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May 2000

Metropolitan Model Deployment Initiative

Seattle Evaluation Report

Final Draft

SmartTrek
Get Connected and Go!

U.S. Department of Transportation

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ITS WEB RESOURCES

ITS Joint Program Office:
http://www.its.dot.gov

ITS Cooperative Deployment Network (ICDN):
http://www.nawgits.com/jpo/icdn.html

ITS Electronic Document Library (EDL):
http://www.its.fhwa.dot.gov/cyberdocs/welcome.htm

ITS Professional Capacity Building Program Catalogue:
http://www.its.dot.gov/pcb/98catalg.htm

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16. Abstract

The Washington State Department of Transportation (WSDOT) and others in the public and private sectors are looking to emerging technologies to help improve the performance of the Seattle region's existing transportation system. Their goal is to apply new technologies including sensors, communications and information systems to help the region to better manage traffic, inform travelers of transportation options, and quickly respond to roadway incidents and changing conditions. In response to the U.S. DOT request for participation in the ITS Metropolitan Model Deployment Initiative (MMDI), WSDOT entered into a partnership with public and private organizations to implement ITS solutions. This partnership was named Seattle Smart Trek. This report presents a discussion of the evaluation findings from the Seattle Smart Trek MMDI deployment experience. The Smart Trek evaluation was conducted based on the utilization of the few good measures evaluation technique. The few good measure areas selected for this evaluation were Institutional Benefits and Issues, Customer Satisfaction, Traveler Mobility, Safety, Costs and Benefits, and Energy and Emissions. For each of these areas, relevant national experts were selected to lead the evaluation. Based on these, and based on the groupings of ITS projects deployed in Seattle, three main evaluations were conducted: Institutional Benefits, Advanced Traveler Information Systems (ATIS) Customer Satisfaction, and ITS Integration Modeling. The results of these three evaluations, along with corresponding conclusions and recommendations, are detailed in this report.

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PREFACE

This report describes the benefits to metropolitan transportation systems that may be achieved through the integration of Intelligent Transportation Systems (ITS). Specifically, it describes the impacts experienced by the Seattle Metropolitan Model Deployment Initiative (MMDI). The results of the evaluation are intended to assist planners, operators, and other transportation professionals in metropolitan areas across the nation who may find themselves seeking a unique solution to mounting transportation needs. Readers are cautioned, however, that there may not be a direct correlation of results from the Seattle experience to their own site. For example, prior to the MMDI, Seattle was already an ITS-rich location. Consequently, the benefits achieved there were relatively conservative compared with what may be obtained at other, less developed sites. Nonetheless, the general magnitude of the findings and the overall lessons learned from the Seattle experience should be transferable to other sites considering similar deployments.

In Autumn 1996, former Secretary of Transportation Frederico Pena announced that the Phoenix, San Antonio, Seattle, and New York/New Jersey/Connecticut areas had been chosen to lead a new program to showcase deployments of ITS. This program, called the MMDI, marked a significant step in the development of Intelligent Transportation Systems (ITS) across the United States. The initiative called for public and private sector partners to develop and integrate ITS technology to reduce travel times, improve safety, and provide enhanced travel information to the public.

Since the inception of the Federal ITS program in 1991, and in fact well before in some cases, regions across the country have been turning to new technologies in the sensors, communications, and computing power arenas to address mounting concerns over the marked increase in traffic congestion. However, as is the case with any emerging technology, many pieces of these systems have evolved independently over time. The MMDI was designed to address this situation by integrating these various pieces in order that the full potential of ITS may be realized.

Through this integration, the MMDI has not only demonstrated the value of ITS technology in improving transportation in the selected sites, but it has also provided numerous real-world examples of ITS technology’s potential application to other metropolitan areas across the country.

To ensure that these valuable lessons were documented and available to be shared, a comprehensive ITS evaluation was performed for the Seattle, San Antonio, and Phoenix MMDI sites. In addition, a national evaluation was performed with a focus on synthesizing findings across the entire program. This report summarizes the evaluation activities, findings, and conclusions that were undertaken to document the lessons learned from the deployment in Seattle.

Similar to other MMDI sites, the Seattle “Smart Trek” Model Deployment was characterized by a broad range of projects (ranging from traveler information Web pages to inter-jurisdictional signal control integration) with a broad range of potential impacts (from improved traveler mobility to enhanced customer satisfaction). Consequently, the evaluators sought to develop a structured, organized approach to the analysis. The result of this effort is summarized in the *Metropolitan Model Deployment Initiative National Evaluation Strategy*.

In general, this evaluation strategy follows two steps: First, the various projects in the deployment were considered in terms of the most relevant ITS component. These components are freeway management, incident management, traffic signal control, electronic toll collection, electronic fare payment, highway-rail intersections, emergency management, transit management, traveler information and, most important for this deployment, integration among components. Second, impacts were examined using a series of measures. These measures are safety, road network efficiency, energy and emissions, benefit-cost, customer satisfaction, and institutional impacts. In order to ensure that each of these measures was appropriately considered, the evaluation team assigned both an experienced evaluation member to each measure as well as a respected government expert to provide oversight.

Beyond the general approach, there was the question of which components and projects to examine in detail and which measures to apply. For a number of reasons, including resources and project delays, not all projects would be considered to the same level as others. Furthermore, not all few good measures need be applied to every project considered. Therefore, a system was developed to identify and assign evaluation priorities.

In establishing these priorities a number of factors were considered:

- what is already known;
- what is not known; and
- for areas where something known, but for which we would like to know more?

These questions were posed from both a national and regional perspectives, with Seattle project participants being asked to assist with the regional perspective through a process of evaluation priority rankings.

The result for Seattle is an evaluation that examines nine projects, covers five major ITS infrastructure components, considers some combination of all six measures, and reflects the interests of both the national evaluation team and the site partners. Also, it should be noted that similar evaluations were conducted for the Phoenix and San Antonio MMDI locations.

Readers interested in the experiences of the Phoenix and San Antonio Model Deployment are encouraged to review the respective site reports for these locations. Those with a specific interest in the institutional issues examined in the Metropolitan Model Deployments should consider the *New York MMDI Lessons Learned Report* and the *Successful Practices for Deploying an Intelligent Transportation System*. For further information on the specifics of integration, a number of Integration Case Studies based on the MMDI deployments should be available soon. Finally, readers interested in an overall summary of all of these reports should reference the *Metropolitan Model Deployment Initiative National Synthesis* document, which will be published in July 2000. These and other benefits documents including information on the benefits of rural and in-vehicle applications of ITS may be found on the ITS Joint Program Office Evaluation Web Site at http://www.its.dot.gov/eval/eval.htm.

Dr. Joseph Peters

ITS Program Assessment Coordinator
U.S. Department of Transportation
ITS Joint Program Office

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ABBREVIATIONS

ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management Systems
AVL	Automatic Vehicle Location
CAD	Computer-Aided Dispatch
CCTVs	Closed Circuit Television Cameras
DOT	U.S. Department of Transportation
FHWA	Federal Highway Administration
IRV	incident response vehicles
ISP	Internet service provider
ITI	Intelligent Transportation Infrastructure
ITS	Intelligent Transportation Systems
MDI	Model Deployment Initiative
MMDI	Metropolitan Model Deployment Initiative
NSATMS	North Seattle Advanced Traffic Management System
PSRC	Puget Sound Regional Council
PTC	Fastline Personal Travel Companion
PuSHMe	Puget Sound Help Me Mayday System
SWIFT	Seattle Wide-area Information For Travelers
TCC	Traffic Control Centers
TRAC	Washington State Transportation Research and Analysis Center
TSMC	Traffic Systems Management Center
TTI	Texas Transportation Institute
VMS	Variable Message Signs
WA	Washington
WSDOT	Washington State Department of Transportation
WSF	Washington State Ferries

1. EXECUTIVE SUMMARY

Background

In the Seattle metropolitan area, demand for transportation facilities and services already exceed the supply. A growing economy, increasing population, and constrained construction of new roads is dramatically decreasing transportation system performance. In addition, over the next 20 years, Washington's economy is expected to grow by almost 40 percent, with corresponding increases of 30 percent in both population and vehicle miles traveled.[1] The largest share of this growth will occur in the Seattle region. Construction of new roadways in this region is not expected to keep pace with this rapid growth.

Figure 1-1. I-5 through Seattle is one of the Most Congested Freeway Corridors in the U.S.

Consequently, the Washington State Department of Transportation (WSDOT) and others in the public and private sectors are looking to emerging technologies to help improve the performance of the Seattle region's existing transportation system. Their goal is to apply new technologies, including sensors, communications, and information systems to help the region better manage traffic, inform travelers of transportation options, and quickly respond to roadway incidents and changing conditions. In response to the U.S. Department of Transportation's (USDOT) request for participation in the Intelligent Transportation Systems (ITS) Metropolitan Model Deployment Initiative (MMDI), WSDOT entered into a partnership with public and private organizations to implement ITS solutions. This partnership was named "Smart Trek."

The Smart Trek program built upon existing ITS institutional relationships and infrastructure in the Seattle region to showcase an integrated Intelligent Transportation Infrastructure (ITI). Smart Trek integrated new and existing data sources; established a transportation information

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[1] Blaine, Larry, "Regional View" newsletter, Puget Sound Regional Council (PSRC), August 1999 (data developed from PSRC's recent 2020 forecast).

network that is integrated, regional, and multi-modal; and greatly expanded the distribution of traveler information. The program is led by WSDOT, in cooperation with the Federal Highway Administration (FHWA) and Federal Transit Administration, and includes public and private partners committed to providing a range of services and products.

The Smart Trek MMDI Evaluation

To ensure that the valuable deployment lessons from three of the major national MMDI sites (i.e., Seattle, Phoenix, San Antonio) were documented and available, a comprehensive ITS evaluation was performed at each site, in addition to a national evaluation that was performed with a focus on synthesizing findings across the entire program. This report summarizes the evaluation activities, findings, and conclusions that were undertaken to document the lessons learned from the Smart Trek deployment in Seattle, Washington.

The evaluation is focused on three main areas:

- Institutional Benefits
- Advanced Traveler Information Systems (ATIS) Customer Satisfaction
- ITS Integration Modeling

Institutional Benefits Evaluation Results

The Institutional Benefits Study of the national evaluation of the MMDI identified specific actions taken at the MMDI sites that facilitated the deployment of ITS products and services. The findings illustrate that the successful actions taken at a particular MMDI site were, in many cases, taken at the other sites as well. For the Seattle MMDI, seven actions, which are applicable to other sites deploying ITS projects, were exemplary in facilitating the Smart Trek MMDI:

- Build on existing relationships.
- Encourage private sector participation.
- Develop the management structure for the MMDI.
- Assign role and responsibilities.
- Select the appropriate procurement mechanisms.
- Develop policies that govern operations.
- Plan for the future.

Among these actions, as detailed in Table 1-1, three are especially noteworthy. The first of these was the involvement of the private sector. In Smart Trek, private sector representatives were included from the project's inception, were involved in developing the project proposal, and had a role in every aspect of the project's development. The Smart Trek decision-making structure also included two deputy project managers and four bundle managers from the private sector. These factors contributed to the overall success of the Smart Trek deployment.

The second action was using the Federal competitive process for the MMDI Request for Proposal. Because the DOT selection team accepted the Smart Trek proposal, with private sector participants included, WSDOT was then able to use a sole-source procurement method to contract with the private sector firms. This streamlined the procurement process, which allowed valuable time to be saved in the deployment life cycle of many of the Smart Trek projects.

Table 1-1. Institutional Benefits Evaluation Overview

Institutional Action	Description	Lessons Learned
Encourage private sector participation	• Private sector reps were involved since Smart Trek's inception and had a role in the development of many projects • The Smart Trek management included 2 deputy project managers and 4 bundle managers from the private sector	• Involving the Private sector in meaningful ITS deployment roles can help to ensure project success
Select the appropriate procurement mechanisms	• Private sector participants who were part of the original Smart Trek proposal to FHWA received sole-source contracts	• Where appropriate, streamlining the procurement process can support on-time successful ITS deployments
Plan for the future	• WSDOT developed a 2-year ATIS business plan based on Smart Trek • The City of Bellevue developed an equipment rental fund to support future O&M requirements for ITS deployments	• ITS deployments should plan for future system expansion • ITS deployments need to plan for future operations and maintenance costs

The third action was the importance given to planning for the future. Staff at the Washington State Transportation Research and Analysis Center (TRAC) recently completed the WSDOT ATIS Business Plan. The plan recommends both actions to be taken within the next two years and in the future to continue and expand the Smart Trek traveler information activities.

Additionally, to address eventual equipment replacement, one project participant developed a unique strategy. The City of Bellevue, Washington, created an Equipment Rental Fund that has been used to replace outdated computers and other equipment. City officials will include Smart Trek MMDI items under the responsibility of the City in this fund.

ATIS Customer Satisfaction Evaluation Results

The Seattle Smart Trek MMDI incorporated nine individual ATIS projects, offering a unique opportunity to evaluate many of these. The ATIS Customer Satisfaction Evaluation covered in detail five of these projects, as detailed below in Table 1-2. Individual reports were produced for each of these projects, drawing on data from five surveys, three sets of focus groups, and an analysis of the log files from the WSDOT traffic Web pages.

For the most part, respondents in the Seattle area Customer Satisfaction evaluations found the ATIS services to be beneficial. The more frequent users of these services typically rated them the most positively. They had specific suggestions for improvements that, if implemented, would presumably improve the service and enhance the satisfaction of these customers. Figure 1-2 shows that users of the WSDOT traffic Web site are very positive in their assessment of the quality of this service, regardless of how frequently they use it.[2] The frequent users of TrafficTV rate that service much more positively than the occasional users, and almost as positively as users rate the WSDOT traffic Web site.

[2] It is important to note that these traffic Web site users are a self-selected sample of respondents who can be expected to be much more positive about the Web site than the average traveler or the average Web site user.

Table 1-2. ATIS Customer Satisfaction Evaluation Overview

ATIS Deployment	Project Description	Results Summary
WSDOT Web Page	• Public traveler information web site covering Seattle Metro Area • Uses WSDOT network of extensive freeway loop detectors and video feeds to provide real time traffic information • Freeway segment travel speeds and incident data are provided • Links to transit, rideshare, rural systems	• Users ranked the web site as their most useful source of traffic info • Web site is heavily used for trips to and from work or school, with route changes being a significant behavior response • Reducing stress was seen as a significant benefit • Web page usage nearly doubled over the evaluation period, typically averaging between 10,000 to 15,000 "User Sessions" per day • Web site usage dramatically increased during adverse weather conditions • Deployment cost: $ 294 K • Annual operations cost: $ 85 K
Traffic TV	• Traffic information Cable TV channel produced by the University of Washington • Uses graphical congestion information provided by WSDOT (display is similar to WSDOT Web Page traffic flow maps and video feeds)	• Most viewers discovered this broadcast while "channel flipping", which indicated a fairly low public awareness level; users suggested that the service needed more promotion in the community • When used by commuters, route changes were the most likely behavior response • Deployment cost: $ 319 K • Annual operations cost: $ 122 K
Metro Online	• Public transit information web site provided by King Country Metro Transit • Contains schedules, routes, fares, trip planning and transfer information	• Provides a valuable service to its users – user base includes many long term users • Users typically access the site to obtain route and schedule information • Metro Online could be made easier to use – route planning and transfers should be reworked
Transit Watch	• Public transit information display system deployed at key transit centers • Provides real-time bus arrival and departure information on a video monitor	• System is both widely used and successful • Actual bus departure times are the feature found most useful by users • Users would like to see such systems put at locations where travel decisions are made • Did not increase the overall user satisfaction with the transit experience, but could help in retention • Deployment cost: $ 773 K • Annual operations cost: $ 180 K
Fastline	• Private personal traveler information subscriber service available for Personal Data Assistants (PDA's) • Provides real-time traffic information, driving instructions, and other local information • Software available for download on the Web	• Very low market penetration due to the lack of any real marketing campaign and limitations in the types of PDA's supported • Limited evidence suggested that users made changes in their travel behavior • Deployment cost: $ 386 K • Annual operations cost: $ 112 K

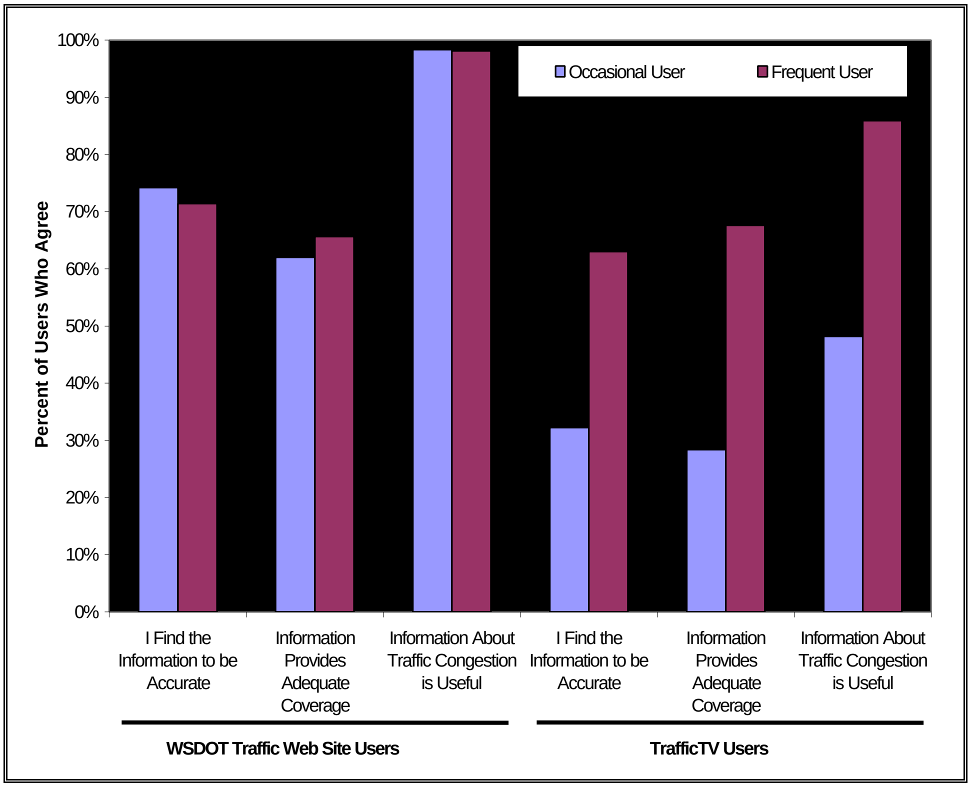

Figure 1-2. Comparisons between Occasional and Frequent Users on Accuracy, Adequacy, and Usefulness of Traffic Information.

In particular, users of the WSDOT Web site ranked the site as one of their most useful sources of information on traffic conditions. The WSDOT Web site is, on average, rated more favorably than any other source of traffic information, including radio and television reports. In addition, reducing stress was cited by a number of respondents as an important benefit of using the WSDOT Web site. Nearly 75 percent of respondents agreed that access to the Web site had helped them “reduce the stress of traveling in the Seattle area.” Moreover, the level of use of the Web page grew significantly over the year-long period of observation, doubling on average, and can be expected to continue to increase in the future as more people gain access to the Internet, as traffic congestion worsens, and as the quality of information on the WSDOT Web site continues to improve.

Of special interest, the impact of weather events was evident in the December 1998 usage levels. Figure 1-3 shows the number of user sessions for each day in the month of December 1998. The average daily number of user sessions for the 31 days in this month was 16,038, which was the highest level reached between May 1998 and April 1999. One of the reasons for the increase in December is because of the effects of three severe snow and ice days in Seattle. Travel was significantly restricted, there were many snow-related highway incidents, and all this occurred during the Christmas holiday. The worst impacts occurred between December 19 and 21, and Figure 3 reflects the component of the traffic Web site activity that can reasonably be attributed to this event. These effects are all the more noteworthy given that two of the three days were weekend days, a period of typically much lower Web usage.

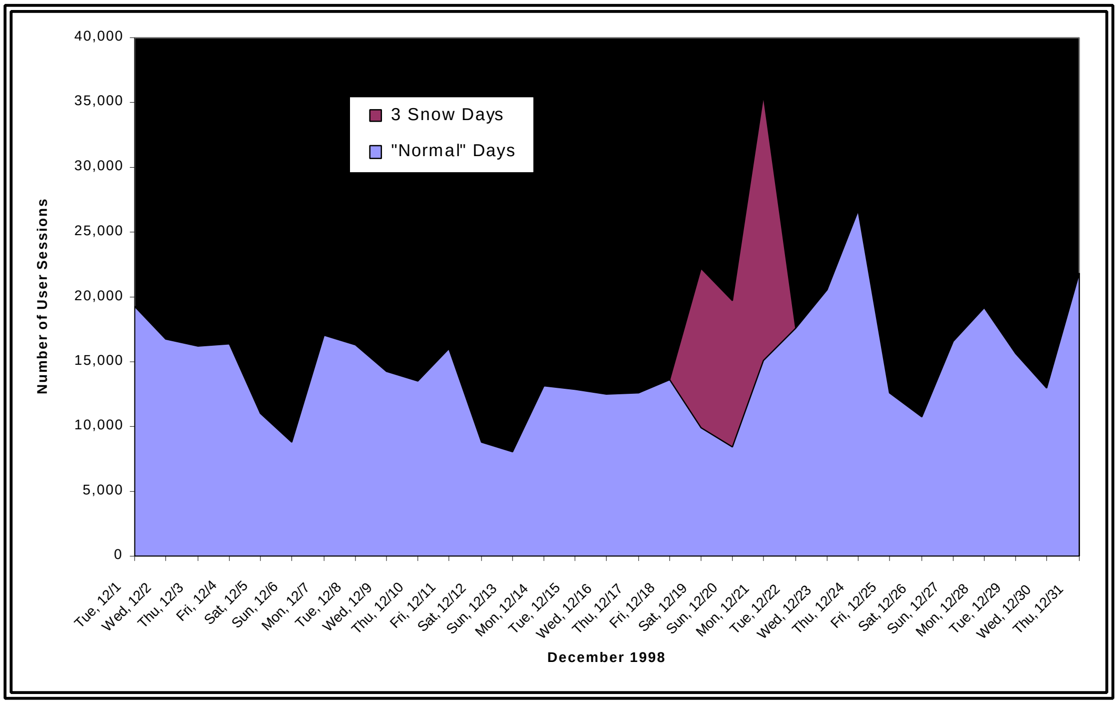

Figure 1-3. WSDOT Web Site Number of User Sessions during a 1998 Winter Storm.

The evaluation of the King County Metro Online Web site concluded that the site provides valuable services to its users. The survey analysis suggested that Metro Online gets a lot of repeat use and that the user base includes many long-term users of the transit system. These findings are further corroborated by the responses to the survey, which indicate that Metro Online is used to obtain a variety of information, route and schedule information chief among them.

However, the Metro Online evaluation also concluded that the site could be made easier to use, especially for new users. The responses suggest that some of the services provided by Metro Online — route information and transfer planning, in particular — can be modified to make the services more user-friendly and easier to navigate.

The evaluation of the Transit Watch bus stop transit information display system found that the system is widely used. Actual bus departure times are the Transit Watch feature found most useful by the users. Although Transit Watch is perceived as a real benefit by its users, they did not seem to think that it increased their overall satisfaction with the transit experience. This analysis indicates that Transit Watch in and of itself is unlikely to significantly change aggregate transit trends and perceptions. However, Transit Watch has a measurable effect on the comfort and satisfaction of new riders with the transit experience, and this has the potential to help retain ridership.

For the TrafficTV Cable television service and the Fastline handheld personal computer traffic software system, the evaluation noted difficulties that highlighted the value and importance of promotional activities in introducing ATIS services. First, for Traffic TV, 85 percent of the survey respondents who said they had ever watched the TrafficTV broadcasts said they found out about the broadcast while flipping through the channels on their TV. This indicates a fairly low level of awareness and use of this program in the population. It also suggests the potential value of promotional efforts to let cable viewers know about this program. Respondents even suggested more attention be given to promoting the program.

Secondly, for the Fastline product, the problem was particularly daunting. Users had to already own the correct type of handheld personal computer before they could load and use the Fastline program. Since the market for these devices is relatively small and users cannot be directly identified, the user had to find Fastline. While an initial promotional blitz was effective in attracting many users in the first few weeks of product implementation, continuing promotion would have been needed to both expand and maintain a viable user base. After the initial promotion in Seattle, there was virtually no follow-up, and user attrition was high.

A survey of users of the TrafficTV service found that the most frequent users are more likely to experience congestion on their commute, particularly unexpected congestion delay. These frequent users are also less likely to use other traffic information sources, suggesting that for some population segments, familiar, non-technical sources of traffic information such as Cable TV are valuable and satisfy a niche need.

ITS Integration Modeling Evaluation

The main purpose of the ITS Integration Modeling Evaluation was to examine, though traffic modeling, the effects of: (1) ATMS arterial signal integration across multiple jurisdictions and traffic control systems in a major metropolitan area; and (2) providing the addition of arterial traffic information to Seattle arterial drivers via the Smart Trek ATIS system deployments. An overview of these two evaluation elements and the corresponding evaluation results are provided in Table 1-3, and discussed in more detail below. These evaluations showed that taking the first steps towards integrating ITS systems in a metropolitan area can provide modest benefits in terms of both congestion relief and emissions reduction.

Table 1-3. ITS Integration Modeling Evaluation Overview

Integration Option	Modeling Case Description	Modeling Results	
		System Traffic Flow	Emissions
ATMS Signal Integration	• Examine traffic flow and emissions effects of implementing multi-jurisdictional signal coordination within a major arterial corridor • Assumes coordinated and fixed signal timing plan • Compare to a baseline case of no traffic signal coordination	• Measurable benefits – 7% reduction in vehicle delay – no adverse impacts on cross-streets – no changes in benefits across varying demand and weather conditions	• No statistical change in emissions • Increases in emissions expected from slight increases in travel and higher speeds is offset by a reduction in vehicle stops
Arterial Data for ATIS	• Estimate arterial corridor traffic flow and emissions effects of providing arterial traveler info • Compare to baseline case which consists of freeway-based traveler information only • Assumes 6% ATIS market penetration	• Measurable benefits – 1.8% reduction in vehicle delay – 5.6% drop in number of stops – slight increase in vehicle throughput	• Across-the-board reductions in emissions – 2% reduction in CO – 2% reduction in NOx

ITS Integration Modeling Evaluation: ATMS Signal Integration

The main purpose of this evaluation was to examine, though traffic modeling, the effects of ATMS arterial signal integration across multiple jurisdictions and traffic control systems in a major metropolitan area. The focus of the evaluation was on the North Seattle ATMS (NSATMS) system deployed under Smart Trek. The NSATMS is able to collect regional traffic data, including volumes, occupancy, speeds, surveillance video/snapshots, incident information, and signal system status. The system combines the results of a substantial customized software development effort, with a significant installation of computer workstations, communications hardware, and detection devices.

The evaluation examined prospective effects of re-timing signals using a coordinated fixed timing plan along two major arterials (SR99 and SR522) in North Seattle, using average queue length data from the NSATMS. Three measures areas were examined: System Traffic Flow Impacts, Energy and Emissions, and Safety.

The evaluation modeling effort showed that traffic signal coordination has measurable benefits on both the primary arterials and surrounding roadways within the 125-square mile corridor. As detailed in Table 1-4, the evaluation showed that a 7 percent reduction in average vehicle delay through the road network could be expected under morning peak conditions. In addition, the evaluation showed that a 2.5 percent reduction in overall crashes could be expected. At the same time, the increase in total traffic throughput through the corridor roadway network is negligible (0.2 percent). The distribution of benefits was fairly evenly distributed across the range of weather and travel demand conditions seen in the corridor. It follows that the system is moving roughly the same number of people through the road network in a more effective, reliable, and safe manner.

Table 1-4. ATMS Signal Integration System Traffic Flow Impacts

Measures for Average AM Peak Period	Baseline	Signal Coordination	Change	% Change
Vehicle-Hours of Delay (annualized)	17,879	16,661	-1,218	-7.0%
Vehicle Throughput (annualized)	209,372	209,774	+402	+0.2%
Coefficient of Trip Time Variation	.242	.237	-.005	-2.1%
Vehicle-Km of Travel	3,438,000	3,455,000	+17,000	+0.4%
Total Number of Stops	1,200,000	1,167,000	-33,000	-2.7%

In addition, the evaluation modeling effort also showed that the majority of cross streets along the SR99 and SR522 corridor would see no adverse impact from mainline traffic signal coordination, primarily because travelers using the cross streets would have the same phase split under both the baseline and coordinated plans. This conclusion is consistent with results from modeling conducted for the Phoenix MMDI evaluation.

