

# **Arizona Connected Vehicle Anthem Pilot Project**

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**ITS Arizona Bluetooth Summit**

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# MCDOT SMART*Drive* Program

- SMART Corridors Program (ongoing)
- **SMART*Drive* Program (Research Phase)**
- Participation in Federal **Connected Vehicle Initiative**
  - Strong advocate of the public sector needs
  - AASHTO, ITE, TRB, ITS America, Connected Vehicle Workshops (Deployment, User Needs, Research)
  - US DOT Pooled Funded
- Arizona Partnership (ADOT, State Universities)
- Sponsoring Projects
  - Phase I and II (with ADOT)
  - Phase III: SMART*Drive* Field Test (Emergency Vehicle and Transit Vehicle Priority)
  - Future Phases – advanced signal operations

# SMART Corridor Benefits

## Bell Road (Loop 101- Grand Ave)



### Background

- **Road Capacity:** 50,000 ADT
- **Year 2001:** Traffic reached up to 50,000 ADT
- **Year 2010:** Traffic reached 70,000 ADT
- **Length of Road:** 6 Miles

Direction	Travel Time Minutes 2008	Travel Time Minutes 2010	TRAVEL TIME MINUTES SAVED
Eastbound (AM)	14	12	2
Westbound (PM)	20	15	5

### Benefits

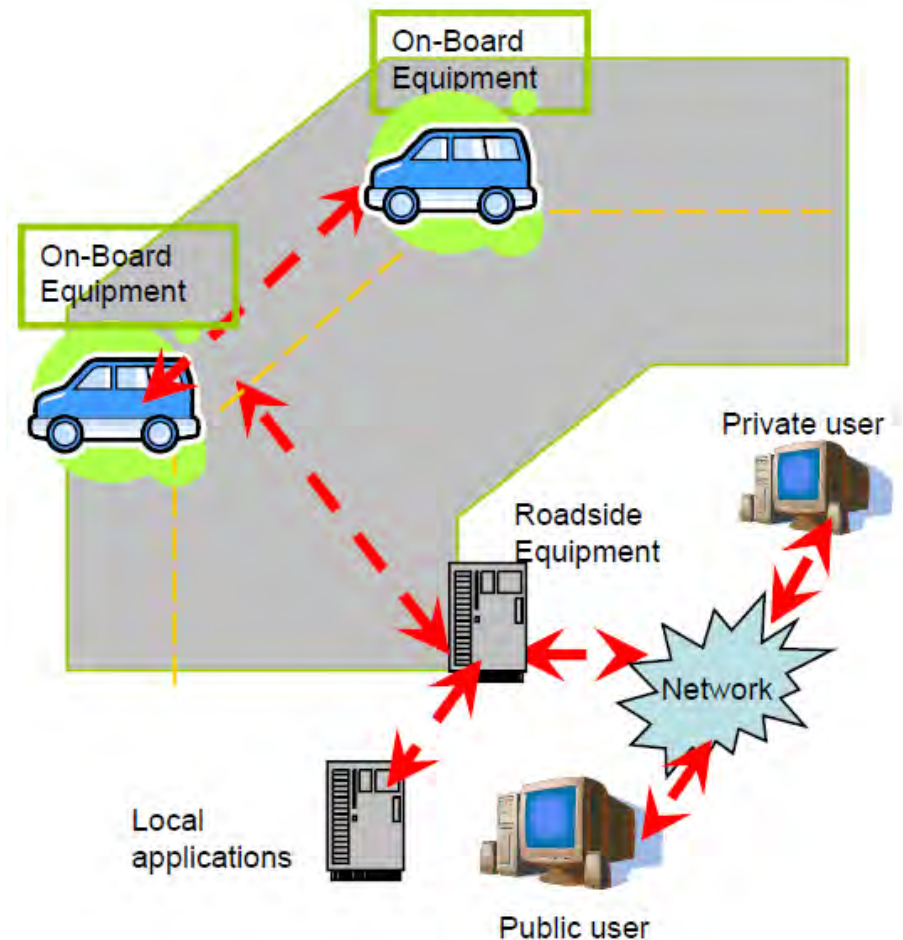
- **Eastbound:** 14% travel time saving
- **Westbound:** 25% travel time saving

#### Direct Reductions from Eliminating 5 minutes of Idling

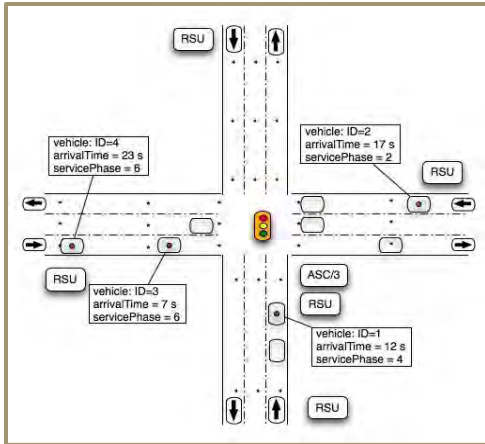
Engine Size	Daily	Annual		
	Gasoline Not Burned	Gasoline Not Burned	Money Not Spent	CO2 Not Emitted
Small	.5 cups	10 gallons	\$30	220 lbs.
8 Cylinder	1 cup	20 gallons	\$60	440 lbs.

# What is Connected Vehicle Technology?

- Formerly known as Vehicle Infrastructure Integration (VII) and IntelliDrive<sup>SM</sup>
- On-board Equipment (**OBE**) with wireless communication (DSRC, 3G/4G, WiFi, Bluetooth, other)
- Roadside equipment (**RSE**) with wireless communication (DSRC, 3G/4G, WiFi, Bluetooth, other)
- **V2X** (vehicle-to-vehicle and vehicle-to-infrastructure) using **DSRC** (Dedicated Short Range Communications) radios at 5.9 GHz and GPS receivers
- A “Backhaul” network will transport this roadside data to/from a central location.



