Work Zone Applications of Bluetooth Traffic Detection

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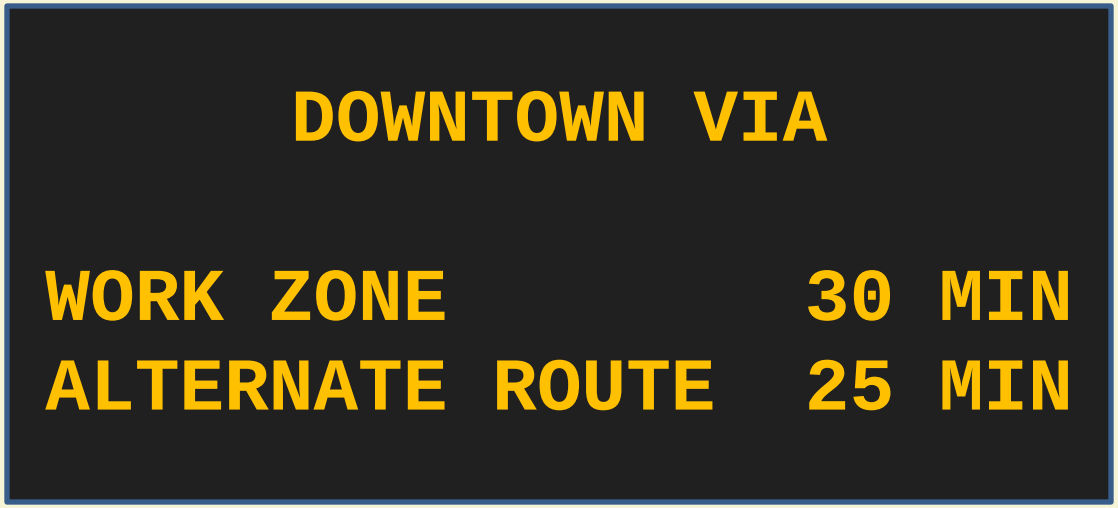
Would You Like To…

- Know when traffic in your work zone is starting to slow down?
- Provide travel times for alternate routes?



Would You Like To…

- Compare actual work zone delay with what was predicted in the TMP/MOT?
- Evaluate locational differences in work zone throughput?
- See how much traffic diverted to the alternate route?
- See whether people who diverted actually saved time?

What is Bluetooth?

- 2.4 GHz wireless system for connecting electronic devices
- Low power, low cost.
- Range ~100 meters.
- High level of data/content security.
- Every device has unique MAC address.
- No master database of MAC addresses.
- Used for traffic detection since 2008.

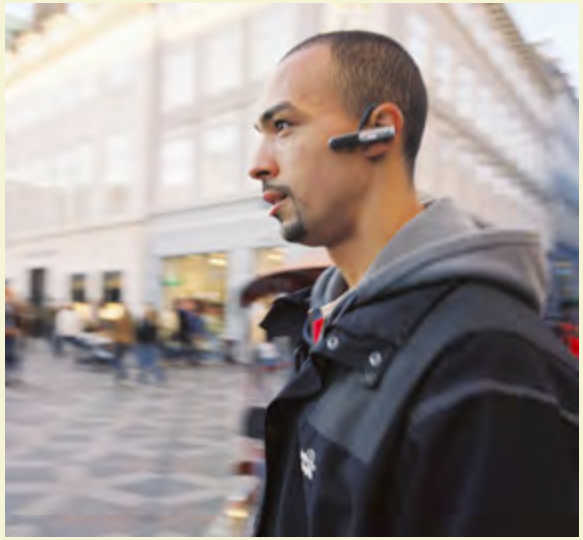
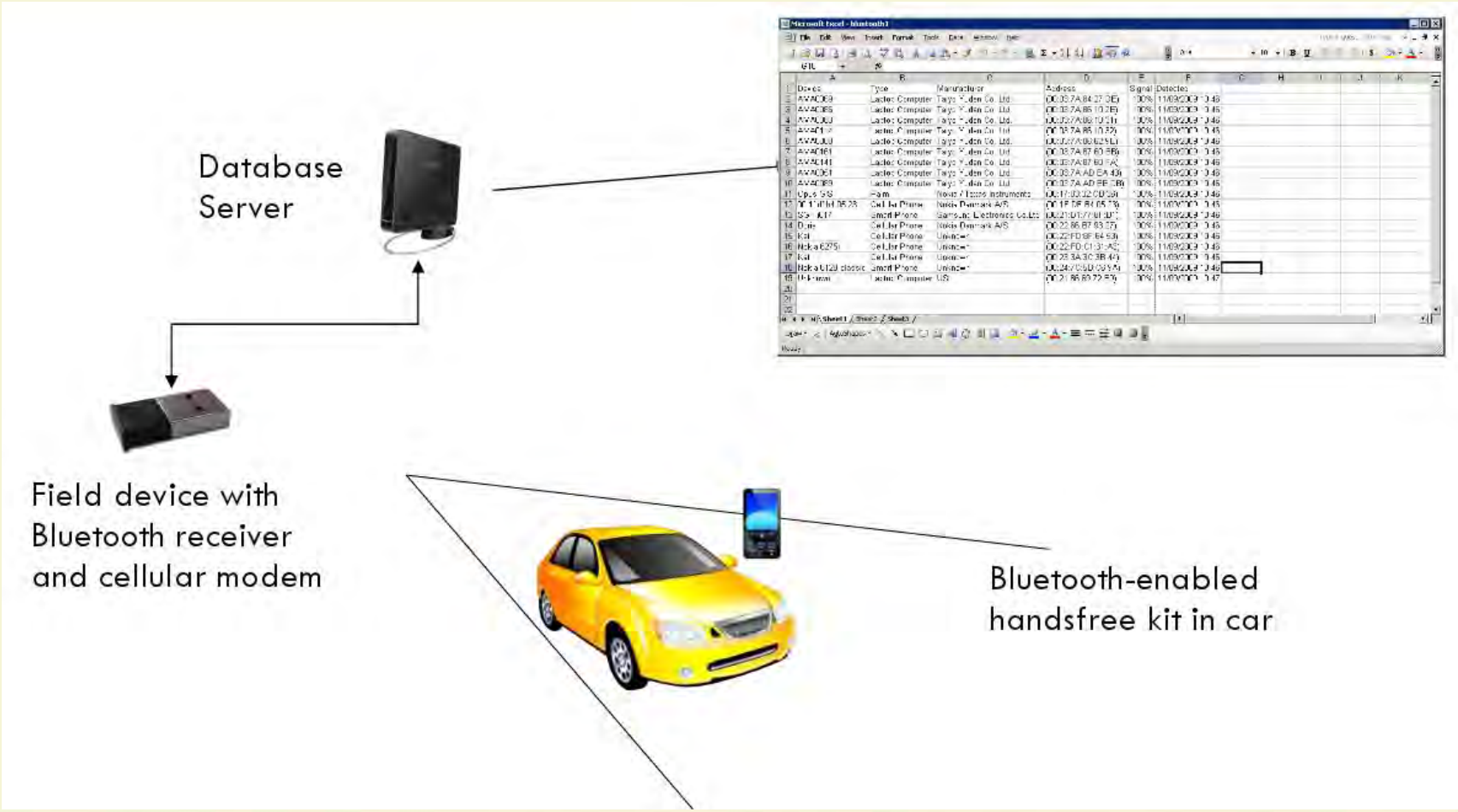


