

# EDC4 Automated Traffic Signal Performance Measures



**every day counts**  
An Innovation Partnership with States

  
U.S. Department of Transportation  
**Federal Highway Administration**



## What is it?

A suite of performance measures, event based data collection, and data analysis tools to support a performance based approach to managing a traffic signal program.

# State of the Practice

## Program Management

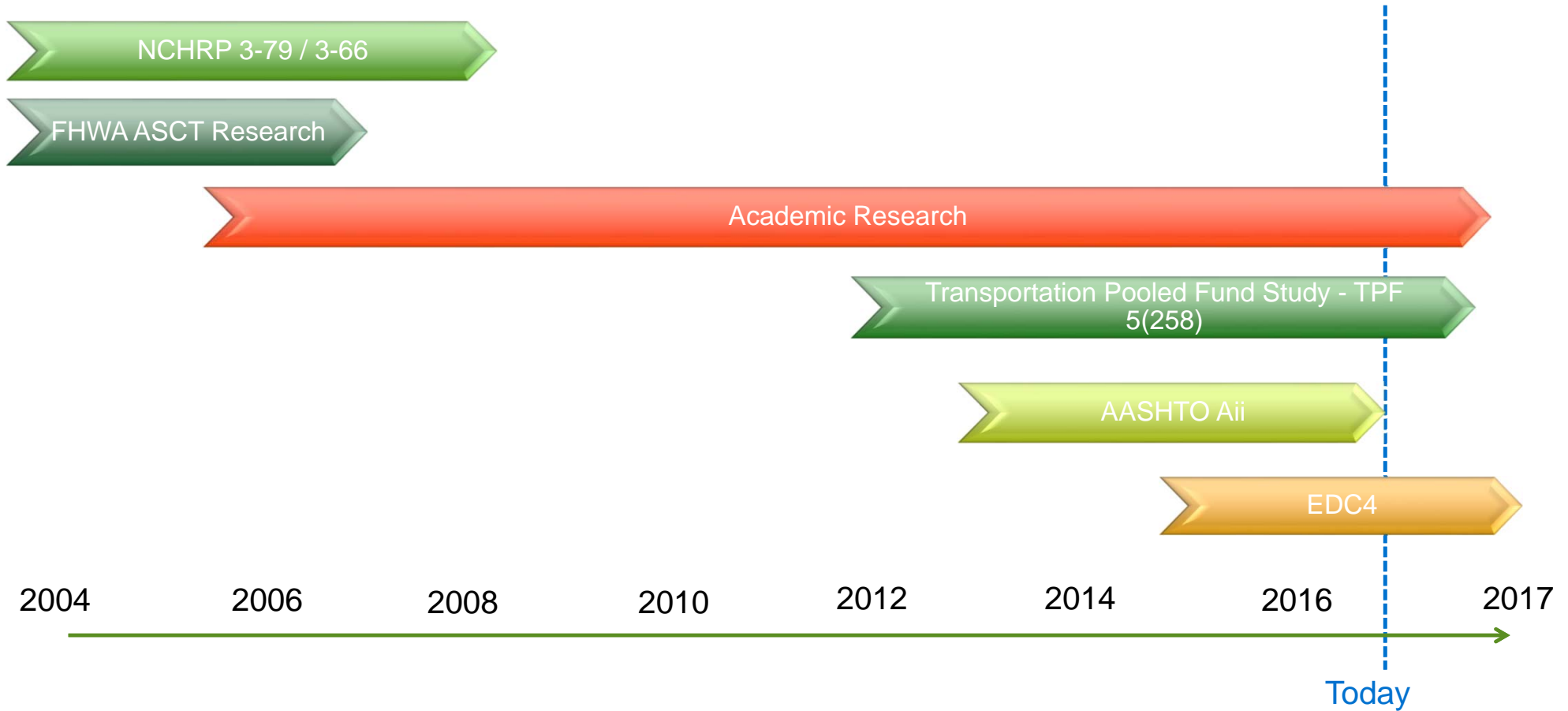
- Ad-hoc Business Practices
- Resource Constrained
- Outdated Equipment

## Performance Assessment

- Complaint Driven
- Reactive Operations & Maintenance
- Project Oriented Before & After



# ATSPM Background



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# Automated Traffic Signal Performance Measures

## Three components

1. **Suite of Performance Measures** that support Objectives & Performance Based Approaches to Traffic Signals for Maintenance and Operations
2. **Data Collection**
3. **Data Analysis**



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## Suite of Measures (Sample)

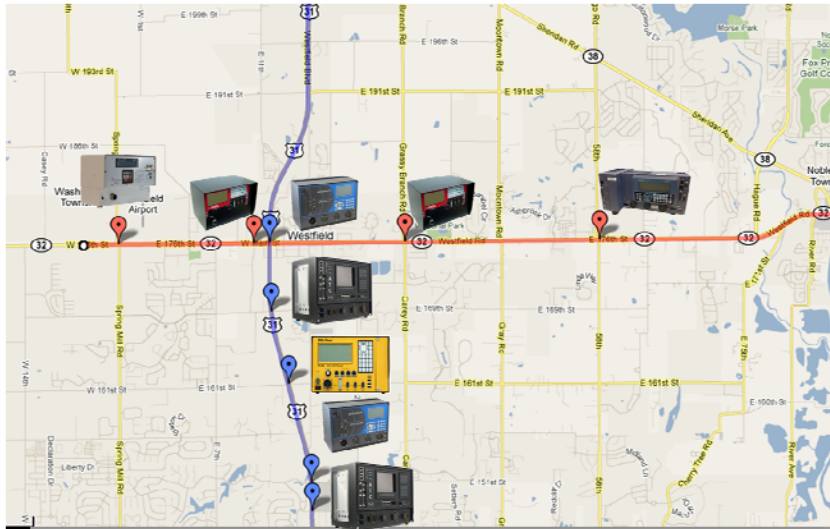
# Operations

- Yellow and Red Actuations
- Arrivals on Red
- Ped/Bike Delay
- Purdue Coordination Diagram
- Split Failure
- Queue length
- Split Monitoring
- Travel Time
- Turning Movement Counts

# Maintenance

- False Calls
- Preemption Details
- Communication Failures
- Alarms

# ATSMP = Fitness Tracker for Traffic Signals



High Resolution Data Collection



Data Analysis and Performance Report Tools



LIVE:TRAFFIC:DATA



+ Other solutions....

Source: FHWA



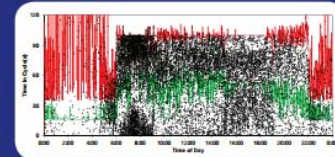
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**EDC**

# PERFORMANCE MEASURES FOR TRAFFIC SIGNAL SYSTEMS

*An Outcome-Oriented Approach*



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# Implementation of **Automated Traffic Signal** Performance Measures

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Over the last few decades traffic signal systems have evolved from rigid, fixed-time electromechanical systems to a distributed computing model with sophisticated detection and communication infrastructure. Although modern signal systems are relatively robust, operating continuously for years under all weather conditions, there is a tendency for operational inefficiencies to accumulate over time, as individual components such as detectors fail, or traffic conditions evolve beyond the parameters that the signal control was designed to accommodate. For a number of years, the engineering community has acknowledged opportunities for improvement, such as retiming or investing in new equipment.<sup>1</sup> However, historically, it has been very difficult to comprehensively evaluate changes in signal operations because the cost of data collection constrained the temporal and spatial extent of study.

