

# Automated Traffic Signal Performance Measures: *A Local Perspective*

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TexITE Dallas/Fort Worth Joint Meeting

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- Overview of Data Source
- Signal Performance Measures
- Infrastructure Requirements
- Lessons Learned



# **Traffic Signal Performance Measures:** a new tool for traffic signal operations

**Performance Metrics:**  
Delay, stops, fuel

**Floating Car Runs**

**Modeling Software**

**Measure?**

**SPMs:**

- Arrivals on Green
- V/C
- Phase Utilization
- Estimated Delay

**Preliminary Splits, Offsets, V/C**

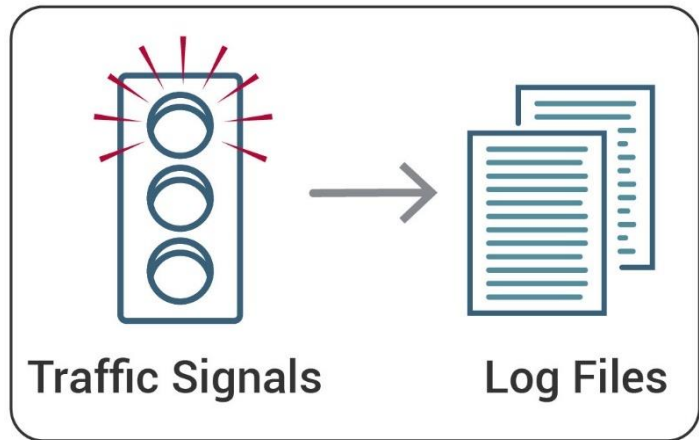
**Field Implementation**

**Fine-Tuning**

**As-built**

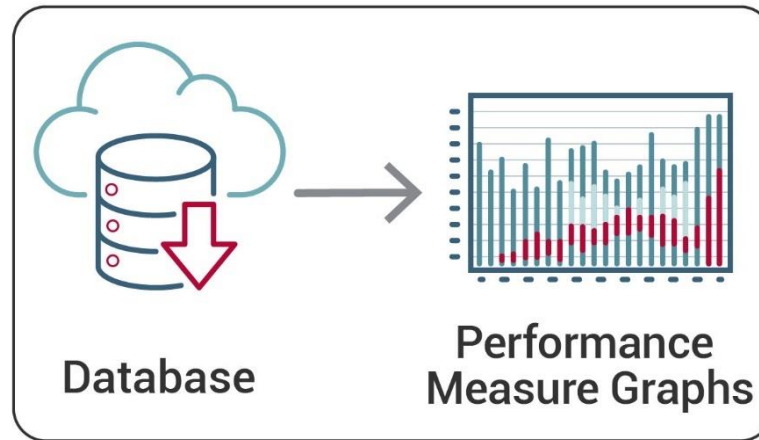


## Field



## High-Resolution Data

## Traffic Management Center



## Performance Measures



# National Practice

- Purdue, INDOT, controller vendors
- UDOT, vendor implementation
- FHWA Every Day Counts
  - Performance-based management
- ATSPM – Automated Traffic Signal Performance Measures

# High-Resolution Data

- Native logging capability in compatible controllers
- For each data point:
  - Event Timestamp
  - Event Code
  - Event Parameter



# Controller Events Logged

- Phase (Vehicular, Pedestrian)
- Overlap
- Phase Control
- Detector
- Preemption
- Coordination
- Cabinet/System

# Sample Hi-Res Data

Event Timestamp	Event Code	Event Parameter	Translation
09:57:27.5	1	6	Begin Green – Phase 6
09:57:36.0	82	9	Detector On – Channel 9
09:57:50.1	82	10	Detector On – Channel 10
09:57:56.3	81	10	Detector Off – Channel 10
09:58:19.8	7	6	Green Termination – Phase 6
09:58:19.8	8	6	Begin Yellow Clearance – Phase 6
09:58:22.8	10	6	Begin Red Clearance – Phase 6
...	...	...	...

# Benefits of Hi-Res Data

- 24/7 data collection not limited by business hours
- Detailed analysis, or aggregated trends
- Larger sample size



**Signal Performance  
Measures**

# Example Uses

- Flagging detector maintenance needs
- Investigating citizen service requests
- Fine-tuning splits & offsets
- Timing plan maintenance
- Measuring performance before and after retiming

# Sample Performance Measures

Objective	Signal System Components	Example Performance Measures & Visualization
Field Infrastructure Reliability	Comm, Detection	Intersections Online Detector Health

Source: Purdue

# Sample Performance Measures

Objective	Signal System Components	Example Performance Measures & Visualization
<b>Minimizing &amp; Balancing Congestion</b>	Local Control	Pedestrian Utilization Vehicle Flow Rates Volume-to-Capacity Ratio Phase Termination Type Red/Green Occupancy Ratio Split Failures Estimated Delay

# Sample Performance Measures

Objective	Signal System Components	Example Performance Measures & Visualization
Intersection Safety	Local Control	Red Light Running

