FINAL REPORT

FY04 ITS INTEGRATION COMPONENT

of the

ITS DEPLOYMENT PROGRAM

VII.J.38.a
Portland State University
Intelligent Transportation Research Initiative
Oregon

Portland State University
Intelligent Transportation Systems Laboratory
Northwest Center for Engineering, Science and Technology
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July 2006

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Final Report Portland State University Intelligent Transportation Research Initiative		**5. Report Date** July 2006
		6. Performing Organization Code
7. Author(s) Robert L. Bertini		**8. Performing Organization Report No.**
9. Performing Organization Name and Address Portland State University Department of Civil and Environmental Engineering P.O. Box 751, Portland, OR 97207-0751		**10. Work Unit No. (TRAIS)**
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address		**13. Type of Report and Period Covered**
		14. Sponsoring Agency Code
15. Supplementary Notes		
16. Abstract		
17. Key Word	**18. Distribution Statement**	
19. Security Classif. (of this report)	**20. Security Classif. (of this page)**	**21. No. of Pages** **22. Price**

Form DOT F 1700.7 (8-72)   Reproduction of completed page authorized

PREFACE

This document serves as the final report for an Fiscal Year 2004 Federal Highway Administration ITS Integration grant entitled the Portland State University Intelligent Transportation Research Initiative, located at Portland State University in Portland, Oregon. The ITS Integration funds ($344,633) supported the design, design, outfit and interior "fit up" for the new regional Intelligent Transportation Systems (ITS) Laboratory suite located in the new $60 million Northwest Center for Engineering, Science and Technology, a major engineering research facility located on the campus of Portland State University in downtown Portland, Oregon. This report provides the final progress report, as well as serving as the Local Evaluation Report, which includes lessons learned in integrating ITS data and providing the MPO with archived ITS data products.

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ACRONYMS

ADUS   Archived Data User Service
APC   Automatic Passenger Counters
AVL   Automatic Vehicle Location
DOT   Department of Transportation
FHWA   Federal Highway Administration
ITS   Intelligent Transportation System
JPACT   Joint Policy Advisory Committee on Transportation
MPO   Metropolitan Planning Organization
NWCEST   Northwest Center for Engineering, Science and Technology
ODOT   Oregon Department of Transportation
PDOT   City of Portland Office of Transportation
PORTAL   Portland Oregon Regional Transportation Archive Listing
PSU   Portland State University
TMOC   Transportation Management Operations Center
TPAC   Transportation Policy Advisory Committee
TransPort   Portland Metropolitan Region ITS Committee
TriMet   Tri-county Metropolitan Transit District

EXECUTIVE SUMMARY

This FY 2004 ITS Integration grant has provided partial funding for design, outfitting, and interior "fit up" for the new regional Intelligent Transportation Systems (ITS) Laboratory suite located in the new $60 million Northwest Center for Engineering, Science and Technology, a major engineering research facility located on the campus of Portland State University in downtown Portland, Oregon. Integration has been achieved through several key strategies: designing and equipping the new ITS laboratory in the NWCEST, including the provision of cable raceways and cable troughs enabling the flexible cabling of the lab as technologies evolve; providing physical communications linkages; providing linkages to ITS data sources that have enabled the establishment, testing, expansion and use of the regional ITS data archive; and the use of traffic management system software and hardware for training, simulation and educational purposes. The objective of this project was to create a regional resource for housing archived ITS data, serving as an emergency back-up transportation management operations center (TMOC) and to provide resources for regional transportation education, research and training. The project was completed on time in December 2005.

The ITS Laboratory at Portland State University now houses the regional archive for transportation data collected by the Oregon Department of Transportation, the City of Portland and TriMet. Other key partner agencies in the development of the region's ITS plan include the Washington State Department of Transportation, CTRAN, Portland Metro, the Southwest Washington RTC, the city of Portland Traffic Signal Management System, the city of Gresham, Washington County Traffic Signal Management and Clackamas County Traffic Signal System. These agencies, plus Portland State University and other partners currently comprise TransPort, the voluntary regional ITS decision-making body that coordinates ITS planning, implementation and operations. The ITS Lab suite is now a center for the integration of ITS data from multiple sources as well as for research and education relevant to regional transportation issues in the Portland area. Uniquely, this is also a bi-state resource, as all ITS efforts are coordinated across the border with the state of Washington. Portland State University is responsible for the construction, long-term operations and maintenance of this integration project.

In addition to this USDOT ITS Deployment Grant, this project is funded from a number of sources. These include State of Oregon General bonds and Revenue bonds, the City of Portland and the Portland Development Commission, private donations from more than 50 individuals, and additional Federal grants from the Department of Education, the Small Business

Administration the Department of Housing and Urban Development.

The project is consistent with the National ITS Architecture, and has followed the regional ITS Architecture. Overall, this project is deemed to have met its objectives. The final report contains a narrative describing lessons learned from both the technical and institutional perspectives. The project has resulted in the implementation of a regional ITS data archive that benefits from strong cooperation among public agencies, the private sector, and Portland State University. Without leadership, commitment, mutual trust, and strong personal relationships, the project would not have succeeded. The new ITS Laboratory is a part of a private and secure regional high speed ITS data network that facilitates the sharing and archiving of operations data in real time. Strong leadership at Portland State University also contributed to the project's success—by demonstrating over multiple years that the university's programs are aimed at enhancing and supporting those of the regional and statewide transportation agencies, an environment of trust and mutual support has been established and maintained. The new ITS Laboratory is positioned to serve as an emergency back-up transportation management operations center, and progress toward this end is still ongoing. The Laboratory is already serving as a hub for regional and statewide ITS research, teaching and training.

The new laboratory is already providing the region's metropolitan planning organization (MPO), known as Metro, with archived ITS data products, as described in detail in this report. For example, time series reports, map based reports, and daily, monthly and annual congestion reports can be automatically generated via PORTAL (the Portland Oregon Regional Transportation Archive Listing, see http://portal.its.pdx.edu). Travel time reliability is an important measure for the regional Congestion Monitoring Program, and measures can easily be generated for Metro via PORTAL. Portland State University has conducted several training sessions for the MPO describing the functions currently available through the data archive, and it is expected that this relationship will continue in the future. It is also envisioned that additional ITS data sources will be archived in the near future which will further enhance its utility, particularly with respect to data available from arterials.

INTRODUCTION AND BACKGROUND

The Portland metropolitan area benefits from an extensive ITS program, including a freeway surveillance, management and information system operated by the Oregon Department of Transportation (ODOT). This includes a traffic management operations center (TMOC), freeway incident response system (COMET), a fiber optics communication backbone, ramp metering, variable message signs, CCTV surveillance and a statewide multimodal traveler information system, Tripcheck (www.tripcheck.com). This ITS project at Portland State University has enhanced the strong commitment that has existed toward providing a regional focus for relevant ITS research, continuing education for ITS professionals and the development of the next generations of engineers who can thrive in the ITS profession. The ITS Lab funded under this project will continue to produce people and projects that are important to the Portland region, the state of Oregon, the Pacific Northwest and the nation as a whole.

The ODOT system is well integrated with other ITS programs, particularly those of the City of Portland and TriMet. For example, the City operates a traffic management center including central control of approximately 1,200 traffic signals and city-owned video surveillance and traveler information (variable message signs) on its arterials. TriMet operates a fleet of approximately 700 AVL-equipped buses, most of which also include automatic passenger counters (APCs). TriMet's light rail/bus operations center includes real-time fleet management capabilities and their Transit Tracker allows customers to receive bus arrival countdown information at key stops and via the Internet.

There are several unique aspects of the ITS program in the Portland Metropolitan Region—first it is a bi-state region (Oregon and Washington); second, it is a region governed by a true regional government (Portland Metro, unique in the nation); third, it is a truly multimodal region, with light rail transit, bus, air, freeways, arterials, and a vibrant freight system (including highway, rail, air and river based facilities); and fourth, the various public and private entities responsible for ITS actively share resources and data sources. The coordinated planning, design and implementation occurs under the auspices of a voluntary organization called TransPort, a voluntary group that has been meeting monthly for over ten years to coordinate ITS-related efforts.

