Agenda

• Overview
  – iPeMS, leading Big Data analytics

• Big Data
  – Types of Big Data
  – NPMRDS & probe data

• Applying Big Data
  – Telling stories & client examples
  – Freight opportunities
  – Software tools to leverage Big Data
Who We Are…

• Iteris is a leader in software-based information solutions for the **Intelligent Transportation Systems (ITS)** market

• We focus on three areas in the ITS market:
  
  – **Sensors:** Intersection and roadway vehicular detection
  
  – **Systems:** Provide local, state and federal agencies traffic management services
  
  – **Analytics:** Focused on traffic and weather-related data and analytics software to both public and commercial customers
What Iteris PeMS Provides...

**Powerful Tools**
Actionable visualizations & reports to support operations & planning

**Analytics**
For states and regions to support System Performance

**Supports Many Data Types**
Loops, radar, GPS, Bluetooth, toll tags, incidents, accidents, lane closures, managed lanes, signals, and transit + more

**Flexible Deployment**
Cloud-hosted or agency-hosted models
What Iteris PeMS Does

Transportation data warehouse

- Real-time Archive Data Management System
- Stores all types of data, normalizes schema
- Always online, always available
- Many operations and planning based-tools

Calculates performance measures

- Rolls data up over space and time
- Stores results for queries
- All calculations are done in real-time

Presents a variety of displays for different users

- Operations, maintenance, planners, decision makers, public
What technologies can you use?

Or a hybrid approach which uses combinations of all detectors
What is big data?

Couple of minutes

Location
Speed
Heading
What is Big Data?

19 mph  |  44 mph  |  63 mph

Segment 1  |  Segment 2  |  Segment 3

@ 7:15 AM
How does Big Data help?

• **Greater accuracy**
  – Current approaches not statistically sound
  – (More vehicles) \(\times\) (More times) \(\times\) (More days)

• **Reduced costs**
  – Travel time runs are expensive
  – Probe data is cheaper

• **Deeper insights**
  – Understand reliability
  – Larger coverage
## Commercial Speed Data Providers

<table>
<thead>
<tr>
<th>Provider</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>HERE</td>
<td>Providing data in District 8, freeways and arterials, every minute in real-time.</td>
</tr>
<tr>
<td>INRIX</td>
<td>MTC purchased INRIX data in the Bay Area</td>
</tr>
<tr>
<td>NPMRDS</td>
<td>Free FHWA dataset to MPOs (for National Highway Network only)</td>
</tr>
<tr>
<td>Tom Tom</td>
<td>Freight and Auto Travel Times</td>
</tr>
</tbody>
</table>
Big Data: Digging Deeper

NPMRDS Overview

- Free to States and MPO’s
- National GPS traffic probe Big Data set
  - Includes both auto and freight
  - Raw (unmodeled) data only
- Historic, not real-time

NPMRDS Spatial Coverage
Includes the National Highway System

Provided by:

here

and

ATRI American Transportation Research Institute
### What does NPMRDS Big Data look like?

<table>
<thead>
<tr>
<th>TMC</th>
<th>Date</th>
<th>Epoch</th>
<th>Travel Time (all)</th>
<th>Travel Time (auto)</th>
<th>Travel time (Freight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>105N04105</td>
<td>9112014</td>
<td>138</td>
<td>59</td>
<td>55</td>
<td>65</td>
</tr>
</tbody>
</table>

**Date**

mddyyyy

**Epoch**

Represents time i.e. 5 min period since midnight (0 - 287)

- 0 00:00:00 to 00:04:59
- 1 00:05:00 to 00:09:59
- 287 23:55:00 to 23:59:59
Managing Big Data: Filling in Gaps

Each vertical line in these figures represent the variation in speed over the course of a day for a TMC on the facility. Gaps in coverage show up as holes in the lines.

For the **interstate** facility, there is good coverage during the day, but gaps occur at early and late hours due to fewer probe points providing data.

On this state **highway**, which has a lower density of observed probe points, many more gaps are present.

