

Utilization of Bluetooth® Technology for Rural Intercity Travel Times and to Collect External Travel Movements Data for Travel Demand Models

Session E2: Weather and Travel Intelligence

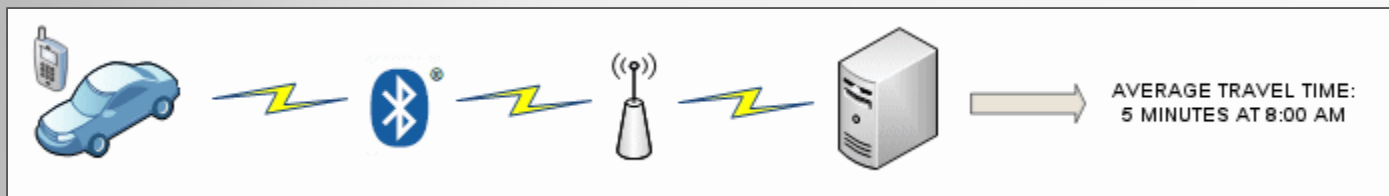
Darrell W. Borchardt, P.E.
Steve Farnsworth

Texas A&M Transportation Institute

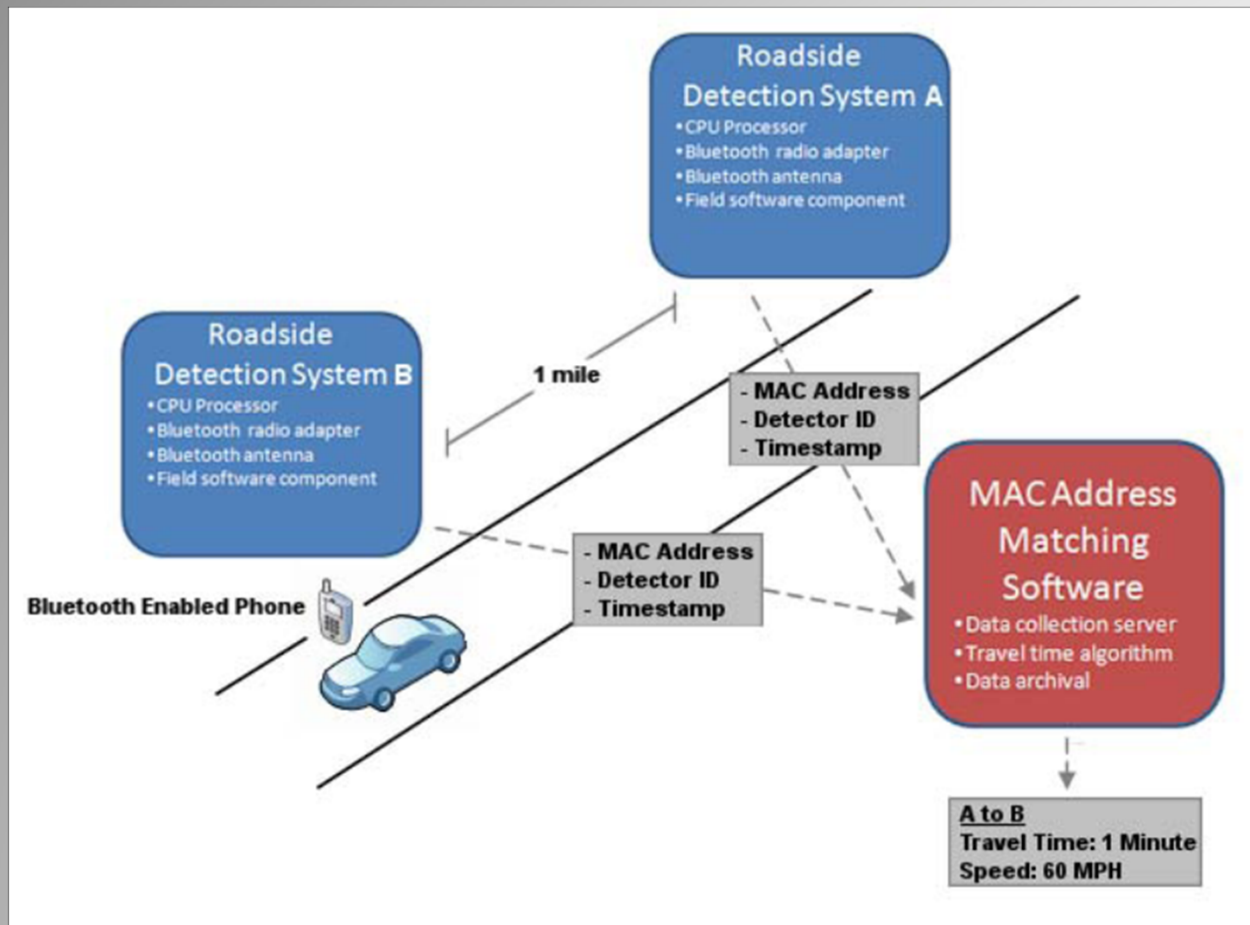
National Rural ITS Conference
August 25-28, 2013
St. Cloud, Minnesota

Bluetooth Overview

- Wireless technology for exchanging data over short distances
- Bluetooth frequently embedded in mobile phones and in-vehicle navigation systems
- Every Bluetooth device has a unique Media Access Control (MAC) address
- Bluetooth devices can be anonymously detected
- Commonly used in developing travel time and speed estimates



