

**Annual Report for Period:**06/2005 - 06/2006**Submitted on:** 08/19/2006**Principal Investigator:** Bertini, Robert L.**Award ID:** 0236567**Organization:** Portland State University**Title:****CAREER:** Mining Archived Intelligent Transportation Systems Data: A Validation Framework for Improved Performance Assessment and Modeling**Project Participants****Senior Personnel****Name:** Bertini, Robert**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Prof. Bertini is the principal investigator on this project.

**Post-doc****Name:** Tufte, Kristin**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Kristin joined the project in May 2005, and has continued to split her time with a joint appointment in both Departments of Civil and Environmental Engineering and Computer Science. Kristin is a database expert and has added immeasurably to the project. Kristin's time is 0.375 FTE on this project.

**Name:** Ahn, Soyoun**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Dr. Soyoun Ahn, who received her PhD from the University of California at Berkeley in 2005, worked as a post-doctoral research associate on this project through July 2006. She is now an Assistant Professor in the Department of Civil and Environmental Engineering at Arizona State University

**Graduate Student****Name:** Yin, Thareth**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Thareth served as the lead graduate research assistant on the project for the academic year 2003-2004. She received full tuition remission and a monthly stipend.

**Name:** Hansen, Steven**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Steven has transitioned over to become the lead graduate research assistant on the project for the academic year 2004-2005. He is receiving full tuition remission and a monthly stipend.

**Name:** Kothuri, Sirisha**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Sirisha is a new Ph.D. student working on the project and has been focusing on improving data quality and also analysis of travel time algorithms.

**Name:** Endo, Sonoko**Worked for more than 160 Hours:** No**Contribution to Project:**

Sonoko worked hourly on the project during the summer of 2004.

**Name:** El-Geneidy, Ahmed

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Ahmed worked on the project on an hourly basis adding his expertise in the area of mapping.

**Name:** Lasky, Matthew

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Matt worked as an hourly student on the project for a short period.

**Name:** Moes, Tom

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Tom worked hourly for a short period.

**Name:** Rose, Michael

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Mike assisted on an hourly basis for a short period.

**Name:** Breakstone, Aaron

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Aaron continued to work as a graduate research assistant on the project focusing on validation of travel time measurements.

**Name:** Bosa, Peter

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Participated as graduate research assistant.

### Undergraduate Student

**Name:** Byrd, Andrew

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Andrew was the lead undergraduate research assistant on the project, and received hourly support throughout the academic year and university breaks.

**Name:** Delcambre, Andrew

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Andy Delcambre has been a key developer of new data processing and imaging tools, and has added substantial capabilities to the Portal tools. Andy has worked hourly on the project. Andy has also worked on several papers connected with the project.

**Name:** Rodriguez, Richard

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Richard 'Andy' Rodriguez also worked hourly on Portal, helped with several papers and was a key developer of several important performance reporting functions--the monthly reports, the dashboard, the data filtering and the congestion reports. He also developed the very useful travel time variability plotting capabilities.

**Name:** Potter, Jessica

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Jessica works hourly on the project and has been focusing on incorporating and analyzing freeway incident data.

**Name:** Rucker, James

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

James works hourly on the project and has focused on improving data aggregation methodologies.

**Name:** Welch, Tim

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Tim worked on the project during the winter, spring and summer 2006, focusing on development of a traffic data user interface.

## Technician, Programmer

## Other Participant

### Research Experience for Undergraduates

**Name:** Dorado, Matthew

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Matthew served as an REU participant on the project.

**Years of schooling completed:** Sophomore

**Home Institution:** Same as Research Site

**Home Institution if Other:**

**Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree

**Fiscal year(s) REU Participant supported:** 2004

**REU Funding:** No Info

**Name:** Byrne, Neil

**Worked for more than 160 Hours:** No

**Contribution to Project:**

**Years of schooling completed:** Junior

**Home Institution:** Same as Research Site

**Home Institution if Other:**

**Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree

**Fiscal year(s) REU Participant supported:** 2004

**REU Funding:** No Info

**Name:** Baglien, Jacob

**Worked for more than 160 Hours:** No

**Contribution to Project:**

**Years of schooling completed:** Junior

**Home Institution:** Same as Research Site

**Home Institution if Other:**

**Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree

**Fiscal year(s) REU Participant supported:** 2004

**REU Funding:** No Info

**Name:** Matthews, Spicer

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Spicer is an undergraduate in Computer Science and has added his hardware and software skills to the project. He was in charge of project management tools, including the development of a project wiki site. Spicer also co-authored several key papers. Spicer has worked hourly on this project.

**Years of schooling completed:** Junior  
**Home Institution:** Same as Research Site  
**Home Institution if Other:**  
**Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree  
**Fiscal year(s) REU Participant supported:** 2006  
**REU Funding:** REU supplement

**Name:** Cottam, Zachary

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Zac is an undergraduate student who has worked hourly on the project focusing on some programming activities.