Since 2000, Portland State University (PSU) has been playing a key role under the auspices of TransPort, providing resources for evaluation, data archiving, training and education in the ITS

arena. For example, the National Science Foundation has supported a project designed to develop the framework for a regional ITS data archive, and PSU has released a working prototype of the user interface. According to the regional ITS architecture, PSU is the official data archiving entity and envisions integrating all forms of ITS data in the future. The archived data user service (ADUS) currently includes freeway loop detector and weather data. In the evaluation realm, PSU has completed evaluations of the COMET incident response program and the regional ramp metering system. This ITS project has supported ongoing operations of the ADUS program in the new ITS Laboratory.

PSU constructed a new engineering research and teaching facility called the Northwest Center for Engineering, Science, and Technology (NWCEST). As part of the Center, PSU has constructed a new Intelligent Transportation Systems Laboratory. The ITS lab is essential for integrating existing ITS systems and meeting the region's needs for ITS research and education, particularly focused on the continuing education of agency ITS employees and preparing the next generation of ITS engineers. The work of the ITS Laboratory is reflecting the priorities of transportation agency partners such as urban transit, freight, and the integration of livability, health, and transportation. This laboratory is a key building block for the University's ability to prepare tomorrow's transportation engineers and planners and to provide lifelong learning and training opportunities for the region's transportation agencies and industry. This facility will serve as a research magnet for businesses needing close access to high quality faculty and students while providing needed assistance to the area's transportation and planning agencies. For example, the PSU ITS lab is developing a regional data archive using data collected by more than 400 loop detectors on Portland area freeways. This research is helping to guide planners and policymakers about ways to keep traffic moving and ways to address congestion during peak hours. The new lab is now housing the regional transportation data archive, is serving as a center for educating and training the transportation workforce on new technology and is contributing to PSU's ability to work with local public and private industry partners on important collaborative research projects. The new lab is also enabling working professionals to earn advance degrees in connection with their employers. These projects are of national peer-reviewed quality and are being developed as a result of regional/national competition. Research results are typically submitted for publication in peer-reviewed archival journals and for presentation at nationally prominent conferences and symposia.

As part of the regional and statewide ITS programs, Portland State University has secured ITS funds through this ITS integration program to design, equip and support research and education

activities in the new ITS Laboratory in the new NWCEST, now constructed at 1930 SW Fourth Avenue (between Lincoln and Harrison) in downtown Portland. The original request for these funds was endorsed by TransPort, and by the regional transportation decision-making body, the Joint Policy Advisory Committee for Transportation (JPACT) which provides policy advice to the Metro Council. The new Intelligent Transportation Systems Laboratory at PSU, completed in December 2005, is serving as a research and educational site for transportation engineering and planning students, as well as a community resource for transportation agencies. This is beginning to enable the university to expand its integration work, particularly in the effort to centralize the archiving of the region's ITS data. It is becoming more likely that this will include developing a warehouse for ITS data at the state, and even the bi-state levels. Furthermore, the project is providing the capacity needed to expand the opportunities for providing advanced degree curricula for transportation agency employees.

Using the region's fiber communications backbone (the new NWCEST shares fiber with the City of Portland, and through the City also shares with ODOT and TriMet), PSU is now one of the nodes on the region's shared ITS communications network, integrating real-time and archived data from all regional transportation partners. In addition to providing the regional data archive, the new facility can now serve as an emergency backup TMOC, a training facility for tabletop simulation exercises, and a regional training and continuing education facility for the region's transportation professionals.

PROJECT OVERVIEW

The Portland State University Intelligent Transportation Research Initiative has created a regional resource for housing multimodal archived ITS data from multiple sources in the new Northwest Center for Engineering, Science and Technology (NWCEST), a major engineering research facility located on the campus of Portland State University in downtown Portland, Oregon, to serve as an emergency back-up transportation management operations center (TMOC) and provide resources for regional transportation education, research and training. The project's objectives were to:

a. Design, outfit, and equip the new regional ITS Laboratory suite located in the NWCEST.
b. Support regional ITS integration activities among regional and statewide transportation agency partners.

c. Provide cable raceways and cable troughs in the NWCEST, enabling the flexible cabling of the lab as technologies evolve.
d. Provide space, power, data communications, and physical communications linkages.
e. Provide linkages to ITS data sources that will enable the establishment, testing, expansion and use of the regional ITS data archive.
f. Provide linkages to ITS data sources that will enable the use of traffic management system software and hardware for training, simulation, and educational purposes.
g. Follow Architecture, Standards and Evaluation procedures.

Based on the experience of implementing this project, it is safe to say that the project's objectives have been met. Prior to the inception of this integration project the Portland metropolitan region did not have an ITS data archive nor did it have a designated site to house this resource. The new ITS Lab is that site. Many transportation agencies still discard their raw data after aggregation and some agencies have limited archiving function on legacy hardware/software systems that does not fit with the National ITS Architecture. This is a serious shortfall in the region's transportation system, and is being addressed by the development of integrated communications, networking and data archiving systems, much of which will be housed at Portland State University. The university involvement is consistent with national research that has indicated that university "ownership" is important to the success of data archiving systems.

Agencies whose data will be archived include the Oregon Department of Transportation, Washington State Department of Transportation, TriMet, CTRAN, Portland Metro, COMET, The City of Portland Traffic Signal Management System, Washington County Traffic Signal Management and Clackamas County Traffic Signal System. Ground was broken in May 2004 for the new 135,000 square foot Northwest Center for Engineering, Science and Technology building on the Portland State University Campus.

The Intelligent Transportation Systems Laboratory suite, necessary for supporting the expanded ITS research and education program consists of 5 specialized labs and two classrooms that can now serve as a critical resource, part of the core of the region's ITS program in the Greater Portland Metropolitan area. The labs were designed in close collaboration with PSU faculty, and involved consultation with the region's ITS partners. This was done to ensure that the long term ITS integration needs of the region are served and supported by the design of the labs. In

addition, the ITS Lab was designed to be flexible enough to grow along with the ITS research and education agenda.

FINAL PROGRESS REPORT

In addition to serving as the local evaluation report, this document provides final details on the actual progress of the project. The following sub-sections report on the project's successful completion as described in the original proposal and subsequent partnership agreements.

Federal Aid Project Number or Contract Number

This project was ITS Deployment Project VII.J.38.a, also described in ITS Partnership Agreement Project No. C000(020) between the Federal Highway Administration and the Oregon Department of Transportation.

Revisions to Project Contacts

The original project contact at Portland State University was Dick Piekenbrock, as Project Manager; he should be replaced with Robyn Pierce, Interim Director of Facilities, phone 503-725-4310.

Revisions to Original Estimated Project Completion Dates

The project completion is defined as submission of the project report to FHWA. The original completion date for the project was expected to be December 1, 2005. Due to some construction delays, the actual certificate of occupancy for the building was granted on December 27, 2005, with final punch list activities completed in April 2006. The final report is being submitted to FHWA in July 2006.

Revisions to Original Estimated Cost Values

There were no changes to the original estimated cost values.

Percent of Funds Expended

The project is complete, therefore a total of 100% of the funds have been expended.

Brief Identification of Milestones Attained

Here is a brief summary of project milestones achieved:

1. Project Design Completion   October 2003
2. Contract documents   February 2004
3. Bidding and Award   March 2004
4. Construction Start Date   May 21, 2004
5. Contract   May 2004-December 2005
6. Certificate of Occupancy   December 27, 2005
7. Punch List Complete   April 2006
8. Final Report Submitted   July 2006

Brief Description of Challenges Encountered

There were no major challenges encountered that affected project scope, created institutional issues or presented other significant considerations. Lessons learned are described later in this report.

Financial Report

Here is a final report of the cost data for this project.