Gaps are even more substantial on **arterials**, where the density of observed probe points is the most sparse.
Managing Big Data: Filling in Gaps

Raw Data

Processed Data
Managing Big Data: Results

**Process**

- Raw Data are processed
- Processing with a series of methods
- Speeds for all time intervals are produced
The Reliability Story

Standard

Reliability

Travel time

Probability density function of travel times

N^{th} percentile
The Reliability Story

![Graph showing frequency vs. travel time with a mean, buffer, and planning sections.]

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning Time</td>
<td>95th Percentile Travel Time</td>
<td>On-time arrival</td>
</tr>
<tr>
<td>Buffer Time</td>
<td>Extra time to allow for trip variation</td>
<td>Quantify the spread</td>
</tr>
</tbody>
</table>
The Congestion & Delay Story

- Speed
- Slowing
- Back of Queue
- Return to Free Flow
- Bottleneck Cause
- Threshold
- Delay
- Postmile

Innovation for better mobility
Iteris Big Data Customer Success

SFCTA

MTC

Top 10 Congested Segments

<table>
<thead>
<tr>
<th>Rank</th>
<th>Route</th>
<th>County</th>
<th>Location</th>
<th>Length (miles)</th>
<th>Hours active</th>
<th>Delay (vehicle-hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I-80 E</td>
<td>SF</td>
<td>US-101 to east of Treasure Island Tunnel</td>
<td>4.1</td>
<td>1:45 to 7:50 PM</td>
<td>4,840</td>
</tr>
<tr>
<td>2</td>
<td>I-80 W</td>
<td>CC/ALA</td>
<td>CA-4 to Powell Street</td>
<td>3.6</td>
<td>6:30 to 10:15 AM</td>
<td>4,160</td>
</tr>
<tr>
<td>3</td>
<td>US-101 S</td>
<td>SCL</td>
<td>Fair Oaks Avenue to Oakland Road</td>
<td>0.7</td>
<td>2:45 to 7:55 PM</td>
<td>3,960</td>
</tr>
<tr>
<td>4</td>
<td>I-80 W</td>
<td>ALA</td>
<td>CA-88/Dewitt Road to A Street</td>
<td>0.2</td>
<td>2:50 to 7:35 PM</td>
<td>3,100</td>
</tr>
<tr>
<td>5</td>
<td>I-80 E</td>
<td>ALA</td>
<td>I-280 to CA-262</td>
<td>1.8</td>
<td>6:35 to 10:15 AM</td>
<td>2,940</td>
</tr>
<tr>
<td>6</td>
<td>I-80 N</td>
<td>ALA</td>
<td>CA-262/Mission Boulevard to Anandale Road</td>
<td>7.1</td>
<td>3:20 to 7:40 PM</td>
<td>2,560</td>
</tr>
<tr>
<td>7</td>
<td>I-80 E</td>
<td>ALA</td>
<td>W Grand Avenue to Glen Avenue</td>
<td>3.7</td>
<td>3:15 to 7:15 PM</td>
<td>2,470</td>
</tr>
<tr>
<td>8</td>
<td>I-80 W</td>
<td>ALA</td>
<td>San Joaquin County line to Airway Boulevard</td>
<td>15.4</td>
<td>5:25 to 9:05 AM</td>
<td>2,460</td>
</tr>
<tr>
<td>9</td>
<td>CA-24 E</td>
<td>ALA/CC</td>
<td>I-980 to Caledcott Tunnel exit</td>
<td>5.3</td>
<td>3:25 to 7:10 PM</td>
<td>2,350</td>
</tr>
<tr>
<td>10</td>
<td>I-80 W</td>
<td>ALA</td>
<td>Gilman Road to I-580 split</td>
<td>3.4</td>
<td>2:00 to 7:05 PM</td>
<td>2,300</td>
</tr>
</tbody>
</table>
Freight vs. Auto: Discovering the Space-Time Pattern Between Freight and Passenger Car Speeds Using the National Performance Measurement Research Data Set

Introduction
The National Performance Management Research Data Set (NPMRDS) reports average travel times for both freight trucks and passenger cars.

