Thurston Region System Architecture

FINAL REPORT

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Thurston Regional Planning Council

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Introduction

This document is the last in a series of five that present sequential results of the Thurston Regional Planning Council (TRPC) Intelligent Transportation System (ITS) planning project. The purpose of this final report is to summarize the process, products, and recommendations associated with that project.

The first major ITS effort for the Thurston Regional Planning Council culminated in development of the Thurston Region ITS Architecture. This provides a common framework for defining, planning and integrating ITS investments on a region-wide basis. This regional framework defines how to integrate different types of existing and future transportation technology projects so they work seamlessly and cost-effectively. The regional architecture identifies agreements and standards for jurisdictions to use in developing new ITS project proposals.

Figure 1, below, illustrates the general relationship between this document and the other documents produced as part of the regional ITS planning project.

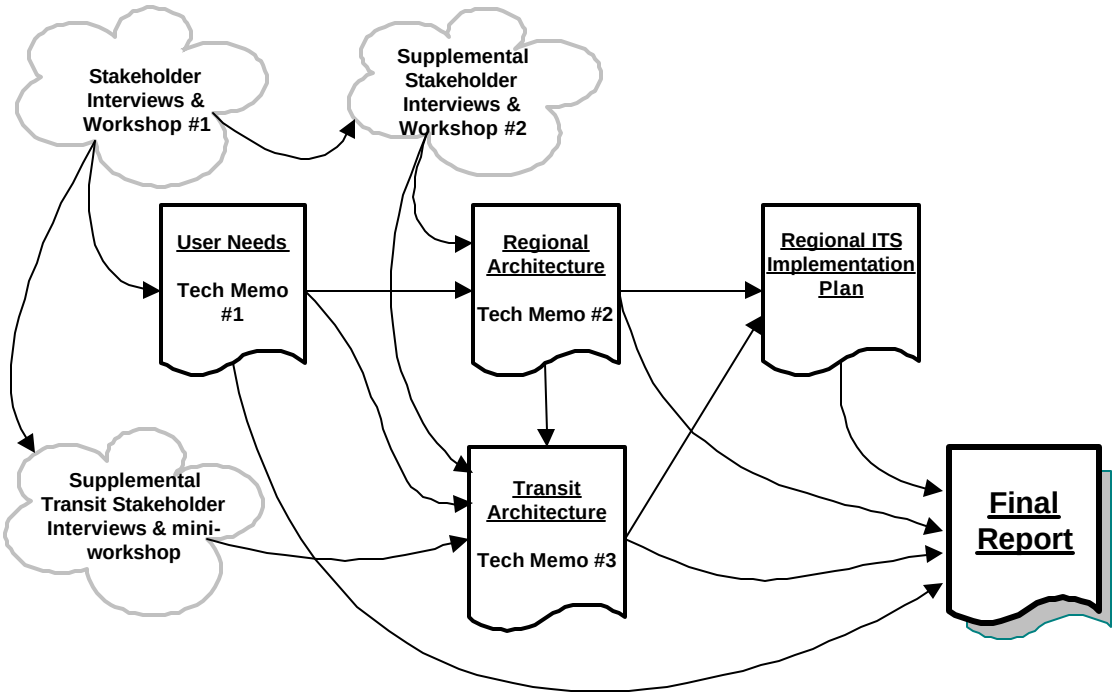

Figure 1: Thurston Region ITS Documents

This report includes a brief discussion of the project process, content, and products, and will be useful for the reader in helping to find products and information to meet more detailed interests.

The four earlier documents that were produced as part of the Thurston Regional Intelligent Transportation Systems planning project include:

Technical Memorandum #1: User Needs, User Services and User Requirements: Technical Memorandum #1 presents results of the stakeholder interviews, workshops, mapping of the Thurston region's User Needs to User Services and subsequently to User Service Requirements, and presents this information as it relates to the six primary areas of interest detailed in the architecture.

