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Think Forward

Modeling for Performance-Based Planning Measures

presented to

NCMUG

11/8/2017

presented by

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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

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Two Laws, Many Regulations

Moving Ahead for Progress in the 21stCentury 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

Highway Safety	Number of fatalities	Rate of fatalities per 100 million VMT	Number of serious injuries	Rate of serious injuries per 100 million VMT	Number of non-motorized fatalities and non-motorized serious injuries

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

Public Transportation Safety	Total number of reportable fatalities and rate per total vehicle revenue miles by mode	Total number of reportable injuries and rate per total vehicle revenue miles by mode	Mean distance between major mechanical failures by mode		

Performance-Based Planning Requirements from New Rulemaking

Transit Asset Management – Effective 10/1/16)

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

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

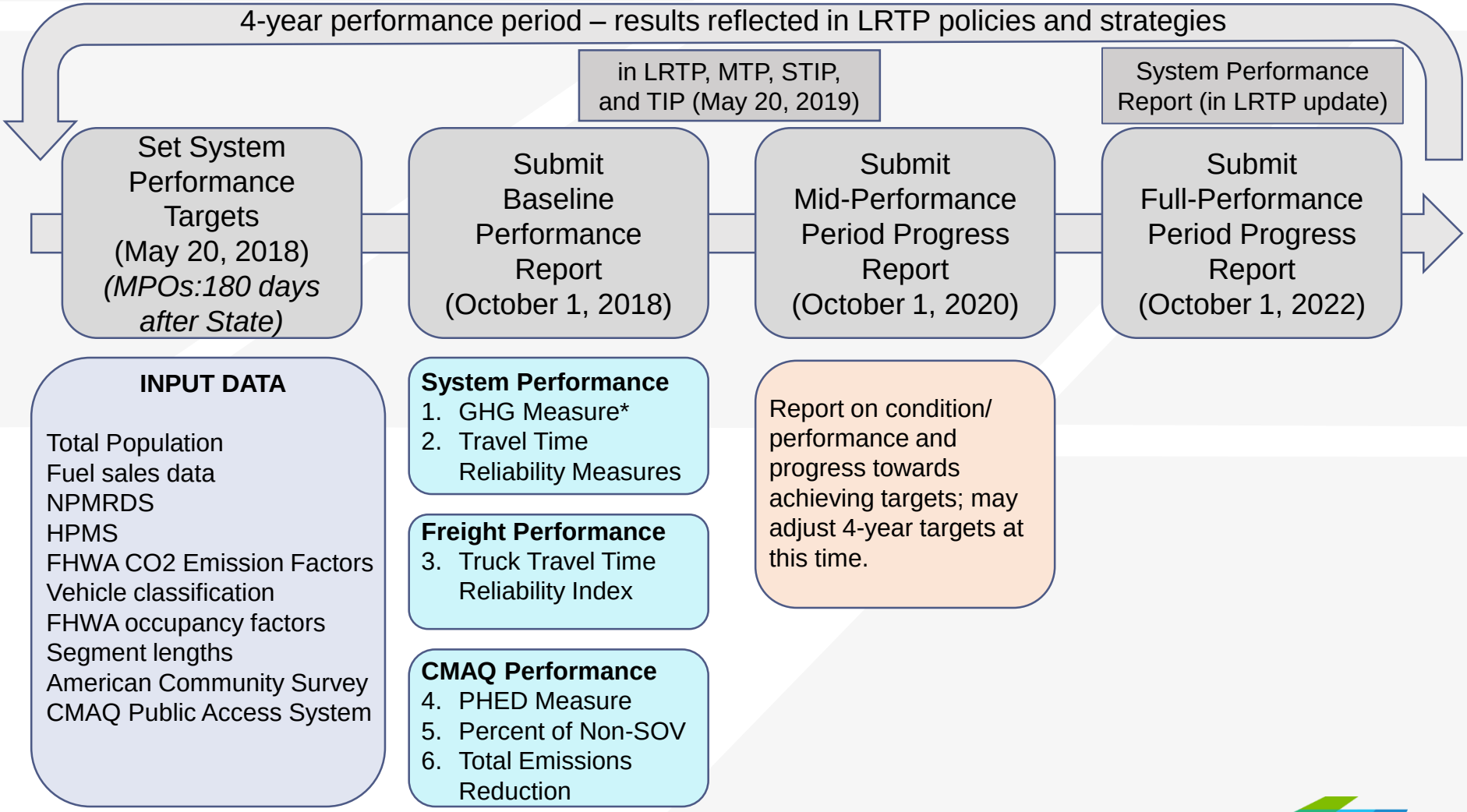
Pavement	Percentage of pavements of the Interstate system in good condition	Percentage of pavements of the Interstate system in poor condition	Percentage of pavements of the non-Interstate NHS in good condition	Percentage of pavements of the non-Interstate NHS in poor condition	
Bridge	Percentage of NHS bridges in good condition	Percentage of NHS bridges in poor condition			

Performance-Based Planning Requirements from New Rulemaking

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

System Performance	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	*Percent change in the tailpipe CO2 emissions on the NHS compared to the calendar year 2017 level (*indefinitely delayed)		
Freight	Truck travel time reliability index on Interstate				
CMAQ	Annual hours of peak hour excessive delay per capita	Percent of non-single occupancy vehicle travel	Total emissions reduction		

System Performance/Freight/CMAQ (PM3) Performance Measures Final Rule



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PM3 Measures and Data

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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

$$LOTTR = \frac{80th\ percentile\ (longer\ travel\ time)}{50th\ percentile\ (normal\ travel\ time)}$$

- 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

NPMRDS V1.0	NPMRDS V2.0
Only contains observed data	Observed data + additional data cleaning
Doesn't report data if data doesn't exist	Null records if data does not exist
External and internal segments combined	Inner and outer TMC segments are available
No data density indicator	Data density indicator
No HPMS conflation	HPMS conflation - 15 data items

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

$$TTTR = \frac{95th\ percentile\ (longer\ truck\ travel\ time)}{50th\ percentile\ (normal\ truck\ travel\ time)}$$

- 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

$$TTTR\ Index = \frac{\sum(segment\ length\ weighted\ TTTR)}{\sum((segment\ length)}$$

$$TTTR\ Index = \frac{3.05}{2.00} = 1.52$$

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

Virginia Transportation Performance Measure Example

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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

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

Virginia Annual Performance Report
Comparison to MAP-21/FAST Act Rulemakings

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

Consistent with MAP-21 measure

Representative of MAP-21 measure

MAP-21 measure not included

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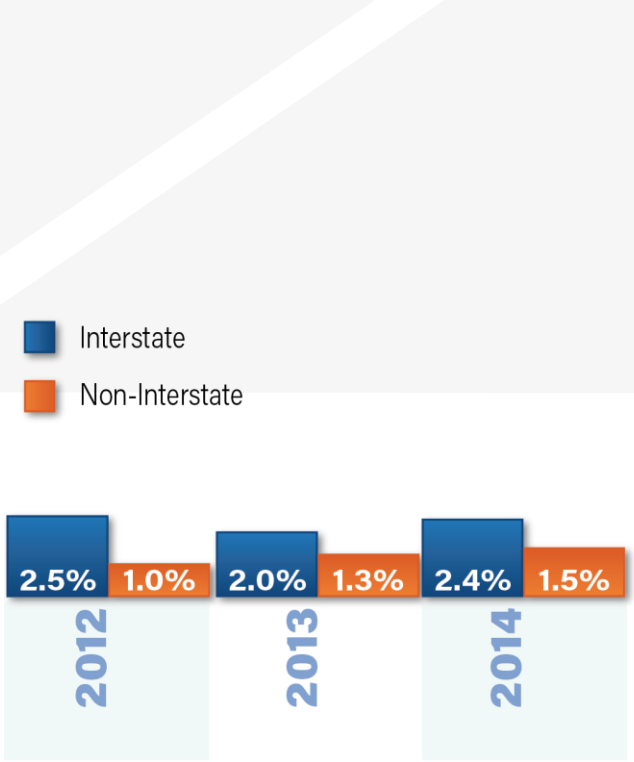
Virginia Data Sources

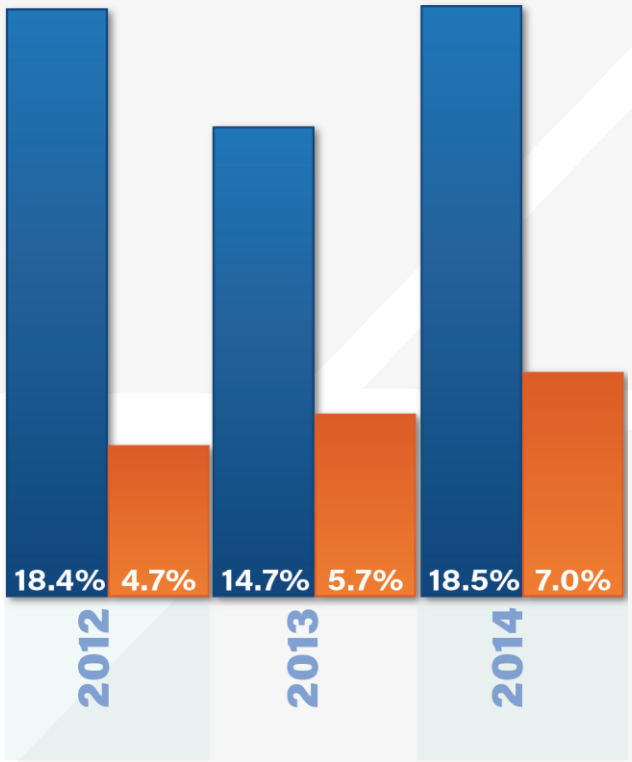
- Traffic and speed
  - VDOT's Traffic Monitoring System (TMS), INRIX
- Commuting time and trip length
  - American Community Survey (ACS)
  - StreetLight data
- Freight
  - IHS Transearch
- Mode share and demographic characteristics.
  - American Community Survey (ACS), National Household Travel Survey (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



