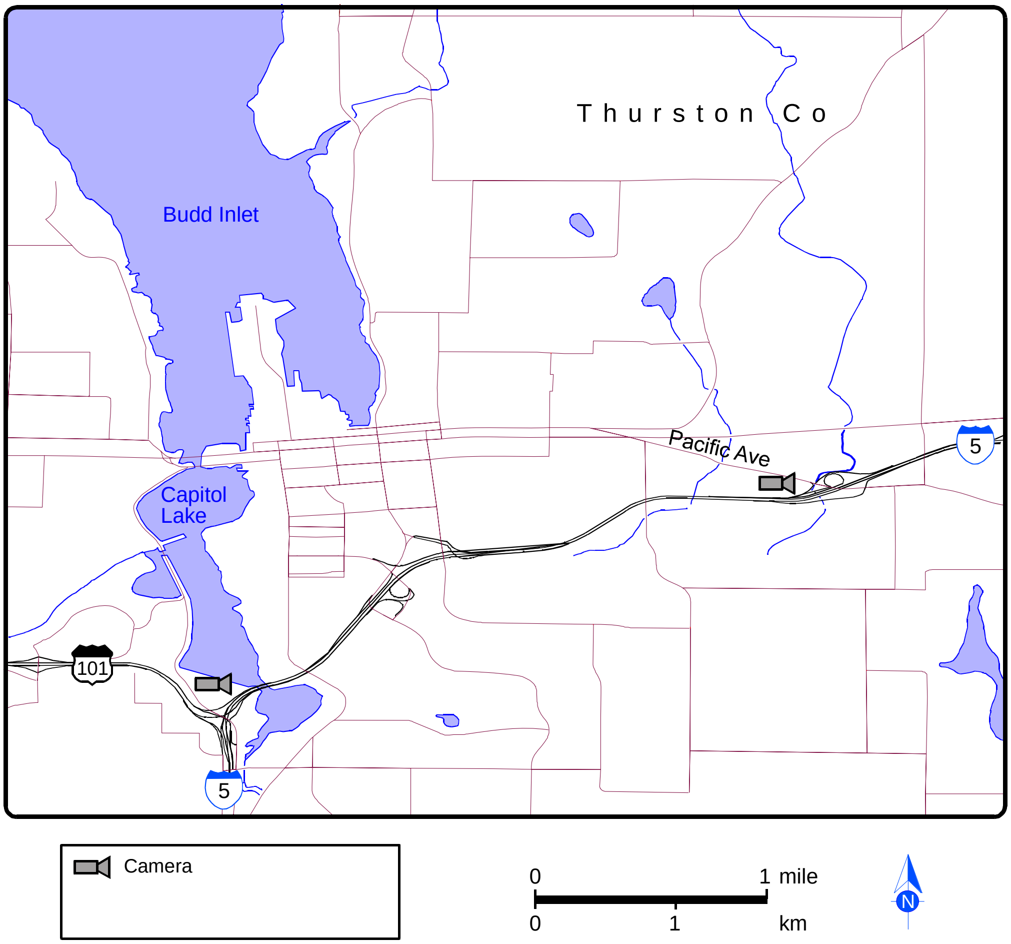

Figure 7. South Puget Sound Operations Improvements

Architecture and Standards

This project clearly demonstrates the kind of data sharing and system connections that the National ITS Architecture effort has tried to promote. The following ITS architecture market packages are represented in this project:

- Network Surveillance (ATMS 01)
- Traffic Information Dissemination (ATMS 06)
- Traffic Incident Management Systems (ATMS 08).

NTCIP standards were used for the project. This project was covered by Thurston County's regional ITS architecture developed by the Thurston Regional Planning Commission, the MPO for the county.

System Usage and Benefits

The CCTV cameras provide real-time traveler information to the public. They also make it possible to obtain visual verification of traffic conditions in the area before a message is broadcast on the HAR. WSDOT, WSP, and local agencies use the video to assist with incident response. The system is used by the following WSDOT Olympic Region offices: TMC, Maintenance, and Incident Response. The WSP, Thurston County Emergency Services, the public, and a local radio station also use it. It is available around the clock and is operated and maintained by WSDOT.

The interviewees thought that the system had met expectations and resulted in improved incident detection, verification, and response. It had also facilitated data sharing with local agencies and improved freeway operations.

The Olympic Region's long-term plans for this corridor include the installation of a fiber optic communications system and five more CCTV cameras on I-5. These plans agree with feedback from the public requesting more cameras in the corridor.

Institutional and Technical Issues

The digital microwave product used for this project was new on the market and did not perform as expected. The problems were corrected, but the project was delayed and additional cost was incurred. Project designers and managers should recognize that using products with proven performance and reliability records is the best way to ensure the completion of the project on time and within budget. Experiments with new products should be conducted in small test deployments or as part of research projects.

4.9: ITS Earmark Project: Spokane Regional Data Warehouse, Federal Aid No. ITS-2003(026)

Background

The Spokane Regional Traffic Management Center (SRTMC) was created as a regional partnership to provide area-wide ITS coverage during peak travel periods, to monitor and respond to incidents, and to share data. The SRTMC was formed by an inter-local agreement between the City of Spokane, City of Spokane Valley, Spokane County, Spokane Regional Transportation Council, Spokane Transit Authority, and WSDOT's Eastern Region.

Collected and stored traffic and transportation data had been held by the respective agencies that generated the data. This practice made it difficult to share data. Researchers, transportation engineers, planners, and the public experienced difficulty in accessing data that should have been simple to obtain.

By using the SRTMC as an information and communications hub, each jurisdiction can maintain its own operations systems. Each is networked with the others and can have interoperability. The SRTMC hardware and software enable real-time monitoring at both the SRTMC as well as at the operations offices of each agency.

The cost of designing and deploying transportation applications such as a regional travel information website or a regional traffic management system can be significantly reduced by having a regional data warehouse. Without the warehouse, these applications need to include connections to each agency's separate databases.

Project Description

The six agencies that formed the SRTMC are using software supplied by a vendor to operate their freeway management and traffic signal systems. The software vendor also supplies a data management and archiving system known as the Performance Management System, or PeMS. This project purchased and installed PeMS at the SRTMC. It uses an Oracle database and can handle 500 data stations.

At this time, the system contains data from radar detectors that cover approximately 20 miles of I-90 through the City of Spokane. The database contains speed, volume, and lane occupancy data.

Architecture and Standards

The Spokane regional ITS architecture and ITS Implementation Plan were developed in May 2000,given a minor update in July 2000, and completely updated in March 2007. The ITS architecture reflects the longstanding regional interest in cooperatively managing transportation and sharing data. This project is one step toward implementing the vision reflected in the ITS architecture.

The following ITS architecture market packages are represented in this project:

- Traffic Forecast and Demand Management (ATMS 09)
- ITS Data Mart (AD1)
- ITS Data Warehouse (AD2).

PeMS was designed to use any and all ITS standards that were available at the time. Here is what the PeMS user manual says about standards:

PeMS conforms to ASTM E2259, Standard Guide for Archiving and Retrieving ITS-Generated Data, by following these Archived Data User Services (ADUS) themes:

- Always store the raw (flow, occupancy and speed) data.
- Document the processing of the data (filtering, cleaning, etc.).
- Tell users the characteristics of the displayed data (a "truth in data" statement that makes it clear the data have been processed).

System Usage and Benefits

The system provides data that are currently used to predict the effects of construction closures. It is also used to provide freeway performance measures for the Spokane area as reported in the WSDOT Grey Notebook, a quarterly performance report WSDOT issues to the governor and legislature. The Spokane Regional Transportation Council (the MPO for the area) uses the data for model calibration.

The system flags bad data and indicates the reason that the data are bad. It tells how it calculated replacement data.

However, the system does not completely meet the original objectives. At this time, it only handles freeway data. No arterial traffic signal data are in the system. While the system can archive raw arterial signal data, it cannot provide summary statistics. A PeMS module to do this is under development. Local agencies that operate arterial roadways are not getting much out of the system at this time. Also, now that the data are archived and bad data are being flagged, some agencies are not happy with the data that some detectors are providing.

There have been problems in training agency staff to use the system. The system is complex, and users often forget the steps necessary to produce a report if more than a few days elapse between user sessions.

The SRTMC analyzed the costs and benefits associated with a proprietary system and decided to purchase it. The system purchased was an existing system, already in use in other areas, so the buyers were aware of the strengths and weaknesses. The fact that the system could be deployed almost immediately after purchase was of primary importance. Probably because this was an off-the-shelf system, it has proved to be very robust, and the vendor has been very responsive.

However, the operators are still a little concerned about having purchased a proprietary system. They realize that the ability to expand or modify the system is limited because funding must be found to hire the vendor to do these tasks. They have a yearly maintenance contract at this time. They are currently participating with the consultant to add data stations and routes into the system. So far, they think that they made the correct decision.

4.10: ITS Earmark Project: US 2 Stevens Pass Variable Speed Limit System, Federal Aid No. ITS-2003(062)

Background

US 2 is an east/west highway in central Washington State that traverses the Cascade Mountains at Stevens Pass. The route is one of only three year-round routes linking central Washington to the urban areas and ports of western Washington. Approximately 2,700 vehicles per day cross the pass in winter and 4,700 in mid-summer.

Stevens Pass is located between the City of Leavenworth, on the east side of the Cascade Mountains, and Everett on the west. The elevation of the summit of the Pass is 4,061 feet, and a popular ski area is located there. Congestion caused by vehicles looking for parking and pedestrians crossing the roadway to access the ski area cause safety problems. A 2-mile long segment of this corridor has been identified as a high accident corridor, primarily because of accidents that occur under snowy or icy conditions.

Although traffic volumes are low in comparison to many parts of the state highway system, this corridor is recognized as a Highway of National Significance (HNS) and is therefore classified as an HNS route. The significance comes from its critical importance to the economy of central Washington State, since it is a key cross-mountain transportation link.

Project Description

Various law enforcement agencies expressed concern to WSDOT over the number of speeding vehicles using the highway in winter. As mentioned, this corridor experienced a disproportionate number of accidents under snowy or icy conditions. WSDOT proposed this project to reduce the number of speeding vehicles and accidents on this roadway in winter.

This project uses VMS and variable speed limit (VSL) signs to inform motorists of regulatory speed limits based on road conditions. The project installed one full-matrix VMS and eight variable speed limit signs along a 23-mile section of US 2. Two, existing, full-matrix VMS were incorporated into the system. A communications system that used a combination of microwave and fiber was installed to communicate with the signs. Static signs indicating that the roadway had an enforceable variable speed limit were installed in both directions at the entrances to the roadway section.