Finally, the modeling evaluation showed that there was no statistically significant change in emissions with the implementation of traffic signal coordination. In general, increases in emissions expected from a slight increase in travel as well as higher travel speeds are offset by a reduction in vehicle stops.

ITS Integration Modeling Evaluation: Arterial Data for ATIS

This evaluation was designed to estimate the traffic flow and emission effects of providing arterial travel time estimates to Seattle drivers via the ATIS system deployments. The arterial travel time estimates are assumed to be provided to the ATIS system by the NSATMS and additional arterial sensors in the North Seattle Corridor. The simulation models the traffic flow and emissions so that the effects of the additional ATIS data can be quantitatively assessed.

The results of the modeling effort showed that the integration of arterial congestion data with freeway-based ATIS clearly improved the effective utilization of ATIS services by the travelers modeled in the North Corridor. As shown in Table 1-5, the travel delay reduction realized when congestion data on parallel arterials was made available to the freeway-based ATIS system (associated with a 6 percent ATIS usage rate) in the morning peak was 1.8 percent. Additionally, a 5.6 percent drop in number of stops under relatively stable total travel resulted in across the board improvements in energy efficiency and emissions reductions.

Table 1-5. Arterial Data for ATIS System Traffic Flow Impacts

Measure per Average AM Peak Period, North Corridor	Freeway ATIS	Freeway ATIS (+ Arterials)	Change	% Change
Vehicle-Hours of Delay	17,619	17,308	-311	-1.8%
Vehicle Throughput	209,382	209,575	+193	+0.0%
Coefficient of Trip Time Variation	.236	.247	+.011	+4.7%
Vehicle-Km of Travel	3,436,000	3,443,000	+7,000	+2.0%
Total Number of Stops	1,201,000	1,134,000	-67,000	-5.6%

Recommendations

Table 1-6 below presents a summary of the major recommendations developed as part of this evaluation. These are based on the experience, results and conclusions that were developed in conducting the Smart Trek evaluation:

Table 1-6. Summary of Evaluation Major Recommendations

Evaluation Category	Recommendations
Institutional Benefits	• The successful involvement of the private sector, which included their participation from the inception of the project, and their involvement in several project management roles, is a model that should be followed in other areas. • Where appropriate, the use of flexible procurement methods should be used by others implementing ITS as a means to ensure project success and reduce potential deployment delays • Future planning such as developing traveler information business plans and forecasting ITS O&M costs should be considered for all ITS deployments
ATIS Customer Satisfaction	• The success of the WSDOT Web Site showed that government-owned and operated traffic information web sites should still be considered as one of the recommended options for disseminating traveler information in a major metropolitan area. • Developers of ATIS Web sites should design their systems to be able to handle substantially increased customer usage during poor weather conditions. • Continuous improvement of the content and quality of traveler information, and responsiveness to expressed user needs, should be implemented for ATIS projects to both attract and retain users, as well as to continually provide the benefits that users expect from these services. • If private industry is to consider deploying traffic information services for handheld personal computers, it is recommended that they pursue an aggressive and sustained marketing campaign.
ITS Integration Modeling	• Where appropriate, cross-jurisdictional signal control integration utilizing ATMS systems should be implemented on major metropolitan arterials where congestion is a serious problem. Jurisdictions should work together to overcome institutional stumbling blocks that have been delaying the full implementation of these systems across the U.S. • Cross-jurisdictional signal integration in major metropolitan areas should be conducted with the goal of establishing a menu of signal timing plans to implement based on a variety of anticipated traffic conditions. • Deployers of ATIS Web sites should strongly consider the addition of applicable ITS sensors to allow for traveler information to be collected on congested arterial corridors. The combination of major arterial traffic flow data with freeway traffic flow data will provide measurable benefits to the public and the transportation system • Analysis of integration in metropolitan model deployment should be made more of priority in future evaluations. The question of what benefits could be expected from a multi-element ITS integration with information being shared and managed/optimized across numerous levels and across multiple corridors and regions will need to be answered in the future.

2. INTRODUCTION

2.1 FORWARD

On February 26, 1996, the U.S. Department of Transportation (USDOT) issued a request for participation in the Intelligent Transportation System (ITS) Model Deployment Initiative (MDI). The MDIs were envisioned to be demonstrations and showcases of measurable benefits resulting from the application of an integrated, regional approach to transportation management and the provision of traveler information services. The first MDI, the Metropolitan Model Deployment Initiative (MMDI), focused on large urban cities. Three metropolitan sites were selected for both deployment and a comprehensive evaluation: Phoenix, San Antonio, and Seattle.

This document presents the results of the evaluation of the Seattle MMDI deployment. Other evaluation reports to date have been prepared for the San Antonio and Phoenix MMDI deployments, and an additional overarching MMDI National Synthesis Report is scheduled to be published in July 2000.

2.2 THE SMART TREK PARTNERSHIP

In the Seattle metropolitan area, demand for transportation facilities and services already exceed the supply. A growing economy, increasing population, and constrained construction of new roads are dramatically decreasing transportation system performance. In addition, over the next 20 years, Washington's economy is expected to grow by almost 40 percent, with corresponding increases of 30 percent in both population and vehicle miles traveled.[3] The largest share of growth will occur in the Seattle region. Construction of new roadways in this region is not expected to keep pace with this rapid growth.

Consequently, WSDOT and others in the public and private sectors are looking to emerging technologies to help improve the performance of the Seattle region's existing transportation system. Their goal is to apply new technologies including sensors, communications, and information systems to help the region better manage traffic, inform travelers of transportation options, and quickly respond to roadway incidents and changing conditions. In response to the USDOT's request for participation in the MMDI program, WSDOT entered into a partnership with public and private organizations to implement ITS solutions. This partnership was named "Smart Trek."

The Smart Trek program built upon existing ITS institutional relationships and infrastructure in the Seattle region to showcase an integrated Intelligent Transportation Infrastructure (ITI). Smart Trek integrated new and existing data sources; established a transportation information network that is integrated, regional, and multi-modal; and greatly expanded the distribution of traveler information. The program is being led by WSDOT, in cooperation with the FHWA and Federal Transit Administration, and includes public and private agencies committed to providing a range of services and products.

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[3] Blaine, Larry, "Regional View" newsletter, PSRC, August 1999 (data developed from PSRC's recent 2020 forecast).

Figure 2-1 presents the main page of Smart Trek organization Web site. This Web site originally served as the focal point for distributing information between the Smart Trek partners and informing the public about the Smart Trek program. It now serves as an information source for the public in the Seattle region in which to access the deployed ITS services developed under Smart Trek and other regional ITS deployments. This web site can be accessed at: http://www.smarttrek.org.

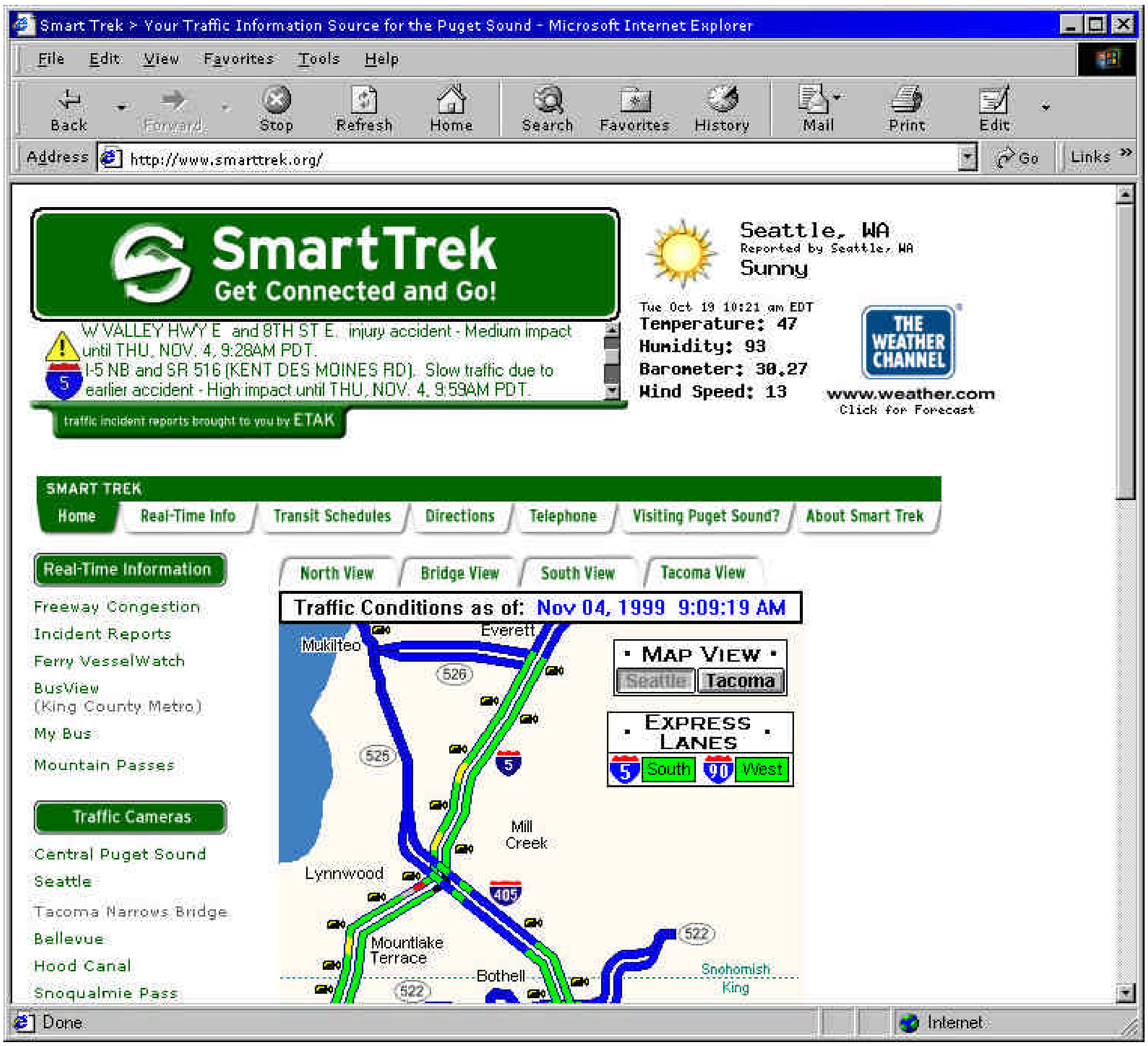

Figure 2-1. Smart Trek Organization Web Site.

A group of 22 public agencies and private companies worked together under Smart Trek to improve the Seattle region's transportation management and information systems. The list of the Smart Trek partners and their roles is shown in Figure 2-2.

PARTNER	ROLE										
	Project Management	Freeway Management	Traffic Signal Control	Incident Management	Emergency Mgmt. Services	Advanced Traffic Management	Traveler Information	Integration	Outreach / Marketing	Evaluation	Oversight
Public Sector Partners:											
WSDOT	X	X	X	X	X	X	X	X	X	X	X
Washington State Ferries (WSF)							X				
University of Washington						X	X				
PSRC									X	X	X
King County DOT	X		X			X	X				X
Port of Seattle						X	X				
City of Bellevue			X			X					
City of Seattle			X			X					X
Greater Redmond TMA							X				
FHWA/JPO	X									X	X
Federal Transit Administration										X	X
Private Sector Partners:											
Battelle	X							X	X		X
Boeing							X			X	
David Evans and Assoc.	X									X	
ETAK, Inc.							X				
Fastline							X				
IBI Group	X				X						
Metro Networks							X				
Microsoft							X				
Pacific Rim Resources	X								X		
PB Farradyne	X	X	X			X	X				

Figure 2-2. Overview of the Roles of the Smart Trek Partners.

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3. SEATTLE SMART TREK EVALUATION RESULTS

The Smart Trek evaluation was conducted based on the utilization of the ***few good measures*** evaluation technique. The few good measure areas selected for this evaluation were Institutional Benefits and Issues, Customer Satisfaction, Traveler Mobility, Safety, Costs and Benefits, and Energy and Emissions. For each of these areas, relevant national experts were selected to lead the evaluation.

The organization of the evaluation report results presented below is based on both the highlights of the major findings of the evaluations, as well as on the specific ITS deployment project areas (e.g., ATIS, ATMS). This organization was developed to allow the major results of the Seattle Smart Trek evaluation to be summarized in the most effective and concise manner possible.

The ***Institutional Benefits Evaluation (Section 3.1)*** discusses the successful processes undertaken by the various institutions and agencies included in the Seattle MMDI. A study plan was developed and included in-depth interviews of the key public sector MMDI participants in Smart Trek.

The ***ATIS Customer Satisfaction Evaluation (Section 3.2)*** describes the results from the Customer Satisfaction Study, which focused on traveler satisfaction, perception and behavior as applied to the ITS technologies being deployed in Seattle. The results were derived from the application of focus groups, interviews, surveys, and Web usage analyses. Here, five ITS deployments are evaluated, consisting of a traffic information Web site, a transit information Web site, a cable TV traffic information system, a transit center bus time display system, and a personal handheld computer traveler information system.

The ***ITS Integration Modeling Evaluation (Section 3.3)*** provides an examination, though traffic modeling, of : (1) the impacts of integrating traffic sensor and signal information for a major arterial corridor in North Seattle, in terms of delay, safety, and energy and emissions; and (2) the impacts of providing the addition of arterial traffic information to Seattle arterial drivers via the Smart Trek ATIS system deployments, in terms of delay and energy and emissions.

Additionally, Table 3-1 is provided below as a project-specific guide to the results contained in this evaluation report. This figure shows which projects were evaluated under which evaluation areas, and where in this evaluation report these projects are addressed. Note here that for a significant number of projects, evaluations were not conducted, but detailed costs estimates were developed. In these cases, the cost estimates as well as brief project descriptions are provided in *Appendix A*.

Table 3-1. Project-Specific Organization of Evaluation Results

Project	ATIS Customer Satisfaction (section)	ITS Integration Modeling (section)	Cost Estimate (section)
ITS Information Backbone System		3.3.2	All ATIS projects [4]
WSDOT Web Site	3.2.2	3.3.2	3.2.2
Cable Television "Traffic TV"	3.2.3	3.3.2	3.2.3
Metro Online Transit Web Site	3.2.4		
Transit Watch Display System	3.2.5		3.2.5
King County BusView Web Applet			Appendix A
Transit AVL System Upgrade			Appendix A
FASTLINE Personal Travel Companion	3.2.6	3.3.2	3.2.6
Etak/Metro Networks ISP Services		3.3.2	Appendix A
WSF ATIS			Appendix A
North Seattle ATMS		3.3.1, 3.3.2	3.3.1
Eastside ATMS			Appendix A
Southside ATMS			Appendix A
Bellevue TMS			Appendix A
WSDOT NW Region TSMC Upgrades			Appendix A
Regional Video System			Appendix A
Improved Incident Video			Appendix A
Emergency Operations Centers			Appendix A
Seattle Center Parking Info. System			Appendix A
Dynamic Ridematch/ Rideshare			Appendix A

3.1 INSTITUTIONAL BENEFITS EVALUATION

The Institutional Benefits Evaluation was conducted in parallel at the MMDI deployment sites of Seattle, Phoenix and San Antonio. The evaluation was primarily focused on answering the following three questions:

- *What institutional and other non-technical impediments did the public sector MMDI participants encounter?*

- *What institutional changes were made to address these impediments?*

[4] Note here that the ITS Information Backbone System costs are "shared" equally among the seven ATIS-related projects which either currently are connected or could potentially be interfaced with ITS Information Backbone System. The ITS Information Backbone System cost elements are thus embedded in each of the ATIS project cost estimate summary tables provided in this report.

- *What benefits did the public sector MMDI participants achieve from making these changes?*

In conducting the evaluation, a set of institutional actions were identified across the three MMDI sites which responded to these questions. The findings illustrate that the successful actions taken at a particular MMDI site were, in many cases, taken at the other sites as well. The fact that a common set of actions emerged among MMDI programs suggests that these steps are highly facilitative, if not requisite, to successfully implementing an ITS program.

Although the study identified a common set of actions at all three MMDI sites, it also revealed that the manner in which the MMDI program participants employed them differed. Furthermore, within an MMDI program, the project participants placed different levels of emphasis on the various actions determined by the appropriateness of the action to the site. Also, the execution of some actions may have started before the MMDI program and were enhanced by it. These three circumstances resulted in some actions being more noticeable than others. In the Seattle MMDI, seven actions, which are applicable to other sites deploying ITS projects, were exemplary in facilitating the *Smart Trek* MMDI:

- Build on existing relationships.
- Encourage private sector participation.
- Develop the management structure for the MMDI.
- Assign role and responsibilities.
- Select the appropriate procurement mechanisms.
- Develop policies that govern operations.
- Plan for the future.

The results presented below are based on how these institutional actions were specifically taken under Smart Trek.

3.1.1 Build on Existing Relationships

The concept of building on existing relationships is particularly relevant to representatives of the Seattle Smart Trek project. The relationships that had been established during field operational tests, which include the North Seattle Advanced Traffic Management System (NSATMS) TravelAid, PuSHMe (Puget Sound Help Me mayday system), and SWIFT (Seattle Wide-area Information For Travelers), facilitated the development of the MMDI. Many individuals and organizations involved in the MMDI participated in the Seattle-area operational tests.

Within the public sector, staff at WSDOT developed a good relationship with the Puget Sound Regional Council (PSRC), the metropolitan planning organization, and with the King County DOT's Transit Division, the area's largest transit provider. Also, staff from the WSDOT Northwest Region previously spoke with representatives of public agencies in the east and south sides of the Seattle area about connecting to the NSATMS. In addition, coordination was established among the regional transit agencies to coordinate funding provided under the Intermodal Surface Transportation Efficiency Act of 1991.

An additional organizational structure that facilitated ITS in Seattle was the Community Task Force, which was begun several years ago to identify ways to communicate with customers. The task force included representatives from the WSF and both the Olympic and Northwest Regions of the WSDOT. This task force looked for ways to communicate with customers and identified the need for a system-wide signage project. After fulfilling its mission, this task force disbanded, but the groundwork established by this group was one of the building blocks on which the MMDI has grown.

Staff from the WSDOT benefited from their existing relationship with the staff of the State's attorney general office. The legal staff gained knowledge during previous ITS activities and applied this knowledge to issues related to the MMDI.

Building on existing institutional relationships allows partnerships the opportunity to grow. Expanding these alliances provides the participants the benefit of not having to reforge relationships as new opportunities arise. Other benefits include a growing interest by the various agencies in managing the transportation elements of a region together. This will lead to an integrated transportation management system for the region that includes transit and other modes, which will simplify intermodal transfers. Other benefits will be more access to traffic flow and bus location information and more and better data available to the MPO for regional planning.

3.1.2 Encourage Private Sector Participation

In Smart Trek, private sector representatives have been included since the inception of the project, were involved in developing the project proposal, and had a role in every aspect of the project's development. The Smart Trek decision-making structure included two deputy project managers and four bundle managers from the private sector. The trusting relationship that was developed among the MMDI participants during some operational tests and enhanced within the MMDI project offered a significant benefit: some decisions on the direction of the MMDI were based on faith in the parties involved.

Because a goal of the Smart Trek MMDI was to involve private sector information service providers in the dissemination of traveler and traffic information, MMDI participants are making the project's traveler and traffic information widely available. The public sector assumes that these service providers will add value to the basic transportation information and receive revenues from the distribution of this information and possibly from advertising. The public sector officials see a benefit in this approach because, as more private firms become involved, more traveler information will be provided to the traveling public. This, in turn, can lead to the better operation of the transportation system.

Benefits of private sector participation in ITS projects include the ability of the projects and services to take advantage of the unique strengths of the private sector. In the Smart Trek project, a private sector organization was responsible for the MMDI's public relations and outreach program. This firm had unique experience and expertise in information dissemination and was able to distribute to a broad and varied audience compelling information about the benefits of ITS to the region. The utilization of this breadth of experience in marketing and public relations has not been traditionally available to the public sector. Benefits to public sector interests, however, come with the development of opportunities for private sector involvement in ITS.

3.1.3 Develop the Management Structure for the MMDI

Representatives of the participating agencies and organizations all thought that WSDOT should manage the program because WSDOT is the only operating agency with a regional perspective. Therefore, because of the experience its staff had with ITS products and services, the WSDOT Advanced Technology Branch was selected as the lead agency for the Smart Trek MMDI. The ITS Program Manager in the Branch became the Project Manager for the Smart Trek MMDI. This individual has the final responsibility for all decisions in this MMDI program. However, all project management decisions are shared with two deputy project managers, one for System Integration and one for Operations and Maintenance. Here, both deputy project managers are from the private sector.

The activities of the Smart Trek project were organized into five components or “bundles.” These bundles were essentially committees as each had a manager and supporting members to oversee a specific element of the project. Bundle areas include (1) Transportation Management Systems; (2) Regional, Multi-modal Traveler Information Services; (3) Transit Management and Electronic Commerce; (4) Emergency Services and Incident Management; and (5) Public Involvement, Outreach, and Marketing. Four of the five bundle managers are from the private sector. The manager of the Transit Management and Electronic Commerce Bundle is from the public sector.

The bundles allow for good cooperation among the different participants. Project participants believe that the traveling public will benefit from this cooperation, as it can potentially lead to seamless, regional, easy access, multimodal traveler information. Because the bundles drive communication, they may also enable the realization of additional projects through blending existing projects and technology transfer.

There is one other group that has been involved in the management of Smart Trek: the Expert Oversight Committee. The Expert Oversight Committee provides guidance to the program management team and, through affiliations with national transportation and ITS organizations, provides a broader ITS knowledge, connections beyond the state, and assistance with outreach efforts. Because the committee members represent the major Smart Trek participants, they also help resolve any problems that develop. The Traffic Services Manager of WSDOT’s Northwest Region chairs this committee.

3.1.4 Assign Agency Roles and Responsibilities

The Smart Trek proposal development process involved many of the agencies in the region. The initial group of partners looked at all the gaps in the existing traveler information systems and identified who needed to be involved. The team that put together the proposal represented different agencies, functional areas, and the private sector. The project partners met monthly for a year to coordinate project elements. They determined the MMDI projects by developing functional areas and building on what was already in place or soon to be in place in the region. The roles that were to be adopted by different agencies within MMDI become obvious to the program participants during this process.

Because of its regional perspective and staff experience with ITS products and services, the WSDOT Advanced Technology Branch leads the Smart Trek MMDI. The project manager is located in this agency.

The WSDOT Northwest Region is managing five projects. These projects center primarily around the transfer of data and information to and from the Northwest Region's traffic management center and the storage of data. The University of Washington's role in the MMDI is to move the regional ITS backbone from a research activity to implementation, expand the backbone as required by the project, design the BusView Web page applet to provide real-time bus location information, and design Transit Watch to predict bus arrival times at three regional transit terminals.

Port Authority of Seattle staff manage projects at the Seattle-Tacoma Airport, which provide airport information to the MMDI ITS Information Backbone system for public dissemination via the Smart Trek ATIS services. The City of Seattle provided the review, approval, and permitting activities necessary to advance the Seattle Center Project, which supplies parking availability information to motorists as they approach the center. The Washington State Ferries (WSF) has been involved in MMDI activities that provide information on vehicle queues and waiting times at the docks as well as the location, capacity, and estimated arrival times of the ferries.

The Puget Sound Regional Council (PSRC) has active in outreach, the congestion management automated data collection program, and various surveys on MMDI products and services. PSRC provides a policy advisor to the management team, whose primary responsibility is to ensure that Smart Trek policies are consistent with state and regional policies.

3.1.5 Select the Appropriate Procurement Mechanisms

The participants in the Smart Trek MMDI took steps to ensure the most appropriate procurement methods were used. These steps included choosing the appropriate lead procurement agency, selecting appropriate procurement instruments, and designing flexibility within contracts.

Choosing the Appropriate Lead Agency

The primary agency responsible for procurement and contracting for Smart Trek has been the Advanced Technology Branch of the WSDOT. Although this office is essentially responsible for MMDI procurement coordination, the entire mechanism used for contracting in this project has been quite flexible. Some of the public sector participants have chosen to buy their own program-related material directly, while some have elected to use private sector participants or other consultants to conduct the required solicitations and purchase equipment.

Selecting Appropriate Procurement Instruments

Because time was such a factor in the MMDI projects, parties involved in the MMDI wanted to make the best use of available resources and contracts that they either had in-place or were quickest to initiate. This need to achieve their project goals in a timely manner led the MMDI participants to use a variety of contracting mechanisms:

- Federal competitive process
- Multi-party agreements
- Competitive contracts
- Sole-source contracts
- Phased contracts

- On-call and other existing contracts

The Smart Trek project has essentially been formed through 17 agreements that involve 19 public agencies and private entities. Eleven of the agreements were contracts obtaining products and services from private vendors and consultants; the remaining contracts were interagency and inter-jurisdictional agreements involving public agency roles, data transfers, and funding. This MMDI partnership used whatever contract mechanism made sense for each particular participant.

The WSDOT personnel have employed a unique procurement procedure in the Smart Trek MMDI. The WSDOT staff used the Federal competitive process for the MMDI Request for Proposal as the competitive process for procuring project participants. After the request for information for the MMDI program was issued, several firms approached WSDOT management requesting to be involved. Representatives of these firms and the WSDOT worked together to develop a proposal that identified the private sector participants. Because the DOT selection team accepted the proposal, with private sector participants included, the WSDOT used a sole-source method to contract with the private sector firms.

The Smart Trek administrators also used a multi-party agreement, which included the WSDOT and three private sector participants, all of whom signed a similar consortium agreement used in the SWIFT field operational test. WSDOT management thought that this method would reduce the time needed to review the intellectual property and liability clauses. The expected benefit of the consortium agreement is that the project team could bring these participants on board at a faster rate than if individual contracts were drawn up for each party. Another benefit was that this agreement also defined the overlapping requirements and inter-dependencies among the tasks of these three information service providers.

In order to begin work, even before the final contract negotiations were completed, the WSDOT used phased contracts with five private sector participants in the early period of the Smart Trek project. These contracts allow for more detailed scope and cost proposals to be developed during the pre-negotiation phase, when a contractor would not normally be paid for their efforts. The parties involved have found that this process makes both sides comfortable during the negotiation process. Contractors are paid for their work with a lump sum amount ranging from $4,000 to $12,000, depending on the actual amount of the full contract.

The Washington State Transportation Center (TRAC) was able to utilize an existing contract to become a participant in Smart Trek. The TRAC, a consortium of the WSDOT and two state universities (University of Washington and Washington State University) already had existing contracts in place with the WSDOT's research office prior to the MMDI. These contracts were then used for the University of Washington's participation in the MMDI, not requiring any new contracts.

Designing Flexibility within Contracts

Resolution on the form of payment and the payment schedule presented major challenges for the MMDI sites. The participants had to resolve whether to pay contractors on a per-hour rate (labor and materials) or on a fixed-price basis. The public sector participants felt that contracts based on "cost-plus" payments, lump-sum payments, or "best efforts" and labor hours payments would not ensure that tangible results or acceptable products would be obtained. The Smart Trek management provides payment based on individual tasks, but they also made cognizant efforts not to obligate the entire funds available for each contract. Smart Trek officials use task orders to specify the cost and functionality of each task. This provides more task oversight and funding controls by the public sector participants.

3.1.6 Develop Policies that Govern Operations

Policies regarding how advanced equipment and how the data they generate are used are critical components in ensuring that all parties operate under the same manner for regional consistency and effectiveness. In particular, the participants in the Smart Trek MMDI developed policies in two areas that can be duplicated by others deploying ITS products and services:

- Replacement of equipment
- Use and distribution of data.

The project participants have had to come to terms with the eventual replacement of the equipment. The City of Bellevue, Washington, has developed an Equipment Rental Fund that has been used to replace outdated computers and other equipment. City officials will include Smart Trek MMDI items under the responsibility of the City in this fund. Although State legislation allows all cities within the State to develop equipment replacement funds, the City of Bellevue has developed the most sophisticated procedures.

There are three independent sub-funds included within the City of Bellevue's Equipment Rental Fund:the Electrical Equipment Rental Fund, the Mechanical Equipment Rental Fund, and the Information Services Replacement Fund. The Equipment Rental Fund was created as an internal process designed to rent equipment to other funds, maintain and repair equipment administered by the Fund, and provide equipment replacement services.