Northern Virginia – By Roadway Type

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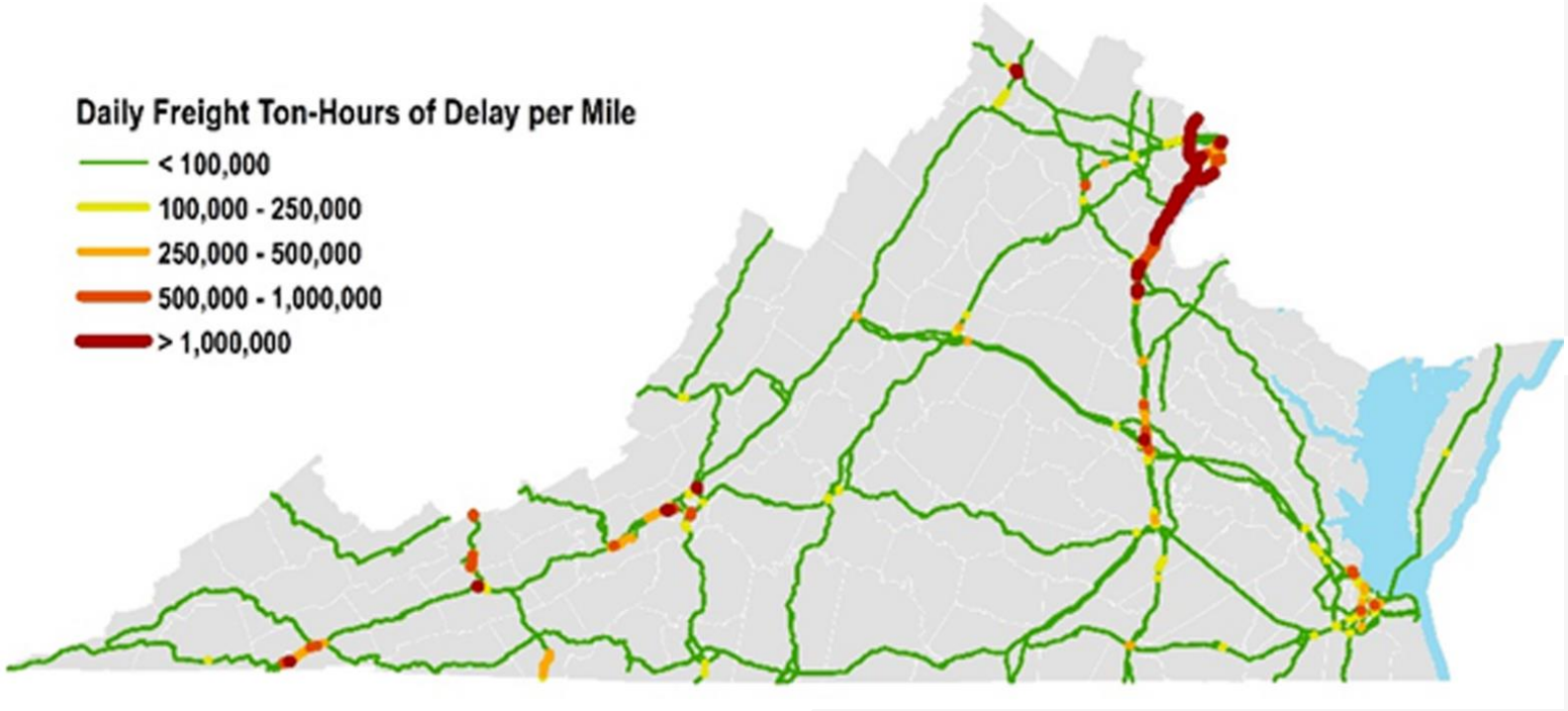
Example: A.2: Reduce the number and severity of freight bottlenecks

Number of highway bottlenecks with daily freight ton hours of delay per mile > 250,000.



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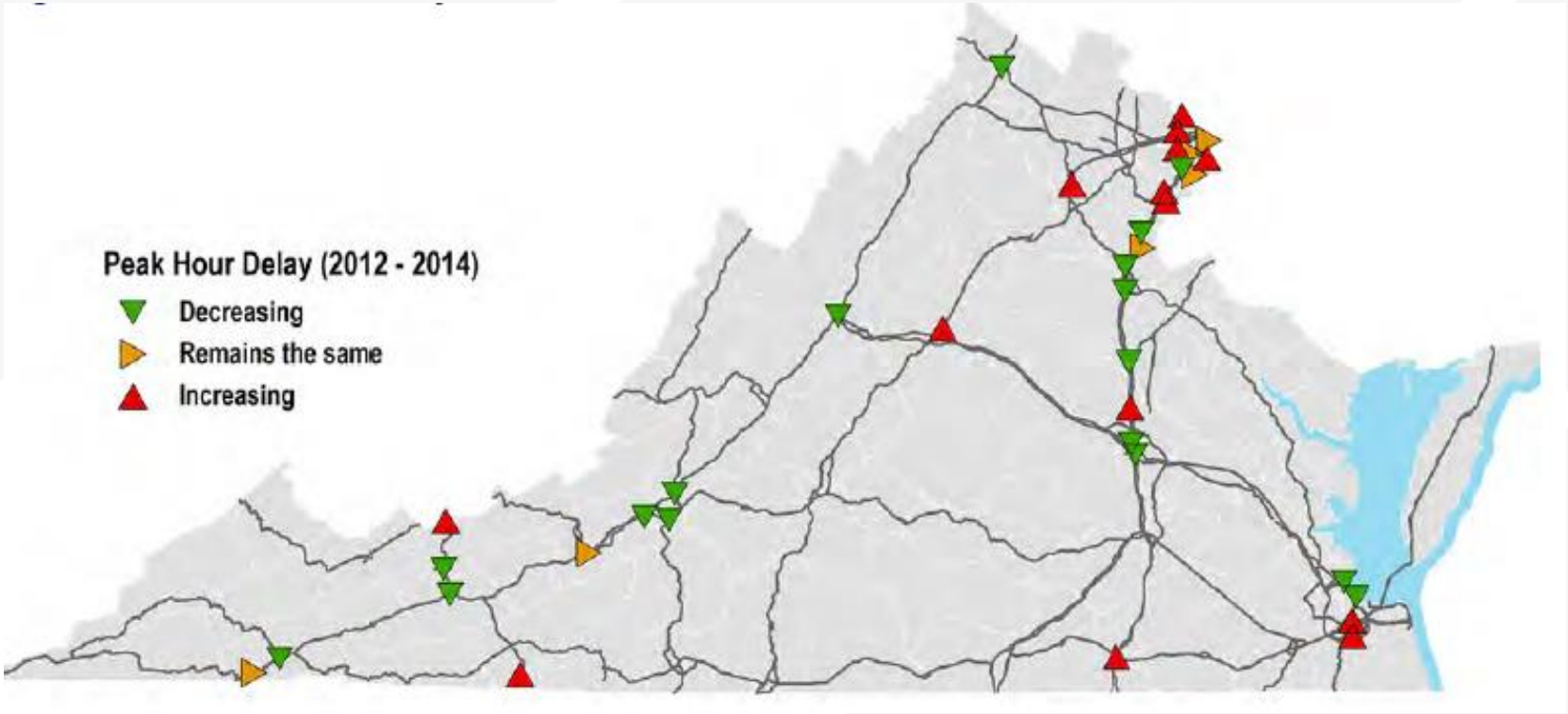
Example: A.2: Reduce the number and severity of freight bottlenecks

Peak hour delay changes at 37 bottleneck locations.



