



I-95 Corridor Coalition

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

Monthly Report: Connecticut



January 2013

I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT VALIDATION OF INRIX DATA OCTOBER 2012

Monthly Report

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Prepared by:

Ali Haghani, Masoud Hamedi, Yang Lu, Yashar Aliari Kardedeh
University of Maryland, College Park

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January 2013

Evaluation Results for the State of Connecticut

Executive Summary

The data from the Vehicle Probe Project is validated using Bluetooth™ Traffic Monitoring (BTM) technology on a near monthly basis. BTMs sensor were deployed on the beginning and ending points of 12 different segments along I-95 between exit 13 (US-1) in the south and exit 32 (Broad St) in the north in Fairfield County, Connecticut. Travel time data was collected for both directions along the freeway. The data was collected between October 19, 2012 and October 28, 2012 with the assistance of Connecticut Department of Transportation (CTDOT) personnel. The dataset collected represents approximately 2154 hours of observations along 12 freeway segments, totaling approximately 35 miles. The number of effective five-minute travel time samples observed was 25851 in total.

ES Table 1, below summarizes the results of the comparison between the validation data and the INRIX data for freeway segments during the above noted periods. As shown, the average absolute speed error (AASE) and Speed Error Bias (SEB) were within specification for all speed bins. Even when errors are measured against the mean (rather than the SEM band) the data meets contract specifications for the AASE and SEB in all speed bins.

ES Table 1 - Connecticut Evaluation Summary for Freeway						
Speed Bin	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	1.4	2.0	0.5	0.6	2002	166.8
30-45 MPH	3.0	4.9	1.9	3.1	859	71.6
45-60 MPH	2.1	4.3	1.8	3.6	3586	298.8
>60 MPH	1.3	3.3	-0.8	-1.6	19404	1617.0
All Speeds	1.5	3.4	-0.3	-0.5	25851	2154.3

Based upon data collected from October 19th, 2012 through October 28th, 2012 across 34.9 miles of roadway.

As part of the on-going validation process, vehicle probe data from each state is validated on a rotating basis. This is the first round of vehicle probe validation in the state of Connecticut.

Data Collection

The data from the Vehicle Probe Project is validated using Bluetooth™ Traffic Monitoring (BTM) technology on a near monthly basis. BTMs sensor were deployed on the beginning and ending points of 12 different segments along I-95 between exit 13 (US-1) in the south and exit 32 (Broad St) in the north. Travel time data was collected for both directions along the freeway. The data was collected between October 19, 2012 and October 28, 2012 with the assistance of Connecticut Department of Transportation (CTDOT) personnel. Segment locations are chosen with a high-likelihood of observing recurrent and non-recurrent congestions during peak or off-peak periods.

Figure 1 presents an overview snapshot of the roadway segments over which Bluetooth sensors were deployed along the I-95 corridor in Connecticut. Blue segments represent freeway segments selected for analysis.

