

A background image showing a road with two cars, a red one on the left and a blue one on the right. There are red circles on the road surface, and a white arrow points from the top left towards the text. A white circle highlights a license plate on the blue car.

Transportation Performance Measures using Both Traffic Volumes and Travel Times

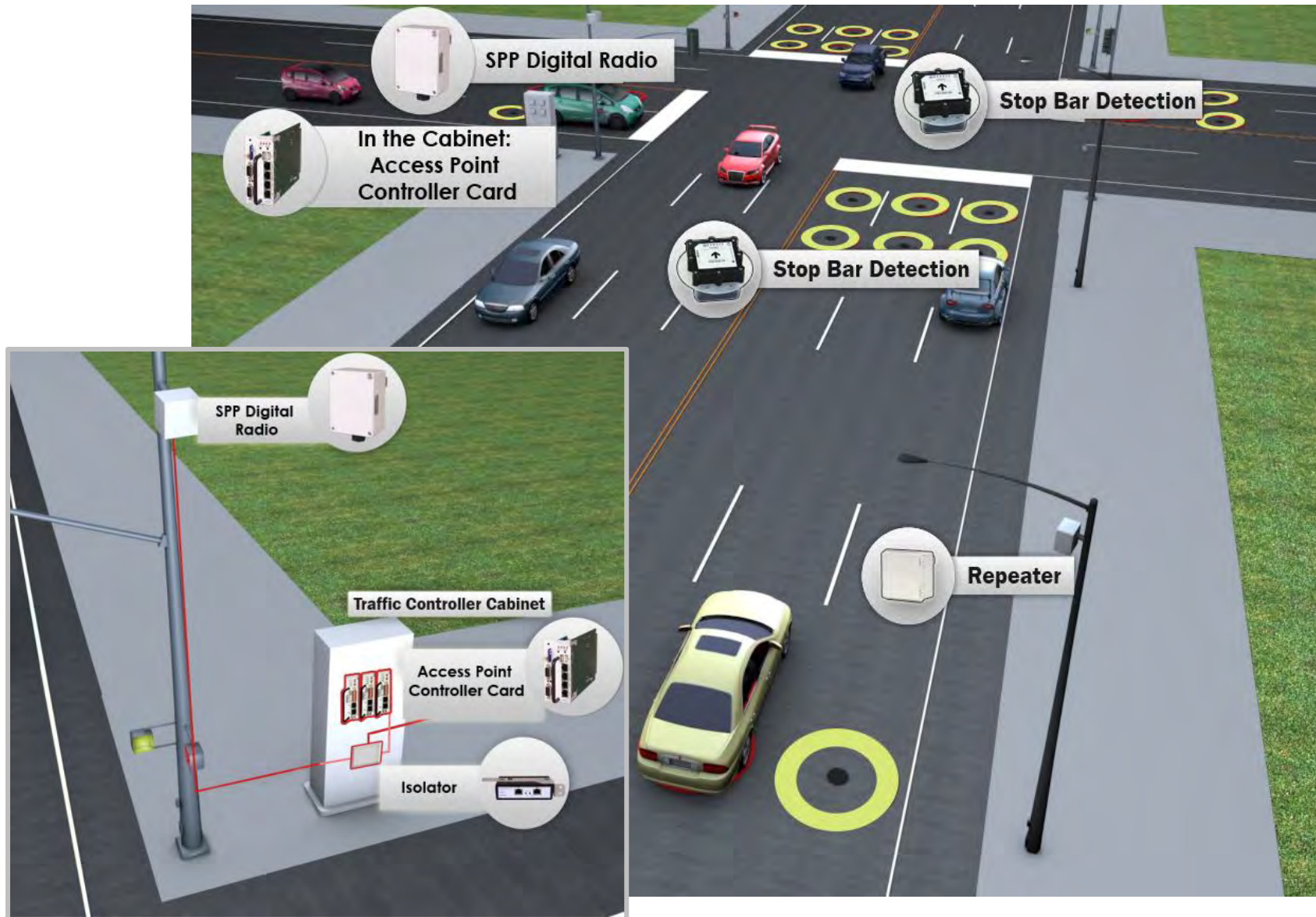
Mid-Colonial District Annual Meeting

Arlington, VA

April 13, 2015



Wireless Detection System Overview



Two "Schools of Thought"

Traffic Engineers

- “What’s the Volume/Capacity ratio peak hour from 2-day counts we did last year”
- Measure and engineer solutions
- Measures based on traffic counts/volume
- Origin/Destination is emerging

Operations Engineers and Personnel

- “What is traffic speeds right now”
- Measure and manage
- Measures based on traffic flow / traffic probe data
- Emerging technology – bluetooth, GPS

Why not both? Volume and flow!

Combine traffic flow with traffic volume

- **Traffic volumes without flow means you don't accurately measure:**
 - Traffic flow outside the point of detection/count
 - Corridor delay and progression
 - Route delay
- **Traffic flow without the volumes means you don't accurately measure:**
 - Impact of delay
 - Impact of operational measures

Reminder

- **Vehicle Hours Travelled (VHT) (per route)** – Sum of product of segment travel time (in hours) and segment volume for each segment in the route
- **Vehicle Miles Travelled (VMT) (per route)** – Sum of product of segment length (in miles) and segment volume for each segment in the route
- Other measures
 - Vehicle delay hours
 - Idle Emissions
 - Congestion Emissions
 - Congestion Index
 - Percentile / Distribution of Travel Time
 - ...What else?!...

