

UDOT AUTOMATED TRAFFIC SIGNAL PERFORMANCE MEASURES

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Opportunity from UDOT Executive Leaders (2011)

“What would it take for UDOT’s traffic signals to be world class?”

“What’s the trend – are signal operations improving, staying the same or getting worse?”

“What are our areas of most need?”

 **Quality
Improvement
Team**



QIT Recommendations

(July 2011)

- Communications and detection maintained during construction
- Proactive signal maintenance
- **Real-time monitoring of system health and quality of operations**

UTAH DEPARTMENT OF TRANSPORTATION

WORLD CLASS
TRAFFIC SIGNAL MAINTENANCE
& OPERATIONS



QUALITY IMPROVEMENT TEAM
Final Report

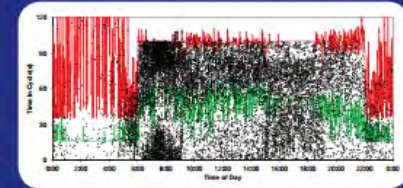
July 2011

<https://www.transportationops.org/publications/udot-signal-ops-qit-final-report>



PERFORMANCE MEASURES FOR TRAFFIC SIGNAL SYSTEMS

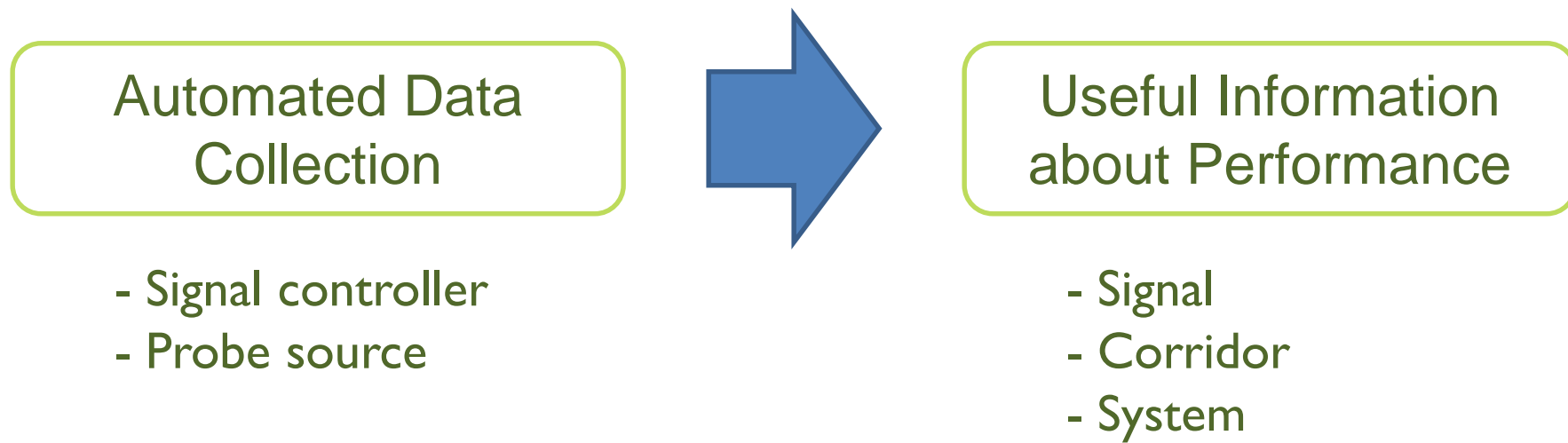
An Outcome-Oriented Approach



Christopher M. Day, Darcy M. Bullock, Howell Li, Stephen M. Remias, Alexander M. Hainen, Richard S. Freije, Amanda L. Stevens, James R. Sturdevant, and Thomas M. Brennan



Automated Traffic Signal Performance Measures (ATSPM) Basic Concept



Why Model what you can Measure?

Standard Controller Enumerations

<http://docs.lib.purdue.edu/jtrpdata/3/>

Purdue University
Purdue e-Pubs

JTRP Data Papers

11-2012

Indiana Traffic Signal Hi Resolution Data Logger Enumerations

James R. Sturdevant
INDOT, jsturdevant@indot.in.gov

Timothy Overman
INDOT

Eric Raamot
Econolite Group Inc.

Ray Deer
Peek Traffic Corporation

Dave Miller
Siemens Industry, Inc.

See next page for additional authors

Standard Controller Enumerations

Active Phase Events:

- 0 Phase On
- 1 Phase Begin Green
- 2 Phase Check
- 3 Phase Min Complete
- 4 Phase Gap Out
- 5 Phase Max Out
- 6 Phase Force Off
- 7 Phase Green Termination
- 8 Phase Begin Yellow Clearance
- 9 Phase End Yellow Clearance
- 10 Phase Begin Red Clearance
- 11 Phase End Red Clearance

Detector Events:

- 81 Detector Off
- 82 Detector On
- 83 Detector Restored
- 84 Detector Fault- Other
- 85 Detector Fault- Watchdog Fault
- 86 Detector Fault- Open Loop Fault

Preemption Events:

- 101 Preempt Advance Warning Input
- 102 Preempt (Call) Input On
- 103 Preempt Gate Down Input Received
- 104 Preempt (Call) Input Off
- 105 Preempt Entry Started

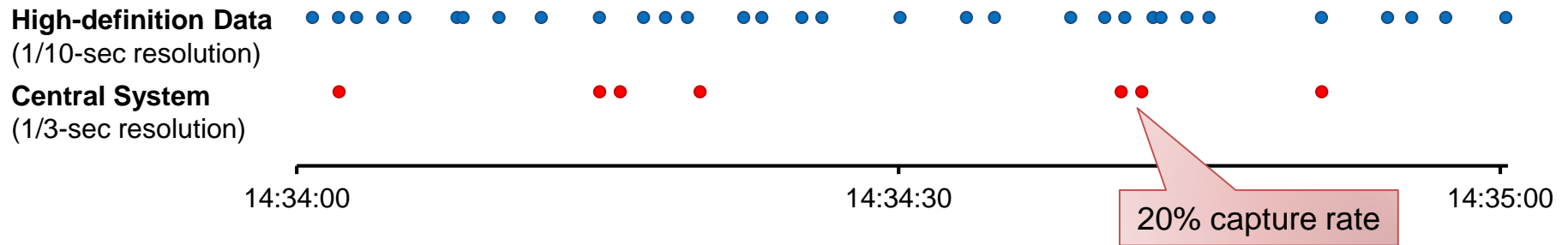
High-resolution Data Example

0.1-second resolution

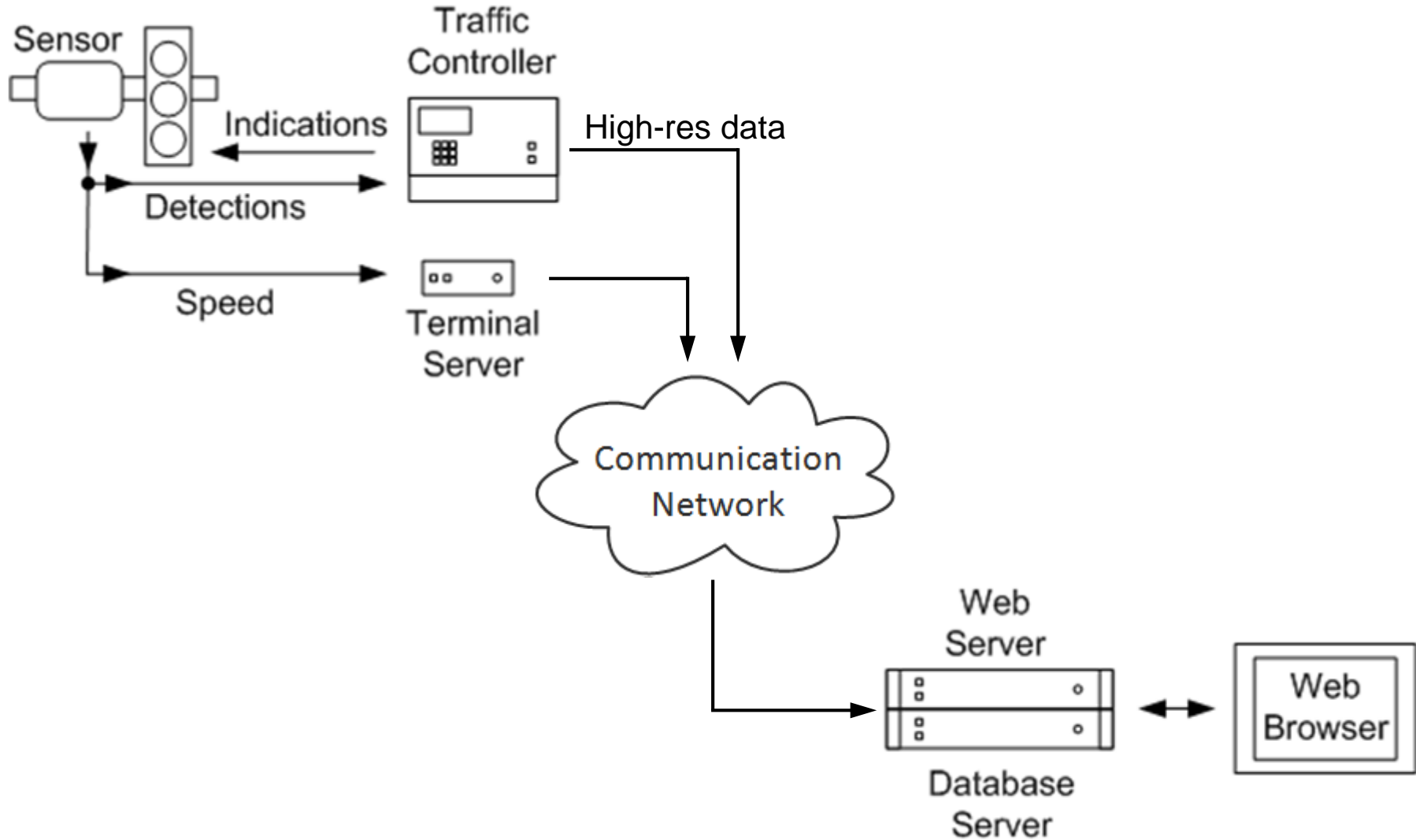
	Timestamp	Event Code	Event Parameter
	6/27/2013 1:29:51.1	10	8
Detector 5 ON	6/27/2013 1:29:51.1	82	5
	6/27/2013 1:29:52.2	1	2
	6/27/2013 1:29:52.2	1	6
	6/27/2013 1:29:52.3	82	2
	6/27/2013 1:29:52.8	82	4
	6/27/2013 1:29:52.9	81	4
	6/27/2013 1:29:54.5	81	2
	6/27/2013 1:30:02.2	8	2
	6/27/2013 1:30:02.2	8	6
Phase 8 GREEN	6/27/2013 1:30:06.1	10	2
	6/27/2013 1:30:06.1	10	6
	6/27/2013 1:30:08.1	1	8
Detector 5 OFF	6/27/2013 1:30:15.8	81	5
	6/27/2013 1:30:18.5	82	6
	6/27/2013 1:30:27.5	81	6
Phase 8 YELLOW	6/27/2013 1:30:30.4	8	8

Why is High-resolution Data Important?

Advanced Detector Count Comparison



ATSPM System Architecture



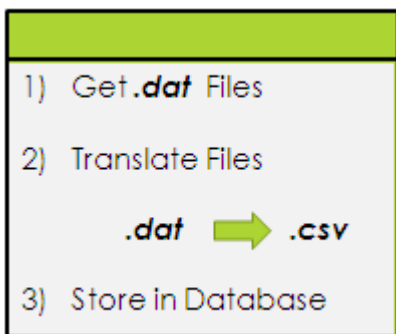
System Requirements



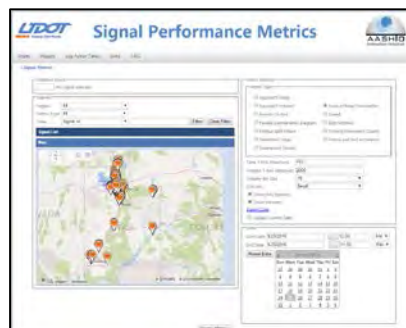
High-resolution Controller
 (or stand-alone data aggregator)



Communications



Server



Software



Detection
 (optional)

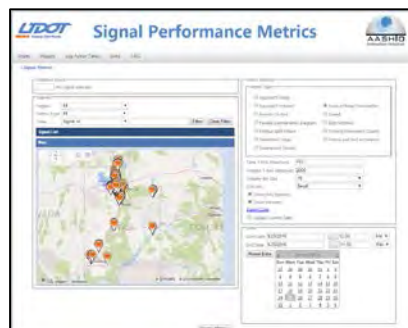
System Requirements



**Does NOT require
Central Traffic Management Software!**

- 1) Get *.dat* Files
- 2) Translate Files
.dat → *.csv*
- 3) Store in Database

Server

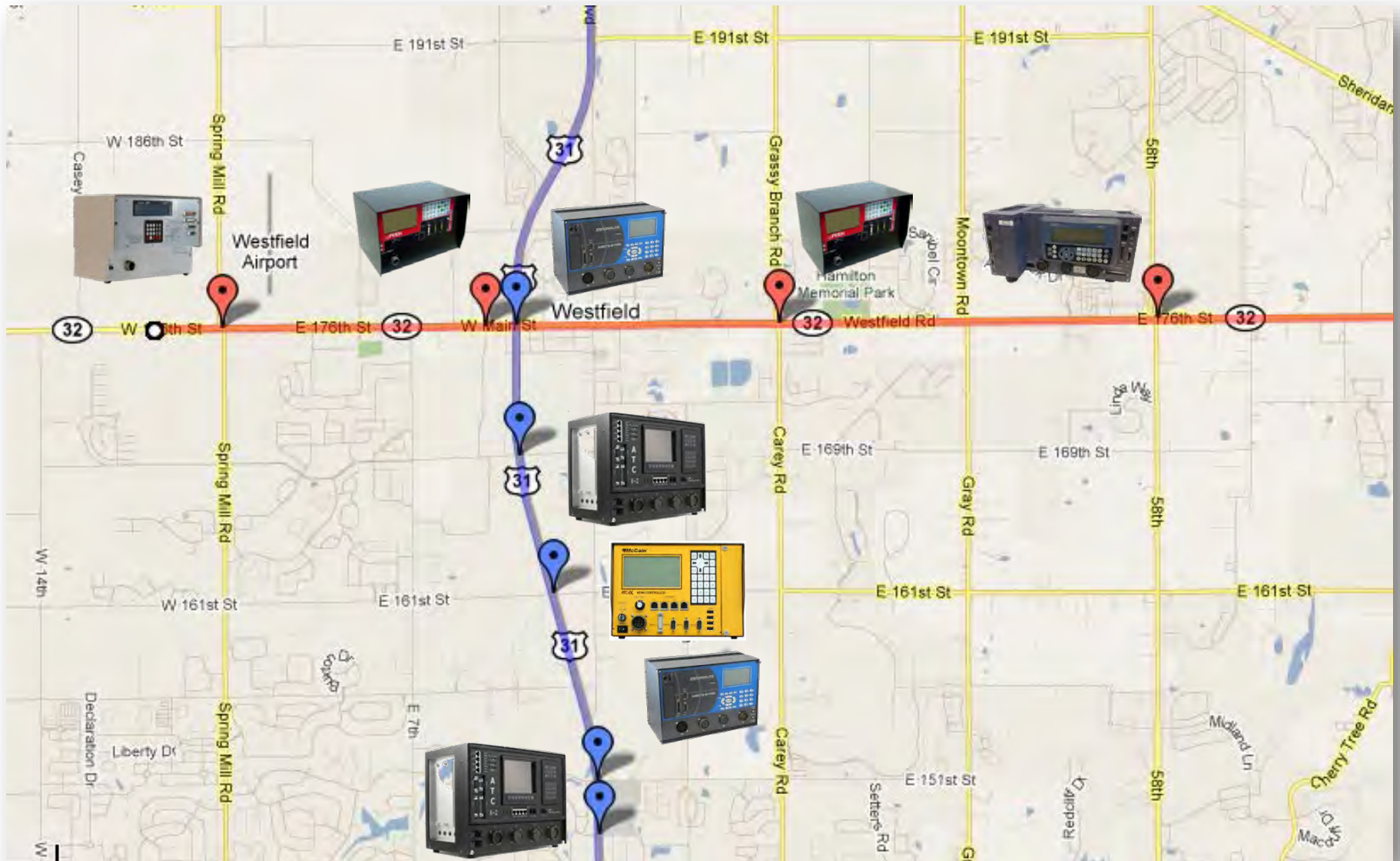


Software



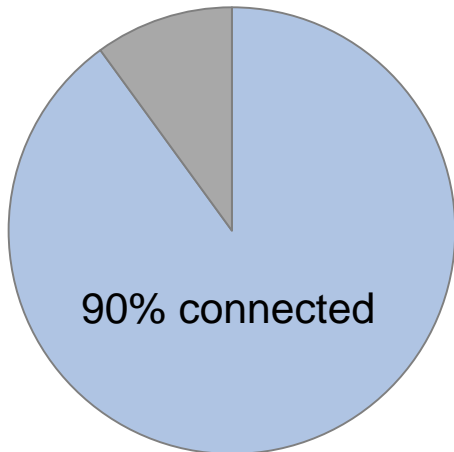
**Detection
(optional)**

Vendor Neutrality

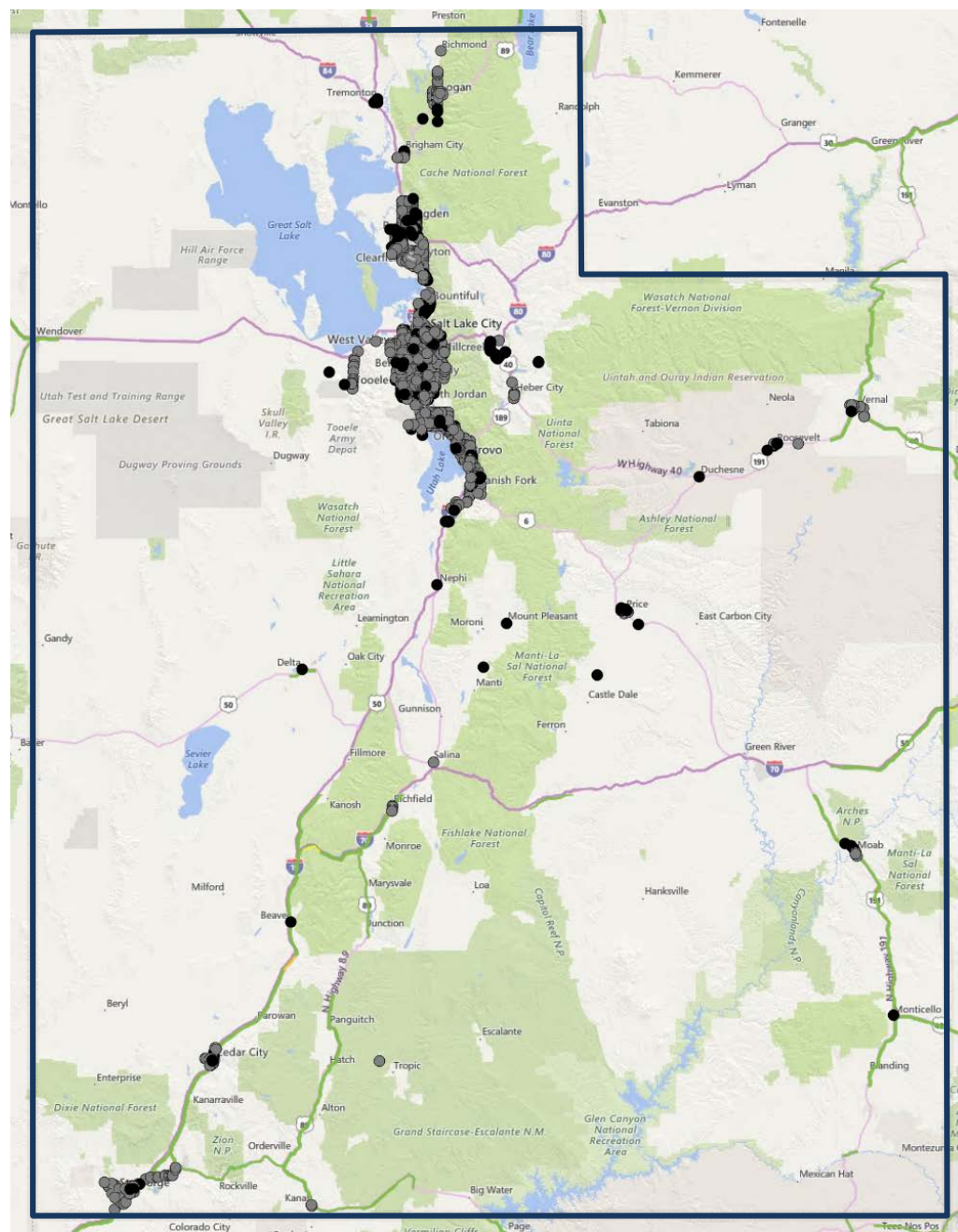
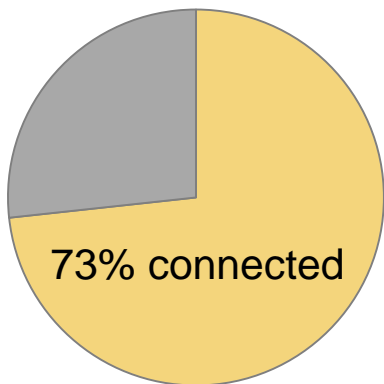


Traffic Signals in Utah

UDOT Signals: 1237



Partner Signals: 887



Signals without Communication

\$100



Controller with High-res Data Logger

Raspberry Pi

- Stores controller logs
- Updates controller clock

GPS Antenna

UDOT's ATSPM Website

<http://udottraffic.utah.gov/ATSPM>



Measures Reports Log Action Taken Links FAQ About

Register Log in

Signal

Signal Selection

Signal ID

7220

Foothill Drive @ 1300 South

Signal List

Signal Map

Region

--Select Region--

Metric Type

--Select a Metric--

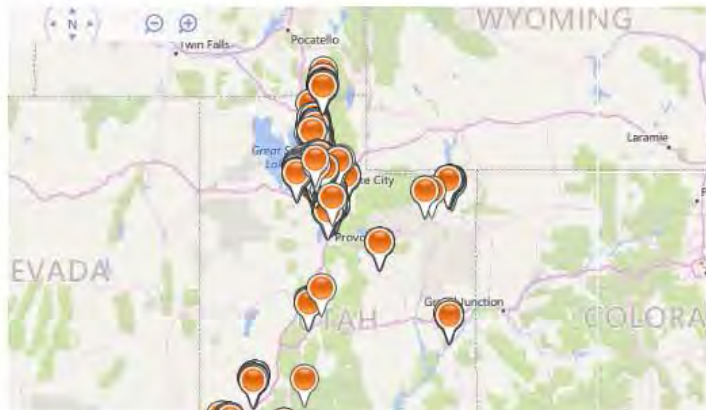


Chart Selection

Metrics List

- Purdue Phase Termination
- Split Monitor
- Pedestrian Delay
- Preemption Details
- Turning Movement Counts
- Purdue Coordination Diagram
- Approach Volume
- Approach Delay
- Arrivals On Red
- Approach Speed
- Yellow and Red Actuations
- Purdue Split Failure

Phase Termination Options

Y-axis Max

Auto

Consecutive Count

1

Show Plans

Show Ped Activity

Date Selection

Start Date

04/19/2017

12:00

AM

End Date

04/19/2017

11:59

PM

Reset Date



Create Chart

UDOT's ATSPM Website

<http://udottraffic.utah.gov/ATSPM>



Measures Reports Log Action Taken Links FAQ About Register Log in

Signal

1

Select signal from map OR enter 4 digit signal number

Filter map by available metrics

The screenshot displays the ATSPM website interface. At the top, there is a navigation bar with links for Measures, Reports, Log Action Taken, Links, FAQ, and About, along with Register and Log in buttons. Below this is a 'Signal Selection' section with a 'Signal ID' input field containing '7220' and a dropdown menu showing 'Foothill Drive @ 1300 South'. There are also buttons for 'Signal List' and 'Signal Map'. Below these are dropdown menus for 'Region' (set to '--Select Region--') and 'Metric Type' (set to '--Select a Metric--'). A map of Utah is shown with several orange location pins. To the right of the map is a 'Phase Termination Options' panel with a dropdown menu for 'Purdue Phase Termination' (set to 'Purdue Phase Termination') and input fields for 'Y-axis Max' (set to 'Auto') and 'Consecutive Count' (set to '1'). There are also checkboxes for 'Show Plans' and 'Show Ped Activity'. Below the map is a 'Date Selection' panel with 'Start Date' (04/19/2017, 12:00 AM) and 'End Date' (04/19/2017, 11:59 PM) fields, a 'Reset Date' button, and a calendar for April 2017 with the 19th highlighted. At the bottom of the page is a 'Create Chart' button.

