Automated Traffic Signal Performance Measures:

A Local Perspective

Lucy Richardson

TexITE Dallas/Fort Worth Joint Meeting

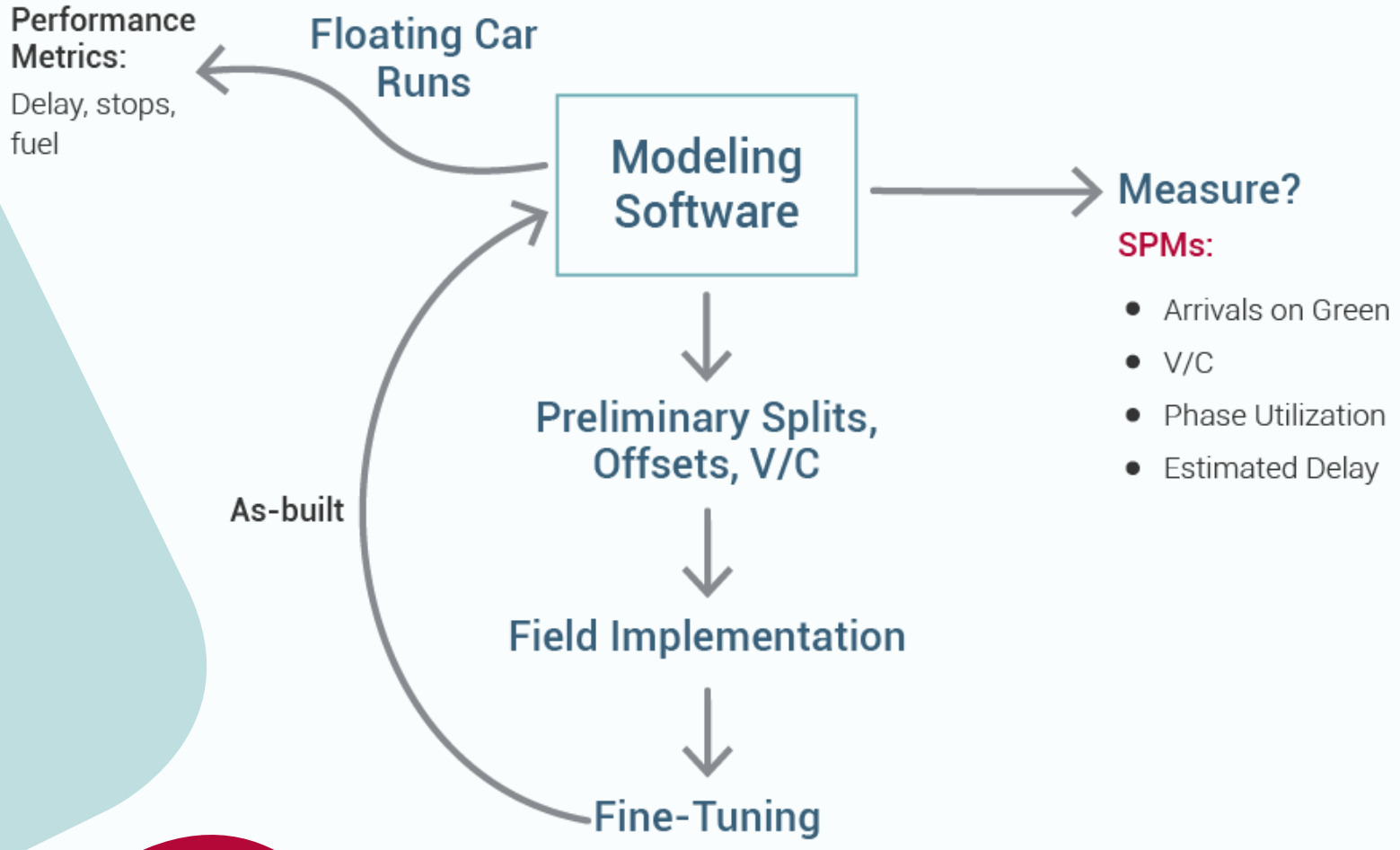
May 11, 2018

Kimley»Horn

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

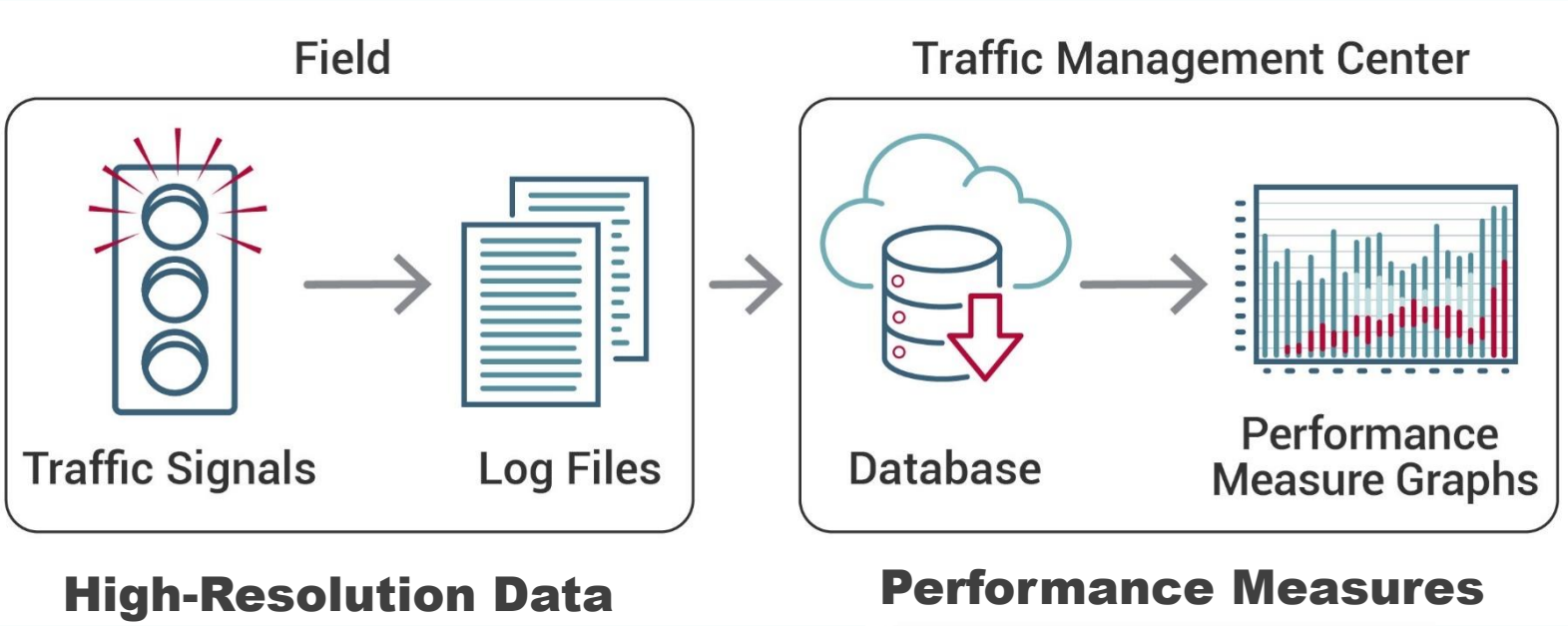
Traffic Signal Performance Measures:

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


12:45
NOV 27
76


June 10, 2017
18,468 steps
8.3
miles
2,889
cals
126
minutes
fitbit



High-Resolution Data

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
Minimizing & Balancing Congestion	Local Control	Pedestrian Utilization Vehicle Flow Rates Volume-to-Capacity Ratio Phase Termination Type Red/Green Occupancy Ratio Split Failures Estimated Delay

Source: Purdue

Sample Performance Measures

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

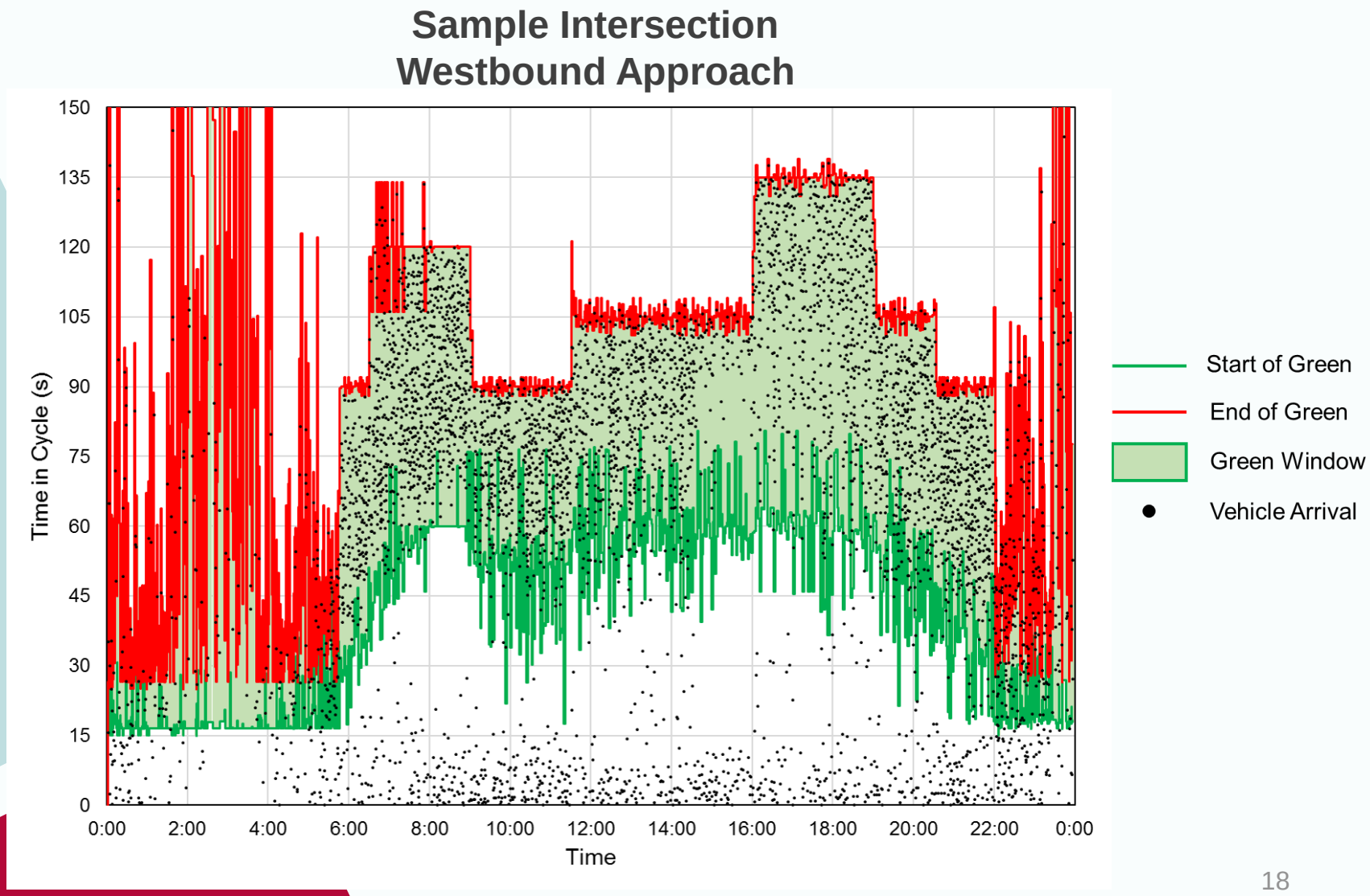
Source: Purdue

Sample Performance Measures

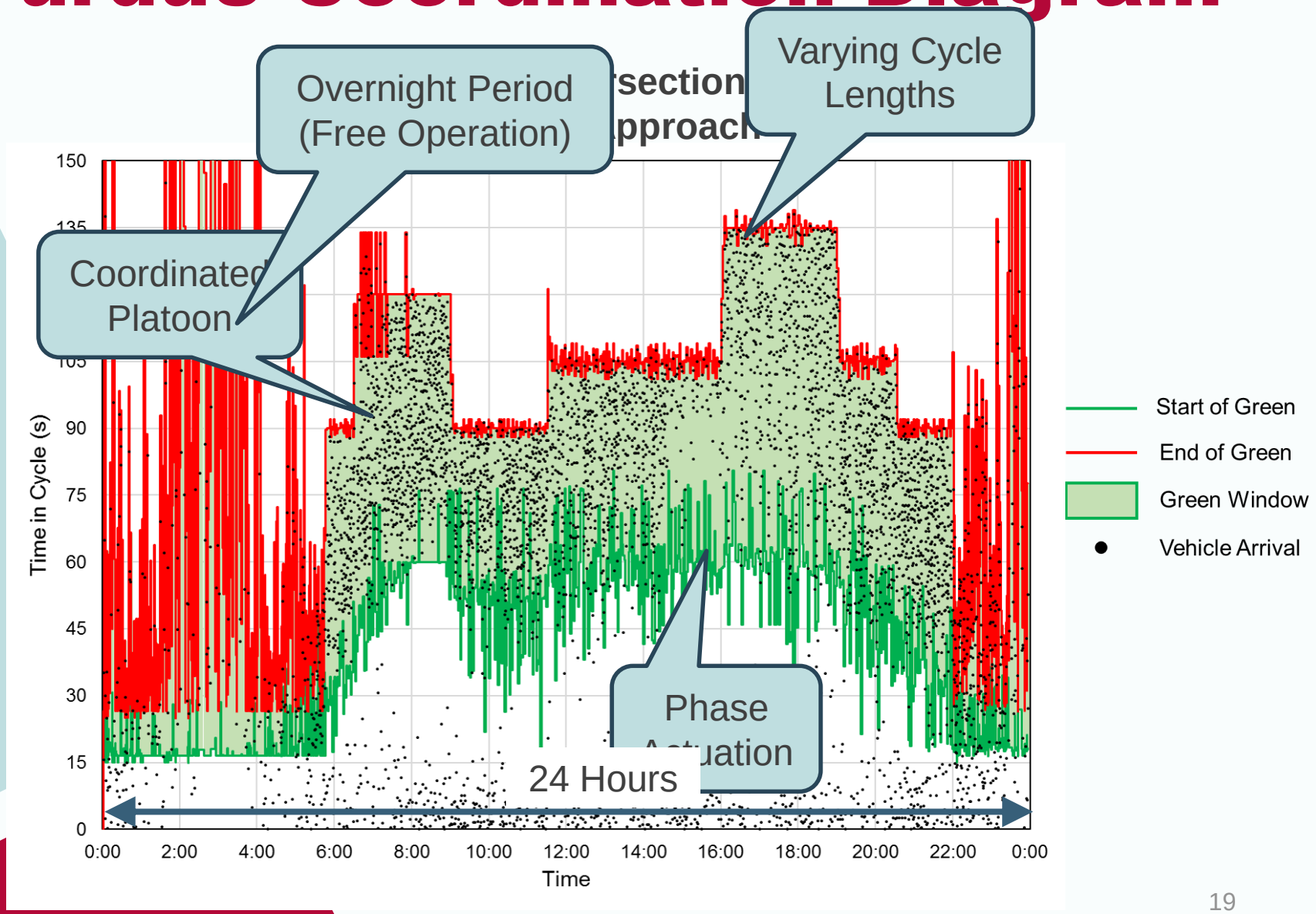
Objective	Signal System Components	Example Performance Measures & Visualization
Smooth Traffic Flow	System Control	Arrivals on Green Platoon Ratio Purdue Coordination Diagram Cyclic Flow Profile Measured Travel Time