What industry is working on:

Signal Timing Tools – fed by 24x7x365 “real-time” data

- Route Delay
- Progression Diagram
- Route speed by Segment
- Timing plan analysis
- Day of week analysis
- Weekly analysis
- Timing run
- Delay by phase
- Delay by approach

Single Platform

- **Accurate and efficient traffic counts via in-pavement wireless magnetometers**
- **Travel time – two solutions**
 1. Magnetic Signatures
 2. WiFi / Bluetooth probe data

(BTW) Same wireless platform can provide

- Stop bar detection
- Wireless Advance / dilemma zone/ green extension
- Bicycle detection

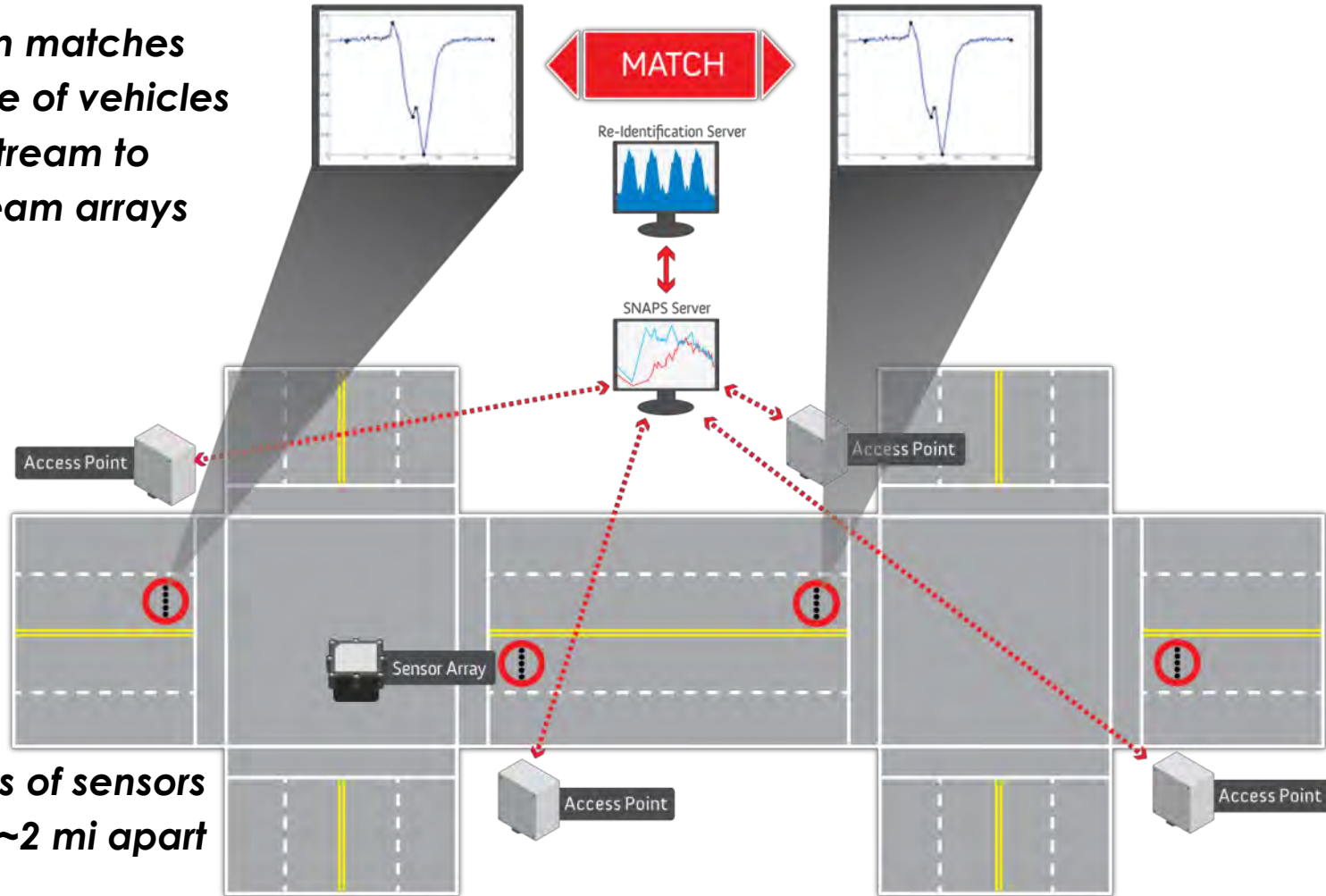
Magnetic Signature Travel Time



- **Based on magnetic-signature technology**
- **Re-identify vehicles anonymously, avoiding privacy issues**
- **6x match rate over other technologies - yields higher update rate**
- **Immune to weather conditions**
- **Measure speeds up to 80mph**

