AUTOMATED TRAFFIC SIGNAL PERFORMANCE MEASURES

TEXITE SPRING MEETING – MAY 30, 2014

American Association of State Highway and Transportation Officials
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DRIVING INNOVATION FOR TRANSPORTATION
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AASHTO TECHNOLOGY IMPLEMENTATION GROUP

Jamie Mackey, Utah DOT

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ITE 3-part Webinar
April, May, June 2014

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Automated Traffic Signal Performance Measur

Learning Hub

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TITLE:	ACHIEVE YOUR AGENCY'S MEASURES-----
DATE:	Wednesday, April 9, 2014
TIME:	12:00 p.m. - 1:30 p.m. East

ITE Journal, March 2014

feature

Helping Traffic Engineers Manage Data to Make Better Decisions

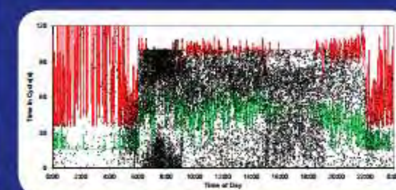
Automated Traffic Signal Performance Measures

By Darcy Bullock, P.E., Rob Clayton, P.E., PTOE, Jamie Mackey, P.E., Steve Misgen, P.E., PTOE, Amanda Stevens, P.E., Jim Sturdevant, P.E., and Mark Taylor, P.E., PTOE

Improved signal operations with smooth and equitable traffic flow are goals for most traffic engineers; however the limited snapshot-view retiming methods that involve manual data collection, traffic signal modeling, and field fine-tuning are resource intensive and unresponsive to changes in traffic patterns. The National Transportation Operations Coalition's 2012 National Traffic Signal Report Card has led agencies to focus resources on these activities and develop methodologies to examine all the components of traffic signal operations.[1] These data-driven program management plans provide objective methods for identifying shortcomings and encourages coordination with neighboring jurisdictions. In addition, agencies need tools to prioritize activities when resources are constrained.

