

I-95 Corridor Coalition -

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



April 2010

I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT: VALIDATION OF INRIX DATA APRIL 2010

Monthly Report

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April 2010

Evaluation Results for the State of Maryland

Executive Summary

Travel time samples were collected along approximately 16 miles of freeways and three miles of arterials in Maryland beginning on Tuesday, February 2, 2010 and compared with travel time and speed data reported by INRIX as part of the I-95 Vehicle Probe project. Due to unprecedented snowstorms in the study area which began on Friday, February 5, traffic volumes on area roadways substantially dropped and later some roads were closed to traffic due to white-out conditions. This setting lasted until Tuesday, February 9, 2010 and produced conditions in which hourly vehicular traffic was well below 500 in each direction on all area roadways. Therefore, validation was not performed on data during these snow days. The decision was made on a case by case basis as to when snow started to have its disruptive effect on the traffic on any given segment and when traffic started to get back on the road. The validation data represents approximately 770 hours of observations along 10 freeway segments in Maryland, six of which are standard TMC segments.

ES Table 1, below summarizes the results of the comparison between the validation data and the INRIX data for freeway segments for the same period. As shown, both the average absolute speed error and speed error bias were within specification for all speed bins. Even when errors are measured as a distance from the mean, INRIX data quality is deemed as satisfactory based on the same requirements.

	Avg Absolute (<10	e Speed Error mph)	Speed Er (<5n	ror Bias nph)	Number of	Hours of
State	Comparison		Comparison		5 Minute	Data Callection
	with SEM	M Comparison with SEM Comparison				Collection
	Band	with Mean	Band	with Mean		
0-30 MPH	3.60	5.10	1.10	1.40	918	76.5
30-45 MPH	4.30	6.60	1.80	2.50	1169	97.4
45-60 MPH	2.10	4.00	-0.10	0.20	4672	389.3
> 60 MPH	2.10	4.40	-1.80	-3.20	2508	209.0
All Speeds	2.53	4.55	-0.20	-0.31	9267	772.3
Based upon	data collected f	rom Feb 2, 2010	through Feb 1	0, 2010 across	16.3 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 the State of Maryland were validated on three occasions: July/August 2008, March 2009, and February 2010. This represents more than 1930 hours of observations along nearly 70 miles of freeway segments in Maryland. ES Table 2 provides a summary of the cumulative validation effort. As shown, both the absolute average speed error and speed error bias were within specification for all speed bins.

ES Table 2 - Maryland - Cummulative to Date										
State	Avg Absolute (<101	Speed Error	Speed Er (<5n	ror Bias nph)	Number of 5					
	Comparison	Comparison	Comparison	Comparison	Minute	Hours of Data				
	with SEM Band	with Mean	with SEM Band	with Mean	Samples	Collection				
0-30 MPH	3.86	5.25	1.43	1.80	1303	108.6				
30-45 MPH	4.36	6.64	1.74	2.55	1767	147.3				
45-60 MPH	1.95	3.90	-0.01	0.34	8413	701.1				
> 60 MPH	1.73	4.02	-1.47	-2.89	11741	978.4				
All Speeds	2.13	4.24	-0.54	-1.04	23224	1935.3				
Based upon data collected in	July/August 2	008, March 20	09, and Februar	y 2010.						

As mentioned, travel time samples were also collected along three miles of arterials in Maryland beginning on Tuesday, February 2, 2010 and compared with travel time and speed data reported by INRIX as part of this project. The arterial data is included for informational purposes noting that INRIX has volunteered arterial data at no cost to the Coalition for the first three years, and that the method to evaluate quality on arterial roadways has not been fully evaluated. As the Coalition collects additional data on arterials, more appropriate quality metrics will be developed.

Data Collection

Bluetooth sensor deployments in Maryland started on Tuesday, February 2, 2010. The actual deployments in Maryland were performed with the assistance of Maryland Coordinated Highways Action Response Team (CHART) personnel. Sensors remained in the same position until they were retrieved four weeks later on Monday, March 1, 2010. This round of data collections in Maryland 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. It is worth noting that due to unprecedented snowstorms in the Washington, D.C. area which began during the late evening on Friday, February 5, traffic volumes on area roadways substantially dropped and later some roads were closed to traffic due to white-out conditions. These conditions essentially lasted until Tuesday, February 9, 2010. These snowstorms produced conditions in which hourly vehicular traffic was well below 500 in each direction on all area roadways. This fact is confirmed by the number of Bluetooth observations in these time intervals which happens to reflect sporadic passage of vehicles in the roadways under investigation. Therefore, validation was not performed on data during these snow days. The decision was made on a case by case basis as to when snow started to have its disruptive effect on the traffic on any given segment and when traffic started to get back on the road.