[www.ite.org](http://www.ite.org) August 2014 27

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## ATSPM Basic Concept

Hi Def Data Logger  
included in controller  
firmware

Hi Def logs retrieved  
every 10-60 minutes  
from controller to server

Website to display  
SPM's

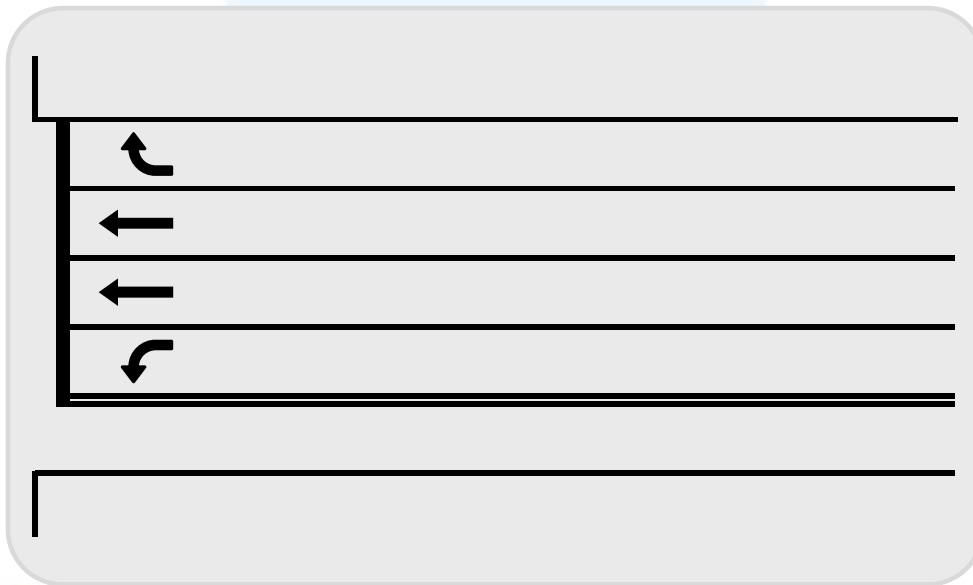


(Or...Retrieve data logs  
from controller manually  
using Raspberry Pi)

Detection		Metric
None		Purdue Phase Termination Split Monitor Preemption Details Pedestrian Delay
Advanced Count		Purdue Coordination Diagram Approach Volume Approach Speed (requires detection with speed service)
Lane-by-lane Presence Lane Group Presence		Purdue Split Failure
Lane-by-lane Stopbar Count		Turning Movement Counts

