ACHIEVE YOUR AGENY'S OBJECTIVES USING AUTOMATED TRAFFIC SIGNAL PERFORMANCE MEASURES

INSTITUTUTE OF TRANSPORTATION ENGINEERS WEBINAR PART 1 – APRIL 9, 2014

ITE Webinar Series on Automatic Traffic Signal Performance Measures (SPMs)

- Achieve Your Agency's Objectives Using SPMs

  April 9, 2014 12:00 pm to 1:30 pm.
- SPMs Case Studies

  May 7, 2014 12:00 pm to 1:30 pm.
- Critical Infrastructure Elements for SPMs

  June 11, 2014 12:00 pm to 1:30 pm.

Automated Traffic Signal Performance Measures

Technology Implementation Group: 2013 Focus Technology

http://tig.transportation.org/

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

Your Speakers Today

Darcy Bullock

Jim Sturdevant

Rob Clayton

Rick Denney

ACHIEVE YOUR AGENCY'S OBJECTIVES USING AUTOMATED TRAFFIC SIGNAL PERFORMANCE MEASURES

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PRESENTED BY DARCY BULLOCK, PURDUE UNIVERSITY, APRIL, 9 2013

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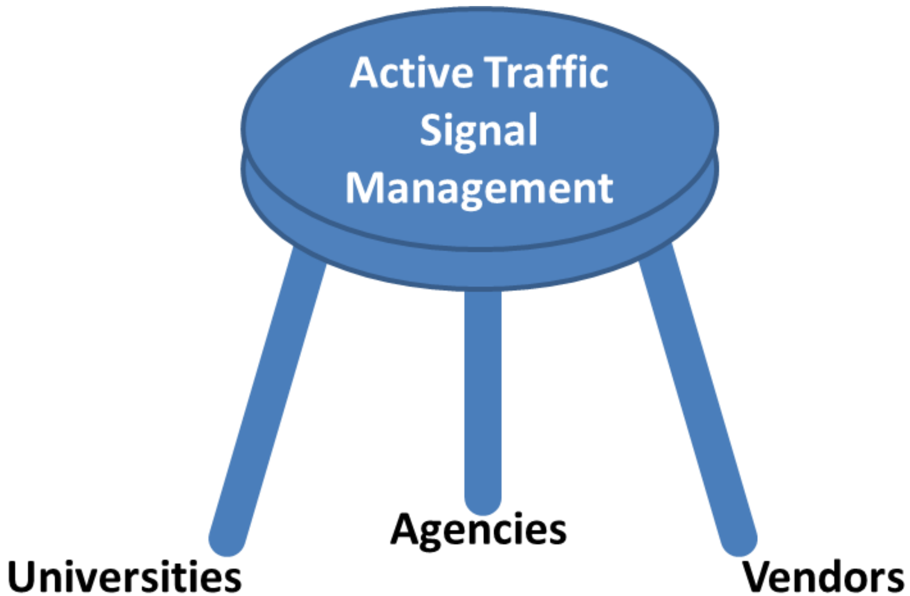
PRESENTED BY JIM STURDEVANT, INDOT, APRIL, 9 2013

How did we get here- Indiana Perspective

INDIANA HISTORY AND PATH TO SPM

- Purdue / INDOT Partnership
- Shared Vision
- Industry Collaboration

Emerging Shared Vision



1. Develop infrastructure and procedures to systematically prioritize investing engineering resources
2. Assess that impact

Dual Cabinets at Purdue 1998-2000

Signal Cabinet (INDOT)

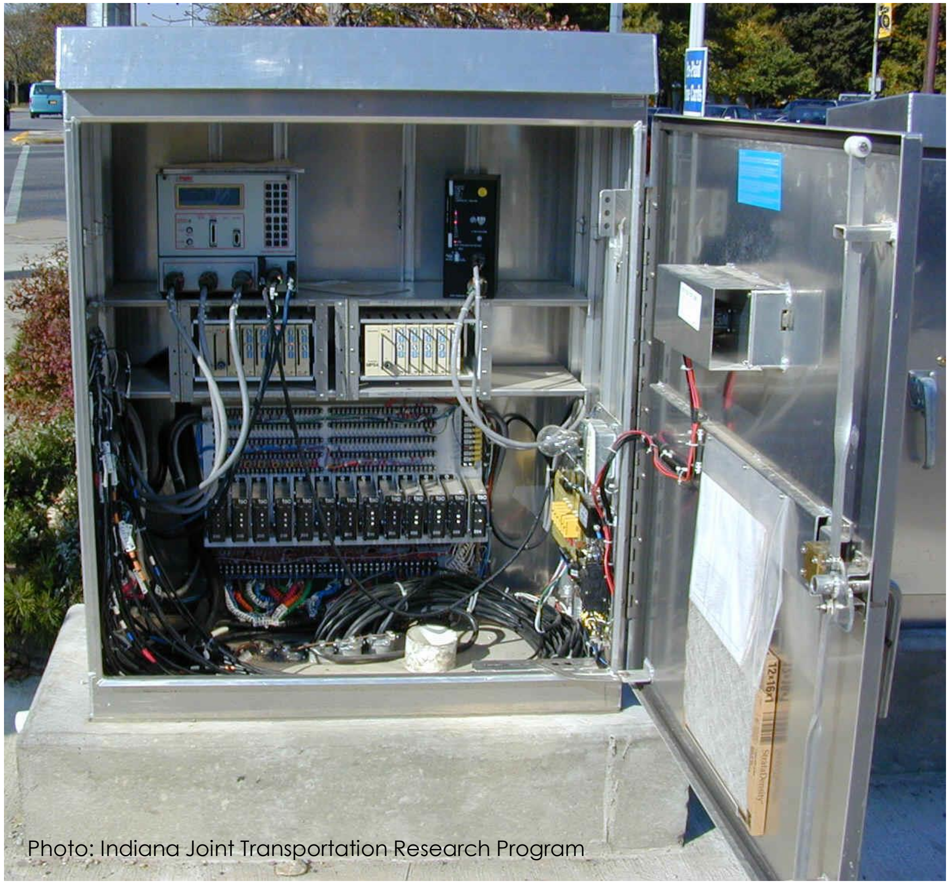


Photo: Indiana Joint Transportation Research Program

Instrumentation Cabinet (Purdue)

- Fiber Connection
- Video Modems
- IP Based I/O Monitoring

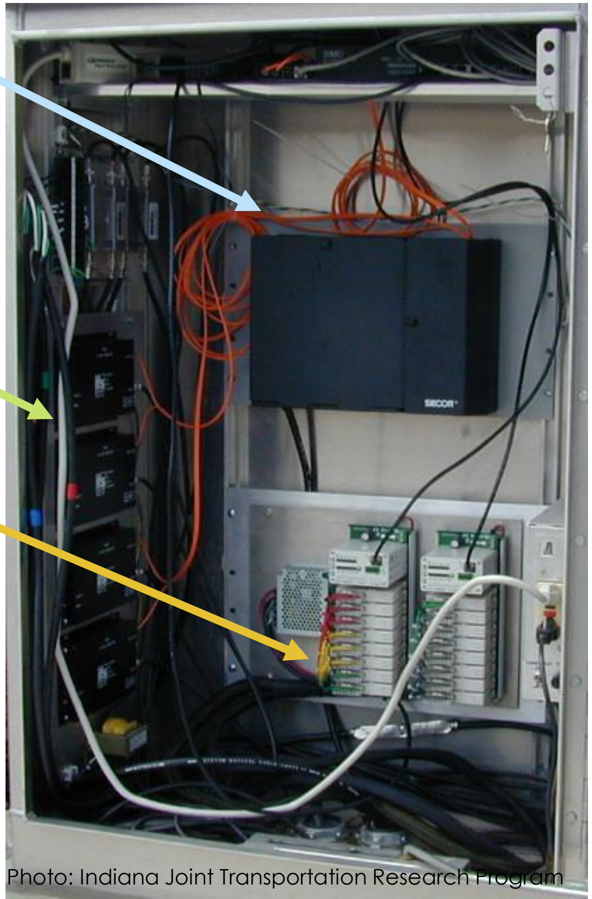
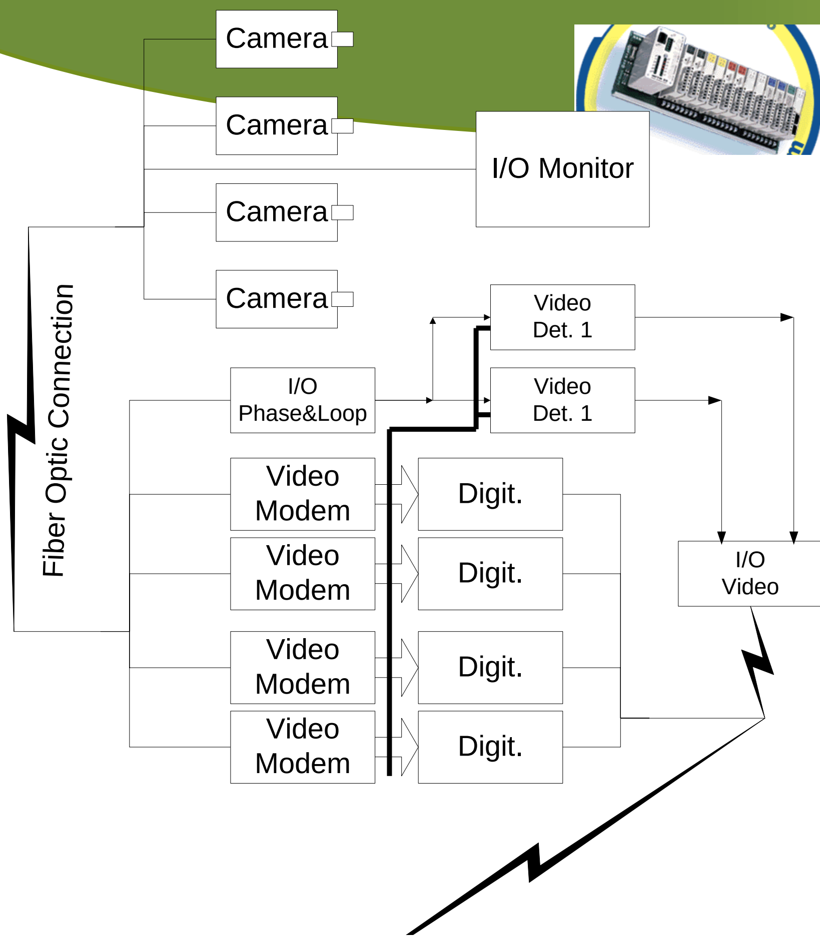


Photo: Indiana Joint Transportation Research Program

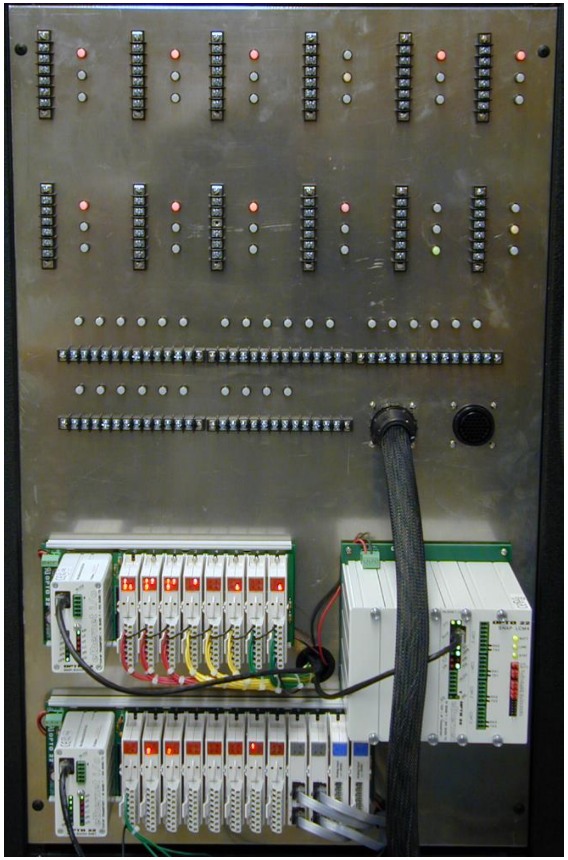
Purdue Indoor Facility

Photo: Indiana Joint Transportation Research Program

Indoor End of Equipment

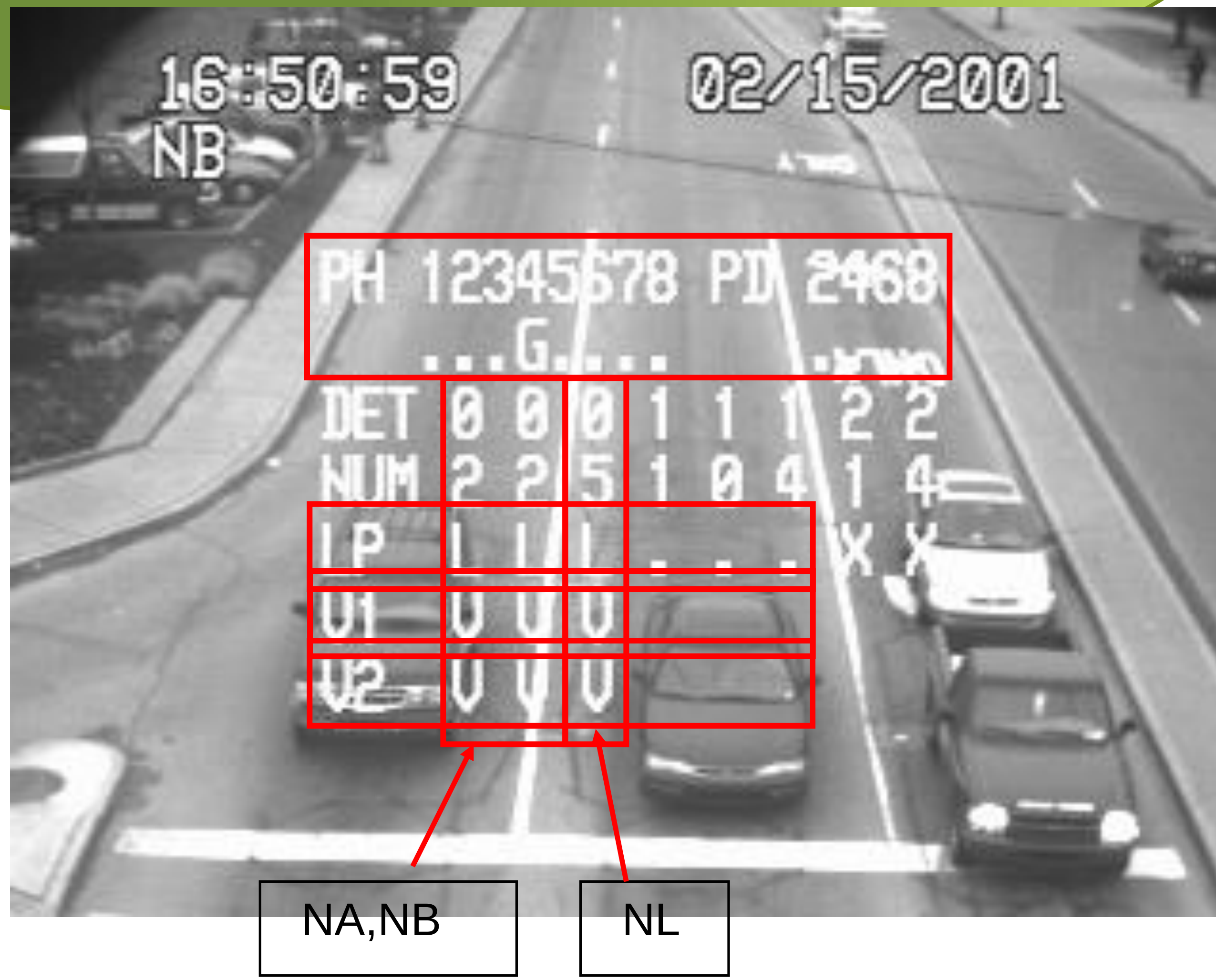


Indoor Interface: Signal Status & Cabinet



Pre-2004 Text Overlay-Phase calls and status

- Phase Indication
- ILD Status
- VID1 Status
- VID2 Status



Early 2000's collaboration and problem solving

- Fall 2001 Purdue Completed study of video detection
  - Report identified some issues
  - INDOT verified issues in field

