THE UNIVERSITY of TENNESSEE KNOXVILLE

Improving Operations with Automated Traffic Signal Performance Measures

tsite
TENNESSEE SECTION INSTITUTE OF TRANSPORTATION ENGINEERS

Center for Transportation Research

Tennessee Section of ITE 2017 Spring Meeting

Franklin, TN

May 23, 2017

National Traffic Signal Report Card 2012

Management	D
Traffic Signal Operations	C
Signal Timing Practices	C
Traffic Monitoring and Data Collection	F
Maintenance	C
OVERALL	**D+**

Source: National Transportation Operations Coalition

Resources

InSync

RHYTHM ENGINEERING

SynchroGreen

Centracs Adaptive

Centracs SPM

SCATS

PEEK

SIEMENS

McCain

Trafficware Engineered by Naztec

FLIR

ECONOLITE

ARADA SYSTEMS

INTELIGHT

SAVARI™

GRIDSMART

CohdaWireless

SENSYS networks

NOCoE

WAVETRONIX

LIVE:TRAFFIC:DATA

mioVision rethink traffic

INRIX

TN TDOT Department of Transportation

U.S. Department of Transportation Federal Highway Administration

Consultants, academia, contractors, MPO's, RPO's, etc, etc, …

Opportunity to coordinate efforts

and

transform the practice!

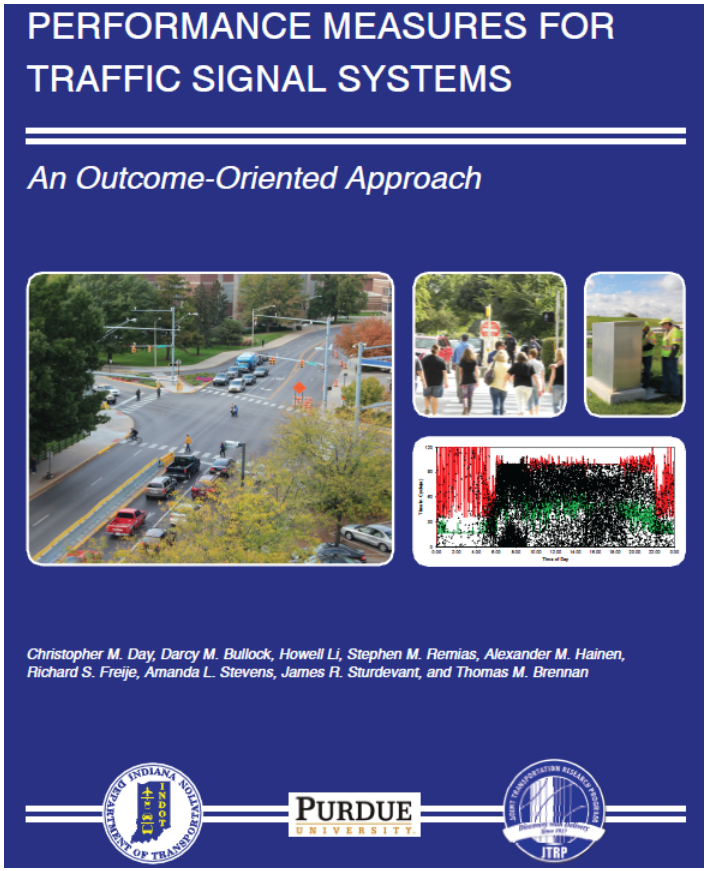
From reactive to proactive.

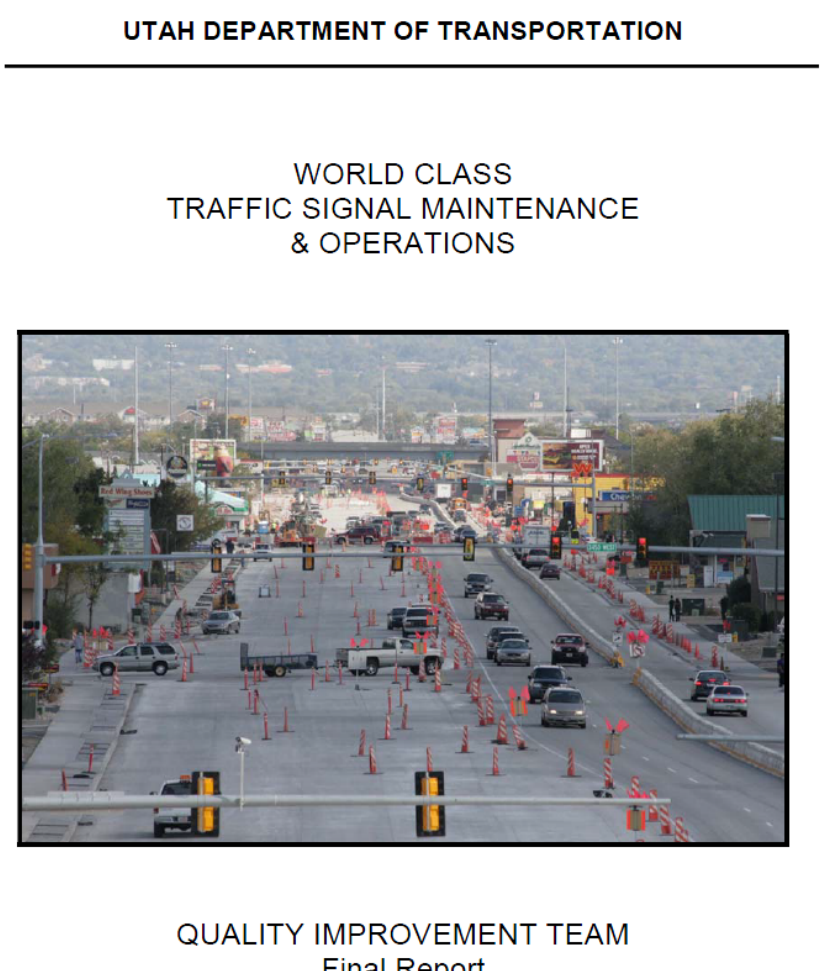
ATSPM

Automated Traffic Signal Performance Measures

Background

ATSPM
Automated Traffic Signal Performance Measures





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ATSPM
Automated Traffic Signal Performance Measures

A Fitness Tracker for Traffic Signals

High Resolution Data Collection

Data Analysis and Performance Report Tools

Source: FHWA

System Requirements

High-resolution Controller

Communications

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

Server

Software

Detection

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Photo courtesy of the Indiana Department of Transportation

Events Codes

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

Source: Purdue University

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

Source: Purdue University

High Resolution Data – Vendor Neutrality

High-resolution Controller with built in data logger using Indiana Enumerations

- Econolite Cobalt: Any Version
- Econolite ASC3 NEMA: V. 2.50+
- Econolite 2070 with 1C CPU Module: V. 32.50+
- Intelight Maxtime: V. 1.7.0+
- Peek ATC Greenwave 03.05.0528+
- Trafficware 980ATC V. 76.10+
- McCain ATC eX NEMA: V. ?
- Siemens M50 Linux & M60 ATC
  - ECOM V. 3.52+
  - NTCIP V. 4.53+