## Detection

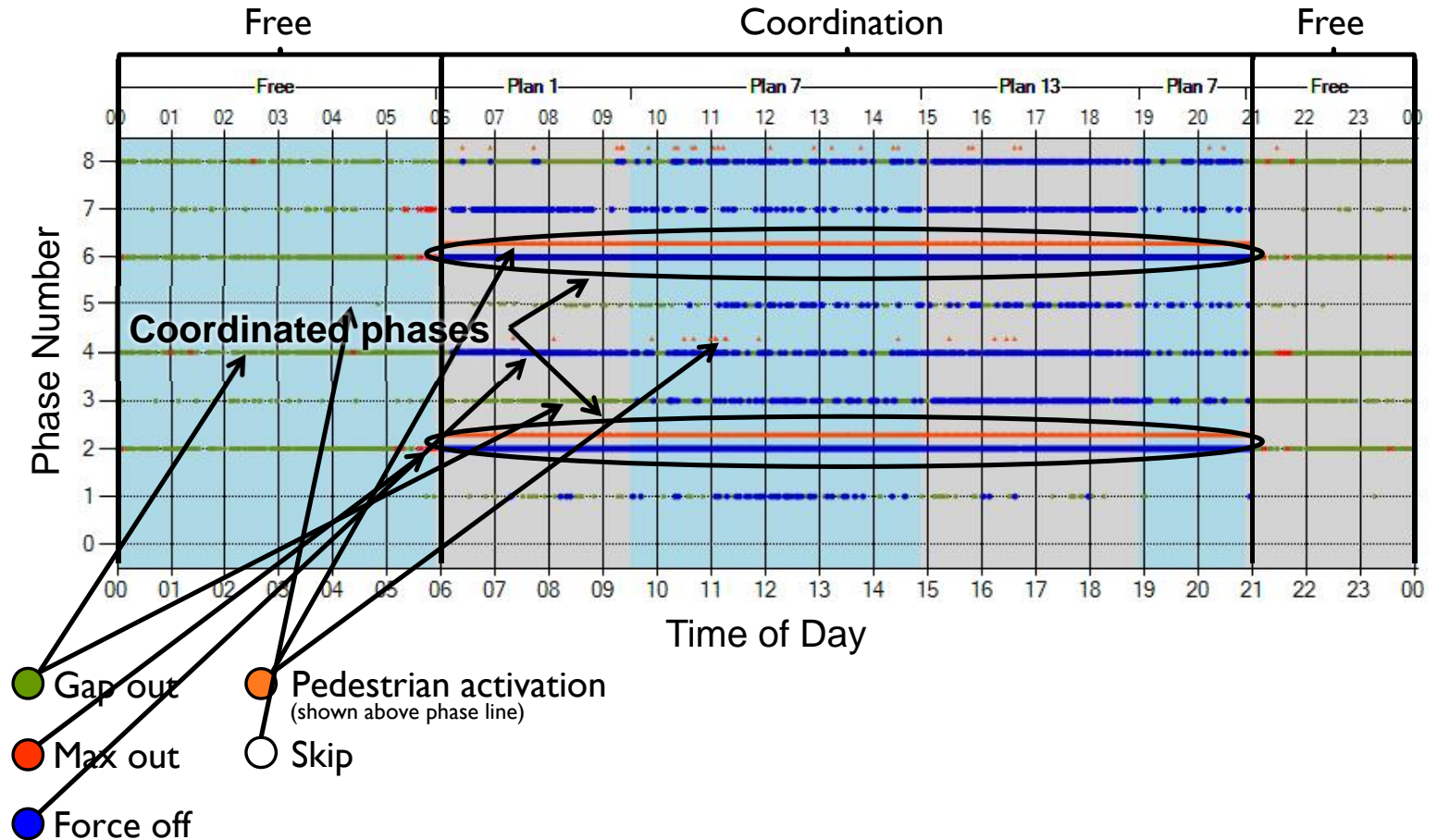
None



## Available Metrics

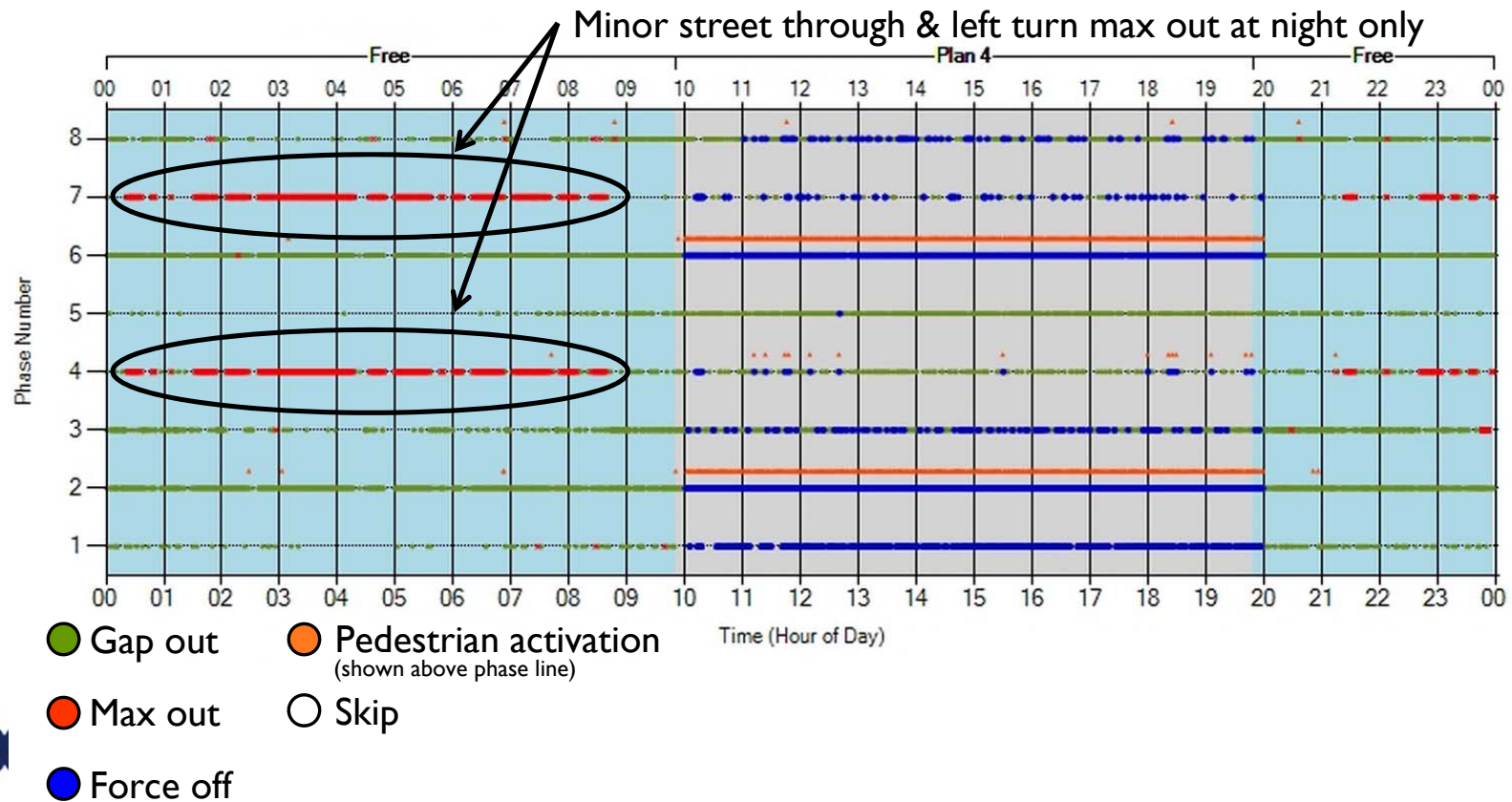
- > Purdue Phase Termination
- > Split Monitor
- > Pedestrian Delay
- > Preemption Details

