Modeling for Performance-Based Planning Measures

presented to
NCMUG

presented by
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11/8/2017
Presentation Outline

- Overview of Performance-Based Planning Requirements
- System Performance/Freight/CMAQ (PM3) Data and Measures
- Implications for Travel Modeling
- Examples
- Challenges and Opportunities
Overview of Performance-Based Planning Requirements
Two Laws, Many Regulations

Moving Ahead for Progress in the 21st Century Act (MAP-21)

Fixing America’s Surface Transportation (FAST) Act

Statewide and Metropolitan Planning

Metropolitan Planning Organization (MPO) Coordination and Planning Area Reform

Public Transit Safety

Transit Asset Management

Highway Safety

National Highway System (NHS) Pavement and Bridge

Performance of the NHS, Freight Movement on the Interstate System, and CMAQ Program
### Performance-Based Planning Requirements from New Rulemaking

#### HSIP & Safety Performance Mgmt. – Effective 4/14/16

<table>
<thead>
<tr>
<th>Highway Safety</th>
<th>Number of fatalities</th>
<th>Rate of fatalities per 100 million VMT</th>
<th>Number of serious injuries</th>
<th>Rate of serious injuries per 100 million VMT</th>
<th>Number of non-motorized fatalities and non-motorized serious injuries</th>
</tr>
</thead>
</table>

#### Public Transit Safety Program – Effective 9/12/16

<table>
<thead>
<tr>
<th>Public Transportation Safety</th>
<th>Total number of reportable fatalities and rate per total vehicle revenue miles by mode</th>
<th>Total number of reportable injuries and rate per total vehicle revenue miles by mode</th>
<th>Mean distance between major mechanical failures by mode</th>
<th></th>
</tr>
</thead>
</table>
## Performance-Based Planning Requirements from New Rulemaking

### Transit Asset Management – Effective 10/1/16

<table>
<thead>
<tr>
<th>Transit Asset Management</th>
<th>Percentage of non-revenue service vehicles that have either met or exceeded their useful life benchmark</th>
<th>Percentage of revenue vehicles within a particular asset class that have either met or exceeded their useful life benchmark</th>
<th>Percentage of track segments with performance restrictions</th>
<th>Percentage of facilities within an asset class, rated below condition 3 on the TERM scale</th>
</tr>
</thead>
</table>

### Pavement & Bridge Condition Performance – 5/20/17

<table>
<thead>
<tr>
<th>Pavement</th>
<th>Percentage of pavements of the Interstate system in good condition</th>
<th>Percentage of pavements of the Interstate system in poor condition</th>
<th>Percentage of pavements of the non-Interstate NHS in good condition</th>
<th>Percentage of pavements of the non-Interstate NHS in poor condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge</td>
<td>Percentage of NHS bridges in good condition</td>
<td>Percentage of NHS bridges in poor condition</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Performance-Based Planning Requirements from New Rulemaking

### Sys. Perf./Freight/CMAQ Measures (PM3) – Eff. 5/20/17

<table>
<thead>
<tr>
<th>System Performance</th>
<th>Percent of the person-miles traveled on the Interstate that are reliable</th>
<th>Percent of the person-miles traveled on the non-Interstate NHS that are reliable</th>
<th>*Percent change in the tailpipe CO2 emissions on the NHS compared to the calendar year 2017 level (*indefinitely delayed)</th>
<th>Freight</th>
<th>Truck travel time reliability index on Interstate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freight</td>
<td></td>
<td></td>
<td></td>
<td>---</td>
<td>---------------------------------------------------------------------</td>
</tr>
<tr>
<td>CMAQ</td>
<td>Annual hours of peak hour excessive delay per capita</td>
<td>Percent of non-single occupancy vehicle travel</td>
<td>Total emissions reduction</td>
<td>---</td>
<td>---------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