Image source: bluetooth.com

Bluetooth®

Bluetooth Data Collection



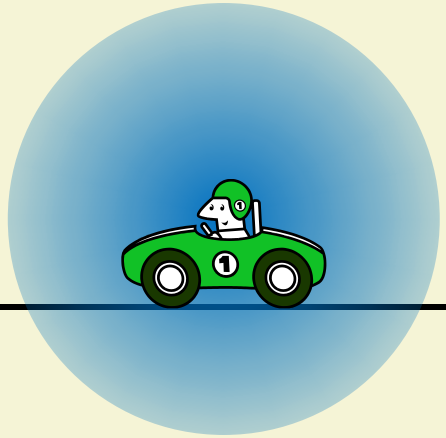
Bluetooth Data Collection

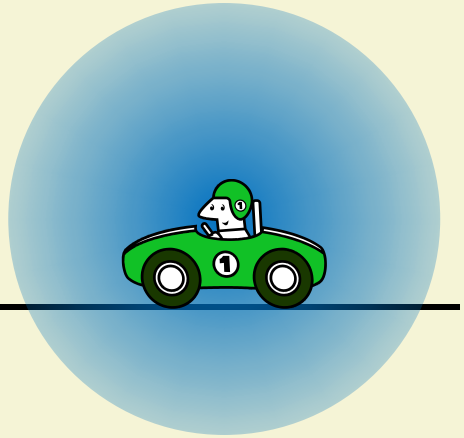
Central Server

MAC ID 1234456890ABCDEF
Elapsed Time 00:02:30
Distance 2 Miles = 48 mph

Detector B at 45.002, -90.0044
MAC ID 1234456890ABCDEF
07:03:35

Detector A at 45.002, -89.9638
MAC ID 1234456890ABCDEF
07:01:05





Vehicle Re-Identification Process

1. **“Listen”** for Bluetooth MAC addresses at two or more locations.
2. **Record** observation time and location.
3. **Transmit** observations to central server.
4. **Match** MAC addresses spatially.
5. **Compute** travel time.
6. **Filter out** unreasonable travel times.
7. **Evaluate and Report** Speed, OD and Route.
8. **Combine** with volume data if appropriate.

What Can Bluetooth Do?

One Detector:

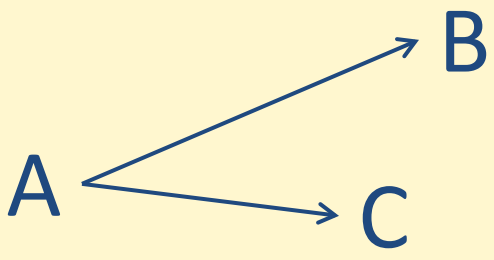
- Not Much

Two Detectors:

- Trip Time (Speed)

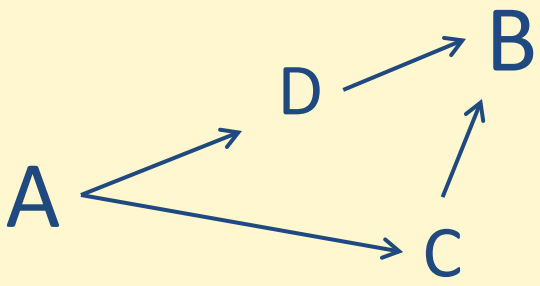
Three Detectors:

- Origin and Destination



Four or More Detectors:

- Route Choice

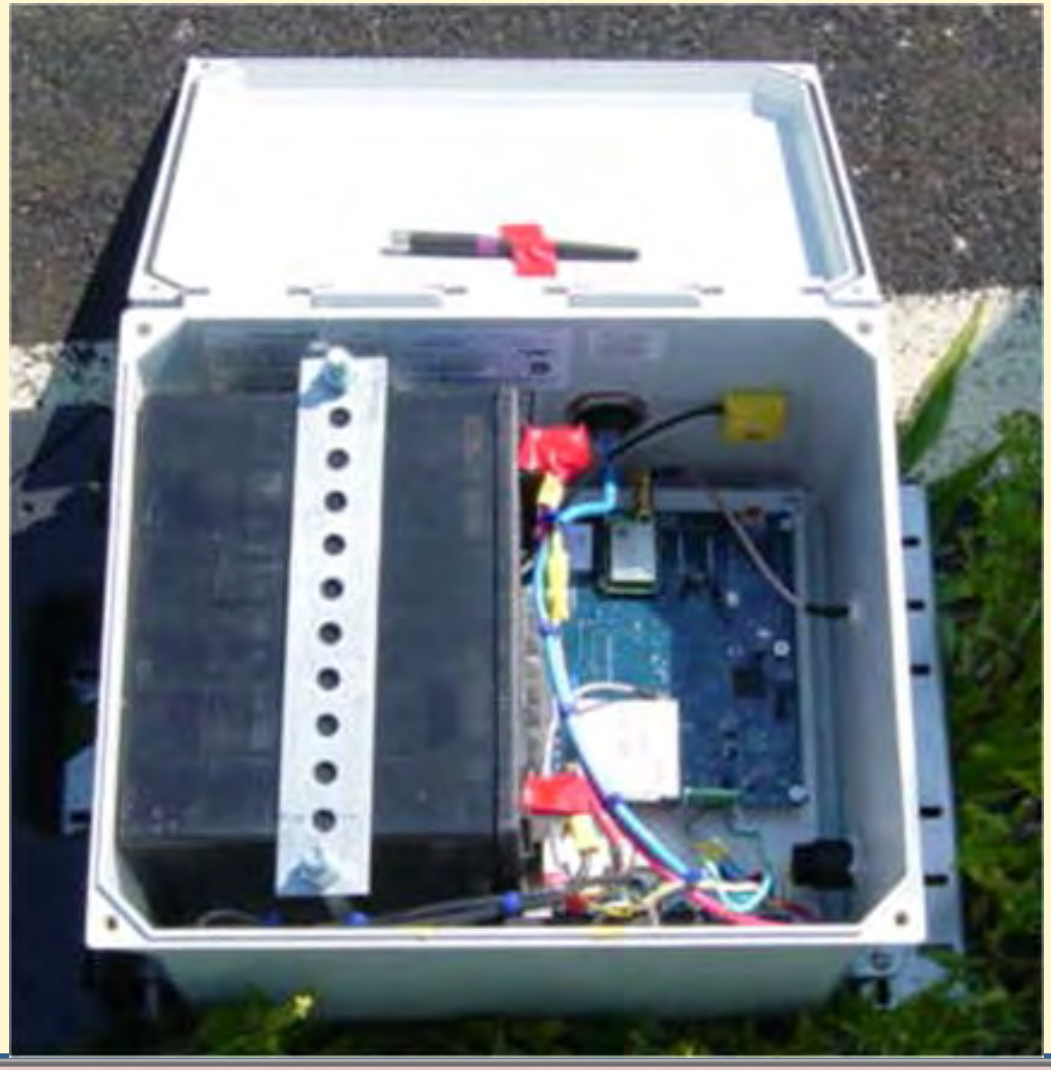


By Itself, Bluetooth Provides...

- Discrete, time-stamped observations of people/vehicles moving around.

- But NOT traffic volume.

Field Equipment



Installation

Equipment Set-up

Cabinet-Mount Examples

DeepBlue (TrafficNow)

BlueFAX (Traffax)

BlueTOAD (Trafficcast)

BlueCompass (Acyclica)

Post Oak Traffic Systems

Other Configurations

Side-Fire (TrafficNow)

MiniTOAD (Trafficcast)

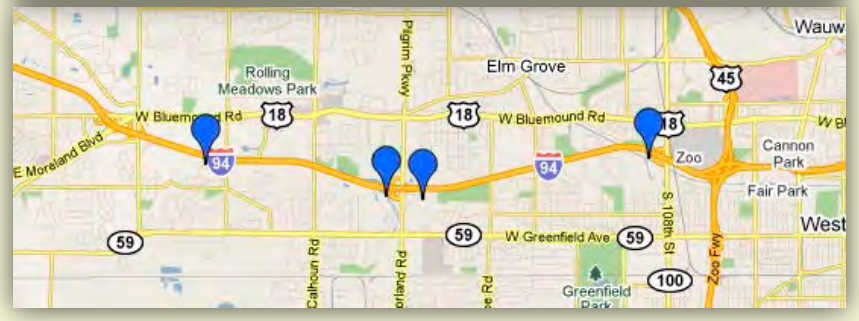
Portable (Acyclica)

DIN Rail (TrafficNow)

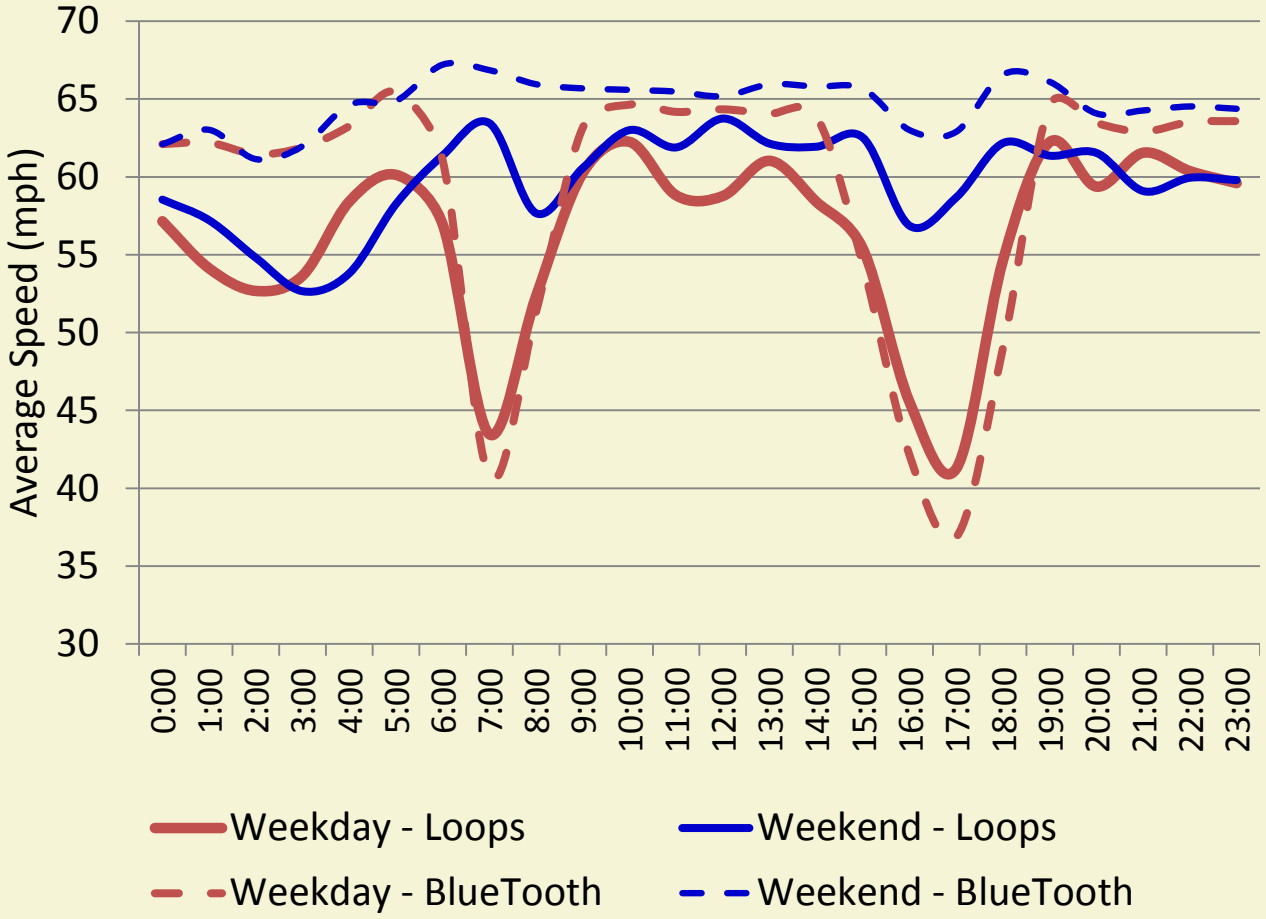
Portable (Traffax)

Travel Time
Western Milwaukee Suburbs

- 5.5 mile segment carrying 130,000 AADT
- WisDOT concerned about accuracy of DMS travel times
- Current system using data from 41 loop detectors
- Some loops reporting zero speeds
- Speeds sensitive to ongoing calibration



Findings



- Loop speeds low in free-flow conditions
- Loop speeds too high in congestion
- BT pairing sampling rate <3% (2010)

Recent Work Zone Field Studies

- Milwaukee
- Portage
- Grafton
- Endeavor

Work Zone Traffic Performance

Freeway Work Zone Capacity

Why do some work zones operate better than others?