# Metric: Purdue Phase Termination



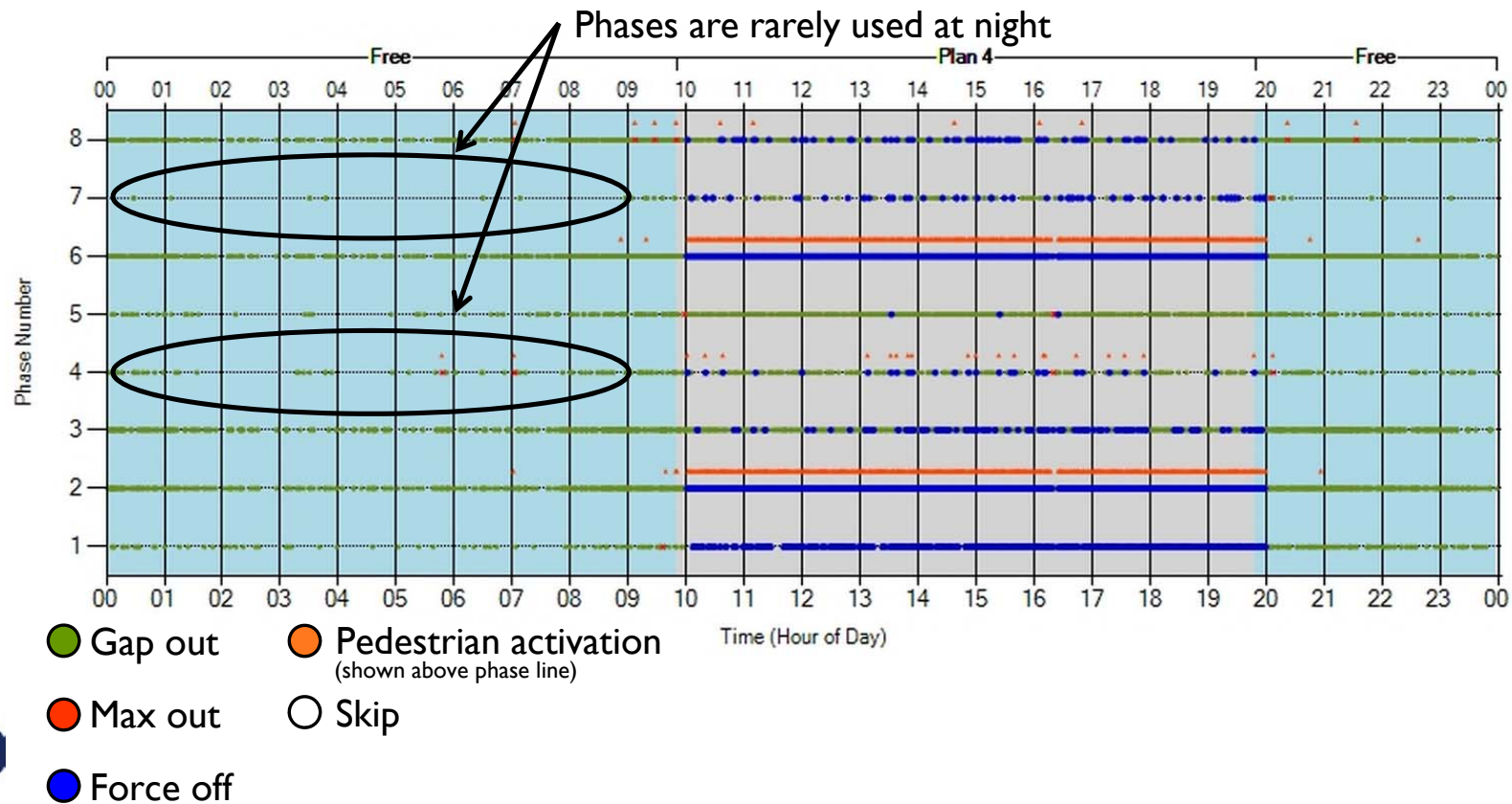
# Nighttime detection problem

- ▶ BEFORE: Detection not working at night



# Nighttime detection problem – Fixed!

- ▶ AFTER: New detection technology installed



# Pedestrian Delay

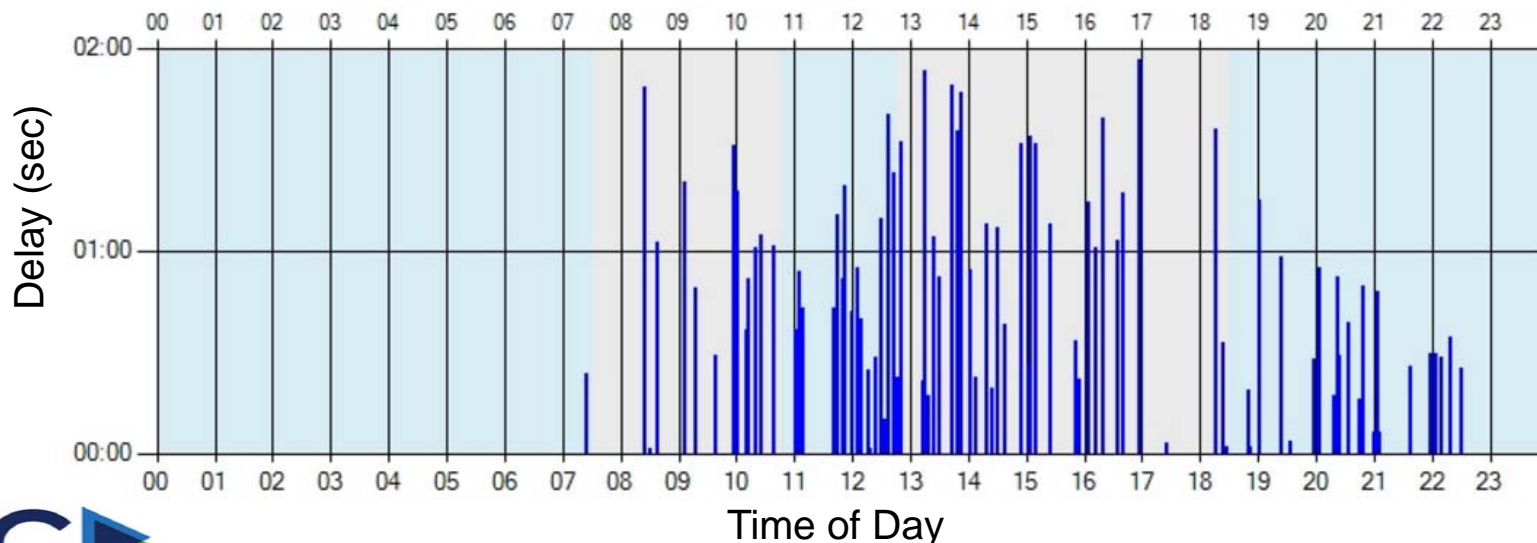
(Time from pedestrian call received to start of the walk indication)

Phase 4 – Side Street – Friday September 16<sup>th</sup> 2016

89 Ped Actuations

48 s = Average Delay

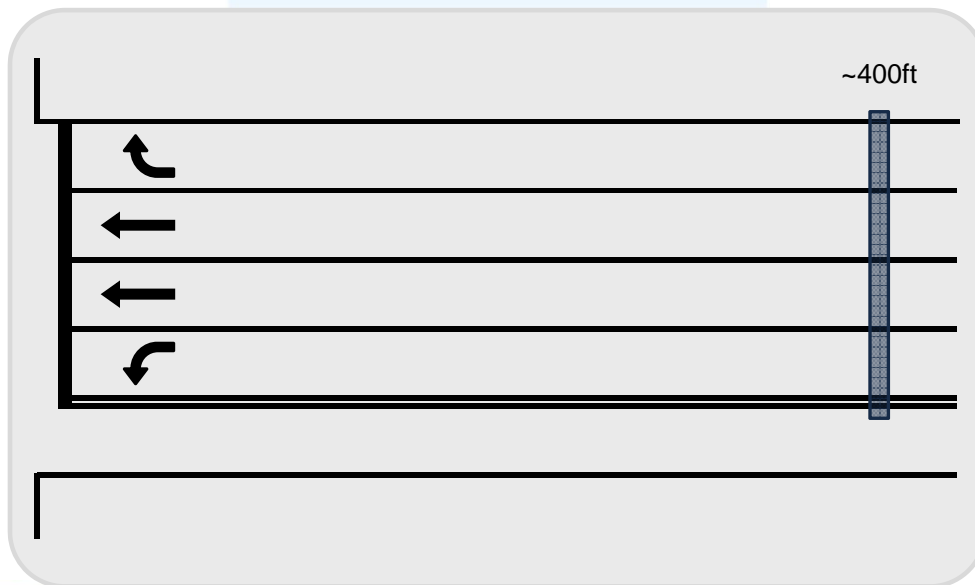
89-Ped Actuations(PA) 00:00-Min Delay 01:56-Max Delay 00:48-Average Delay(AD)





## Detection

Setback Count Zones



## Available Metrics

- > Purdue Coordination Diagram
- > Approach Volume
- > Arrivals on Red
- > Approach Delay

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# Purdue Coordination Diagram