**Years of schooling completed:** Sophomore  
**Home Institution:** Same as Research Site  
**Home Institution if Other:**  
**Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree  
**Fiscal year(s) REU Participant supported:** 2006  
**REU Funding:** No Info

**Name:** Pulice, Scott

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Scott worked on the project as an REU student.

**Years of schooling completed:** Junior  
**Home Institution:** Same as Research Site  
**Home Institution if Other:**  
**Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree  
**Fiscal year(s) REU Participant supported:** 2005  
**REU Funding:** No Info

**Name:** Guttierrez, Rodger

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Rodger worked as an REU student on the project.

**Years of schooling completed:** Junior  
**Home Institution:** Same as Research Site  
**Home Institution if Other:**  
**Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree  
**Fiscal year(s) REU Participant supported:** 2005  
**REU Funding:** No Info

**Name:** VanElswyk, Abram

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Abram assisted on the project as an REU student.

**Years of schooling completed:** Junior  
**Home Institution:** Same as Research Site  
**Home Institution if Other:**  
**Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree

**Fiscal year(s) REU Participant supported:** 2005

**REU Funding:** No Info

**Name:** Coons, Andrew

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Andrew worked on the project as an REU student during spring 2006 focusing on analysis of arterial performance using transit data.

**Years of schooling completed:** Junior

**Home Institution:** Same as Research Site

**Home Institution if Other:**

**Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree

**Fiscal year(s) REU Participant supported:** 2006 2006

**REU Funding:** REU supplement

### Organizational Partners

#### **Oregon Department of Transportation**

The Oregon Department of Transportation (ODOT) has contributed immeasurably to this project. First they feed the raw data to us in real time. Next, they have supported the project by funding the purchase of a high capacity disk array (1.2 TB) for database storage. Next, ODOT has helped obtain a further grant to improve the truck counting capabilities of their sensors (PSU will receive the grant). In addition, ODOT has encouraged us to develop features that they can utilize in their day to day operations in the traffic management center by providing feedback to our user interface.

#### **City of Portland**

The City of Portland provides the fiber optic communications network that facilitates the activation of the realtime data archiving capability. The City of Portland's freight committee has also supported our project.

#### **TriMet**

TriMet is the regional transit agency, who provides data and collaborative research.

#### **Metro**

Metro, the only elected governmental agency in the U.S., is collaborating with Portland State University to develop and implement new transportation performance measures. Metro's decision making body on transportation, the Joint Policy Advisory Committee on Transportation (JPACT) has supported the project, as well as its subcommittee on intelligent transportation systems (TransPort ITS). Metro is developing improvements to their congestion management system that will incorporate results from this project.

#### **Oregon Museum of Science and Industry**

#### **Washington Department of Transportation**

The Washington State Department of Transportation will be providing data to our project as well as suggestions on how to make our performance measures more useful to their operations.

#### **University of Washington**

The University of Washington's STAR Lab and TRAC center have been developing collaborative research ideas with us, have hosted us on several exchange visits and have shared data and research results. We have hosted them on one exchange visit.

#### **The Oregonian**

We have shared data with the Oregonian and they have done one major story using our data and graphics.

#### **Port of Portland**

The Port of Portland hopes to share data with us in the near future.

**Federal Highway Administration****Oregon State University**

A new project, funded by the Oregon Department of Transportation and with co-PIs Logendran and Tadepalli of Oregon State University is moving forward (Bertini is third co-PI) and uses data from this project.

**Other Collaborators or Contacts**

We currently have 189 registered users of our data archive, including participants from the following organizations:

Washington County  
 Federal Highway Administration  
 Oregon Department of Transportation  
 Clark County Regional Transportation Commission  
 TriMet  
 Metro  
 Siemens  
 University of Idaho  
 Port of Portland  
 CTRAN  
 Kittelson and Associates, Inc.  
 City of Beaverton  
 Clackamas County  
 City of Portland  
 Malaysia University of Science and Technology  
 University of Washington  
 Washington State Department of Transportation  
 Mid-Willamette Valley Council of Governments  
 Marion County, Oregon  
 U.S. Department of Transportation Research and Innovative Technology Administration  
 Bureau of Transportation Statistics  
 The Oregonian  
 URS  
 IBI Group  
 David Evans & Associates  
 Cambridge Systematics  
 DKS Associates  
 Oregon Bridge Delivery Partners

We also have begun collaborations with faculty from several international universities:

Technical University of Munich, Germany  
 Technical University of Dresden, Germany  
 University College, London  
 University of Calabria  
 Queensland University of Technology, Australia  
 Toyo University, Japan  
 City University of New York  
 Texas Transportation Institute

We have also had numerous visitors to our lab, including the following:

Staff from Members of Congress  
 City Commissioner and Mayoral Candidate Jim Francesconi  
 Portland State University Alumni  
 Oregon Legislative Candidates