UDOT's ATSPM Website

<http://udottraffic.utah.gov/ATSPM>



- Measures
- Reports
- Log Action Taken
- Links
- FAQ
- About

Signal

2

Select metric from list
(Note: not all metrics are available at all signals)

Signal Selection

Signal ID: Foothill Drive @ 1300 South

Signal List

Signal Map

Region:

Metric Type:

Chart Selection

Metrics List

- Purdue Phase Termination
- Split Monitor
- Pedestrian Delay
- Preemption Details
- Turning Movement Counts
- Purdue Coordination Diagram
- Approach Volume
- Approach Delay
- Arrivals On Red
- Approach Speed
- Yellow and Red Actuations
- Purdue Split Failure

Phase Termination Options

Y-axis Max:

Consecutive Count:

Show Plans

Show Ped Activity

Date Selection

Start Date:

End Date:

UDOT's ATSPM Website

<http://udottraffic.utah.gov/ATSPM>



Measures Reports Log Action Taken Links FAQ About

Register Log in

Signal

Signal Selection

Signal ID: Foothill Drive @ 1300 South

Signal List

Signal Map

Region:

Chart Selection

Metrics List

- Purdue Phase Termination
- Split Monitor
- Pedestrian Delay
- Preemption Details
- Turning Movement Counts
- Purdue Coordination Diagram
- Approach Volume
- Approach Delay
- Arrivals On Red
- Approach Speed
- Yellow and Red Actuations
- Purdue Split Failure

Phase Termination Options

Y-axis Max:

Consecutive Count:

Show Plans

Show Ped Activity

Date Selection

Start Date

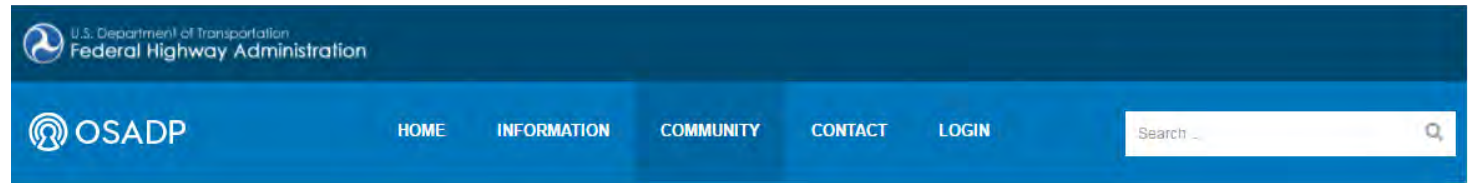
End Date

3 Select time and date range

4 Click "Create Chart"

UDOT ATSPM Source Code

<https://www.itsforge.net>



U.S. Department of Transportation
Federal Highway Administration
















OSADP

HOME INFORMATION COMMUNITY CONTACT LOGIN

Search

Explore Applications

APPLICATION CATEGORIES

 All Active Releases	48
 Arterial Management	21
 Collision Avoidance	5
 Collision Notification	5
 Commercial Vehicle Operations	9
 Crash Prevention & Safety	10
 Driver Assistance	19
 Electronic Payment & Pricing	0
 Emergency Management	6
 Freeway Management	20
 Information Management	23
 Intermodal Freight	7
 Road Weather Management	5
 Roadway Operations & Maintenance	7
 Traffic Incident Management	6

Sort by Name

Show 5 Items

Filter Applications

<< Previous Next >> Last >>



AMS_TCA_Aimsun_v1 STABLE

Trajectory Conversion Algorithm-Aimsun (TCA-A)

Version: AMS_TCA_Aimsun_v1
Modified: May 24, 2017
Downloads: 7

Keywords: Connected Vehicles traffic simulation communication



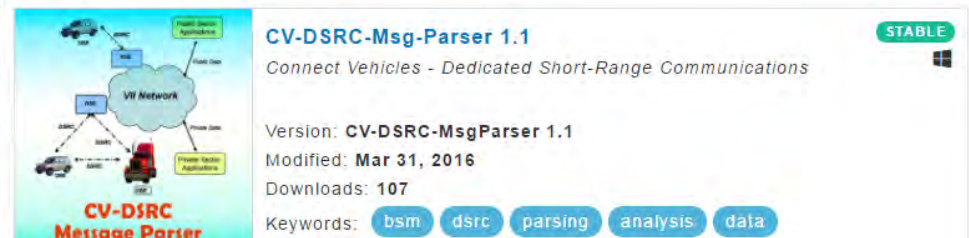
Automated Traffic Signal Performance Measures (ATSPM) 4.0.1 STABLE

Automated Traffic Signal Performance Measures 4.0.1

Version: ATSPM-4.0.1
Modified: Apr 20, 2017
Downloads: 64

Keywords: signals ATSPM Performance Measures Signal Metrics

Signal Measures



CV-DSRC-Msg-Parser 1.1 STABLE

Connect Vehicles - Dedicated Short-Range Communications

Version: CV-DSRC-MsgParser 1.1
Modified: Mar 31, 2016
Downloads: 107

Keywords: bsm dsrc parsing analysis data

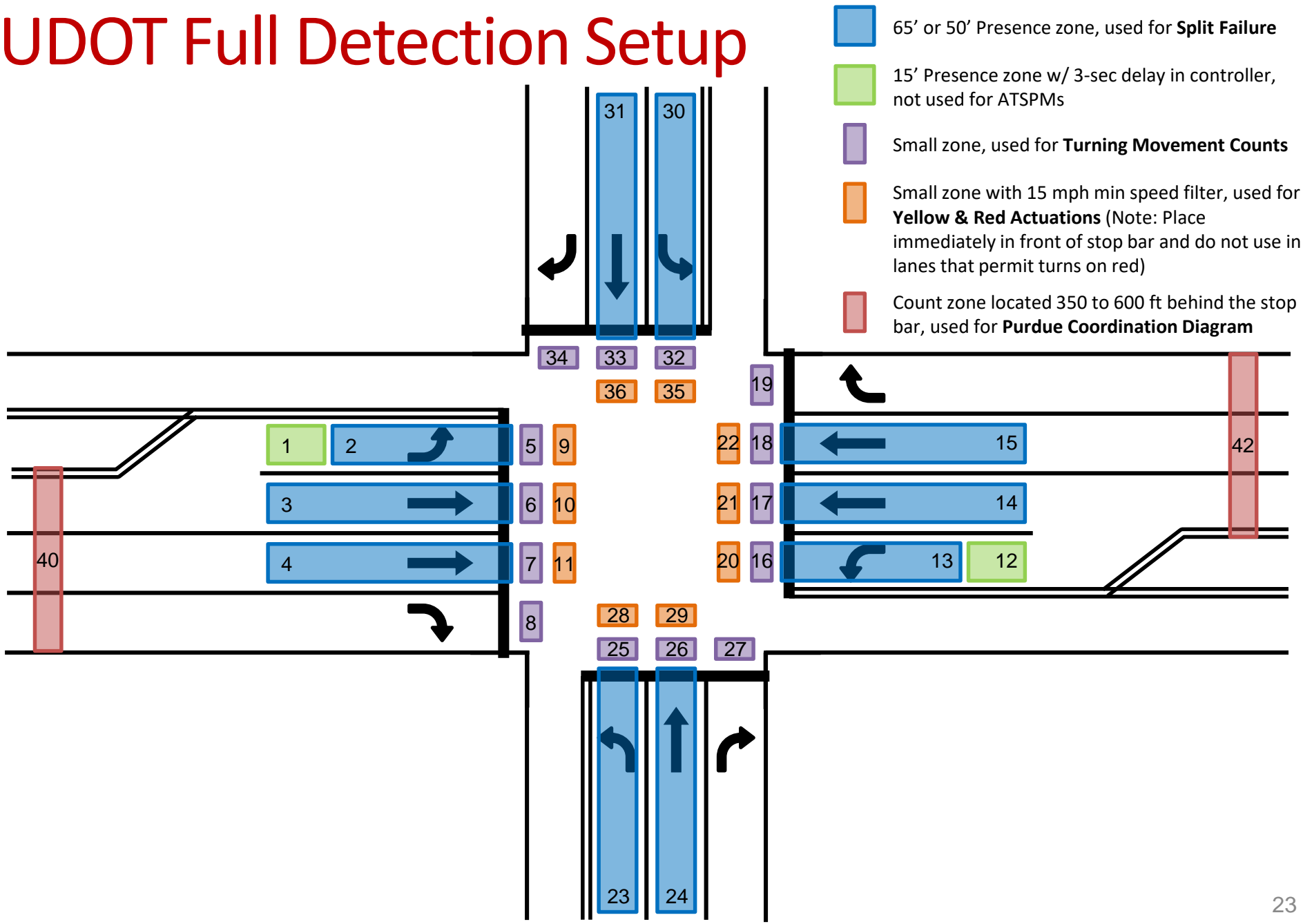
UDOT ATSPM Implementation Cost

	Small System (~50 signals)	Large System (~1000 signals)
Controllers w/ High-definition Loggers	Unknown	Unknown
Communication or In-cabinet Data Storage	Unknown	Unknown
UDOT ATSPM Software	\$0	\$0
Server	\$3,000	\$20,000
SQL Database License	\$7,000	\$100,000
IT Consultant	\$5,000	\$10,000
Engineering Consultant (detector configuration)	\$5,000	\$100,000
Total	\$20,000	\$230,000
<i>Cost per signal</i>	<i>\$400</i>	<i>\$230</i>

DETECTION

UDOT Automated Traffic Signal Performance Measures

UDOT Full Detection Setup



Turning Movement Counts Detection



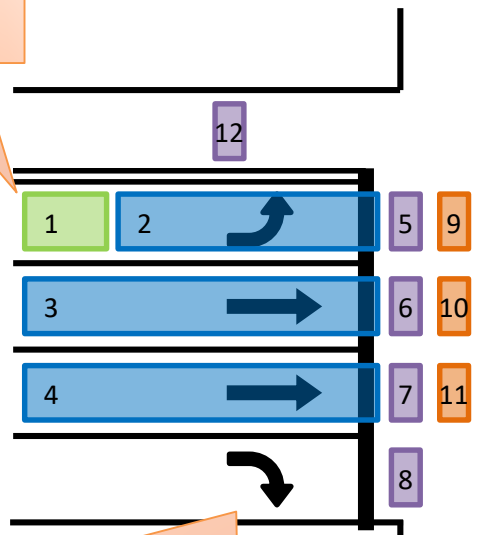
Wavetronix
SmartSensor
Matrix



Wavetronix
Cabinet Interface Device
Click 650

Wavetronix Matrix – Standard Detection Layout w/ Click 650

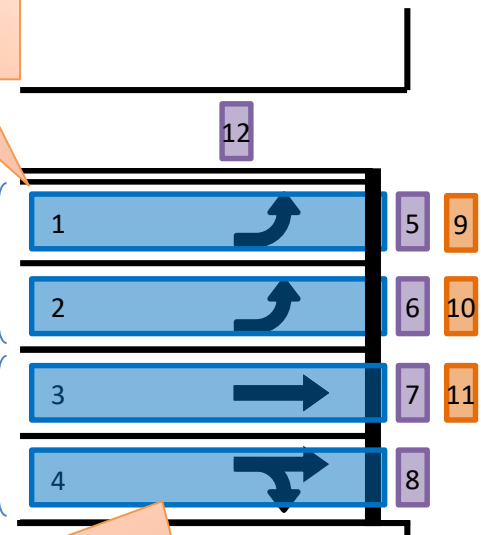
Queue zone for P&P left turns



Presence zones can be combined within lane groups

No presence or YRA in right-turn lane

Protected-only left-turn lanes



Presence zones can be combined within lane groups

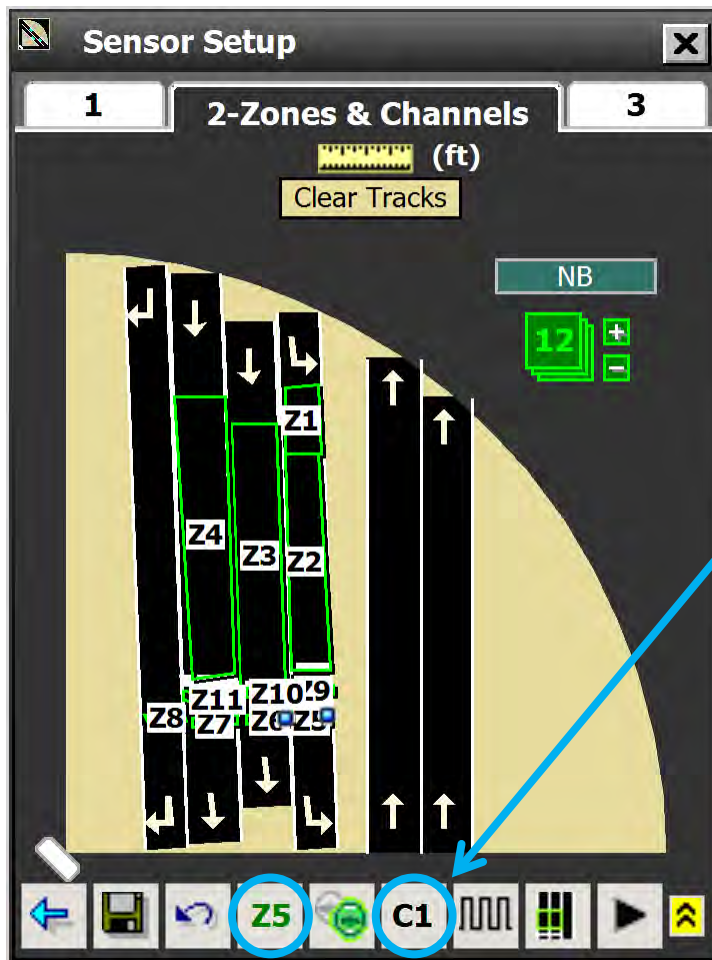
No YRA in shared through/right lane

- ### Detection Channel Order
1. Presence zones, inside to outside. If P&P zones, the queue zone is first.
 2. Count channels, inside to outside
 3. YRA zones, inside to outside
 4. Count zones in exit lanes, inside to outside (*often skipped*)

- ### Matrix Sensor Order
1. Phase 2
 2. Phase 6
 3. Phase 4
 4. Phase 8

- 65' or 50' Presence zone, used for **Split Failure**
- 15' Presence zone w/ 3-sec delay in controller, not used for ATSPMs
- Small zone, used for **Turning Movement Counts**
- Small zone with 15 mph min speed filter, used for **Yellow & Red Actuations** (Note: Place immediately in front of stop bar and do not use in lanes that permit turns on red)

Wavetronix Matrix – Configuration for Turning Movement Counts



Zone Configuration

C5

Z1	Z2	Z3	Z4
Z5	Z6	Z7	

D = -- s
 E = -- s
 DI = --
 Φ = --

Channel Type: Counting
 Invert:

Min Speed: None
 Max Speed: None

Min Speed = 15 or 20 mph for Yellow & Red Actuations (YRA)

Channel Configuration

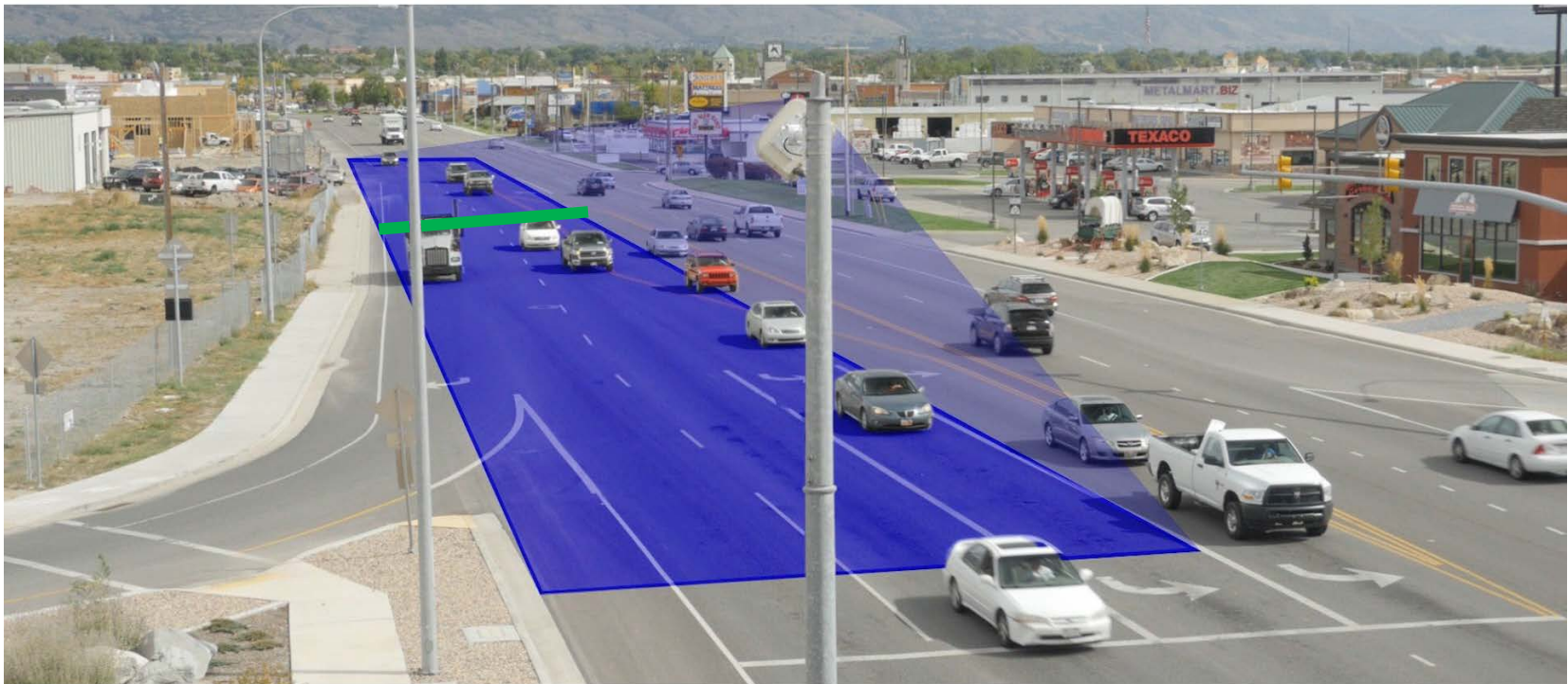
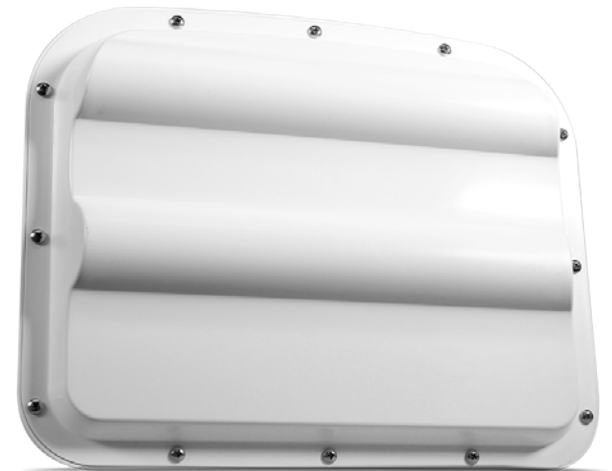
Z5

Delay (secs): 00.0
 Extend (secs): 00.0

Make small zone

Approach Volume Detection

Wavetronix
SmartSensor
Advance



Wavetronix Advance Count Setup

Channel 1 – Dilemma Zone and Queue Clearance
Channel 2 – Counting

Channels-Alerts-Zones

1 | **2-EB Count** | 3 | 4 | 5 | 6 | 7 | 8

Name: **EB Count**

Type: **Pulse**

Enabled

Zone Settings

Range (feet): **390 to 400**

Speed (mph): 035 - 100

20

OK | Undo | Cancel

Verify Channels-Alerts-Zones

Ch2-A1-Z1

SB Count: **00006** Pu

Total: **00006**

Reset

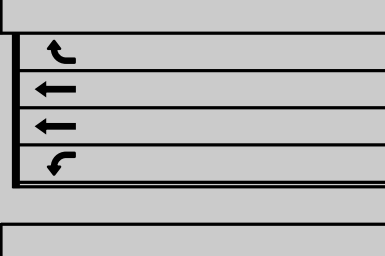
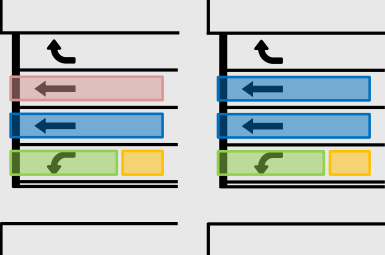


Range	Speed	ETA
460	54	5.8
335	51	4.4
240	50	3.2
175	51	2.3
70	49	0.9

Ch2

Callout: Monitor trackers and place count zone at distance with good detection. Preference is 400-500 ft from stop bar.

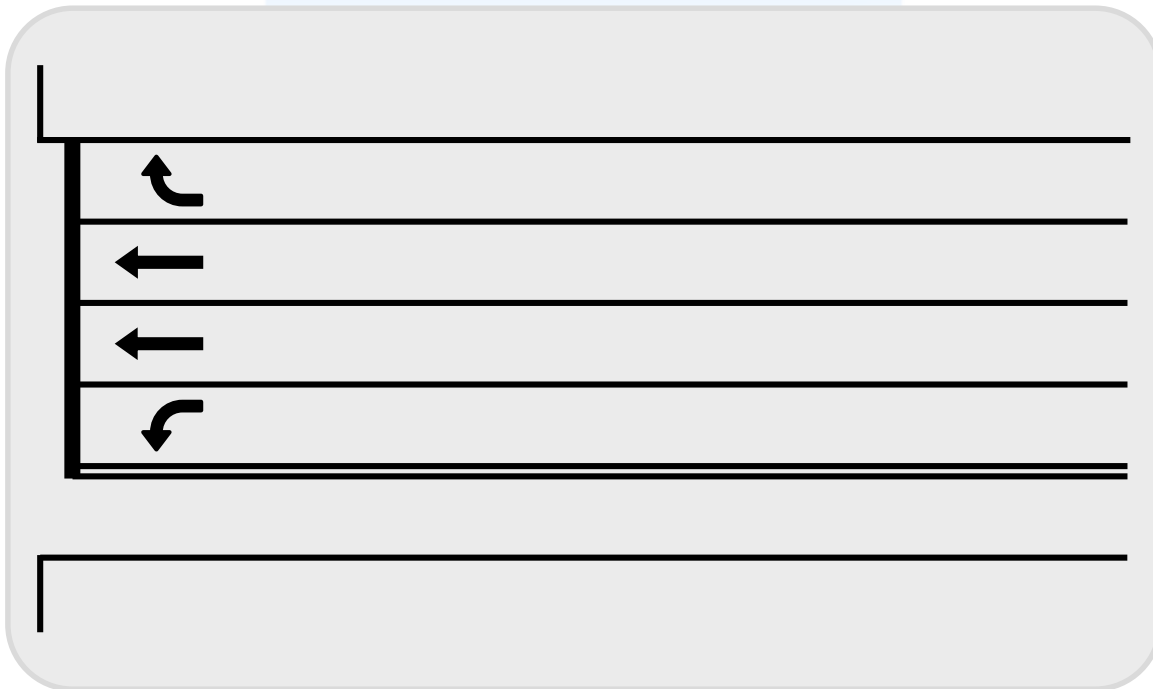
METRICS

UDOT Automated Traffic Signal Performance Measures

Detection	Metric
<p>None</p> 	<p>Phase Termination Chart Split Monitor Preemption Details Pedestrian Delay</p>
<p>Lane-by-lane or Lane Group Presence</p> 	<p>Purdue Split Failure</p>
<p>Lane-by-lane Stop Bar Count</p> 	<p>Turning Movement Counts</p>
<p>Advanced Count</p> 	<p>Purdue Coordination Diagram Purdue Link Pivot Offset Optimization Approach Volume Approach Speed (requires detection with speed service)</p>

