

**Massachusetts Bay  
Transportation Authority**

# Advancing TSP Measures for Greater Boston Region

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MassDOT Innovation Conference

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# Agenda

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**01**

TSP Background

**02**

TSP Challenges

**03**

TSP Performance Measures

**04**

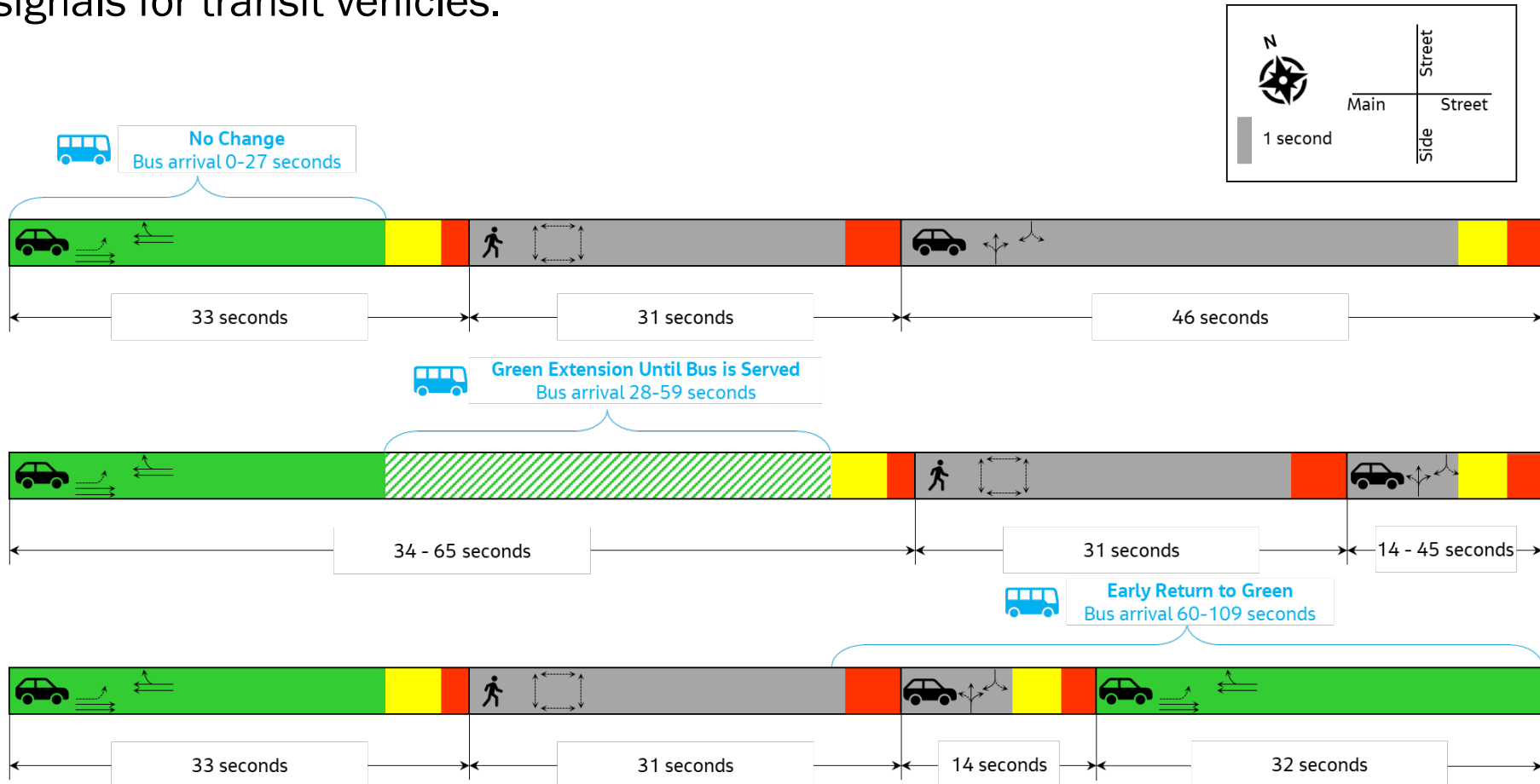
Next Steps



# Transit Signal Priority

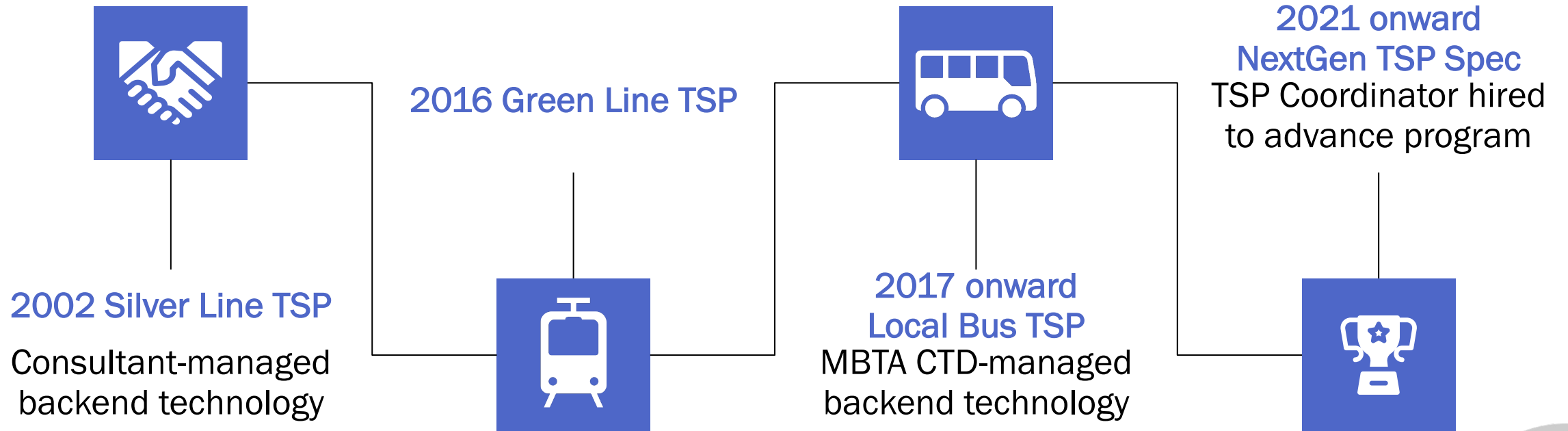
Passive TSP: Prioritizing transit without dynamic signal timing changes.