**Note:** *indefinitely delayed*
System Performance/Freight/CMAQ (PM3) Performance Measures Final Rule

INPUT DATA
- Total Population
- Fuel sales data
- NPMRDS
- HPMS
- FHWA CO2 Emission Factors
- Vehicle classification
- FHWA occupancy factors
- Segment lengths
- American Community Survey
- CMAQ Public Access System

4-year performance period – results reflected in LRTP policies and strategies

Set System Performance Targets (May 20, 2018) (MPOs: 180 days after State)

Submit Baseline Performance Report (October 1, 2018)

Submit Mid-Performance Period Progress Report (October 1, 2020)

Submit Full-Performance Period Progress Report (October 1, 2022)

System Performance
1. GHG Measure*
2. Travel Time Reliability Measures

Freight Performance
3. Truck Travel Time Reliability Index

CMAQ Performance
4. PHED Measure
5. Percent of Non-SOV
6. Total Emissions Reduction

Report on condition/performance and progress towards achieving targets; may adjust 4-year targets at this time.

in LRTP, MTP, STIP, and TIP (May 20, 2019)

System Performance Report (in LRTP update)
PM3 Measures and Data
Four out of the six PM3 measures are travel time-based

- National Highway Performance Program System Performance (Reliability)
  - Percent of Person Miles Traveled on the Interstate that are reliable
  - Percent of Person Miles Traveled on the Non-Interstate NHS that are reliable

- Freight (Reliability)
  - Truck Travel Time Reliability (TTTR) Index

- CMAQ Traffic Congestion (Peak Hour Excessive Delay)
  - Annual (Person) Hours of Peak Hour Excessive Delay Per Capita

These measures require the use of travel times from the NPMRDS or equivalent

Source: FHWA
Travel Time Reliability

Measures
- Percent of the person-miles traveled on the Interstate that are reliable
- Percent of the person-miles traveled on the non-Interstate NHS that are reliable

Metric
- Level of Travel Time Reliability (LOTTR) based on all-vehicle travel time

Threshold
- LOTTR = 1.5

Time Periods
- Weekdays: 6 am – 10 am
- Weekdays: 10 am – 4 pm
- Weekdays: 4 pm – 8 pm
- Weekends: 6 am – 8 pm

Source: FHWA
Travel Time Reliability Data

- Travel times of all traffic (NPMRDS)
- Length of segments (NPMRDS)
- Average vehicle occupancy (FHWA)
- Annual traffic volume data (NPMRDS 2.0 via HPMS conflation)

Source: FHWA
National Performance Management Research Data Set (NPMRDS)

- Data set provided by FHWA monthly to State DOTs and MPOs
- Includes travel times derived from all traffic using the highway system, in 5-minute bins
- Includes a breakdown of travel times of freight vehicles and all traffic (freight and passenger vehicles)
- Uses travel times that are reported via vehicle probes on contiguous segments of roadway covering the entire mainline NHS
- Uses vehicle probes that could include mobile phones, vehicle transponders, and portable navigation devices

Source: FHWA
## NPMRDS

### NPMRDS V1.0: Jul. 2013 – Jan. 2017

### NPMRDS V2.0: Feb. 2017 – Dec. 2022

<table>
<thead>
<tr>
<th>NPMRDS V1.0</th>
<th>NPMRDS V2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only contains observed data</td>
<td>Observed data + additional data cleaning</td>
</tr>
<tr>
<td>Doesn’t report data if data doesn’t exist</td>
<td>Null records if data does not exist</td>
</tr>
<tr>
<td>External and internal segments combined</td>
<td>Inner and outer TMC segments are available</td>
</tr>
<tr>
<td>No data density indicator</td>
<td>Data density indicator</td>
</tr>
<tr>
<td>No HPMS conflation</td>
<td>HPMS conflation - 15 data items</td>
</tr>
</tbody>
</table>

Source: FHWA
Truck Travel Time Reliability

Measure
» Truck Travel Time Reliability Index

Metric
» Truck Travel Time Reliability: 95th Percentile/50th Percentile Truck Travel Time
  ▪ Substitute “All Vehicle” travel time when truck travel time is missing