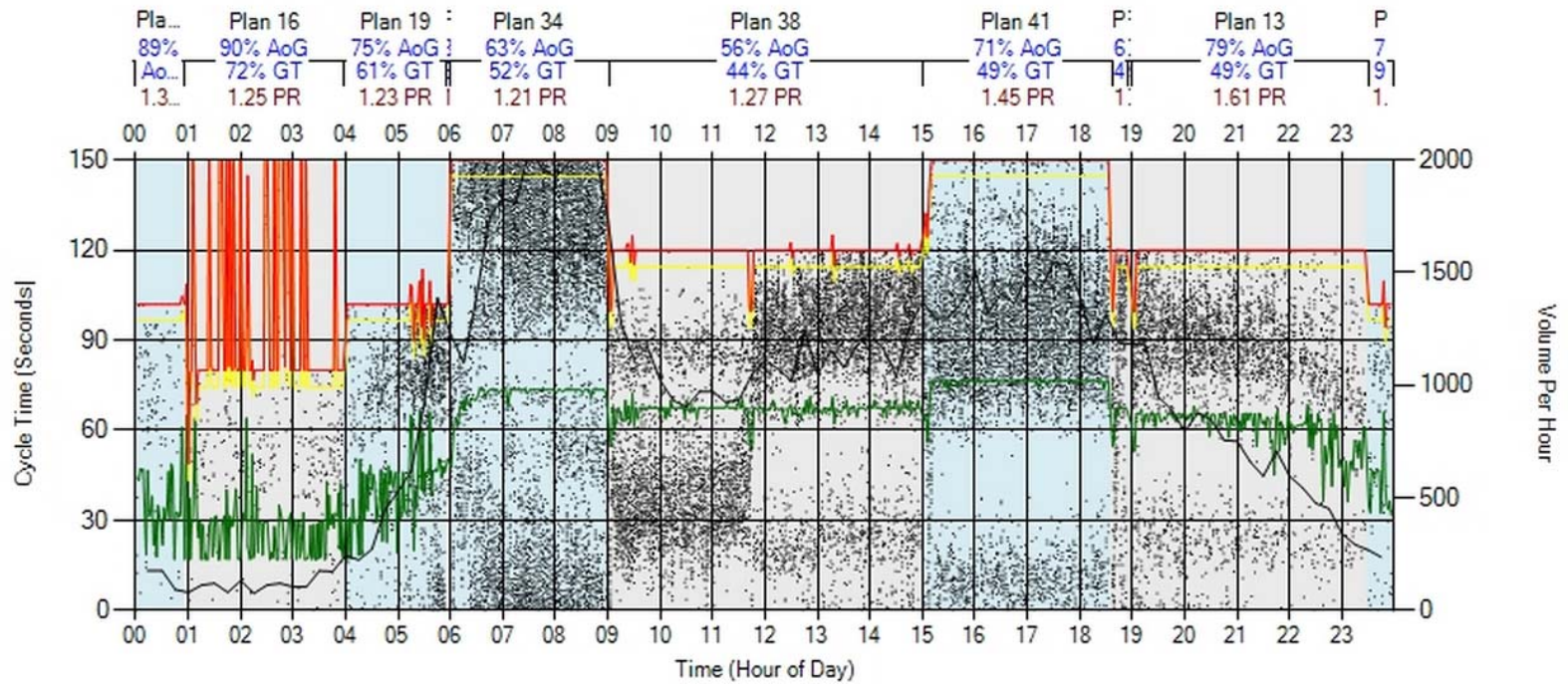
## VIDEO

<https://www.youtube.com/watch?v=YhrtTuhcjMw>

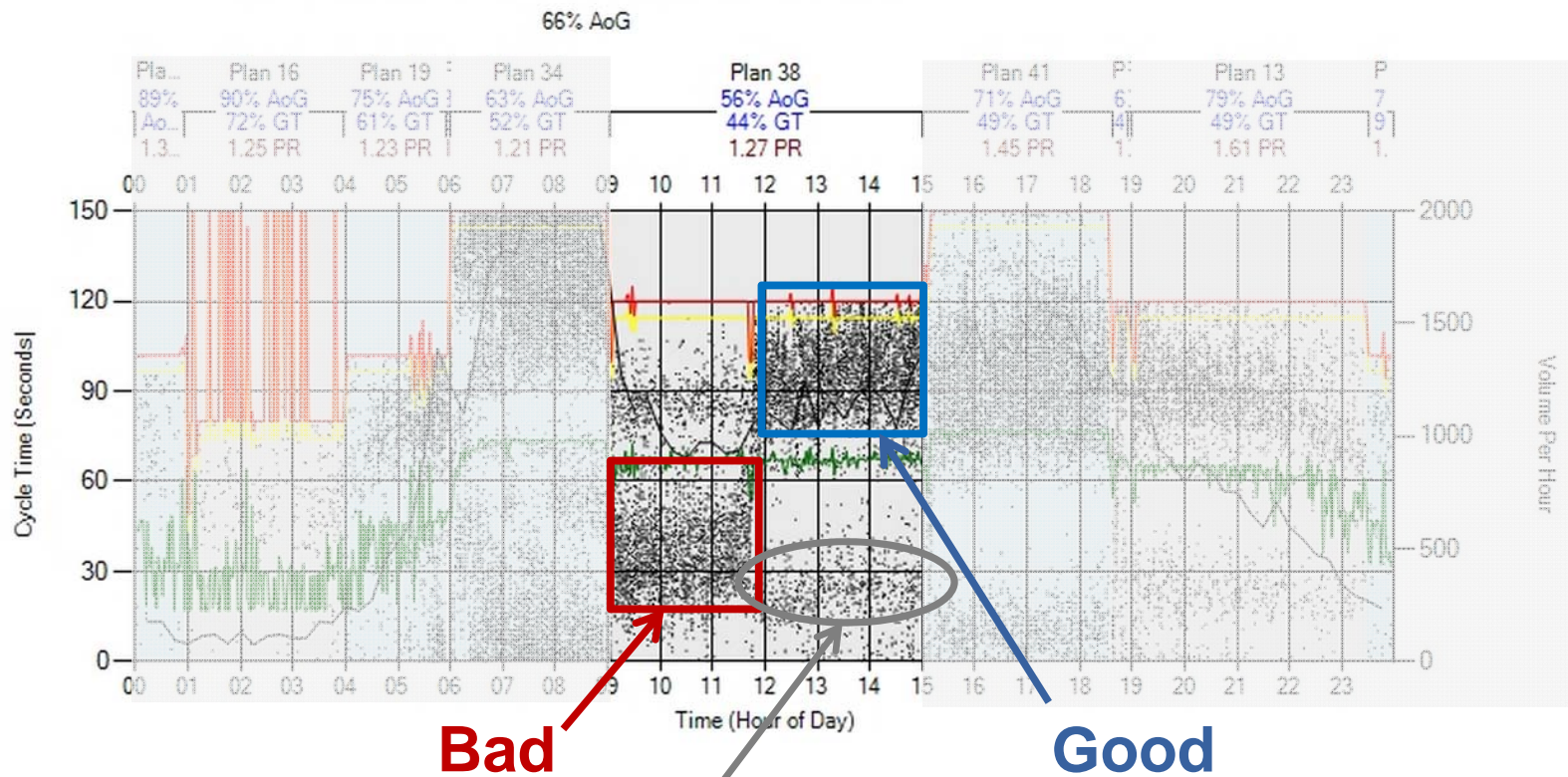
# Purdue Coordination Diagram

Bangerter Hwy (SR-154) 5400 South (SR-173) Signal 7063 Overlap: 10 Northbound  
 Thursday, March 07, 2013 12:00 AM - Thursday, March 07, 2013 11:59 PM