Technical Memorandum #2: Thurston Region System Architecture: This is the "framework" that identifies how ITS is expected to be used in the Thurston region. It includes the types of systems to be implemented and how the various systems and agencies will coordinate with one another. Technical Memorandum #2 allows the reader to view operational systems from a physical perspective as well as from functional and technical perspectives.

Technical Memorandum #3: Public Transportation System Architecture and Strategic Deployment Plan: This report describes an ITS Strategic Deployment Plan for Intercity Transit (I.T.), the public transit provider for Thurston County. The plan identifies a specific, phased set of investments that will implement many of the I.T.-related components contained in the regional, multi-modal transportation technology vision. The report also focuses and builds upon the public transportation system architecture developed as part of the Thurston Region System Architecture by discussing the relevant physical systems and subsystems for public transportation systems, regardless of the specific provider.

Thurston Region System Architecture Implementation Plan: This report presents an overall implementation plan for the Thurston region. It identifies ITS implementation strategies in the context of the region and of the Metropolitan Planning Organization – TRPC – with consideration of federal guidelines and other ITS planning and deployment activities. It also identifies ways to integrate ITS considerations into the existing regional planning and programming process and provides some specific recommendations for effectively nurturing ITS in the Thurston region.

Background

The goal of the Thurston Region Intelligent Transportation Systems planning project was to better understand how congestion, safety, efficiency and other transportation challenges can be effectively addressed through the use of Intelligent Transportation Systems, and to identify some strategic early-deployment opportunities.

ITS, or "intelligent transportation systems," describe the application and use of modern communications, computing and information technology to use and manage our transportation systems more effectively. ITS investments can make our existing and future transportation system more safe and efficient.

An ITS architecture is simply a framework, or a foundation, for understanding and simplifying more complex relationships between the entities that must cooperate and share information and technologies in order to operate, maintain, and use the transportation system. This ITS framework integrates telecommunications, data collection, computing and information processing. At the same time, the framework addresses the systems, the system operators, the users, travelers, and so on—the complete "universe" of ITS.

Architecture is also an expression of an overall regional plan – within the framework of how ITS components relate to one another. That is, the ITS architecture suggests what work is needed and what interactions are appropriate to accomplish the regional goals for transportation systems operation and maintenance, without dictating exactly how these are done.

This architecture can be used to guide the overall direction of transportation technology deployment and implementation. The architecture itself must be reviewed and modified over time to reflect the completion of specific projects, necessary upgrades to adapt to changing regional challenges and needs, and adaptations that take advantage of advances in technology.

The reports produced for this project discuss the architecture from two viewpoints - physical and logical. Initially there is a "physical" viewpoint in that we can review and categorize deployed, operational systems in tangible ways, and we can visualize and plan how additional systems can be deployed to meet current and future needs. Alternatively, there is the "logical" viewpoint in that we can view planned or operational systems from a functional basis. These terms come from systems engineering and the design of information processing systems. They are part of a standardized language that is used in conjunction with ITS and its architecture.

The Project

Project Need

This project was undertaken because the region needed to meet new federal guidelines that require an ITS architecture concurrent with, or prior to conducting an ITS project using federal assistance and grant funding.

That's the short answer, and only represents a small part of the regional need and realized benefit. That is because this project helped to realign the region's thinking from an infrastructure-dominated approach to a more balanced infrastructure and technology-based operations approach. Recent federal legislation has solidified this same idea in the Transportation Equity Act of the 21st century (TEA-21). TEA-21 emphasizes the use of ITS in operations and management.

Project Process

This ITS Architecture project began in December 2000 and concluded one year later using the general process illustrated in Figure 2.

