



NCDOT ATSPM AND ARTERIAL RETIMING PRIORITIZATION

ITS Carolinas Conference | February 13, 2018
Bastian Schroeder

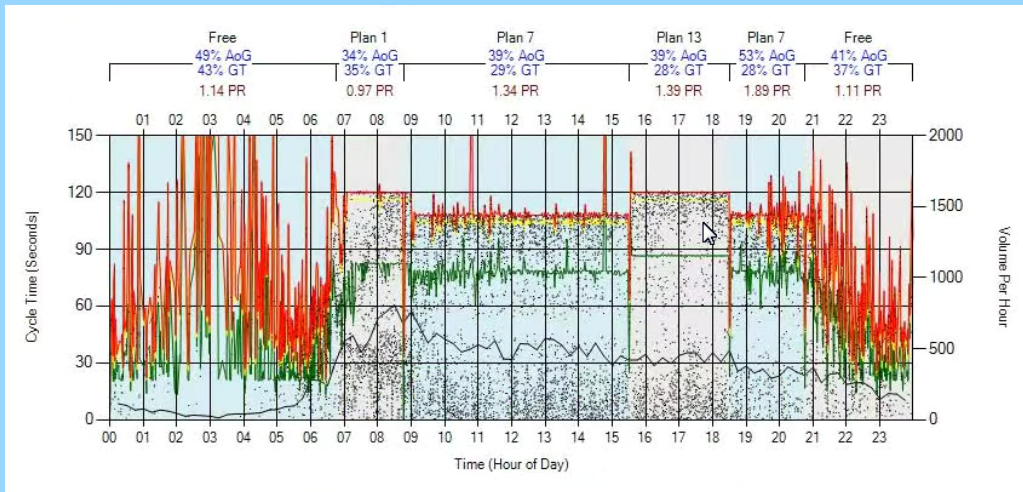
Acknowledgments

- ▶ NCDOT Partners
 - ▶ Jennifer Portanova
 - ▶ Zach Clark
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- ▶ ITRE Teaming Partners
 - ▶ Thomas Chase, Chris Cunningham, Shams Tanvir
- ▶ Kittelson Project Team
 - ▶ Alison Tanaka, Lake Trask, Bradley Reynolds

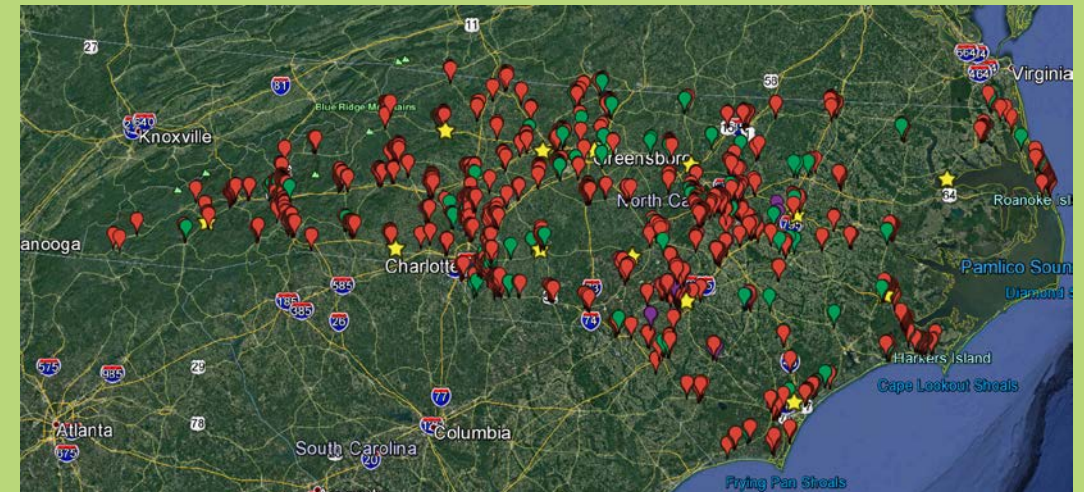


Project Objectives

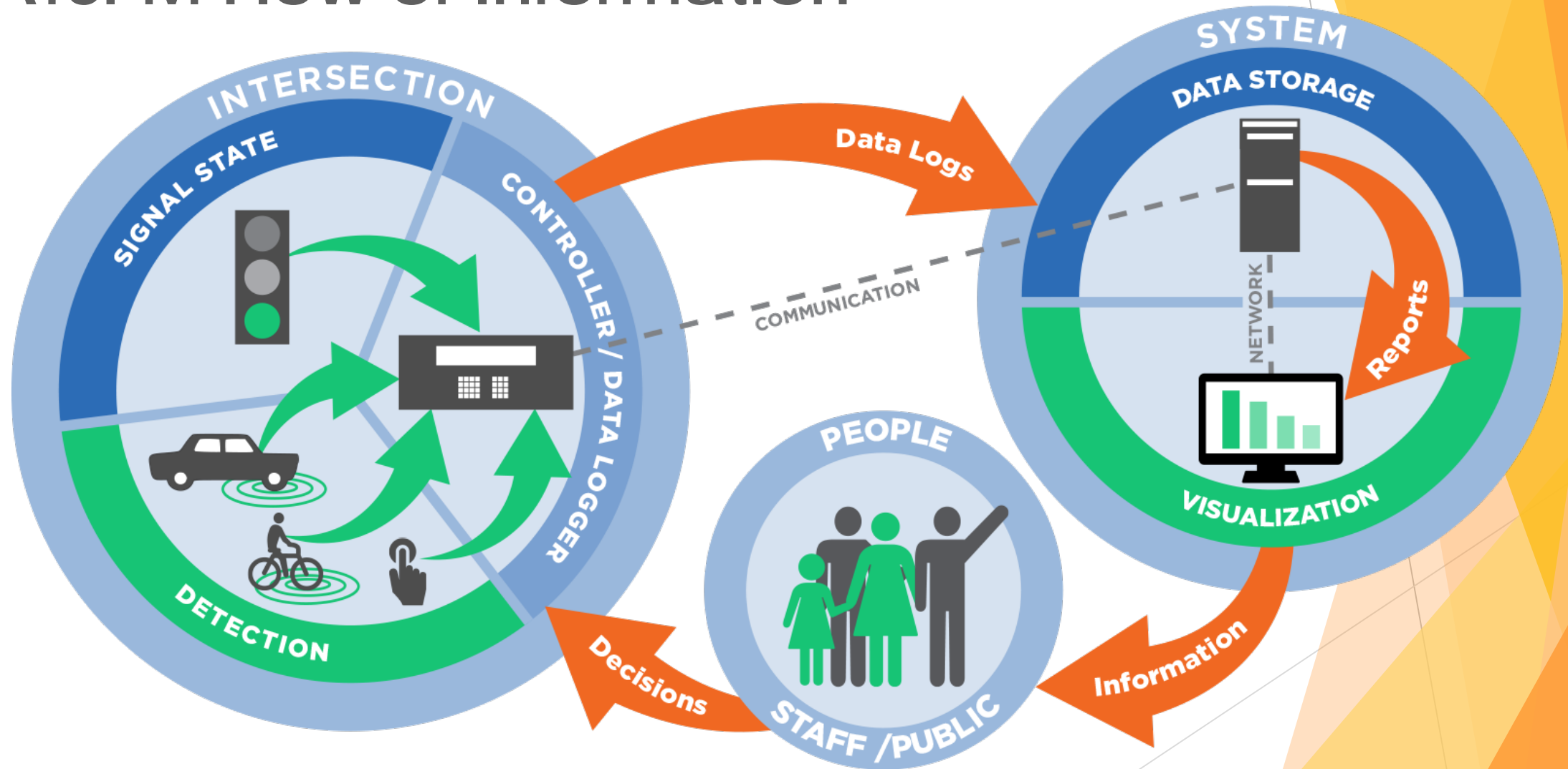
- ▶ assist NCDOT in evaluating technology hardware and software options for upgrading all or parts of NCDOT-maintained traffic signals to support ATSPM



- ▶ evaluate the use of probe-based travel time data to support analysis of signalized corridors in North Carolina, and to prioritize corridors for retiming



