
I-95 Corridor Coalition

I-95 Corridor Coalition Vehicle Probe Project: Validation of INRIX Data Monthly Report Delaware

December 2011



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I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT: VALIDATION OF INRIXDATA DECEMBER 2011

Monthly Report

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December 2011

Evaluation Results for the State of Delaware

Executive Summary

Travel time samples were collected along approximately 11 freeway miles from Tuesday, June 28, 2011 through Wednesday, July 13, 2011, in Delaware. Freeway segments studied were located along I-95 and I-495 in New Castle County, Delaware. Data collected was compared with travel time and speed data reported by INRIX as part of the I-95 Vehicle Probe Project. The freeway validation data below represents approximately 1160 hours of observations along eight freeway segments, totaling more than 11 miles.

ES Table 1, below summarizes the results of the comparison between the validation data and the INRIX data for freeway segments during this period. As shown, the average absolute speed error is within specification for all speed bins. Even when errors are measured against the mean (rather than the SEM band), INRIX data quality meets contract quality standards for the average absolute speed error (AASE). The speed error bias is within specifications for all speed bins except below 30 miles per hour.

ES Table 1 - Delaware Evaluation Summary						
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Number of 5 Minute Samples	Hours of Data Collection
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	7.10	9.50	6.80	8.70	451	37.6
30-45 MPH	6.70	9.90	4.70	6.40	221	18.4
45-60 MPH	1.80	4.70	1.00	2.90	1349	112.4
> 60 MPH	1.40	3.70	-0.90	-2.20	11904	992.0
All Speeds	1.71	4.08	-0.38	-1.22	13925	1160.4

Based upon data collected from June 28, 2011 through July 13, 2011 across 11.3 miles of roadway.

As part of the on-going validation process, vehicle probe data from each state is validated on a rotating basis. Since the inception of the validation process, data on roadways in Delaware was validated on six occasions: September 2008, February 2009, August 2009, April 2010, November 2010, and June/July 2011. These six validations represent more than 5980 hours of observations along approximately 68 miles of freeway segments in Delaware. ES Table 2 provides a summary of the cumulative validation effort. As shown, the absolute average speed error and speed error bias are within specification for all speed bins.

ES Table 2 - Delaware - Cumulative to Date						
Speed Bin	Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Number of 5 Minute Samples	Hours of Data Collection
	Comparison w ith SEM Band	Comparison w ith Mean	Comparison w ith SEM Band	Comparison w ith Mean		
0-30 MPH	5.77	7.62	4.31	5.40	1817	151.4
30-45 MPH	5.08	7.61	2.39	3.74	2436	203.0
45-60 MPH	1.86	4.06	-0.17	-0.03	18363	1530.3
> 60 MPH	2.16	4.69	-1.91	-3.80	49167	4097.3
All Speeds	2.28	4.70	-1.16	-2.35	71783	5981.9

Data Collection

Bluetooth sensor deployments in Delaware started on Tuesday, June 28, 2011. The actual deployments in Delaware were performed with the assistance of Delaware Department of Transportation (DelDOT) personnel. Sensors remained in the same position until they were retrieved two weeks later on Wednesday, July 13, 2011. This round of data collections in Delaware was designed to cover segments of the highways along which both recurrent and non-recurrent congestions could be expected during both peak and off-peak periods.

Figure 1 presents snapshot of the roadway segments over which Bluetooth sensors were deployed in Delaware. As shown, the freeway segments studied were located along I-95 and I-495 in New Castle County, Delaware.

Table 1 presents a list of specific TMC segments that were selected as the validation sample in Delaware. These segments cover a total length of approximately 11 freeway miles. Since some TMC segments in this corridor are less than one mile long, when appropriate, consecutive TMC segments are combined to form path segments longer than one mile. This document includes the results of validation performed on eight freeway segments; two of which are path segments combined from multiple standard TMC segments. The coordinates of the locations at which the Bluetooth sensors were deployed throughout the state of Delaware are highlighted in Table 2. It should be noted that the configuration of consecutive TMC segments is such that the endpoint of one TMC segment and the start point of the next TMC segment are overlapping, so one Bluetooth sensor in that location is covering both TMC segments.

Finally, Table 3 summarizes the segment definitions used in the validation process which also presents the distances that have been used in the estimation of Bluetooth speeds based on travel times. Details of the algorithm used to estimate equivalent path travel times based on INRIX data feeds for individual TMC segments are provided in a separate report. This algorithm finds an equivalent INRIX travel time (and therefore travel speed) corresponding to each sample Bluetooth travel time observation on the path segment of interest.