The project began with review, research and analysis of ITS applications currently in use in the Thurston region. Preliminary materials from TRPC contacts were used to formulate a strategy for interviews, and to identify stakeholders who could provide a broad regional perspective as well as identify specific issues and challenges. The interviews with the

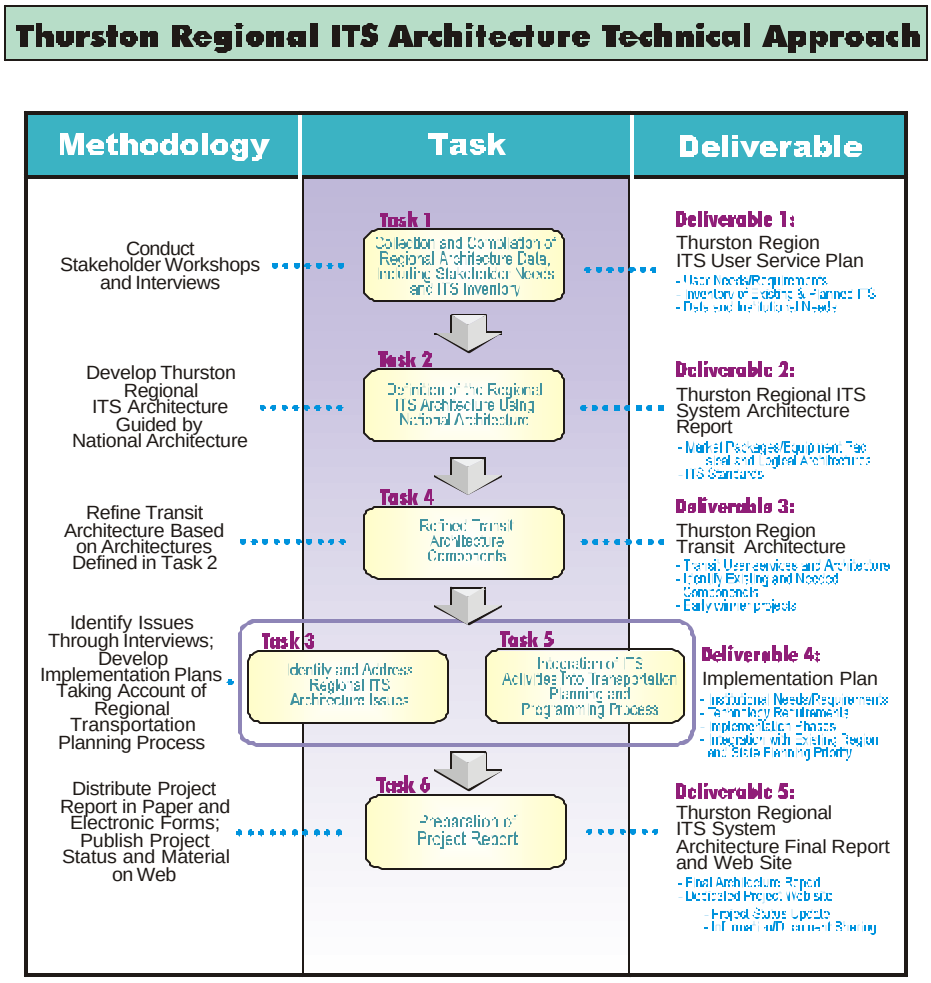

Figure 2: Thurston Regional ITS Project Approach

initial stakeholders generated information and identified additional stakeholders and new ideas. This outreach, information flow and heightened awareness were exactly what was needed to stimulate discussion, and formulate the basis for the workshops.

The two workshops were held April 18th, 2001 in Lacey and July 25th, 2001 in Olympia. Both were well attended by a diverse group of stakeholders, including traffic, transit, police, fire, school, and communications interests. The discussions reinforced the needs identified during the interviews, and outlined new paths of interest for regional ITS. In the first workshop, an emergency response and management scenario based on effects and follow-up to a major earthquake provided the basis for an interdisciplinary discussion. Input from participants reflected recent, real-life experiences – good and bad – that resulted from the February 28th earthquake that shook this region. The scenario stimulated discussion about how agencies could - or could not - share information, unexpected system failures, opportunities that would have been available with better communication and coordination, and ideas for future cooperation and ITS needs to improve emergency preparedness throughout the region.