Bluetooth Technology



Key Points About TTI's Bluetooth

- Installation does not require lane closures
- Bluetooth devices are detected anonymously
- Collects samples of 'actual' trip-making that can be expanded to total traffic
- Each unit collects data in both directions
- Field units can be battery powered or located in roadside cabinets
- Option to not transmit duplicates to host server
- Collects ample percentages of Bluetooth 'reads' to total traffic
 - 5 to 25% of traffic, depending on roadway and area
 - More than adequate sample sizes
- Patent pending process that has been commercialized

Bluetooth development at TTI

- Staff has worked with AVI [toll tag] system for travel times on Houston freeways since 1996
- Local agencies desired arterial coverage, but technology was expensive and alternatives were explored
- 2007 began development of AWAM technology using Bluetooth
- Traditional Bluetooth discovery cycle process was not sufficient to provide comparable data

Bluetooth development at TTI

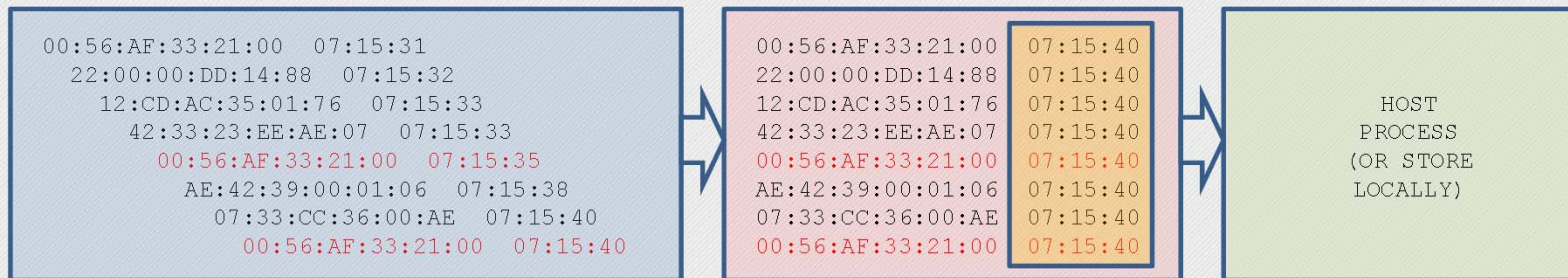
- Developed Asynchronous I/O process
 - MAC address immediately sent as read in field
 - Provides for more reads
- Field Software Enhancements
 - Duplicates identified in field; criteria available to send to host or not
 - Anonymous process can be completed in field before transmitting to host

AWAM Development

Difference Between Synchronous and Asynchronous

Travel Time Monitoring Application

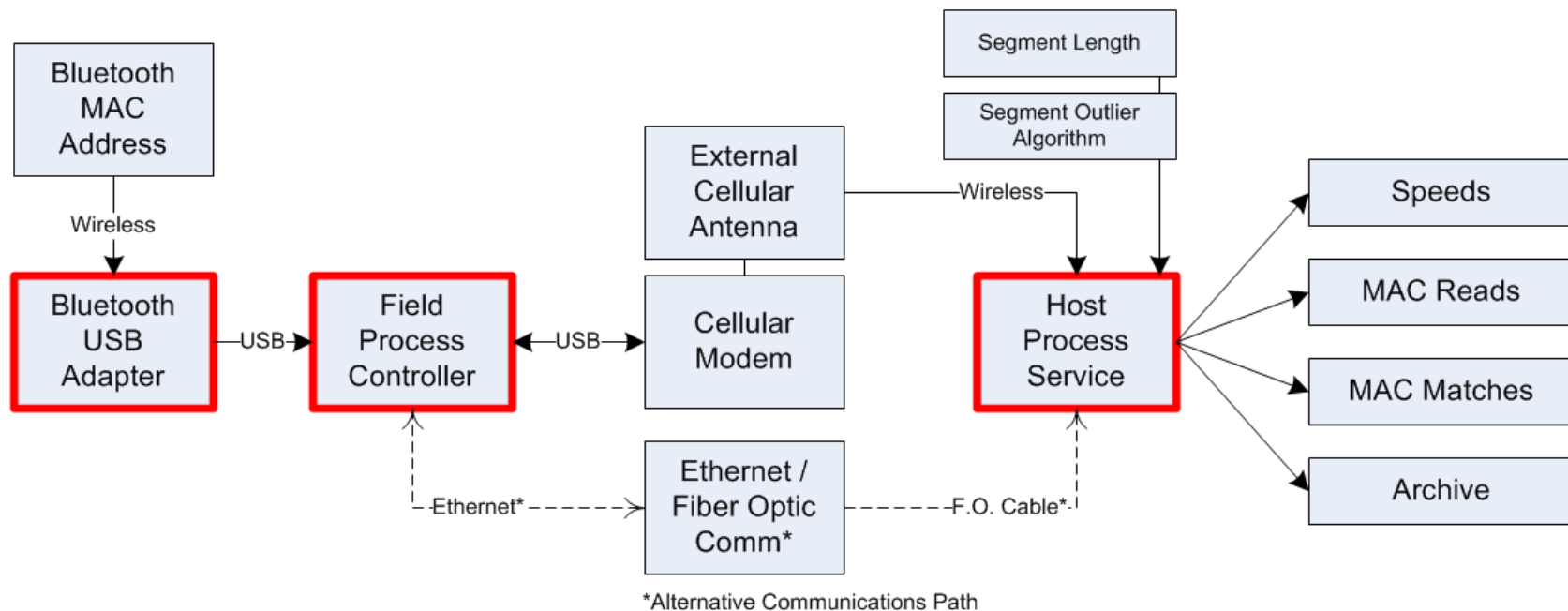
Synchronous: 8-10 second cycle (default process)