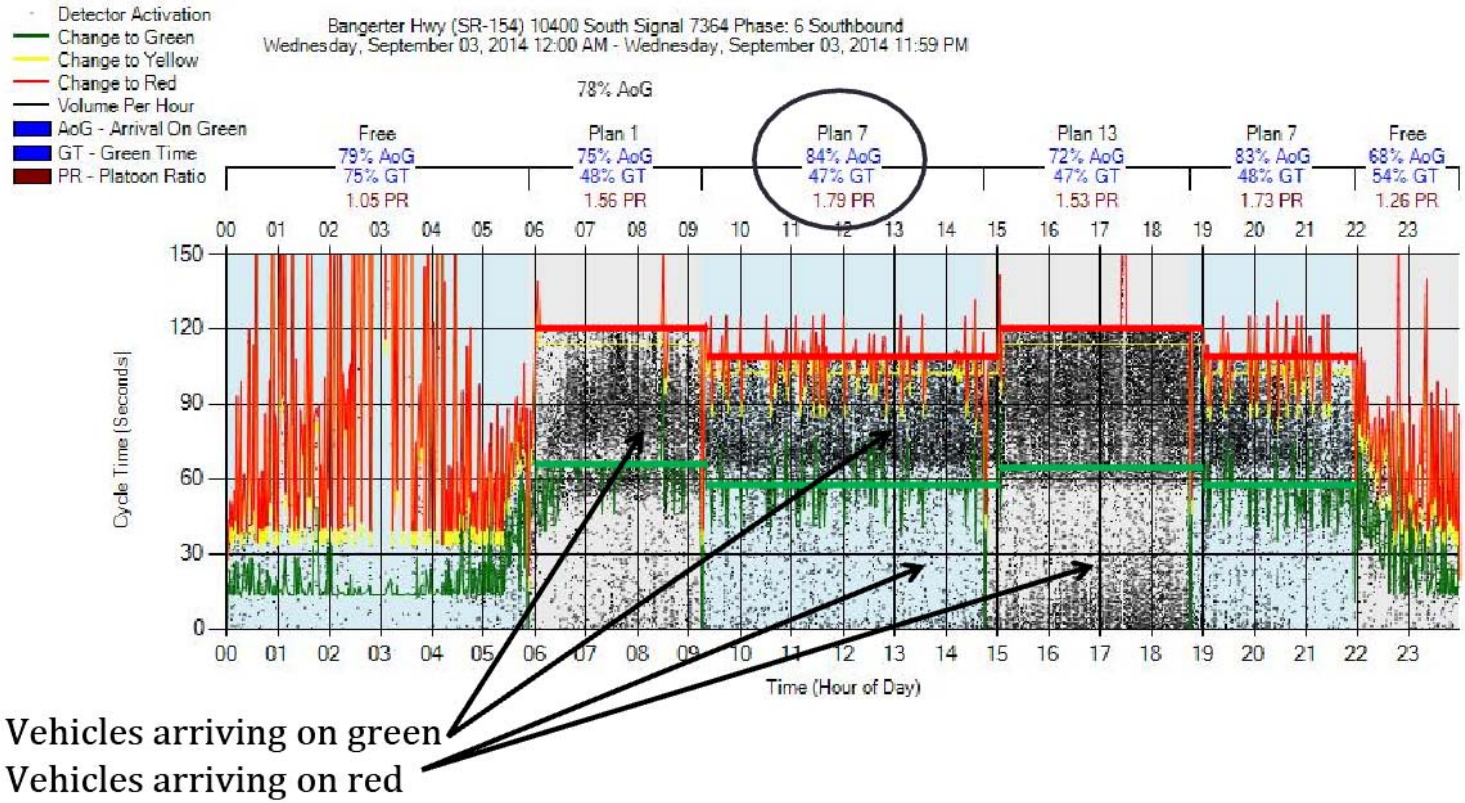
Data Logger records to the 1/10 second resolution

Source: Utah DOT

High Resolution Data

Source: Youtube

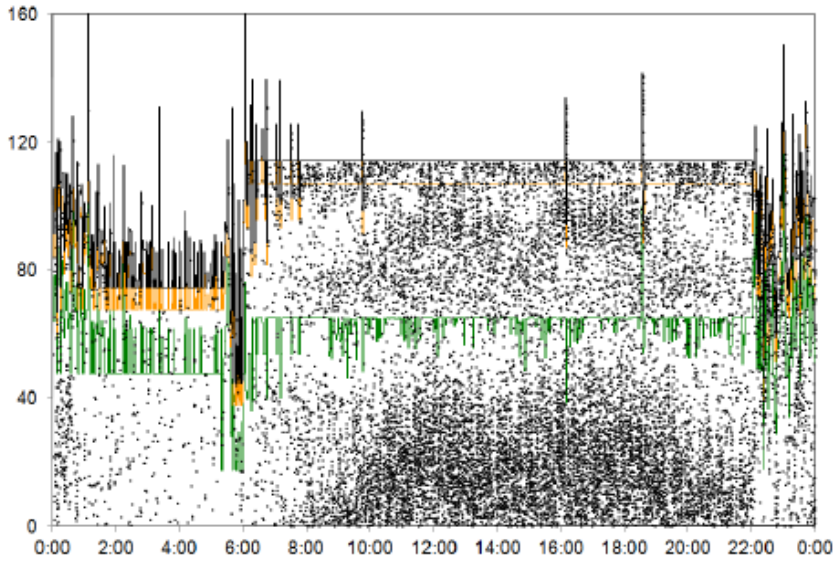
Progression Quality



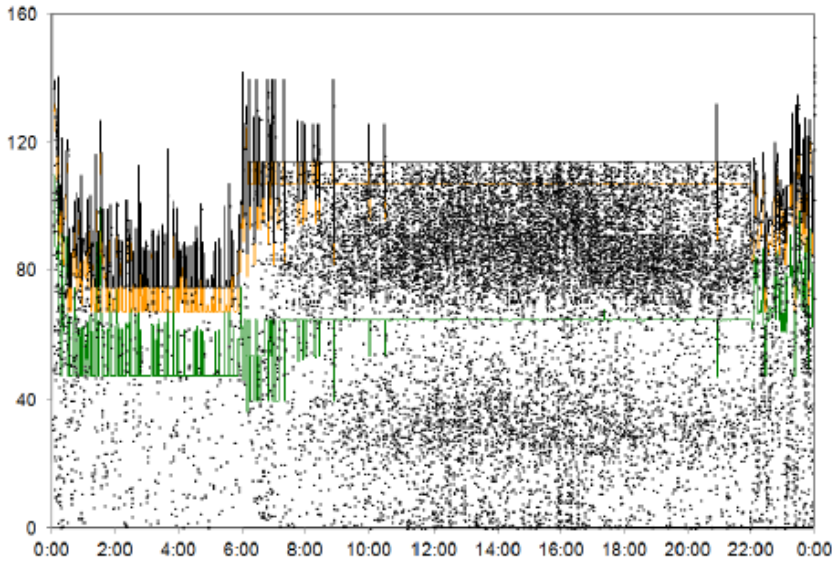
The PCD's are instrumental in optimizing offsets, identifying oversaturated or under saturated splits for the coordinated phases, the effects of early return of green and coordinated phase actuations, impacts of queuing, adjacent signal synchronization, etc.

Source: Purdue University

Progression Quality



Before Offset Optimization



After Offset Optimization

How do we typically fine tune offsets today?