Detection

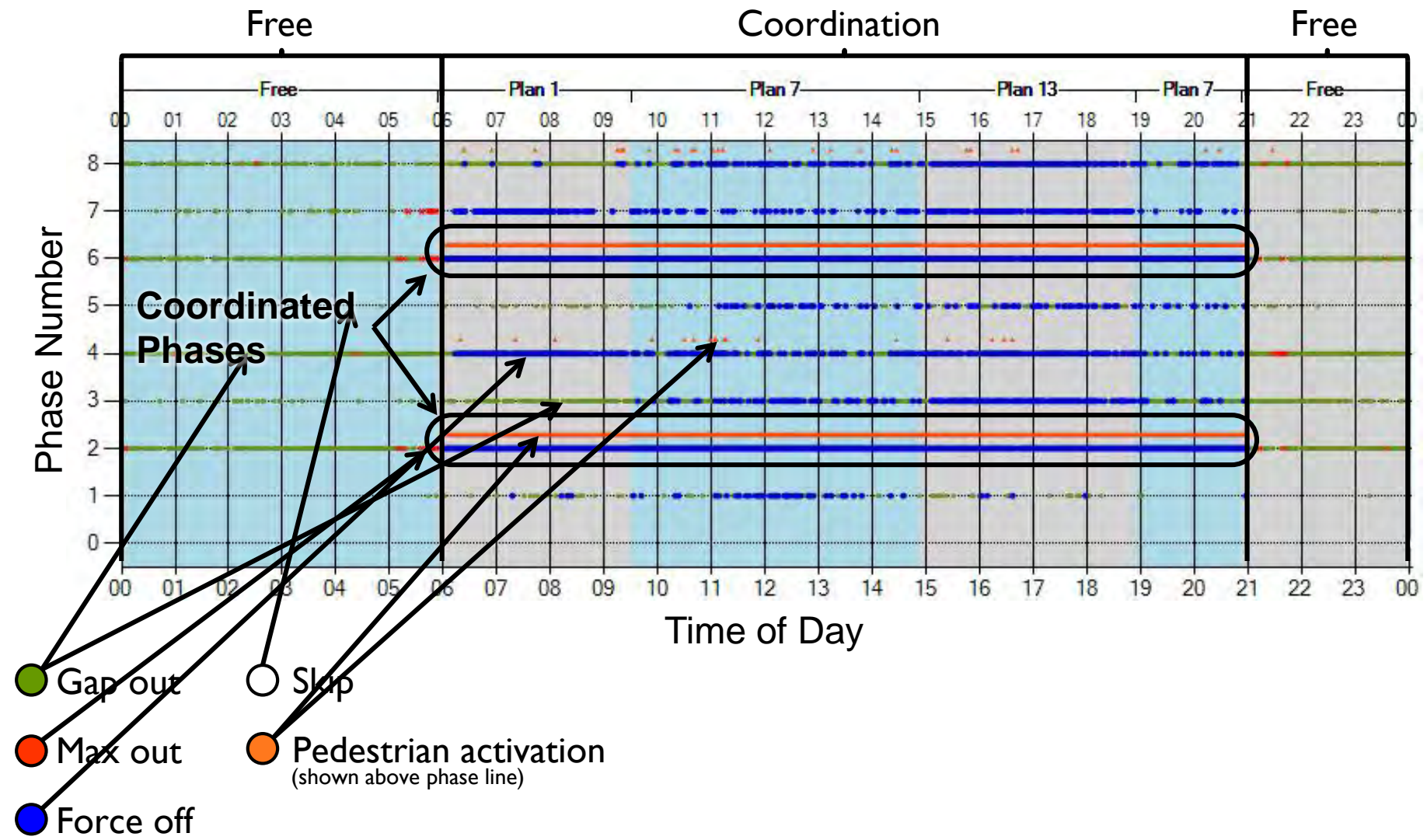
None



Available Metrics

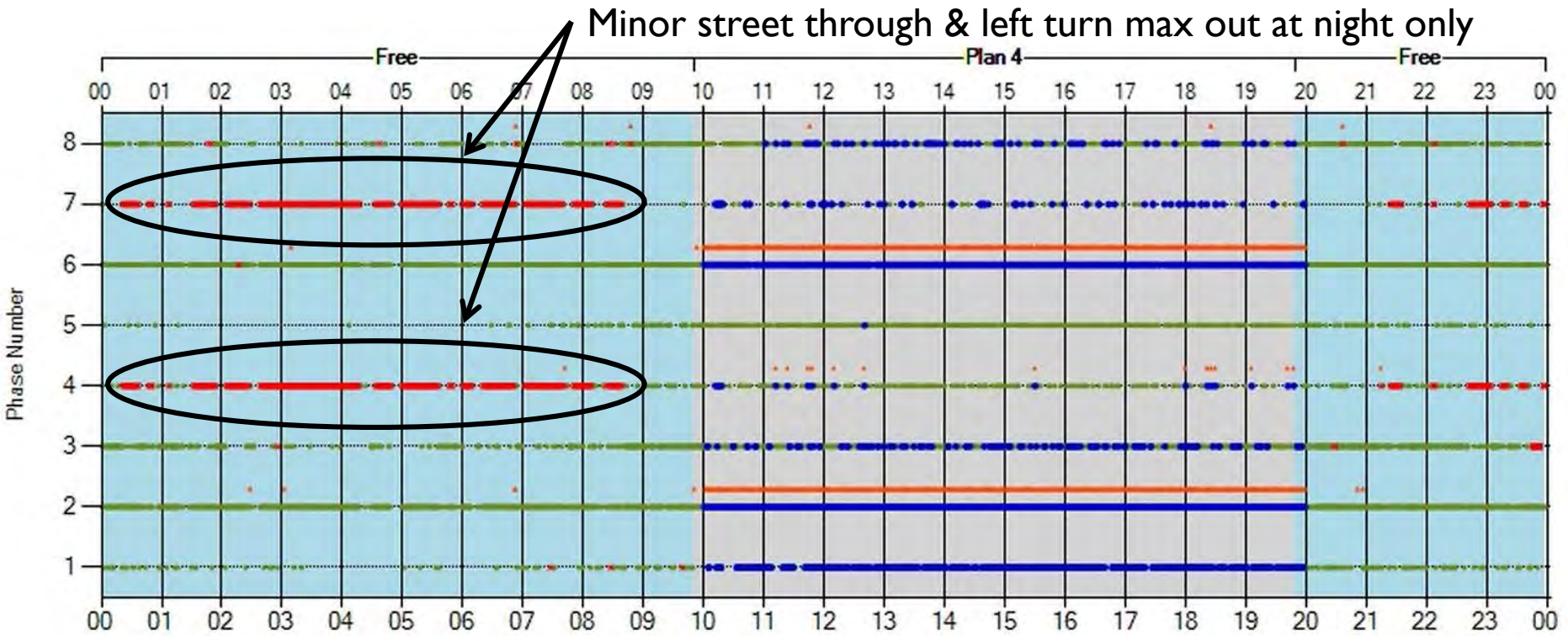
- Phase Termination Chart
- Split Monitor
- Pedestrian Delay
- Preemption Details

Metric: Phase Termination Chart



Complaint: Long main street red at 2 a.m.

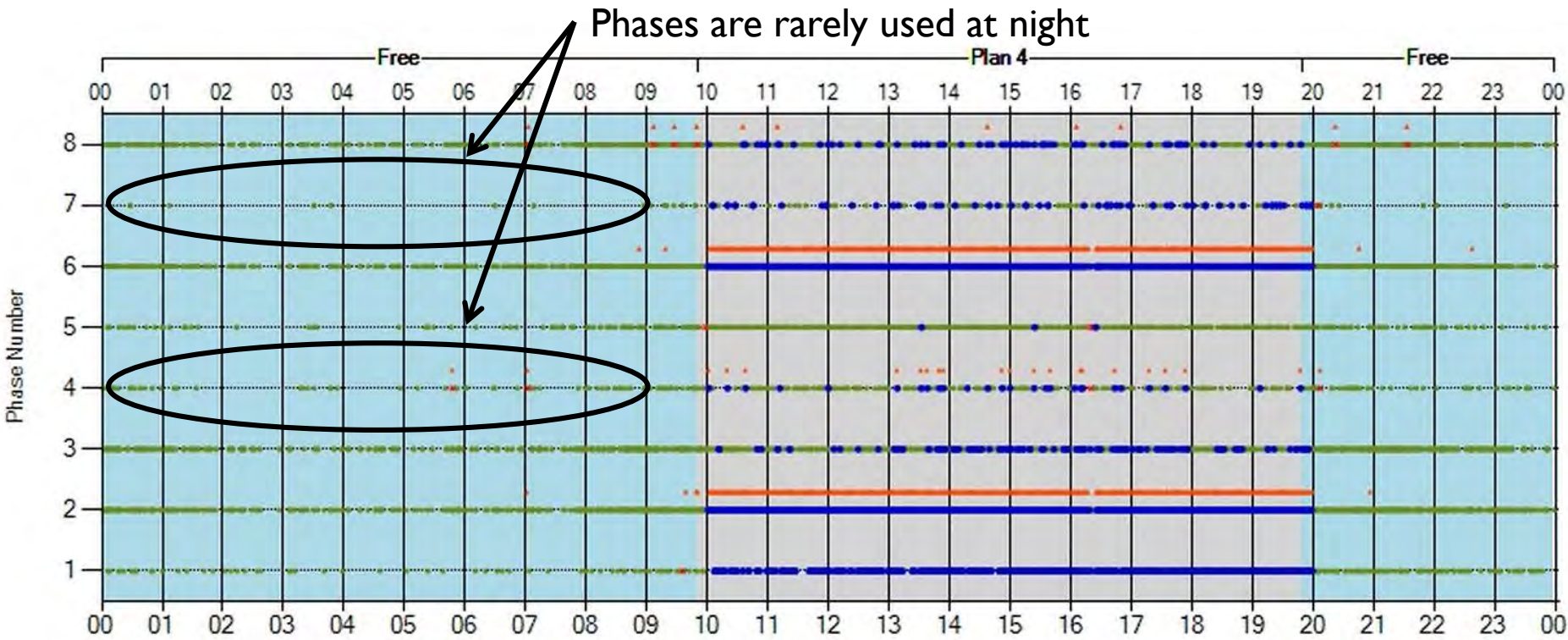
Before Video detection not working at night



- Gap out
- Max out
- Force off
- Skip
- Pedestrian activation
(shown above phase line)

Complaint: Long main street red at 2 a.m.

After New detection technology installed

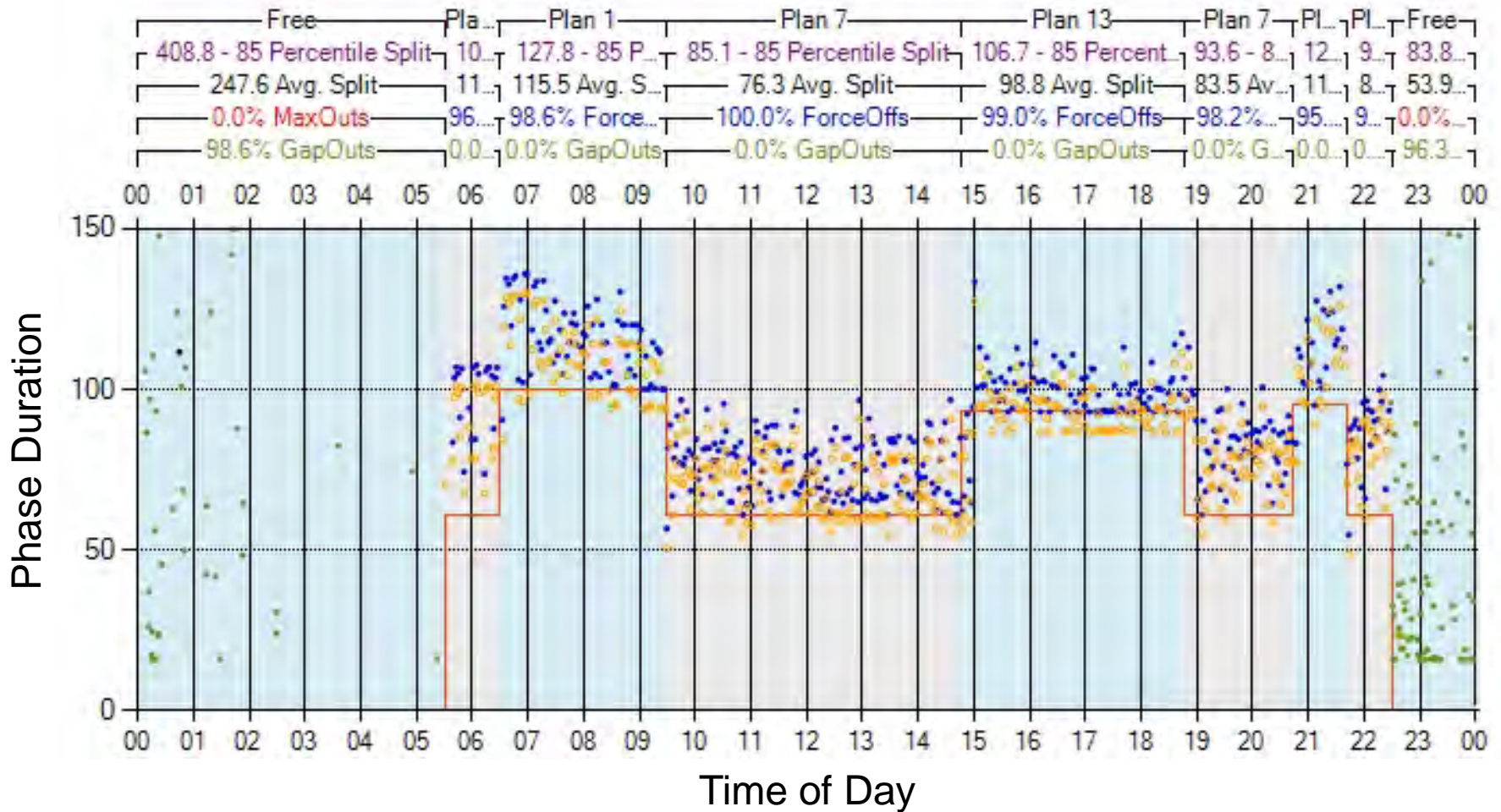


- Gap out
- Max out
- Force off
- Skip
- Pedestrian activation
(shown above phase line)

Metric: Split Monitor

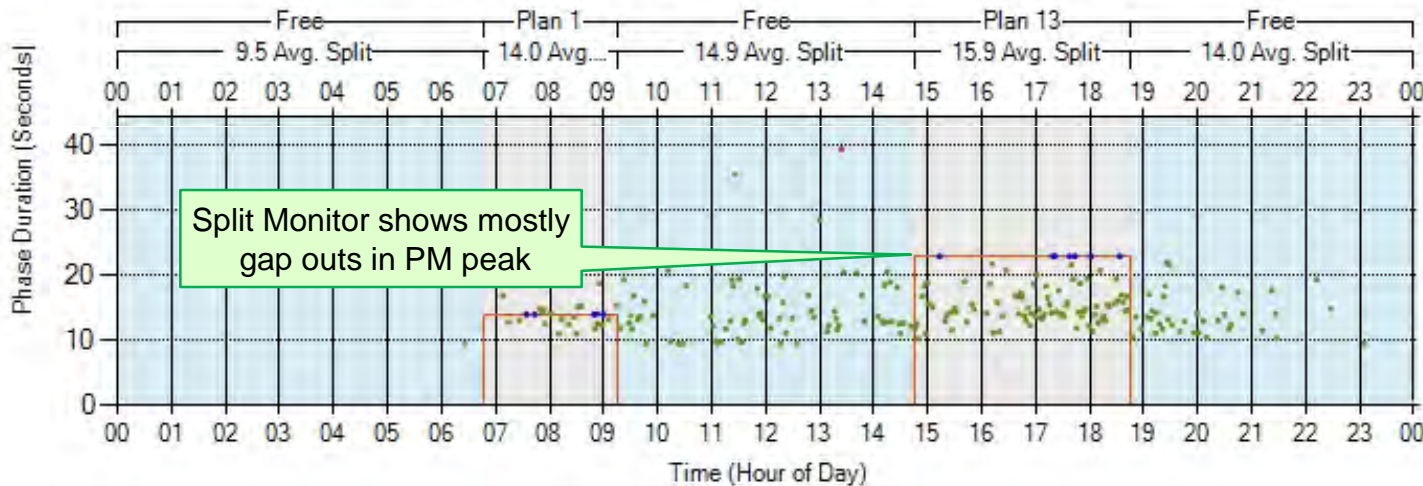
Foothill Drive @ 1300 South - SIG#7220
 Wednesday, June 14, 2017 12:00 AM - Wednesday, June 14, 2017 11:59 PM

Phase 6



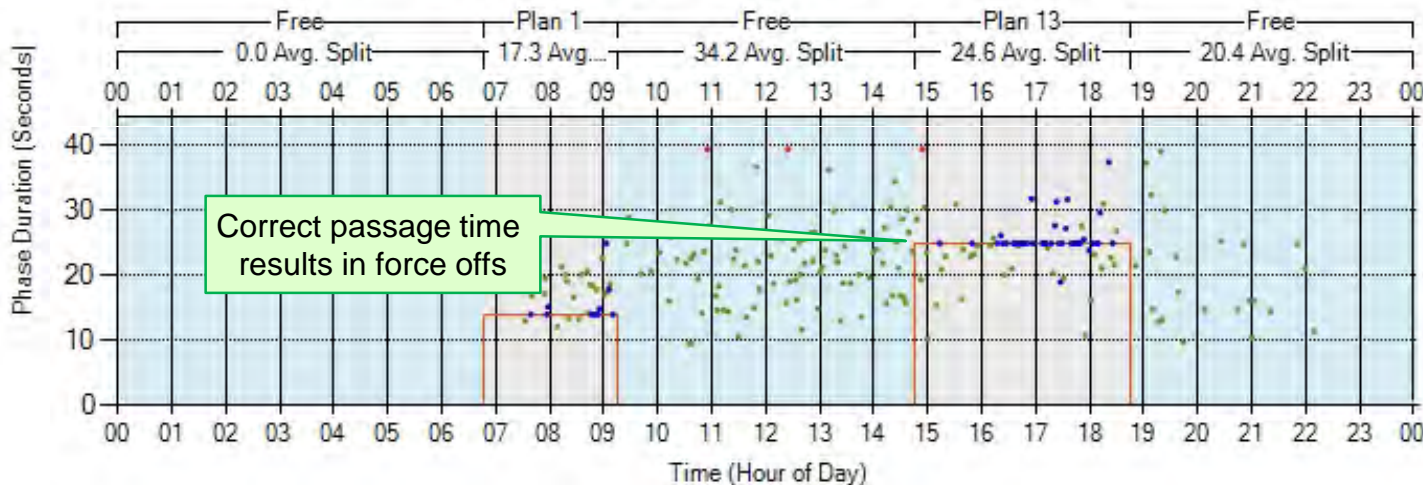
Complaint: Long queue, short green, PM peak

Bangerter Hwy (SR-154) 13800 South SIG#7355 Phase 1
Wednesday, August 12, 2015 12:00 AM - Wednesday, August 12, 2015 11:59 PM



Before

Bangerter Hwy (SR-154) 13800 South SIG#7355 Phase 1
Wednesday, August 10, 2016 12:00 AM - Wednesday, August 10, 2016 11:59 PM



After

Example: I-15 Freeway Closure, September 9-12, 2014



Heavy rain rips apart I-15 in Nevada, forces freeway closure

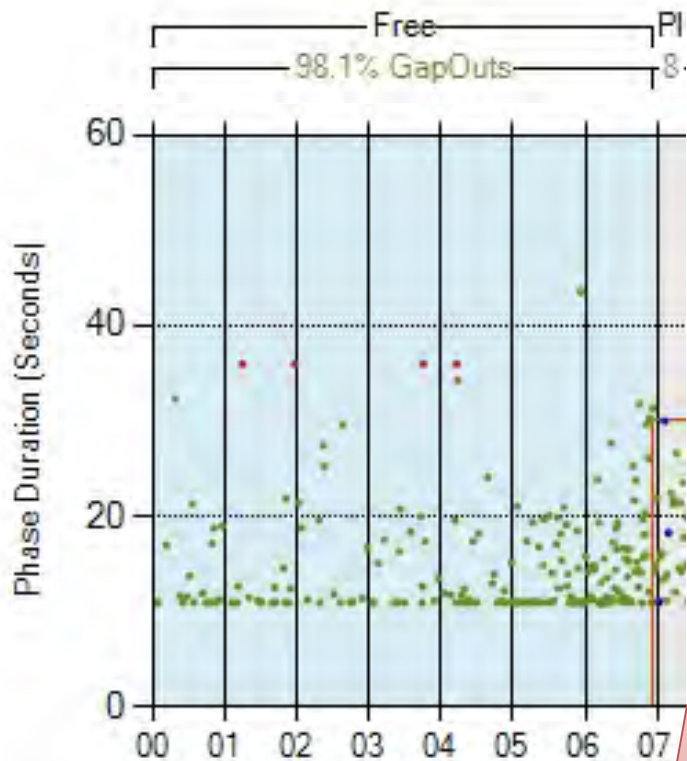
By Ken Ritter, Michelle Rindels , Associated Press | Posted Sep 9th, 2014 @ 7:44pm

Split Monitor for Incident Management

Split Monitor

200 N. (Cedar City) @ 1400 W/I-15 SB - SIG#8223
 Tuesday, September 09, 2014 12:00 AM - Tuesday, September 09, 2014 11:59 PM

Phase 4 Revise Timing Plan for better % gap outs



Detour starts

Implement Timing Plans

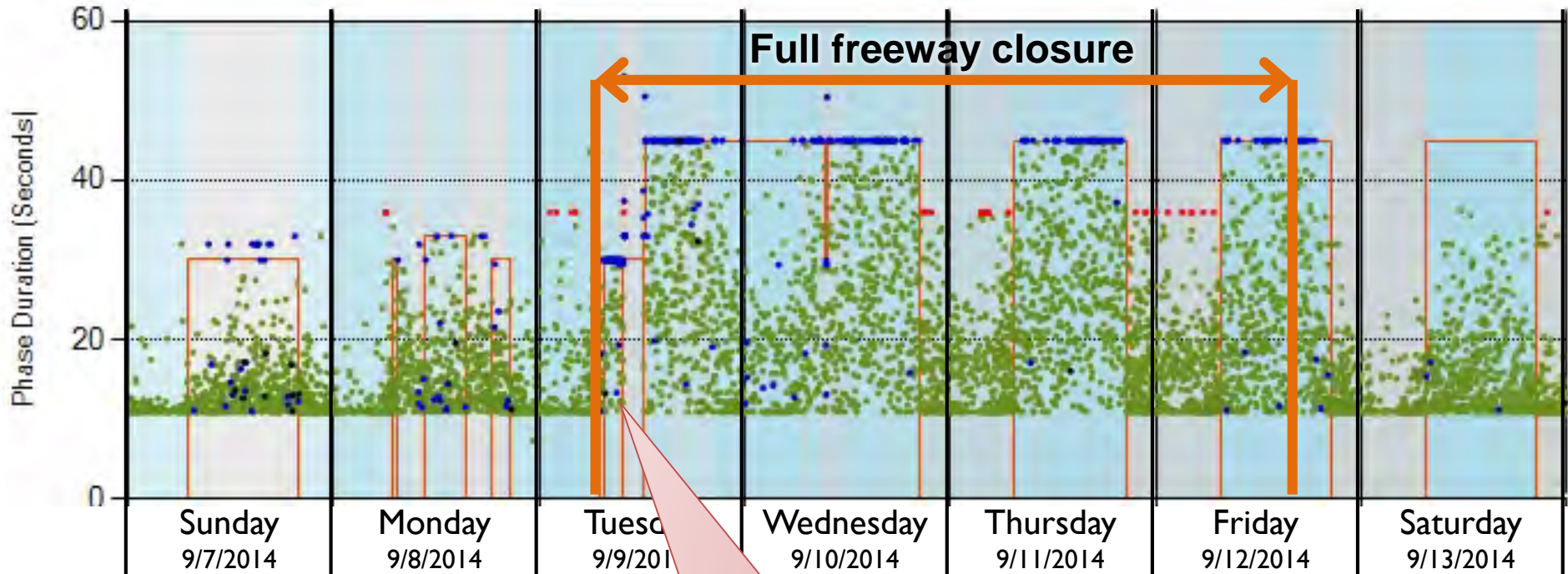
Split Monitor for Incident Management

Split Monitor

200 N. (Cedar City) @ 1400 W/I-15 SB - SIG#8223
 Sunday, September 07, 2014 12:00 AM - Saturday, September 13, 2014 11:59 PM

Phase 4

Fr... Plan 4 Free P... P... Free P... Plan 8 P... Plan 8 Free Plan 8 Free Plan 8 Free Plan 8 Free Plan 8 F...
 10... 92.2% 98.2% 91.9% 99.9% 98.5% 95.0% 87.0% Gap 84.8% 96.4% 90.3% 98.1% 93.1% 100.0% 99.4% 91.9%

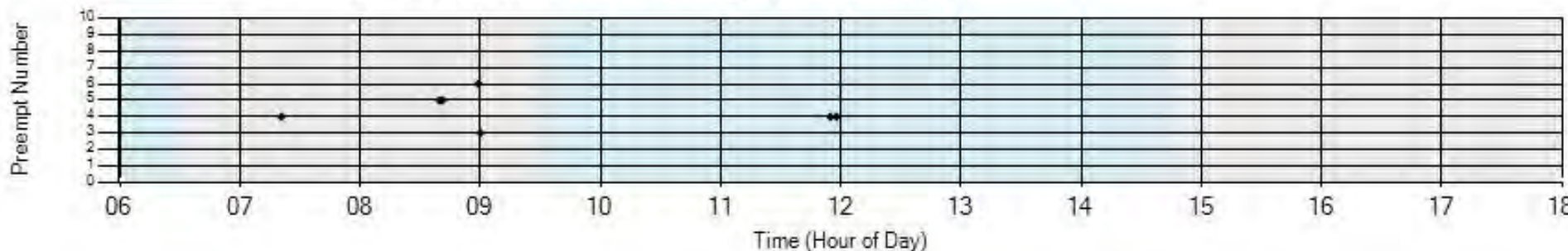


Implemented timing plans

Metric: Preemption Details

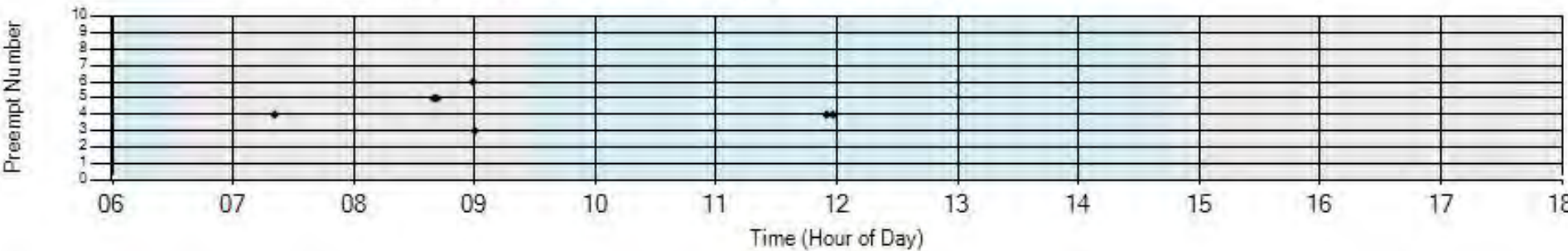
Preempt Service Request

State Street @ Center Street - SIG#6311
 Wednesday, April 05, 2017 6:00 AM - Wednesday, April 05, 2017 6:00 PM