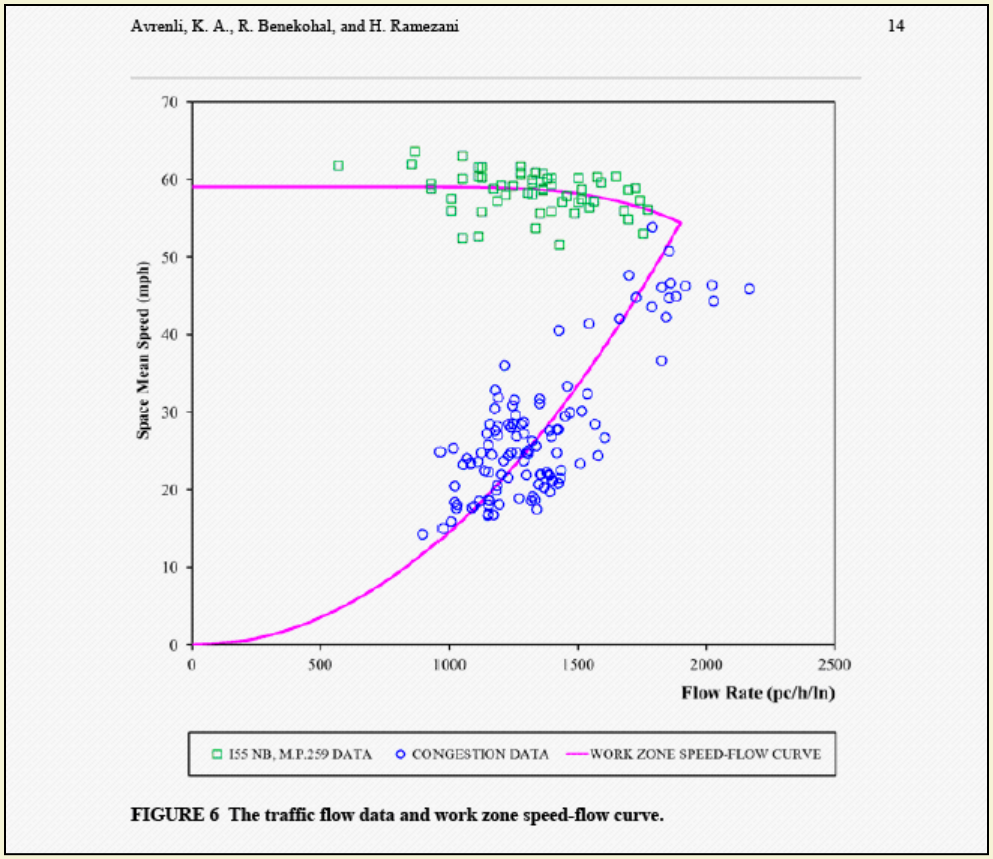
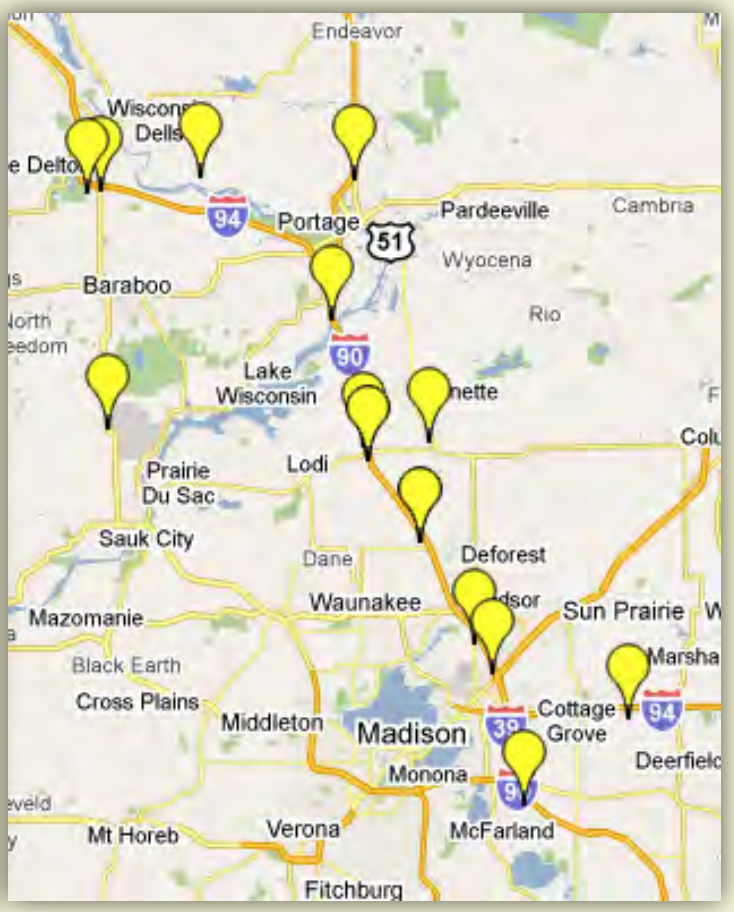