Project Costs	Percent	Federal	Percent	Match	Total
Design & Planning of ITS Laboratory	65%	$137,633	35%	$ 75,745	$213,378
Construction of ITS labs as part of NWCEST	65%	$207,000	35%	$113,920	$320,920
Project Management	0%	$ 0	100%	$ 80,685	$ 80,685
Total		**$344,633**		**$270,350**	**$614,983**

CONSISTENCY WITH THE NATIONAL ITS ARCHITECTURE

This project followed the regional ITS architecture which is continuing to be developed, enhanced, and expanded. The Portland Metropolitan Region's ITS Architecture is being developed under the auspices of TransPort, and is coordinated at the state levels with the Oregon Department of Transportation and the Washington State Department of Transportation. This integration project at Portland State University has developed the region's ITS archived data user service (ADUS), which will is consistent with the Regional Architecture.

LESSONS LEARNED IN INTEGRATING ITS DATA

In the original project proposal, the intent was for integration to be achieved through several key strategies: designing and equipping the new ITS laboratory in the NWCEST, including the provision of cable raceways and cable troughs enabling the flexible cabling of the lab as technologies evolve; providing physical communications linkages; providing linkages to ITS data sources that will enable the establishment, testing, expansion and use of the regional ITS data archive; and the use of traffic management system software and hardware for training, simulation and educational purposes.

Through the design and equipping of the new ITS laboratory facilities, connections have now been made via physical communications linkages between ITS equipment deployed in the field and the lab where the data archive system interface is located. Actual servers are located in two separate secure server rooms on the PSU campus for redundancy and security reasons. Data are backed up daily. In order to accommodate the control and operations of additional systems in the future, it may be necessary to replace, reroute or augment the communications media in the lab; therefore, exposed cable raceways have been provided in the floor, along the ceiling and walls of the lab, enabling students and faculty to "see" the communications media and use the maintenance of these cables as part of the research and educational process.

The proposed ITS data archive is based on the National ITS Architecture and stems from the feed provided by the ODOT TMOC. As the system expands, additional data will be provided by the City of Portland, TriMet, the Washington State Department of Transportation, and other regional transportation agencies. The data will be shared (via a permission based web access system) with regional transportation partner agencies. This has already occurred with Metro (the regional MPO), as the PSU ITS lab has provided performance measures for the region's long range planning and public outreach program as well as updated volume-delay functions for the Highway 217 Corridor Study. Future integration is envisioned with cities and counties, plus the regional 911 centers as they develop their ITS and communications systems. The PSU ITS data archive is scalable and flexible, using open source software. It is also secure and robust enough to perform as the region's official data archive system.

The PSU ITS Lab is a member agency in the TransPort technical advisory committee, which has brought together the primary transportation agencies in the Portland metropolitan region

including southwest Washington in a joint effort to implement Intelligent Transportation Systems (ITS) applications. Participating agencies include:

a. ODOT
b. TriMet
c. City of Portland
d. Portland State University
e. Clackamas County
f. Washington County
g. Multnomah County
h. Port of Portland
i. Metro
j. C-TRAN.
k. City of Vancouver.
l. City of Camas.
m. Clark County.
n. Washington State Department of Transportation (WSDOT) Southwest Region.
o. Regional Transportation Council (RTC).
p. Federal Highway Administration (FHWA)

The TransPort committee has coordinated a bi-state, multi-agency ITS strategy to improve the safety and efficiency of the transportation system in the urbanized four county areas. The TransPort ITS Architecture was developed utilizing the "National ITS Architecture" framework, to allow for the total integration of all transportation information systems, transportation management systems, and transportation control systems for the urbanized area of the region.

This ITS project is a partnership among Portland State University, the Oregon Department of Transportation, the City of Portland, TriMet, and other transportation agencies under the auspices of TransPort. Due to the unique multimodal nature of this partnership, there were a number of institutional and technical issues to overcome in this integration project.

- From a technical standpoint, the ITS integration project has achieved its objectives in that there is now a direct fiber optic connection leading into the ITS Laboratory, providing real-time access to the ODOT and PDOT CCTV system with live images from more than 100 cameras.

- The ITS Laboratory is currently receiving a real time feed from nearly 500 freeway sensors (inductive loop detectors) reporting data at 20-second intervals via a private internet connection. The detectors report count, occupancy and vehicle speed in each lane on the freeway mainline, and provide count data for freeway on-ramps.

- New private, secure high speed, transportation data network (gigabit Ethernet) organized by TransPort and including PSU, ODOT, PDOT and TriMet as the first four nodes. TriMet has led this important effort, with support from PSU's College of Engineering and Computer Science computer support staff. Strong data security and organizational plans have been established through this process.

- The ITS Laboratory is nearly ready to begin receiving freeway sensor data over the new transportation network.

- Soon the ITS Laboratory will begin receiving incident data, transit vehicle location and traffic signal system data for archiving.

- The ITS Laboratory is also currently archiving statewide weigh-in-motion (WIM) data from 21 weigh stations.

- One issue that took some time to resolve was the access to the freeway sensor data via the firewall with ODOT. Universities have a reputation for potential security issues due to possible student mischief, but after some trust-building, ODOT has gained confidence with PSU's campus-wide security practices.

- PSU has several different computer support groups—one that is campus-wide and one that operates within the College of Engineering and Computer Science. It took some time to coordinate efforts among these groups, as well as with the campus-wide telecommunications office to make sure that the fiber optics, Ethernet and other data feeds were configured correctly.

- The ITS Laboratory was constructed as part of the overall NWEST project that included thousands of data connections and interfaces. Project oversight and lines of authority were not clear. Initial fiber optics connection produced unacceptable video quality. The

building contractor and subcontractors refused to investigate the reasons for the poor quality video. Thanks to support from PDOT and ODOT, a contractor was hired (by the City of Portland) to trace the fiber connection from the city's termination to the ITS Laboratory. Approximately 10 instances of shoddy construction, dirty and poorly terminated connections were discovered and repaired, resulting in more than acceptable quality video performance. This is an example of the value of the transportation agency partnerships in the Portland metropolitan area.

- The communications closet in the ITS Laboratory is connected to a series of cable trays and troughs that were supposed to be designed to provide video and data feeds directly to video monitors at the front of the room and to desktops at console stations in the center of the laboratory. Upon investigation, however, after building occupancy, it was discovered that the main floor trough was filled with water and other debris and the covers were screwed down with the screw heads painted. There were no holes in the tray covers that would allow video and data to reach through the floor. The building contractor refused to address this issue. But, thanks to the cooperation of the Department of Mechanical and Materials Engineering technician, the trough was cleaned, screws removed and holes bored in the covers so that the proper connections could be made.

- The ITS laboratory now houses archived freeway sensor data via an archived data user service called PORTAL (Portland Oregon Regional Transportation Archive Listing). The new laboratory provides space for students, staff, and faculty to develop and enhance the data archive in a secure and modern setting. So in this sense, the primary objective of this ITS integration project has been achieved. In addition to serving regional needs, there is interest in serving statewide and bi-state needs.

- It is very clear that the main reason that this project was successful is due to the strong, voluntary collaborative relationship among transportation agencies, private industry and Portland State University in the ITS arena. The TransPort committee's spirit of data sharing, resource leveraging, communication, and mutual support contributes to an environment that enables personal and professional relationships to develop and bear fruit. This project would not have been successful without the open, supportive, cooperative relationships that exist in the ITS community in Portland and Oregon. Without the commitment of the ODOT staff at the TMOC and at the ITS Unit in Salem (who helped

address important firewall issues), and the PDOT ITS staff, this project would never have been successful.

- At the regional level, the TransPort committee, the Transportation Policy Advisory Committee (TPAC), the Joint Policy Advisory Committee on Transportation (JPACT), the Metro Council, other transportation agency executives and staff all supported this request and contributed to the success of this project. Strong communications was a critical part of the project's success.

- Not only was it critical to have interested, committed and trusting public agency partners, but it was also important to have university leadership present to make the development of the ITS laboratory possible. The PSU president, the special assistant for government relations, the director of business affairs, the director of facilities, the dean and staff of the College of Engineering and Computer Science, the chair of the Department of Civil and Environmental Engineering, the telecommunications office, the College of Engineering and Computer Science computer support team, the campus-wide computer support staff, the transportation faculty and the director of the Intelligent Transportation Systems laboratory, good communication, creative leadership and extra energy above the call of duty resulted in a successful project. In addition, current PSU students have assisted in the implementation of the ITS lab and have provided valuable labor in making final data connections.