# Connected Vehicle Applications for Emergency Responders

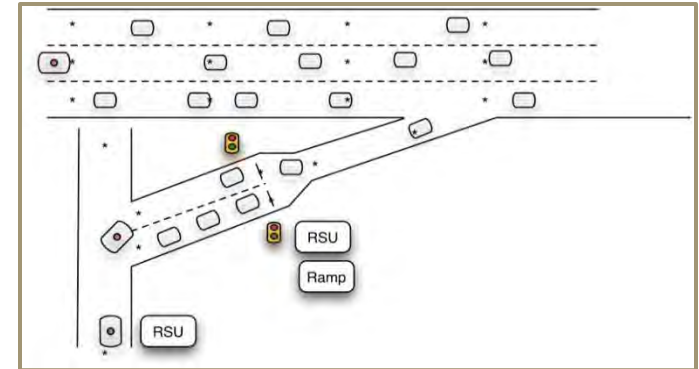


## US DOT Standards

- NTCIP 1202, 1211
- IEEE 802.11p, 1609 and SAE J2735
- ISO TC204

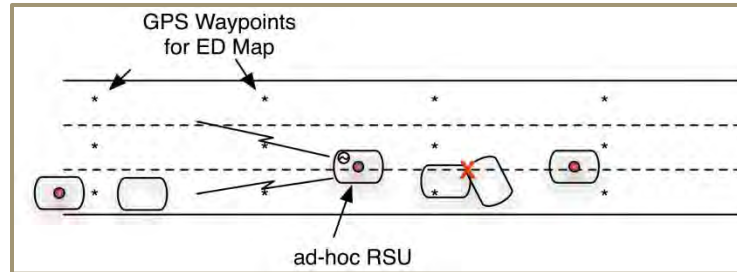
## Traffic Signal Priority

- Multiple Requests
- GPS Intersection Map
- DSRC 2-way communications between vehicles and signal (V2I)



## Ramp Meter Priority

- GPS Ramp Map
- DSRC 2-way communications between vehicles and controller (V2I)



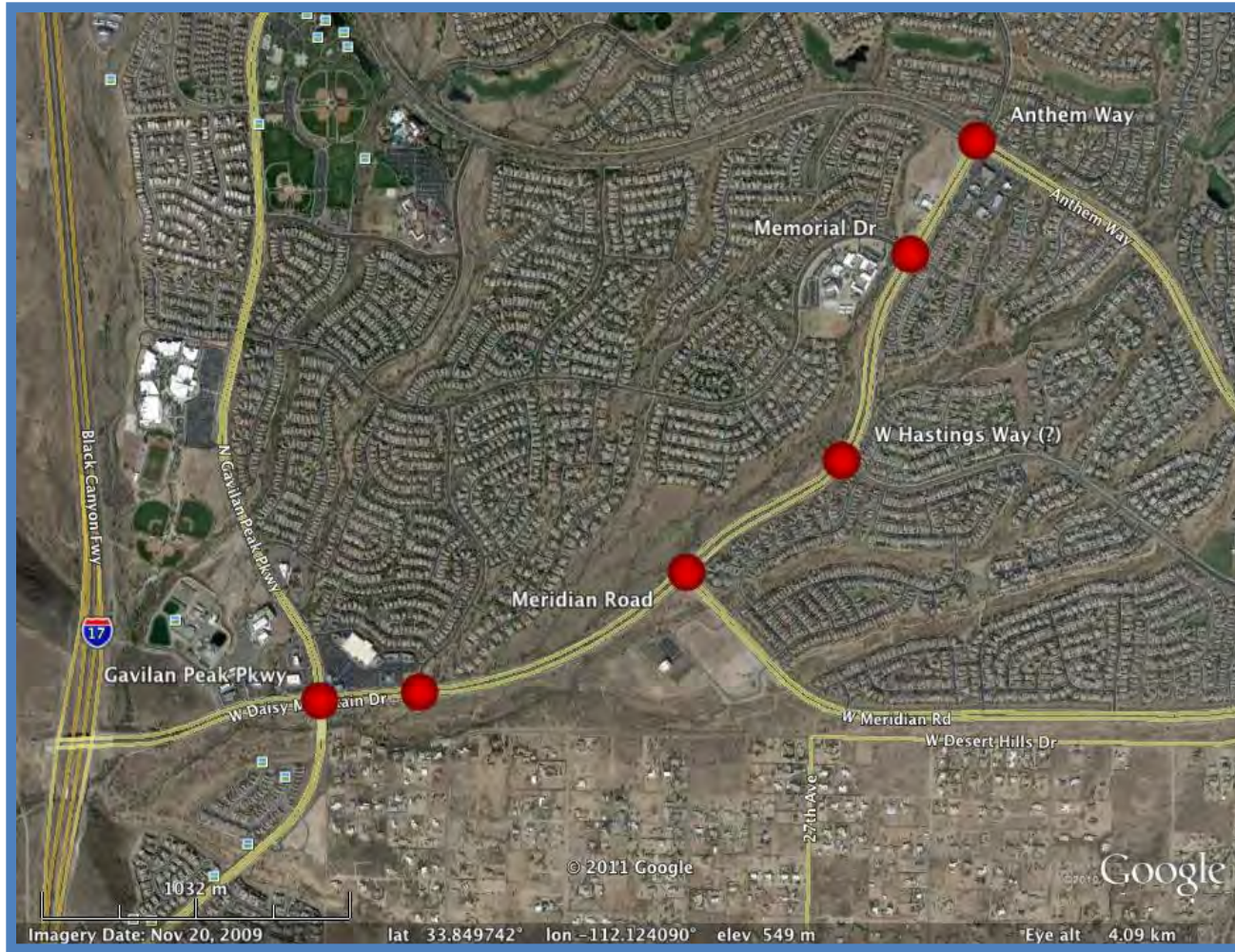
## AZ511 Information via Backhaul

## Ad-Hoc Warning Beacon

- GPS Roadway Map
- DSRC communications between vehicles and vehicles (V2V)

Phase I and II funded in cooperation between ADOT and MCDOT

# Field Test Location – Anthem W. Daisy Mountain Dr.



# Anthem Field Test Activities

- Equipment Installation
  - 5.9GHz DSRC
  - Bluetooth Readers
- Test and Verification
- Application Tests and Evaluations
  - Emergency Vehicle Priority
  - Transit Vehicle Priority
  - **Travel Time Data Collection (Bluetooth)**
  - Arterial System Performance Assessment (Equipped Vehicles – BSM)



Pole Mounted Roadside Equipment (RSE)

# Anthem Field Test Applications

- Task 1: Application 1 – Traffic Signal Priority for Emergency Vehicles and Transit
  - Emergency Vehicles
    - Incident Response through several signals with and without Priority (multiple Vehicles)
  - Transit Vehicles
    - Schedule/Headway based operations with and without Priority
    - Use buses/vans to show benefits of Traffic Signal Priority for Transit Vehicles



# **Anthem Field Test Applications**

- Task 4: Bluetooth Travel Time Data Collection
  - [www.sparta.arizona.edu/bttravel](http://www.sparta.arizona.edu/bttravel)

# Task 5: Vehicle Data for Traffic Signal Performance

- On-Vehicle application that collects data about traffic signal operations
  - Delay (stopped)
  - Travel Time (Overall Delay)
  - Arrival on Red/Green
  - Queue Length