Bruce Warner, Former Oregon Department of Transportation Director  
 Matthew Garrett, Director, Oregon Department of Transportation  
 Sue Kiel, Director, Portland Office of Transportation  
 Ed Fischer, State Traffic Engineer, Oregon Department of Transportation  
 Transportation Staff, Portland Public Schools  
 Oregon Model Steering Committee  
 Metro Transportation Policy Advisory Committee (TPAC)  
 TriMet Manager of Information Systems  
 TriMet Manager of Government Relations  
 Metro Councilor Rex Burkholder

We have begun collaborative discussions with some private partners including:

BMW  
 Daimler Chrysler (Freightliner)  
 INRIX  
 BeatTheTraffic.com  
 PBSJ  
 Cambridge Systematics

## Activities and Findings

### **Research and Education Activities:**

The research activities for the project during this past year have included development and expansion of the real-time transportation data archive. Many new features have been added to the archive in the past year. These features have provided researchers in the Portland State University Intelligent Transportation Systems Laboratory with the ability to conduct additional analysis of the archived data.

The areas of research work over the past year are as follows:

**Improved Mapping Capabilities:** Using Scalable Vector Graphics (SVG), a new interface for mapping and viewing speed data has been developed. This interface can be used to view the 'current' speed map, or to view and compare speeds over two different time periods. Using this interface, users could, for example, graphically view congestion over the 7:30-8:30 time period for weekdays in the last month and could compare congestion from 7:30-8:00 to 8:00-8:30 to determine which time period has more severe congestion.

**Data Quality and Aggregation:** New aggregation and data filtering procedures have been developed and implemented and testing of these procedures is in process. The data filtering is based on a set of data quality flags which are applied to the 20-second data received from ODOT. The data is aggregated to 5-minute, 15-minute and 1-hour intervals using well-defined and documented aggregation procedures. In addition, a new Data Quality Report has been developed. This report will be produced on a monthly basis and provided to ODOT. The report identifies detectors showing the most severe configuration and communication problems. ODOT maintenance staff will inspect the listed detectors and provide feedback to PSU which will be used to improve the report. This research has been submitted to the annual Transportation Research Board conference.

**Google Traffic:** A prototype web page for viewing and uploading traffic count data using the Google Local interface has been developed. Traffic count files (typically pdfs) and meta-information about those files are stored in the PORTAL database. Through the interface, the user may access summary count information by simply clicking on a marker on a map and may proceed to download the count file for more detail, if desired. Additionally, new data can be easily uploaded through the interface. This web page, called Google Traffic, has been shown to allow easy access to data that was previously paper-based and difficult to retrieve. This research has been submitted to the annual Transportation Research Board conference.

**Incident Data:** An automated process for incorporating incident data into the database has been developed and has been used to incorporate incident data, received from ODOT, for the Portland Metropolitan area for the period July 1999-Dec 2005 into PORTAL. Incorporating incident data into the database requires cleaning and aggregating of the data. In the raw incident data, each incident has multiple entries and some of the data is inconsistent as it is human-entered. The automated process cleans the data and aggregates multiple incident entries into one record for each incident. Information such as duration and highwayid are calculated and assigned during this process. This research has been

submitted to the annual Transportation Research Board conference.

**Travel Time:** Analysis directed at improving travel time estimates from the PORTAL database has been conducted. Travel time estimates from the Midpoint algorithm currently used by ODOT as well as a published algorithm developed by Coifman (cite?) were evaluated for accuracy under varying traffic conditions. Various scenarios were tested using traffic data from both upstream and downstream detector stations. The results indicate that both the midpoint and the Coifman algorithms generate accurate travel time estimates under free flow conditions. The Coifman algorithm using data from the upstream detector provided the best estimate of travel time for a link during congestion as well as in periods after an incident occurred. This research has been submitted to the annual Transportation Research Board conference.

**Arterial Data and Travel Times:** Arterial performance and travel time is important to understanding Portland-area traffic. Tri-Met is the Portland-area transit system; all Tri-Met buses are equipped with Automatic Vehicle Location (AVL) systems and generate lots of data, including some real-time data, about arterial conditions. Initial work has been done to load a sample of bus AVL data into PORTAL and a prototype interface for viewing arterial speed data has been developed.

**Vehicle Classification:** Freight traffic is predicted to increase significantly over the next ten years. To attempt to address this issue, a vehicle classification algorithm was implemented in PORTAL. This algorithm uses the loop detector data to estimate what percentage of the traffic over a specified segment of freeway during a particular time consisted of long vehicles (i.e trucks). The results are displayed graphically. This research has been submitted to the annual Transportation Research Board conference.