ATSPM Flow of Information

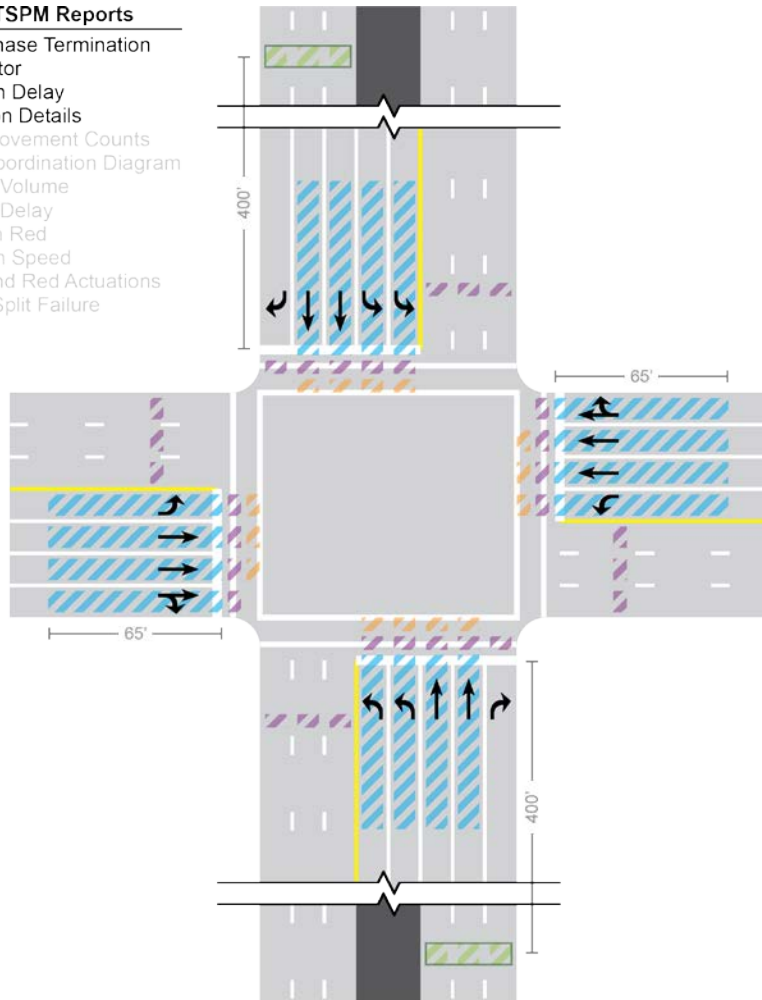


Detection Needs

Detector Configuration A: No Additional Detection

Available ATSPM Reports

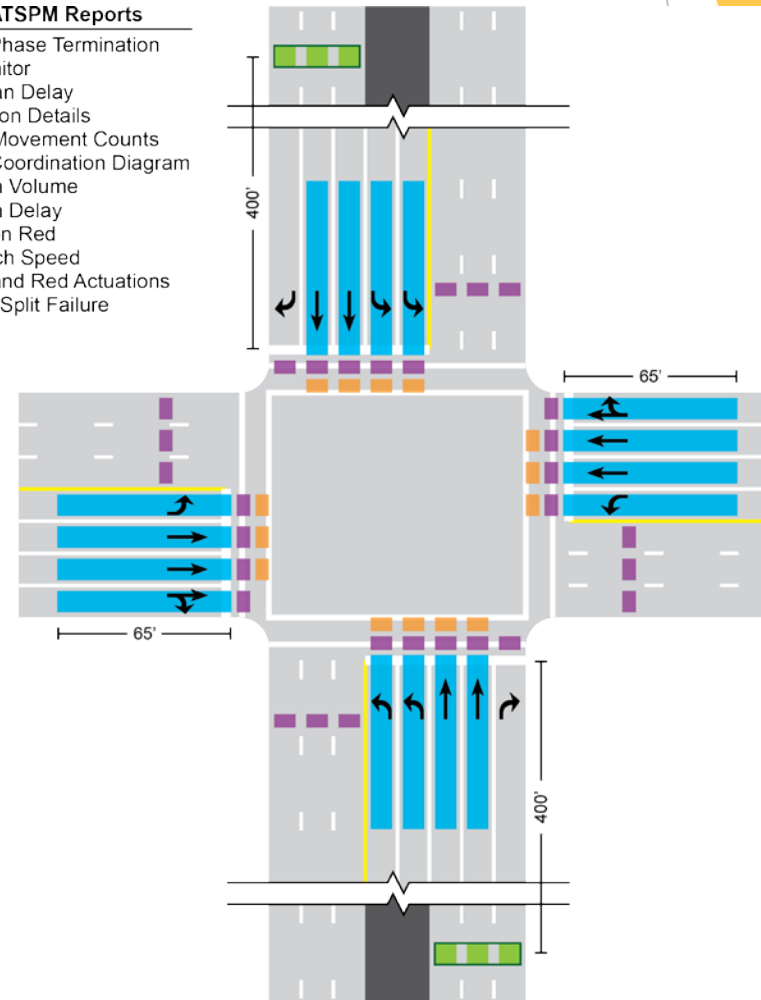
1. Purdue Phase Termination
2. Split Monitor
3. Pedestrian Delay
4. Preemption Details
5. Turning Movement Counts
6. Purdue Coordination Diagram
7. Approach Volume
8. Approach Delay
9. Arrivals on Red
10. Approach Speed
11. Yellow and Red Actuations
12. Purdue Split Failure



Detector Configuration D: All Detection

Available ATSPM Reports

1. Purdue Phase Termination
2. Split Monitor
3. Pedestrian Delay
4. Preemption Details
5. Turning Movement Counts
6. Purdue Coordination Diagram
7. Approach Volume
8. Approach Delay
9. Arrivals on Red
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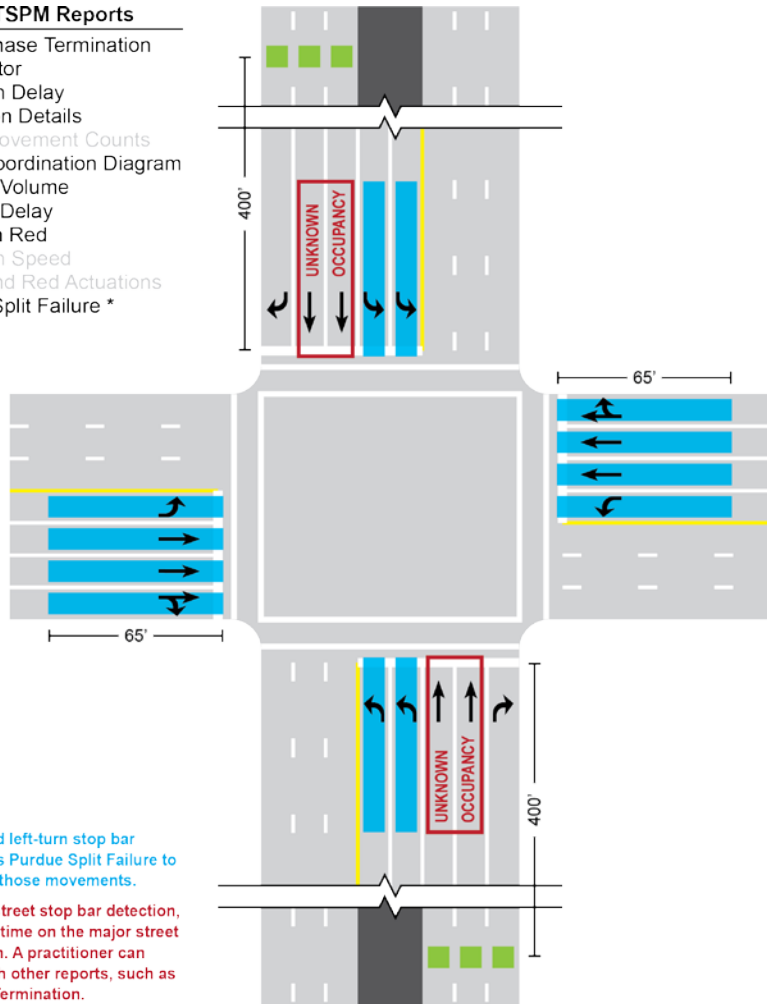


NCDOT Detection Layouts

Detector Configuration E: Minor Stop Bar & Major Advance (Lane-by-Lane)