Figure 1 presents snapshots of the roadway segments over which Bluetooth sensors were deployed in Maryland. In this figure, red segments represent freeway segments while blue segments are the ones that are chosen on arterials.

Table 1 presents a list of specific TMC segments that were selected as the validation sample in Maryland. These segments cover a total length of approximately 16 freeway

miles as well as 3 miles of arterials. 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. In this document results of validation performed on ten freeway segments are reported; six of which are standard TMC segments and the other four 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 Maryland 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 and 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 feeds for individual TMC segment are provided in a separate report titled "Estimation of Travel Times for Multiple TMC Segments" (dated February 2010) and available on the I-95 Corridor Coalition website. 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. In all speed bins, 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. Even when errors are measured as a distance from the mean, INRIX data quality is deemed as satisfactory based on the same requirements.

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 Maryland. Tables 6 and 7 present detailed data for individual TMC segments in Maryland in similar format as Tables 4 and 5 respectively.

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 Maryland, respectively. These figures correspond to Table 4.



Figure 1 TMC segments selected for validation in Maryland

 Table 1

 Traffic Message Channel segments picked for validation in Maryland

						LENGTH
ТҮРЕ	TMC	HIGHWAY	STARTING AT	ENDING AT	DIRECTION	(mile)
Freeway	110-04626	I-495	EXIT 27	MD-650/NEW HAMPSHIRE AVE/EXIT28	COUNTERCLOCKWIS	0.7
Freeway	110N04626	I-495	MD-650/NEW HAMPSHIRE AVE/EXIT28	MD-650/NEW HAMPSHIRE AVE/EXIT28	COUNTERCLOCKWIS	0.5
Freeway	110-04625	I-495	MD-650/NEW HAMPSHIRE AVE/EXIT28	MD-193/UNIVERSITY BLVD/EXIT 29	COUNTERCLOCKWIS	1.1
Freeway	110N04625	I-495	MD-193/UNIVERSITY BLVD/EXIT 29	MD-193/UNIVERSITY BLVD/EXIT 29	COUNTERCLOCKWIS	0.2
Freeway	110-04624	I-495	MD-193/UNIVERSITY BLVD/EXIT 29	US-29/COLESVILLE RD/EXIT 30	COUNTERCLOCKWIS	0.6
Freeway	110N04624	I-495	US-29/COLESVILLE RD/EXIT 30	US-29/COLESVILLE RD/EXIT 30	COUNTERCLOCKWIS	0.1
Freeway	110-04623	I-495	US-29/COLESVILLE RD/EXIT 30	MD-97/GEORGIA AVE/EXIT 31	COUNTERCLOCKWIS	1.1
Freeway	110N04623	I-495	MD-97/GEORGIA AVE/EXIT 31	MD-97/GEORGIA AVE/EXIT 31	COUNTERCLOCKWIS	0.4
Freeway	110-04622	I-495	MD-97/GEORGIA AVE/EXIT 31	MD-185/CONNECTICUT AVE/EXIT 33	COUNTERCLOCKWIS	1.6
Freeway	110N04622	I-495	MD-185/CONNECTICUT AVE/EXIT 33	MD-185/CONNECTICUT AVE/EXIT 33	COUNTERCLOCKWIS	0.7
Freeway	110-04621	I-495	MD-185/CONNECTICUT AVE/EXIT 33	MD-355/WISCONSIN AVE/EXIT 34	COUNTERCLOCKWIS	1.1
Freeway	110+04622	I-495	MD-355/WISCONSIN AVE/EXIT 34	MD-185/CONNECTICUT AVE/EXIT 33	CLOCKWISE	1.1
Freeway	110P04622	I-495	MD-185/CONNECTICUT AVE/EXIT 33	MD-185/CONNECTICUT AVE/EXIT 33	CLOCKWISE	0.4
Freeway	110+04623	I-495	MD-185/CONNECTICUT AVE/EXIT 33	MD-97/GEORGIA AVE/EXIT 31	CLOCKWISE	1.8
Freeway	110P04623	I-495	MD-97/GEORGIA AVE/EXIT 31	MD-97/GEORGIA AVE/EXIT 31	CLOCKWISE	0.5
Freeway	110+04624	I-495	MD-97/GEORGIA AVE/EXIT 31	US-29/COLESVILLE RD/EXIT 30	CLOCKWISE	1.0
Freeway	110P04624	I-495	US-29/COLESVILLE RD/EXIT 30	US-29/COLESVILLE RD/EXIT 30	CLOCKWISE	0.4
Freeway	110+04625	I-495	US-29/COLESVILLE RD/EXIT 30	MD-193/UNIVERSITY BLVD/EXIT 29	CLOCKWISE	0.2
Freeway	110P04625	I-495	MD-193/UNIVERSITY BLVD/EXIT 29	MD-193/UNIVERSITY BLVD/EXIT 29	CLOCKWISE	0.4
Freeway	110+04626	I-495	MD-193/UNIVERSITY BLVD/EXIT 29	MD-650/NEW HAMPSHIRE AVE/EXIT28	CLOCKWISE	1.1
Freeway	110P04626	I-495	MD-650/NEW HAMPSHIRE AVE/EXIT28	MD-650/NEW HAMPSHIRE AVE/EXIT28	CLOCKWISE	0.6
Freeway	110+04627	I-495	MD-650/NEW HAMPSHIRE AVE/EXIT28	EXIT 27	CLOCKWISE	0.5
SUBTOTAL						16.3