Speed limits are determined by assessing visibility and pavement conditions. The maximum speed is 60 mph, and the speed limit decreases in 10 mph increments to a minimum of 30 mph, when all vehicles, except those with 4-wheel drive, are required to install chains. (See Table 3 for a detailed breakdown of criteria for determining the speed limit.)

Figure 8 shows the approximate location of the components installed on this project.

Architecture and Standards

The following ITS architecture market packages are represented in this project:

- Traffic Information Dissemination (ATMS 06)
- Speed Monitoring (ATMS 19).

The VMS installed as part of this project were NTCIP compliant.

Table 3. Stevens Pass Variable Speed Limit Reference

Speed Limit	Traction Requirements	Pavement Conditions	Visibility
60	None	Dry or Bare/Wet	Good: Clear>0.5 Miles
50	Traction Advisory	Light Snow, Slush, or Ice in Places	Moderate: Fog<0.2 Miles
40	Traction Tires Required	Comp. Snow/Ice, Deep Slush, Shallow Water	Poor: Blowing Snow<0.1 Miles
30	Chains Required All Vehicles Except 4-Wheel Drive	Severe Freezing Rain, Deep Snow, Slush or Standing Water	Poor: Blowing Snow<0.1 Miles
25	Emergencies or Extreme Conditions Only	Use this speed for severe conditions as requested by crews on the scene. Confirm with Supv., when available. Poorest possible road conditions. Conditions should be well documented. Return to higher speed limit as soon as possible.	

As of 9/29/2006

Note: Traffic speeds may differ eastbound and westbound if traffic conditions differ.

The speed limit may be lowered in the case of traffic collisions and incidents that block the highway or portions of the travel lanes. Set the speed limit based on guidance provided by the supervisor on the scene and WSP.

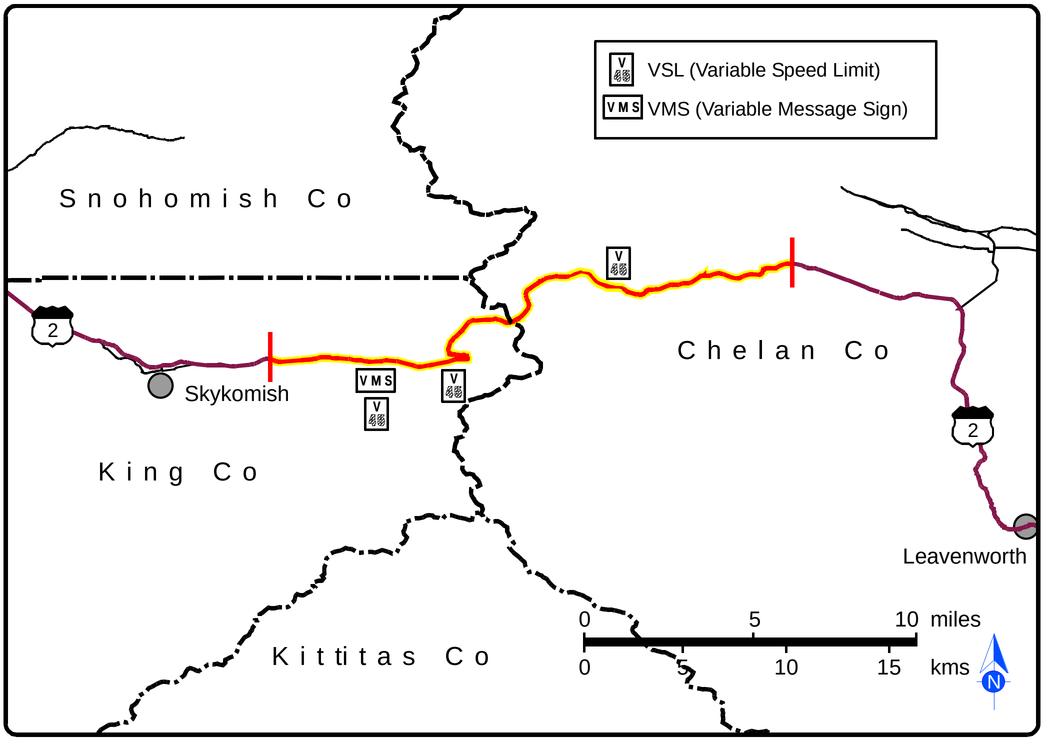

Figure 8. US 2 Stevens Pass Variable Speed Limit System

System Usage and Benefits

The interviewees indicated that the system is used several times a week. For most of the winter, the speed limit is reduced to 50 mph. During the first year of operation, WSDOT personnel set speed limits. Traffic engineers at the Traffic Management Center and the WSDOT Maintenance Supervisor for Steven Pass made the decision. The Washington State Patrol (WSP) requested an opportunity to participate in the setting of the reduced speed limits, and WSDOT has agreed to coordinate with the WSP in the second year of operation. The WSP would like more flexibility in setting speed limits; for example, by reducing speeds in 5-mph increments or reducing speeds only in the roadway section where adverse conditions exist and not throughout the entire corridor.

While the interviewees thought that the system has met its objectives, the system has not been operating long enough for an accident analysis to be conducted. They mentioned that additional VSL signs are needed. There are currently long distances between some of the signs. Additional signs would provide the flexibility that WSP would like to set the speed limit to reflect local conditions rather than having to set them on the basis of the worst conditions in the corridor, which may be 10 or more miles away.

Institutional and Technical Issues

US 2 is listed as a historic highway. It passes through a very scenic area, particularly in the winter when the mountains are snow covered and in the fall when the leaves on the trees turn color. It passes through the Wenatchee National Forest, so permits from the U.S. Forest Service are needed for improvements to the highway. In addition, because it is a historic highway, permits are needed from the State Office of Archeology and Historic Preservation. Not enough time was built into the schedule to consult with these agencies and obtain permits from them.

Two technical integration issues were encountered on this project. The first involved getting access to unused, privately owned communications conduit in the project area. Despite many attempts to contact the correct people at the communications companies that owned the fiber, the connections were not made. WSDOT installed the fiber for this project.

The other integration issue involved the use of two software packages for VMS control. The existing signs are on one system, and the new signs on another. At this time, the two systems have not been integrated, so the TMC operators must remember to use both when operating the system.

4.11: ITS Earmark Project: I-90 Truck/Wind Warning System, Federal Aid No. ITS-2003(039)

Background

I-90 is the only east/west Interstate highway in Washington. It crosses the Columbia River at Vantage in central Washington (milepost 137-139). At this location, the average daily traffic count is 13,000 vehicles per day, 22 percent of which are trucks. The Vantage Bridge is frequently subjected to very high cross-winds. These winds can make it difficult for large trucks and recreational vehicles to safely traverse the span.

Additionally, trucks approaching the bridge from the east (westbound) must negotiate a sweeping curve onto the bridge at the end of a long downhill grade. The speed limit for trucks on I-90 at this location is 60 mph; however, the curve advisory speed is 50 mph. Trucks regularly overturn at this curve, often closing I-90 in both directions for extended periods.

There is also an interchange with ramps to/from SR 26 that merge at the curve, adding to the complexity of driver decisions at this location. This combination of contributing factors makes the accident history at this location worse. As a result of the number and severity of accidents that occur here, WSDOT has identified the site as a high accident location.

The roadway has been signed with static signs: chevrons, 50 mph advisory speeds, and signs warning of severe side winds.

Project Description

Two systems were installed at this location. One warns truckers who are traveling too fast for conditions, and it is expected to reduce accidents at the curve. It consists of loop detectors to measure vehicle speeds and a piezo-electric detector to classify vehicles. A VMS was installed before the 50 mph curve at the bottom of the steep, downhill section for westbound traffic. When the system detects a truck that is traveling over 55 mph, a message is displayed on the VMS warning the truck that the advisory speed for this section is 50 mph.

The other system is a real-time, high wind warning system. It consists of an RWIS with an anemometer to measure wind speed. This system uses the same VMS installed for downhill truck warning. Two additional VMS were also installed; one for eastbound traffic on I-90 and the other for traffic on the SR 26 on-ramp to I-90. When gusts of 45 mph or sustained winds of 35 mph are detected, high wind warning messages are displayed on these two VMS, as well as on the westbound one that displays the truck speed warning. A ranking of message display priority has been developed. This system is expected to reduce truck and recreational vehicle accidents on the bridge.

A combination of microwave and fiber provides communications to the systems.

Figure 9 shows the approximate locations of the components installed for this project.