Iteris has processed more than three years worth of NPMRDS data, computing various performance measures such as average speed, travel time reliability/variability, and links with data as a proxy for traffic volume, separately for passenger cars and freight trucks.

Analysis
We consider weekday PM peak period in February 2015. We calculate:

- **Truck / passenger car traffic ratio**
  \[ \frac{\text{ (# links with freight truck data) \div (# links with passenger car data) }}{\text{ which states have roadways used more by freight trucks relative to passenger cars?}} \]

- **Truck / passenger car travel time reliability ratio**
  \[ \frac{\text{ (Planning time index of freight truck data) \div (Planning time index of passenger car data) }}{\text{ which states have worse travel time reliability for freight trucks relative to passenger cars?}} \]

- planning time index (PTI) = 95th percentile travel time / free flow travel time.

Conclusion
With appropriate aggregates of NPMRDS data, we can gain insights into freight truck traffic volume and travel time reliability relative to passenger cars.

Similar analysis could be done at county level as well as individual roadway segment level.

- **Insight:** Freight trucks have more traffic than passenger cars in rural states.

- **Insight:** Freight trucks have higher PTI than passenger cars in general. They are more so in some ports states, California and North Carolina, in particular.
Incorporating Big Data Into Software

Real-time and Historic Data Access
- Map-based visualizations of traffic speeds
- User-selectable date ranges on reports

Performance Management & Analytics
- Reports for Links and Routes
- Time series, time of day, day of week
- Congestion contour plots

Archived Data Access
- Clearinghouse containing daily files of various time aggregates to support agency processing

Interactive Map Functions
- Speeds, quality and speed anomalies
- Link based speeds
• Real-time speed
• Link information
• Option to compare to monthly values
Traffic Anomalies Map
Creating Routes
Innovation for better mobility

Time Series Speed, Travel Time & Travel Time Reliability

Route A73: Riverside Avenue NB (Easton Street to Sierra Avenue)

Performance > Aggregates > Time Series

- From 07/13/2015 to 07/16/2015
- Granularity: 5 Minutes

Average Travel Time (mins)

Mon 07/13/2015 to Thu 07/16/2015

Average Travel Time (mins)

07/16/2015 23:55:00 - 07:00
Average Travel Time (mins): 6.84
Average Speed (mph)
Fri 08/01/2014 to Wed 08/13/2014

Minimum: 23
Mean: 60
Maximum: 71
Routes: Contour Plots
Finding Bottlenecks
### Facilities & Devices > Third Party Data > Route Performance