Preempt Service

State Street @ Center Street - SIG#6311
 Wednesday, April 05, 2017 6:00 AM - Wednesday, April 05, 2017 6:00 PM



Metric: Preemption Details

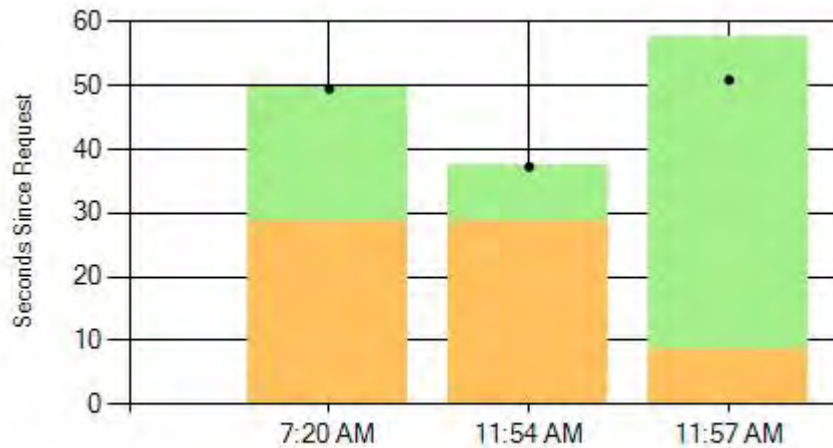
- ▲ Gate Down
- Input Off
- Input On
- * Call Max Out
- Dwell Time
- Track Clear
- Time to Service
- Delay

Emergency Vehicle

Preemption Details

State Street @ Center Street - SIG#6311
Wednesday, April 05, 2017 12:00 AM - Wednesday, April 05, 2017 11:59 PM

Preempt Number: 4

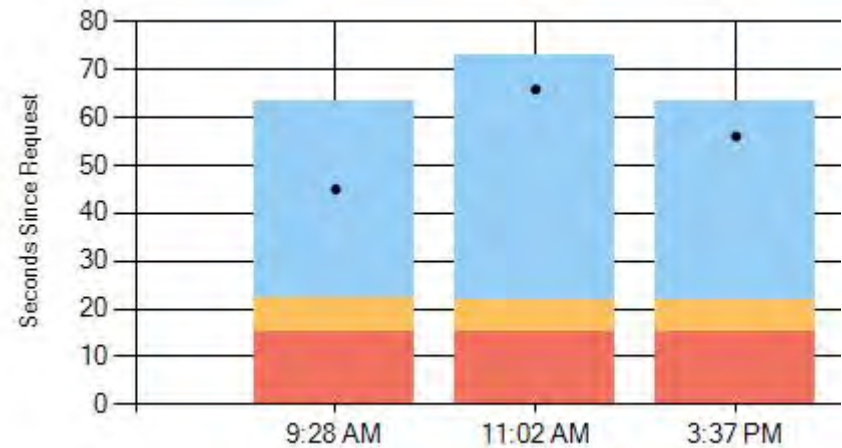


Railroad

Preemption Details

Geneva Rd. @ 200 S (Lindon) - SIG#6057
Thursday, May 18, 2017 12:00 AM - Thursday, May 18, 2017 11:59 PM

Preempt Number: 1

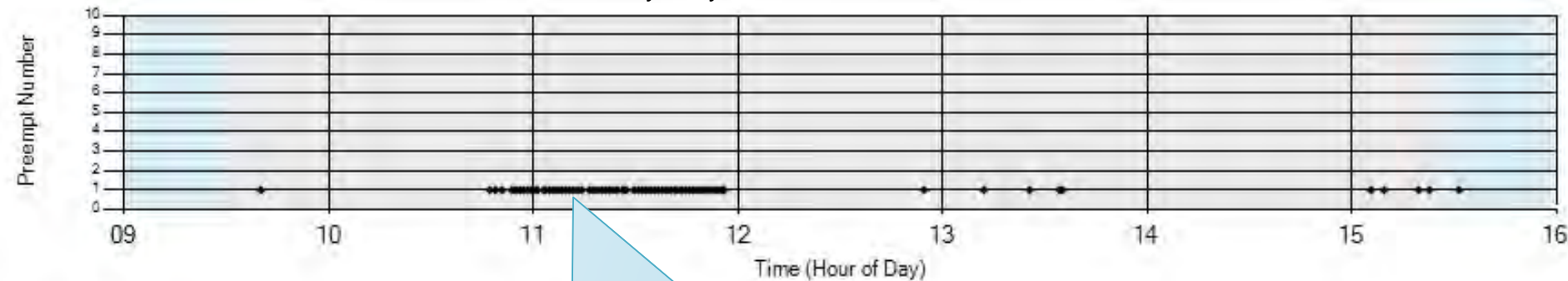


Case Study: Preemption



Case Study: Preemption

Preempt Service Chart
 SIG#6057 Geneva Rd & 200 S (Lindon)
 Wednesday, May 25, 2016, 9:00 AM to 4:00 PM

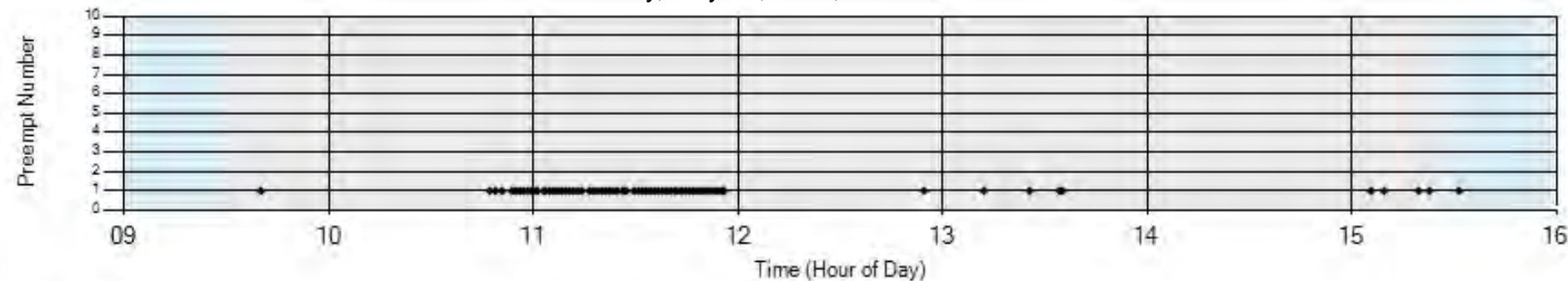


56 Preempt Requests & Services in **70** minutes
 Gate down **35%** of the time

Case Study: Preemption

Preempt Service Chart

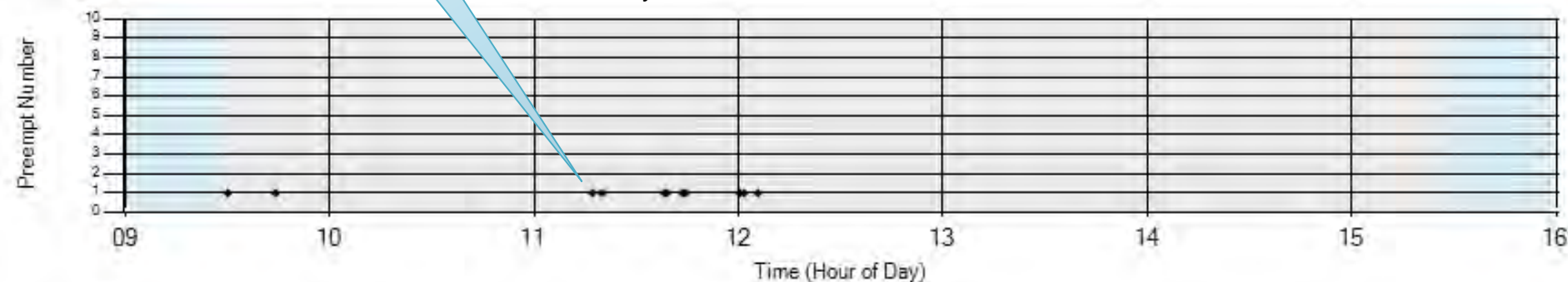
SIG#6057 Geneva Rd & 200 S (Lindon)
 Wednesday, May 25, 2016, 9:00 AM to 4:00 PM



Fixed!

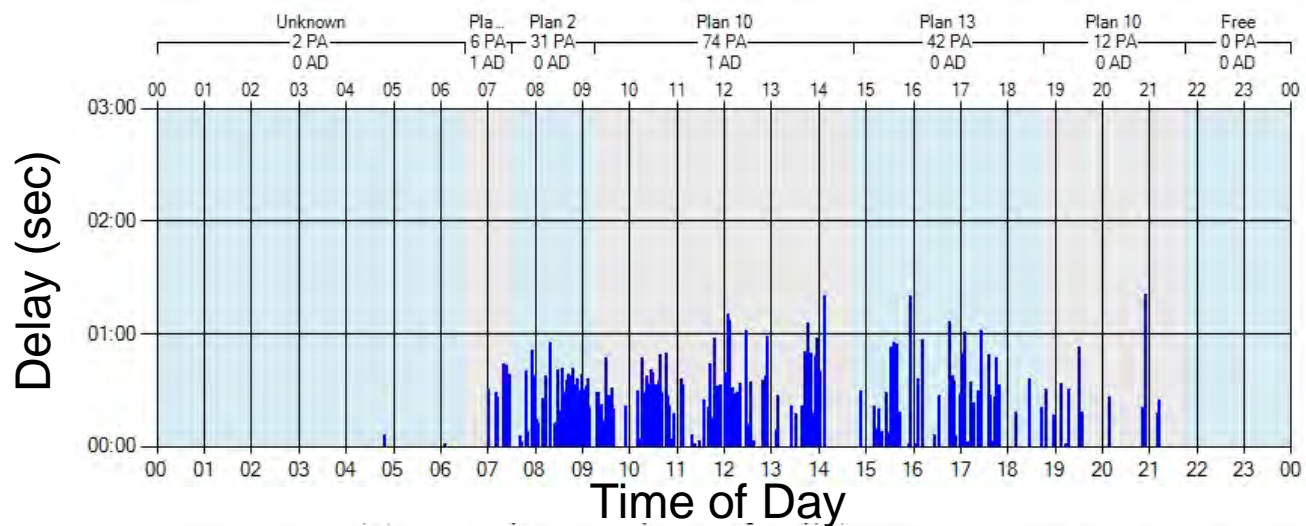
Preempt Service Chart

SIG#6057 Geneva Rd & 200 S (Lindon)
 Wednesday, June 22, 2016, 9:00 AM to 4:00 PM

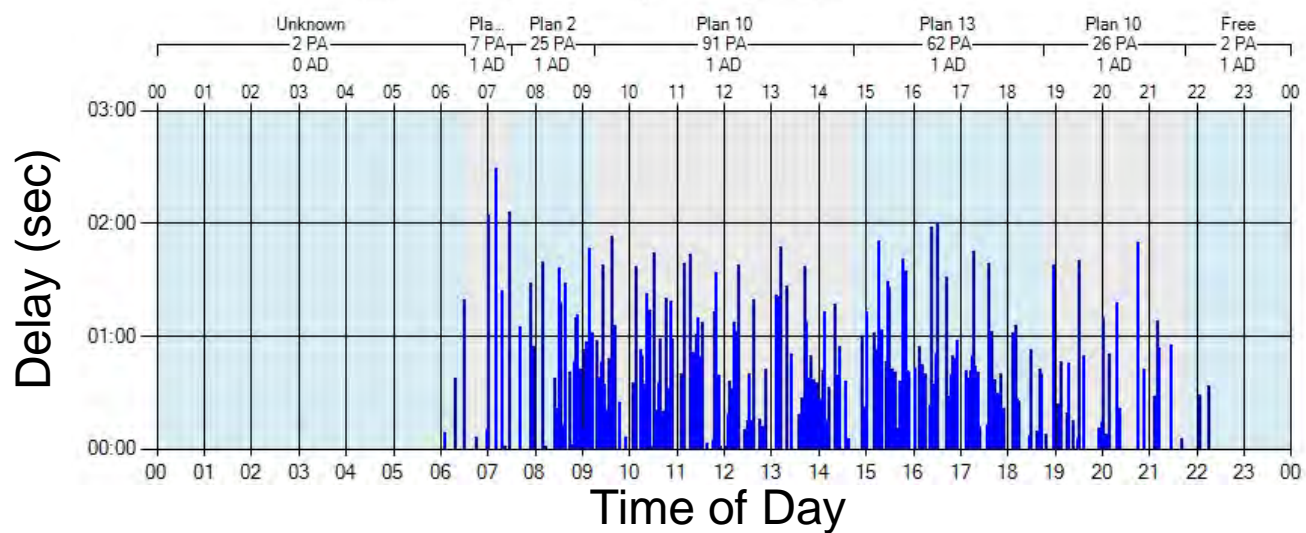


Metric: Pedestrian Delay

Pedestrian Delay
500 South Guardsman Way (1580 E.) Signal 7216
Tuesday, September 01, 2015 12:00 AM - Wednesday, September 02, 2015 12:00 AM
Phase 2
167-Ped Acutations(PA) 00:00-Min Delay 01:20-Max Delay 00:30-Average Delay(AD)

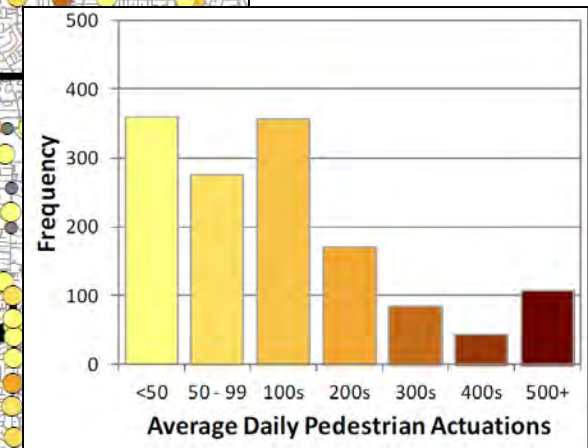
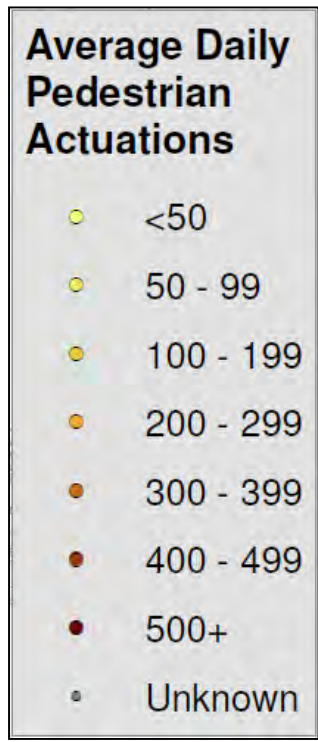
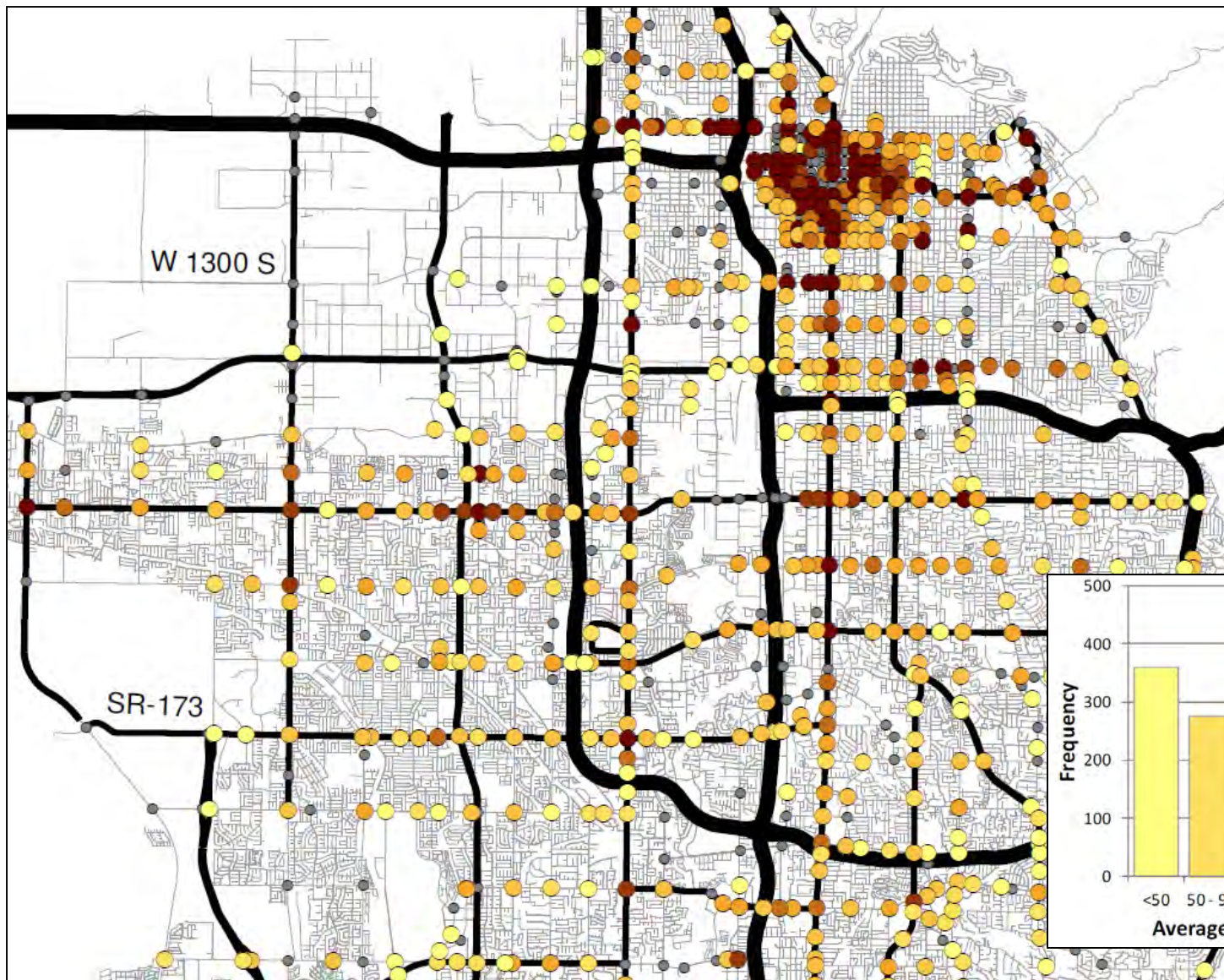


Phase 2
Coordinated phase



Phase 4
Side street

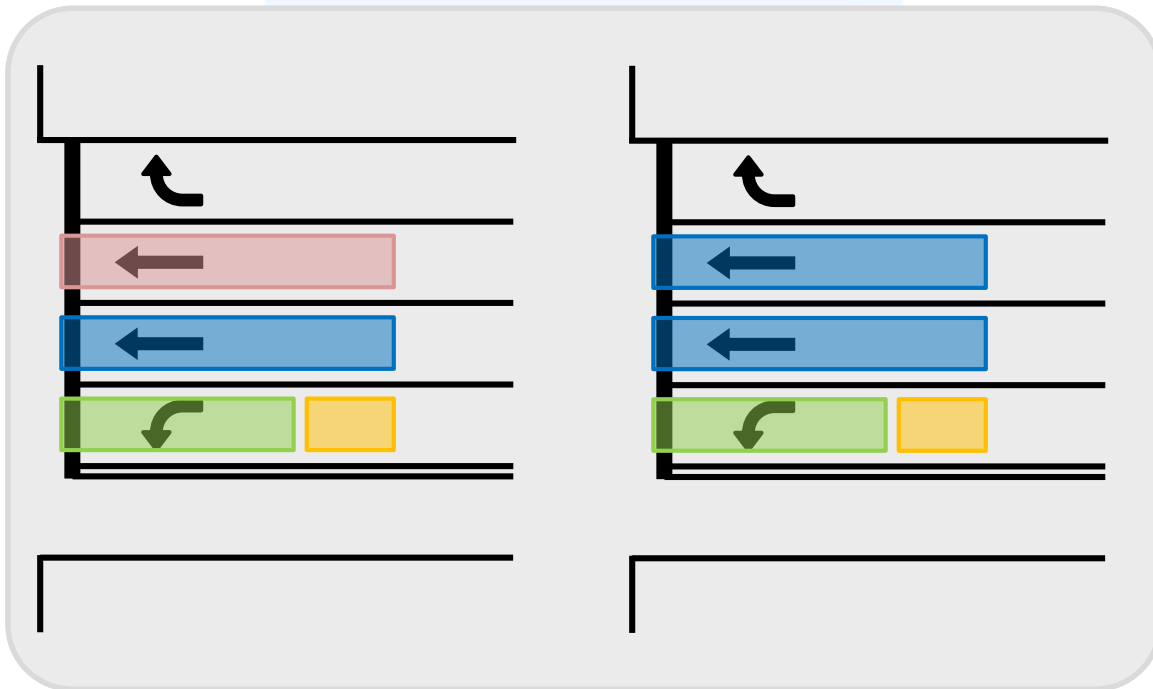
Active Transportation



Detection

Lane-by-lane Presence

Lane Group Presence



Available Metrics

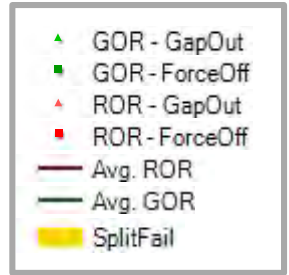
➤ Purdue Split Failure

Metric: Purdue Split Failure

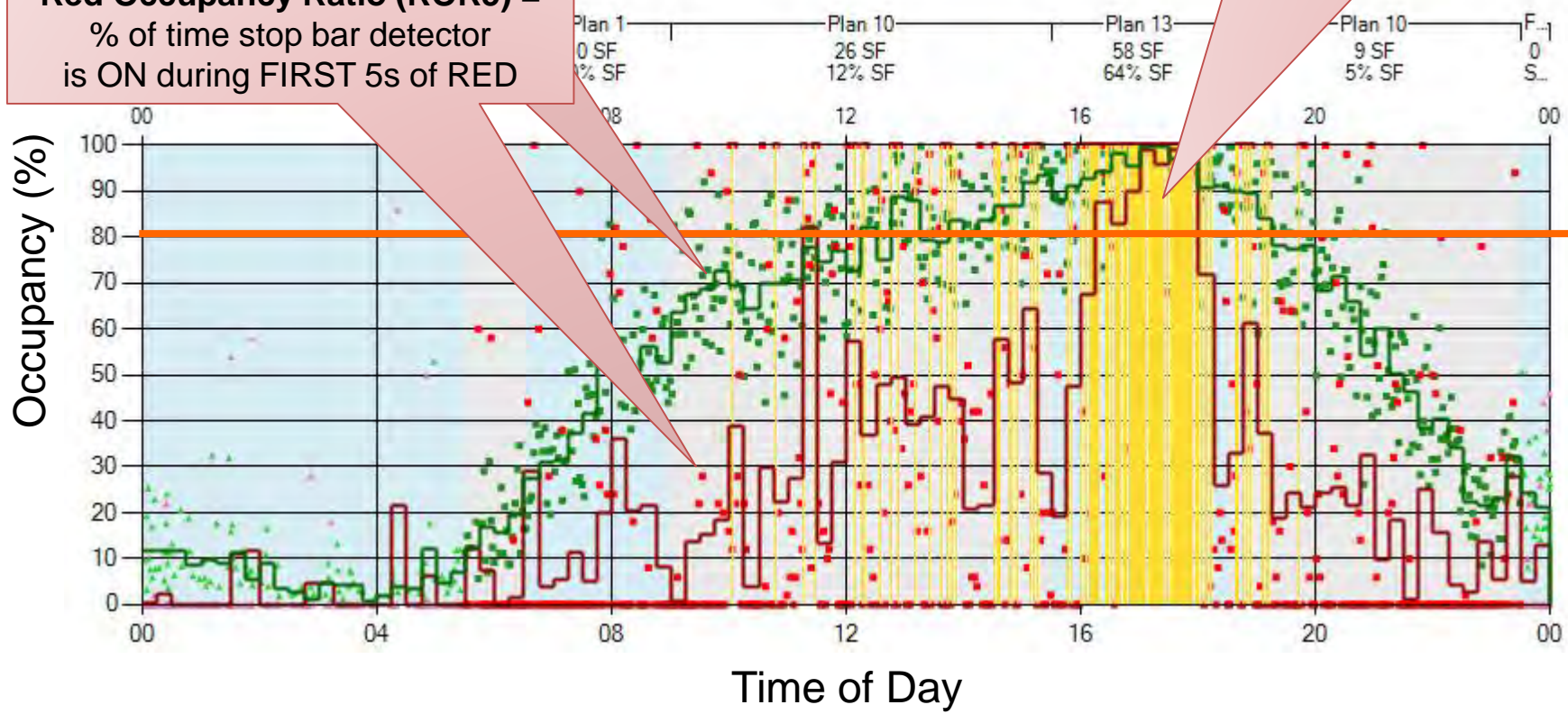
Green Occupancy Ratio (GOR) =
% of time stop bar detector
is ON during GREEN

Red Occupancy Ratio (ROR5) =
% of time stop bar detector
is ON during FIRST 5s of RED