2002-2003 Indiana Detection Performance Concerns

- Summer 2002
  - Vendors proposed new design procedures for poles/arms/camera placement. .**Will it work?**
  - INDOT drafts design and performance specifications **..Will sensors meet it?**
  - INDOT plans for a test site with optimal camera placement **..With capabilities to measure performance!**
- Fall 2003
  - INDOT Constructs test facility in Noblesville to evaluate design and performance specifications
  - Laid the ground work for further research.

High resolution intersection data "Instrumented Intersections" Built

- Noblesville, IN
  - Suburban, High speed
  - Completed summer 2003.
- West Lafayette, IN
  - Urban, Pedestrians
  - Completed summer 2004

Lots of sensors!

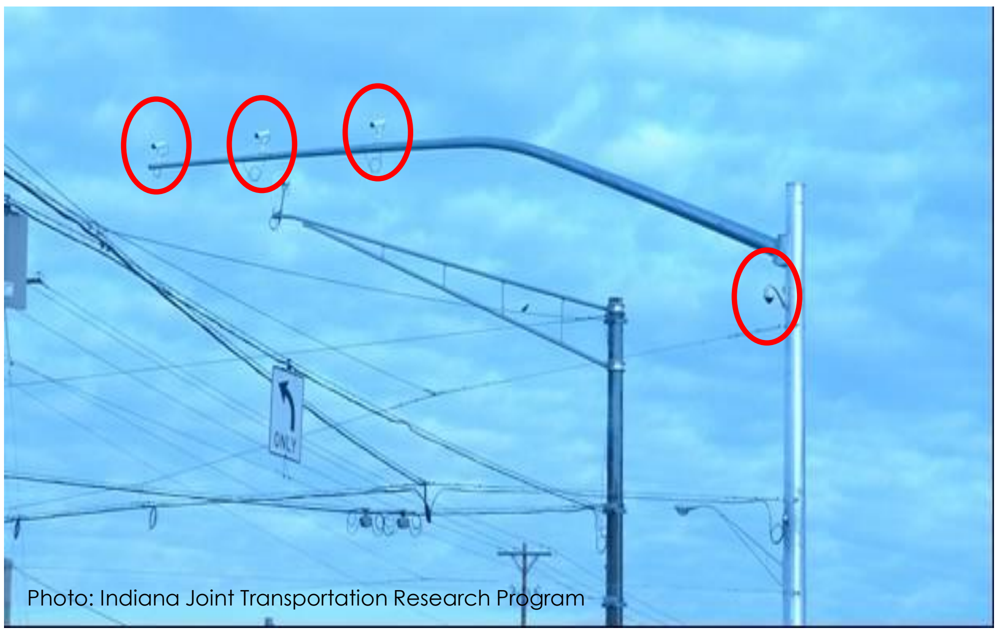


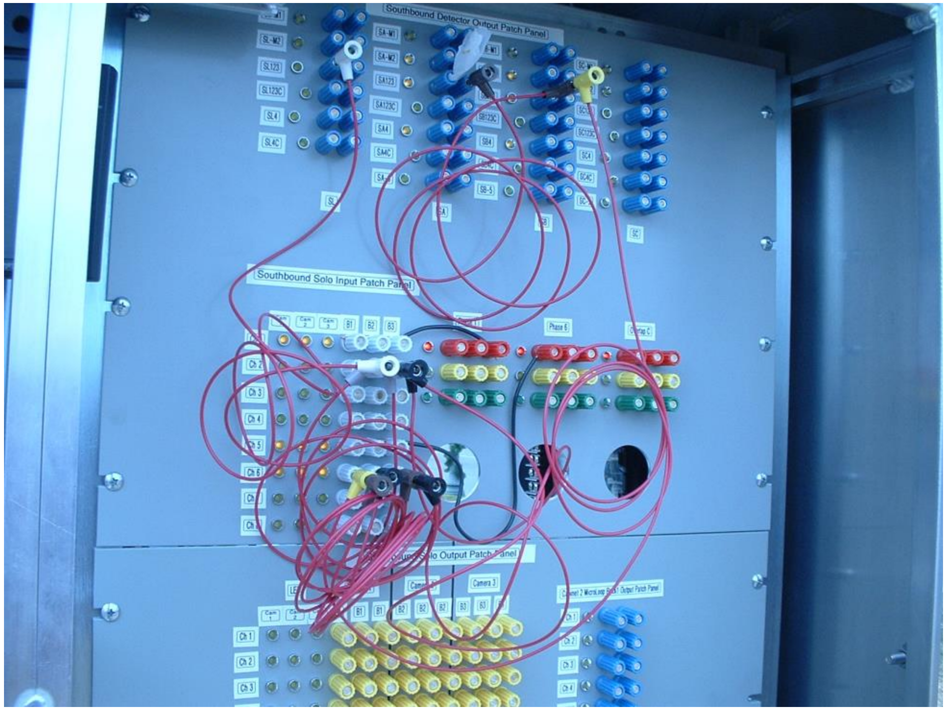
Photo: Indiana Joint Transportation Research Program

Photo: Indiana Joint Transportation Research Program

Lots of Conduit!

Photos: Indiana Joint Transportation Research Program

Data collection- Switchboard



Patch Panel Switchboard

Homebrewed design/build

Dual Cabinets

Front view (INDOT, Purdue)

Rear view (Purdue, INDOT)

October 2006 State of the practice

Displays: 2000 Vs 2004

2003-2005 Intersection Subsystem Metrics

- Stopbar Detection
- Advance Detection
- Non-loop technologies
- Lane by Lane opportunities
- Controller features/ and functions