- The new ITS Laboratory is configured to potentially serve as an emergency back-up transportation management operations center, but the details of this possibility are not in place yet. ODOT and PDOT are both interested in using the new facility for training and educational purposes, and we expect to proceed with designing training programs in the near future. Through the conduct of these exercises, the potential for the use of the ITS Laboratory as an emergency back-up will be explored.

- It is also envisioned that the ITS Laboratory will serve as a hub for regional transportation education, research and training. The space has already been used for teaching a course Intelligent Transportation Systems (CE 458/558), and for numerous events and lectures. During the winter and spring of 2006, approximately 25 students, faculty and staff worked in the Laboratory on a variety of sponsored research projects, including some funded by the National Science Foundation, ODOT and BMW. We

expect to continue to strengthen the regional educational, training and research efforts in the future.

PROVIDE MPO WITH ARCHIVED ITS DATA PRODUCTS

One of the main functions of the completed ITS lab is to house and operate the Portland metropolitan region's multimodal ITS data archive. PSU is already providing limited archived ITS data products to Metro—the region's metropolitan planning organization (MPO), and it is anticipated that the new archive will result in enhanced services for Metro's planning efforts.

As a designated Metropolitan Planning Organization in a region with at least 200,000 people (see Figure 1), Portland is required under federal transportation law, starting with ISTEA, to fulfill the requirements of the Congestion Management Process (CMP), known prior to SAFETEA-LU as Congestion Management System (CMS). A CMP is "a systematic process for managing congestion that provides information on transportation system performance and on alternative strategies for alleviating congestion and enhancing mobility." A CMP must have the following elements:

1. An ongoing method to monitor and evaluate the transportation system, identify the causes of congestion, identify and evaluate alternative actions, and evaluate the efficiency and effectiveness of implemented actions;
2. Defining parameters for measuring the extent of congestion and for supporting the evaluation of the effectiveness of congestion reduction and mobility enhancing strategies;
3. Establishing a program for data collection and system performance monitoring;
4. Identifying and evaluating the anticipated benefits of both traditional and non-traditional congestion management strategies;
5. Identifying an implementation schedule, implementation responsibilities, and possible funding sources for each strategy; and
6. Implementing a process for periodic assessment of the efficiency and effectiveness of implemented strategies, in terms of the area's established performance measures.

In the Spring of 2006, Metro completed a process of revamping its approach to meeting the CMP requirement. The "roadmap" product of this endeavor reflects recent trends and certain approaches or methods that have recently been promoted by FHWA and in the literature. One is a shift to planning-oriented performance measures and to the concept of reliability in particular.

Another is the notion of "planning for operations," which in this case means building closer ties between planning agencies such as the MPO and operating agencies such as the Oregon DOT and TriMet, the transit agency. The five specific areas comprising the roadmap include:

1. Measure transportation system performance
2. Identify the causes of congestion
3. Identify and evaluate alternative actions
4. Implement cost-effective solutions
5. Evaluate the efficiency and effectiveness of implemented actions

Recent transportation trends have revealed a nationwide shift towards understandable user-centric performance measures, such as reliability and travel time delay. Portland's congestion management approach is focused on educating policy-makers in the MPO committee structure about congestion so that they can weigh it, among other major planning factors, during planning and programming decisions. This depends on quantitatively demonstrating the difference between recurrent and non-recurrent delay so that the MPO can prioritize the appropriate type of investment in each context.
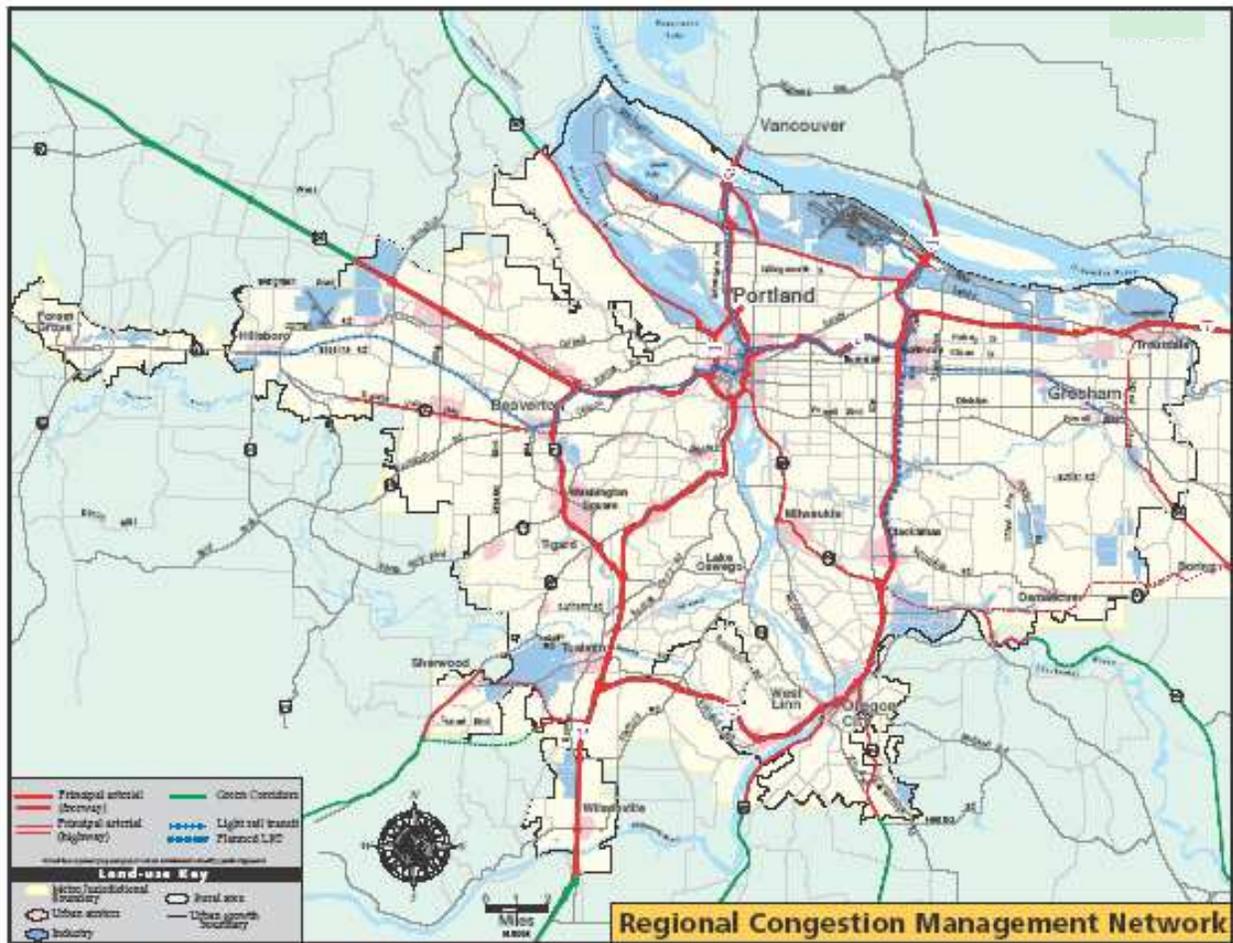
Figure 1: Portland Regional Congestion Management Network

PSU is the Portland region's official ITS data archiving center. The PSU Intelligent Transportation Systems Lab has developed the Portland Oregon Regional Transportation Archive Listing (PORTAL, http://portal.its.pdx.edu) that archives the region's freeway sensor data at a 20-second level. Several useful automated performance reports have been created that Metro will use in pursuit of the CMS roadmap. Figure 2 shows the user interface for PORTAL. As an example of a report that is being provided to Metro, the Portland MPO, Figure 3 shows a sample Portland Congestion Report produced for January 2006 that contains several standard performance measures such as the travel time index and the buffer index.