AWAM Asynchronous



Modular System Design



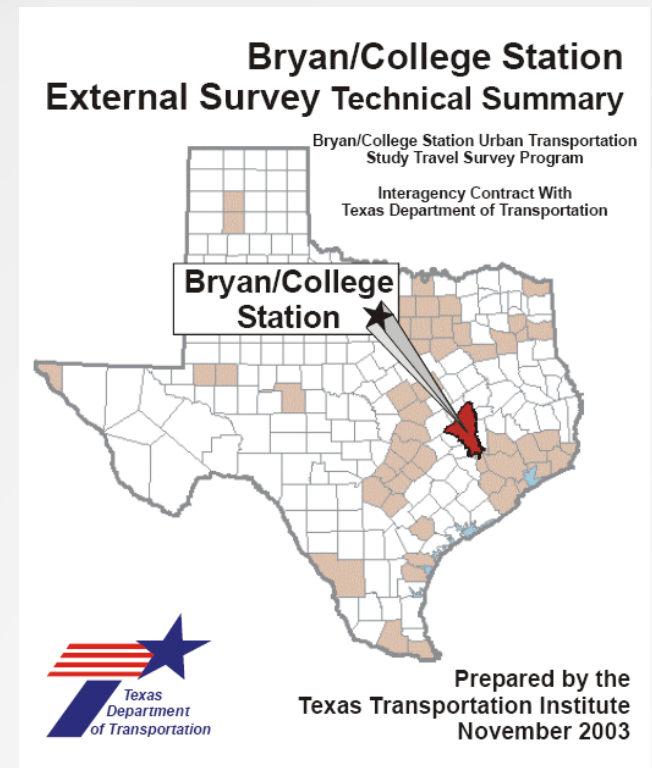
Bluetooth Data Collection for E-E Surveys

- Bryan/College Station TX – validation research
- Alice, TX – SH 44 by-pass planning study
- Corpus Christi, TX – Harbor Bridge analysis
- Omaha, NE – regional E-E study
- *Alabama @ Texas A&M Football [Sept 14, 2013]*
- *Austin, TX – CV bypass study [Oct 2013 & Mar 2014]*
- *Dallas-Ft. Worth, TX – regional E-E study [Oct 2013]*

Bryan/College Station Validation

- Bryan/College Station External Survey
- Original Survey conducted in 2002
- Externals surveyed via roadside/ intercept method
- Developed E-E trip tables

Project Approach – develop E-E estimates using Bluetooth data and compare to previous external survey results.