# UA Living Lab Installation (Data for Discussion)

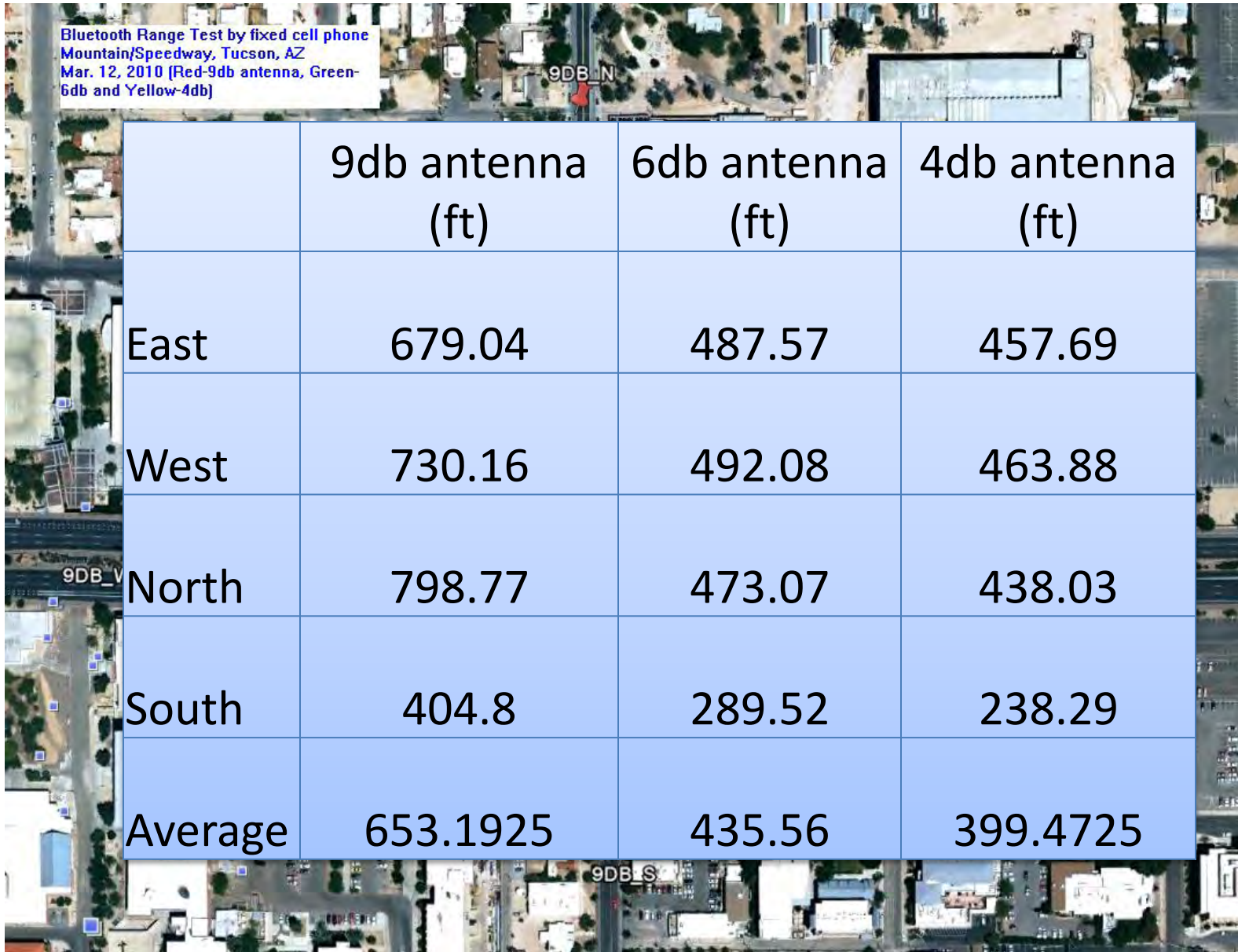
- Installed Savari Networks MobileWave and Streetwave DSRC Radios in Tucson for Development Testing
  - DSRC (5.9GHz)
  - Wi-Fi (2)
  - **Bluetooth**
  - 3G



# Techniques in travel time estimation

- Vehicle-side techniques
  - Probe vehicles Costly, small sample size
  - GPS/GIS Small sample size
  - Cellular phone Low accuracy
- Road-side techniques
  - Inductive loop detectors Costly, untraceable
  - License plate recognition Costly
  - **Bluetooth (since 2008)** Low cost, large sample size, no control over technology
- Hybrid Techniques
  - Connected Vehicles Emerging Technology, multiple applications