Figure 2: Travel Time and Congestion for Interstate 5

As another measure of regional freeway performance, travel times can also be tracked at particular points and over longer freeway segments. Using a user-oriented set of pull-down menus, specific locations, time periods and levels of aggregation can be selected. As an example, Figure 4 shows a sample for a segment of Interstate 5, covering a two-month period in 2006 and showing the average travel time and +/- one standard deviation. This clearly shows that travel time not only increases during the peak period but its variability also increases.
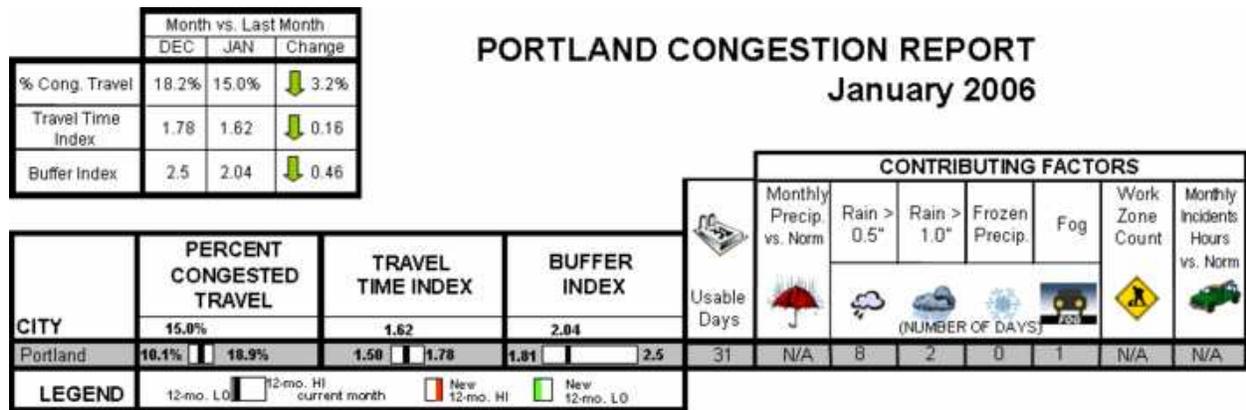
Figure 3: Portland Congestion Report

Travel Time for Delta Park NB, I-5 NORTH   2006-02-01-2006-04-30
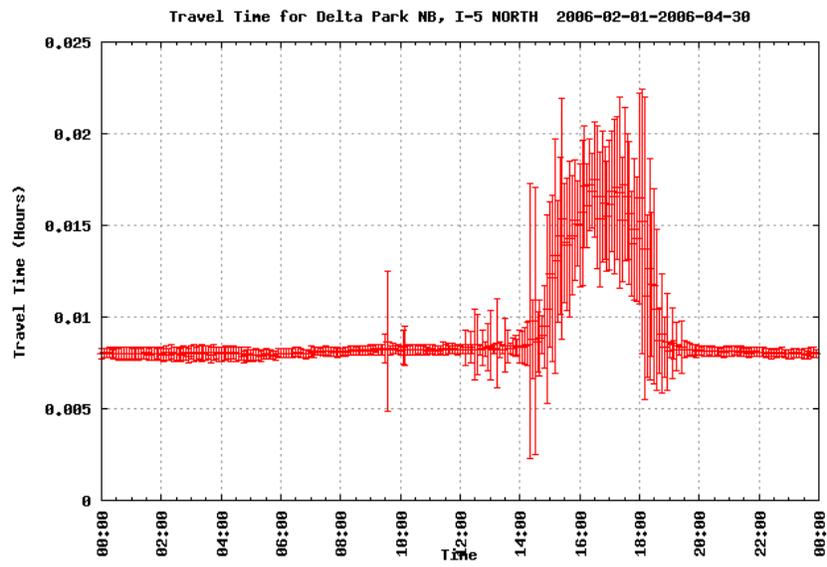
Figure 4: Travel Time Reliability
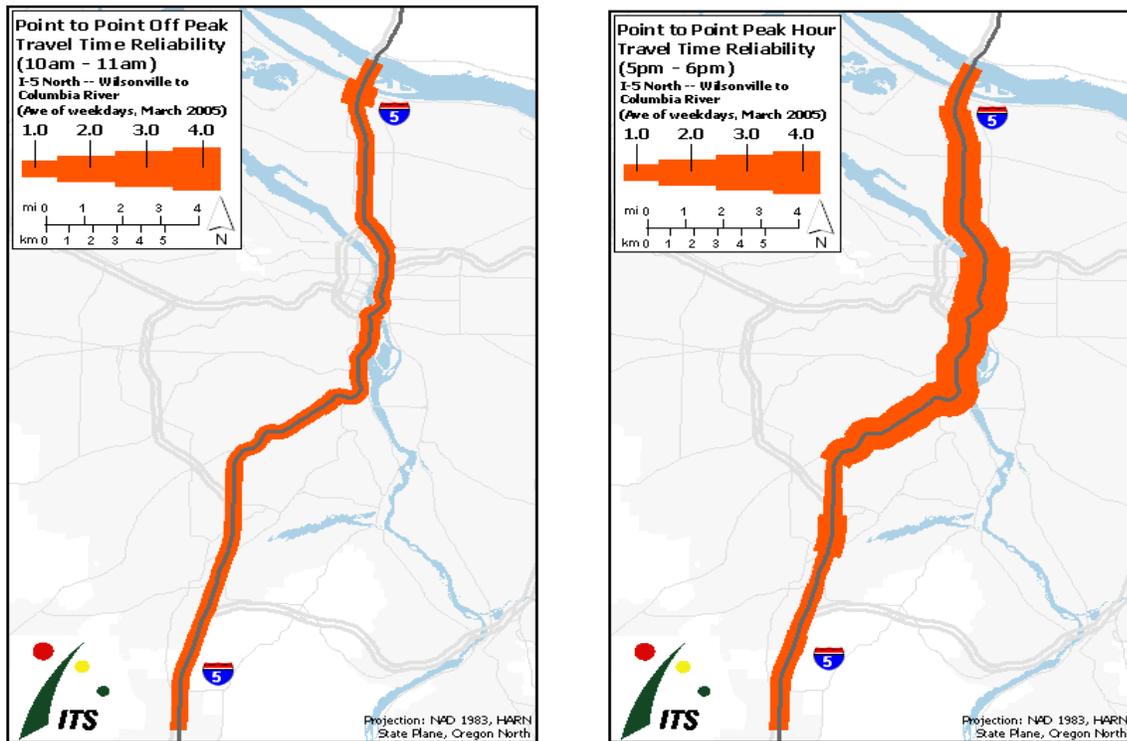
Figure 5: Sample Travel Time Reliability Plot

At a larger scale, it is also possible to analyze congestion and travel time reliability of a much longer distance. Figure 5 illustrates the difference in travel time reliability for northbound Interstate 5 for an off peak time (10-11 am) and a peak time (5-6 pm).