 Table 1

 Traffic Message Channel segments picked for validation in Maryland (Cont'd)

						LENGTH
ТҮРЕ	TMC	HIGHWAY	STARTING AT	ENDING AT	DIRECTION	(mile)
Arterial	110-05862	MD-355	CEDAR LN	JONES BRIDGE RD	SOUTHBOUND	0.64
Arterial	110N05862	MD-355	JONES BRIDGE RD	JONES BRIDGE RD	SOUTHBOUND	0.01
Arterial	110-05861	MD-355	JONES BRIDGE RD	WOODMONT AVE	SOUTHBOUND	0.04
Arterial	110N05861	MD-355	WOODMONT AVE	WOODMONT AVE	SOUTHBOUND	0.08
Arterial	110-05860	MD-355	WOODMONT AVE	MD-410/MD-187	SOUTHBOUND	0.72
Arterial	110+05861	MD-355	MD-410/MD-187	WOODMONT AVE	NORTHBOUND	0.73
Arterial	110P05861	MD-355	WOODMONT AVE	WOODMONT AVE	NORTHBOUND	0.02
Arterial	110+05862	MD-355	WOODMONT AVE	JONES BRIDGE RD	NORTHBOUND	0.10
Arterial	110P05862	MD-355	JONES BRIDGE RD	JONES BRIDGE RD	NORTHBOUND	0.03
Arterial	110+05863	MD-355	JONES BRIDGE RD	CEDAR LN	NORTHBOUND	0.62
SUBTOTAL						3.0
TOTAL						19.3

 Table 2

 TMC segment lengths and distances between sensor deployment locations in the state of Maryland

