PORTAL Advisory Committee

Initial Meeting
January 22, 2009
Intelligent Transportation Systems: Saving Lives, Time and Money

Agenda

9:00 Introductions – All
9:10 Overview of PORTAL System – Dr. Kristin Tufte, PSU
10:00 Data Collection – All
10:30 PORTAL work program – Dr. Kristin Tufte, PSU
10:50 Committee Housekeeping – Deena Platman, Metro
11:00 Adjourn
What’s in the PORTAL Database?

Loop Detector Data
20 s count, lane occupancy, speed from 500 detectors (1.2 mi spacing)

Incident Data
140,000 since 1999

Incident Data
140,000 since 1999

Bus Data
1 year stop level data
140,000,000 rows

Data Archive
Days
Since July 2004
About 900 GB
7.1 Million
Detector Intervals

Weather Data

VMS Data
19 VMS since 1999

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PORTAL Web Site

- Graphical display of archived data
- Performance Reports, Traffic Counts, Freight Data, ...
Performance Measures Used

- Volume
- Speed
- Occupancy
- Vehicle Miles Traveled
- Vehicle Hours Traveled
- Travel Time
- Delay

Initial work done on Green Measures: Emissions, Energy Consumption, Delay Cost, Person Mobility
Previous PORTAL Funding

- Developed with CAREER grant from National Science Foundation
- Additional financial support from NSF, FHWA
- Large investment in developing regional transportation archive
- Approx $1 million in external funding (NSF, FHWA)
Intelligent Transportation Systems: Saving Lives, Time and Money
Performance Report - Reliability

Portland Oregon Regional Transportation Archive Listing

Click here for zipped data file

Estimated Monthly Travel Time
I-5N: Dec-2008

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Incident on NB I-205, log truck rear-ended a nursery truck, two cars also involved, duration over 4 hours.

11/15/2005 Northbound I-205
Monthly Incident Reports

Incident Types

- stalled: 35.6%
- crash: 19.8%
- debris: 11.7%
- other incident: 8.6%
- tow: 1.2%
- construction: 2.3%

Number of Lanes Affected

- 0 lanes: 63.4%
- 1 lane: 32.3%
- 2 lanes: 4.3%

Locations of Incidents

- right shoulder: 47.8%
- right lanes: 17.6%
- left lanes: 10.3%
- full lanes: 7.6%
- move: 2.2%
- center lanes: 1.6%
- left shoulder: 1.6%
- cone area (right): 0.8%
- other: 7.2%

Number of Incidents Starting each Hour

- crash: green
- stall: blue
- debris: pink
- construction: brown
- total: total lines
Grouped Data – Travel Time
Weather Popup

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Bivariate Plots

X-axis:
- Occupancy (veh / x)
- Station:
  - I-5 NORTH mile 301.09 - Morrison BR WB to NB
- Date:
  - February 01, 2006

Y-axis:
- Flow (veh / hour)
- Lane:
  - HOV: all
- Include Hours:
  - 00:00 to 24:00

Flow vs Occupancy

DISCLAIMER: Portland State University Portal project: portal.its.pdx.edu * Data provided by Oregon Department of Transportation (ODOT).
## Monthly Report

### PORTAL: Portland Oregon Regional Transportation Archive Listing

#### Info

<table>
<thead>
<tr>
<th>Date</th>
<th>May 2005</th>
</tr>
</thead>
</table>

#### PORTLAND CONGESTION REPORT

**May 2005**

<table>
<thead>
<tr>
<th>CITY</th>
<th>PERCENT CONGESTED TRAVEL</th>
<th>TRAVEL TIME INDEX</th>
<th>BUFFER INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland</td>
<td>11%</td>
<td>1.59</td>
<td>2.14</td>
</tr>
</tbody>
</table>

**Legend**

- **12-mo. LO**: 12-month Low
- **12-mo. HI**: 12-month High
- **current month**: Current Month
- **New 12-mo. HI**: New 12-month High
- **New 12-mo. LO**: New 12-month Low

#### Contributing Factors

- Monthly Precip. vs. Norm
- Rain > 0.5" vs. Norm
- Rain > 1.0" vs. Norm
- Frozen Precip. vs. Norm
- Fog
- Work Zone Count
- Monthly Incidents