The WSDOT policy for sharing data, which is also applied to Smart Trek, is that WSDOT staff will give the data to anyone who requests it, as long as there is not a substantial cost to the WSDOT to provide the information. WSDOT officials have been willing to fund the distribution of the data because the dissemination of data benefits the MMDI project. Transportation-related information from the WSDOT is regularly distributed on the Internet. Presently, the primary restriction to information access is the physical limitations of the system. Access to this information will be greater as the system moves from phone line connections to expanded Internet availability.

Because of the media's ability to quickly reach a wide audience, the WSDOT information sharing policy actually gives the media a priority over other users. The WSDOT provides video images to the media, but the media outlet has to make the connection. If external agencies put in the receivers, WSDOT staff will make the connection with them. Currently, there is no charge for the connection and none is anticipated. There is, however, no existing policy that would preclude implementing a charge. Legal agreements are being developed that clarify the process of data retrieval and access to video input from other agencies by the WSDOT and the independent service providers. A legal agreement will also be developed regarding the distribution of traveler information by an information service provider.

Because staff at the University of Washington is developing the MMDI information backbone, there is a great deal of data that is passed through its operations. The University's policy is to make the traveler information available to anyone who wants to build products that add value to the data. However, personal information is stripped from the data to protect the privacy of individuals. Each data source has a computer, or "firewall," to strip out any private data before it goes into the Smart Trek system. The stripped data always resides at the source agency. For example, the computer residing at Metro Transit extracts bus driver identification information before vehicle identification data is passed to the communications backbone.

3.1.7 Plan for the Future

Project success can be greatly aided when commitments, goals, and expectations for the project are explicitly and unmistakably presented, or as one Seattle Smart Trek participant said, "put in writing." One example of a highly recommended written tool is using business plans to map out questions of long-term operations and management. Staff at the Washington State Transportation Center recently completed the *Washington State DOT Advanced Traveler Information System Business Plan*. This plan identifies WSDOT's view of appropriate roles, responsibilities, and allocation of costs for public and private providers of advanced traveler information system services. It describes business opportunities for the private sector and the need to balance those opportunities with public sector goals. The plan also recommends actions to be taken within the next two years and in the longer term.

The Washington State Transportation Commission has also adopted two other notable policies. The first policy covers the use of advanced technologies within the WSDOT. The second policy was developed to ensure a linkage between telecommunications and transportation, especially including ITS activities.

3.2 ATIS CUSTOMER SATISFACTION EVALUATION

3.2.1 MMDI ATIS Customer Satisfaction Analysis Overview

The Seattle Smart Trek MMDI incorporated nine individual ATIS projects, offering a unique opportunity to evaluate many of these from the perspective of customer satisfaction. The customer satisfaction evaluation covered five of these projects in detail, producing individual reports based on five surveys, three sets of focus groups, and an analysis of the WSDOT traffic Web pages. Full results from these analyses are contained in separate Smart Trek ATIS Customer Satisfaction reports, the highlights of which are distilled in sections 3.2.2 to 3.2.6 below.

The number and breadth of the customer satisfaction analyses at each of the three MMDI sites offer a unique opportunity to assess and better understand the factors and conditions that affect ATIS use. An emerging finding across all MMDI ATIS evaluations is that a set of relatively consistent factors appears to influence the propensity of travelers to seek out, use, and benefit from traveler information. Each ITS product or service has attracted particular market segments of a site area's population as users. Factors that make up these market segments include such characteristics as frequency of using an ATIS service, local commuting conditions, and what value users place on these information services. Some factors have shown similar results and others have ranged widely across sites. This remainder of this subsection will review comparatively selected findings from these evaluations.

Factors in ATIS Use

A central finding from the Seattle, Phoenix, and San Antonio evaluations is that the potential of traffic and transit information to satisfy travelers and enhance their travel experiences is mediated by four primary components:

- The regional or situational context;
- The quality of the ATIS service;
- The characteristics of the trip, specifically users travel experiences; and
- The characteristics of the traveler (the ATIS users). [5]

The situational context includes attributes of the region such as the road network, its capacity and accessibility of alternative travel routes and modes, and traffic congestion (and factors that affect it such as population density, growth, vehicle-miles traveled, and number of trips). This context tends to determine whether travelers are likely to be motivated to learn about and use ATIS products and services in the first place, and may help define thresholds for customer use of ATIS services.

A second critical determinant of ATIS use is the quality of traveler information available to users. Quality is an indicator of the ability of the information to meet customer needs with respect to timeliness, relevancy, specificity, frequency, and accuracy. More specifically, information quality is determined by the following:

- the breadth of geographic coverage,
- whether both highways and arterial streets are included,
- the time frame of information (e.g., static, near real-time, or real-time),
- media characteristics (pre-trip, en route, in-terminal/wayside, or a combination), and
- the user interface and resulting ease of using the service.

The elements of quality determine whether, how frequently, and with what level of confidence the user consults traveler information and adjusts travel choices accordingly.

A third factor is trip character. The trip purpose, the time of the trip in relation to peak congestion periods, trip length, and the particular route or route choices available to the individual traveler all have a significant effect on whether the individual will consult traffic information. The availability and convenience of alternative mode choices for a given trip also affect traveler behavior. Arrival time flexibility associated with the individual's trip is another determinant in the choice to consult traffic information.

The fourth factor includes characteristics of the user, or potential user, of ATIS products and services. Attitudes toward such things as comfort with high technology equipment and how well a traveler knows local roads are important determinants of user awareness, use patterns, behavioral responses, and valuation of ATIS.

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[5] This discussion is elaborated upon in two companion MMDI evaluation documents: *Traveler Information User Profiles: Customer Satisfaction Evaluation.* Draft MMDI Evaluation Report. October 1999; and, *Customer Satisfaction Evaluation Overview: National Synthesis.* Draft MMDI Evaluation Report. [Document in preparation].

Seattle: The Regional Context

The key factor that helps to explain the propensity to use ATIS is how much congestion occurs in the city. We can measure congestion by using an index based on the kinds of contextual factors shown in Table 3-2 (plus a number of other factors incorporated into the congestion index developed by the Texas Transportation Institute (TTI), and we also can ask people about their day-to-day travel experiences in each of these areas. Based on the TTI congestion index, Seattle's freeways are much more congested than those in Phoenix or San Antonio. Based on comments from focus group participants and responses from the several ATIS surveys in the Seattle area, congestion is a *very* serious problem for many travelers much of the time. Also, based on their responses to direct questions about commute experiences, these respondents reported longer commutes and more congested commutes in the Seattle region compared with reports from commuters in Phoenix or San Antonio.

Table 3-2. Selected Characteristics of MMDI Sites

Site Attribute	Seattle	Phoenix	San Antonio
1990 Population for MSAs/CMSAs[6]	2,559,164	2,122,101	1,302,099
1997 Population Density for MSAs[7]	466.2	194.8	454.3
Rate of Population Growth for MSA/CMSA: 1990-1997[8]	13.4%	26.9%	14.1%
Miles of Instrumented Roadways[9]	120 miles	50 miles	26 miles (plan to increase to 191 mi)
TTI Congestion Index and Rank[10]	1.27 (6th most congested US city)	1.24 (15th most congested US city)	0.99 (44th most congested US city)
VMT per Freeway Lane-mile (1996)[11]	16,870	15,085	12,705
Congested Freeway Travel (%)[7]	80%	65%	45%

Figure 3-1 shows that commutes are longer in the Seattle area compared with Tempe/Phoenix, and the component of the total commutes that can be attributed to traffic congestion, over and above free flowing conditions, is also higher in the Seattle area. In two of the three user groups, the frequent users of ATIS tend to have longer commutes overall, but in all three cases, the

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[6] The 1990 US Census of Population, Metropolitan Statistical Areas, available at http://venus.census.gov/cdrom/lookup

[7] Persons per square mile for Metropolitan Statistical Areas, 1997, available at: http://www.census.gov/Press-Release/metro06.prn

[8] Rate of change in population for Metropolitan Statistical Areas, available at: http://www.census.gov/Press-Release/metrolis.htm

[9] Based on discussions with transportation experts at each site.

[10] A description of TTI's Roadway Congestion Index can be found at: http://mobility.tamu.edu/study/rci.stm. This discussion states in part, "The resulting ratio indicates an undesirable level of areawide congestion if a value greater than or equal to 1.0 is obtained."

[11] Data provided by the TTI at: http://mobility.tamu.edu/.

portion of their total commute time that can be attributed to congestion is largest for the frequent users. Specifically, about 40 percent of the total commute time is due to congestion in the Seattle area and slightly less than that in Tempe for the frequent ATIS users.

The evaluation of usage patterns of the WSDOT traffic Web site offered additional insights into elements of the regional context that appear to influence how many people use the site, how often they use it, when they use it, and how they use it in conjunction with other ATIS services in the Seattle region. The differences in higher use patterns for WSDOT's Web site when compared to traveler information Web sites at the two other MMDI locations, Phoenix and San Antonio, shed further light on the nature of these differences and their association with differences in the level of congestion and locational context of each site.

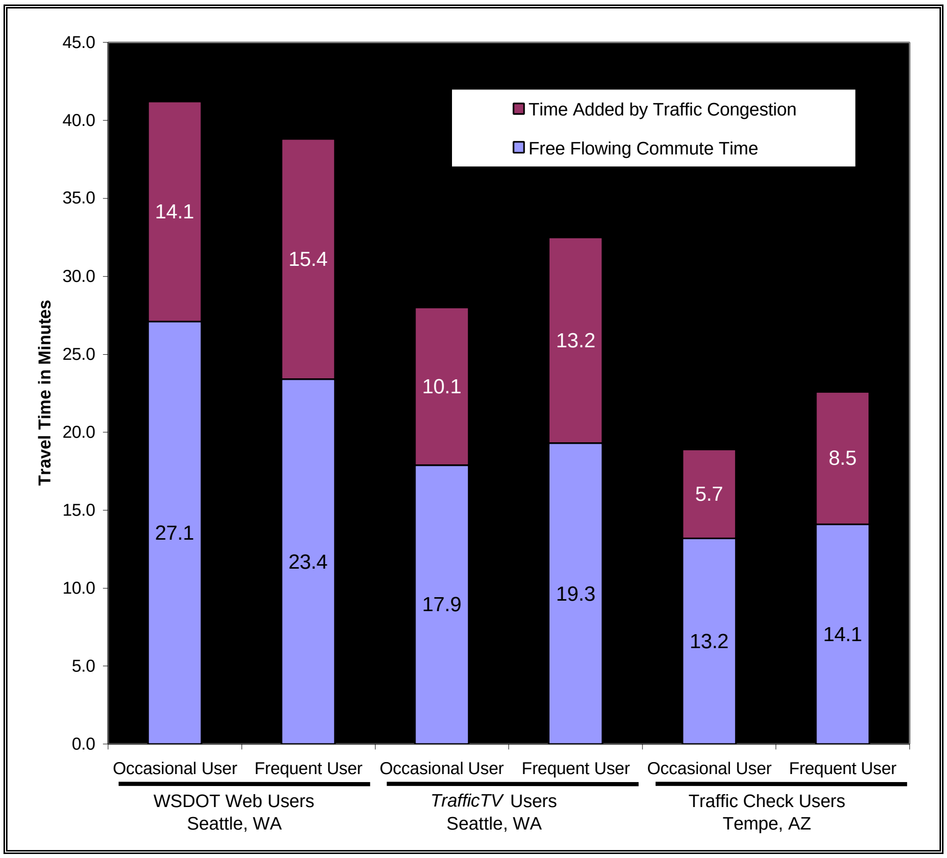

Figure 3-1. Comparisons between Occasional and Frequent Users on Length of Commute Time and Impact of Congestion on Total Commute Time.

ATIS Marketing and Promotion

Another critical factor that helps determine use rates for ATIS is the amount of effort put into advertisement and promotion of the ATIS services. Clearly, if potential users of ATIS are unaware of the existence or availability of the service, then they cannot become *actual* users. Part of the issue is one of timing, as it typically takes time for new information technologies to diffuse into a population of potential users. Marketing and outreach were important components of each of the Smart Trek projects, designed to build awareness and understanding. Some of the projects were more challenging than others in terms of building product awareness.

In the case of Fastline, the problem was particularly daunting. Users had to already own the correct type of handheld personal computer before they could load and use the Fastline program. Since the market for these devices is relatively small and users cannot be directly identified, the user had to find Fastline. While an initial promotional blitz was effective in attracting many users in the first few weeks of product implementation, continuing promotion would have been needed to both expand and maintain a viable user base. After the initial promotion in Seattle, there was virtually no follow-up, and user attrition was high. The value and importance of promotional activities is illustrated by this case. A bigger question is whether customers, once aware of any ATIS service, can be retained as active long-term users. That's where the other factors listed earlier come into play.

ATIS User Profiles

Individual travelers vary in many ways that influence their potential responses to ATIS services, including demographic characteristics (such as age, education, income, family status), and attitudes towards information technologies of the types evaluated under the MMDI program (such as comfort with computers and the Internet, propensity to take risks with new technologies, personal reactions to deadlines or traffic delays, need to plan ahead). As part of the overall MMDI evaluation, respondents in a long-standing representative household panel survey of travel behaviors and attitudes in Seattle, were segmented into eight groups based on their responses to a series of attitude questions.[12] Subsequently, respondents to each of five of the MMDI Customer Satisfaction ATIS surveys were assigned to these segments. Four of these surveys were conducted with users of selected Seattle ATIS applications.

Figure 3-2 presents demographic data for occasional and frequent users of four of the ATIS services in the Seattle area. The data indicate that females predominate as users of both Transit Watch and Metro Online. Males are particularly likely to be users of the WSDOT Web site compared with females, especially as frequent users. We see that older retirement aged travelers rarely use either of the transit information services or the WSDOT Web site, but constitute a significant minority of users of TrafficTV. This underscores the value of offering a variety of ways for the public to have access to traveler information, under the presumption that some segments of the population will be more comfortable with some types of services compared with others. In this case, many older travelers prefer television to the more high technology applications such as the Internet for obtaining this kind of information.

Figure 3-2 also shows that the most frequent TrafficTV viewers tend to have lower education and lower household incomes, compared with the occasional users, and also compared with users of the high tech WSDOT Web site. The users of transit information, regardless of their frequency of use, tend to have less education and lower household incomes compared with users of the WSDOT Web site, though the users of the transit and traffic Web sites are more similar to each other.

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[12] See the draft user profile report for a detailed explanation of the methods by which these segments were identified. *Traveler Information User Profiles: Customer Satisfaction Evaluation.* Draft MMDI Evaluation Report. October 1999.

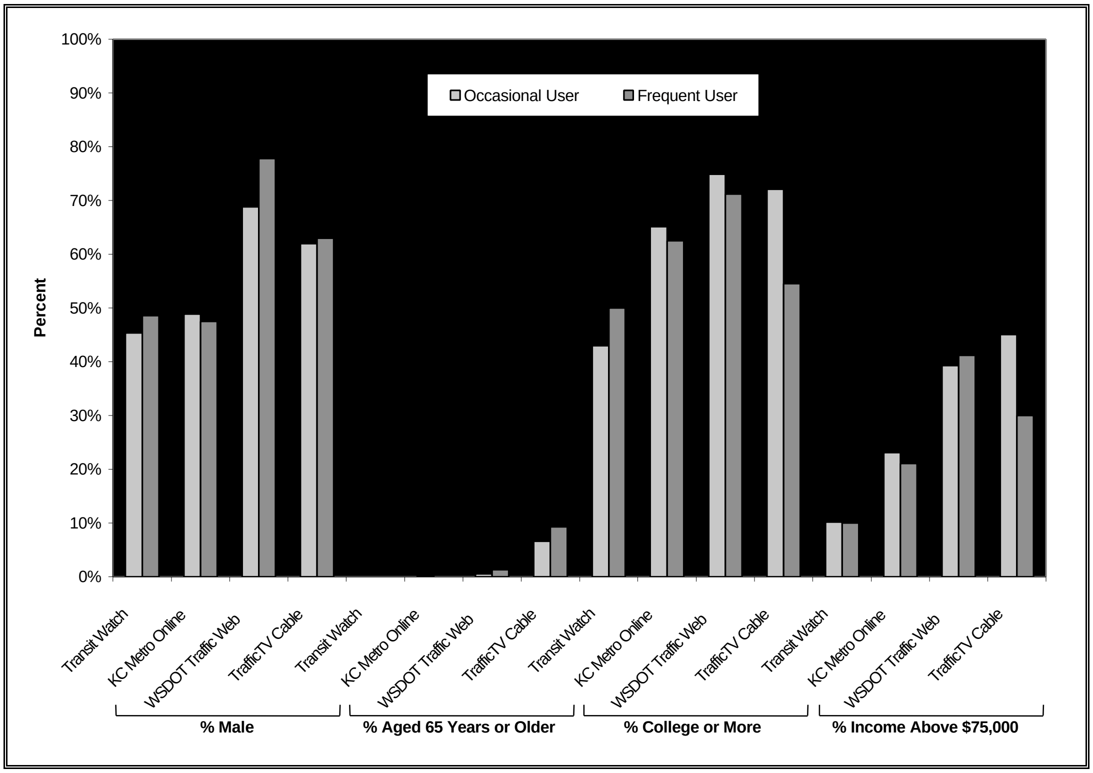

Figure 3-2. Comparisons between Occasional and Frequent Users on Gender, Age, Education, and Household Income.

The results of the user profiling analysis reinforce findings from the direct analysis of the individual survey data. As discussed in the User Profile report, individual characteristics help identify distinct user segments that are associated with a range of ATIS use patterns and offer insight into the identification of segments that are likely to be fruitful marketing targets for ATIS in the future. However, favorable *user characteristics* have to coincide with favorable *trip* and *regional characteristics,* and with *high quality* ATIS services to attract and retain satisfied customers.

ATIS Usage and User Satisfaction

For the most part, respondents in the Seattle area Customer Satisfaction evaluations found the ATIS services to be useful and beneficial. The more frequent users of these services typically rated them the most positively. They had specific suggestions for improvements that, if implemented, would presumably improve the service and enhance the satisfaction of these customers. Figure 3-3 shows that users of the WSDOT traffic Web site are very positive in their assessment of the quality of this service, regardless of how frequently they use it. The frequent users of TrafficTV rate that service much more positively than the occasional users, and almost as positively as users rate the WSDOT traffic Web site. Again, the data illustrate the apparent “niche” appeal of television as a medium for presenting traffic information.

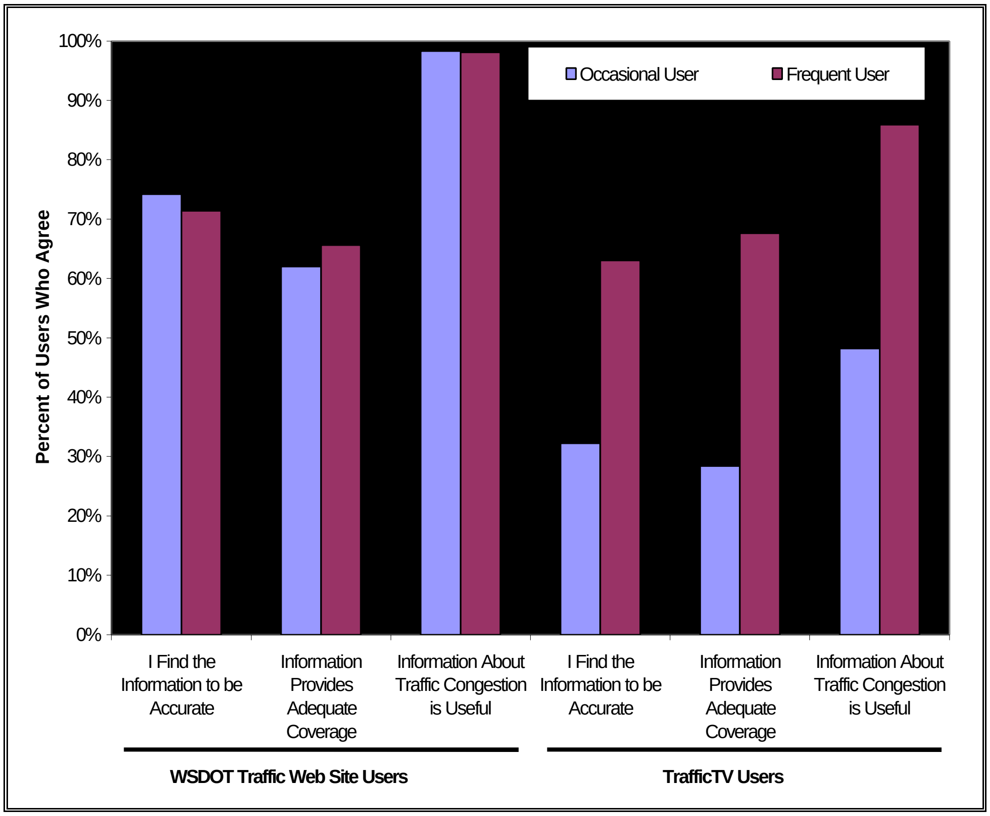

Figure 3-3. Comparisons between Occasional and Frequent Users on Accuracy, Adequacy, and Usefulness of Traffic Information.

Travel Decisions and Behavior Changes

Travelers access ATIS information sources because they seek to learn about current traffic conditions on or near the routes they plan to travel. If they are accessing this information prior to commencing their trip, they then have several choices they could make. They could make changes in their route, change the timing of their trip, change their mode of travel, decide to postpone or cancel their trip, or make any number of other minor adjustments to their trip plans. In two of the Seattle MMDI evaluations, respondents to the WSDOT Web site traveler information pages survey, and respondents to the TrafficTV cable survey, were asked how they might change their travel plans if they learned of a problem that would result in a 15-minute delay on their route. Figure 3-4 shows the results, represented as the average (mean) number of times the respondent said they would make the indicated behavior change out of five times. The data are based on the trip from work to home for the WSDOT respondents, and the trip from home to work for the TrafficTV respondents, as these are the two heavy ATIS use scenarios for these groups of users.

The data in Figure 3-4 suggest that, generally, frequent users are somewhat more likely to make a behavioral change than occasional users. Also, the TrafficTV users report a higher likelihood of making a number of different behavioral changes compared with the WSDOT Web site users. The most pronounced difference in behavior patterns is that WSDOT Web site users are more likely to elect to leave their office later when faced with problems on their route, and TrafficTV users are more likely to leave home for work earlier. This distinction makes intuitive sense. On average, some form of route change is slightly more likely than a timing change as the preferred way to avoid traffic problems, but this varies by user and circumstances. Mode changes are relatively infrequent.

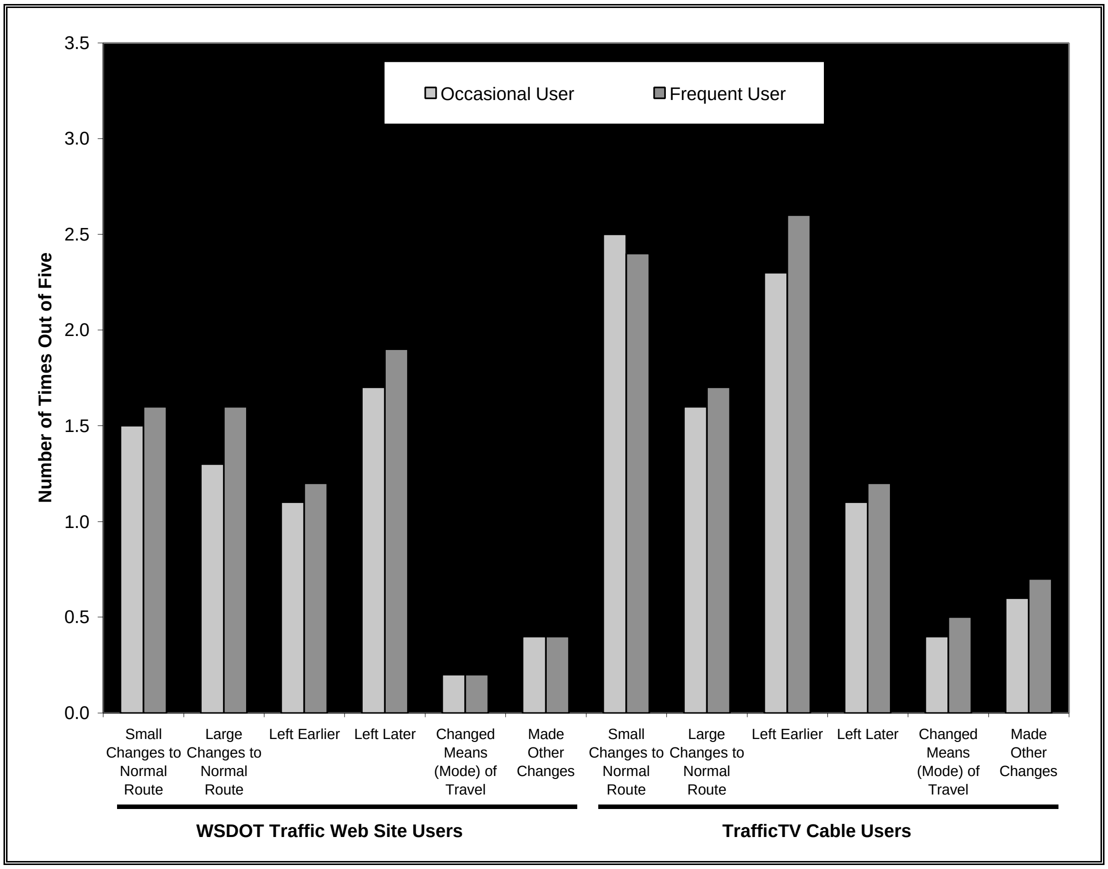

Figure 3-4. Comparisons between Occasional and Frequent Users Regarding Alternative Trip Decision Choices.

Implications for the Future of ATIS in the Seattle Area

It appears to be important to offer a range of different ways that consumers can acquire traffic information. While in some locations, in some markets, or for some user segments, customers may desire many options and prefer to select from a variety of pre-trip and en-route traveler information venues, others may prefer to stick with a few information sources with which they are most comfortable.

Evidence from the Seattle area focus groups and user surveys consistently indicates that travelers in the Seattle region are faced with significant traffic congestion daily, which is an important factor in motivating them to seek out and use high quality traffic information. The Customer Satisfaction evaluation has elicited a wide range of comments and suggestions that offer a valuable source of feedback that both the public and private sector service providers can use to further enhance the content and quality of these services. Effective promotion remains an important tool in raising levels of customer awareness, as the various evaluations illustrate that many travelers in the area are not using and have little or no awareness of the many ways to acquire traveler information. The insights gained from these evaluations about the profile characteristics of users and potential users that should help in efforts to better market the various traveler information products and services. Once users have discovered these services and the benefits they offer, they tend to continue to use them, and their satisfaction with and enthusiasm for these ITS tools dealing with the oppressive traffic congestion in the Seattle region is high.

3.2.2 WSDOT Web Site Evaluation

3.2.2.1 Project Description

The WSDOT Traffic Conditions Web Site provides people with a wide variety of traffic and travel information for the Seattle region. The site opens to a large colored map, referred to as the FLOW map, of the Seattle metropolitan region with major highways indicated. Highway segments are color coded to indicate current traffic volumes. The map reloads automatically every three minutes, as updated reports become available. Figure 3-5 presents snapshots from the WSDOT Web site showing Seattle and regional traffic flow conditions, video views, and local and regional transportation links.

Visitors to the site can choose different map orientations and more detailed maps of specific portions of the Seattle region — including the Tacoma area and the bridges across Lake Washington — to look at more information on road segments of interest. The page provides links to text descriptions of traffic incidents that may affect travel, as well as links to information on construction and road closures. There are camera pages that provide real time video images of traffic on selected roads. There are also links to mountain pass reports. The page contains links to information on other transportation alternatives, including transit, bicycles, and the Sea-Tac Airport. Also, there are links to information on express and HOV lanes, emergency road closures, air quality, and WSDOT travel information. The address for the site is http://www.wsdot.wa.gov/PugetSoundTraffic. Figure 3-6 shows a view of the WSDOT Northwest Regional TSMC that provides video input to the Web site.