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

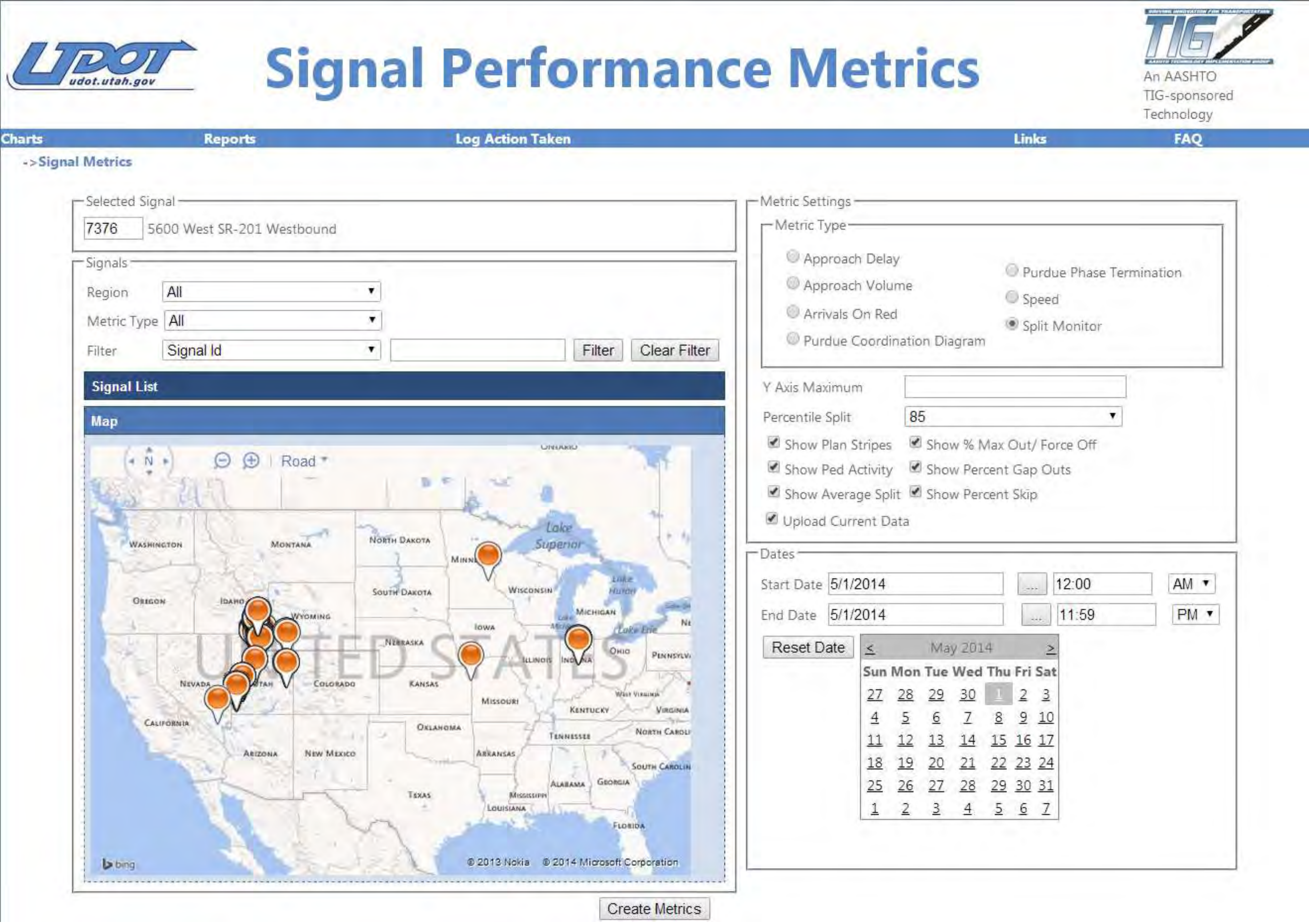
SPM Basic Concept

Automated Data Collection

- Signal controller
- Probe source

Useful Information about Performance

- Signal
- Corridor
- System



http://udottraffic.utah.gov/signalperformancemetrics

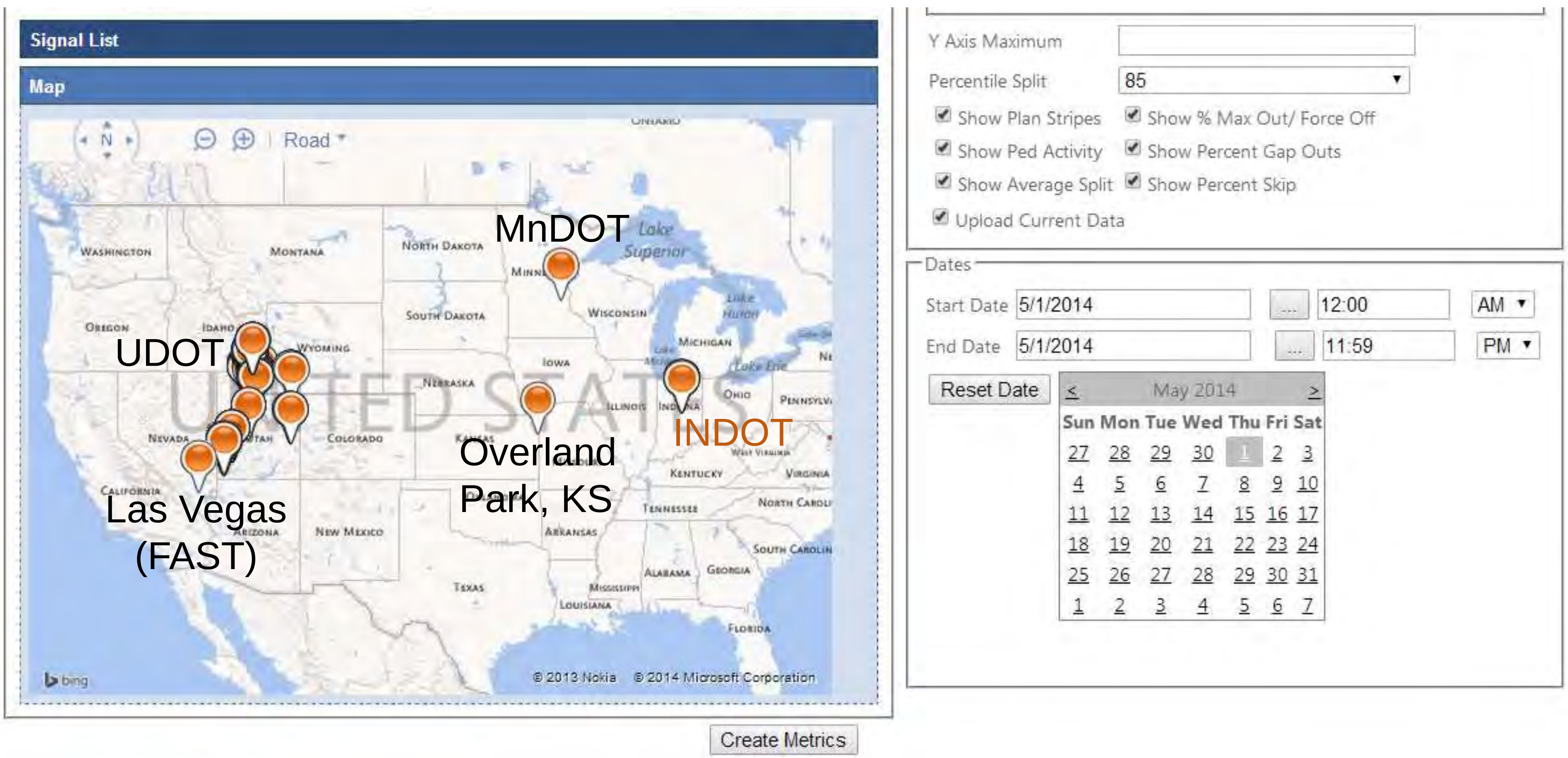
udot.utah.gov

Signal Performance Metrics

An AASHTO TIG-sponsored Technology

Charts | Reports | Log Action Taken | Links | FAQ

Agencies using UDOT software for SPMs



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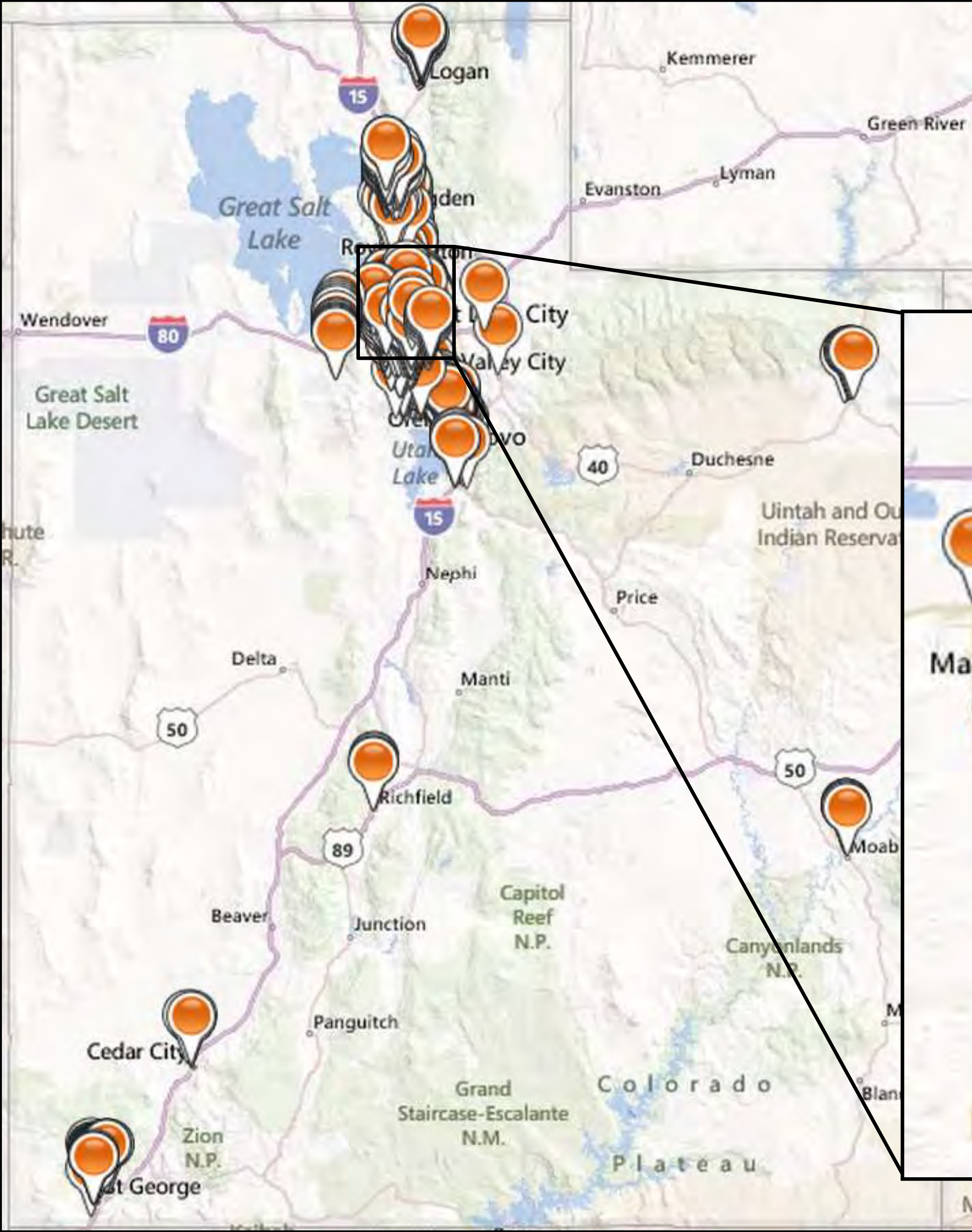
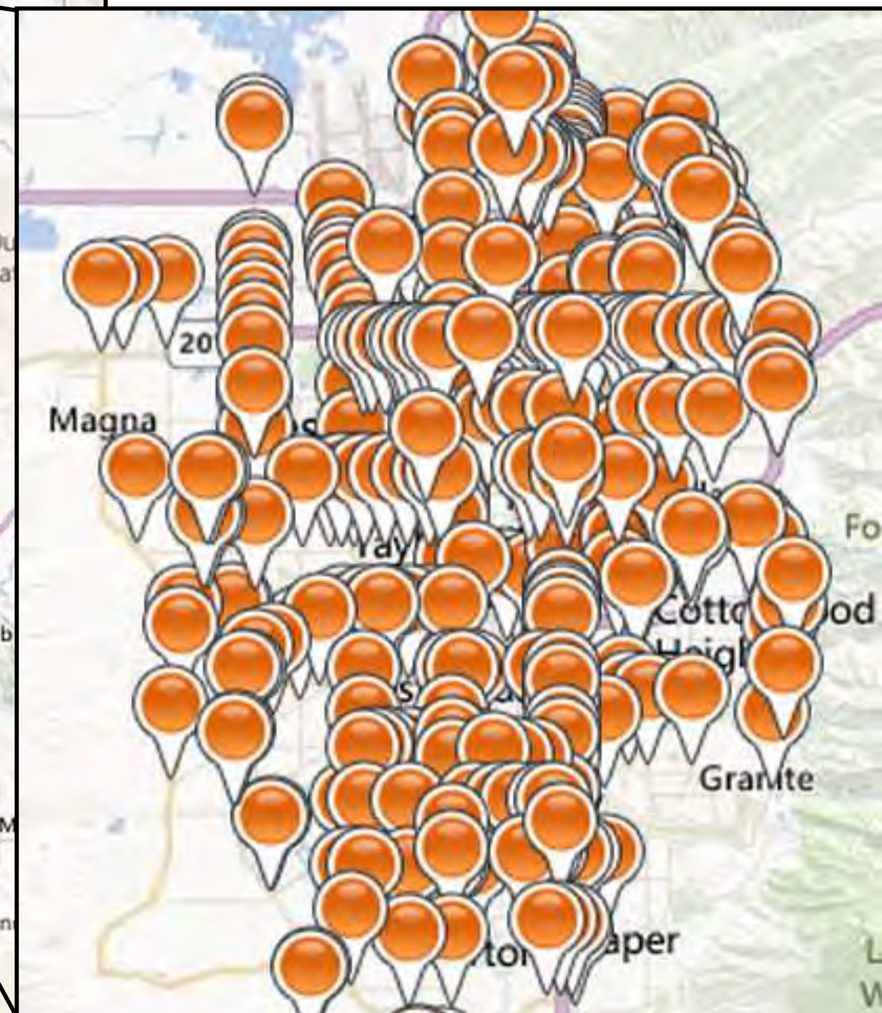


Salt Lake Valley

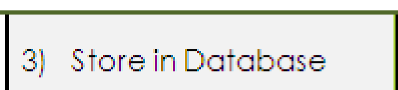


System Requirements

High-resolution Controller

Communications

Can be done <u>independent</u> of a Central System!