2004-2006 Dual Cabinet Data Collecting Procedure

24V signal or load switch

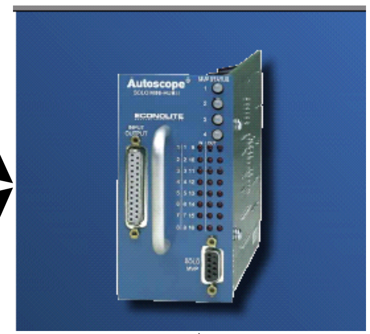
Loop detector rack outputs

8 inputs

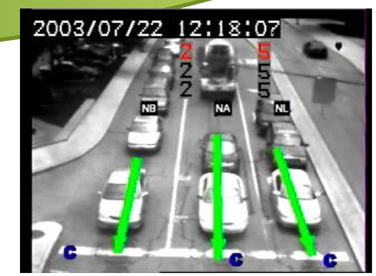
LT green

Th green

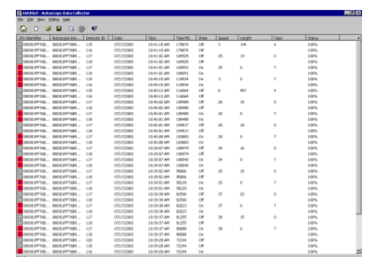
6 auxiliary for detector monitoring



6 pair cable from camera

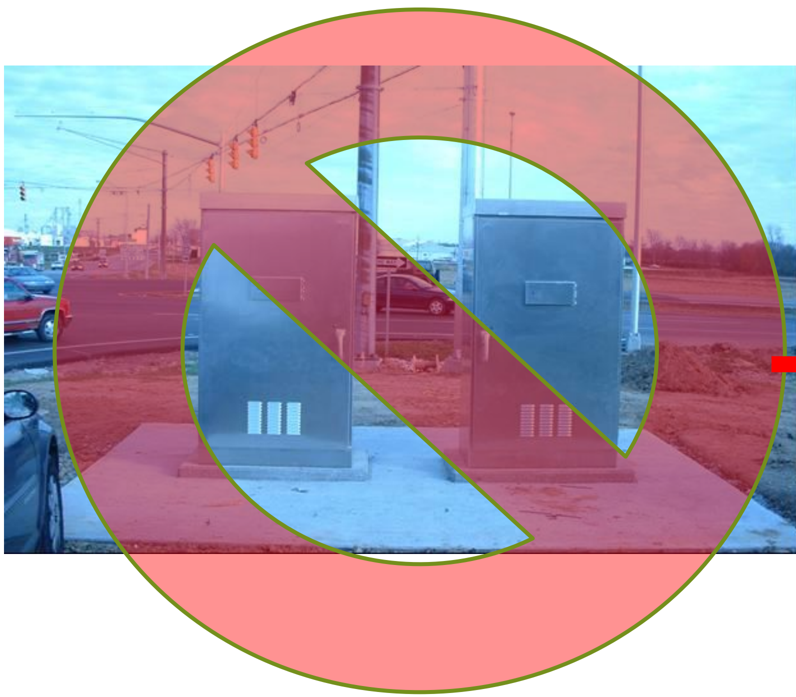


Overlay



Data file

Needed a scalable solution for all signal performance metrics



2008 Team Discussion of High Resolution Data Logging

Architecture

Log Events

Standard Enumerations

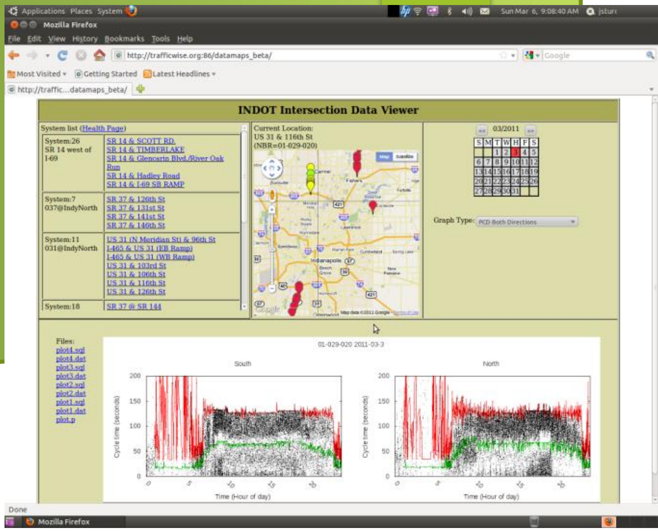
100 ms

30 hours storage

Ethernet

FTP Protocol

Translate to CSV

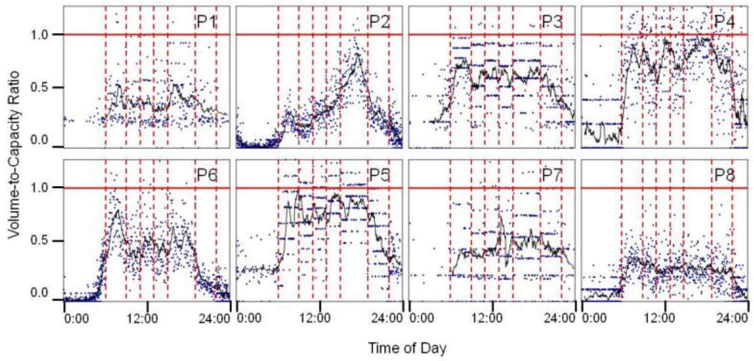


NCHRP 3-79a
Sept 2008-Dec 2009

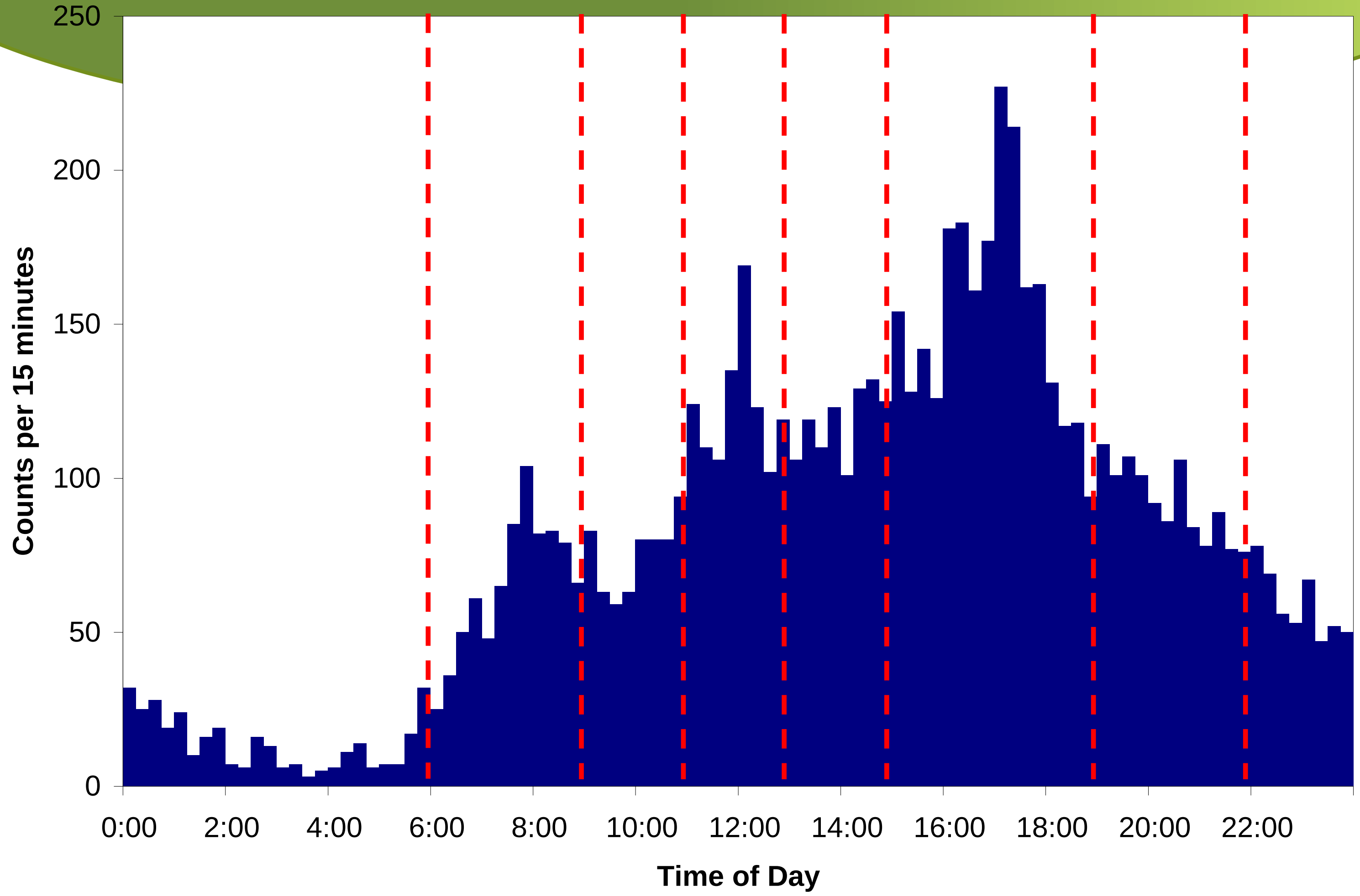
- Accepted Traffic Engineering Methods
- Applied to Traffic Controllers
- Picture book methods
- Surrogate for a trip to the field

2006-2008 Intersection Metrics

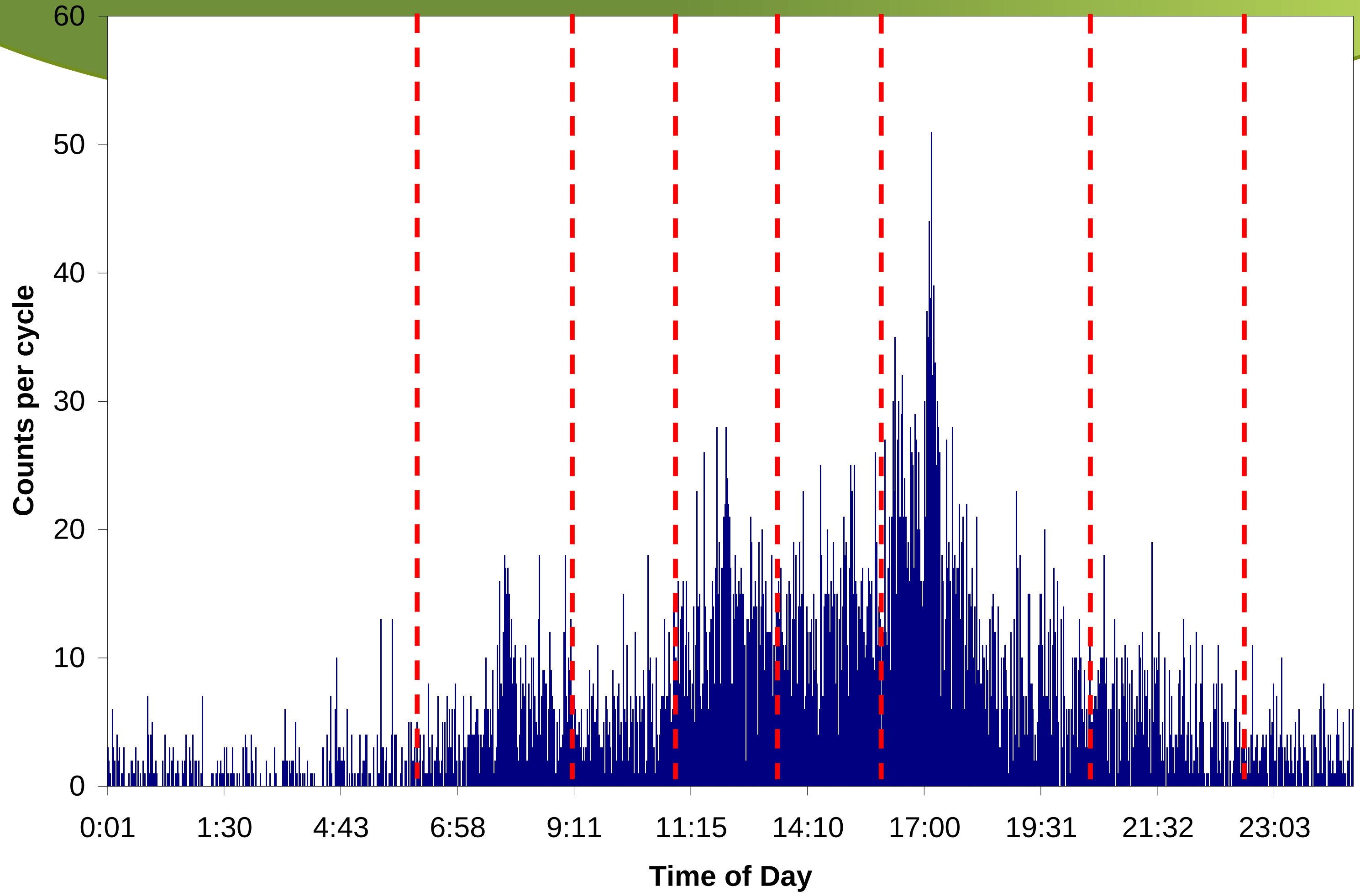
- Volume to Capacity
- Intersection Saturation
- Lane by Lane detection
- Actuated Coordination
- Counting detectors
- Advance detectors



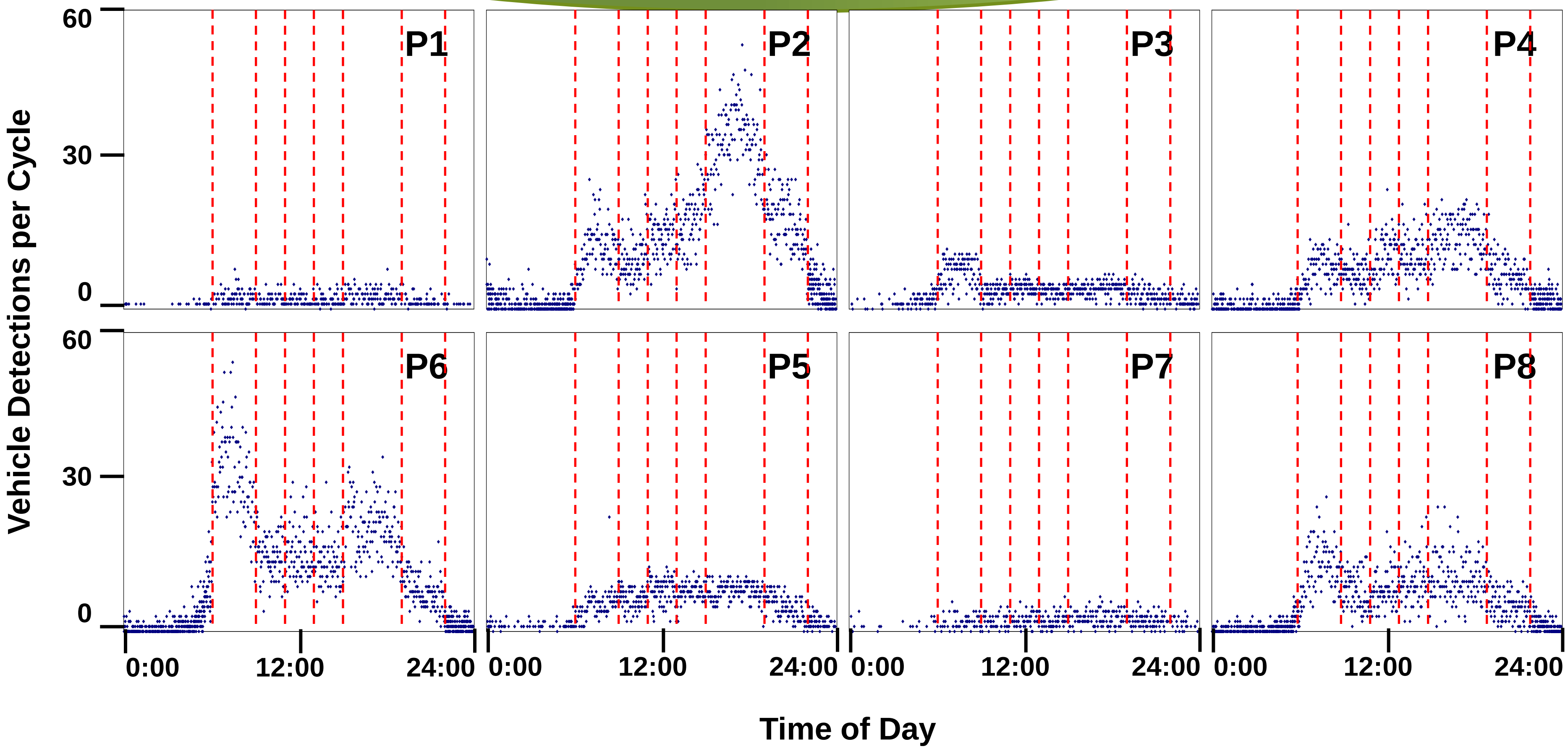
15-Minute Counts (Phase "n")



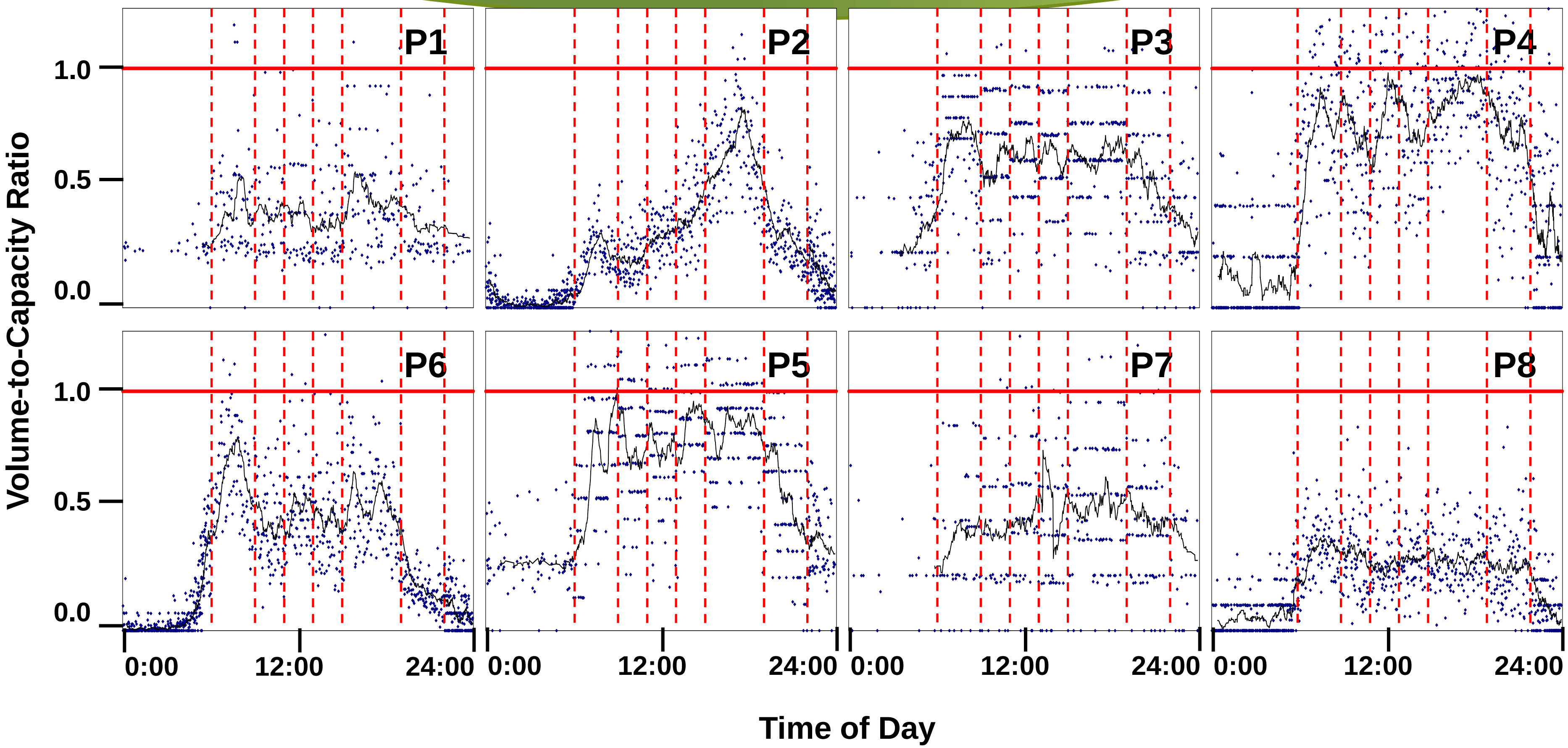
Cycle-By-Cycle Counts (Phase "n")



