QUALITY ASSESSMENT OF OUTSOURCED PROBE DATA ON SIGNALIZED ARTERIALS:

NINE CASE STUDIES IN MID-ATLANTIC REGION

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Abstract

This paper presents results of an I-95 Corridor Coalition sponsored project to assess the ability of outsourced vehicle probe data to provide accurate travel time on signalized roadways for the purposes of real-time operations as well as performance measures.

Introduction

- The quality of outsourced probe data on freeways has led many D.O.Ts to consider such data for arterial performance monitoring.
- From April 2013 through June of 2014, the UMD Center for Advanced Transportation Technology (CATT) gathered travel times from several arterial corridors within the mid-Atlantic region using Bluetooth traffic monitoring (BTM) equipment, and compared these travel times with the data reported to the I95 Vehicle Probe Project (VPP) from an outsourced probe data vendor.
- The analysis consisted of several methodologies:
  1) A traditional analysis using precision and bias speed metrics.
  2) A slowdown analysis which quantified the percentage of significant traffic disruptions accurately captured in the VPP data.
  3) A sampled distribution method in which uses overlay methods to enhance and analyze recurring congestion patterns.

Case Study Locations

Case Study Number	Data Set (State-ID#)	Road Number	Validation Date Span	# of Segments	# of Through Lanes	AADT Min-Max / Weighted Average (in 1000s)	Length (mile)	# Signals / Density	# of Access Points	Median Barrier	Speed Limit (mph)
1	NC-06	NC-55	Apr 30-May 13, 2013	18	1-3	15-43/25	30.3	62 / 2.05	231	Partial	35-50
2	MD-07	MD-355	July 6-20, 2013	10	2-4	32-67/44	17.1	67 / 3.9	221	Partial	30-45
		MD-586		6	2-3	21-43/34	6.2	19 / 3.1	56	Yes	30-45
3	NJ-11	US-1	Sep 10 - 24, 2013	10	2-4	33 – 90/70	14.2	10 / 0.7	112	Yes	55
		NJ-42		8	2	25-54/48	12.5	23 / 1.8	260	Yes	45-50
		US-130		10	3	42-42/42	14.3	28 / 2.0	229	Yes	50
4	NJ-12	NJ-38	Nov 5-19, 2013	16	2-4	32-80/46	24.5	44 / 1.8	235	Yes	50
		NJ-73		18	2-4	33-74/52	23.9	41 / 1.7	236	Yes	45-55
5	PA-05	US-1	Dec 3 - 14, 2013	28	2 - 3+3	21 – 100/45	30.6	107 / 3.5	178	Yes	40 - 50
		US-322		6	1-2	22 – 34/25	14.3	7 / 0.5	48	No	35 - 45
6	PA-06	PA-611	Jan 9 - 22, 2014	14	1-4	18-32/27	20.5	68/ 3.3	227	Partial	15-45
		PA-611		12	2-4	16-30/21	12.5	144/ 11.5	251	Partial	25-40
7	VA-07	VA-7	April 5-16, 2014	30	2-4	45-60/56	30.5	57 / 1.9	203	Yes	35-55
		US-29		4	2	14-25/21	4.4	22 / 5.0	114	Partial	30
8	VA-08	US-29	May 8-19, 2014	26	2-4	15-45/33	31.9	115/3.6	287	Partial	35-50
9	MD-08	MD-140	Jun 5-17, 2014	20	1 – 3	19-44/31	17.4	68 / 3.9	221	No	30-40
				8	2 – 3	40-53/42	15.5	18/ 1.2	52	Partial	50-55

Analysis Methods

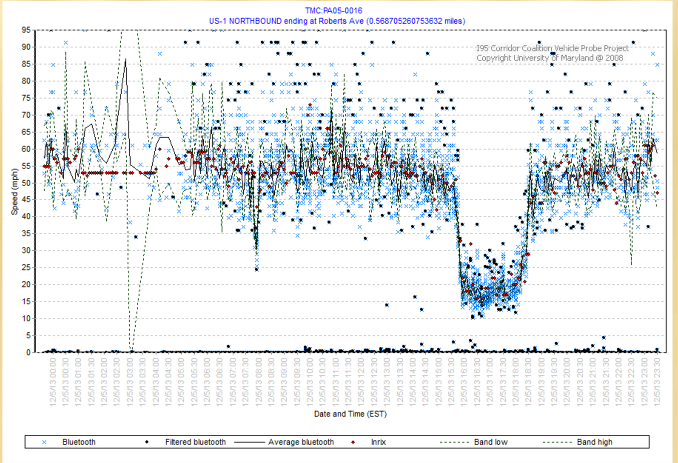
Traditional Validation

- Daily 24-hour data plots contrasting the VPP data with the BTM reference data were generated for each corridor.
- Average Absolute Speed Error (AASE): The mean absolute value of the difference between the mean speed reported from the VPP and the reference mean speed for a specified time period.
- Speed Error Bias (SEB): The average speed error in each speed bin. A typical set of speed ranges for an arterial was 0-15 mph, 15-30 mph, 30-45 mph, and >45 mph, though the actual range differs based on the facility.
- Due to insufficient sample size, high-variance, and multi-modal data traditional methods are less effective on arterials.
- The natural variance induced by signals tended to mask actual performance.
- This led to using other methods.