Analysis of Results

Table 4 summarizes the data quality measures obtained as a result of comparison between Bluetooth and all reported INRIX speeds. For the average absolute speed error, INRIX data meets the data quality measures set forth in the contract when errors are measured as a distance from the 1.96 times the standard error band and when compared to the mean. For the speed error bias, in all speed bins, except below 30 miles per hour, INRIX data meets the data quality measures set forth in the contract when errors are measured as a distance from the 1.96 times the standard error band.

Table 5 shows the percentage of the time intervals that fall within 5 mph of the SEM band and the mean for each speed bin for all TMC segments in Delaware. Tables 6 and 7 present detailed data for individual TMC segments in Delaware in similar format as Tables 4 and 5, respectively. Note that for some segments and in some speed bins the comparison results may not be reliable due to small number of observations.

Figures 2 and 3 show the overall speed error biases for different speed bins, and the average absolute speed errors for all validation segments in Delaware, respectively. These figures correspond to Table 4.



Figure 1
TMC segments selected for validation in Delaware

Table 1
Traffic Message Channel segments picked for validation in Delaware

TYPE	TMC	HIGHWAY	STARTING AT	ENDING AT	COUNTY	DIRECTION	LENGTH (mile)
Freeway	103+04104	I-95	DE-58/Exit 4	Exit 5A	NEW CASTLE	Northbound	1.2
Freeway	103-04103	I-95	Exit 5A	DE-58/Exit 4	NEW CASTLE	Southbound	1.2
Freeway	103+04107	I-95	I-495/I-295/Exit 5	DE-4/Maryland Ave/6th Ave/Exit 6	NEW CASTLE	Northbound	2.1
Freeway	103-04106	I-95	DE-4/Maryland Ave/6th Ave/Exit 6	I-495/I-295/Exit 5	NEW CASTLE	Southbound	1.6
Freeway	103+04176	I-495	Terminal Ave/Exit 2	12th St/Exit 3	NEW CASTLE	Northbound	1.2
Freeway	103-04175	I-495	12th St/Exit 3	Terminal Ave/Exit 2	NEW CASTLE	Southbound	1.1
Freeway	103+04110	I-95	DE-52/Delaware Ave/W 7th St/Exit 7	US-202/Concord Pike/Exit 8	NEW CASTLE	Northbound	0.6
Freeway	103P04110	I-95	US-202/Concord Pike/Exit 8	US-202/Concord Pike/Exit 8	NEW CASTLE	Northbound	0.8
Freeway	103N04110	I-95	US-202/Concord Pike/Exit 8	US-202/Concord Pike/Exit 8	NEW CASTLE	Southbound	0.9
Freeway	103-04109	I-95	US-202/Concord Pike/Exit 8	DE-52/Delaware Ave/W 7th St/Exit 7	NEW CASTLE	Southbound	0.6
TOTAL							11.3

Table 2
TMC segment lengths and distances between sensor deployment locations in the state of Delaware

SEGMENT TYPE	TMC	STANDARD TMC					SENSOR DEPLOYMENT			
		Endpoint (1)		Endpoint (2)		Length (mile)	Endpoint (1)		Endpoint (2)	
		Lat	Long	Lat	Long		Lat	Long	Lat	Long
Freeway	103+04104	39.688416	-75.641698	39.695012	-75.620673	1.2	39.6885	-75.64014	39.69473	-75.62082
Freeway	103-04103	39.695217	-75.620799	39.688650	-75.641743	1.2	39.69549	-75.62009	39.68866	-75.64201
Freeway	103+04107	39.710169	-75.587152	39.734171	-75.564972	2.1	39.71	-75.58649	39.73434	-75.56477
Freeway	103-04106	39.735194	-75.564183	39.717357	-75.581666	1.6	39.7357	-75.5638	39.7179	-75.58121
Freeway	103+04176	39.720181	-75.540096	39.732576	-75.524300	1.2	39.72045	-75.53985	39.73298	-75.52357
Freeway	103-04175	39.732740	-75.524405	39.721286	-75.538924	1.1	39.73283	-75.52437	39.72155	-75.53866
Freeway	103+04110	39.753940	-75.553068	39.762612	-75.549287	0.6	39.753	-75.55327		
Freeway	103P04110	39.762612	-75.549287	39.767877	-75.536976	0.8			39.76796	-75.53658
Freeway	103N04110	39.768915	-75.535907	39.762747	-75.549406	0.9	39.76804	-75.53732		
Freeway	103-04109	39.762747	-75.549406	39.754280	-75.553169	0.6			39.75325	-75.55357
TOTAL						11.3				