24 Hour Counts by phase

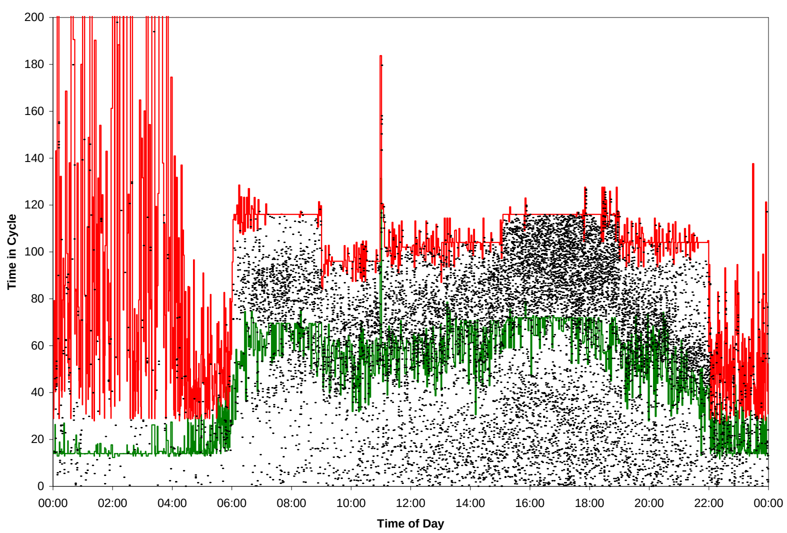


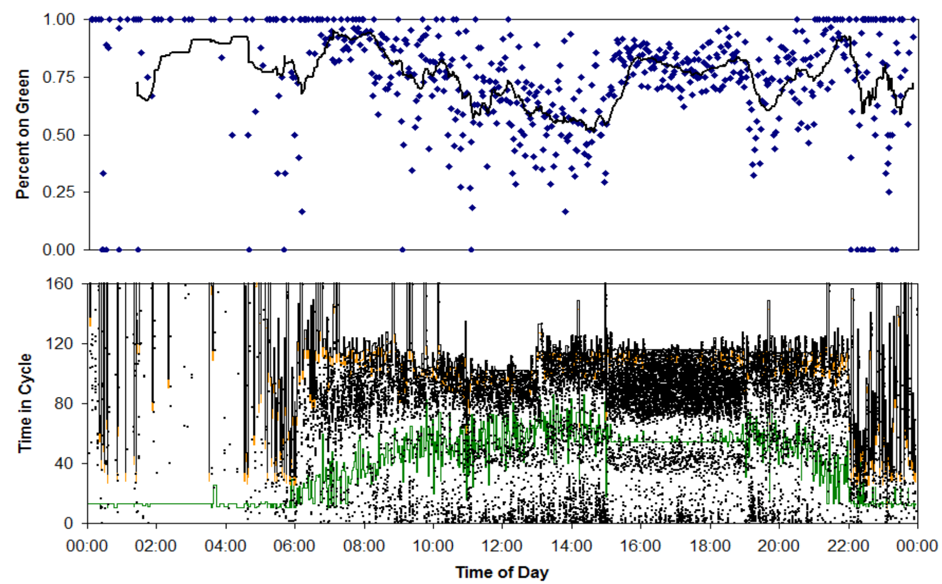
V/C Ratios by Phase, 24 Hours



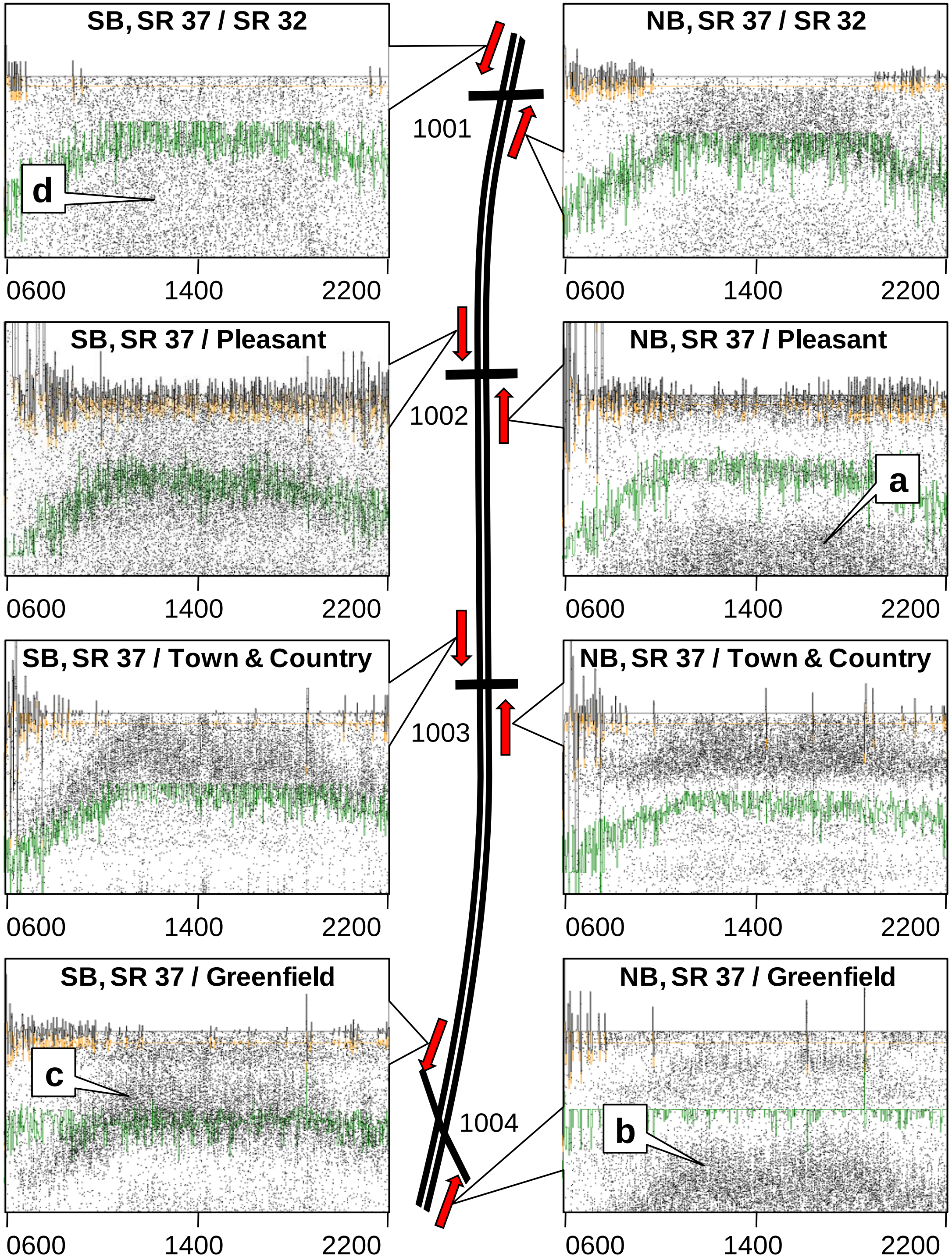
3/13/2008- Systemwide Metrics begin

Early PCD and POG- Created 4/30/08



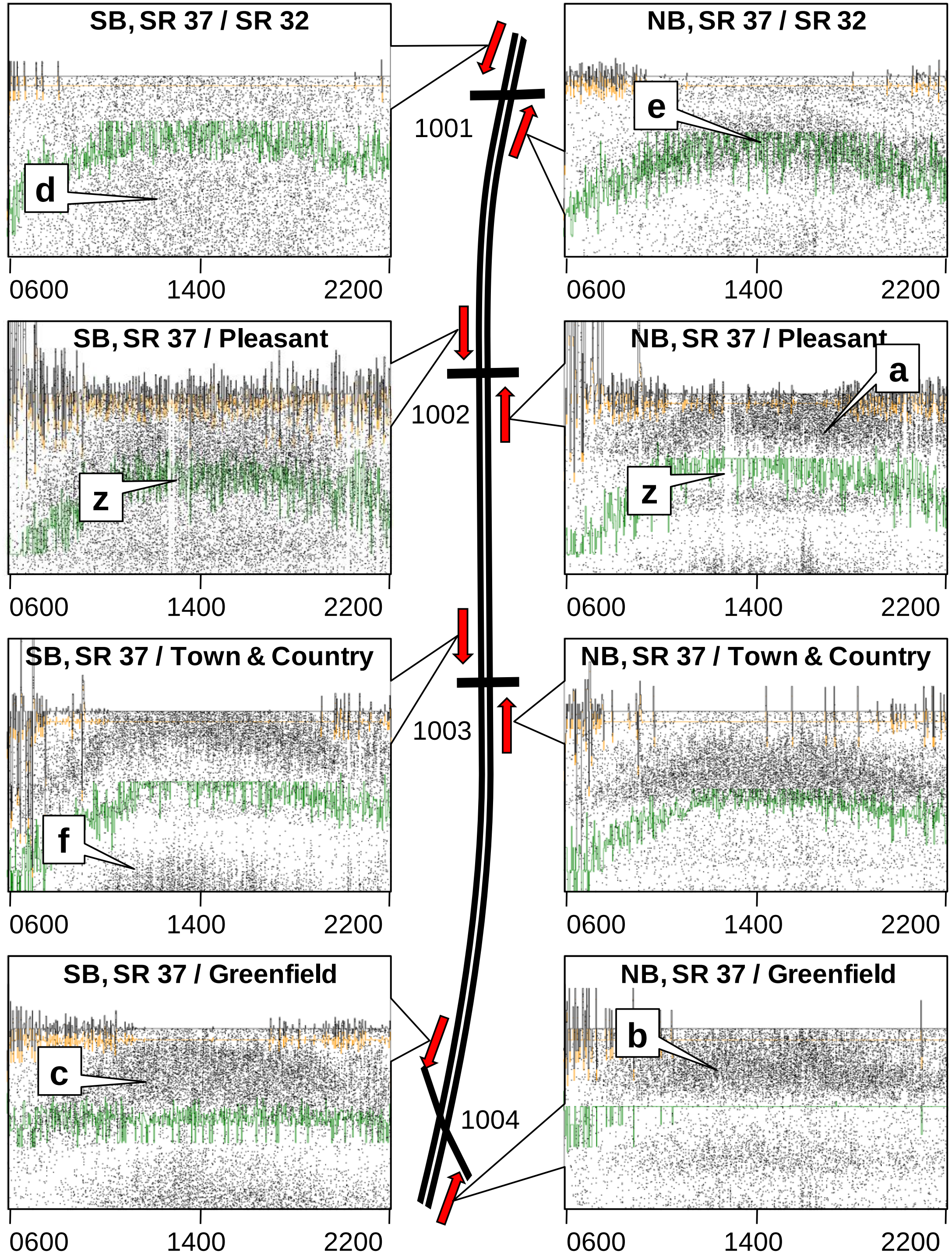


Before



SB, SR 37 / SR 32
NB, SR 37 / SR 32
SB, SR 37 / Pleasant
NB, SR 37 / Pleasant
SB, SR 37 / Town & Country
NB, SR 37 / Town & Country
SB, SR 37 / Greenfield
NB, SR 37 / Greenfield
1001
1002
1003
1004
a
b
c
d
0600
1400
2200

After



SB, SR 37 / SR 32
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SB, SR 37 / Town & Country
NB, SR 37 / Town & Country
SB, SR 37 / Greenfield
NB, SR 37 / Greenfield
1001
1002
1003
1004
a
b
c
d
e
f
z
z
0600
1400
2200

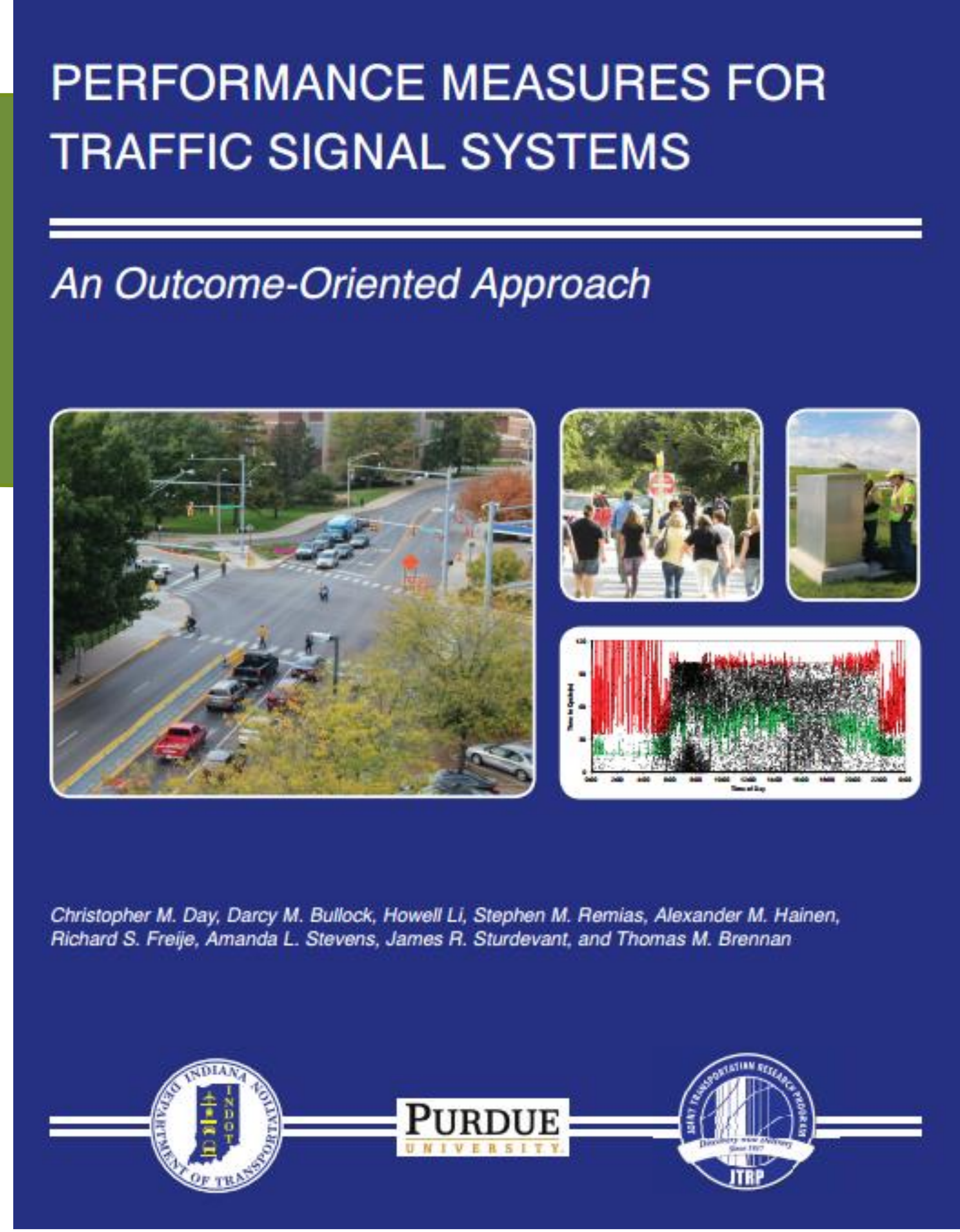
2014:Enumeration Support by 5 vendors

- Econolite
- Peek
- Eagle
- Intelight
- Naztec (Beta)

http://dx.doi.org/10.5703/1288284315018

2014:Monograph documenting

- Volumes
- v/c ratios
- Pedestrian Service
- Preempt Operation
- PCD
- Link Pivot Optimization
- Split Failures (GOR/ROR)
- Probe Data Assessment Techniques
- Detector Mapping



http://dx.doi.org/10.5703/1288284315333

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INSTITUTE OF TRANSPORTATION ENGINEERS WEBINAR PART 1 – APRIL 9, 2014

PRESENTED BY ROB CLAYTON, UDOT

Utah Department of Transportation Brief Facts

- Population 2,800,000 (34th largest state)
  - 80% live along the Wasatch Front
- Land Area: 84,900 sq. mi (13th largest state)
- 1900 Traffic Signals in the State of Utah
  - 1150 owned and operated by UDOT
  - 750 owned and operated by cities /counties
- All partners share same ITS communications
  - 83% of UDOT signals connected
  - 71% of non-UDOT signals connected

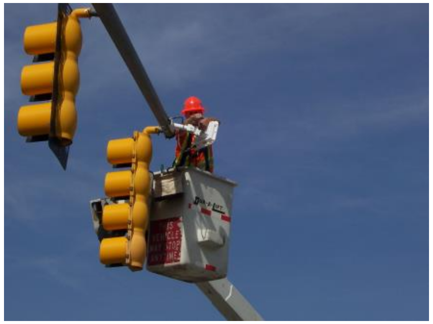
Quality Improvement Team (QIT) 2011

John Njord, former UDOT Director & former AASHTO President:

"What would it take for UDOT's Traffic Signal Operations to be <u>World Class</u>?"