Split Fail = GOR & ROR5 ≥ 80%



Purdue Split Failure
700 East @ 900 South - SIG#7184
Wednesday, April 27, 2016 12:00 AM - Thursday, April 28, 2016 12:00 AM
Protected Phase 6: Southbound Thru
Total Split Failures = 93



Future Metric: Purdue Split Fail Ticker

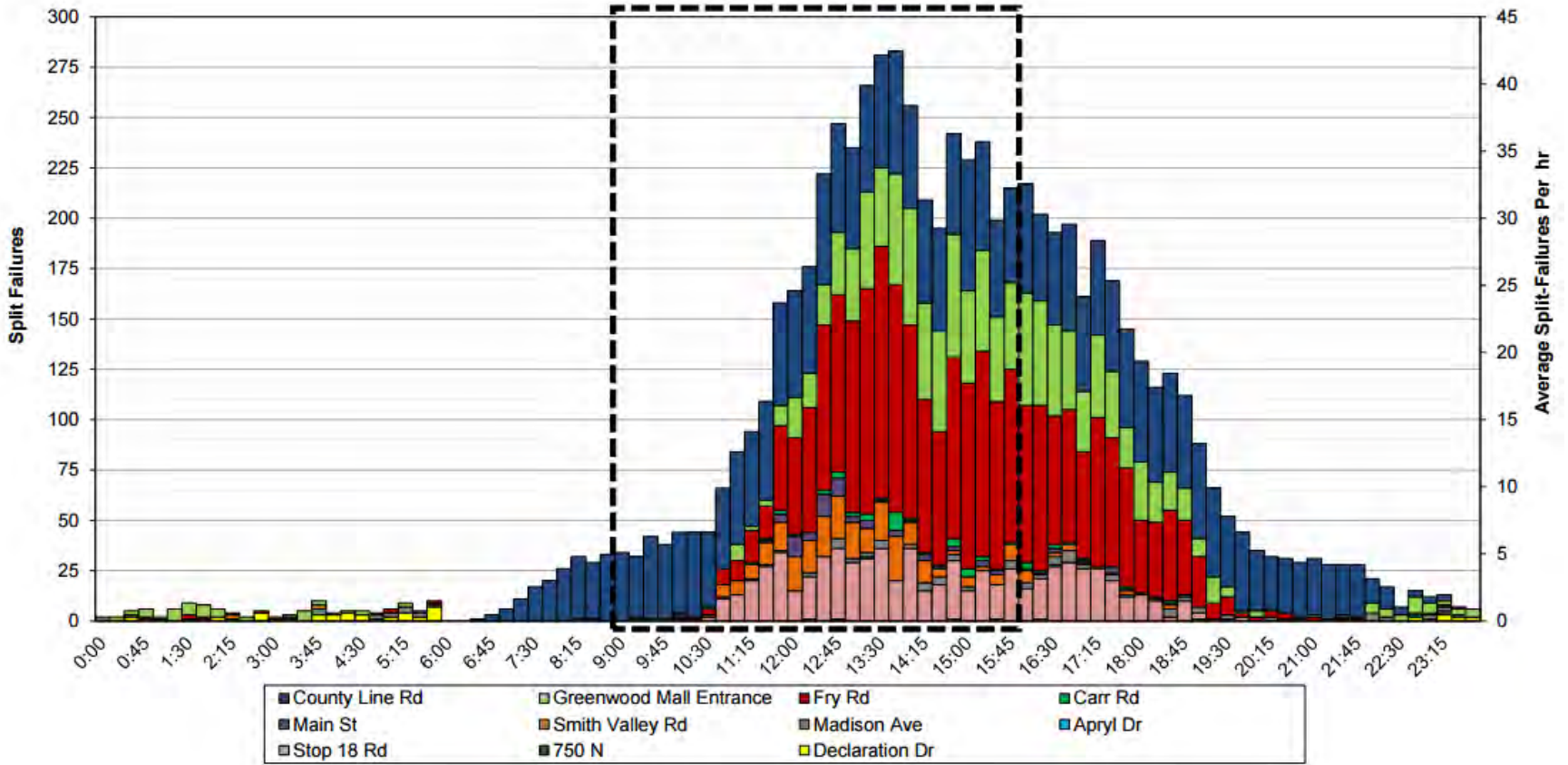


Figure 9. Aggregated split-failures over 24 hours on US-31 Greenwood for all Saturdays from January 1 to June 30, 2015.

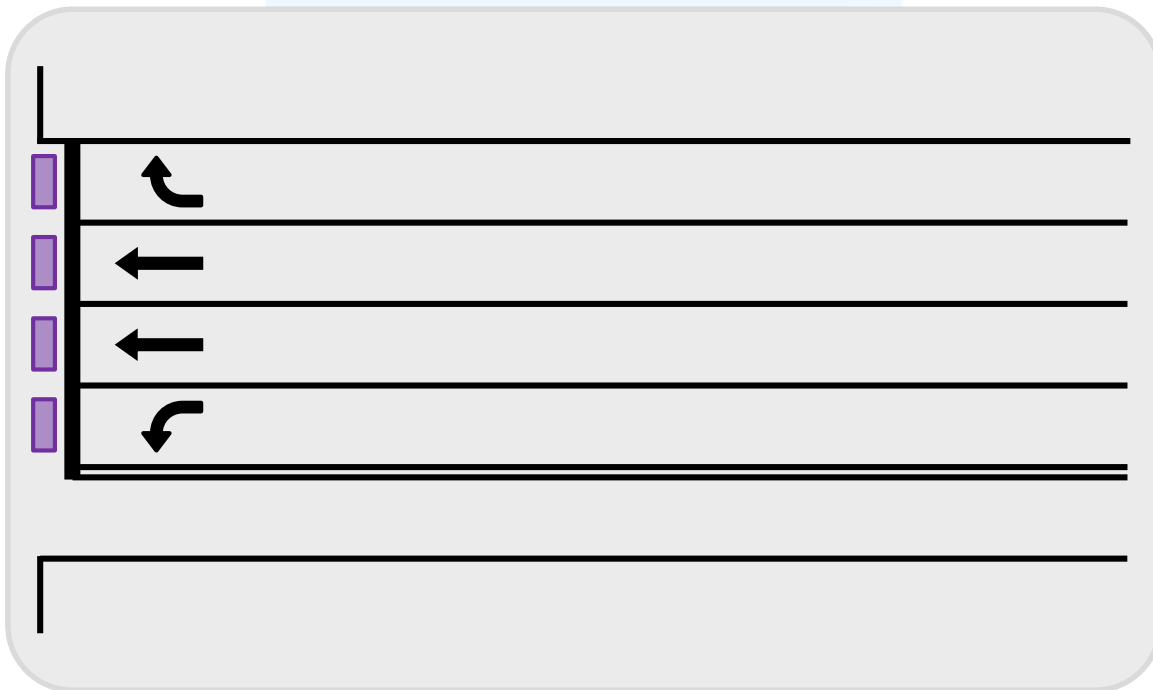
Source: Scaling detailed high-resolution data split performance measures to statewide system level management (Paper No. 16-4149).

Detection

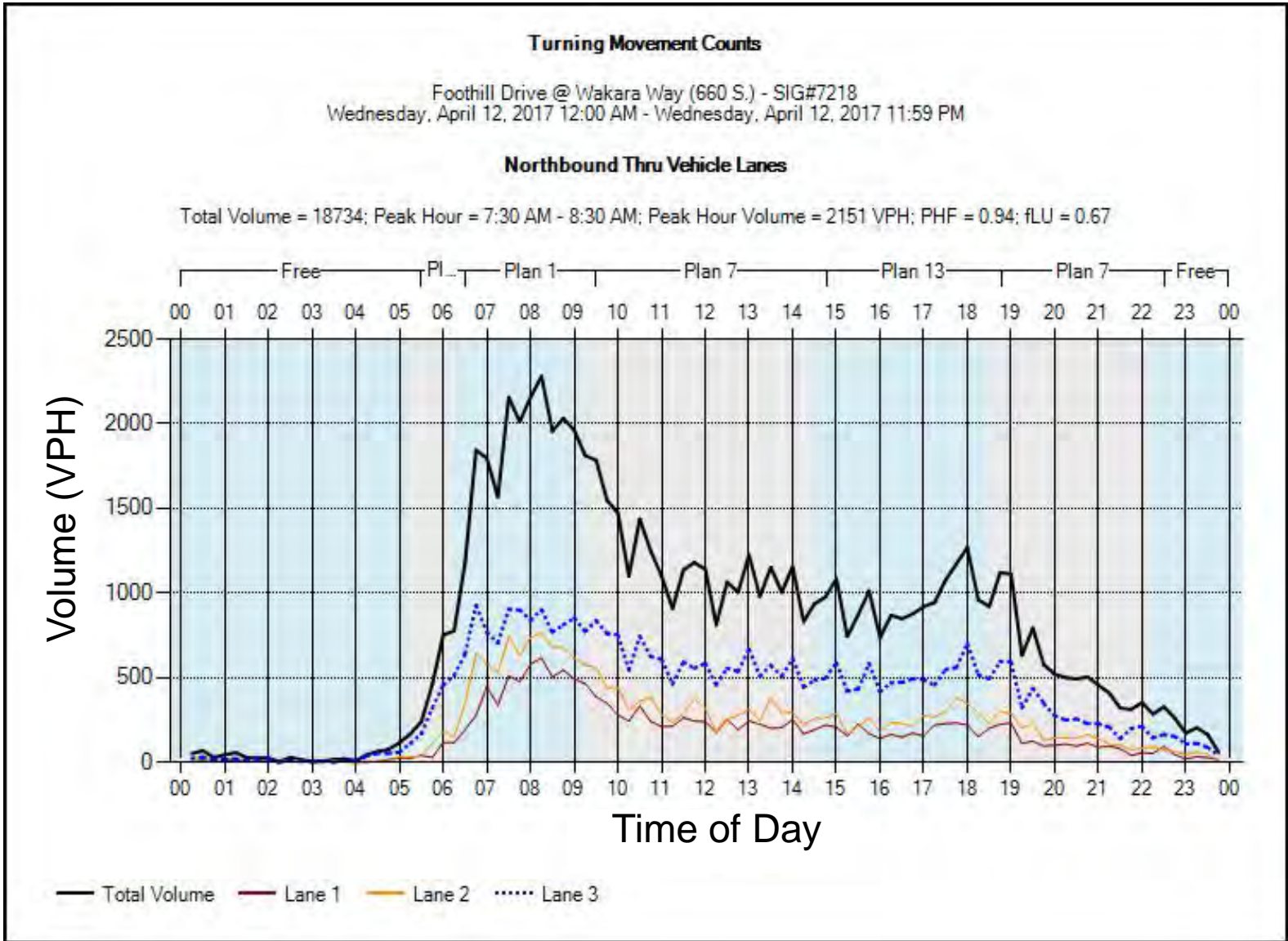
Lane-by-lane Count

Available Metrics

➤ Turning Movement Counts



Metric: Turning Movement Counts



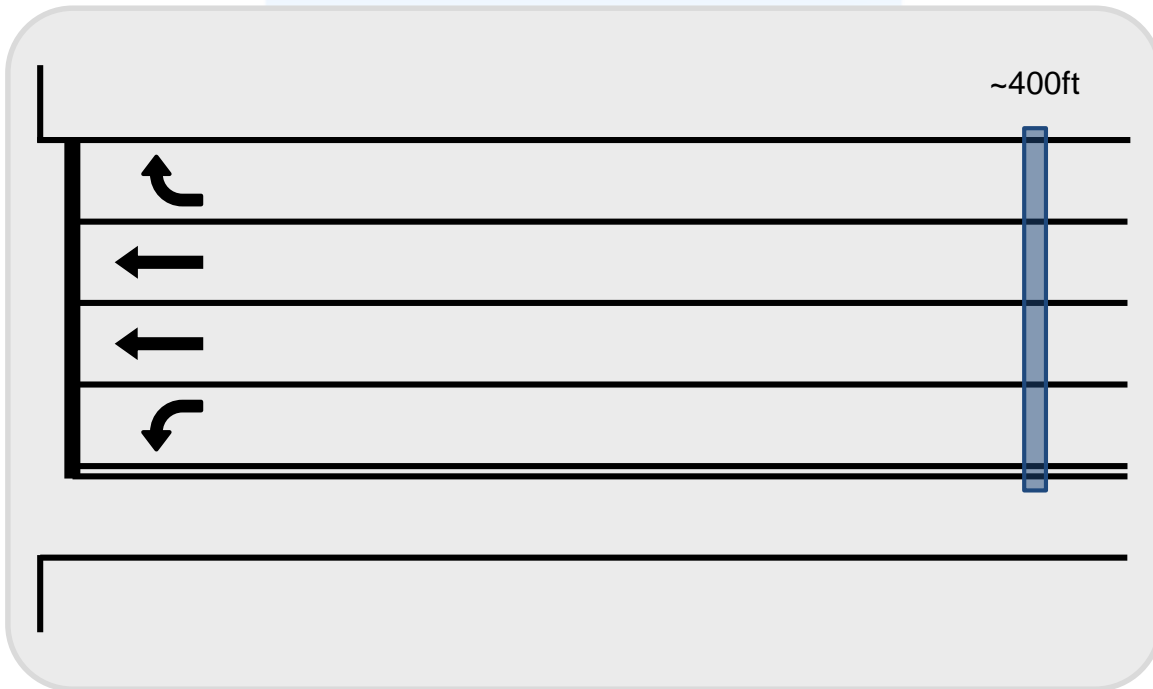
TMC Data Table

	Vehicle															Vehicle Total
	Eastbound			Westbound			Northbound				Southbound					
	L	R	Total	L	R	Total	L	T	R	Total	L	T	R	Total		
4:00 PM	18	29	47	202	181	383	2	217	50	269	51	468	9	528	1227	
4:15 PM	7	35	42	188	186	374	4	212	40	256	59	415	4	478	1150	
4:30 PM	13	37	50	206	165	371	9	219	36	264	67	479	6	552	1237	
4:45 PM	10	20	30	202	188	390	7	230	36	273	64	483	7	554	1247	
5:00 PM	7	17	24	214	192	406	4	236	42	282	53	423	4	480	1192	
5:15 PM	5	19	24	187	163	350	5	269	44	318	46	478	10	534	1226	
5:30 PM	7	21	28	163	149	312	7	293	40	340	49	415	9	473	1153	
5:45 PM	9	11	20	122	124	246	5	317	45	367	51	382	4	437	1070	
Total	76	189	265	1484	1348	2832	43	1993	333	2369	440	3543	53	4036	9502	

	Peak Hour (PHF = 0.98)															Vehicle Total
	Eastbound			Westbound			Northbound				Southbound					
	L	R	Total	L	R	Total	L	T	R	Total	L	T	R	Total		
4:30 PM - 5:30 PM	35	93	128	809	708	1517	25	954	158	1137	230	1863	27	2120	4902	

Detection

Setback Count Zones

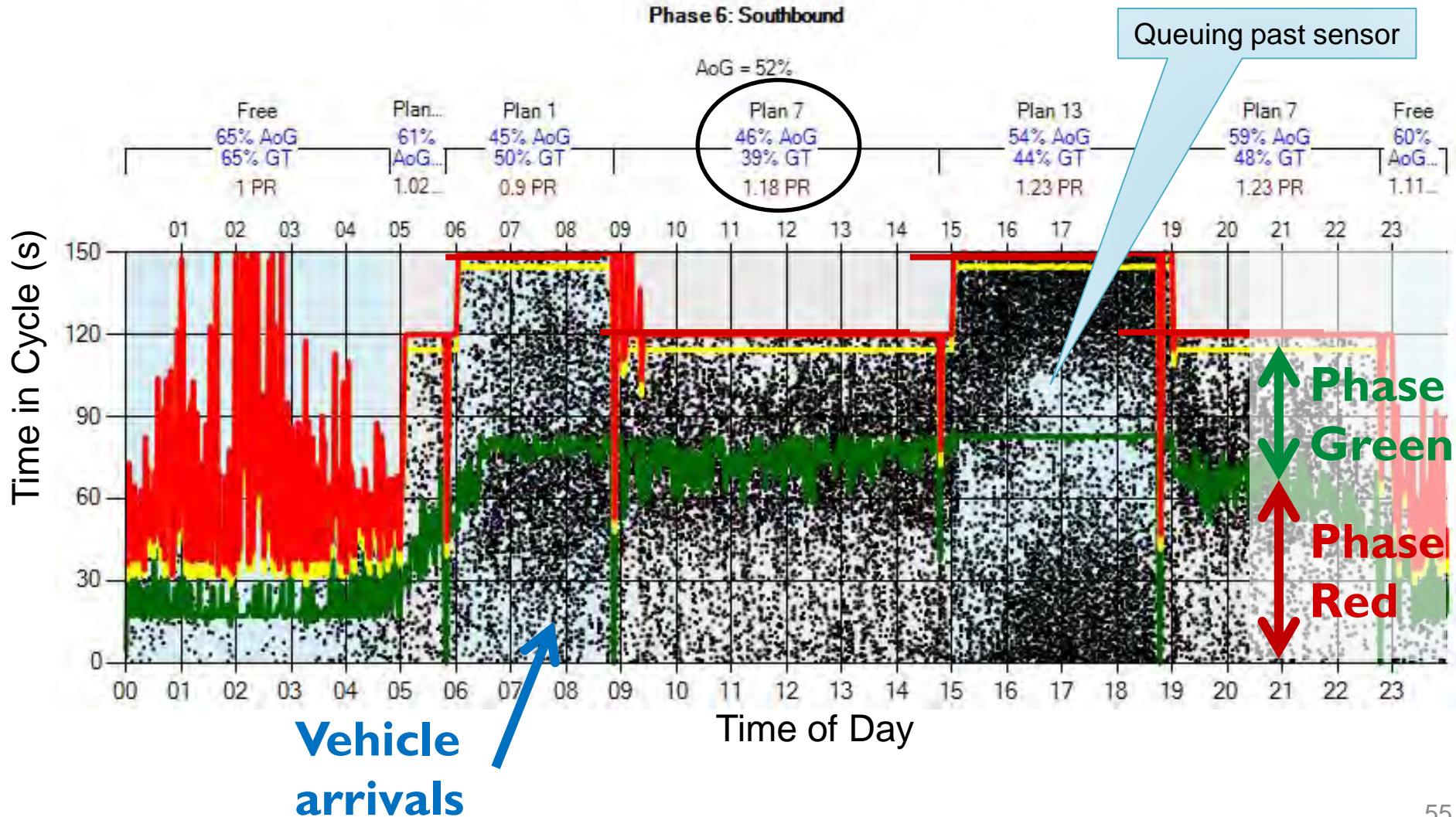


Available Metrics

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

Metric: Purdue Coordination Diagram

Bangerter Hwy (SR-154) @ 9000 South - SIG#7067
 Tuesday, January 17, 2017 12:00 AM - Tuesday, January 17, 2017 11:59 PM
 Advanced detector located 377 ft. upstream of stop bar

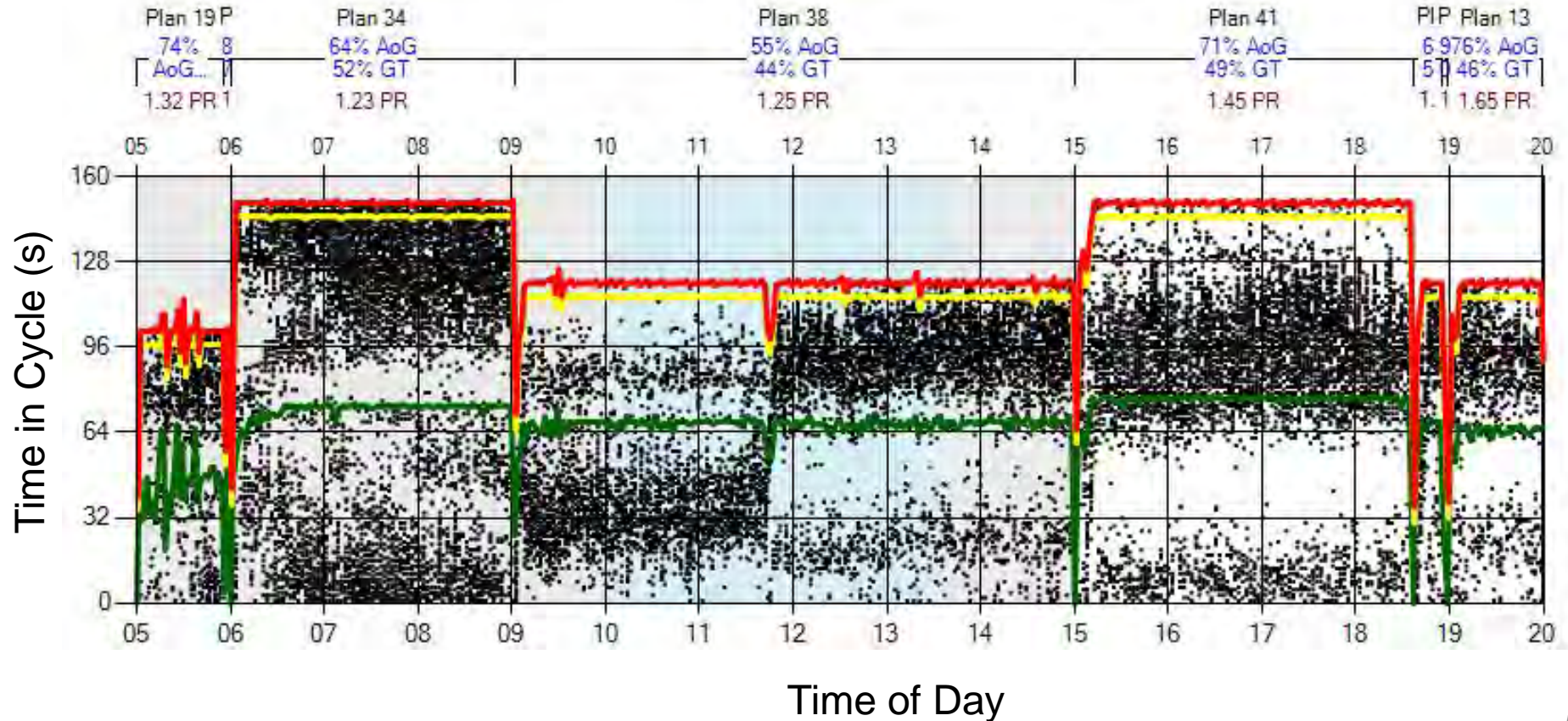


Purdue Coordination Diagram: Progression Quality

Bangerter Hwy (SR-154) @ 5400 South (SR-173) - SIG#7063
 Thursday, March 07, 2013 5:00 AM - Thursday, March 07, 2013 8:00 PM
 Advanced detector located 350 ft. upstream of stop bar

Phase 10: Northbound

AoG = 63%



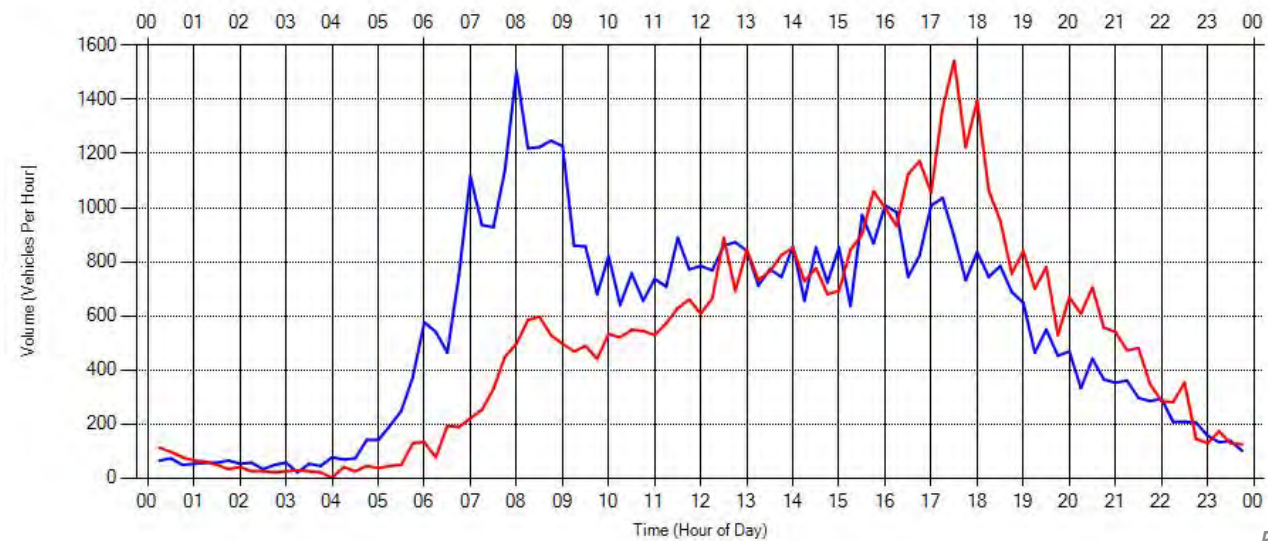
Metric: Approach Volume

Northbound
Southbound

Approach Volume
University Avenue @ East Bay Boulevard - SIG#6402
Wednesday, May 17, 2017 12:00 AM - Wednesday, May 17, 2017 11:59 PM
Northbound and Southbound Approaches
Wavetronix Matrix at stop bar



