

Probe Vehicle Data for Arterial Performance Monitoring

NEITS Annual Conference, April 25, 2019

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OUR MISSION

We support national, state, and local efforts to provide safe and efficient transportation systems through improved operations and management by means of research and development, technology implementation, training, and education.





Big Data Analytics Information Visualization Systems Integration Performance Management Lab-only: 40+ full-time professional staff (programmers, IT, UX designers, customer service, and managers), plus 30-60 students...





...and 50+ affiliated researchers nearby (and growing)

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Topics for Today

- 1. XD probe data overview and benefits
- 2. New display formats from Purdue
- 3. PennDOT's needs for corridor performance monitoring
- 4. New analytical tools on the RITIS Platform

Topics for Today

1. XD probe data overview and benefits

XD Vehicle Probe Data

Two advantages over "traditional" probe data:

1. Increased network coverage



2. Shorter segment lengths



Benefits of XD Probe Data

Because XD can assess the performance of corridors down to the intersection level, it potentially can:

- greatly reduce cost and effort to collect signalized corridor and intersection performance data
- be the basis for continuous monitoring of signalized corridor and intersection performance
- replace simulation models with real-world observations of performance
- improve SMART signal control

Topics for Today

2. New display formats from Purdue

Cumulative Distribution Chart



Speed Limit Travel Time (SLTT) (minutes)

Travel Time Comparison, Time 1 vs. Time 2



Reliability Measurement – Interquartile Range (IQR)



←→ Interquartile-Range (IQR) = 14.7 – 13.2 = 1.5 minutes

Reliability Comparison – T2 is less reliable





Example 1: Display of Seasonal Variations

(westbound US13 through Philadelphia, 6:00 to 9:00 a.m., 2-month periods)



Topics for Today

3. PennDOT's needs for corridor performance monitoring

PennDOT objective:

Develop an automated procedure to monitor and compare the performance of individual or sets of arterial corridors anywhere in the state, tracking both congestion (travel time) and reliability

Desired Capabilities

- Find and quantify poorly performing corridors for any time period
- Show the impact of signal timing changes (before-after studies)
- Evaluate the impact of work zones (before-during studies)
- Assess signal timing plans by time-of-day
- Identify and rank segments/intersections with largest change in congestion and/or reliability between any two time periods
- Visualize the relationship between congestion and reliability for any corridor

Research / Proof of Concept PURDUE

- 138 "Super-Critical" corridors in Philadelphia area
- Covered 2,184 signals on 766 miles of arterials



(PennDOT slide / Steve Gault)

Probe Data Options

Pennsylvania INRIX coverage

- 25,000 TMC segments = 16,600 miles
- 112,000 XD segments = 23,200 miles (20,200 on arterials)



(PennDOT slide / Steve Gault)

PennDOT Decision for Arterial Corridors

We will use XD segments and the Purdue analytical procedures to monitor and compare the performance of arterial corridors anywhere in the state.

Next, we need this to be automated, scaled up, and distributed for use by agency staff statewide.

Topics for Today

4. New analytical tools on the RITIS Platform

What we have today



TRAVEL TIME COMPARISON

Chart travel times to compare performance for different time periods.



<u>Help</u> <u>History</u>



TRAVEL TIME DELTA RANKING

Rank roads based on their change in travel time performance between two time periods.

Help History



(More under development)

1. Travel Time Comparison



TRAVEL TIME COMPARISON

Chart travel times to compare performance for different time periods.



Explore the congestion and reliability relationship between <u>two</u> parallel corridors in a single direction (or <u>one</u> corridor in <u>both</u> directions) during multiple date ranges and time-of-day periods

<u>Help</u> <u>History</u>







PRINCETON

Delaware

And Rarita

2063

Trenton

US-13

2063

HAMMONTON

EGG HARBOR CITY

Mousing-over a curve will display the travel time values of each curve at the selected percentile:

At 50th percentile: **Mar-Apr = 122 min.** Jul-Aug = 119 min.Dec-Jan = 134 min.

