iPeMS USER WEBINAR

April 17, 2019
Asking Questions

• Please pose your questions using the chat box

• Questions will be monitored then answered by the speakers either following the presentation or at the end of the webinar
Welcome & Introductions

Denise Markow, PE, I-95 Corridor Coalition
Speakers

Anita Vandervalk, PE, PMP
Iteris, Inc.
Associate Vice President

Mena Lockwood, PE
Virginia DOT
Assistant State Traffic Engineer

Kelly Njord, PE, PTOE
Utah DOT
Statewide Traffic Performance Engineer

Scott Perley
Iteris, Inc.
VP, Performance Analytics
<table>
<thead>
<tr>
<th>Agenda Item</th>
<th>Presenter/Affiliation</th>
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<tbody>
<tr>
<td>VDOT iPeMS Comprehensive Data Management</td>
<td>Mena Lockwood, PE Virginia DOT</td>
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<tr>
<td>Real-Time Traffic Data and Performance Analytics</td>
<td>Kelly Njord, PE, PTOE Utah DOT</td>
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<tr>
<td>Guiding Users Further</td>
<td>Scott Perley, Iteris</td>
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<td>Wrap Up</td>
<td>Denise Markow I-95 Corridor Coalition</td>
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VDOT iPeMS COMPREHENSIVE DATA MANAGEMENT

Mena Lockwood, PE
Virginia Department of Transportation
Overview

iPeMS: Comprehensive Transportation Performance Measurement

- History and Timeline
- Freeway iPeMS background and data
- Features and tools in Freeway PeMS
- Integration with 3rd Party data
- Weather Map Layer
- SmarterRoads
Purpose

Traffic Data and Performance Monitoring System (TDPMS)

1. Assist in decision making in building and optimizing operations on Virginia’s highway network.
2. Compile the myriad data at VDOT’s disposal.
4. Support VDOT staff to identify causes and impacts of congestion on our roadways.
5. Begin the process of identifying strategies to improve safety and efficiency in the trouble spots.
How does iPeMS Help?

**Challenge**
- Presentation of results
- Computation of performance measures
- Identifying bad detectors & dealing with bad data
- Data collection, storage & management

**Solution**
- Performance measures via GIS displays, graphs, reporting & exports
- Tracks changes, normalize & stores data for all time
- Deals with issues in a systematic manner, including imputation
- One place for all types of data
What iPeMS Does

Real-time and historical processing
- Performance Calculations
- Diagnostics & Imputation
- Aggregation

Visualizations
- Reports, Calculations & Tools
- Visualize
- Analyze

Performance Measurement System
- Algorithms
- Normalization
- Visualizations
iPeMS VDOT Modules

FREEWAY MODULE

MANAGED LANES

THIRD PARTY DATA

EVENT
How we got here:
VDOT iPeMS & SmarterRoads Timeline

2015
- Launch
- All data now in one place

2016
- Waze
- 25,000 / day

2017
- Enhanced route functionality
- SmarterRoads to get data to others

2018
- Hurricane Evacuation
- Supports emergency management
iPeMS Data Sets

- VDOT Detector Data (2010+)
- VDOT Incidents, construction, events and weather (2010+)
- Crash records (2010+)
  - Updated quarterly
- INRIX speeds and travel times (2015+)
- Waze incidents (2016+)
- VDOT Dynamic Message Signs (2015+)
- VDOT Streaming Video (live only)
Uses For the Data

Why have access to real-time and historical data and what can you do with it?

• Input into planning studies
• Reliability
• Event Management
• Before and after studies
• Legislatively required monitoring e.g. Congestion Monitoring Program / MAP-21
• Monitor the impact of a construction project
• Network-wide trend analysis
VDOT iPeMS Examples
Performance Data Reports

- Volume based measures and Delay
- AADT
- LOS
- Incident Top Segments
- Hotspots
- Lane Closure Analysis
- Incident Analysis
Incident Density
Hurricane Evacuation Tool in iPeMS

Key Features

- Look for volume anomalies on stations
- Anomaly is detected using comparison with historical monthly average volume
- Current flow versus historical average and range
Waze Data

What did we do with Waze data?