Source: Purdue

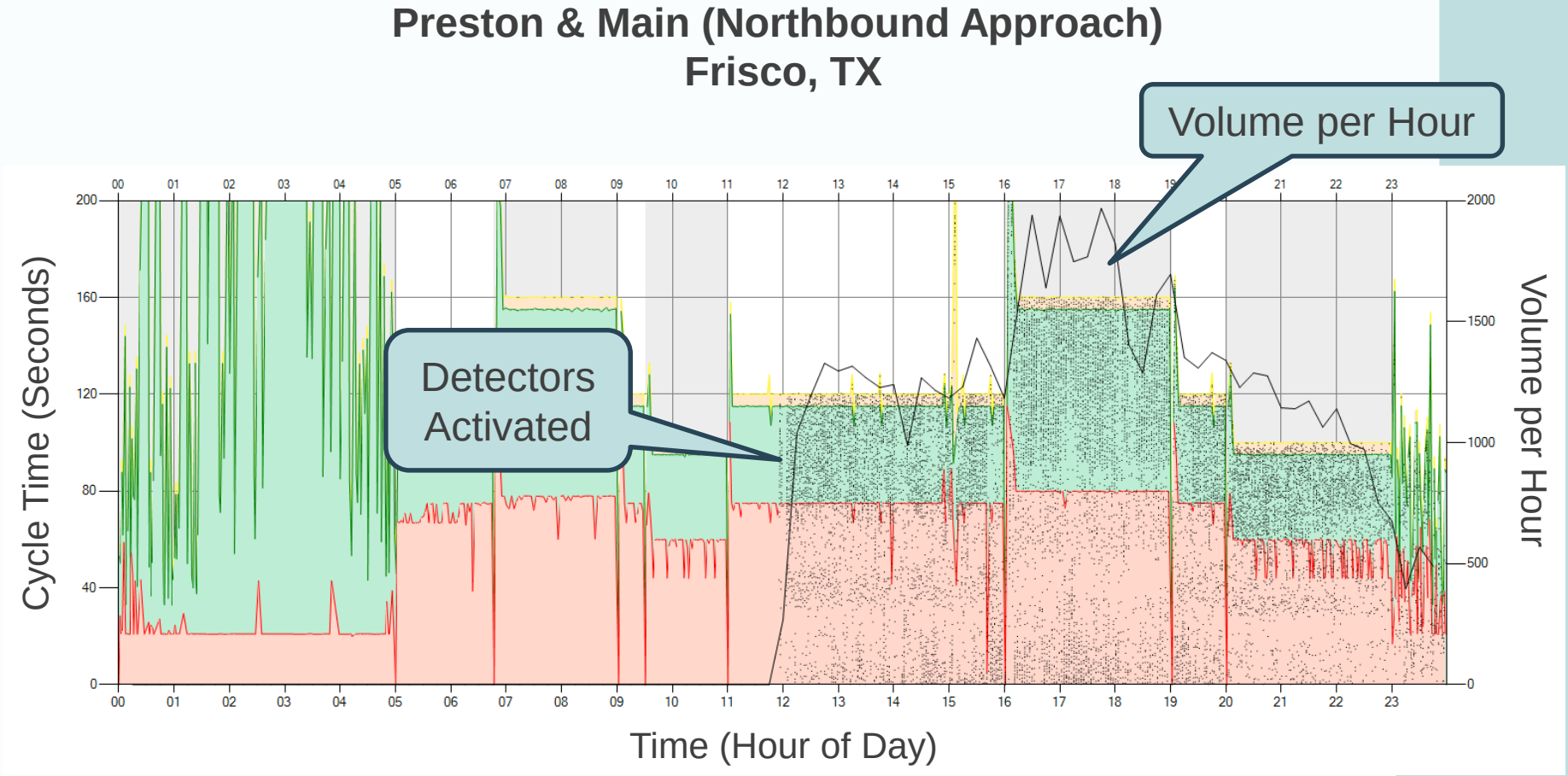
Purdue Coordination Diagram



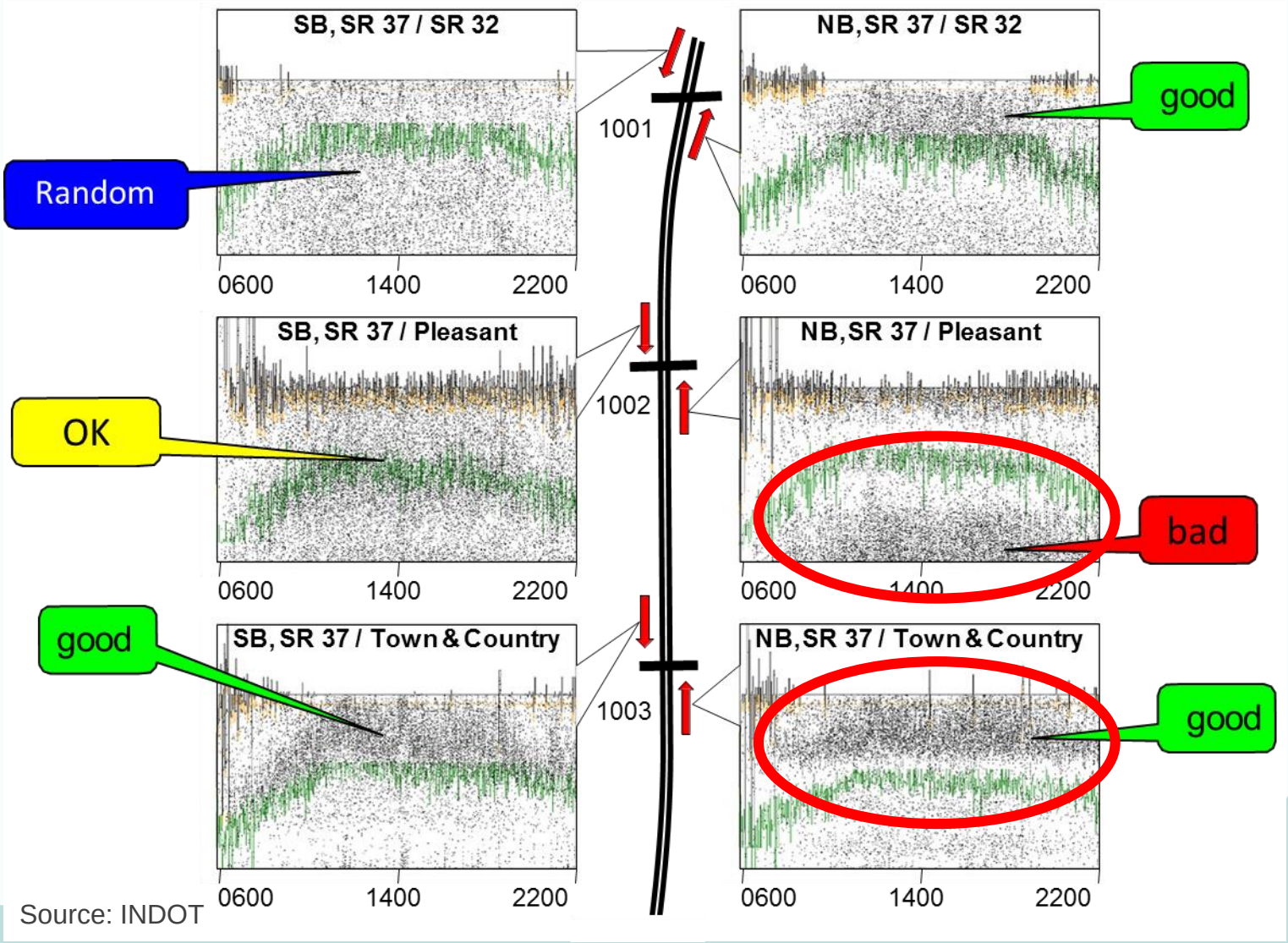
Purdue Coordination Diagram



Sample PCD

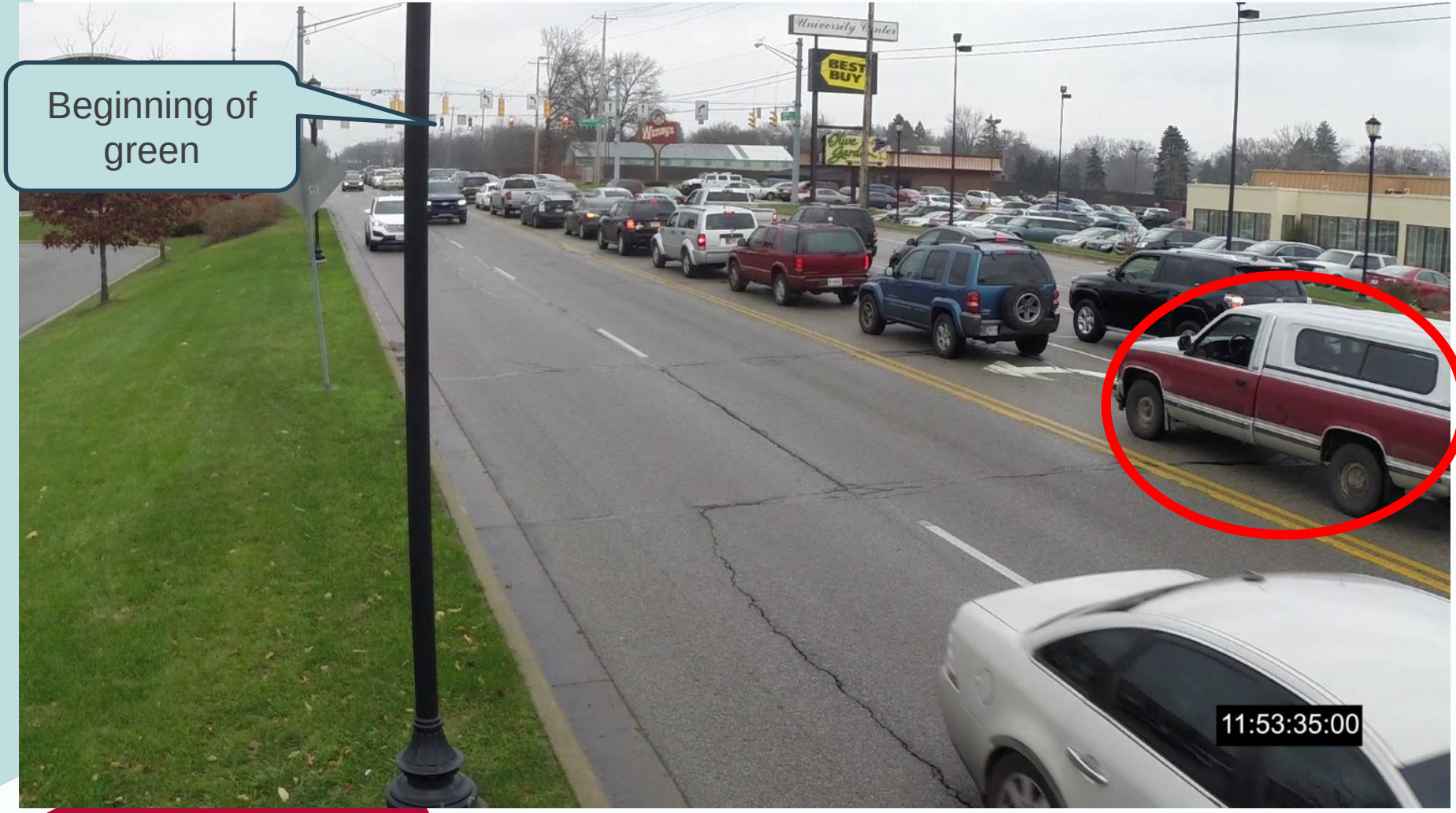

Preston & Main (Northbound Approach)
Frisco, TX
Volume per Hour
Detectors Activated
Cycle Time (Seconds)
Volume per Hour
Time (Hour of Day)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
0 40 80 120 160 200
0 500 1000 1500 2000