**Usable Days**

- 21 days

**178%**

**2**

**0**

**0**

**0**

**N/A**

**N/A**
Mapping – Speed By Month

July 2005

December 2005

Average Evening Peak Speed (5-6 pm)
Mapping – Speed Subtraction

Average Evening Peak Speed (5-6 pm)

Difference
July-December 2005

Speed (mph)
- < -15
- -15 -- -10
- -10 -- -5
- -5 -- 0
- 0 -- 5
- 5 -- 10
- 10 -- 15
- 15 <
- No Data

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Bus Data → Arterials
Uses of PORTAL

- Resource for local transportation professionals
- Metro RTP
- Projects
  - SWARM
  - Travel Time
  - Bottleneck Identification
  - Data Quality Evaluation
  - Gap Filling
  - TriMet Data Analysis
  - Oregon Freight Data Mart
  - Incident Autopsy
Bottleneck Identification

Time-series speed surface plot for I-5 NORTH on November 07, 2007 (Units in mph)

- **Bottleneck**: A, B, C
- **Activation**: 90% percentile of historical bottlenecks
- **Deactivation**:
- **Estimated Propagation Speed**:
  - A – 25 mph
  - B – 22 mph
  - C – 21 mph

Data Provided by ODOT
Portal In Action: Metropolitan Congestion Over Time

<table>
<thead>
<tr>
<th></th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Cross Section Study

Speed-Volume Analysis (2005)

2004-05 Speed Comparison

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Cross Section Comparison

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Good Free-flow performance

Geographic Bottlenecks
Looming Danger
Design Flaws
Mega-project!
Despite a slightly higher metering rate, SWARM's earlier activation appeared to delay the onset of congested speeds and allowed for higher and more stable mainline flows.

Vehicle-Hours of Delay

<table>
<thead>
<tr>
<th>Station</th>
<th>28-Sep (P)</th>
<th>21-Sep (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunnyside</td>
<td>272</td>
<td>161</td>
</tr>
<tr>
<td>Johnson Creek</td>
<td>1054</td>
<td>818</td>
</tr>
<tr>
<td>Foster</td>
<td>1075</td>
<td>711</td>
</tr>
<tr>
<td>Corridor Total</td>
<td>3775</td>
<td>2358</td>
</tr>
</tbody>
</table>

Note: SWARM Metering Activation Data not collected at Foster
Real Time Travel Time Estimation

- **Goal:** Assess accuracy of current travel time estimates and suggest improvements

- **Analysis**
  - 500 ground truth runs (GPS-enabled iQue)
  - Compared ground truth with estimates using PORTAL data

- **Results**
  - Average error 11%
  - Identified need for additional detection
  - Methods for evaluating benefits of additional detection
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Travel Time Estimation Error

Percent of Runs

<table>
<thead>
<tr>
<th>Percent Error</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; -30%</td>
<td>2.9%</td>
</tr>
<tr>
<td>-30% to -20%</td>
<td>6.1%</td>
</tr>
<tr>
<td>-20% to -10%</td>
<td>14.7%</td>
</tr>
<tr>
<td>-10% to 0%</td>
<td>29.0%</td>
</tr>
<tr>
<td>0% to 10%</td>
<td>31.4%</td>
</tr>
<tr>
<td>10% to 20%</td>
<td>10.3%</td>
</tr>
<tr>
<td>20% to 30%</td>
<td>2.6%</td>
</tr>
<tr>
<td>&gt; 30%</td>
<td>2.9%</td>
</tr>
</tbody>
</table>
Incident Autopsy: 6/12/06

8:15 2-vehicles collide
8:19 Crash reported
8:27 VMS message: CENTER LANES CLSD
8:40 COMET requests tow
9:10 Tow arrives
9:27 Lanes clear
9:30 Traffic starts to clear
9:45 Traffic half clear
10:00 Traffic all clear
Incident Autopsy: 6/12/06

Crash

Tow Arrives

All Traffic Clear

All Lanes Clear

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Sensor Data Quality

- ODOT products (speed map, ramp metering) are only as good as the input data
- Use PORTAL to identify poorly performing detectors; prioritize maintenance on those detectors (improve efficiency)
- Key Question: How do data anomalies correlate with problems in the field?
Oregon Freight Data Mart

Oregon Freight Data Mart Prototype

A map-based interface to freight-related data with data from Port of Portland, PORTAL, and ODOT.