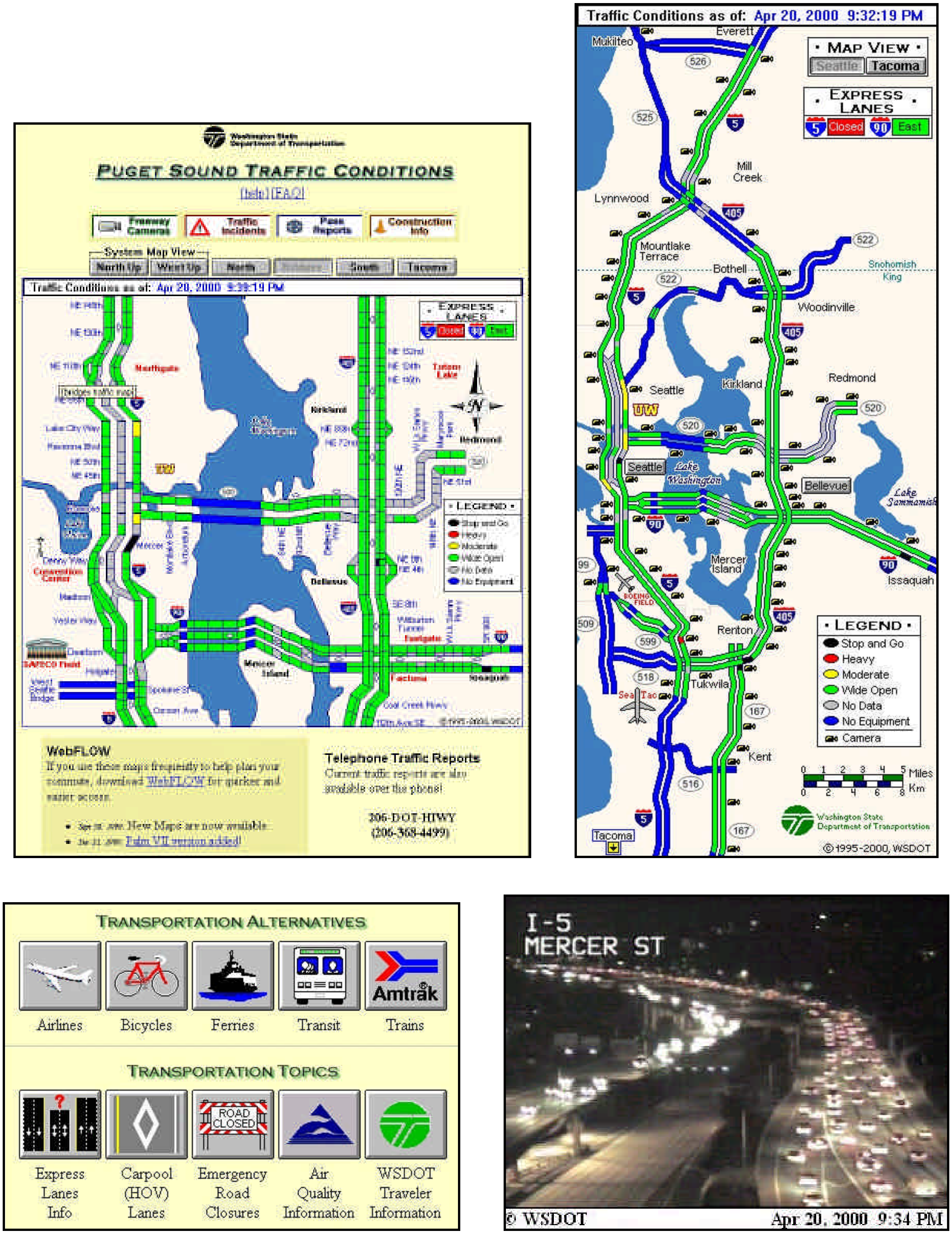

Figure 3-5. Snapshots of WSDOT Web Site Major Elements

Figure 3-6. WSDOT Northwest Regional TMSC Provides Web Site Video Inputs.

The MMDI costs to deploy the WSDOT Web Page are presented in Table 3-3 below. The major costs are the annual operations and maintenance costs. However, it is important to note that much of the Web site hardware and software costs had already been incurred before Smart Trek and are not included in this estimate.

Table 3-3. WSDOT Web Page Cost Estimate[13]

Equipment Description	Non-Recurring Costs	Recurring Costs
Web MIS & Technical Support Staff		$ 125,000
Web Content Staff		$ 125,000
14% Share of 3 Pentium Workstations & Associated Equipment	$ 3,393	
14% Share of Labor (including indirect costs and benefits)	$ 78,324	
14% Share of Other Direct Costs	$ 3,585	
14% Share of Hardware & Supplies (replaced every 2 years)		$ 1,696
14% Share of Fiber Link & Other Contractual Services		$ 2,428
14% Share of Operations Labor (3 UW FTEs)		$ 40,178
Totals	**$ 85,302**	**$ 294,302**

[13] Note that a 14% share of the ITS Information Backbone System cost elements have been included here as part of this cost estimate since relevant ITS information is either currently exchanged between this system and the Backbone, or because this system has the potential to interface with the Backbone in the near future.

In noting that two major ATIS Web pages were also deployed at two other MMDI sites (San Antonio and Phoenix), some conclusions on cost can be made regarding recurring costs. Here, the costs ranged from $32K for San Antonio, $108K for Phoenix, and $294K for Seattle (as shown above). There are three major cost drivers that explain this difference:

- Level of Automation: The Transguide Web Site in San Antonio is the most automated of the three, so its operating cost is less. The WSDOT Web Page, which has the highest operations cost, requires significant staff labor for creating real-time traffic maps, controlling video feeds, and generating Web traffic reports.

- Required Upgrades: The Phoenix TrailMaster Web Site at $108K has significant costs built into is operations and maintenance budget that allow for the replacement of the main server unit every two years.

- Use of Real-time Video: The Phoenix and Seattle Web pages utilize more real-time video feeds than the lower cost San Antonio Web page.

3.2.2.2 Evaluation Overview

The WSDOT Web site was selected as one of the ATIS projects under Seattle's Smart Trek program to be evaluated from a customer satisfaction standpoint. The objectives of the Customer Satisfaction evaluation of the WSDOT Web site follow:

- Understand who is using this service, including when and how they use it and frequency of use, and describe the characteristics of users based on a sample survey.

- Understand what aspects of the service are considered more useful or beneficial than other aspects, and what kinds of improvements or modifications are suggested that could enhance user acceptance and satisfaction.

- Understand how use of the WSDOT Web site compares with use of other available sources of traffic information for the sample.

- Understand whether and how use of the WSDOT Web site affects travel decisions and behaviors.

- Assess the value and benefits of the WSDOT Web site to users.

- Provide recommendations for enhancing the benefits of real-time traveler information provided over the Internet.

From May 11 through June 8, 1999, a banner on the WSDOT Web site invited all users to participate in an on-line survey to help improve the Web site. Users filled out the survey by clicking on the banner; they were then taken to a separate Web site that housed the survey questions. Incentives were offered to encourage participation in the survey. A total of 608 users of the Web site completed the questionnaire.[14]

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[14] A pilot version of the questionnaire was sent in late March to 23 people selected from those who had responded to an October, 1998, invitation to participate in focus group discussions about WSDOT Web site use. A total of 13

Readers are cautioned in their interpretation of these data for several reasons. First, all users of the site were solicited for their participation, and respondents are self-selected into the sample. Thus, we cannot know the number of potential survey respondents. Second, in interpreting these results, we cannot be confident that the respondents to the questionnaire are a representative sample of all WSDOT Web site users. We do not know how these respondents may differ from people who use the Web site but did not complete the questionnaire. Third, it is worth repeating that the sample is one of WSDOT Web site users, not of users of traffic and traveler information Web sites generally. We did not advertise for respondents on other Web sites to complete the questionnaire about WSDOT, so we do not have available detailed comparisons between WSDOT Web site users and users of other sites. Based on these cautions, the results from this analysis should be considered suggestive. Additional research will be needed to confirm these findings.

3.2.2.3 Results

Who used the WSDOT Web Site, when/how they used it, frequency of use, and user characteristics

The majority of the sample was male (71 percent) and tended to use a wide range of different communications media. An overwhelming majority of the sample (nearly 89 percent) said they considered themselves to be comfortable using high-tech equipment, giving themselves a rating of 9 or 10 on a scale from 0 to 10. Nearly 94 percent could access e-mail or the Internet from work or school. The vast majority of respondents were commuters — 95 percent — who said that they commuted to a workplace outside their home or to school or college at least three days in an average week. When asked what modes of commuting they usually used, over 87 percent of commuters said they usually commuted by driving alone in a car, sport utility vehicle, or van. About 23 percent said they usually traveled with family or friends in a household vehicle, and nearly 13 percent said they used public transportation (other than a ferry). The sample tended to be composed of long-term users of the site. Eighty-three percent of all respondents said that they had first used the site anywhere from six months to two years prior to completing the questionnaire.

Most respondents, 47 percent, said they learned about the Web site by hearing about it from someone else. Learning via the Internet was the next most popular means: 18 percent said they found the WSDOT page from a link from another Web site, and 17 percent said they had searched the Web for traffic information and came across the site. The percentages of respondents learning about the site from radio, television, newspapers or magazines, or other sources were small – less than 4 percent each. Women were more likely than men to say that they learned about it from someone else, and men were more likely to say they located the site through the Internet.

Ninety-eight percent of the sample said that they consulted the WSDOT Web site once or more per month for traffic information. The average number of times respondents said they consulted the Web site for traffic information in the previous month was about 23.

Commute characteristics were related to frequency of use of the WSDOT Web site:

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respondents completed the pilot questionnaire. Since the pilot questionnaire was similar to the final version, these respondents make up part of the 608 total and are included in all of the following analyses.

- Users who could travel freeways most of the way accessed it more: 24.7 times in the previous month, compared with 19.1 times for those who did not travel freeways.

- People who could use alternative freeway segments consulted the site an average of 26.3 times in the previous month, compared with 23.1 times for those who could not select alternatives.

- Length of commute delay was also related to frequency of use. People who estimated a delay of 16 to 25 minutes due to congestion consulted the site an average of 28 times in the previous month. Those with estimated delays of 15 minutes or less, or of 26 minutes or more, consulted the site less frequently.

Respondents to the questionnaire used the Web site for a wide range of different types of trips. About 90 percent of commuters[15] used the Web site for information about their commute trips. They also used it for business travel in the course of work in the region (41.0 percent), and for personal appointments, such as going to the doctor (35.0 percent). Fewer commuters used the site for trips to visit friends and relatives (27.4 percent), recreational trips (26.9 percent), or shopping (13.5 percent). This is supported by the WSDOT Web log data analysis, which shows that the site is used much more heavily during the weekdays than on the weekends.

For the period May 1998 to April 1999,[16] the level of usage of the Seattle WSDOT traffic information Web pages ranged from a low of 236,653 user sessions in August 1998 to a high of 497,192 user sessions in December 1998. As detailed in Figure 3-7, the level of use, measured as average daily number of user sessions, has grown significantly over the period of observation, doubling on average over the period of observation, and can be expected to continue to increase in the future, assuming server capacity is enhanced to handle additional user demand with a high level of service.

As is the case with other traffic Web sites, travelers have a strong preference for dynamic traveler information over other static forms of information, including frequent updates on traffic flow and speeds, along with real-time camera views of traffic conditions. Eight of the top ten page views on the WSDOT site recorded in April 1999 involved camera or video-related material.

The impact of weather events was evident in the December 1998 usage levels. Figure 3-8 shows the number of user sessions for each day in the month of December 1998. The average daily number of user sessions for the 31 days in this month was 16,038, which is the highest level reached between May 1998 and April 1999. One of the reasons that the number of user sessions increased so much in December is because of the effects of three severe snow and ice days in Seattle. Travel was significantly restricted, there were many snow-related highway incidents, and all this occurred during the Christmas holiday. The worst impacts occurred between December 19 and 21, and Figure 3-8 reflects the component of the traffic Web site activity that can reasonably be attributed to this event. These effects are all the more noteworthy given that two of the three days were weekend days, a period of much lower Web usage.

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[15] Commuters were defined as people who indicated that they went to a workplace outside their home, or to school or college, at least three days in the average week. Thus, there are people whom we label non-commuters who do make commute trips, but they travel from home on average less than three days per week.

[16] This period was selected to include the bulk of the MMDI project deployments, with May 1998 generally preceding those deployments and April 1999 being the most recently available month of log data.

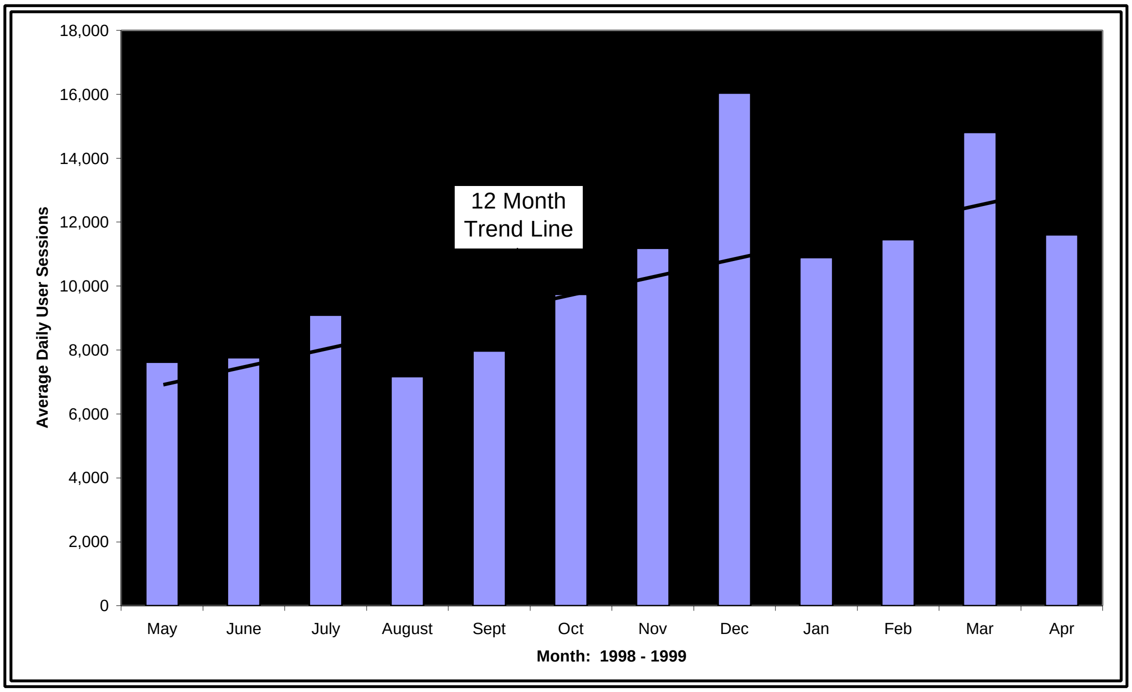

Figure 3-7. WSDOT Web Page Usage from May 1998 to April 1999.

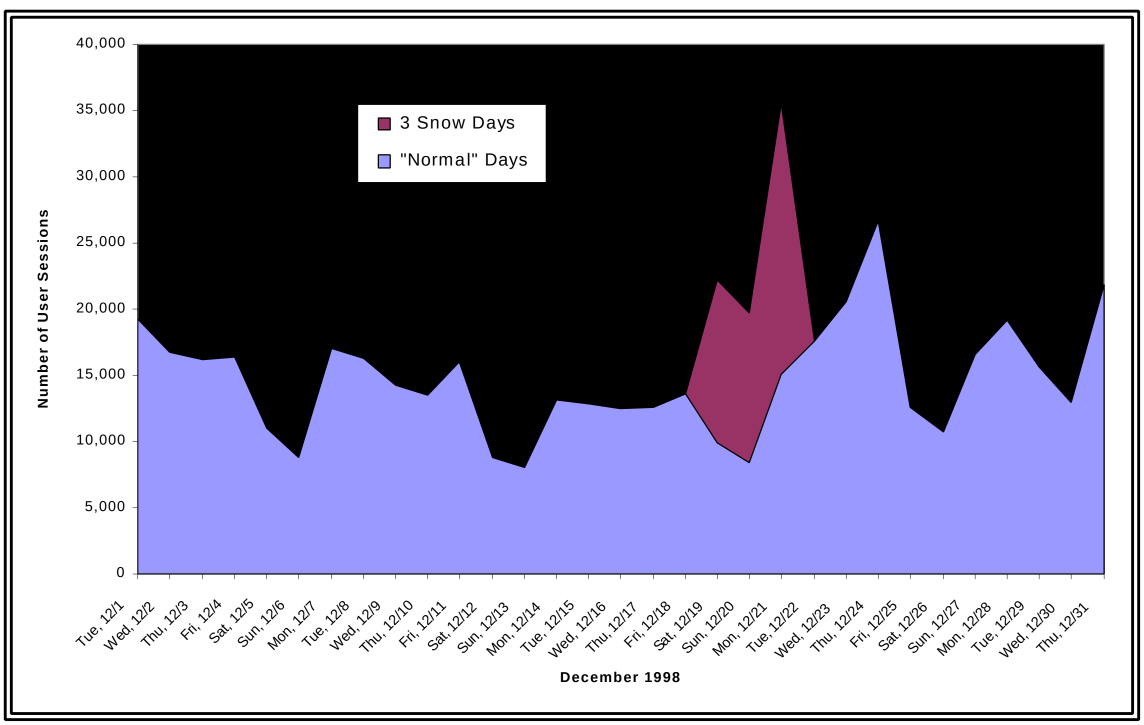

Figure 3-8. Number of User Sessions during a 1998 Winter Storm.

Aspects considered most useful or beneficial, and suggested improvements or modifications

Respondents were generally satisfied with the current features on the Web site:

- Over 60 percent agreed that the Web site provided adequate coverage about traffic conditions along the routes they traveled.

- Nearly three-quarters of the respondents agreed that they were satisfied with the accuracy of the congestion information shown on the Traffic Conditions map.

- Eighty-seven percent of respondents disagreed that it was “difficult to interpret the colored bars on the Traffic Conditions map.”

People generally had very enthusiastic reactions to the Web site in their open-ended comments, although many also took the opportunity to encourage WSDOT to expand its coverage and services. Additional coverage of highways, Seattle streets, Tacoma, and areas north were the most frequent spontaneous suggestions for improvements to the WSDOT Web site.

Over half of the sample expressed concern with the timeliness of information over the Internet, indicating some degree of agreement with the statement that “The traffic information from the WSDOT Web site is already out of date by the time I get out on the road.”

To identify suggestions for improving the Web site, respondents were asked to assess features of the Web site in several different ways. First, they were presented with a list of possible improvements to the site and asked to rank the three that they considered to be the most important. Second, they were asked to agree or disagree with statements about the presentation of information on the site. Finally, respondents had several opportunities to write open-ended comments with their suggestions for the Web site. A summary of the results is as follows:

- Among the choices presented, the most popular suggestions for additions to the Web site were filling in the gaps on the freeway network where traffic flow data were currently not available (59.1 percent) and adding more major roadways and arterials to the traffic conditions map (57.1 percent). Users were also in favor of receiving estimates of travel times between two points that they specified (44.7 percent) and of direct measures of speed for each freeway segment (34.5 percent). All other improvements were favored by fewer than 20 percent of respondents.

- Three-quarters of respondents agreed with a statement that they “would like to see more details on traffic incidents (such as expected duration of congestion) included with the traffic information pages on the WSDOT Web site.”

- A majority — almost 60 percent — also agreed that “it would be helpful to include the local weather conditions along with the traffic information on the WSDOT Traffic Conditions map.”

- In open-ended comments, after expansion of traffic information coverage, the most frequent features respondents indicated they most wanted to see added were incident information or icons on the FLOW map, integrating cameras into the FLOW map, traffic speed information, and other features similar to what Sidewalk.com had provided (including recommended alternate routes and travel time estimates).

- Some respondents wished for no changes at all, and worried about the possible impact of additions to the site in terms of server response time.

- A number of respondents indicated that they wanted the ability to customize the WSDOT maps in a variety of ways. Some wanted smaller maps to fit computer screens, others wanted larger ones. People also wanted the ability to look at just the information that they needed.

- Several people complained about the way in which the page reloaded: “I can’t stand the fact that every time the page refreshes, it goes back to the top of the page and I have to scroll down to see the map again. Please allow a page to refresh and not go back to the top.”

- A number of respondents noted that understanding the direction the cameras were pointing was difficult: “I don't use the camera shots much because they take a long time to download and I can't easily tell which direction they're facing. It takes too much time to figure out which lanes are traveling in which directions. Better labeling would help.”

How use of the WSDOT Web Site compares with other sources of traffic information

Relative to other sources of traffic information, respondents highly rated the usefulness of the WSDOT Web site. Eighty-five percent of users said they found the WSDOT traffic pages very useful, and 99 percent said they were useful or very useful. No other source was rated so favorably. Eighty-seven percent of users rated personal experience and traffic knowledge as useful or very useful, followed by traffic reports on the radio (84.5 percent); electronic highways signs (73.8 percent); highway advisory radio (57.0 percent); and traffic pages on other Web sites (44.6 percent). Users rated TV news reports as not very or not at all useful most frequently (43.2 percent).

Commuters were asked what times of day they regularly consulted different sources of traffic information. For the trip to work or school, most commuters relied on the radio for information on traffic conditions (60.9 percent), followed by TV reports (26.4 percent). About one-fifth of the commuters (21.8 percent) said that they checked the WSDOT traffic congestion maps before leaving for work, and only 13.2 percent said they checked the WSDOT camera pages. Less than 1 percent of this group said that they consulted other Web sites for traffic information. Just under 11 percent of commuters (10.9 percent) said that they did not consult any traffic information sources before leaving for work or school.

En route, radio is the dominant source for traffic information: 90.2 percent of commuters reported that they used the radio as a source for information on traffic conditions while traveling to work or school. Surprisingly, 1.3 percent of commuters said that they checked the WSDOT traffic congestion maps while en route, and 1.1 percent reported that they checked the camera pages.

Use of the WSDOT Web site dominates the trip from work or school: 90.2 percent of commuters said that they checked the WSDOT traffic congestion maps before leaving work or school, and 61.8 percent said they consulted the camera pages. The next most widely used source was radio, with 28.3 percent of commuters reporting that they listened to traffic reports on the radio before leaving from work or school. Traffic information on other Web sites was used by only 4.8 percent of this group. Only 3.8 percent of commuters said that they did not consult any sources for traffic information for this type of trip.

The pattern of heavy use of the Web site for the trip from work or school reflects the trends seen in the WSDOT Web log analysis. Those data show that Web use experiences a small peak between 7:00 AM and 9:00 AM and a much more pronounced peak between 2:00 PM and 5:00 PM, when people are likely to be considering their trip from work or school. The pattern of use also supports people's beliefs about the traffic situation in the Seattle region; nearly 57 percent of respondents indicated some level of agreement with the statement that they found "it much harder to predict what traffic conditions will be like for the afternoon commute than for the morning commute."

How use of the WSDOT Web site affects travel decisions and behaviors

People reported using the site most frequently for the following:

- determining traffic congestion on their route (99.3 percent)
- judging the effects of incidents or unusual congestion on a trip (96 percent)
- helping to decide among alternative routes (94.8 percent)
- providing reliable indications of how long a trip would take (92.1 percent)
- helping to decide when to start a trip (88.5 percent).

Travel behavior for the majority of trips to work or school seemed unaffected by use of the WSDOT Web site, primarily because use of the Web site is greatest for the trip from work or school. Most respondents who indicated that they made some sort of travel change for this type of trip reported that they checked neither the WSDOT flow maps nor the camera pages prior to these trips. Respondents may feel less need to check the Web site for the trip to work or school since they seemed to generally feel that their morning commute was more predictable than the afternoon commute.

Because so few respondents check the Web site for their trip from home to work, travel choices for this trip were examined for all commuters in the survey sample.[17] The most frequently checked travel behavior changes among commuters for the trip to work or school were leaving later (52.8 percent), small changes to the normal route (51.4 percent),taking a whole different route from the normal one (49.3 percent), and leaving earlier (46.1 percent). People were less likely to report that they added stops (17.3 percent); decided not to make the trip at all (10.5 percent); or changed mode (8.8 percent). About 13 percent of the sample (13.3 percent) reported that they made no changes to these trips in the previous four weeks.

Since most of the commuter respondents to the survey consult the WSDOT Web site for their trip from work to home, travel choices for this trip segment were examined for those commuters who reported they consulted the Web site prior to their trip (either the FLOW map or camera pages). Over 71 percent of these commuters said that they had left later. The next most frequently cited behavior change was making small changes to route (64.8 percent), followed by taking a whole different route from their normal one (61.8 percent). Over half (53.0 percent) of those who consulted the Web for this type of trip indicated that they had left work or school earlier, and just over a third (35.9 percent) said that they had added stops that they otherwise

[17] For this question, respondents were asked to check any behavior change they could remember having done at least once in the last four weeks.

would not have made. Only 8.1 percent said that they chose not to make the trip, 7.6 percent said they changed mode, and 5.5 percent said that they had made no changes at all.

Among people who said they checked either the FLOW map or camera pages before leaving from work or school, 41.2 percent of respondents said that leaving later was the most likely change they would make.[18] Thirty-nine percent said that their most likely change was in route, either taking a whole different route (20.1 percent) or making small changes to their normal one (18.7 percent). Only a few respondents (9.8 percent) said that their most likely change was to leave earlier.

Value and benefits of the WSDOT Web Site to users

Users were asked to agree or disagree with statements about the different kinds of benefits that use of the Web site generated for them.

- Overwhelmingly, 93 percent of respondents agreed with the statement that “using traffic information on the Web has helped me to save time.”

- Respondents believed that the Web site helped them to avoid traffic incidents and congestion. Eighty-one percent *disagreed* with a statement that the information from the Web site did *not help* them avoid traffic problems.

- About one third of the sample agreed that they used the information from the Web site to help them avoid unsafe driving conditions.

- Almost three-quarters of the respondents agreed that access to the Web site had helped them “reduce the stress of traveling in the Seattle area.”

Respondents were not asked about their willingness to pay for access to WSDOT Web site, but they were asked about their feelings toward subsidizing the WSDOT Web site with advertising revenue. People were asked to report their level of agreement with the following: “I wouldn’t mind seeing advertisements on the WSDOT Web site if they didn’t interfere with my ability to get timely traffic information.” Respondents were generally split on this issue, divided pretty evenly between agreement and disagreement. There was a more polarized negative response, however, with nearly 20 percent of users disagreeing completely with this statement. Only about 10 percent of users said they agreed completely.

Nearly 60 percent of the sample said they used the WSDOT Web site to decide whether road conditions make it unsafe to drive. Just over half of these respondents (51.3 percent; 30.5 percent overall) said they found the site useful or very useful for this purpose.

Nearly half of the commuters (48.3 percent) reported that they consulted the WSDOT Web site when they were considering traveling during severe or extreme weather conditions. Respondents who indicated that they did check the Web site in severe weather conditions were then asked how often they made various changes or adjustments to their travel behavior:

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[18] For this question, respondents were asked to check the one behavior change that they were likely to make most often as a result of learning about traffic problems before leaving on their trip.

- Leaving earlier was cited most frequently; 28.1 percent said they left earlier often, and 53.2 percent said they sometimes left earlier.

- Nearly two-thirds (66.3 percent) said they often or sometimes left later when faced with bad weather.

- Over half the commuters (54.2 percent) said they often or sometimes made no adjustments to their usual travel behavior in the face of inclement weather.

- Forty-four percent reported that they often or sometimes would decide not to make the trip at all.

- Mode shift was the least likely travel behavior adjustment, with only 18.5 percent of the commuters saying they would change their means of travel often or sometimes.

3.2.2.4 Summary and Discussion of Major Findings

The Major Findings of this analysis are summarized and discussed below:

- Respondents to the questionnaire were comfortable with high-tech equipment and open to new products and services. Respondents to the questionnaire were more likely to be male and tended to have higher levels of education and income. They were likely to be commuters. They overwhelmingly could access the Web site from work or school, and used portable communications devices such as cellular phones and pagers. Due to the nature of the sample, however, it cannot be known what proportion of all WSDOT Web site users fit this profile.

- Respondents rank the WSDOT Web site as their most useful source of information on traffic conditions. The WSDOT Web site is on average rated more favorably than any other source of traffic information that respondents used, including radio and television reports.

- The WSDOT Web site is heavily used for commute trips. Regular commuters used the Web site most frequently for the commute trips that they took. In particular, commuters overwhelmingly accessed the Web site for the trip from work or school. Commute characteristics affected use of the site.