Table 3
Path segments identified for validation in Delaware

Type	Validation Segment	STANDARD SEGMENTS INCLUDED		STARTING AT	ENDING AT	LENGTH (MILE)		
		TMC(1)	TMC(2)			Standard	Deployment	Error (%)
Freeway	103+04104	103+04104	103P04110	DE-58/Exit 4	Exit 5A	1.2	1.11	-8.24%
Freeway	103-04103	103-04103		Exit 5A	DE-58/Exit 4	1.2	1.26	4.58%
Freeway	103+04107	103+04107		I-495/I-295/Exit 5	DE-4/Maryland Ave/6th Ave/Exit 6	2.1	2.07	0.56%
Freeway	103-04106	103-04106		DE-4/Maryland Ave/6th Ave/Exit 6	I-495/I-295/Exit 5	1.6	1.56	-0.27%
Freeway	103+04176	103+04176		Terminal Ave/Exit 2	12th St/Exit 3	1.2	1.22	1.67%
Freeway	103-04175	103-04175		12th St/Exit 3	Terminal Ave/Exit 2	1.1	1.09	-1.47%
Freeway	DE06-0001	103+04110		DE-52/Delaware Ave/W 7th St/Exit 7	US-202/Concord Pike/Exit 8	1.4	1.51	5.59%
Freeway	DE06-0002	103N04110		103-04109	US-202/Concord Pike/Exit 8	DE-52/Delaware Ave/W 7th St/Exit 7	1.5	1.48
TOTAL						11.27	11.30	0.24%

Table 4
Data quality measures for freeway segments greater than one mile in Delaware

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SE Band		Mean		
	Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
0-30	6.8	7.1	8.7	9.5	451
30-45	4.7	6.7	6.4	9.9	221
45-60	1.0	1.8	2.9	4.7	1349
60+	-0.9	1.4	-2.2	3.7	11904

Table 5
Percent observations meeting data quality criteria for freeway segments greater than one mile in Delaware

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SE Band		Mean		
	Percentage falling inside the band	Percentage falling within 5 mph of the band	Percentage equal to the mean	Percentage within 5 mph of the mean	
0-30	20%	55%	0%	44%	451
30-45	20%	48%	0%	32%	221
45-60	50%	88%	0%	66%	1349
60+	53%	92%	0%	74%	11904

Table 6
Data quality measures for individual freeway validation segments greater than one mile in the state of Delaware

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SE Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
103+04104	1.2	1.1	0-30	6.0	6.1	8.8	9.4	138
			30-45	11.4	11.4	15.8	15.8	9*
			45-60	2.2	3.4	4.2	5.7	44
			60+	-0.9	1.5	-2.0	3.7	1988
103+04107	2.1	2.1	0-30	1.4	3.3	2.2	5.1	16*
			30-45	2.6	3.0	3.8	6.3	10*
			45-60	1.3	1.4	2.8	3.1	124
			60+	-1.6	1.7	-3.4	3.9	2045
103+04176	1.2	1.2	0-30	26.0	26.0	28.1	28.2	20*
			30-45	12.2	12.2	16.7	16.7	10*
			45-60	2.7	2.7	6.9	6.9	165
			60+	-0.2	0.8	-0.5	3.1	2081
103-04103	1.2	1.3	0-30	9.5	9.9	12.9	13.6	67
			30-45	5.3	6.9	7.4	10.2	129
			45-60	2.2	2.6	5.0	5.9	169
			60+	-1.2	1.9	-2.6	4.4	1459
103-04106	1.6	1.6	0-30	4.5	4.7	5.3	6.0	155
			30-45	4.9	6.6	5.8	9.1	33
			45-60	1.1	1.4	3.0	3.7	255
			60+	-1.1	1.4	-2.4	3.3	1522
103-04175	1.1	1.1	0-30	11.4	11.7	12.4	14.0	8*
			30-45	-9.8	9.8	-11.4	11.4	1*
			45-60	1.2	1.6	5.7	6.2	107
			60+	-0.6	1.0	-1.6	3.4	1815
DE06-0001	1.4	1.5	0-30					
			30-45	-2.8	3.5	-4.9	6.2	19*
			45-60	-0.8	1.4	-0.7	3.9	379
			60+	-1.5	1.8	-4.3	4.9	407
DE06-0002	1.5	1.5	0-30	5.4	6.4	6.6	8.6	47
			30-45	1.1	3.8	3.0	6.9	10*
			45-60	1.2	1.4	3.3	3.8	106
			60+	-1.1	1.4	-2.6	3.9	587