Floating car runs,…

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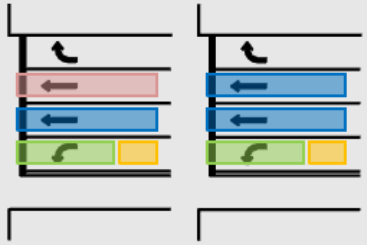
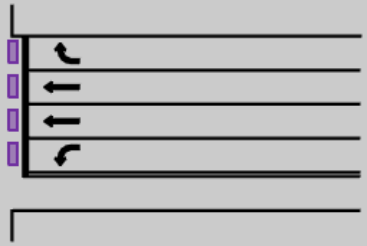
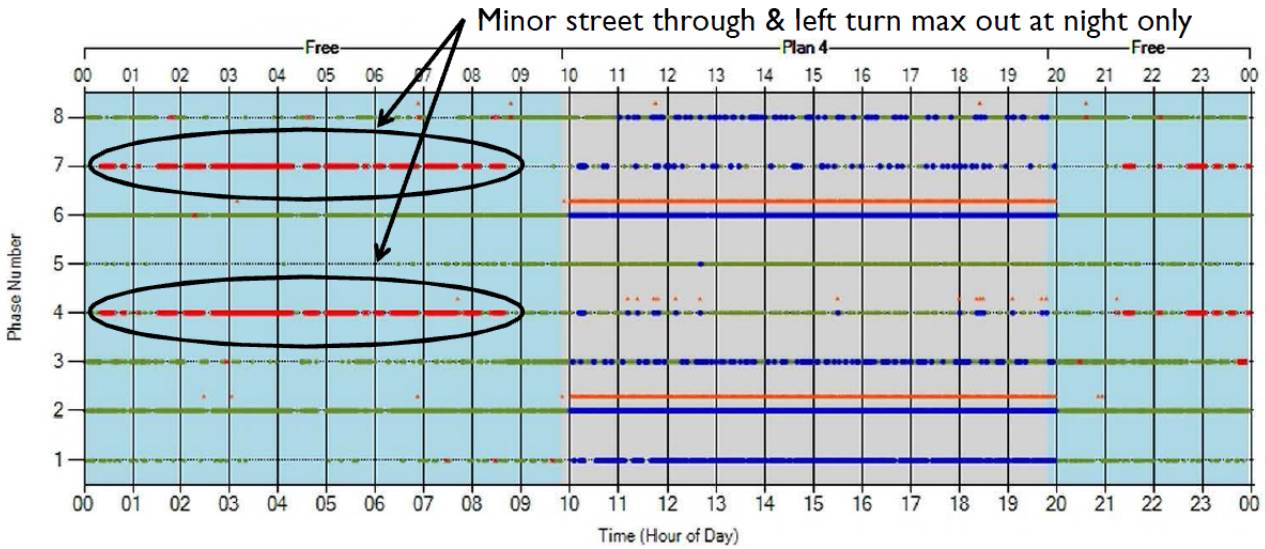
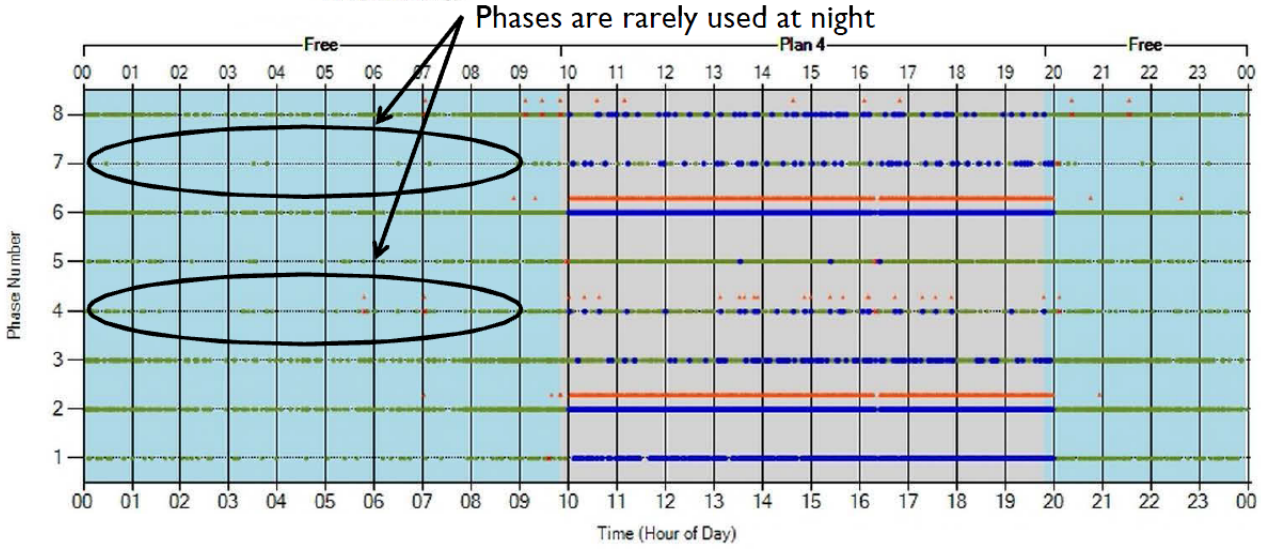
Source: Purdue University

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

Phase Termination Chart



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



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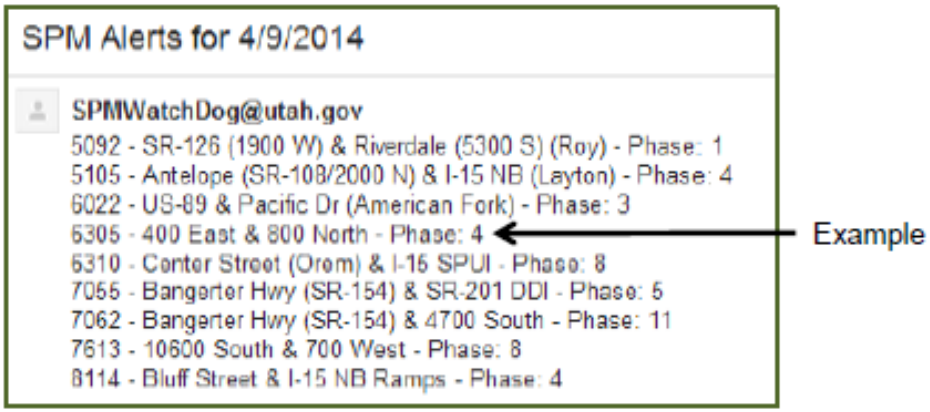
Source: Purdue University

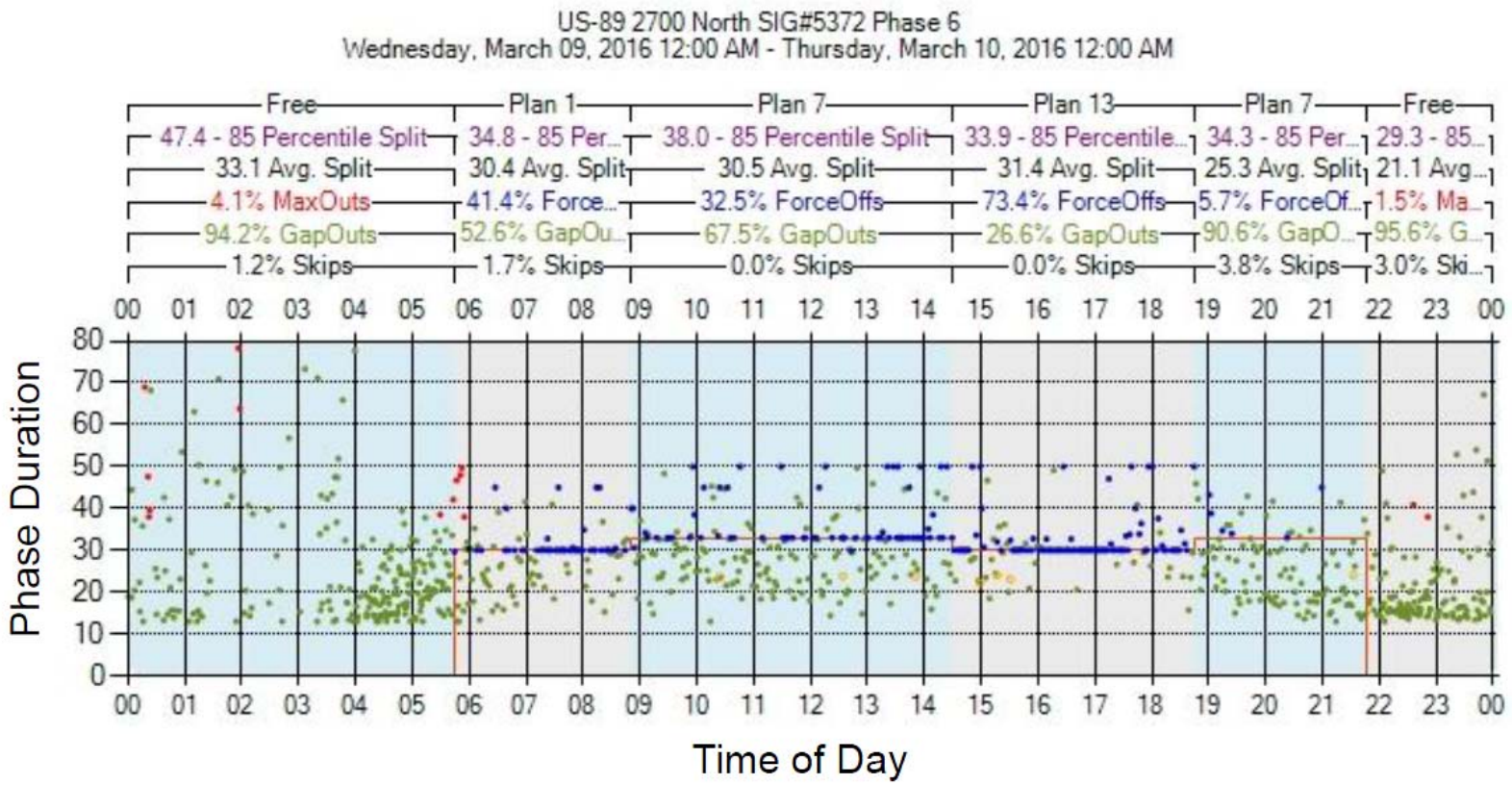
Alert Example: 100% Max Out



- 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.