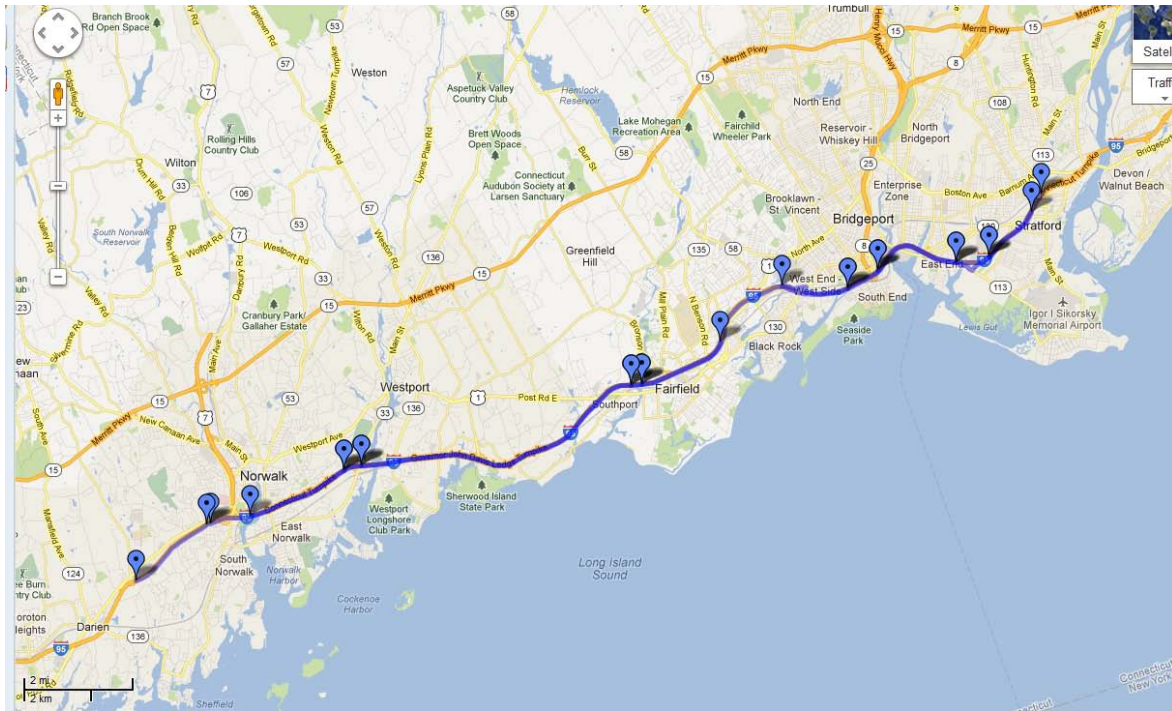


Figure 1 — Locations of all segments selected for analysis in Connecticut

TMC segments selected for validation in Connecticut

Table 1 presents a list of data collection segments from Connecticut. In total, these segments cover a total length of approximately 35 freeway miles. Data collection segments are comprised of one or more Traffic Message Channel (TMC) base segments, such that total length of the data collection segment is one mile long or greater for freeways. When appropriate, consecutive TMC segments are combined to form a data collection segment longer than one mile. The results of validation performed on 12 freeway segments are included in this report. Table 1 contains summary information on each data collection segment. The latitude/longitude coordinates of the locations at which the Bluetooth sensors were deployed throughout the state of Connecticut are provided in Table 1 as well as an active map link to view the data collection segment in detail. Click on the map link to see a detailed map for the respective data collection segment. It should be noted that the configuration of test segments is often such that the endpoint of one segment coincides with the start point of the next segment, so that one Bluetooth sensor covers both data collection segments.

Table 1 also provides data on the precise length of the TMCs comprising the test segment as compared to the measured length between BluetoothTM Traffic Monitoring (BTM) sensors placed on the roadway. Details of the algorithm used to estimate equivalent path travel times based on INRIX data feeds for individual data collection segments are provided in a separate report. This algorithm finds an equivalent INRIX travel time (and therefore travel speed) corresponding to each sample BTM travel time observation on the test segment of interest.

Table 1
Segments selected for validation in Connecticut

SEGMENT (Map Link)	DESCRIPTION			TMC CODES		Deployment		
	Highway Direction	State County	Starting at Ending at	Begin End	Number Length	Begin Lat/Lon End Lat/Lon	Length % Diff	
FREEWAYS								All Lengths in Miles
F1 (120+04841)	I-95 Northbound	Connecticut FAIRFIELD	US-1/Post Rd/Exit 13 Fairfield Ave/Exit 14	120+04841 120+04842	3 1.7	41.089505 -73.453736 41.104593 -73.428577	1.82 -6.6%	
F2 (120+04843)	I-95 Northbound	Connecticut FAIRFIELD	Fairfield Ave/Exit 14 CT-33/CT-136/Exit 17	120+04843 120+04845	5 2.7	41.105054 -73.427196 41.119298 -73.379717	2.69 0.4%	
F3 (120P04845)	I-95 Northbound	Connecticut FAIRFIELD	CT-33/CT-136/Exit 17 Bronson Rd/Exit 20	120P04845 120+04848	6 5.9	41.119298 -73.379717 41.141994 -73.277827	5.94 -0.7%	
F4 (120P04848)	I-95 Northbound	Connecticut FAIRFIELD	Bronson Rd/Exit 20 Wordin Ave/Exit 26	120P04848 120P04854	13 4.8	41.141994 -73.277827 41.167819 -73.200884	4.81 -0.2%	
F5 (120+04855)	I-95 Northbound	Connecticut FAIRFIELD	Wordin Ave/Exit 26 CT-113/Lordship Blvd/Exit 30	120+04855 120+04858	7 2.4	41.167819 -73.200884 41.174796 -73.162489	2.28 5.3%	
F6 (120P04858)	I-95 Northbound	Connecticut FAIRFIELD	CT-113/Lordship Blvd/Exit 30 Broad St/Exit 32	120P04858 120+04861	6 1.8	41.174796 -73.162489 41.18817 -73.135681	1.84 -2.2%	
F7 (120N04861)	I-95 Southbound	Connecticut FAIRFIELD	Broad St/Exit 32 Surf Ave/Exit 30	120N04861 120-04859	4 1.5	41.19314 -73.132072 41.17637 -73.150661	1.51 -0.7%	
F8 (120N04859)	I-95 Southbound	Connecticut FAIRFIELD	Surf Ave/Exit 30 CT-25/CT-8/Exit 27	120N04859 120-04855	8 2.4	41.17637 -73.150661 41.1725712 -73.1900382	2.36 1.7%	
F9 (120N04855)	I-95 Southbound	Connecticut FAIRFIELD	CT-25/CT-8/Exit 27 Fairfield Ave/State St/Exit 25	120N04855 120N04853	5 1.9	41.1725712 -73.1900382 41.168519 -73.224289	1.97 -3.6%	