Server

Website

Detection
(optional)

Photo courtesy of the Indiana Department of Transportation

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

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

High-resolution Data

Detector 5 ON

Phase 8 GREEN

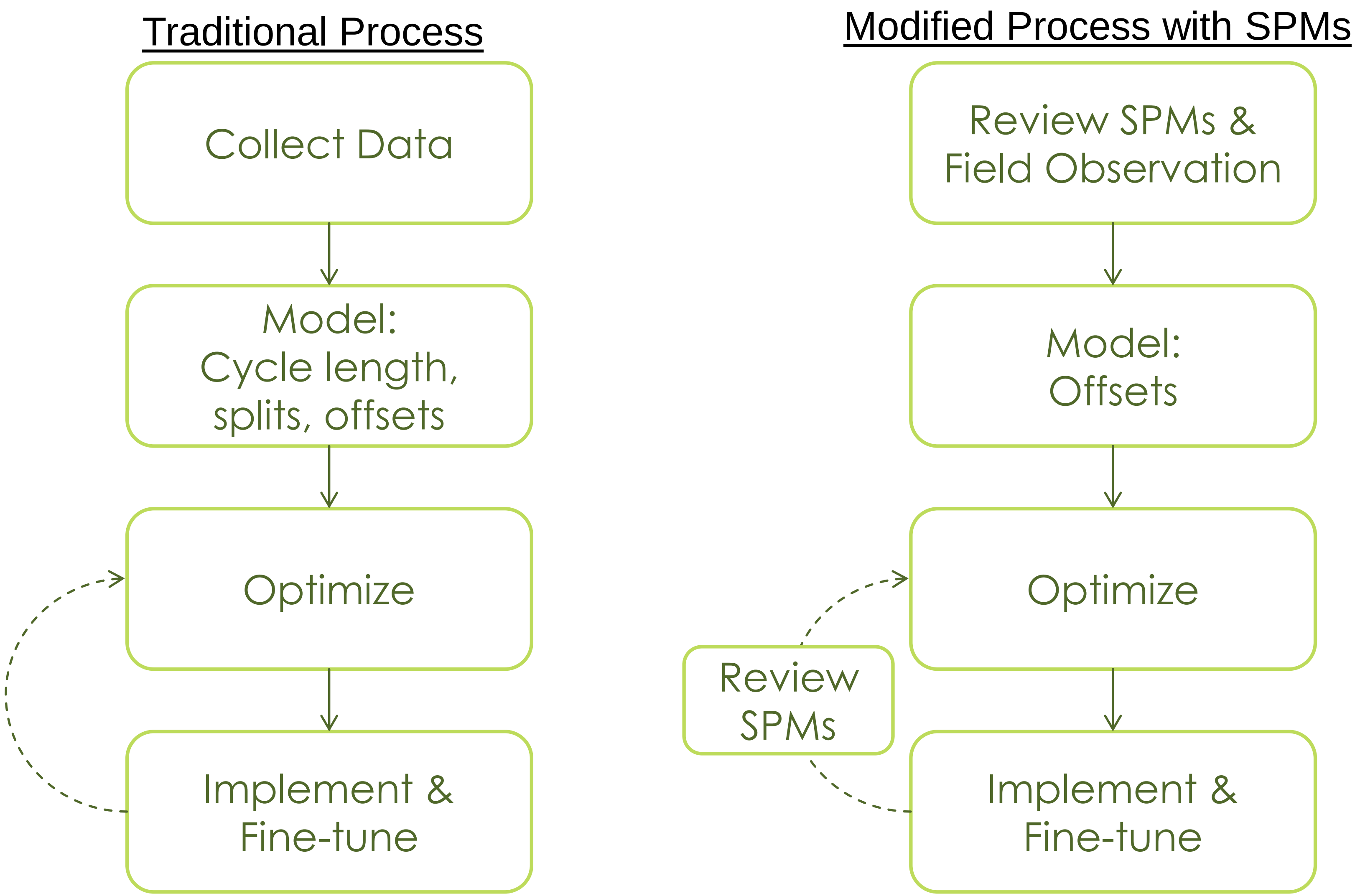
Detector 5 OFF

Timestamp	Event Code	Event Parameter
6/27/2013 1:29:51.1	10	8
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 1:29:53.3	81	6
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
6/27/2013 1:30:02.2	33	2
6/27/2013 1:30:02.2	33	6
6/27/2013 1:30:02.2	32	2
6/27/2013 1:30:02.2	32	6
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
6/27/2013 1:30:13.1	32	8
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
6/27/2013 1:30:30.4	8	8

Performance Metrics Uses

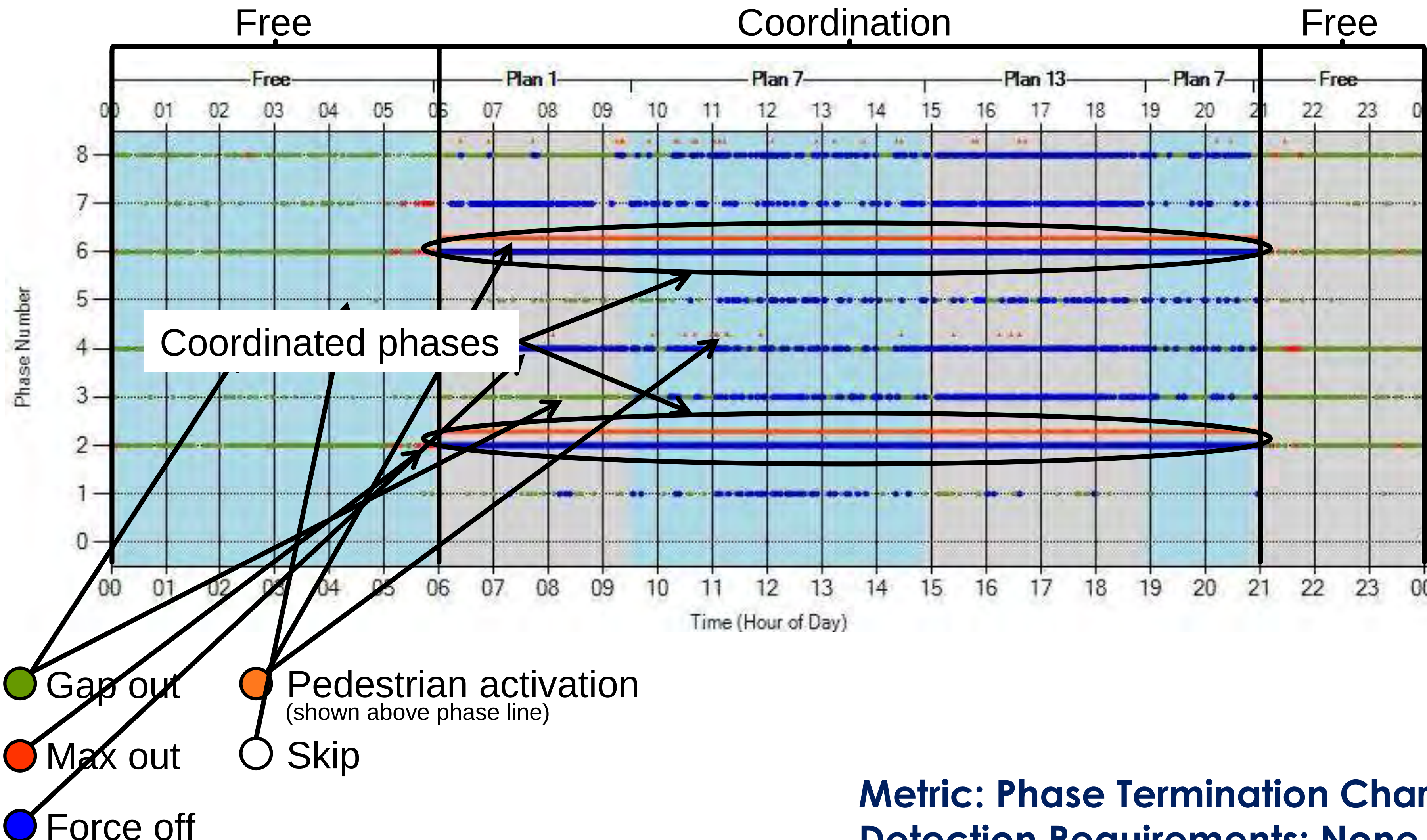
- Daily Operations
  - Basic parameters
  - Detection problems
  - Complaint response/ troubleshooting
  - Coordination
  - Events, Incidents, Weather, & Construction
  - Alerts
- Reporting
  - Prioritize signal needs
  - Communicate system status to region/senior leaders and public
- Modeling/planning
  - Approach Volumes
  - Turning Movement Counts
  - Speed