- Collected in real-time
- In maps and reports
- Uses user reliability filters
- Supports permissions
Waze Incidents / INRIX Speeds
## Route Comparison

### Route Performance

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### Route Report Card

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<th>Travel Time PM (min)</th>
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### Time Comparison

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- Comparing User defined routes over any path
- Using “Tags” feature of the reports was used to run the report for only the selected routes
Smarter Roads
Welcome to SmarterRoads, VDOT's open data portal.

Through SmarterRoads VDOT makes raw and processed transportation data available to approved users. This portal provides raw and processed data from VDOT and participating third parties. A variety of data is available including information on road conditions, incidents, work zones, and multi-modal transportation and road information like road signs. Signal data is also accessible to support the connected and automated vehicle industry, third party enterprises and the public. Data sets range from real-time and near real-time sensor streams, to annual data files. Become a registered data user and explore available data sets, then create a free account to get started as a consumer of a data provider.

About SmarterRoads

The data sets on this portal are all available to approved users. Create a free account to sign the required data sharing use agreement. Once approved, you will receive an email with login instructions. When you are logged into the SmarterRoads data portal, you can customize your settings to subscribe to specific data sets. Additional logins may be required for some data sets.
Example Data Sets

Available Datasets

- Controller Status
- Green Split
- Signal Phase and Timing
Example Data Sets

Available Datasets

- **Dynamic Message Signs (Active)**
  - Information on the location and the current active messages of all active Dynamic Message Signs (DMS) signs across the state.
  - **UPDATE RATE:** 1 Minute

- **Dynamic Message Signs (All)**
  - Locations and current messages of all Dynamic Message Signs (DMS) signs across the state, regardless of being active or not.
  - **UPDATE RATE:** 1 Minute

- **Signal Data: Detector Data**
  - Real-time detector measures for all local and system detectors.
  - **UPDATE RATE:** 1 Minute

- **Traffic Sensor Stations**
  - Data from Traffic Sensor Stations (TSS).
  - **UPDATE RATE:** 1 Minute

- **Travel Advisories & Closures**
  - Weekly lane closures and potential travel advisories based on information from VDOT’s 511 tools.
  - **UPDATE RATE:** 1 Minute

- **Truck Parking**
  - Parking information for trucks.
  - **UPDATE RATE:** 1 Minute

- **VDOT Incidents**
  - Information on VDOT incidents.
  - **UPDATE RATE:** 1 Minute

- **Weather Events (Long)**
  - Information on long-term weather events.
  - **UPDATE RATE:** 1 Minute

- **Weather Events (Short)**
  - Information on short-term weather events.
  - **UPDATE RATE:** 1 Minute

- **Weather**
  - • Long Events
  - • Long Defaults
  - • Short Events

- **DMS Active**
- **DMS All**
- **Signal Data: Detector**
- **Traffic Sensor Stations**
- **Travel Advisories & Closures**
- **Truck Parking**
- **VDOT Incidents**
- **Weather**
  - • Long Events
  - • Long Defaults
  - • Short Events
Thank You!

Questions?

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REAL-TIME TRAFFIC DATA AND PERFORMANCE ANALYTICS

Kelly Njord, PE, PTOE
Utah Department of Transportation
Real-Time Traffic Data and Performance Analytics

Kelly Njord, PE, PTOE
Statewide Traffic Performance Engineer
Utah Department of Transportation

4/17/2019
Big Data Collection

- Probe Data
- Sensor Data
- Historical Data
- Social Data
- Weather Data
- Camera Data
- Transit Data
iPeMS® Solution

iPeMS collects, analyzes, and visualizes Smart Transportation data in the cloud.
PeMS Modules

- Freeway Module
- AVC Module
- Third Party Data Module
- Events Module
- Managed Lanes Module
- Bluetooth Module
- Transit Module
- ATSPM
iPeMS Solution for UDOT

FEATURES

 ✓ Coverage
   ✓ Interstates, US and Utah primary highways, and additional TMC coded roadways
   ✓ Includes highly granular sub-TMC data
   ✓ Includes non-TMC coded DLR segments

 Map features
 ✓ A rich set of map features and roadway characteristics used to understand the underlying context of the traffic
   ✓ Variety of base maps and backgrounds including satellite and hybrid
   ✓ Includes distance markers, posted speed limits and more
iPeMS Solution for UDOT

Analytics tools

- Visualizations of speed, travel time and reliability measures
- Historical map animations, saving of map animation favorites
- Map based bottlenecks, top bottleneck report
- Reliability Map Index
- Incidents Layer
- Monthly and daily contours and spatial congestion reporting
- Data confidence layer in map and numbers in reports
- Variability in reports (mean/max/min, percentiles, +/− standard dev)
- APIs for integration with other systems in UDOT
Homepage