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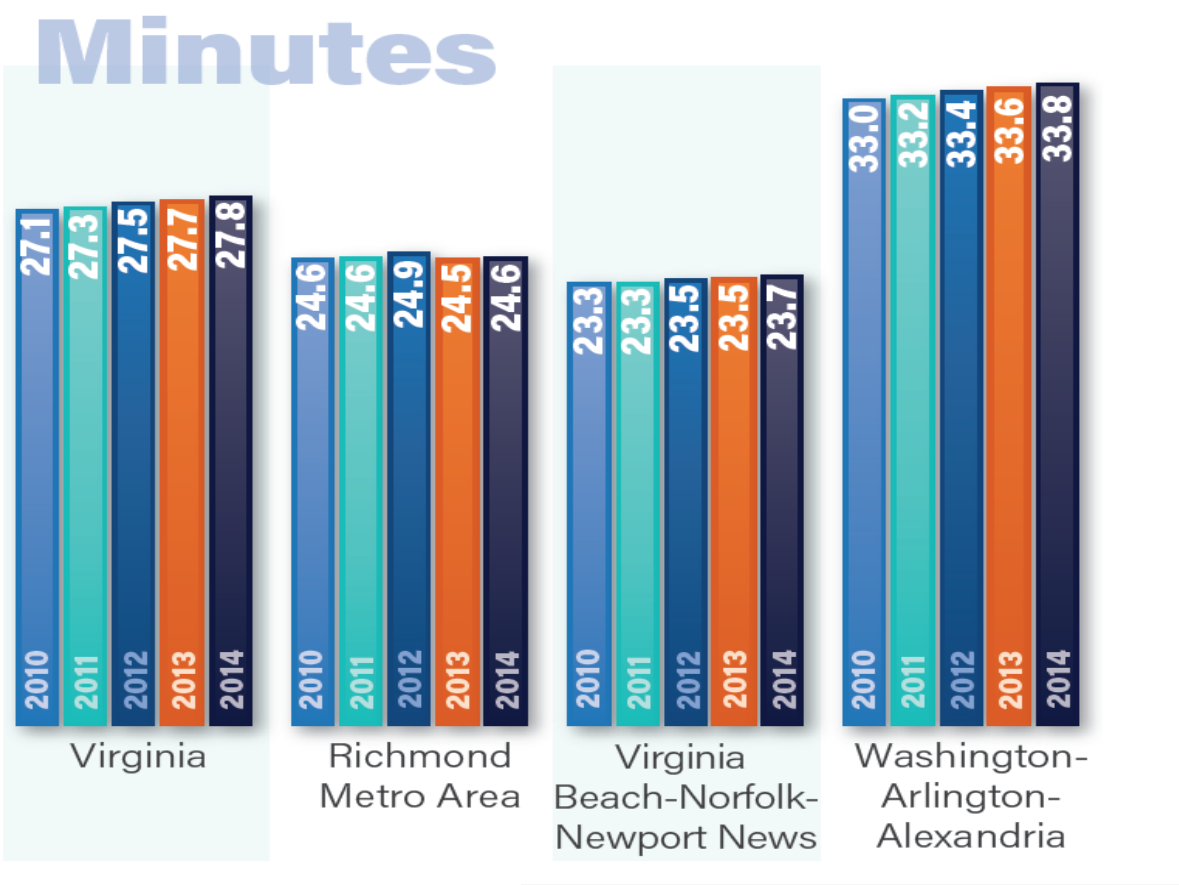
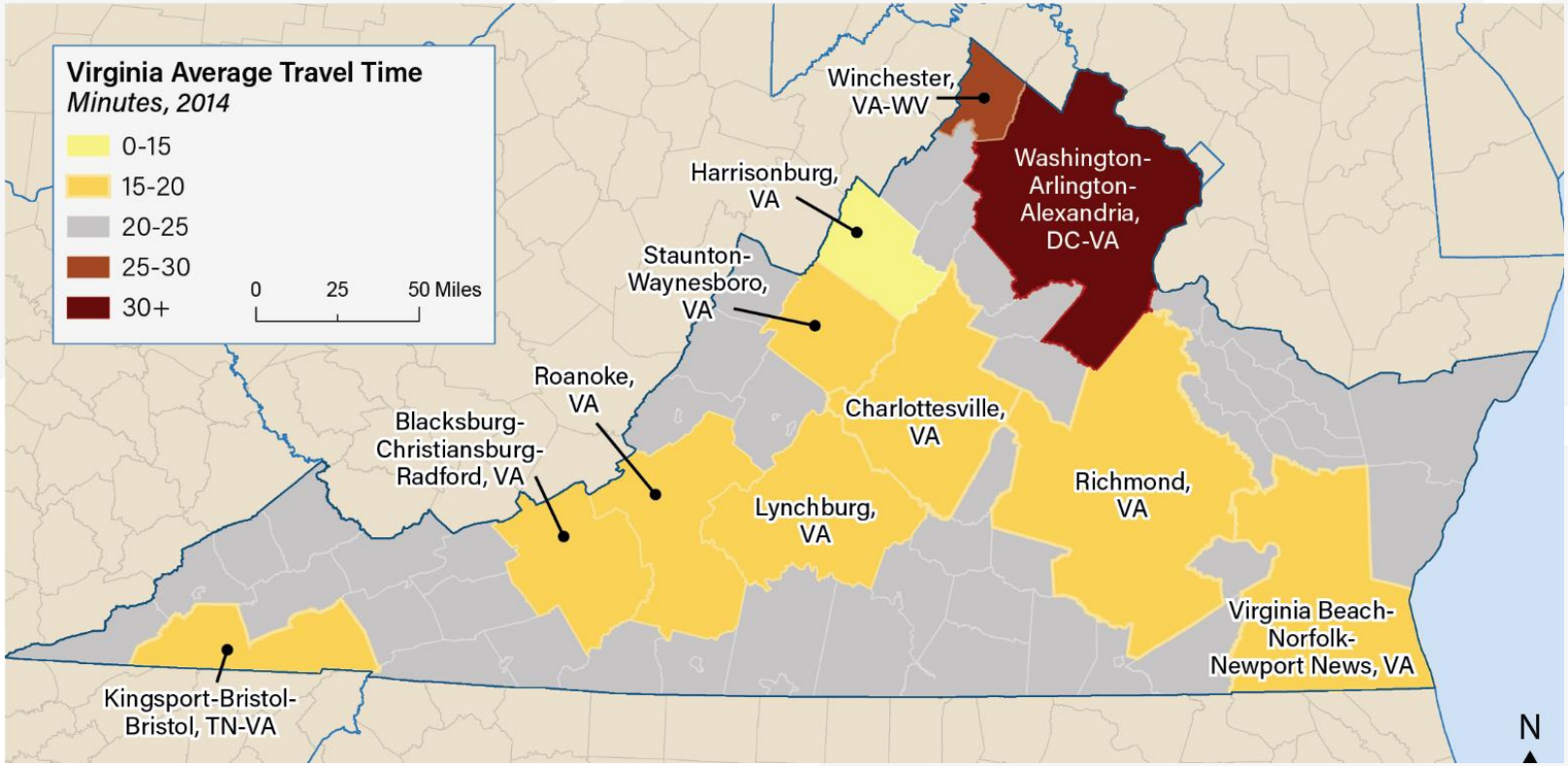
Example: B.1: Reduce average peak-period travel times in metropolitan areas

Average commute time by metropolitan area.



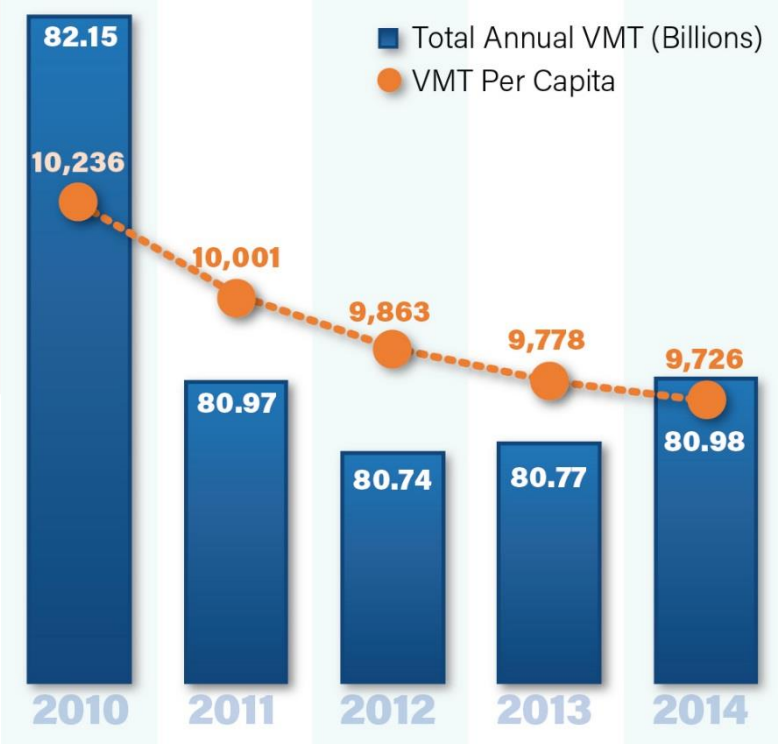
Example: B.1: Reduce average peak-period travel times in metropolitan areas

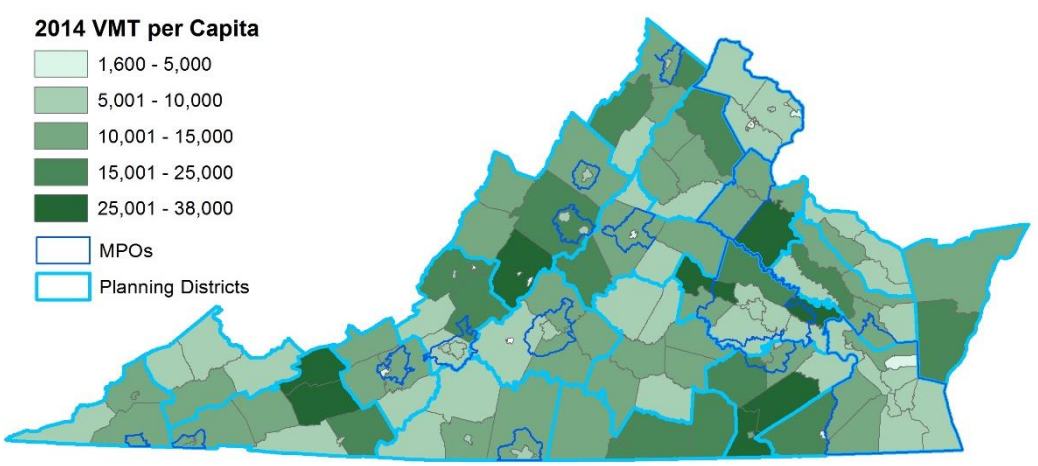
Average commute time by metropolitan area.



Example: E.1 Reduce per-capita vehicle miles traveled

Vehicle miles traveled (VMT) per capita.