A synthesis of the interviews, workshop discussions and follow-up phone contacts pointed to several intermediate conclusions about the Thurston region's ITS needs. These conclusions were then mapped to the National ITS Architecture, and tailored as needed to accurately represent the Thurston situation. These are the results expressed as findings in the documentation products.

The process used to conduct the ITS planning project should become the model for continued regional dialogue about ITS. This process shows how diverse public agencies can engage in discussions about their common issues and challenges, and reach agreement on proposed solutions to issues that are broader than just ITS. The architecture provides a framework to guide the interagency cooperation and information-sharing necessary to implement ITS projects successfully.

This process, and its long-term value to the region, far outweighs the near-term value achieved by the design documents themselves. Although these products are important at this time, the long-term value will come from how the region's partners interact and continue the meaningful dialogue that was embodied in the ITS planning process.

Examples of Regional Needs and Findings

From information gathered in the interviews and workshops, regional ITS technological needs were identified. Examples of regional needs include:

- ?? More reliable and coordinated communications capability
- ?? Closed Circuit Television (CCTV) images of major construction sites (e.g., 4th Avenue Bridge) for traveler information
- ?? Enhanced transit schedule, arrival, and route information
- ?? Weigh-in-motion capabilities in Thurston County to minimize delays in freight movement on I-5, US 101, and other alternate freight corridors
- ?? Pre-planned, redundant incident response system
- ?? Timely congestion information for travelers and commercial freight operators

The needs are expressed in terms of User Services, a term introduced in the National ITS Architecture. User Services establish the high level services that will address identified problems and/or needs. User Services often answer the question: "What needs to be done?" Thirty-one user services form the basis for the National ITS Architecture. Example User Services include:

- ?? Pre-trip Travel Information
- ?? Public Transportation Management
- ?? Incident Management

These User Services were used to generate the list of "User Service Requirements" (USR). USRs provide "…a specific functional statement of what must be done to support the ITS User Service" and are phrased using "shall" or "must" terminology. An example USR is: *"The Thurston Regional ITS shall provide a Pre-Trip Travel Information capability to assist regional travelers, public agencies and commercial operators in making mode choices, travel time estimates, and/or route decisions prior to trip departure (USR 1.1.0)*."

Both User Services and User Service Requirements are specific elements of the architecture. From this collected information and the workshops we were able to identify and validate six primary areas of need for the region:

Traffic -- this category includes all issues, concerns and needs related to traffic management and control on freeways and county and city roadways within the region. It also includes operation and maintenance of those roadways under normal and adverse conditions. Adverse conditions may include weather, traffic incidents, and planned or unplanned special events.

Transit -- this category includes issues, concerns and needs related to public transportation service in the region, including that provided by Intercity Transit as well as by smaller non-profit and private providers. It includes enhancements and modernization. It also includes tools for more effective operation and maintenance of the transit system, its vehicles, and its management and control systems. Further, it includes cooperation and interoperability with regional transit operations, special needs public transportation providers, and school district transportation systems.

Incident/Emergency Response and Management -- this includes the detection, verification and response to traffic or other incidents, and all types of emergency response -- medical, fire, police, towing, natural disaster, HAZMAT, etc. While not limited in scope, primary importance and focus is on improvement of those incident management and response situations that use, are impacted by, or affect the operational elements of the transportation system.

Freight Mobility -- this includes all aspects of freight mobility within the region including short- and long-haul truck, rail, air, or waterborne shipping. This also includes access and transshipment of freight at rail, roadway, water facilities, and any special considerations for the management of commercial freight through-traffic.

Traveler Information – all of the above transportation system activities can produce data and information that is essential and of immediate use. Subsets and extensions of this information may be very useful in real-time to the traveler, and historically for use in data gathering for research and planning purposes. Traveler information addresses how that data is formulated, synthesized, and distributed to travelers for their use in trip planning, route guidance, and other decisions related to travel throughout the region. As it is used here, travelers include commuters, residents, tourists, commercial vehicle operators, transit drivers, City-County-State operations and maintenance personnel, as well as publicly provided or assisted transportation providers such as school bus and paratransit systems.