Source: Purdue



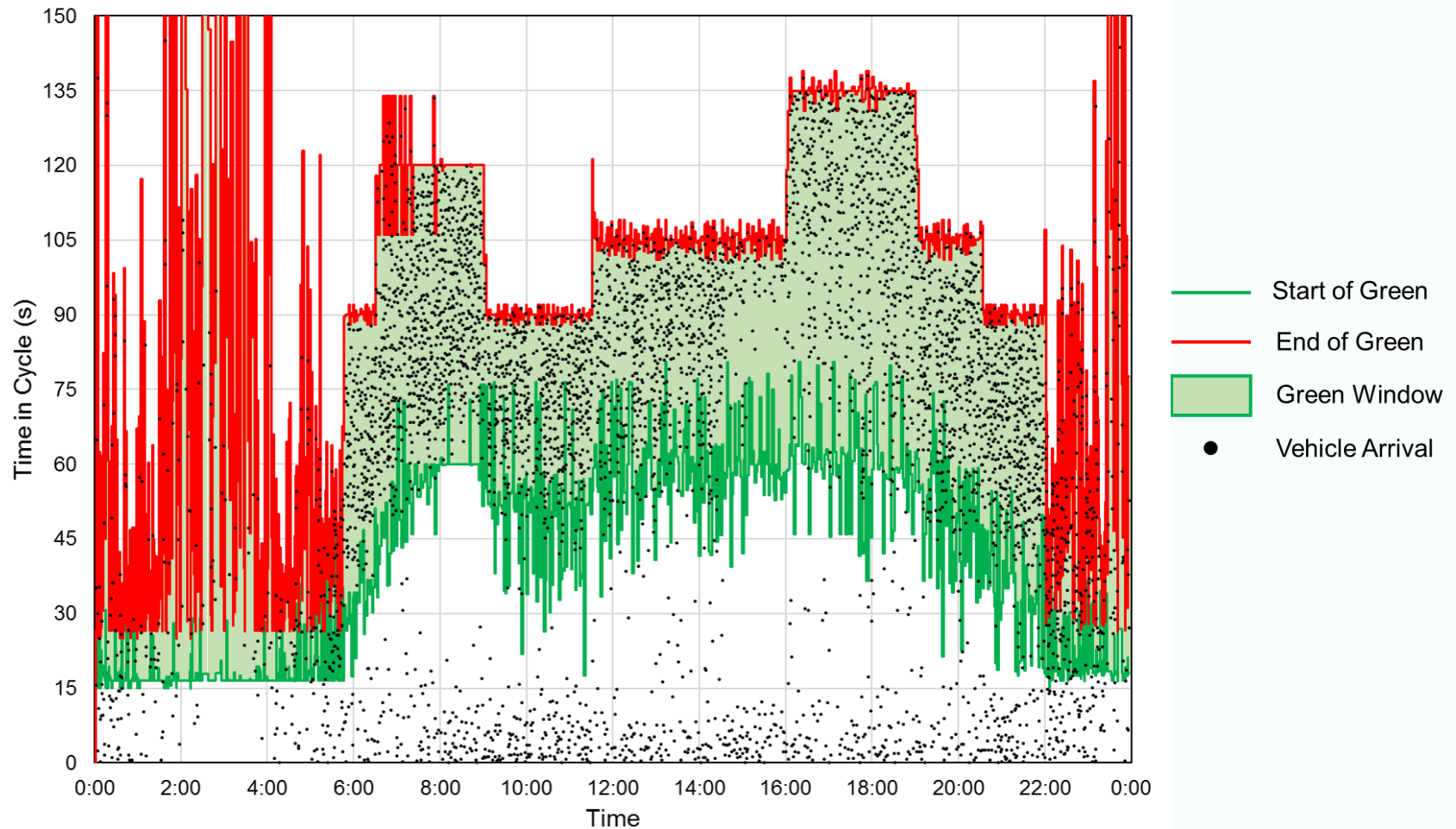
# Sample Performance Measures

Objective	Signal System Components	Example Performance Measures & Visualization
Smooth Traffic Flow	System Control	Arrivals on Green Platoon Ratio Purdue Coordination Diagram Cyclic Flow Profile Measured Travel Time