System Overview: Magnetic Re-Identification Technology

Algorithm matches sequence of vehicles from upstream to downstream arrays



Arrays of sensors spaced ~2 mi apart

Travel Time via MAC Address Probe

Bluetooth and Wi-Fi



48:27:45:67:89:fb

01:23:11:56:76:ab

00:42:24:54:34:cf

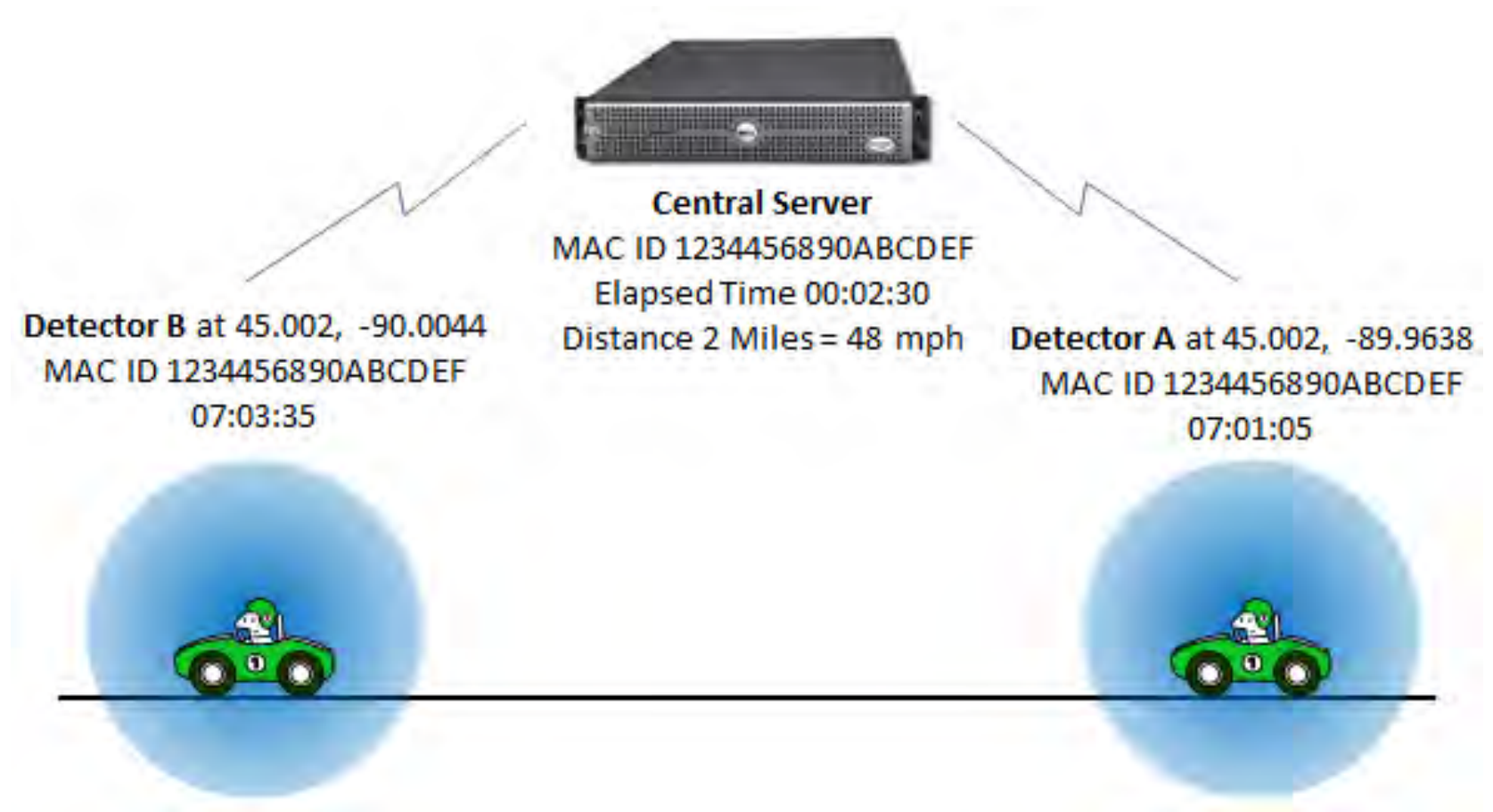
13:30:65:12:19:af

03:30:76:67:37:ab

MAC addresses anonymized for privacy

MAC Address Re-ID

Bluetooth and Wi-Fi



* Image courtesy of FHWA website

Unique industry solution to combine counts with travel time

- **Traffic Planning**
 - Origin-Destination flows

- **Traffic Management**
 - VHT and VMT reports
 - Total intersection delay
 - Total route delay

- **Volume, Occupancy, Speed Reports**
 - Volume vs. Occupancy
 - Occupancy vs. Speed
 - Speed vs. Volume

