

# Arterial Performance Measures using MAC Readers – Portland's Experience

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# Presentation Overview

- › The Journey → How did we get here?
- › Does this really work? → Validation
- › MAC Reader Applications → Travel time & OD
- › What's next?



# Presentation Inspiration

- › **What gets measured gets done**
  - We collect **data** on our arterial street system
  - We need to convert that data into **information** → better **decisions**
- › Example: **Gauge travel time competitiveness** of transit vs. auto modes?
  - Transit performance with our Automatic Vehicle Location System
  - Probe vehicle travel times via MAC readers
  - Transit signal priority or transit operations changes?



# Presentation Inspiration

- › What data do we want?
  - *NCHRP 3-79 describes significant amount of techniques including wireless*
  - *Aha! Moment in the research*
- › What data can we get inexpensively now?
  - *MAC Address readers probe data*



# MAC Reader Technology Overview

- Media Access Control (MAC) = unique identifier by manufacturer, 48 bit (>28 trillion) characters
- Bluetooth™ = common name for wireless radio frequency communication protocol between electronic devices

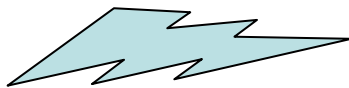
## PERSONAL DEVICE



Auto  
Pedestrian  
Bike  
Bus/LRT

Truncated MAC Address

00:1E:3D:AF:DA:C5



## FIELD RADIO & ANTENNA



## MINI COMPUTER (IN CABINET)



TEXT FILE

MS ACCESS FILE

KAI CUSTOM SOFTWARE

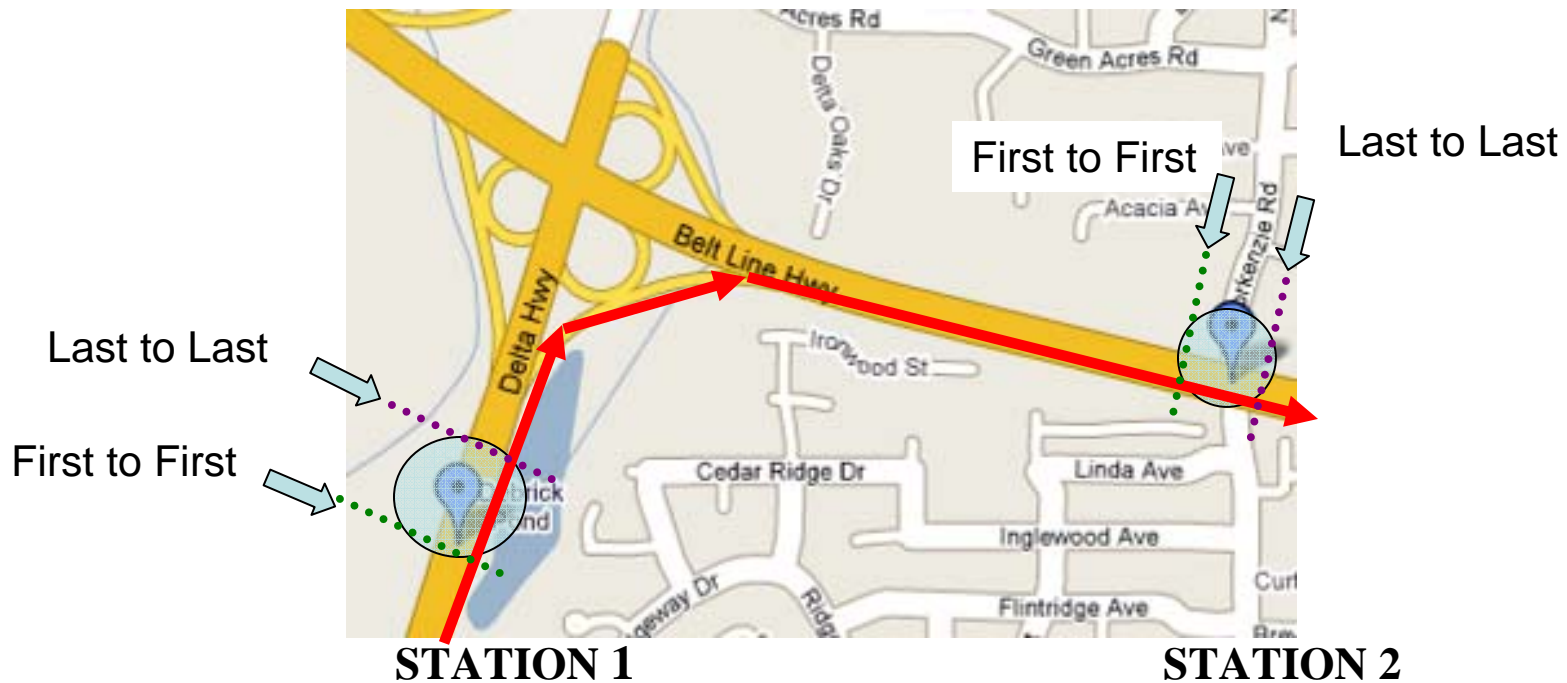
OUTPUT



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# MAC Address Matching – Probe Sample



Address	First Detected On	Last Detected On
00:1c:c1:7b:b7:06	9:06:09 PM	9:06:09 PM
00:c0:1b:04:d6:9d	9:06:09 PM	9:07:10 PM
00:1e:45:69:4d:1f	[REDACTED]	[REDACTED]
00:1c:cc:90:12:d7	[REDACTED]	[REDACTED]
00:15:b9:d2:82:e2	[REDACTED]	[REDACTED]

Address	First Detected On	Last Detected On
00:10:86:e8:56:14	9:05:44 PM	9:05:44 PM
00:1e:45:69:4d:1f	9:12:00 PM	9:12:00 PM
00:15:b9:d2:82:e2	9:18:40 PM	9:18:40 PM

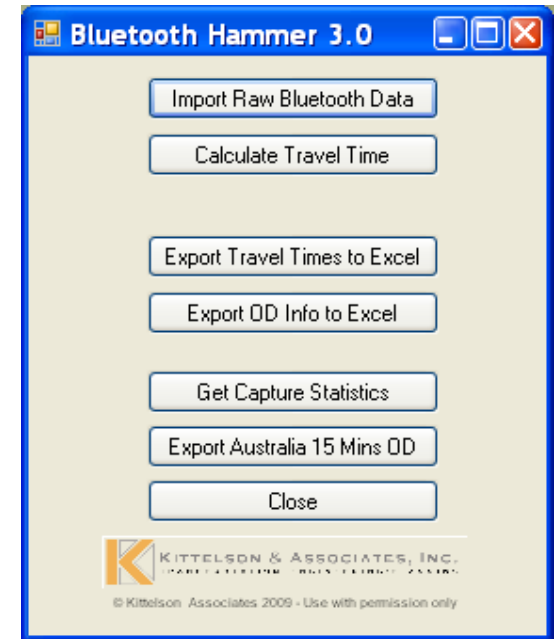


# The Journey – Equipment



# The Journey – Software Automation

- › Converts raw data to database
- › Filtering by reference
  - *First-First, Last-Last, etc.*
- › Clock correction, if needed
- › Capture statistics – data integrity check
  - *Raw individual records*
  - *Grouped by hour by station*
    - # Pings
    - # of Hits/Devices



StationCapturesHourly : Table						
	UID	Station	StartHour	Pings	Hits	Devices
		2011_Powell-21	10 9:00:00 AM	5778	130	130
	1	2011_Powell-21	10 10:00:00 AM	10656	254	246
	2	2011_Powell-21	10 11:00:00 AM	11702	216	213
	3	2011_Powell-21	10 12:00:00 PM	17286	260	252
	4	2011_Powell-21	10 1:00:00 PM	16282	261	249
	5	2011_Powell-21	10 2:00:00 PM	10448	278	269
	6	2011_Powell-21	10 3:00:00 PM	36210	355	347
	7	2011_Powell-21	10 4:00:00 PM	31970	332	322
	8	2011_Powell-21	10 5:00:00 PM	11250	337	335
	9	2011_Powell-21	10 6:00:00 PM	8742	256	253
	10	2011_Powell-21	10 7:00:00 PM	5934	169	163
	11	2011_Powell-21	10 8:00:00 PM	6644	134	131
	12	2011_Powell-21	10 9:00:00 PM	5806	129	127
	13	2011_Powell-21	10 10:00:00 PM	3552	98	96
	14	2011_Powell-21	10 11:00:00 PM	5954	68	66