66% AoG



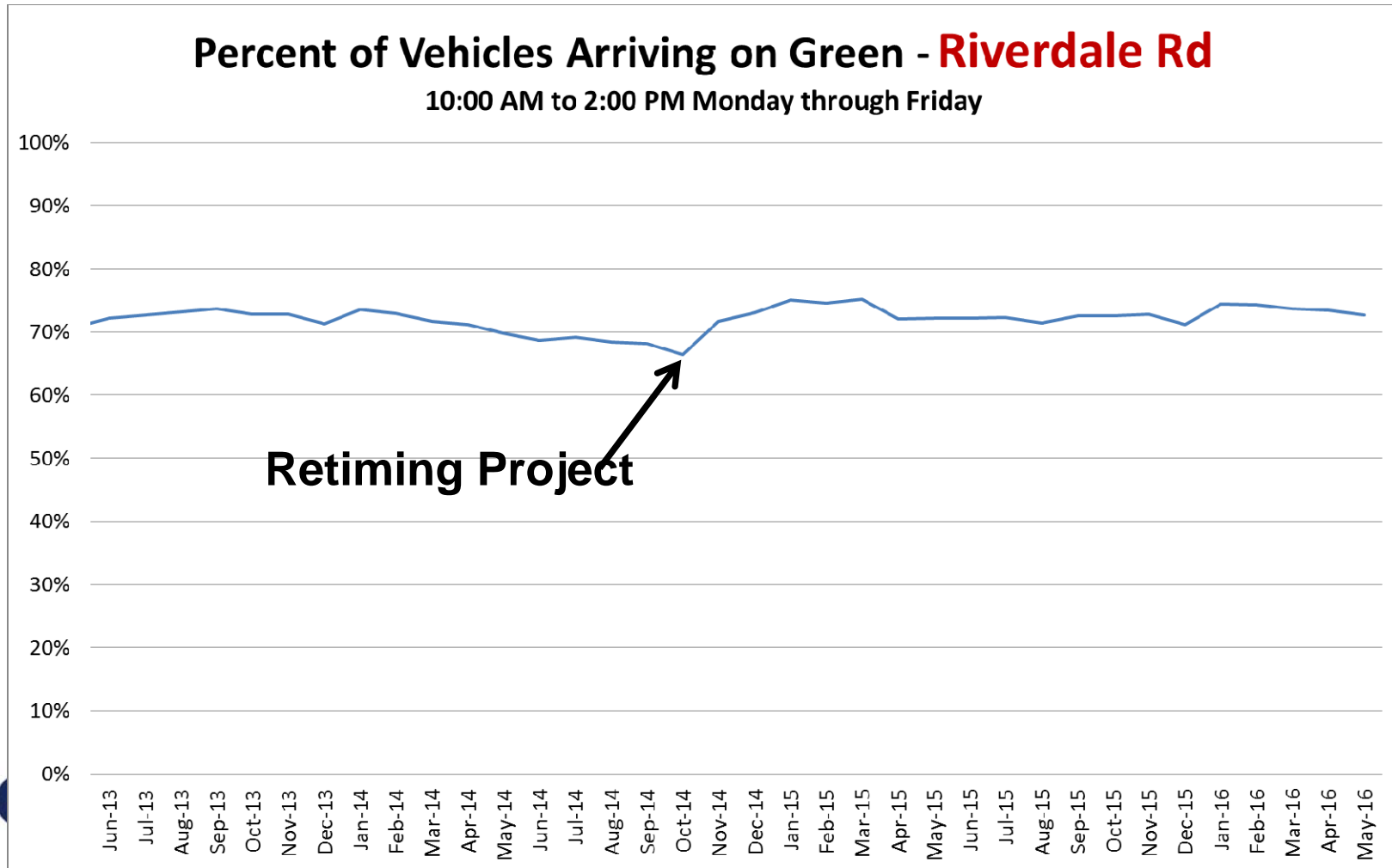
# Purdue Coordination Diagram



Left turns from upstream signal

# Monitoring Trends

(Riverdale Rd – 11 intersections)



# System Health Alerts

- 1 No SPM Data
- 2 Too many max outs
- 3 Too many force offs
- 4 Too many ped calls
- 5 Low detector count
- 6 High detector count

## SPM Alerts for 5/22/2016

SPMWatchdog@utah.gov

to marktaylor, me, signaldesk, shanejohnson, bryan.meenen, kbarnes, SWinters, tforbush, jay.smith,

--The following signals had too few records in the database:  
4671 - 13400 South & 4500 West - Phase: 0 (Missing Records)  
5701 - 500 South & 400 East (Btfl) - Phase: 0 (Missing Records)

--The following signals had too many force off occurrences:  
1224 - North Temple & Main Street - Phase: 3 (Force Offs 97.6%)  
7252 - 500 South & Main Street - Phase: 2 (Force Offs 100%)  
7252 - 500 South & Main Street - Phase: 6 (Force Offs 100%)

--The following signals had too many max out occurrences:  
1123 - Wolcott St & 100 South - Phase: 2 (Max Outs 100%)  
1124 - Sunnyside (850 S) & Gaurdsman Way - Phase: 2 (Max Outs 100%)  
1124 - Sunnyside (850 S) & Gaurdsman Way - Phase: 6 (Max Outs 100%)  
4024 - 7000 South (Fort Union) & 1300 East - Phase: 7 (Max Outs 92.6%)  
4029 - 7200 South & 700 East - Phase: 1 (Max Outs 100%)  
4103 - 4680 South (Murray-Holladay) & 2320 East (Holladay) - Phase: 5 (Max Outs 100%)  
4118 - 6200 South & 3655 West (Dixie) - Phase: 2 (Max Outs 100%)  
4511 - 4100 South & 3200 West - Phase: 4 (Max Outs 100%)  
4820 - 4835 South & 2700 West - Phase: 2 (Max Outs 100%)  
5063 - Lincoln & 24th - Phase: 4 (Max Outs 100%)  
5063 - Lincoln & 24th - Phase: 8 (Max Outs 100%)  
5080 - Washington & Adams - Phase: 5 (Max Outs 100%)  
5170 - 200 N (Kaysville) & Main St. - Phase: 4 (Max Outs 100%)  
5305 - Main St. & 200 North (Logan) - Phase: 7 (Max Outs 96.2%)  
5900 - 900 W. (Kays Dr.) & 200 North, (Kaysville) - Phase: 4 (Max Outs 90.4%)  
6035 - Pioneer Crossing & Millpond Drive - Phase: 8 (Max Outs 91.9%)  
6608 - 100 West & 100 North - Phase: 8 (Max Outs 98.5%)  
7107 - Redwood Road & 4700 South - Phase: 5 (Max Outs 93.2%)

