Innovation for Better Mobility

FDOT Data Symposium
Analyzing Bottlenecks with Various Data Sources
Who We Are...

- **Iteris** is a leader in traffic and weather systems
- Three focus areas:

  - **iPerform** (Weather & Traffic Analytics)
iPerform Traffic & Weather Data & Analytics

Data Aggregation
- Public Traffic Sensor Data
- GPS Probe Data
- Weather Reports & Sensors
- Traffic Incident Reports
- Traffic and Weather Video

Big Data Fusion by Iteris PeMS (iPeMS) & ClearPath Weather

iPeMS Data Feed & APIs

Applications
- Precision Ag
- Financial/Insurance
- Automotive
- TRAFFIC MONITORING & PERFORMANCE MANAGEMENT
- Road Maintenance

Innovation for better mobility
iPeMS

Tools to Support Planning and Operations
iPeMS Performance Measurement

- Reliable measurement of transportation networks, freeways, integrated corridors, routes and artierals
- Real-time and actionable decision support data and historical planning reports
- Incorporates traffic data from loops, radar, bluetooth, probe, incidents, lane closures, managed lanes, signals, and transit
- Delivered and visualized in key analytics, reports, dashboards and mapping
Performance Measurement Constituencies

- Tracking
- Planning
- Operations
- Mode
iPeMS Bottleneck Visualizations

- Operations and Planning
  - Real-time dashboards
  - Summary maps, plots and contours
- Understand performance
  - Through visualizations and analytics
- Sample report types
  - Dashboards
  - Regional indexes
  - Incident analysis and visualization
  - Travel time reliability
Performance Measurement: Regional Planning

Bottlenecks
Bottlenecks are identified with large speed drops including bottleneck durations, upstream queues and total delay as well as filterable top bottlenecks on maps and lists.

VMT
Detector stations are aggregated spatially to show Vehicle Miles Traveled (VMT) in lists or displayed in charts.

Long Term Trends
Report provides user with a view of commonly used freeway performance measures over long periods of time. It segments the values to commonly used time ranges for peak and off-peak hours over large geographic segments including State, Districts and Counties.
Bottlenecks in PeMS

- Statistics about bottlenecks for any geographical segment
- Statewide or along a freeway-direction
- This table shows the bottlenecks that were discovered during the last month
# Bottlenecks in PeMS: Additional facts

- **# days active**: during the time period, how many times was this particular bottleneck activated?
- **Avg extent**: what is the average spatial extent of congestion for this bottleneck when it’s activated?
- **Avg delay**: what’s the average delay caused by this bottleneck?
- **Ave duration**: how long does the bottleneck last on average?

<table>
<thead>
<tr>
<th>Station Name</th>
<th>Shift</th>
<th>Fwy</th>
<th>Abs PM</th>
<th>State PM</th>
<th># Days Active</th>
<th>Avg Extent (Miles)</th>
<th>Avg Delay (veh-hrs)</th>
<th>Avg Duration (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>741 SB I-15 @ 1200 N - OREM</td>
<td>AM</td>
<td>I15-S</td>
<td>272.24</td>
<td>272.24</td>
<td>31</td>
<td>1.2</td>
<td>426.2</td>
<td>284.8</td>
</tr>
<tr>
<td>99409 NB I-15 @ 4550 S HOV Lane</td>
<td>AM</td>
<td>I15-N</td>
<td>301.52</td>
<td>301.52</td>
<td>31</td>
<td>0.4</td>
<td>127.2</td>
<td>224.8</td>
</tr>
<tr>
<td>700 NB I-15 @ 1200 N - OREM</td>
<td>AM</td>
<td>I15-N</td>
<td>272.24</td>
<td>272.24</td>
<td>25</td>
<td>1.2</td>
<td>105.3</td>
<td>206.6</td>
</tr>
<tr>
<td>369 NB I-15 @ 13400 S</td>
<td>AM</td>
<td>I15-N</td>
<td>289.96</td>
<td>289.96</td>
<td>1</td>
<td>0.3</td>
<td>22.5</td>
<td>195.0</td>
</tr>
<tr>
<td>612 EB I-80 @ SR 65 (WEST SIDE)</td>
<td>AM</td>
<td>I80-E</td>
<td>133.58</td>
<td>133.58</td>
<td>1</td>
<td>0.5</td>
<td>43.5</td>
<td>180.0</td>
</tr>
</tbody>
</table>
Bottleneck Exploring: Lists and Plots

- I15-S
- PM 280-310
- Weekdays
- PM period
Different Types of Analysis: Detector Bottleneck Map

- The PeMS Bottleneck Identification Algorithm
  - Finds places where there is a persistent slowdown in speed
  - When viewed over many days, the trends become clear
- Size = number of days the bottleneck was activated
- Color = spatial extent of the backup
Different Types of Analysis: Detector Bottleneck Map

- Can adjust filters
  - Time of Day (AM & PM Peak, mid-day, All Day)
  - Number of days
  - Length of queue
Different Types of Analysis: Adding Causes - Incidents

- Adding incident data lets you see other patterns
- Are bottlenecks correlated to incidents?
- Example shows persistent and long bottlenecks in the LA region Sep 2014 vs. heat map of CHP incident data for the same region
Different Types of Analysis: Adding Causes - Weather
Volume Impacts: Spatial AADT

- Is the issue volume?
- Spatial AADT along a freeway in a direction (I-15 SB)
Long-term Trends: AADT

- And you can export to KML to see the AADT data on a map
Performance Measurement: Operations Tools

Ramp Metering
Ramp metering analysis lets users compare ramp data with data and performance measures from nearby stations.

Managed Lanes Dashboard
The Managed Lanes Dashboard monitors the performance of HOV lanes and other managed facilities. Includes overall and peak congestion, weekly performance timeseries, weekly demand time series and weekly ratio of demand.