Table 1 (Cont'd)
Segments selected for validation in Connecticut

SEGMENT (Map Link)	DESCRIPTION			TMC CODES		Deployment			
	Highway Direction	State County	Starting at Ending at	Begin End	Number Length	Begin Lat/Lon End Lat/Lon	Length % Diff		
FREEWAYS								All Lengths in Miles	
F10 (120-04850)	I-95 Southbound	Connecticut FAIRFIELD	US-1/Exit 23 Bronson Rd/Exit 20	120-04850 120-04848	5 1.7	41.153448 -73.246005 41.142361 -73.273977	1.82 -6.6%		
F11 (120N04848)	I-95 Southbound	Connecticut FAIRFIELD	Bronson Rd/Exit 20 CT-33/CT-136/Exit 17	120N04848 120-04845	6 5.8	41.142361 -73.273977 41.120617 -73.373425	5.73 1.2%		
F12 (120N04845)	I-95 Southbound	Connecticut FAIRFIELD	CT-33/CT-136/Exit 17 US-7/Exit 15	120N04845 120-04843	4 2.3	41.120617 -73.373425 41.106988 -73.413012	2.32 -0.9%		
TOTALS					72 34.9		35.1		

Analysis of Freeway Results

Table 2 summarizes the data quality measures obtained as a result of comparison between Bluetooth and all reported INRIX speeds. Specifications include the Average Absolute Speed Error (AASE) and the Speed Error Bias (SEB).

Average Absolute Speed Error (AASE)

The AASE is defined as the mean absolute value of the difference between the mean speed reported from the VPP and the ground truth mean speed for a specified time period. The AASE is the primary accuracy metric. Based on the contract specifications, the speed data from the VPP shall have a maximum average absolute error of 10 miles per hour (MPH) in each of four speed ranges: 0-30 MPH, 30-45 MPH, 45-60 MPH, and > 60 MPH.

Speed Error Bias (SEB)

The SEB is defined as the average speed error (not the absolute value) in each speed range. SEB is a measure of whether the speed reported in the VPP consistently under or over estimates speed as compared to ground truth speed. Based on the contract specifications, the VPP data shall have a maximum SEB of +/- 5 MPH in each of speed ranges as defined above.

The results are presented as compared against the mean of the ground truth data as well as the 95th percent confidence interval for the mean, referred to as the Standard Error of the Mean (SEM) band. The SEM band takes into account any uncertainty in the ground truth speed as measured by BTM equipment due to limited samples and/or data variance. Contract specifications are assessed against the SEM band. (See the *Vehicle Probe Project: Data Use and Application Guide* for additional details on the validation process.) The AASE in the lower two speed bands have proven to be the critical specification (and most difficult) to attain, and are highlighted in Table 2. AASE below 10 MPH meet contract specifications. AASE below 5 MPH are considered exceptional quality. As shown, the average absolute speed error (AASE) and Speed Error Bias (SEB) were within specification for all speed bins. Even when errors are measured against the mean (rather than the SEM band) the data meets contract specifications for the AASE and SEB in all speed bins.