Source: Utah DOT

Split Monitor (amount of time left)



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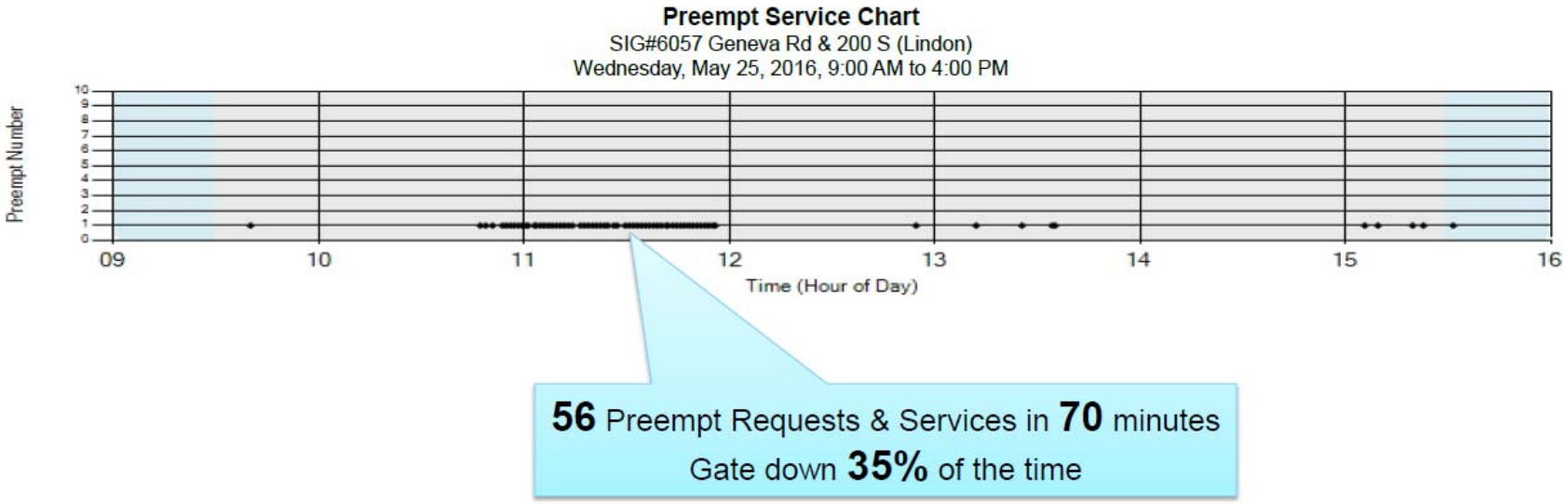
Source: Purdue University

Preemption Details

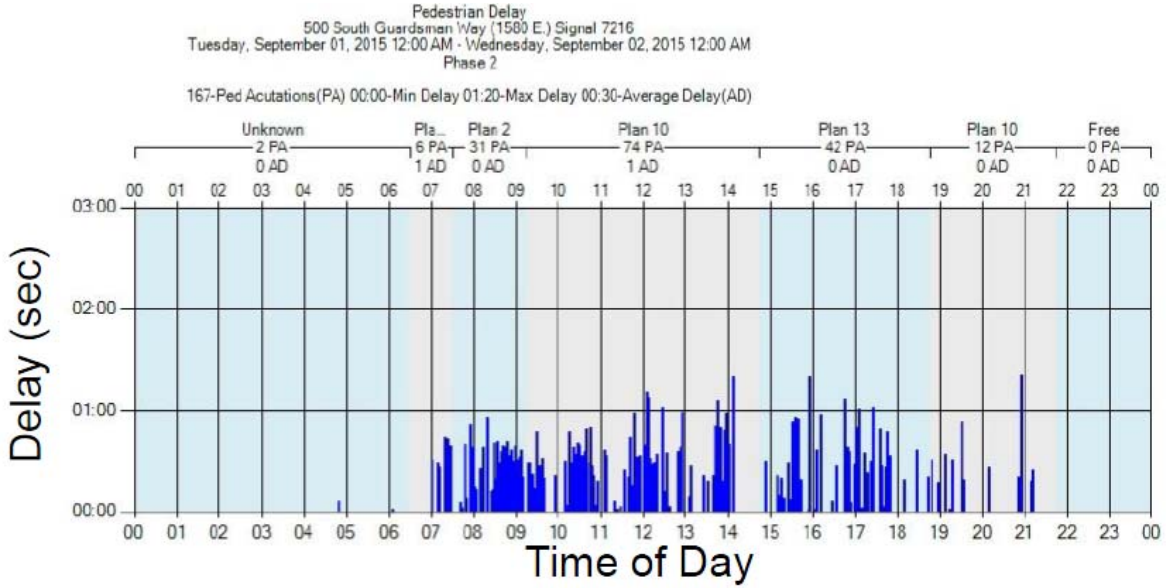


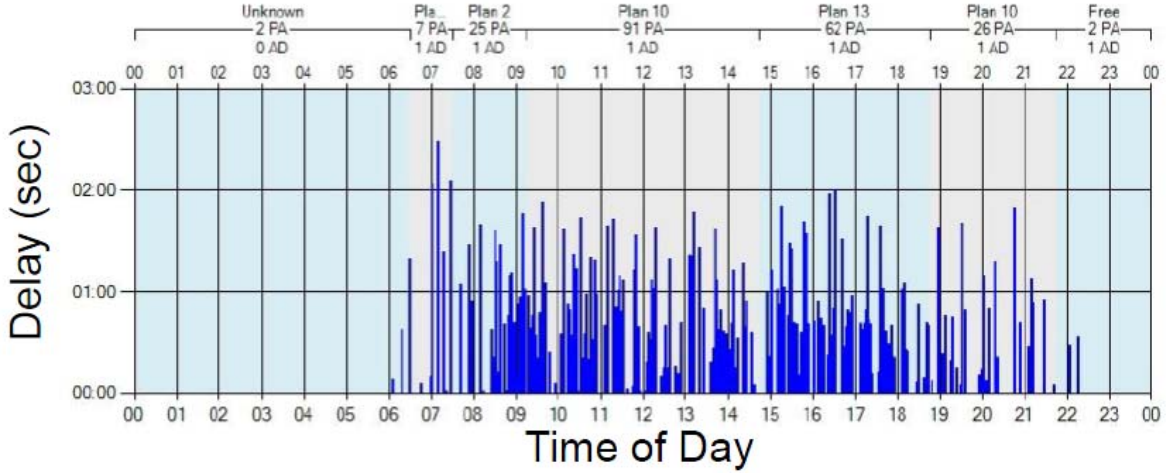
- Train passes through 2x a day Monday, Wednesday, Friday
- Complaints received monthly for a long time. Techs frustrated at this signal.
- Previously, there was no data to provide Union Pacific.