Information Storage and Management -- this includes the needs and requirements for collecting and archiving data and information beyond that of immediate operational use in the region. This information storage and management archival capability supports the needs of system operations and maintenance, near-, mid- and long-term planning and budgetary discussions and decision-making processes. It is also of critical importance in several federally-mandated reports that the region must provide in order to express interest and remain competitive in federal grant funding opportunities.

Products of this Project

User Needs, User Services, and User Requirements

To be successful, ITS requires the coordinated involvement of a number of agencies and stakeholders. This report outlines stakeholder interests and needs, and the process used to involve them. From a series of one-on-one interviews and workshops, users needs were identified and translated into User Services and User Requirements, in a format consistent with the National ITS Architecture development process. The needs analysis that makes up Technical Memorandum #1 also includes an initial inventory of operational ITS and planned ITS projects that are relevant to the architecture development process. Finally, the report identifies baseline data needs, process specifications and institutional cooperation that is needed to support the regional ITS architecture effectively.

Thurston Region System Architecture

From the information obtained during the interviews and workshops, and further clarified in Technical Memorandum #1, the project team was able to construct physical and logical viewpoints of this initial regional architecture. It should be noted that this initial architecture is a good basis for near-term action within the region. However, changing requirements, advances in technology, or changes in interagency cooperation and information sharing will necessitate that this architecture be reviewed and updated on a regular basis. Regional cooperation and discussion will be key tools for architectural review and update. This initial architectural viewpoint is contained in Technical Memorandum #2, and illustrated in Figure 3.

