Towards Incorporating Arterial Performance Quality in the PORTAL Archived Data User Service

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Outline

- What is PORTAL?
- Arterial performance
- Our prototype using:
  - Existing traffic signal infrastructure
  - Probe (bus) geolocation data
- Did it work?
- Next steps
Welcome to the Portland Transportation Archive Listing (PORTAL). The purpose of this project is to implement the U.S. National ITS Architecture’s Archived Data User Service for the Portland metropolitan region. This system is being developed at Portland State University by students and faculty in the Intelligent Transportation Systems Laboratory under the direction of Dr. Robert Bertini. We are working in close cooperation with the Oregon Department of Transportation, Metro, the City of Portland, TriMet and other regional partners. This work is supported by the National Science Foundation.

We welcome your participation in our project. The current PORTAL system archives the Portland metropolitan region’s freeway loop detector data at its most detailed level and also archives area weather data. We plan to expand the capabilities of our system and to include multimodal data sources from both Oregon and Washington. We provide access to the system by password. To request access to the system click on the Request Account link to the left.
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

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

Weather Data
- Every day since 2004

VMS Data
- 19 VMS since 1999

WIM Data
- 22 stations since 2005
  - 30,026,606 trucks

Crash Data
- All state-reported crashes since 1999 - ~580,000

Days
- Since July 2004
- About 300 GB
- 4.2 Million Detector Intervals

001497

NATMEC 2008
What’s Behind the Scenes?

**Database Server**
PostgreSQL Relational Database Management System (RDBMS)

**Storage**
2 Terabyte Redundant Array of Independent Disks (RAID)

**Web Interface**
### Selected Arterial Performance Measures

<table>
<thead>
<tr>
<th>Metric</th>
<th>Measurement Interval</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Speed</td>
<td>per Vehicle</td>
<td>per Lane</td>
</tr>
<tr>
<td>Average Speed</td>
<td>per Person</td>
<td>per Lane Group</td>
</tr>
<tr>
<td>Speed Index&lt;sup&gt;a&lt;/sup&gt;</td>
<td>per Distance</td>
<td>per Approach</td>
</tr>
<tr>
<td>Density</td>
<td>per Time</td>
<td>per Segment</td>
</tr>
<tr>
<td>Running Time</td>
<td>(cycle, 15 min, hour, day)</td>
<td>per Facility</td>
</tr>
<tr>
<td>Travel Time</td>
<td></td>
<td>per Area</td>
</tr>
<tr>
<td>Travel Time Variance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Delay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Delay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Queue Length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platoon Ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Stops</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signal Failure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of Congestion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Incidents</td>
<td>per Day/Peak Period</td>
<td></td>
</tr>
<tr>
<td>Duration Incidents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonrecurring Delay</td>
<td>per Event</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
<sup>a</sup> Ratio of average speed to posted speed.
Inspiration – Signal System Data Only
This Project: Combine Signal and Bus AVL
Past and Ongoing Efforts – Signal Data

- Using stop bar detectors to generate an arterial performance map
  - Hallenbeck, Ishimaru, Davis, Kang
  - Liang

- Performance based on summation of delay components
  - Liu, Ma
  - Skabardonis, Geroliminis

- Intersection/Signal Performance
  - Sharma, Bullock, Bonneson
  - Smaglik, Bullock, Sharma

Oregon Historical Society
Signal System Data:
Portland’s Detection Infrastructure

Data Aggregation
- Count Station
  5 min
- Other Detector
  15 min
- 7 Day Sample

System Detector
Traffic Signal
Arterial Street
Case Study: Barbur Blvd. Speed Map

[Map with marked locations and directions]

- Sheridan
- Hooker
- Hamilton
- 3rd Terwilliger
- Bertha
- 19th
- I-5 Off-ramp
- 30th
- Park & Ride
Detectors at Barbur and Bertha
5 Minute Speed and Occupancy (at Hamilton)
AM Peak Speed Map From Detector Data

Slope = Distance / Time

Sheridan
Hamilton
Bertha
Park & Ride

7:00 AM 9:00 AM
Signal Data Only Summary

- **Point Detection**
  - Detector spacing and coverage
  - How to extrapolate measurement to link level?
- **Very Limited Time Aggregation**
  - 5 Minute Won’t Work!
- **Lack of Access to Real Time Data**
Past and Ongoing Efforts – Bus Geolocation

- Buses as probes
  - Bertini & Tantiyanugulchhai (2003)
  - Vandehey, Parks, Koonce & Bonneson (2006 working paper)

- Measuring & reporting congestion
  - Hall and Vyas (2000)

- Measuring network LOS
  - Uno, Tamura, Iida, Nagahiro and Yamawaki (2007)
<table>
<thead>
<tr>
<th>Route No.</th>
<th>Service Date</th>
<th>Leave Time</th>
<th>Stop Time</th>
<th>Arrive Time</th>
<th>Badge</th>
<th>Direction</th>
<th>Trip No.</th>
<th>Location ID</th>
<th>Dwell</th>
<th>Door</th>
<th>Lift</th>
<th>Ons</th>
<th>Offs</th>
<th>Est. Load</th>
<th>Max Speed</th>
<th>Pattern</th>
<th>Distance</th>
<th>X Coor.</th>
<th>Y Coor.</th>
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<tbody>
<tr>
<td>9</td>
<td>01NOV2001</td>
<td>8:53:32</td>
<td>8:49:15</td>
<td>8:53:28</td>
<td>285</td>
<td>0</td>
<td>1120</td>
<td>4964</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