*Results in the specified row may not be reliable due to small number of observations

Table 7
Observations meeting data quality criteria for individual freeway validation segments
greater than one mile in the state of Delaware

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SE Band				Mean				
		Speed Error Bias		Average Absolute Speed Error		Speed Error Bias		Average Absolute Speed Error		
		No. falling inside the band	% falling inside the band	No. falling within 5 mph of the band	% falling within 5 mph of the band	No. equal to the mean	% equal to the mean	No. within 5 mph of the mean	% within 5 mph of the mean	
103+04104	0-30	29	21%	69	50%	0	0%	40	29%	138
	30-45	0	0%	1	11%	0	0%	1	11%	9*
	45-60	8	18%	33	75%	0	0%	22	50%	44
	60+	889	45%	1821	92%	0	0%	1462	74%	1988
103+04107	0-30	3	19%	14	88%	0	0%	10	63%	16*
	30-45	3	30%	7	70%	0	0%	2	20%	10*
	45-60	67	54%	110	89%	0	0%	102	82%	124
	60+	818	40%	1848	90%	0	0%	1428	70%	2045
103+04176	0-30	2	10%	5	25%	0	0%	4	20%	20*
	30-45	0	0%	2	20%	0	0%	1	10%	10*
	45-60	50	30%	134	81%	0	0%	50	30%	165
	60+	1334	64%	2000	96%	1	0%	1674	80%	2081
103-04103	0-30	7	10%	23	34%	0	0%	16	24%	67
	30-45	24	19%	62	48%	0	0%	43	33%	129
	45-60	61	36%	138	82%	0	0%	98	58%	169
	60+	669	46%	1261	86%	0	0%	937	64%	1459
103-04106	0-30	38	25%	110	71%	0	0%	103	66%	155
	30-45	7	21%	14	42%	0	0%	11	33%	33
	45-60	124	49%	230	90%	0	0%	199	78%	255
	60+	818	54%	1402	92%	0	0%	1206	79%	1522
103-04175	0-30	2	25%	3	38%	0	0%	2	25%	8*
	30-45	0	0%	0	0%	0	0%	0	0%	1*
	45-60	39	36%	98	92%	0	0%	35	33%	107
	60+	1177	65%	1720	95%	0	0%	1413	78%	1815
DE06-0001	0-30									
	30-45	6	32%	13	68%	0	0%	8	42%	19*
	45-60	261	69%	348	92%	0	0%	296	78%	379
	60+	197	48%	352	86%	0	0%	240	59%	407
DE06-0002	0-30	8	17%	26	55%	0	0%	22	47%	47
	30-45	4	40%	8	80%	0	0%	4	40%	10*
	45-60	69	65%	94	89%	0	0%	83	78%	106
	60+	348	59%	537	91%	1	0%	421	72%	587

*Results in the specified row may not be reliable due to small number of observations