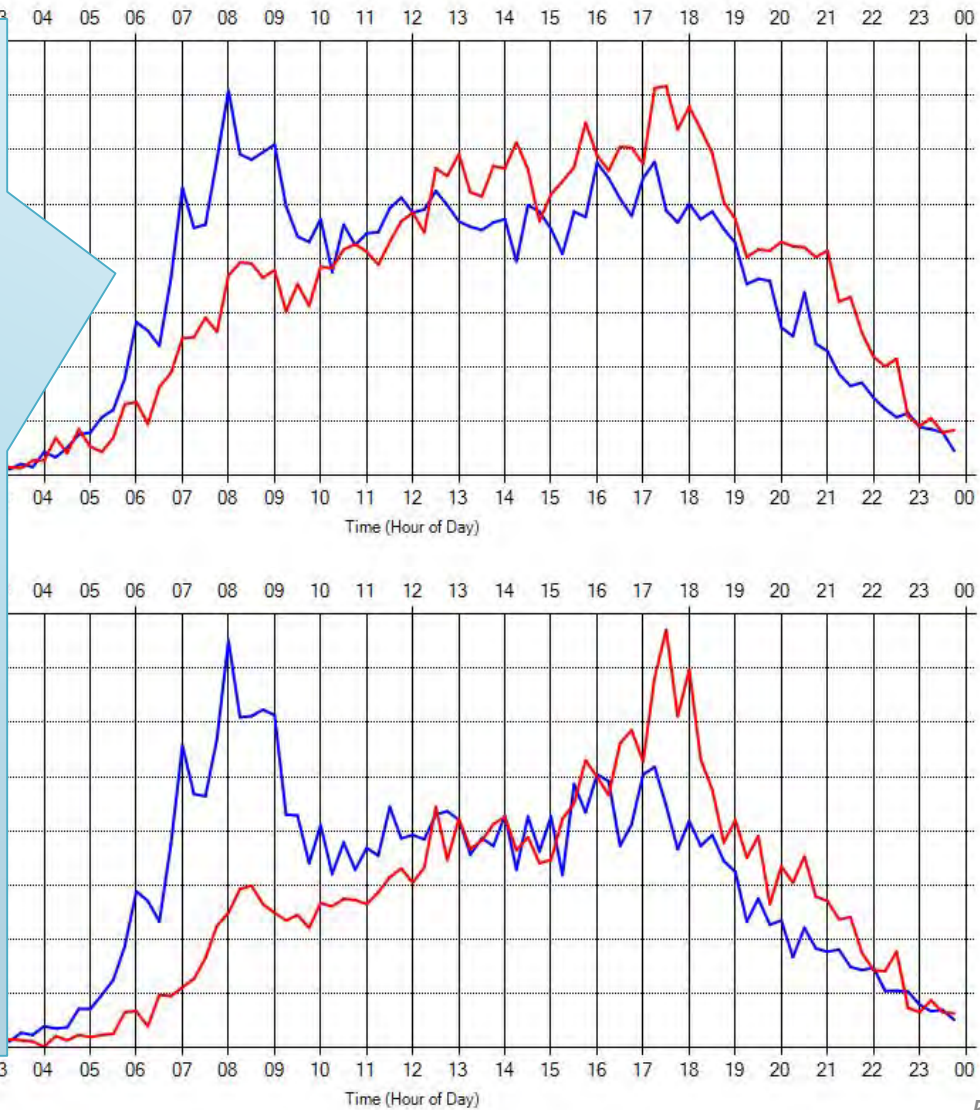
Approach Volume
University Avenue @ East Bay Boulevard - SIG#6402
Wednesday, May 17, 2017 12:00 AM - Wednesday, May 17, 2017 11:59 PM
Northbound and Southbound Approaches
Wavetronix Advance located 400ft. upstream of the stop bar



Metric: Approach Volume

— Northbound
— Southbound

Metric	Value
Peak Hour	5/17/2017 5:15:00 PM
Peak Hour Factor	0.364
Peak Hour Volume	9028
Peak Hour Factor	0.927
Total Volume	24827
-	-
Northbound Peak Hour	8:00 AM - 9:00 AM
Northbound Peak Hour D Value	0.424
Northbound Peak Hour K Value	0.394
Northbound Peak Hour Volume	5196
Northbound Peak Hour Factor	0.864
Northbound Total Volume	13204
-	-
Southbound Peak Hour	5:15 PM - 6:15 PM
Southbound Peak Hour D Value	0.632
Southbound Peak Hour K Value	0.476
Southbound Peak Hour Volume	5532
Southbound Peak Hour Factor	0.896
Southbound Total Volume	11623



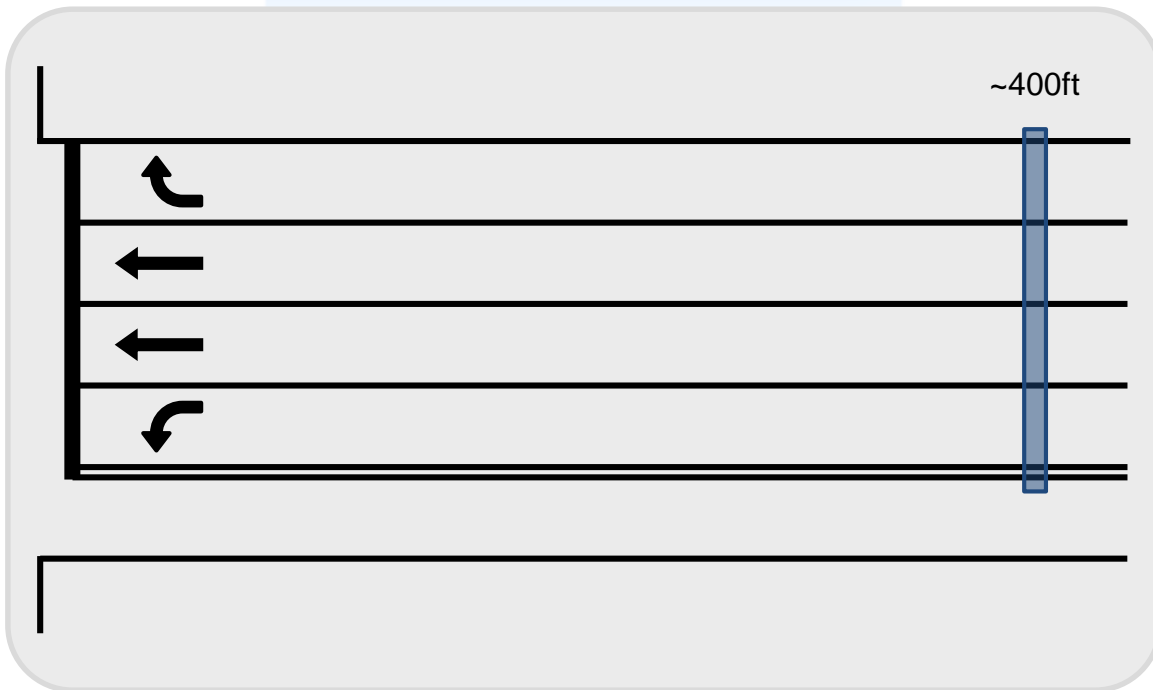
Allow Lane Closures

Volume report for University Avenue East Bay Boulevard on the Northbound and Southbound approaches.
7/7/2016 12:00:00 AM - 7/7/2016 11:59:00 PM - Using Advanced Detection



Detection

Setback Count Zones
with speed



Available Metrics

➤ Approach Speed

Metric: Approach Speed

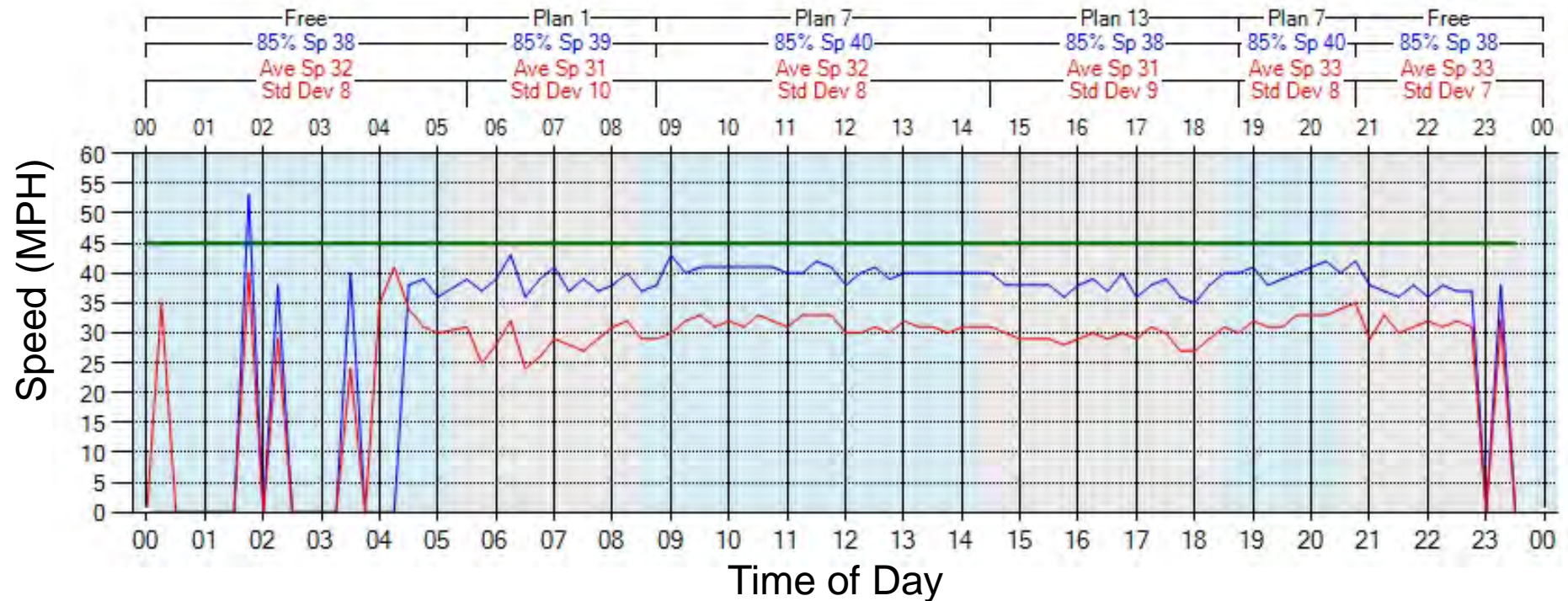
Approach Speed

SR-126 (1900 W) @ 5700 South (Roy) - SIG#5088
 Wednesday, September 30, 2015 12:00 AM - Wednesday, September 30, 2015 11:59

- Posted Speed
- 85th Percentile Speed
- Average MPH

Phase 6: Southbound

Detection Type: Unknown; Speed Accuracy +/- 2 mph
 Detector Distance from Stop Bar: 350 feet;
 Includes records over 5mph that occur between 15s after start of green to start of yellow.



Metric: Approach Speed

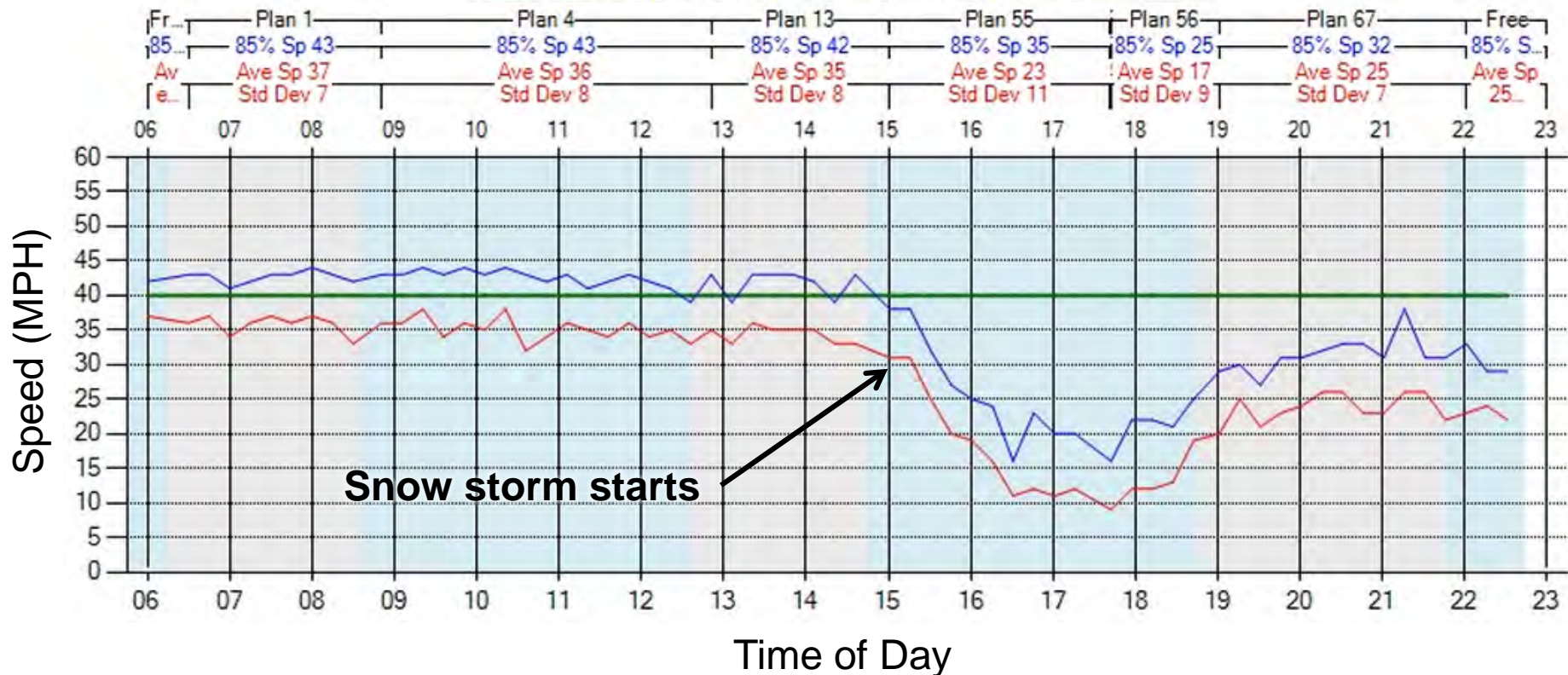
Approach Speed

Riverdale Rd @ Shopko - SIG#5008
Thursday, January 10, 2013 12:00 AM - Thursday, January 10, 2013 11:59 PM

- Posted Speed
- 85th Percentile Speed
- Average MPH

Phase 2: Northbound

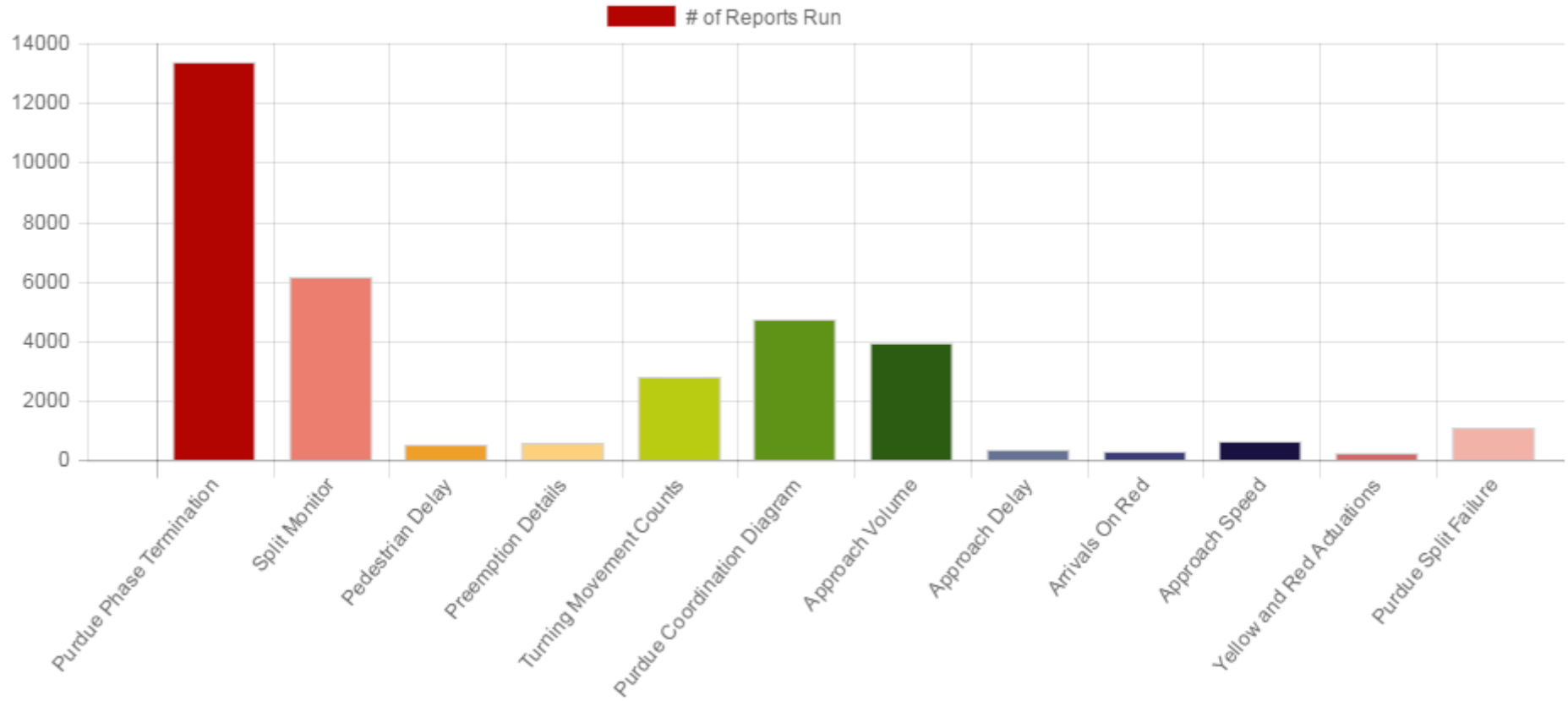
Detection Type: Wavetronix Advance; Speed Accuracy +/- 2 mph
Detector Distance from Stop Bar: 285 feet;
Includes records over 5mph that occur between 15s after start of green to start of yellow.



Metric Usage

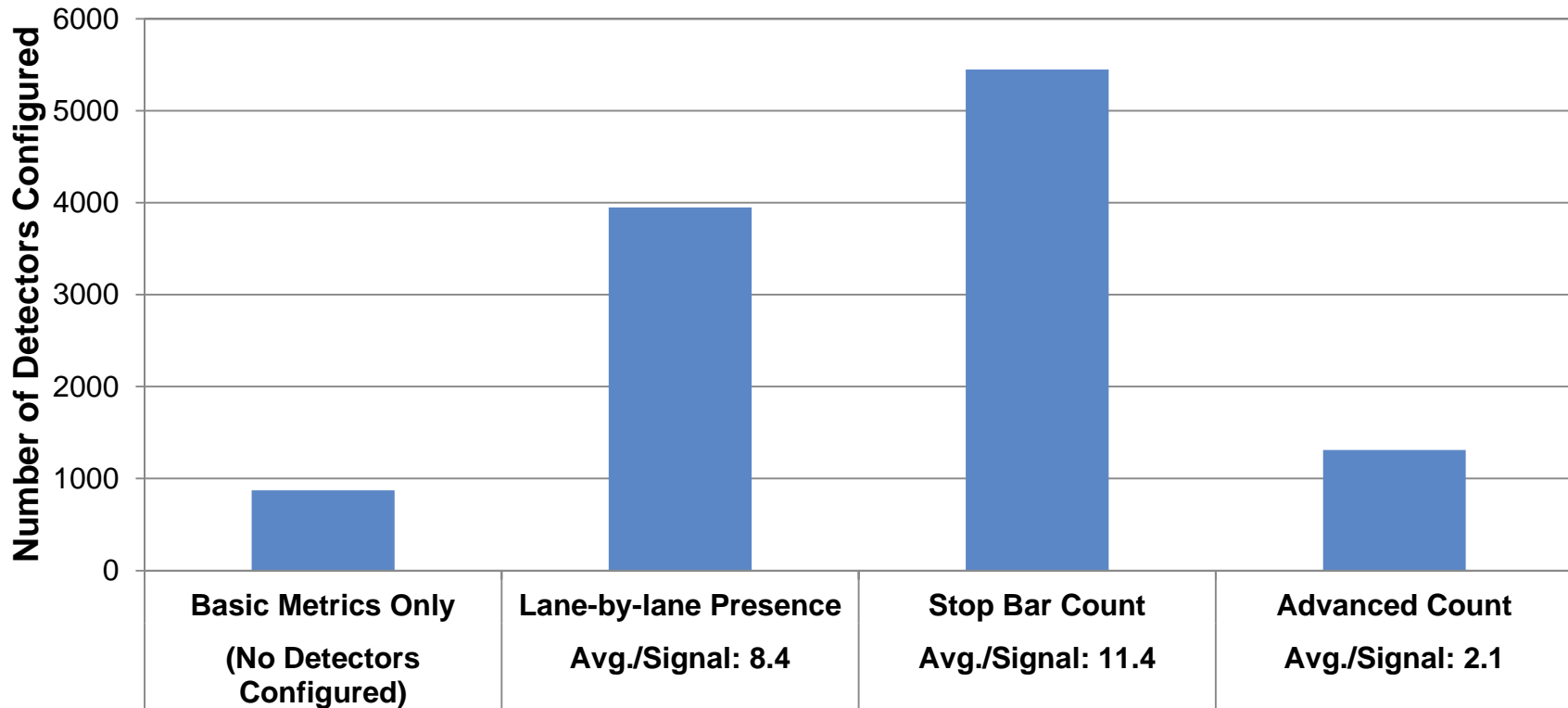
Metrics Run
1/1/2017 – 5/21/2017

Collected by automatic logger



UDOT ATSPM Configuration Records

Detector Count by Metric



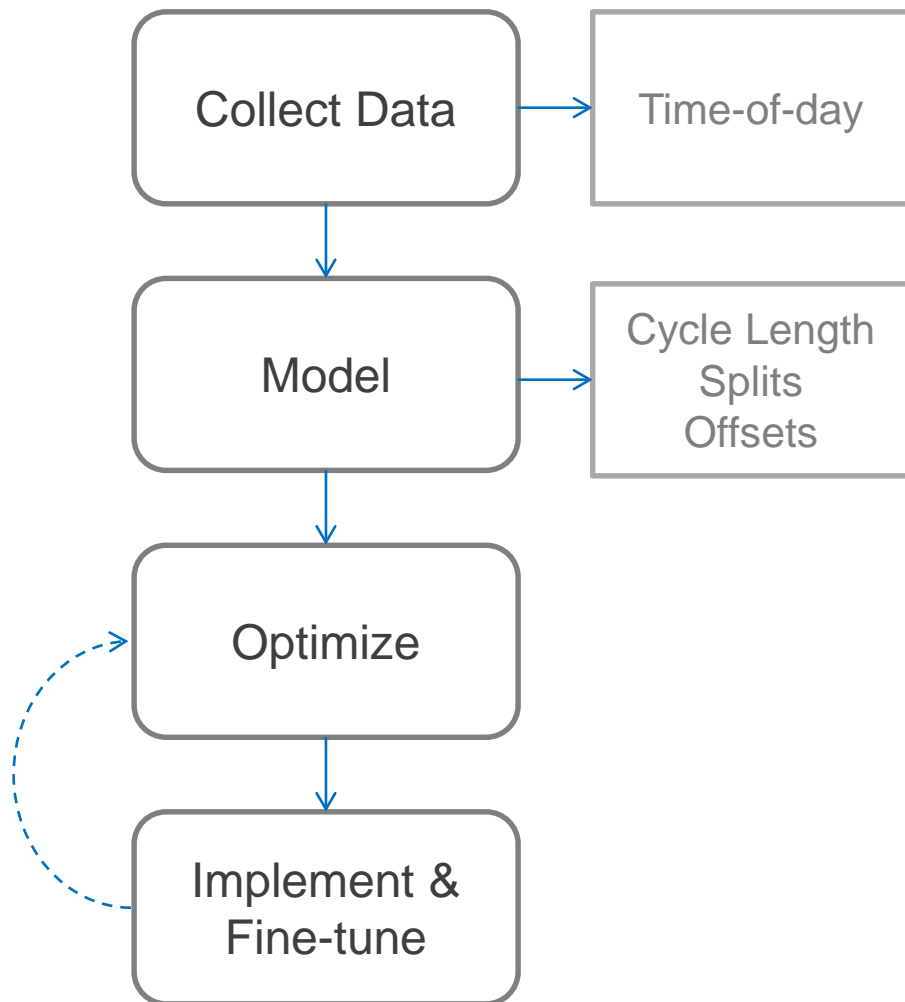
Total: 10,700 detectors + 1785 signals

SIGNAL OPTIMIZATION

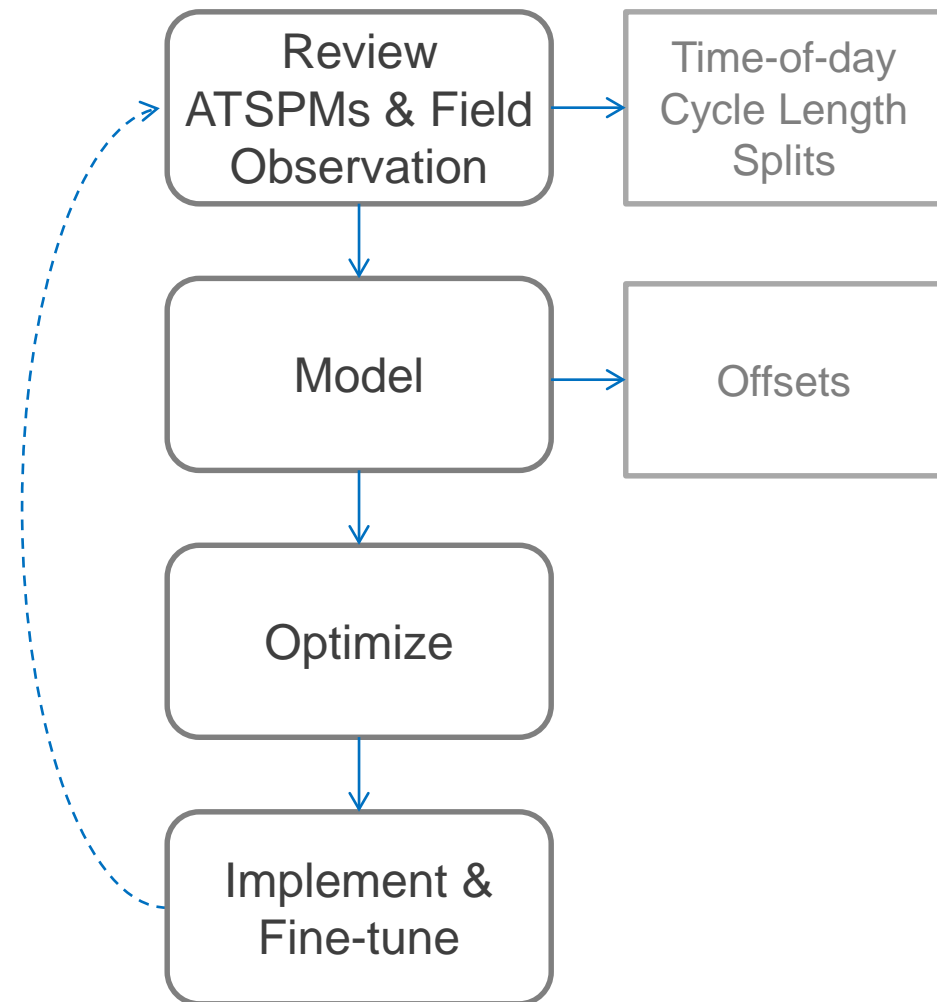
UDOT Automated Traffic Signal Performance Measures