- Commute flexibility had a different relationship to use depending on the type of commute trip. In the trip to work or school, those who had less flexibility were more likely to use the WSDOT Web site than those who had more flexibility. Perhaps these respondents worked at jobs where they had less flexibility in their arrival time and thus used the Web to reduce uncertainty in their travel time. In contrast, in their commute from work or school, commuters with greater flexibility were more likely to consult the Web site. This may be again due to type of job – people with more flexibility in their commute from work or school are more likely to work at jobs (or be at school) where they have access to the Web or the Internet.

- People emphasized avoiding traffic congestion and time savings as their main reasons for making changes to their trip from work or school. Nearly 97 percent of commuters who used the WSDOT Web site for this type of trip said avoiding traffic congestion was a very or somewhat important reason for making the changes they did.

- Reducing stress was cited by a number of respondents as an important benefit of using the Web site. Nearly 75 percent of respondents agreed that access to the Web site had helped them “reduce the stress of traveling in the Seattle area.” Several people mentioned in their open-ended comments how using the Web site reduced the stress of commuting specifically.

- Safety plays some role in use of the WSDOT Web site, but it is not people's primary concern. Respondents indicated that safety considerations, such as whether weather conditions made it unsafe to drive, were somewhat important reasons for using the site (and less important than saving time and avoiding congestion), but did not seem to affect travel behavior.

- Respondents generally like the existing features on the WSDOT site. Most respondents indicated that they were satisfied with the existing WSDOT features. Their suggestions for improvement tended to focus on expanding the geographical coverage by filling in the gaps on the Traffic Conditions map where data for road segments were unavailable, and adding information on additional road segments to the Traffic Conditions map. These suggestions were particularly strong in the open-ended comments. Respondents indicated that they would also like to see incidents indicated on the FLOW map, an indication of traffic speeds on the roadways, and integration of the camera and FLOW map pages. Respondents also wished for options that would allow them to customize the page, from sizing the map to fit their screens better, to setting preferences so the page would open to the information of particular interest to them. A number of respondents commented that the information on both the FLOW map and camera pages needed to be updated more frequently.

3.2.3 UW Cable Television “Traffic TV” Evaluation

3.2.3.1 Project Description

Traffic TV is a traffic information program broadcast to subscribers of AT&T Cable Services[19] in the Seattle region at various times during the morning and evening commute periods and over the noon hour. The program format and presentation were designed and produced by the University of Washington, and it is broadcast on local cable TV Channel 76, one of two educational channels produced by the University of Washington. Traffic TV has been placed on the air for a limited period of time to assess its value to Seattle area travelers. It is sponsored and financed under the Smart Trek MMDI program.

The Traffic TV program was aired initially on June 1, 1998, and reached an estimated 60,000 households. AT&T Cable Services has been building out its service in the region and increasing the number of households that can access this channel. By early 1999, AT&T estimated that about 105,000 households had viewing access to Traffic TV, primarily in King County. AT&T anticipated completing its digital build-out by March 2000, at which time Traffic TV was expected to be available in 484,000 households in King and Pierce Counties. Figure 3-9 presents two typical displays for Traffic TV.

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[19] Formerly TCI Cable, Inc.

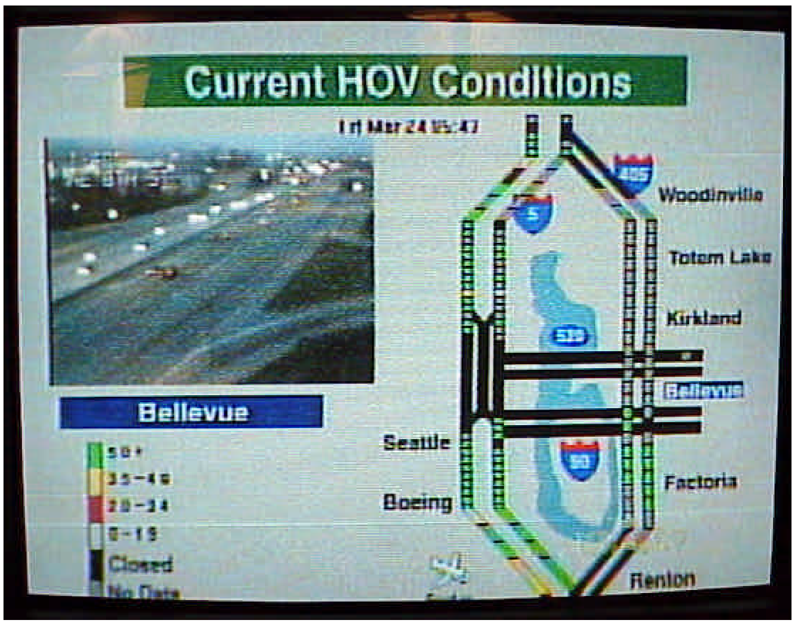

Figure 3-9. Traffic TV Typical Displays.

The Traffic TV broadcasts are shown a total of 10 and a half hours a day, from 5:00 AM to 9:00 AM, 11:00 AM to 1:30 PM, and 3:30 PM to 7:30 PM, seven days a week. They are composed of a 30-second sequence that displays four Seattle region traffic speed maps (taken from the Washington State DOT traffic Web site) for a period of 7.5 seconds each. The broadcast rotates 15 minutes of Traffic TV, followed by 5 minutes of Seattle region satellite weather maps. Traffic video images acquired from four different roadside cameras display live video of the major congestion points in Seattle and Bellevue. The map images alternate between main line traffic and high occupancy vehicle lanes. The live video images alternate from Seattle, Bellevue, and both the bridges over Lake Washington. Color-coded map displays show traffic speeds. Background music is played during the broadcast, and there are no spoken messages.

The MMDI costs to deploy Traffic TV are presented in Table 3-4 below. The major costs of this project were the labor costs for the development of the system. Of note, annual operations and maintenance costs for the project are estimated to be approximately 38 percent of the deployment costs. The relatively high costs of operations are mainly due to the annual television airtime charges for the program.

Table 3-4. Cable Television Traffic TV Cost Estimate[20]

Equipment Description	Non-Recurring Costs	Recurring Costs
Hyperconverter	$ 3,484	
Pentium Pro 200 mHz	$ 4,767	
Video Converter Card, DeMux and Mux	$ 8,265	
Other Equipment (Proposed Budget)	$ 40,000	
Supplies and Materials	$ 2,685	
Labor (Including Indirect Costs and Benefits)	$ 170,805	
Contractual Services	$ 3,700	
UWTV Station Airtime Charge		$ 78,000
14% Share of 3 Pentium Workstations & Associated Equipment	$ 3,393	
14% Share of Labor (including indirect costs and benefits)	$ 78,324	
14% Share of Other Direct Costs	$ 3,585	
14% Share of Hardware & Supplies (replaced every 2 years)		$ 1,696
14% Share of Fiber Link & Other Contractual Services		$ 2,428
14% Share of Operations Labor (3 UW FTEs)		$ 40,178
Total	**$ 319,008**	**$ 122,302**

3.2.3.2 Evaluation Description

Traffic TV was selected as one of the ATIS projects under Seattle's Smart Trek program to be evaluated from a customer satisfaction standpoint. The objectives of the Customer Satisfaction evaluation of the Traffic TV were to assess the extent of awareness of this service:

- Understand who was using this service, including when and how they use it, and describe the characteristics of users and non-users.
- Understand what aspects of the service are considered more useful or beneficial than other aspects, and what kinds of improvements or modifications are suggested that could enhance user acceptance and satisfaction.
- Understand whether and how use of Traffic TV affects driving decisions and behaviors, including the factors that help explain these behaviors.
- Assess the value and benefits of Traffic TV to users.

[20] Note that a 14% share of the ITS Information Backbone System cost elements have been included here as part of this cost estimate since relevant ITS information is either currently exchanged between this system and the Backbone, or because this system has the potential to interface with the Backbone in the near future.

- Provide recommendations for enhancing the benefits of real-time traveler information provided over cable TV.

The evaluation had two components: a qualitative focus group and a quantitative mail-out survey questionnaire. The purpose of focus groups was to develop in-depth understanding of attitudes and behavior, and to help shape the questions for the survey. The remainder of the discussion below focuses on the mail-in survey administration and results.

Working closely with AT&T Cable Services, a stratified, random sample of 10,000 households with access to this program was identified from 21 Seattle zip codes (all on the west side of Lake Washington). Somewhat less than half of all households in the sampled zip code areas were believed to have access to Traffic TV, though there was a lot of variability across zip code areas due to the different stages of AT&T's service buildout. Questionnaires were mailed to the households during the week of April 19, 1999, under Smart Trek letterhead. For legal reasons, no incentives were offered to encourage responses. As of June 1, 1999, 1,705 (17 percent) completed questionnaires had been returned (226 viewers and 1,479 non-viewers). This sample of viewers constitutes 13.3 percent of the returned questionnaires, which is an estimate of the viewership rate in the population. Of the 1,479 non-viewers, 226 were randomly selected and included in the analysis. The 452 returns were edited, cleaned, keyed, and verified and made available for analysis July 29, 1999. After cleaning the data, the final sample included 223 viewers and 222 non-viewers for a total working sample of 445.

In order to allow the survey findings to represent the population of households with viewing access, the sample was weighted to adjust for differential non-response by zip code and to scale up the non-viewer component of the sample to reflect the actual number of returns from non-viewers by zip code.

3.2.3.3 Results

Respondent Characteristics

Respondents in the weighted, representative sample are older, better educated, and have higher household incomes compared with the general metropolitan area population. Most also report that they personally use at least once a week a variety of high technology communication and information devices, such as personal computers at home (64.0 percent) or at work (62.8 percent), the Internet at home (51.2 percent) and at work (45.7 percent), and cell phones (50.5 percent). The majority commute at least three days in an average week (75.1 percent), mostly in personal vehicles (84.2 percent). Public transportation other than a ferry is used by 15.9 percent. The sample is split between those who say they regularly watch television weekday mornings or evenings (49.8 percent say they do watch TV). As expected, respondents who say they have ever watched Traffic TV are more likely to regularly watch morning or evening television, but 37.5 percent of Traffic TV viewers say they *don't* regularly watch television.

Awareness of Traffic TV

Viewers of Traffic TV were asked to indicate how they first found out about this traffic program. Most reported that they found it while flipping through the channels on their television (85.8 percent). A few found out from friends (3.9 percent), and some learned about it by having received the survey (2.4 percent). The remainder reported other ways or said they couldn't remember how they first heard about it. This helps explain why more people whose households are connected to cable with access to this program have never seen the program. The higher numbered broadcast channels may not readily be encountered through casual channel surfing, and there has been no formal campaign to advertise or promote this traffic information service.[21]

Who used Traffic TV, when/how they used it, and user/non-user characteristics

While the Traffic TV program has been available for viewing by these respondents for about a year, the sample is composed mostly of very recent viewers. Among viewers, 43.3 percent had been watching for one month or less, just over half (50.6 percent) had watched for two months or less, and 88.0 percent had watched for six months or less prior to the survey. More reported viewing Traffic TV in the mornings (41.1 percent) than the afternoons (25.0 percent) or during mid-day (11.1 percent). This is logical, given that 78.4 percent of the users of Traffic TV are commuters, and commuters are less likely to have access to a TV at their office during the day. Commuters are as likely as non-commuters to view Traffic TV in the mornings (41.2 percent vs. 40.0 percent), but much less likely than non-commuters to view mid-day (9.1 percent vs. 18.4 percent) or afternoons (21.7 percent vs. 37.5 percent).

Users are more likely to be male (62.0 percent male vs. 38.0 percent female). Education and income appear unrelated to having ever viewed Traffic TV. Traffic TV viewers in Seattle were less likely to be elderly, in contrast to traffic TV viewers in Tempe, AZ, who were more likely to be elderly.

Frequency of Use. A little less than one-third of the viewers of Traffic TV (29.2 percent) watch the broadcasts more than once a week, 31.3 percent watch two to four times a month, and 39.5 percent watch less than once a month.[22] Those who have been viewers for the longest period of time are much more likely to be frequent viewers than those who recently started watching. Over half (56.7 percent) of the viewers have been viewers for two or more months, and 40.4 percent of them watch more than once a week.

Aspects of Traffic TV considered most useful or beneficial, and suggested improvements or modifications to enhance user acceptance and satisfaction

The survey asked respondents who had seen Traffic TV to agree or disagree with opinion statements describing different aspects of program, such as how information is presented, the content of the program, and its value to the viewer. Overall viewers responded as follows:

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[21] Note that WSDOT did issue a press release announcing this service, and several of the news media, including the local network TV stations, ran stories on Traffic TV.

[22] After adjusting for non-responses and invalid responses to the frequency of use question in the weighted sample, 57 respondents report that they view TrafficTV more than once a week. These are our "frequent viewers," who constitute approximately 4 percent in the population.

- 75.4 percent would like to be given more information about the type and extent of incidents, special events, and trouble spots.

- 65.4 percent want an indication of the direction of traffic flow as shown on the camera view.

- 63.9 percent would like the same type of information to always appear on the same part of the screen;

- 63.8 percent would like the broadcasts to suggest alternative route possibilities when there are conditions that slow or block traffic.

- 60.5 percent of the respondents would like to hear a voice describing what is happening on the maps.

- 54.7 percent feel that the explanation of the different traffic speeds is too small to read easily.

- 53.2 percent would like the broadcast to help them decide whether road conditions make it unsafe to drive.

- 45.0 percent feel that the way in which the screens change from one view or map to another is distracting.

- 26.0 percent would like to have a number they could phone with suggestions for improvements to Traffic TV.

In addition, several statements ask about the usefulness and accuracy of Traffic TV:

- 44.6 percent agree that the broadcasts provide adequate coverage about travel conditions along the routes they travel.

- Only 5.0 percent find that the information on *Traffic* TV is inaccurate.

- 43.1 percent find the weather information on Traffic TV useful.

- 47.9 percent agree that Traffic TV helps them to avoid traffic congestion.

- 34.2 percent report that Traffic TV lets them estimate how long their trip will take.

Those who had ever viewed Traffic TV were also asked if they had any other comments about how Traffic TV could be improved to make it more useful. Far and away the most commonly suggested improvement was for more cameras and camera coverage, especially to provide coverage of arterials and major intersections. Some respondents felt that Traffic TV should be better publicized. A few viewers suggested showing maps by districts and collecting and displaying additional information. In addition, several mentioned specific areas that they would like to see added to Traffic TV.

Value and benefits of Traffic TV to users

Frequent users place significantly greater value on Traffic TV than do less frequent viewers. While, overall, only 6.9 percent of the viewers report that they would be willing to pay an extra

$1 each month with their cable bill for Traffic TV, frequent viewers are much more likely than occasional viewers to report that they would be willing to pay (16.1 percent versus 0.8 percent).

3.2.3.4 Summary and Discussion of Major Findings

The Major Findings of this analysis are summarized and discussed below:

- Out of the 223 respondents who said they had ever watched the Traffic TV broadcasts, 85 percent said they found out about the broadcast while flipping through the channels on their TV. This is similar to what we learned about the traffic TV program in Tempe, Arizona, and indicates a fairly low level of awareness and use of this program in the population. It also suggests the potential value of promotional efforts to let cable viewers know about this program. Respondents even suggested more attention be given to promoting the program. Viewers of Traffic TV are much more likely to report that they regularly watch television weekday mornings or evenings (63.2 percent) than those who say they have not viewed the Traffic TV broadcasts (45.2 percent), and this is consistent with how they stumbled upon the Traffic TV program.

- Viewers of Traffic TV report that they also use a variety of other technologies, such as personal computers, the Internet, and pagers and are more likely to use these compared with non-viewers. However, when we look at the subset of viewers who are the most frequent users of Traffic TV, we find they are *less* likely to use these other technologies, though the differences generally are not statistically significant. These frequent users of television for traffic information fit the segment profile called “low-tech pre-trip info seekers” as defined and analyzed in a companion report.[23]

- Among all the users of Traffic TV*,* 45 percent say they use the broadcasts for commuting, and among just the regular commuters (who represent 75 percent of our entire sample), 55 percent use Traffic TV for commuting. The non-commuters are much more likely than commuters to use the program for other purposes, such as visiting friends, shopping, and recreation. Frequent viewers of the broadcasts also say they use the program for a wider variety of trip purposes compared with the infrequent viewers.

- Most commuters (80 percent) experience congestion that, on average, lengthens their normal trip by 8.6 minutes over what it would be if traffic were free-flowing. Most commuters (83 percent) disagree (mild to strong disagreement) with the statement: “I rarely encounter unexpected traffic congestion,” and almost half (48 percent) agree with the statement: “At least twice a week there’s an unexpected delay on my route.” The frequent viewers of Traffic TV are much more likely to experience congestion than less frequent viewers and non-viewers. On average, congestion adds 13.2 minutes to their commute every day, unless an unexpected event occurs to further increase their commute time.

- Route changes were the most likely choice for viewers who commute and said they had consulted any source of traffic information. The most frequently indicated behaviors are route changes (31 percent take a mostly different route; 22 percent make small route changes) and trip timing changes (20 percent leave earlier and 14 percent leave later). The reasons for these changes are to avoid congestion (94 percent say this is important to

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[23] *Traveler Information User Profiles,* a Customer Satisfaction MMDI report.

them), saving time (91 percent), using time more effectively (80 percent), reducing stress (74 percent), reducing the risk of an accident (40 percent), saving gasoline (32 percent), and saving miles (18 percent).

- Severe weather occurs from time to time in the Seattle region, and we asked commuters how they respond when learning from Traffic TV broadcasts about weather-related problems on their route. Under these conditions, such as high wind, heavy rain, snow, and ice, leaving earlier or postponing the trip altogether are much more likely responses than under normal congestion.

- In this survey we asked viewers of Traffic TV how they would respond when they learned that their trip from home to work/school would take 15 minutes longer than normal. Then we asked the same question under the condition of a 30-minute delay. Both these times exceed their average congestion delays by large amounts. Leaving earlier is the most frequently selected response given a 15-minute delay, followed by small route changes and large route changes. But when the delay is doubled to 30 minutes, respondents select each of these three options more often, and are *much more likely* to select a large route change. Among those who say they are less likely to make the small route change when faced with the 30-minute delay, 74 percent of them *increase* the frequency of selecting a large route change.

3.2.4 King County "Metro Online" Transit Web Site Evaluation

3.2.4.1 Project Description

Metro Online (http://transit.metrokc.gov/) is the Metro Transit Web site for the King County (WA) DOT. Metro Online provides users with information about Metro bus services in the Seattle metropolitan region, including schedules, routes, fares, and trip planning and transfer information. The Web site was launched in December 1994, as part of the federally-funded Riderlink Demonstration Project. Figure 3-10 presents a snapshot of the Metro Online Transit Web site main page.

3.2.4.2 Evaluation Description

A survey of the Metro Online Web site was carried out as part of the Customer Satisfaction evaluation. The survey had three main objectives:

- To characterize the Metro Online users and to compare their characteristics with those of transit riders using Metro Transit in general.

- To analyze the use of Metro Online, to understand what works well and what works less well for users, and to explore possible improvements to the Web site.

- To assess the satisfaction and behavioral responses of transit riders based on their use of the information provided on the Metro Online site.

Metro Online users were presented with this survey throughout the month of July 1999. The final sample of 571 completed questionnaires represents a self-selected group of respondents; therefore, they are not representative of all users of this Web site.

Figure 3-10. Metro Online Web Site Main Page Snapshot.

3.2.4.3 Results

Metro Online user characteristics and comparison with Metro Transit riders in general.

All the respondents were asked a series of questions regarding demographics, travel behavior, technology use, and awareness of the site. This information allowed us to construct a profile of the Metro Online respondent. Results of an independent 1998 survey of transit riders in the Seattle metropolitan region, commissioned by the King County DOT, facilitated the comparison of the profiles of the Metro Online user and the average Seattle region transit rider.[24]

Age. The respondents were younger than the general population of Seattle region riders. In particular, fewer Metro Online users were older than 55 years of age compared to the general population of transit riders (3 percent vs. 20 percent).

[24] Northwest Research Group, Inc., "1998 Rider/Nonrider Survey — Final Report," submitted to King County Department of Transportation, Transit Division, 1998. This is the most current in a series of annual rider/nonrider surveys.

Income. Respondent household incomes were not statistically different from the general population of Seattle transit riders reported in the 1998. In addition, similar to the general population of Seattle region transit riders, 46 percent of the survey respondents are male.

Education. The respondents indicated that 88 percent had attended at least some college. Comparable figures were not available for the general population of Seattle transit riders, but the average education for all transit riders is assumed to not be as high as in this sample.

Bus Usage. We found that bus use characteristics — longevity of use and intensity of use — in the sample were similar to those of transit rider characteristics in Seattle in general:

- About three-quarters of the respondents indicated they had been using the bus transit system for over a year.

- About 37 percent indicated that they used the bus for most of their transportation needs, 44 percent used the bus for some of their transportation, and the remaining 18 percent used the bus for a small proportion of their transport needs.

Use of Technology. Respondents were asked about their use and ownership of high-technology products such as cellular phones and personal computers. All the respondents were also asked a battery of questions designed to elicit information about their attitudes – questions relating mostly to travel, information seeking, and technology use behavior. No comparable statistics were available for the general population of Seattle region transit riders. These data indicate the following:

- As expected, most of the respondents indicated that they had regular access to desktop computers and the Internet.

- The respondents are comfortable trying out new technologies.

- Respondents strongly endorsed real-time bus information and statements such as "I feel better just knowing about traffic or bus delays, even if I can't do anything about them."

Awareness of the Web Site. Most users' first experience with Metro Online was through a Web search (33 percent). Other respondents indicated word of mouth (15 percent) and "surfing the Web" (13 percent). Few respondents (1.4 percent) first learned of the site through broadcast or print media. However, most of the 25 percent who stated that they learned of Metro Online through "other" means stated that they found out about the Web-site from bus schedules or posters on buses.

Metro Online usage, opinions, and suggested improvements.

Users of Metro Online services were asked how often they used Metro Online and a battery of questions about their opinions of the Web site. In addition, respondents commented on ease of use, and offered general comments and suggested improvements.

Metro Online Usage:

- *Metro Online attracts a significant amount of repeat use.* To the extent that repeat users are an indicator of a useful, relevant, and effective (well-designed) Web site, Metro Online fares well: about 40 percent of the respondents stated that they had been using the site for over a year, and 15 percent of them had been using it for more than two years. First-time users constituted about 14 percent of the sample.

- *Very few respondents accessed the site more than once a week on average.* About 80 percent (76 percent of the non-first-time users) accessed the Web site five or fewer times in the last four weeks. About 9 percent of respondents accessed the site 10 or more times over the previous four weeks.

Web Site Opinion Questions. Respondents answered the opinion questions by picking a number on an 11-point scale that ranged between -5 (complete disagreement) and 5 (complete agreement) with a score of 0 indicating indifference. In general, the survey responses show that a majority of respondents find the Web site an easier source for transit information than other available alternatives, though there were also many respondents who did not agree. We found the following:

- The respondents weakly *agreed* with the statement "Getting metro bus information from the Web is *much* more convenient than any other way."

- The respondents were largely *indifferent* to the statement "Working out bus transfers on the Web is not as easy as working from printed bus timetables."

- The respondents weakly *disagreed* with the statement "It's hard to find the maps for individual bus routes on the Web site."

- The respondents strongly *disagreed* with the statement "The Metro Web site was designed for people who are more comfortable using computers than I am."

Ease of Use. In general, the results were consistent with the responses to the opinion questions: between half and two-thirds of users found it reasonably easy to use most of the services the Web site offers. In addition, we found little systematic correlation between a respondent's length and intensity of use of the Web site and how easy he or she found it to use. In particular:

- *Schedule information.* Close to three-quarters of the users (71 percent) stated that they found it very or somewhat easy to access schedule information. There was no discernible difference across users with respect to longevity or intensity of use of the Web site.

- *Route information.* About 61 percent of the users stated that they found it very or somewhat easy to find the routes they needed on Metro Online. This was consistent across both light and heavy users of the site.

- *Information relating to transfers.* Respondents who said they had used the Web site to plan trips that required transfers were asked separate questions that examined the user-friendliness of six different elements of the site's capabilities in this regard: determining the bus routes involved, the time and location of the first bus, the location and length of time of the transfer, and the location of the final destination.

    - About three-quarters of the respondents found it very or somewhat easy to obtain information on transfer routes (72 percent), the timing of the first bus (79 percent), and the location of the transfer stop (78 percent).

- – The results indicate that respondents had slightly more trouble determining the length of wait at the transfer stop (60 percent found it very easy or somewhat easy), and the location at which they needed to get off the bus (66 percent).

- *Information relating to fares and passes.* About two-thirds of the respondents felt that getting fare information off the Web site was somewhat or very easy. A similar proportion of users (69 percent) found it very easy or somewhat easy to get pass ticket information off the site.

Suggested Improvements. Three main types of suggestions accounted for over half of all the comments to the question: "Could the information provided on the Metro Web site be improved in any way to make it more useful to you? Please think about both the information that is presented, and its appearance on the screen."

- *The KC Metro Web site should provide a door-to-door route planning service,* whereby users could enter their starting and ending addresses and receive a complete public transit itinerary, including transfer locations and times.

- *The Web site should provide more detailed maps and specific information about the bus routes and stops.* Respondents feel that the neighborhood maps need to be more detailed, especially downtown, and that using the maps can be difficult if one is not already familiar with the area in question.

- *Make it easier to read and print the bus schedules.* Respondents want the font, sizing, and color of the schedules to be changed so the whole schedule can be read easily, and so all the information can be seen at once.

- Behavioral responses and satisfaction based on the use of Metro Online.

Questions here were designed both to examine the influence of Metro Online on travel behavior (mode choice, trip-time choice, and route choice) and to elicit reactions to various aspects and attributes of the Web site:

- *Mode choice.* About half (49 percent) of all respondents found the Web site somewhat or very useful in making mode choice decisions. Most of the others were neutral (17 percent) or stated they had not used the Web site for input into a mode choice decision (21.4 percent).

- *Time of travel.* More than half (57 percent) of all respondents found the information from Metro Online useful (somewhat or very useful) in making decisions about time of travel.

- *Choosing the fastest route to destination.* Forty-six percent of all respondents found Metro Online to be at least somewhat useful in determining the fastest route to their destination.

- Information on Metro Online was comprehensive, complete, and of higher quality than printed information. The respondents also agree with the statement "With the information on the Web site, I can work out how to make an unfamiliar bus trip a lot faster than I could before."

- Respondents generally disagreed with statements such as "I use the Metro Web site most often when the weather is bad."

- Though Metro Online is useful, it does not by itself increase the respondents' propensity or frequency of riding the bus.

3.2.4.4 Summary and Discussion of Major Findings

The Major Findings of this analysis are summarized and discussed below:

- *The users are younger than the general Seattle transit rider.* Availability of personal computers and Internet access continues to proliferate, and we expect the character (and size) of the population that will access Metro Online a year from now will be different from, and more representative of, the general population than the present sample. Even so, somewhat surprisingly, we found that the user sample mirrored the general population of Seattle area transit riders in terms of income, gender, availability of private vehicles, and bus use behavior. The sample also was more highly educated than is likely for the average Metro ridership in Seattle, which is consistent with users of computers and the Internet.

- *The Web site provides valuable services to its users.* Our analysis suggests that Metro Online gets a lot of repeat use and that the user base includes many long-term users. This in itself is evidence that the site is useful and is providing value to its users. These findings are further corroborated by the responses to the survey, which indicate that Metro Online is used to obtain a variety of information, *route* and *schedule* information being chief among them.

- *Metro Online can be made easier to use, especially for new users.* The responses suggest that some of the services provided by Metro Online — route information and transfer planning, in particular — can be modified to make the services more user-friendly and easier for the user to navigate. Our analysis suggests that first-time users find it more difficult than experienced users to use the Web site as it is presently designed.

- The users were very articulate about the kinds of enhancements to the Web site they believed would provide value. Following were the three most popular enhancements:

  - A door-to-door trip planning service.
  - More detailed maps and specific information about the bus routes and stops.
  - Maps and schedules that are easier to print.

3.2.5 King County "Transit Watch" Evaluation

3.2.5.1 Project Description

Transit Watch is a video monitor providing transit information at two transit centers in the Seattle metropolitan region: Northgate and Bellevue. The video monitors were installed in mid-1998 as part of the Smart Trek MMDI program. The monitors provide information about the bay number at which the bus will arrive, the scheduled times of arrival and departure, and the expected *actual* departure times for all of the bus routes using the transfer centers. Actual times are based on information obtained from an Automated Vehicle Location (AVL) system. Transit Watch is shown in Figure 3-11.