Source: Purdue University

Pedestrian Delay

EVENT CODES
45 – Ped Call on
21 – Ped Walk on





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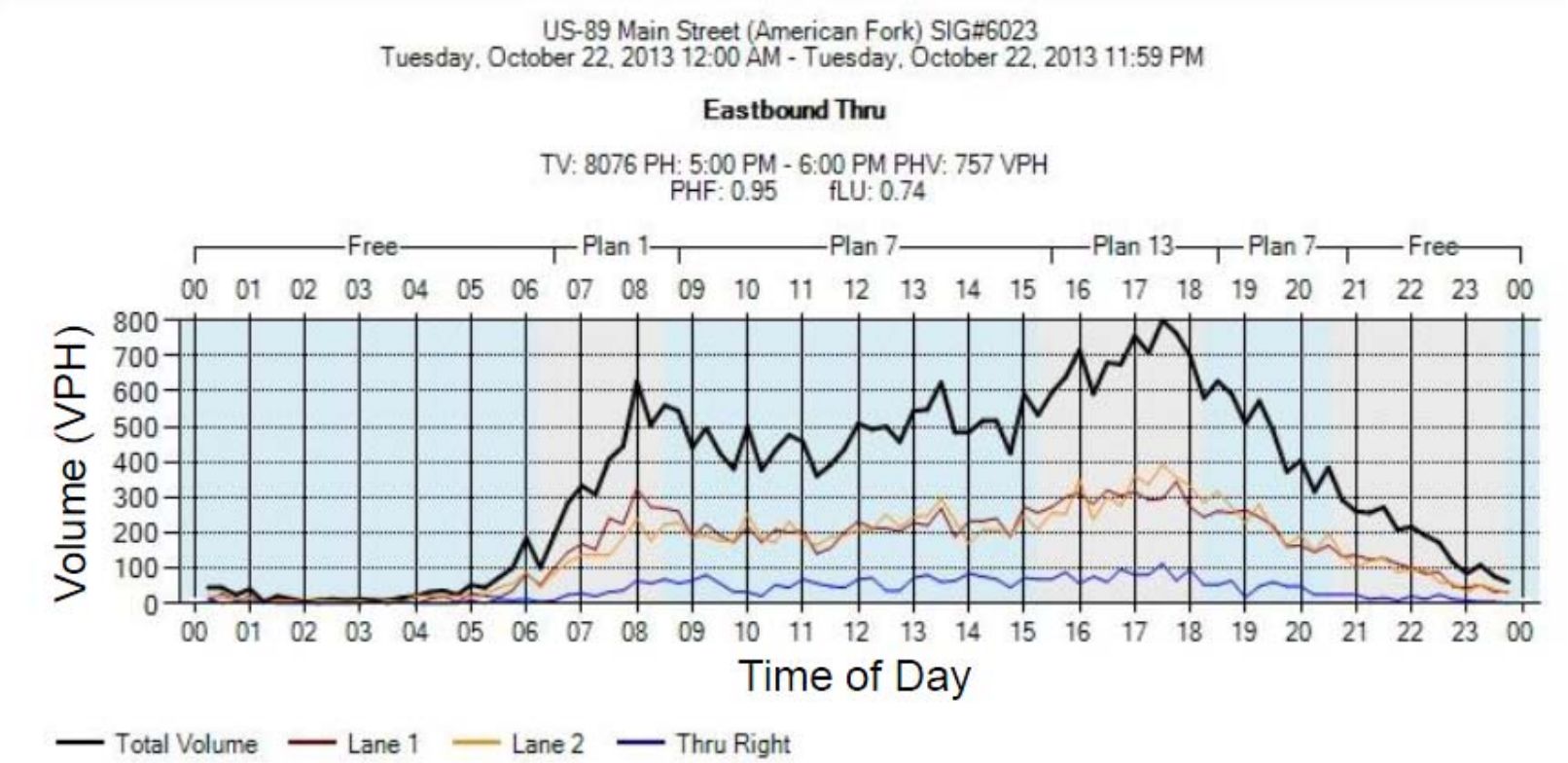
Source: Purdue University

Turning Movement Counts, Lane Utilization (construction activities)



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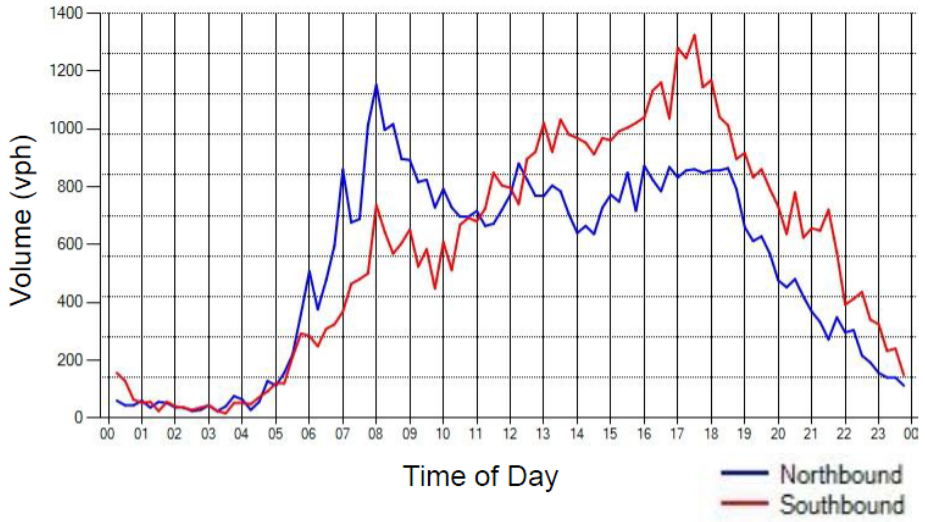
Source: Purdue University

Approach Volumes

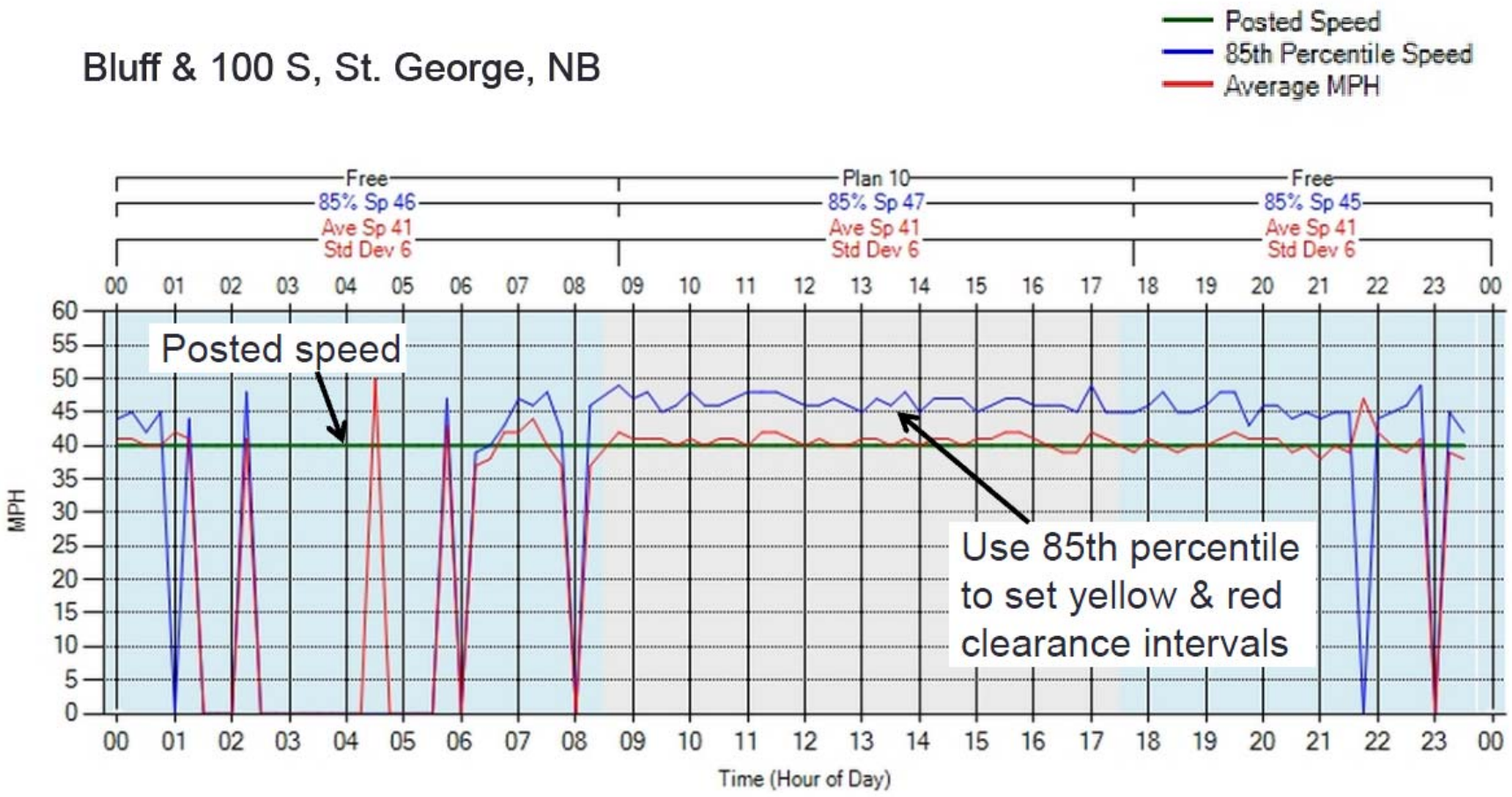


Enhance MPO's, RPO's, TPO's data!