Available ATSPM Reports

1. Purdue Phase Termination
2. Split Monitor
3. Pedestrian Delay
4. Preemption Details
5. Turning Movement Counts
6. Purdue Coordination Diagram
7. Approach Volume
8. Approach Delay
9. Arrivals on Red
10. Approach Speed
11. Yellow and Red Actuations
12. Purdue Split Failure *



* NOTE

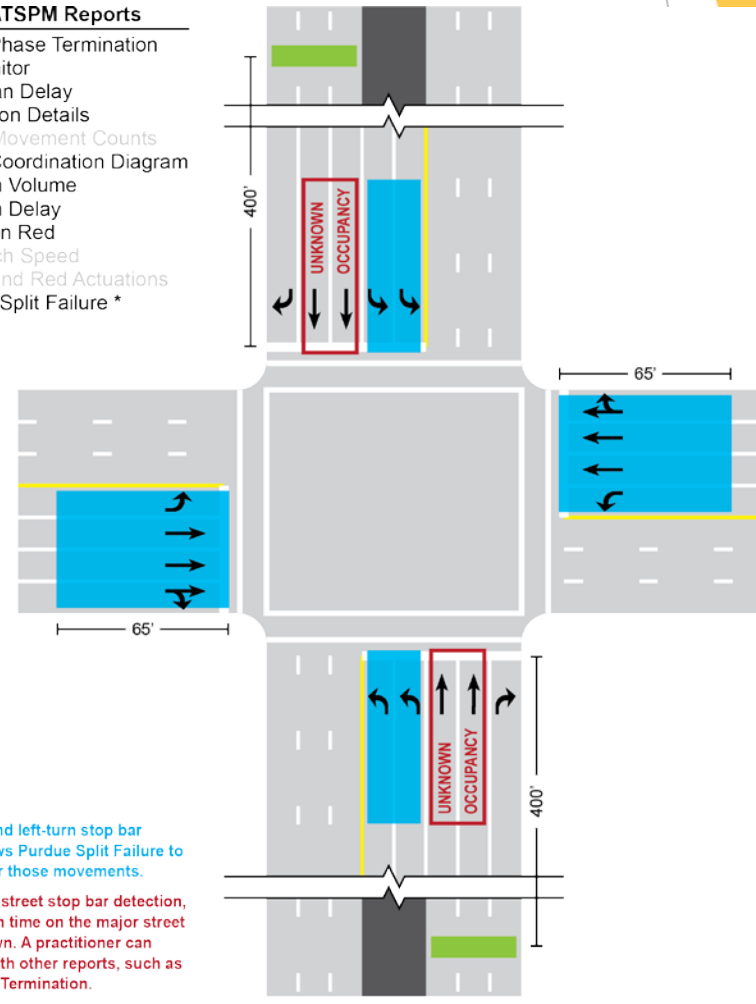
Minor street and left-turn stop bar detection allows Purdue Split Failure to be reported for those movements.

Without major street stop bar detection, available green time on the major street will be unknown. A practitioner can supplement with other reports, such as Purdue Phase Termination.

Detector Configuration F: Minor Stop Bar & Major Advance (Lane Groups)

Available ATSPM Reports

1. Purdue Phase Termination
2. Split Monitor
3. Pedestrian Delay
4. Preemption Details
5. Turning Movement Counts
6. Purdue Coordination Diagram
7. Approach Volume
8. Approach Delay
9. Arrivals on Red
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* NOTE

Minor street and left-turn stop bar detection allows Purdue Split Failure to be reported for those movements.

Without major street stop bar detection, available green time on the major street will be unknown. A practitioner can supplement with other reports, such as Purdue Phase Termination.

Pilot Site Overview

No	Location	Controller Vendor	Communications	ATSPM Tool
1	US 401 – Garner South System (3 Signals)	Econolite	Yes	Centracs + Centracs MOE
2	NC 55 – Broad Street (5 Signals)	Trafficware	Yes	Trafficware Cloud-Based Signal Performance Measures
3	NC 50 – Benson Road (3 Signals)	Econolite	No (Raspberry Pi)	UDOT Open Source Code
4	US 17 – Market Street (3 signals)	Econolite	No (Raspberry Pi)	UDOT Open Source Code

Traffic Signal Hierarchy

PLUS REPORTS!

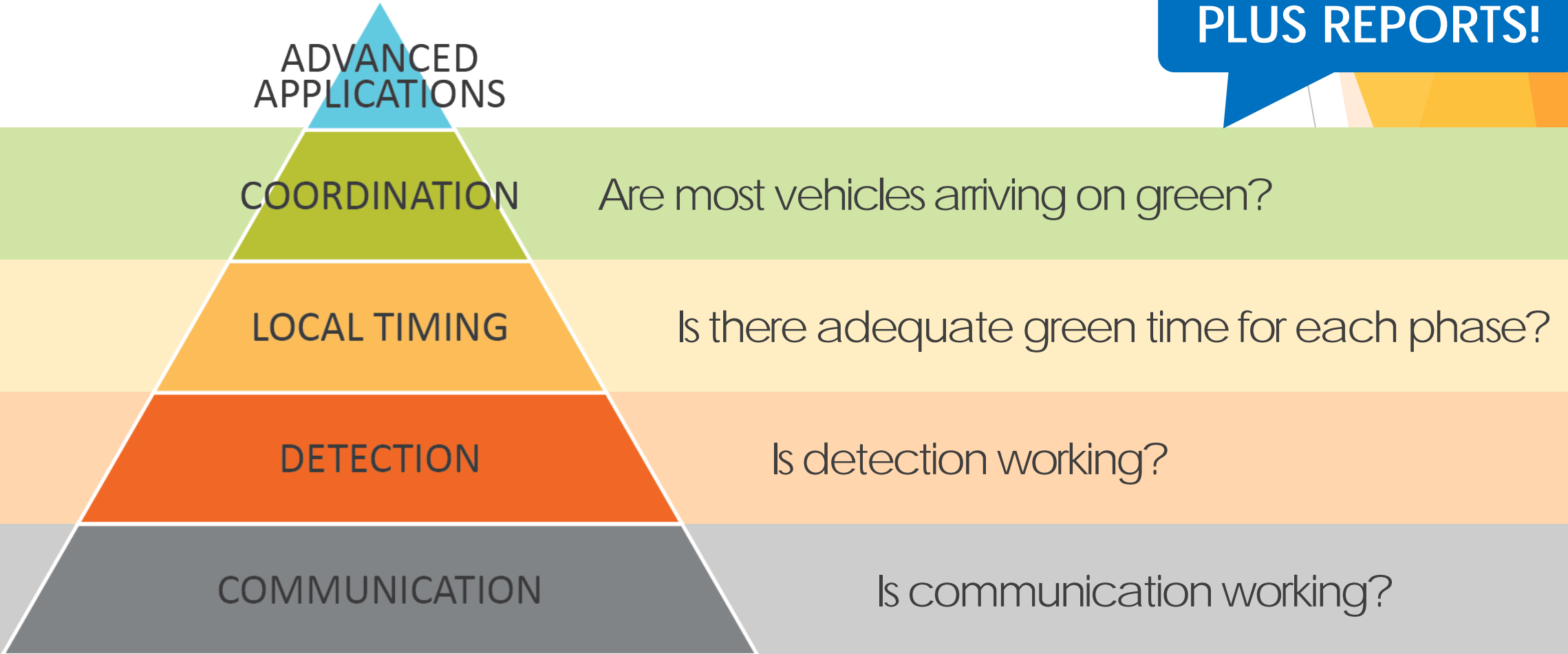
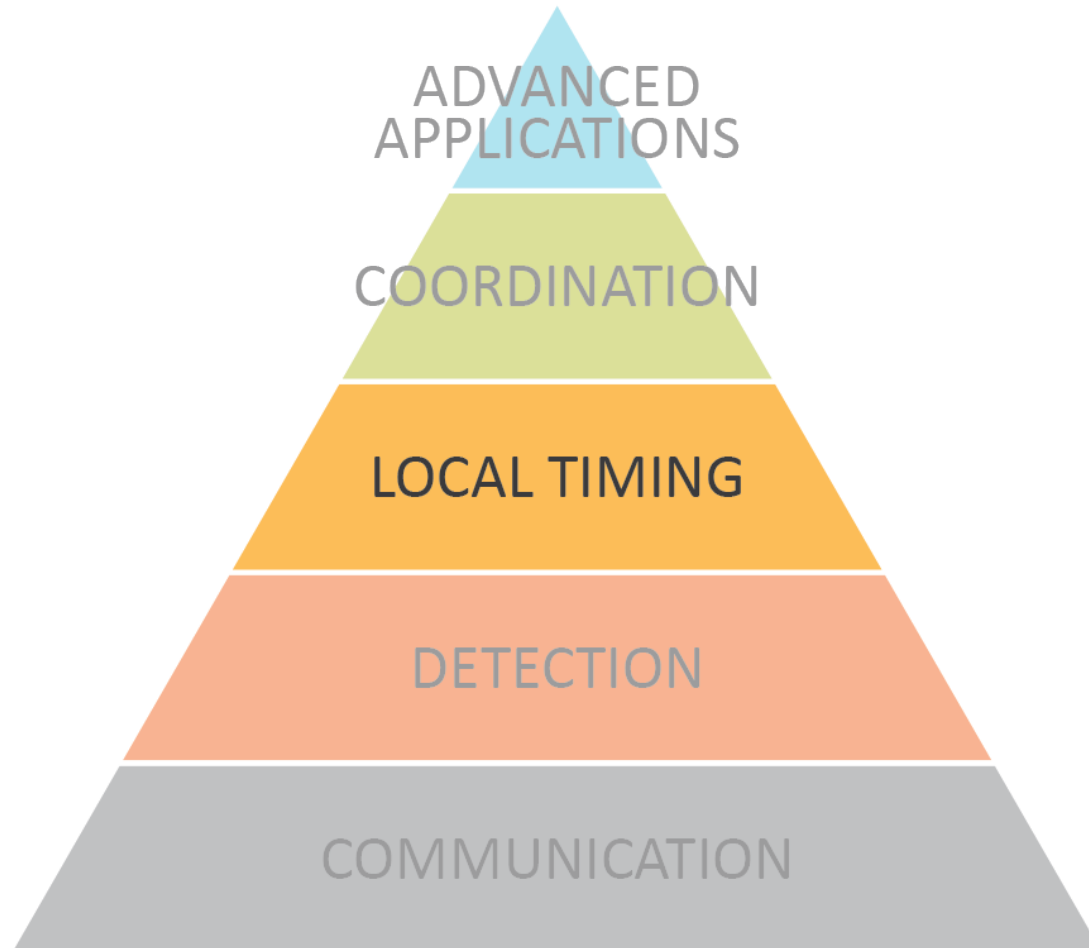