Njord, John. , Portrait. August 28, 2007. Retrieved from udot.utah.gov.

What Defines World-Class Signals?



Signal Equipment Fully Functional

Signal Timing Optimal

Active Monitoring (SPMs)

Photos courtesy of the Utah Department of Transportation

World Class Signals
Best Practices Identified

World Class Best Practice	UDOT Practice	Grade
SIGNAL OPERATIONS		
Use of traffic signal control software to manage signal operations	UDOT uses Siemens i2 software, as do all of our partner agencies.	
Re-time signals every 30 to 36 months	Not possible with current resources. Efforts focus on obvious problems.	
Automated, real-time monitoring of signal system health and performance	None	
Performance measurement of signal operations	None	
Quality signal timing during construction	Not required or common. Large projects sometimes hire timing consultants.	
Quality signal timing during incidents, civic events, and weather events	Limited. There are no stated goals, or resources identified to support those goals.	
Implementation of adaptive signal operations	2 demonstration projects: SCATS in Park City; ACS Lite in Heber	

Sample QIT Recommendations (July 2011)

"Transition from reactive to proactive signal maintenance by increasing signal maintenance funding."

"Require that communications and signal detection be maintained during construction projects, and require signals to be fully functional before turning them on."

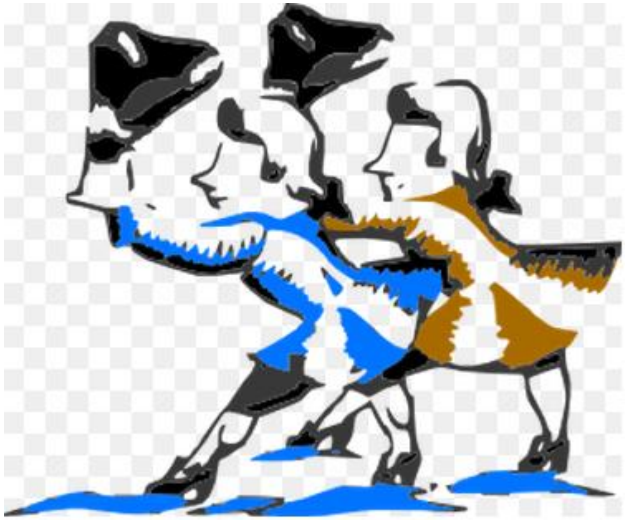
"Implement real-time monitoring of system health and quality of operations."

Hats off!

Purdue University & Indiana DOT
Paving the Way since 2005

Automated Traffic Signal Performance Metrics

Darcy Bullock



Jim Sturdevant

Photos courtesy of Darcy Bullock and Jim Sturdevant

Performance Metrics Goals

- Transparency and Unrestricted Access
  - No Special Software – No Passwords – No Firewalls
- Access for Everyone
  - Intra Agency
  - Consultants
  - Academia
  - MPO's
  - Local & Federal Governments
  - Executive Leaders
  - Public

Automated Signal Performance Metrics *(How does it work?)*

1. Traffic signal controllers – 1/10th s. data logger time-stamps (Event Code, Parameter, Time Stamp)

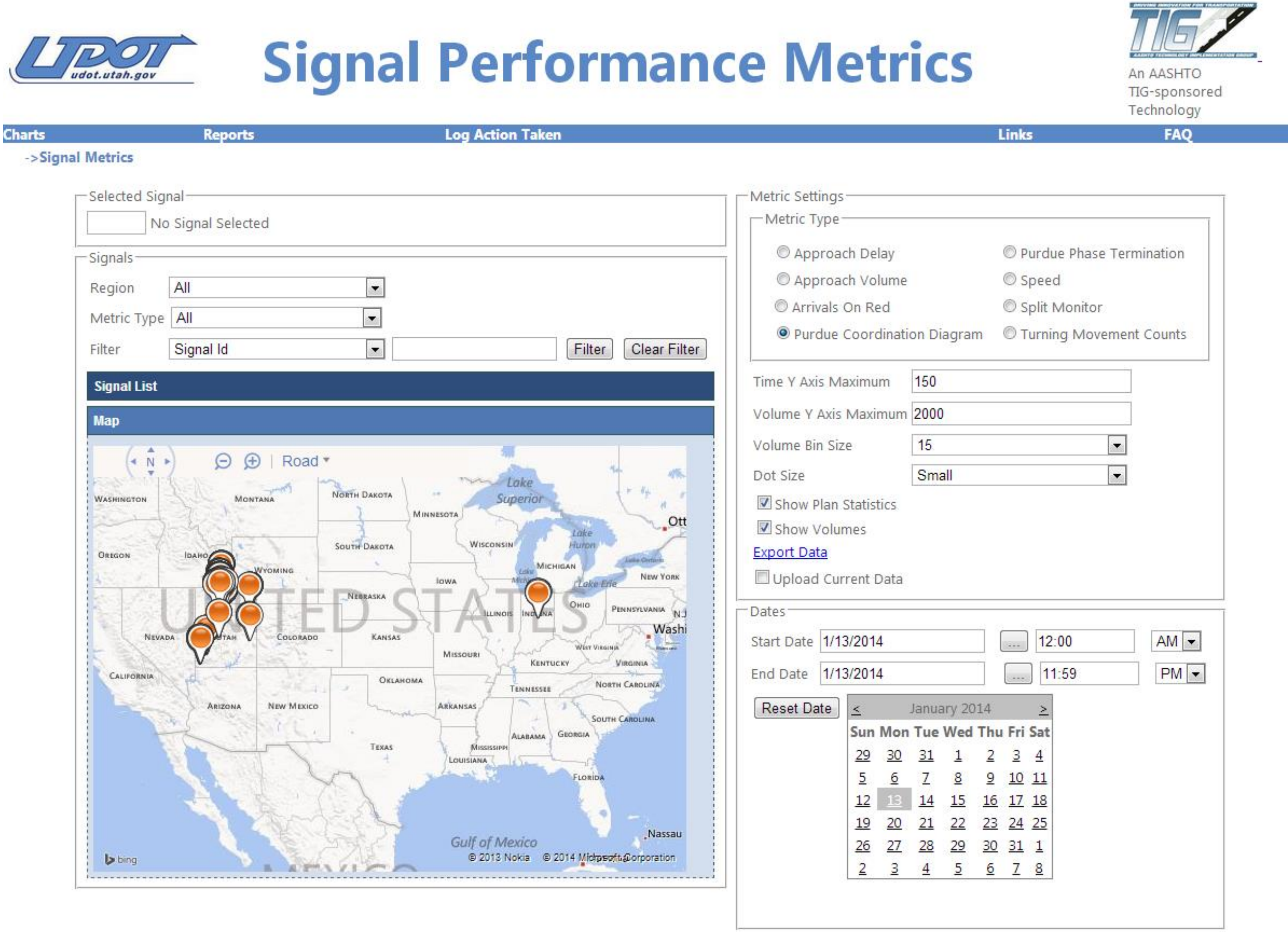
   -- Econolite (ASC3; Cobalt) -- Intelight ATC -- Naztec (Beta)

   -- PEEK ATC -- Siemens Linux / ATC

2. Communications or storage memory on controllers needed
3. Server to store hi-def Indiana enumerations
4. FTP connections made every 10 minutes to signals on system
5. Enumerations analyzed and graphed

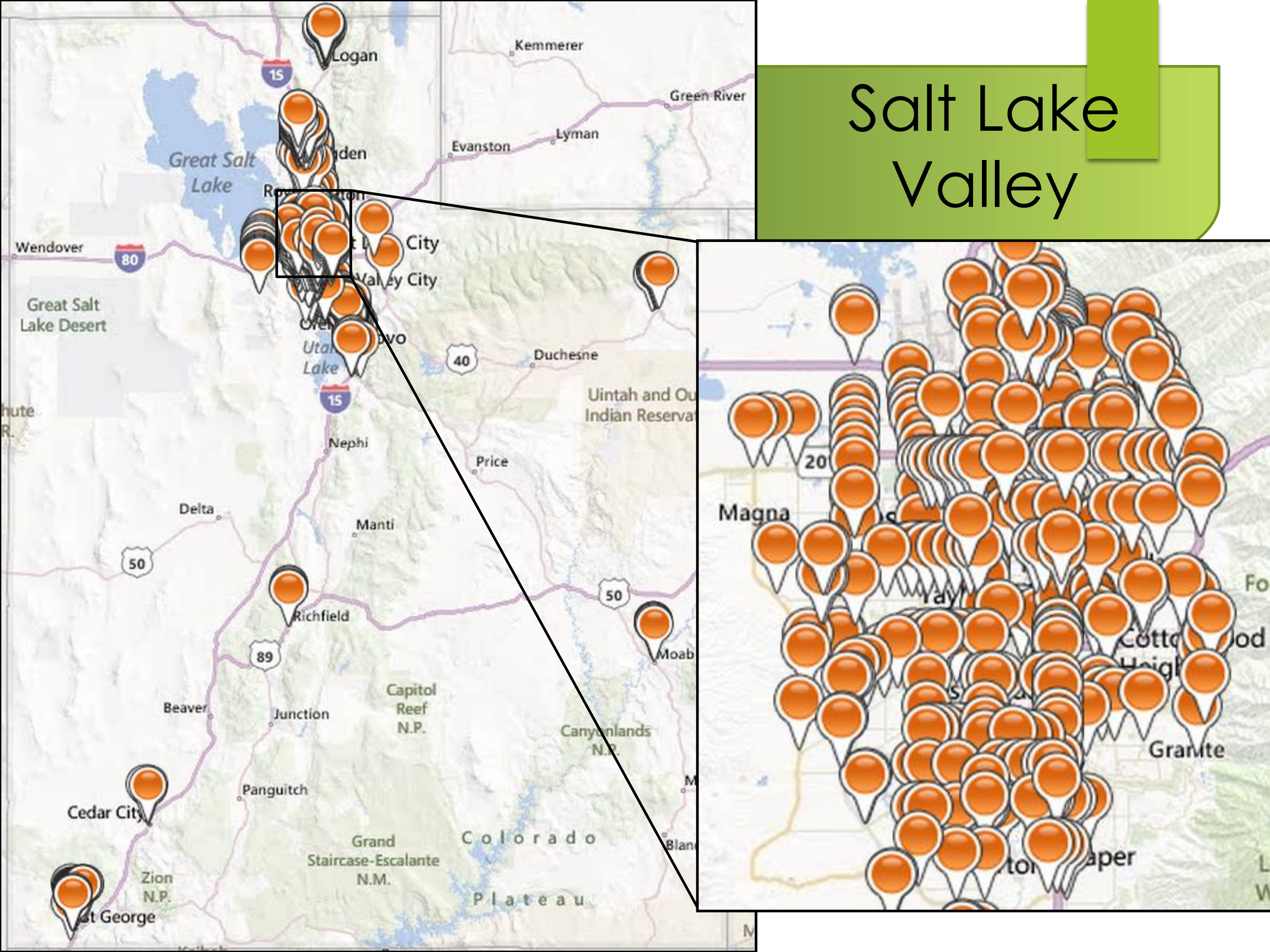
CENTRAL SIGNAL SYSTEM NOT USED OR NEEDED