**Bivariate Plots:** Transportation researchers use plots of the three basic traffic parameters: speed, count, and occupancy to understand inductive loop detector and performance and traffic characteristics. A new PORTAL page allows users to create scatter plots of using raw 20-second speed, count and occupancy readings. Particularly useful are flow-occupancy plots where count is plotted against occupancy. These plots have been used by researchers at PSU to analyze detector performance. A poor shape in the flow-occupancy plot often indicates poor detector performance.

**Additional Aggregation:** Aggregations at the 15-minute level have been added to the database. These aggregations complement the existing 5-minute and 1-hour aggregations.

#### Sustainability:

PORTAL consists of a data archive (stored in a relational database) and a web-based front end. Traffic data is fetched from ODOT and loaded into PORTAL every twenty seconds. PORTAL is actively used by a variety of people including researchers and local transportation personnel. In addition, PORTAL is in the process of being developed and expanded. As a part of this process, the PORTAL code base must be maintained to ensure that the code base is sustainable and up-to-date with the latest technology. As a part of the sustainability process, the following tasks were completed:

- The scripts that fetch data from the ODOT server were rewritten. This rewrite significantly improved the usability of the scripts and reduced the data lost in transmission.
- The code for the menu on the PORTAL web site was rewritten. This rewrite significantly improved usability and programmability of the code.
- A new server was purchased and installed. This server supports development and the web site.
- Various performance improvements were implemented.
- The security code was updated.

We have made the following recent conference presentations during the 2005-2006 year:

Bertini, R.L. 'Transportation Research and Education at Portland State University.' Kittelson & Associates, Inc. Lunchtime Seminar, August 10, 2006.

Bertini, R.L. 'Developing Comparative Congestion Measures to Improve Transportation System Performance.' Fifth International Conference on Traffic & Transportation Studies (ICTTS), Xi'an, China, August 2, 2006.

Bertini, R.L. 'Unlocking the Mysteries of Freeway Sensor Data to Diagnose Detailed Bottleneck Dynamics.' Fifth International Conference on Traffic & Transportation Studies (ICTTS), Xi'an, China, August 3, 2006.

Bertini, R.L. and Makler, J. 'Using Real Time Transportation System Performance Measures to Fuel a Regional Congestion Management System,' Institute of Transportation Engineers, District 6 Annual Meeting, Honolulu, Hawaii, June 26, 2006.

Bertini, R.L. and Kothuri, S. 'Improving Travel Time Estimation for Freeway Traffic Management and Traveler Information Systems.' First International Symposium on Freeway & Tollway Operations, Athens, Greece, June 7, 2006.

PORTAL: Implementing a New Generation Archived Data User Service in Oregon, Metro, Portland, Oregon, February 22, 2006.

Bertini, R.L., 'Portal: Implementing an Archived Data User Service in Oregon,' Northwest Transportation Conference, Corvallis, Oregon, February 8, 2006.

Bertini, R.L., 'International Definitions of Congestion: An Examination of Macroscopic Models.' Technische Universität München, Department of Traffic Engineering and Control, Munich, Germany, January 27, 2006.

Bertini, R.L., 'You Are the Traffic Jam: An Examination of Congestion Measures.' Transportation Research Board, 85th Annual Meeting, Washington, D.C., January 2006.

Bertini, R.L., 'TTS Data Applications.' Guest Lecture, CEE 412/599 Transportation Data Management and Analysis, Department of Civil and Environmental Engineering, University of Washington, December 7, 2005.

Bertini, R.L. and Monsere, C., 'Graduate Studies and Transportation Research at PSU.' Guest Lecture, University of Portland, Department of Civil Engineering, December 6, 2005.

Bertini, R.L., Hansen, S., Matthews, S. and Delcambre, A. 'PORTAL: Implementing a New Generation Archived Data User Service in Portland, Oregon.' 12th World Congress on Intelligent Transport Systems, San Francisco, November 8, 2005.

Bertini, R.L., 'Transportation Research, Education and Outreach at Portland State University,' Portland Traffic and Transportation Course, City of Portland, October 27, 2005.

Bertini, R.L., 'Congestion: the Good, the Bad and the Ugly.' PSU Weekend, October 22, 2005.

Kloos, B. and Bertini, R.L. 'Intelligent Transportation Systems and Freight,' Portland Freight Committee, October 6, 2005.

Bertini, R.L., Matthews, S., Hansen, S., Delcambre, A., and Rodriguez, A. 'ITS Archived Data User Service in Portland, Oregon: Now and Into the Future.' 8th International IEEE Conference on Intelligent Transportation Systems, Vienna, Austria, September 13-16, 2005.

Bertini, R.L. 'What is Traffic Congestion,' Department of Civil and Environmental Engineering, Imperial College, London, June 28, 2005.

Bertini, R.L., Hansen, S. and El-Geneidy, A. 'Using the Portland Regional Transportation Archive Listing (PORTAL) to Measure the Performance of the Portland, Oregon Regional Transportation System.' 9th International Conference on Computers in Urban Planning and Urban Management Conference (CUPUM), London, June 29, 2005.