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SHRP2 C11 Post-Processor to the Travel Demand Model

- Cambridge Systematics, Inc. and Weris, Inc. SHRP2 Project C11: Reliability Analysis Tool:Technical Documentation and User's Guide
- Richard Margiotta, Beth Alden, and Gena Torres. Incorporating Reliability and Safety into the Long-Range Transportation Plan: the Hillsborough Experience. 2016 TRB Annual Meeting
- Richard Margiotta and Beth Alden. Reliability and Safety Prediction for Planning. Florida Model Task Force, December 2016

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Background

- 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

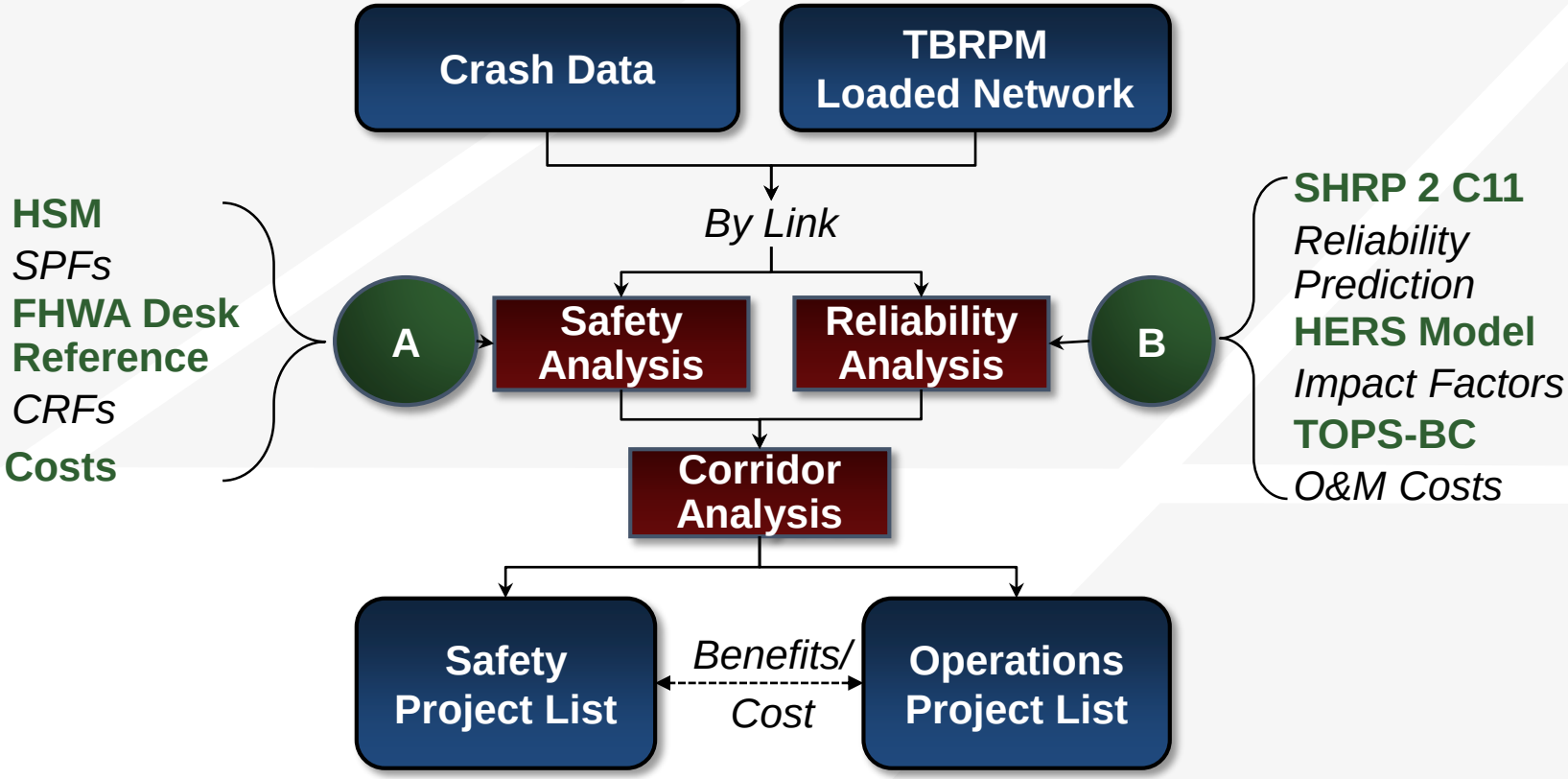
Background

- 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*

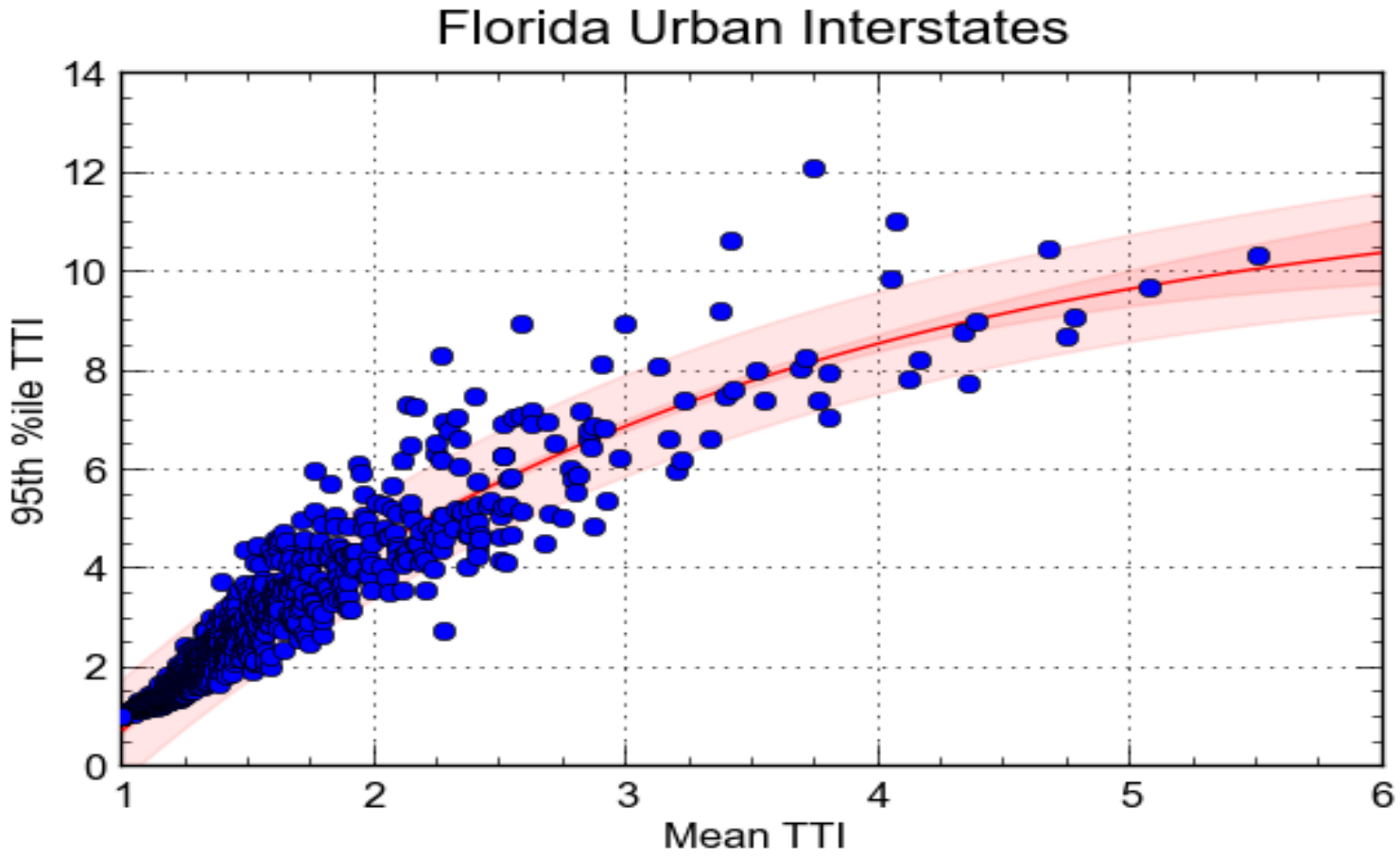
Background

- 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



Freeway Relationship



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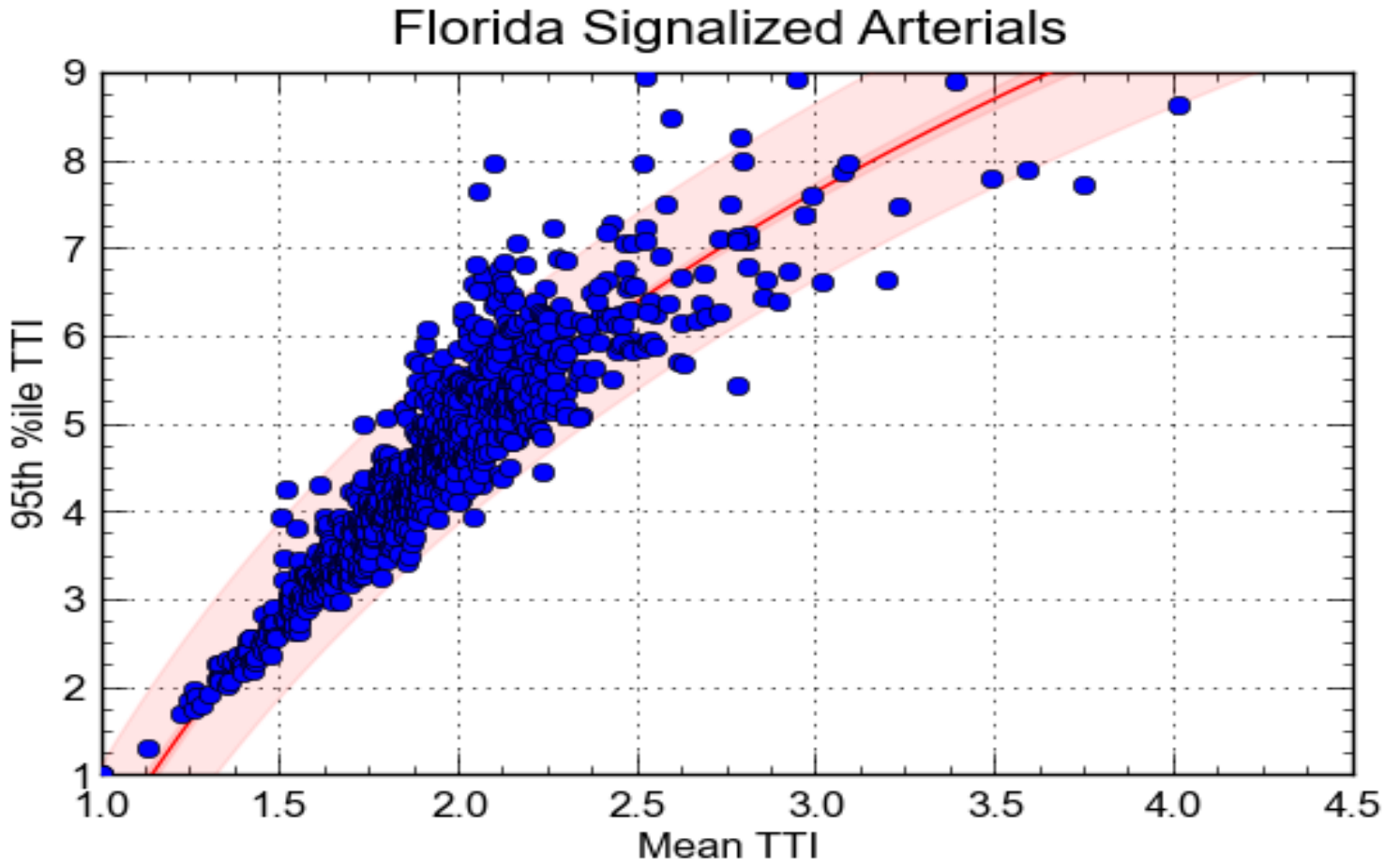
Arterial Relationship