Freeway Service Patrol
The Freeway Service Patrol (FSP) beats dashboard summarizes performance of freeways that are patrolled by roving tow trucks that help stranded motorists, clear debris, and assist Highway Patrol with incident response during peak hours.

Lane Closures
Lane closure reports provide visibility into the quantities and types of lane closures that can be grouped, measured and compared.
Operations Bottleneck Tools: Ramp Data and Metering

- Ramp metering
  - In the morning from 6:30am-9:15am
  - Is it working?
  - If yes, during AM peak on-ramp flow should be restricted

- Plots to show on-ramp flow vs. mainline flow
  - As mainline flow is increases, on-ramp flow will stay at constant metering rate
Operations Bottleneck Tools: Dashboard Visualizations
Visualizations: Map Based Bottleneck Identification

- Third-party speeds (e.g. Nokia HERE)
- Full road network graph
- Forecast recurrent bottlenecks
Bottleneck detection: Generalize to road network

- Previously: limited to single linear road (e.g. sequence of detectors)

- Generalization: Look for queue on all parts of network upstream of bottleneck

Linear bottleneck on freeway mainline (Toll booth of Richmond bridge)

Linear bottleneck not on freeway mainline (Dumbarton bridge)
“Nonlinear” bottlenecks

- We also see bottleneck-like conditions with multiple, branching queues (i.e. on and off mainline)

Bottleneck with nonlinear queue (US-101 & SR-92)
Operations Bottleneck Tools:
Regional Passenger & Freight Planning

2013 CONGESTED FREEWAY MILES (FREIGHT)

REGION: CA > County > San Bernardino

Data Type: All

Performance Measure: Congested %

Monthly Average (Weekdays)

September:
Last Year: 15.1%
Current Year: 19.0%
Operations Bottleneck Tools: Regional Passenger & Freight Planning

FEBRUARY

CONGESTED (%)
13.1%
-1.70% - 3.90%

TRAVEL TIME INDEX
1.29
-0.26 + 0.03

PLANNING TIME INDEX
1.54
-0.62 + 0.11
Bottlenecks, Congestion, Travel Time and Measures for Routes and Corridors

**Time Series**
The time series plots allow the user to show volume, delay and other variables over time by individual lane or aggregated by direction and lane type.

**Contour Plots**
Visualize traffic speeds from traffic sensor data through contour plots that show congestion, bottleneck and incident patterns.

**Departure Time Series**
Departure Time Series lets users see the variability in travel time for a specified time of day.

**Lane Requirements Chart (Planning for Closures)**
Determine the number of lanes to keep open during construction based on capacity and demand on the freeway.
Blizzard with over 200 crashes or slide-offs
Freezing Rain Storm
Consistent Congestion

????

I-15 SB Weekdays: SLC to Draper January

Travel Time (min)

Time of Day

Maximum
75th Percentile
Average
Using Delay to Show Bottlenecks

- **Vehicle Speeds Under 55 mph**
  
  \[ \text{Vehicle-Hours} = \text{Vehicle Volumes} \times \text{Additional Travel Time} \]

  All Days: I-15 SB SLC to Draper
Bottlenecks: Timeseries Contour Plots

Aggregated Speed (mph) for I15-S (91% Observed)
Thu 05/22/2014 06:00-18:59
Traffic Flows from Bottom to Top

Corridor length of queue 10 miles

Congested period 3:30-6:30pm
Contour Patterns

Demand based congestion
- Queue builds and shrinks with demand: queue shrinks from the end.

Incident-based congestion
- Capacity is suddenly restored: queue doesn’t dissipate from the end.
Long Term Timeseries Contour Plots

- Looking at recurrent bottlenecks

The same queue, but on the Friday before Memorial Day it stared earlier and lasts longer
55+ mph: Free-flow conditions
40 – 55 mph: Delay
20 – 40 mph: Congestion
0 – 20 mph: Severe Congestion

Speed Contours
I-15 SB SLC to Draper

SLC

Draper

Travel Path in Congestion

Normal Travel Path

Incident Impact Level
1: Not blocking any lane
2: Blocking less than ½ thru lanes
3: Blocking at least ½ thru lanes

Friday
12/14
Bottlenecks by Travel Time: Time of Day Timeseries

- Showing travel time over the course of the day, over many days
- Can see the ridge that is the morning commute
Case Study: I5 SB Santa Fe Additional Lanes

- SB I-5 approaching San Diego is a heavy AM commute route
- Where SR56 merges with I5 is especially bad
- Over time, demand has risen along with congestion
- Plotting the weekday AM travel time per quarter over 7 years
Case Study: I5 SB Santa Fe Additional Lanes

- Decided to do a construction project to add a lane in the southbound direction at SR56 merge
- Construction done during the summer of 2007
- We can compare the "Before" scenario (timeframe was September/October 2006)
- And "After" scenario (timeframe was September/October 2008)
- Here we’re showing a “route” that has been defined in PeMS for that section of freeway
- Routes allow us to compute certain performance measures over that section of freeway
• Top shows travel time versus time of day (M-Th). Left is Sep/Oct ‘06, Right is Sep/Oct ’08.
• Bottom shows speed contour for weekdays. Left is Sep 2006, Right is Sep 2008.
• In both cases we can see significant AM savings
Case Study: I-5 SB Santa Fe Aux Lanes Open

- Extended the travel time plot through 2008
- Can see a significant decrease in travel times
- Graphs and charts are used to present to decision makers and public officials that efforts by the DOT and MPO are effective
Contact Information

Scott Perley
Product Manager, iPeMS
Iteris, Inc
570-470-4081
sip@iteris.com