Exhibit modified from *Integrating Traffic Signal Performance Measures into Agency Business Processes* (Day et al. 2015)



Is there
adequate
green time for
each phase?

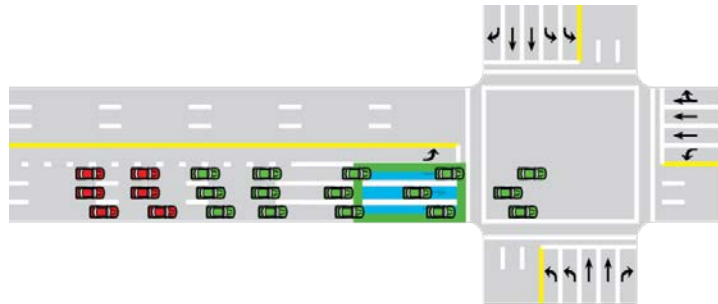
Example: Split Failures

SPLIT FAILURE

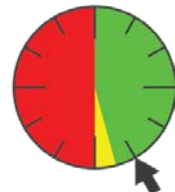
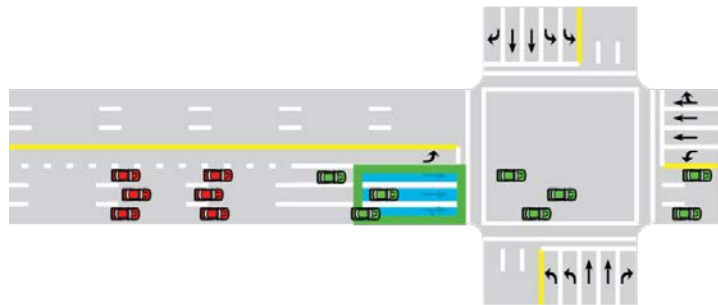
>80%
Occupancy
During Green



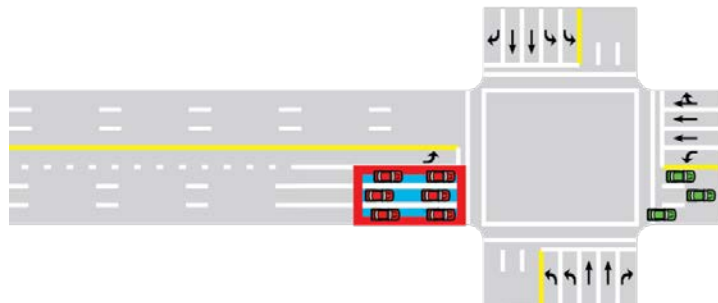
>80%
Occupancy
During First 5
Seconds of Red



Start of Green



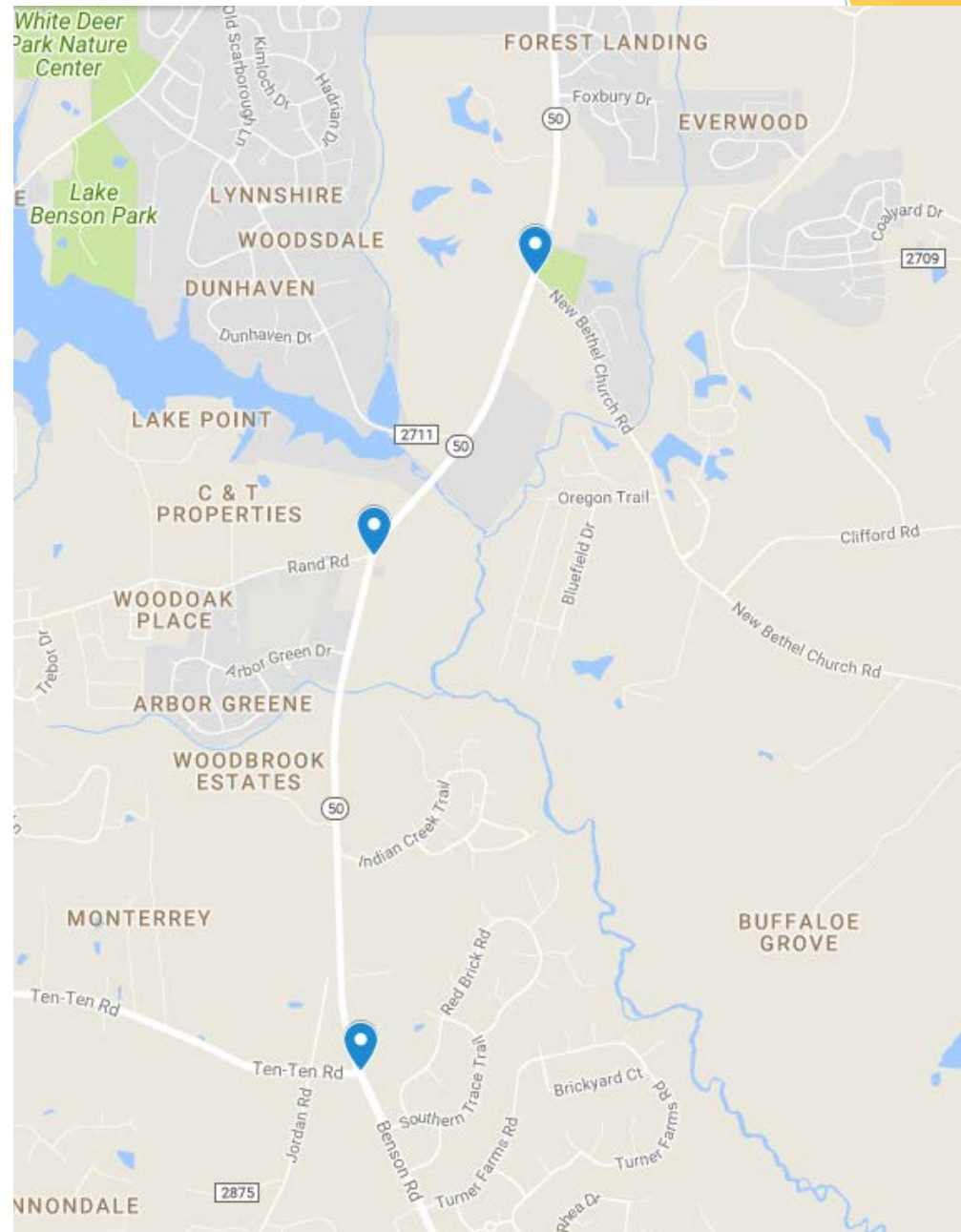
Vehicles Traveling
at Saturation Flow
Rate