Travel Time Comparison

US-1 and US-13

Speed Limit Travel Time (1) ----

- ✓ 04/03/2018 05/31/2018 SMTWTFS
- 07/03/2018 08/30/2018 SMTWTFS
- 12/04/2018 01/31/2019 SMTWTFS

Curve colors: Mar-Apr Jul-Aug

Dec-Jan US-13 bearing west 04/03/2018 - 05/31/2018 SMTWTFS 50% of readings are 122.4 ininutes or below 86.7 min 07/03/2018 - 08/30/201 SMTWTFS 50% of readings are 118.6 n inutes or below



US-13 WB 6-9 a.m.

2. Travel Time Delta Ranking

Between any two date ranges (T1 and T2)...

and by direction...

...rank and display travel time and reliability changes (deltas) for up to 12 corridors at a time.



TRAVEL TIME DELTA RANKING

Rank roads based on their change in travel time performance between two time periods.

Help History



Normalization before ranking and plotting



For apples-to-apples comparisons, divide both travel times and IQRs by corresponding speed limit travel times (SLTT)

(PennDOT slide / Steve Gault)

1. Normalization of (median) travel time



13.4 / 11.0 =



2. Normalization of IQR (reliability)



1.5 / 11.0 =



Interquartile-Range (IQR) = 1.5 minutes

Corridor Ranking Table between date ranges T1 & T2

Option 1: Rank based on congestion (normalized TT)

Travel Time T1 T2 Delta

Rank	Мар	Corridors	 Direction 	👻 TTSL 👔	🔺 Median Before 👔	👻 Median After 🌖	👻 🛆 Median 👔	🗸 IQR Before 👔	🗕 IQR After 👔	🗕 🛛 IQR 🌖	🗸 Incidents 👔
1	<	US 1 - State Rd - Twp line Rd - City Ave	E	16.3	172%	157%	-15	37%	21%	-16	1
2		US 30 - Lancaster Ave	E	16.4	156%	162%	6	60%	53%	-7	2
3		US 202 Parkway - Welsh Rd to PA 313	E	15.8	145%	167%	22	70%	81%	11	2
4		US 1 - State Rd - Twp line Rd - City Ave	W	16.4	144%	123%	-21	97%	54%	-43	0
5		US 202 - Dekalb Pk	N	10.8	129%	120%	-9	24%	15%	-9	1
6		US 30 - Lancaster Ave	W	16.4	125%	119%	-6	64%	78%	14	3
7		US 202 - Dekalb Pk	S	10.5	117%	113%	-4	24%	12%	-12	0
8		US 202 Parkway - Welsh Rd to PA 313	W	15.4	113%	126%	13	6%	47%	41	3 .

(This table was ranked by median travel time during T1, by clicking on header)

Corridor Ranking Table

Option 2: Rank based on reliability (normalized IQR)



T2

Delta

T1

Corridors	 Direction 	👻 TTSL 👔	🔺 Median Before 👔	👻 Median After 👔	👻 🛆 Median 🌘	🗸 🗸 IQR Before 👔	👻 IQR After 👔	🗕 🕁 IQR 🌖	👻 Incidents	1
US 1 - State Rd - Twp line Rd - City Ave	E	16.3	172%	157%	-15	37%	21%	-16	1	
US 30 - Lancaster Ave	E	16.4	156%	162%	6	60%	53%	-7	2	
US 202 Parkway - Welsh Rd to PA 313	E	15.8	145%	167%	22	70%	81%	11	2	
US 1 - State Rd - Twp line Rd - City Ave	W	16.4	144%	123%	-21	97%	54%	-43	0	
US 202 - Dekalb Pk	N	10.8	129%	120%	-9	24%	15%	-9	1	
US 30 - Lancaster Ave	w	16.4	125%	119%	-5	64%	78%	14	3	
US 202 - Dekalb Pk	S	10.5	117%	113%	-4	24%	12%	-12	ø	
US 202 Parkway - Welsh Rd to PA 313	W	15.4	113%	126%	13	6%	47%	41	3	
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Welsh Rd to PA 313 E 15.8 145% US 1 - State Rd - Twp line Rd - City Ave W 16.4 144% US 202 - Dekalb Pk N 10.8 129% US 30 - Lancaster Ave W 16.4 125% US 202 - Dekalb Pk S 10.5 117% US 202 - Dekalb Pk S 10.5 117% US 202 - Dekalb Pk S 10.5 117%	Corridors Direction TTSL () Median Before () Median After () US 1 - State Rd - Twp line Rd - City Ave E 16.3 172% 157% US 30 - Lancaster Ave E 16.4 156% 162% US 202 Parkway - Welsh Rd to PA 313 E 15.8 145% 167% US 1 - State Rd - Twp line Rd - City Ave W 16.4 144% 123% US 202 - Dekalb Pk N 10.8 129% 120% US 30 - Lancaster Ave W 16.4 125% 119% US 202 - Dekalb Pk N 10.8 129% 120% US 202 - Dekalb Pk S 10.5 117% 113% US 202 - Dekalb Pk S 10.5 117% 113% US 202 - Dekalb Pk S 10.5 117% 113%	Corridors Direction TTSL () Median Before () Median After () A Median After () <td>Corridors Direction TTSL () Median Before () Median After () A Median () IQR Before () VS 1 - State Rd - Twp line Rd - City Ave E 16.3 172% 157% -15 37% VS 30 - Lancaster Ave E 16.4 156% 162% 6 60% VS 202 Parkway - 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Slope Chart: Plot of TT and IQR deltas for all corridors