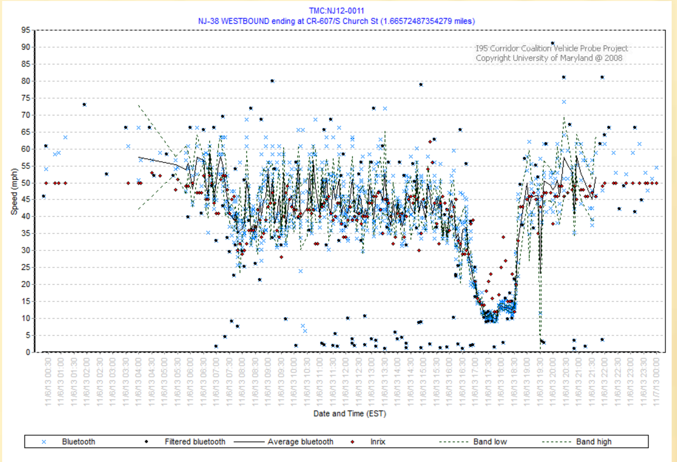
Slowdown Analysis Method

- The slowdown analysis is effective in assessing the ability of probe data to capture significant disruptions in traffic.
- The significant disruption is defined as a speed reduction of at least 15 mph from nominal for a period of one hour or more. On slower speed arterials, the threshold may be reduced to 10 mph, and 30 minutes.

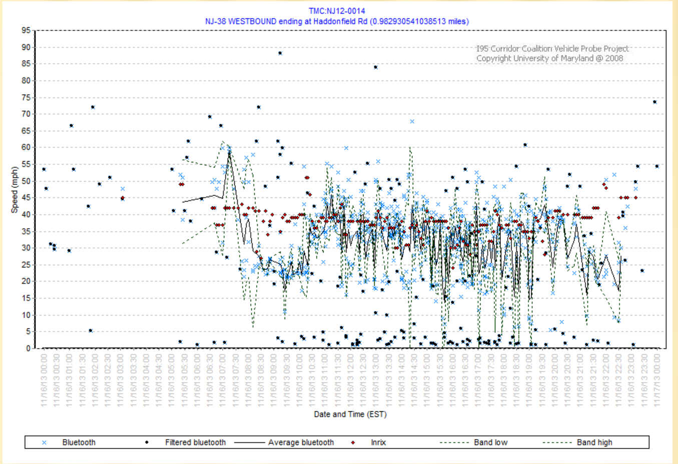
  - A *Fully Captured* slowdown: The probe data indicated a significant disruption in traffic flow, and accurately (threshold of 80%) characterized its magnitude both in reduction in speed, and in length of duration.



  - *Partially Captured* slowdown: The probe data indicated a significant disruption to traffic, but the magnitude of the slowdown was not accurate either in reduction of speed or duration of event.



  - *Failed to Capture*: The probe data either completely missed the slowdown, or the extent of severity of the slowdown was significantly different from the reference data such that the slowdown would not be interpreted as a significant disruption to traffic.



Sampled Distribution Method

- The sampled distribution method is based on 24-hour overlay plots and corresponding cumulative frequency diagrams (CFDs).
- Overlay plots are constructed by graphing multiple days of data on a single 24 hour timeline.
- Typically only data from weekdays
- Each cumulative frequency diagrams (CFDs) is constructed from the percentiles of the travel time data in the overlay plot for the respective hour.
- Common performance measures (TTI , PTI, BTI, IQR, 25th, 50th, 75th and 95th Percentiles) could be directly calculated for peak periods.
- Whereas the strength of the traditional analysis and slowdown analysis is to assess the performance of the traffic data during specific slowdowns or incidents, this method reinforces repeatable traffic phenomenon, enhancing the density of travel-time samples and thus increasing the detail of any recurring congestion.