First 5 Seconds of
Red

NC-50 Benson Rd

- ▶ New Bethel Ch Rd to 1010
- ▶ Controller Vendor: Econolite
- ▶ Communications: No (Raspberry Pi)
- ▶ ATSPM Tool: UDOT Open Source Code
- ▶ Coordinated 10/11/2017





NCDOT EX: Split Failures

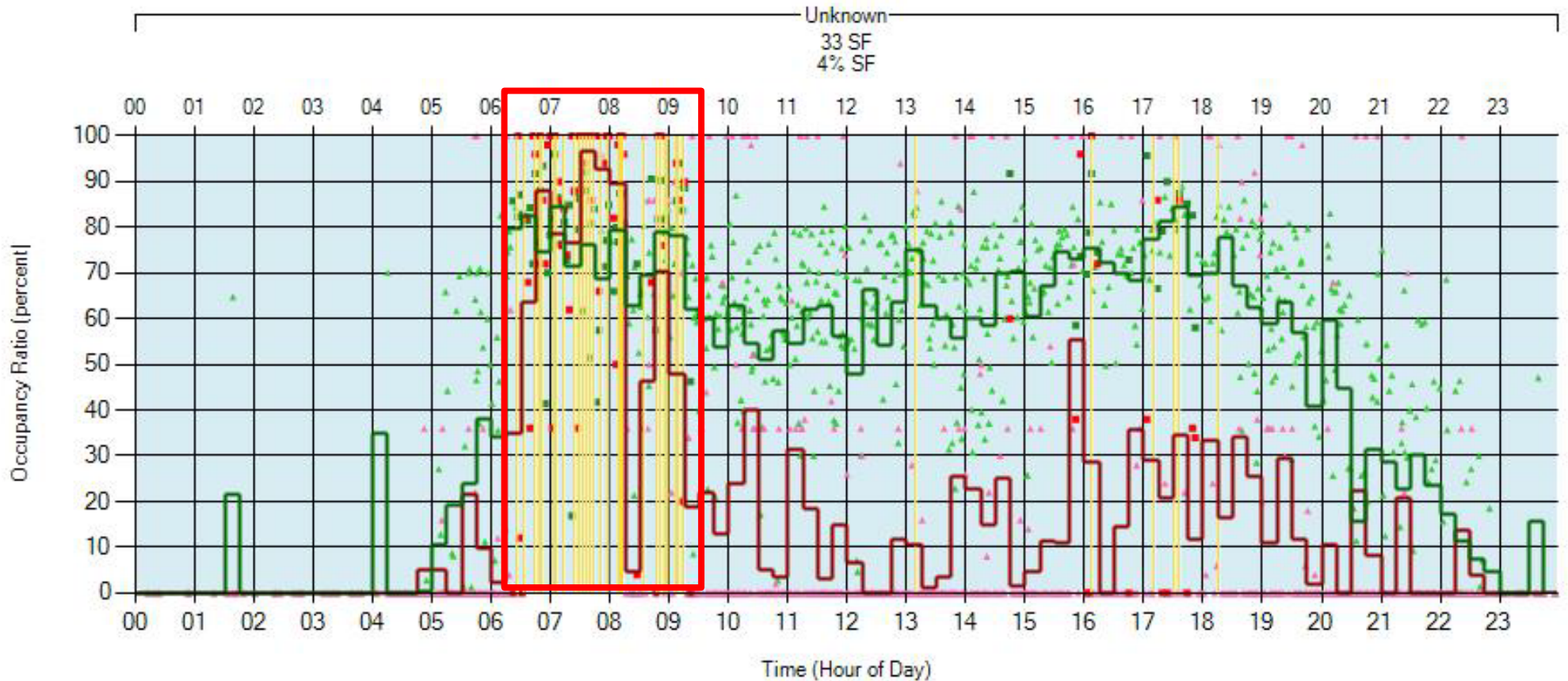
051158 – NC 50 (Benson Road) & SR 2728 (Rand Road)

Before – Free Operation

Protected Phase 4: Eastbound Left

Total Split Failures = 33

- SplitFail
- GOR - GapOut
- GOR - ForceOff
- ROR - GapOut
- ROR - ForceOff
- Avg. ROR
- Avg. GOR
- Percent Fails





NCDOT EX: Split Failures

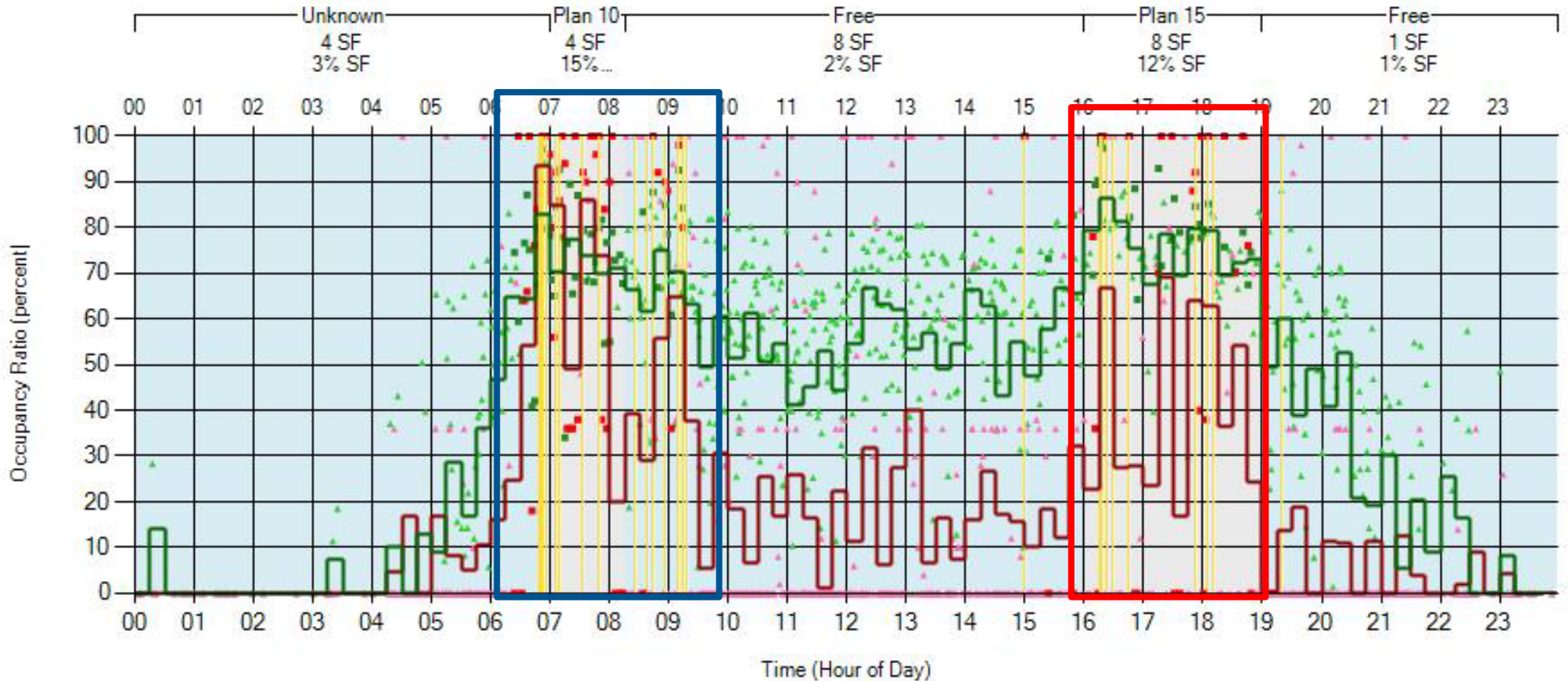
051158 – NC 50 (Benson Road) & SR 2728 (Rand Road)