# The Journey – Software Automation

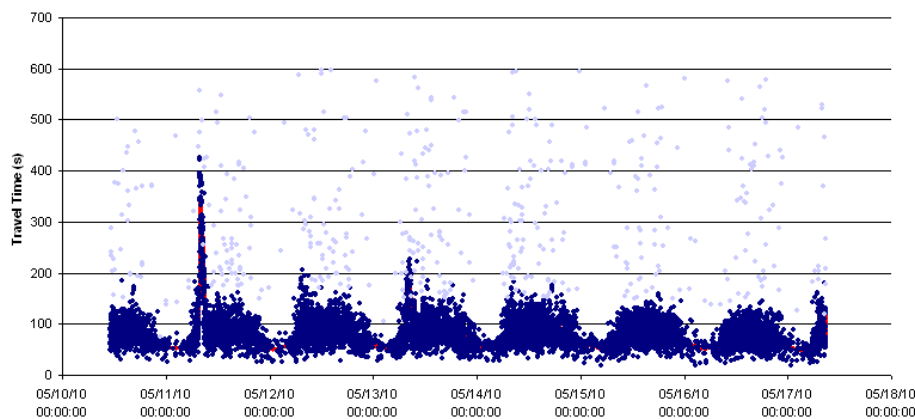
- › Output = graphical and tabular

## Bluetooth observed travel time between Powell & 33rd and Powell & 21st

5/10/2010 11:05:36 AM - 5/17/2010 8:50:07 AM

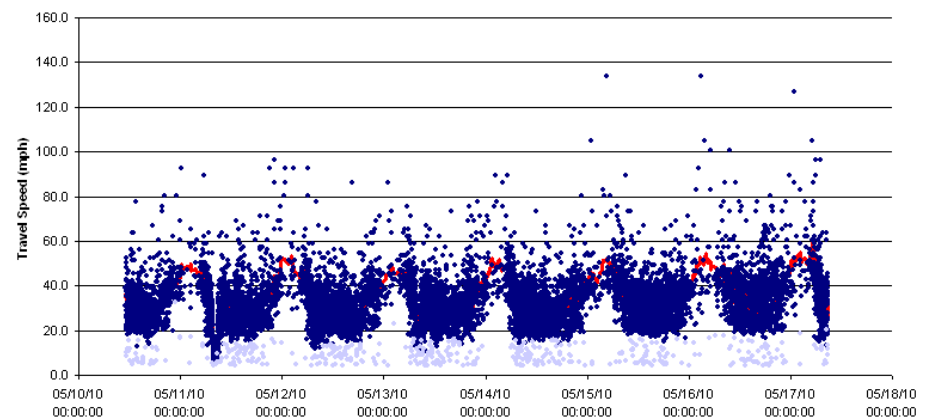
Travel Time Statistics				
Number of Trips	Average Speed (mph)	Average Travel Time	Standard Deviation	
11000	32.1	84.3	33.5	
Travel Time Reliability Measures (Derived from the input sample periods. These measures have the most validity with full day cross-sections.)				
Travel Time Index	Buffer Index	Planning Time Index	95th Percentile Travel Time	Free Flow Travel Time (15th Percentile)
1.5	48	2.3	132	58

Observed Travel Times from Powell & 33rd to Powell & 21st



• Travel Time Record • Discarded Travel Time Record — Average Travel Time

Observed Travel Speeds from Powell & 33rd to Powell & 21st

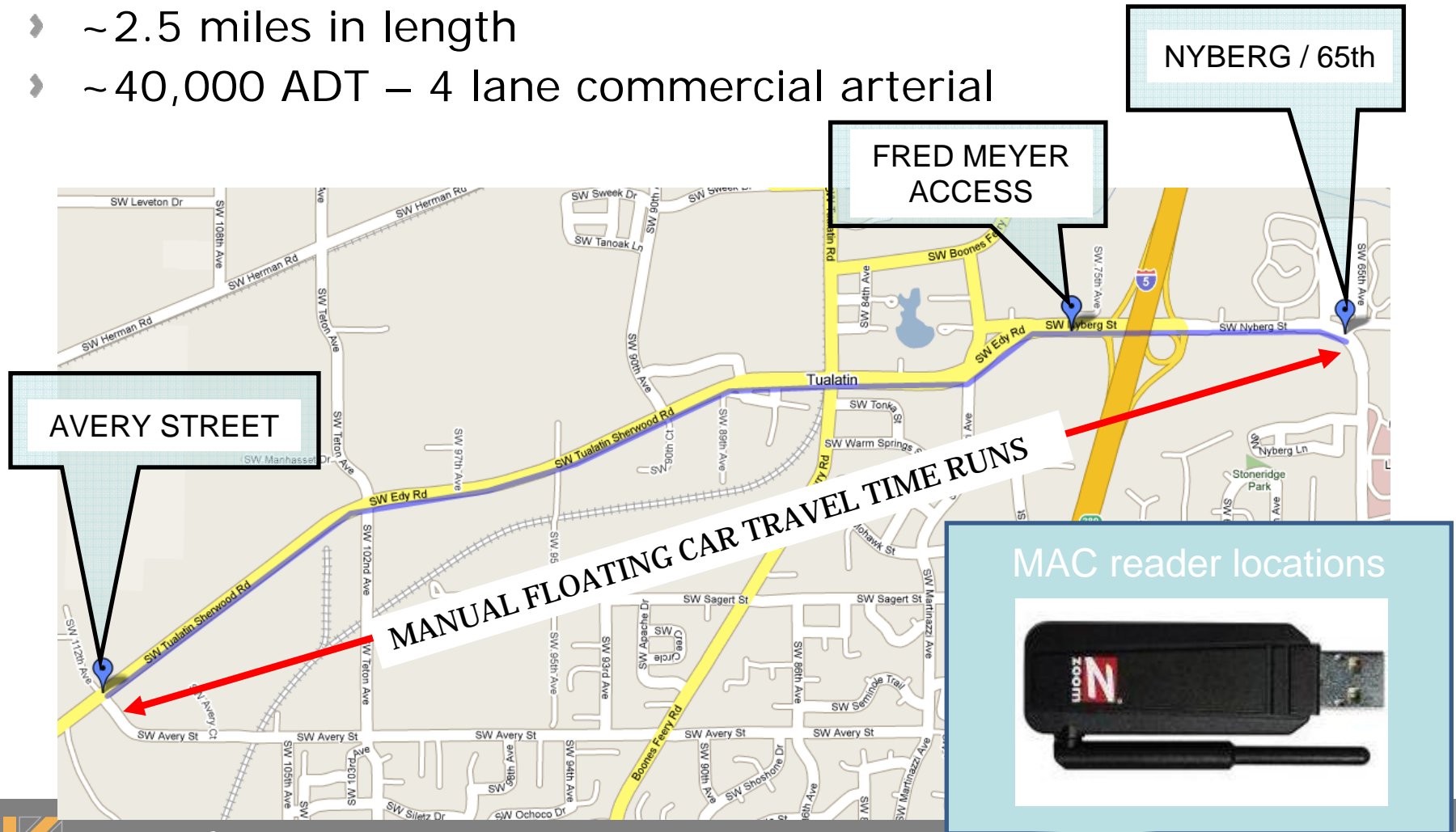


• Travel Speed Record • Discarded Travel Speed Record — Average Speed

Hourly Average Speed	Hourly Average Travel T	Hourly Number of Trips	Tube Counts	Percent Capture
5/10/2010 11:00	28.5	84.5	66	
5/10/2010 12:00	28.7	84.0	81	
5/10/2010 13:00	29.4	82.1	99	
5/10/2010 14:00	29.1	82.8	93	
5/10/2010 15:00	27.1	89.0	114	
5/10/2010 16:00	25.0	96.4	85	1089 7.8%
5/10/2010 17:00	26.9	89.6	108	1067 10.1%
5/10/2010 18:00	27.4	87.9	74	998 7.4%
5/10/2010 19:00	34.0	71.0	47	783 6.0%
5/10/2010 20:00	34.5	70.0	46	655 7.0%
5/10/2010 21:00	35.9	67.3	42	593 7.1%
5/10/2010 22:00	39.4	61.2	29	410 7.1%

# Does it work? Tualatin-Sherwood Road (SW Portland Suburbs)

- › Tualatin-Sherwood Road (SW Portland Suburbs)
- › ~2.5 miles in length
- › ~40,000 ADT – 4 lane commercial arterial



# MAC Reader Corridor Test 1

## › Objectives

- *Compare manual vs. MAC travel times*

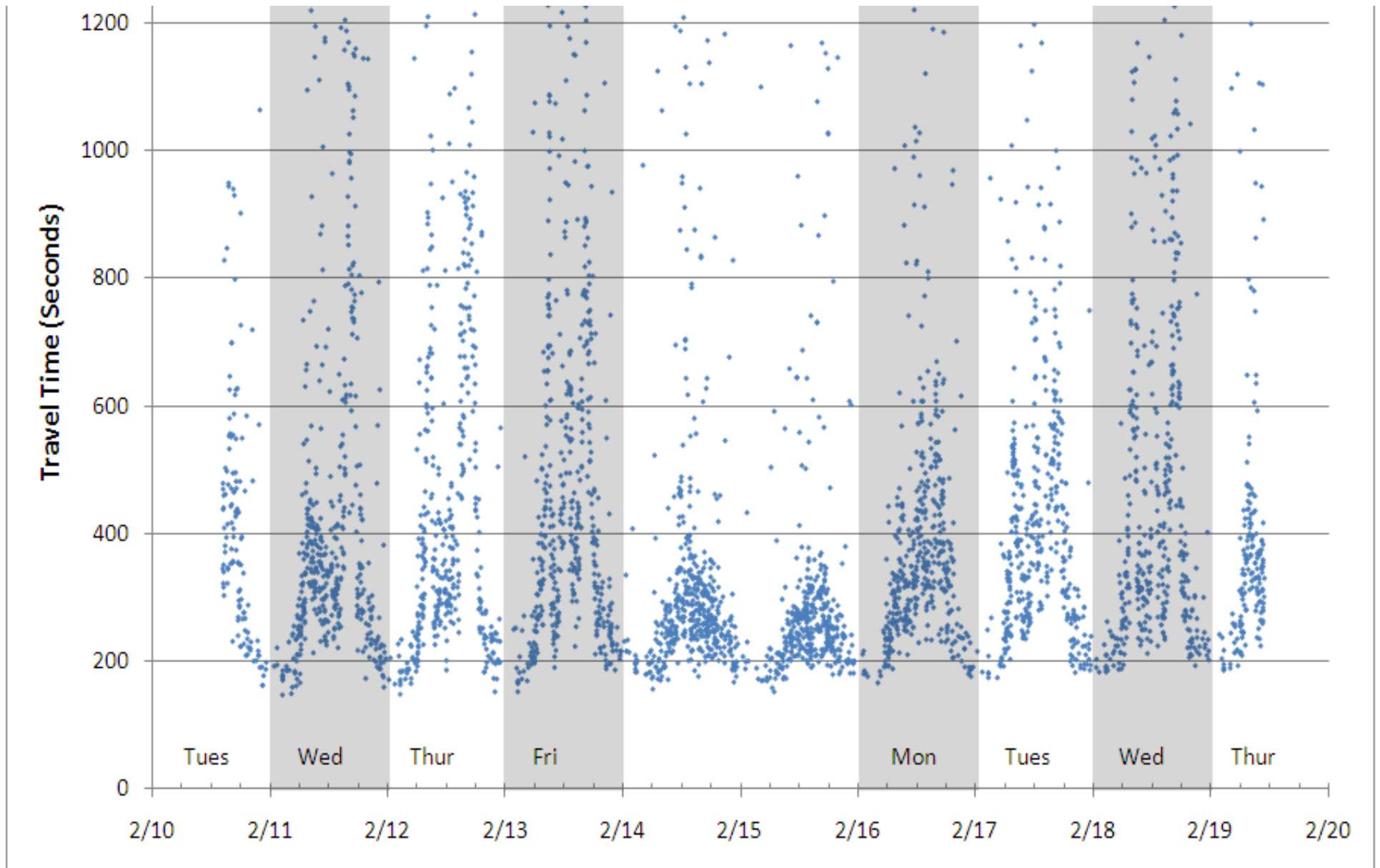
## › Manual floating car GPS travel time runs