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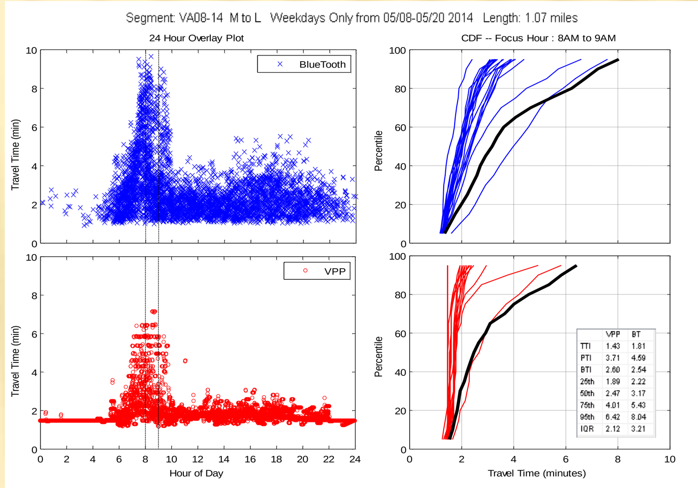
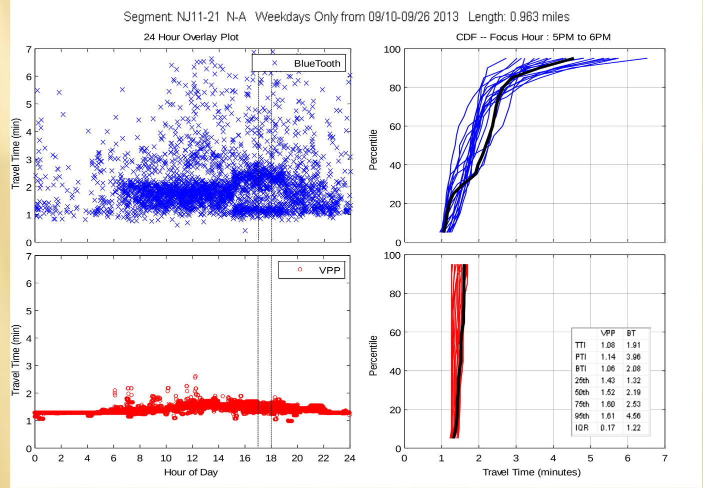


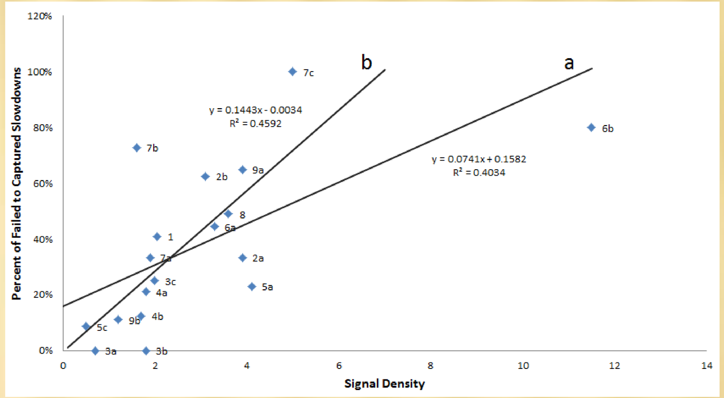
Good Agreement

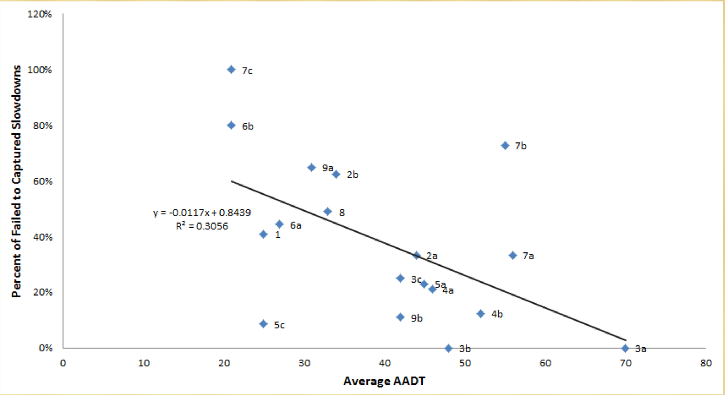


Poor Agreement

Results

Quality of probe data correlated best with density of signals and then with AADT.





Conclusion

✓ RECOMMENDED	SHOULD BE TESTED	✖ NOT RECOMMENDED
• <= 1 signal per mile • AADT > 40,000 vpd (2-way) • Limited curb cuts	• 1 to 2 signals per mile • AADT 20K to 40K vpd (2-way) • Moderate number of curb cuts	• >= 2 signals per mile • AADT < 20K (2-way) - low volume • Substantial number of curb cuts
Principal Arterials	Minor Arterials	Major Collectors
Likely to have accurate probe data…	Possibly accurate probe data…	Unlikely probe data is accurate…

- Fundamental issues with Arterial Performance and Probe Data:
  - Whenever there is a bi-modal speed distribution, probe data almost invariably reports the faster of the two modes.

- Recommendations Moving Forward:
  - Outsourced probe data fidelity should be continued to be validated on arterails.
  - Measures that convey the distribution of travel time, including flagging the presence of bi-modal progression needs to be addressed by industry.

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