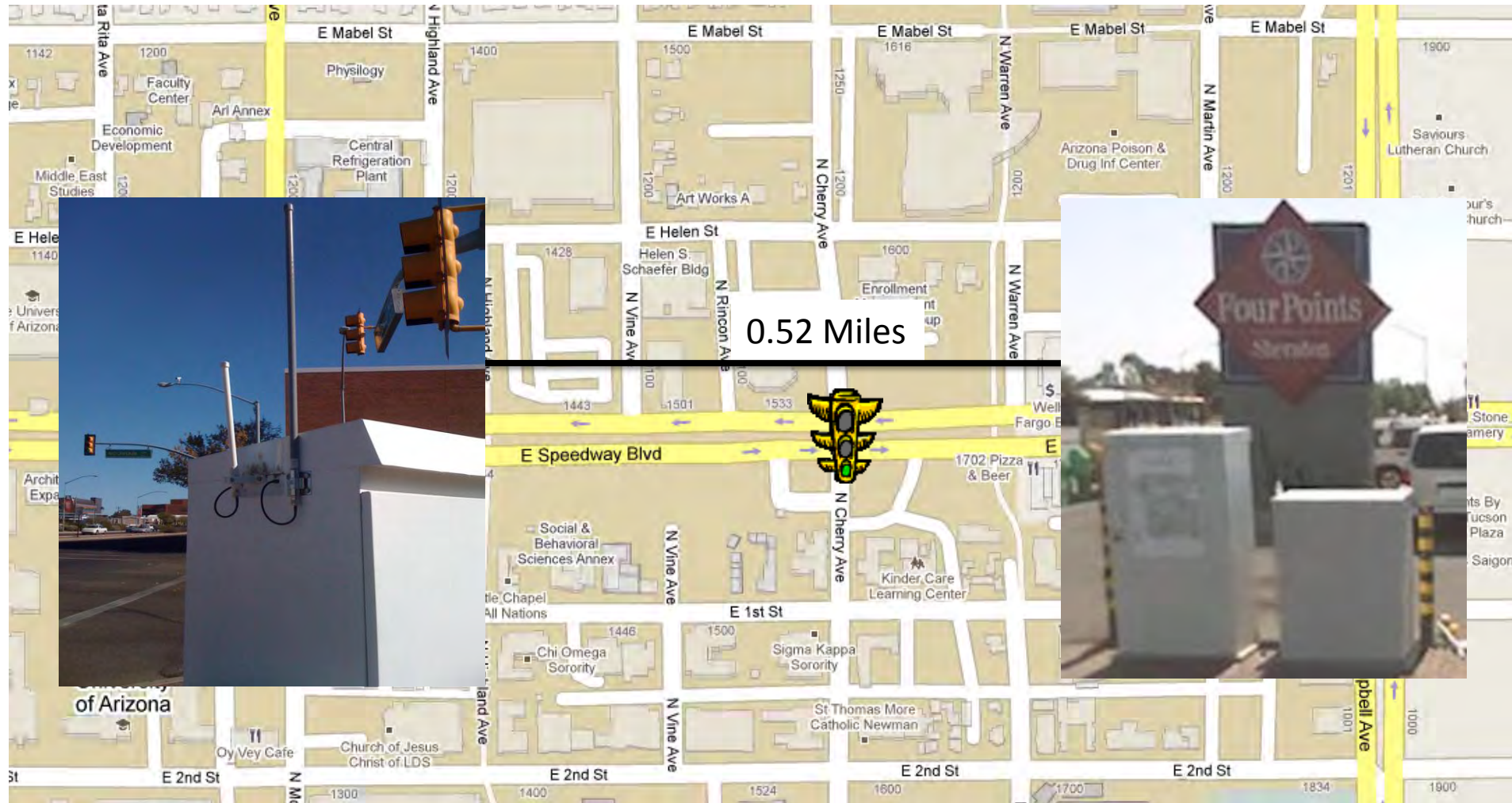
# Bluetooth detection range test



# DSRC Comparison



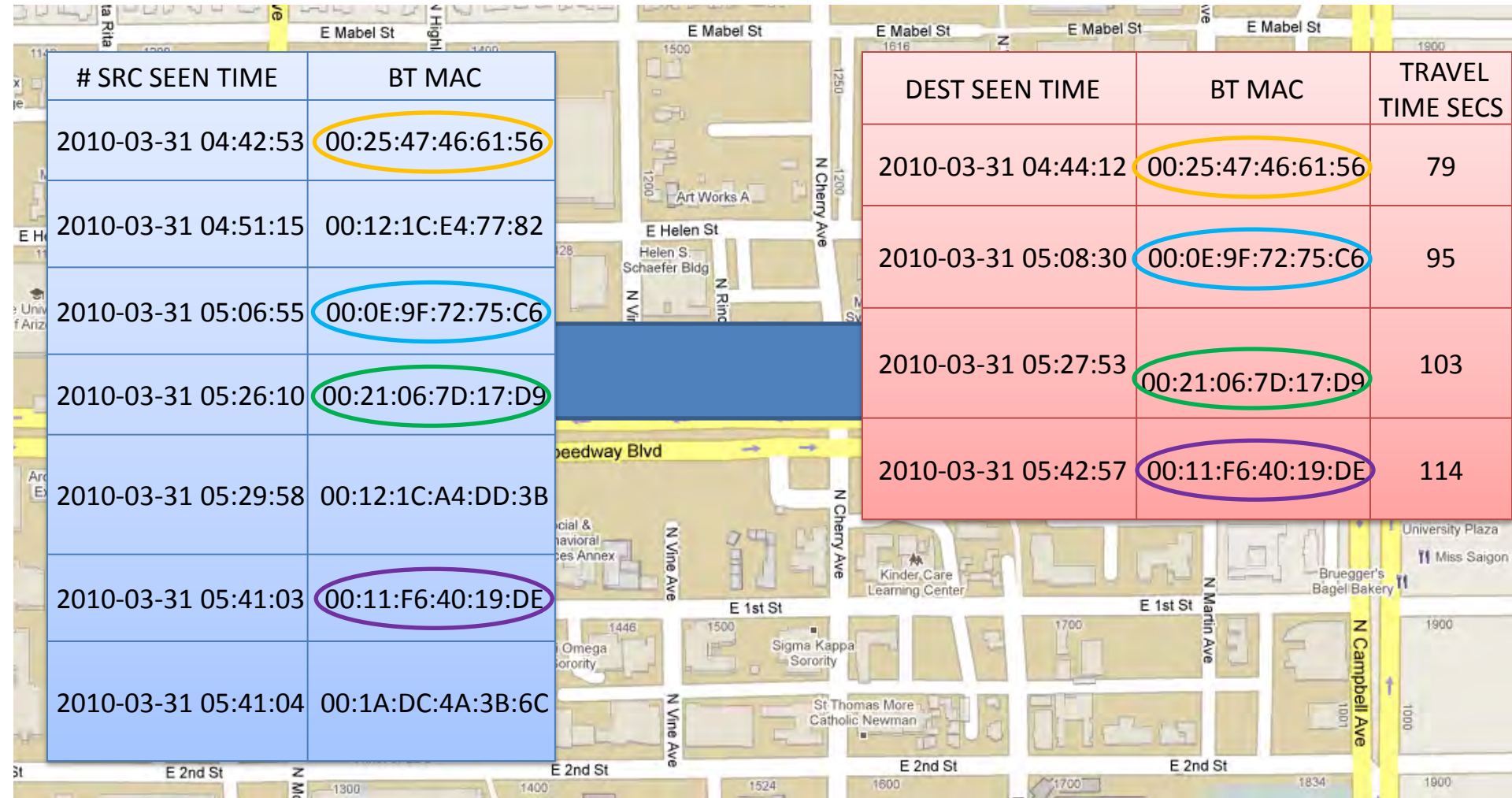
# UA Connected Vehicle Test Sites



# How it works

# SRC SEEN TIME	BT MAC
2010-03-31 04:42:53	00:25:47:46:61:56
2010-03-31 04:51:15	00:12:1C:E4:77:82
2010-03-31 05:06:55	00:0E:9F:72:75:C6
2010-03-31 05:26:10	00:21:06:7D:17:D9
2010-03-31 05:29:58	00:12:1C:A4:DD:3B
2010-03-31 05:41:03	00:11:F6:40:19:DE
2010-03-31 05:41:04	00:1A:DC:4A:3B:6C

DEST SEEN TIME	BT MAC	TRAVEL TIME SECS
2010-03-31 04:44:12	00:25:47:46:61:56	79
2010-03-31 05:08:30	00:0E:9F:72:75:C6	95
2010-03-31 05:27:53	00:21:06:7D:17:D9	103
2010-03-31 05:42:57	00:11:F6:40:19:DE	114