(The signal metrics are independent of any central signal system)



http://udottraffic.utah.gov/signalperformancemetrics

Salt Lake Valley



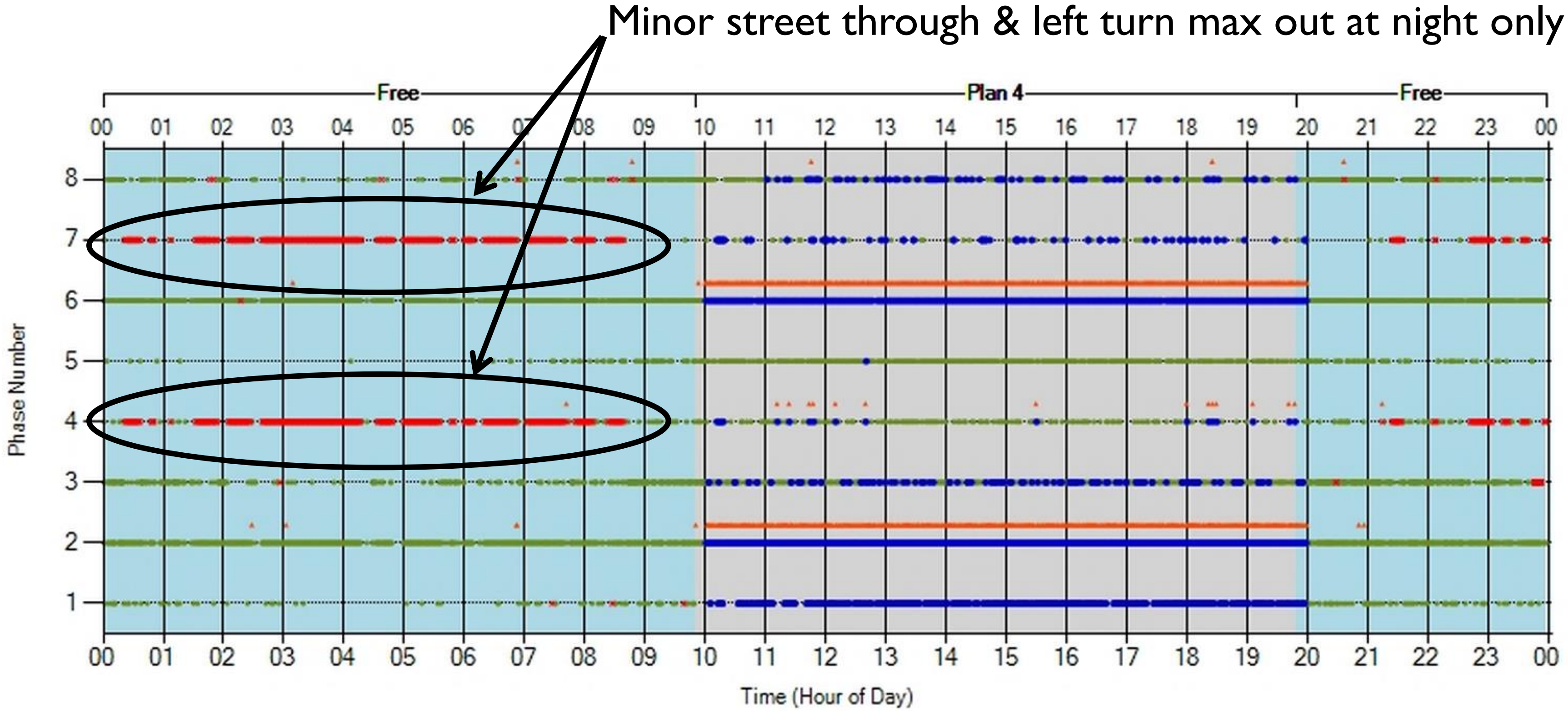
SPM Metric	Detection Requirements
Purdue Phase Termination	No detection needed or used
Split Monitor	No detection needed or used
Purdue Coordination Diagram	Setback count (350 ft – 400 ft)
Approach Volume	Setback count (350 ft – 400 ft)
Approach Delay	Setback count (350 ft – 400 ft)
Arrivals on Red	Setback count (350 ft – 400 ft)
Executive Reports	Setback count (350 ft – 400 ft)
Approach Speed	Setback count w/ speed (350 ft – 400 ft)
Turning Movement Counts	Stop bar (lane-by-lane) count
Purdue Travel Time Diagram	Probe travel time data (GPS)

Phases 4 & 7 Maxing Out Only at Night

Before Condition: Riverdale Road & 700 West, Ogden, UT – Sunday, March 24, 2013

Video Detection not working well at night

Minor street through & left turn max out at night only



Gapout

Max out

Force off

Pedestrian activation (shown above phase line)

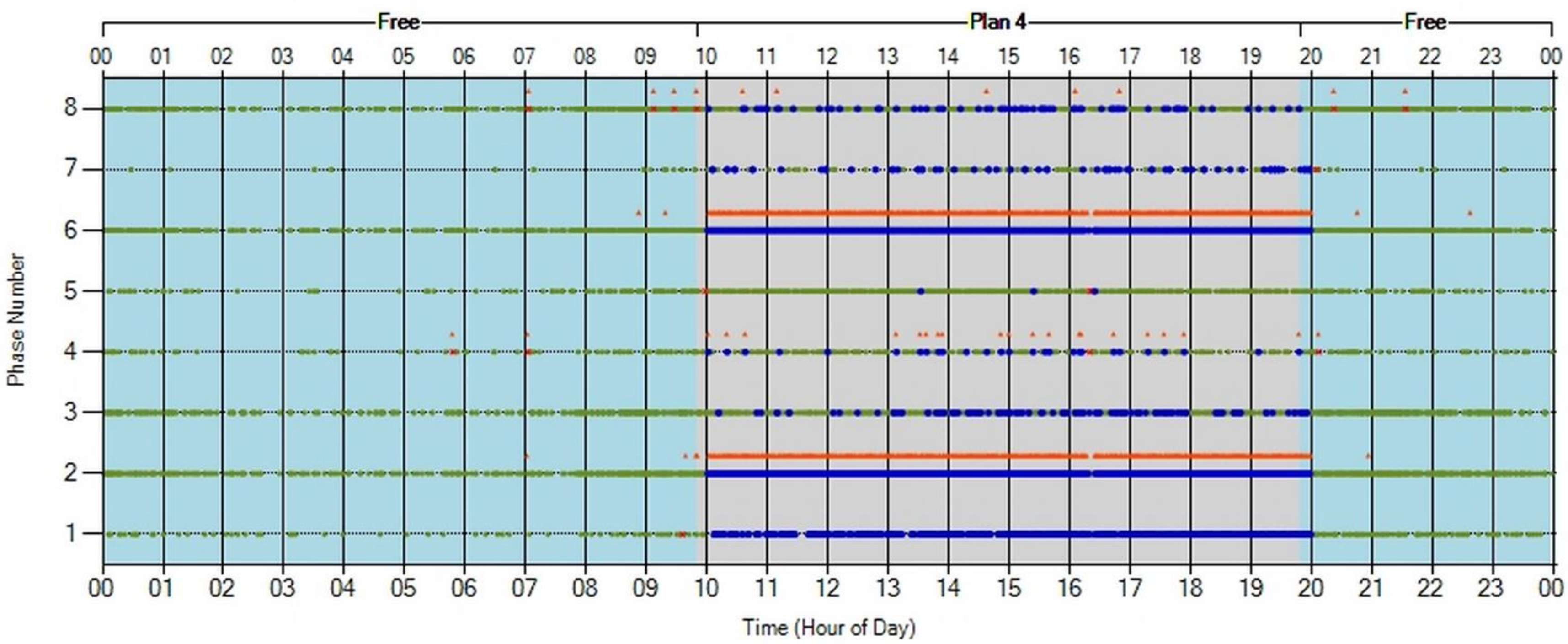
Skip

Metric: Purdue Phase Termination

Phases 4 & 7 Maxing Out at Night - Fixed

After Condition: Riverdale Road & 700 West, Ogden, UT – Sunday, March 31, 2013

Video Detection replaced with a different detector technology



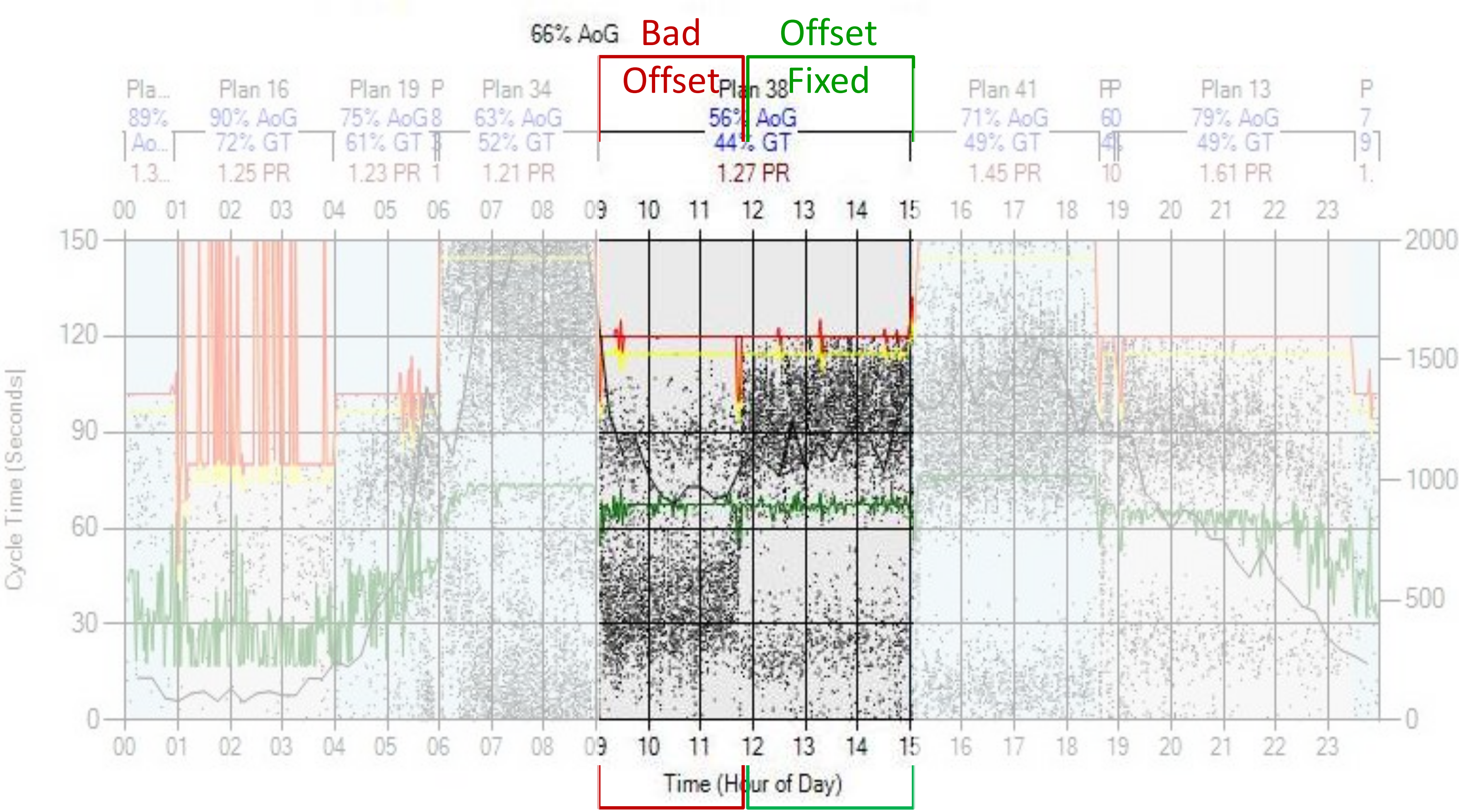
- Gapout
- Max out
- Force off
- Pedestrian activation (shown above phase line)
- Skip