Threshold
» N/A

Time Periods
» Weekdays: 6 am – 10 am
» Weekdays: 10 am – 4 pm
» Weekdays: 4 pm – 8 pm
» Weekend: 6 am – 8 pm
» Overnight: 8 pm – 6 am

Source: FHWA
Truck Travel Time Reliability Index

\[
TTTR \text{ Index} = \frac{\sum (\text{segment length weighted } TTTR)}{\sum (\text{segment length})}
\]

\[
TTTR \text{ Index} = \frac{3.05}{2.00} = 1.52
\]

Source: FHWA
Truck Travel Time Reliability Data

- Travel times of trucks (NPMRDS)
- Length of segments (NPMRDS)

Source: FHWA
Peak Hour Excessive Delay (PHED)

Measure
» Annual Hours of Peak Hour Excessive Delay Per Capita

Metric
» Annual Hours of Peak Hour Excessive Delay

Threshold
» N/A

Time Periods
» Weekdays: 6 am – 10 am
» Weekdays: 3 pm – 7 pm OR 4 pm – 8 pm

Source: FHWA
PHED Segment-Level Calculation

- For each 15-minute period
  - Calculate the difference between the measured travel time and the delay threshold travel time
    - Delay threshold: 20 mph or 60% of speed limit, whichever is greater
  - Multiply travel time delay by number of people traveling during that 15-minute period
- Sum up delay over all peak periods in the year

Source: FHWA
PHED Data

- Travel times of all traffic (NPMRDS)
- Length of segments (NPMRDS)
- Annual vehicle classification data (NPMRDS 2.0 via HPMS)
- Annual vehicle occupancy factors (FHWA)
- Hourly volume estimation
- Posted speed limit
- Urbanized Area Population

Source: FHWA
Implications for Travel Modeling
Implications for Now

- Travel modelers may already be familiar with the data sources
- Extension of network and other analyses to compile measures
- Modeling tools and scripts can potentially be adapted to support process automation
Implications for Now

More Data Options

- NPMRDS
- HERE
- INRIX
- TomTom
- Bluetooth & Other

New Applications

- Growth through sharing of resources, technologies, and data
Implications for the Future

- Greater emphasis on the PM3 performance measures in project development, prioritization, and selection for programming.

- Travel modelers will be asked to evaluate the potential benefits of projects (or project alternatives) in moving the performance measures.

- Regional mode share may not be easy to impact with individual projects.

- Forecasting travel time and travel time reliability is an emerging practice area.

- Timelines will require speedy advancement in ability to report on travel time and reliability implications.
Examples

- Virginia Transportation Performance Measures
- SHRP2 C11 Post-Processor to the Travel Demand Model (Florida and Maryland)
- Albany Visualization and Informatics Lab Tools
Measuring Performance in Virginia

National emphasis on performance-based planning
» Now required by state code and federal legislation

Key steps
» Establish key objectives that will be measured
» Establish baseline conditions
» Evaluate recent trends
» Establish process for setting targets and measuring progress
### Annual Performance Report