## Findings:

Findings for this year have included:

- 1) We have continued development of an online intelligent transportation systems data archive. The database includes over two years of freeway loop detector data, weather data, incident data from July 1995-December 2006
- 2) Several types of new analysis have been added to the web site for the data archive:
  - a. Bivariate Plots û Users can create and view plots comparing any two of count, occupancy, and speed for any detector for any day. These plots have been found to be very useful for researchers using the PORTAL data.
  - b. Vehicle Classification û Users can view
- 3) Improved data quality and aggregation procedures have been implemented. A monthly report to be provided to the Oregon Department of Transportation to help guide their loop detector maintenance has been developed.
- 4) We have incorporated new types of data into the archive.
  - a. Incidents û An automated process for incorporating incident data into the archive has been developed and used to incorporate incident data from July 1999-December 2005 into the database.
  - b. Initial work has been done on incorporating Automatic Vehicle Location (AVL) data from the Portland-area transit system into the archive.
- 5) Improved mapping capabilities have been added to the archive through the use of Scalable Vector Graphics (SVG). The archive includes a custom SVG map of the Portland area. Users can view current speed maps and compare speed maps from two time periods using the SVG interface.
- 6) Travel Time

7) An interface for storing and viewing traffic count data, such as intersection counts has been implemented. This interface was developed in conjunction with the principal of a local consulting firm.

### **Training and Development:**

This year, the research team has continued to develop further significant research skills by working on this project in the collaborative environment provided in the Intelligent Transportation Systems Laboratory. Similar to the last two years, the students' backgrounds in civil engineering, computer science, urban and regional planning and others have provided a platform for all students to learn about one another's fields and have expanded their skills communication and in research. By working side by side, the students have developed teaching skills by cross training across disciplines. For example, all students have learned about basic traffic theory principles and about database programming. Through meetings with transportation agency practitioners, the students have improved their communications skills and have gained insights into the needs of the transportation community. Through participation in weekly lab meetings and numerous lab visits by outside community members and prospective students, the research team has learned to describe their research work in ways that are understandable by people from diverse backgrounds. By working with the REU students, the graduate students have served as mentors and have inspired the undergraduates to become more involved in research and think about graduate studies themselves. This year, several students had the opportunity to travel to conferences and present their results to large audiences. The efforts to prepare and submit draft papers, respond to comments, prepare final papers and presentations, raise travel funds, and then actually attend the conferences all contributed to the students' learning processes. Several students (particularly the undergraduate students) had never worked on a research paper before, so this project helped present wonderful opportunities for students to expand their horizons. The students' experiences in the actual paper presentations also improved their presentation and communication skills and increased their confidence levels and passion for the subject.

### **Outreach Activities:**

The outreach component of the PORTAL project has consisted of a number of activities:

1. Project website and entry to data archive <http://portal.pdx.edu>
2. Numerous presentations to outside groups and conferences about our project, including international, national, statewide, regional, and local conferences, plus our regular participation in the regional technical advisory committee on Intelligent Transportation Systems and individual constituency agencies.
3. Demonstrations of PORTAL to numerous academics, students, visitors, high school students, community members, colleagues, professionals, decision makers, elected officials, etc. in our lab and at other venues.
4. Demonstration of PORTAL at local technology fair.
5. Coordination with Oregon Museum of Science and Industry for a small exhibit (still in development).
6. Hosting high school student groups for data collection exercises and tours.
7. Hosting numerous campus visitors to our lab including elected officials, members of the media, alumni, new students, prospective students, professionals, public agency partners, private partners and staff members of elected officials (including staff from U.S. Senators and Representatives).
8. Interviews with newspapers, radio and television explaining traffic phenomena.
9. Released first annual Portland Transportation Performance Report to communicate trends in transportation performance to the public.

### **Journal Publications**

Bertini, R.L., Hansen, S., Byrd, A. and Yin, T., "PORTAL: Experience Implementing the ITS Archived Data User Service in Portland, Oregon", *Transportation Research Record: Journal of the Transportation Research Board*, p. 90, vol. 1917, (2005). Published

Bertini, R.L., Monsere, C., Byrd, A., Rose, M. and El-Seoud, T., "Using Custom Transportation Data Collection Software with Handheld Computers for Education, Research, and Practice", *Transportation Research Record: Journal of the Transportation Research Board*, p. 37, vol. 1924, (2005). Published

Bertini, R.L., Byrd, A. and Yin, T., "Implementing the ITS Archived Data User Service in Portland, Oregon", *Proceedings of the IEEE 7th Annual Conference on Intelligent Transportation Systems*, p. -, vol. -, (- ). Published

Monsere, C., Breakstone, A., Bertini, R.L., Deeter, D. and McGill, G., "Validating Dynamic Message Sign Freeway Travel Time Messages Using Ground Truth Geospatial Data", *Transportation Research Record: Journal of the Transportation Research Board*, p. , vol. , ( ). Accepted