Metric: Purdue Phase Termination

Quality of Progression

NB Bangerter Hwy: New Off-Peak Coordination Plan (38) installed on March 7, 2013

Bangerter & 5400 S Intersection

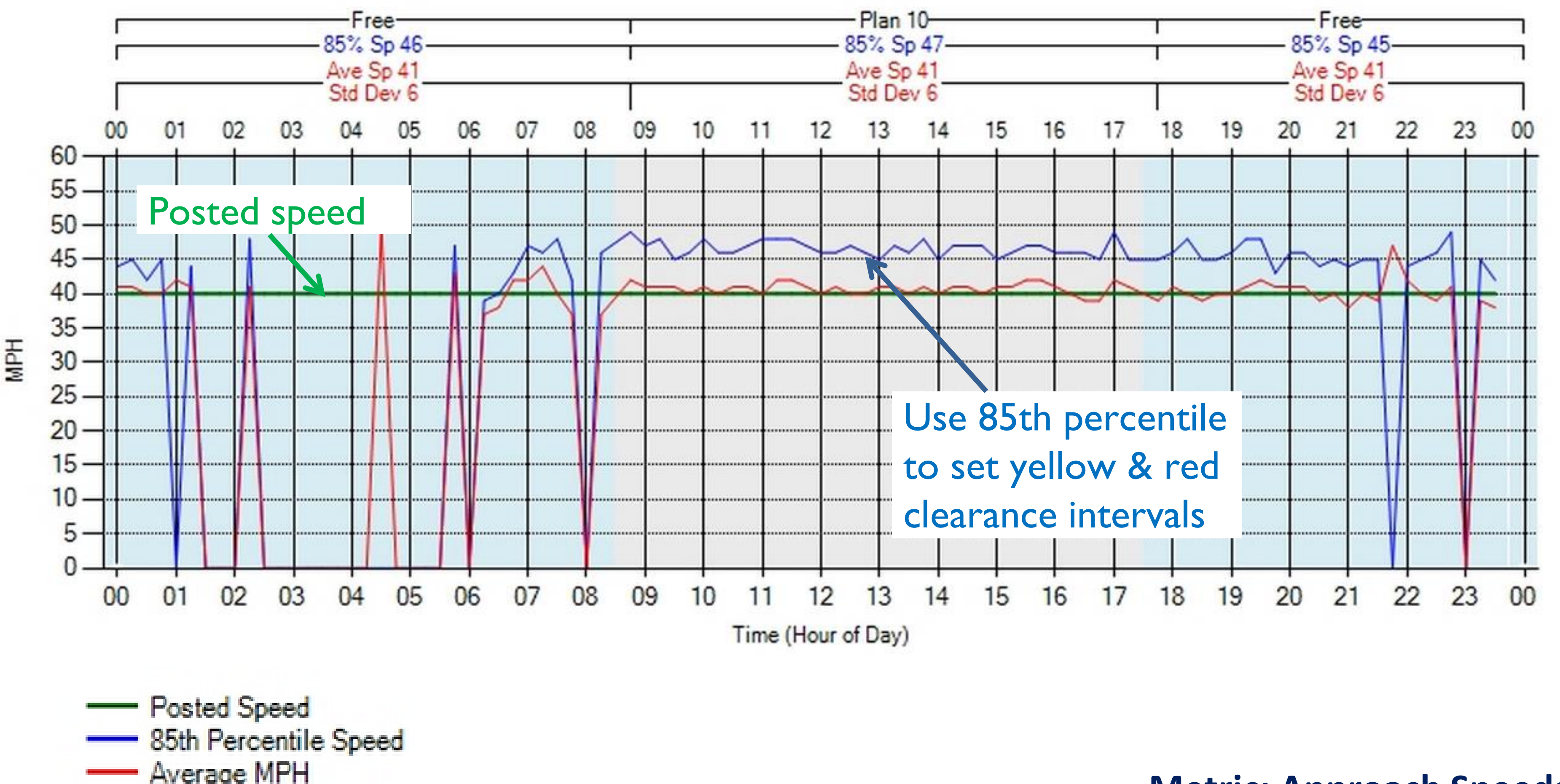


Metric: Purdue Coordination Diagram

Setting Yellow and All-Red using 85th%-tile Speeds

Yellow Changed from 4.0 to 4.5 seconds

Location: NB Bluff St & 100 South, St George, UT – Sunday, May 5, 2013

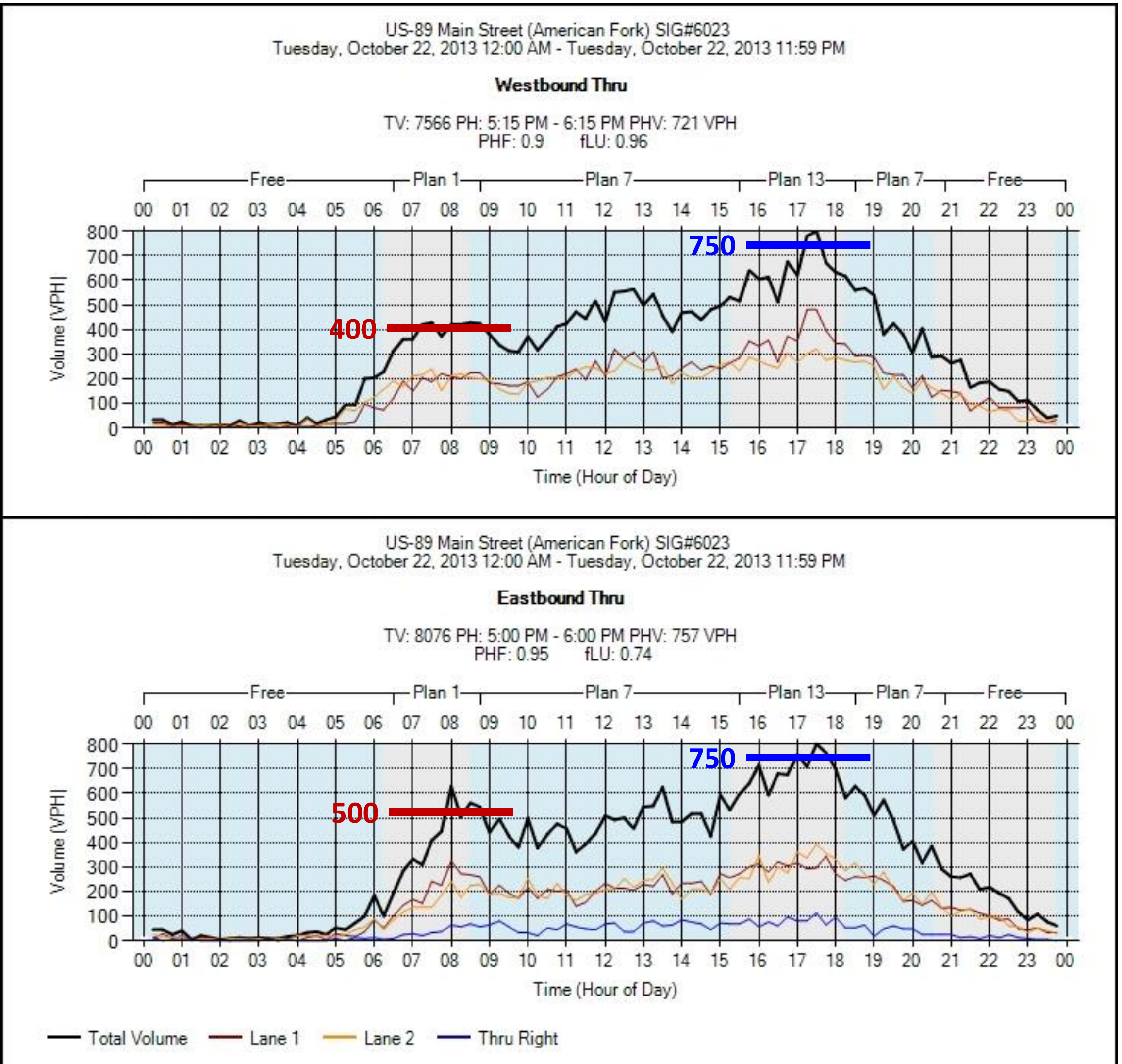


Metric: Approach Speeds

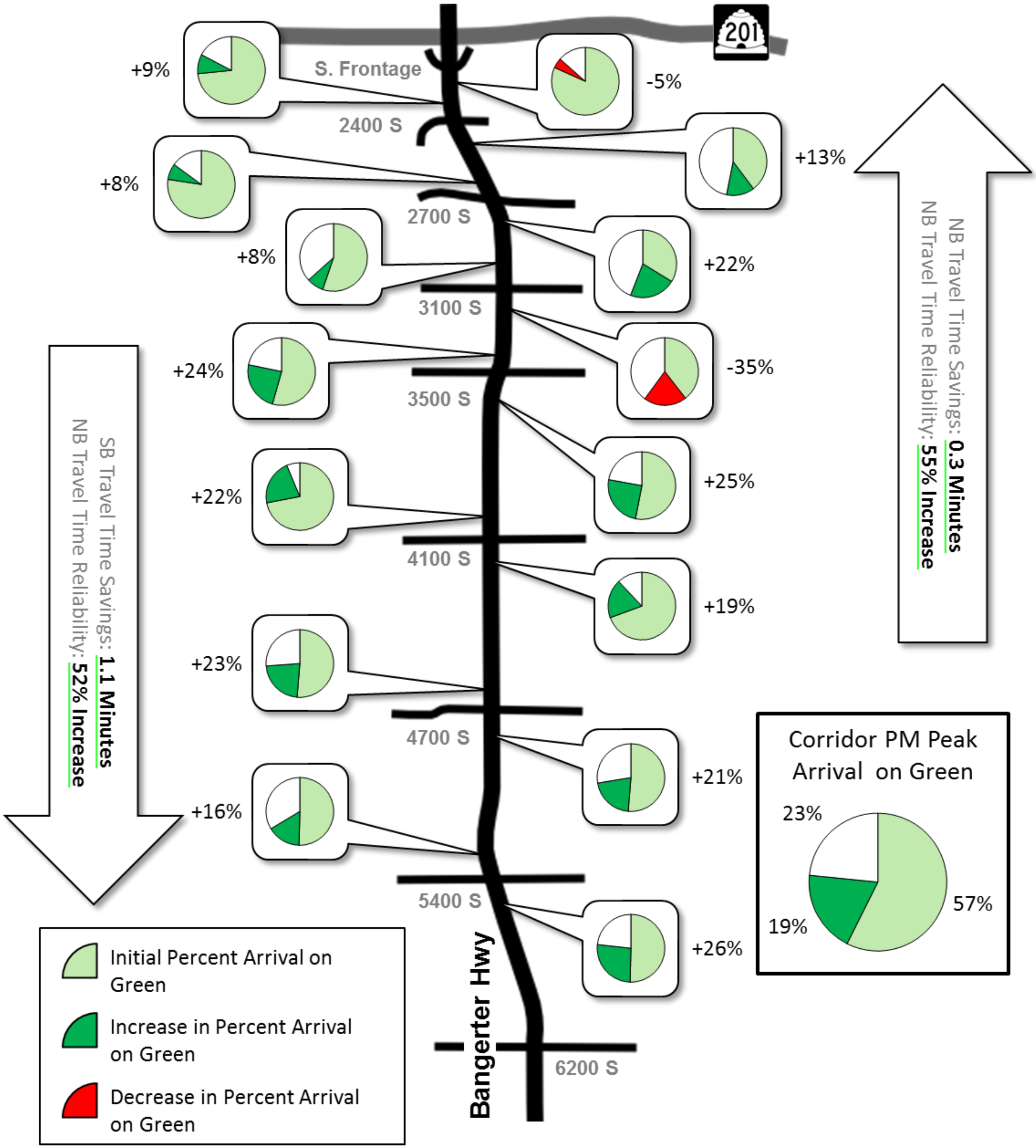
Lane-by-Lane Volume Counts

Use for models, adjust splits, coordination balance, traffic studies

Location: US-89 & Main St, American Fork, UT – Tuesday, October 22, 2013



Metric: Turning Movement Counts



Before and After Coordination

Corridor: Bangerter Hwy, SLC

To/From: SR-201 - 6200 South

Date: March 2013

Time Period: PM Peak

Results:

- 19% Increase Arrival on Green

- NB TT Savings: 0.3 Minutes
- NB Reliability: 55% Increase

- SB TT Savings: 1.1 Minute
- SB Reliability: 52% Increase

Executive Reports

Are things getting better, getting worse or staying the same?

udot.utah.gov

Signal Performance Metrics

Charts | Reports | Log Action Taken | Links | FAQ

->Executive Reports->Average Daily Summary

Report

Report Type: Full Report

Dates

Start Date: 12/2/2013 ... October 2013

End Date: 12/3/2013 ... November 2013

Run Report

Statewide Summary

Arrival on Red		Delay		Volume	Intersections	
Percent	Platoon Ratio	Daily Average Per Approach (hrs)	Average Per Veh (sec)	Daily Average Per Approach	Total	Number Of Approaches
29 %	1.01	21	7.47	10,329	289	571

Region Summary

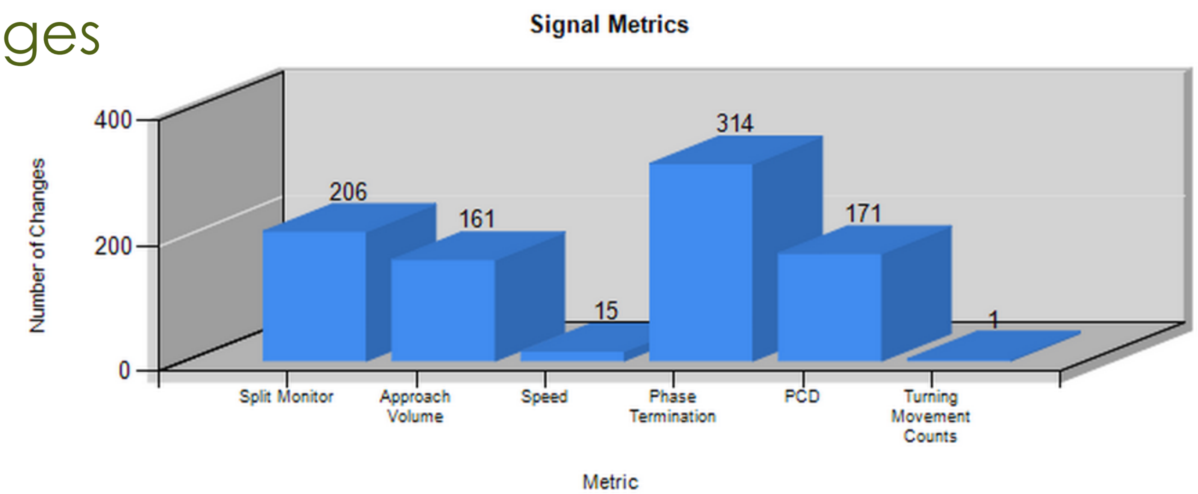
Region	Arrival on Red		Delay		Volume	Intersections	
Name	Percent	Platoon Ratio	Daily Average Per Approach (hrs)	Average Per Veh (sec)	Daily Average Per Approach	Total	Number Of Approaches
1	25 %	0.96	13	4.26	10,859	72	137
2	32 %	1.04	28	9.48	10,739	118	239
3	29 %	1.01	20	7.41	9,713	92	183
4	28 %	0.94	6	3.63	5,529	7	12

	Corridor	Arrival on Red		Delay		Volume	Intersection
	Name	Percent	Platoon Ratio	Daily Average Per Approach (hrs)	Average Per Veh (sec)	Daily Average Per Approach	Number Of Approaches
gion 1	US-89 NB	19 %	0.95	9	1.89	17,668	2
	US-89 SB	22 %	0.95	12	2.56	17,543	4
	Riverdale NB/EB	26 %	0.99	26	5.98	15,935	11
	Riverdale SB/WB	25 %	0.99	25	5.96	15,159	11
	SR-126 SB	22 %	0.99	11	3.80	9,959	11

Metric: Executive Reports

Intersection Adjustments using SPMs
January 1, 2013 to December 31, 2013

- Adjustments made at 325+ intersections
  - 185 work orders for detector problems
  - 40 offset adjustments
  - 5 time-of-day corrections
  - Several other changes



Metric: Usage Reports

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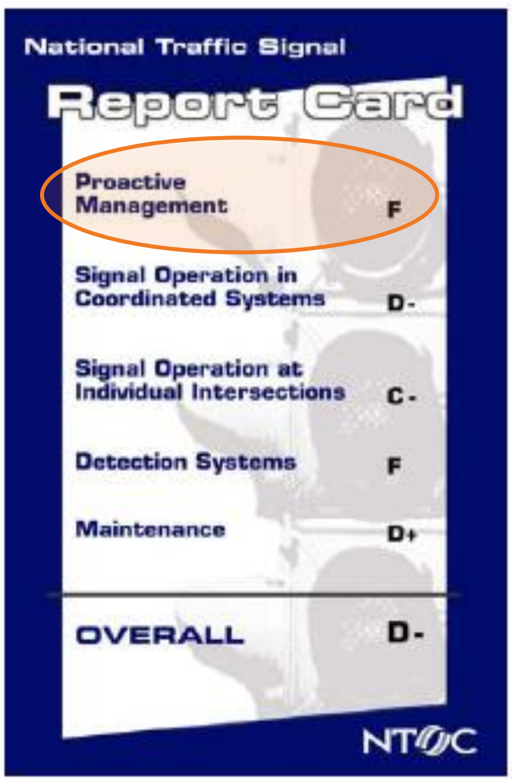
PRESENTED BY RICK DENNEY, FHWA, APRIL, 9 2013

FHWA Perspective

- Traffic Signal Report Card
- Traffic Signal Management (Good Basic Service)
- Asset Management
- Capability Maturity
- Planning for Operations and Systems Engineering
- Performance Management, Importance and Principles

Traffic Signal Report Card



Traffic Signal Management

- Good Basic Service
  - Objectives-Driven
  - Outcome-Oriented
  - Focused on what is important
    - What achieves agency vision and goals
    - What achieves motorist expectations

Good Basic Service

- Demands understanding of performance
  - For demonstration that program supports agencies vision and goals
  - For guidance to staff for day-to-day actions
  - For managing expectations
  - For achieving all that can be achieved

Asset Management

- Signal timing database ***is an asset***
  - It costs money and resources to develop
  - It costs money and resources to maintain
  - **Frequency** and **type** of maintenance are key issues…
  - …that cannot be determined without understanding performance