# Website/database server

## Bluetooth Based Travel Measurements

Ver: 0.6

### Help

DB Summary

Place Summary

Travel  
Times/Cnts

Travel Now

Save DB

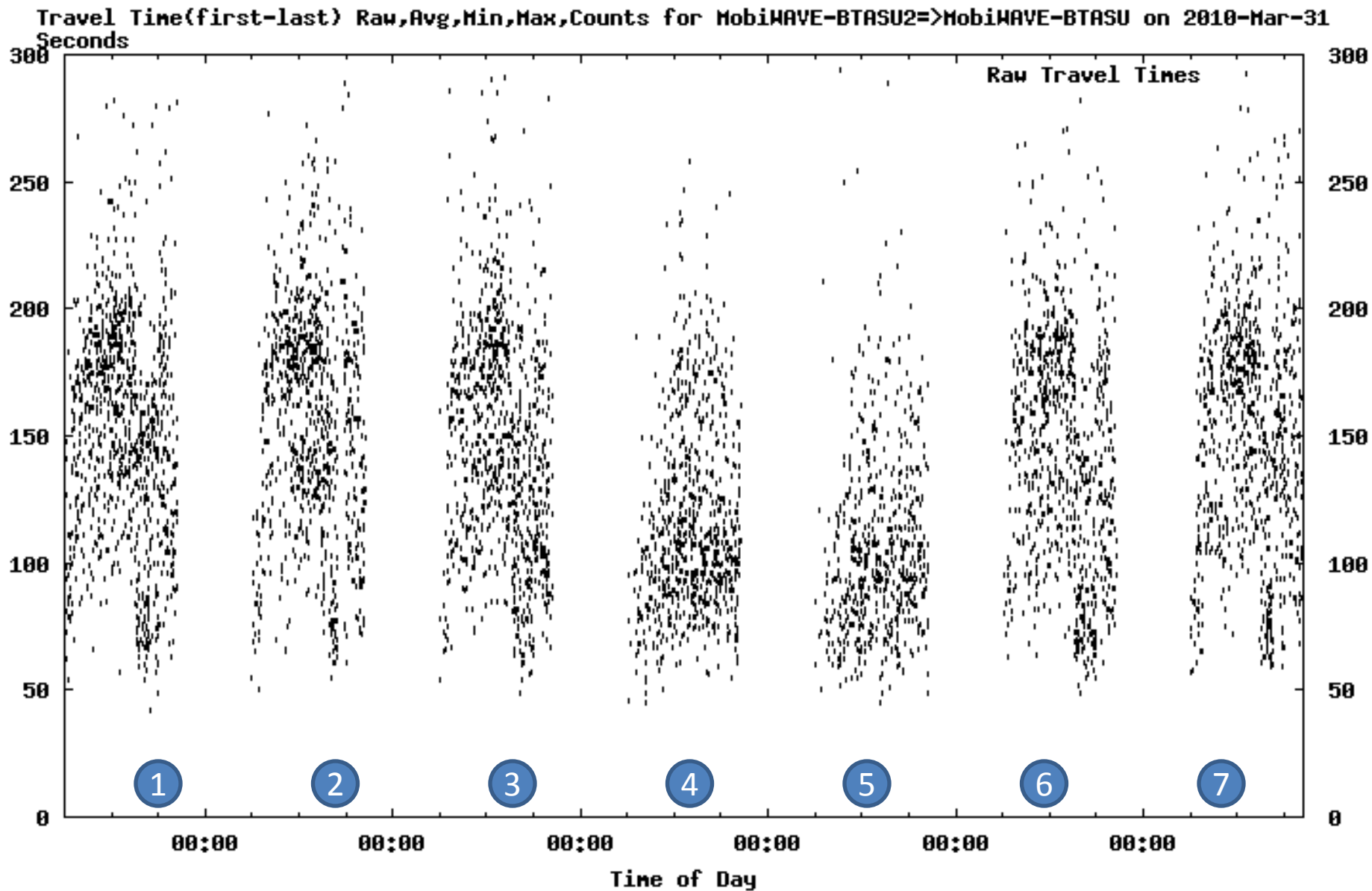
Restore DB

Save Report

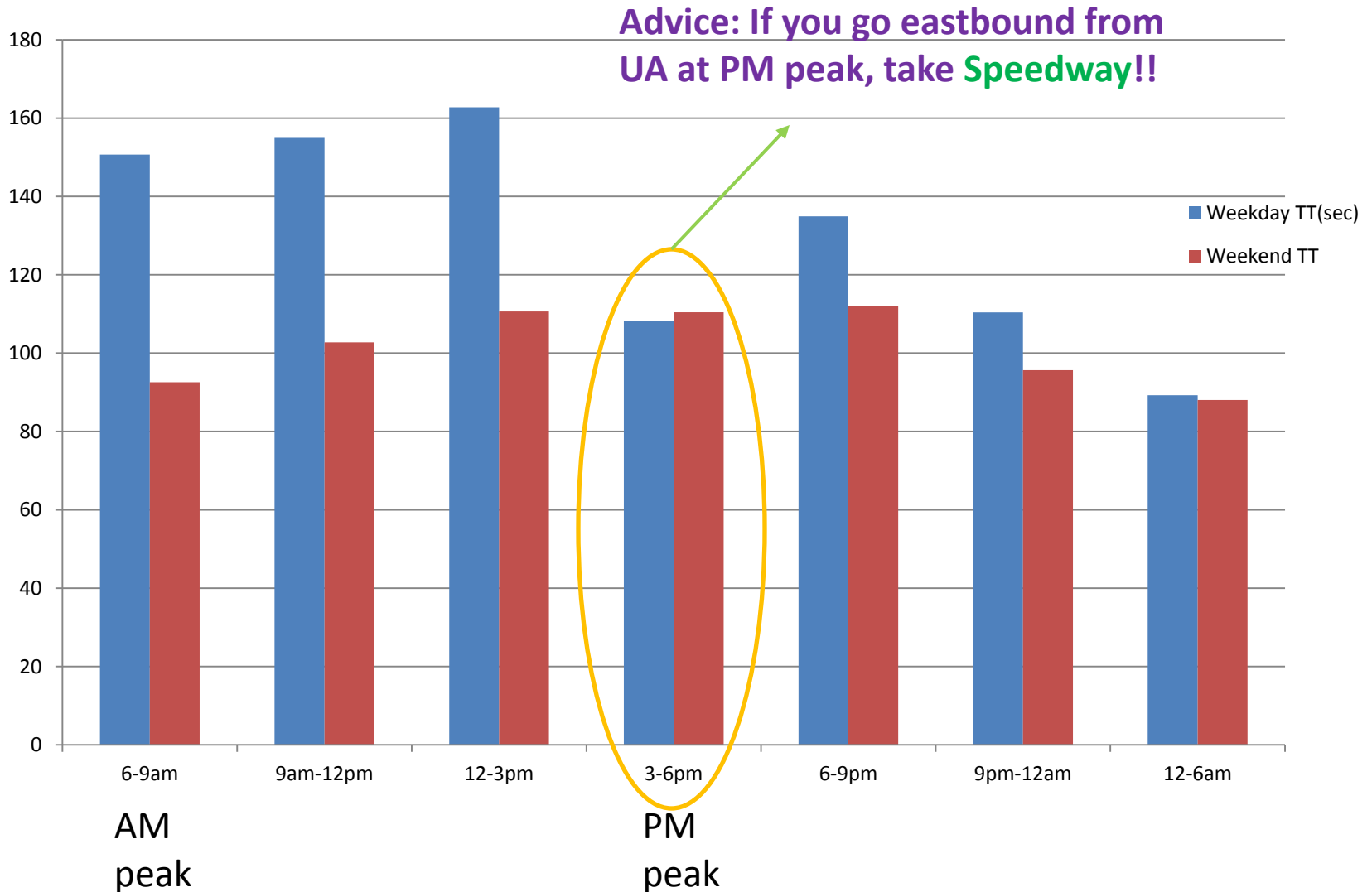
Help

<b>DB Summary</b>	Summary of Bluetooth Enabled Road Side Units along with map of locations
<b>Place Summary</b>	Summary of a Bluetooth Enabled Road Side Unit. Tells about congestion (if there is any), BT device count over time, ...
<b>Travel Times/Cnts</b>	Queries the bluetooth device scans on the roadways for travel Times and number of vehicles passed between two points. This is useful for analysis of historical data
<b>Traffic Now</b>	Report on current traffic conditions
<b>Save DB</b>	Saves the current Database
<b>Restore DB</b>	Restores previously saved Database
<b>Save Report</b>	Saves the content in this frame. Useful for saving bluetooth scan query results
<b>Help</b>	Displays this page