**Active TSP:** Modify traffic signal timing or phasing to reduce dwell time at traffic signals for transit vehicles.

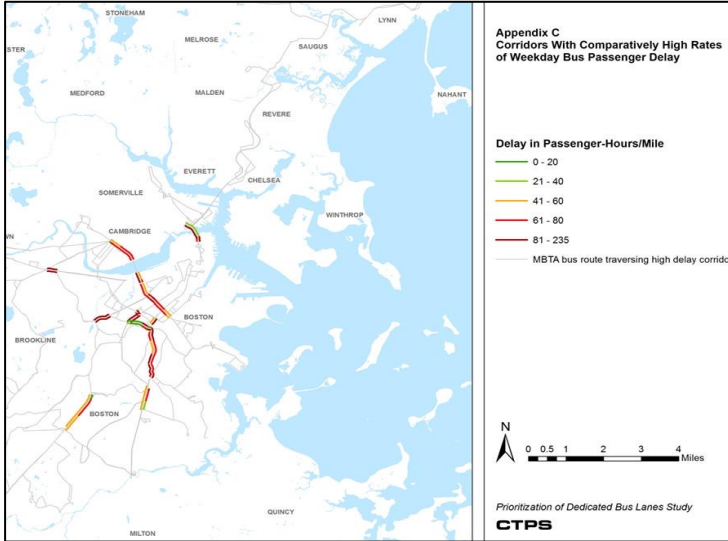


# TSP History at MBTA

85 TSP signals in operation



# Transit Priority Vision



## Data-driven

Founding based on successful pilots and on Prioritization of Dedicated Bus Lanes Report (CTPS, 2016)

## Collaborative

Four dedicated staff working with many, many internal and external stakeholders

## Implementation Focus

Collaborating with stakeholders to deliver projects that **improve travel time and reliability** for buses\*

\*and light rail TSP for at-grade signalized intersections.