After-Actuated-Coordinated

Protected Phase 4: Eastbound Left

Total Split Failures = 25

- SplitFail
- GOR - GapOut
- GOR - ForceOff
- ROR - GapOut
- ROR - ForceOff
- Avg. ROR
- Avg. GOR
- Percent Fails

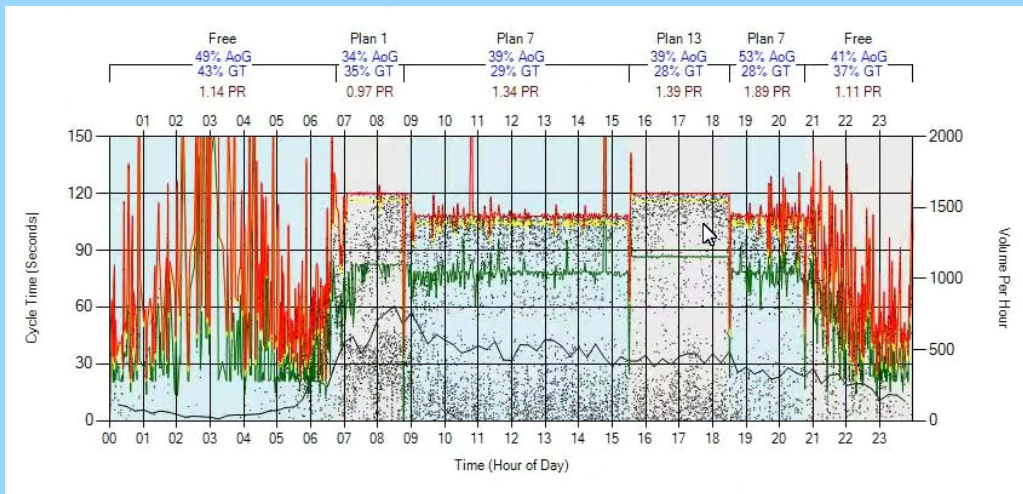


ATSPM Takeaways

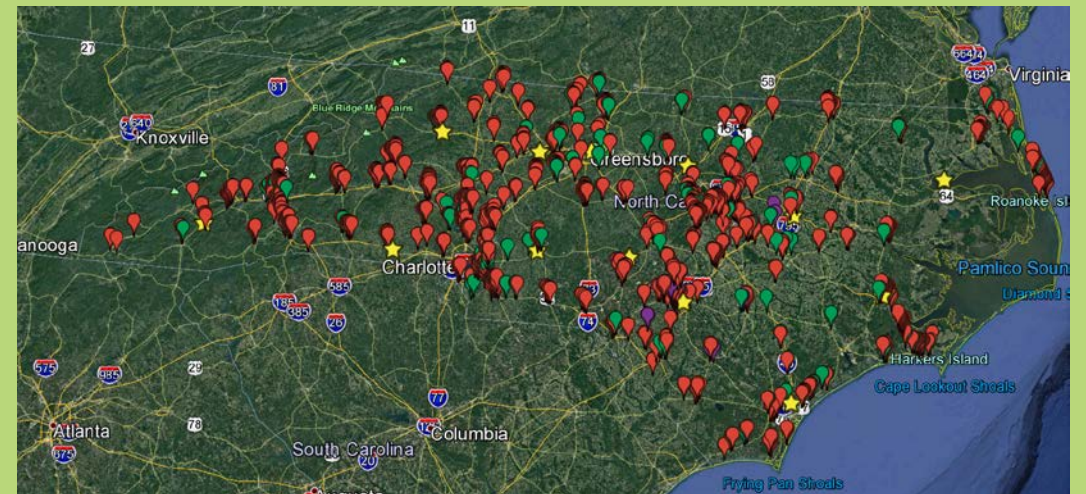
- ▶ Monitor system 24/7
- ▶ Solve problems quickly
- ▶ More measuring, less modeling
- ▶ Make informed decisions
- ▶ Prioritize tasks efficiently
- ▶ Evaluate spending
- ▶ Tell better stories
- ▶ Prepare for connected vehicles

Project Objectives

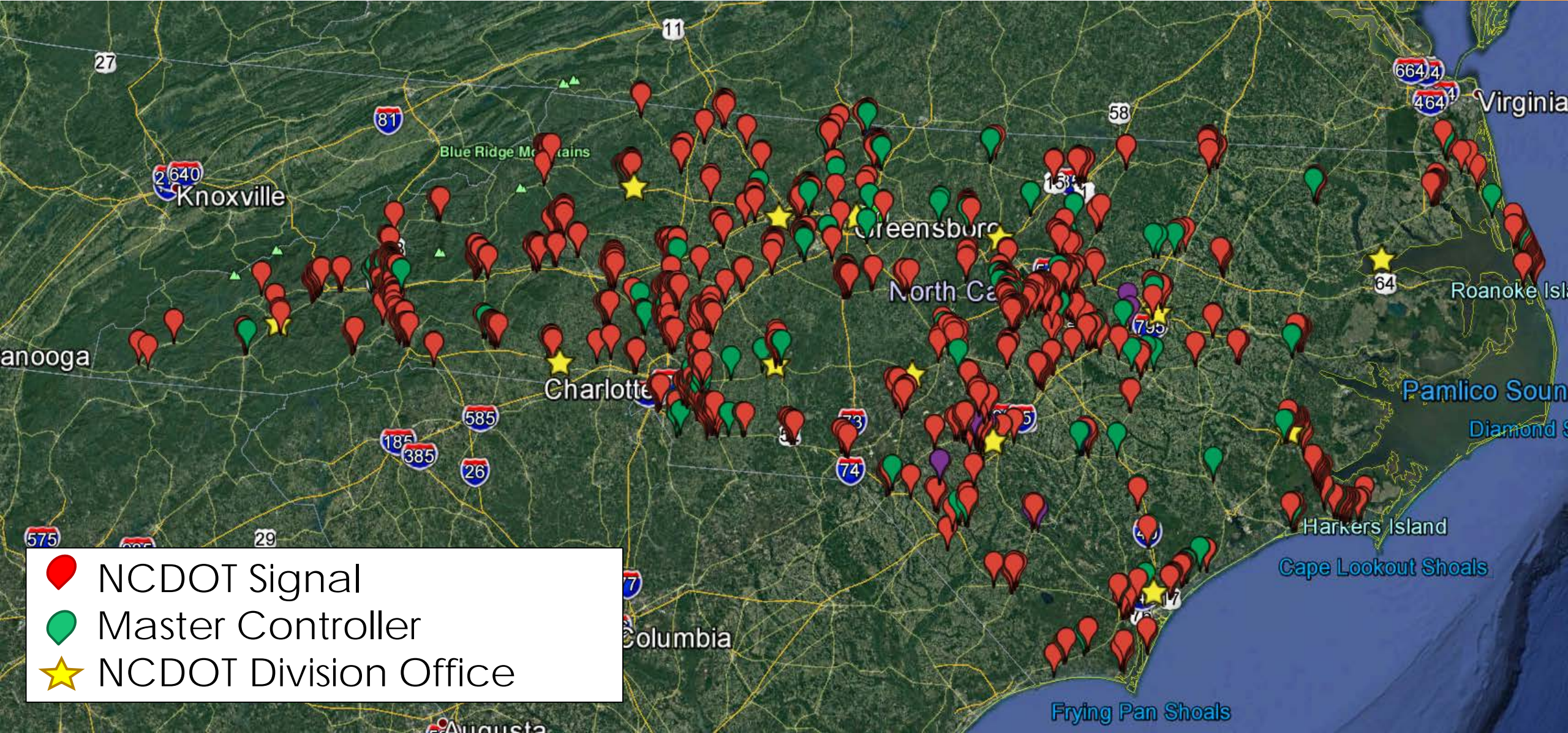
- ▶ assist NCDOT in evaluating technology hardware and software options for upgrading all or parts of NCDOT-maintained traffic signals to support ATSPM