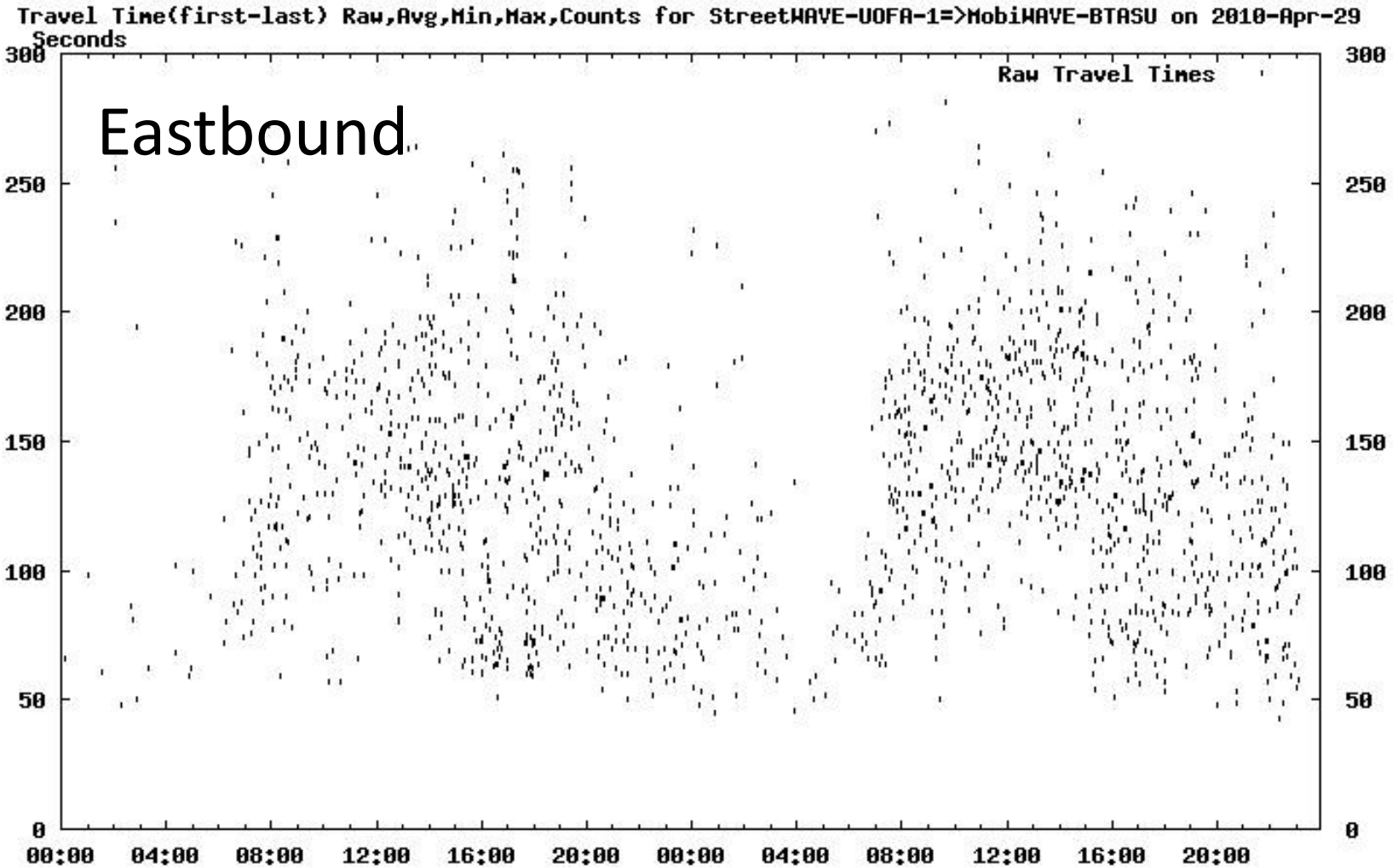
# Bluetooth hits in a week



# Average Travel time summary from Mountain to Campbell on Speedway (EB)



# Eastbound