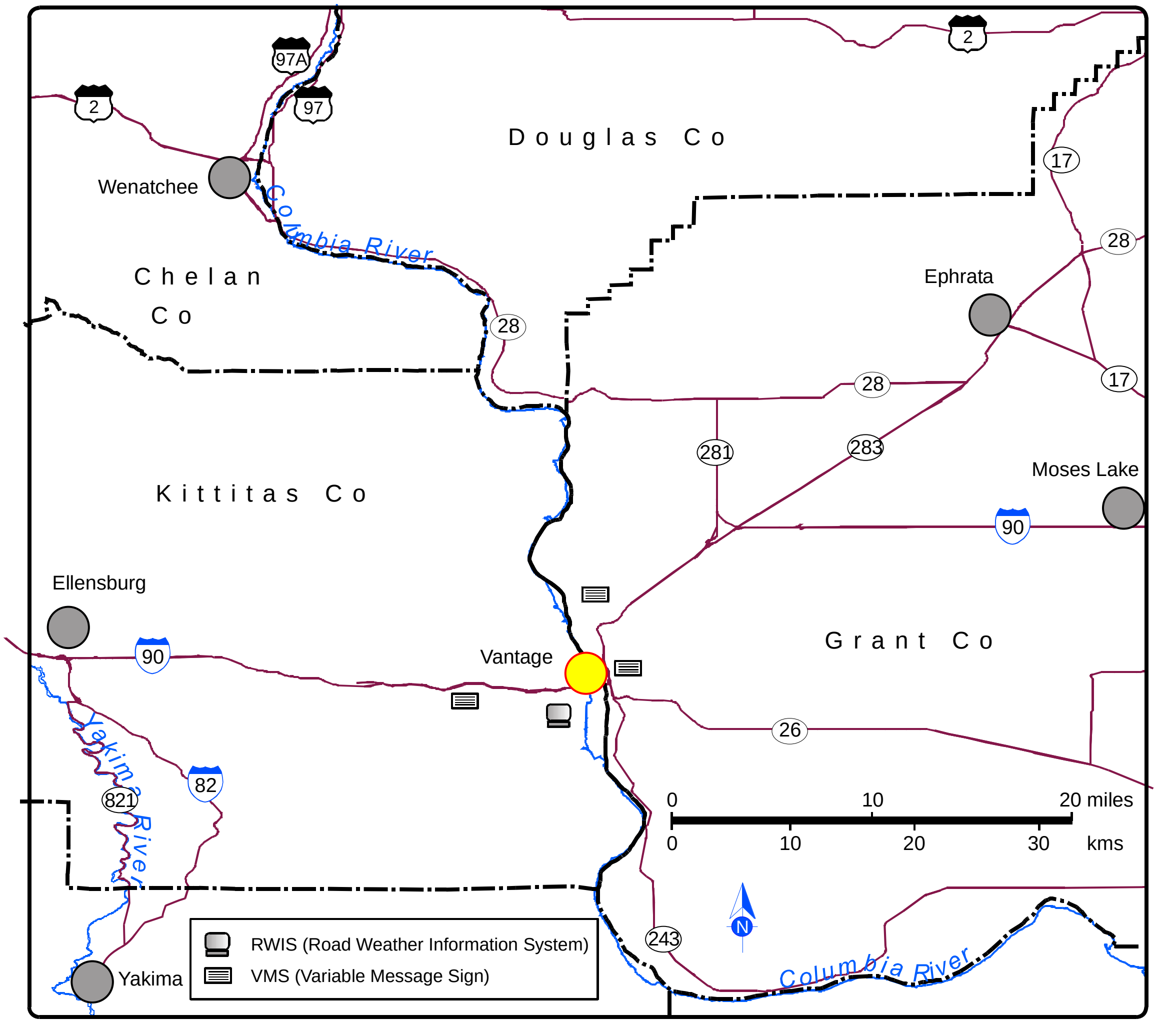

Figure 9. I-90 Truck/Wind Warning System

Architecture and Standards

The following ITS architecture market packages are represented in this project:

- Network Surveillance (ATMS 01)
- Traffic Information Dissemination (ATMS 06)
- Speed Monitoring (ATMS 19)
- Road Weather Data Collection (MC 03)
- Weather Information Processing and Distribution (MC 04).

The VMS installed as part of this project were NTCIP compliant.

System Usage and Benefits

During initial operation, an estimated 90 percent of trucks triggered the truck speed warning system. Video taken by WSDOT shows trucks applying their brakes (indicated by brake lights) when a speed message was displayed on the VMS.

At the time of the evaluation interview, the site had not experienced high winds, so there were no usage data for the wind warning system.

The interviewees indicated that the system met all of its original objectives, and all parties were satisfied with the system.

Institutional and Technical Issues

No institutional or jurisdictional issues involved outside agencies because the project was deployed completely on state highways under WSDOT control. WSDOT communications systems were used for communications, and WSDOT operates and maintains the entire system.

However, there were some technical integration issues. An off-the-shelf system was available and would have been easier to deploy, but it was too expensive for the project budget. Instead, WSDOT purchased the system components from different vendors and integrated the system. The integration team consisted of personnel from ITS Maintenance, Information Technology (IT), and Radio Communications. There were no assurances that these components were going to work together. The interviewees thought that the key to getting this system to work properly was the teamwork that existed among the personnel assigned to the project. There were no in-house, jurisdictional disputes, and all personnel joined together to make the system work. Also, there was good technical assistance from the two main product suppliers and good cooperation between the two.

The interviewees indicated that the team is satisfied with the choice to assemble a system from individual components and perform the system integration because they now have a good understanding of how the system works.

4.12: ITS Earmark Project: Whatcom Regional ITS Fiber Optic Integration, Federal Aid No. ITS-2001(027)

Background

Bellingham is a city in Whatcom County in northwestern Washington State. It is located approximately 90 miles north of Seattle and 20 miles south of the USA/Canada border. The city's arterial street system comprises approximately 75 miles of arterial streets and 105 intersections. The city is divided in half by I-5, and three additional state highways (SR 11, SR 539 and SR 542) help transport regional traffic into and out of the city. In addition, inter-local agreements are currently in place with Whatcom County, the City of Ferndale, and the City of Linden to allow Bellingham to operate and maintain traffic signal systems in those communities.

One of the technologies that Bellingham implemented in 1997 to help maintain the capacity of the arterial street system is a network of CCTV cameras and a series of vehicle detectors embedded in the roadways to monitor traffic volumes along heavily traveled corridors. Real-time video and data are transmitted via fiber optic cable to the TMC located in Bellingham's City Hall.

WSDOT has installed freeway management system components on I-5 through Bellingham. These include vehicle detectors, CCTV cameras, HAR, and VMS. A TMC has been installed in WSDOT's maintenance facility in Bellingham.

As roadway congestion degrades safety and efficiency, emergency response times, and air quality, it is necessary to manage congestion on a regional level. To do this, it is necessary to share resources across agency boundaries. The City of Bellingham has taken the first step in this direction by purchasing the equipment necessary to expand its fiber optic network. The city now owns a fusion splicer and has trained staff available to pull new cable and install equipment at the cable ends. Inter-local agreements are currently in place with the Port of Bellingham and Whatcom County to participate in a joint venture to construct a multi-jurisdictional fiber optic network to facilitate countywide transmission of video and data. Additional agreements will be developed for other agencies as data become available.

Project Description

This project accomplished the following tasks:

- Expanded a modest collection of fiber links into a system of over 37 miles of fiber that runs throughout the city.
- Upgraded a closed-loop, master controller-based traffic signal system to a central signal management system that communicates via a server over the fiber network to signal controllers in the field. Forty new signal controllers were installed. A workstation tied directly to the server was installed at the WSDOT TMC so both agencies can share, monitor, and revise signal timing.
- Two CCTV cameras with no management software were expanded into a system for the management of over 35 cameras covering freeways, major arterials, downtown crime monitoring, and water treatment facility security.

The project partners were as follows:

- The Whatcom Transit Authority participated in the funding of traffic signal upgrades to allow the deployment of transit signal priority.
- WSDOT participated in the funding of improvements at the intersections that are under WSDOT control and the integration of the two TMCs.
- The Bellingham School District participated in the installation of fiber to serve its facilities.
- The Port of Bellingham participated in the installation of fiber to serve port facilities.

City traffic engineering personnel use the system's CCTV cameras to monitor city arterials and are able to use the signal management system to adjust traffic signal timing. Water treatment facility operators monitor the security of their facility by using the CCTV cameras. Police officers use the system to monitor and record downtown crime prevention cameras. WSDOT engineers can monitor signal timing, and their freeway CCTV cameras and the camera images are sent to the WSDOT Northwest Region TMC in the Seattle area.

Architecture and Standards

This project was covered by the regional ITS architecture that was prepared for Whatcom County by the Whatcom Council of Governments. The number of partners that share video, data, and traffic signal control demonstrate that this project conforms to the regional and national ITS architectures and provides an example of the kind of information flows that the ITS architecture process is designed to promote. The following ITS architecture market packages are represented in this project:

- Network Surveillance (ATMS 01)
- Surface Street Control (ATMS 03)
- Regional Traffic Control (ATMS 07).

NTCIP standards were employed for the traffic signal and CCTV camera installations.

System Usage and Benefits

The interviewees indicated that all parties are satisfied that the system meets the original objectives of the project. The system is in continual operation, and City Traffic Engineering and Communications personnel operate and maintain the system. The city's project manager said that the biggest strength of the project was that it enabled the city to complete its fiber network, interconnect and upgrade its signal system, and complete its CCTV camera system at one time with one project. Staff attention can now be focused on operating and improving the system.

The only comments from the public concerning the system come from the grade school kids who tour the TMC each year who think that the system is "cool."

Institutional and Technical Issues

This project is a great example of what can be done when a lead agency is able to think and act regionally. Additional time was initially spent to develop a project that would incorporate the goals of many partners. Scattered ITS components and traffic signals were integrated into a fiber network, a regional traffic signal system, and a system of CCTV cameras. This integration of infrastructure prepares the agencies for integrated, regional operations.

4.13: ITS Earmark Project: Spokane Regional Transportation, Construction and Weather Website, Federal Aid No. ITS-2002(018)

Background

The Spokane Regional Traffic Management Center (SRTMC) was created as a regional partnership to provide area-wide ITS coverage during peak travel periods, to monitor and respond to incidents, and to share data. The SRTMC was formed by an inter-local agreement between the City of Spokane, City of Spokane Valley, Spokane County, Spokane Regional Transportation Council, Spokane Transit Authority, and WSDOT's Eastern Region. One of the goals of the SRTMC is to provide traveler information to the public to assist with trip planning.

Prior to this project, the only Internet-based source for travel information in the Spokane area was the WSDOT travel information website. It provides information on incidents, construction, and weather-related road closures as well as CCTV camera images for the entire WSDOT Eastern Region. There was no website that provided specific information for the Spokane area.

Project Description

The objective of this project was to develop a website that served as a one-stop shop for traveler information that covered primarily Spokane County. Data from the Spokane area traffic management system are combined with data from WSDOT's Condition Acquisition and Reporting System (CARS) and WSDOT's CCTV camera images to produce the travel information Web page (www.srtmc.org). A screen shot of the Web page is shown in Figure 10. The website displays a color-coded congestion map (Traffic Flow Map) that covers approximately 20 miles of I-90 through Spokane. It also displays icons that indicate incident, construction, or weather-related closures (linked to text boxes with more detailed information), CCTV images, and current messages on a VMS on I-90. No data are currently provided from the network of RWIS in the area. Weather-related road condition messages that are entered into CARS are also displayed on this website.

The new Web page has links to the partner agencies' Web pages.