Figure 3-11. A Deployed Transit Watch System in Seattle.

Figure 3-12. Transit Watch is Deployed at the State-of-the-Art Northgate Transit Center.

The MMDI costs to deploy the Transit Watch are presented in Table 3-5. The major cost drivers here were the UW development labor costs and the system hardware costs. Annual operations and maintenance costs for the project are estimated to be approximately 19 percent of the deployment costs.

Table 3-5. Transit Watch Cost Estimate[25]

Equipment Description	Non-Recurring Costs	Recurring Costs
King Co. Hardware (2 PC's, 5 monitors, modems, routers)	$ 39,500	
King Co. Facilities Improvements	$ 6,400	
King Co. Boeing Transit Watch	$ 20,000	
King Co. Engineering & Management Support	$ 3,300	
King Co. Software Development Support	$ 5,000	
King Co. Design Consultant	$ 43,000	
King Co. Other Labor	$ 28,000	
UW Total Equipment Purchases (Proposed Budget)	$ 25,000	
UW Total Supplies & Materials (Proposed Budget)	$ 19,900	
UW Development Labor	$ 447,475	
King Co. Maintenance		$ 4,100
Operations Labor (1 UW FTE's)		$ 131,250
14% Share of 3 Pentium Workstations & Associated Equipment	$ 3,393	
14% Share of Labor (including indirect costs and benefits)	$ 78,324	
14% Share of Other Direct Costs	$ 3,585	
14% Share of Hardware & Supplies (replaced every 2 years)		$ 1,696
14% Share of Fiber Link & Other Contractual Services		$ 2,428
14% Share of Operations Labor (3 UW FTEs)		$ 40,178
Total	**$ 722,877**	**$ 179,652**

3.2.5.2 Evaluation Description

The survey documented in this report was carried out as part of the Customer Satisfaction evaluation of MMDI programs. This survey had four primary objectives:

- To characterize the passengers who use the transit center and Transit Watch.
- To analyze the use of the monitors and to explore possible improvements to the monitor-based system and provide guidance in that planning.
- To assess the satisfaction, value, and behavioral responses of transit riders based on use of Transit Watch and access to real-time bus status information.
- To assess the potential influence of Transit Watch on ridership.

[25] Note that a 14% share of the ITS Information Backbone System cost elements have been included here as part of this cost estimate since relevant ITS information is either currently exchanged between this system and the Backbone, or because this system has the potential to interface with the Backbone in the near future.

Respondents for the Transit Watch survey were initially recruited in January 1999 at both the Bellevue Transit Center and the Northgate Transit Center. Telephone interviews were conducted between January and March 1999, resulting in a total of 505 completed questionnaires.

3.2.5.3 Results

Transit Watch Usage, Transit Center User Characteristics and Suggested Improvements.

The respondents were representative of people using these two Transit Centers, but we cannot generalize from the experiences of riders at these centers to all riders or locations in the King County Metro system. Three out of every four respondents were aware of Transit Watch. About 22 percent of the entire sample stated that they *always* use Transit Watch. About another one in four (28 percent) said that they use it sometimes, 26 percent said that they rarely use Transit Watch, and 25 percent said they had never seen the monitors.[26]

The regular users — those who said they always use Transit Watch —are slightly younger, slightly more educated (though not statistically significant), and slightly more technologically savvy than the non-users. There is no significant difference in the incomes of Transit Watch users and non-users. Regular and occasional Transit Watch users are likely to use the bus system somewhat more extensively and for a greater variety of purposes than the non-users.

A majority of the respondents were long-term users of the bus service, and most of them (Transit Watch users and non-users alike) indicated a high awareness of bus schedules. Providing *actual bus departure times* is the Transit Watch feature found most useful by the users. The scheduled departure times and route number descriptions also seem to be useful.

Suggestions for Improvement. Although almost half of the aware respondents (as well as the regular and occasional user segments) had no suggestions for improvements to the Transit Watch monitors. Those who did, mentioned *improved accuracy* most often.

All of the respondents were presented with a series of options for getting real-time bus departure time information and asked if they thought that such information would be useful. Respondents were also asked to rank and identify the three information sources they thought were most useful. We found the following:

- 71 percent of the regular Transit Watch users (and 63 percent of the occasional users and 49 percent of the non-users) said that video monitors that provided bus departure time information in nearby shopping malls and the lobbies of major buildings would be useful.

- About half (55 percent of the regular Transit Watch users, 50 percent of the occasional users, and 59 percent of the non-users) said that having a large changeable sign outside the Transit Centers that could be read from the street would be useful.

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[26] The user group, composed of regular and occasional users of Transit Watch, comprises 50 percent of the sample, and the balance of the respondents are combined into a non-user group for this analysis. Percentages may not sum to 100 percent due to rounding.

- 70 percent of both the regular and occasional Transit Watch users (and 55 percent of the non-users) said more monitors at Transit Centers would be useful.

- About two-thirds of the regular Transit Watch users (as well as 55 percent of the occasional users and 45 percent of the non-users) said an Internet Web site providing bus departure information would be useful.[27] Phone lines providing this information were slightly less popular.

Satisfaction, Value and Behavioral Responses of Transit Riders Based on Use of Transit Watch and Access to Real-time Bus Status Information

In general, users seem to be satisfied with the content, accuracy, presentation, and location of Transit Watch information. Both regular and occasional Transit Watch users view Transit Watch as a real benefit – more than a cosmetic addition to the Transit Centers. However, the responses also suggest that although Transit Watch seems to provide a variety of benefits to many users – some peace of mind and some flexibility – it does not significantly increase their satisfaction with their decision to use the bus. However, use of Transit Watch has a measurable effect on the comfort and satisfaction of new riders with the transit experience, and this has the potential to help retain ridership.

- Over three-quarters of the regular users indicated that information about actual and scheduled departure times, and the description of different route numbers was "very useful."

- Eighty-six percent of the users thought that the screen was very readable at close proximity, and over 90 percent thought that the locations of the screens were acceptable ("good" or "OK").

Behavioral Responses. The survey asked users about their reactions to learning about cancelled or delayed bus service (over five minutes) from Transit Watch. Users were also prompted for a wide range of possible behavioral responses and asked if they had ever reacted to late/cancelled bus information from Transit Watch with each of those responses. The analysis of the responses to these questions suggests the following:

- About three-quarters of the users of Transit Watch recalled at least one occasion when the Transit Watch video monitors informed them of serious delays (more than 5 minutes). Forty percent of these respondents agreed that in such situations, the information from the video monitors made them *less worried*.

- Moreover, a significant number of users indicated that they had responded with actions (e.g., calling home, taking different buses, driving home, etc.) to cancelled or late bus information provided by the video monitors.

Potential Influence of Transit Watch on Ridership

The results suggest that use of Transit Watch does have a measurable effect on the comfort and satisfaction of new riders with the transit experience. While we can't really say with these

[27] Since this survey was completed, King County Metro has implemented on a trial basis for selected bus stops an Internet version of Transit Watch called MyBus. This new application will be evaluated separately outside of the MMDI program.

data whether a decision to implement Transit Watch at many other transit centers in the Metro system will retain more riders, increase their intensity of use of transit, or perhaps even attract new riders to the system, we can say that Transit Watch has had a positive effect on selected groups of transit riders who are traditionally more difficult to attract and retain. New frequent transit riders report the most satisfaction with their decision to take the bus since the introduction of Transit Watch. There is also some evidence here that some of these new riders are inclined to stay with transit, even when they do have options. However, bus information, such as that provided by Transit Watch, is only one factor out of many that can impact ridership.[28]

3.2.5.4 Summary and Discussion of Major Findings

The Major Findings of this analysis are summarized and discussed below:

- Transit Watch is both widely used and useful. Actual bus departure times are the Transit Watch feature found most useful by the users.

- Real-time information at locations where key travel decision are made (e.g., office buildings) would be used and considered useful by a majority of transit passengers. Transit Watch users particularly endorsed this suggestion.

- The content, location, accuracy, and presentation of the current Transit Watch monitors are satisfactory for most transit riders who use them, though many also offered suggestions for improvements.

- Although Transit Watch and the improved information *is* perceived as a real benefit by its users, the users did not seem to think that it increased their *overall* satisfaction with the transit experience. Our analysis indicates that Transit Watch in and of itself is unlikely to significantly change aggregate transit trends and perceptions. However, use of Transit Watch has a measurable effect on the comfort and satisfaction of new riders with the transit experience, and this has the potential to help retain ridership.

- Real-time information at locations where key travel decisions are made would be used and considered useful by a majority of passengers*.* Consumers expressed interest in a variety of forms other than Transit Watch monitors that would allow them access to real-time traffic information. The responses indicate that easy access to real-time information provided at *key decision points* would be useful. Consumer also suggested installation of Transit Watch-type video monitors at major bus stops. However, this finding may just reflect the important role of hands-on experience in framing consumer perceptions. Apart from video monitors at major bus stops, the most worthwhile information related investments seemed to be:

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[28] See Charles River Associates, *Trends in Single Occupant Vehicle Miles and Miles of Travel Growth in the United States*, Final Report, 1998, published as "Web Document 5" by the Transit Cooperative Research Program and available at the National Academy Press Web site at www.nap.edu. This article includes a discussion of the determinants of transit ridership and the role that policy can play to influence ridership. Also, see Northwest Research Group, Inc., *1998 Rider / Nonrider Survey*, a report prepared for the King County Department of Transportation, Transit Division. This report identifies several key factors affecting ridership, including direct service to riders' destinations, more direct runs without a need to transfer, and service frequency, especially to work sites.

– *Internet Web sites* that consumers could check before leaving work or home

– Video monitors at *malls or office buildings close to major bus stops* that would allow consumers to maximize the time spent at their trip ends.

3.2.6 Fastline Personal Travel Companion System Evaluation

3.2.6.1 Project Description

Fastline's software, called Personal Travel Companion (PTC), provides traveler information to travelers who have portable handheld or palmtop computers with the Microsoft Windows-CE operating system. Users can visit the Fastline Web site (http://www.Fastline.com/index.html) and download the free PTC software and obtain a local map database. After registering, users can connect over the Internet to the Fastline server to get free real-time updates for display on the map installed on the user's handheld device. Fastline's approach has been to offer the PTC free of charge for a period of time during early deployment, to be followed at a later date by a fee-based information service.

Figure 3-13. Fastline Software Program Operating on Handheld Computer.

Fastline PTC provides the user with:

- real-time traffic conditions, traffic speeds
- road conditions, incidents, closures, construction sites
- transit schedules, fares, and real-time bus locations
- detailed street maps, navigation, turn-by-turn driving instructions

- weather
- points of interest
- airport locations and airline information
- related travel information.

The Internet connections can be made over regular wired phone lines, or the traveler can connect over a wireless modem and thereby obtain traffic and navigation information while en-route. The PTC software loaded on a handheld computer is illustrated in Figure 3-13.

The MMDI costs to deploy the Fastline PTC are presented in Table 3-6 below. The major costs of this project were the system design and development labor costs and the Fastline operations and maintenance staffing. Overall, operations and maintenance costs were high, estimated at approximately 29 percent of the deployment costs.

Table 3-6. Fastline PTC Cost Estimate[29]

Equipment Description	Non-Recurring Costs	Recurring Costs
Materials	$ 5,000	
System Design	$ 58,000	
System Development	$ 69,000	
System Integration	$ 25,000	
System Test	$ 14,000	
Final Program Code Release	$ 10,000	
Project Mobilization	$ 20,000	
Operations and Maintenance Support	$ 7,500	
PDA Application Marketing, Awareness	$ 14,500	
User Evaluation Support	$ 8,000	
Travel	$ 5,000	
Fastline In-Kind Contribution	$ 65,000	
FASTLINE O&M Staffing (1)		$ 59,500
Hardware Maintenance @ 10% Capital Cost		$ 500
Software Maintenance (5% Soft Development Cost)		$ 7,550
14% Share of 3 Pentium Workstations & Associated Equipment	$ 3,393	
14% Share of Labor (including indirect costs and benefits)	$ 78,324	
14% Share of Other Direct Costs	$ 3,585	
14% Share of Hardware & Supplies (replaced every 2 years)		$ 1,696
14% Share of Fiber Link & Other Contractual Services		$ 2,428
14% Share of Operations Labor (3 UW FTEs)		$ 40,178
Total	**$ 386,302**	**$ 111,853**

[29] Note that a 14% share of the ITS Information Backbone System cost elements have been included here as part of this cost estimate since relevant ITS information is either currently exchanged between this system and the Backbone, or because this system has the potential to interface with the Backbone in the near future.

3.2.6.2 Evaluation Description

In order to meet the initial launch of Fastline's PTC in Seattle, an on-line survey form was developed and placed on Fastline's server in April 1998. The survey questionnaire served a couple of purposes. One was to acquire marketing data for Fastline, and the other was to collect data to assess user satisfaction with the product consistent with similar survey designs being developed for the other Customer Satisfaction evaluations at the four MMDI sites. Because the survey would reside on Fastline's server, the plan was to have a single survey that could support the evaluation of each of Fastline's deployments of the PTC application in Seattle, WA, and Phoenix, AZ.

A revised survey was placed on the server in August 1998, but by that time very few new Seattle registrants were visiting the Web site. Furthermore, the Phoenix deployment was launched in September 1998 in the absence of any promotion of the PTC application in the local area. Consequently, the number of handheld personal computers owners capable of taking advantage of the PTC who became aware of the opportunity to register for use over the Internet, and then followed up and actually did so, were too few to warrant any further efforts to analyze their responses to the on-line survey.

3.2.6.3 Results

Because it proved very difficult to identify and recruit a sufficient customer base for the product, use levels were too low to support the evaluation as planned. Initial survey results are presented; however, due to the small sample size, coupled with the self-selected non-random nature of the sample, it is not appropriate to generalize findings from these data to any other population.

Fastline recorded two kinds of data related to usage of the PTC application. The first included the responses to the registration questionnaire, and the second was a log of users who accessed the server for real-time information from their handheld personal computer via a modem. Registration data were examined for May and June, 1998. During this two month period, 129 individuals registered on the Fastline server. After removing "insiders" and persons accessing the site from outside of the Seattle area, and cleaning the remaining data, 84 usable individual records remained. Most of the accesses to the site occurred during the first month after the product launch, during the time when the product was actively promoted.

Given that the population of candidate users is unknown (and likely to be small) and that only a small number of self-selected registrants filled out the on-line survey, the findings from these data cannot reliably represent the attitudes or behaviors of any larger population in the Seattle area or elsewhere. Therefore, instead of presenting tables and figures based on these very limited data, a brief discussion of the results is provided. These results may be suggestive, but clearly additional research on a larger, more appropriately constructed sample is needed.

When asked how they learned about Fastline's PTC, about two-thirds of the respondents learned about it from the media and one-third from the Internet (primarily from the Smart Trek Web site). About 39 percent of the registrants learned about it from the ads displayed on Metro buses. Only a small number heard about it through word of mouth, from either friends or co-workers.

Registrants were asked what benefits they hoped to derive from the PTC. Almost half of them said they were just curious to see what it does and one-third thought it would be fun new software for their handheld personal oomputer. The half of the sample who appeared more serious about using the PTC said it would be helpful for pre-trip planning, on-the-road trip planning, and route guidance, all in roughly equal numbers. Less than one-third of the registrants indicated that they currently use their handheld personal computer with a wireless modem, which would limit their ability to use the PTC software for en-route planning purposes.

The level of awareness of various sources of traffic information was generally high. Most of the registrants (94 percent) were aware of radio traffic reports, though fewer listened to these reports during most of their commute trips (57 percent) or before their trip (42 percent). About 57 percent were aware of TV traffic reports, but only about 28 percent said they viewed or listened to these reports pre-trip. Awareness of traffic information on the Internet was quite high (68 percent), but only about one quarter of the sample said they checked the Internet before leaving on a trip. Travel behavior changes based on learning about traffic conditions before leaving on the trip generally followed the findings from other travel behavior studies. About two-thirds said they took a different route, a little over half said they changed the time of departure, and about one-third said they decided not to make the trip.

Use of the Fastline server to obtain real-time traffic or transit information was very limited by this group of registrants. Given that many registered on line primarily out of curiosity, it is perhaps not surprising that few took the extra time to connect to the server to download the real-time data. We also know that only a minority of the sample had wireless capability, without which the value of the real-time data may have appeared inconsistent with the cost in time and effort to obtain it. For those few who did access the real-time data, the great majority (77 percent) were interested in the version of BusView, a King County Metro Web page applet that shows the location of all buses at any time on selected bus routes. Many of these users were presumed to be transit riders, since they reported that they found out about this application from bus advertisements.

Most of the individuals who accessed the server did so several times in a session, but about half of those only visited the server a few times over a couple of days. A few of the heaviest users accessed the server information over a period between about 10 and 30 days with between one and five accesses per session. However, this sub-sample of registrants who actually used the server is much too small to allow for general conclusions from their limited behavior.

3.2.6.4 Summary and Discussion of Major Findings

The Major Findings of this analysis are summarized and discussed below:

- The traveler information technology deployed by Fastline under the Smart Trek program is usable by a relatively small market niche. It requires specialized hardware (a handheld personal computer running Windows CE), and reasonably sophisticated users who know how to work with the Internet. Then, in order to acquire real-time travel information, a modem must be connected to the handheld personal computer, and furthermore, to benefit from the easy portability of the handheld personal computer and to use it during a trip, the user would need to have a wireless modem. All this makes for a complex, expensive package.

- The challenge for Fastline and Smart Trek was to inform qualified users and get them to sign up for PTC. The promotional campaign was quite effective in attracting potential users to Fastline’s Web site. What seems clear now is that a one shot campaign is not nearly enough to get the word out and sustain interest; rather, it would appear that an ongoing promotion of the PTC will be needed to inform potential users and convince them both to register and then to stay with the technology and engage in periodic server connections to get real-time traffic and transit data. Effective ways also are needed to target handheld personal computer owners directly with information about the Fastline capability.

- Limited evidence from this survey suggests that registrants made useful changes in their travel behavior, such as route and timing changes, in response to information about traffic conditions. The premise behind this deployment is that making this information available in a variety of different ways, including some that are highly portable, offers travelers attractive value. It is unfortunate, given low response to this particular deployment, that a more careful assessment of willingness-to-pay for PTC could not be undertaken. Thus, while we can't quantify the value customers place on the deployment of PTC, the limited evidence obtained under this Smart Trek deployment suggests that portable access to real-time traveler information would be of value. How this evolves in the future would appear to depend upon how rapidly the handheld personal computer technology diffuses throughout the general population, as well as how effectively the PTC software can be promoted to these potential customers.

3.3 ITS INTEGRATION MODELING EVALUATION

The main purpose of the ITS Integration Modeling Evaluation was to examine, though traffic modeling, the effects of:

1) ATMS arterial signal integration across multiple jurisdictions and traffic control systems in a major metropolitan area (Section 3.3.1)

2) Providing the addition of arterial traffic information to Seattle arterial drivers via the Smart Trek ATIS system deployments (Section 3.3.2)

As detailed below, the results of these evaluations show that taking the first steps towards integrating ITS systems in a metropolitan area can provided modest benefits in terms of both congestion relief and emissions reduction. These ITS interactions can be best viewed as initial evolutionary steps towards such a fully integrated metropolitan ITS deployment.

3.3.1 ATMS Signal Integration Evaluation

3.3.1.1 ATMS Signal Integration Concept

Under Smart Trek, the following three major arterial corridor ATMS signal integration projects were established:

- North Seattle ATMS (NSATMS)
- Southside ATMS
- Eastside ATMS

For each of these systems/corridors, the goal was to develop a capability that would allow not only for the sharing of traffic data and signal status across jurisdictions/systems, but also for the potential integration of the signal timing such that a vehicle traveling the length of the corridor would do so in a more efficient manner. This, in turn, could potentially reduce travel times, improve safety, and reduce emissions.

One of the original intentions of the Seattle Smart Trek MMDI deployment was to begin a process that would eventually lead to the full implementation of signal integration across the jurisdictions/systems in these three corridors. However, implementation of signal integration has been delayed partly due to a concern that the implementation of signal control across these arterial corridors could cause increased congestion problems on cross-streets along the arterials. Hence, it became an important part of this evaluation to try to model the impacts of arterial corridor signal integration on cross-streets to provide for results that could address this concern.

In order to focus the evaluation, the NSATMS was selected as the arterial corridor most appropriate for modeling. This was largely based on the fact the NSATMS would be the first of the three major Smart Trek ATMS arterial corridors to be deployed, with the other two regional ATMS corridor projects to be deployed later. Furthermore, an existing regional traffic modeling capability had been previously developed for the North Seattle subarea as a part of an ongoing ITS evaluation methodology development effort being conducted by Mitretek Systems.[30] [31]

Under Smart Trek, the NSATMS was enhanced to allow the integration of agency traffic signal systems for as many as 19 cities in the Northern Seattle metro area. The NSATMS also provided interconnection of regional planning and advanced transportation management systems, or Traffic Control Centers (TCC), of nine cities (Seattle, Shoreline, Edmonds, Bothell, Mountlake Terrace, Lynnwood, Mill Creek, Everett, and Marysville), two counties (King and Snohomish), three transit agencies, the PSRC, and WSDOT's arterial signal and freeway ramp metering systems. In addition, the NSATMS is interoperable with its "sister" deployments, the Eastside and Southside AMTS systems. An overview of the geographical coverage of the NSATMS corridor is provided in Figure 3-14.

[30] see "Mitretek Simulation Analyses in Support of Seattle MMDI Evaluation," ITS-L-001, Mitretek Systems, Washington, DC, April 1998.

[31] also see "Incorporating ITS into the Transportation Planning Process: Seattle Case Study," (also referred to as "Mitretek 2020 Study 21A"), Mitretek, September 1999.

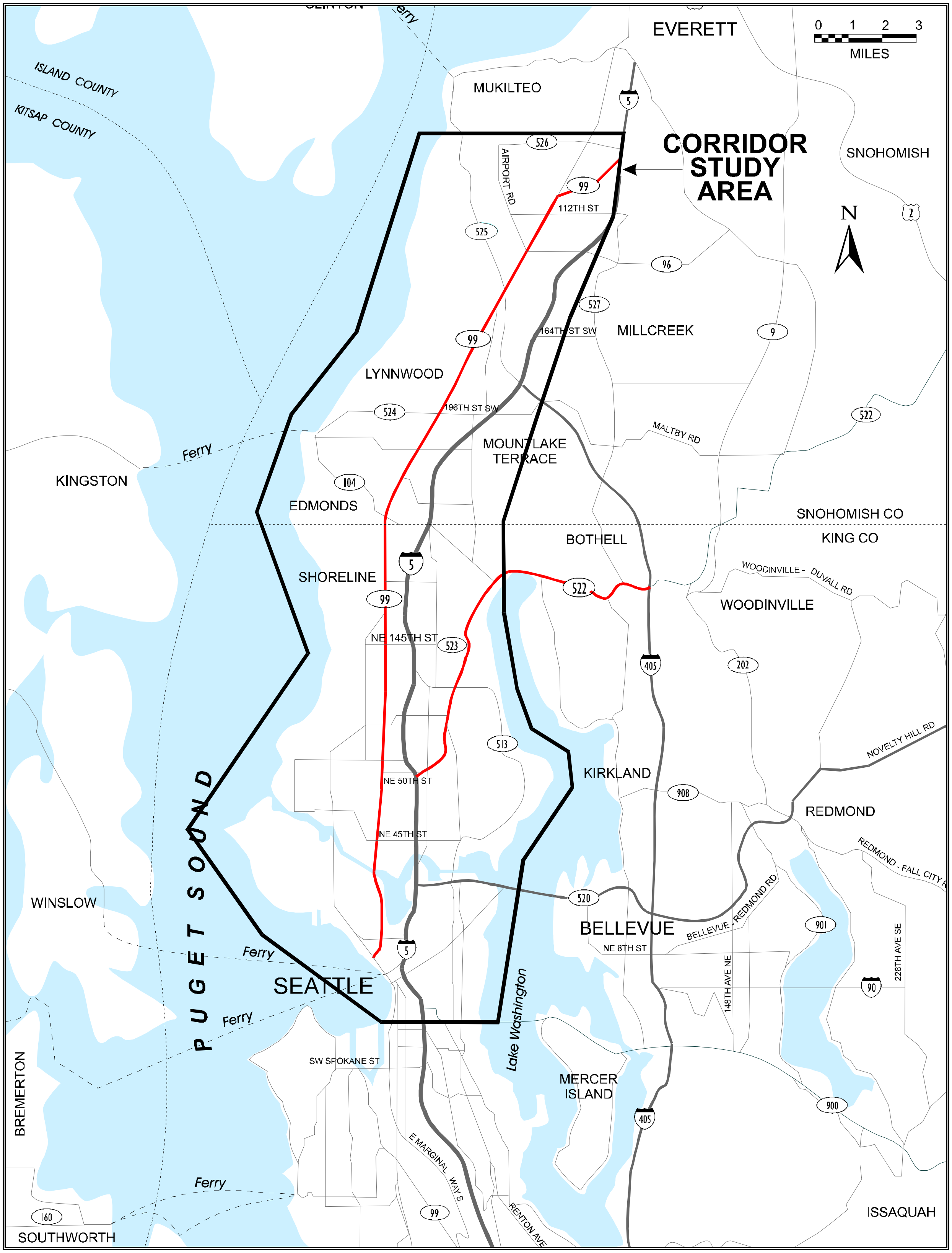

Figure 3-14. North Seattle ATMS Corridor

The NSATMS is able to collect regional traffic data, including volumes, occupancy, speeds, surveillance video/snapshots, incident information, and signal system status. The system combines the results of a substantial customized software development effort, with a significant installation of computer workstations, communications hardware, and detection devices.

The MMDI costs to deploy the North Seattle ATMS are presented in Table 3-7. Here, the major cost driver for this project is the software development effort for the system. Of note, annual operations and maintenance costs for the project are estimated to be approximately 8 percent of the deployment costs.

Table 3-7. North Seattle ATMS Cost Estimate [32]

Equipment Description	Non-Recurring Costs	Recurring Costs
Detection Devices (budget figure)	$ 200,000	
Network/Database Server	$ 56,883	
MIST Server	$ 20,050	
HTML Server	$ 18,472	
Communications/Device Driver Server	$ 37,411	
Spare Server	$ 30,168	
Miscellaneous Equipment	$ 22,960	
Operator Interface	$ 10,093	
Communications Equipment	$ 8,926	
NTCIP Computer & Equipment	$ 49,834	
Commercial Software	$ 8,047	
Annual Hardware O&M @ 10% of Capital Cost		$ 37,955
33% Share of Software Development	$ 653,462	
33% Share of Pre-Design	$ 247,367	
33% Share of Design	$ 289,689	
33% Share of Management Reserve/Contingencies	$ 88,163	
33% Share of City of Seattle Coordination	$ 13,333	
33% Share of ATMS Local Agency Coordination (1 FTE)		$ 34,168
33% Share of ATMS System Administration (1 FTE)		$ 34,168
33% Share of ATMS System Operations (1 FTE)		$ 34,168
Totals	**$ 1,754,858**	**$ 140,459**

It should be noted here that these deployment costs funded by MMDI were a subset of the total costs required for deployment of the NSATMS – significant Federal and state funding from several other sources were also utilized, and some basic components of the NSATMS were already deployed before the Smart Trek project began. It should also be noted that the NSATMS includes the traffic management computer server, which also serves both the East Seattle ATMS and the South Seattle ATMS.

As an aside, while not directly part of the evaluation, it should be noted that the NSATMS is supported and integrated with several other Smart Trek projects, including the Smart Trek

[32] Where the "33 percent share" figures are shown, ATMS costs are shared at 33.3. percent of the total ATMS system cost for each of the three Seattle ATMS signal integration project deployments (North Seattle ATMS, Eastside ATMS, Southside ATMS).

NorthWest Region TSMC enhancements project (providing improved incident capture and processing and improved incident video), as well as the development of the Smart Trek Regional Video System project.