vs Westbound



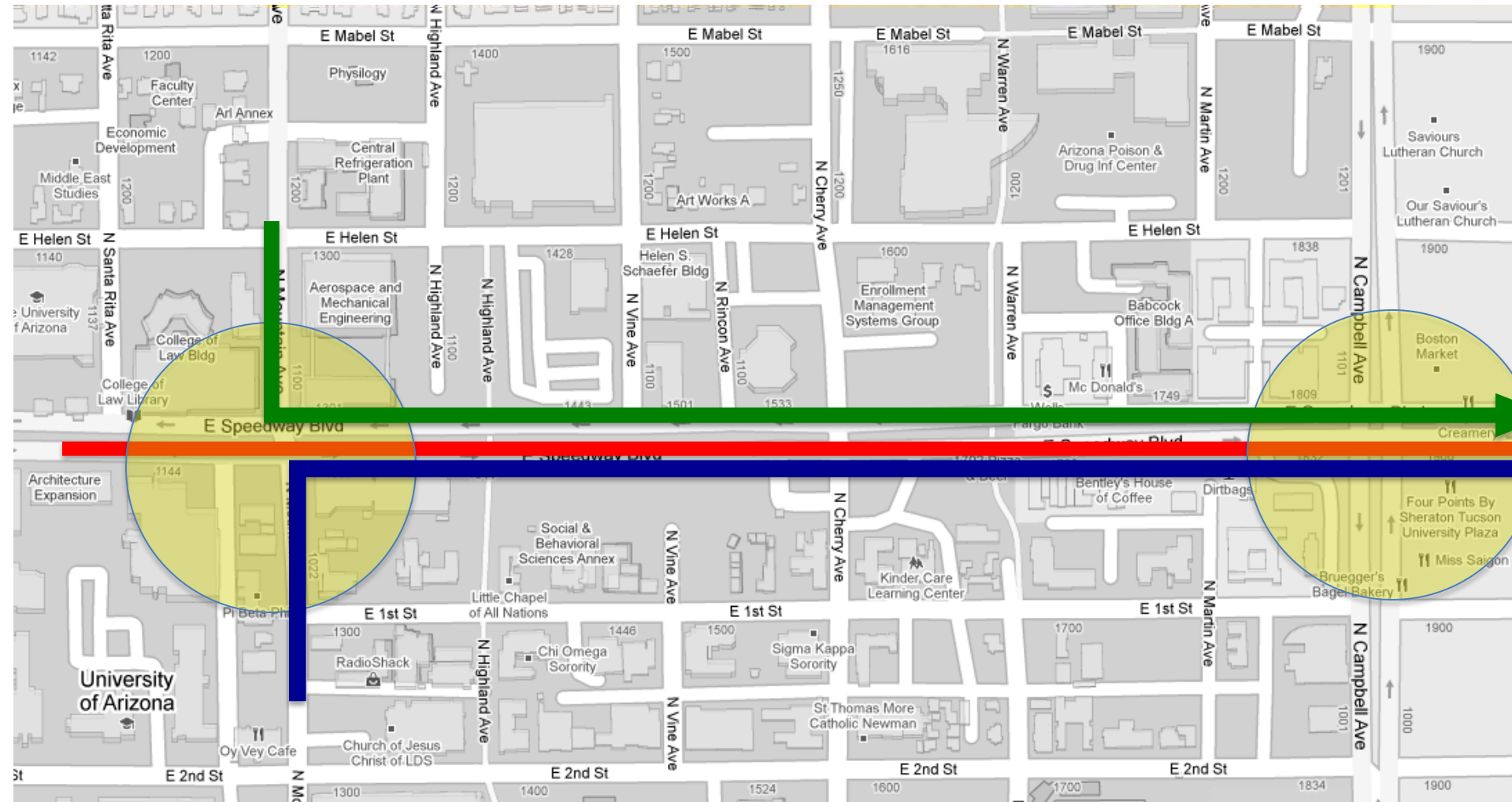
What mode was that MAC address?

00:12:1C:E4:77:82

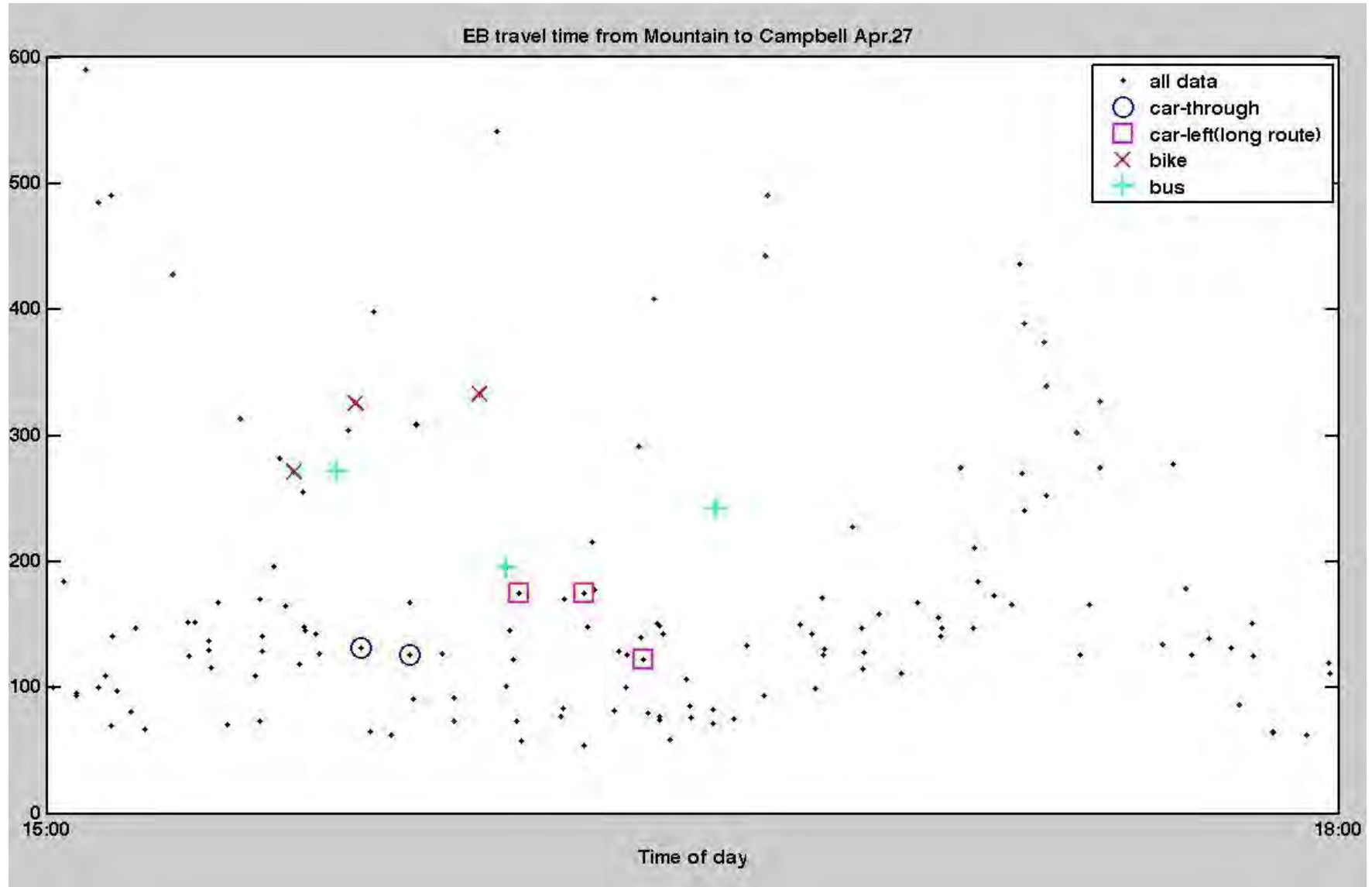


???