- *Approximately 12 two-way trips (3 drivers)*
- *Low sample, one day and only in peak hours*

## › MAC Reader Technology Deployment

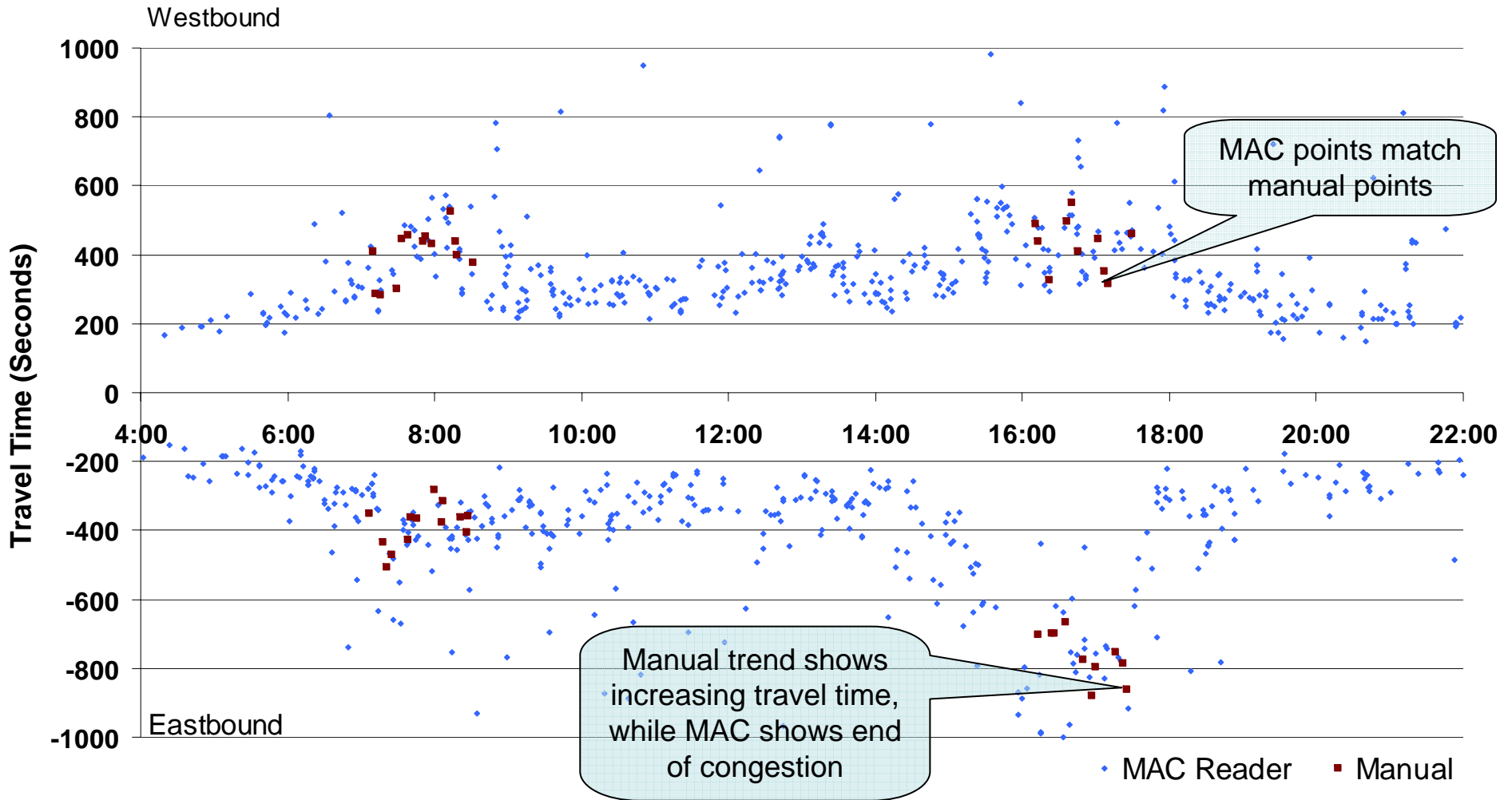
- *24 hours/7 days a week*
- *9 days*
- *Capture rate ~ 3 to 4% of ADT*

# Travel Time Profile (~9 days)



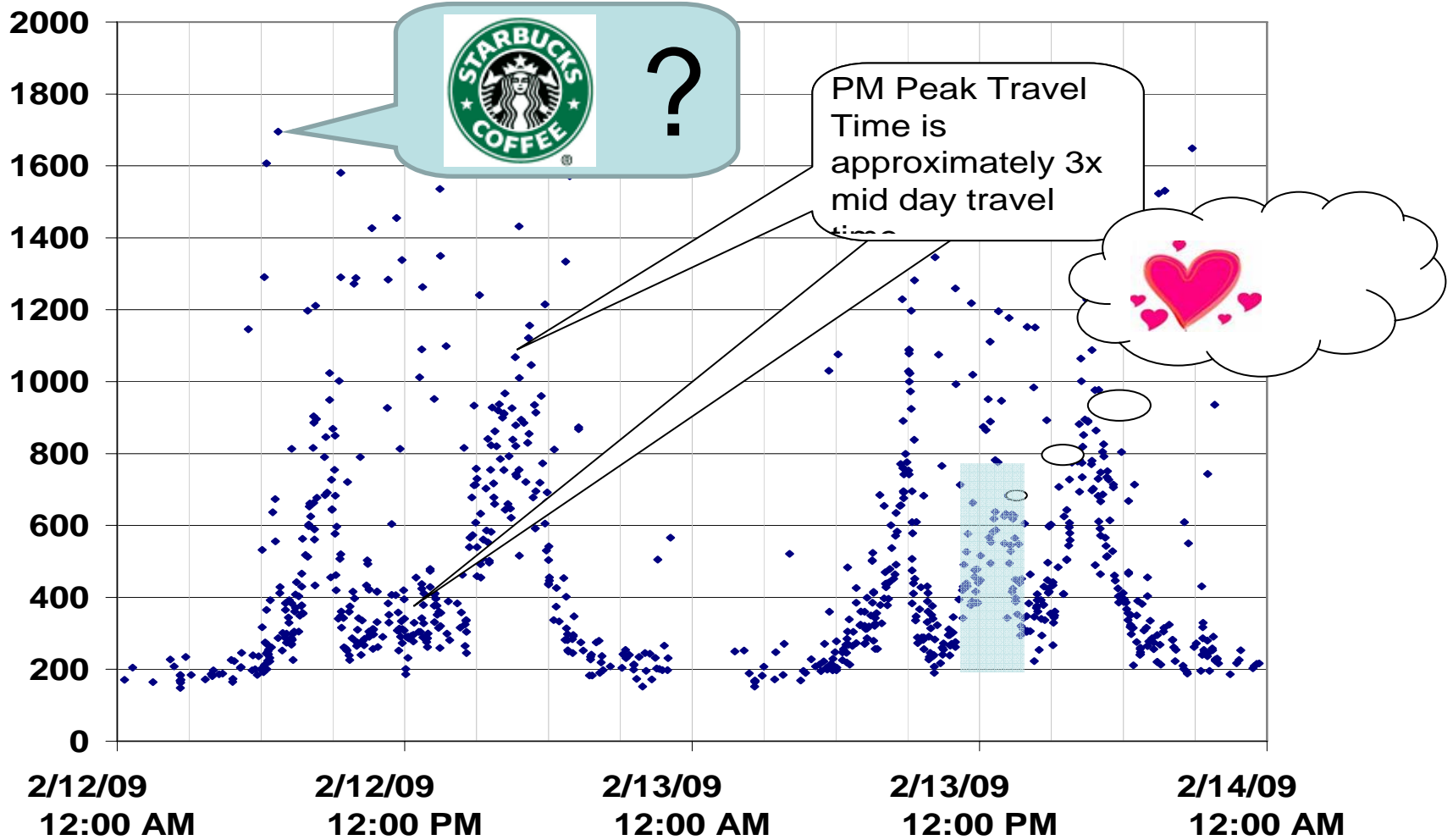
# Travel Time: Manual vs. MAC Validation