Corridor Visualization



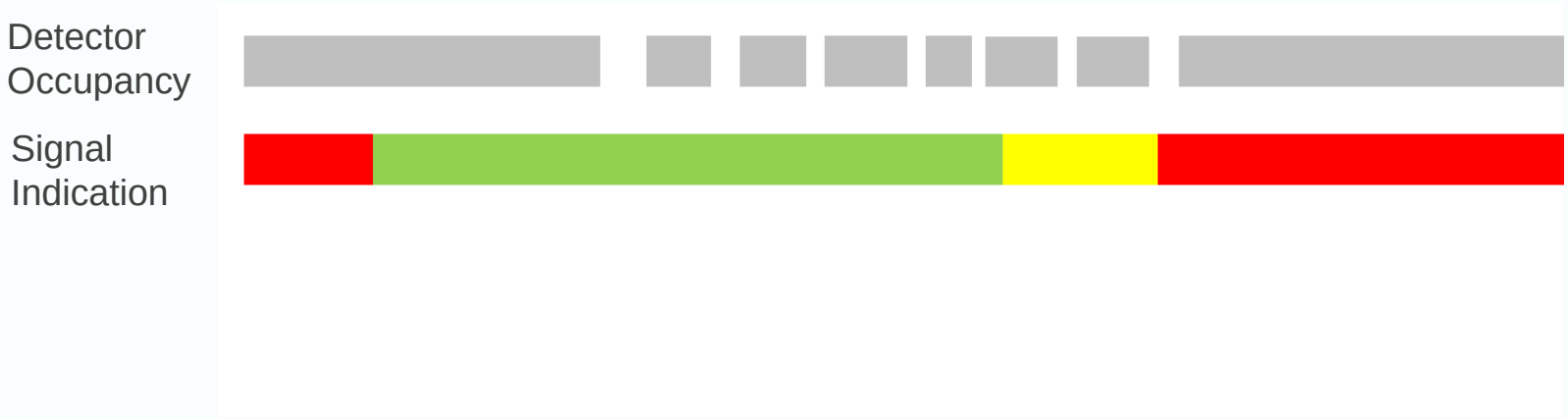
Source: INDOT

Split Failures



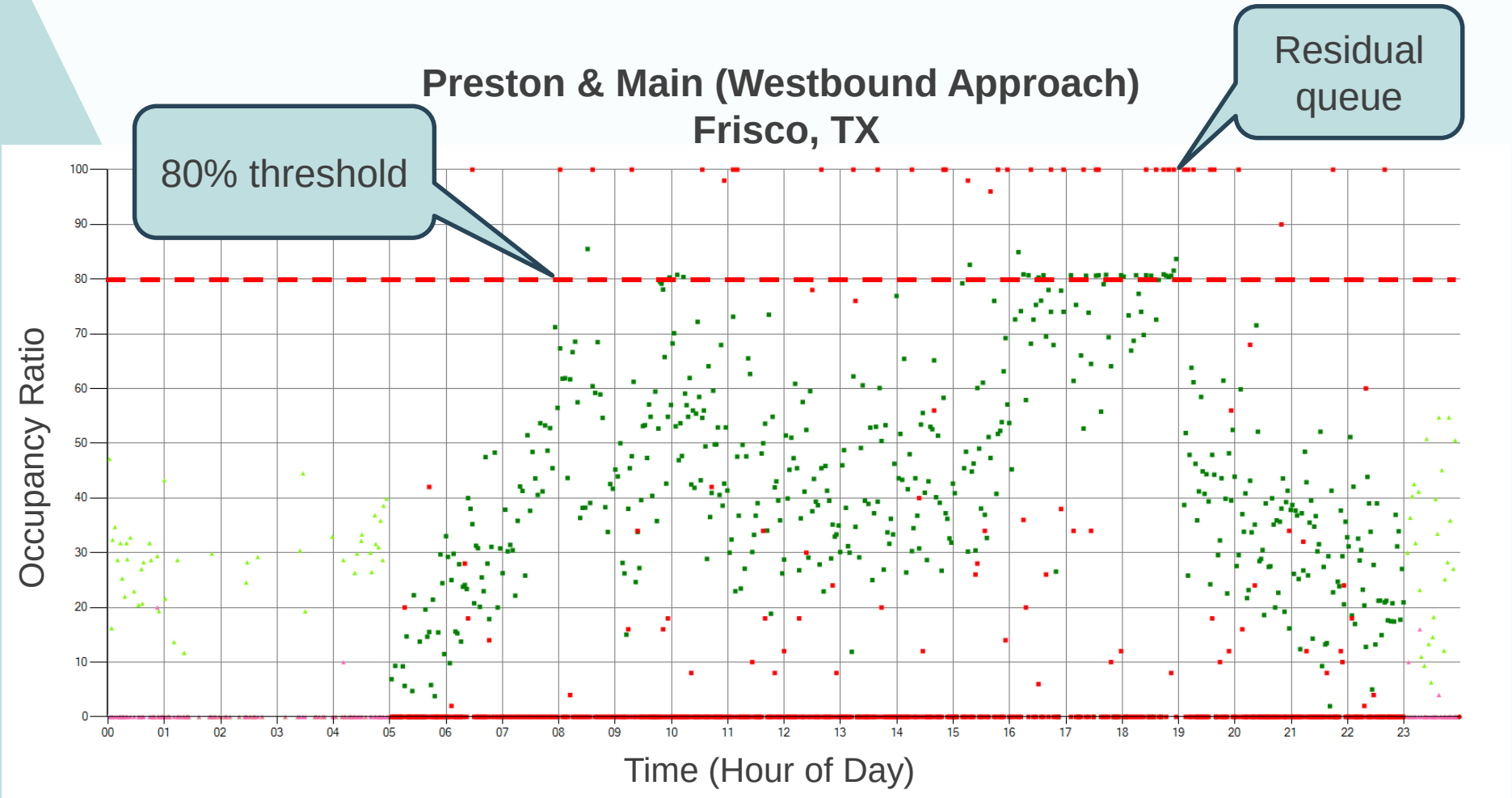
Split Failures

Split Failures

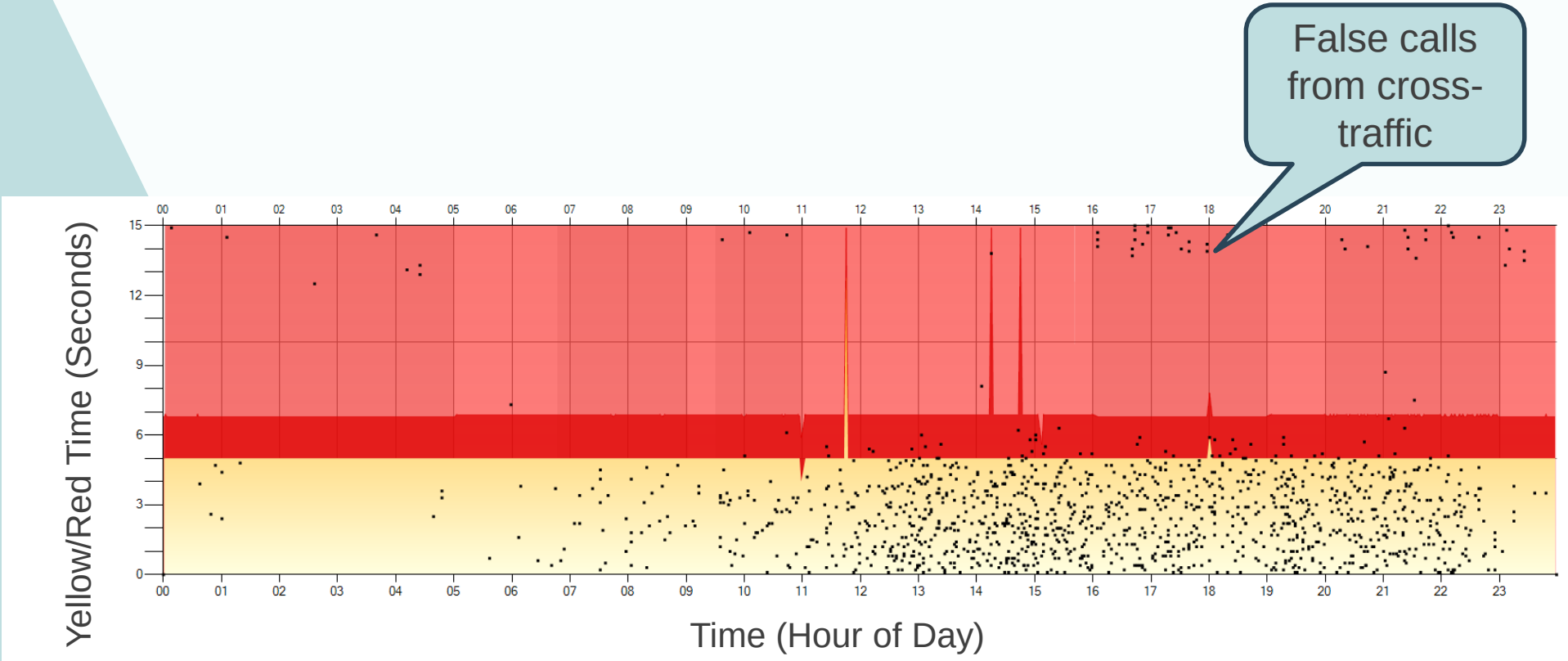


GOR ≥ 80% & ROR_5 ≥ 80% → split failure

Split Failures



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

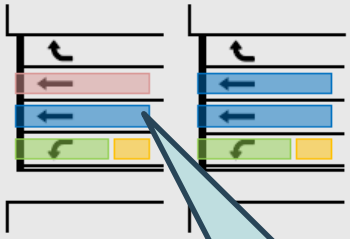
Source: Purdue

Detection

Detection	Metric
None 	Phase Termination Chart Split Monitor Preemption Details Pedestrian Delay