Differences between MAC addresses

Bluetooth™

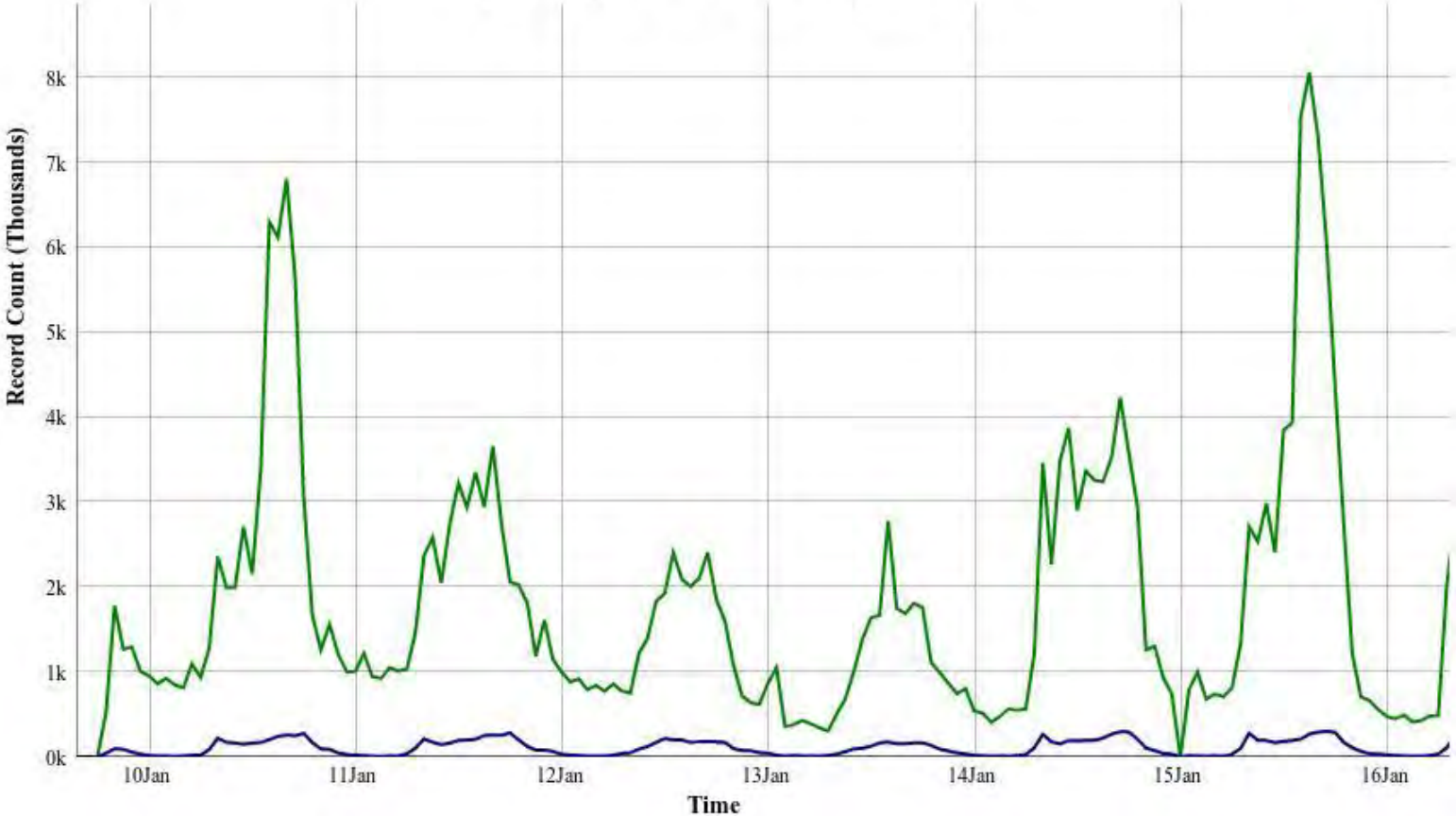
- **Match Rate = 3% - 4%**
 - **Slow** update rates
 - **Unsuitable** for real-time applications
- **Requires phone to be in discover mode**
 - Manufacturers now ship devices with discover mode **off**
 - Trend is for **fewer and fewer** Bluetooth™ devices to be in discover mode

Wi-Fi

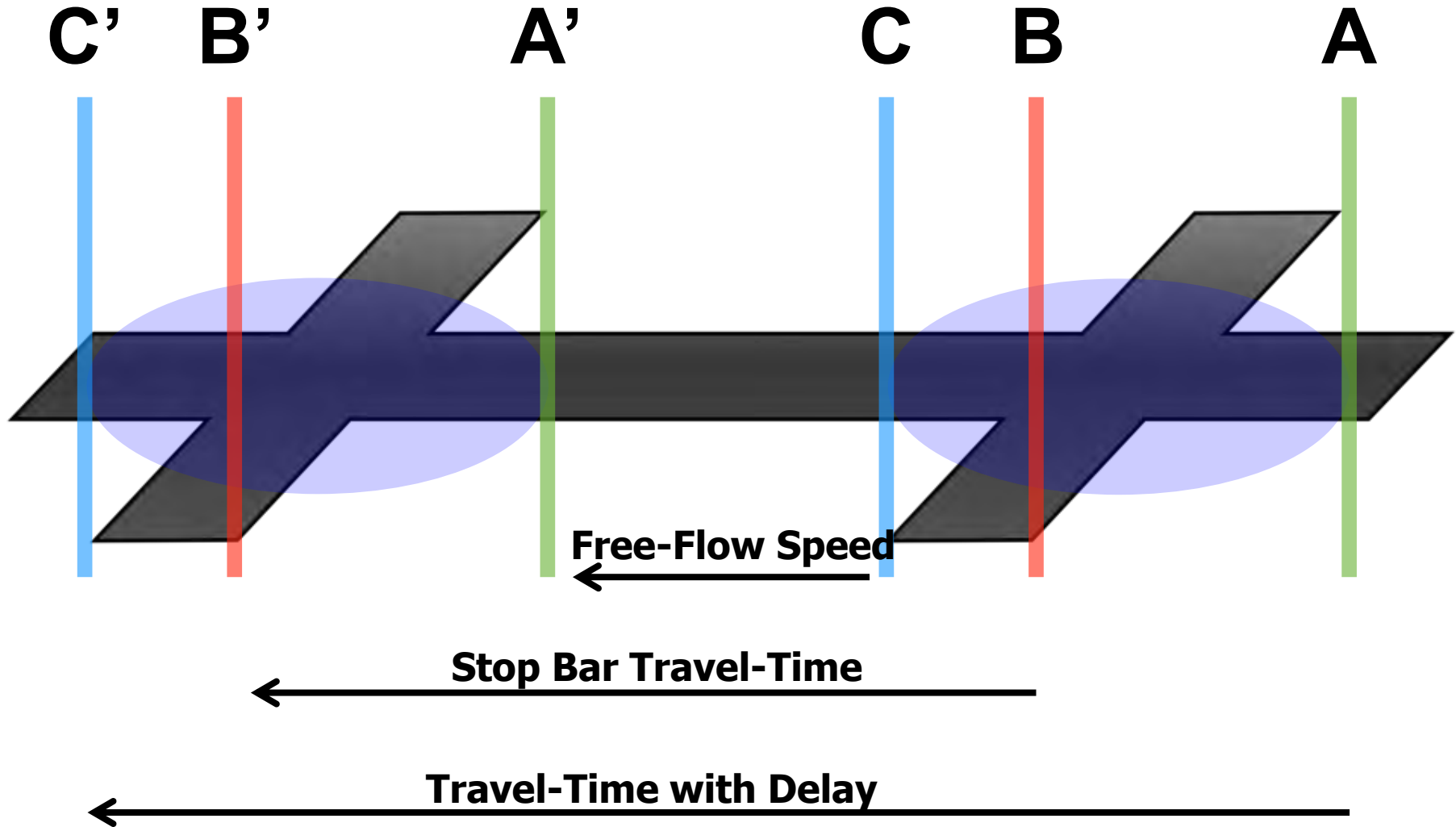
- **Match Rate = 30% - 45%**
 - **Quick** update rates
 - **Suitable** for real-time applications
- **Signal strength measured**
 - Provides nuanced data about behavior at intersection
 - Supports many measures of **delay**, dwell time
 - **More and more** devices operating with Wi-Fi