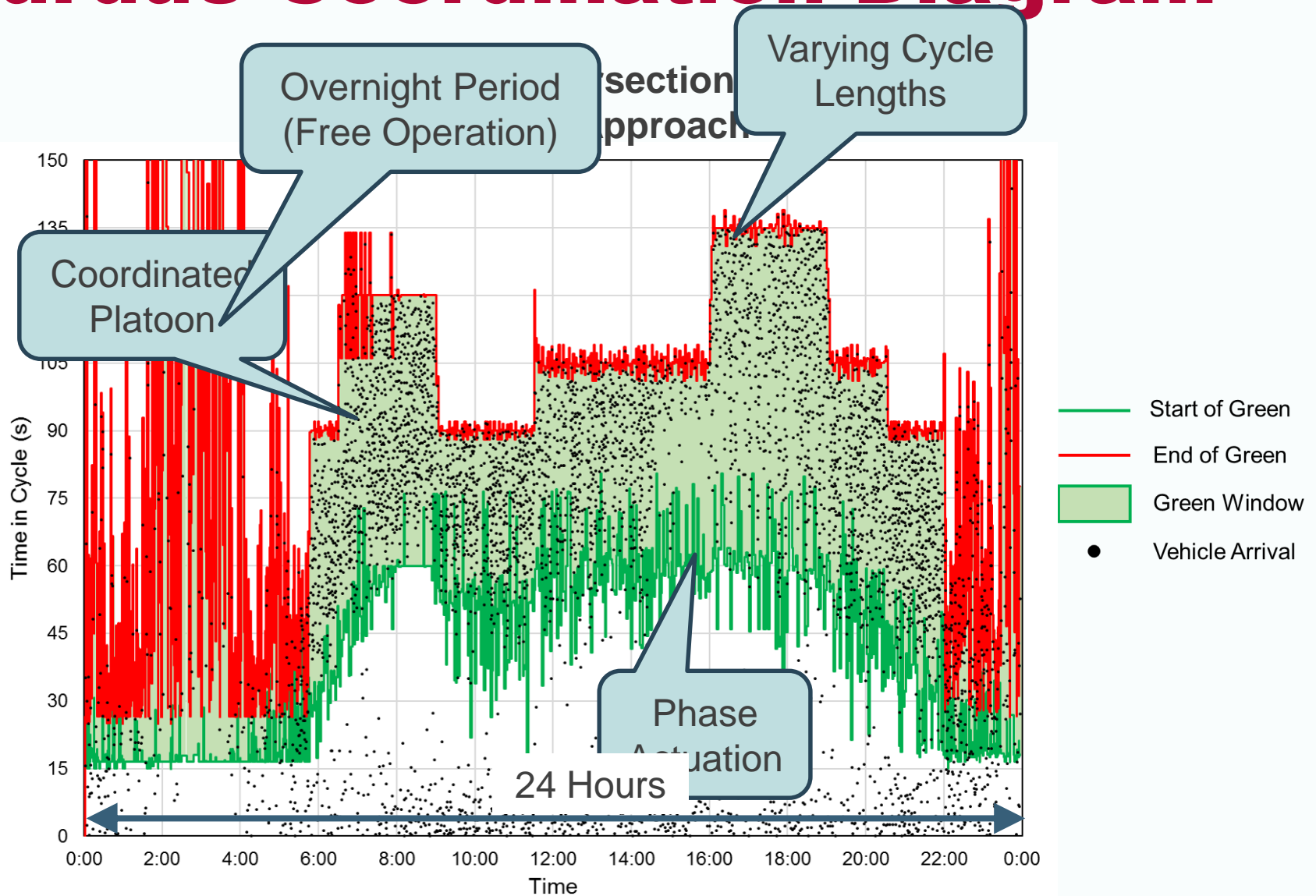
Source: Purdue

# Purdue Coordination Diagram

## Sample Intersection Westbound Approach

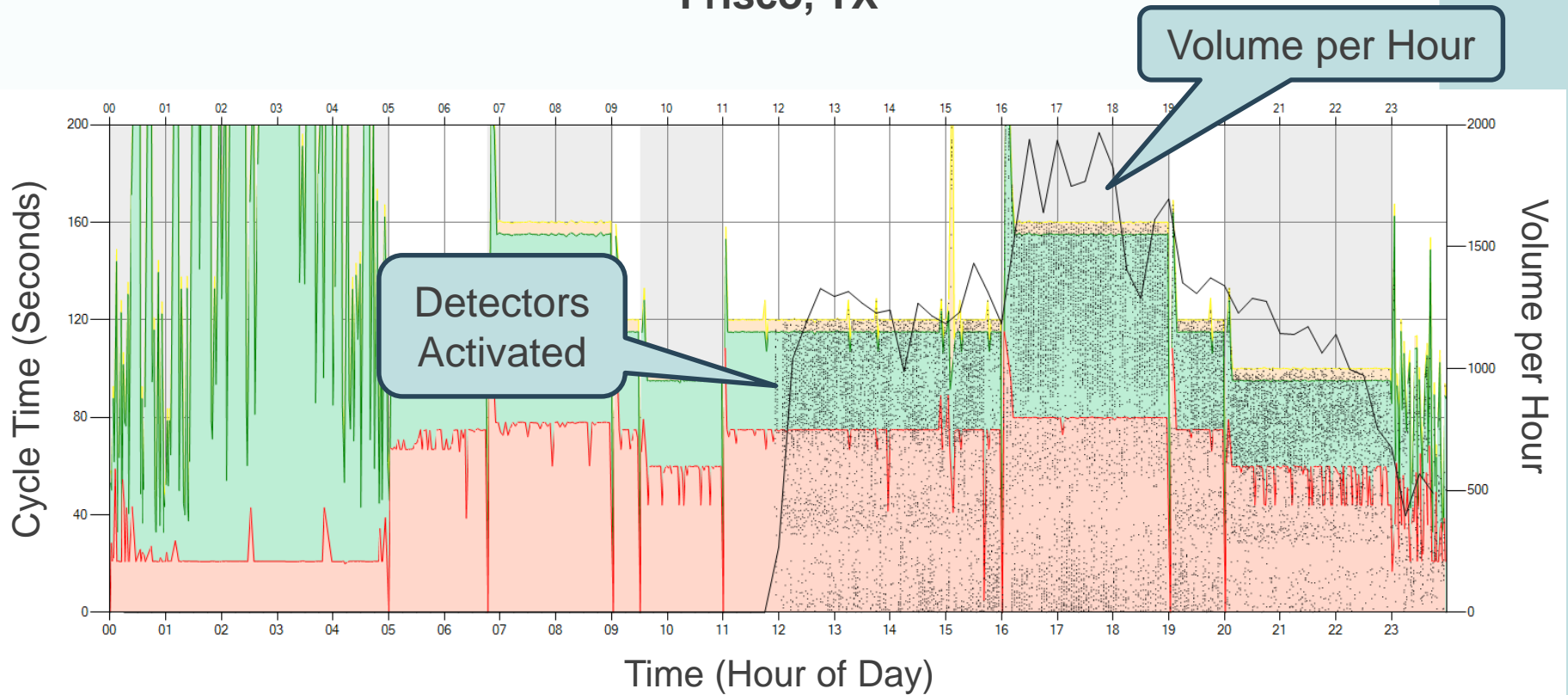


# Purdue Coordination Diagram

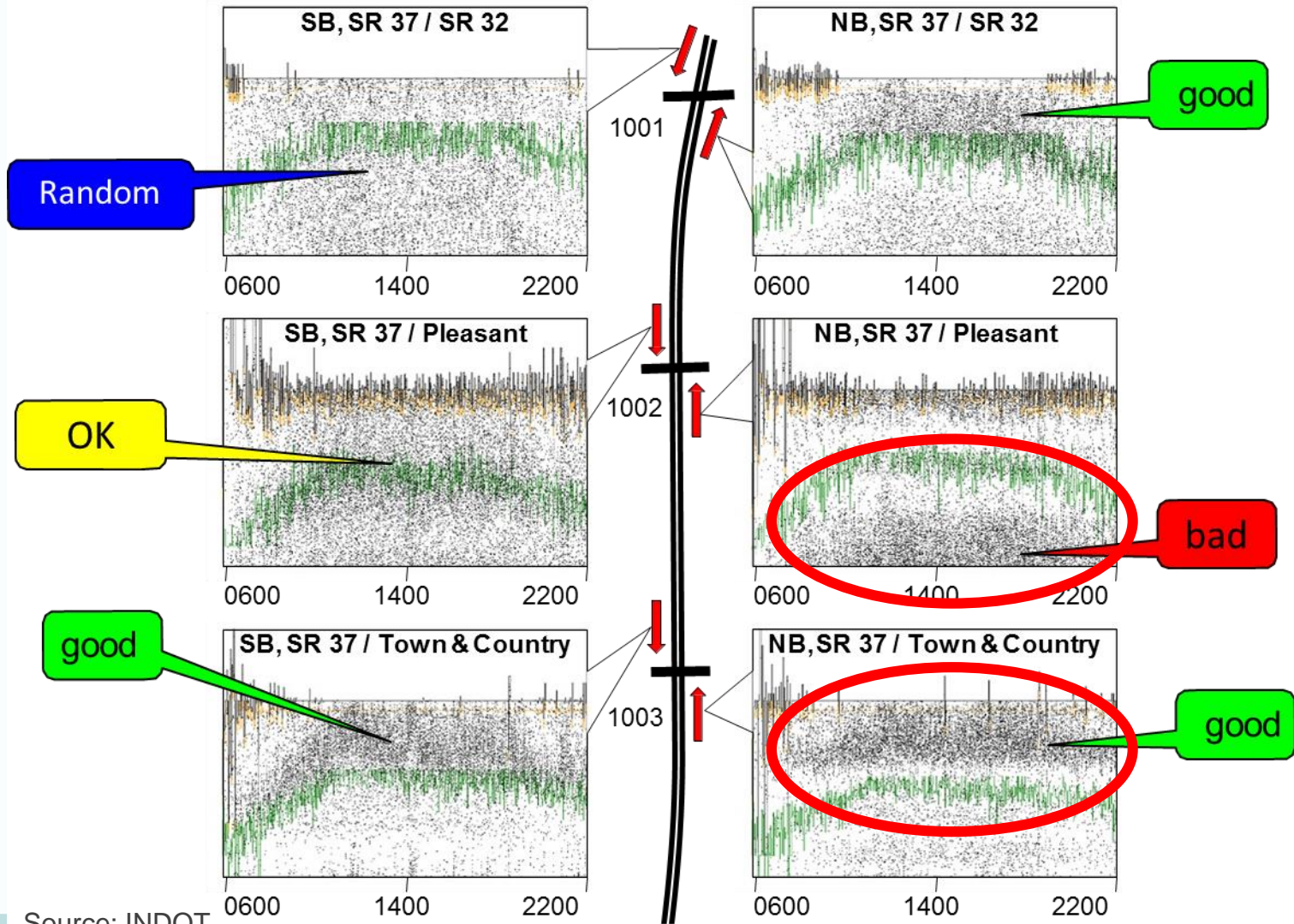


# Sample PCD

## Preston & Main (Northbound Approach) Frisco, TX



# Corridor Visualization

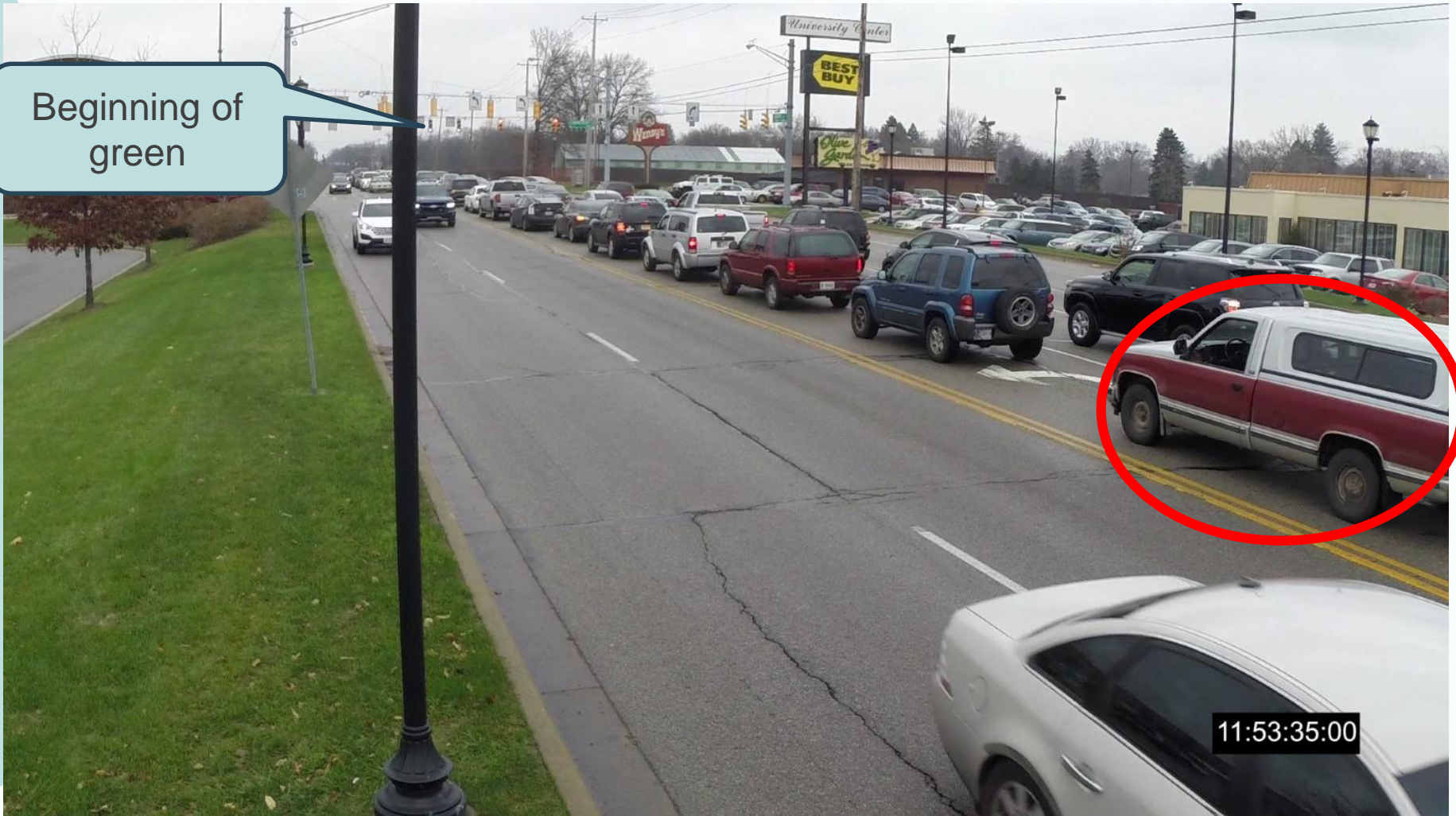


Source: INDOT



# Split Failures

Beginning of green



# Split Failures

Beginning of  
yellow



# Split Failures

Detector  
Occupancy



Signal  
Indication



$GOR \geq 80\% \ \& \ ROR_5 \geq 80\% \ \rightarrow \text{split failure}$