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Reliability Results

Safety and Reliability TDM Model

FDOT user

Scenario: I-4 Base

Reliability Scenario: Reliability I-4 Base

Time period: PM

Operations Budget Cap: Unlimited

10 records per page

Corridor	Functional Class	Length	TTI Median	TTI Mean	TTI Pctile80	TTI Pctile95	Delay	Vmt	Vht	Space Mean Speed	Total Cost
I-4 (Hillsborough Co): FROM I-275 TO I-75	Freeway	8.043	1.539	1.887	2.376	3.795	2,361	159,678	0	46	$0
I-4 (Hillsborough Co): FROM I-75 TO Hillsborough / Polk County Line	Freeway	18.052	2.219	2.747	3.845	6.09	8,588	294,945	0	37	$0

Showing 1 to 2 of 2 entries

← Previous 1 Next →

Summary by Functional Class

Functional Class	Length	TTI Median	TTI Mean	TTI Pctile80	TTI Pctile95	Delay	Vmt	Vht	Space Mean Speed	Total Cost
Freeway	26.095	1.98	2.445	3.329	5.284	10,949	454,623.0	0	41	$0

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Albany Visualization and Informatics Lab Tools

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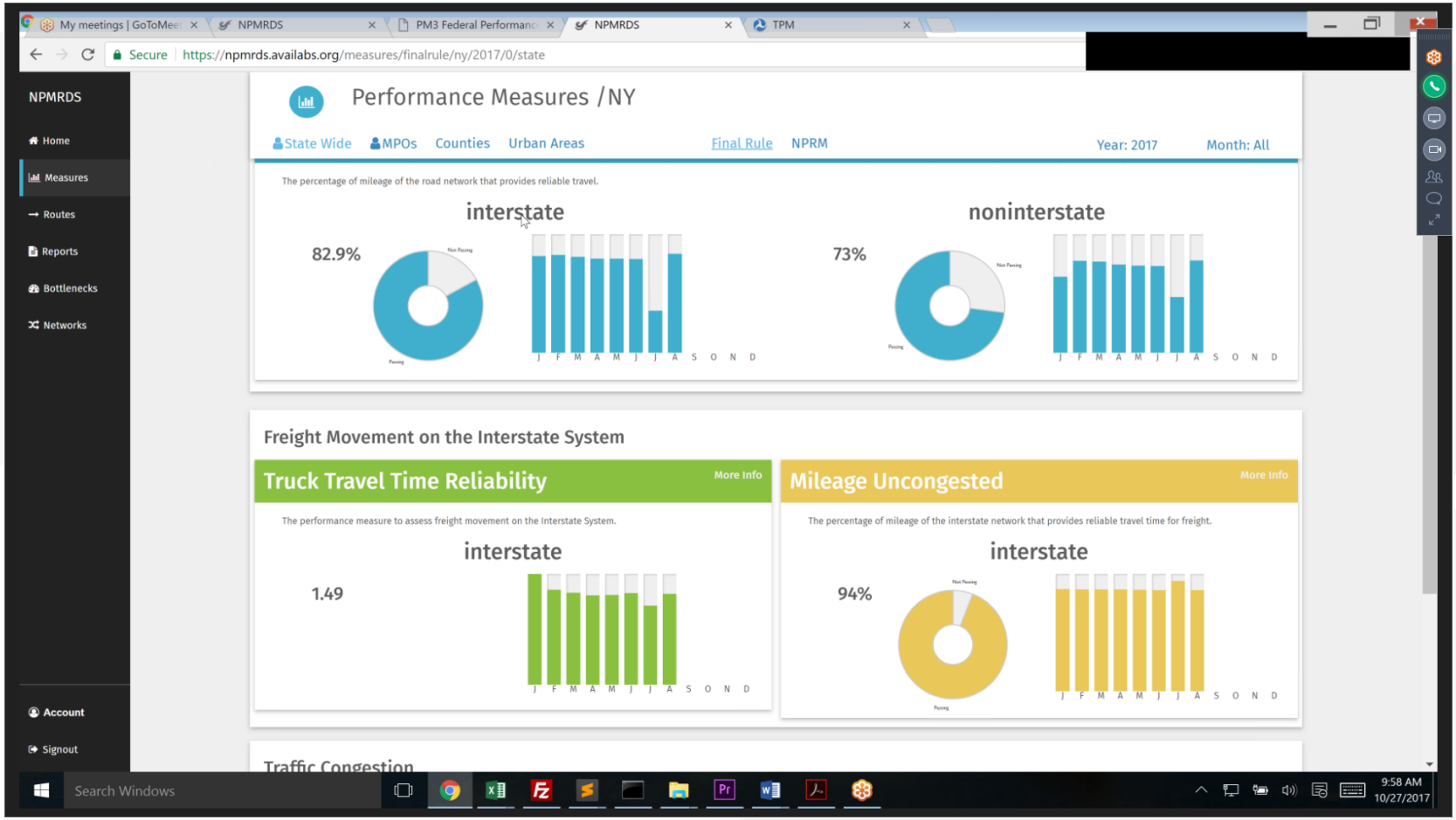
Service Centers for PM3

- 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



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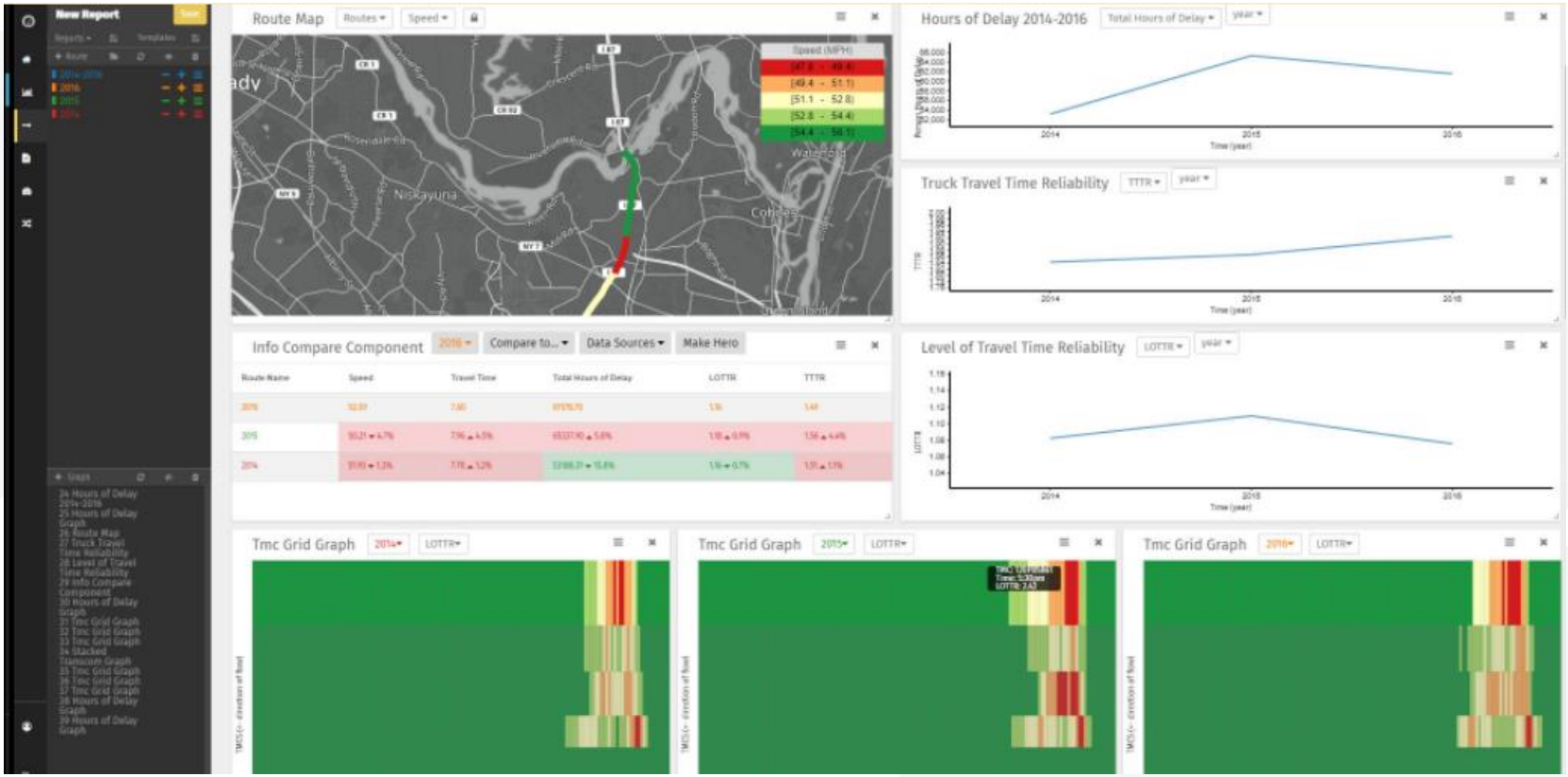
AVAIL Use Cases