- ▶ evaluate the use of probe-based travel time data to support analysis of signalized corridors in North Carolina, and to prioritize corridors for retiming



The Solution Space



-  NCDOT Signal
-  Master Controller
-  NCDOT Division Office

Proposed NCDOT Prioritization Framework



Prioritization Framework

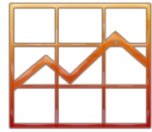
- ▶ Travel Time
 - ▶ PennDOT Normalized Travel Times
- ▶ Reliability
 - ▶ PennDOT Interquartile Range
 - ▶ FHWA LOTTR
- ▶ Exposure
 - ▶ Traffic Volumes , AADT, and v/c ratios
- ▶ Safety
 - ▶ Crash patterns, frequency, rates
- ▶ Trend
 - ▶ Changes in Performance over Time



Tying Metrics to Actionable Items

- ▶ High Growth Corridor
 - ▶ Steady increase in Mean and 95th TTI that begins to exceed capacity
 - ▶ Capital improvement may be needed
- ▶ Sudden Growth (perhaps new development on arterial)
 - ▶ Disjointed increase in Mean/95th TTI
 - ▶ Retiming if below capacity, capital improvement otherwise
- ▶ Poor performance at edge of peak periods
 - ▶ Poor reliability around timing plan transitions
 - ▶ Retiming to change plan period
- ▶ etc

Combining the Measures



Flagging Sudden Changes and Outliers



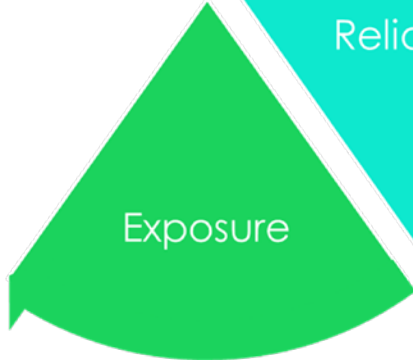
Trend



Prioritizing Corridors with high crash occurrence



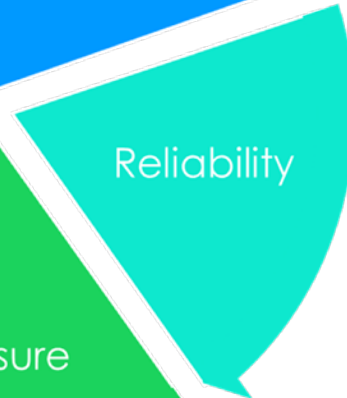
Safety



Exposure



Travel Time



Reliability

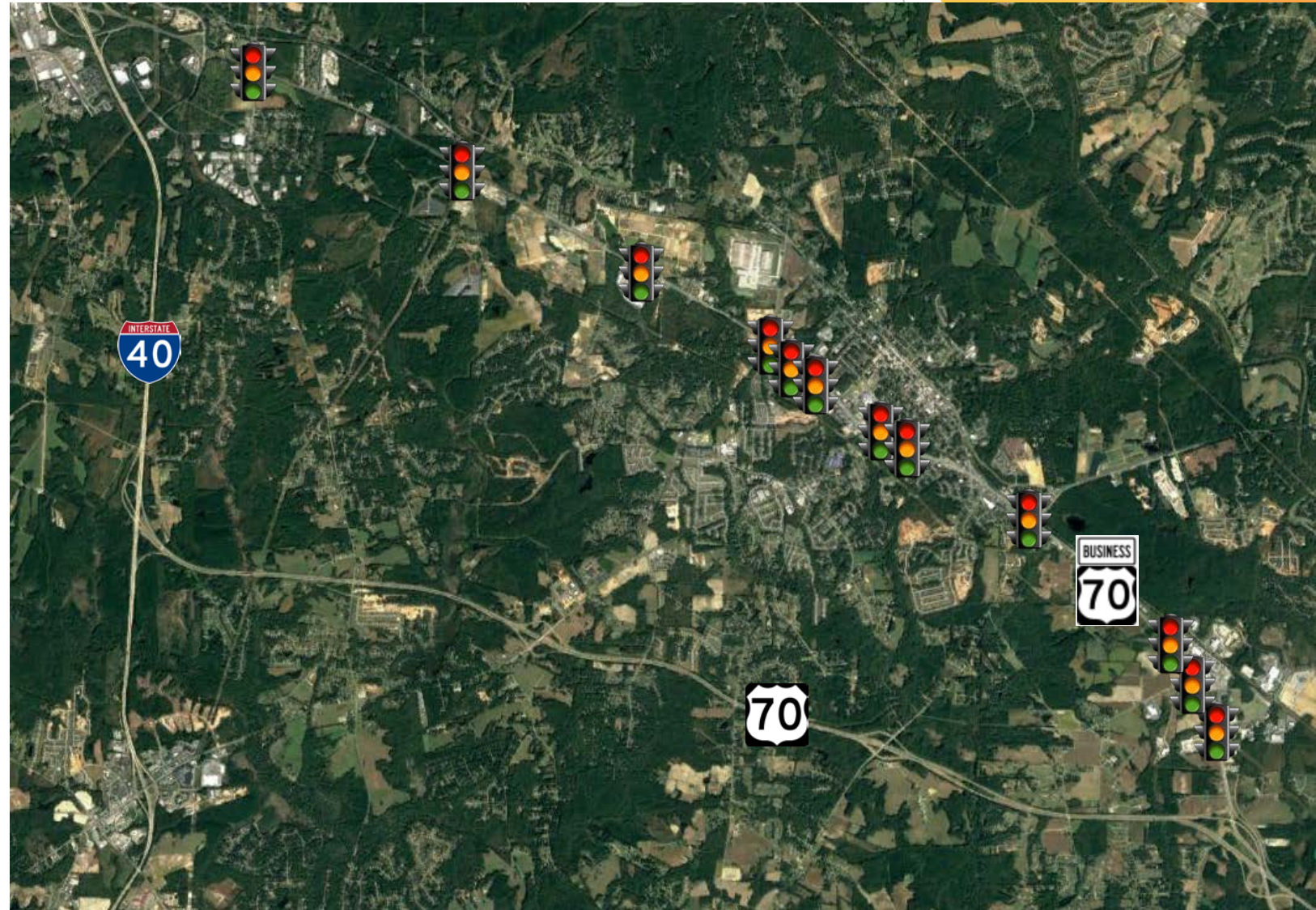


Monetizing Benefits through User Cost

US 70 Business, Clayton

Division 4

- ▶ 12 signals over 9.5 miles
- ▶ Small town commuter corridor (20,000-35,000 AADT)
- ▶ Several new developments in recent years
- ▶ Scored high priority in 2016