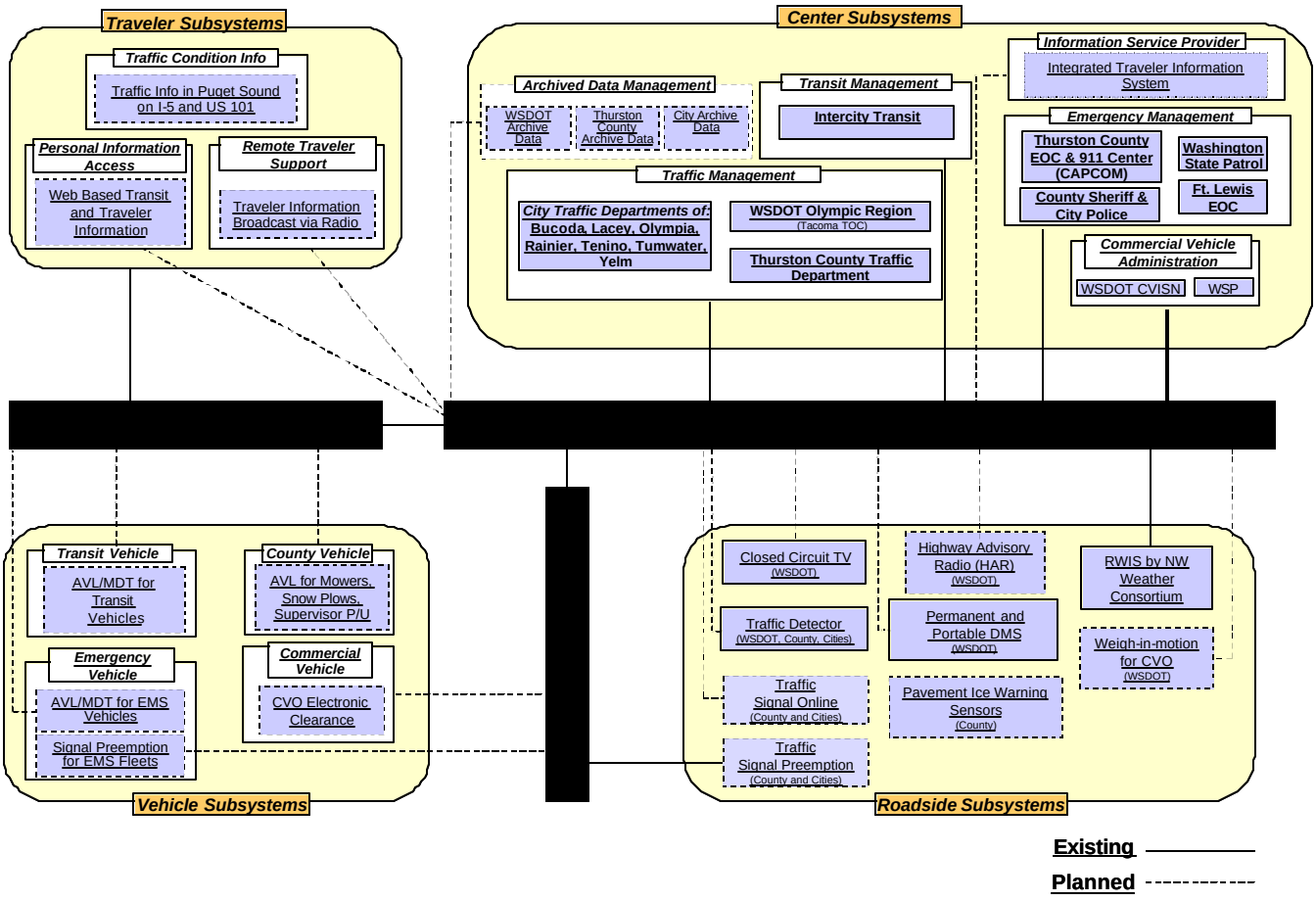

Figure 3: Thurston Region Top-Level ITS Architecture

Public Transportation System Architecture and Strategic Deployment Plan

Once the broader regional architecture viewpoints were completed, those elements of architecture unique to the operation of the regional transit system were examined. Discussion with public transportation stakeholders helped develop a more specific architecture and strategic deployment plan for use by Intercity Transit. While the deployment strategies are specific to Intercity Transit, the public transportation discussion about information sharing and cooperation between service providers includes not only I.T. but also other public, non-profit, and private service providers in this and adjacent regions. This transit-specific architecture and strategic deployment plan makes up Technical Memorandum #3.

Thurston Region System Architecture Implementation Plan

Discussion during interviews, workshops, and follow-up conversations sparked ideas and recommendations on how to implement and maintain this regional architecture. These near-term, mid-term and long-term strategies form the essence of an integrated plan for implementation of ITS within the Thurston region. It also identifies ways to integrate ITS considerations into the existing regional planning and programming process.

Thurston Region System Architecture Final Report

This Final Report ties the pieces together into a single roadmap of the successful regional dialogue that has only just begun. It also serves as a well-defined end to the initial work of architecture development.

Recommendations

As mentioned earlier, the initial benefit of the Thurston Regional ITS planning project is the preparation of the documents that capture the results of the project process and enable the region to comply with federal requirements. But the long-term benefit of the project will come from continued discussion of regional challenges among a diverse group of stakeholders, and follow-up action on recognized priorities.

It is recommended that TRPC facilitate this continuing regional dialogue, and ensure that the region's ITS architecture evolves to reflect advances in technology, to leverage federal grant opportunities, and effectively meet ever-changing transportation challenges and needs.

APPENDIX A

Examples of National ITS Benefits

Benefits of ITS

Currently, there is relatively little ITS transportation technology deployed in the Thurston region, so a direct statement of benefits specific to the region isn't readily available. But there are benefits reported nationally and by the US DOT. Many of these benefits are attributed to situations that have parallels to this region, and are therefore very relevant and comparable to what can be expected here.

Following are tables of benefits based on ITS program areas for similar metropolitan and rural regions.