- 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



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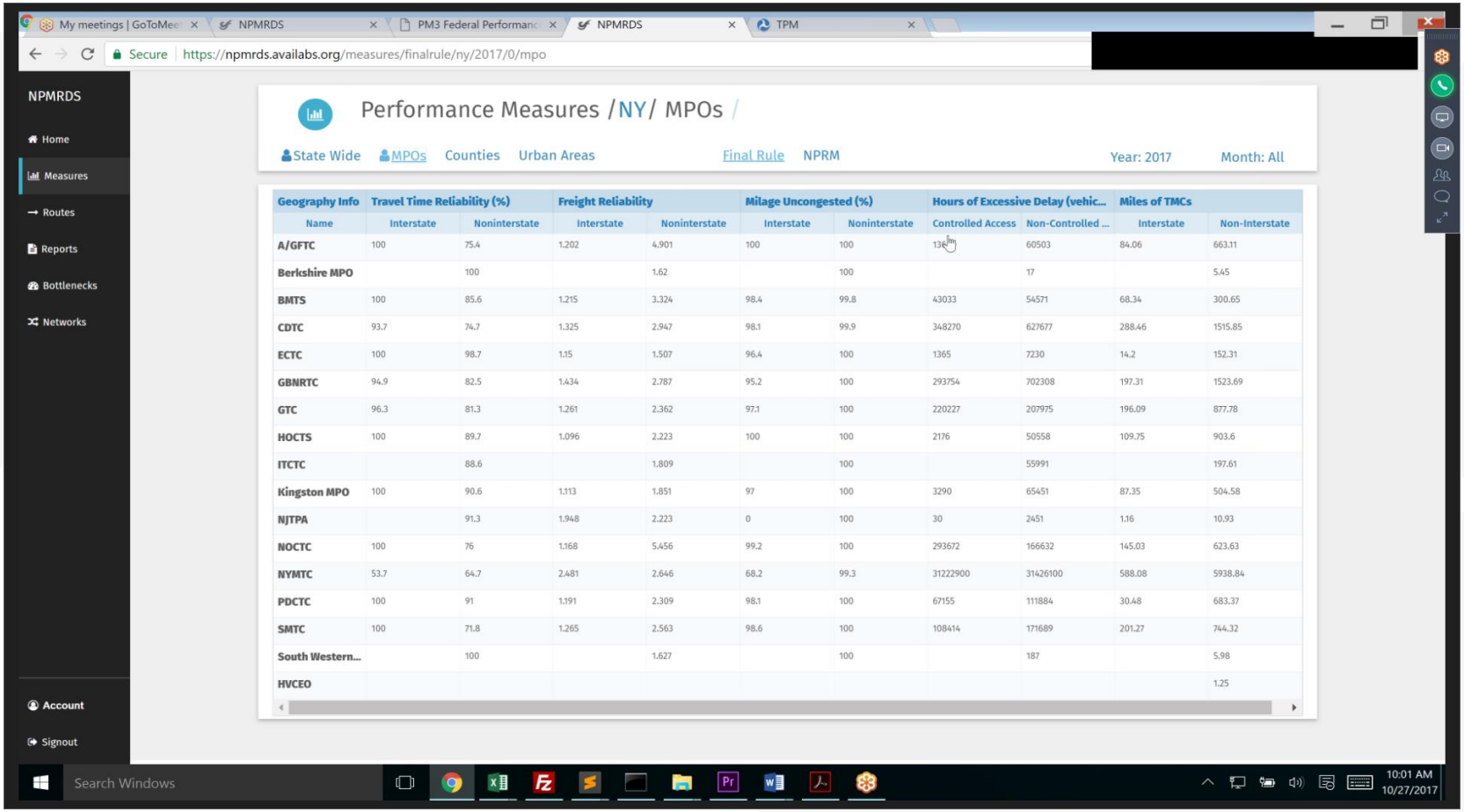
AVAIL Example Tabulations



Geography Info	Travel Time Reliability (%)		Freight Reliability		Milage Uncongested (%)		Hours of Excessive Delay (vehic...		Miles of TMCs	
Name	Interstate	Noninterstate	Interstate	Noninterstate	Interstate	Noninterstate	Controlled Access	Non-Controlled ...	Interstate	Non-Interstate
A/GFTC	100	75.4	1.202	4.901	100	100	136	60503	84.06	663.11
Berkshire MPO		100		1.62		100		17		5.45
BMTS	100	85.6	1.215	3.324	98.4	99.8	43033	54571	68.34	300.65
CDTC	93.7	74.7	1.325	2.947	98.1	99.9	348270	627677	288.46	1515.85
ECTC	100	98.7	1.15	1.507	96.4	100	1365	7230	14.2	152.31
GBNRTC	94.9	82.5	1.434	2.787	95.2	100	293754	702308	197.31	1523.69
GTC	96.3	81.3	1.261	2.362	97.1	100	220227	207975	196.09	877.78
HOCTS	100	89.7	1.096	2.223	100	100	2176	50558	109.75	903.6
ITCTC		88.6		1.809		100		55991		197.61
Kingston MPO	100	90.6	1.113	1.851	97	100	3290	65451	87.35	504.58
NJTPA		91.3	1.948	2.223	0	100	30	2451	1.16	10.93
NOCTC	100	76	1.168	5.456	99.2	100	293672	166632	145.03	623.63
NYMTC	53.7	64.7	2.481	2.646	68.2	99.3	31222900	31426100	588.08	5938.84
PDCTC	100	91	1.191	2.309	98.1	100	67155	111884	30.48	683.37
SMTC	100	71.8	1.265	2.563	98.6	100	108414	171689	201.27	744.32
South Western...		100		1.627		100		187		5.98
HVCEO										1.25

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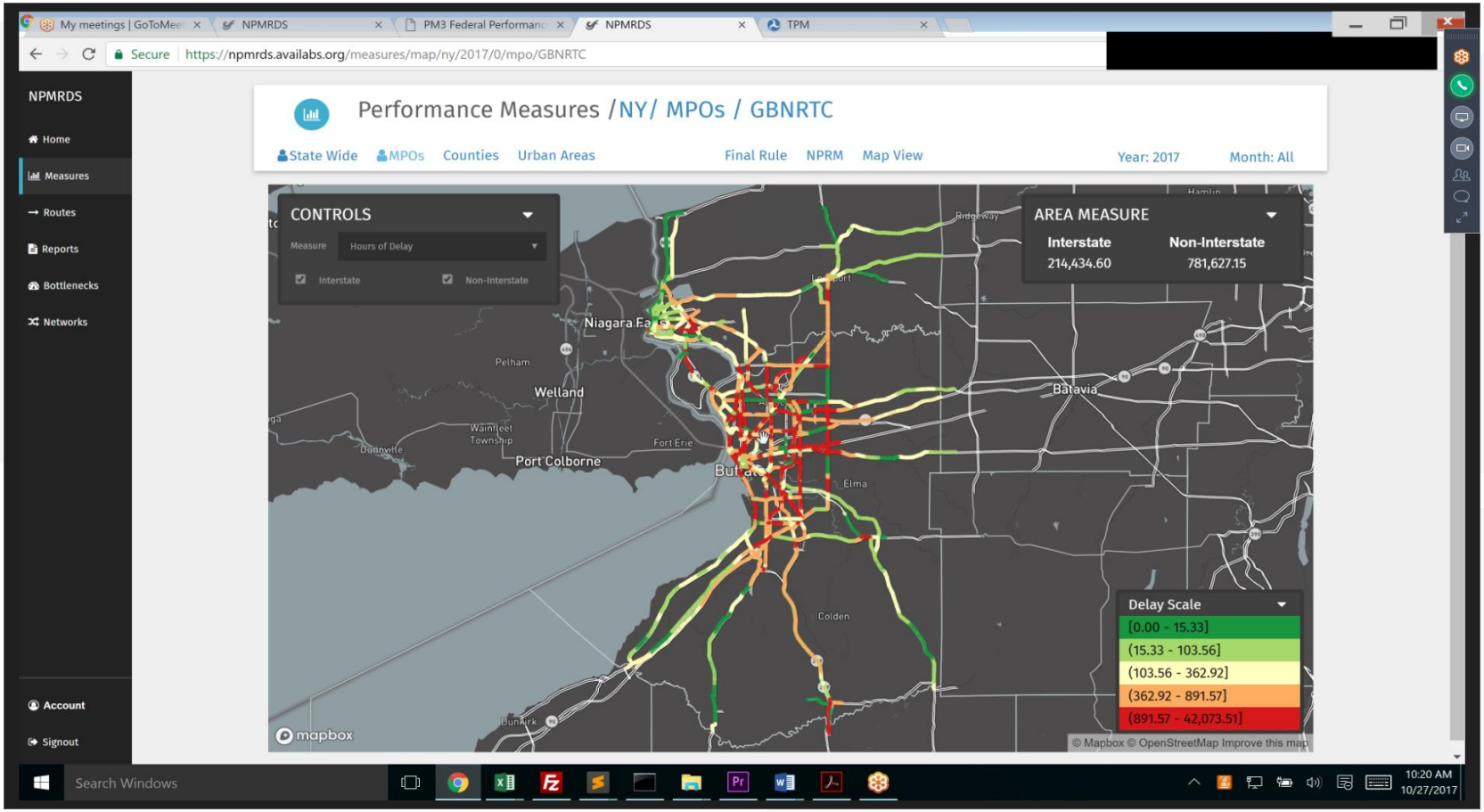
AVAIL Example Graphics