**VTrans2040 Goals / Objectives / Measures**

<table>
<thead>
<tr>
<th>GOAL / OBJECTIVE</th>
<th>MEASURE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VTrans Goal: Economic Competitiveness and Prosperity</strong></td>
<td></td>
</tr>
<tr>
<td>A.1</td>
<td>Percent peak hour VMT occurring in congested conditions.</td>
</tr>
<tr>
<td>A.2</td>
<td>Number of highway bottlenecks with daily freight ton hours of delay per mile &gt; 250,000.</td>
</tr>
<tr>
<td>A.3</td>
<td>Roadway Buffer Time Index (BTI).</td>
</tr>
<tr>
<td>A.3</td>
<td>Rail/Transit On-Time Performance (OTP).</td>
</tr>
<tr>
<td><strong>VTrans Goal: Accessible and Connected Places</strong></td>
<td></td>
</tr>
<tr>
<td>B.1</td>
<td>Average commute time by metropolitan area.</td>
</tr>
<tr>
<td>B.2</td>
<td>Average trip length by metropolitan area.</td>
</tr>
<tr>
<td>B.3</td>
<td>Number of jobs within 45 minutes of an average household within a metropolitan area by mode.</td>
</tr>
<tr>
<td><strong>VTrans Goal: Safety for All Users</strong></td>
<td></td>
</tr>
<tr>
<td>C.1</td>
<td>Total number of motorized fatalities and severe injuries.</td>
</tr>
<tr>
<td>C.1</td>
<td>Number of motorized fatalities and severe injuries per 100 million vehicle miles.</td>
</tr>
<tr>
<td>C.2</td>
<td>Total non-motorized fatalities and severe injuries.</td>
</tr>
<tr>
<td><strong>VTrans Goal: Proactive System Management</strong></td>
<td></td>
</tr>
<tr>
<td>D.1</td>
<td>Percent of bridge area rated as structurally deficient.</td>
</tr>
<tr>
<td>D.2</td>
<td>Percent of lane miles of pavement in fair or better condition.</td>
</tr>
<tr>
<td>D.3</td>
<td>Percent of transit fleet under recommended maximum age.</td>
</tr>
<tr>
<td><strong>VTrans Goal: Healthy Communities and Sustainable Transportation Communities</strong></td>
<td></td>
</tr>
<tr>
<td>E.1</td>
<td>Vehicle miles traveled (VMT) per capita.</td>
</tr>
<tr>
<td>E.2</td>
<td>Annual emissions of NOX, VOC, PM, and CO2 in tons.</td>
</tr>
<tr>
<td>E.3</td>
<td>Estimated active transportation (bicycling and walking) trips.</td>
</tr>
</tbody>
</table>
## Virginia Annual Performance Report
Comparison to MAP-21/FAST Act Rulemakings

<table>
<thead>
<tr>
<th>Rulemaking Status</th>
<th>National Highway System Performance</th>
<th>VA Performance Report Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program.</td>
<td>These metrics are not reported but related metrics are reported:</td>
</tr>
<tr>
<td>Performance Measures</td>
<td>1. Percent person-miles traveled on the Interstate System that are reliable</td>
<td>- Percent peak hour VMT occurring in congested conditions (Objective A1)</td>
</tr>
<tr>
<td></td>
<td>2. Percent person-miles traveled on the Non-Interstate NHS that are reliable</td>
<td>- Roadway Buffer Time Index (Objective A3)</td>
</tr>
<tr>
<td></td>
<td>3. Percent Interstate System mileage providing for reliable truck travel times</td>
<td>- Number of highway bottlenecks with daily freight ton hours of delay per mile &gt; 250,000 (Objective A2)</td>
</tr>
<tr>
<td></td>
<td>4. Annual hours of peak-hour excessive delay per capita</td>
<td>- Average peak period travel time in metropolitan areas (Objective B1)</td>
</tr>
</tbody>
</table>

- Consistent with MAP-21 measure
- Representative of MAP-21 measure
- MAP-21 measure not included
Virginia Data Sources

Traffic and speed
- VDOT’s Traffic Monitoring System (TMS), INRIX

Commuting time and trip length
- American Community Survey (ACS)
- StreetLight data

Freight
- IHS Transearch

Mode share and demographic characteristics.
- American Community Survey (ACS), National Household Travel Survey (NHTS).
Example: A.1: Reduce the amount of travel that takes place in severe congestion

Percent peak hour VMT occurring in congested conditions.