Oregon Freight Data Mart Project Description

Data Layers

- Bottlenecks
- FHWA Bottlenecks
- Grades
- Signals
- Truck Incidents
  - Incident Level: Min: 0, Max: 4
  - Date Range: From: 1999-01-01, To: 2009-01-21
  - Num Incidents to Display: 25
- Truck Volumes
- Truck Generators
- Weigh-In-Motion Stations
- Google Traffic
- Google Street View
- Highway Speed and Reliability
  - I-5 NB AM Peak (7-9 AM)
  - I-5 NB PM Peak (4-6 PM)
  - I-5 SB AM Peak (7-9 AM)
  - I-5 SB PM Peak (4-6 PM)

Highway: I-5 SOUTH
Milepost: 308.6
Approx Length (mi): 1
Approx Activation Time: 07:30:00
Approx Activation Length (hr): 2
Description: lane drop just after Interstate Ave exit at Victory Blvd

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Oregon Freight Data Mart Prototype

A map-based interface to freight-related data with data from: Port of Portland, PORTAL, and ODOT.

Data Layers
- Bottlenecks
  - All AM PM
- FHWA Bottlenecks
- Grades Signals Capacity
- Truck Incidents
  - Incident Level: Min: 4 Max: 4
  - Date Range: From: 1999-01-01 To: 2009-01-21
  - Num Incidents to Display: 25
- Truck Volumes
- Truck Generators
- Weigh-in-Motion Stations
- Google Traffic
- Google Street View
- Highway Speed and Reliability
  - I-5 NB AM Peak (7-9 AM)
  - I-5 NB PM Peak (4-6 PM)
  - I-5 SB AM Peak (7-9 AM)
  - I-5 SB PM Peak (4-6 PM)

Intelligent Transportation Systems: Saving Lives, Time and Money
Media Use

Think the commute’s bad now? More jobs may mean more jams

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A snapshot of congestion

5:30 p.m. Thursday: Traffic creeps at Interstate 84 and the Northeast Martin Luther King Jr. Boulevard overpass, where more than 150,000 vehicles pass each day.

An ODOT map, updated every two minutes, shows travel speeds on most sections of Portland-area freeways. Right before you leave for your commute, you can check out how traffic is moving at www.tripcheck.com/pages.

Note: Average daily traffic figures are for June 2005.

*Only 2004 numbers were available for these areas.

Source: Oregon Department of Transportation
Data Collection

- What types of data should the region be archiving in PORTAL?
- What are the issues for collecting and managing PORTAL data?
PORTAL Work Plan

• Current Work
  – Data Quality
  – Aggregation
  – Web 2.0 Interface

• Going Forward
  – Sustainability
  – Enhancements
High-Level Data Quality Analysis

• **Goal:** Identify high-level data quality concerns

• **Four categories of readings**
  - No Traffic
  - Zero Occupancy
  - Very High Speeds
  - Low Overnight Speeds

• **Written Report on PORTAL Web Site**
  - Description of data received
  - Data quality conclusions
No Traffic Readings

No Traffic Readings and Flow by Hour of Day (September 2008)

Conclusion: Most No Traffic readings likely valid; still possibly some SWARM interference in the afternoon
Zero Occupancy

- 5.8% of readings in September had occupancy = 0, but speed and volume > 0 (theoretically invalid)
- Conclude these readings are likely valid and may be due to occupancies near zero being rounded to zero
Zero Occupancy Analysis

Calculated Vehicle Lengths; Count = 1; Occupancy = 0.5% (September 2008)

Mean: 3.4 ft
Standard Deviation: 2.6
Unusual High and Low Speeds

• **Very High Speeds**
  - September 2008 - 0.6% of detector speed readings reported > 100 mph
  - 80% of these readings come from the three detectors at US 26 WB at milepost 73.33 (Jefferson to Sunset WB)

• **Low Overnight Speeds**
  - Known problem
  - Identified a set of problematic detectors
  - Information to be provided to ODOT
Aggregation

• Aggregation methodology documented and validated
• Verified with ADUS standards and data archiving experts at TTI
• Report to be published on web site soon
  – Documents data received and calculated measures (VMT, VHT, Delay, Traveltime)
  – Evaluates alternative aggregation methodologies
  – Describes selection of aggregation methodology and provides supporting analysis
Going Forward…

• **Sustainability**
  - Validate performance metric calculations
  - Documentation and semi-automated tests of primary interface pages
  - Automate import of incident data
  - Meta-data update and backup procedures

• **Training**
  - Two training sessions in the first year
Going Forward...Enhancements

- Add new types of data?
- Clean up existing interface?
- Move to Web 2.0 interface?
- Customized performance reports?