Bertini, R.L., "Congestion and Its Extent", *Access to Destinations: Rethinking the Transportation Future of our Region*, p. --, vol. --, (-- ). Published

- Bertini, R.L., "You Are the Traffic Jam: An Examination of Congestion Measures", Proceedings of the 85th Annual Meeting of the Transportation Research Board, p. --, vol. , (2006). Published
- Bertini, R.L., Matthews, S., Hansen, S., Delcambre, A., and Rodriguez, A., "ITS Archived Data User Service in Portland, Oregon: Now and Into the Future", Proceedings of the 8th International IEEE Conference on Intelligent Transportation Systems, Vienna, Austria, September 13-16, 2005., p. --, vol. , (2005). Published
- Bertini, R.L., Hansen, S., Matthews, S. and Delcambre, A., "PORTAL: Implementing a New Generation Archived Data User Service in Portland, Oregon", Proceedings of the 12th World Congress on Intelligent Transport Systems, San Francisco, November 5-10, 2005, p. --, vol. , (2005). Published
- Bertini, R.L., Hansen, S., Byrd, A., Delcambre, A., Rodriguez A. and Matthews, S., "Improving Travel Time-Delay Functions for the Highway 217 Corridor Study Using a Regional ITS Data Archive", Proceedings of the Institute of Transportation Engineers, District 6 Annual Meeting, Kalispell, Montana, July 10-13, 2005., p. --, vol. , (2005). Published
- Hansen, S., Byrd, A., Delcambre, A., Rodriguez, A. Matthews, S. and Bertini, R., "Toward Real Performance Measurement: Portland Oregon Regional Transportation Archive Listing (PORTAL)", Proceedings of the Institute of Transportation Engineers, District 6 Annual Meeting, Kalispell, Montana, July 10-13, 2005, p. --, vol. , (2005). Published
- Bertini, R.L., Hansen, S., Nolan, C., Bosa, P. and El-Geneidy, A., "Deriving Metropolitan Planning Performance Measures from a Real-Time Regional Transportation Data Archive", Proceedings of the 9th International Conference on Computers in Urban Planning and Urban Management Conference (CUPUM), London, 2005., p. --, vol. , (2005). Published
- Hansen, S., Byrd, A., Delcambre, A., Rodriguez, A. Matthews, S. and Bertini, R., "Using Archived ITS Data to Improve Regional Performance Measurement and Travel Demand Forecasting", Proceedings of the Canadian Institute of Transportation Engineers, Quad Conference, Vancouver, B.C., April 7-9, 2005, p. --, vol. , (2005). Published
- Hansen, S., Byrd, A., Delcambre, A., Rodriguez, A. Matthews, S. and Bertini, R., "PORTAL: An On-Line Regional Transportation Data Archive with Transportation System Management Applications", Proceedings of the Canadian Institute of Transportation Engineers, Quad Conference, Vancouver, B.C., April 7-9, 2005., p. --, vol. , (2005). Published
- Bertini, R.L. and Hansen, S., "Educational Applications of the Portland, Oregon Regional Archived Data User Service (ADUS)", Proceedings of the American Society of Engineering Education Annual Conference, Portland, Oregon, June 12-15, 2005, p. --, vol. , (2005). Published
- Kothuri, S., Tufte, K., Ahn, S. And Bertini, R.L., "Using Archived ITS Data to Generate Improved Freeway Travel Time Estimates", Transportation Research Record: Journal of the Transportation Research Board, p. , vol. , ( ). Submitted
- Bertini, R.L., Horowitz, Z., Tufte, K. and Matthews, S., "Techniques for Mining Truck Data to Improve Freight Operations and Planning", Transportation Research Record: Journal of the Transportation Research Board, p. , vol. , ( ). Submitted
- Ahn, S., Bertini, R.L., Auffray, B. and Ross, J., "Evaluating the Benefits of a System-Wide Adaptive Ramp-Metering Strategy in Portland, Oregon", Transportation Research Record: Journal of the Transportation Research Board, p. , vol. , ( ). Submitted
- Tufte, K., Ahn, S., Bertini, R.L., Auffray, B. and Rucker, J., "Toward the Systematic Improvement of Data Quality in the Portland, Oregon Regional Transportation Archive Listing (PORTAL)", Transportation Research Record: Journal of the Transportation Research Board, p. , vol. , ( ). Submitted
- Potter, J., Tasnim, S., Tufte, K. and Bertini, R.L., "Incorporating Incident Data into a Freeway Data Archive for Improved Performance Measurement", Transportation Research Record: Journal of the Transportation Research Board, p. --, vol. , (-- ). Submitted
- Welch, T., Tufte, K., McCourt, R., Bertini, R.L. and Snook, A., "Implementing a User-Oriented Web-based Traffic Data Management and Archive System", Transportation Research Record: Journal of the Transportation Research Board, p. , vol. , ( ). Submitted