The data archiving and analysis being done at PSU is integral to Metro's approach to diagnosing congestion in the region. In turn, much of the ITS lab's work is made possible by the investments that have been made in data collection technologies and communications infrastructure, namely the fiber optic network that connects PSU with the Oregon DOT, Portland DOT, TriMet and others.
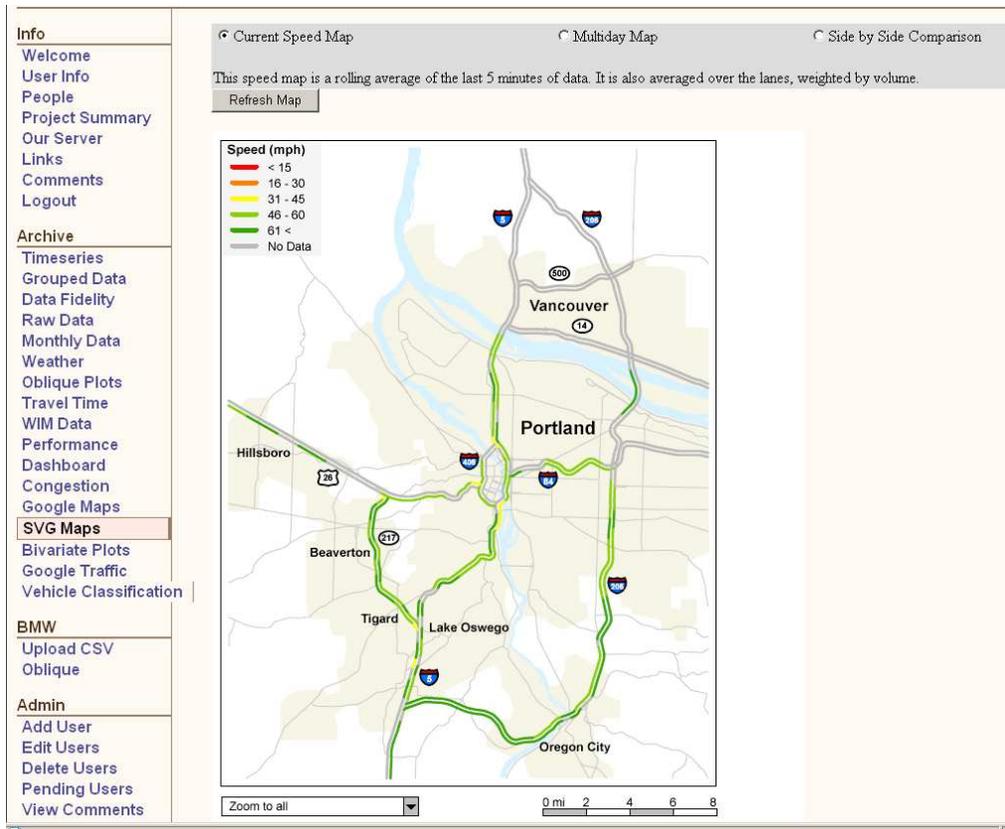
Figure 6: Current Speed Map

Further efforts have focused on additional mapping of traffic related parameters. For example, Figure 6 shows a current speed map that can be obtained by a user via the PORTAL user interface. To explore freeway speed across other dimensions, Figure 7 shows a multi-day speed map that can be used to display average speed across multiple days and time periods. This example shows the average speed for one hour (on one day in this example), for a PM peak period.

The mapping capability is powerful—for further investigation, one can plot a side-by-side comparison map as shown in Figure 8. This example shows the average freeway segment speed for two PM peak hours (5PM-6PM) for entire months—in this case July and December 2005. As shown there are some differences at certain segments along the freeway network. Figure 9 takes the side-by-side comparison a step further by showing a subtraction of one speed map from another in order to highlight differences spatially. The figure shows the difference between average speeds measured in March 2005 and those measured in November 2004. As shown there are several locations where the speed differences are notable.
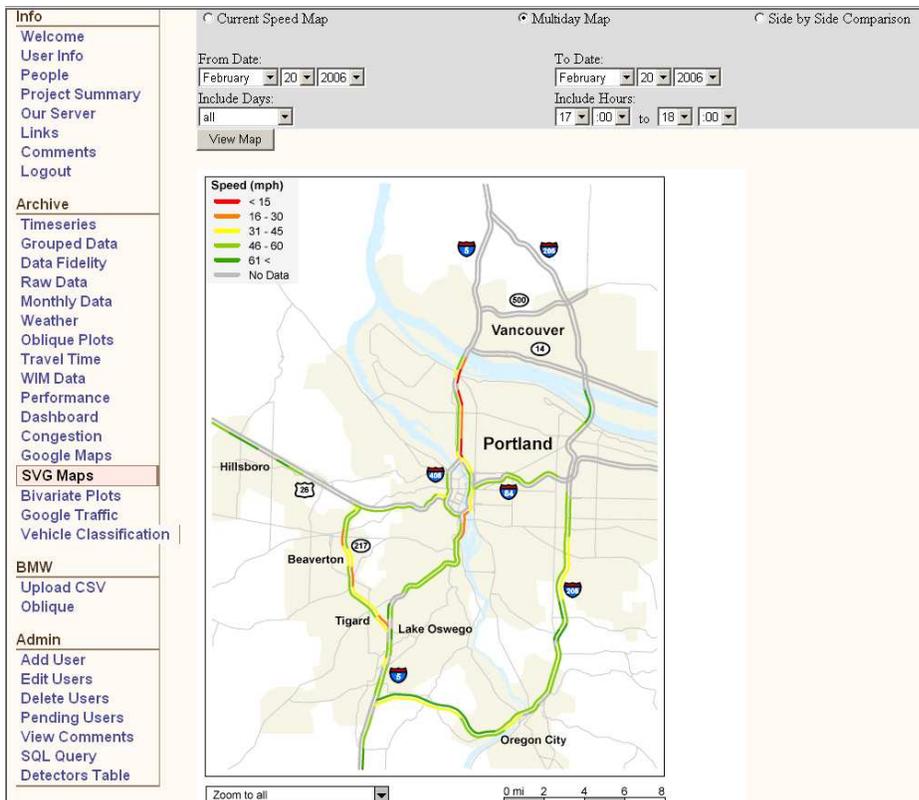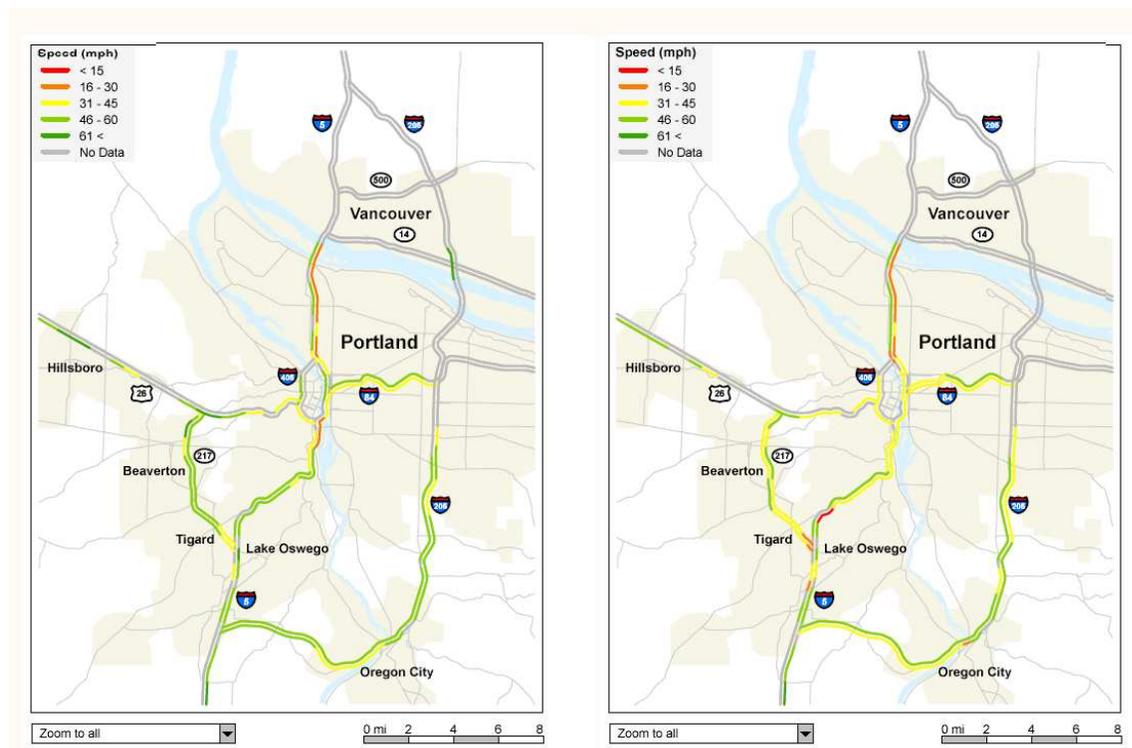
Figure 7: Average Speed Map for PM Peak (5PM-6PM)