Metric	Value
Total Volume	26,065
Peak Hour	5:00 PM - 6:00 PM
Peak Hour Volume	2,097
PHF	0.96
Peak-Hour K-factor	0.0805
Northbound Total Volume	12,330
Northbound Peak Hour	7:45 AM - 8:45 AM
Northbound Peak Hour Volume	1,044
Northbound PHF	0.906
Northbound Peak-Hour K-factor	0.0847
Northbound Peak-Hour D-factor	0.586
Southbound Total Volume	13,735
Southbound Peak Hour	5:00 PM - 6:00 PM
Southbound Peak Hour Volume	1,248
Southbound PHF	1
Southbound Peak-Hour K-factor	0.0909
Southbound Peak-Hour D-factor	0.68

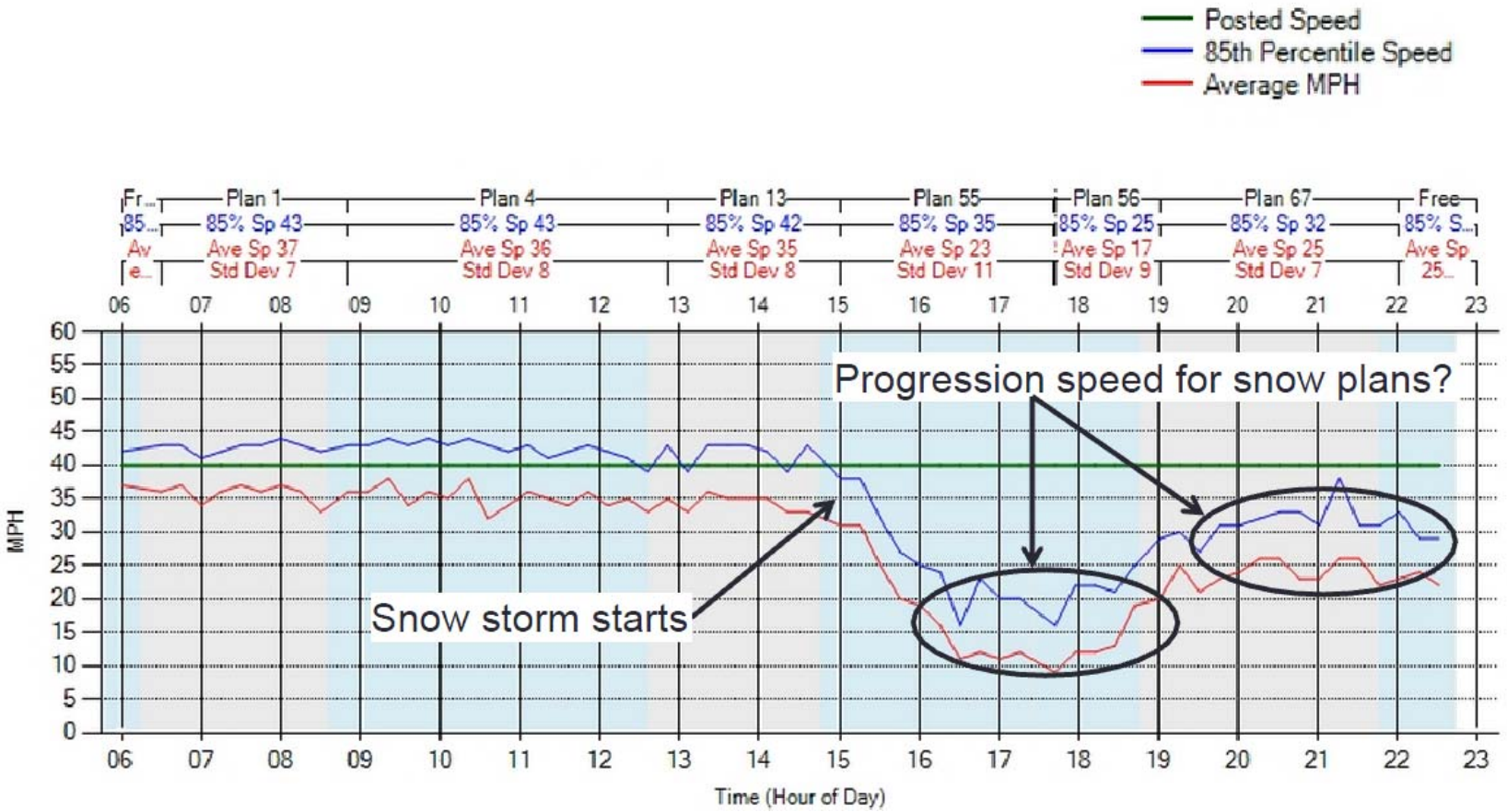
Source: Purdue University

Approach Speed



Source: Purdue University

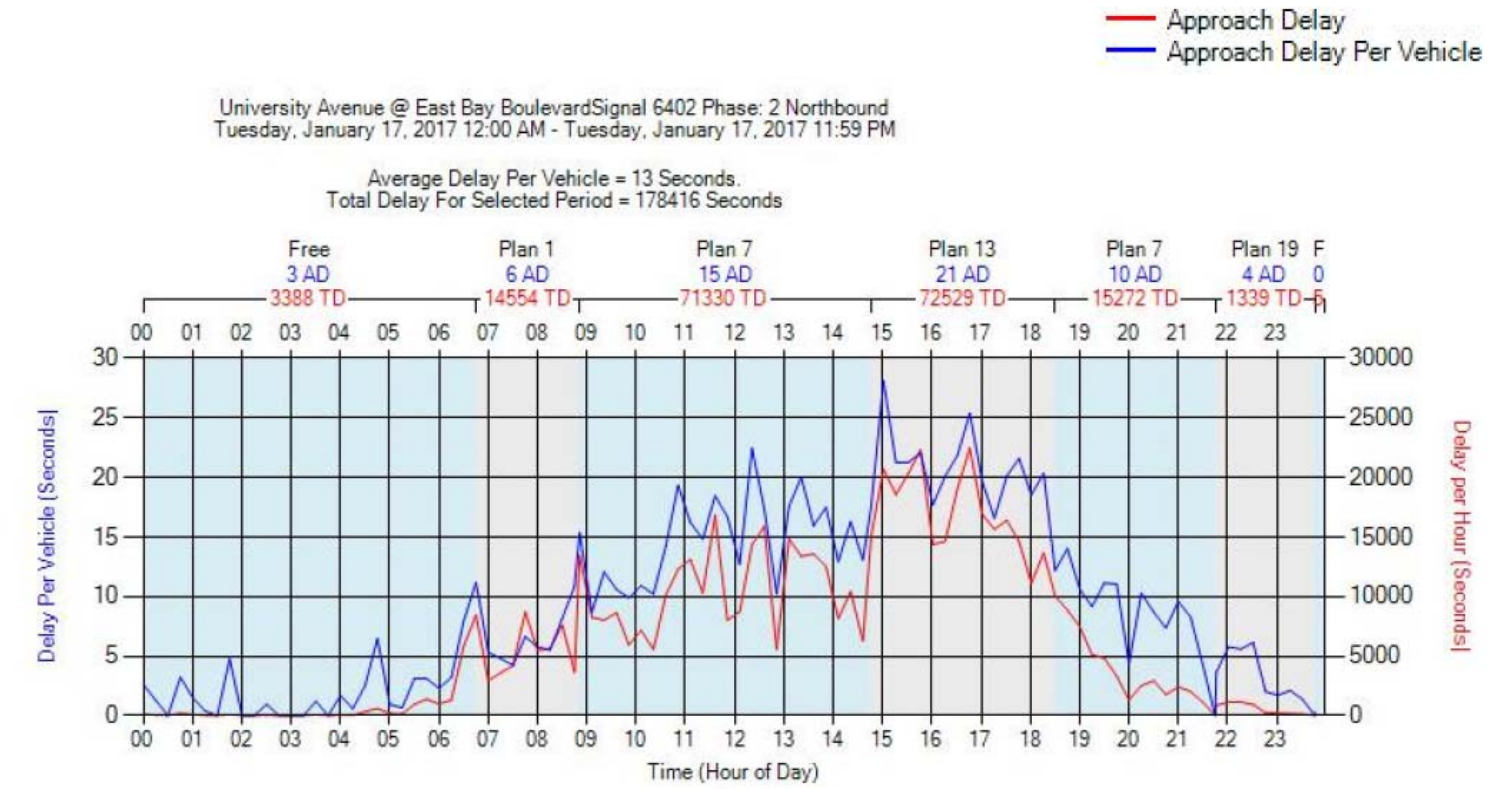
Approach Speed (change of timing plans)