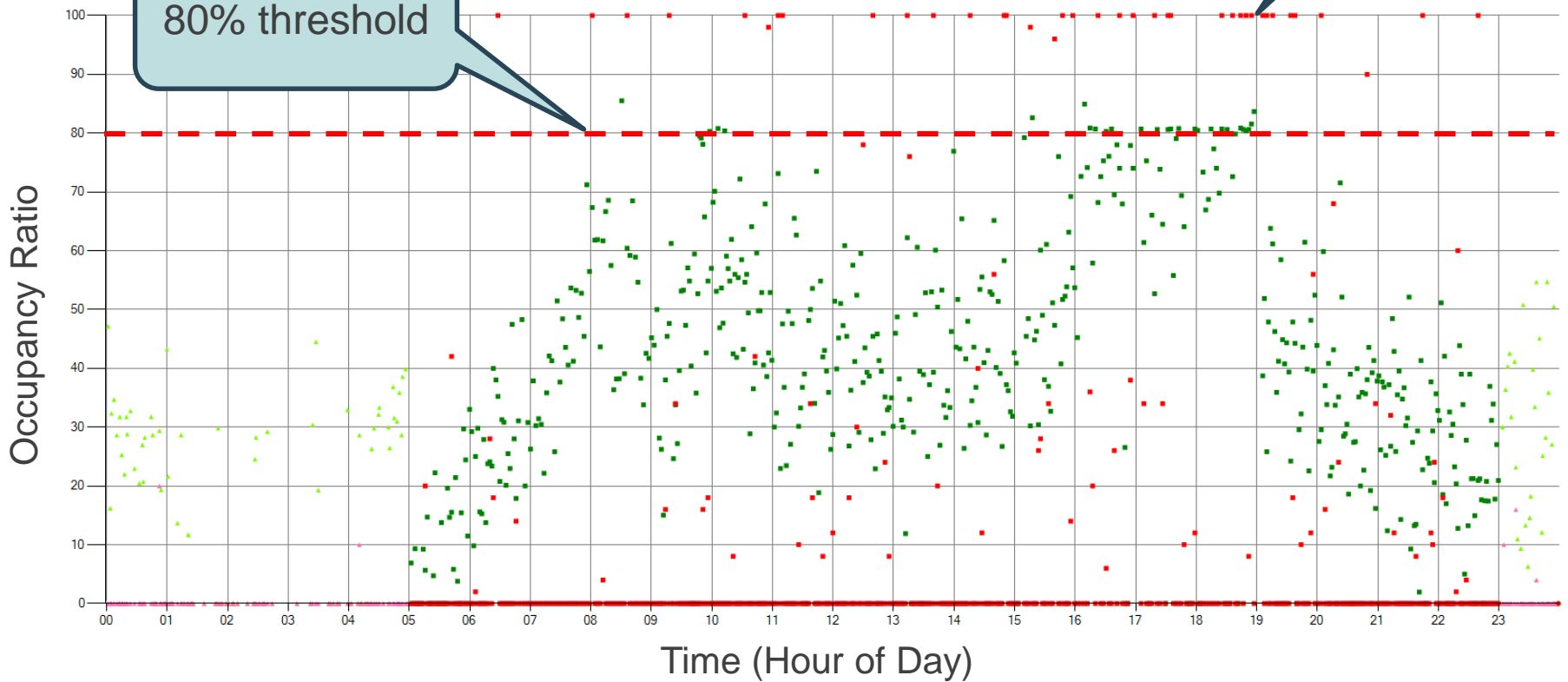


# Split Failures

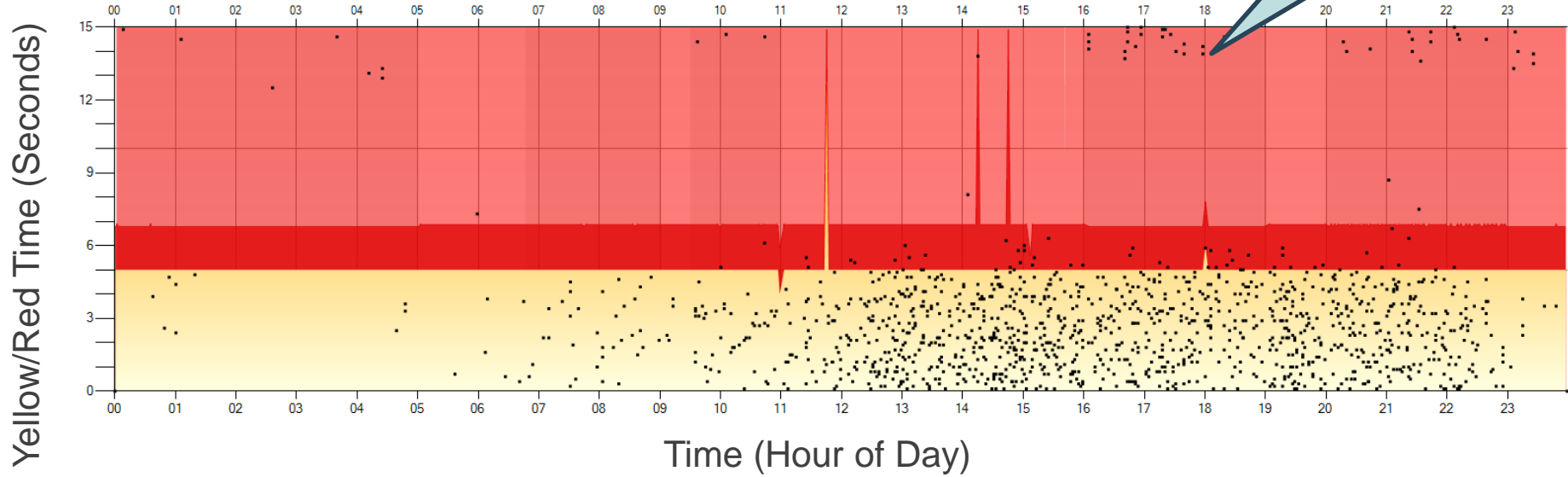
Preston & Main (Westbound Approach)  
Frisco, TX

80% threshold

Residual queue



# Red Light Running





# **Infrastructure Requirements**

# Overview


- Compatible controllers
- Detection for the desired performance measures
- Reliable communication
- Data processing & storage

# Controllers

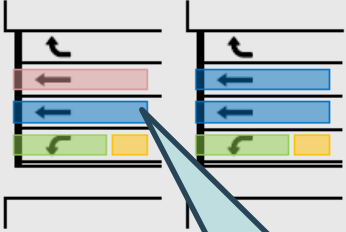
Vendor	Model	Firmware Version
Econolite	ASC/3	OS version 01.14.03 or higher Application version 12.50 or higher
	Cobalt	Any version
Intelight	All	1.7.0 or higher
Peek	ATC-1000	03.05.0528 or higher
Siemens	M52	3.52 or higher