# Transit Signal Priority Challenges

## Problem

- No Dedicated Strategy
- No measurement capabilities
- Overwhelmed Stakeholders
- “Check the box” signal item

## Opportunity

- Develop Clear Strategy
- Measure Effectiveness
- Involve Stakeholders
- Measure Effectiveness

## Our Approach

- Six Key Focus Areas
- T-SPMs
- RFI & NextGen Spec
- Improvement Iterations

### Develop Strategy: Six Key Focus Areas

- |                     |                     |
|---------------------|---------------------|
| 1. Interoperability | 4. Reliability      |
| 2. Scalability      | 5. Adaptability     |
| 3. Measurability    | 6. Forward Thinking |

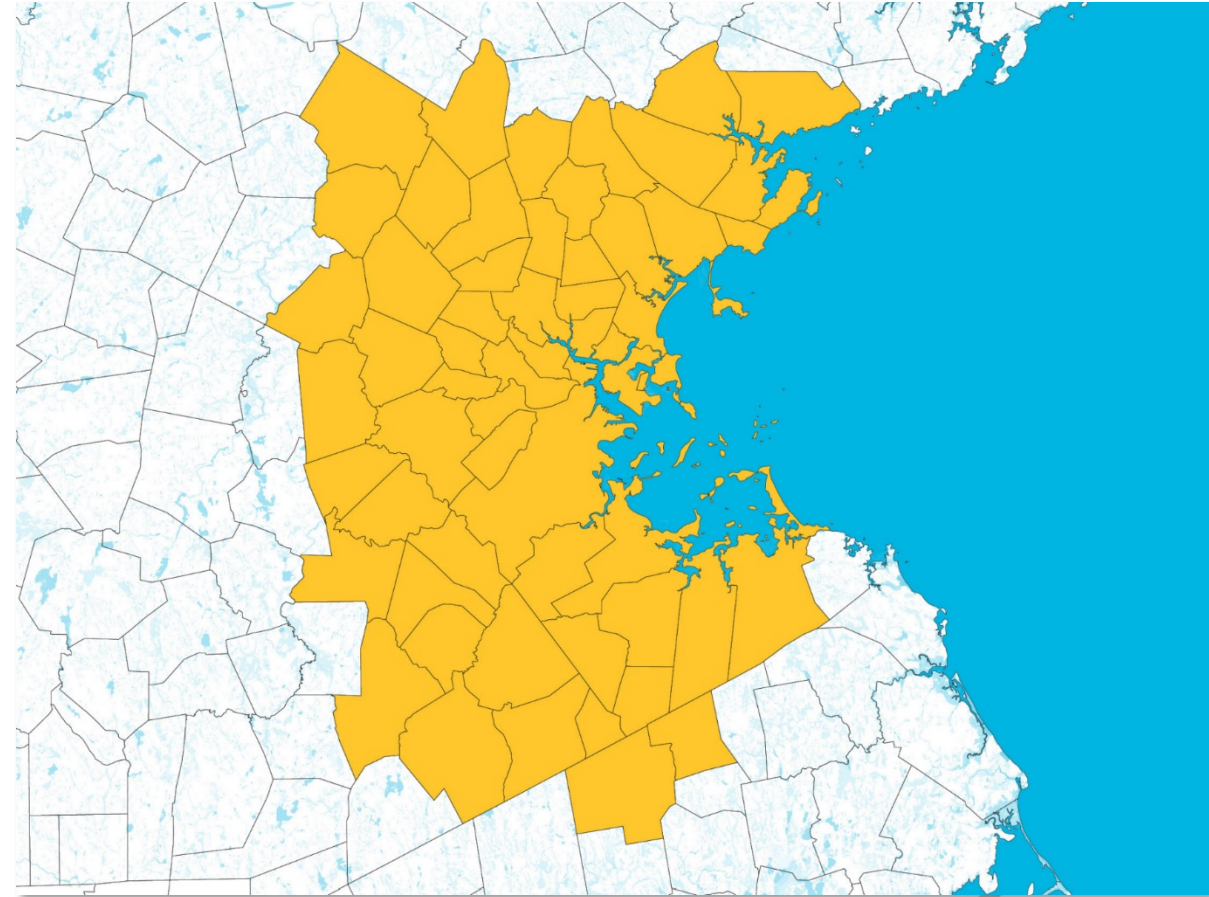
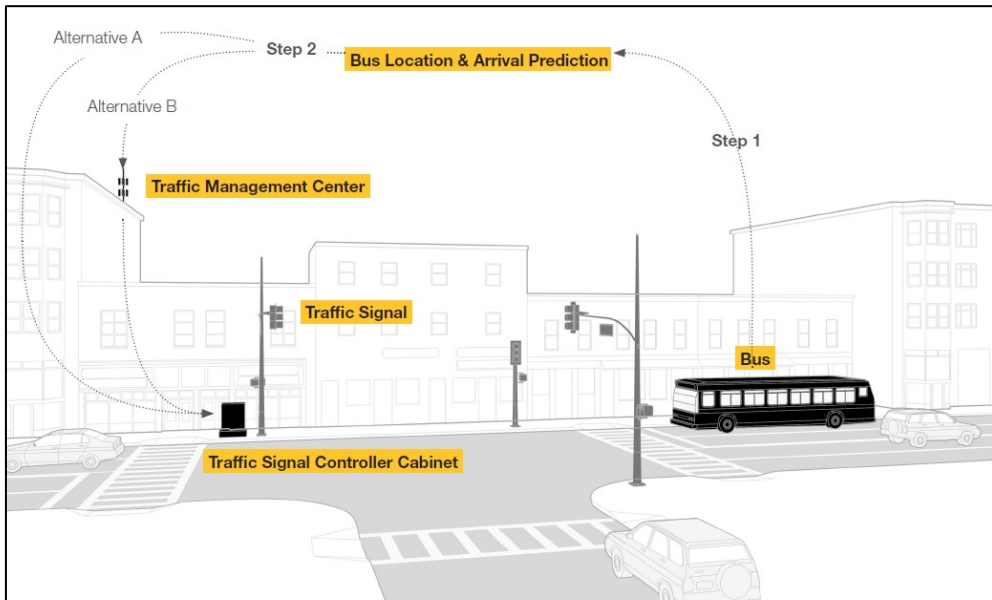
### Next Gen TSP Spec