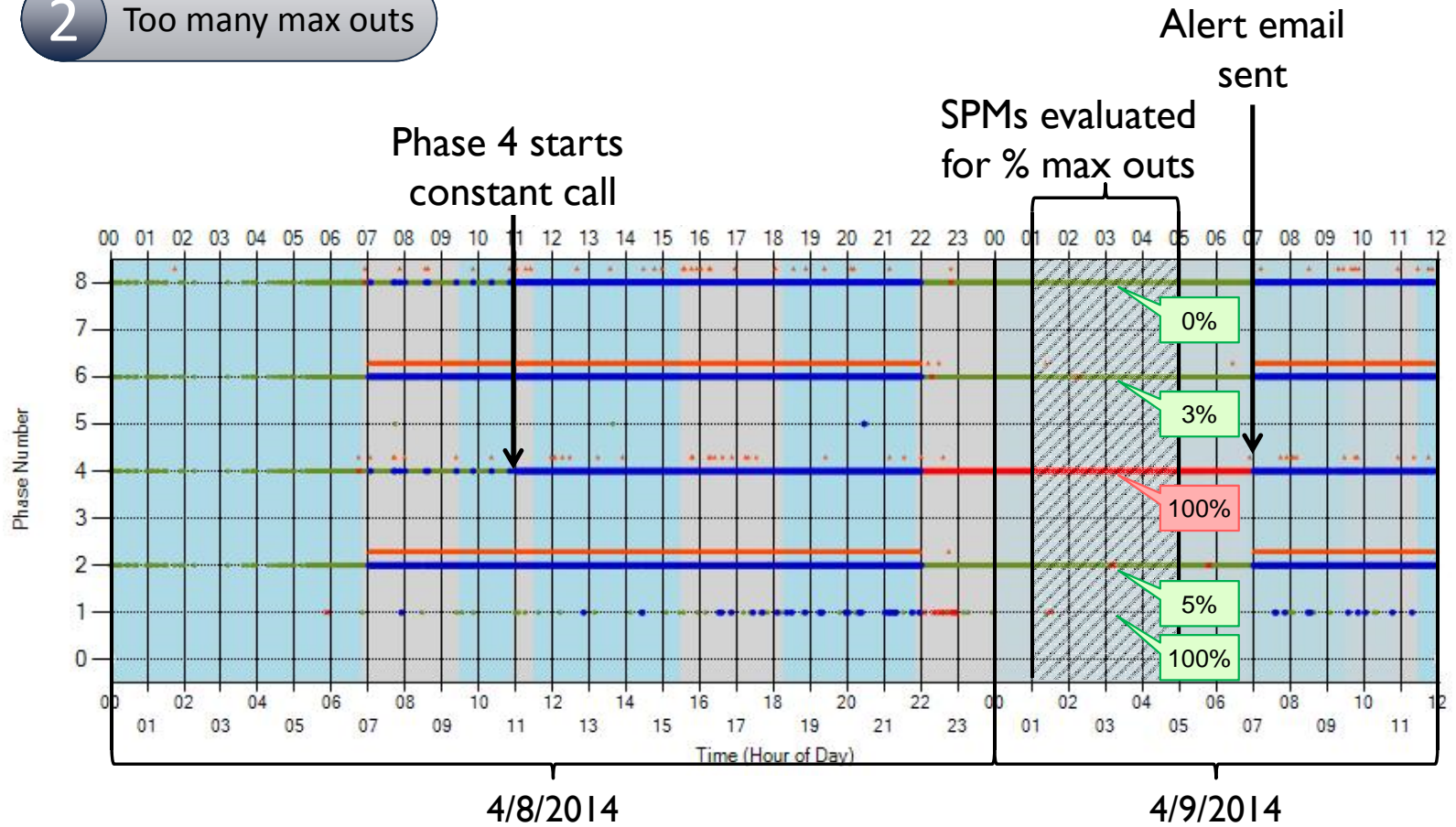
--The following signals had unusually low detector hits:  
5134 - SR-193 (700 S) & I-15 NB (Clearfield) - Phase: 2 ( Has Unusually Low Counts. )  
7061 - Bangerter Hwy (SR-154) & 4100 South - Phase: 1 ( Has Unusually Low Counts. )  
7061 - Bangerter Hwy (SR-154) & 4100 South - Phase: 7 ( Has Unusually Low Counts. )  
7361 - Bangerter Hwy (SR-154) & 13400 South - Phase: 1 ( Has Unusually Low Counts. )

--The following signals have stuck ped detectors:  
1023 - South Temple & 200 West - Phase: 2 (Stuck Ped )  
1023 - South Temple & 200 West - Phase: 4 (Stuck Ped )  
1023 - South Temple & 200 West - Phase: 6 (Stuck Ped )  
1023 - South Temple & 200 West - Phase: 8 (Stuck Ped )  
4511 - 4100 South & 3200 West - Phase: 4 (Stuck Ped )  
6009 - Main (Lehi) & I-15 SPUl - Phase: 6 (Stuck Ped )  
7826 - 9800 S (Little Cottonwood Rd) & Wasatch Blvd (3500 E) - Phase: 4 (Stuck Ped )



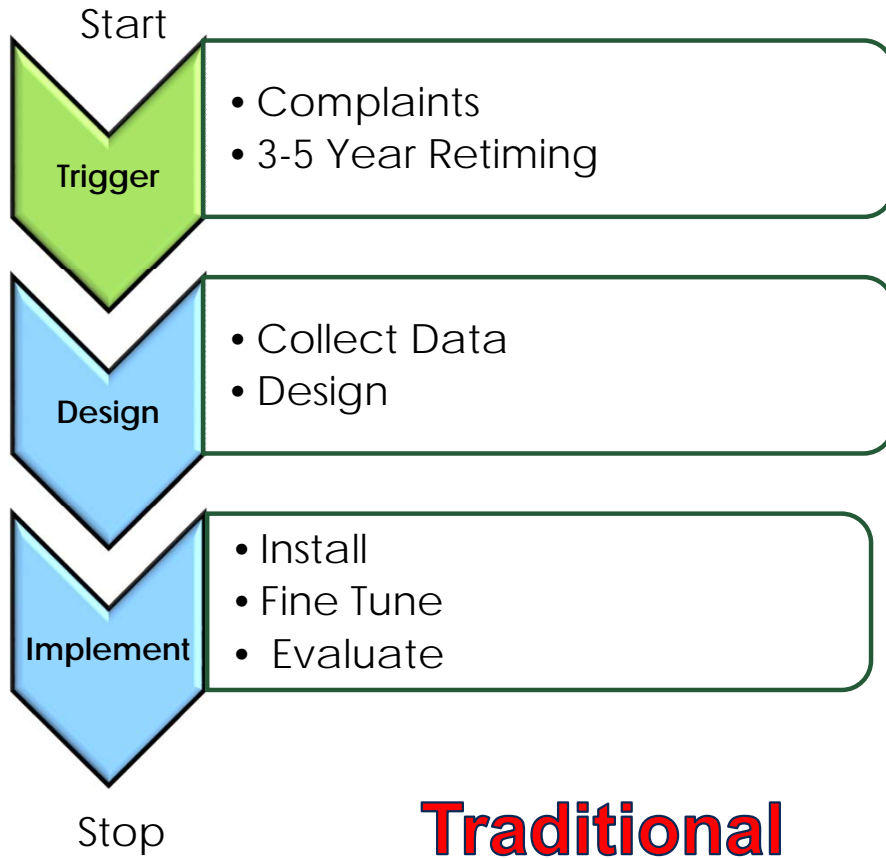
2

Too many max outs



Metric: Purdue Phase Termination  
Detection Requirements: None

## An Opportunity to Transform the Practice



**Traditional**



**Recommended**



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# Benefits

## Transforms Maintenance and Operations Activity from Reactive to Proactive

- Lower Costs
- Higher Quality of Service to Customers
- Improved Safety and Efficiency

## Improve Safety, Efficiency and Reliability

- Monitor Safety related performance measures
- Data driven allocation of green time
- Objectives & Performance Based Approach

## Supports Asset Management

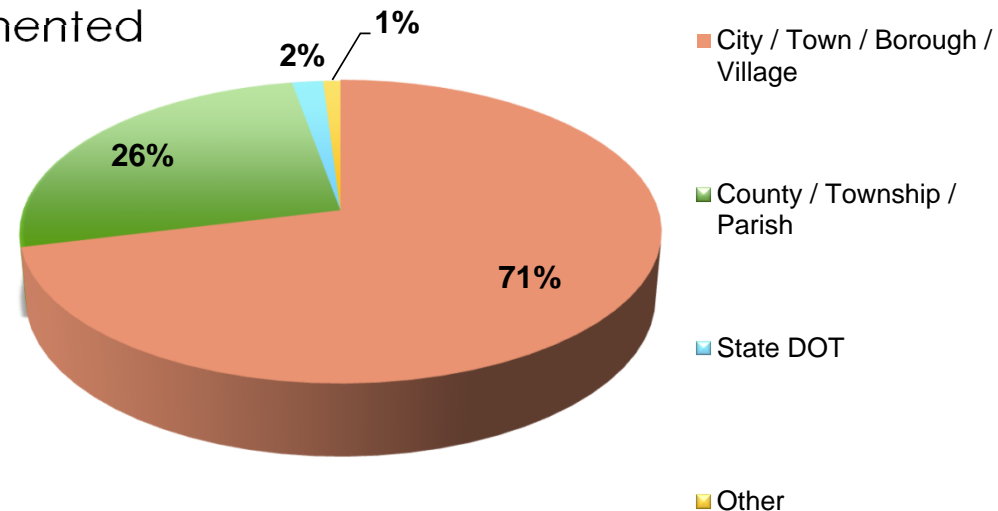
- Life Cycle Analysis
- **Support for funding needs**