Between Fred Meyer and Avery - 24 Hour





# Travel Time Profile – Trend Exploration



# MAC Reader Application – Identify and Address Inefficiencies

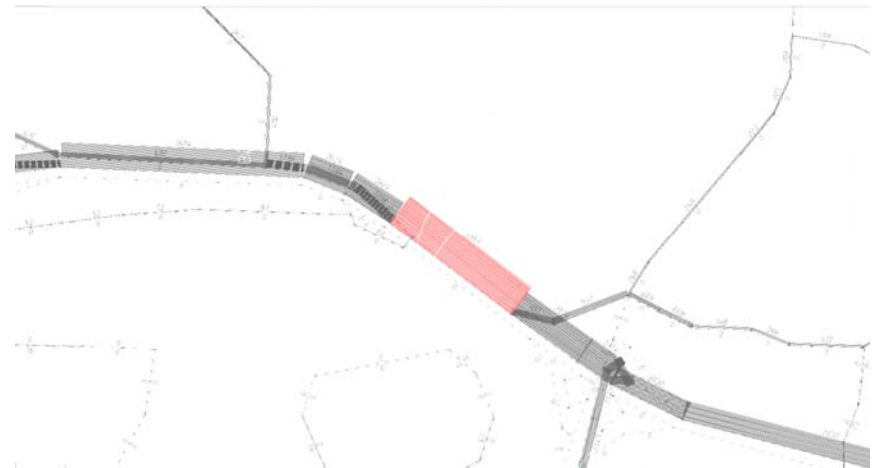
## ➤ Travel Time – Running Speeds

- *Corridor character → pass-by or mode split?*
- *Affect of operational changes → signal timing and incident example*



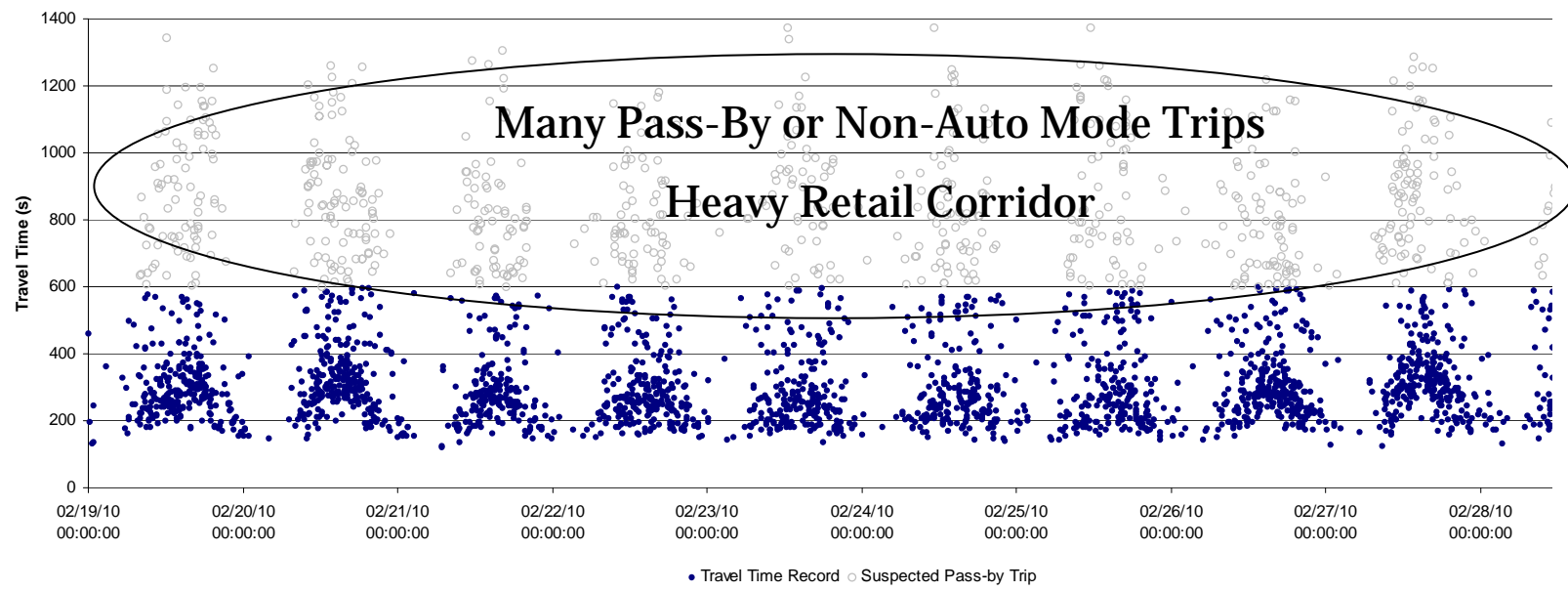
## ➤ Origin-Destination

- *Linear for signal progression*
- *Network for routing – travel demand model / trip distribution*

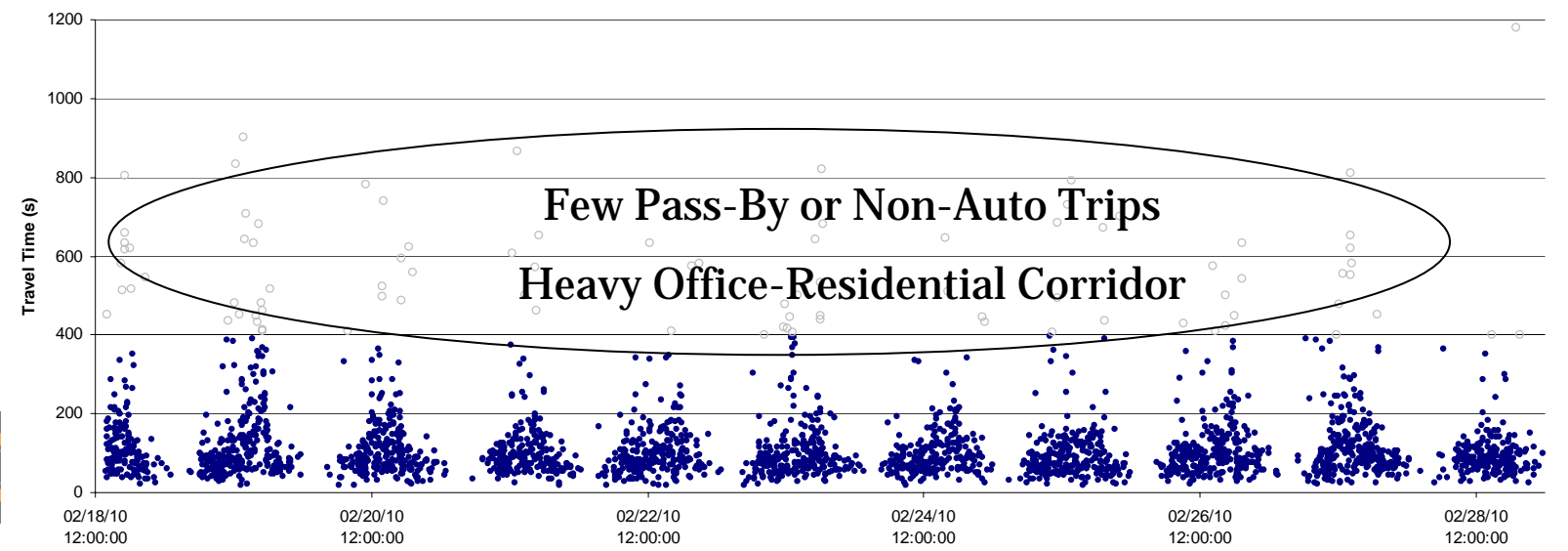


# Corridor Travel Character thru MAC Readers

Observed Travel Times NB 82nd Avenue from Sunnyside (2013) to JCB (2011)