Bluetooth versus Wi-Fi

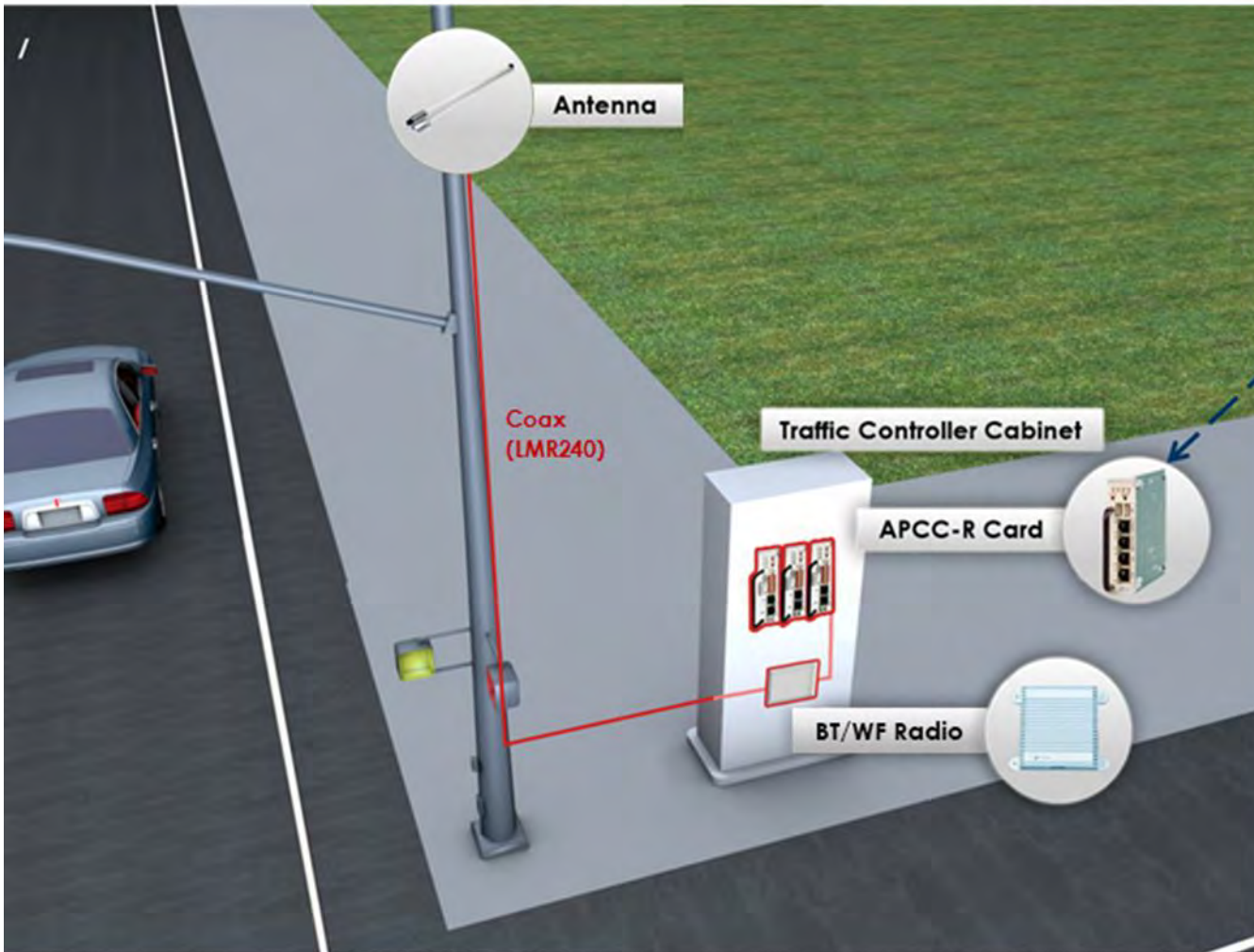
Bay County 77 & 9th Records per Hour



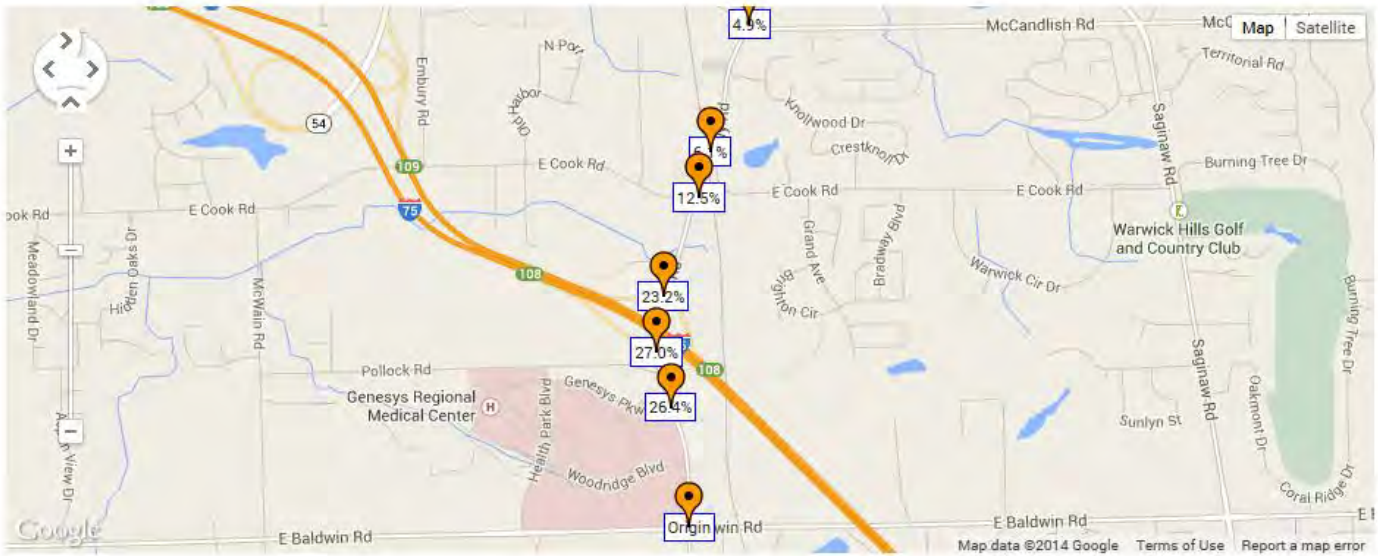
Available Wi-Fi Travel Time Measures



System Architecture



Analytics: Origin-Destination Reporting



Map | Satellite

Map data ©2014 Google Terms of Use Report a map error

Origin

Percentage
4.9%
5.1%
12.5%
23.2%
27.0%
26.4%

Start time: 09/02/14 11:45
End time: 09/03/14 11:45