- **Statewide – By Roadway Type**
  - 2012: Interstate 2.5%, Non-Interstate 1.0%
  - 2013: Interstate 2.0%, Non-Interstate 1.3%
  - 2014: Interstate 2.4%, Non-Interstate 1.5%

- **Northern Virginia – By Roadway Type**
  - 2012: Interstate 18.4%, Non-Interstate 4.7%
  - 2013: Interstate 14.7%, Non-Interstate 5.7%
  - 2014: Interstate 18.5%, Non-Interstate 7.0%
Example: A.2: Reduce the number and severity of freight bottlenecks

Number of highway bottlenecks with daily freight ton hours of delay per mile > 250,000.
Example: A.2: Reduce the number and severity of freight bottlenecks

Peak hour delay changes at 37 bottleneck locations.
Example: B.1: Reduce average peak-period travel times in metropolitan areas

Average commute time by metropolitan area.
Example: B.1: Reduce average peak-period travel times in metropolitan areas

Average commute time by metropolitan area.
Example: E.1 Reduce per-capita vehicle miles traveled

Vehicle miles traveled (VMT) per capita.
SHRP2 C11 Post-Processor to the Travel Demand Model


Florida DOT funded a project to implement *Travel Time Reliability* tools developed under the Strategic Highway Research Program 2 (SHRP2)

One of these was the SHRP2 Project C11 tool, a sketch planning tool for studying reliability impacts and costs for individual projects.

The tool is being updated and extended to work with a travel demand forecasting model.
Background

- Test case is Hillsborough County (Tampa)
- Team developed an analysis procedure to work with the loaded network file from the Tampa Bay Regional Planning Model
  - Allows the consideration of Operations and Safety projects to address deficiencies
  - Produces reliability and crash-related performance measures
  - Safety prediction was added because of the high interest for the LRTP update
- Analysis incorporated into Imagine 2040
Background

- Developed user-grade tool for the SHRP2 C11 sketch planning TDM post-processor; updated relationships
- Adopted new *Highway Capacity Manual* reliability procedure
- Added reliability and operations considerations to FDOT planning and project programming
Basic Structure

- Crash Data
- TBRPM Loaded Network

By Link

Safety Analysis
Reliability Analysis

Corridor Analysis

Safety Project List
Operations Project List

SHRP 2 C11
Reliability Prediction
HERS Model
Impact Factors
TOPS-BC
O&M Costs

HSM
SPFs
FHWA Desk
Reference
CRFs
Costs
Freeway Relationship
Arterial Relationship
## Reliability Results

### Safety and Reliability TDM Model

**Scenario:** I-4 Base  
**Reliability Scenario:** Reliability I-4 Base  
**Time period:** PM  
**Operations Budget Cap:** Unlimited

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Functional Class</th>
<th>Length</th>
<th>TTI Median</th>
<th>TTI Mean</th>
<th>TTI Pctile80</th>
<th>TTI Pctile95</th>
<th>Delay</th>
<th>Vmt</th>
<th>Vht</th>
<th>Space Mean Speed</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-4 (Hillsborough Co): FROM I-275 TO I-75</td>
<td>Freeway</td>
<td>8.043</td>
<td>1.539</td>
<td>1.887</td>
<td>2.376</td>
<td>3.795</td>
<td>2.361</td>
<td>159,678</td>
<td>46</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>I-4 (Hillsborough Co): FROM I-75 TO Hillsborough / Polk County Line</td>
<td>Freeway</td>
<td>18.052</td>
<td>2.219</td>
<td>2.747</td>
<td>3.845</td>
<td>6.09</td>
<td>8.588</td>
<td>294,945</td>
<td>37</td>
<td>$0</td>
<td></td>
</tr>
</tbody>
</table>

Showing 1 to 2 of 2 entries

### Summary by Functional Class

<table>
<thead>
<tr>
<th>Functional Class</th>
<th>Length</th>
<th>TTI Median</th>
<th>TTI Mean</th>
<th>TTI Pctile80</th>
<th>TTI Pctile95</th>
<th>Delay</th>
<th>Vmt</th>
<th>Vht</th>
<th>Space Mean Speed</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeway</td>
<td>26.095</td>
<td>1.98</td>
<td>2.445</td>
<td>3.329</td>
<td>5.284</td>
<td>10,949</td>
<td>454,623.0</td>
<td>41</td>
<td>$0</td>
<td></td>
</tr>
</tbody>
</table>
Albany Visualization and Informatics Lab Tools
Service Centers for PM3

Example of Albany Visualization and Informatics Lab (AVAIL)

PM3 Reporting and Analysis

» Multi-geographic: PM3 measures by state, MPO, county, and urbanized area or by TMC, route, and corridor

» Multi-temporal: View Measures by year, month, and day.