Source: Purdue University

Approach Delay

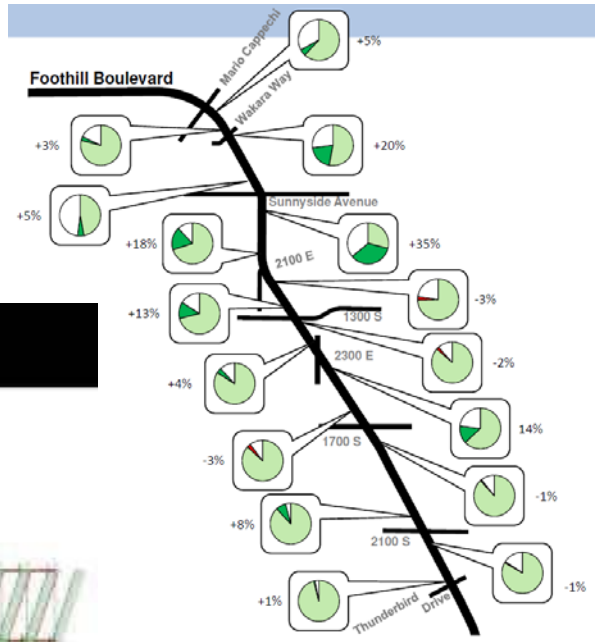
Detection Requirements: Approach counts

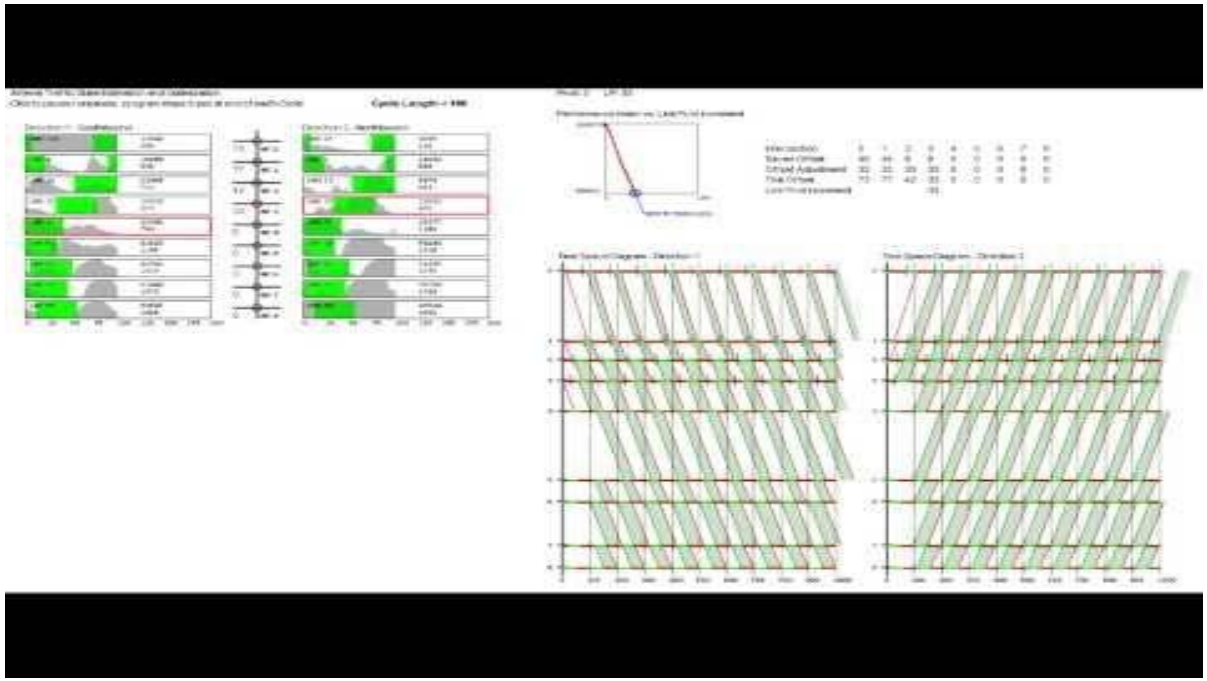


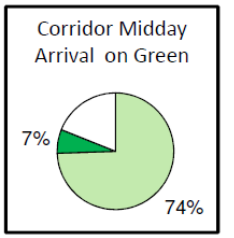
Simplified Approach Delay. Displays time between approach activation during the red phase and when the phase turns green.
Does NOT account for start up delay, deceleration, or queue length that exceeds the detection zone.