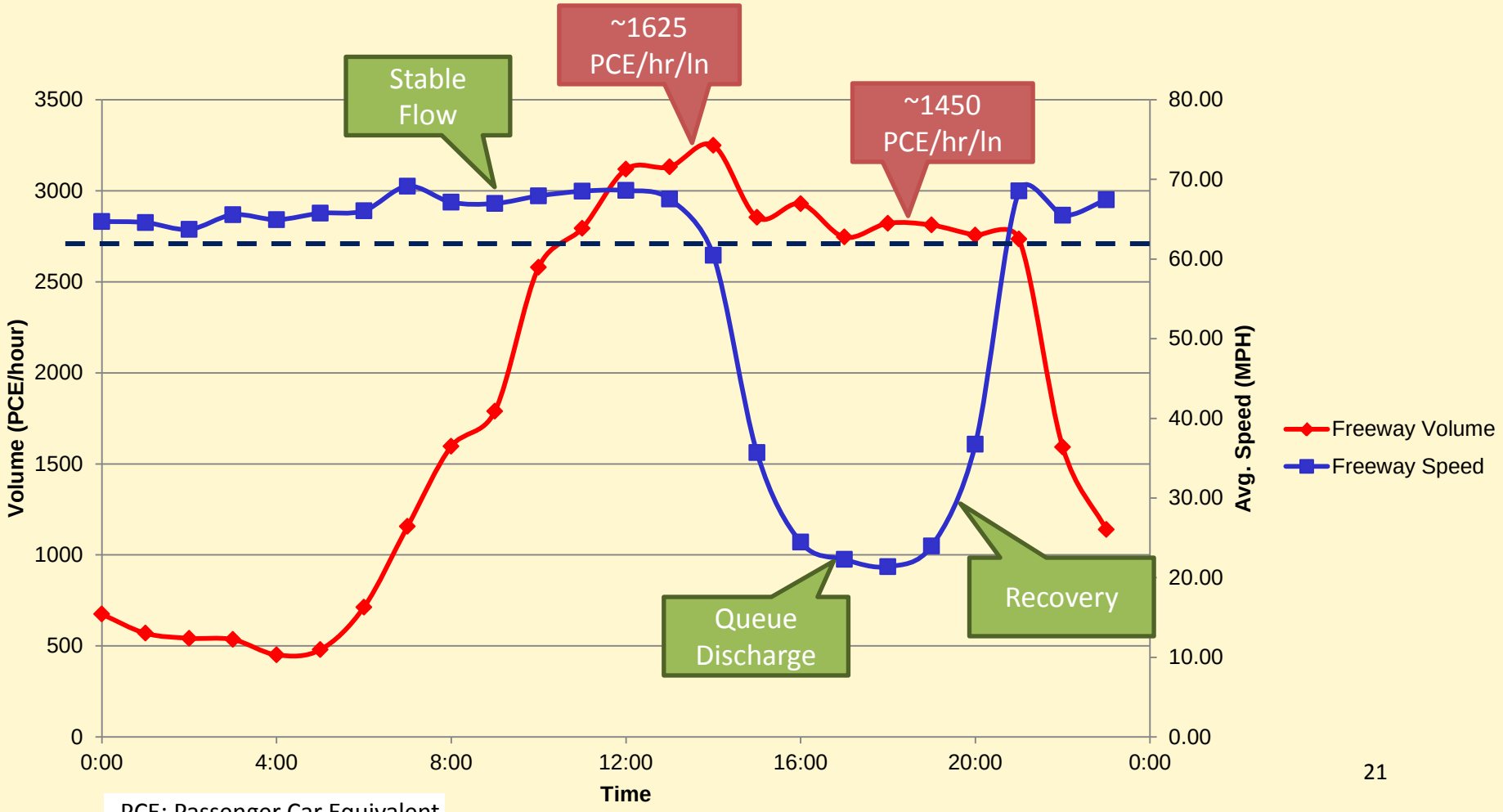
FIGURE 6 The traffic flow data and work zone speed-flow curve.

Rural Freeway WZ Capacity, Delay & Route Choice (Portage, WI)



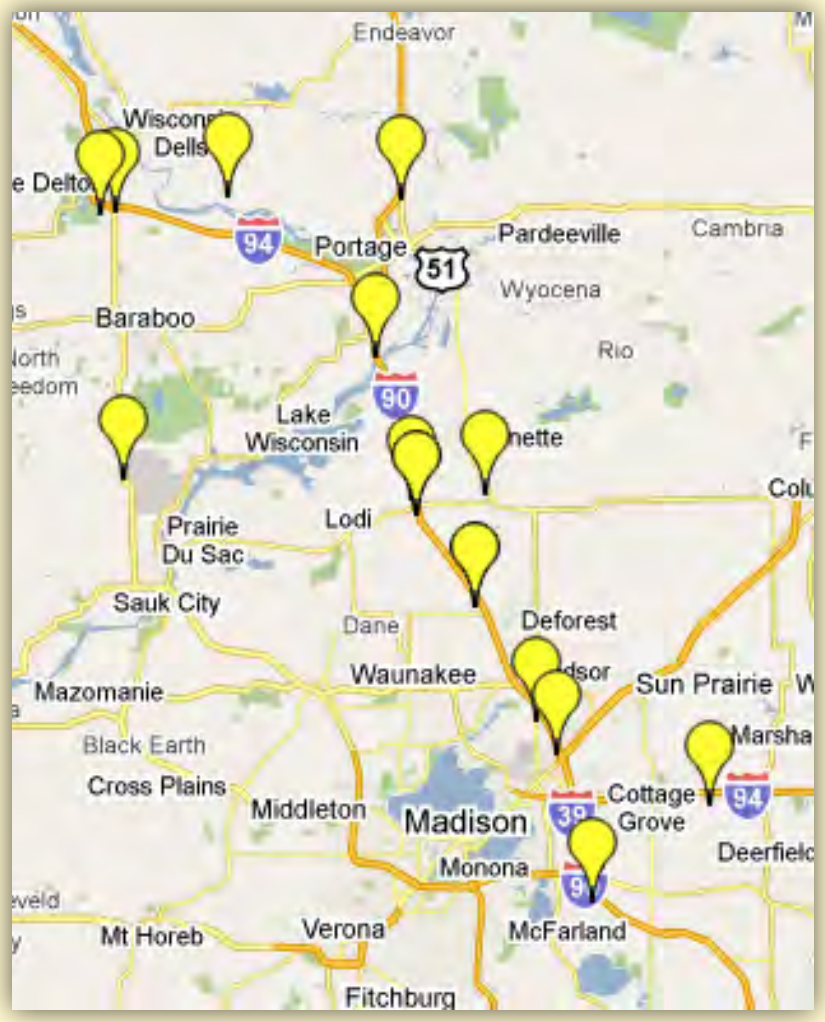
- Weekend recreational route
- 30+ miles
- 13 BT units
- Mainline + Alternates
- Volume counts