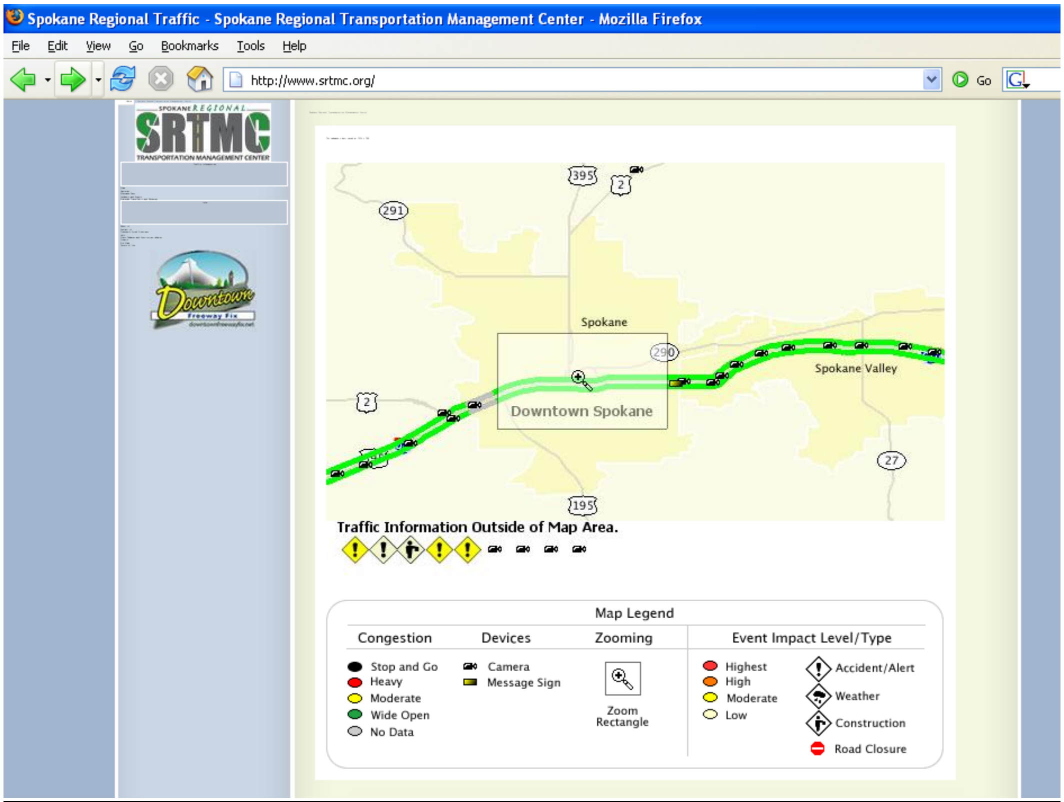

Figure 10. Spokane Regional Transportation, Construction and Weather Website

Architecture and Standards

The Spokane regional ITS architecture and ITS Implementation Plan were developed in May 2000,given a minor update in July 2000, and completely updated in March 2007. The ITS architecture reflects the longstanding regional interest in cooperatively managing transportation and sharing data.

The following ITS architecture market packages are represented in this project:

- Traffic Information Dissemination (ATMS 06)

The only ITS standard used on this project was xml, which was used for the Web page.

System Usage and Benefits

About 150 users visit the system each day. Many of these are repeat visitors. Many are directed to the site from the Spokane area newspaper website. There has been little feedback from the public.

The system was designed to keep data entry to a minimum. The TMC operators do not have to enter incident or closure data into CARS and then enter the same data into the SRTMC database for display on the website. The data are entered into CARS, and then a consultant-developed "Active Push" application sends the data to the SRTMC website.

Institutional and Technical Issues

The major technical problem with the website is the lack of arterial data. Only about a dozen arterial system detectors in the Spokane area can provide arterial speed data. This is not enough coverage to provide good arterial travel information.

In addition, there is a delay from the time that an incident is first entered into the system to the time that it is displayed on the website. This delay can be as long as four minutes. Given that the duration of congestion in the Spokane area can be relatively short (less than an hour), a four-minute reporting delay is significant.

The project managers think that the website look and usability need to be improved. A traffic management system consulting engineering firm developed the website and the SRTMC Board approved the design. However, the Board consists of engineers who lack training in website design. Those involved with the project sought feedback on the website from non-technical family members and friends but thought that it would have been useful to conduct a focus group or usability testing on the website. Using some unspent project funds, the SRTMC is planning to hire a Web developer to make improvements to the website.

Multi-jurisdictional projects can take longer to implement than projects involving just one agency because of the need to reach consensus before anything is implemented. In general, the project managers think that the benefits to the public of thinking and operating regionally are worth the extra effort that is necessary. To help simplify and speed the process of putting content on the website, the SRTMC is developing a content management system. That will allow individual agencies to manage their own content (arterial traffic data or incident data, for example), but it will have the correct appearance and format when it is sent to the SRTMC to be placed on the website. No time or staff resources will be needed to reformat the data to integrate them into the website.

4.14: ITS Earmark Project: Alpowa Summit Winter Traveler Information System, Federal Aid No. ITS-2002(032)

Background

A 29-mile section of SR 12 links Pomeroy and Clarkston in the southeast corner of Washington State. The roadway generally runs in a valley, but about midway between these two towns it rises to an elevation of 2,785 feet at Alpowa Summit. (Figure 11 shows the project location.) Motorists may experience safe driving conditions while in the valley and then experience high winds, icy roads, and fog at the Summit. WSDOT's South Central Region used two flip signs, one on each approach, to inform motorists of conditions, specifically any tire chain requirements. When a warning message was required, a maintenance worker had to travel to the site and flip the sign so that it displayed the proper message. Only two message choices were available: chains required or no message. A road weather information station (RWIS) and CCTV camera had been installed previously at the Summit. The region wanted to have more message flexibility and wanted to eliminate the need for someone to travel to the Summit to activate the signs.

Project Description

Two variable message signs (VMS) were installed on the approaches to Alpowa Summit, one in each direction. The signs are controlled by software at the region TMC in Union Gap, Washington. The region uses a communications link offered by a satellite Internet provider to control the signs. Operators can see the data on road and atmospheric conditions that are collected by the RWIS and can observe the CCTV camera images from the Summit. They use this information, as well as input from Maintenance personnel, to decide on the appropriate message to display on the sign.

Architecture and Standards

The following ITS architecture market packages are represented in this project:

- Traffic Information Dissemination (ATMS 06)
- Early Warning System (EM 07)

NTCIP 1201 and 1203 were used for the project.

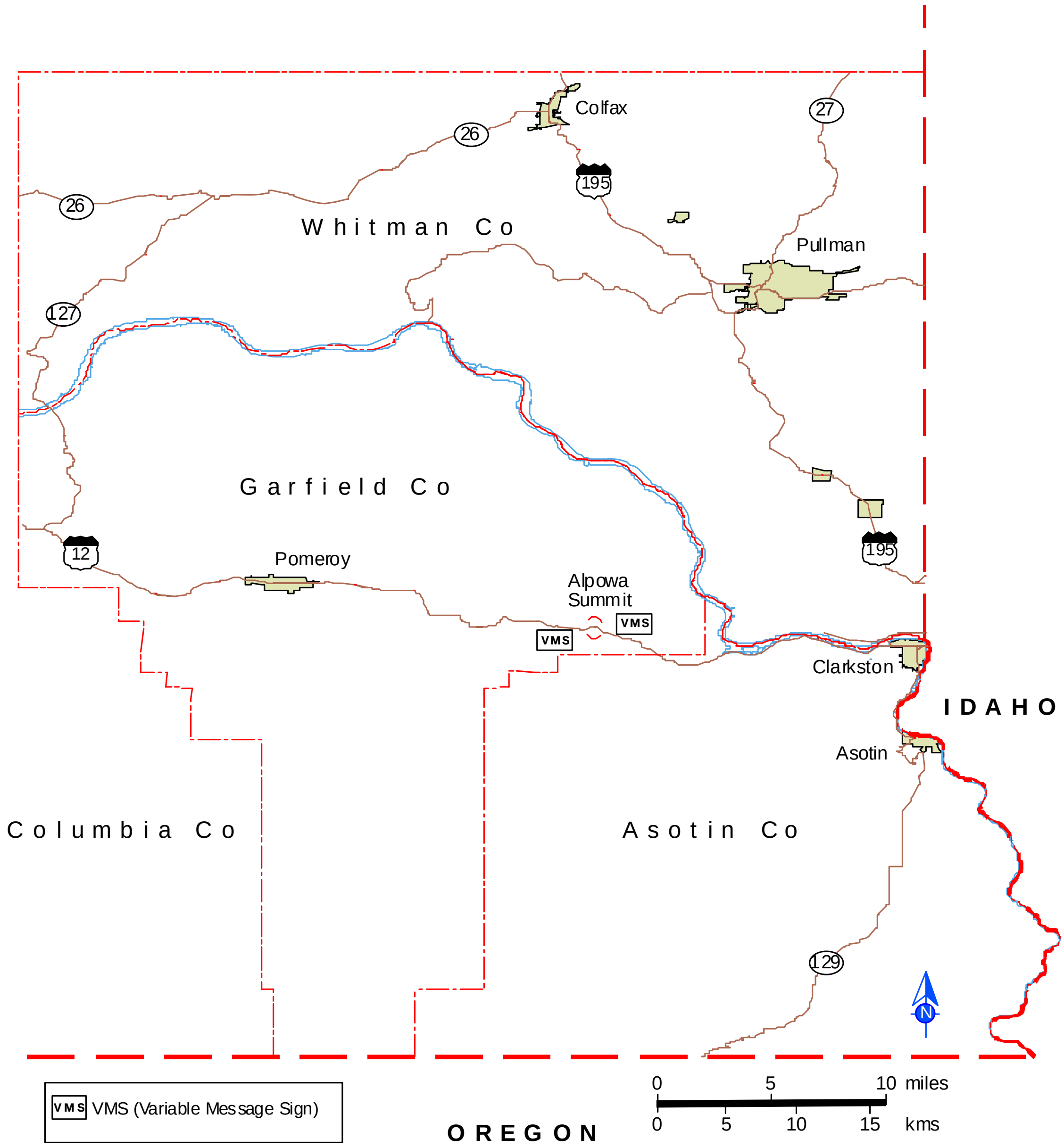

Figure 11. Alpowa Summit Winter Traveler Information System

System Usage and Benefits

It was estimated that winter usage would be three or four times per week. In addition, the system can be used as to indicate an Amber Alert. WSDOT personnel located at the region TMC at Union Gap operate the system. WSDOT maintenance personnel maintain the system.

<u>Institutional and Technical Issues</u>

The completion of the project was delayed by approximately one year. Staff turnover was responsible for some of that delay. The person hired to design the project resigned from WSDOT after working for a little over one month on the project.