	M60 ATC	4.52 or higher
Trafficware	970 ATC	76.10 or higher
	980 ATC	
	ATC	
	2070 L, LN, E, EN, ATC	
McCain	ATC eX	1.7.0.5484 or higher
D4	n/a	1.5L-20 or higher

Source: Purdue

# Detection


Detection	Metric
<p>None</p>  <p>The diagram shows a traffic signal with four horizontal phases. From top to bottom: 1. A left-turn arrow pointing left. 2. A through arrow pointing up. 3. A through arrow pointing up. 4. A right-turn arrow pointing right.</p>	<p>Phase Termination Chart Split Monitor Preemption Details Pedestrian Delay</p>

# Detection

Detection	Metric
<p>Lane-by-lane or Lane Group Presence</p>  <p>The diagram illustrates two detection methods for a two-lane road. On the left, 'Lane-by-lane' detection shows individual vehicles (represented by colored rectangles) in each lane, with arrows indicating their movement. On the right, 'Lane Group Presence' detection shows a single detection for the entire lane group, represented by a single colored rectangle spanning both lanes. A callout bubble points to the lane-by-lane method, stating 'Lane-by-lane is ideal'.</p>	<p>Purdue Split Failure</p>

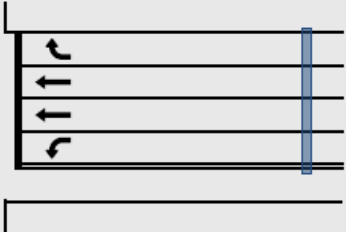
Lane-by-lane is ideal

# Detection

Detection	Metric
Lane-by-lane Stop Bar Count 	Turning Movement Counts Red Light Running