**From 06/22/2015 to 06/30/2015**

**Road Type** All

**Time of Day** All, Include Days: All

<table>
<thead>
<tr>
<th>Route ID</th>
<th>Route Name</th>
<th>Average Speed (mph)</th>
<th>Travel Time (min)</th>
<th>Travel Time Index</th>
<th>Length (mi)</th>
<th>Road Type</th>
<th>LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>I-10 EB Climbing Lanes</td>
<td>60.9</td>
<td>2.15</td>
<td>1.08</td>
<td>2.2</td>
<td>Freeway</td>
<td>A</td>
</tr>
<tr>
<td>26</td>
<td>S E Street (San Manuel Stadium)</td>
<td>23.2</td>
<td>5.14</td>
<td>1</td>
<td>1.8</td>
<td>Arterial</td>
<td>A</td>
</tr>
<tr>
<td>62</td>
<td>T1: State Route 2 EB (County Line to Sheep Creek Drive)</td>
<td>37.3</td>
<td>3.67</td>
<td>1.02</td>
<td>2.3</td>
<td>Highway - Class II &amp; III</td>
<td>A</td>
</tr>
<tr>
<td>63</td>
<td>H1: State Route 2 EB (Sheep Creek Drive to Junction Route 138)</td>
<td>49.6</td>
<td>4.92</td>
<td>1</td>
<td>4.1</td>
<td>Highway - Class I</td>
<td>C</td>
</tr>
<tr>
<td>64</td>
<td>H2: State Route 2 WB (Junction Route 138 to Sheep Creek Drive)</td>
<td>47</td>
<td>5.22</td>
<td>1.01</td>
<td>4.1</td>
<td>Highway - Class I</td>
<td>A</td>
</tr>
<tr>
<td>65</td>
<td>T2: State Route 2 WB (Sheep Creek Drive to County Line)</td>
<td>36.8</td>
<td>3.72</td>
<td>1.02</td>
<td>2.3</td>
<td>Highway - Class II &amp; III</td>
<td>A</td>
</tr>
<tr>
<td>66</td>
<td>T3: State Route 18 NB (Junction Route 210 to Waterman Canyon Road)</td>
<td>42.3</td>
<td>4.22</td>
<td>1</td>
<td>2.9</td>
<td>Highway - Class II &amp; III</td>
<td>A</td>
</tr>
<tr>
<td>67</td>
<td>T4: State Route 18 SB (Waterman Canyon Road to Junction Route 210)</td>
<td>41.3</td>
<td>4.29</td>
<td>1.01</td>
<td>2.9</td>
<td>Highway - Class II &amp; III</td>
<td>A</td>
</tr>
<tr>
<td>68</td>
<td>H3: State Route 18 NB (Waterman Canyon Road to Junction Route 210)</td>
<td>47.5</td>
<td>10.62</td>
<td>1</td>
<td>8.3</td>
<td>Highway - Class I</td>
<td>C</td>
</tr>
</tbody>
</table>
• Using historical data or patterns
• Monthly and annual comparisons
• Summary charts, metrics and grades
• Animated maps to show TOD and DOW data
Probe Data: Dashboard for Real-Time Operations

- **Freeway Congestion**: 74.7% ↓
- **Arterial Congestion**: 39.1% ↓
- **Fwy. Travel Time Index**: 11% ↓

**Top Bottlenecks**:
- US-101
- I-880
- I-580
- N 1ST ST
- CA-4

**Bottleneck Categories**:
- Non-Recurrent (34.4%)
- Recurrent (65.6%)

**Updates**
- CHP
- Us101 S / Us101 S College Ave Ofc
Dashboard for Map-21
Historical Analysis using NPMRDS Data
Innovation for better mobility

All elements change with new selection

- Dynamic Geotags
- Monthly Comparison
- Day and Time Sliders
- Maps & Graphs
- Boundaries
- Measure Selection
- Color as context
- Navigation
- Month to Month & Year to Year
- KPI
iPeMS Dashboard: Map Visuals
Dashboard: Time of Day

February:
- TOD (weekdays): This Month 29.4%, Previous Month 25.5%, Previous Year 22.3%
- TOD (weekends)
- DOW (8 AM)
- DOW (5 PM)
- DOW (All Times)

Congested (%):
- This Month: 13.1%
- Previous Month: ↓ 1.70%
- Previous Year: ↑ 3.90%

Travel Time Index:
- This Month: 1.29
- Previous Month: ↓ 0.26
- Previous Year: ↑ 0.03

Planning Time Index:
- This Month: 1.54
- Previous Month: ↓ 0.62
- Previous Year: ↑ 0.11
Dashboard: Day of Week

FEBRUARY

TOD (weekdays)  TOD (weekends)  DOW (8 AM)  DOW (5 PM)  DOW (All Times)  ?

This Month: 37.2%  Previous Month: 31.3%  Previous Year: 21.1%
Dashboard: TTI

FEBRUARY

This Month: 1.68
Previous Month: 1.98
Previous Year: 1.62

5PM

Graph showing traffic flow from 12AM to 10PM with different filters for weekdays, weekends, 8 AM, 5 PM, and all times.
Dashboard: Adding Volume to Get Delay
Big Data Summary

• New data sets provide new opportunities
  – Broader coverage
  – More times
  – New types of data

• Working together with existing data sets
  – Can tell new and richer stories
  – Aggregate to understandable summaries and detailed reports
Questions?

For additional questions:
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VP, Performance Analytics
Phone: 570.470.4081
E-Mail: sip@iteris.com