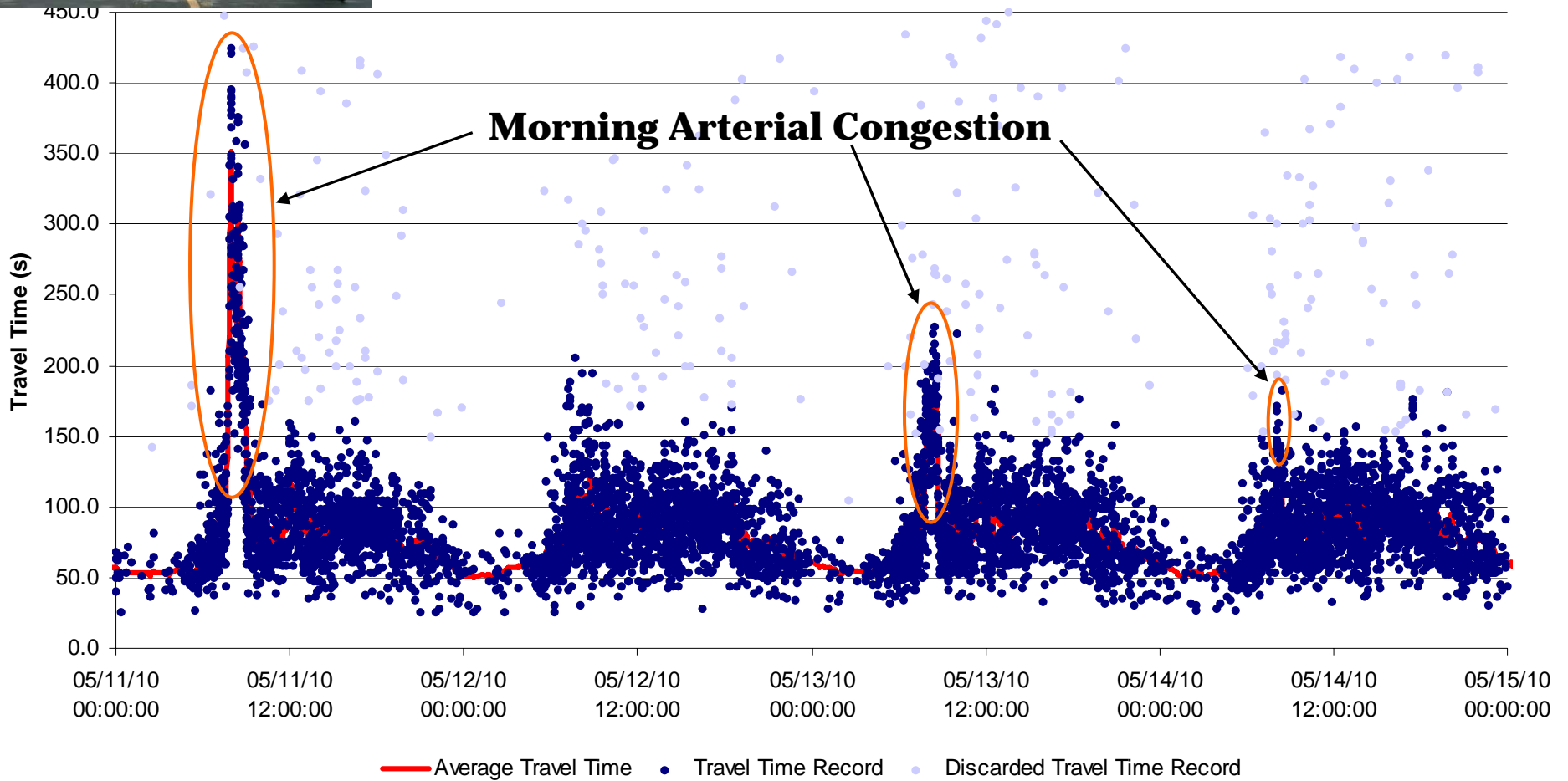
Observed Travel Times WB Johnson Creek Blvd from 92nd Avenue (2012) to 82nd Avenue (2011)





# Recurring Weekday AM Peak Incident

Observed Travel Times from Powell & 33rd to Powell & 21st

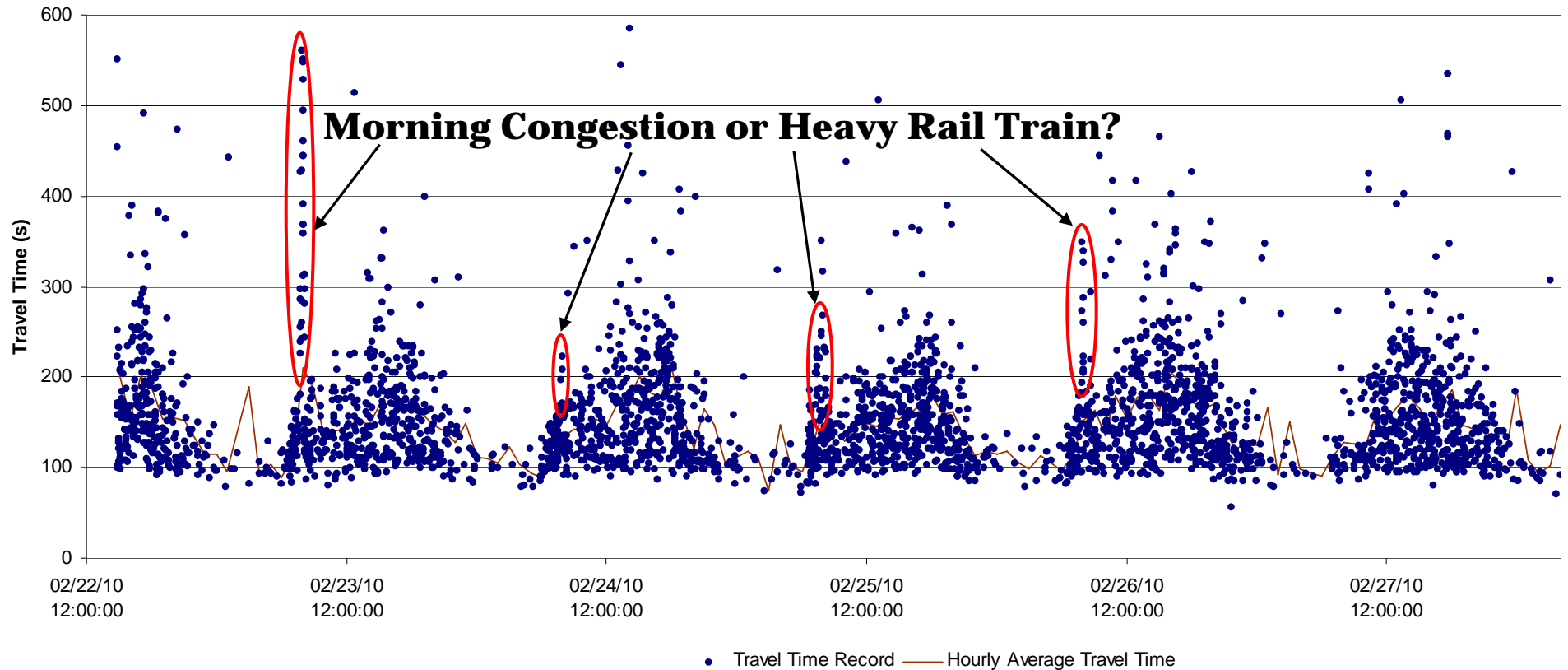


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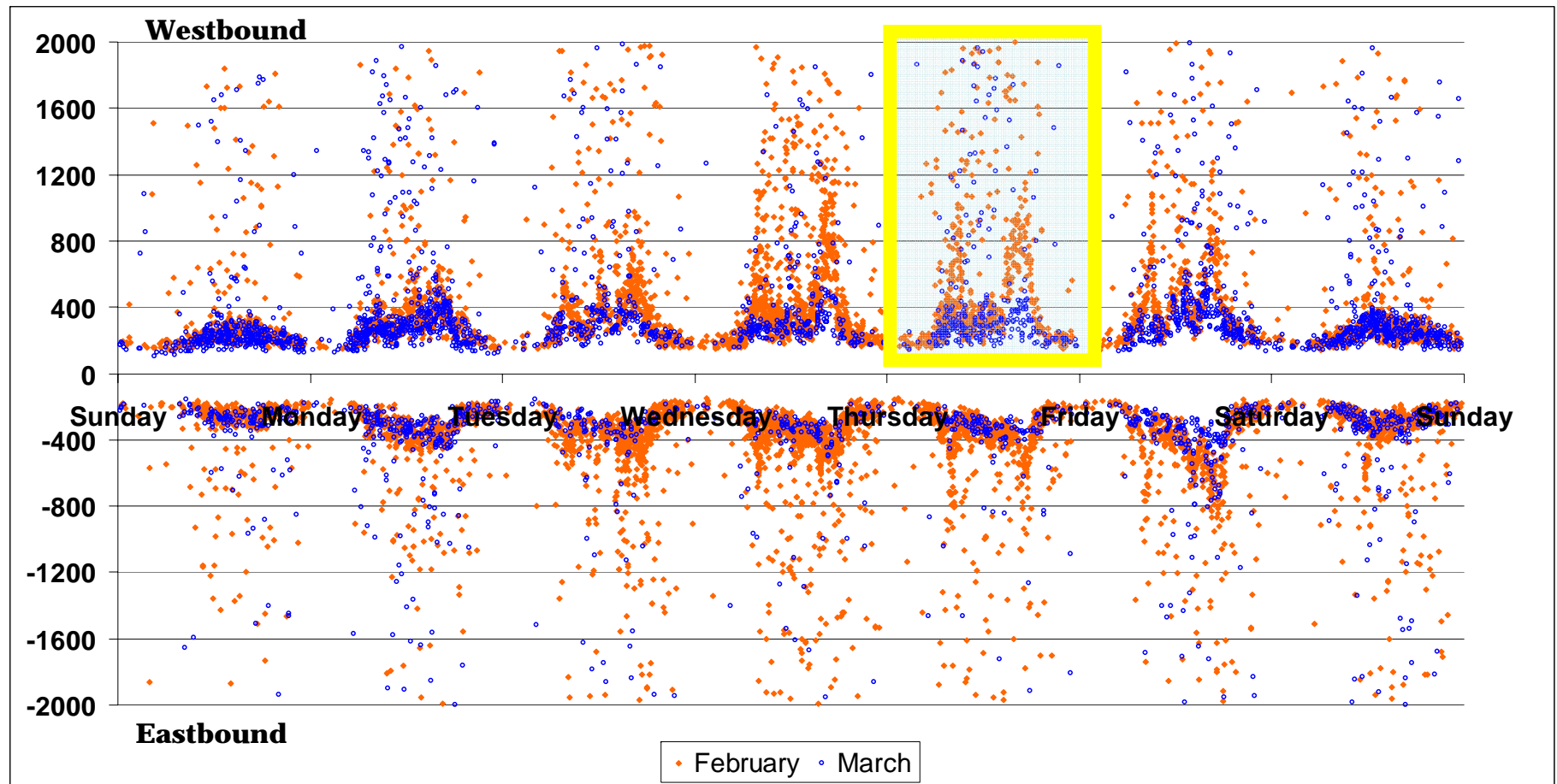
# MAC Reader Detected Recurring Weekday AM Peak Incident