3.3.1.2 ATMS Signal Integration Evaluation Overview

Technical and institutional impediments are traditional barriers to coordinating traffic signals along key arterial roadways. The traffic management system enhancements in Seattle were deployed to integrate the traffic information from various local cities, thus allowing traffic managers to monitor traffic data and conditions across jurisdictions and effectively adjust their own signal timing plans. The next major goal involves institutional cooperation to implement coordinated traffic signal timing plans for major arterial roadways across jurisdictions. However, many local planners and traffic managers are unsure of the associated effects on the overall system as well as the potential for negative impacts on roadways crossing the major arterials. A modeling effort was undertaken to address these concerns and estimate the potential effect on two major arterials and surrounding roadways in North Seattle. This section describes the evaluation of a potential coordinated signal timing plan developed from archiving more comprehensive, accurate arterial traffic data at inter-connected local traffic control centers in North Seattle.

At the beginning of the evaluation, MMDI team leaders recognized that leveraging the existing North Seattle modeling resources developed by Mitretek was a logical and efficient option to examine the effects of coordinated timing plans prior to implementation. Modeling and simulation techniques are used to examine the likely effects on system traffic flow, energy and emissions, and safety.

In order to examine projected benefits, a Baseline traffic signal control condition was established consisting of fixed, time-of-day signal timing plans that were based on vehicles traveling at the speed limit. “Fixed” refers to plans developed by the controlling jurisdiction, based on average peak or off-peak demand, that cannot be changed in real-time. No adaptive control was modeled in the Baseline, although simple signal actuation was a feature at some intersections. “Time-of-day” indicates that for high-volume arterials, there is a morning and evening peak plan rather than a generic peak period plan. Typical cycle lengths, phase splits, and other data in the area were taken from the Seattle ATMS Control Strategies Report[33].

For comparison with the Baseline condition, a Traffic Signal Coordination condition was developed by modifying the Baseline signal timing plan to reflect changes at major intersections using the average queue length at each intersection. At minor intersections, signal coordination was implemented by link free flow speed, speed-at-capacity, and capacity.[34]

Two arterials in North Seattle were modeled: SR99 (running parallel to and just west of the I-5 freeway) and SR522 (carrying traffic from the northern edge of Lake Washington to its southern terminus with I-5). These arterials are of significant length and both pass through several jurisdictional boundaries where the responsibility for setting timings changes. Within the North Seattle ATMS coverage area, SR99 has three such boundaries, SR522 has one. In the morning peak period, signals along these two arterials are generally timed for speed limit progression.

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[33] “Seattle ATMS Control Strategies Report,” prepared by PB Faradyne for WSDOT, December 1995.

[34] for more detail see Wunderlich, et. al., “ITS Impacts Assessment for Seattle MMDI Evaluation Final Report: Modeling Methodology and Results,” prepared by Mitretek for FHWA, September 1999.

Three distinct effects of signal re-timing in the North Seattle corridor were modeled in the simulation:

- The impact of coordinating signals at major intersections from “top to bottom” along SR99 and SR522 without regard to the current jurisdictional boundaries.
- The coordination of minor signals along these same corridors at progression speeds selected between major intersections.
- The calculation of progression speeds between major intersections based both on speed limit and average queue length measured at each approach to a major intersection.

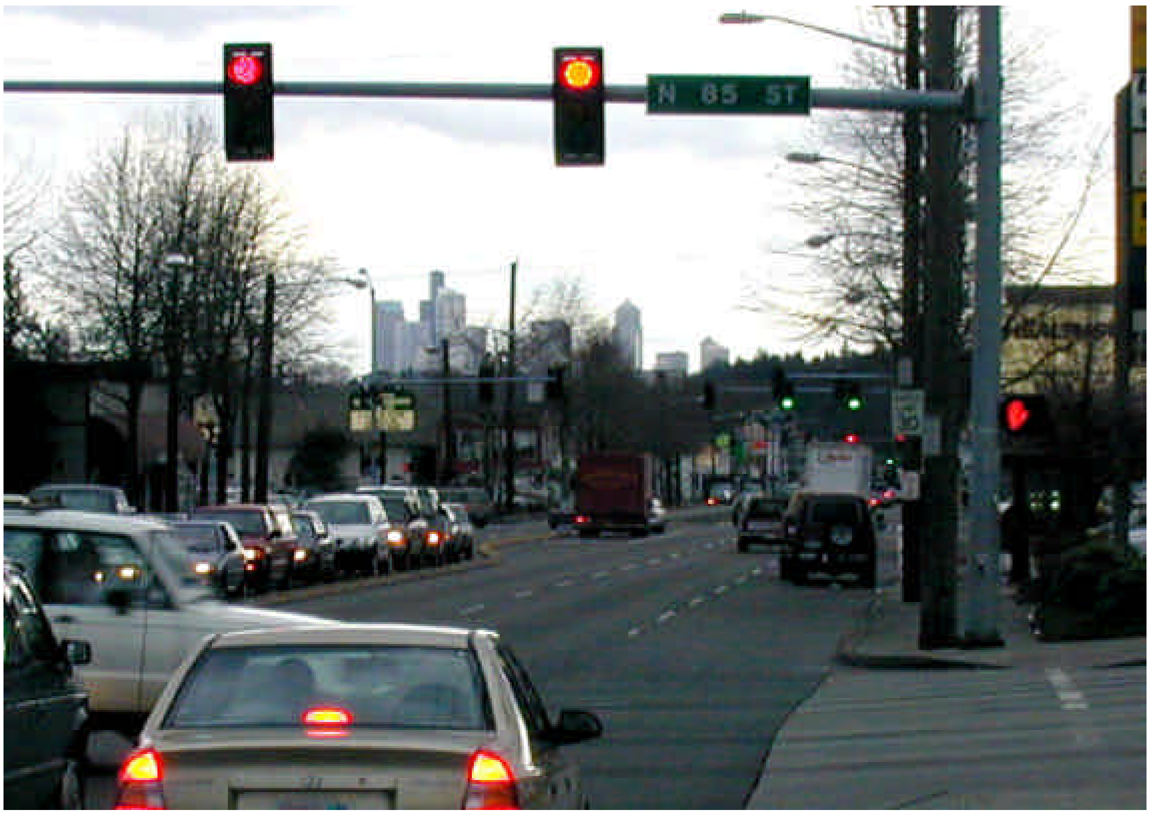

Figure 3-15. SR-99 Arterial in North Seattle.

Thirty scenarios were developed for the model based on conditions observed in the morning peak period. Three sources of system variability were used: incidents and accidents on localized road network capacity, weather (including fog and visibility effects) on global road network capacity, and variation in day-to-day travel demand. In the simulation, incidents and accidents were modeled as temporal reductions in link capacity. Weather effects were modeled as global reductions in road network maximum travel speed, capacity, and speed at capacity. Travel demand variability was modeled by uniformly increasing or decreasing origin-destination traffic flow rates.[35]

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[35] Ibid.

It should be noted that the modeling approach relied on a well-calibrated model, which was able to accurately simulate the traffic flow across the North Seattle corridor today. Moreover, with the detailed technical specification of the ITS improvements available (e.g., the signal timing parameters), the confidence level is high in the ability of the model to approximate the implementation of the ATMS signal integration.

3.3.1.3 ATMS Signal Integration Evaluation Results

The evaluation examined prospective effects of re-timing signals using a coordinated fixed timing plan along two major arterials (SR99 and SR522) in North Seattle utilizing average queue length data from the NSATMS. Three measures were examined: System Traffic Flow Impacts, Energy and Emissions, and Safety.

System Traffic Flow Impacts measured average system delay and total vehicle throughput with respect to all travel in the North Seattle corridor subarea. Delay reduction was the difference in the average delay between the Baseline condition and the Traffic Signal Coordination condition as a percentage of the Baseline average delay. Throughput measured the number of trips from the total traveler population that were started and completed within the AM peak period (6:15–9:30 AM). Other measures calculated included the coefficient of variation associated with day-to-day travel variability and the number of expected stops per vehicle-kilometer of travel.

For energy and emissions estimates, Mitretek employed a post-processing analysis of simulation link-level speed and stop data at the subarea level. The relationships among travel speed, stops, and energy and emission rates were developed as a part of the national MMDI evaluation effort. The introduction of stop data as well as speed data into the energy and emissions analysis represents an advance in the current state-of-the-art. The new technique applied for the Seattle MMDI evaluation was consistent with ongoing energy and emissions impact assessments associated with the MMDI in Phoenix and San Antonio.[36]

A related safety post-processing technique was employed to predict total crash and fatal crash rates. This safety analysis used speed ranges at the corridor-level and applied speed-sensitive crash rates from national statistics.[37]

System Traffic Flow Impacts

The simulation analysis indicated that traffic signal coordination improvements had a measurable effect on overall system performance. Signal coordination had impacts that were distributed across a broad range of scenarios with the largest delay reduction in scenarios where the ratio of travel demand to road network capacity was close to expected. Table 3-8 shows the system traffic flow measures and results for the Baseline and Traffic Signal Coordination conditions.

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[36] see “MMDI San Antonio Evaluation Final Report,” April 2000, FHWA, and “MMDI Phoenix Evaluation Final Report,” April 2000, FHWA.

[37] for more detail see Wunderlich, et. al., “ITS Impacts Assessment for Seattle MMDI Evaluation Final Report: Modeling Methodology and Results,” prepared by Mitretek for FHWA, September 1999.

Table 3-8. ATMS Signal Integration System Traffic Flow Impacts

Measures for Average AM Peak Period	Baseline	Signal Coordination	Change	% Change
Vehicle-Hours of Delay (annualized)	17,879	16,661	-1,218	-7.0%
Vehicle Throughput (annualized)	209,372	209,774	+402	+0.2%
Coefficient of Trip Time Variation	.242	.237	-.005	-2.1%
Vehicle-Km of Travel	3,438,000	3,455,000	+17,000	+0.4%
Total Number of Stops	1,200,000	1,167,000	-33,000	-2.7%

Delay Reduction. The largest delay reduction occurred in scenarios where demand was close to or slightly higher than expected with clear weather conditions or under rainy conditions. Delay reduction was evident across scenarios, with statistically significant overall delay reduction seen in all but the lowest-demand (and hence lowest delay) scenarios. Annually, the Traffic Signal Coordination condition was found to reduce Vehicle Hours of Delay by 1,218 hours per morning peak period. This represented an annualized system delay reduction of 7.0 percent compared to the Baseline condition.

Throughput. The effect of coordinated signal timing on throughput was a mixture of small improvements and reductions. Throughput effects outside of heavy demand and weather conditions is negligible. Annually, the Traffic Signal Coordination condition improved throughput by 0.2 percent, corresponding to roughly 402 additional vehicles able to complete trips every day during the morning peak period over the Baseline condition.

Coefficient of Variation. The Baseline condition coefficient of variation was 0.242. Applying this to a trip with an expected duration of one hour, a traveler would have to budget 1.40 hours (84 minutes) to arrive at his/her destination on-time 95 percent of the time. In the Traffic Signal Coordination condition, the value was 0.237, indicating that travel has become slightly more predictable across the system. Under the constraints of our hypothetical one-hour trip, the amount of time needed to budget to be on-time 95 percent of the time is 83 minutes, a 2.1 percent reduction in trip time variability

Percentage of Vehicle-Kilometers of Travel By Speed Range. The impact of traffic signal coordination on facility speeds was small and indeterminate in nature. Freeway speeds in the higher ranges appear to have slowed somewhat, while a slight increase in higher-speed arterial travel was found.

Expected Number of Stops per Vehicle-Kilometer of Travel. Positive effects in terms of traffic smoothing were found for the urban arterial system, as well as a smaller effect on freeway links in the road network. The smoother arterial travel is related to the improved coordination of traffic signals along SR99 and SR522, which see the largest reduction in stops per kilometer of any arterial facilities. Overall, the number of stops drop by 33,000 per morning peak period, a 2.7 percent decrease.

Effect of Traffic Signal Coordination on Cross Street Traffic Flow. The majority of cross streets along the SR99 and SR522 corridor see no adverse impact from mainline traffic signal coordination, primarily because travelers utilizing the cross streets have the same phase split under both the Baseline and Coordinated plans.

Energy and Emissions

Cross-jurisdictional signal coordination was found to result in a 0.2 percent increase in vehicle throughput, 2.7 percent fewer stops, and negligible change in vehicle km of travel compared to the Baseline. Evaluation of energy and emission impacts indicated that fuel usage and emissions would not change significantly. Overall, small increases were estimated for fuel consumption and the three major pollutants (HC, CO, NOx), but statistical tests indicated that none of these increases are statistically significant.

Safety

Overall, the expected number of crashes decreased by 2.5 percent. The total number of fatal crashes projected over a 10-year period decreased by 1.1 percent, from 114.9 to 113.7. This reduction can be attributed to a shift from lower-speed travel (32-40 km/h) to higher-speed travel (60-80 km/h). These results are consistent with the safety post-processor's utilization of travel speed to determine number of crashes and its bias toward slightly safer travel at higher speeds.

3.3.1.4 ATMS Signal Integration Evaluation Discussion

The evaluation of coordinated signal timing plans utilizing traffic data from the NSATMS illustrated the anticipated effects of implementing jurisdictional cooperation for signal control. The combination of better data on arterial queue length in the morning peak and the coordination of signals at variable progression speeds (both major and minor) is projected to reduce system-wide delay by 7 percent. The model used for this effort and the evaluation performed were not detailed enough to produce a traffic signal timing plan that can be directly implemented in the field. However, for traffic engineers in Seattle, Lynnwood, and other jurisdictions in the North Seattle, the 7 percent delay reduction provides a quantitative estimate of potential benefit that can be used in prioritizing the development of a detailed plan for SR99 or SR522. Further, the delay reduction figure demonstrates to local jurisdictions that cooperation on timing plans has a quantifiable potential benefit, bolstering an argument that was heretofore conjecture.

Overall, system delay reduction was concentrated in scenarios where travel demand was higher than expected or when system capacity was reduced by weather conditions. No sensitivity to delay from accidents or incidents was found. This performance pattern is not surprising, given that the fixed signal timing plans were optimized for near-normal conditions and cannot adjust to accidents or incidents. Annually, overall throughput increased slightly (0.2 percent) but was not evident in all scenarios, indicating that the signal timing plans optimized for average conditions may be less than optimal under some extreme condition scenarios.

The evaluated showed that signal coordination can be designed to have no negative impacts on cross street traffic flow if travelers utilizing the cross streets have the same phase split under the signal coordination plans. This conclusion is consistent with results from modeling conducted for the Phoenix MMDI evaluation.[38]

The evaluation indicated that coordinated signal timings would increase throughput without significantly increasing energy and emissions, would decrease crashes by 2.5 percent (300 to 700 fewer crashes over 10 years) and decrease fatal crashes 1.1 percent over a 10-year period.

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[38] "MMDI Phoenix Evaluation Final Report," April 2000, FHWA.

3.3.2 Arterial Data for ATIS Evaluation

3.3.2.1 Arterial Data for ATIS Concept

With Smart Trek having already deployed enhanced ATIS services with an integrating ITS Information Backbone communications sytem, and WSDOT now planning a near-term expansion of ATMS sensors on several major arterials (e.g., SR-99), it was of special interest to examine the potential effects that information sharing between the ATIS and ATMS arterial deployments could have on traffic flow and emissions within the corridor. Developing an understanding of the impacts of these first components of an integrated ITS system was one of the most interesting aspects of the Seattle MMDI Evaluation. Since the potential interaction between the Smart Trek ATIS and ATMS arterial components have not yet been deployed or tested, a modeling and simulation approach was required.

Here, the deployed ATIS system is assumed to consist of traveler information dispensed through many of the Smart Trek ATIS components. As detailed in section 3.2, in terms of public usage, the most successful of these ATIS components to date is the WSDOT Traffic Information Web Site, accessible at http://www.wsdot.wa.gov/PugetSoundTraffic/. This Web site has evolved rapidly over the past several years into one of the leading traffic information Web sites in the nation. The site offers traffic condition maps that provide real-time traffic flow, speeds, and congestion information for the regions freeway system. Additionally, the following ATIS components are also part of the ATIS system deployment that the modeling effort here assumes are utilized:

- Etak/Metro Networks ISP Services (a private traveler information network)
- Fastline Personal Travel Companion
- UW Cable “Traffic TV”
- Traffic Telephone[39]
- Microsoft Sidewalk[40]

Much of the information presented in this deployed ATIS system is based on an extensive network of loop detectors located every half-mile on the major freeways. The data from these detectors is processed in the WSDOT Traffic Systems Management Center (TSMC), and configured for dissemination to the appropriate ATIS component. In addition, WSDOT has also

[39] Traffic Telephone, which is not part of the Smart Trek ITS deployment, is a deployed traffic information system available to citizens of the Seattle region. It is a standard touch-tone-based telephone traffic information system such as has been deployed over the past twenty years in a number of U.S. metropolitan areas.

[40] Microsoft Sidewalk was a commercial Web site that is no longer in existence. The original purpose of this site under Smart Trek was that Microsoft would incorporate traffic and transportation information that was available from WSDOT and other traffic information centers into its “Sidewalk” entertainment guide Web page. Similar to the WSDOT Web site, it provided real-time views of area highways, traffic speeds, and incident locations. Microsoft also had intended to expand the site to advise users with customized route guidance and traffic reports via email, as well as to expand its traffic information content by funding an improved server system capable of incorporating video. One of the reasons that this Web site may have been discontinued was likely due to the success of the WSDOT Web site (see Section 3.2.2), which already provided similar high fidelity traffic information to regional users.

installed a system of Closed Circuit Television Cameras (CCTVs) throughout the region, of which current pictures are made available to some of the ATIS components as well.

Note that as with the ATMS Signal Integration evaluation, the Seattle North Corridor was chosen as the most appropriate area to conduct these evaluations. This decision was primarily made so as to easily build upon the ATMS Signal Integration traffic modeling that had already been conducted (see section 3.3.2). In addition, in terms of the ATIS element, the customer satisfaction focus groups conducted during the MMDI evaluation for the very successful WSDOT Traffic Information Web Site showed that traffic information for the Seattle North Corridor was the most desired traffic data requested by the users – in fact, one of the main points that a majority of users of the Web site agreed on was that the North Corridor traffic information should be expanded to include arterials, and to specifically include SR-99 traffic information.

Again, the Seattle North Corridor utilizes the NSATMS system. The NSATMS is able to collect regional traffic data, including volumes, occupancy, speeds, surveillance video/snapshots, incident information, and signal system status. The system also provides for the potential integration of agency traffic signal systems for as many as 19 cities in the Northern Seattle metro area. The NSATMS also provides for interconnection of regional planning and advanced transportation management systems, or TCCs, of nine cities (Seattle, Shoreline, Edmonds, Bothell, Mountlake Terrace, Lynnwood, Mill Creek, Everett, and Marysville), two counties (King and Snohomish), three transit agencies, the PSRC, and WSDOT's arterial signal and freeway ramp metering systems. In addition, its is interoperable with its "sister" deployments, the East and South Seattle AMTS systems.

It is also important to detail here that the information can be shared between the WSDOT Traffic Information Web Site (as well as any of the other Smart Trek ATIS deployments) and any ATMS traffic flow sensors that are to be deployed, via utilization of the ITS Backbone Communications System. This system was developed by the University of Washington as part of the Smart Trek deployment. The ITS Information Backbone is the single point of connection, and single means of distribution for consolidated ITS information for the Seattle region. Viewed as a process, it includes data acquisition, value-added processing, self-describing data, and redistribution of data streams for dissemination as output to a variety of information consumers. The ITS Information Backbone is the interface between the regional public systems and agencies and the Smart Trek ATIS components, including commercial value-added ISPs. As applied here, this system will allow for the arterial sensor data to be formatted, standardized, and delivered from the NSATMS to the Smart Trek ATIS systems.

Figure 3-16. ITS Information Backbone Servers at the University of Washington.

3.3.2.2 Arterial Data for ATIS Evaluation Overview

The Arterial Data for ATIS Evaluation was designed to estimate the traffic flow and emission effects of adding arterial travel time estimates to the existing "freeway-based" Seattle Smart Trek ATIS system. The arterial travel time estimates are assumed to be provided to the ATIS system by the NSATMS and additional arterial sensors in the North Seattle Corridor.

More specifically, this experiment models the impacts of the integration of data from arterial loop detectors along SR99 and SR522 into the freeway-based ATIS available on the WSDOT Web site and the other ATIS deployments. Additionally, adding surveillance is assumed on the rest of SR-99 north of Green Lake and on SR 522 between I-5 and Bothell. Also modeled is the impact of the ITS Backbone project to integrate arterial detector congestion data into the traveler information services assumed to be operating in the ATIS experiments. For modeling purposes, an overall ATIS usage rate of 6 percent was assumed for this simulation – there is some limited evidence that suggests that this could be a reasonable projection of near future ATIS market penetration in the Seattle region.[41]

No changes to existing traffic signal control along the two arterials are modeled. The only change implemented is that users of ATIS may now consider real-time estimates of congestion on the two arterial routes in addition to I-5 conditions when making travel decisions. It is

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[41] The 6% value is based on the extrapolation of PSRC survey rates and the WSDOT Web site user session growth since the time of the survey. See Footnote #42 for a detailed explanation of the use of the 6% ATIS market penetration value in this analysis.

assumed that the arterial data is updated every 15 minutes and is provided as a combined estimate of both link travel time and intersection delay.

In summary, this evaluation compares the results of a 6 percent market penetration of the Smart Trek ATIS system for two cases of available ATIS information.[42] For the first case, the baseline case, the ATIS users are receiving the current available traffic data, which covers the Seattle Area Freeway network and major bridges. For the second case, the "Arterial Data for ATIS" case, the users are also receiving the North Seattle arterial data, much of which is being provided by the sensors on the NSATMS system. The simulation models the traffic flow and emissions for each case so that the effects of the additional ATIS data can be quantitatively assessed.

3.3.2.3 Arterial Data for ATIS Evaluation Results

System Traffic Flow Impacts

As shown in Table 3-9, the provision of arterial data increased the system impacts of ATIS in the North Corridor. Vehicle hours of delay were reduced by 311, a 1.8 percent decrease, while the number of stops decreased by 5.6 percent. Vehicle throughput is slightly higher, with an additional 193 vehicles successfully traversing the road network on average each morning peak period. Additionally, trip time reliability is marginally worsened, while total travel is slightly increased.

Table 3-9. Arterial Data for ATIS System Traffic Flow Impacts

Measure per Average AM Peak Period, North Corridor	Freeway ATIS	Freeway ATIS (+ Arterials)	Change	% Change
Vehicle-Hours of Delay	17,619	17,308	-311	-1.8%
Vehicle Throughput	209,382	209,575	+193	+0.0%
Coefficient of Trip Time Variation	.236	.247	+.011	+4.7%
Vehicle-Km of Travel	3,436,000	3,443,000	+7,000	+2.0%
Total Number of Stops	1,201,000	1,134,000	-67,000	-5.6%

Overall, it is clear that the provision of travel time estimates on the primary alternatives to I-5 in the North Corridor allows travelers to make more efficient route choice decisions. Patterns of

[42] Note that the Mitretek modeling report (see Wunderlich) provides a detailed modeling analysis of the baseline case here, which addressed the potential traffic impacts from the deployment of the major Smart Trek "freeway-based" ATIS elements only. This analysis showed that a 6 percent level of market penetration of these freeway-based ATIS elements could potentially reduce stops in the Seattle North Corridor by 1.5 percent (as compared to a "no-ATIS" case). This analysis is sensitive to the derived value of 6 percent market penetration, and this derived value itself relies on the extrapolation of both regional survey results and the projection of a limited set of ATIS usage data over time into future ATIS usage growth rates. However, in the "Arterial Data for ATIS" evaluation presented here, we are measuring the "delta" between the impacts of an "Arterial Data for ATIS" option versus this baseline case of freeway-based ATIS only; therefore, these delta results focus on measuring the potential impacts of adding arterial ATIS data. The potentially contentious 6 percent ATIS market penetration value should be viewed as an assumption for this analysis rather than an actual derived value.

use are also changed – total freeway to arterial diversion decreases when the arterial data appears in ATIS. This is because unwarranted diversions away from the freeway are reduced given that travelers now have a more current accurate estimate of arterial performance.

Energy and Emissions Impacts

A 5.6 percent drop in number of stops under relatively stable total travel resulted in across-the-board improvements in energy efficiency and emissions reductions. Most notably, a 2.7 percent reduction in total CO emissions and total NOx emissions was indicated, primarily due to the result of a reduction in high-speed stops. A smaller reduction was indicated for HC, while overall fuel consumption dropped by 0.7 percent.

3.3.2.4 Arterial Data for ATIS Evaluation Discussion

The integration of arterial congestion data with freeway-based ATIS clearly improved the effective utilization of ATIS services by the travelers modeled in the North Corridor. The travel delay reduction realized when congestion data on parallel arterial facilities (SR99 and SR522) was made available to the baseline freeway-based ATIS system (associated with a 6 percent ATIS usage rate) in the morning peak was 1.8 percent.

This impact should be interpreted while understanding the focus of the evaluation road network on corridor-specific travel. Travelers planning for long trips from the extreme north to south within the Seattle region (e.g., Everett to Tacoma) have freeway-to-freeway alternatives (I-5 vs. I-405) that were not represented by the North Corridor model used in this analysis. The range of choices in this model was limited to the corridor level (SR99 vs. I-5), so some underestimation of benefits for these types of trips was expected here. Providing arterial congestion data is likely more useful for the inter-corridor, moderate length trip maker than for the long regional trip maker.

4. CONCLUSIONS

The following conclusions can be drawn from the evaluation of Institutional Benefits conducted for the Smart Trek deployment:

- The participants in the Seattle MMDI demonstrated a number of actions that enabled the *Smart Trek* project to move forward to successful implementation. Although the participants faced several obstacles, none of them proved to be insurmountable barriers or drastically affected the ITS deployments. The methods they used to involve the private sector are most noteworthy. Through an innovative procurement mechanism, the participants were able to engage the private sector parties quickly, saving time and other resources.

- Private Sector involvement was a key aspect of Smart Trek. Once the private sector firms were under contract, the Smart Trek participants tapped the expertise of the companies' staffs by including them in managing the project. Private sector employees filled many of the key management positions.

- The MMDI parties developed a long-range vision. The development of a business plan and the creation of an ITS equipment replacement fund will help ensure that the services provided under the MMDI will continue after the demonstration period has ended.

The following conclusions can be drawn from the ATIS Customer Satisfaction evaluations of the Smart Trek ATIS deployments:

- ***WSDOT Traffic Information Web Site Evaluation Major Conclusions***

  - Respondents rank the WSDOT Web site as their most useful source of information on traffic conditions. This Web site rated more favorably than any other source of traffic information that respondents used, including radio and television reports.

  - The WSDOT Web site is heavily used for commute trips. Regular commuters used the Web site most frequently for the commute trips that they took. In particular, commuters overwhelmingly accessed the Web site for the trip from work or school. Commute characteristics affected use of the site.

  - Reducing stress was cited by a number of respondents as an important benefit of using the WSDOT Web site. Nearly 75 percent of respondents agreed that access to the Web site had helped them "reduce the stress of traveling in the Seattle area."

  - The level of use of the Web page grew significantly over the year-long period of observation, doubling on average, and typically reaching levels of between 10,000 and 15,000 Web "user sessions" per day. This increase in usage can be expected to continue to increase in the future as more people gain Internet access, as traffic congestion worsens, and as the quality of information on this Web site improves.

  - The Web site received a dramatic increase in usage by the public during a severe Winter storm in Seattle. This highlighted the importance of traffic information web sites to provide the public with valuable information during severe weather, and also pointed out the need for these web sites to have the capability to handle spikes in usage during severe weather and perhaps other emergencies or special events.

- ***Cable Television Traffic TV Evaluation Major Conclusions***

  – Out of the 223 respondents who said they had ever watched the TrafficTV broadcasts, 85 percent said they found out about the broadcast while flipping through the channels on their TV. This is similar to what we learned about the traffic TV program in Tempe, Arizona, and indicates a fairly low level of awareness and use of this program in the population. It also suggests the potential value of promotional efforts to let cable viewers know about this program. Respondents even suggested more attention be given to promoting the program.

  – Route changes were the most likely choice for viewers who commute and said they had consulted any source of traffic information. The most frequently indicated behaviors are route changes (31 percent take a mostly different route; 22 percent make small route changes) and trip timing changes (20 percent leave earlier and 14 percent leave later). The reasons for these changes are to avoid congestion (94 percent say this is important to them), saving time (91 percent), using time more effectively (80 percent), reducing stress (74 percent), reducing the risk of an accident (40 percent), saving gasoline (32 percent), and saving miles (18 percent).