TABLE 2
Data quality measures for freeway segments
in Connecticut

SPEED BIN	Data Quality Measures for				No. of 5 Minute Samples	Hours of Data Collection
	1.96 SEM Band		Mean			
	SEB 5 mph	AASE 10 mph (contract specifications)	SEB	AASE		
0-30	0.5	1.4	0.6	2.0	2002	167
30-45	1.9	3.0	3.1	4.9	859	72
45-60	1.8	2.1	3.6	4.3	3586	299
60+	-0.8	1.3	-1.6	3.3	19404	1617

Table 3 shows the percentage of the time INRIX data falls within 5 mph of the SEM band and the mean for each speed bin for all freeway data segments in Connecticut.

Table 3 Percent observations meeting data quality criteria for freeway segments in Connecticut

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SEM 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	26%	95%	0%	93%	2002
30-45	18%	81%	0%	69%	859
45-60	30%	88%	0%	68%	3586
60+	50%	92%	0%	77%	19404

Tables 4 and 5 present detailed data for individual TMC segments in Connecticut in a similar format as Tables 2 and 3, respectively. Note that for some segments and in some speed bins the comparison results may not be reliable due to small number of observations.

Table 4
Data quality measures for individual freeway validation segments greater than one mile in the state of Connecticut

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SEM Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
CT01-0001	1.7	1.82	0-30	0.2	1.1	0.2	1.7	880
			30-45	3.7	4.2	5.1	6.1	99
			45-60	2.1	2.8	3.9	5.0	446
			60+	-0.3	1.0	-0.7	2.9	990
CT01-0002	2.7	2.69	0-30	1.4	2.0	1.6	2.5	138
			30-45	2.7	3.0	3.2	3.8	96
			45-60	1.8	1.9	3.5	3.8	639
			60+	0.3	0.6	0.6	2.2	1481
CT01-0003	5.9	5.94	0-30	0.8	2.0	0.8	2.3	121
			30-45	1.1	2.7	1.3	3.2	152
			45-60	2.5	2.9	4.1	4.7	123
			60+	-0.2	0.7	-0.4	2.4	1954
CT01-0004	4.8	4.81	0-30	-1.1	2.3	-1.5	3.0	4*
			30-45	1.6	1.8	4.3	4.7	103
			45-60	2.0	2.0	5.0	5.1	155
			60+	-0.1	0.6	-0.3	2.4	1012
CT01-0005	2.4	2.28	0-30	-	-	-	-	0
			30-45	2.2	5.4	4.2	9.4	4*
			45-60	1.8	2.0	3.5	4.1	395
			60+	0.0	0.8	0.1	2.4	871
CT01-0006	1.8	1.84	0-30	0.3	2.4	0.4	3.1	4*
			30-45	1.6	2.1	1.6	3.6	7*
			45-60	1.0	1.9	2.3	4.1	30
			60+	-1.9	2.0	-3.8	4.3	2320
CT01-0007	1.5	1.51	0-30	-	-	-	-	0
			30-45	12.1	12.1	16.6	16.6	3*
			45-60	2.2	2.2	4.9	4.9	315
			60+	0.2	0.8	0.3	2.7	1942
CT01-0008	2.4	2.36	0-30	1.2	1.2	1.8	2.0	10*
			30-45	3.5	4.5	5.3	7.5	19*
			45-60	1.7	1.8	3.5	3.9	673
			60+	0.0	0.8	0.0	2.5	1556
CT01-0009	1.9	1.97	0-30	0.4	1.0	0.5	1.6	154
			30-45	1.1	3.3	2.8	6.6	19*
			45-60	-0.4	1.1	0.1	3.6	47
			60+	-2.3	2.4	-4.5	5.0	2117

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

Table 4 (Cont'd)
Data quality measures for individual freeway validation segments greater than one mile in the state of Connecticut