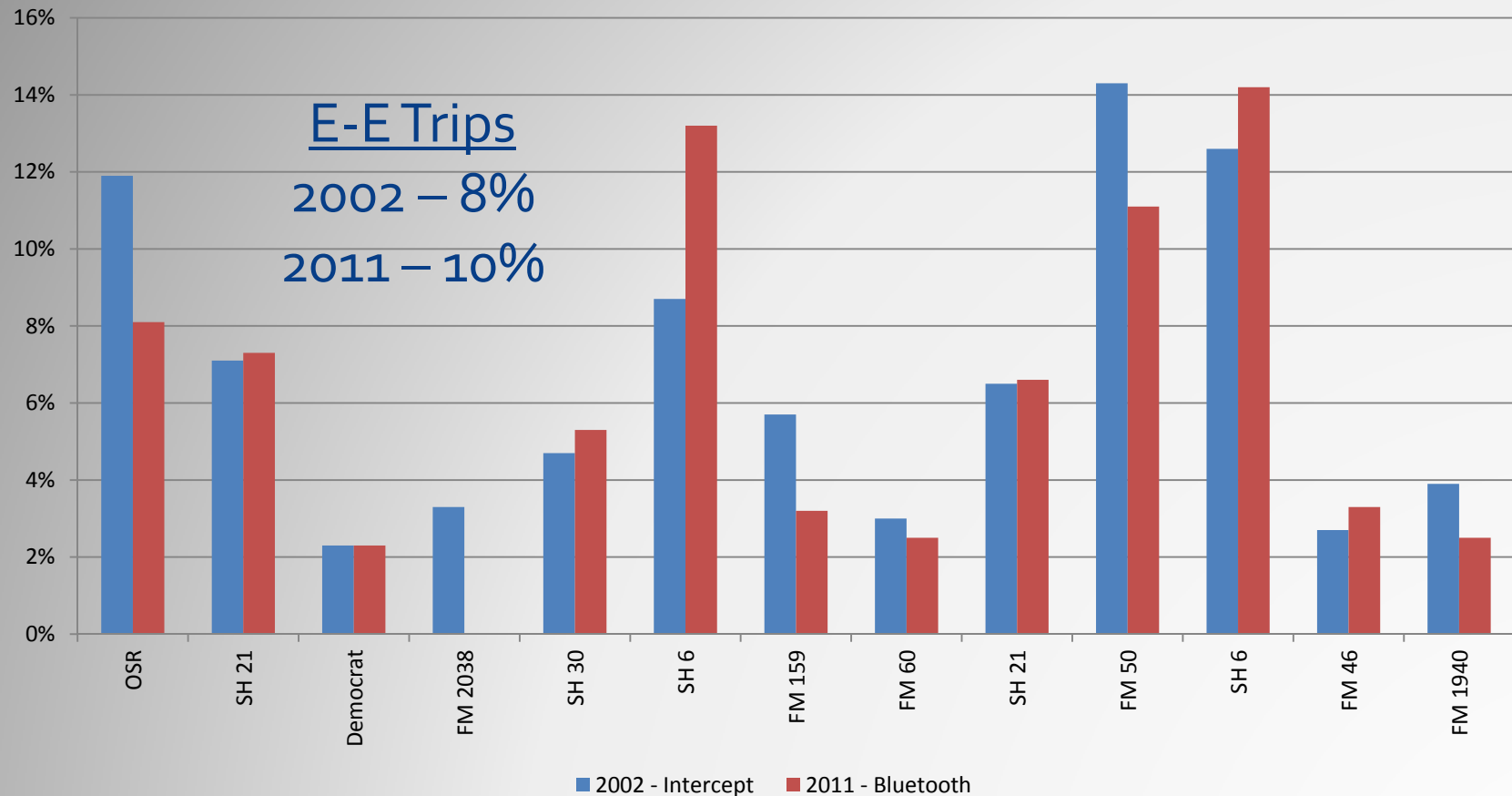


Validation Study Results

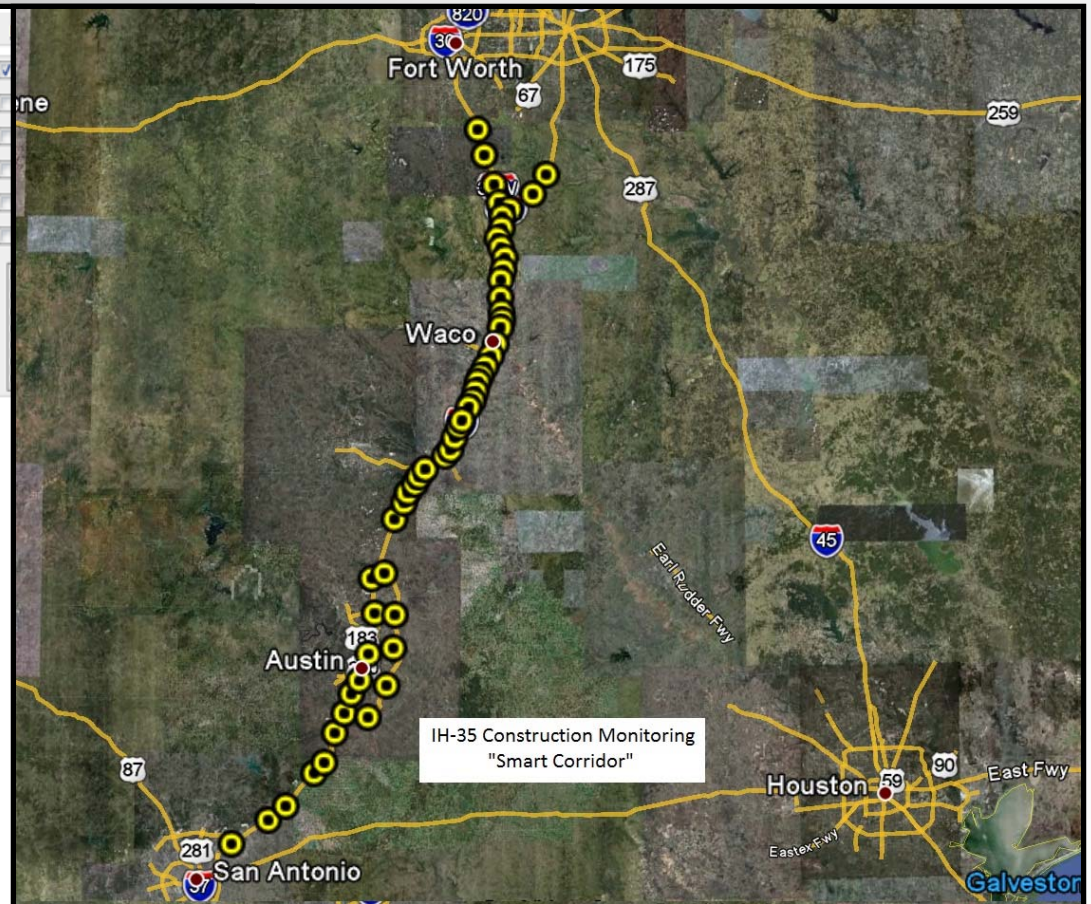
- Data collected anonymously
- Data collection can be monitored in 'real time'
- Data can be processed in 'real time'
- Estimates based on actual trip making
- E-E trip tables for commercial and non-commercial vehicles
- Allows for 24-hour data collection in any weather conditions and on weekends
- Study results reasonably replicated previous roadside intercept survey results

Comparison of 2002 and 2011 Results

Percent E-E Trips



AWAM Bluetooth for Intercity Travel Times



Real-Time O-D Trip Matrix Generator

Anonymous Wireless Address Matching
For Traffic Information



[Matches](#)
[Reads](#)
[Match Sample Rates](#)
[Reader Performance](#)
[Origin-Destination Matrix](#)
[Real-Time Data Summary](#)
[Export Data](#)

Bluetooth Travel Time Monitor – Origin-Destination Trip Matrix Generator

Instructions

Generate Origin/Destination trip tables by adding AWAM readers to the Selected Readers list. Specify the parameters for the trip tables including the minimum and maximum travel time as well as the start and end date and time. All travel times must begin and end within the start and end date and time.