Optimization with SPMs



Normal Intersection Example: Phase Termination Chart

- 8-phase signal with working detection

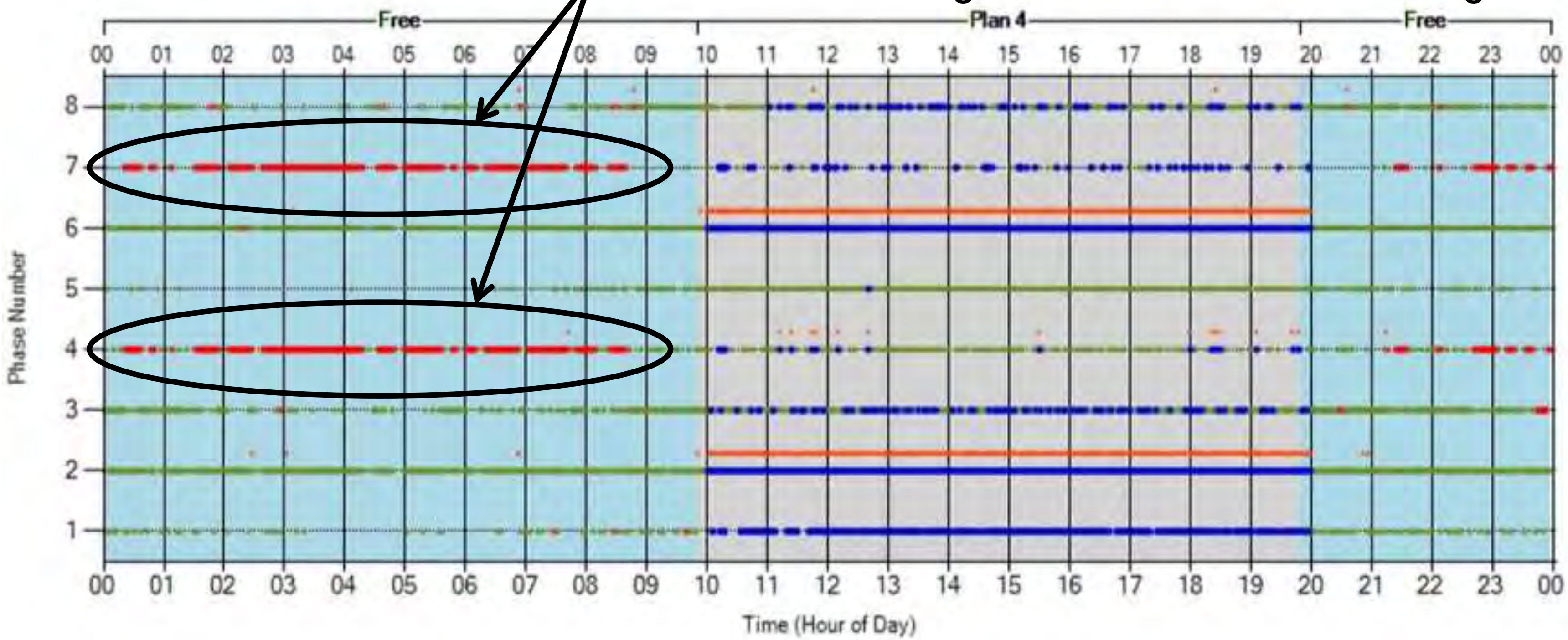


Metric: Phase Termination Chart
Detection Requirements: None

Maintenance Example: Nighttime detection problem

- BEFORE: Video detection not working at night

Minor street through & left turn max out at night only



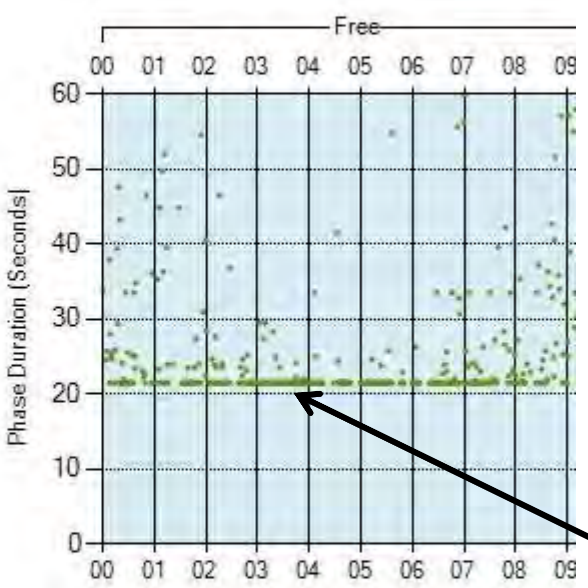
Gap out
Max out
Force off
Pedestrian activation (shown above phase line)
Skip

Metric: Purdue Phase Termination
Detection Requirements: None

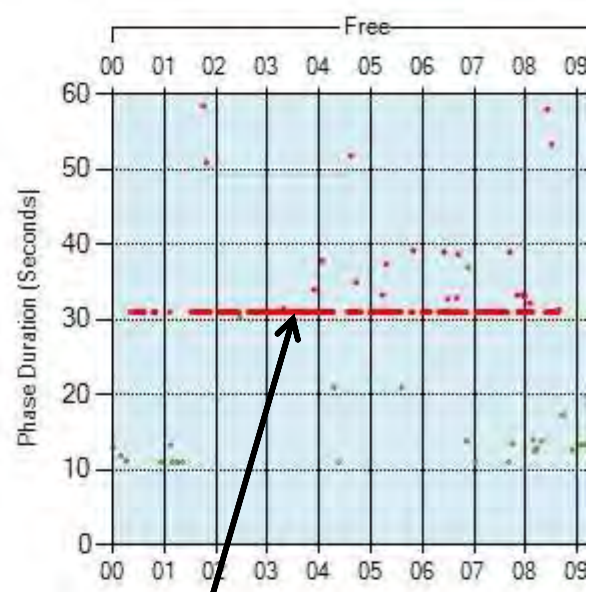
Maintenance Example: Nighttime detection problem

- BEFORE: Video detection not working at night

Major Street (Ø2)



Minor Street (Ø4)



Major Street sees 20s of green and 30s of red.

Gap out

Pedestrian activation
(shown above phase line)

Max out

Skip

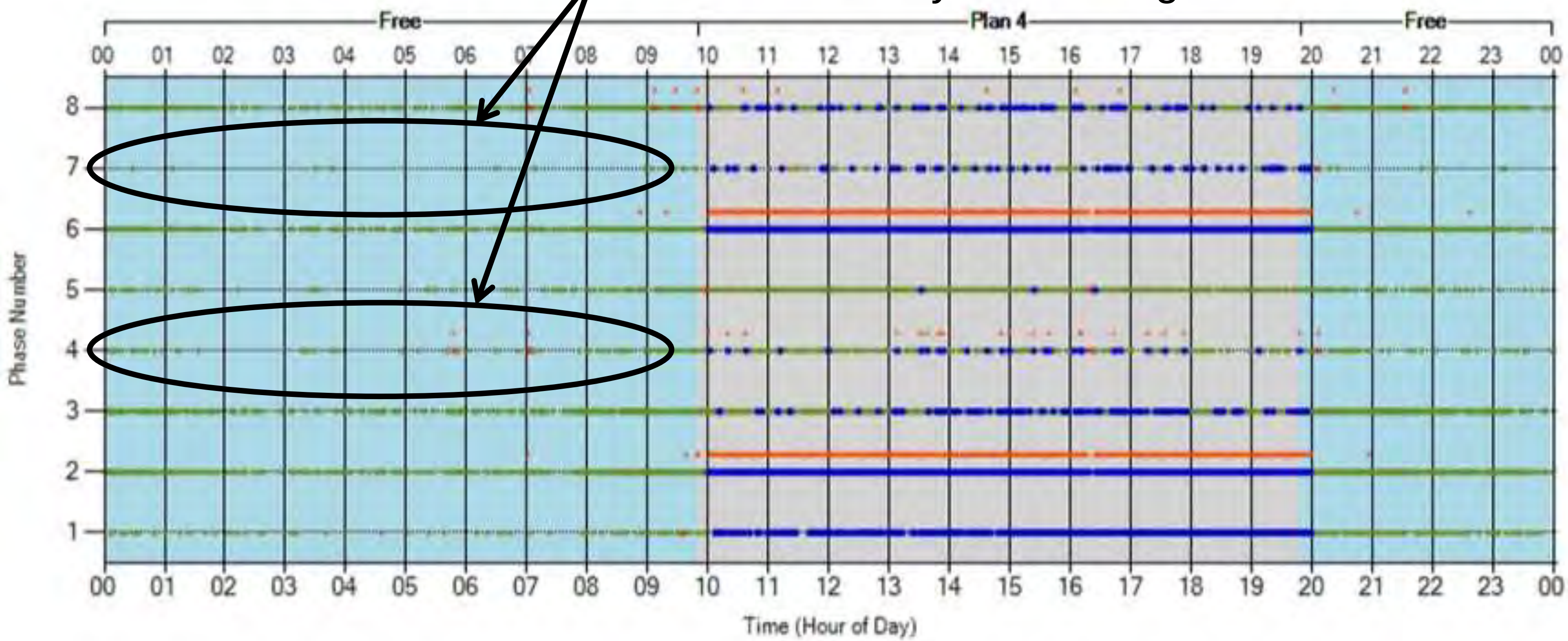
Force off

Metric: Split Monitor
Detection Requirements: None

Maintenance Example: Nighttime detection problem

- AFTER: New detection technology installed

Phases are rarely used at night



Gap out

Pedestrian activation (shown above phase line)