» Fast Loading Times: PM3 measures for the entire state load in under 1 second.
AVAIL Example Dashboards
AVAIL Use Cases

» Pinpoint Analysis of PM3 Measures
  » Discover which TMCs are contributing negatively to performance scores.

» Track PM3 Progress
  » Month over month and year over year analysis.

» Easy to Use Visualization and Analysis Tools
  » Default Templates for quick and easy analysis as well as highly customizable features for more in-depth analyses.

» Publish Reports Directly to the Web
AVAIL Example Graphics
## AVAIL Example Tabulations

![Performance Measures /NY/ MPOs](image)

### Table: Performance Measures for NY MPOs

<table>
<thead>
<tr>
<th>Geography Info</th>
<th>Travel Time Reliability (%)</th>
<th>Freight Reliability</th>
<th>Mileage Uncongested (%)</th>
<th>Hours of Excessive Delay (veh-mi)</th>
<th>Miles of TIMCs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Interstate</td>
<td>Non-Interstate</td>
<td>Interstate</td>
<td>Non-Interstate</td>
<td>Interstate</td>
</tr>
<tr>
<td>A/GFCT</td>
<td>100</td>
<td>75.4</td>
<td>1.202</td>
<td>4.901</td>
<td>100</td>
</tr>
<tr>
<td>Berkshire MPO</td>
<td>100</td>
<td>160</td>
<td>1.62</td>
<td>100</td>
<td>17</td>
</tr>
<tr>
<td>BMTS</td>
<td>100</td>
<td>85.6</td>
<td>1.195</td>
<td>3.324</td>
<td>98.4</td>
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<tr>
<td>COTC</td>
<td>93.7</td>
<td>74.7</td>
<td>1.125</td>
<td>2.967</td>
<td>98.1</td>
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<tr>
<td>ECTR</td>
<td>100</td>
<td>98.7</td>
<td>1.15</td>
<td>1.587</td>
<td>96.4</td>
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<tr>
<td>GBNRTC</td>
<td>94.9</td>
<td>80.5</td>
<td>1.424</td>
<td>2.787</td>
<td>95.2</td>
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<td>GTC</td>
<td>95.3</td>
<td>81.3</td>
<td>1.281</td>
<td>2.362</td>
<td>97.1</td>
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<tr>
<td>HOCTS</td>
<td>100</td>
<td>89.7</td>
<td>1.094</td>
<td>2.223</td>
<td>100</td>
</tr>
<tr>
<td>ITCTC</td>
<td>84.6</td>
<td>84.6</td>
<td>1.809</td>
<td>15.3</td>
<td>100</td>
</tr>
<tr>
<td>Kingston MPO</td>
<td>100</td>
<td>90.8</td>
<td>1.113</td>
<td>1.851</td>
<td>97</td>
</tr>
<tr>
<td>RJTPA</td>
<td>91.3</td>
<td>91.3</td>
<td>1.144</td>
<td>2.223</td>
<td>0</td>
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<tr>
<td>ROCCT</td>
<td>100</td>
<td>76</td>
<td>1.058</td>
<td>5.456</td>
<td>99.2</td>
</tr>
<tr>
<td>RMRTC</td>
<td>53.7</td>
<td>64.7</td>
<td>2.451</td>
<td>2.646</td>
<td>68.2</td>
</tr>
<tr>
<td>PDCTC</td>
<td>100</td>
<td>91</td>
<td>1.191</td>
<td>2.309</td>
<td>98.1</td>
</tr>
<tr>
<td>SMTC</td>
<td>100</td>
<td>71.8</td>
<td>1.265</td>
<td>2.563</td>
<td>98.6</td>
</tr>
<tr>
<td>South Western</td>
<td>100</td>
<td>61.0</td>
<td>1.157</td>
<td>1.627</td>
<td>187</td>
</tr>
</tbody>
</table>
AVAIL Example Graphics
Challenges and Opportunities
Variability by Data Source