There were also delays in getting the project advertised for bids from contractors. The project was going to be advertised as part a contract to install a weigh-in-motion system at the Plymouth Weigh Station. Just prior to the advertisement for bids, the WSDOT Project Engineer's office found out that the Alpowa Summit project was partially funded with federal funds. It immediately dropped the Alpowa Summit work from its project. The fear was that the additional paper work required to meet federal requirements would complicate and delay the weigh station project.

The Alpowa Summit project then had to be assigned to another Project Engineer to manage the sign installation contract. (The signs were purchased with a statewide procurement contract for VMS.) In addition to delaying the project, this reassignment turned out to be expensive. Costs for project documentation and inspection of the work in the field were very high. Although no cost overruns occurred, the budget was barely adequate to cover these costs.

The project manager recommended that the state VMS procurement contract be changed in the future to include installation. There is a state procurement contract for RWIS, which gives an agency the option to purchase just the RWIS or to include installation in the purchase price. It may not be feasible to include installation in VMS procurement contracts because of the variety of VMS types and installation locations.

The problems experienced in getting this project delivered illustrate the problems described in section 3.2 Lessons Learned Summary concerning the deployment of low cost ITS projects.

A technical problem that arose once the system was operational involved communication with the signs over the available telephone infrastructure. Old telephone lines are susceptible to signal "noise" that causes connectivity problems. These don't affect voice communication, but they can disrupt the transmission of the data necessary for sign control. Region personnel have now switched to a satellite Internet provider for communications. The cost to install a small satellite dish on the sign was less than the cost of running conduit and a telephone line to the sign. The monthly charge is slightly more, but the bandwidth available is much higher.

APPENDIX A: INTERVIEW SCRIPT

INTRODUCTION

***Brief introduction:**

*Just as background, the information that we're gathering is part of an evaluation of five ATIS-related ITS earmark projects around the state, of which the ___ traveler information project is one. We have two objectives: **One** is to develop an understanding of ATIS issues for all project stages, including planning, design, implementation, O&M, and agency or institutional issues, and try to develop guidelines and lessons learned that would be useful for future ATIS-related projects. **Second**, we're reviewing the results of all these ATIS-related ITS earmark projects around the state, with the goal of developing a standardized method of evaluating the benefits of traveler information in a way that might also provide useful inputs to the state priority programming and funding processes.

We would like to get your perspective on the development and operations of the ATIS enhancements for the ___.

Do you have any questions for us before we get started?

A. Project background

B. System features

C. System operations

D. System usefulness

E. Public response

F. Project management

G. Lessons learned

A. Project Background: (Why was the project developed?)

First, could you describe your position, and nature of your involvement in the development of this traveler information system?

What were the primary issues that originally prompted the development of this project, and what were the primary objectives that the system was designed to achieve?

a.

b.

c.

Were there any other participants in this project besides WSDOT (public and private sector, e.g., WSDOT, city, chamber of commerce, other state agencies, contractors):

What were their roles in the project (build, operate, maintain, advise, etc.)

Approximate cost breakdown (design, construction, O&M)

B. System Features: (What was the original plan, and what was eventually built?)

PLANNED:

Next, we want to just review the system features that were originally planned, and which were built:

In the original concept for this project, what were the primary system functions and physical components (ITS hardware and software, and other components):

a.

b.

c.

BUILT:

What system components were eventually built:

a.

b.

c.

(During the design and construction process, were any of the principal system components modified, removed, or added compared to the original design? Or did the basic design remain unchanged?)

C. System Operating Process: (How, and how well, does the system function)

SKIP IF NO INFO:

First, we have some questions about how the system is typically used, e.g.,

(Alternatively: Could you describe how the system was designed to be used, e.g.,)

What is the decision making process for posting/updating info via VMS or HAR:

To start: what is the nature of the monitoring process

(sequence of events that leads to posting info) what personnel are involved, your role

what types of situations or data tend to initiate the process of sending traveler info (VMS and HAR)

how frequently does monitoring take place (periodic or constant)

What is the decision-making flow; who makes the call on posting

threshold for determining that you should send VMS/HAR traveler info (length of delay, type of events, queues)

how long does decision-making process usually take

what type of information is posted (queues, wait time, schedule change advisories) Other, e.g., incidents?

How frequently is the system used?

When is the system typically used (year-round, highly seasonal variations)?

Do variations affect system staffing?

What types of posted data are or can be routinely archived (message content, time stamps, system status/down time)?

Are the VMS and HAR messages usually logged?

Describe the level of O&M effort required to support the system.

(Who has responsibilities, level of staffing req'd)

How are the new systems integrated with existing ITS infrastructure or information sources, e.g., existing ATIS devices, WSDOT Regional office, etc.?

Has system use changed over time since the initial deployment, e.g., in terms of

Usage:

Frequency of use

Types of information given to travelers

Process:

Type of data that you monitor

Level of staff effort for O&M

Were there any unexpected technical performance results, either good or bad, in terms of:

TECHNICAL

a. The functionality of the system

b. Technical performance of the hardware components

O&M

c. O&M issues

COORDINATION AND STAFFING

d. Coordination between agency partners

e. Unexpected staffing requirements or other staffing issues

Do you interact with other local agencies?

Overall, what is your level of satisfaction with technical system performance, in terms of

Equipment:

reliability

Infrastructure locations (usefulness to traveler, as well as maintenance access)

Ease of use for the operator (WSDOT, etc.):

Information flow (e.g., does the system/process, from detection to posting of info, facilitate a timely response)

Quality of the traveler information:

Message accuracy (sufficient sources to make a decision)

Message timeliness (e.g., does the system facilitate timely response)

Does the completed project meet the original technical specifications?

Are there any notable strengths, weaknesses or limitations of the resulting system (either the technology and the organizational interactions)?

D. System Usefulness and Project Objectives: (Does the system meet its **transportation** objectives?)

To what extent has the system met its original objectives (from question 1)

a. transportation

b. organizational

c. other

Changes in traveler behavior, either measurable long-term, or individual examples

Have there been any noticeable changes in traveler behavior or traffic patterns since the system was implemented? If so, what kind? (e.g., reduced demand during congestion, shift in demand to alternate routes, changes in tourism levels)

Were there any unexpected transportation effects, either good or bad:

a. transportation

b. organizational

c. other

Usefulness within WSDOT? Vs. public benefit?

E. Response from the Public and Others: (What is the response to the project?)

What type of feedback, if any, have you received regarding the performance or usefulness of the system:

a. From the public

b. From other public agencies

c. Any other groups

Have there been any specific lessons learned, or changes made, as a result of this feedback?

F. Project Management: (How successful was the project implementation process?)

During the planning, design, and construction phases, were there any unexpected technical or project management issues or events, either good or bad, related to

a. Technical implementation

b. Relationships with the contractor

c. Coordination between agency partners

Did any of those issues eventually affect

a. Project scope (functions, devices)

b. Project budget

c. Schedule

If so, how?

Was the project completed according to the original schedule and budget? (Estimated and actual completion dates)

If not, what were the principal sources of schedule and budget changes?

G. Lessons Learned:

<u>This project</u>

In hindsight, is there anything you would have done differently for your project, or suggestions you would recommend for future projects of this type, in terms of:

(ITEMIZE)

a. System functionality that was implemented
b. System technology or vendor choices that were made
c. Project management or agency coordination
d. O&M logistics or division of responsibilities
e. Anything else?

Other projects

Are there any suggestions you would offer to an agency considering a similar type and scale of ATIS project in the future:

f. System functionality

g. System technology or vendor choices

h. Project management or agency coordination

i. O&M logistics

j. Anything else?

Any other general comments about the project?

For follow-up questions, is there anyone else that you would recommend we talk with about the project?

APPENDIX B: LESSONS LEARNED WRITE-UPS

Statewide ITS Architecture and Communications Plan

Highway Performance Monitoring

Traveler Information System Expansion

SR 821Yakima Corridor Communications Safety Project

Yakima County Adverse Weather Operations

Tacoma Interagency Communications Coordination

Port of Tacoma Trucker Notification System

South Puget Sound Operational Improvements

Spokane Regional Data Warehouse

US 2 Stevens Pass Variable Speed Limit System

I-90 Truck/Wind Warning System

Whatcom Regional ITS Fiber Optic Integration

Spokane Regional Transportation, Construction and Weather Website

Alpowa Summit Winter Traveler Information System

Lesson Title: Statewide or regional ITS plans, architectures, and communications plans are valuable components of an ITS program.

ITS Earmark Project: Statewide ITS Architecture and Communications Plan, Federal Aid No. ITS-2002(042)

Date Reported: April 2007

Location: Washington State, USA

Background

The statewide ITS architecture project was developed to cover areas of the state not already covered under existing regional ITS architectures. The following areas had regional ITS architectures before this project:

- The greater Seattle metropolitan area, consisting of King, Kitsap, Pierce and Snohomish counties. The Puget Sound Regional Council (PSRC),the metropolitan planning organization (MPO) for this area, led this effort.
- Spokane County. The Spokane Regional Transportation Council, the MPO for this area, led this effort.
- Clark County, which includes Vancouver, Washington. This effort was led by the region's MPO, the Southwest Washington Regional Transportation Council.
- Thurston County, which includes the Olympia area. Thurston County abuts Pierce's County's southern border and includes the southern Puget Sound shoreline, which is not covered by the PSRC's planning efforts. This effort was led by the region's MPO, the Thurston Regional Planning Council.
- Whatcom County which is the county that abuts Canada's southern border in British Columbia. This effort was led by the region's MPO, the Whatcom Council of Governments.

While these urban area ITS architectures provided guidance for the majority of Washington State's ITS projects and expenditures, ITS deployments were also being planned for vast, rural areas of the state not covered by these architectures. Systems to be deployed included weigh-in-motion sensors installed where trucks carrying farm products access state highways, road/weather information stations on highways in areas where bad weather often creates hazardous travel conditions, and traveler information delivery systems such as highway advisory radio or variable message signs. These needed to be covered by an ITS architecture in order to be eligible for federal funds. In addition to producing a statewide ITS architecture, this project also produced ITS architectures for WSDOT's North Central and South Central Regions.

The extensive ITS deployments in the state's urban areas increased the need for communications bandwidth. In addition, the extensive rural deployments mentioned above required innovative and often expensive communications systems to make them function. The need for a comprehensive communications plan that could coordinate the needs of the Washington State Department of Transportation's (WSDOT) urban and rural regions became apparent.

Lesson Learned

- While it often isn't possible to follow a well defined, sequential process when building a statewide or regional ITS program, eventually time and resources should be devoted to "housekeeping," i.e., developing an ITS architecture, ITS plans, communications plans, and ITS implementation plan.