Max out

Skip

Force off

Metric: Purdue Phase Termination
Detection Requirements: None

Alert Example: 100% Max Out

SPM Alerts for 4/9/2014

SPMWatchDog@utah.gov

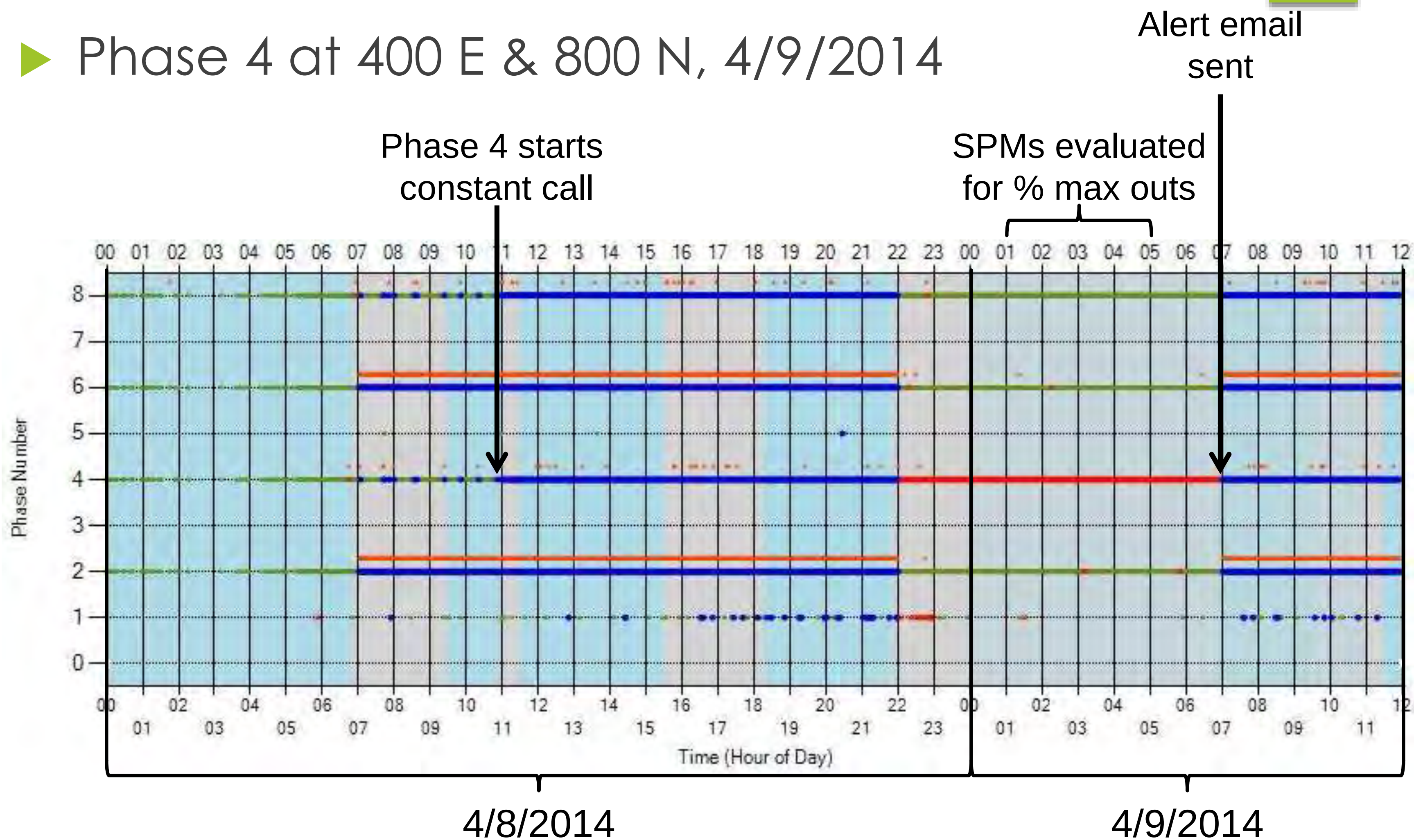
5092 - SR-126 (1900 W) & Riverdale (5300 S) (Roy) - Phase: 1
5105 - Antelope (SR-108/2000 N) & I-15 NB (Layton) - Phase: 4
6022 - US-89 & Pacific Dr (American Fork) - Phase: 3
6305 - 400 East & 800 North - Phase: 4 ← Example
6310 - Center Street (Orem) & I-15 SPUI - Phase: 8
7055 - Bangerter Hwy (SR-154) & SR-201 DDI - Phase: 5
7062 - Bangerter Hwy (SR-154) & 4700 South - Phase: 11
7613 - 10600 South & 700 West - Phase: 8
8114 - Bluff Street & I-15 NB Ramps - Phase: 4

- Daily email at 7 a.m.
- Uses Purdue Phase Termination chart data
- Flags phases with >90% max-outs on each phase between 1 a.m. and 5 a.m.
- Compare to previous day’s list. Only phases with new flags are sent in the email.

Metric: Purdue Phase Termination
Detection Requirements: None

Alert Example: 100% Max Out

- Phase 4 at 400 E & 800 N, 4/9/2014

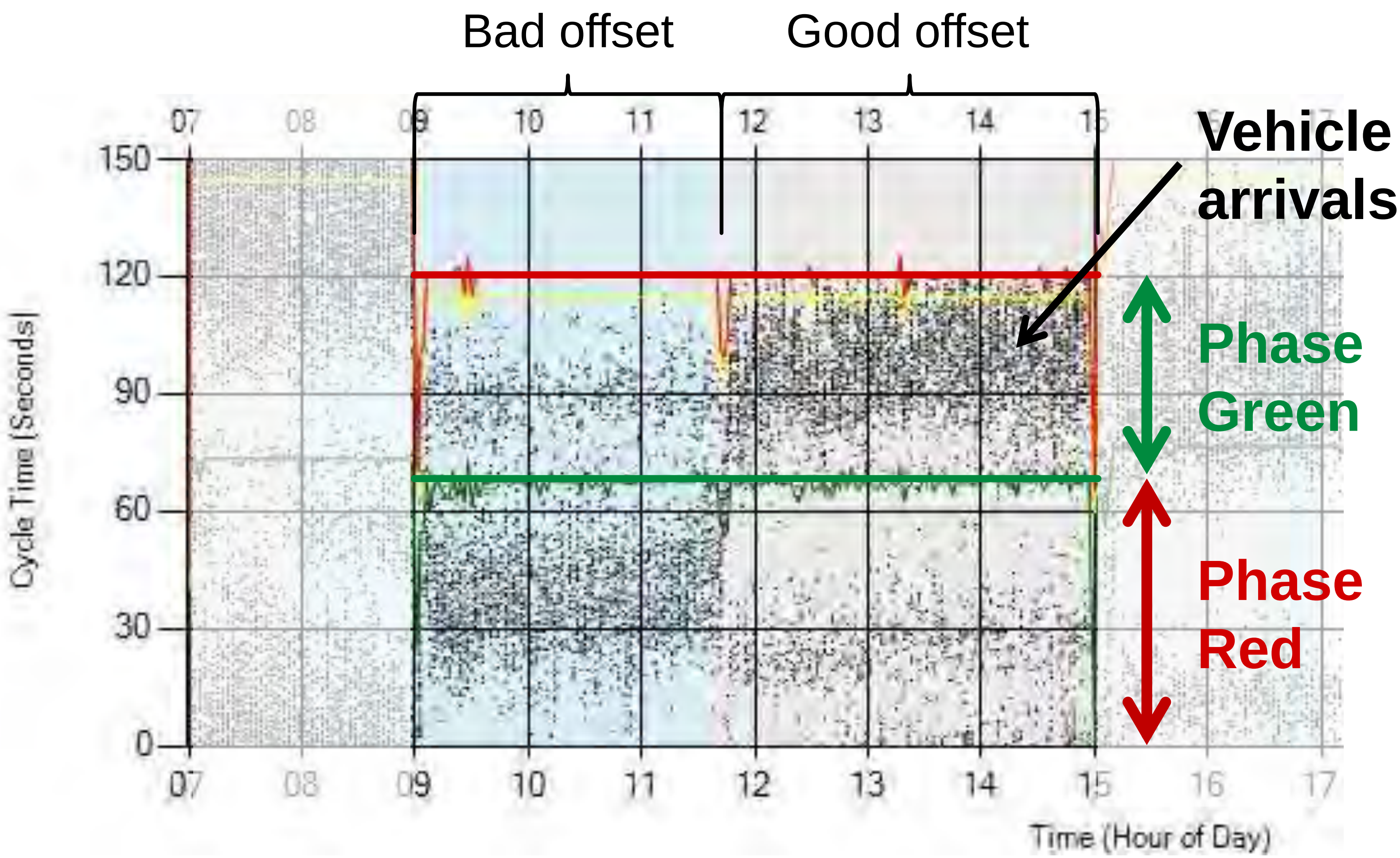


Gap out
Max out
Force off
Pedestrian activation (shown above phase line)
Skip

Metric: Purdue Phase Termination
Detection Requirements: None

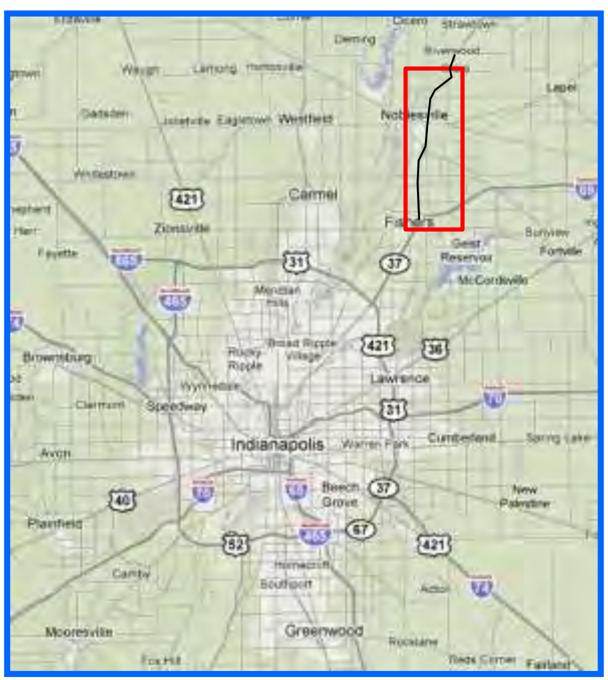
Optimization Example: Progression Quality