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Challenges and Opportunities

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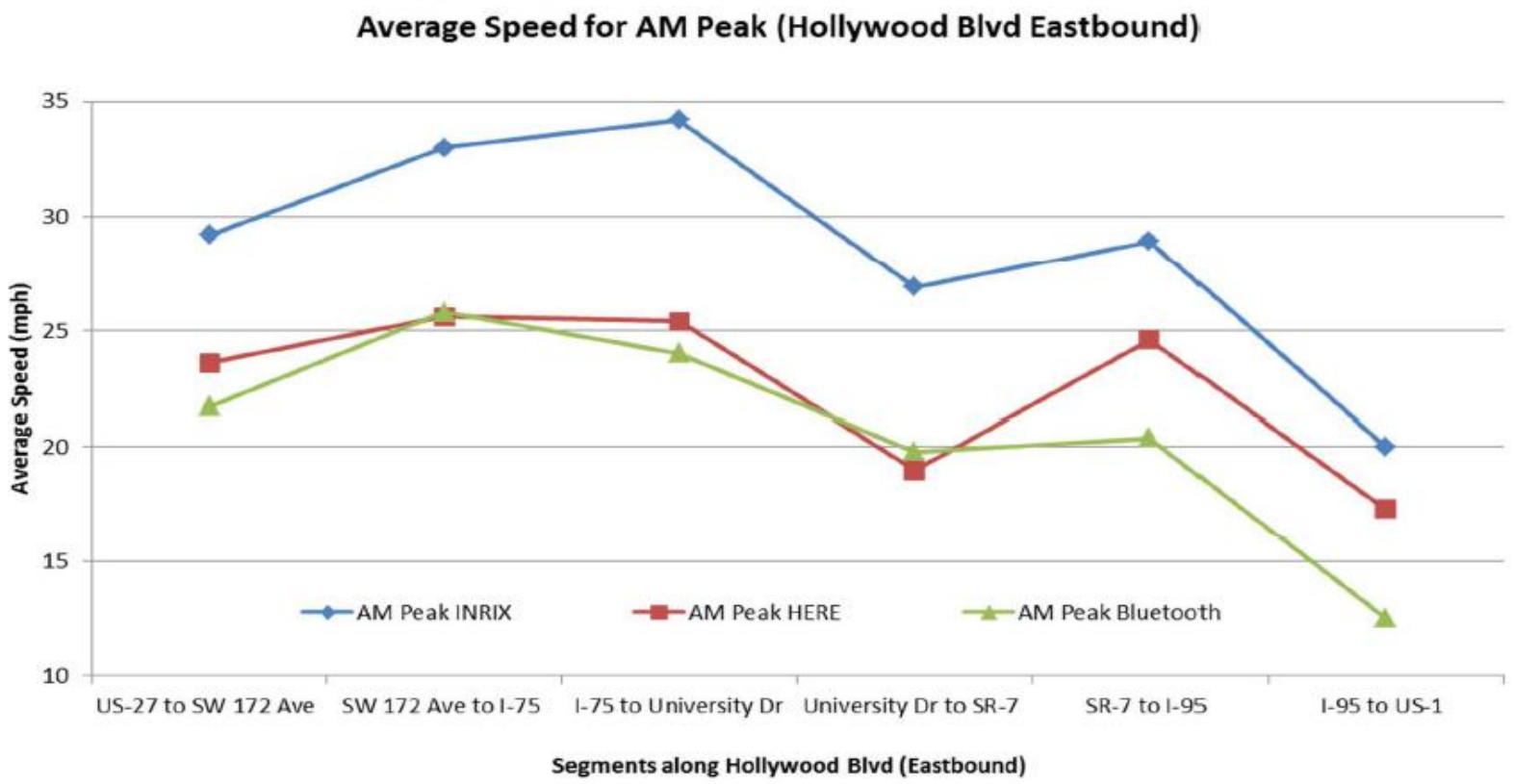
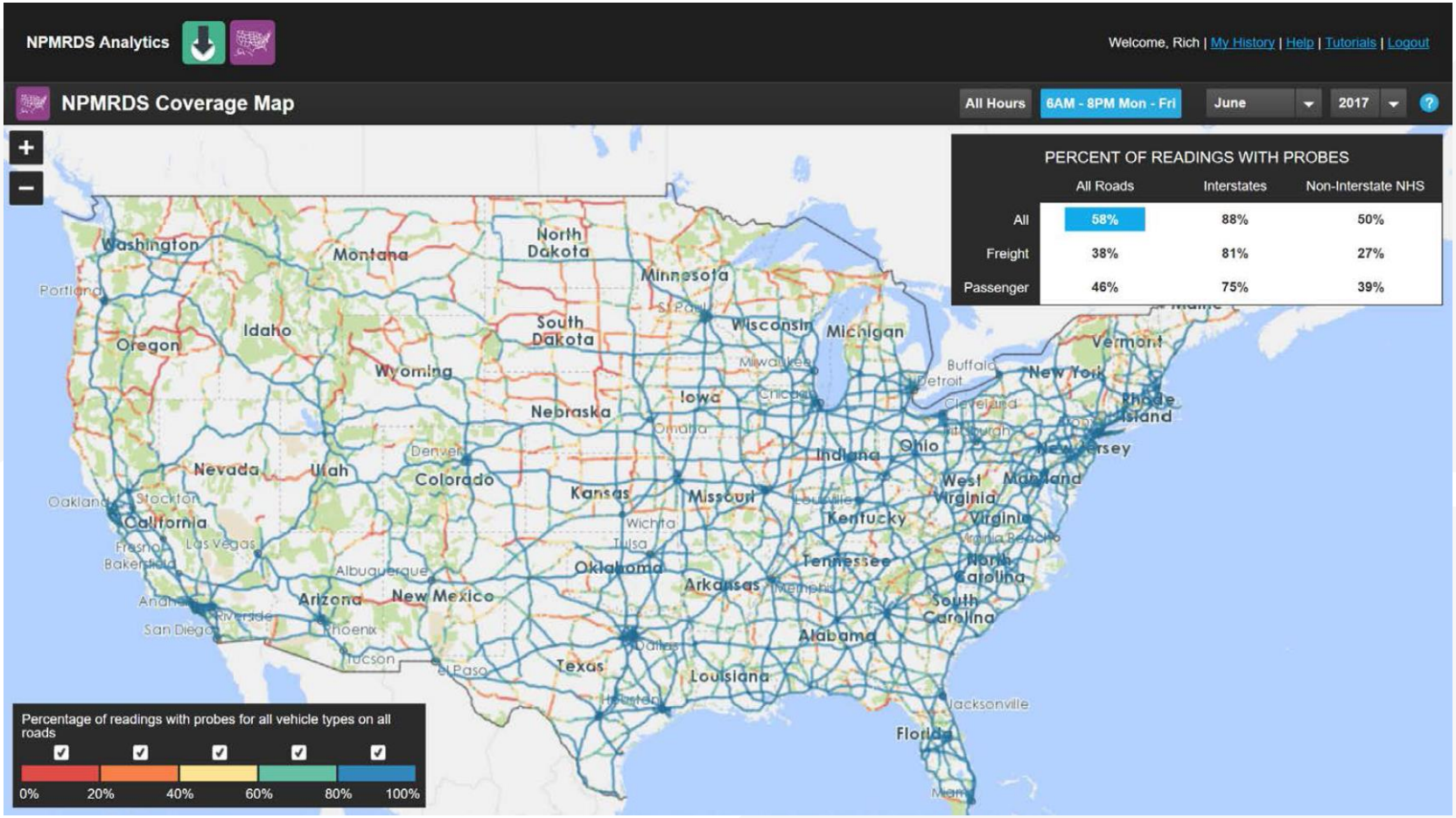
Variability by Data Source