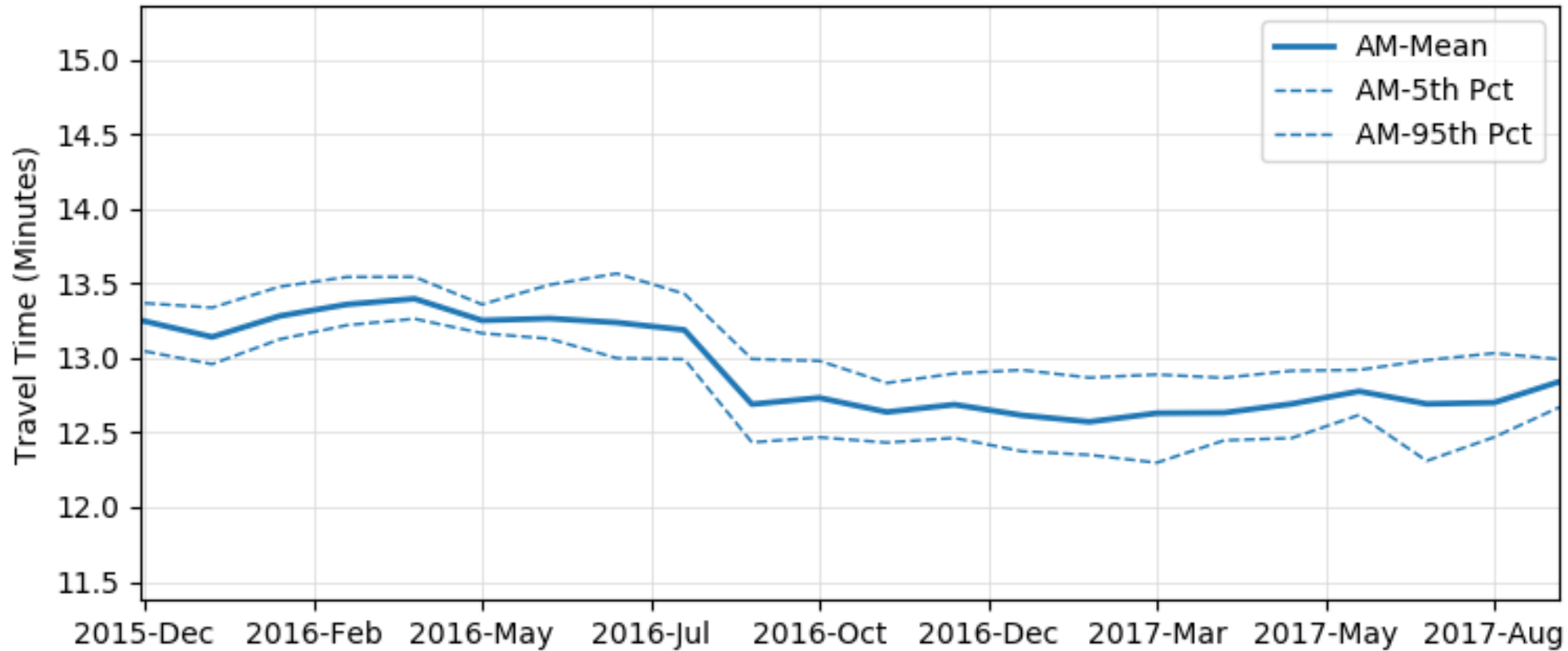


US 70 Business, Clayton - Westbound

Division 4

- AM Peak hour - noticeable reduction of travel times starting in August 2016

Site 2 WB Weekday: AM Peak Travel Times by Month

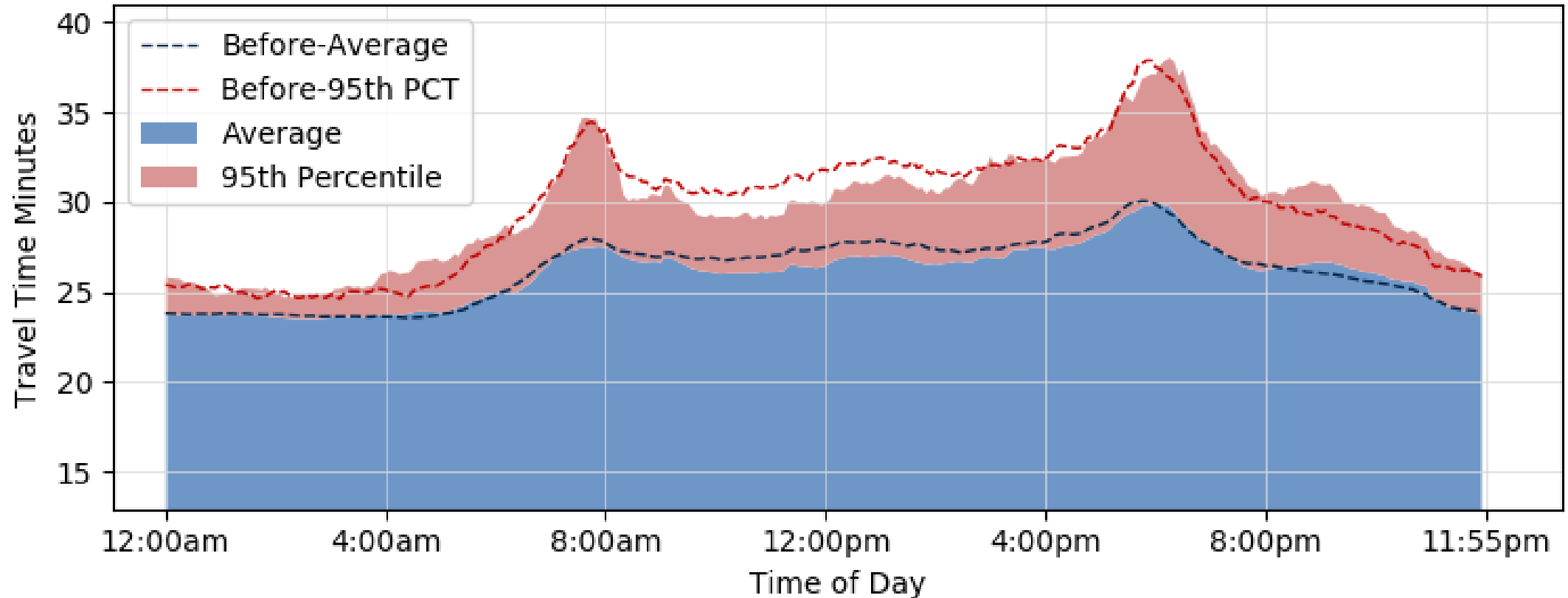


US 70 Business, Clayton

Division 4

- ▶ 12 signals over 9.5 miles

Site 2: 2016 vs 2017



NCDOT Online Prioritization Tool

- ▶ Web-based platform (requires login)
- ▶ Database with statewide performance measures
- ▶ Online visualization of performance data
- ▶ Prioritization ranking

GOAL: Data-driven input for NCDOT prioritization process

Home [Travel Time & Reliability](#) [Safety](#) [Exposure](#) [Trends](#) [User Cost](#) [Results](#) [Corridor](#) [About](#)

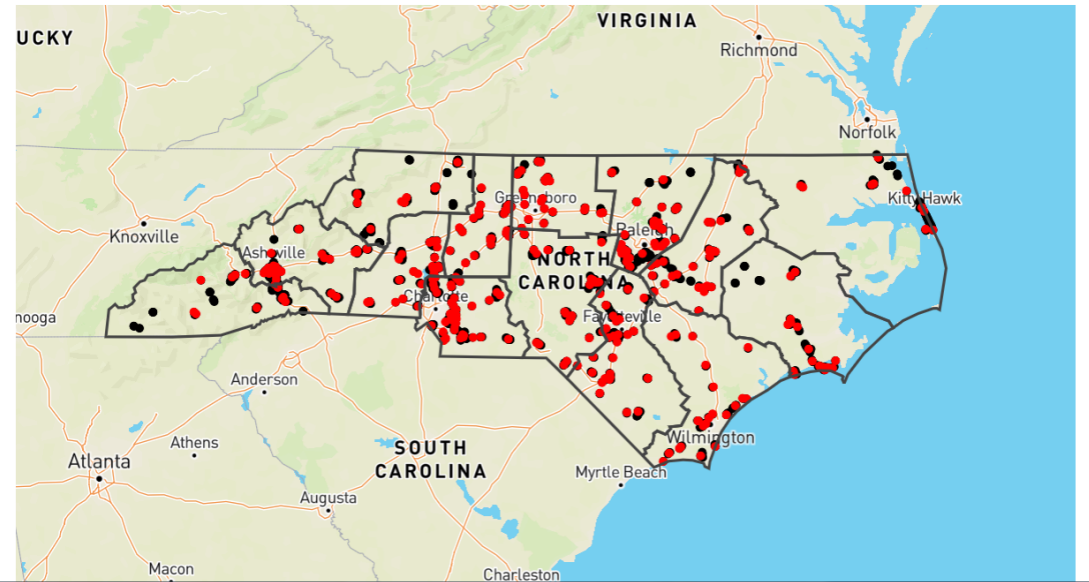
NCDOT COST Retiming Prioritization Tool



This tool is designed to assist COST and NCDOT Divisions in identifying signal systems in need of retiming using an interactive data-driven approach.

To begin, continue to the next page: [Travel Time & Reliability](#)

This tool is currently under development. Development is sponsored by NCDOT Research Project 2017-45. For more information, contact project steering committee chair Jennifer Portanova.



Prioritization Next Steps

- ▶ Meeting with Divisions on 2/15
- ▶ Tool Completion in March 2018
- ▶ Prioritized List of Corridors to NCDOT in April 2018
- ▶ Implementation Plan for ATSPM and prioritization in May 2018

Questions?