SEGMENT			STA	ANDARD TM	IC .			SENSO	R DEPLOYN	IENT		ERROR IN
ТҮРЕ	TMC	Endp	oint (1)	Endp	oint (2)	Length	Endp	oint (1)	Endp	oint (2)	Length	SEGMENT LENGTH
		Lat	Long	Lat	Long	(mile)	Lat	Long	Lat	Long	(mile)	(%)
Freeway	110-04626	39.020162	-76.958232	39.018558	-76.970559	0.67	39.020555	-76.958010				
Freeway	110N04626	39.018558	-76.970559	39.019864	-76.980603	0.55			39.020128	-76.979382		
Freeway	110-04625	39.019864	-76.980603	39.015834	-77.001145	1.15	39.020128	-76.979382	39.016053	-77.000818	1.19	3.8%
Freeway	110N04625	39.015834	-77.001145	39.015365	-77.005355	0.23	39.016053	-77.000818				
Freeway	110-04624	39.015365	-77.005355	39.015987	-77.015934	0.58						
Freeway	110N04624	39.015987	-77.015934	39.016043	-77.018664	0.15			39.016718	-77.020915		
Freeway	110-04623	39.016043	-77.018664	39.013442	-77.038472	1.13	39.016718	-77.020915	39.013655	-77.037203	0.94	-17.0%
Freeway	110N04623	39.013442	-77.038472	39.013586	-77.045273	0.37	39.013655	-77.037203	39.013727	-77.044908	0.42	15.0%
Freeway	110-04622	39.013586	-77.045273	39.006482	-77.070519	1.61	39.013727	-77.044908	39.006800	-77.070567	1.63	1.0%
Freeway	110N04622	39.006482	-77.070519	39.005764	-77.083150	0.69	39.006800	-77.070567	39.005743	-77.082275	0.64	-7.0%
Freeway	110-04621	39.005764	-77.083150	39.016434	-77.098330	1.13	39.005743	-77.082275	39.016978	-77.099322	1.24	9.6%
Freeway	110+04622	39.015629	-77.096938	39.005185	-77.082227	1.10	39.015347	-77.096767	39.006510	-77.085322	0.89	-19.0%
Freeway	110P04622	39.005185	-77.082227	39.005774	-77.074669	0.41	39.006510	-77.085322	39.005483	-77.073298	0.67	63.5%
Freeway	110+04623	39.005774	-77.074669	39.013444	-77.046431	1.78	39.005483	-77.073298	39.012938	-77.043528	1.87	5.2%
Freeway	110P04623	39.013444	-77.046431	39.013267	-77.037358	0.49	39.012938	-77.043528				
Freeway	110+04624	39.013267	-77.037358	39.016116	-77.020426	0.98			39.016047	-77.020402		
Freeway	110P04624	39.016116	-77.020426	39.016248	-77.012525	0.43	39.016047	-77.020402				
Freeway	110+04625	39.016248	-77.012525	39.015953	-77.008328	0.23						
Freeway	110P04625	39.015953	-77.008328	39.015796	-77.000479	0.44			39.015482	-76.999213		
Freeway	110+04626	39.015796	-77.000479	39.019698	-76.980924	1.09	39.015482	-76.999213				
Freeway	110P04626	39.019698	-76.980924	39.018362	-76.969369	0.63						
Freeway	110+04627	39.018362	-76.969369	39.018984	-76.960131	0.50			39.018758	-76.960017		
SUBTOTAL						16.32						

Table 2 (continued) TMC segment lengths and distances between sensor deployment locations in the state of Maryland (Cont'd)

SEGMENT			STA	ANDARD TM	IC			SENSO	R DEPLOYN	1ENT		ERROR IN
ТҮРЕ	TMC	Endp	oint (1)	Endp	oint (2)	Length	Endp	oint (1)	1) Endpoint (2)		Length	SEGMENT LENGTH
		Lat	Long	Lat	Long	(mile)	Lat	Long	Lat	Long	(mile)	(%)
Arterial	110-05862	39.006140	-77.097682	38.996931	-77.096706	0.64	39.006580	-77.097922				
Arterial	110N05862	38.996931	-77.096706	38.996827	-77.096697	0.01			38.996265	-77.096698		
Arterial	110-05861	38.996827	-77.096697	38.996273	-77.096644	0.04	38.996265	-77.096698				
Arterial	110N05861	38.996273	-77.096644	38.995126	-77.096530	0.08						
Arterial	110-05860	38.995126	-77.096530	38.984814	-77.094330	0.72			38.984765	-77.094422		
Arterial	110+05861	38.984722	-77.094164	38.995129	-77.096367	0.73	38.984765	-77.094422				
Arterial	110P05861	38.995129	-77.096367	38.995352	-77.096395	0.02						
Arterial	110+05862	38.995352	-77.096395	38.996836	-77.096553	0.10			38.996265	-77.096698		
Arterial	110P05862	38.996836	-77.096553	38.997232	-77.096586	0.03	38.996265	-77.096698				
Arterial	110+05863	38.997232	-77.096586	39.006166	-77.097485	0.62			39.006580	-77.097922		
SUBTOTAL						2.98						
TOTAL						19.30						