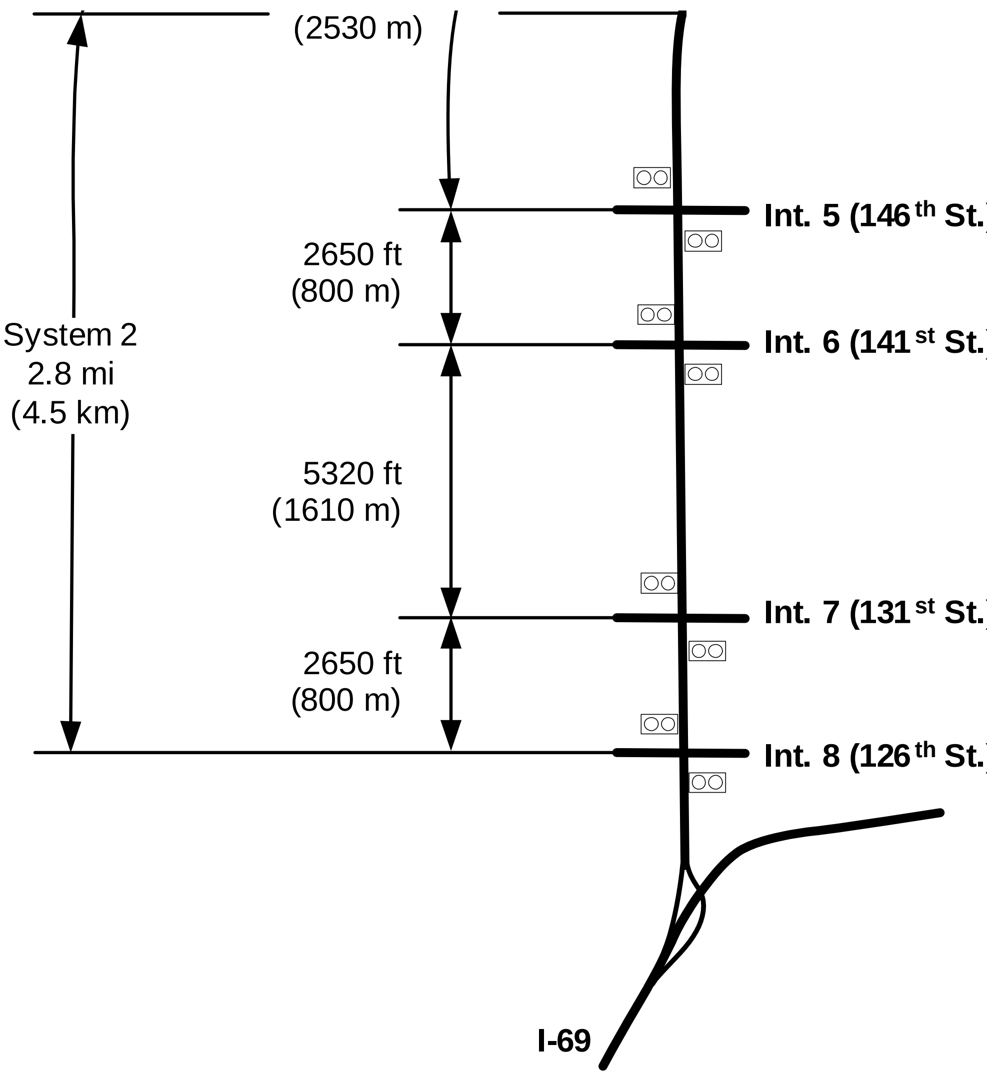
- Fine-tuning new coordination plans



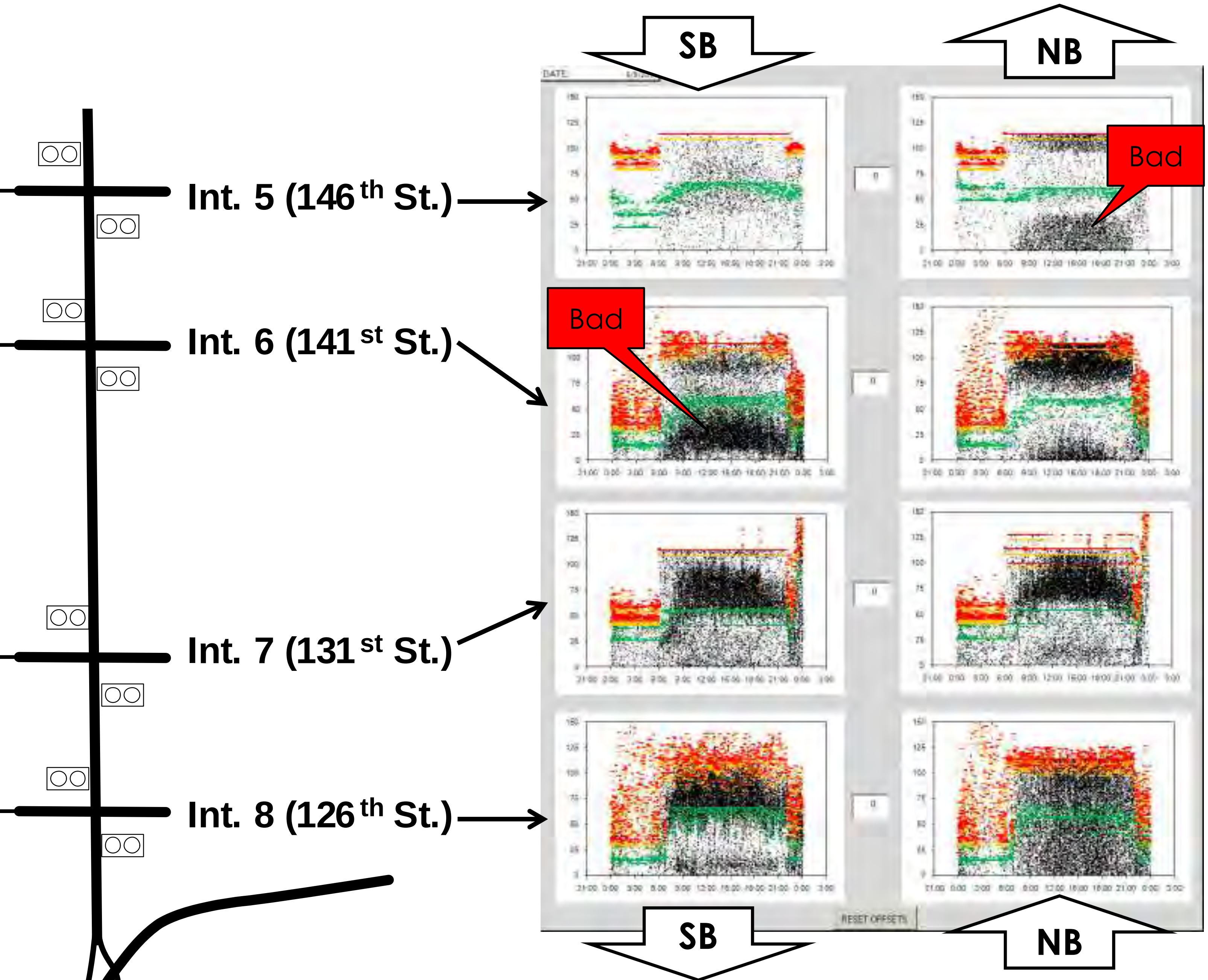
Metric: Purdue Coordination Diagram
Detection Requirements: Advance