- Horowitz, Z. and Bertini, R.L., "Using PORTAL Data to Empirically Diagnose Freeway Bottlenecks Located on Oregon Highway 217", *Transportation Research Record: Journal of the Transportation Research Board*, p. , vol. , ( ). Submitted
- Tufte, K., Ahn, S., Auffray, B. and Bertini, R.L., "Toward Automated Detection of Systematic Error in Loop Detector Data", *Proceedings of the 11th World Conference on Transport Research*, Berkeley, California, USA, 2007, p. , vol. , ( ). Submitted
- Potter, J., Tasnim, S., Bertini, R.L. and Tufte, K., "Using Archived Freeway Incident Data to Evaluate Incident Management Strategies and Improve Performance Measurement", *Proceedings of the 11th World Conference on Transport Research*, Berkeley, California, USA, 2007, p. , vol. , ( ). Submitted
- Kothuri, S., Tufte, K., Ahn, S., and Bertini, R.L., "Development of an ITS Data Archive Application for Improving Freeway Travel Time Estimation", *Proceedings of the 9th International IEEE Conference on Intelligent Transportation Systems*, Toronto, Canada, September 17-20, 2006, p. , vol. , ( ). Accepted
- Bertini, R.L., Tufte, K., Rucker, J., Potter, J., and Welch, T., "Expansion of an ITS Data Archive with Applications for Improving Spatial Analysis and Tracking Non-Recurrent Congestion", *Proceedings of the 9th International IEEE Conference on Intelligent Transportation Systems*, Toronto, Canada, September 17-20, 2006, p. , vol. , ( ). Accepted
- Bertini, R.L., Tufte, K., and Horowitz, Z., "Estimating Truck Flows on a Freeway Network to Improve Freight Operations and Planning", *Proceedings of the 13th World Congress on Intelligent Transport Systems*, London, October 8-12, 2006, p. , vol. , ( ). Accepted
- Kothuri, S., Ahn, S., Tufte, K., and Bertini, R.L., "Improving the Accuracy of Freeway Travel Time Estimates Using Archived ITS Data", *Proceedings of the 13th World Congress on Intelligent Transport Systems*, London, October 8-12, 2006, p. , vol. , ( ). Accepted
- Bertini, R.L., "Developing Comparative Congestion Measures to Improve Transportation System Performance", *Proceedings of the Fifth International Conference on Traffic & Transportation Studies (ICTTS)*, Xi'an, China, August 2-4, 2006, p. --, vol. , (-- ). Published
- Bertini, R.L. and Makler, J., "Using Real Time Transportation System Performance Measures to Fuel a Regional Congestion Management System", *Compendium of Technical Papers*, Institute of Transportation Engineers, District 6 Annual Meeting, Honolulu, Hawaii, June 25-28, 2006, p. --, vol. , (-- ). Published
- Auffray, B., Tufte, K., Horowitz, Z., Matthews, S. and Bertini, R.L., "Evaluation of Single-loop Detector Vehicle-Classification Algorithms using an Archived Data User Service System", *Compendium of Technical Papers*, Institute of Transportation Engineers, District 6 Annual Meeting, Honolulu, Hawaii, June 25-28, 2006, p. --, vol. , (-- ). Published
- Potter, J., Tasnim, S., Tufte, K. and Bertini, R.L., "Incorporating Incident Data into a Freeway Data Archive for Improved Performance Measurement", *Compendium of Technical Papers*, Institute of Transportation Engineers, District 6 Annual Meeting, Honolulu, Hawaii, June 25-28, 2006, p. --, vol. , (-- ). Published
- Bertini, R.L. and Kothuri, S., "Improving Travel Time Estimation for Freeway Traffic Management and Traveler Information Systems", *Proceedings of the 1st International Symposium on Freeway & Tollway Operations*, Athens, Greece, June 4-7, 2006, p. --, vol. , (-- ). Published
- Tufte, K., Monsere, C., Bertini, R.L., Kothuri, S. and Breakstone, A., "Comparative Analysis of Various Travel Time Estimation Algorithms to Ground Truth Data Using Archived Data", *Proceedings of the North American Travel Monitoring Exhibition & Conference (NATMEC)*, Minneapolis, Minnesota, June 4-7, 2006., p. --, vol. , (-- ). Published
- Monsere, C., Bertini, R.L., Horowitz, Z. and Tufte, K., "Incorporating Freight Performance Measures in an Archived Data User Service", *Proceedings of the North American Travel Monitoring Exhibition & Conference (NATMEC)*, Minneapolis, Minnesota, June 4-7, 2006, p. --, vol. , (-- ). Published
- Breakstone, A. and Bertini, R.L., "Using Ground Truth Geospatial Data to Validate Advanced Traveler Information Systems Freeway Travel Time Messages", *Compendium of Technical Papers*, Institute of Transportation Engineers, District 6 Annual Meeting, Kalispell, Montana, July 10-13, 2005, p. --, vol. , (-- ). Published

## Books or Other One-time Publications

### Web/Internet Site

**URL(s):**

<http://portal.its.pdx.edu>

**Description:**

The TransPort Portal website is the main project website providing access to the new Portland Transportation Archive Listing.