Metropolitan ITS Benefits by Program Area		
Program Area/Benefit Measure		**Summary**
Arterial Management Systems	Safety Improvements	Automated enforcement of traffic signals has reduced red-light violations 20-75%.
	Delay Savings	Adaptive signal control has reduced delay 14-44%.
	Customer Satisfaction	In Michigan, 72% of surveyed drivers felt "better off" after signal control improvements.
	Cost Savings	Transit signal priority on the Toronto Transit Line allowed same level-of-service with less rolling stock.
	Environmental	Improvements to traffic signal control have reduced fuel consumption 2-13%.
	Other	Adaptive signal control has reduced stops 10-41%.
Freeway Management Systems	Safety Improvements	Ramp Metering has shown a 15-50% reduction in crashes.
	Delay Savings	In Minn-St. Paul, ramp metering reduced freeway travel time 22% for an annual savings of 25,121 vehicle-hours.
	Throughput	Ramp metering increased throughput 13% in Glasgow, Scotland; and 16% in Minn-St. Paul.
	Customer Satisfaction	After the Twin Cities ramp meter shutdown test, 69% of travelers supported modified continued operations.

Metropolitan ITS Benefits by Program Area		
Program Area/Benefit Measure		**Summary**
	Cost Savings	The GA Navigator (integrated system) supported incident delay reductions for an annual savings of $44.6 million.
	Other	Ramp Metering has shown an 8-60% increase in freeway speeds.
Transit Management Systems	Safety Improvements	In Denver, AVL systems with silent alarms have supported a 33% reduction in bus passenger assaults.
	Delay Savings	CAD/AVL has improved on-time bus performance 9-23%.
	Customer Satisfaction	In Denver, installation of CAD/AVL decreased customer complaints by 26%.
	Cost Savings	In San Jose, AVL has reduced paratransit expense from $4.88 to $3.72 per passenger.
	Other	More efficient bus utilization has resulted in a 4-9% reduction in fleet size.
Incident Management Systems	Safety Improvements	In San Antonio, integrated VMS and incident management systems decreased the crash rate by 2.8%.
	Delay Savings	Incident management in city and regional areas has saved 0.95-15.6 million vehicle-hours of delay per year.
	Customer Satisfaction	Customers have been very satisfied with service patrols (hundreds of letters).
	Cost Savings	Cost savings have ranged from 1-45 million dollars per year depending on coverage area size.
	Environmental	Models of the Maryland CHART system have shown fuel savings of 5.8 million gallons per year.
	Other	The I-95 TIMS system in PA has decreased highway incidents 40%, and cut closure time 55%.

Metropolitan ITS Benefits by Program Area		
Program Area/Benefit Measure		**Summary**
Emergency Management Systems	Safety Improvements	In Palm Beach, GPS/AVL systems reduced police response times by 20%.
	Customer Satisfaction	95% of drivers equipped with PushMe Mayday system felt more secure.
Electronic Fare Collection	Customer Satisfaction	Europe has enjoyed a 71-87% user acceptance of smart cards for transit/city-coordinated services.
	Cost Savings	The Metro Card System saved New York approximately $70 million per year.
Highway Rail Intersections	Safety Improvements	In San Antonio, VMS with railroad crossing delay information decreased crashes at intersections by 8.7%.
	Customer Satisfaction	School bus drivers felt in-vehicle warning devices enhanced awareness of crossings.
	Environmental	Automated horn warning systems have reduced adjacent noise impact areas by 97%.
Regional Multimodal Traveler Information	Delay Savings	A model of SW Tokyo shows an 80% decrease in delay if 15% of vehicles shift their departure time by 20 min.
	Customer Satisfaction	38% of TravTek users found in-vehicle navigation systems useful when traveling in unfamiliar areas.
	Environmental	EPA-model estimates of SmarTraveler impacts in Boston show 1.5% less NOx, and 25% less VOC emissions.
	Other	Models of Seattle show freeway-ATIS is 2x more effective at reducing delay if integrated with arterial-ATIS.