- Cabinet
- Controller
  - Regional data standard
- Non-intrusive detection
- Communications
- PRG/PRS



# Working with 50+ municipalities

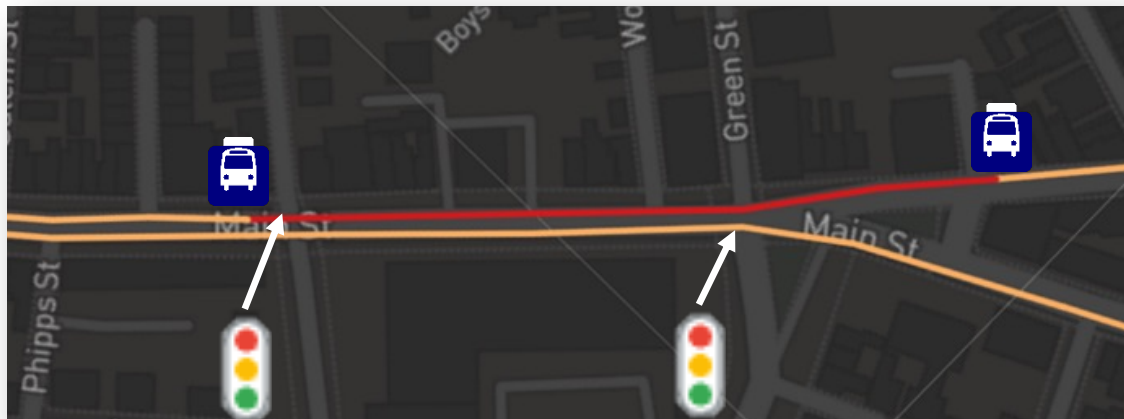
- Variability across region
  - Centralized VS Decentralized
  - Signal Technology and Age
  - Political Interest and Structure
- Most municipalities eager but unsure how to start