Select geography
Area-wide data
Detailed data

Real time map
Real Time Map: Anomalies

Anomalies, compared to speed percentiles

- Baseline for anomaly detection can be adjusted to different speed percentiles instead of average.
- The colors represent the difference in the current speed to the baseline for the current time period for each link over the last month. Green means the speed is faster than usual, red means it is slower than usual.
Real Time Map: Quality

- The quality layer shows percentage of high quality samples for different segments
Real Time Map: Coverage

Coverage

- Functional Classifications are provided by the probe data provider.
- These are plotted on the coverage layer.
- Refer to the legend in the lower right.
Bottlenecks represent a location with extended delay.

Bottlenecks can be filtered by:

- “Delay Per Vehicle” and
- “Queue Length”
Incidents Mapping

• HERE data contains a feed of incident data including:
  • Accident
  • Advisory
  • Breakdown
  • Closure
  • Congestion
  • Hazard/Debris
  • Police
  • Weather
  • Other

• Incident display may be adjusted using filters
Animation

- Animation tool allows playback of historical speeds and incidents for the entire network.
- Clicking on the animation icon makes animation toolbar to appear on the screen.
- This tool allows the user to go back in time, and look at the speed patterns at the desired zoom level.
- Users can see bottleneck formation, expansion and contraction on the animation.
- Incidents may also overlay on the animation.
- Animations can be saved for future viewing and sharing.
Weather Layer

- Iteris’s ClearPath feed includes high resolution weather maps and data
- Several weather layers are available in iPeMS for UDOT including:
  - **Real-Time**
    - Radar
    - Temperature
    - Visibility
    - Wind Speed
  - **Past**
    - Liquid Precipitation
    - Snow Accumulation
  - **Forecasted**
    - Liquid Precipitation
    - Snow Accumulation
    - Minimum Visibility
Routes in PeMS
Routes

“A user defined directional path between two points”

“Aggregation of data from multiple links”

Searching for Existing Routes

Creating New Routes

Area-wide Route Performance Report

Detailed Route Reports
Creating and saving a route

- PeMS has an intuitive yet powerful tool for creating routes
- User can click and select start point, end point and if necessary any number of waypoints to create and see the route
- Points can be adjusted by dragging and dropping the icons
- Routes can be given names, tags and description, and can be saved and shared
Detailed Route Reports

Aggregates Reports

Timeseries
- Shows variables over time

Time of Day
- Shows the averages over the time of day
- What is the typical speed at 7am?
- This plot is used to review typical weekday traffic patterns.

Day of Week
- Review the difference in performance between the days of the week
- How is a Monday’s performance different from a Wednesday?

Analysis Reports

Spatial Congestion
- Congestion along the length of the route

Contours
- Visual heat map of congestion in time and space
- Understand where and when congestion is occurring

Monthly Contours
- Same as Contour plots, except there is a plot for each day in a month.
- Review congestion trends across a month
- Visually review the route reliability

Congestion Cost Reports

User Delay Cost
- User delay cost, for passenger cars and trucks

Wasted Fuel Cost
- Wasted fuel cost due to congestion, for passenger cars and trucks, based on EPA models
Example: Holiday Traffic – Memorial Weekend

• "I-15 S: Utah County “ is an existing route in iPeMS
• Selected route is also displayed on the map
• Does Memorial Day Weekend change traffic pattern on this route? Let’s look at
  • Timeseries
  • Speed contour
  • Spatial congestion
Example: Holiday Traffic

- Select 5/24/2018 to 5/28/2018 period
- Set granularity to 5 minutes
- Select Average Travel Time for quantity
- Notice the spike in travel time during Friday PM hours?
- Use the mouse to zoom on the spike
- Travel times during 6:00 to 7:30 pm on this 43 mile route have climbed to nearly two hours
Example: Holiday Traffic Daily Contour

- Select Contours from the Performance>Analysis menu
- Create contour for noon to 10 PM
- The first four miles of the road have been heavily congested from 2:30 to 7:30 pm
- Portion of the road from exit 271 to exit 263 has been congested from 6 to 8 pm, the highest speed reductions have occurred between hours of 6:15 to 7 pm
Example: Holiday Traffic Monthly Contour

May 2018

- The monthly contour report shows a thumbnail of daily contours for the entire month.
- This report shows that travel patterns of the Memorial Weekend Friday are different from other days.
- Clicking on each thumbnail shows full contour plot for the selected day.
Sample Analysis

Bottleneck Identification and Ranking
Bottleneck Definition

• Bottlenecks are defined as locations where there is a temporary or permanent drop in capacity compared to adjacent downstream locations. The bottleneck head is the point downstream of which road capacity increases and traffic again flows freely.