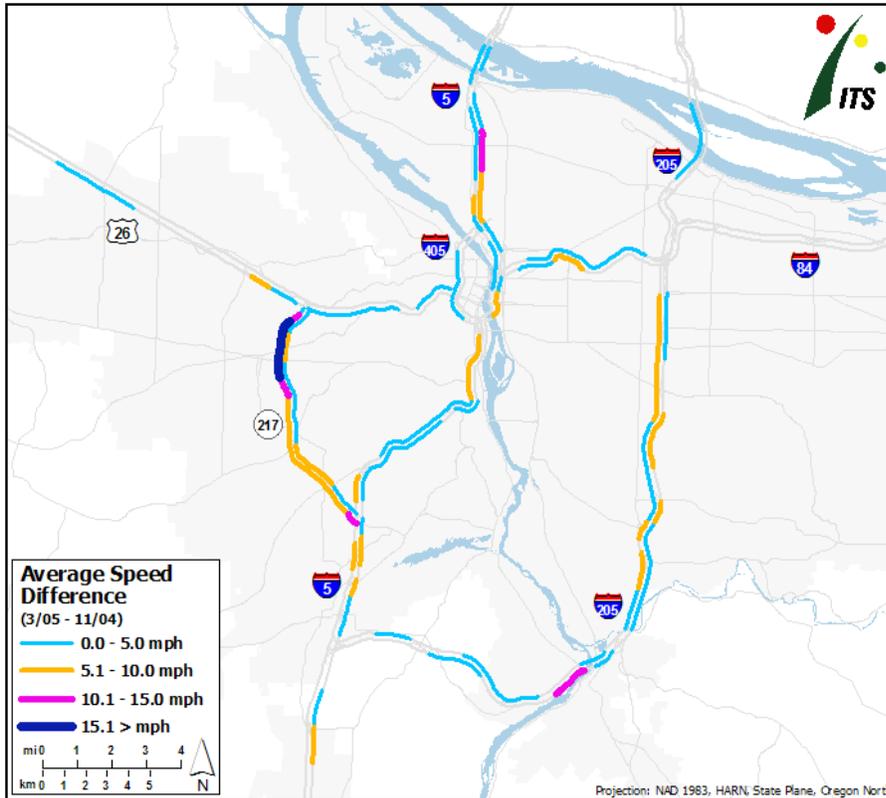**Figure 8: Average Evening Peak Speed (5PM-6PM) for July and December 2005**

Figure 9: Average Speed Difference

The Travel Time Index is the ratio of free flow speed (55 mph) to the average speed. This is a very common congestion measure and is useful for examining the time periods and locations where speeds fall into congested conditions. Figure 10 shows the Travel Time Index for the regional highways. The Buffer Index measurement is simply the ratio of the free flow speed to the 95 percentile speed. This measurement is useful for showing travel time reliability—for example, this index is an indicator of the travel time allowance for which a user will be late on average one day per month for a work trip. Figure 10 also shows the Buffer Index ratings during the month of March for the regional highways. The concept of travel time reliability is gaining more and more attention. Figure 11 shows an example of how this parameter can be displayed graphically. By taking the 95th percentile travel time and dividing by the mean travel time for a segment a reliability value can be calculated (this is actually the buffer index divided by the travel time index). This value is displayed on the map for weekday peak hours in March 2005. This reveals that two segments (one on eastbound OR 26 and one on northbound I-5) were the least reliable for travelers.

PORTAL can also provide monthly reports for specific freeway segments or for the entire freeway system. Figure 12 shows a monthly report for a 25-mile segment of northbound Interstate 5 for May 2005. As shown, the average travel time, the 95th percentile travel time, the free flow travel time and the congestion frequency for the month are shown. This indicates the extent of peaking that occurs and also clearly indicates the amount of buffer time that is needed to traverse this highway segment. For example, at 8 AM, the average travel time is about 32 minutes, while the 95th percentile travel time is about 52 minutes—revealing a 20 minute buffer that would be needed for a traveler to arrive late on average one day per month. Finally Figure 13 shows the average measured volume across all lanes on I-5 for the same month.
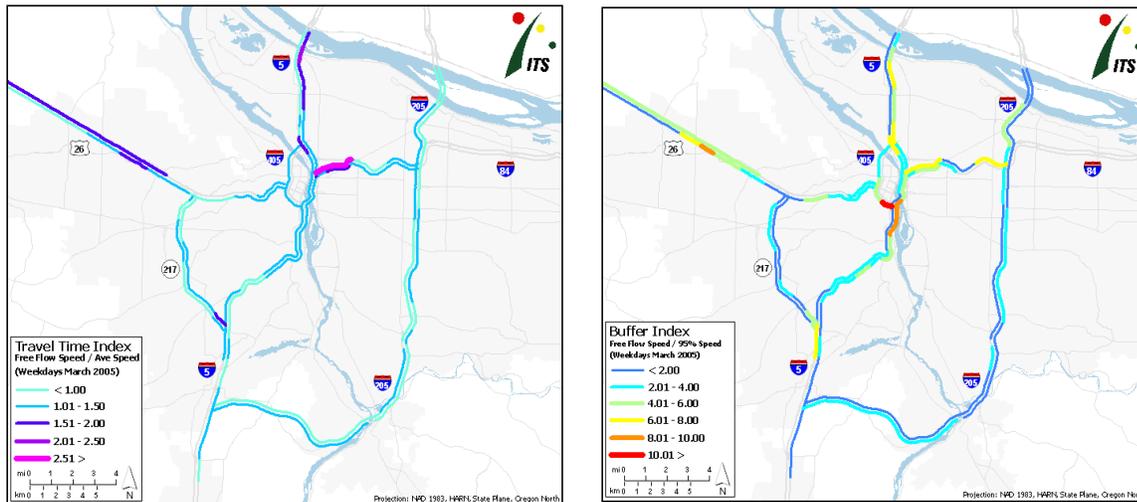