- ***"Metro Online" Transit Web Site Evaluation Major Conclusions***

  – The Web site provides valuable services to its users. Our analysis suggests that Metro Online gets a lot of repeat use and that the user base includes many long-term users. This in itself is evidence that the site is useful and is providing value to its users. These findings are further corroborated by the responses to the survey, which indicate that Metro Online is used to obtain a variety of information, route and schedule information being chief among them.

  – Metro Online can be made easier to use, especially for new users. The responses suggest that some of the services provided by Metro Online — route information and transfer planning, in particular — can be modified to make the services more user-friendly and easier for the user to navigate. Our analysis suggests that first-time users find it more difficult than experienced users to use the Web site as it is presently designed.

- ***Transit Watch Transit Display System Evaluation Major Conclusions***

  – Transit Watch is both widely used and useful. Actual bus departure times are the Transit Watch feature found most useful by the users.

  – Real-time information at locations where key travel decision are made (e.g., office buildings) would be used and considered useful by a majority of transit passengers. Transit Watch users particularly endorsed this suggestion.

  – Although Transit Watch and the improved information is perceived as a real benefit by its users, the users did not seem to think that it increased their overall satisfaction with the transit experience. Our analysis indicates that Transit Watch in and of itself is unlikely to significantly change aggregate transit trends and perceptions. However, use of Transit Watch has a measurable effect on the comfort and satisfaction of new riders with the transit experience, and this has the potential to help retain ridership.

- ***Fastline Personal Travel Companion Evaluation Major Conclusions***

  – The traveler information technology deployed by Fastline under the Smart Trek program is usable by a relatively small market niche. It requires specialized hardware (a handheld personal computer running Windows CE), and reasonably sophisticated users. A modem must also be installed; moreover, to benefit from the portability of the handheld PC and to use it during a trip, the user would need to have a wireless modem. All this makes for a complex, expensive package, which would likely require a robust and sustained marketing campaign to achieve even modest market penetration.

  – Limited evidence from this survey suggests that registrants made useful changes in their travel behavior, such as route and timing changes, in response to information about traffic conditions.

The following conclusions can be drawn from the ITS Integration Modeling Evaluation of both arterial traffic signal integration and in making arterial traffic data available to ATIS:

- Benefits of Traffic Signal Coordination. Traffic signal coordination has measurable benefits on both the primary arterials and surrounding roadways. The evaluation showed that a 7 percent reduction in average vehicle delay at the subarea level through the road network could be expected under peak conditions. In addition, the evaluation showed that a 2.5 percent reduction in overall crashes could be expected. At the same time, the increase in total traffic throughput through the road network is negligible; the system is moving roughly the same number of people through the road network in a more effective and safe manner.

- Effect of Traffic Signal Coordination on Cross Street Traffic Flow. The majority of cross streets along the SR99 and SR522 corridor see no adverse impact from mainline traffic signal coordination, primarily because travelers utilizing the cross streets have the same phase split under both the Baseline and coordinated plans. This conclusion is consistent with results from modeling conducted for the Phoenix MMDI evaluation.

- Effect of Traffic Signal Coordination on Emissions. There was no statistically significant change in emissions with the implementation of traffic signal coordination. In general, the emissions resulting from a case of frequent stopping of vehicles from lower speeds in a non-signal controlled environment is roughly equal to the emissions resulting from less frequent stopping of vehicles from higher speeds in a signal controlled environment.

- Arterial data improved the effectiveness of ATIS**.** The integration of arterial congestion data with freeway-based ATIS clearly improved the effective utilization of ATIS services by the travelers modeled in the Seattle North Corridor. The travel delay reduction realized when congestion data on parallel arterial facilities (SR99 and SR522) was made available to the freeway-based ATIS system (associated with a 6 percent ATIS usage rate) in the morning peak was 1.8 percent. Additionally, a 5.6 percent drop in number of stops under relatively stable total travel resulted in across-the-board improvements in energy efficiency and emissions reductions.

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5. RECOMMENDATIONS

The following recommendations have been developed based on the conclusions and experience in conducting the Smart Trek Evaluation:

- The participants of the Smart Trek ensured that the private sector was involved in the MMDI deployment. This helped to reduce program risk and support on-time deployment of ITS projects. This approach, which included working with private sector parties from the inception of the project and including them in the management of the project, is a model that should be followed in other areas.

- The use of the Federal procurement process as the competitive process to obtain private sector parties under sole-source contracts is a good example of applying flexible procurement methods. This tactic enabled WSDOT staff to quickly procure services from the private sector participants once the MMDI award was granted. The use of flexible procurement methods should be used by others implementing ITS.

- The MMDI participants addressed the issue of long-term operations and management of the systems being developed in the project. Collectively, they developed a business plan, and individually, one agency modified its equipment replacement fund to include the equipment gained through the MMDI. Long-term vision and planning should be applied in all areas deploying ITS.

- The success of the WSDOT Web site demonstrates that government-owned and operated traffic information Web sites should still be considered as one of the recommended options for disseminating traveler information in a major metropolitan area. During the observation period for the WSDOT Web site, the level of usage of the Seattle WSDOT traffic information Web pages grew significantly over the period of observation, doubling on average over the period of observation, and is expected to continue to increase in the future.

- The WSDOT Web site should be enhanced in several major ways. First, by improving the geographical coverage of the information provided, by filling in the gaps on the Traffic Conditions map where data for road segments were unavailable, and by adding information on additional road segments to the Traffic Conditions map. Also, incidents should be indicated on the FLOW map, as well as an indication of traffic speeds on the roadways, and integration of the camera and FLOW map pages. In addition, personal customization features should be added, from sizing the map to fit their screens better, to setting preferences so the page will open to the information of particular interest to users. Finally, information on both the FLOW map and camera pages should be updated more frequently.

- Based on the significant Web usage spikes seen on the WSDOT Web site during inclement weather in Seattle, developers of ATIS Web sites should design their systems to be able to handle substantially increased customer usage during poor weather conditions.

- The King County Metro Online Web site should be enhanced in several ways, including adding the provision of a door-to-door trip planning service, providing for more detailed maps and specific information about the bus routes and stops, and by making the maps and schedules easier to print.

- If the Transit Watch system is going to be expanded, it could be improved by providing real-time information at locations where key travel decisions are made and where the information would be considered most useful by a majority of transit passengers. This could include video monitors at malls or office buildings close to major bus stops that would allow consumers to maximize the time spent at their trip ends.

- If private industry is to consider deploying traffic information services for handheld personal computers, it is recommended that they pursue an aggressive and sustained marketing campaign. The one shot campaign that advertised Fastline's service in Seattle is not nearly enough to get the word out and sustain interest; rather, it would appear that an ongoing promotion of the service will be needed to inform potential users and convince them both to register and then to stay with the technology and engage in the necessary communications regime to get real-time traffic data.

- Where appropriate, cross-jurisdictional signal control integration utilizing ATMS systems should be implemented on major metropolitan arterials where congestion is a serious problem. This evaluation showed that significant arterial congestion relief benefits can be realized with no adverse impacts to cross-streets. Jurisdictions should work together to overcome institutional stumbling blocks that have been delaying the full implementation of systems such as these across the U.S.

- While cross-jurisdictional signal coordination was shown to be beneficial, the range of conditions (particularly the combination of weather and travel demand variations) seen in North Seattle cannot always be satisfied with a single fixed plan. Even more benefit could be expected if alternative plans are implemented based on particular observed conditions. For example, a coordinated plan with shorter cycle lengths and faster vehicle progression speeds could be developed for light demand conditions. This signal control strategy would require daily cooperation between jurisdictions to select the appropriate coordinated plan from a list of approved alternatives. It is thus recommended that cross-jurisdictional signal coordination in major metropolitan areas be conducted with the goal of establishing a menu of signal timing plans to implement based on a variety of anticipated traffic conditions.

- In major metropolitan areas where ATIS web sites are in development or are already deployed, the deployers should strongly consider the addition of applicable ITS sensors to allow for traveler information to be collected on congested arterial corridors. The combination of major arterial traffic flow data with freeway traffic flow data will provide measurable benefits to the public and the transportation system.

- Analysis of integration in metropolitan model deployment should be made more of a priority in future evaluations. The results from the ITS Integration Modeling evaluations showed modest benefits from the partial integration of ITS within a corridor, but did not answer the question of what benefits could be expected from a multi-element ITS integration with information being shared and managed/optimized across numerous levels and across multiple corridors and regions.

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APPENDIX A: ADDITIONAL PROJECT COST ESTIMATES

This appendix presents the remaining cost estimate summary tables not previously presented in this report that were developed as part of the Smart Trek evaluation effort. Table A-1 provides for the location in this report of all of the project cost estimate summary tables. The detailed cost estimate spreadsheets that these tables are based on have been provided to Mitretek for inclusion in the National ITS Cost Database.

Table A-1. Location of Smart Trek Project Cost Estimates Within this Report

Project	Report Section
ITS Information Backbone System [43]	3.2.2, 3.2.3, 3.2.5, 3.2.6, A.1, A.3, A.4
WSDOT Web Site	3.2.2
Cable Television "Traffic TV"	3.2.3
Transit Watch Display System	3.2.5
King County BusView Web Applet	A.1
Transit AVL System Upgrade	A.2
FASTLINE Personal Travel Companion	3.2.6
Etak/Metro Networks ISP Services	A.3
Washington State Ferries ATIS	A.4
North Seattle ATMS	3.3.1
Eastside ATMS	A.5
Southside ATMS	A.6
Bellevue TMS	A.7
WSDOT NW Region TSMC Upgrades	A.8
Regional Video System	A.9
Improved Incident Video	A.10
Emergency Operations Centers	A.11
Seattle Center Parking Info. System	A.12
Dynamic Ridematch/ Rideshare	A.13

One of the primary reasons to collect cost data is to provide a costing tool for ITS implementers. Once collected, cost data for ITS deployments can be used by various metropolitan planning agencies (including those providing the data) when evaluating their transportation alternatives. In this regard, a major goal of MMDI cost analysis has been to support the collection of cost data which can support both the National ITS Cost Database currently being developed for the USDOT-JPO by Mitretek, as well as to support the ITS Deployment Assessment System (IDAS) cost-benefit analysis model currently being developed by CSI for the USDOT-JPO.

[43] Note here that the ITS Information Backbone System costs are "shared" equally among the seven ATIS-related projects which either currently are connected or could potentially be interfaced with ITS Information Backbone System. Thus, for each of these seven projects, a 14% share of the information backbone cost elements is shown.

A.1 KING COUNTY BUSVIEW WEB APPLET

BusView provides real-time bus location information on the Internet so riders can see whether their bus will arrive on time. Graphically depicted on a map, commuters are able to track their bus on their home or office computers as it approaches their stop. Bus location information is provided by King County Metro Transit's AVL System. Additional information, such as estimated times of arrivals at major destinations, traffic incidents, and traffic speed information may become available later in the project.

Note that a 14% share of the ITS Information Backbone System cost elements have been included here as part of this cost estimate since relevant ITS information is either currently exchanged between this system and the Backbone, or because this system has the potential to interface with the Backbone in the near future.

Table A-2. King County BusView Web Applet Cost Estimate

Equipment Description	Non-Recurring Costs	Recurring Costs
UW Total Equipment Purchases (Proposed Budget)	$ 8,500	
UW Total Supplies & Materials (Proposed Budget)	$ 2,300	
UW Development Labor	$ 221,016	
King Co. Engineering & Management Support	$ 16,000	
Operations Labor (1 UW FTE's)		$ 131,250
14% Share of 3 Pentium Workstations & Associated Equipment	$ 3,393	
14% Share of Labor (including indirect costs and benefits)	$ 78,324	
14% Share of Other Direct Costs	$ 3,585	
14% Share of Hardware & Supplies (replaced every 2 years)		$ 1,696
14% Share of Fiber Link & Other Contractual Services		$ 2,428
14% Share of Operations Labor (3 UW FTEs)		$ 40,178
Total	**$ 333,118**	**$ 175,552**

A.2 TRANSIT AVL SYSTEM UPGRADE

Metro Transit uses an AVL Computer-Aided Dispatch (CAD) system to monitor and control real-time operation of its entire bus fleet. This system has been fully operational since 1993. In emergencies, bus operators can use a silent alarm that alerts the control center and initiates priority vehicle tracking. The most significant benefits of this system are improved security for bus operators and passengers, efficient restoration of service, and immediate access to information about schedule adherence and travel time that can be used to fine-tune schedules. The Smart Trek funding allowed this system to be upgraded to provide increased performance to this system to better support transit traveler information systems such as BusView and Transit Watch.

Table A-3. Transit AVL System Upgrade Cost Estimate

Equipment Description	Non-Recurring Costs	Recurring Costs
ARI CPU Boards (Quantity:1360)	$ 442,570	
Modem Boards (Quantity: 1360)	$ 247,410	
Termination Boards (Quantity:1360)	$ 26,206	
Labor to Retrofit MDU Units (Quantity: 1360)	$ 34,284	
Delivery and Pickup of MDU and Cases (Quantity: 1360)	$ 3,834	
Sales Tax on Above	$ 70,000	
AVL Software	$ 250,000	
MDU Test Tool (Software and Hardware)	$ 55,200	
Contract Management Labor	$ 40,660	
Basic System Maintenance (Hardware)		$ 10,000
Basic System Maintenance (Labor - 1 FTE)		$ 125,000
ISP Costs (3 lines)		$ 2,700
Total	**$ 1,170,164**	**$ 137,700**

A.3 ETAK/METRO NETORKS ISP SERVICES

The traffic work station that Etak and Metro Networks, successfully demonstrated as part of the SWIFT Field Operational Test, was expanded under Smart Treak to handle more data sources, and to support the development of a commercial Internet service provider (ISP) content service. Metro Networks now operates additional servers for increased information dissemination. Etak has established partnerships with several other ISPs and is planning to include wireless delivery of traveler information to PDAs (Hewlett-Packard), two-way pagers (SkyTel), portable computers, and in-vehicle navigation devices (e.g., Clarion, and Volvo). These ISPs may use communications media such as packet radio, and paging frequencies. If appropriate, user software components for this service will be distributed free of charge via the Internet.

Note that a 14% share of the ITS Information Backbone System cost elements have been included here as part of this cost estimate since relevant ITS information is either currently exchanged between this system and the Backbone, or because this system has the potential to interface with the Backbone in the near future.

Table A-4. Etak/Metro Networks ISP Services Cost Estimate

Equipment Description	Non-Recurring Costs		Recurring Costs	
Etak Development	$	34,830		
Etak Management	$	3,870		
Recurring Value of Metro Networks Content			$	48,000
14% Share of 3 Pentium Workstations & Associated Equipment	$	3,393		
14% Share of Labor (including indirect costs and benefits)	$	78,324		
14% Share of Other Direct Costs	$	3,585		
14% Share of Hardware & Supplies (replaced every 2 years)			$	1,696
14% Share of Fiber Link & Other Contractual Services			$	2,428
14% Share of Operations Labor (3 UW FTEs)			$	40,178
Total	**$**	**124,002**	**$**	**92,302**

A.4 Washington State Ferries (WSF) ATIS

WSF is the State's second largest transit system, but travelers often do not know if incoming ferries are on schedule or the length of the queue waiting for the ferry. This information would enable travelers to plan trips to avoid congestion, and choose among several ferry routes and terminals. The Smart Trek improvements identified the location of ferries via a global positioning system, which in turn had now been made available on the Internet. Detectors were installed at the Bainbridge Island, Kingston, and Clinton ferry terminals, with the resulting average wait time calculated and distributed to travelers via Variable Message Signs (VMS) and the Internet.

Note that a 14% share of the ITS Information Backbone System cost elements have been included here as part of this cost estimate since relevant ITS information is either currently exchanged between this system and the Backbone, or because this system has the potential to interface with the Backbone in the near future.

Table A-5. WSF ATIS Cost Estimate

Equipment Description	Non-Recurring Costs	Recurring Costs
Vessel Transponder Assembly	$ 125,000	
Vessel Installation	$ 23,200	
Server (Compaq Proliant 2500) and Associated Hardware	$ 18,151	
Operator Interface- Compaq DeskPro 6000 System	$ 4,711	
Workstations- Compaq DeskPro 4000 Systems (Quantity: 3)	$ 6,909	
Misc. Hardware and Supplies	$ 16,196	
Vessel Monitoring & Display Software	$ 7,800	
WSF Custom Software	$ 23,500	
Delivery of Queue/Delay System	$ 11,000	
Other Software	$ 4,528	
Software Development	$ 235,000	
Mgmt, Development, Sys. Engr., Training & Support Labor	$ 215,700	
Hardware Maintenance (10% of Capital Hardware Cost)		$ 19,417
Software Maintenance		$ 3,766
14% Share of 3 Pentium Workstations & Associated Equipment	$ 3,393	
14% Share of Labor (including indirect costs and benefits)	$ 78,324	
14% Share of Other Direct Costs	$ 3,585	
14% Share of Hardware & Supplies (replaced every 2 years)		$ 1,696
14% Share of Fiber Link & Other Contractual Services		$ 2,428
14% Share of Operations Labor (3 UW FTEs)		$ 40,178
Total	**$ 776,997**	**$ 67,485**

A.5 EASTSIDE ATMS

Smart Trek included the creation of three expanded ATMS facilities in the region. These new regional facilities are compatible, interoperable, and are able to share information with other regional agencies. To facilitate the regional sharing of traffic information, Smart Trek also built into these ATMS systems the capability to integrate agency traffic signal systems across multiple jurisdictions in each region.

The Eastside ATMS includes traffic management system responsibilities for the suburban area approximately 15 miles east of downtown Seattle, portions of King County and the cities of Bellevue, Issaquah, Kirkland, Redmond, and Woodinville. Information will be provided to ITS Information Backbone for value-added processing and dissemination to other public and private users.

Note here that a significant portion of the cost elements were common between the three major regional ATMS elements. Therefore, these costs elements are "shared" across these three deployments (i.e, 33.3% of the costs are assigned to each ATMS project – North Seattle ATMS, Eastside ATMS, Southside ATMS).

Table A-6. Eastside ATMS Cost Estimate

Equipment Description	Non-Recurring Costs		Recurring Costs	
Concept Design	$	13,822		
Project Management/Administration	$	51,524		
System Engineering	$	51,072		
Software Development	$	109,727		
Documentation/Training	$	29,465		
Other Direct Costs	$	20,200		
Hardware	$	100,000		
Annual Hardware O&M @ 10% of Capital Cost			$	8,200
33% Share of Software Development	$	653,462		
33% Share of Pre-Design	$	247,367		
33% Share of Design	$	289,689		
33% Share of Management Reserve/Contingencies	$	88,163		
33% Share of City of Seattle Coordination	$	13,333		
33% Share of ATMS Local Agency Coordination (1 FTE)			$	34,168
33% Share of ATMS System Administration (1 FTE)			$	34,168
33% Share of ATMS System Operations (1 FTE)			$	34,168
Totals	**$**	**1,667,824**	**$**	**110,704**

A.6 SOUTHSIDE ATMS

Smart Trek included the creation of three expanded ATMS facilities in the region. These new regional facilities are compatible, interoperable, and are able to share information with other regional agencies. To facilitate the regional sharing of traffic information, Smart Trek also built into these ATMS systems the capability to integrate agency traffic signal systems across multiple jurisdictions in each region.

The Southside ATMS improvement includes TMS responsibilities for the region south of the Seattle city limits, portions of King County. and including the cities of Federal Way, Tukwila, SeaTac, Burien, Des Moines, Kent, and Aubum. Information will be provided to ITS Info. Backbone for value-added processing and dissemination to other public and private users.

Note here that a significant portion of the cost elements were common between the three major regional ATMS elements. Therefore, these costs elements are "shared" across these three deployments (i.e, 33.3% of the costs are assigned to each ATMS project – North Seattle ATMS, Eastside ATMS, Southside ATMS).

Table A-7. Southside ATMS Cost Estimate

Equipment Description	Non-Recurring Costs	Recurring Costs
Concept Design	$ 13,822	
Project Management/Administration	$ 51,524	
System Engineering	$ 51,072	
Software Development	$ 109,727	
Documentation/Training	$ 29,465	
Other Direct Costs	$ 20,200	
Hardware	$ 100,000	
Annual Hardware O&M @ 10% of Capital Cost		$ 8,200
33% Share of Software Development	$ 653,462	
33% Share of Pre-Design	$ 247,367	
33% Share of Design	$ 289,689	
33% Share of Management Reserve/Contingencies	$ 88,163	
33% Share of City of Seattle Coordination	$ 13,333	
33% Share of ATMS Local Agency Coordination (1 FTE)		$ 34,168
33% Share of ATMS System Administration (1 FTE)		$ 34,168
33% Share of ATMS System Operations (1 FTE)		$ 34,168
Totals	**$ 1,667,824**	**$ 110,704**

A.7 BELLEVUE TMS

The City of Bellevue used Smart Trek funding to upgrade signal hardware and software and implement transit signal priority. Specific Smart Trek improvements were combined with other ongoing improvements to the City of Bellevue TCC to share regional traffic and transit data.

Table A-8. Bellevue TMS Cost Estimate

Equipment Description	Non-Recurring Costs	Recurring Costs
King County Transit Signal Priority System	$ 500,000	
Bellevue TMS Installation Labor	$ 157,000	
Bellevue TMS Computer System Upgrade	$ 120,000	
Bellevue TMS Software Development	$ 300,000	
Hardware Maintenance @ 10% of Capital Cost		$ 77,700
Software Maintenance @ 5% of Capital Cost		$ 15,000
Totals	**$ 1,077,000**	**$ 92,700**

A.8 WSDOT NORTHWEST REGION TSMC UPGRADES

The WSDOT Northwest Region TSMC is the centralized facility for the Seattle region's comprehensive freeway management system. This facility collects, integrates, processes, and disseminates regional freeway system information. The facility and the regional roadway systems include traffic surveillance using inductive loop sensors to detect and report measures of traffic flows on the freeways, and pan-tilt-zoom closed-circuit TV to allow WSDOT operators to observe traffic on the freeways, ramp metering systems with associated sensor loops, and weather stations distributed in the region.

Under Smart Trek, this system was upgraded to enhance the content available to support the traffic information needs of the WSDOT Web site and other Smart Trek ATIS projects over the ITS Information Backbone system.

Table A-9. WSDOT Northwest Region TSMC Upgrades Cost Estimate

Equipment Description	Non-Recurring Costs	Recurring Costs
Surveillance Equipment	$ 870,000	
Fiber Connection	$ 57,000	
CD Duplicators (TMSC History Data)	$ 5,700	
Programming (TSMC History Data)	$ 93,750	
State Design	$ 35,000	
Blank CD's, Printing, Misc. Software		$ 2,000
Surveillance Equipment (2% of Capital Cost)		$ 4,350
Totals	**$ 1,061,450**	**$ 6,350**

A.9 REGIONAL VIDEO SYSTEM

Several local television stations use live traffic video provided by WSDOT's closed-circuit television cameras during the news broadcasts. The enhancements to this system under Smart Trek enabled additional television stations and regional agencies to receive WSDOT's real-time CCTV video. An expanded video switch allows for 448 cameras and 80 monitors to be connected. Connections were made among state and city CCTV cameras and operations centers. The system provides more roadway surveillance video to TV stations and other public/private agencies and jurisdictions.

Table A-10. Regional Video System Cost Estimate

Equipment Description	Non-Recurring Costs	Recurring Costs
Expanded Video Switch	$ 50,439	
Transmission Equipment	$ 99,384	
Transmission Short Haul	$ 34,128	
Fiber to Bellevue	$ 17,000	
Fiber to Seattle	$ 34,000	
Fiber to UW	$ 15,000	
Video Display Screens (Quantity: 6)	$ 67,000	
Video Monitors (Quantity: 23)	$ 18,000	
WSDOT Engineering	$ 5,000	
Video Camera Maintenance		$ 10,000
Totals	**$ 339,951**	**$ 10,000**

A.10 IMPROVED INCIDENT VIDEO

The WSDOT operates roving incident response vehicles (IRVs). The Smart Trek Project installed two-way video communications equipment in IRVs and provided a link between the TSMC and the IRVs so that incident and traffic video information could be exchanged. Images are sent to the TSMC from the scene of accidents for regional traffic management and freeway camera images are sent to the IRVs for enhanced on-site traffic management. Five WSDOT IRVs are equipped with 2-way video between vehicles and the TSMC. The system provides for the following major capabilities:

- Slow scan video transmitted from IRV to TSMC and WSP personnel.
- Real time video snap shots and flow map available to incident response teams on the scene.
- Capability to record at least two hours of full motion video at scene.

Table A-11. Improved Incident Video Cost Estimate

Equipment Description	Non-Recurring Costs	Recurring Costs
Pan & Tilt (PTZ) Cameras (Quantity: 2)	$ 22,000	
Installation of PTZ Cameras	$ 8,000	
Snapshot Camera	$ 1,000	
WSDOT Engineering	$ 10,000	
Camera Equip 2% of Capital Cost		$ 460
Totals	**$ 41,000**	**$ 460**

A.11 EMERGENCY OPERATIONS CENTERS

A key barrier to effective communication among Emergency Operations Centers in the region was the lack of a shared communication media. Based upon the results of workshops and meetings, it was determined that the first step toward better cooperation would be the purchase of radios that operate on the same frequencies. The Smart Trek project purchased these radios for all of the regional Emergency Operations Centers.

Table A-12. Emergency Operations Centers Cost Estimate

Equipment Description	Non-Recurring Costs	Recurring Costs
800 mHz Two-way Radios (Quantity: 16)	$ 27,200	
Repeater station upgrades (Quantity: 3)	$ 30,000	
Misc. Equipment	$ 8,000	
Misc. Equipment	$ 8,000	
Consulting Fees	$ 30,000	
Lifeline Route Plan Data Collection/GIS	$ 35,000	
IBI Emergency Management Scope Development	$ 13,500	
Communications System Maintenance (5% of Capital Cost)		$ 2,860
Totals	**$ 151,700**	**$ 2,860**

A.12 SEATTLE CENTER ADVANCED PARKING INFORMATION SYSTEM

The Seattle Center, site of the 1962 World's Fair, is a major cultural and sports activity center playing host to theater, opera, and special events and recreation, including the Seattle Sonics basketball team. Through the use of automatic monitoring technology and roadside VMSs, the Seattle Center Parking Information System provides information on, and directs traffic to, three major parking lots in a manner that is safe, efficient, and results in minimum traffic congestion and neighborhood disruption. It also provides parking and trip planning information to travelers before they leave for the Center and while enroute so that they can make informed route and mode choices. The information is also being made available to ISPs who will transmit the information to the public on cellular phones, pagers, and the Internet.

Table A-13. Seattle Center Advanced Parking Information System Cost Estimate

Equipment Description	Non-Recurring Costs		Recurring Costs	
Central Computer System, Hardware and Software	$	11,540		
VMS Controllers & Cabinets (Quantity: 2)	$	99,675		
VMS Structures & Installation (Quantity: 2)	$	70,000		
5th Ave. Monitoring System (Groundhog System)	$	21,250		
Mercer Garage Monitoring System Hardware	$	38,300		
Mercer Garage Monitoring System Installation Labor	$	8,000		
1st Ave. Garage Monitoring System Hardware	$	12,000		
1st Ave. Garage Monitoring System Installation Labor	$	2,000		
Communications System Hardware	$	5,900		
Communications System Labor	$	3,600		
Software Development	$	95,000		
Core Consultant Services	$	146,000		
IBI Consulting Services	$	412,000		
Maintenance @ 7 of Capital Cost			$	18,973
Telephone Line Cost/Year			$	300
Parking Management Staff			$	31,250
Total	**$**	**925,265**	**$**	**50,523**

A.13 DYNAMIC RIDEMATCH/RIDESHARE

Building on a previous successful demonstration, this project uses advanced communication networks to facilitate dynamic ride sharing. Users can quickly and easily learn of others who share their transportation needs for any specific trip or set of trips that have been entered on an Internet Website. (www.RIDEQUEST.COM) E-mail is used to alert riders and drivers to a potential ridematch.

Table A-14. Dynamic Ridematch/Rideshare Cost Estimate

Equipment Description	Non-Recurring Costs	Recurring Costs
Computer Hardware	$ 12,000	
Software Licenses	$ 14,000	
Develop Stand-Alone IBRMS	$ 104,865	
Link IBRMS to Regional System	$ 11,520	
Project Management	$ 21,682	
Other Direct Costs	$ 9,000	
Hosting		$ 8,400
Maintenance		$ 3,000
Annual Software Licensing		$ 1,500
Totals	**$ 173,067**	**$ 12,900**