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

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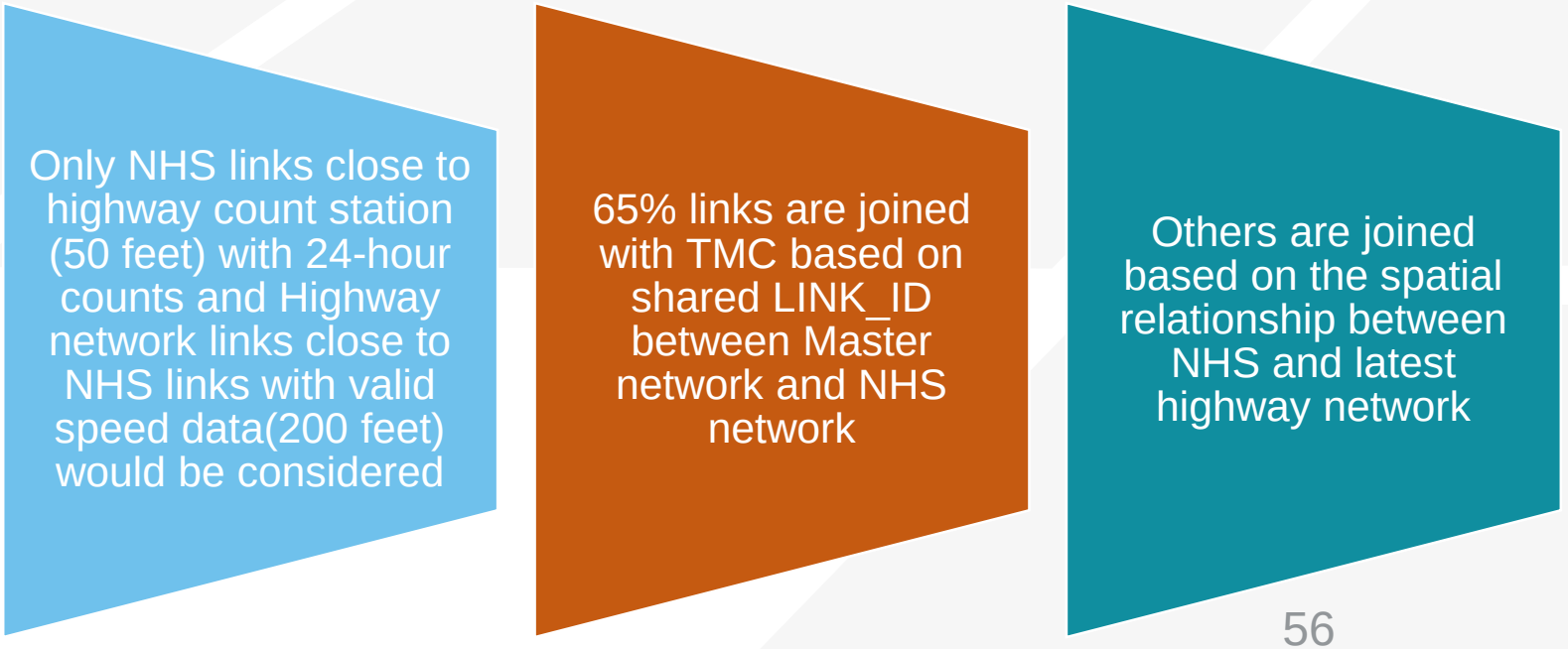
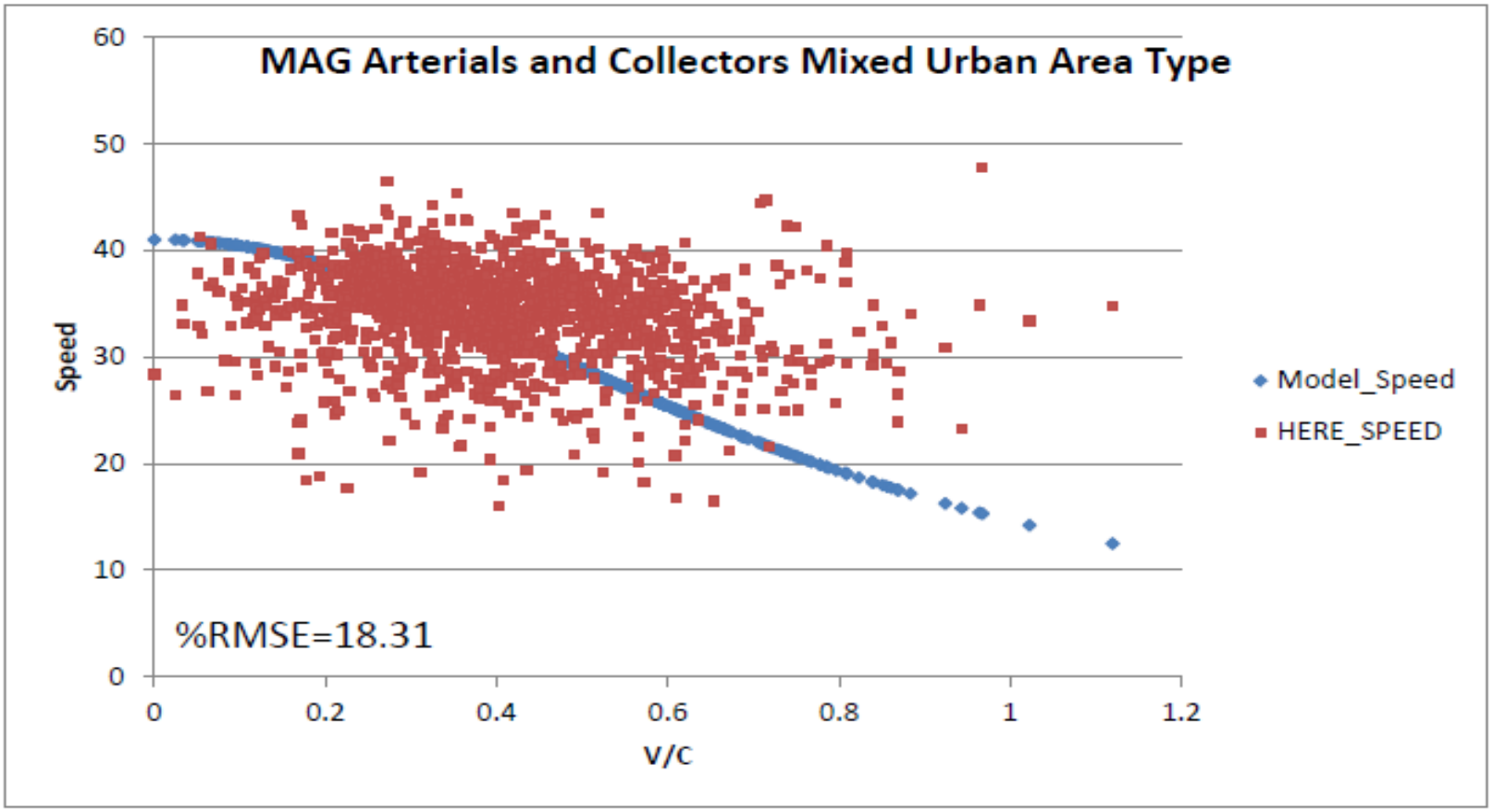
Challenge: “Getting the data into the model”

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.



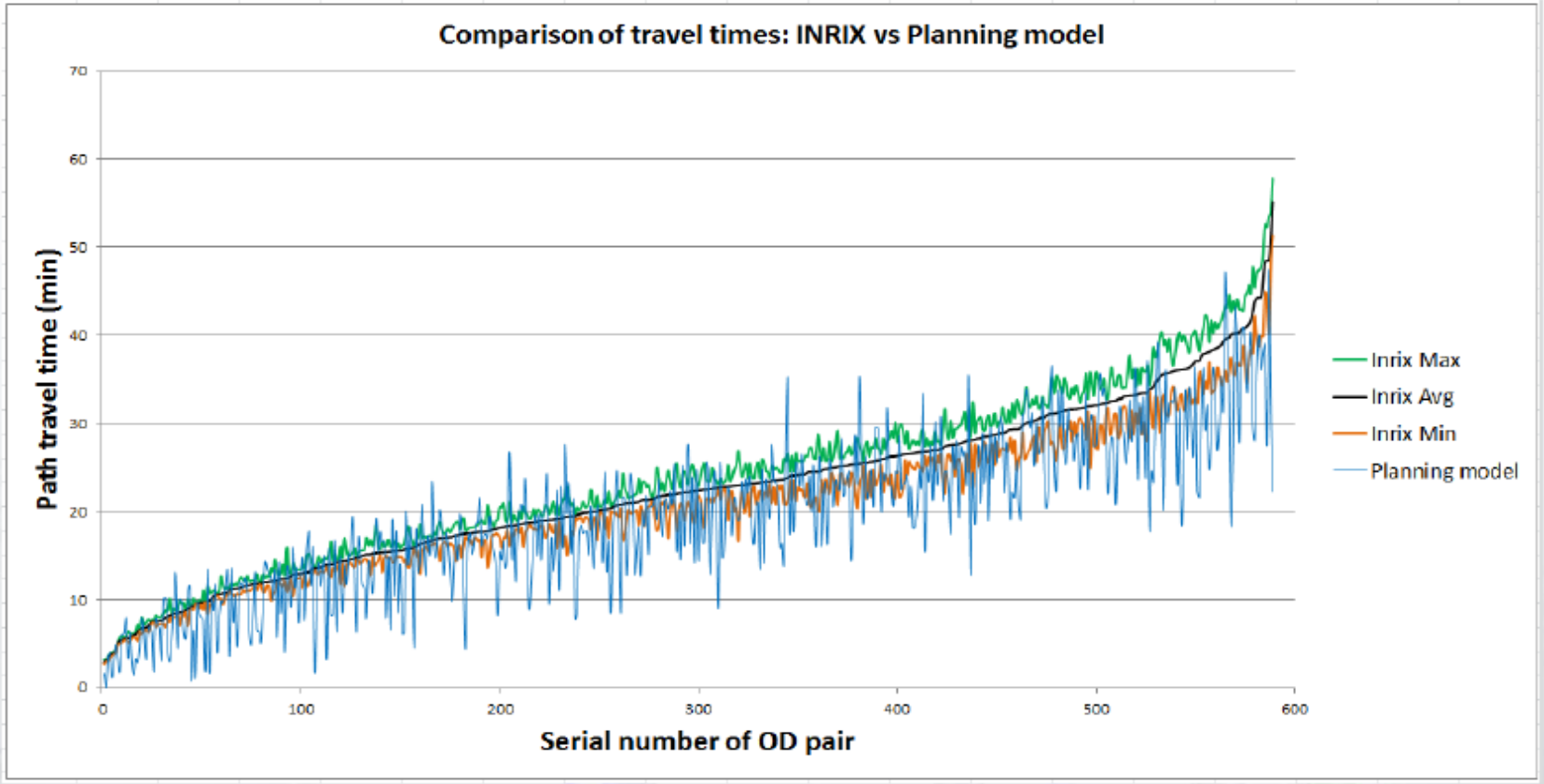
Observed vs Model Speeds

Figure 8-16 Comparison of MAG and HERE Speeds for Urban Arterials and Collectors



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

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

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

CAMBRIDGE SYSTEMATICS

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