# Data Challenges

- Granularity of AVL data is not sufficient for TSP measurement
- Traditional signal data is not transit specific
- Existing data collection is 'labor intensive'

## Total delay between bus stops\*



Courtesy: Nick Caros, MIT

\*excludes dwell

## Raw Data Output File

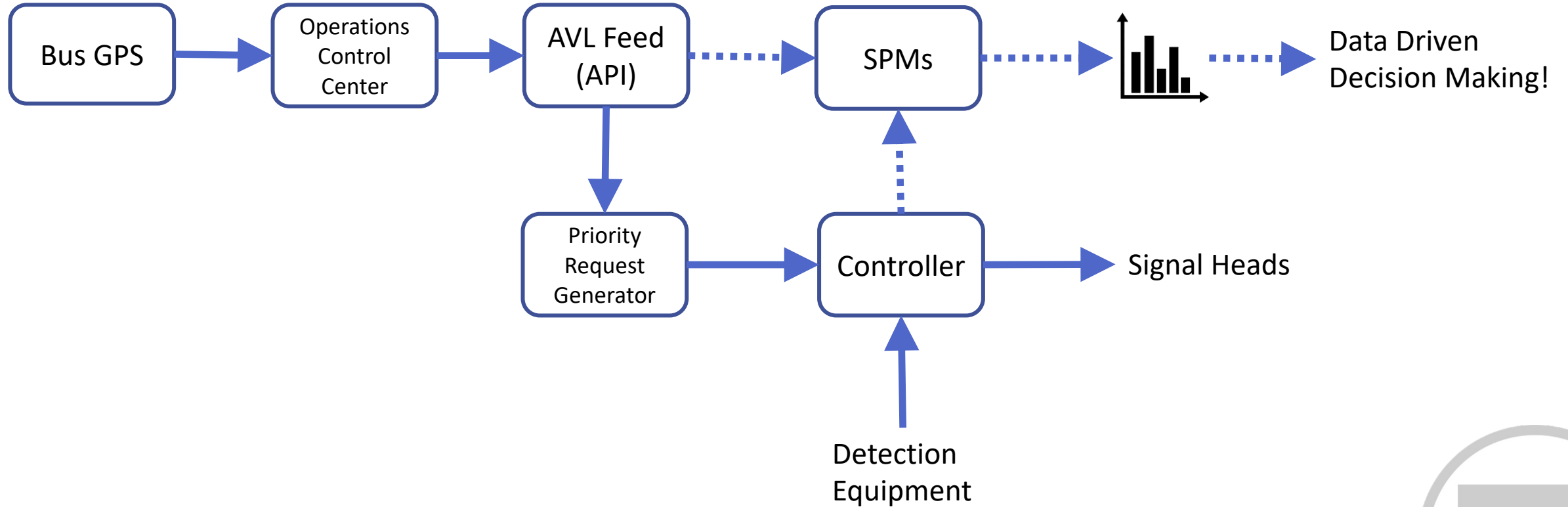
	A	B	C
1	Time	Event	Param
1565	18:18.3	81	3
1566	18:19.5	82	3
1567	18:20.1	3	2
1568	18:20.1	3	3
1569	18:20.5	82	5
1570	18:20.5	2	4
1571	18:20.5	43	4
1572	18:21.6	81	3
1573	18:21.9	81	5