Offset Optimization Case Study

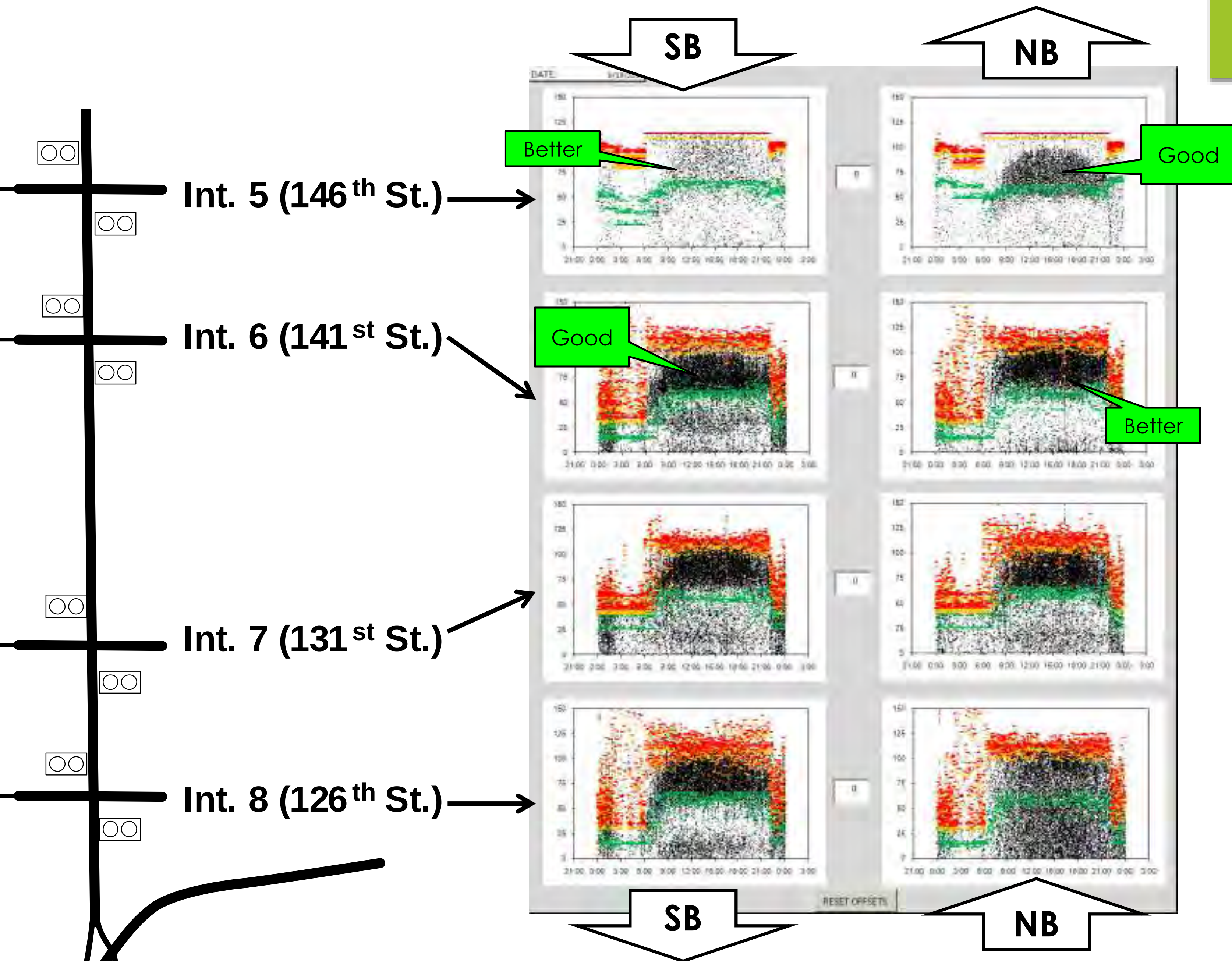


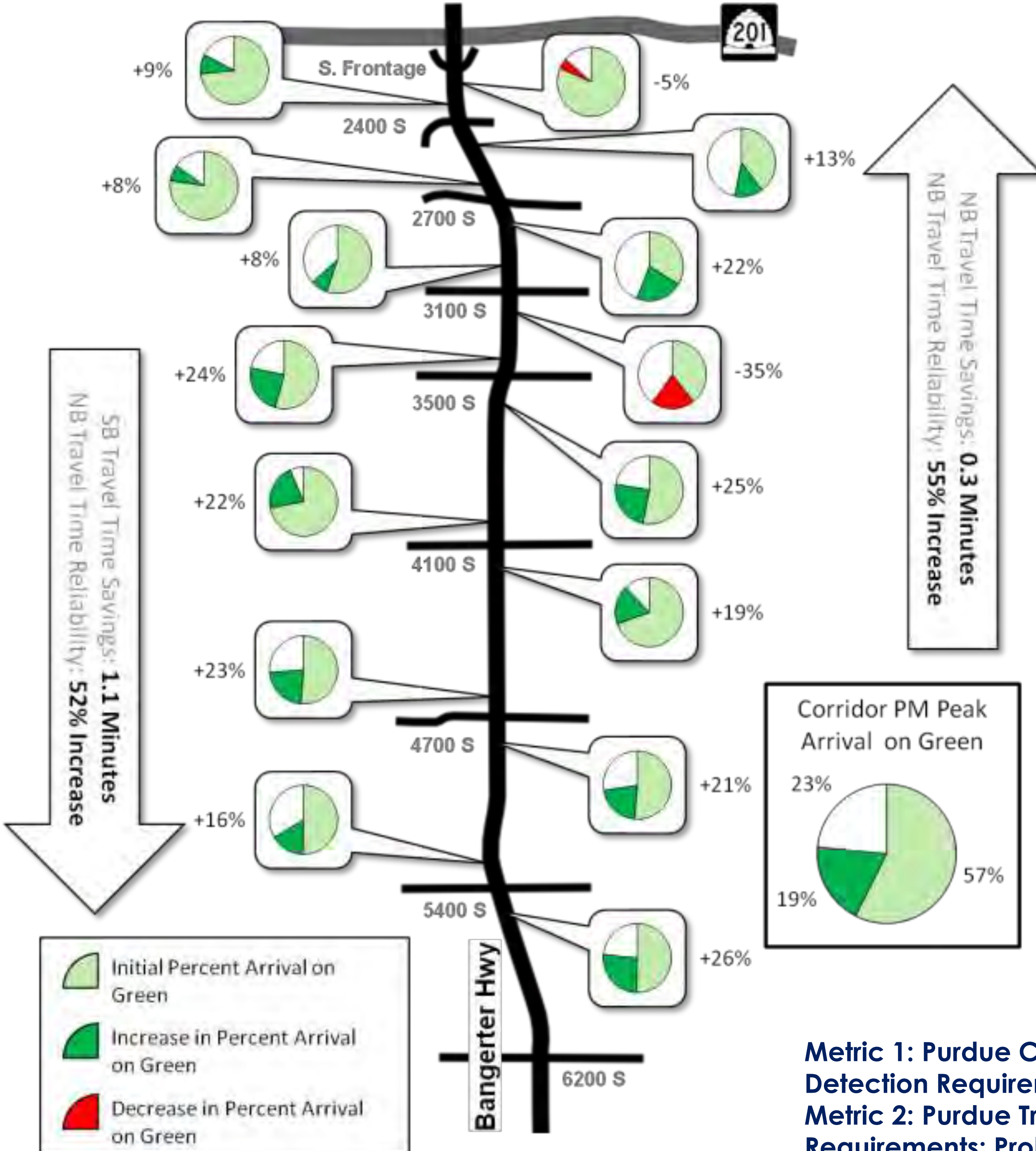


Offset Optimization - BEFORE



Offset Optimization – AFTER





Metric 1: Purdue Coordination Diagram
Detection Requirements: Advance
Metric 2: Purdue Travel Time Diagram
Requirements: Probe data set

Metrics & Detection Requirements

Controller high-resolution data only

Purdue Phase Termination

Split Monitor

Advanced Count Detection (~400 ft behind stop bar)

Purdue Coordination Diagram

Approach Volume

Platoon Ratio

Arrivals on Red

Approach Delay

Executive Summary Reports

Advanced Detection with Speed

Approach Speed

Lane-by-lane Presence Detection

Split Failure (future)