Results: Rural Freeway Capacity



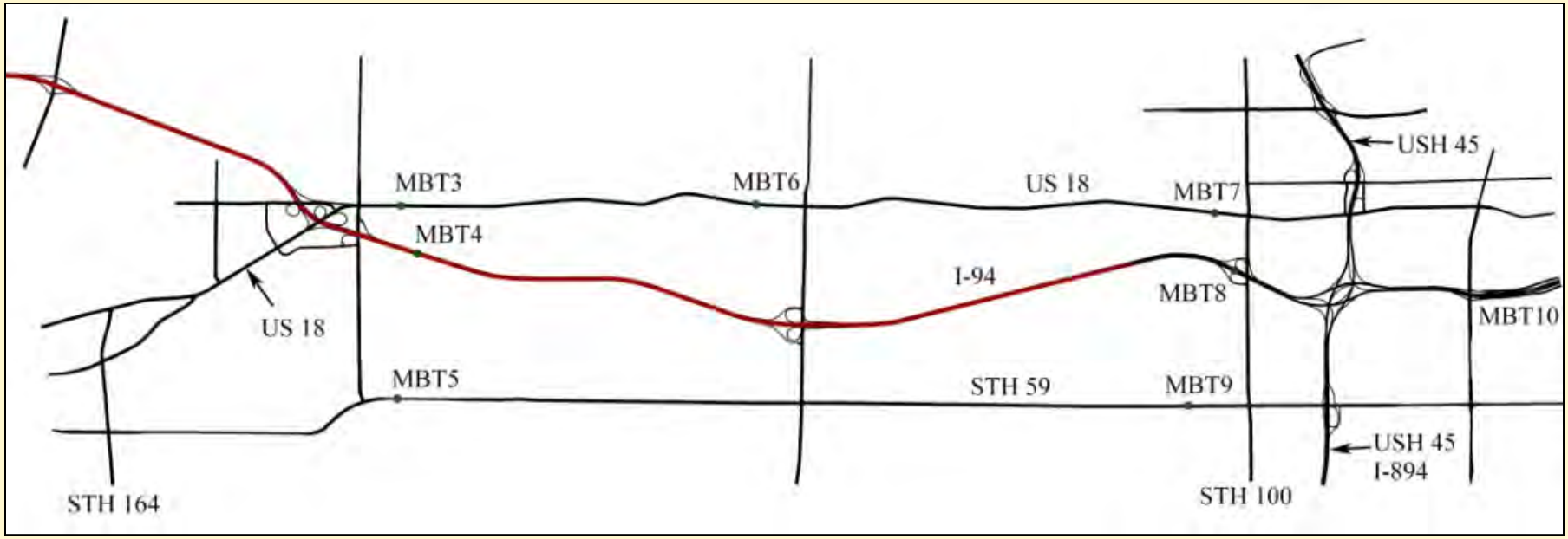
PCE: Passenger Car Equivalent

Results: Rural Route Choice



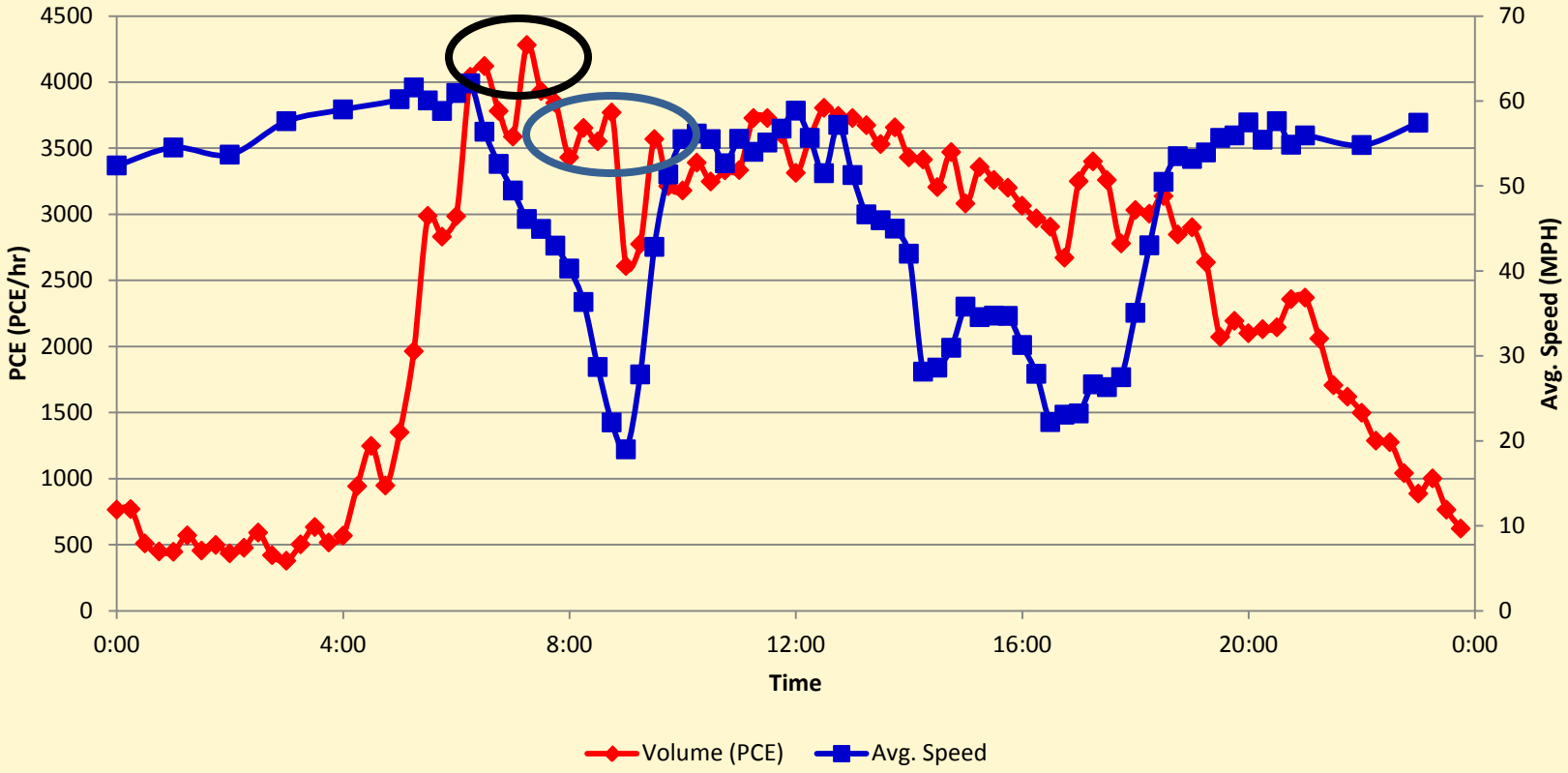
- Drivers can respond to WZ congestion in a variety of ways.
- Modest increases in traffic on alternate routes
- Relatively few exited and then returned to freeway.
- More commonly, local traffic stayed on local routes until past the work zone.