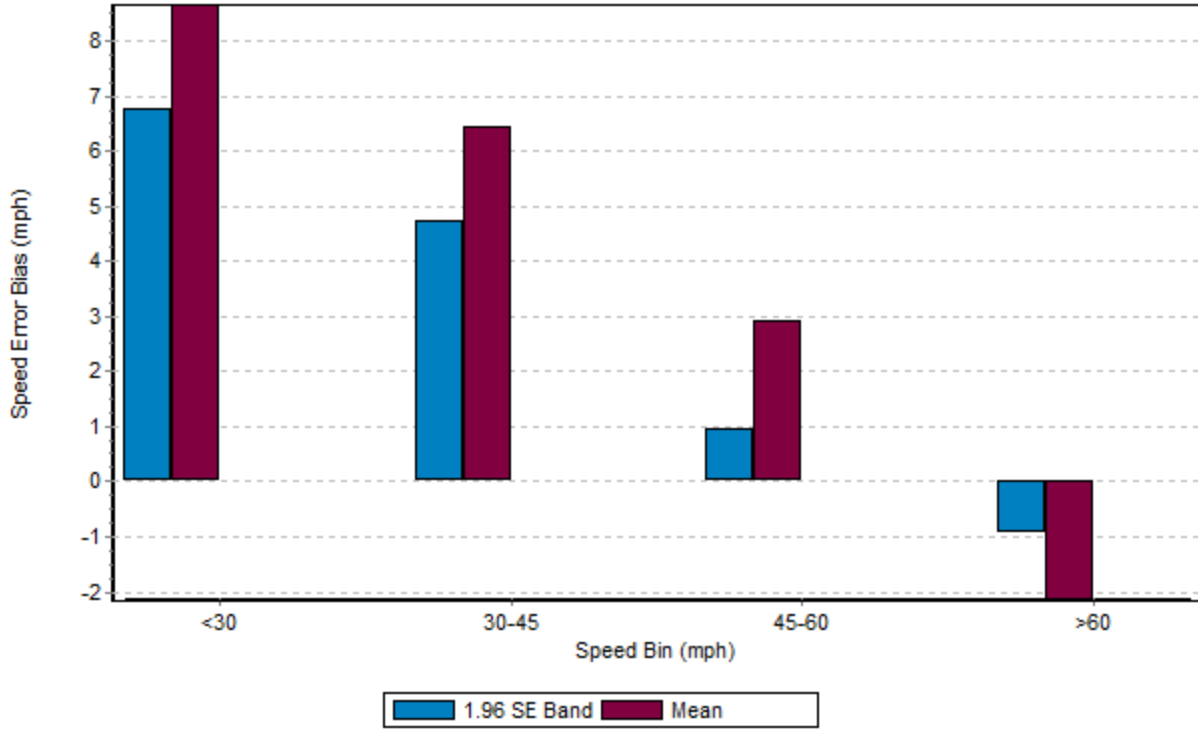


Figure 2
Speed error bias for freeway segments greater than one mile in Delaware

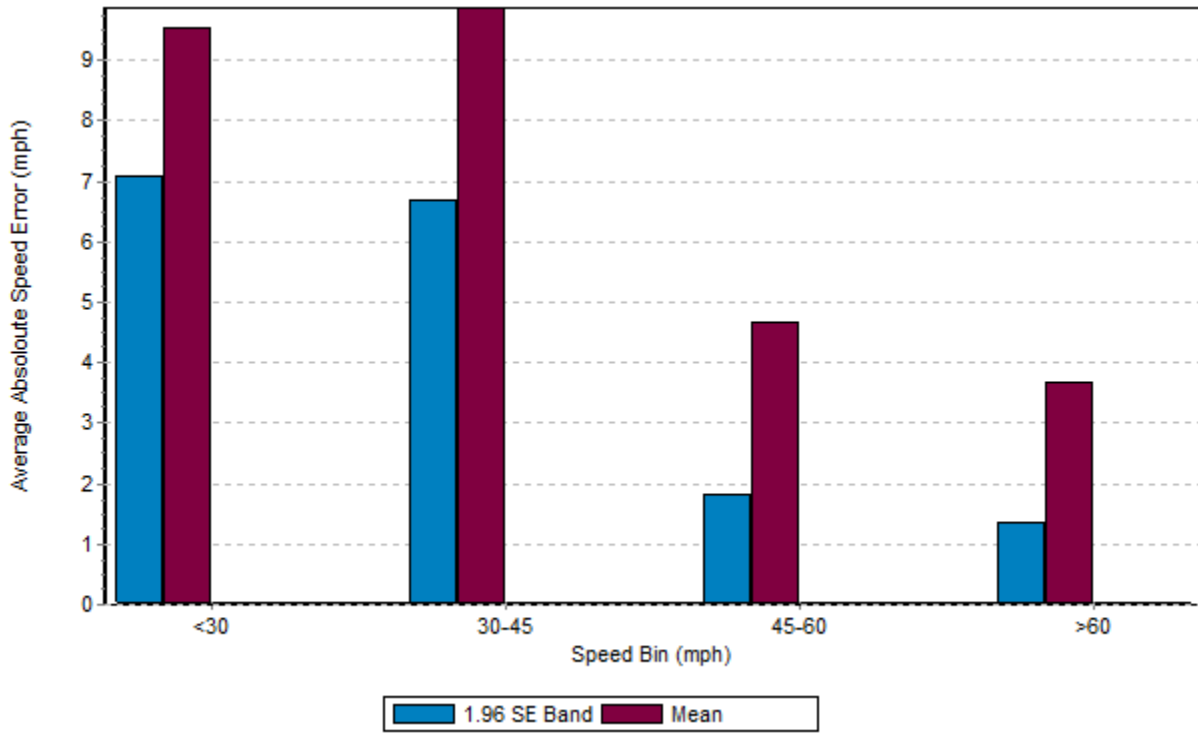


Figure 3
Average absolute speed error for freeway segments greater than one mile in Delaware