# Detection

Detection	Metric
<p>Advanced Count</p> 	<p>Purdue Coordination Diagram Purdue Link Pivot Offset Optimization Approach Volume Approach Speed (requires detection with speed service)</p>

# Communication

- Remote retrieval of data and performance measures
- Options for local storage of data

# Software

- UDOT software
  - Free download of software
  - Agency must install software
  - Agency must store data on-site

# UDOT Software



## Signal

### Signal Selection

**Signal ID**  
 **Main (Moab) @ Center St**

**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
- Purdue Split Failure

### Purdue Coordination Diagram Options

**Y-axis Max**

**Secondary Y-axis Max**

**Volume Bin Size**

**Dot Size**

Show Plans

Show Volumes

### Date Selection

**Start Date**

**End Date**

July 2017

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

# Software

- Vendor solution
  - Cost for software
  - Limited technical configuration needed
  - Cloud storage of data

# Vendor Solution

**T Trafficware**  
Engineered by **NJ Naztec**

**Signal Performance Measures** Report Detector

**Signal**  
337 - Warren - Internet ATC

**From Date**  
11/16/2017 12:00 AM

**To Date**  
11/16/2017 11:59 PM

**Metric Type**  
Approach Delay

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

**Delay Per Vehicle Y Axis Maximum**  
Auto

**Total Delay Per Hour Y Axis Maximum**  
Auto

**Volume Bin Size**  
15

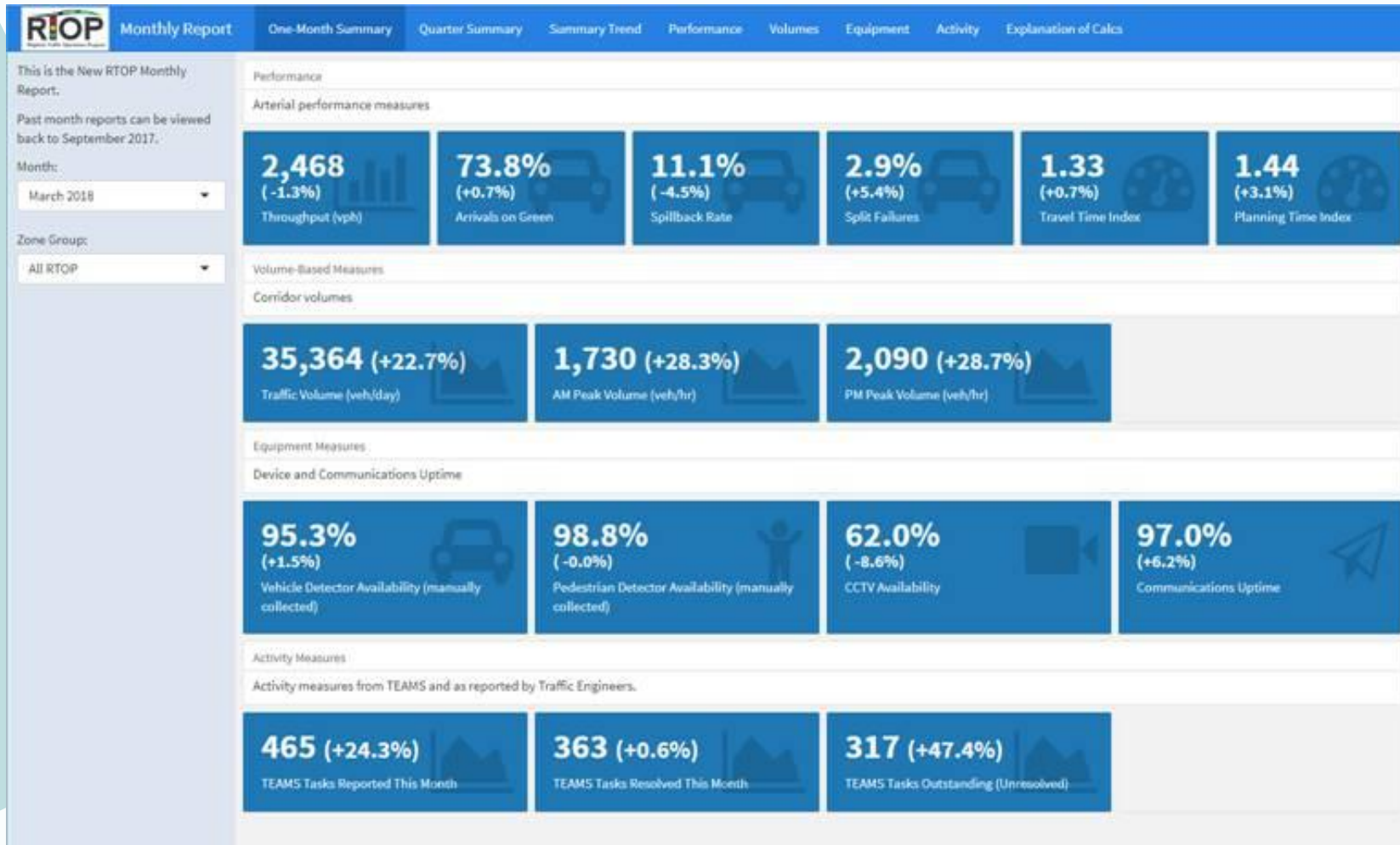
Show Plan Statistics

Show Total Delay Per Hour

Show Delay Per Vehicle






**337 - Warren - Internet ATC**  
**337**

# GDOT Interface



# Software Configuration

- Mapping each detector & phase for translation of raw data

 Channel 1 Northbound Left Lane 1	prot 1, perm 2, OL 0 Split Fail
 Channel 2 Southbound Thru Lane 1	prot 2, perm 0, OL 0 Split Fail
 Channel 3 Eastbound Left Lane 1	prot 3, perm 4, OL 0 Split Fail
 Channel 4 Westbound Thru Lane 1	prot 4, perm 0, OL 0 Split Fail
 Channel 5 Southbound Left Lane 1	prot 5, perm 6, OL 0 Split Fail