* Note that the totals presented are intended to be

AWAM Origin-Destination Trip Distribution (Match Count)

Reader Locations	Origins/Destinations	IH10_US69	IH10W_BrazosRiver	IH-45_IH-20	IH-45_Loop-336North	IH-45Gulf_Causeway	US-290_FM-2920
34th_US290	IH10_US69	-1	210	12	34	14	30
BriarForest_SH-6	IH10W_BrazosRiver	143	-1	6	18	6	20
BW8-East_JacintoPort	IH-45_IH-20	12	12	-1	255	11	17
BW8-East_LittleYork	IH-45_Loop-336North	37	31	378	-1	13	28
BW8-East_Wallisville	IH-45Gulf_Causeway	13	18	17	37	-1	8
BW8-East_Winfield	US-290_FM-2920	22	38	22	21	6	-1
BW8-North_JFK							
BW8-North_JohnRalston							
BW8-North_Wilson							
ClayRoad_SH-6							
Fairbanks_US290							
FM529_BarkerCypress							

Minimum Travel Time

Hours: 0 Minutes: 0

Maximum Travel Time

Hours: 24 Minutes: 0

Start Date

9/7/2012

End Date

9/7/2012

Start Time

12 00 AM

End Time

11 59 PM

Generate O-D Trip Matrix

Copyright © 2012 Texas Transportation Institute.

Bluetooth Real-Time Data Summary

Bluetooth Monitor - Windows Internet Explorer

http://tti.houston.tamu.edu/bluetooth/bluetooth_summary.aspx?i=transtar

File Edit View Favorites Tools Help

Convert Select

AVG Search Safe Do Not Track Weather Facebook

Favorites Bluetooth Monitor

Anonymous Wireless Address Matching
For Traffic Information

Matches Reads Match Sample Rates Reader Performance Origin-Destination Matrix Real Time Data Summary Export Data


Bluetooth Travel Time Monitor – Real-Time Data Summary

System ID: TxDOT Dallas Location ID: IH-45 Get Summary

IH-45 Northbound

From	To	Data Age	Distance (miles)	Travel Time (mm:ss)	Speed (mph)
FM-80 (Streetman)	SH-14 (Richland)	03:08 PM	8.6	7:29	69
SH-14 (Richland)	Business 45 (Corsicana)	03:08 PM	15.5	13:26	69
Business 45 (Corsicana)	US-287 (Ennis)	03:08 PM	11.7	10:41	66
US-287 (Ennis)	FM-879	03:08 PM	8.5	7:15	70
FM-879	Malloy Bridge (Ferris)	03:08 PM	11.2	9:52	68
Malloy Bridge (Ferris)	Wintergreen (Hutchins)	03:08 PM	6.1	5:35	66
Wintergreen (Hutchins)	IH-20	03:08 PM	4.2	3:46	67
IH-20	Loop-12	03:08 PM	2.6	2:30	62
Summary			68.4	60:34	68

Houston TranStar Route Builder



Greater Houston Transportation and
Emergency Management Center

> City of Houston > METRO
> Harris County > TxDOT

Home | Contact Us | About Houston TranStar

Hurricane Information | Bluetooth™ Traffic Data

News Room | Tours

Houston TranStar Route Builder

Manage Route

Add Location Below to Route







Sensor Locations	Distance (miles)
No further destinations available	

[Remove Last Sensor From Route](#) | [New Route](#) | [Real-time Traffic Map](#)







*Add this route to your web browser's favorites or bookmarks to access it later.


My Route - Using Live Data

Current Travel Time

Sensor Locations	Distance (miles)	Travel Time (m:ss)	Speed (mph)
 IH-10 Katy Westbound			
Pin Oak			
Pederson	3.70	3:06	72 
Woods	2.40	2:00	72 
FM-1489	2.80	2:25	70 
Brazos River	4.20	3:33	71 
Route Totals	13.1	11:04	71 

Speeds (MPH)

 < 20
 20-29
 30-39
 40-49
 50+
 No Data

 **Your travel time is 21 seconds faster than a typical Wednesday.**

Site Map | Disclaimers, Content Usage, and Privacy

Copyright © 2013 Houston TranStar, All Rights Reserved

Houston TranStar Route Builder

Manage Route

Add Location Below to Route

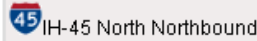

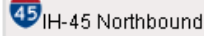






















Sensor Locations	Distance (miles)
	6.1

[Remove Last Sensor From Route](#) | [New Route](#) | [Real-time Traffic Map](#)

*Add this route to your web browser's favorites or bookmarks to access it later.