Observed Travel Times WB Harmony Road from 82nd Avenue (2013) to Linwood Avenue (2019)



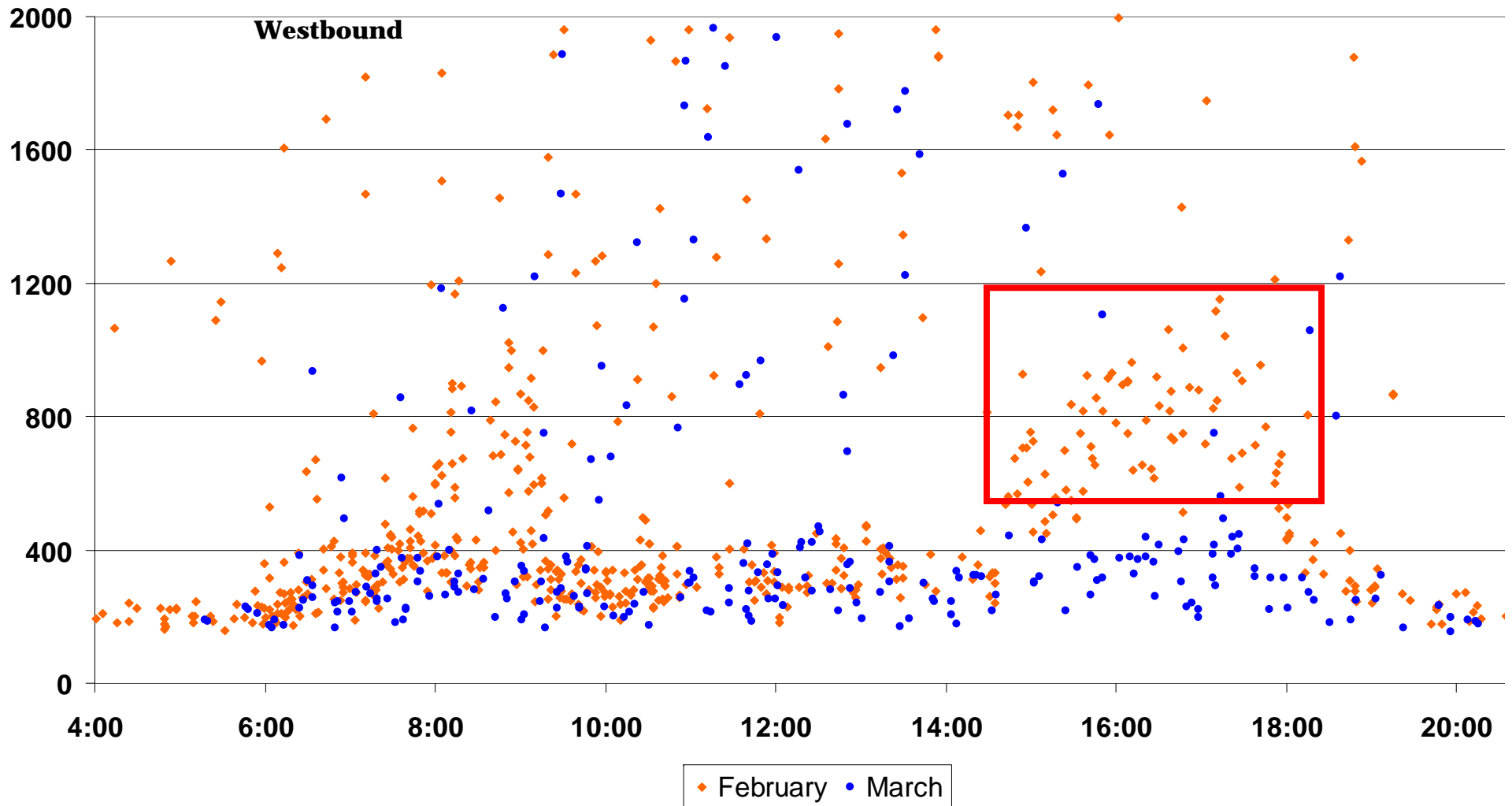


# Before (Orange) and After (Blue) Signal Timing Change



Significant reduction in travel time and variability

# Before (Orange) and After (Blue) Timing Change

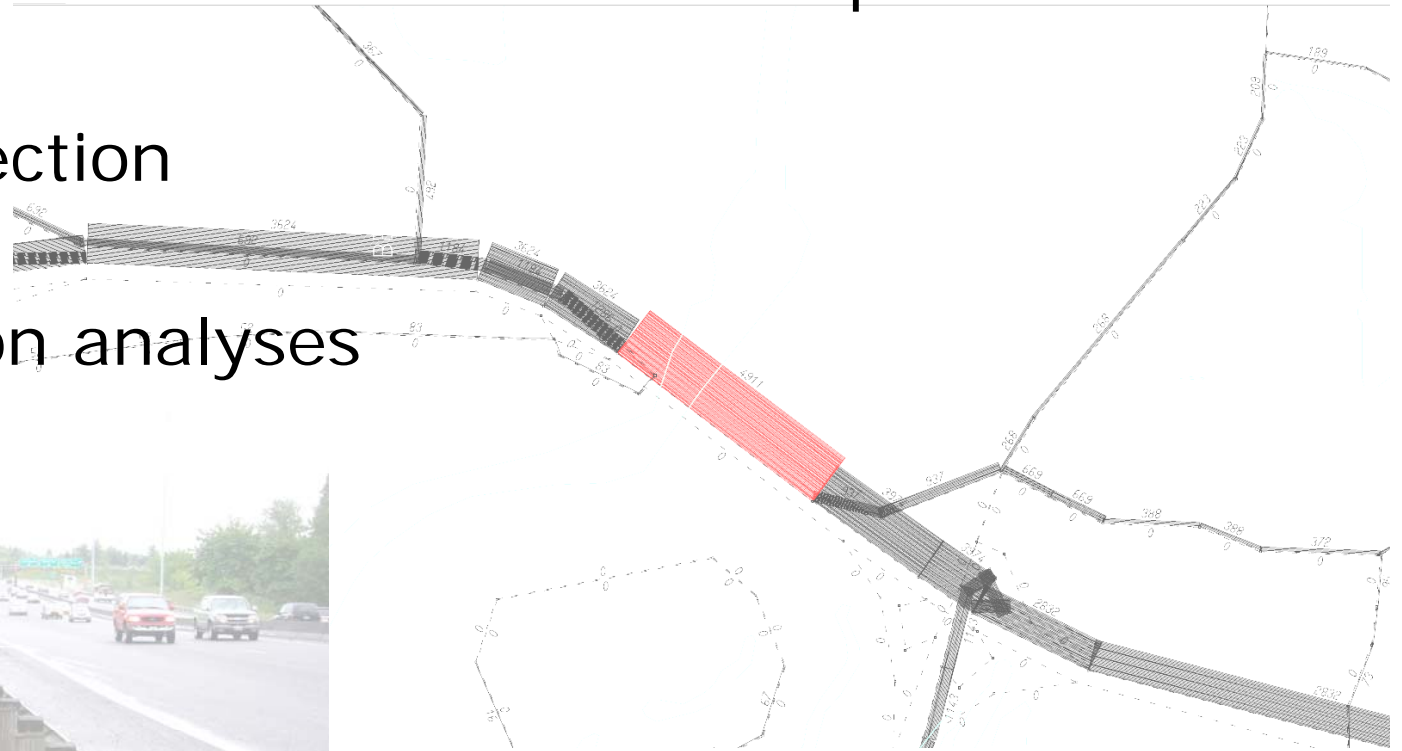


# Impact of Signal Timing Change

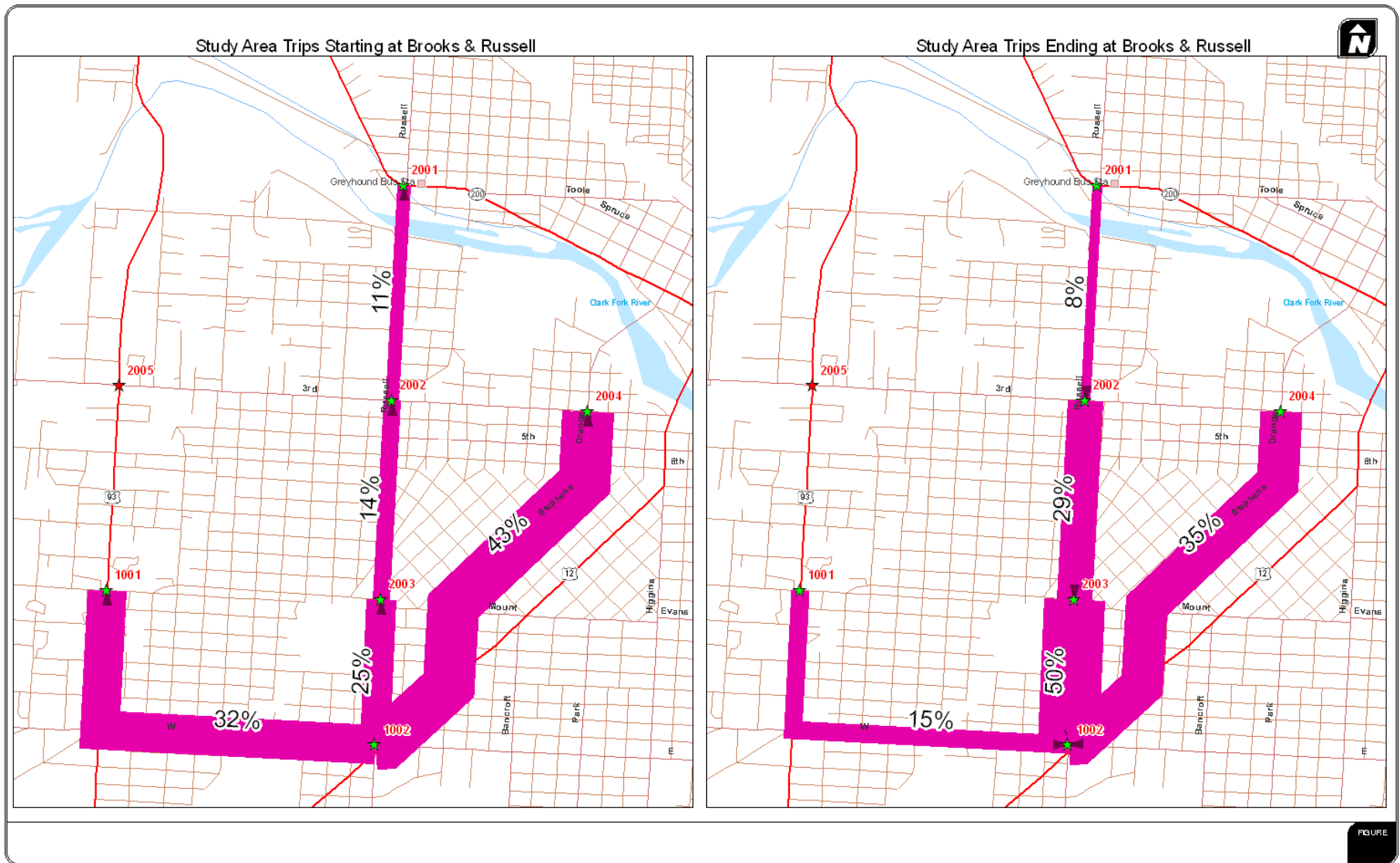
		Travel Time (sec.)		Speed (mph)	
		East	West	East	West
AM	February	335	332	20.8	21.0
	March	278	291	25.1	23.9
	Difference	-57	-40	4.3	2.9
PM	February	360	371	20.1	19.0
	March	336	366	19.4	18.8