Other Lessons

- Take a flexible approach to developing ITS architectures. The need to meet federal requirements specifying that ITS projects using federal funds must conform to the national and regional ITS architectures has caused MPOs to take the lead in implementing ITS architectures in Washington State's urban areas. These agencies are responsible for transportation planning and certifying compliance with federal regulations. In the rural areas of the state, where ITS deployments are less extensive and are primarily deployed on major (state) roadways, WSDOT needed to lead the ITS architecture effort.
- Look for ways to ease the burden of regulations on agencies with fewer resources. Having a statewide ITS architecture in place saved the cities, counties, and regional transportation planning organizations (RTPOs) from Washington State's rural areas from having to delay their ITS projects until many, individual ITS architecture efforts had been completed. Incidentally, there was no funding source for these local efforts, so it would have been necessary to use scarce project funds to develop such architectures.
- Utilize local working relationships when trying to gather and disseminate information. Coordinate with stakeholders early and often. WSDOT's regional offices were asked to host these meetings and decide which local agencies to invite. The regions used their local contacts to ensure a good turnout at the stakeholder meetings. These stakeholder meetings were a good opportunity to gather information on ITS deployments planned by the rural counties and smaller cities in the regions and a good opportunity to do some ITS outreach. Many agency personnel had little knowledge of the national ITS program and the state's extensive ITS program.
- Sometimes the best option is to create a committee or task force to study things some more. Improving WSDOT statewide communications and solving all of the existing problems was a big task. It was made bigger by a change in the scope of work that expanded the study to include all of WSDOT enterprise communications requirements rather than just ITS requirements. The result of the study was a series of recommendations that required non-existing funding sources and organizational changes to implement. An implementation task force was formed to carry out the changes and conduct further, more detailed studies. Sometimes that's the best thing can be done to start a process to solve complex problems.

Lesson Title: Data from a variety of intelligent transportation systems used for traffic management applications can be made available and useful for planning, research, and other applications.

ITS Earmark Project: Highway Performance Monitoring, Federal Aid No. ITS-2002(019)

Date Reported: April 2007

Location: Washington State, USA

Background

The Washington State Department of Transportation (WSDOT) currently deploys a variety of intelligent transportation systems (ITS). These systems routinely include the deployment of data collection sensors. The data collected are then used in near-real time to make a variety of traffic management decisions. Storage and analysis of these data allow evaluation of the performance of these ITS, as well as improved management decisions based on analysis of the archived data.

Data collected by ITS deployments can often be useful for other, non-traffic management, purposes within both WSDOT and its partner transportation agencies in the state. Consequently, the collection, storage, retrieval, analysis, and reporting of data collected by ITS have considerable potential value to the state. In order to make those data useful they must be aggregated and summarized into more traditional engineering statistics. In addition, mechanisms must exist to allow users to determine what data are available and to provide access to those data.

This project was designed to help WSDOT explore the issues involved in storing, analyzing, using, and reporting ITS data related to traffic system performance. It created three Web-accessible, ITS-related databases and linked those databases through the spatial identifiers stored in WSDOT's geographic information system (GIS).

The databases created are the CVISN truck tag database, the Average Car Occupancy database and the Summary FLOW database, which provides access to summary statistics from WSDOT's Seattle area freeway management system (called the FLOW system.)

Summary statistics that could be useful to a range of WSDOT staff were developed from each of these databases. All three databases are accessible through an online, map-based interface based on WSDOT's maps and linear referencing system. The URL is http://trac29.trac.washington.edu/tracmap/mapserver

Lessons Learned

- The primary goal of every archive should be to support the traffic management decisions that the ITS supplying the data are intended to improve. The data collected for real-time management are often very fine-grained. To derive meaningful performance statistics, they must be aggregated, filtered, and summarized into more widely used performance metrics. Continued storage of performance metrics can then grow over time, allowing the analysis of archived data to describe
    - trends that are occurring in system performance
    - the impacts of system management policies
    - the success or failure of specific treatments applied to make the transportation system function more efficiently.
- Mechanisms must exist to allow users to easily determine what data are available and to provide access to those data at a useful level of detail.
    - The usability of the database program often determines how useful the database is. As databases, and the programs that allow users to manipulate them, become easier to use, fewer requests for data are received because users are able to retrieve the data themselves.

Lesson Title: Fiber connections between TMCs can lead to improved operations and travel information.

ITS Earmark Project: Traveler Information System Expansion, Federal Aid No. ITS-2002(037)

Date Reported: April 2007

Location: Washington State, USA

Background

The Washington State Department of Transportation (WSDOT) operates two traffic management centers (TMCs) in the Puget Sound area: one in the Seattle area (Shoreline) and one in the Tacoma area (Parkland). The TMCs are also in two different administrative regions: the Seattle TMC is in the Northwest Region, and the Tacoma TMC is in the Olympic Region. Because of this, the ITS deployments in the area between Seattle and Tacoma were not well aligned. One reason for this is that the majority of ITS deployments are included in conventional roadway projects, often resulting in gaps in ITS device coverage. Many commute trips cross the boundary between the DOT regions (the King-Pierce County line is the boundary), and there is a need for traveler information in this area. There is also a need for devices to help both regions cooperatively monitor and manage major incidents in this area.

The goal of this project was to connect the two WSDOT regions and provide a seamless advanced traveler information system (ATIS) for the area between Seattle and Tacoma. The project extended the fiber optic communications backbone, along with freeway management system devices (vehicle detection, ramp meters, and surveillance cameras), to cover a 3-mile gap in the southern part of the Northwest Region. The Olympic Region used other funding to extend its fiber system 3 miles to the north so that they both reached the county line, where they were connected.

The following operations were integrated with this project:

- The two TMCs have direct access to each other’s CCTV cameras and highway advisory radio systems. This has been helpful in managing incidents that have occurred in one region and affected traffic in the other.
- The interconnection allows direct monitoring of the status of each TMCs systems and quick information exchange during the management of incidents.
- Travel information is now seamless between the regions. The existing gap in CCTV camera coverage has been filled. Loop detector data from the two regions can now be combined to provide travel times for cross-region trips. The major TV stations that show video images from the Northwest Region’s system can now also show video from the Olympic Region’s Tacoma area cameras.

Lesson Learned

- The exchange of data between TMCs can result in better coordination of incidents, more interaction because device control is shared, and seamless travel information.

Other Lessons

- Specifications for the installation of fiber optic cable should be written without designating the method of installation. There is no way to predict which method will be the cheapest. This is especially true in estimating overall costs for lighted fiber. It may be cheaper to install conduit by using a particular method but more expensive overall when the costs to pull the fiber are included.
- The timing of an ITS installation may be crucial. ITS installed prior to major roadway construction can be used to mitigate construction impacts. However, information on the location of the fiber must be provided to roadway designers and construction personnel so that they can avoid damage to the fiber.
- Install the maximum amount of conduit and fiber that the budget will allow. Other agencies will eventually want to be connected to the fiber in order to share information. Additional devices will need to be added to the fiber system, increasing the demand for bandwidth.

Lesson Title: ITS projects need local support, a dedicated project manager, adequate staff, and defined roles for each participating agency, just like other transportation projects.

ITS Earmark Project: SR 821 Yakima Corridor Communications Safety Project, Federal Aid No. ITS-9853(001)

Date Reported: April 2007

Location: Washington State, USA

Background

SR 821 is a 25-mile-long stretch of two-lane road that winds through a scenic canyon cut by the Yakima River in central Washington, east of the Cascade Mountains. The roadway was selected as one of the first Highway Safety Corridor project locations in the state because of its accident history. Highway Safety Corridor projects involve a multi-agency approach to applying the “3 Es”—Education, Enforcement, and Engineering —to implement low-cost traffic operations solutions to safety problems.

A unique feature of the SR 821 corridor was the lack of communications infrastructure in the canyon. Landline phone service was available for the first 1 mile on the north end of the corridor and for 5 miles on the south end. Only two establishments existed within the central part of the corridor, and only one of those had landline phone service that was provided by phone lines coming over the canyon rim. When accidents or emergencies occurred (either highway accidents or recreational accidents involving use of the river), people were unable to call for help without driving to either end of the corridor. The drive to find a telephone would use up most of the injured person’s “Golden Hour” (the first hour after a victim’s injury during which, if he or she receives assistance, chances of survival are greatly increased). In addition, first responder emergency crews were unable to communicate with each other or their dispatchers while in the canyon, and WSDOT experienced dead spots in its communications.

The goal of this project was to improve safety in the SR 821 corridor by improving communications. The project installed two full-matrix variable message signs on I-82, which connects to SR 821 at either end, to enable traffic to be diverted to or from SR 821 depending on conditions. Six solar-powered, cellular motorist aid call boxes were also installed (at high usage areas such as boat launches and campgrounds), and new communications facilities were installed on Manastash Ridge and Mt. Baldy to improve WSDOT and first responder communications. Funding was also provided to develop a WSDOT traffic management center at Union Gap (near Yakima) to manage the corridor devices and coordinate incident response in this area.

Primary Lessons Learned

- Provide a dedicated project manager for any complex project to keep the project on schedule and within budget. This is most important when other agencies and public services are involved.
- Devote adequate resources to accomplish a project. Delays will occur if existing operations staff has to take on design and construction work that they can only accomplish as time permits.
- For multi-agency projects, clearly define the roles and responsibilities of each agency. This is especially important when working with agencies that are not usually involved in transportation projects. Make sure all parties are working toward the same objectives.

Other Lessons

- Anticipate problems when agency staff lack experience in ITS, communications systems design, or any other type of non-traditional transportation project. Items such as variable message sign procurement, radio system procurement, call box installation, and radio site property leases will all present significant problems for inexperienced staff (as well as many experienced staff).
- Having State Procurement Contracts in place for ITS equipment such as variable message signs is important in reducing project time delays and simplifying the process.
- Make sure that projects are developed with ownership at the local level by using input from those who will have to design, build, operate, and maintain the new systems.
- Flexibility of the scope is important. This project was originally scoped to put many call boxes through the corridor. When this was determined to be extremely expensive (because of communications issues) and not as important because of the increased availability of personal cell phones, the flexibility in the Earmark to spend the money on communications for emergency service providers was very helpful.

Lesson Title: Time spent up front defining what a system should do and how it is expected to perform will save time and money in the long run.