Lane-by-lane Count Detection

Turning Movement Counts

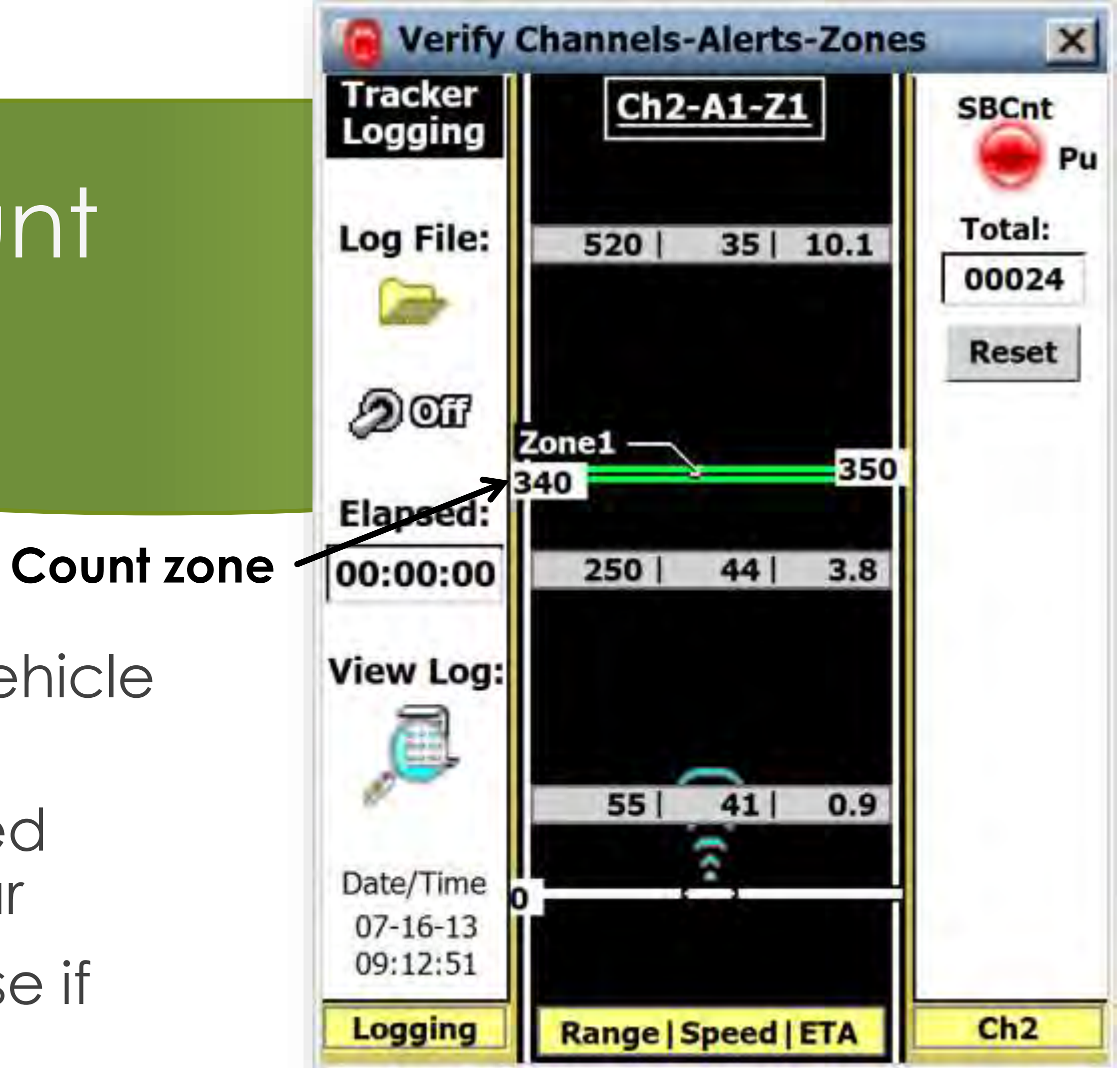
Probe Travel Time Data (GPS or Bluetooth)

Purdue Travel Time Diagram

Setback Count Detectors

<u>Wavetronix Advance</u>

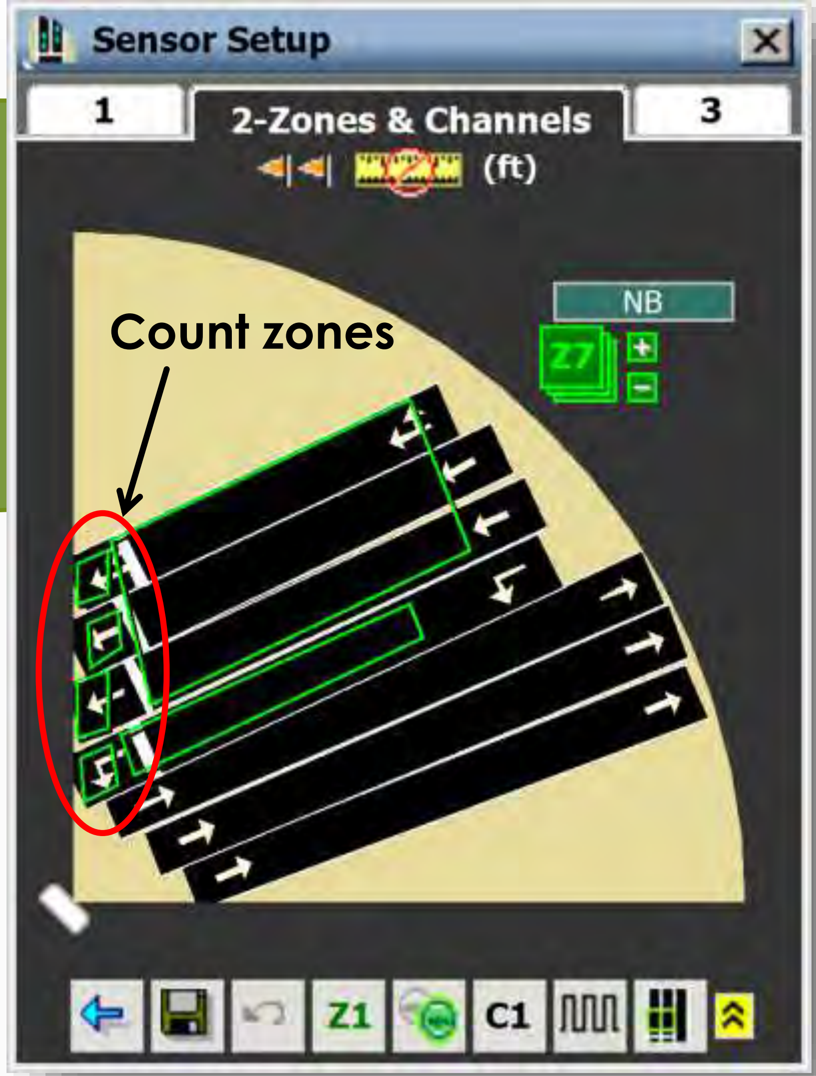
- Used to timestamp vehicle arrivals
- 10’ count zone placed ~350’ behind stop bar
- No additional expense if already in place for dilemma zones
- May undercount dense traffic



Stop Bar Count Detectors

Wavetronix Matrix

- Used for turning movement counts
- Lane-by-lane detection zones in front of stop bar
- Requires detection rack card for every two zones ($$$$$$) or Click 650 Detector BIU




A
B
C
D


D
C
B

Automated Traffic Signal Performance Measures

Technology Implementation Group: 2013 Focus Technology

http://tig.transportation.org

Mission: Investing time and money to accelerate technology adoption by agencies nationwide

American Association of State Highway and Transportation Officials
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Driving Innovation for Transportation
TIG
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Find out more: http://tig.transportation.org

AASHTO TIG

- TIG Home
- About TIG
- Focus Technologies
- Executive Committee
- Feedback
- Additionally Selected Technologies
- TIG-Solicitation
- Lead States Team Guidance

TIG Home

AASHTO > AASHTO Technology Implementation Group > TIG Home

AASHTO's Technology Implementation Group — or TIG — scans the horizon for outstanding ad
technology and invests time and money to accelerate their adoption by agencies nationwide.

Each year, TIG selects a highly valuable, but largely unrecognized procedure, process, software
that has been adopted by at least one agency, is market ready and is available for use by othe

Guided by the vision of "a culture where rapid advancement and implementation of high payoff,
expectation of the transportation community," TIG's objective is to share information with AAS
agencies, and their industry partners to improve the Nation's transportation system.

Recently selected technologies with links to additional information are listed below. Also, you m
and Additionally Selected Technologies categorized by AASHTO subcommittee interest area.

Lead States Team Focus Technologies

2013 Focus Technologies

- Automated Traffic Signal Performance Measures
- UPlan Phase II

Prior Four Years Focus Technologies

- Embedded Data Collector
- Environmental Planning GIS Tools

Additionally Selected T

2013 ASTs

- Double Crossover Dia

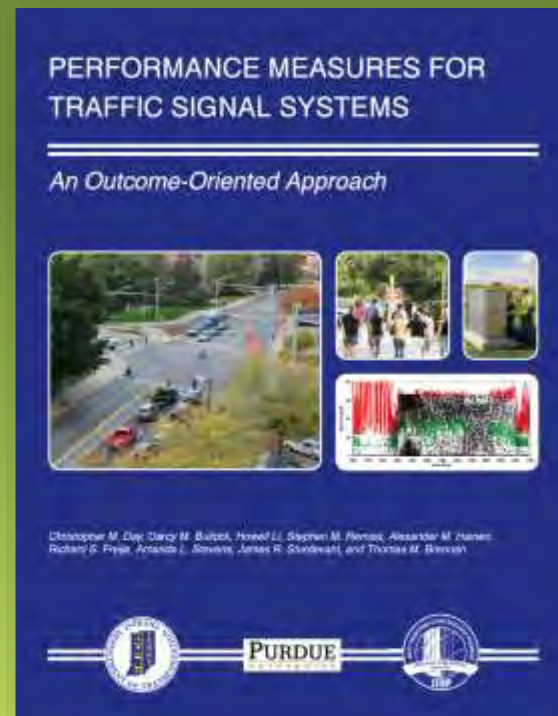
Prior Four Years ASTs

- Anonymous Wireless Time Data Collection
- Curvature Extension f

Additional Information

UDOT Signal Performance Metrics
http://udottraffic.utah.gov/ signalperformancemetrics

Purdue/INDOT JTRP Report →
http://tinyurl.com/signalmoe



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