Plotting the Deltas for Time Period 1



(IQR as % of SLTT)

Plotting the Deltas from Time Period 1 to 2



Plotting the Deltas on a Slope Chart



Plotting the Deltas on a Slope Chart



Plotting the Deltas on a Slope Chart



Changes from T1 to T2:

(IQR as % of SLTT)

X-Axis: Reliability

Example 3: 12 corridors compared between spring and summer



Example 3: Output ranking table

🛃 Travel Time Delta Ranking

Before April 2	: 018 -	After: May 2018 ѕмтwтгѕ July 2018 - Augu	st 2018	SMTWTF	Hours s 6 AM -	of day: 9 AM, 4 PM - 7 F	PM				
Rank	Show	Corridor	Bearing	TTSL 🕕	Median Before 🕕	Median After 🕕	Δ Median 🕕	IQR Before 🕕	IQR After 🕕	Δ IQR 🕕	Incidents 🕕
1	✓	US-1 bearing west between Horizon Boulevard and North Front Street	West	17 m	164.4%	164.8%	0.4	49.6%	49.0%	-0.6	2
2		US-1 bearing east between North Front Street and I 276	East	18 m	134.1%	130.3%	-3.8	42.5%	37.4%	-5.1	0
3	✓	US-1 bearing west between City Avenue and Pa 320	West	15 m	133.4%	128.9%	-4.5	61.4%	51.0%	-10.4	0
4		US-1 bearing east between Pa 320 and City Avenue	East	14 m	137.5%	131.1%	-6.4	59.6%	49.0%	-10.6	0
5	✓	PA-3 bearing east between Pa 320 and Chestnut Street	East	16 m	147.1%	144.9%	-2.2	59.5%	54.7%	-4.8	0
6		PA-3 bearing west between Market Street and Pa 320	West	17 m	168.5%	163.6%	-4.9	76.1%	67.1%	-9.0	1
7	✓	US-13 bearing east between Bustleton Avenue and I 276	East	25 m	120.4%	120.7%	0.3	26.6%	26.0%	-0.6	0
8		US-13 bearing east between I 476 and Pa 3	East	20 m	167.9%	166.4%	-1.5	47.6%	46.5%	-1.1	0
9	✓	US-13 bearing west between Green Lane and Bustleton Avenue	West	26 m	118.9%	116.2%	-2.7	28.0%	25.0%	-3.0	1
10		US-13 bearing west between North 34Th Street and South Stewart A	West	22 m	176.0%	173.3%	-2.7	58.9%	56.9%	-2.0	0
11	✓	PA-611 bearing south between Fitzwatertown Road and I 676;Us 30	South	26 m	150.8%	143.6%	-7.2	57.9%	52.1%	-5.8	1
12	✓	PA-611 bearing north between Spring Garden Street and Fitzwaterto	North	25 m	157.6%	152.1%	-5.5	55.6%	50.9%	-4.7	0

T1 (before) = spring period

T2 (after) = summer period

Example 3: Output map w/ rankings



10 of 12 corridors improved with both metrics (green tabs)

T1 = spring period T2 = summer period

Example 3: Slope Chart, spring vs. summer



10 of 12 corridors improved with both metrics (green arrows)

T1 = spring period T2 = summer period

More Information

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Thanks to Steve Gault at PennDOT for sharing his slides

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