My Route - Using Historical Data

Friday at 5:00 PM Departure Time

Sensor Locations	Distance (miles)	Travel Time (m:ss)	Speed (mph)	
				
Woodlands Parkway				
FM-1488	5.90	6:22	56	
				
FM-1488	0	0:00	56	
Loop-336 North	6.9	6:28	64	
FM-1097	6.2	12:04	31	
New Waverly Weigh Station	7	6:06	69	
Huntsville State Park	5.7	4:50	71	
SH-19 (Huntsville)	5.2	4:21	72	
SH-75 (Huntsville)	6.3	5:25	70	
Walker County Rest Area	5.3	4:19	74	
FM-2989	8.7	7:09	73	
Spur-67	5.1	4:04	75	
SH-21 (Madisonville)	4.6	4:16	65	
OSR	9.8	8:08	72	
Centerville Weigh Station	13.6	11:18	72	
US-79 (Buffalo)	13	10:44	73	
US-84 (Fairfield)	20.1	16:38	73	
FM-80 (Streetman)	11.8	9:38	73	
SH-14 (Richland)	8.6	7:21	70	
Business 45 (Corsicana)	15.5	13:21	70	
US-287 (Ennis)	11.7	9:55	71	
FM-879	8.5	7:24	69	
Malloy Bridge (Ferris)	11.2	9:45	69	
Route Totals	190.7	169:36	67	

Speeds (MPH)  < 20  30-39  50+
 20-29  40-49  No Data

Route Builder Departure Decision Assistance

☐ [Hide Adjacent Departure Times](#)

Departure Time	Total Travel Time (m:ss)	Time Savings	
4:30 PM	161:36	Costs 1 minute and 22 seconds	Show Report
4:45 PM	159:52	Saves 22 seconds	Show Report
Your 5:00 PM Departure	160:14	-	
5:15 PM	159:01	Saves 1 minute and 13 seconds	Show Report
5:30 PM	159:08	Saves 1 minute and 6 seconds	Show Report

DMS Travel Times on I-35



Travel Time to West on I-35



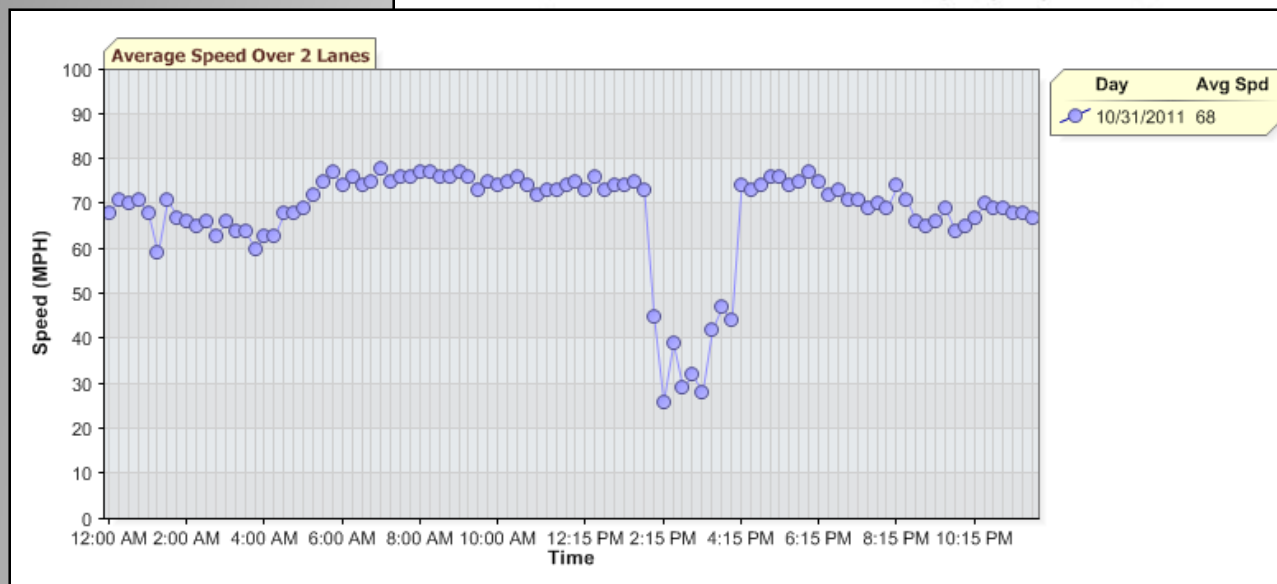
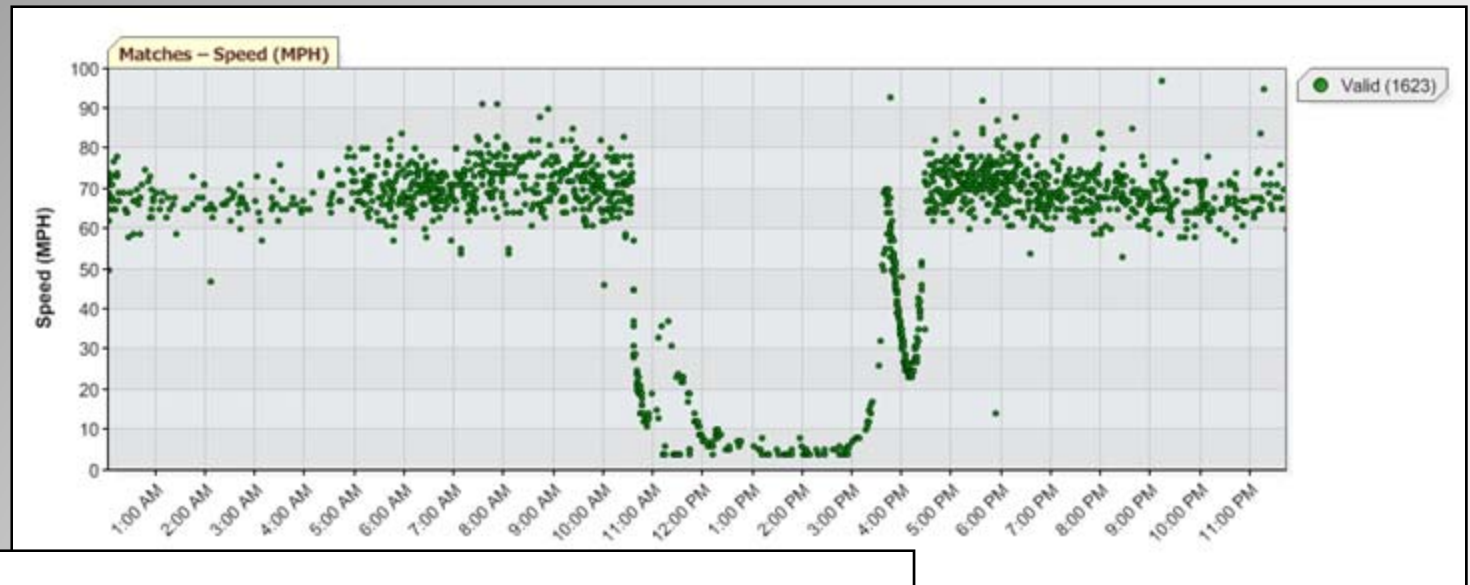
I-10 Eastbound West of Brookshire