Origin / Destination 1
Origin - Destination

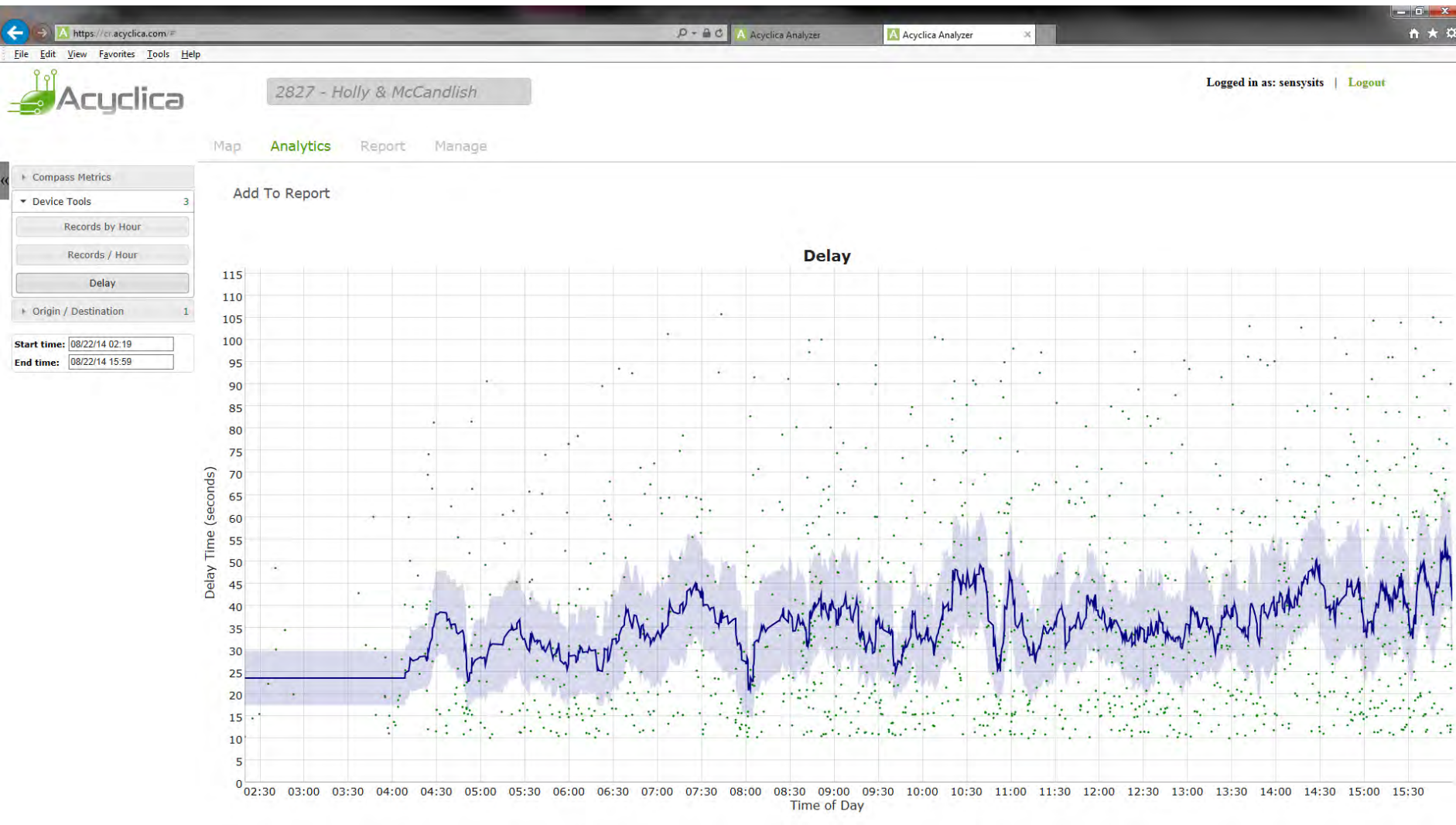
Map Analytics Report Manage

Counts Percentage Travel-Time Map View

Origin / Destination Destination / Origin

https://vims.sensysnetworks.net/#ind_od_tabs_time

Analytics: Intersection Delay Reporting



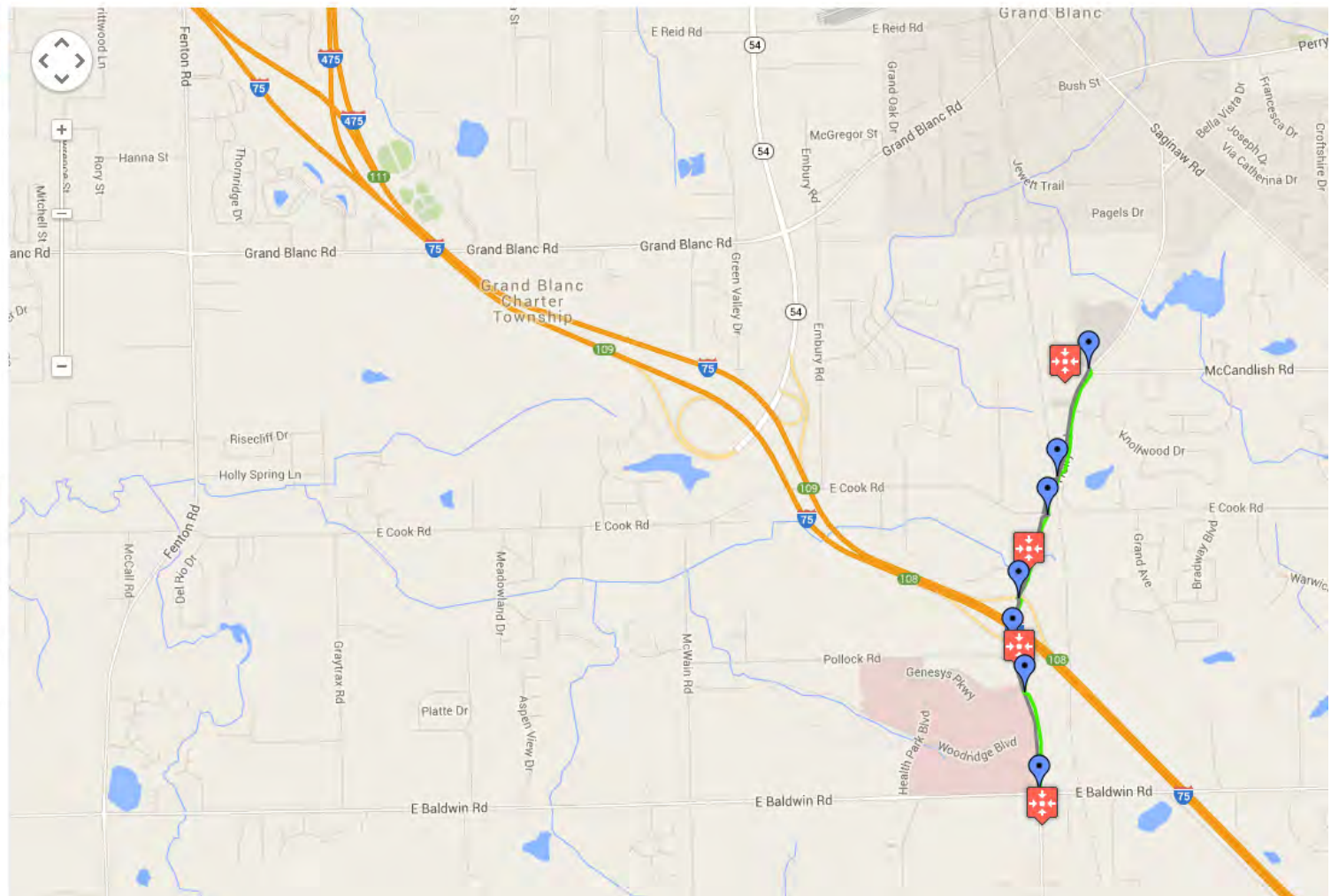
Next Gen Performance Measures

Map Analytics Report Manage

- Compass Metrics 3
- Signal Timing Tools 7