**** Source: http://www.benefitcost.its.dot.gov (September 2001)

Rural ITS Benefits By Program Area	
Program Area	**Summary**
Crash Prevention and Security	California installed an advanced curve warning system at five curves along Interstate 5 in a rural mountainous area. The advanced warning systems consisted of dynamic message signs installed before each of the curves displaying warning messages about the upcoming curves. For three of the five installation sites, the reduction in the speed of trucks traveling through the curves was statistically significant for at least one of the three sites. The two sites that demonstrated a significant reduction in truck speeds for all three visits after installation had downgrades greater than five percent.
Emergency Services	In field tests conducted on the Ford-Lincoln Continental Remote Emergency Satellite Cellular Unit (RESCU) security system, drivers were able to make voice contact with a response center operator within one minute. On average, emergency response vehicles arrived within 11 minutes of system activation.
	The Georgia Department of Transportation installed a cellular telephone call box system along 39 miles (62.7 kilometers) of Interstate 185. During a six-month study period, system costs were roughly $120,000. Benefits associated with injury and fatality reductions were projected to be $289,000, while benefits associated with other incidents (e.g., flat tires, road debris, etc.) were estimated to be approximately $40,000. The benefit/cost ratio of the call box system was found to be 2.76:1.
Transit and Mobility	Use of coordinated paratransit with a dispatch system including AVL, which can coordinate trips among up to five agencies, has the potential to reduce fraud in Medicaid transportation by $11 million annually in the State of Florida.

Rural ITS Benefits By Program Area	
Program Area	**Summary**
	The computer-assisted dispatching system in Sweetwater County, Wyoming, which allows same-day ride requests to be accepted, has contributed to an increase in ridership from 5,000 passengers monthly to 9,000 monthly without increasing the dispatch staff and a reduction of operational expense of 50% over a five-year period on a per passenger-mile basis.
Operations and Maintenance	In Utah 's Salt Lake Valley, a warning system comprised of visibility sensors and dynamic message signs (DMS), which display recommended speed limits under foggy conditions, increased average vehicle speeds by 15% while decreasing speed variability by 22 percent.
	In the Netherlands, an automatic fog-signaling system with 20 sensors installed along 7.5 miles (12 kilometers) of the A16 motorway decreased vehicle speeds by approximately 5.6 mph (9 kph).
	The Finnish National Road Administration (FinnRA) evaluated the profitability and effectiveness of an experimental RWIS installed along 8.7 miles (14 kilometers)of E18. The RWIS was comprised of 36 variable speed limit signs, five DMS, and two environmental sensor stations (ESS). In the winter, recommended speed limits were varied based upon pavement condition, precipitation, visibility, and wind. When speed limits were reduced, the reason for reduced speeds, such as "slippery road surface," was displayed on the DMS. It was estimated that the average speed decreased 0.4%to 1.4%due to the RWIS. The average yearly crash rate was projected to decrease by 8%to 25%. Annual costs were expected to decrease by $234,500. The anticipated benefit-cost ratio of the system was 1.1:1.0 and the remunerative rate of interest, which indicates how effective the use of invested capital has been, was 14%. These values show that the system has been socio-economically profitable.

Rural ITS Benefits By Program Area	
Program Area	**Summary**
	The Indiana Department of Transportation utilizes the Computer Aided System for Planning Efficient Routes (CASPER) software to design winter maintenance routes. The number of routes needed to service the roadway network decreased by 8%to 10%. Winter maintenance cost reductions were anticipated to be between 11 million and 14 million dollars.
	The Wisconsin Department of Transportation (DOT) utilizes the Wisconsin Winter Weather System (WWWS) to dispatch winter maintenance equipment. The system utilizes ice detection systems and a snow forecasting model to plan work schedules, determine appropriate treatment times, identify treatment locations, and reduce costs. Cost reductions were achieved by minimizing personnel overtime costs and decreasing the use of de-icing chemicals. For each storm, the system is expected to reduce personnel costs by $144,000 and save roughly $75,000 due to reduced salt usage.

Source: ITS Benefits: 2001 Update, USDOT, June 2001