Source: UDOT

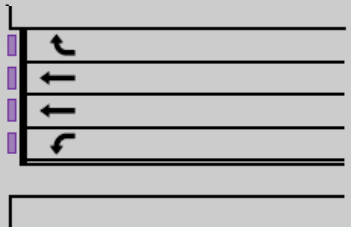
Detection

Detection	Metric
Lane-by-lane or Lane Group Presence 	Purdue Split Failure

Lane-by-lane is ideal

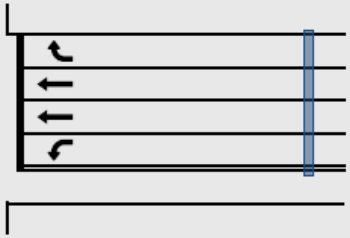
Source: UDOT

Detection

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

Source: UDOT

Detection

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

Source: UDOT

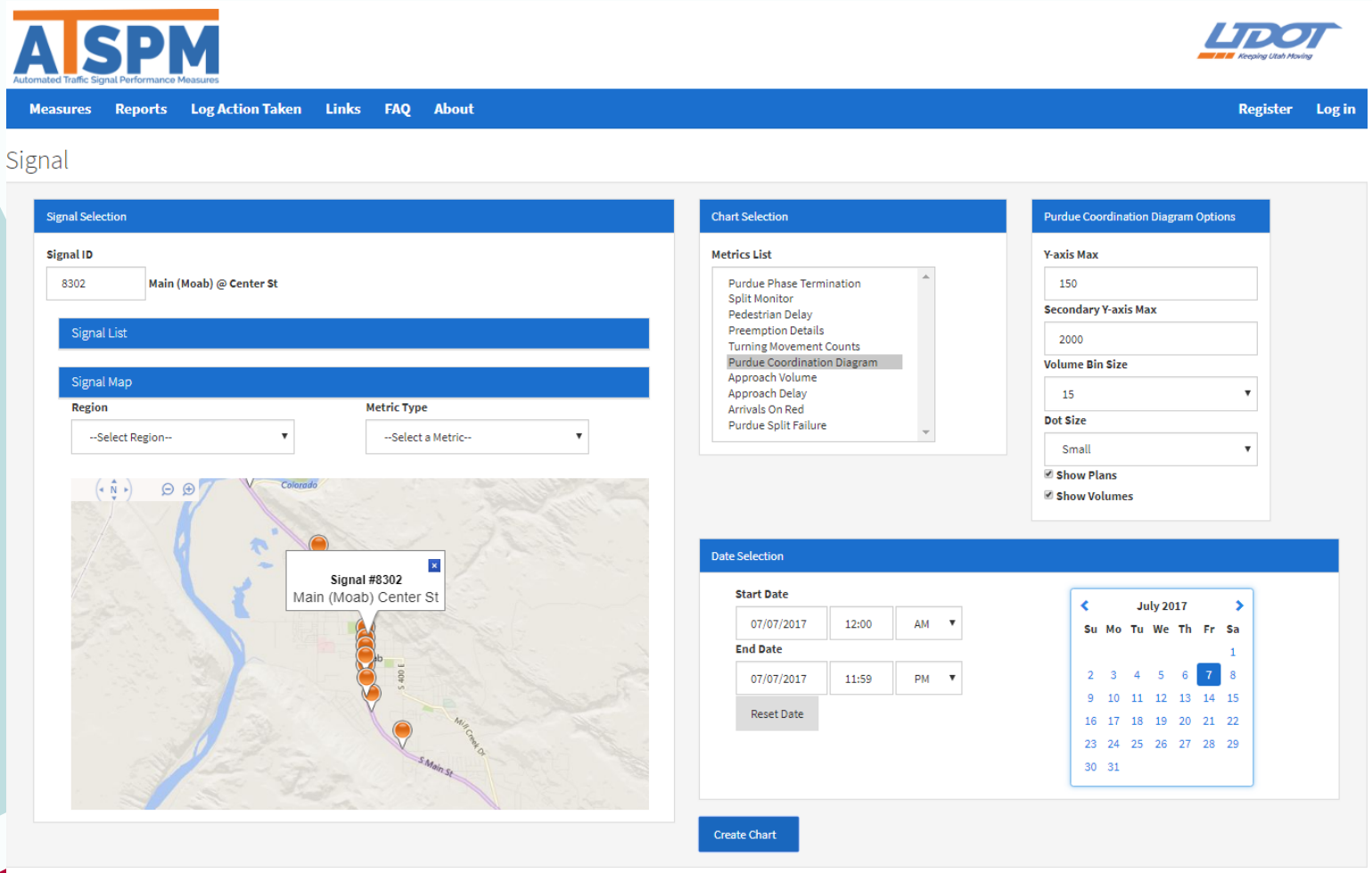
Communication

- 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