Table 3Path segments identified for validation in Maryland

		STANI	DARD SEGN	IENTS INC	LUDED				LE	NGTH (MIL	E)
Туре	Validation						CTADTING AT			D 1 (Error
	Segment	TMC(I)	TMC(2)	TMC(3)	TMC(4)	TMC(5)	SIAKIING AI	ENDING AT	Standard	Deployment	(%)
							EXIT 27	MD-650/NEW			
Emonwow	MD02 0001	110 04626	110104626					HAMPSHIKE	1.22	1 10	2 200/
Fleeway	MD05-0001	110-04020	1101004020				MD (50/MEW	AVE/EAT120	1.22	1.10	-3.30%
							MD-030/NEW	MD- 102/UNIVEDSITV			
Froowow	110 04625	110 04625					AVE/EVIT29	DI VD/EVIT 20	1.15	1 10	2 770/
Ficeway	110-04025	110-04025						MD 07/CEODCIA	1.15	1.17	5.7770
Froowow	110 04623	110 04623					PD/EVIT 30	MD-97/OEOROIA	1 13	0.04	16.06%
Ficeway	110-04023	110-04023					MD 07/GEODCIA	MD	1.15	0.94	-10.90%
							MD-97/OEOROIA	MD- 185/CONNECTICUT			
Freeway	110-04622	110-04622					AVL/LAIT JI	$\Delta VF/FXIT 33$	1.61	1.63	1.02%
Treeway	110-04022	110 04022					MD_	MD-355/WISCONSIN	1.01	1.05	1.0270
							185/CONNECTICUT	AVE/EXIT 34			
Freeway	110-04621	110-04621					AVE/EXIT 33		1.13	1.24	9.59%
	110 01021	110 01021					MD-	MD-	1110		210270
							355/WISCONSIN	185/CONNECTICUT			
Freeway	110+04622	110+04622					AVE/EXIT 34	AVE/EXIT 33	1.10	0.89	-19.04%
-							MD-	MD-97/GEORGIA			
							185/CONNECTICUT	AVE/EXIT 31			
Freeway	110+04623	110+04623					AVE/EXIT 33		1.78	1.87	5.23%
							MD-97/GEORGIA	US-29/COLESVILLE			
Freeway	MD03-0002	110P04623	110+04624				AVE/EXIT 31	RD/EXIT 30	1.46	1.31	-10.46%
							US-29/COLESVILLE	MD-			
							RD/EXIT 30	193/UNIVERSITY			
Freeway	MD03-0003	110P04624	110+04625	110P04625				BLVD/EXIT 29	1.09	1.15	5.07%
							MD-	EXIT 27			
-							193/UNIVERSITY				
Freeway	MD03-0004	110+04626	110P04626	110+04627			BLVD/EXIT 29		2.22	2.17	-2.24%
SUBTOTA	L	1							13.90	13.57	-2.36%
Arterial	MD03-0005	110-05862	110N05862	110-05861	110N05861	110-05860	CEDAR LN	MD-410/MD-187	1.49	1.52	2.01%
Arterial	MD03-0006	110+05861	110P05861	110+05862	110P05862	110+05863	MD-410/MD-187	CEDAR LN	1.49	1.52	2.01%
SUBTOTA	L								2.98	3.04	2.01%
TOTAL									16.88	16.61	-1.59%

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

	[Data Quality	Measures	for				
	1.96 \$	SE Band	Σ	Mean				
SPEED BIN	Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Speed Absolute Error Speed Bias Error				
0-30	1.1	3.6	1.4	5.1	918			
30-45	1.8	4.3	2.5	6.6	1169			
45-60	-0.1	-0.1 2.1		4.0	4672			
60+	-1.8	2.1	-3.2	4.4	2508			

Table 5

Percent observations meeting data quality criteria for freeway segments greater than one mile in Maryland

		Data Quality	Measures for		
	1.96 SI	E Band	Ме		
SPEED BIN	Percentage Percentage falling falling within 5 inside the mph of the band band		Percentage equal to the mean	Percentage within 5 mph of the mean	No. of Obs.
0-30	17%	76%	0%	66%	918
30-45	27%	66%	0%	50%	1169
45-60	39%	87%	0%	71%	4672
60+	41%	85%	0%	66%	2508