# Data Storage

- Raw data & aggregated metrics
- Up to 20 MB/intersection/day
  - Depending on number of detectors & actuations
- Agency policy for data archival

The background features a large red shape on the right side, with a white border separating it from a teal shape on the top left and a dark grey shape on the bottom left. The text "Lessons Learned" is centered in the red area.

# Lessons Learned

# Relationship with IT Department

- Important to work together
- Firewalls
- Servers for data processing and storage

# Detection Upgrades

- Prioritize detection upgrades based on desired SPMs & critical intersections
  - Piecemeal upgrades can work
- Consider different types of non-intrusive detection
  - Understand limitations of each

# Detection Numbering

- Standardization will make software configuration much easier
- Use available inputs wisely

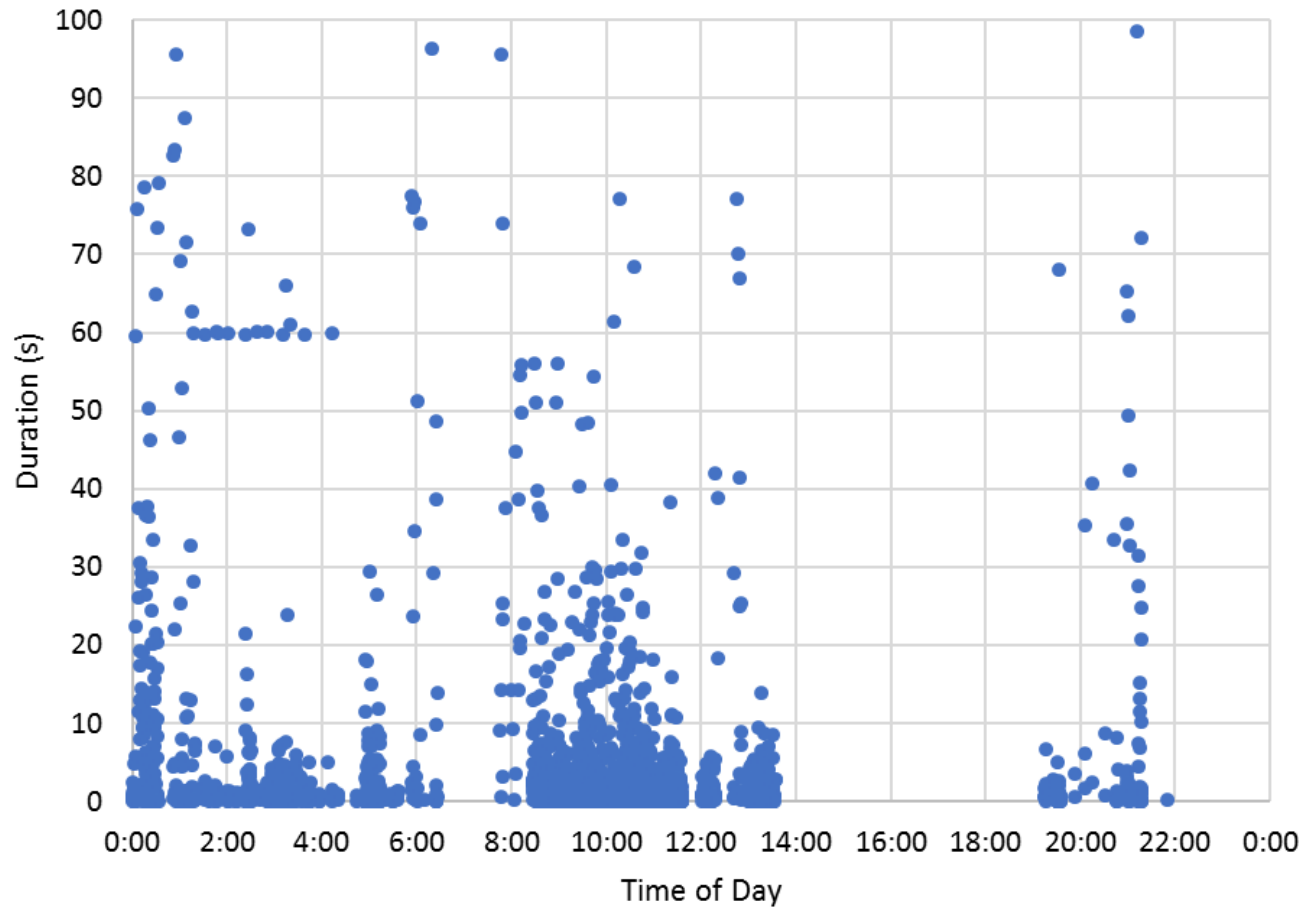
# Leverage Funding Sources

- For controller, communication, detection upgrades

# Get Creative

- New metrics and ways to analyze data
- Excel can be used for small analyses of raw data

# Austin Example









Questions?

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