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# Challenges

## Organizational Capability

- Shift to Objectives & Performance from Ad-hoc Management
  - Business Processes not well Documented
  - Workforce
  - Systems & Technology
    - Signal Control
    - Communication
    - Detection



## Dispersed Audience

- Connecting with Local Agencies

## Automated Traffic Signal Performance Measures State Implementation Goals

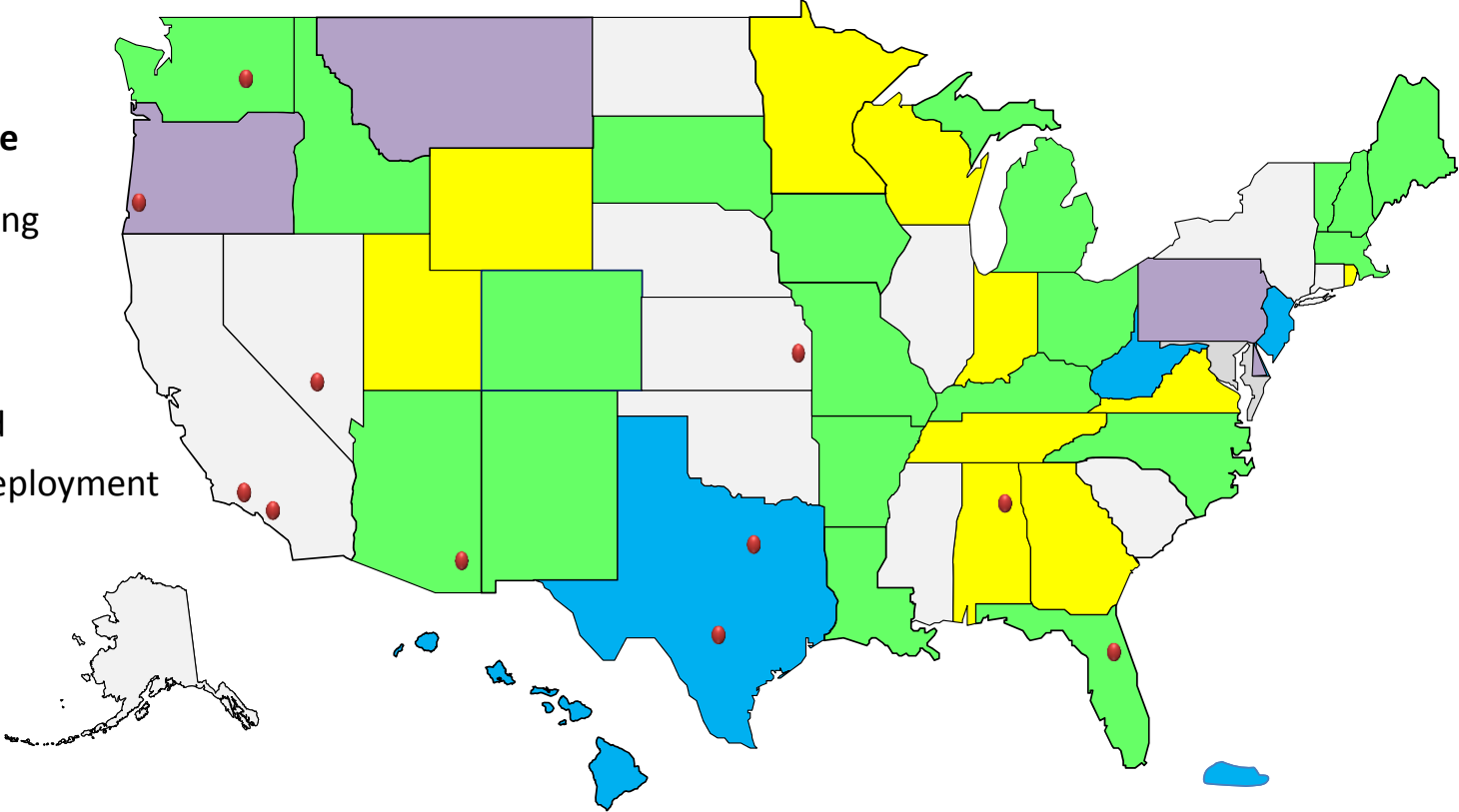
State(s)	Initial Stage	Final Stage	Description of Final Implementation Stage
AK, CA*, CT*, FLH, IL*, KS*, MD*, MS*, ND, NE, NV*, OK, SC, VI, (14)	Not Implementing	Not Implementing	The State is not currently using ATSPMs or interested in pursuing implementation.
HI, PR, WV (3)	Not Implementing	Development Stage	The State is interested in ATSPMs and intends to increase implementation readiness at State and/or local level through <b><u>capacity building activities</u></b> .
DC TX (2)	Development Stage		
AR, AZ, CO, FL, IA, ID, KY, LA, MA, ME, MO, NC, NH, NM, OH, SD, VT, WA (18)	Development Stage	Demonstration Stage	The State or local agency(s) has or plans to advance a <b><u>pilot implementation</u></b> of ATSPMs and will assess one or more performance measures.
MI (1)	Demonstration Stage		
DE, MT, PA (3)	Development Stage	Assessment Stage	The State is beyond testing/piloting ATSPMs. <b><u>ATSPMs are being actively implemented</u></b> to monitor the performance of signalized intersections in one or more jurisdictions within the State and actively promoting full implementation on all signalized intersections where appropriate.
OR (1)	Demonstration Stage		
NJ, TN, WY(3)	Development Stage	Institutionalized	ATSPMs is <b><u>adopted</u></b> by the State's transportation community <b><u>to support an objectives and performance based approach</u></b> to maintenance, operation management and design of signalized intersections.
AL, MN, VA (3)	Demonstration Stage		
IN, RI, WI (3)	Assessment Stage		
GA, UT (2)	Institutionalized		

\*ATSPM Implementation Currently Active

# EDC-4/ATSPM State Implementation Goals

### Implementation Stage

- Not Implementing
- Development
- Demonstration
- Assessment
- Institutionalized
- Local Agency Deployment



## Resources

### Transportation Pooled Fund Study 5-528

<http://www.pooledfund.org/Details/Study/487>

#### ☐ Publications

- Performance Measures for Traffic Signal Systems: An Outcome-Oriented Approach - <http://docs.lib.purdue.edu/jtrpaffdocs/3/>
- Integrating Traffic Signal Performance Measures into Agency Business Processes - <http://docs.lib.purdue.edu/jtrpaffdocs/24/>

### AASHTO innovation initiative

<http://aii.transportation.org/Pages/AutomatedTrafficSignalPerformanceMeasures.aspx>

### ATSPM Workshop Proceedings 1/2016

<http://docs.lib.purdue.edu/atspmw/2016/>



# Questions?

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