Capability Maturity Model (SHRP2 Program)

- The **best agencies** depend on brilliant staff (Level 1), but are vulnerable to staff loss
- Mitigate that risk by developing brilliant processes (Level 2), but then vulnerable to becoming slaves to process
- Mitigate that risk by **measuring process effectiveness** (Level 3), and
- Optimizing processes against measurement (Level 4)

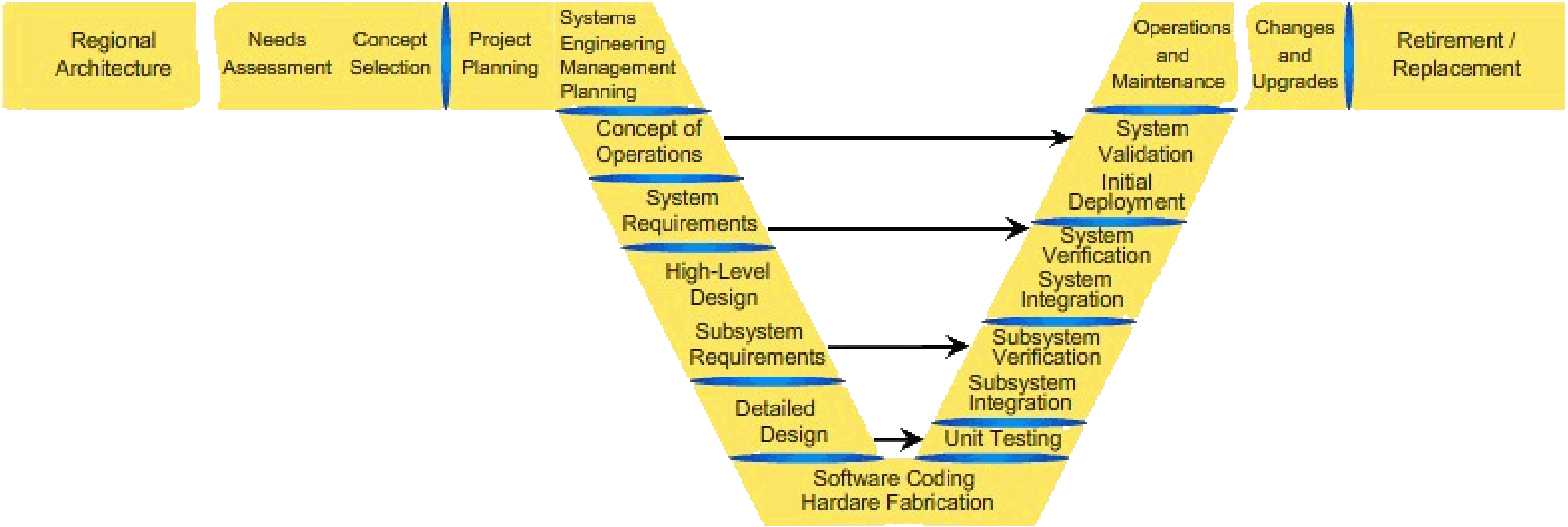
Planning for Operations and Systems Engineering

- Planning for Operations
  - Objectives-Driven
  - Performance measured against objectives
- Systems Engineering (23CFR940.11)
  - Needs and Requirements-Driven
  - Projects verified and validated against requirements and needs
  - Include performance measurement as use case

Planning For Operations Process

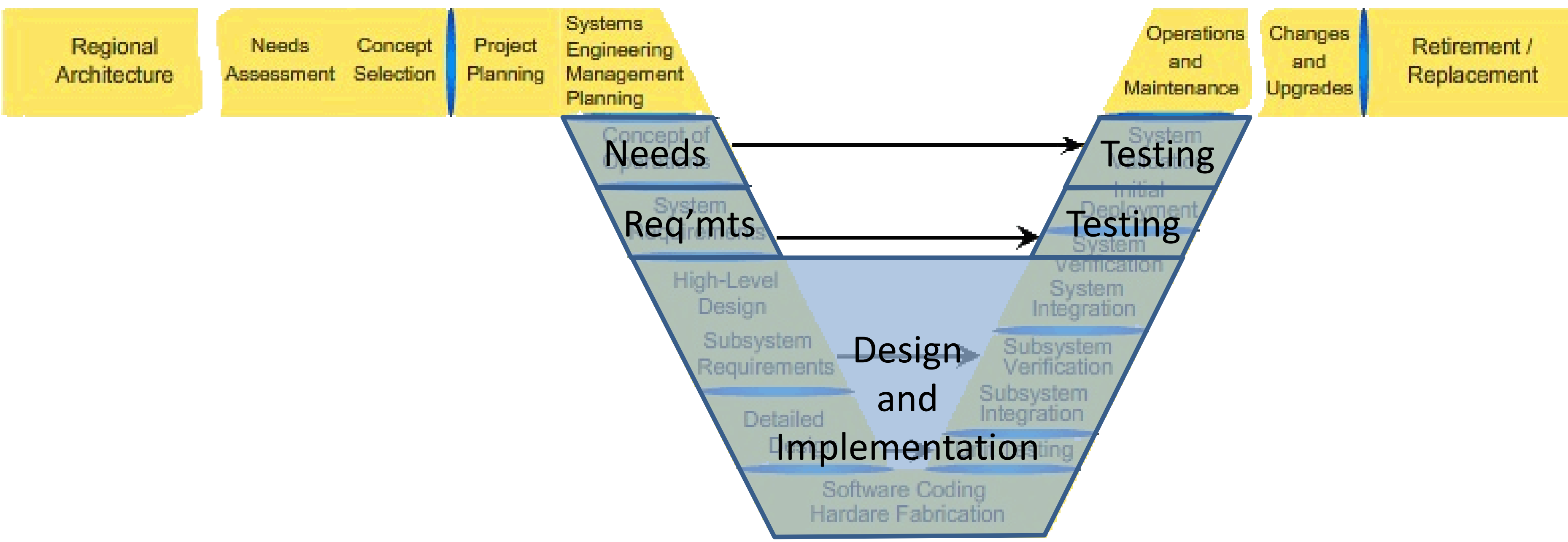
Systems Engineering Process

- Systems Engineering Guidebook



Systems Engineering Process

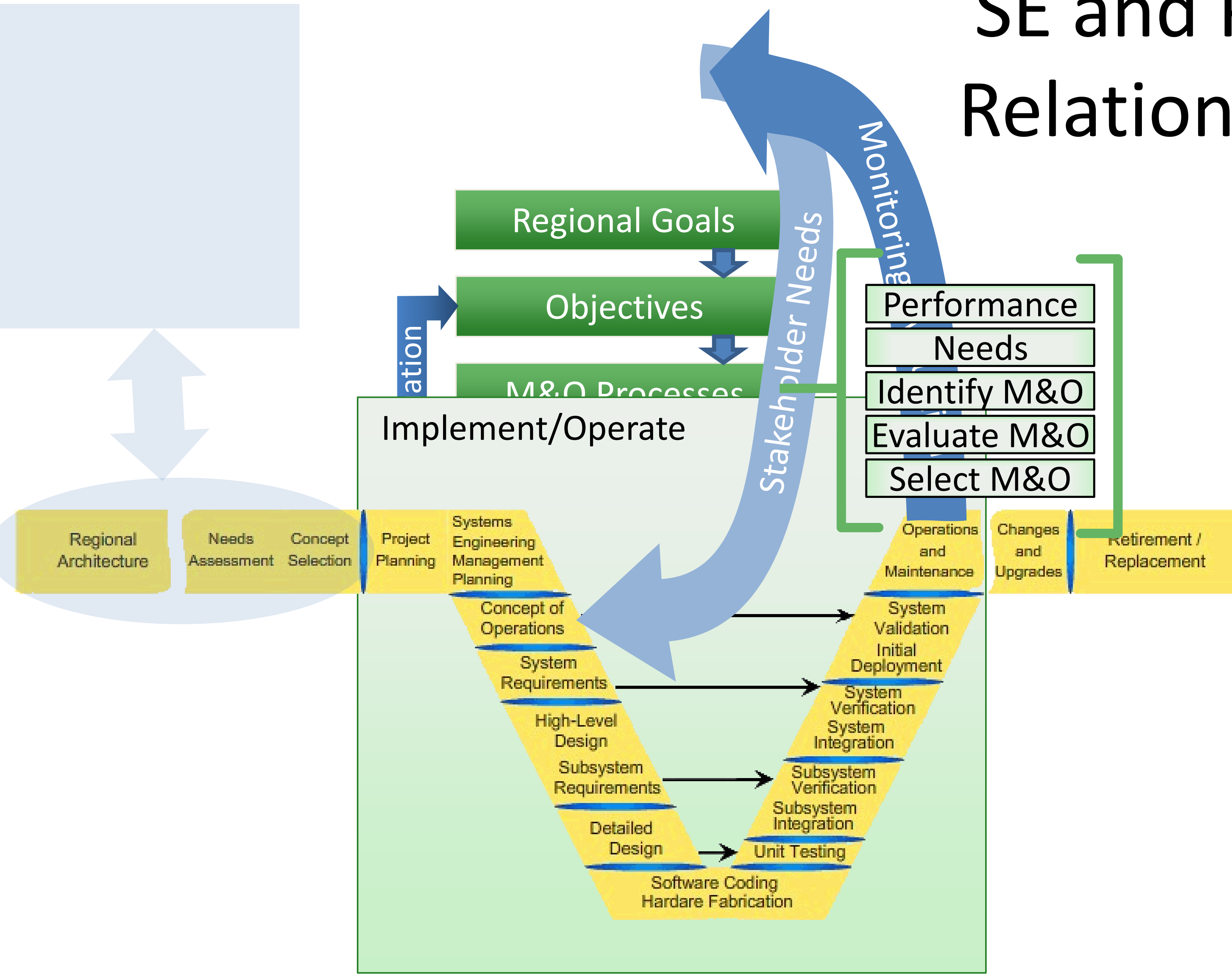
- Systems Engineering Guidebook



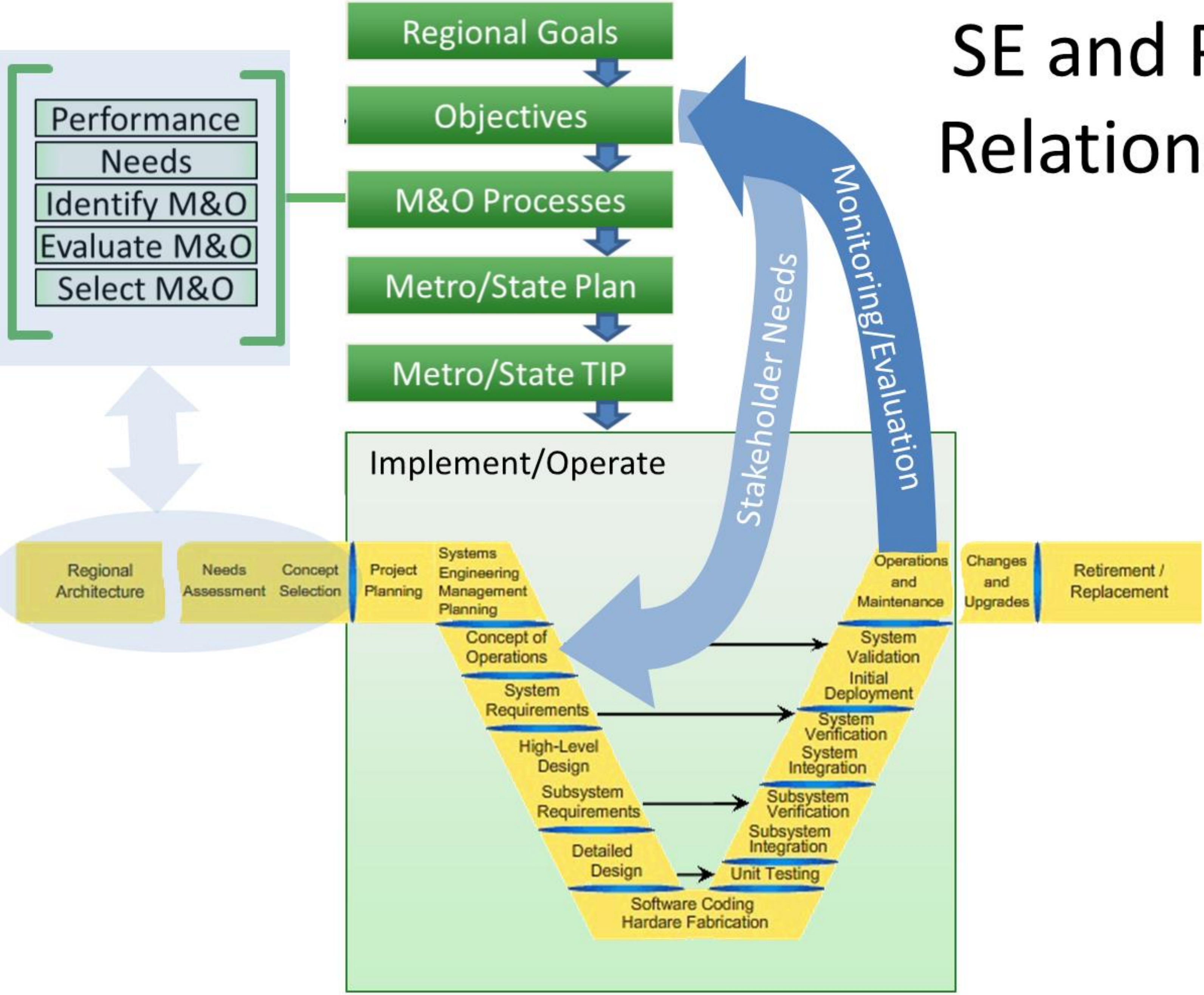
Planning For Operations Process

Planning For Operations Process

SE and P4O Relationship



SE and P4O Relationship



Importance

- When resources are constrained:
  - Data is everything
  - Demonstrating effectiveness key to program sustainability and funding
  - Increasing use of performance basis for funding decisions
- Resources are always constrained

Effective Performance Measurement

- Is sensitive to agency goals
  - But that's not enough by itself
- Demonstrates achievement of objectives
  - Both funding objectives and engineering objectives
- Guides day-to-day operational decisions
  - Provide **actionable** operational assessment
- Guides decisions on *frequency* and *type* of operational resource expenditure

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Thank you.

QUESTIONS & ANSWERS FOR OUR PRESENTER'S?

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