	Difference	-23	-4	0.7	0.2

# MAC Probe Data – Origin-Destination Sampling

- › Regional travel demand model comparisons
- › Route selection
- › Progression analyses



# MAC Probe Data – OD Sampling for Route Selection

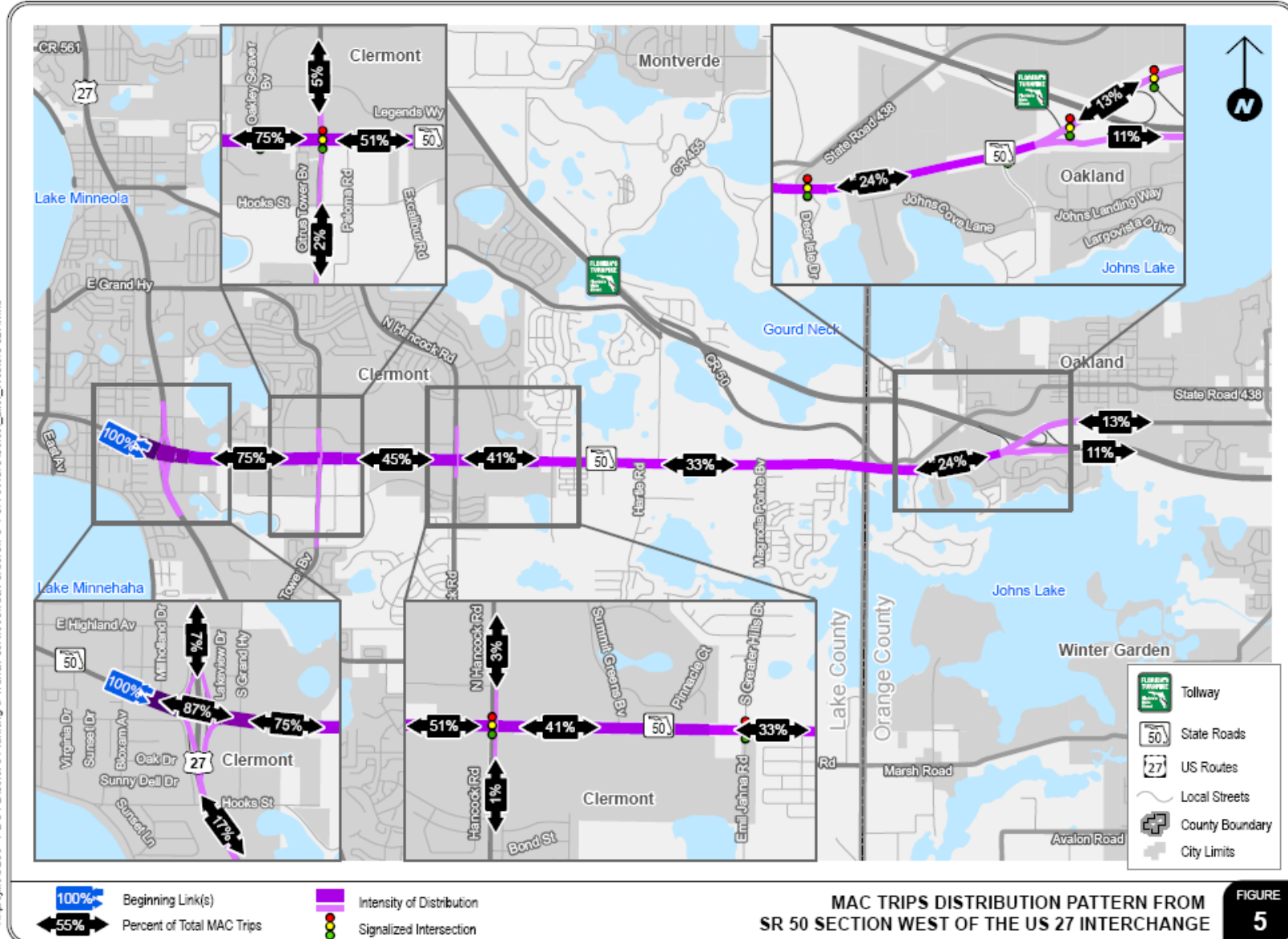




# MAC Probe Data – OD Sampling vs. Regional TDM

SR 50 Corridor Study

December 2009



MAC TRIPS DISTRIBUTION PATTERN FROM SR 50 SECTION WEST OF THE US 27 INTERCHANGE

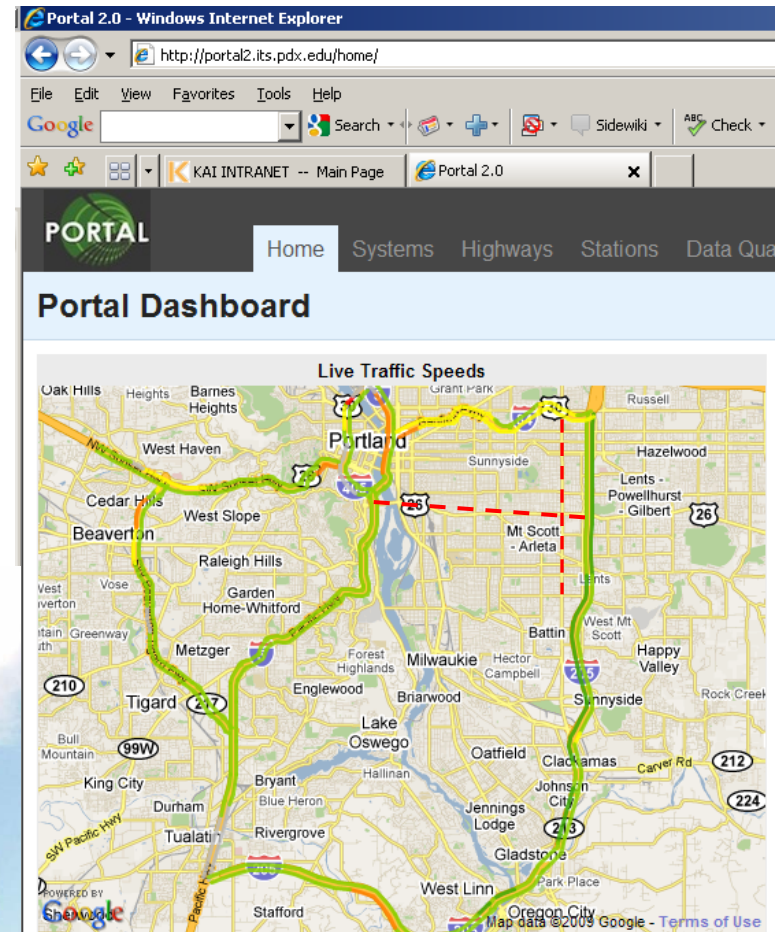
FIGURE 5



H:\profile\9253 - FDOT District 5 Planning & Transit Services\Task Order\TO-4 SR 50\GIS\Select\_Link\_Westoff\SR27.mxd