Crash damaged overhead sign & TxDOT had to remove structure
Monday, October 31st 2011 @ 10:50am



I-10 Eastbound West of Brookshire

From Brazos River to FM-1489 (4.2 miles) - Individual MAC Address Matches & TxDOT Radar Site



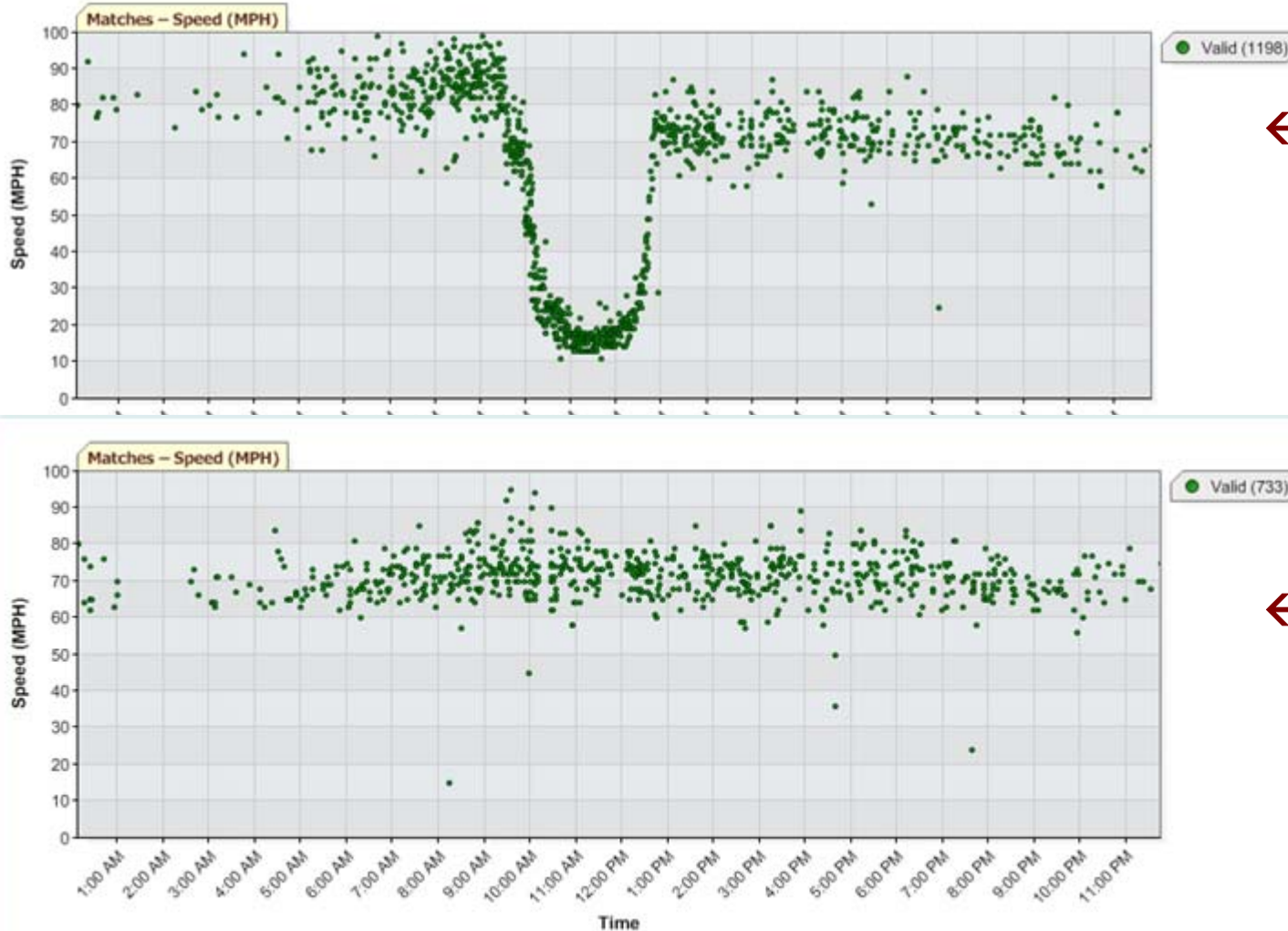
I-10 Eastbound West of Brookshire

Comparison of Radar Speed Data vs. Bluetooth Probe-Based Travel Time Data

Time Start	Radar Site @ Weigh Station	Bluetooth Data -- Brazos River to FM 1489
	Avg Speed [mph]	Avg Speed [mph]
10:00am	74	67
10:15am	75	71
10:30am	76	60
10:45am	74	22
11:00am	72	14
11:15am	73	20
11:30am	73	18
11:45am	74	15
12:00pm	75	7
12:15pm	73	6
12:30pm	76	6
12:45pm	73	7