Optimization with ATSPMs

Traditional Process

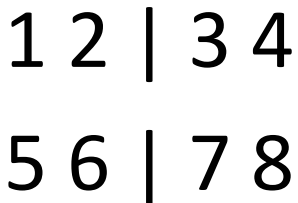


Modified Process with SPMs

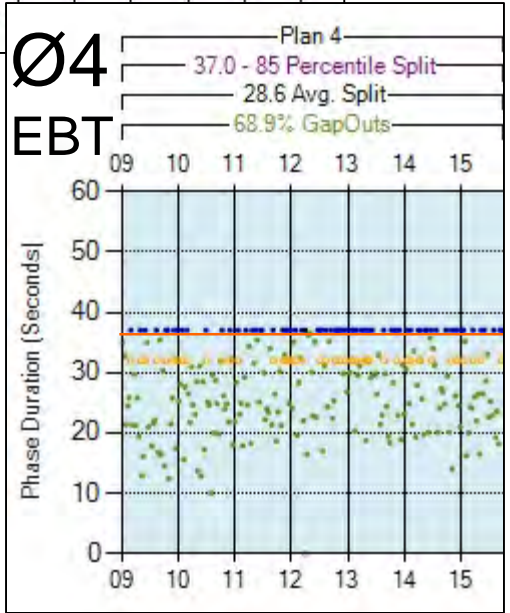
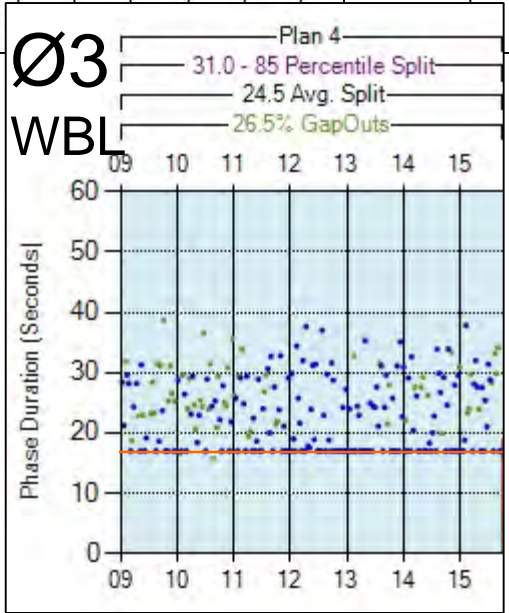
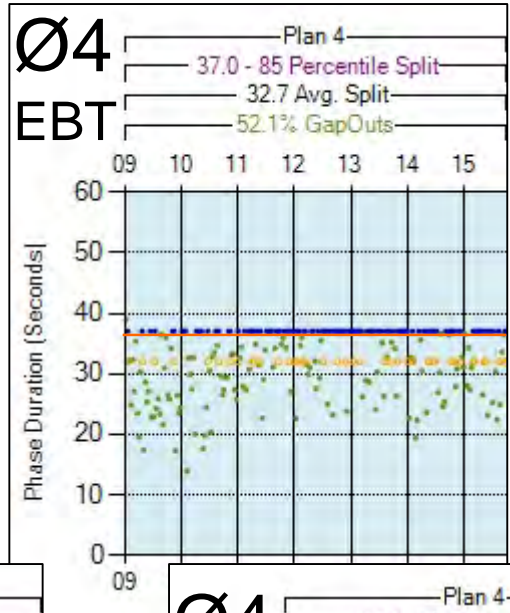
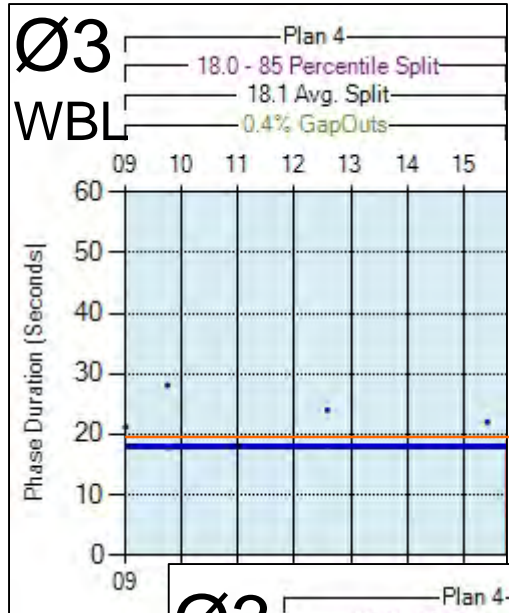
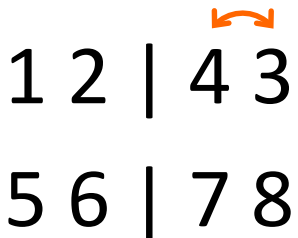


Evaluate Impact of Timing Change

- Before:

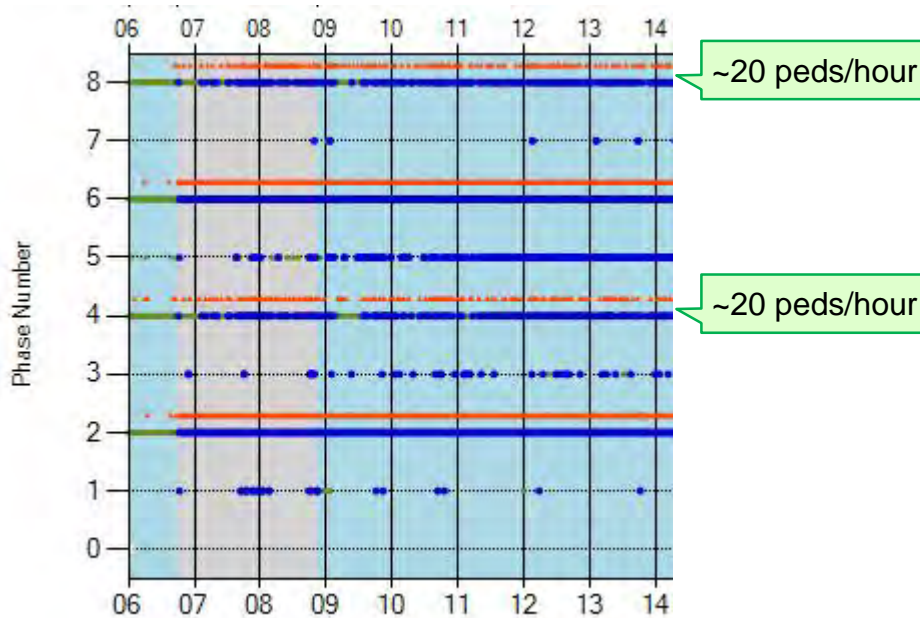


- After:

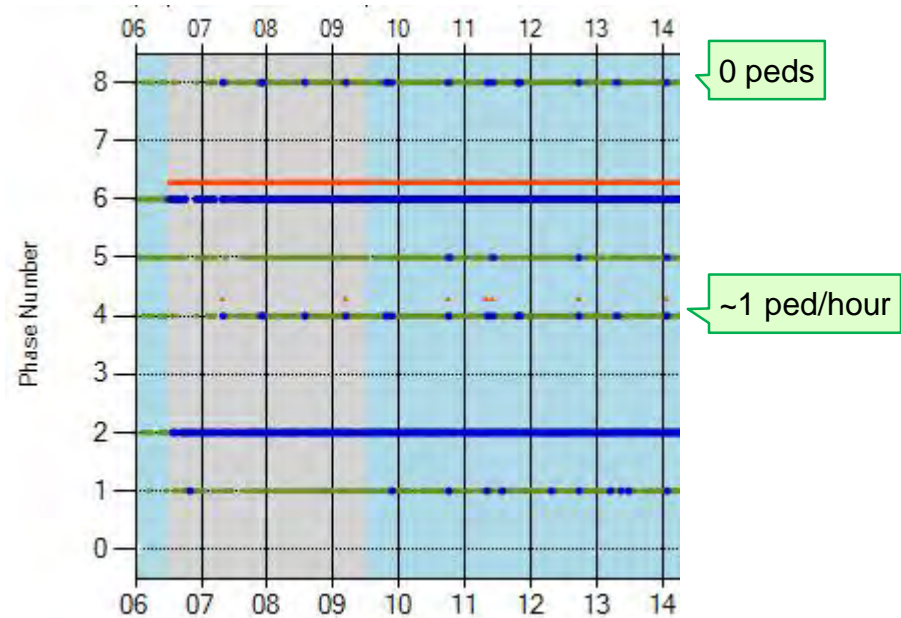


“Can we oversize the peds?”

Peds for Phases 4 & 8 are called **frequently**
Recommendation: Do not oversize peds



Peds for Phases 4 & 8 are **rarely** called
Recommendation: Oversize peds, if needed



- Gap out
- Pedestrian activation (shown above phase line)
- Max out
- Force off
- Skip

SYSTEM HEALTH ALERTS

UDOT Automated Traffic Signal Performance Measures

System Health Alerts

1

No SPM data: identifies signals with less than 500 records in the database between midnight and midnight the previous day

2

Too many max outs: identifies phases with more than 90% max outs in at least 50 activations between 1 a.m. and 5 a.m.

3

Too many force offs: identifies phases with more than 90% force offs in at least 50 activations between 1 a.m. and 5 a.m.

4

Too many ped calls: identifies phases with more than 200 pedestrian activations between 1 a.m. and 5 a.m.

5

Low PCD detector count: identifies phases with PCD detectors that have less than 100 vehicles counted between 5 p.m. and 6 p.m. the previous day.

SPMWatchdog@utah.gov

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

--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 SPUI - Phase: 6 (Stuck Ped)
7826 - 9800 S (Little Cottonwood Rd) & Wasatch Blvd (3500 E) - Phase: 4 (Stuck Ped)

Alert Evaluation

1 No ATSPM data

- Check communication to signal
- Check controller clock
- Check IP address in SPM configuration
- Check VIOT = NO & DB State = All Saved (Econolite MM 9-3-1 SpFn*3)
- Try enabling Upload Current
- Create a WO to cold start the controller

2 Too many max outs

- Check for recalls
- Check for constant call on a detector channel
- Consider whether a bandaid is necessary

3 Too many force offs

- Should the signal be in coordination?
- Is a non-coordinated phase maxing out?
- Skip only 2-6 pairs and dummy phases

4 Too many ped calls

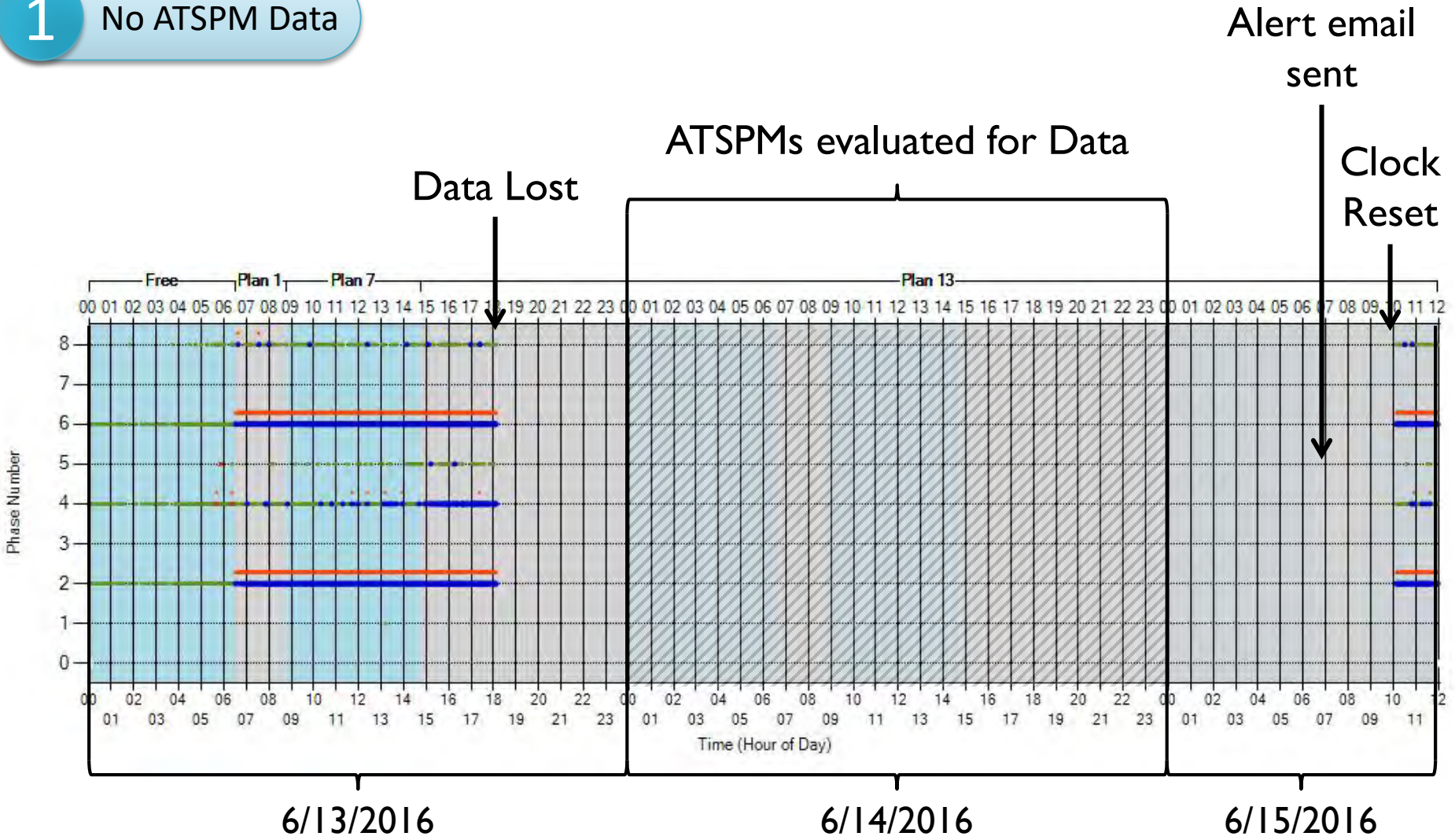
- Check for recalls
- Check for constant call on a detector channel

5 Low PCD detector count

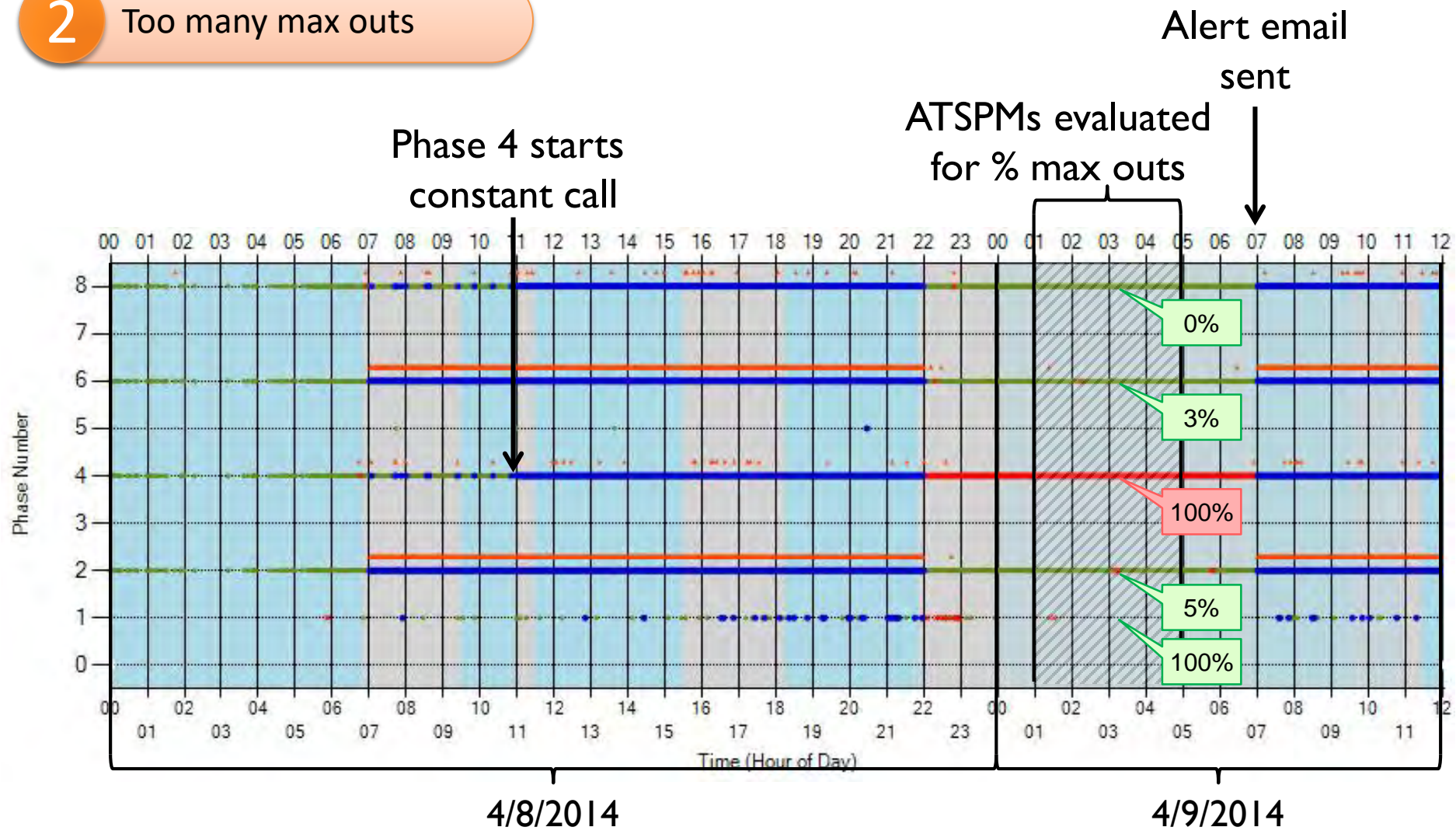
- Note: Evaluate the VOLUME on the PCD charts, not the phase data*
- Is count channel configured correctly in SPM Config Tool?
- Is ECPI Log enabled for count channel?
- Is the detector working?
- Is the detector communicating to the controller?
- Try resetting the sensor and VERIFY with Upload Current