• The bottleneck queue is the section of roadway upstream of the bottleneck head along which traffic is moving slowly (or is stopped) due to the reduced capacity at the bottleneck head.

• In iPeMS, a bottleneck is marked as sustained if it was detected during at least 5 out of 7 continuous 5-minute time periods.
Bottleneck Detection

- The iPeMS third-party bottleneck algorithm is highly unique in that it can detect multiple ‘branches’ of the same bottleneck and sum up their delay values.
- Bottlenecks are displayed on the iPeMS Real-time map, as an overlay on any of the other layers.
- The bottlenecks also work with the iPeMS Animation feature, making it possible to visualize how bottlenecks grow and shrink over time in different locations in the network.
- iPeMS also has a third-party Top Bottlenecks report, which lets users query over date and time parameters to see a table of all of the bottlenecks in a selected region.
Top Bottlenecks Report

- Select time period
- Specify your query
- Choose bottleneck type
- Fine tune the query
## Top Bottlenecks Report

- **Report can be sorted on**
  - Roadway Type
  - Time Period
  - Days Active
  - Average Max Queue (mi)
  - Max Queue (mi)
  - Average Max Delay (min/veh)
  - Max Delay (min/veh)
  - Average Duration (min)
  - Max Duration (min)

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</tbody>
</table>
Example: Top Bottlenecks Report for May 2018

- Select 5/1/2018 to 5/29/2019
- Let's find some major bottlenecks
  - Set Average Max Queue >= 2 miles
  - Set Average Max Delay >= 10 mins/veh
  - Set Average Duration >= 20 mins
- Click on VIEW TABLE
- Sort the report by ‘Days Active’
- Click on the Head Node of the top bottleneck on the list, to see its location on the map
I-15 Spatial AADT

- Each red bar shows 2018 AADT on corresponding portion of I-15.
- This visualization is produced using tools in Freeway iPeMS.
- Max AADT is on the I-15 and I-215 junction.
- The data correlates with the top bottlenecks of the 3rd Party Report.
Top Bottlenecks Report and Spatial AADT Report
Travel Time Reliability

Reliability Index Map
Reliability Index Map

- A map layer to visualize a combination of travel time reliability measures
- UDOT uses a combination of Travel Time Index (TTI) and Buffer Time Index (BTI)
Reliability Index Map

• A color coded map based on a combination of Travel Time Index (TTI) and Buffer Time Index (BTI) values

• Month, year and time periods can be selected from boxes on the screen

• Clicking on a link shows corresponding TTI and BTI values
Benefits of Reliability Index Map

• Reduce labor to produce reliability reports
• Visualize reliability over more hours of the day, and months of the year
• Compare changes in reliability due to major events that affect capacity (i.e. construction projects, long term road closure) for before and after studies
• Customizable based on UDOT’s needs
• Values for reliability measures for each segment can be revealed by clicking on the map, or imported to other applications using APIs
Thank You!
GUIDING USERS FURTHER

Scott Perley
Iteris
Overview

What's Next? Multimodal More data
What’s Next
What’s Next

• Answering why

• Improving Reliability Models
  \[ \log(LOTTR - 1) = \beta_1 + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \beta_5 X_{i5} + \beta_6 X_{i6} + \beta_7 X_{i7} + \varepsilon_1 \]

• Dynamically answer congestion causes
Multimodal

Segment: I-75 (N)
(TUE 9/25/2018 TO THU 10/25/2018)

Average Speed (Passenger): 9.6 MPH
Average Speed (Truck): 8.2 MPH

Left click and drag to zoom.
Left click to view the map.

CV
Fleet
Transit
Pedestrian
Thank You!
Question & Answers

Denise Markow, I-95 Corridor Coalition
Wrap Up

Denise Markow, I-95 Corridor Coalition
In Closing…

Thank you for joining today

For Additional Information, please contact:

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