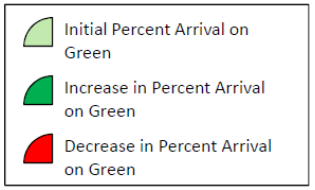
Source: Utah DOT

Purdue Link Pivot





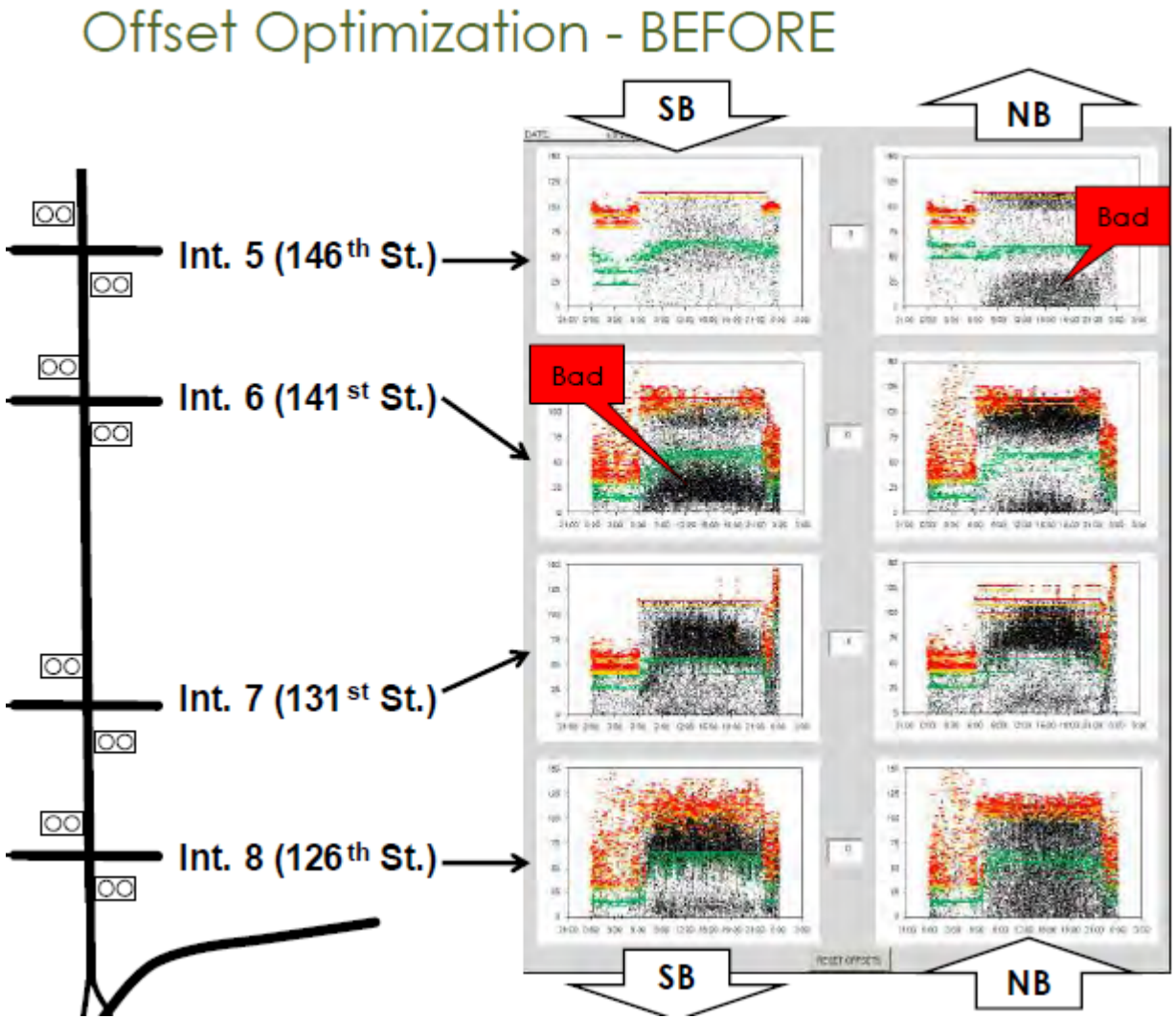




The algorithm works by stepping through possible offsets at each intersection while trying to find the minimum delay or maximum arrivals on green.

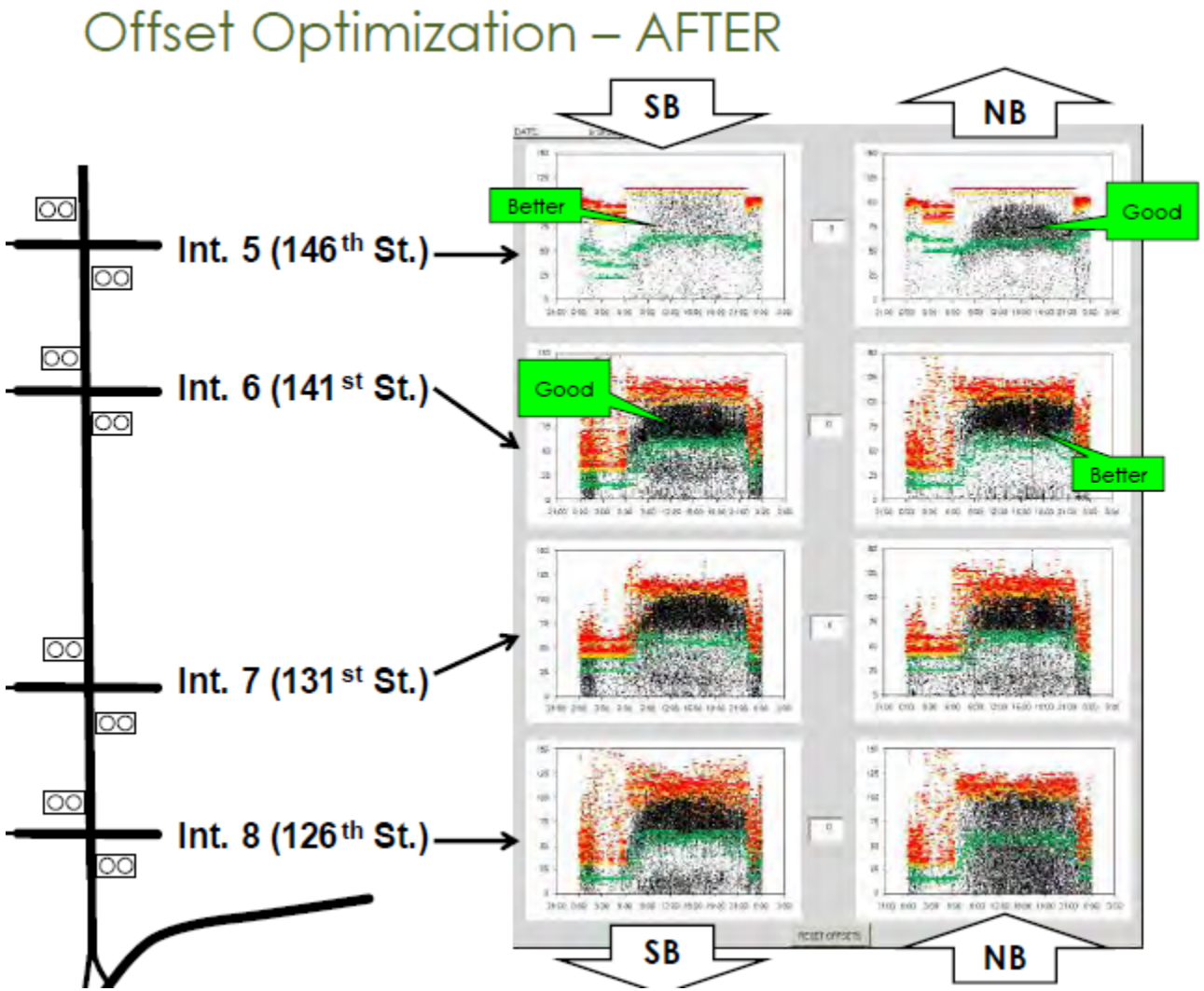
Source: Purdue University

Purdue Link Pivot



Source: Purdue University

Purdue Link Pivot



Source: Purdue University

ATSPM In Practice

Source: GDOT

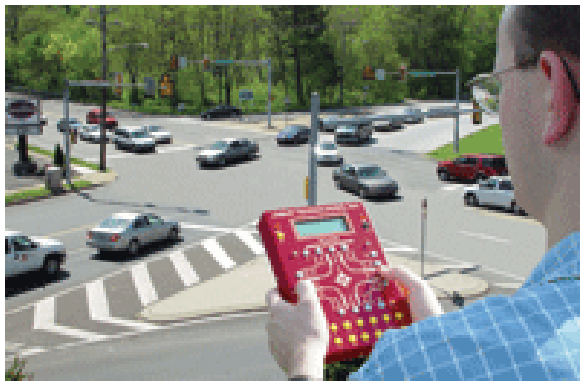
State Efforts

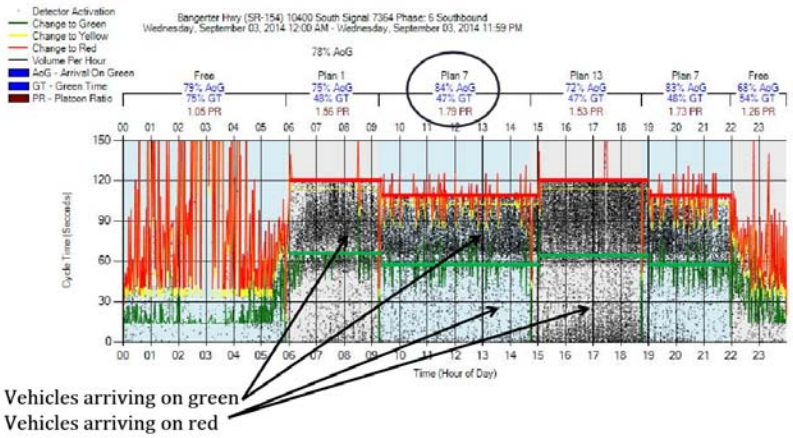
- Collaboration with the City of Knoxville (ATMS)
- Focus on arterials
- TDOT/FHWA identifying additional potential local agencies
- TN Traffic Signal Users Group

Challenges:

- Detection
- $$$
- Using the data

ATSPM
Automated Traffic Signal Performance Measures





- Asset management tool
- Aids timing and coordination
- Assists planning, justify investments

Airton Kohls

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Thank You!