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SEM Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
CT01-0010	1.7	1.82	0-30	-0.1	1.8	-0.2	2.8	95
			30-45	-1.2	2.0	0.6	5.7	87
			45-60	0.5	1.4	2.2	4.1	83
			60+	-3.0	3.1	-5.5	5.8	2019
CT01-0011	5.8	5.73	0-30	0.8	2.2	0.9	2.6	139
			30-45	1.6	3.1	2.8	4.7	132
			45-60	1.7	2.5	2.8	4.2	197
			60+	-0.2	0.7	-0.6	2.3	1892
CT01-0012	2.3	2.32	0-30	0.6	1.4	0.8	2.2	457
			30-45	3.0	3.8	4.0	5.4	138
			45-60	1.4	2.0	3.1	4.2	483
			60+	0.1	0.9	0.3	2.7	1250

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

Table 5
Observations meeting data quality criteria for individual freeway validation segments
greater than one mile in the state of Connecticut

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SEM 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	
CT01-0001	0-30	253	29%	850	97%	0	0%	835	95%	880
	30-45	20	20%	66	67%	0	0%	49	49%	99
	45-60	142	32%	347	78%	0	0%	263	59%	446
	60+	560	57%	961	97%	0	0%	818	83%	990
CT01-0002	0-30	26	0.1884	127	0.9203	0	0	124	0.8986	138
	30-45	14	15%	79	82%	0	0%	69	72%	96
	45-60	177	28%	575	90%	0	0%	468	73%	639
	60+	920	62%	1455	98%	0	0%	1343	91%	1481
CT01-0003	0-30	10	8%	112	93%	0	0%	110	91%	121
	30-45	17	11%	130	86%	0	0%	127	84%	152
	45-60	17	14%	101	82%	0	0%	79	64%	123
	60+	1119	57%	1914	98%	1	0%	1765	90%	1954
CT01-0004	0-30	0	0	4	1	0	0	4	1	4*
	30-45	29	28%	96	93%	0	0%	81	79%	103
	45-60	54	35%	138	89%	0	0%	88	57%	155
	60+	663	66%	993	98%	1	0%	912	90%	1012
CT01-0005	0-30	-	-	-	-	-	-	-	-	0
	30-45	0	0%	2	50%	0	0%	0	0%	4*
	45-60	94	24%	357	90%	0	0%	270	68%	395
	60+	515	59%	852	98%	1	0%	793	91%	871
CT01-0006	0-30	0	0	4	1	0	0	4	1	4*
	30-45	1	0.1429	7	1	0	0	6	0.8571	7*
	45-60	11	37%	27	90%	0	0%	19	63%	30
	60+	790	34%	2028	87%	0	0%	1450	63%	2320
CT01-0007	0-30	-	-	-	-	-	-	-	-	0
	30-45	0	0%	0	0%	0	0%	0	0%	3*
	45-60	87	28%	273	87%	0	0%	183	58%	315
	60+	1172	60%	1870	96%	0	0%	1671	86%	1942
CT01-0008	0-30	5	50%	9	90%	0	0%	9	90%	10*
	30-45	5	26%	14	74%	0	0%	9	47%	19*
	45-60	234	35%	600	89%	0	0%	483	72%	673
	60+	951	61%	1503	97%	0	0%	1375	88%	1556

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

Table 5 (Cont'd)
Observations meeting data quality criteria for individual freeway validation segments greater than one mile in the state of Connecticut

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SEM 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	
CT01-0009	0-30	54	35%	149	97%	0	0%	149	97%	154
	30-45	3	16%	14	74%	0	0%	11	58%	19*
	45-60	26	55%	44	94%	0	0%	36	77%	47
	60+	597	28%	1777	84%	0	0%	1102	52%	2117
CT01-0010	0-30	21	22%	90	95%	0	0%	89	94%	95
	30-45	22	25%	79	91%	0	0%	59	68%	87
	45-60	36	43%	76	92%	0	0%	63	76%	83
	60+	469	23%	1534	76%	0	0%	867	43%	2019
CT01-0011	0-30	17	12%	128	92%	0	0%	124	89%	139
	30-45	17	13%	108	82%	0	0%	95	72%	132
	45-60	40	20%	168	85%	0	0%	129	65%	197
	60+	1145	61%	1846	98%	0	0%	1696	90%	1892
CT01-0012	0-30	130	28%	432	95%	0	0%	420	92%	457
	30-45	27	20%	98	71%	0	0%	83	60%	138
	45-60	159	33%	432	89%	0	0%	350	72%	483
	60+	765	61%	1203	96%	1	0%	1077	86%	1250

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