- Route Number
- Vehicle Number
- Service Date
- Actual Leave Time
- Scheduled Stop Time
- Actual Arrive Time
- Operator ID
- Direction
- Trip Number
- Bus Stop Location
- Dwell Time
- Door Opened
- Lift Usage
- Ons & Offs (APCs)
- Passenger Load
- Maximum Speed on Previous Link
- Distance
- Longitude
- Latitude
1 Year’s Worth of TriMet Data

- 92 Bus Line
- 7,600 Stop Locations
- 273,469 Runs
- 140,751,486 Stops
- 50 Gigabytes of Data
- Extensive Network Coverage
- Opportunity to Evaluate Multiple Routes on Same Arterial
Building on Powell Blvd. Study

- Begin with limited signal system data.
- Gather **archived** TriMet AVL data.
- **Merge** two data sources to examine synergies due to **data fusion**.
- Use geolocation data to calibrate influence areas from loops.
Buses Inform Detector Readings – 2/12/07

Intersection Name

Sheridan
Hamilton
Bertha
Park & Ride

Distance (miles)

Occupancy
- 0 - 7.5%
- 7.5 - 22.5%
- 22.5 - 45%
- 45 - 100%
Bus Speed
- > 34 mph
- 25 - 34 mph
- 10 - 24 mph
- 0 - 0 mph
Bus Trajectory
Congestion Interval

Intersection

8:00 AM
9:00 AM

3.5
4.5
3.5
1.9
0
Midpoint Method Using 5-Minute Data

Intersection Name

Sheridan

Hamilton

Bertha

Park & Ride

Occ: 0 - 7.5%
7.5 - 22.5%
22.5 - 45%
45 - 100%
Bus Trajectory

Distance (miles)

5:00 PM
5:30 PM
6:00 PM
Bus Data Confirms Adjustment

Intersection Name

- Sheridan
- Hamilton
- Bertha
- Park & Ride

Distance (miles)

- 0
- 1.9
- 3.5
- 4.5

Occupy

- 0 - 7.5%
- 7.5 - 22.5%
- 22.5 - 45%
- 45 - 100%

Bus Speed

- > 35 mph
- 25 - 35 mph
- 10 - 24 mph
- 0 - 9 mph

Bus Trajectory

Concentration Interval

NATMEC 2008
Reveals Gaps in Detection
New Occupancy Map From Combined Sources

Intersection Name

Sheridan

Hamilton

Bertha

Park & Ride

5:00 PM  5:30 PM  6:00 PM

Distance (miles)

0  1.9  3.5  4.5

Occupancy
- 0 - 7.5%
- 7.5 - 22.5%
- 22.5 - 45%
- 45 - 100%

Bus Speed
- > 35 mph
- 25 - 35 mph
- 10 - 24 mph
- 0 - 9 mph

Bus Trajectory
An Improvement Over Mid-Point Method

NATMEC 2008

Intersection Name

Sheridan
Hamilton
Bertha
Park & Ride

Distance (miles)

5:00 PM 5:30 PM 6:00 PM

0 1.9 3.5 4.5

Occupancy
- 0 - 7.5%
- 7.5 - 22.5%
- 22.5 - 45%
- 45 - 100%

Bus Trajectory
The Proof?

Travel Time (minutes)

- Actual Bus
- Max Speed Method
- Signal
- Max Speed x 1.25
- Signal + Bus

- Morning Peak
- Midday Off-Peak
- Evening Peak
Last Point -- Bus Frequency

Signalized Intersections:
- Hooker
- Hamilton
- Bertha (E)
- Bertha (W)
- SW 19th Ave
- SW 24th Ave
- SW 30th Ave
- Park & Ride

Bus Speed:
- > 34 mph
- 25 - 34 mph
- 10 - 24 mph
- 0 - 9 mph

Route 94 (Express)
Route 12

Time:
- 6:00AM
- 6:30AM
- 7:00AM
- 7:30AM
- 8:00AM
- 8:30AM

Distance:
- 0
- 0.5
- 1
- 1.5
- 2
- 2.5
- 3
- 3.5
- 4
- 4.5
- 5
Conclusions

- Our attempt to fuse data sources appears promising
  - Confirms TriMet buses can be probes
  - Signal data needs work
- Challenges
  - Detailed AVL Data (Stop Level) Not Available in Real Time (?)
  - Travel Times Limited by Detector Data
- What to “archive” is still an open question
Acknowledgements

- **TransPort Members**
- FHWA: Nathaniel Price
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- ITS Lab: John Chee, Rafael Fernandez
Thank You!
www.its.pdx.edu