Figure 10: Travel Time Index and Buffer Index

Research across industries indicates that effective data archiving systems start as small prototypes with a single data source. Studies consistently indicate that freeway detector data is the most useful archived data, and for this reason we have chosen to first archive these data. The Portland region has a wealth of additional data sources that will be archived at the appropriate time. PSU is developing an archive of the Portland Regional Land Information System (RLIS), which contains several land use, land coverage, and transportation data in a GIS format. The RLIS archive will enable detection of major changes in land use in the Portland region, and overlay it with changes in the traffic flow that occurred along freeways, which can be easily obtained from PORTAL. RLIS was launched in 1995, and is updated quarterly through Metro, the Portland regional planning organization. The implications of integrating transportation and land use data will provide a rich source of data, contributing to research investigating how transportation decisions have been shaping land use over time, and vice versa.
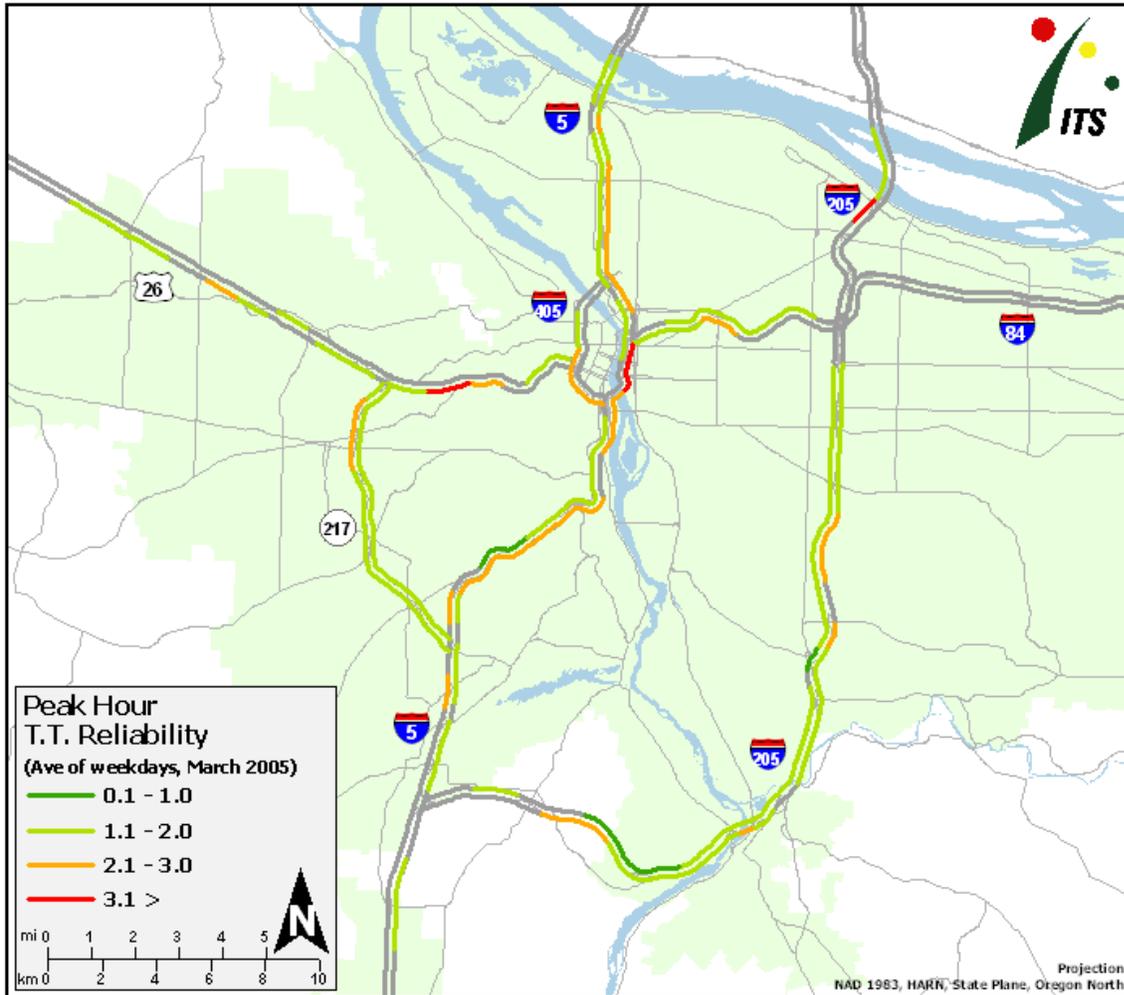
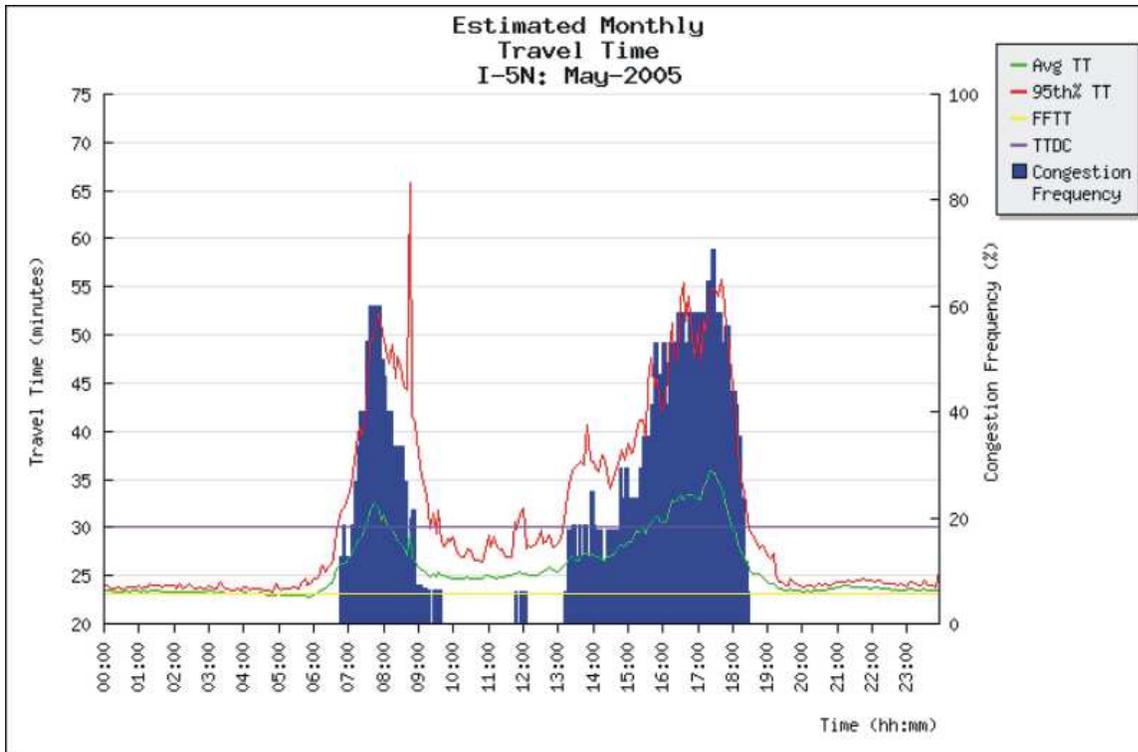**Figure 11: Peak Hour Travel Time Reliability**
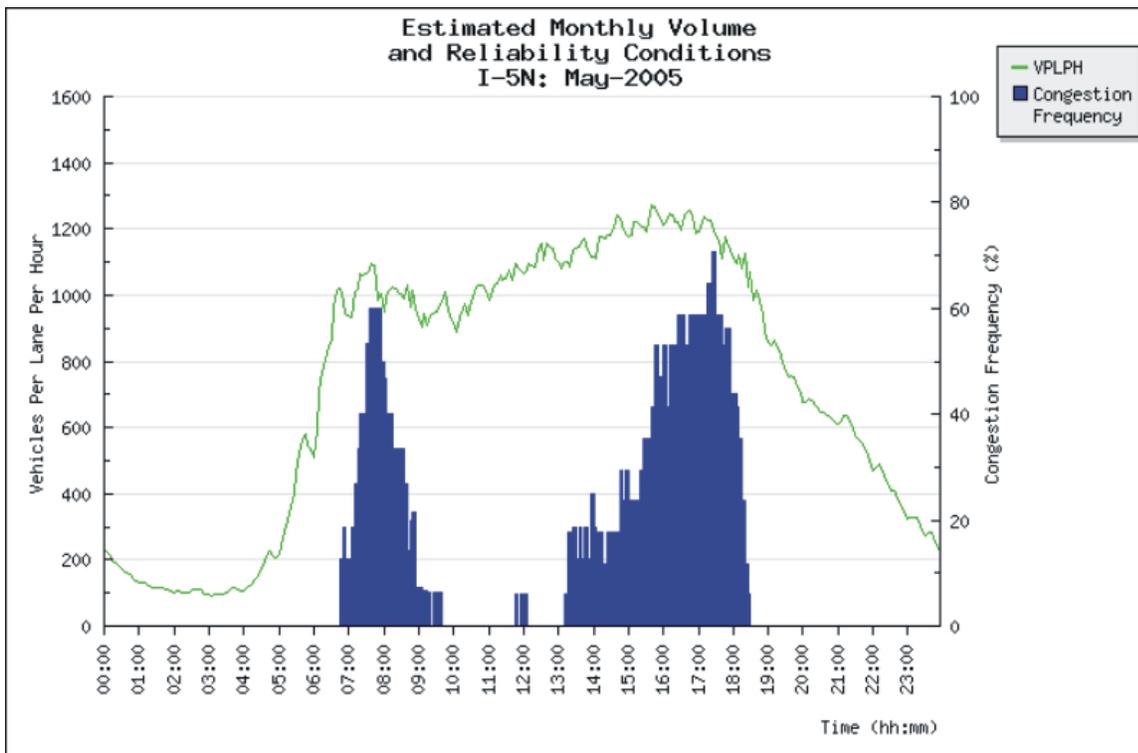
Figure 12: Freeway Performance for I-5 Northbound

Figure 13: Freeway Performance for I-5 Northbound