1 No ATSPM Data

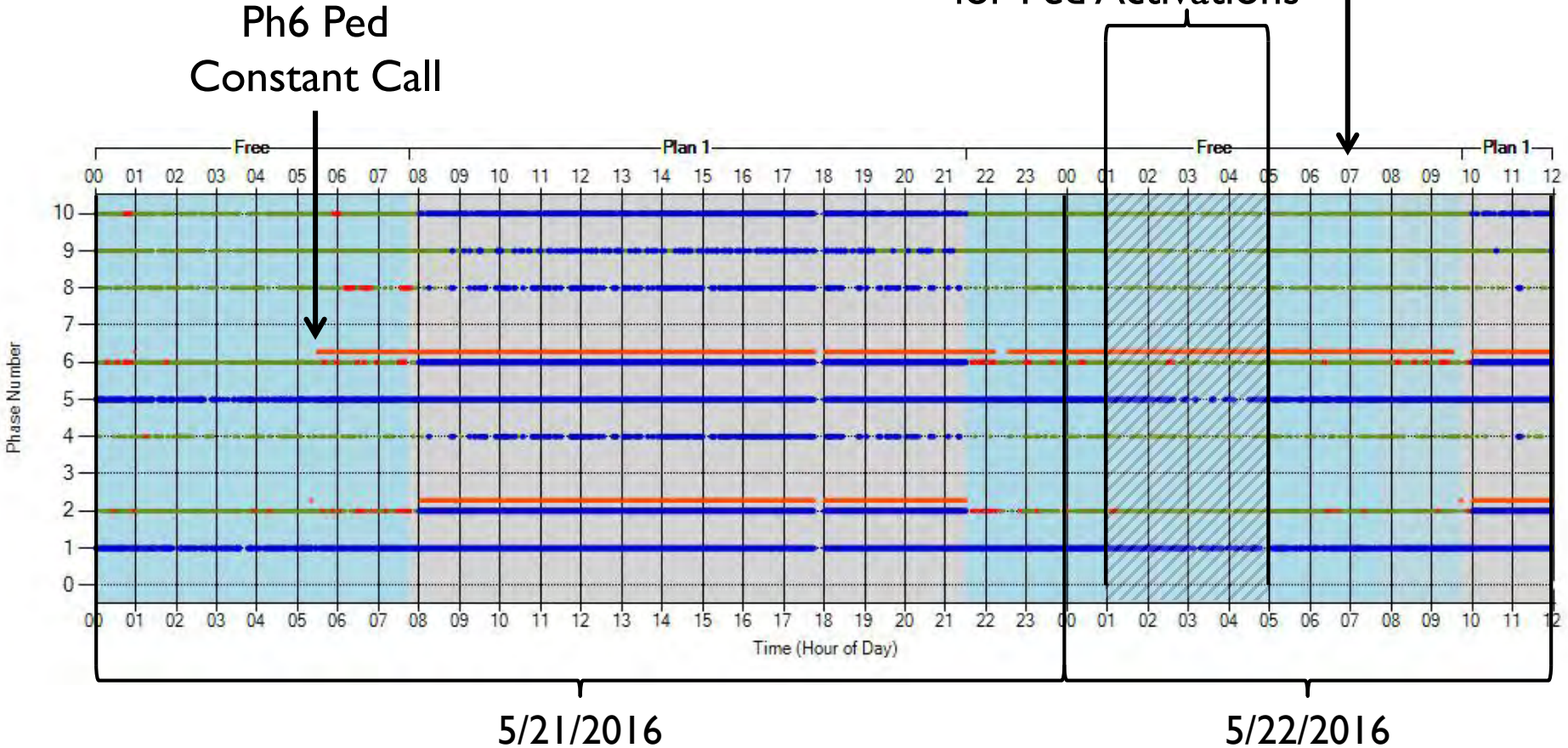
No ATSPM Data



2 Too many max outs



4 Too many ped calls



5 Low PCD detector count

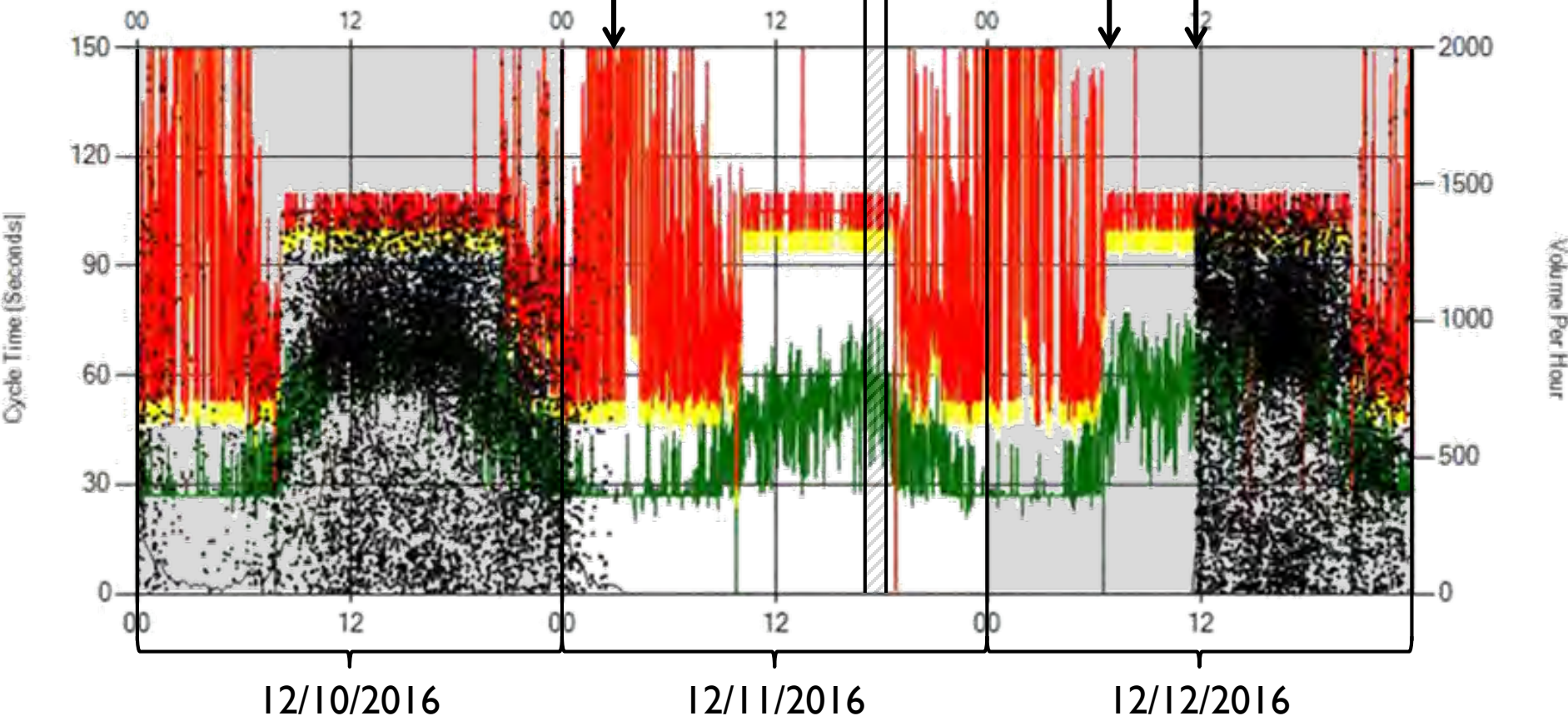
ATSPMs evaluated for PCD

Detector Volume

Sensor Reset

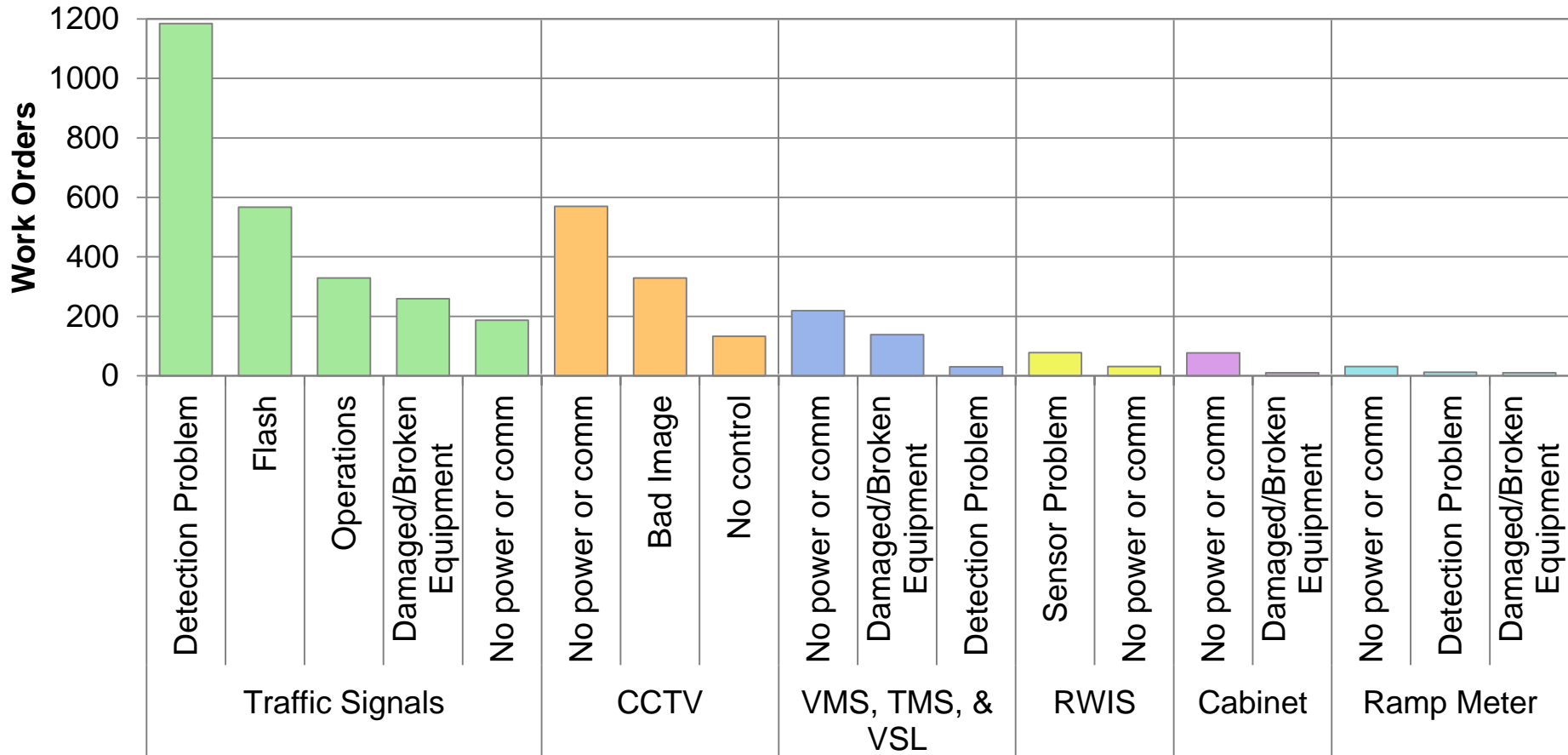
Sensor quits working

Alert email sent



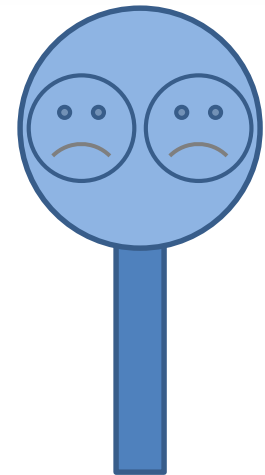
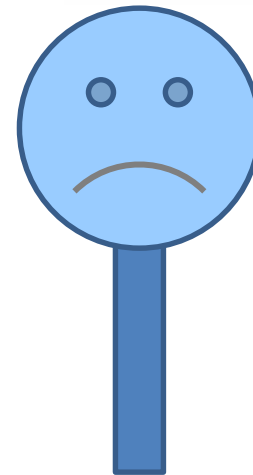
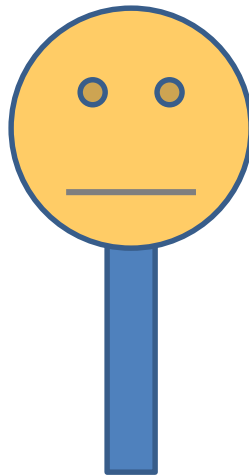
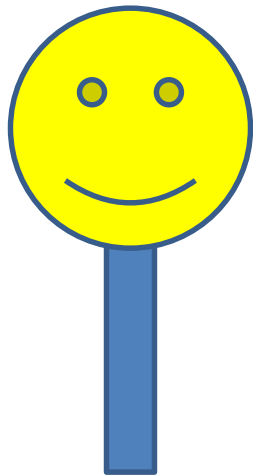
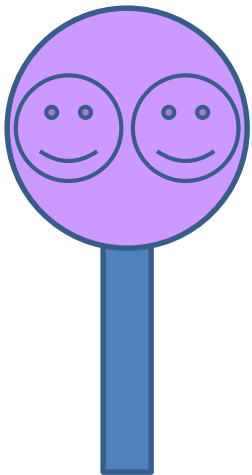
Work Orders

**# Work Orders for ATMS Equipment
July 2015 to July 2016**



UDOT Signal Timing Focus Group (July 2014)

- *How do you feel about UDOT?*
- *How do traffic signals make you feel?*



Focus Group Key Findings (July 2014)



- UDOT is perceived positively, with innovation as the primary driver of positive impressions.



- Drivers believe traffic signal synchronization is improving.



- Drivers feel UDOT should be open about its accomplishments in a way that protects its credibility.



60s Commercial – Green Lights

<http://udot.utah.gov/greenlights>



<https://www.itsforge.net>

UDOT ATSPM Source Code

U.S. Department of Transportation
Federal Highway Administration

OSADP

HOME INFORMATION COMMUNITY CONTACT LOGIN

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Explore Applications

APPLICATION CATEGORIES

All Active Releases	48
Arterial Management	21
Collision Avoidance	5
Collision Notification	5
Commercial Vehicle Operations	9
Crash Prevention & Safety	10
Driver Assistance	19
Electronic Payment & Pricing	0
Emergency Management	6
Freeway Management	20
Information Management	23
Intermodal Freight	7
Road Weather Management	5
Roadway Operations & Maintenance	7
Traffic Incident Management	6

Sort by Name

Show 5 Items



AMS_TCA_Aimsun_v1

Trajectory Conversion Algorithm-Aimsun (TCA-A)

STABLE

Version: AMS_TCA_Aimsun_v1

Modified: May 24, 2017

Downloads: 7

Keywords: **Connected Vehicles** **Traffic simulation** **communication**



Automated Traffic Signal Performance Measures (ATSPM) 4.0.1

Automated Traffic Signal Performance Measures 4.0.1

STABLE

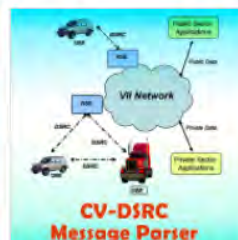
Version: ATSPM-4.0.1

Modified: Apr 20, 2017

Downloads: 64

Keywords: **signals** **ATSPM** **Performance Measures** **Signal Metrics**

Signal Measures



CV-DSRC-Msg-Parser 1.1

Connect Vehicles - Dedicated Short-Range Communications

STABLE

Version: CV-DSRC-MsgParser 1.1

Modified: Mar 31, 2016

Downloads: 107

Keywords: **bsm** **dsrc** **parsing** **analysis** **data**

21 Installations of UDOT ATSPMs



Community Forums

National Operations Center of Excellence (NOCoE)

<http://forum.transportationops.org/forum/5-traffic-signals/>

➤ General ATSPM topics (e.g. how to use metrics, detection setup, lessons learned, upcoming workshops & seminars, etc.)

FHWA's Open Source Application Development Portal

<https://www.itsforge.net/forum/ATSPM>

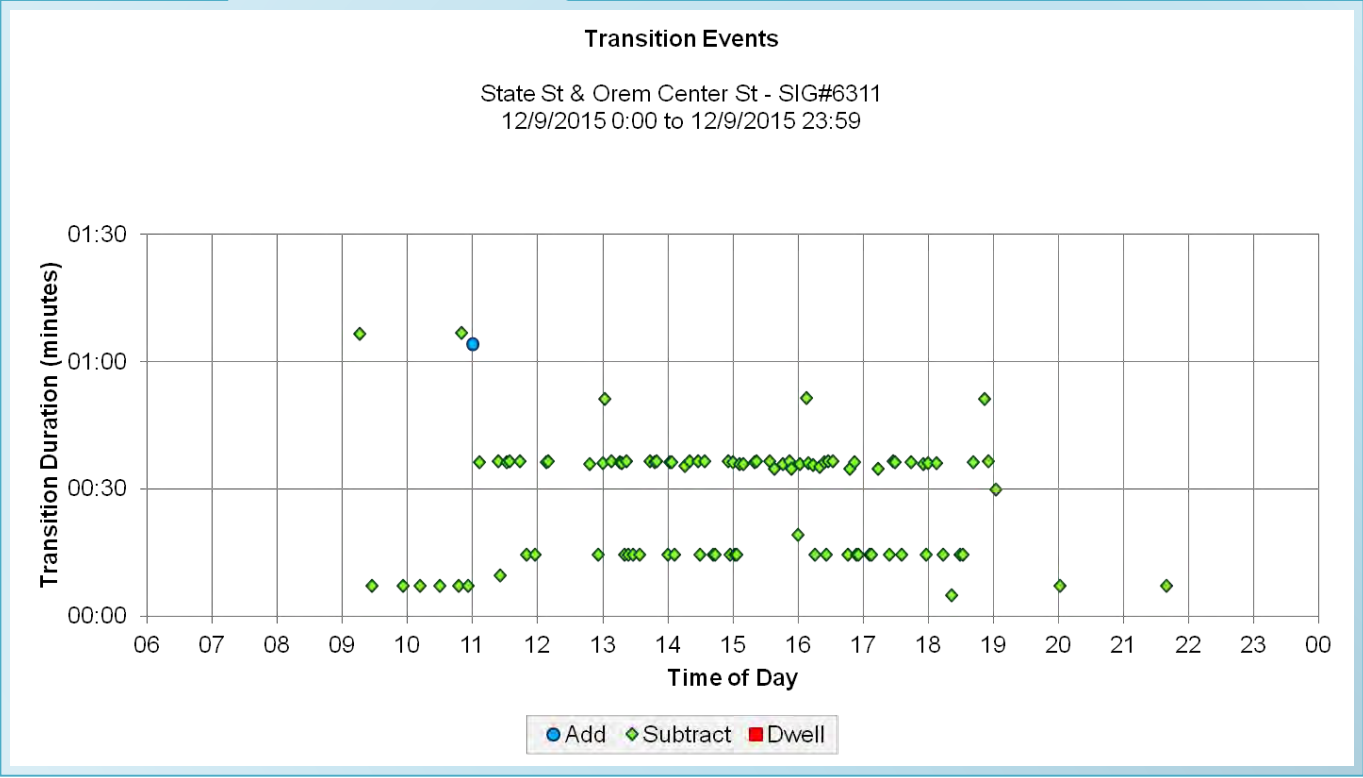
➤ Questions regarding UDOT's ATSPM source code (e.g. problems with installations, bugs, plans for future development, etc.)

What's Next

- New Metrics
 - Transition
 - Transit Signal Priority
- Watchdog analytics (GDOT)
- 15-minute data aggregation
- High-level reporting and alerts

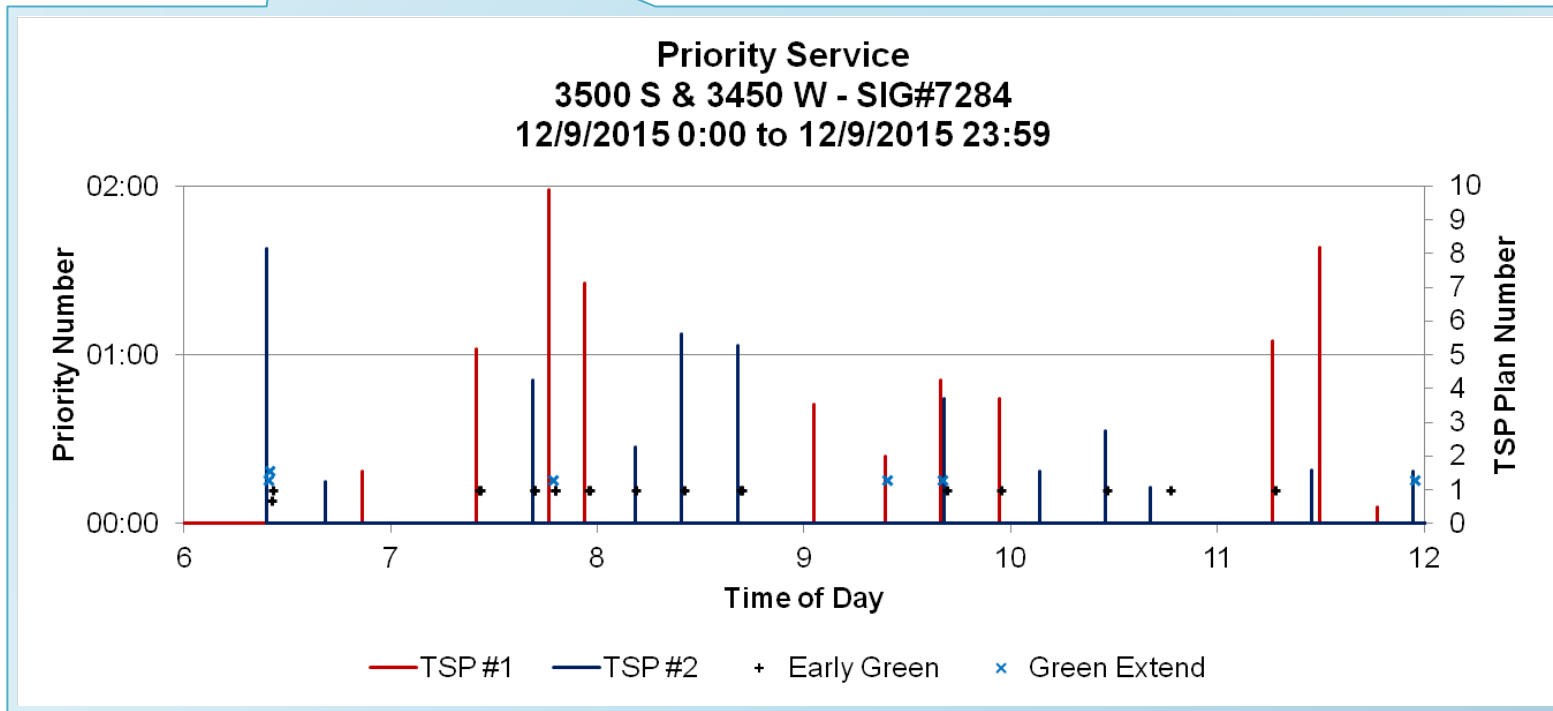
What's Next

- New Metrics
 - **Transition**
 - Transit Signal Priority
- Watchdog analysis (OT)
- 15-minute data aggregation
- High-level reporting and alerts



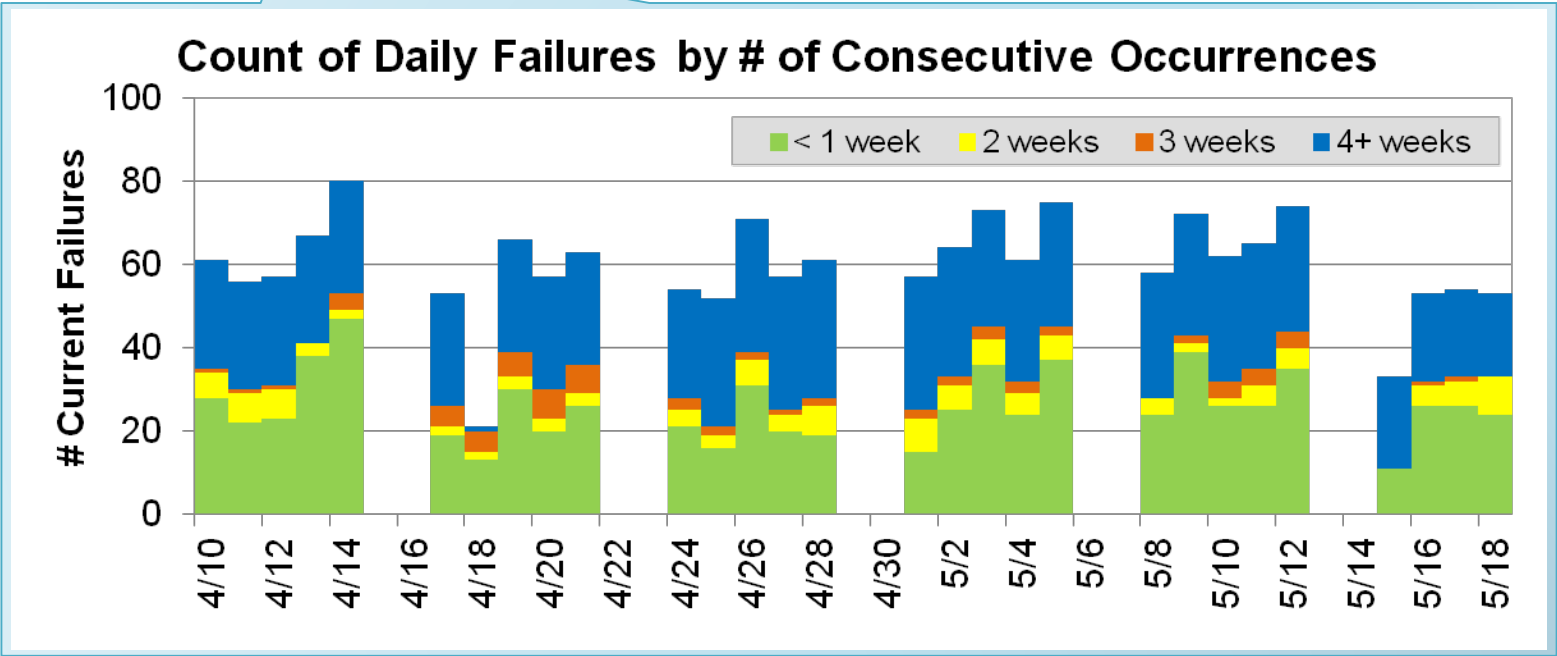
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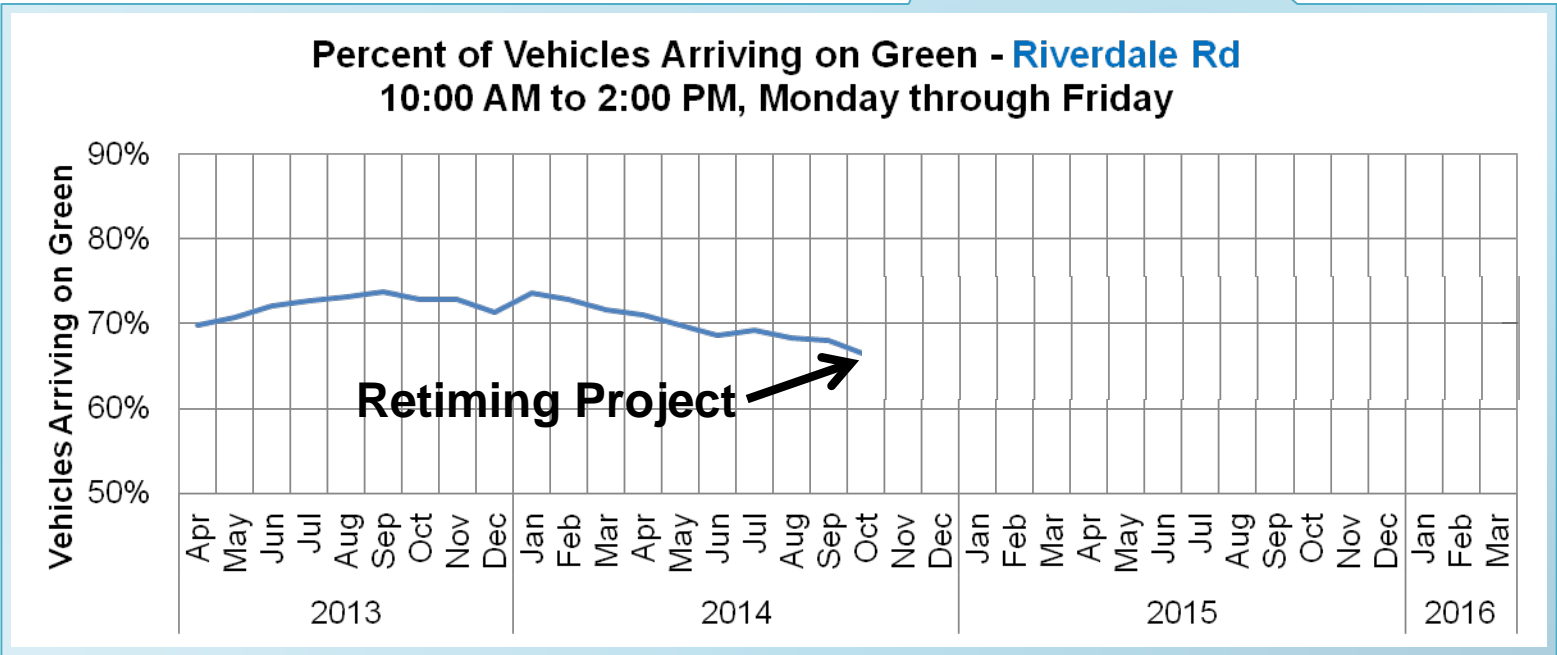
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More Information

Jamie Mackey

UDOT Statewide Signal Engineer
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UDOT ATSPMs

ATSPM Website

<http://udottraffic.utah.gov/ATSPM>

Green Lights Commercial

<http://udot.utah.gov/greenlights>

FHWA's Open Source Application Development Portal (OSADP)

<https://www.itsforge.net>

ATSPM Forums

National Operations Center of Excellence (NOCoE)

<http://forum.transportationops.org/forum/5-traffic-signals/>

➤ General ATSPM topics

FHWA's Open Source Application Development Portal (OSADP)

<https://www.itsforge.net/forum/ATSPM>

➤ Questions regarding UDOT's ATSPM source code

Crossing Guard Key Switch to Extend Walk Time

\$40



Emergency Response Plan – Additional support from non-technical personnel

2-3 per maintenance shed