ITS Earmark Projects:

- Yakima County Adverse Weather Operations, Federal Aid No. ITS-2002(019)
- Yakima County Adverse Weather System, Federal Aid No. ITS-2003(054)
- Yakima County Adverse Weather Monitoring System - Phase 2, Federal Aid No. ITS-2004(054)

Date Reported: April 2007

Location: Washington State, USA

Background

Yakima County is a large area with diverse terrain and severe winter weather. The county wanted to improve its ability to keep its roads passable in the winter. It was particularly concerned about the safety of school buses using county roads in winter. Another problem, particularly for trucks, was ice on the steep grade of the Naches-Tieton Road. Flooding during the spring and summer also caused roadway problems.

These projects were proposed to help make better use of county maintenance resources, particularly those for snow and ice control. The county wanted to use more deicing chemical treatment, and to do that it needed additional, and more detailed, winter weather information. In addition, the county wanted to provide winter traveler information to the public.

The first two of these projects installed fiber optic communications equipment, deployed eight road and weather information stations (RWIS), and integrated the data from the RWIS into the Washington State Department of Transportation's (WSDOT) regional server. In addition, the county contracted for hydrologic modeling services in an attempt to provide warning of flash floods that could affect county roads. The third project installed a system consisting of an RWIS with a non-invasive, infrared and laser pavement sensor and a variable message sign (VMS) on the Naches-Tieton Road. When the pavement sensor detects ice on the roadway, it contacts the pager of the County Maintenance Supervisor for this area. A message indicating the need for trucks to use chains on the steep grade is recommended, and the Supervisor can confirm or reject the message. If the message is confirmed, it is automatically displayed on the VMS. A closed circuit TV camera on the RWIS can be used to confirm that the correct message is displayed on the sign. In addition, the county installed its own RWIS server, which operates independently from the WSDOT server, providing the county with a more reliable system.

Lesson Learned

- Even if a system is assembled from off-the-shelf components, more time than expected will still be required to research equipment availability and operation. Make sure an adequate amount of time is budgeted to meet with vendors, define how a system should operate, and how it will be expected to perform. Allocate enough time for inspection to ensure that the features work as expected.

Other Lessons

- Reliability is important for any information system that provides critical information. Some RWIS were originally installed in rural areas with poor quality power. Poor quality power can cause the RWIS to crash, requiring maintenance personnel to make a trip to the device. The installation of an uninterruptible power supply (UPS) to filter the power improved reliability a great deal.
- Learn from others who have already installed these types of systems. The county looked at the WSDOT mountain pass cameras and realized that the view wasn't very useful at night. In order for the county video to be useful to school officials trying to decide in the very early morning whether to install chains on school buses, a good view of the road conditions was critical, so the county included illumination wherever it installed cameras.
- Each agency may not get equal treatment when resources are shared. Server problems during critical times would cause the WSDOT server to lose the data from the county RWIS but not the WSDOT RWIS. The county eventually purchased a server to store its own data.

Lesson Title: ITS projects often require contractors with special skills, but it isn't possible to hire those contractors if the contract is not properly written.

ITS Earmark Project: Tacoma Interagency Communications Coordination (Gravelly Lake to 49th St. Fiber Optic Cable Installation), Federal Aid No. ITS-2002(031)

Date Reported: April 2007

Location: Washington State, USA

Background

Communications with existing field devices (detectors, closed circuit TV cameras, variable message signs, and highway advisory radio) on I-5 through the Tacoma area had been accomplished with a combination of analog/digital microwave, city-owned fiber optic cable, and telephone lines.

The phone lines and the microwave system were unreliable. However, the limited capacity of these systems made it difficult to connect new devices to the system. The limited capacity also prevented sharing traffic information with local agencies.

This project installed a fiber optic communications system along I-5 from the Gravelly Lake interchange to 49th Street in Tacoma, Washington. It connected existing field devices to the fiber and installed additional closed circuit TV cameras and vehicle detectors.

Lesson Learned

- ITS projects often require contractors with special skills, but it isn't possible to hire them if the contract is not properly written. On a subsequent project, language was added to the special provisions to allow the selection of a more qualified contractor.

Other Lessons

- The installation of fiber optic communications systems results in improvements in all aspects of communications: increased bandwidth, reduced operating and maintenance costs, and improved picture and data quality.
- Sharing fiber allows more fiber to be installed.
- Plan for future connections. At the time of this project one agency said that it didn't want to be connected to the fiber. WSDOT ended the fiber near that agency but put extra, coiled fiber in the junction box. At a later time the agency requested to be connected to the fiber. WSDOT is currently working to connect it, which will be relatively inexpensive thanks to foresight and the coiled fiber.

Lesson Title: Developing partnerships with local agencies to install fiber may be a quick and inexpensive way to get fiber capacity. Recognize, however, that this often results in a loss of control over the project, potentially leading to missed deadlines, cost overruns, and poor workmanship.

ITS Earmark Project: Port of Tacoma Trucker Notification System, Federal Aid No. ITS-2002 (039)

Date Reported: April 2007

Location: Washington State, USA

Background

Three freeway interchanges on I-5 in provide access to the Port of Tacoma. The most direct one for southbound traffic the Port of Tacoma Road interchange. Approximately 300 feet from the southbound off-ramp intersection with the Port of Tacoma Road is a railroad crossing. When long trains traverse the crossing, truck traffic backs up onto the mainline of I-5, causing a safety problem. This project installed a system to monitor the queues on the ramp and alert approaching trucks to use an alternative route.

The project installed fiber optic communications equipment to link field devices in this area to the traffic management center. It also installed an additional closed circuit TV camera and a fixed message sign with flashing beacons that could be activated to tell truckers to take an alternative route.

This project made it possible to change the existing field devices (detectors, variable message signs, and closed circuit TV cameras) from a combination of communications systems (analog and digital microwave, city owned fiber, and telephone lines) to a more reliable fiber optic communications system owned and operated by the Washington State Department of Transportation (WSDOT).

Lesson Learned

- It is usually best to install fiber in agency right-of-way by using agency personnel or contractors. When that is not possible, it may be worth the effort to deal with partners to get access to fiber.

Another Lesson

- ITS planners and designers need to be aware of the agency’s capital improvement program to avoid duplication of efforts. Shortly after this project was completed, a railroad over-crossing was constructed on Port of Tacoma road, eliminating the delays caused by trains. As a result, the sign with flashing beacons was never used.

Lesson Title: The use of products with proven performance and reliability records is the best way to ensure the completion of a project on time and within budget.

ITS Earmark Project: South Puget Sound Operational Improvement, Federal Aid No. ITS-2002(030)

Date Reported: April 2007

Location: Washington State, USA

Background

Washington State's capitol city, Olympia, is located approximately 60 miles south of Seattle and 30 miles south of Tacoma. I-5 passes through Olympia, carrying both commuter traffic and through-traffic traveling from points south to both Seattle and Tacoma. Heavy truck traffic also travels to and from the ports of Seattle and Tacoma on I-5 in this area.

The Washington State Department of Transportation's (WSDOT) Olympic Region had almost no ability to monitor traffic or manage incidents on this section of I-5. A highway advisory radio (HAR) station and a road/weather information station (RWIS) were the only field devices in the area. The Olympic Region traffic management center communicated with these devices by telephone lines.

This project installed two closed circuit TV cameras on I-5 in the Olympia area. It connected the new cameras and the old devices (HAR and RWIS) to a new digital microwave system that provided a communications link to the Olympic region traffic management center.

The closed circuit TV cameras provide travel information to the public. They allow visual verification of traffic conditions on the freeway before the HAR is activated. The camera images are used by the Washington State Patrol, Thurston County Emergency Services, and various WSDOT departments for emergency management and incident response. The digital microwave system improves communications and reduces cost by eliminating telephone lines.

Lesson Learned

- The digital microwave product used for this project was new on the market and did not perform as expected. The problems were corrected, but the project was delayed and additional cost was incurred. Recognize that the use of products with proven performance and reliability records is the best way to ensure the completion of a project on time and within budget. Experiments with new products should be conducted in small test deployments or as part of research projects.

Lesson Title: Consider proprietary, off-the-shelf systems if they will markedly shorten the time or reduce the cost of deployment. Make sure to factor the cost of upgrades and improvements and the responsiveness of the supplier into the analysis.

ITS Earmark Project: Spokane Regional Data Warehouse, Federal Aid No. ITS-2003(026)

Date Reported: April 2007

Location: Washington State, USA

Background

Six agencies in Spokane County in eastern Washington State have combined resources to manage traffic. The six agencies are the City of Spokane, City of Spokane Valley, Spokane County, Spokane Transit, the Spokane Regional Transportation Council (SRTC), and the Washington State Department of Transportation (WSDOT). These agencies use software supplied by a vendor to operate their freeway management and traffic signal systems.

The six agencies wanted to share and archive the data from these management systems. The software vendor also supplies a data management and archiving system known as the Performance Management System, or PeMS. This ITS earmark project purchased and installed PeMS at the Spokane regional transportation management center.

At this time, the system contains data from radar detectors that cover approximately 20 miles of the I-90 freeway through the City of Spokane. The database contains speed, volume, and lane occupancy data. No arterial traffic signal data are in the system at this time. While the system can archive raw arterial signal data, it cannot provide summary statistics. A PeMS module to do this is under development.

The system provides data that are currently used to predict the effects of construction closures. It is also used to provide freeway performance measures for the Spokane area as reported in the WSDOT Grey Notebook, a quarterly performance report WSDOT issues to the governor and legislature by WSDOT. The SRTC (the area metropolitan planning organization) also use the data for model calibration.

Lesson Learned

- Recognize the costs and benefits associated with a proprietary system. In this case, the system purchased was an existing system, so the buyers were aware of its strengths and weaknesses. The fact that the system could be deployed almost immediately after purchase was of primary importance. Probably because this was an off-the-shelf system, it has proved to be very robust, and the vendor has been very responsive.

Other Lessons

- Populating data archive systems with data is often a difficult task, especially if it requires agencies to use resources to add data to the database. Agencies are often reluctant to participate in data sharing unless they can see some value in doing so, but, of course, there is no value until data are available to be shared. Breaking this circle of inaction is often difficult unless a champion emerges.
- There is a learning curve for unfamiliar software systems. Training staff and potential users from other agencies is important. Potential users are less likely to utilize data if they find the system complex and difficult to navigate.

Lesson Title: ITS can solve problems in scenic or historic areas where major construction is not possible. However, extra time must often be added to the schedule for obtaining permits from resource or historic preservation agencies.