# What route did that MAC address take?

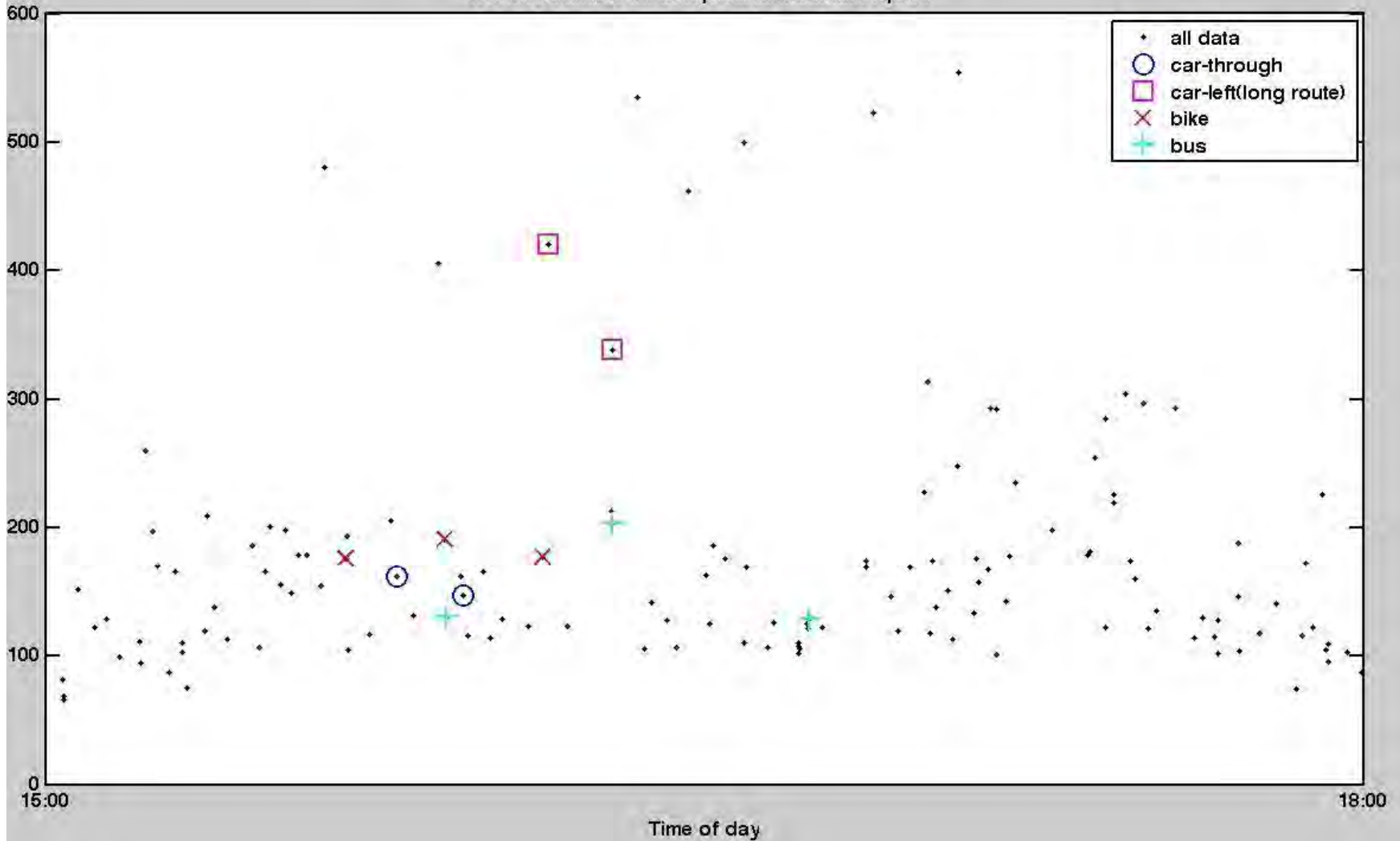


# EB – Mode and Route



# WB – Mode and Route

WB travel time from Campbell to Mountain Apr.27

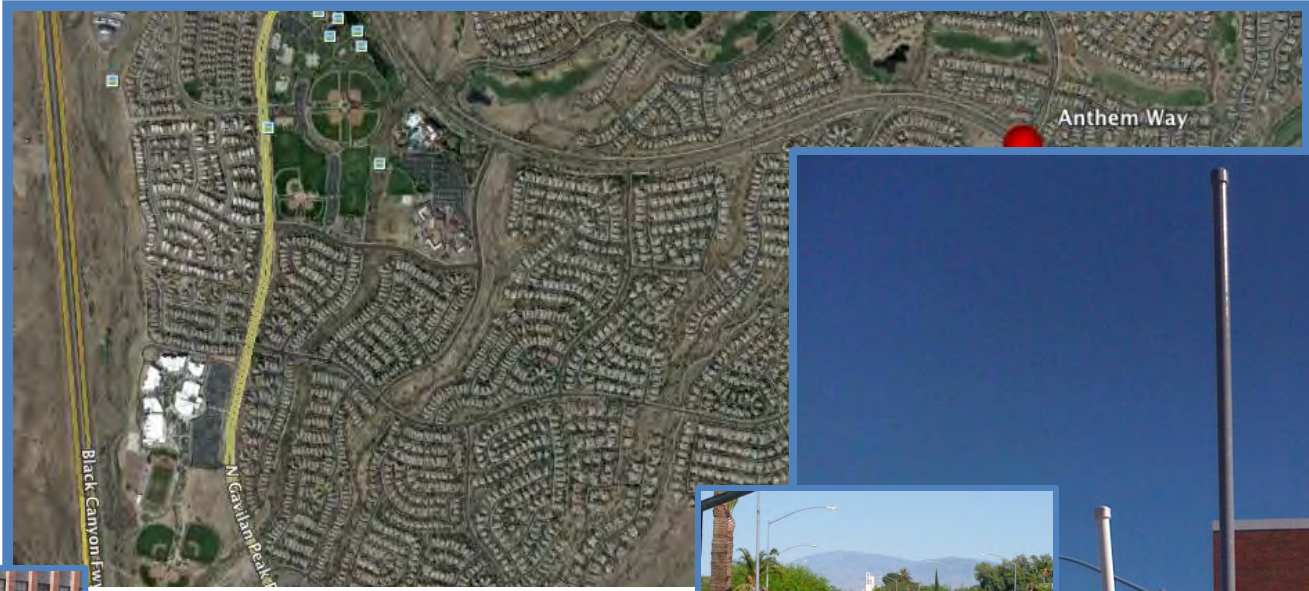




# Observations

- DSRC for Connected Vehicles
  - Communications for Critical Applications –
    - EV Priority
    - Transit Priority
    - Basic Safety and Traffic Operations
    - **Performance Assessment**
- Bluetooth (part of the Radio we use)
  - Communications for non-Critical Applications
    - Travel Time – Much better range than expected
      - We can't tell what mode it was ---- implications for use of data
- Wi-Fi
  - Communications for other applications
    - Pedestrians? Bicycles?
- 3G
  - Backhaul Communications

# Questions?



Raw, Avg, Min, Max, Counts for StreetMAVE-UOFA-1=>MobiMAVE-BTASU on  
Raw Travel Time