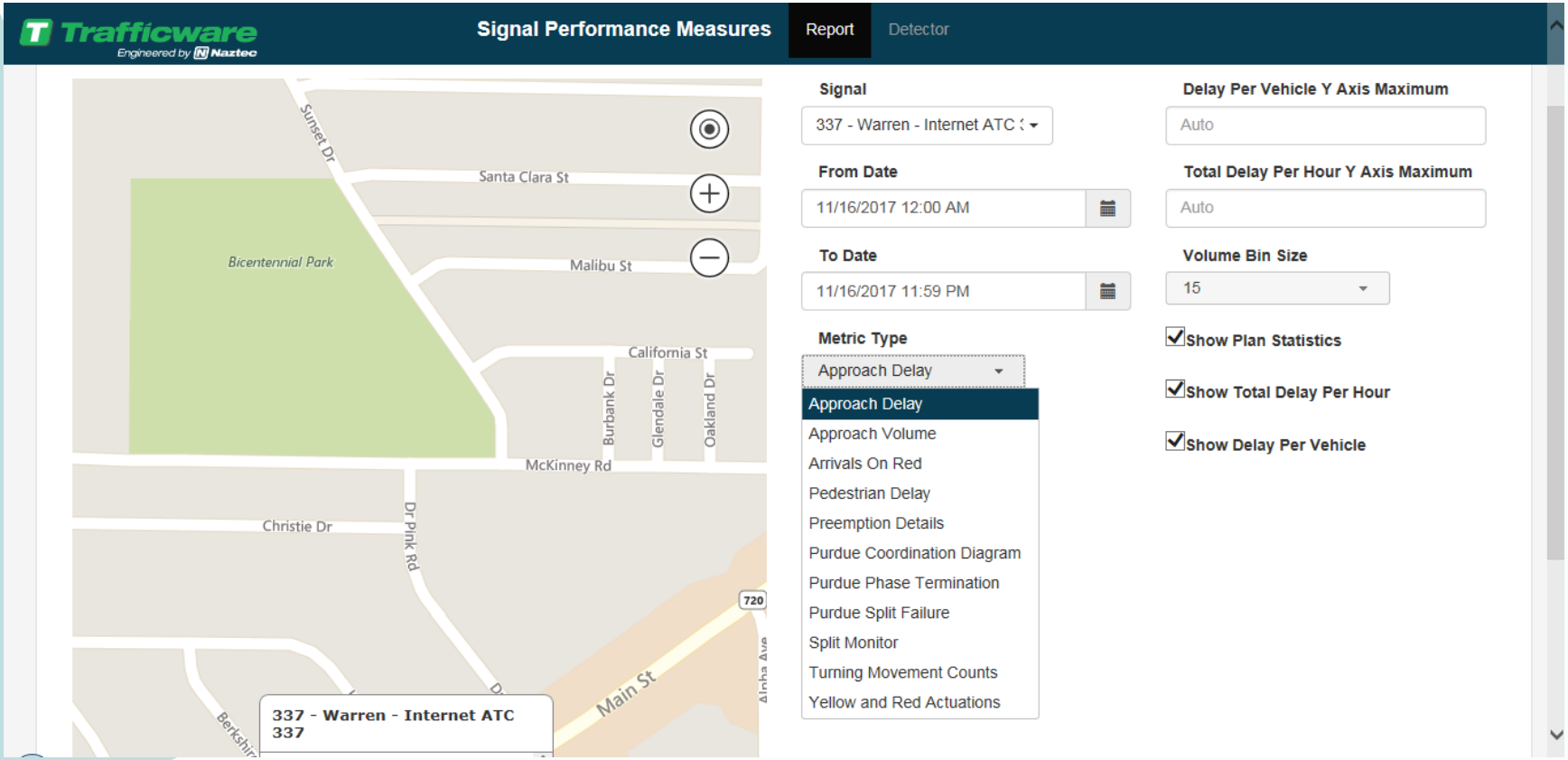
UDOT Software



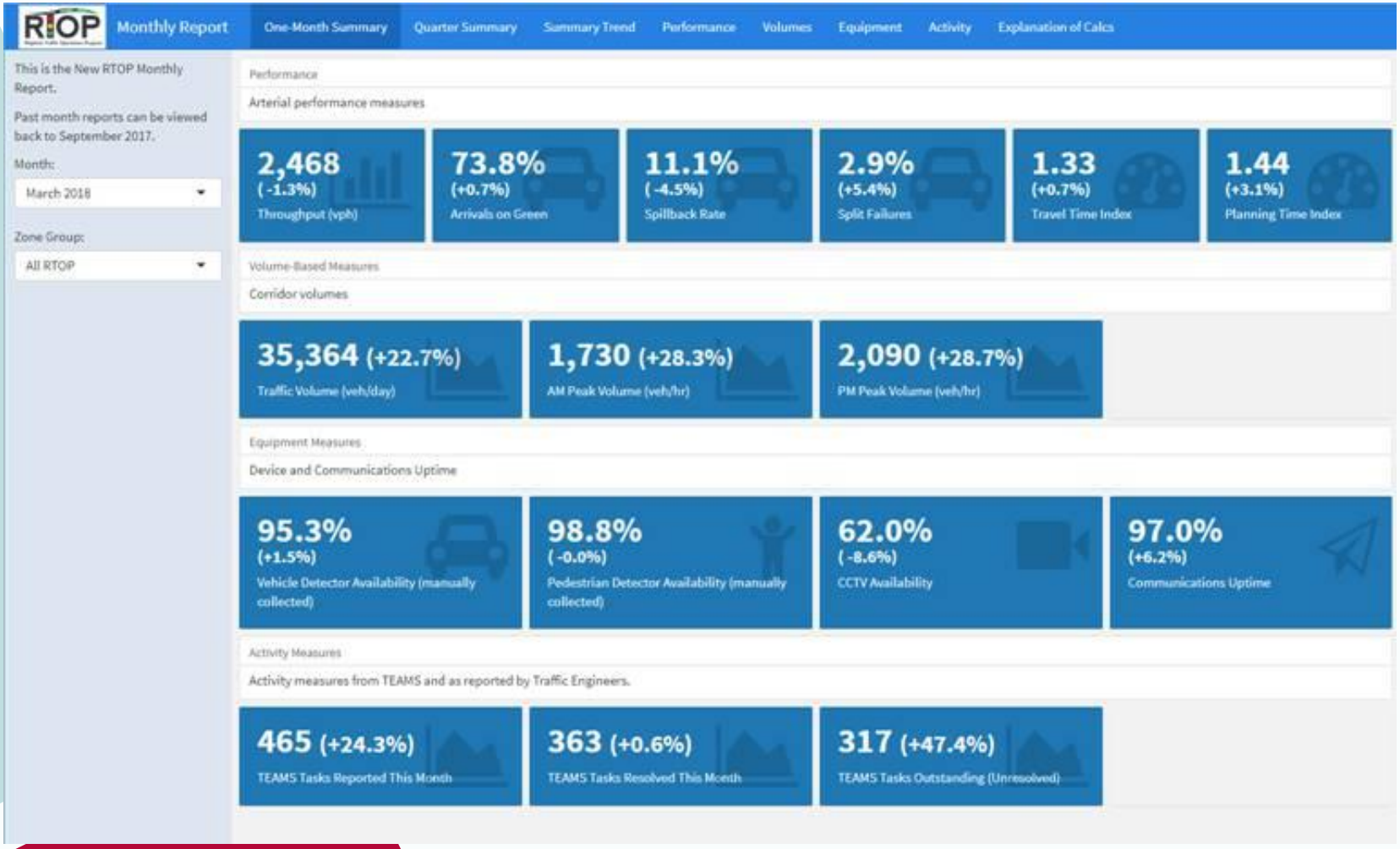
Software

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

Vendor Solution



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

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

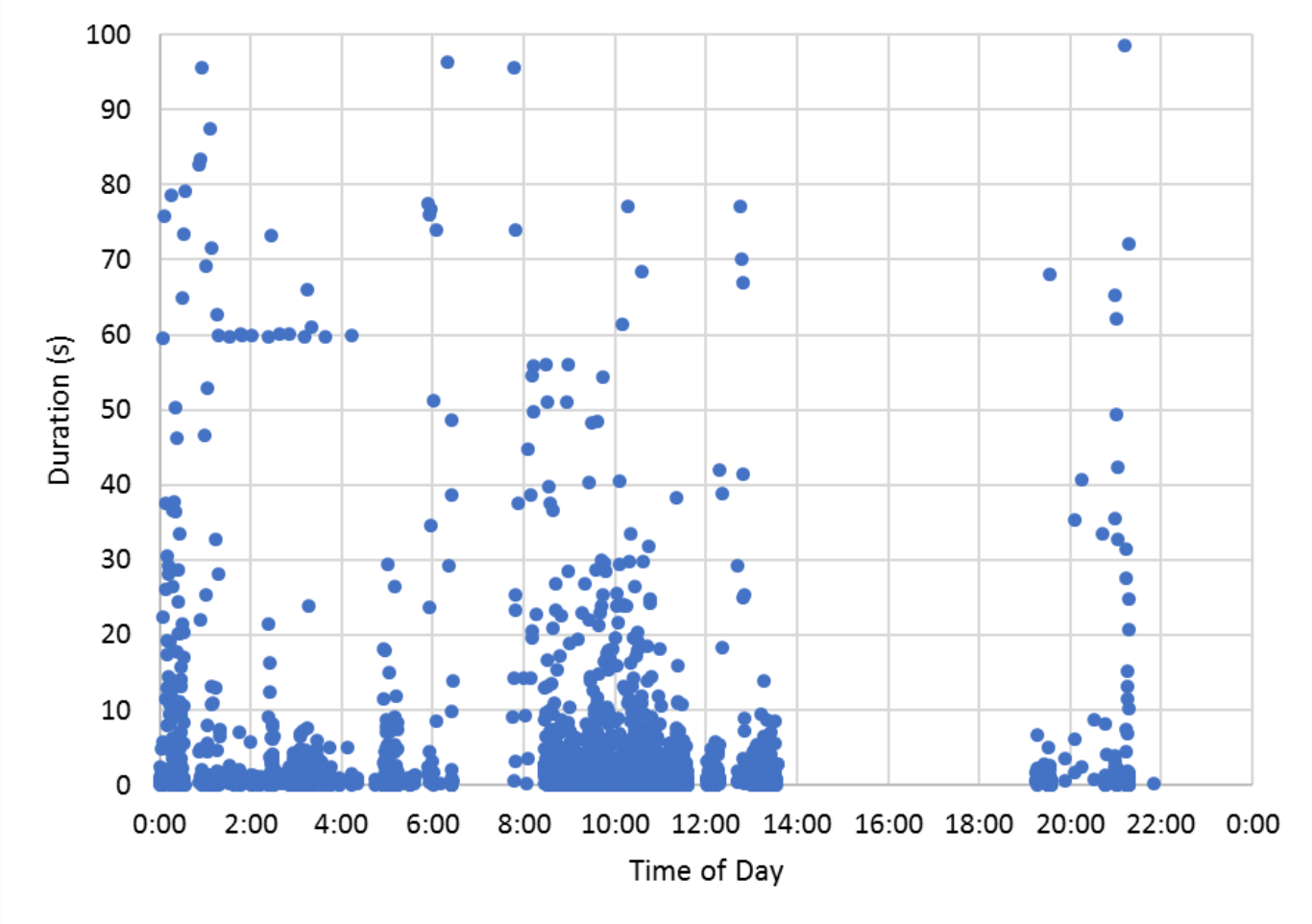
Leverage Funding Sources

- For controller, communication, detection upgrades

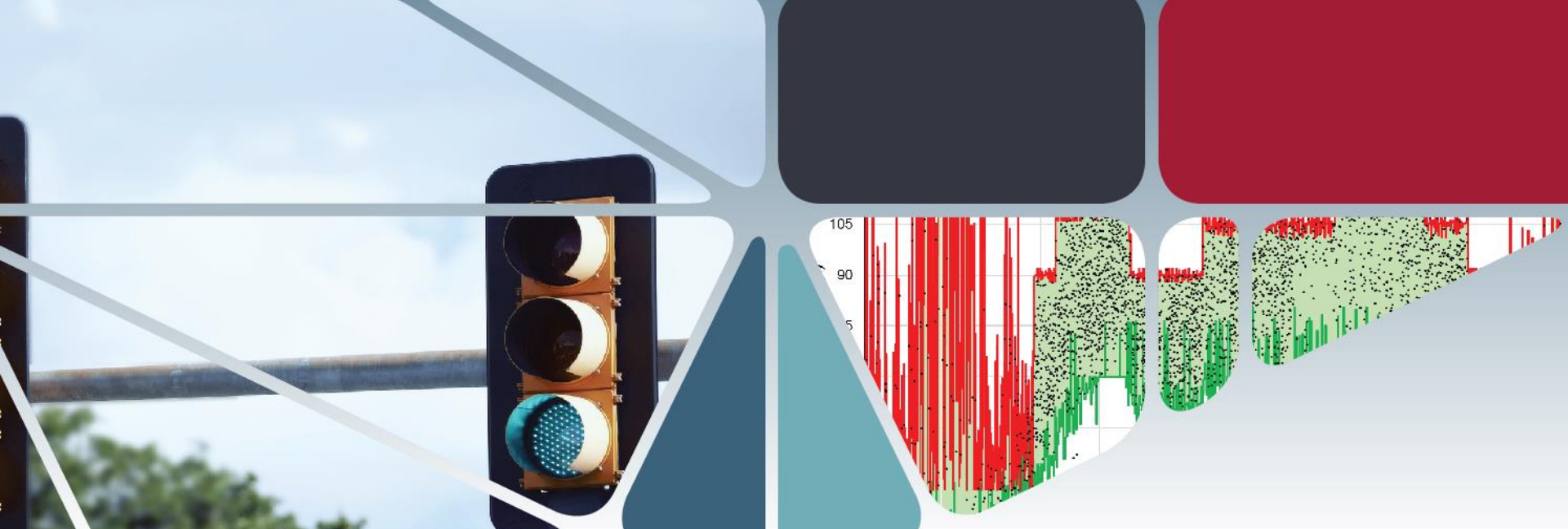
Get Creative

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

Austin Example




PLAN
your objectives and target performance measures
PROCURE
necessary hardware (servers, detection devices, etc.)
INSTALL
the UDOT software
CONFIGURE
your signals and detection devices in the system
INTEGRATE
the data into daily operations
ANALYZE
the data to drive decisions and future initiatives



Questions?

Lucy Richardson
Lucy.Richardson@kimley-horn.com

Kimley»Horn