1:00pm	74	n/a
1:15pm	74	6
1:30pm	75	7
1:45pm	73	5
2:00pm	45	n/a
2:15pm	26	4
2:30pm	39	5
2:45pm	29	4
3:00pm	32	4
3:15pm	28	4
3:30pm	42	10
3:45pm	47	32
4:00pm	44	33
4:15pm	74	28
4:30pm	73	68
4:45pm	74	72

Are You Ready for some FOOTBALL?

US 290 Westbound – FM 1098 to Hempstead (4.5 miles) – 9/24 vs. 10/1

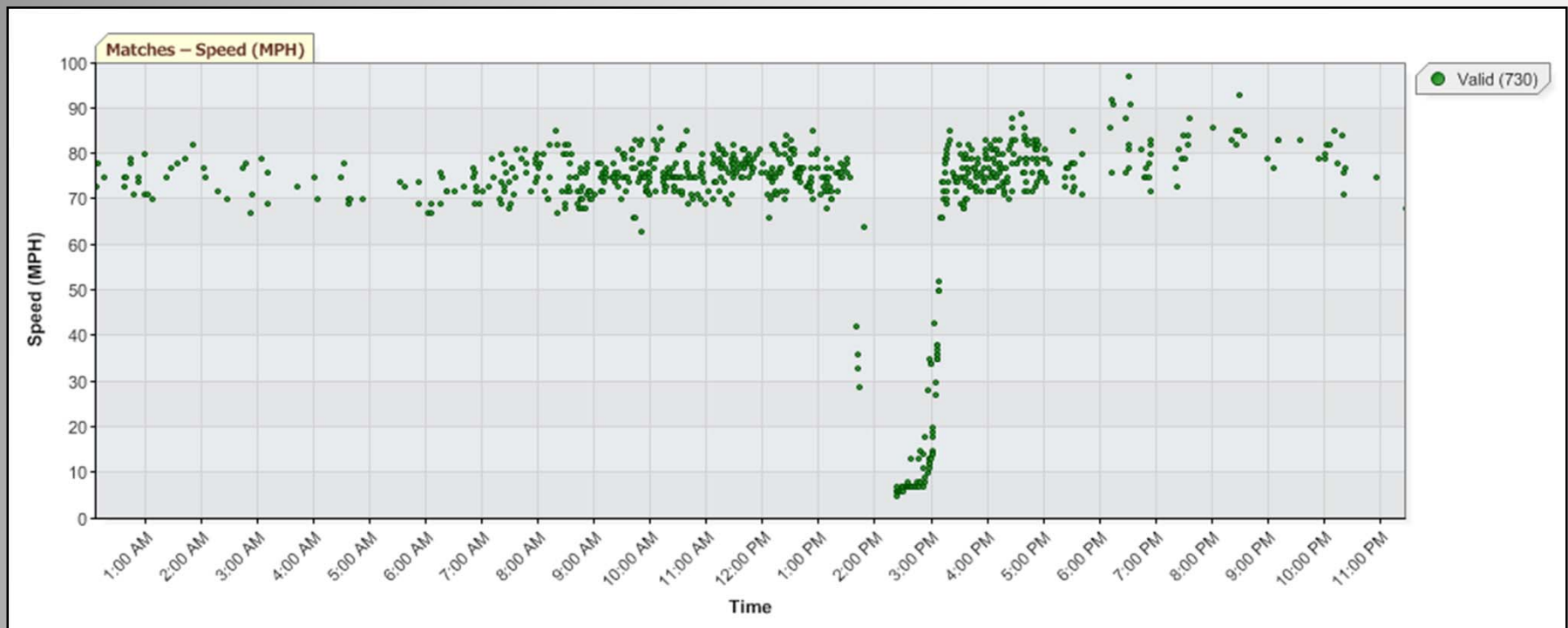


← 9-24 2:30 kick-off

← 10-1 no football

Vehicle Fire with Total Roadway Closure

US 290 Westbound From Roberts to Kickapoo (3.5 miles)
Individual MAC Address Matches - - Sunday 8/18/2013



Questions????

Darrell Borchardt

d-borchardt@tamu.edu

713-686-2971

Steve Farnsworth

s-farnsworth44@tamu.edu

979-862-4927