Source: Comparing Arterial Speeds from “Big-Data” Sources in Southeast Florida (Bluetooth, HERE and INRIX); TRB National Transportation Planning Applications Conference (Atlantic City, NJ)
NPMRDS Coverage

Source: FHWA
Challenge: “Getting the data into the model”

Attach TMC from NPMRDS speed data to highway network links using count station lookup, or spatial join between highway network and NHS network shape file.

Only NHS links close to highway count station (50 feet) with 24-hour counts and Highway network links close to NHS links with valid speed data (200 feet) would be considered.

65% links are joined with TMC based on shared LINK_ID between Master network and NHS network.

Others are joined based on the spatial relationship between NHS and latest highway network.
Observed vs Model Speeds

Source: “Traffic Assignment and Feedback Research to Support Improved Travel Forecasting”; FTA: Office of Planning and Environment, July 2015
Observed vs Model Speeds

Source: "Traffic Assignment and Feedback Research to Support Improved Travel Forecasting"; FTA: Office of Planning and Environment, July 2015
Observed vs Model Speeds

Table 8-4 Comparison of NCTCOG AM Modeled and HERE TMC VHT and Speeds

<table>
<thead>
<tr>
<th>Category</th>
<th>Observations</th>
<th>HERE VHT</th>
<th>Model VHT</th>
<th>VHT %RMSE</th>
<th>VHT %Difference</th>
<th>HERE AVG SPEED</th>
<th>MODEL AVG SPEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCTCOG All TMC</td>
<td>9739</td>
<td>567,576</td>
<td>620,774</td>
<td>74.83</td>
<td>9.37</td>
<td>41.28</td>
<td>37.92</td>
</tr>
<tr>
<td>Freeway 65mph</td>
<td>329</td>
<td>31,599</td>
<td>36,697</td>
<td>63.47</td>
<td>16.13</td>
<td>62.74</td>
<td>55.77</td>
</tr>
<tr>
<td>Expressway 60mph</td>
<td>391</td>
<td>50,319</td>
<td>62,713</td>
<td>71.44</td>
<td>24.63</td>
<td>49.20</td>
<td>41.43</td>
</tr>
<tr>
<td>Arterial 40mph no Int Delay</td>
<td>104</td>
<td>1,549</td>
<td>1,635</td>
<td>66.18</td>
<td>5.53</td>
<td>31.04</td>
<td>33.43</td>
</tr>
<tr>
<td>Arterial 40mph with Delay</td>
<td>304</td>
<td>9,702</td>
<td>11,423</td>
<td>154.48</td>
<td>17.74</td>
<td>27.16</td>
<td>27.00</td>
</tr>
<tr>
<td>NCTCOG All Filtered</td>
<td>1128</td>
<td>93,168</td>
<td>112,468</td>
<td>82.81</td>
<td>20.71</td>
<td>51.17</td>
<td>44.29</td>
</tr>
</tbody>
</table>

Source: “Traffic Assignment and Feedback Research to Support Improved Travel Forecasting”; FTA: Office of Planning and Environment, July 2015
Opportunities

- Improve Volume Delay Functions (VDFs)
  - Select the right functional form of VDF
  - Develop more accurate “free-flow” speeds

- Improve speed “forecasts” (e.g., post-processors)

- Integrate with Dynamic Traffic Assignment (DTA) models

- Maintain relevance to project development, planning, and programming decisions
Closing
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