ITS Earmark Project: US 2 Stevens Pass Variable Speed Limit System, Federal Aid No. ITS-2003(062)

Date Reported: April 2007

Location: Washington State, USA

Background

US 2 is an east/west highway in central Washington State that traverses the Cascade Mountains at Stevens Pass. A popular ski area is at the summit of the pass. The county sheriff and the Washington State Patrol had been concerned about the number of speeding vehicles on the roadway in winter. The section of roadway across the pass contains several locations with high accident rates, primarily during winter conditions.

This project installed one full-matrix VMS and eight variable speed limit signs along a 23-mile long section of US 2. Two existing, full-matrix VMS were incorporated into the system. A combination of microwave and fiber systems was installed to communicate with the signs. Static signs indicating that the roadway section had an enforceable variable speed limit were installed in both directions at the entrances to the section.

Speed limits are determined by assessing visibility and pavement conditions. The maximum speed is 60 mph, and the speed limit decreases in increments of 10 mph to a minimum of 30 mph when all vehicles except those with 4-wheel drive are required to install chains.

Lesson Learned

- US 2 is listed as a historic highway. It passes through a very scenic area, particularly in the winter when the mountains are snow covered and in the fall when the trees turn color. It passes through the Wenatchee National Forest, so permits from the U.S. Forest Service are needed for improvements to the highway. In addition, because it is a historic highway, permits are needed from the State Office of Archeology and Historic Preservation. Several ITS projects in Washington State have experienced delays because adequate time was not included in the schedule to obtain permits from agencies concerned with resource conservation or historic preservation.

Another Lesson

- Providing communications to rural ITS devices is always a challenge. In this project a combination of fiber and microwave systems was used. Although unused conduit exists in part of this corridor, it is privately owned, and project managers were unable to utilize it for this project. Success often depends on making the right contacts.

Lesson Title: A good team and cooperation can make a complex and difficult job look easy.

ITS Earmark Project: I-90 Truck/Wind Warning System, Federal Aid No. ITS-2003(039)

Date Reported: April 2007

Location: Washington State, USA

Background

I-90 is the only east/west Interstate highway in Washington. It crosses the Columbia River at Vantage in central Washington. There is a very steep downgrade for vehicles heading westbound toward the bridge over the Columbia River. In addition, the river canyon tends to concentrate high winds on the bridge, making it difficult for trucks and other high-sided vehicles to stay in their lanes across the bridge. The Washington State Department of Transportation (WSDOT) has identified this site as a high accident location.

Two systems were installed at this location. One consists of loop detectors to measure vehicle speeds and a piezo-electric detector to classify vehicles. A variable message sign (VMS) was installed before a 50 mph curve at the bottom of a steep, downhill section for westbound traffic. When the system detects a truck that is traveling faster than 55 mph, a message is displayed on the VMS warning the truck that the advisory speed for this section is 50 mph.

The other system consists of a road weather information station (RWIS) with wind detection components. This system also uses the VMS installed for downhill truck warning. Two additional VMS were installed, one for eastbound traffic on I-90 and the other for traffic on the SR 26 on-ramp to I-90. When gusts of 45 mph or sustained winds of 35 mph are detected, high wind warning messages are displayed on these two VMS and the westbound one that displays the truck speed warning. A ranking of message display priority has been developed.

A combination of microwave and fiber provides communications to the systems.

Lesson Learned

- WSDOT's North Central Region Traffic Office conceived and managed this project. ITS maintenance staff, IT support staff, and radio communications staff from the region were key contributors to the project. The team procured various system components and integrated them into an operational system that promises to improve motorist safety. They were not sure how or even if all of the components were going to work together but thought that a team of people with the right skills and knowledge should be able to build a successful system. One key factor seemed to be that there were no territorial disputes to resolve, and everyone involved was interested in making the system work. This included two vendors who cooperated with the WSDOT personnel and each other.

Lesson Title: There are often many potential partners that can provide expertise, data, and funding to expand and improve a project.

ITS Earmark Project: Whatcom Regional ITS Fiber Optic Integration, Federal Aid No. ITS-2001(027)

Date Reported: April 2007

Location: Washington State, USA

Background

Bellingham is a city in Whatcom County in northwestern Washington. It is located approximately 90 miles north of Seattle and 20 miles south of the USA/Canada border. This project accomplished the following tasks:

- It expanded a modest collection of fiber links into a system of over 37 miles of fiber that runs throughout the City of Bellingham.
- It upgraded a closed-loop, master controller-based traffic signal system to a central signal management system that communicates via a server over the fiber network to signal controllers in the field. Forty new signal controllers were installed. A workstation tied directly to the server was installed at the Washington State Department of Transportation (WSDOT) traffic management center (TMC) so that both WSDOT and the city can share, monitor and revise signal timing.
- Two closed circuit TV (CCTV) cameras with no management software were expanded into a system for the management of over 35 cameras covering freeways, major arterials, downtown crime monitoring, and water treatment facility security.

The project partners were as follows:

- The Whatcom Transit Authority participated in the funding of traffic signal upgrades to allow the deployment of transit signal priority.
- WSDOT participated in the funding of improvements at intersections that are under WSDOT control and the integration of the two TMCs.
- The Bellingham School District participated in the installation of fiber to serve its facilities.
- The Port of Bellingham participated in the installation of fiber to serve port facilities.

City traffic engineering personnel use the system's CCTV cameras to monitor city arterials and are able to use the signal management system to adjust traffic signal timing. Water treatment facility operators monitor the security of their facility by using the CCTV cameras. Police officers use the system to monitor and record downtown crime prevention cameras. WSDOT engineers can monitor signal timing and their freeway

CCTV cameras, and the camera images are sent to the WSDOT Northwest Region TMC in Seattle.

Lesson Learned

- There are many potential partners that can provide expertise, data, and funding to expand and improve a project. It is often worth the time and effort to develop a project that incorporates the goals of many partners. These complicated projects often accomplish much more than a mere "summing of the parts" would suggest. By working together to plan, fund, and construct a project, agencies set the stage for working together to operate the system.

Lesson Title: Focus groups and usability testing are often necessary to produce a good travel information website.

ITS Earmark Project: Spokane Regional Transportation, Construction and Weather Website, Federal Aid No. ITS-2002(018)

Date Reported: April 2007

Location: Washington State, USA

Background

The Spokane Regional Traffic Management Center (SRTMC) was created as a regional partnership to provide area-wide ITS coverage during peak travel periods, to monitor and respond to incidents, and to share data. The SRTMC was formed by an inter-local agreement between the City of Spokane, City of Spokane Valley, Spokane County, Spokane Regional Transportation Council, Spokane Transit Authority, and WSDOT's Eastern Region. One of the goals of the SRTMC is to provide traveler information to the public to assist with trip planning.

Prior to this project, the only Internet-based source for travel information in the Spokane area was the WSDOT travel information website. It provides information on incidents, construction, and weather-related road closures as well as CCTV camera images for the entire WSDOT Eastern Region. There was no website that provided specific information for the Spokane area.

The objective of this project was to develop a website that served as a one-stop shop for traveler information that covered primarily Spokane County. Data from the Spokane area traffic management system are combined with data from WSDOT's Condition Acquisition and Reporting System (CARS) and WSDOT's CCTV camera images to produce the travel information Web page (www.srtmc.org). The website displays a color-coded congestion map (Traffic Flow Map) that covers approximately 24 miles of I-90 through Spokane. It also displays icons that indicate incident, construction, or weather-related closures (linked to text boxes with more detailed information), CCTV images, and current messages on a VMS on I-90. No data are currently provided from the network of RWIS in the area. Weather-related road condition messages that are entered into CARS are also displayed on this website.

The new Web page has links to the partner agencies' Web pages.

Lesson Learned

- A traffic management system consulting engineering firm developed the website, and the SRTMC Board approved the design. However, the Board consists of engineers who lack training in website design. Those involved with the project sought feedback on the website from non-technical family members and friends but thought that it would have been useful to conduct a focus group or usability testing on the website. Using some unspent project funds, the SRTMC is planning to hire a Web developer to make improvements to the website.

Another Lesson

- Multi-jurisdictional projects can take longer to implement than projects involving just one agency because of the need to reach consensus before anything is implemented. In general, the project managers think that the benefits to the public of thinking and operating regionally are worth the extra effort that is necessary. To help simplify and speed the process of putting content on the website, the SRTMC is developing a content management system. That will allow individual agencies to manage their own content (arterial traffic data or incident data, for example), but it will have the correct appearance and format when it is sent to the SRTMC to be placed on the website. No time or staff resources will be needed to reformat the data to integrate them into the website.

Lesson Title: New communications systems are becoming cost effective in rural areas where existing systems are not suitable or unreliable.

ITS Earmark Project: Alpowa Summit Winter Traveler Information System, Federal Aid No. ITS-2002(032)

Date Reported: April 2007

Location: Washington State, USA

Background

A 29-mile section of SR 12 links Pomeroy and Clarkston in the southeast corner of Washington State. The roadway generally runs in a valley, but about midway between these two towns it rises to an elevation of 2,785 feet at Alpowa Summit. Motorists may experience safe driving conditions while in the valley and then experience high winds, icy roads, and fog at the Summit. WSDOT's South Central Region used two flip signs, one on each approach, to inform motorists of conditions, specifically any tire chain requirements. When a warning message was required, a maintenance worker had to travel to the site and flip the sign so that it displayed the proper message. Only two message choices were available: chains required or no message. A road weather information station (RWIS) and CCTV camera had been installed previously at the Summit. The region wanted to have more message flexibility and wanted to eliminate the need for someone to travel to the Summit to activate the signs.

Two variable message signs (VMS) were installed on the approaches to Alpowa Summit, one in each direction. The signs are controlled by software at the region TMC in Union Gap, Washington. The region uses a communications link offered by a satellite Internet provider to control the signs. Operators can see the data on road and atmospheric conditions that are collected by the RWIS and can observe the CCTV camera images from the Summit. They use this information, as well as input from maintenance personnel, to decide on the appropriate message to display on the sign.

Lesson Learned

- A technical problem that arose once the system was operational involved communication with the signs over the available telephone infrastructure. Old telephone lines are susceptible to signal "noise" that causes connectivity problems. These don't affect voice communication, but they can disrupt the transmission of the data necessary for sign control. Region personnel have now switched to a satellite Internet provider for communications. The cost to install a small satellite dish on the sign was less than the cost of running conduit and a telephone line to the sign. The monthly charge is slightly more, but the bandwidth available is much higher.