# What's Next?

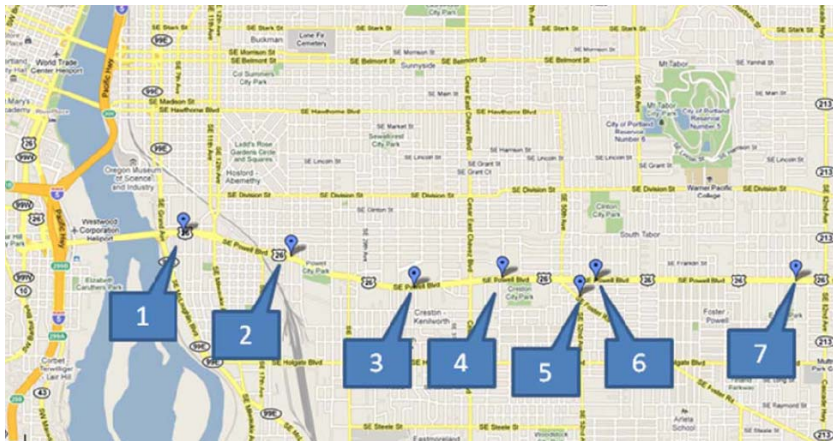
- ▶ City of Portland/ODOT Permanent MAC Reader Pilot – Powell Boulevard
  - *Real-time* and archived travel speed/time data → publish for traveler information
  - *Testing permanent equipment*
  - *Testing communication system and determining best permanent practices*





# What's Next?

- City of Portland/ODOT Permanent MAC Reader Pilot – Powell Boulevard
  - In-Step with SCATS Adaptive Project*



# Summary MAC Probe Benefits

## › Higher amounts of collected data

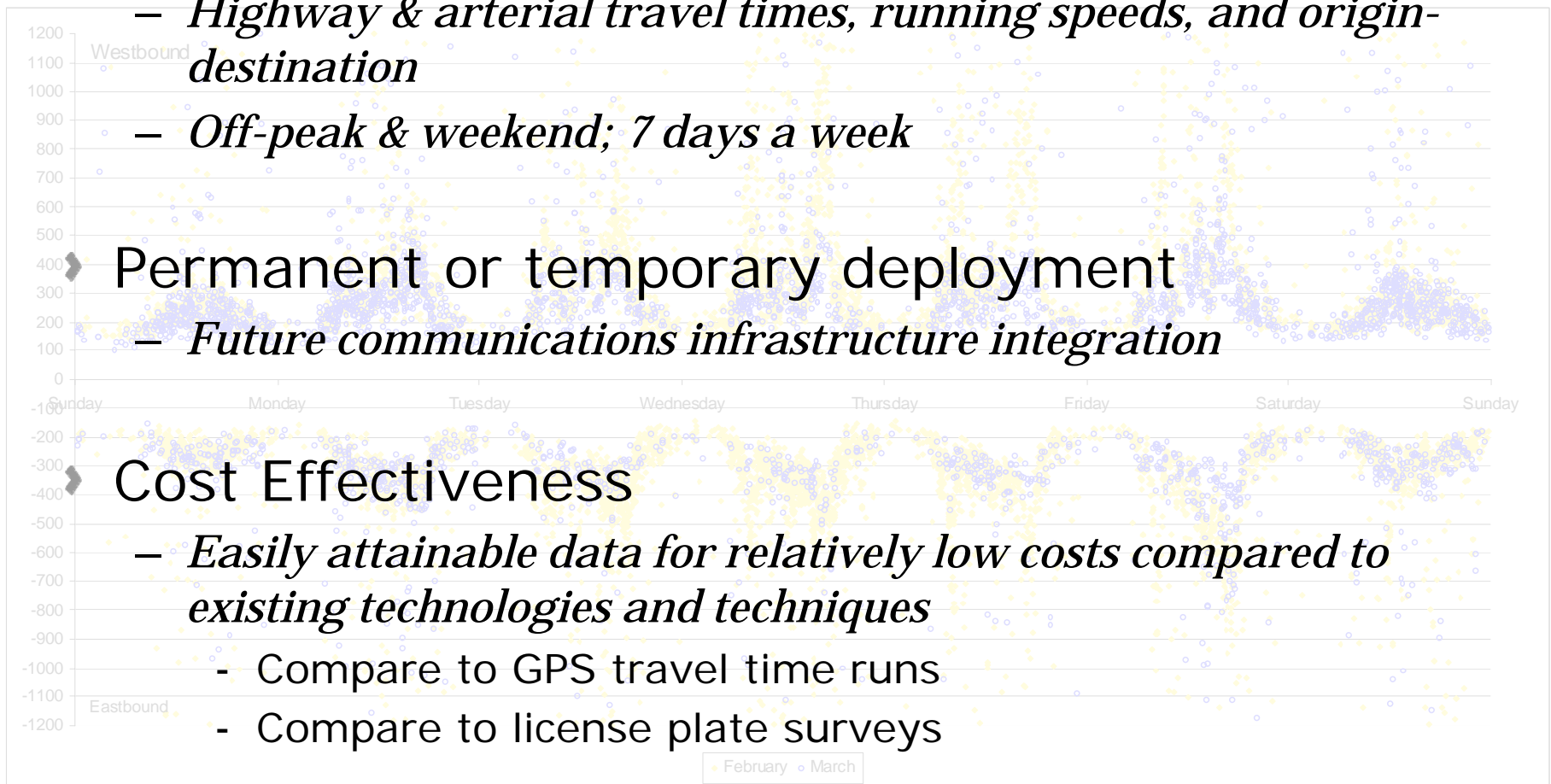
- *Highway & arterial travel times, running speeds, and origin-destination*
- *Off-peak & weekend; 7 days a week*

## › Permanent or temporary deployment

- *Future communications infrastructure integration*

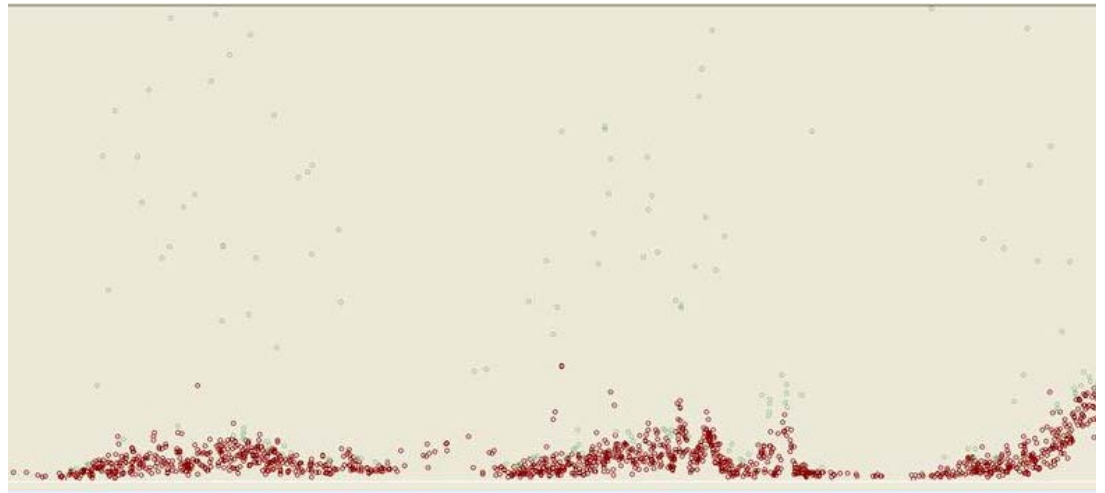
## › Cost Effectiveness

- *Easily attainable data for relatively low costs compared to existing technologies and techniques*
  - Compare to GPS travel time runs
  - Compare to license plate surveys



# Summary MAC Probe Challenges

- › Travel Time Outliers (pass-by trips, peds, etc.)
  - *Good data vs. bad data*
  - *“Average” travel times*
  - *Multiple modes*
- › Fidelity
  - *Data is macroscopic*
  - *No “stop” data*
- › Strategic placement
  - *Influences of variable traffic conditions*
  - *Mid-block is preferred, but not always available*





# References

- › NCHRP 3-79: Predicting Travel Speeds for Urban Streets
- › MAC Address Tracking
  - *Wasson, J.S., J.R. Sturdevant, D.M. Bullock, "Real-Time Travel Time Estimates Using MAC Address Matching," Institute of Transportation Engineers Journal, ITE, Vol. 78, No. 6, pp. 20-23, June 2008.*
  - *Bullock, D.M., C.M. Day; J.S. Sturdevant, "Signalized Intersection Wasson J.S., S.E. Young, J.R. Sturdevant, P.J. Tarnoff, J.M. Ernst, and D.M. Bullock, , "Evaluation of Special Event Traffic Management: The Brickyard 400 Case Study".*
  - *Malinovskiy, Y., Y.J. Wu, Y. Wang, U. Lee, "Field Experiments on Bluetooth-based Travel Time Data Collection." TRB 89<sup>th</sup> Annual Meeting, Washington D.C., 2010.*



# Questions?

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