Urban Freeway WZ Capacity, Delay & Route Choice (Milwaukee Suburbs)



- Freeway Mainline + Two Alternate Routes
- Bluetooth Detectors + Volume Counts

Results: Urban Freeway Capacity



Stable Flow

AM: 1825-2200 PCE/hr/lane

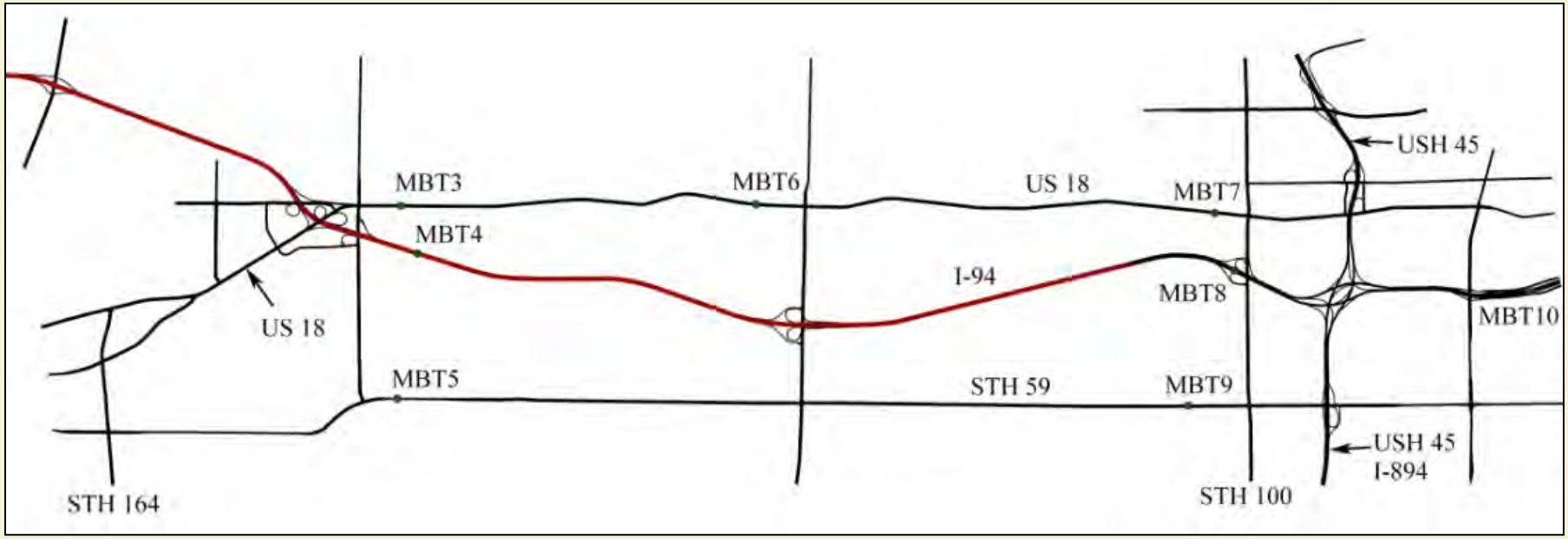
PM: 1825-1950 PCE/hr/lane

Queue Discharge

AM: 1600-1825 PCE/hr/lane

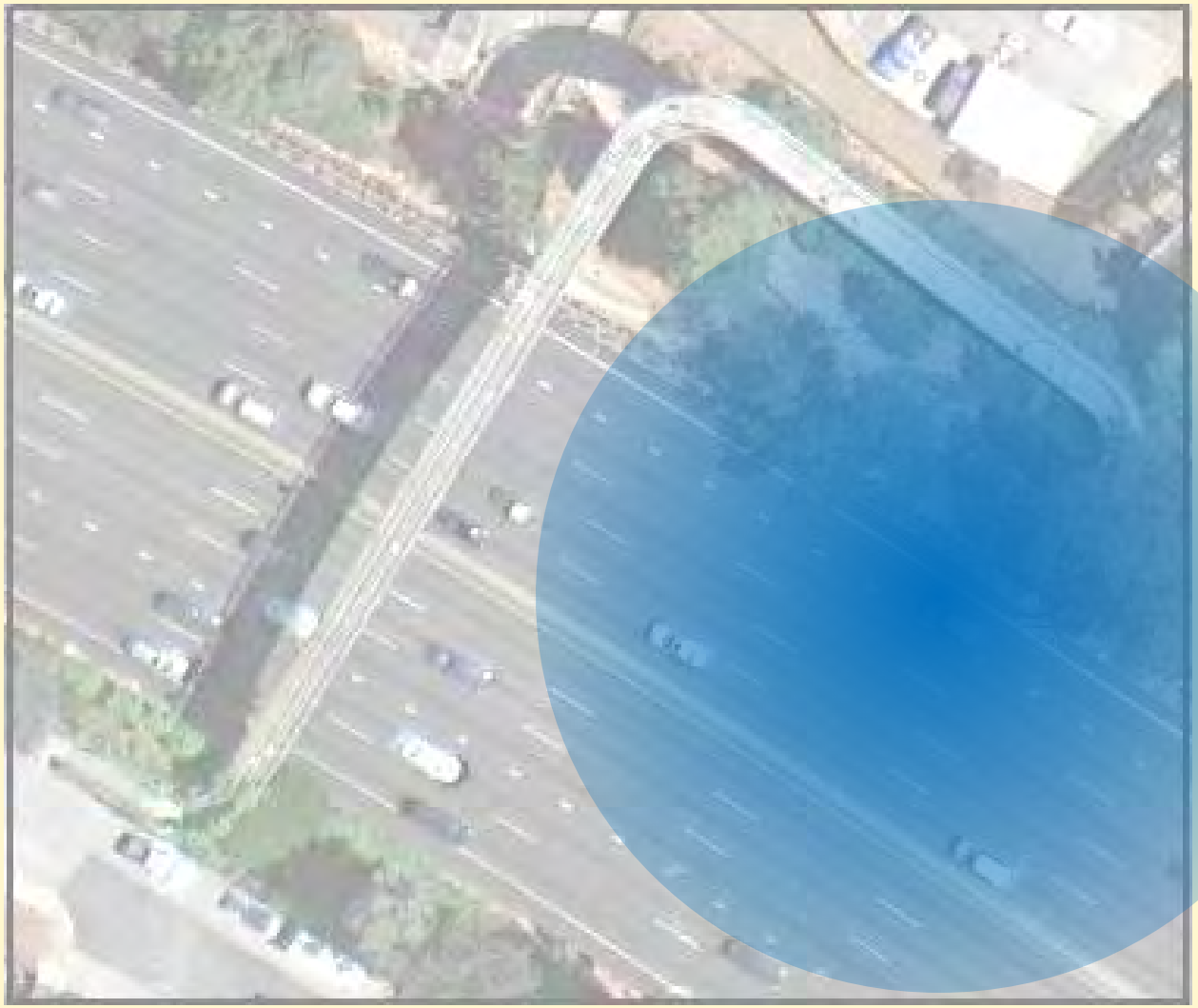
PM: 1725-1825 PCE/hr/lane

Results: Urban Route Choice



- Commuters very willing to use alt routes.
- Increased traffic on alt routes even when mainline was *not* congested.

Lessons Learned



Lessons Learned

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- Detection rates vary by route type and time of day
- Since Jan 2012, USDOT requires truck drivers to use hands-free devices.

Data Processing Matters

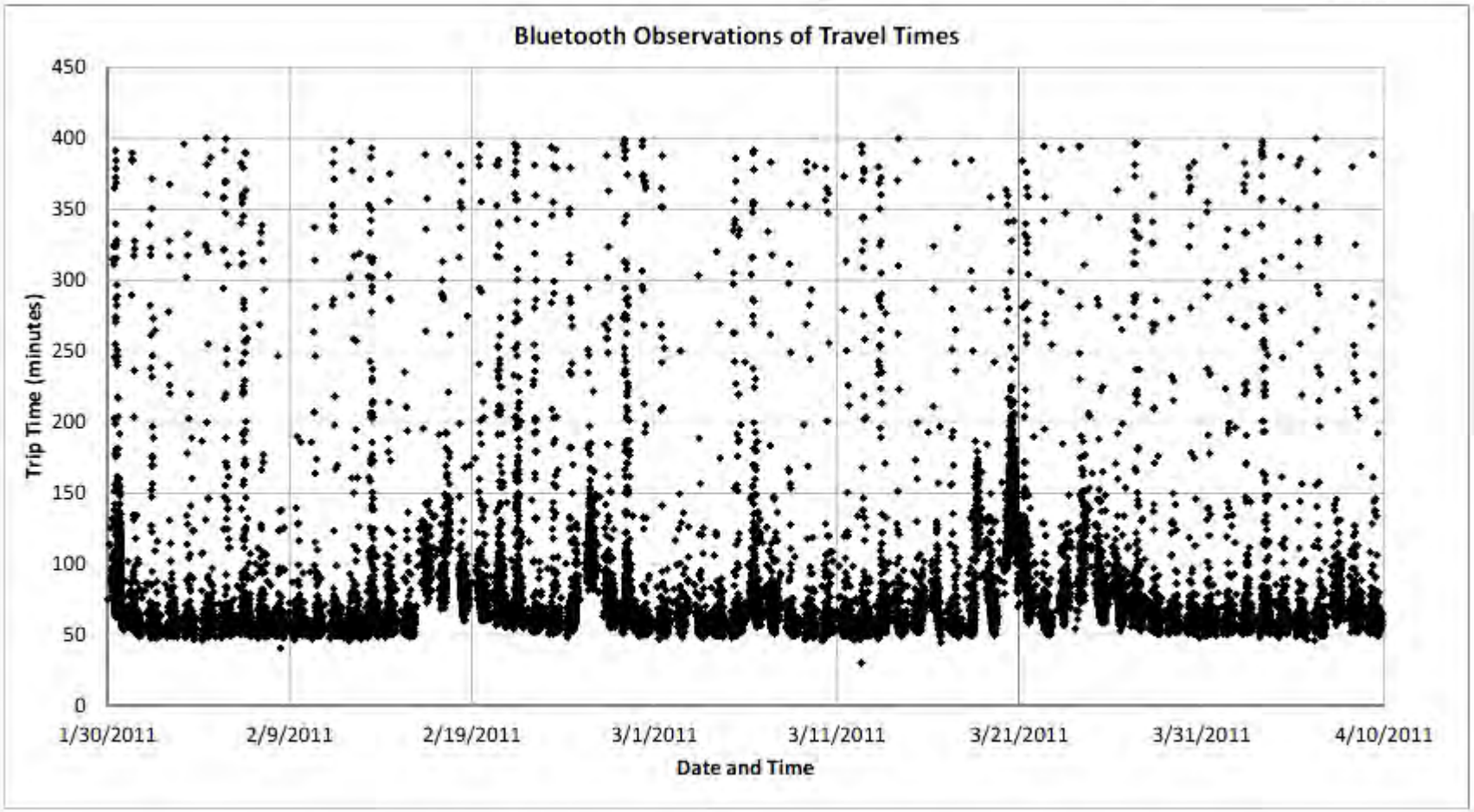

Figure 3-13: Raw Observations. US-50. South Lake Tahoe. CA to Placerville. CA

The Secret is in the Software

Options

- Proprietary vendor-supplied filtering and matching services
- Free software from sensor vendors (basic)
- Third-party software (advanced)

Bluetooth vs Side-Fire Radar

Bluetooth

- Speed (lagging)
- Travel time for a route segment
- Accurate at all speeds
- Many mounting options
- Observes all traffic
- Low power consumption
- Requires at least 2 detectors
- $2500-5000 per detector
- Some vendors offer rental

Radar

- Speed + Volume
- Point speed at a specific location
- Not accurate at low speed
- Pole-mount at roadside
- Observes specific lanes
- 8 to 11 watts continuous
- Can get data from a single detector
- About $5000 per detector

Bluetooth Pro & Con

Strengths

- Inexpensive
- Low power consumption
- Highly accurate speed data
- Easy to extend study duration
- Efficient method for collecting OD info
- Only practical way to collect route choice data

Limitations

- Low sampling rates
- Capture rates can vary by time of day (prob. trucks)
- Sometimes sensitive to:
  - Site Characteristics
  - Antenna Placement
  - Loss of Power/Comm
  - Data processing assumptions

Questions?

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