### Other Specific Products

**Product Type:**

**Data or databases**

**Product Description:**

TransPort Portal  
Portland Transportation Archive Listing

This database collects traffic sensor data from 500 freeway sensors every 20 seconds, 24 hours a day, 365 days a week. We also collect hourly weather data and are expanding the database to include regional transit data, city traffic signal/arterial data and statewide weigh in motion data.

**Sharing Information:**

The database is accessible through our web interface at <http://portal.pdx.edu>.

**Product Type:**

**Teaching aids**

**Product Description:**

We have produced a web-based database interface that allows students to explore archived transportation data, and download it in customized formats for individual class project analysis.

**Sharing Information:**

This aid will be shared via our project website, class project reports and presentations to stakeholders.

### Contributions

**Contributions within Discipline:**

After three years, our project continues to make an impact to the transportation discipline within civil and environmental engineering, resulting in several more journal and conference proceedings publications and many presentations at conferences. Further, the results of the project have resulted in additional invitations to participate in other conferences and publications in the U.S. and internationally. Many entities involved in data archiving now know about our project and seek us out at conferences asking for the latest developments. Within the State of Oregon, it is safe to say that PORTAL has already helped change the way people think about transportation data--due to the high level of interest in our project, we are considering expanding the database to include data from other sources, including incidents, arterials, transit and trucks. From an educational standpoint, the PORTAL project has helped attract two new post-doctoral research associates, several prospective graduate students at the Ph.D. and master's level as well as undergraduate students in the civil engineering program. The PORTAL project, funded by NSF, has helped gain much attention to the transportation research program after only three years. The results have far exceeded our expectations.

As a result of this project, it is clear in Oregon that the connection between archived transportation data and traffic modeling and performance measurement is improving transportation practice. By developing a solid database backbone build on solid traffic flow theory concepts, and by insisting that we provide easy access to the archived data for all users (avoiding the need to interface with legacy database software and hardware systems), we have freed transportation researchers and practitioners from time consuming manual manipulation of large data sets and is allowing more time to be devoted to new ways of thinking about traffic modeling.

We have made major strides in the development of new travel time and data filtering algorithms that will appear in forthcoming publications. We look forward to another successful year.

**Contributions to Other Disciplines:**

Two years ago our university doubled the size of our Computer Science department by adding ten new faculty. Through regular meetings, we have continued to build linkages with several of these faculty and a number of graduate students. Further, via our conference presentations, seminars and publications this project has demonstrated the possibilities for computer science applications in the transportation field. On campus, linkages with geography, mathematics, urban planning, statistics and computer science have broadened the horizons of students and faculty in those disciplines. It has been exciting to see all of the new intellectual connections that are flourishing.

**Contributions to Human Resource Development:**

The PORTAL project has continued to provide opportunities for bachelor's, master's and doctoral students as well as post-doctoral researchers to expand their research skills and develop important communication skills (writing and speaking) by participating in daily research activities, weekly project and lab staff meetings, external meetings, presentations and conferences. By serving as co-authors on publications and presenting their work at various professional meetings and conferences, students have expanded their horizons, gain confidence, make professional contacts and realize their potential. Students are often amazed at conferences when they see how well our work stacks up against work done at other, major universities. Through these experiences, students are empowered to excel and reach their potential. These experiences are preparing them for the workforce and for further academic work.

Through project presentations to working professionals, we are contributing to the continuing education needs in the region/state, and are attracting younger students to the civil engineering field. The excitement around this project has encouraged several working professionals to return to graduate school at PSU and we are now attracting graduate school applicants from around the U.S. who are also considering such major institutions as Berkeley, MIT and the University of Washington.

**Contributions to Resources for Research and Education:**

After three years, the project has helped create a new paradigm at the university for research computing support. We share a database server with another faculty member in geography (study of glaciers) and have helped spawn new thinking about university resources. By helping to provide 'time and space' for devotion to these research and education activities, the project has created a sense of place and a focal point for transportation related activities on the university campus and around the Portland region. These results will continue to expand over the life of the project.

**Contributions Beyond Science and Engineering:**

The PORTAL project has helped inform several important regional initiatives with regard to congestion management and the development of a freight transportation plan for the City of Portland. Regional transportation operations staff regularly report to decision makers using PORTAL data.

**Special Requirements**

**Special reporting requirements:** None

**Change in Objectives or Scope:** None

**Unobligated funds:** less than 20 percent of current funds

**Animal, Human Subjects, Biohazards:** None

**Categories for which nothing is reported:**

Any Book