- What do you want?
- What features are the most useful?

- Help us help you...
Committee Houskeeping

- How often should the committee meet?
- Chair?
Thank you!
Gap Filling

Correlated information can help find mechanisms for filling the data gaps

\[ \hat{S}_B = f(S_A, S_C) \]

By looking at available information from nearby stations, models fitted on historical data can provide an online estimate of the missing conditions. Different choices of estimation models exist, some more computationally intensive than others.
10/1 (Pre-Timed) & 9/17 (SWARM)

Vehicle-Hours of Delay

Station 1-Oct (P) 17-Sep (S)

8
205
61
491

(1) SWARM activation matches drop in speed
(2) But metering at Sunnyside (and likely Foster) activated later under SWARM than Pre-Timed
(3) Slightly higher metering rates under SWARM than Pre-Timed
(4) SWARM appears to implement a lower metering rate, responding to lower speeds.
SWARM Summary

- **SWARM** allows more vehicles onto the freeway at each on-ramp. (Counter to ODOT’s initial assumptions)
- **Pilot study on OR-217 SB** demonstrated a tradeoff between decreased ramp delay and increased mainline delay
  - Could not conclude that higher on-ramp volumes were the sole cause.
  - SWARM’s earlier activation times reduce mainline delay under some conditions.
- **Adjustment of metering rates and other SWARM parameters** is needed to improve performance
- **Communications failures** impact quality of SWARM operation
  - Tradeoff between frequently updating ramp metering plans, and increased need for maintenance and tuning w/adaptive system
- **Logging capabilities** for SWARM/ATMS would make evaluation efforts easier
  - Ramp queue loop detectors, meter activation times, and actual metering rates set by the SWARM system
WORK PLAN

This following is a description of the work required to carry out this research effort.

Task 1. Maintenance

Handle all software, hardware and system upgrades (ATMS, TATII) that impact PORTAL

Time Frame: This task will extend throughout the life of the project.

Deliverable: Maintenance actions will be documented as they occur for dissemination to PORTAL users (likely via a PORTAL blog).

Task 2. Training and Support

The PORTAL team will respond to questions from agency and academic personnel. The PORTAL team will run two training sessions for agency personnel and other interested parties. The purpose of these sessions is to gather information about what agency personnel would like to see in PORTAL and to train personnel on the use of PORTAL.

Time Frame: One training session in each 6 months of the project.

Deliverable: Two training sessions.

Task 3. PORTAL Sustainability

The PORTAL data archive was developed as a research tool. As such, it needs sustainability work to improve the professionalism, maintainability and accessibility of the PORTAL system. Such work includes code maintenance, documentation, and testing. Below is a proposed list of tasks. Tasks will be approved by the PORTAL Advisory Committee.

Clean Up of Primary PORTAL Tabs

- We define the following tabs to be ‘Primary’ tabs: Timeseries, Grouped Data, Dashboard, Performance, Weather, Bivariate Plots, Incident Reports.
- Document the primary tabs including definitions and documentation of calculations. Limited documentation will appear on the web site itself, more complete documentation will appear on the wiki or other web site.
- Create a semi-automated test suite for the primary tabs so that we can verify that new changes do not affect existing primary tabs.
- As needed, code will be improved to improve its maintainability.

Automate import of incident data. PORTAL currently stores ODOT incident data; however the import process is manual. The import process should be automated.

Review and update meta-data backup procedures. PORTAL has automated backup procedures for the ODOT loop detector data. Automated backup needs to be implemented for meta-data.

Time Frame: First 6 months of the project.

Deliverable: Documentation of primary tabs; test suite; automation scripts.
Metropolitan Mobility the Smart Way

Metropolitan Mobility
The Smart Way
The State of Intelligent Transportation Systems in the Portland Region
What’s Behind the Scenes?

Database Server
PostgreSQL Relational Database Management System (RDBMS)

Development Server
Ubuntu Linux distribution

Storage
1 Terabyte Redundant Array of Independent Disks (RAID)

Web Interface