Data Quali	ty Measures	for	
Standard 1.96 SE Band	Ν	Mean	1
TMC TMC Bluetooth SPEED Speed Absolute length distance BIN Speed Absolute Bias Error	Speed Error Bias	Average Absolute Speed Error	No. of Obs.
0-30 1.6 3.4	2.1	4.6	179
110,04622 1.12 0.80 30-45 1.0 4.6	1.6	6.7	283
45-60 -0.8 2.3	-0.8	3.9	884
60+ -1.7 1.8	-3.0	3.9	69
0-30 1.2 4.2	1.5	5.6	89
110+04623 1.81 1.87 30-45 2.0 3.6	2.6	5.3	95
45-60 -0.1 1.5	0.1	3.4	469
60+ -1.7 1.8	-3.9	4.8	67
0-30 1.2 3.3	1.5	4.9	100
110-04621 1.15 1.24 30-45 2.9 4.9	3.8	7.3	107
45-60 -0.8 2.1	-1.0	3.8	514
60+ -1.9 2.2	-3.6	4.5	166
0-30 2.4 5.0	2.6	5.8	86
110-04622 1.57 1.63 30-45 3.6 5.7	4.8	7.7	158
45-60 1.4 1.9	2.4	3.8	702
60+ -1.0 1.4	-1.9	3.3	83
0-30 0.7 4.6	0.8	5.4	81
110-04623 1.09 0.94 30-45 2.6 4.9	3.6	6.9	86
45-60 -0.5 2.3	-0.1	4.5	253
60+ -1.7 2.0	-2.9	4.1	479
0-30 1.2 4.0	1.4	5.2	88
110-04625 1.15 1.19 30-45 2.3 3.7	2.7	6.6	46
45-60 -1.5 3.1	-1.9	5.5	139
60+ -2.0 2.3	-3.6	4.5	631
0-30 0.9 2.5	1.2	3.5	83
MD03-0001 1.22 1.18 30-45 2.2 4.3	3.3	7.3	82
45-60 0.7 1.9	1.3	3.9	616
60+ -0.9 1.4	-1.5	3.2	143
0-30 1.0 2.4	1.9	4.4	60
MD03-0002 1.48 1.31 30-45 1.5 3.5	2.2	6.1	95
45-60 0.4 1.8	1.4	4.1	402
60+ -0.6 0.8	-1.6	3.1	146
0-30 -1.5 2.8	-1.3	4.1	66
MD03-0003 1.02 1.15 30-45 -1.4 3.9	-1.9	6.0	70
45-60 -2.8 2.9	13	5.1	308
60+ -4.5 4.5	-4.5		
	-4.3	7.3	335
	-4.3 -7.3 0.7	7.3 7.3	335 86
MD03-0004 2.26 2.17 30-45 1.1 3.0 45.50 0.5 1.0 <	-4.3 -7.3 0.7 1.9	7.3 7.3 5.8	335 86 147 385

 Table 6

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

Det O alle Man and a										
				Da	ta Quality	Measures	for			
			1.96 SI	E Band			М	ean		
	Z	C. J.F.	D'	Average	Absolute	G 1 E	D'	Average	Absolute	
	BI	Speed El	rror Blas	Speed	Error	Speed E	rror Blas	Speed	Error	No. of
TMC	PEED	No.	%	No. falling	% falling			No.	%	Obs.
	\mathbf{S}	falling	falling	within	within	No.	%	within	within	
		inside	inside	5 mph	5 mph	equal	equal	5 mph	5 mph	
		the band	the band	of the band	of the	to the	to the	of the	of the	
	0-30	30	17%	142	79%	0	0%	125	70%	179
	30-45	68	24%	182	64%	0	0%	137	48%	283
110+04622	45-60	309	35%	767	87%	0	0%	661	75%	884
	60+	31	45%	60	87%	0	0%	51	74%	69
	0-30	13	15%	60	67%	0	0%	52	58%	89
110.04(22	30-45	26	27%	65	68%	1	1%	53	56%	95
110+04623	45-60	229	49%	425	91%	0	0%	358	76%	469
	60+	22	33%	62	93%	0	0%	42	63%	67
	0-30	17	17%	81	81%	0	0%	59	59%	100
110 04621	30-45	27	25%	65	61%	0	0%	51	48%	107
110-04021	45-60	210	41%	450	88%	0	0%	381	74%	514
	60+	67	40%	144	87%	0	0%	110	66%	166
	0-30	8	9%	55	64%	0	0%	50	58%	86
110-04622	30-45	31	20%	89	56%	0	0%	68	43%	158
110-04022	45-60	261	37%	620	88%	0	0%	501	71%	702
	60+	40	48%	74	89%	0	0%	64	77%	83
	0-30	9	11%	56	69%	0	0%	54	67%	81
110-04623	30-45	22	26%	51	59%	0	0%	41	48%	86
	45-60	100	40%	212	84%	0	0%	165	65%	253
	60+	218	46%	412	86%	0	0%	340	71%	479
	0-30	10	11%	70	80%	0	0%	64	73%	88
110-04625	30-45 45 60	18	39% 280/	54 109	74%	0	0%	21	59%	40
	45-00	220	38%	108	/8%	0	0%	85 411	61%	621
	0.20	230	20%	72	0470	0	0%	411	0370 920/	031 92
	30-45	26	20%	73 55	67%	0	0%	<u></u>	50%	82
MD03-0001	45-60	20	3 <u>2</u> %	53 546	89%	0	0%	426	69%	616
	60+	70	49%	131	92%	0	0%	115	80%	143
	0-30	17	28%	50	83%	0	0%	41	68%	60
	30-45	22	23%	68	72%	0	0%	49	52%	95
MD03-0002	45-60	169	42%	360	90%	0	0%	273	68%	402
	60+	92	63%	140	96%	0	0%	118	81%	146
	0-30	9	14%	55	83%	0	0%	49	74%	66
	30-45	19	27%	52	74%	0	0%	37	53%	70
MD03-0003	45-60	113	37%	240	78%	0	0%	186	60%	308
	60+	46	14%	208	62%	0	0%	93	28%	335
	0-30	27	31%	59	69%	0	0%	47	55%	86
MD03-0004	30-45	51	35%	114	78%	0	0%	80	54%	147
11100-0004	45-60	145	38%	338	88%	0	0%	262	68%	385
	60+	208	53%	365	94%	2	1%	315	81%	389