 - Route Delay
 - Progression Diagram
 - Route Speed by Segment
 - Timing Plan Analysis
 - Day of Week Analysis
 - Weekly Analysis
 - Timing Run
 - Delay by Phase
 - Delay by Approach
- Performance Measures 9
- Device Tools
- Detector Analytics
- Origin / Destination 2

Start time: 10/14/14 12:19

End time: 10/21/14 12:19



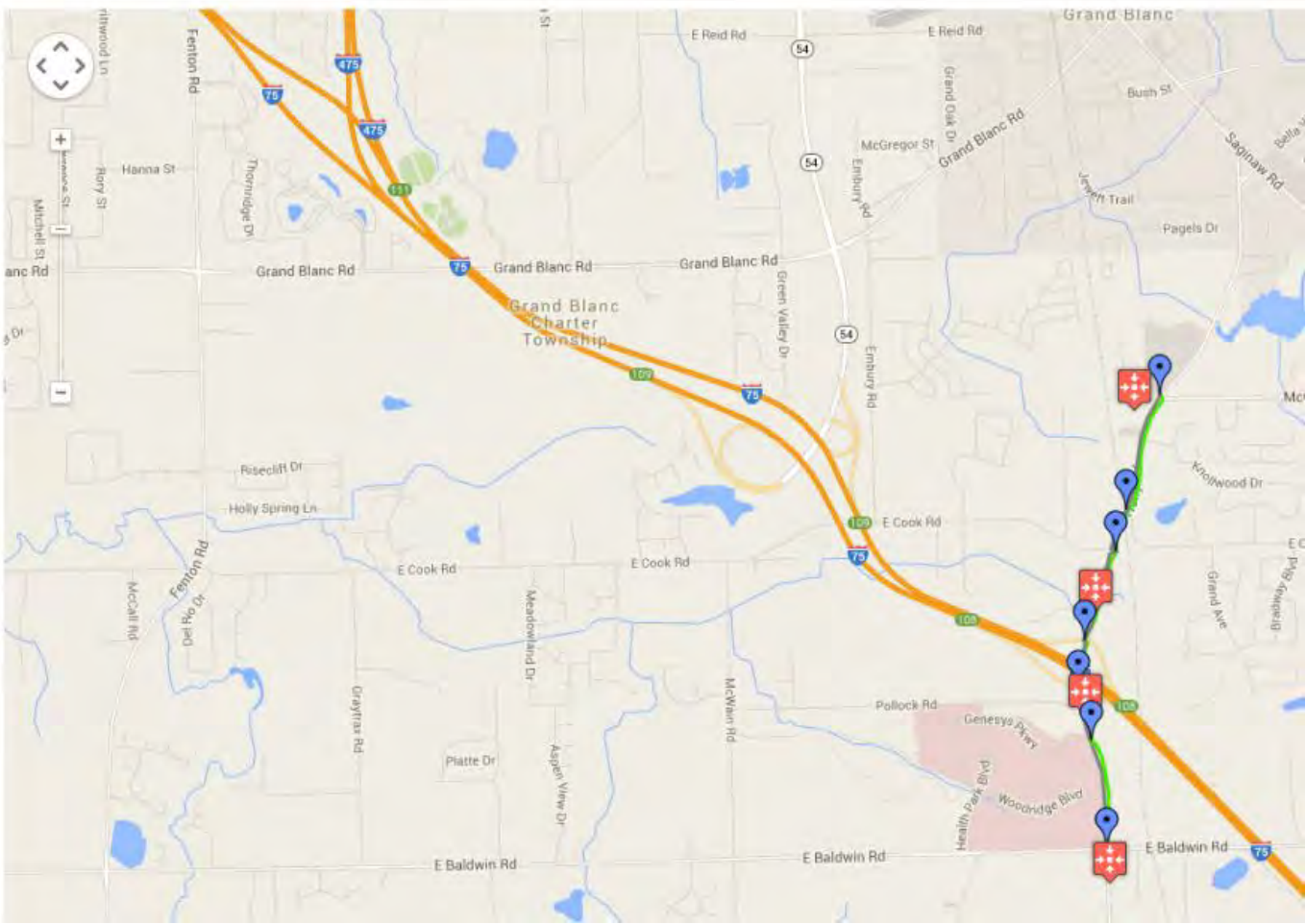
Next Gen Performance Measures



Map Analytics Report Manage

- Compass Metrics 3
- Signal Timing Tools 7
- Performance Measures 9
 - LARIC
 - Vehicle Delay Hours
 - Idle Emissions
 - Congestion Emissions
 - Congestion Index
 - Percentile TT
 - Vehicle Hours Traveled
 - Vehicle Miles Traveled
 - VMT vs. VHT
- Device Tools
- Detector Analytics
- Origin / Destination 2

Start time: 10/14/14 12:19
End time: 10/21/14 12:19



Questions?

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