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



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



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

Analysis of Results for Arterials

Table 8 summarizes the data quality measures obtained as a result of comparison between Bluetooth and all reported INRIX speeds on two arterial segments considered in this round of validations. In all speed bins below 45mph, 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. In addition, no observation is made in the speed bins above 45 mph which is compatible with the posted speed limits on the arterial segments in question.

Table 9 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 arterial segments in Maryland. Tables 10 and 11 present detailed data for individual arterial segments in Maryland in similar format as Tables 8 and 9, 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 4 and 5 show the overall speed error biases for different speed bins, and the average absolute speed errors for all considered arterial segments in Maryland, respectively. These figures correspond to Table 8.

Table 8Data quality measures for arterial segments greater than
one mile in Maryland

	[Data Quality	Measures	s for	
	1.96 \$	SE Band	Μ		
SPEED BIN	Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	No. of Obs.	
0-30	3.6	4.9	5.2	7.4	695
30-45	-0.5	0.5	-2.4	3.5	4
45-60					
60+					

Table 9

Percent observations meeting data quality criteria for arterial segments greater than one mile in Maryland

	Data Quality Measures for						
	1.96 SI	E Band	Ме				
SPEED BIN	Percentage 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	No. of Obs.		
0-30	24%	61%	0%	42%	695		
30-45	75%	100%	0%	75%	4		
45-60							
60+							

Table 10 Data quality measures for individual arterial validation segments greater than one mile in the state of Maryland

	Standard TMC length	Bluetooth distance	SPEED BIN					
				1.96 S	E Band	Mean		
ТМС				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	No. of Obs.
		1.52	0-30	3.3	4.7	4.7	7.1	418
MD03-0005	1.40		30-45	0.0	0.0	0.4	0.4	1*
141005-0005	1.49		45-60					
			60+					
	1.40	1.52	0-30	4.0	5.2	6.0	7.8	277
MD03-0006			30-45	-0.7	0.7	-3.4	4.5	3*
141003-0000	1.49		45-60					
			60+					

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

 Table 11

 Observations meeting data quality criteria for individual arterial validation segments greater than one mile in the state of Maryland

тмс	SPEED BIN	Data Quality Measures for								
		1.96 SE Band			Mean					
		Speed Error Bias		Average Absolute Speed Error		Speed Error Bias		Average Absolute Speed Error		No. of
		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	Obs.
MD03-0005	0-30	102	24%	262	63%	1	0%	181	43%	418
	30-45	1	100%	1	100%	0	0%	1	100%	1*
	45-60									
	60+									
MD03-0006	0-30	67	24%	159	57%	0	0%	108	39%	277
	30-45	2	67%	3	100%	0	0%	2	67%	3*
	45-60									
	60+									

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



Figure 4 Speed error bias for arterial segments greater than one mile in Maryland



Figure 5 Average absolute speed error for arterial segments greater than one mile in Maryland