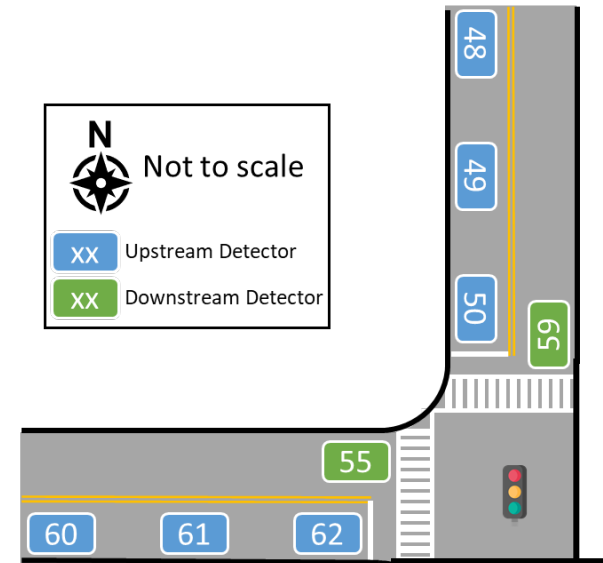
# MBTA TSP System

- Vendor Agnostic and Interoperable



# Example Bus Detection Specification

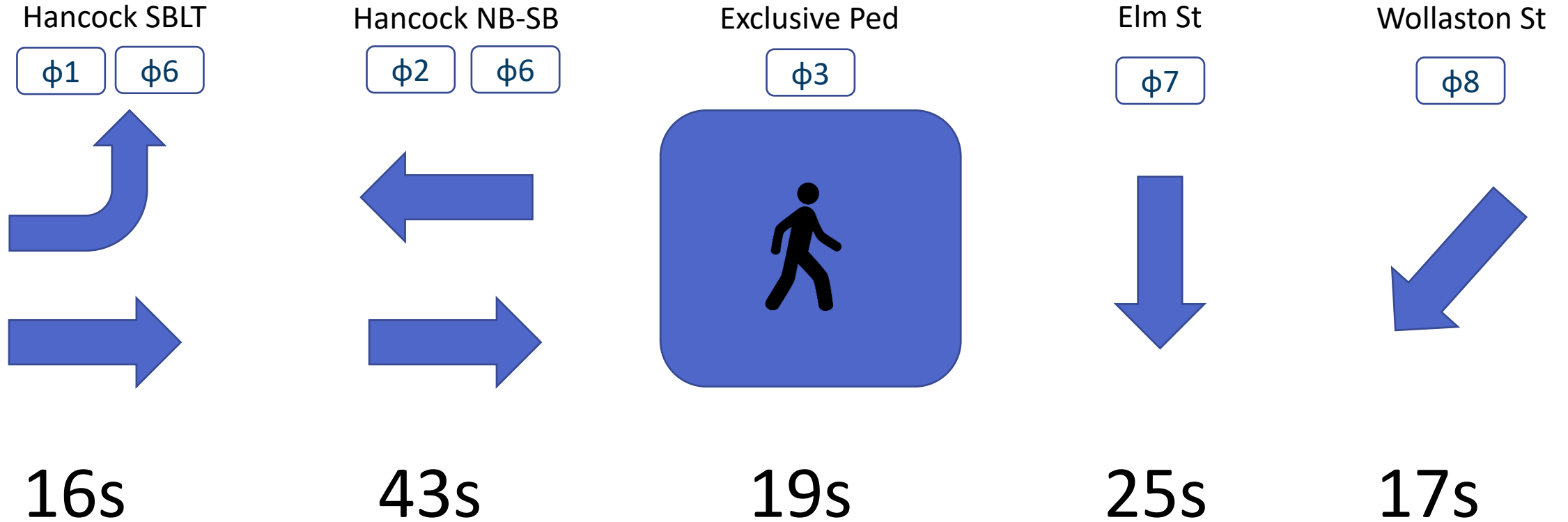
- Two to three virtual detectors at each approach
  - Location based on intersection density
  - Size based on travel speed, GPS pin rates, and system requirement
- Log Detector activation and Deactivation when the bus enters and leaves the virtual detectors
  - Same across the region



# Hancock St @ Elm/Wollaston, Quincy, MA



# Programmed Signal Phasing



Cycle length: 120 s



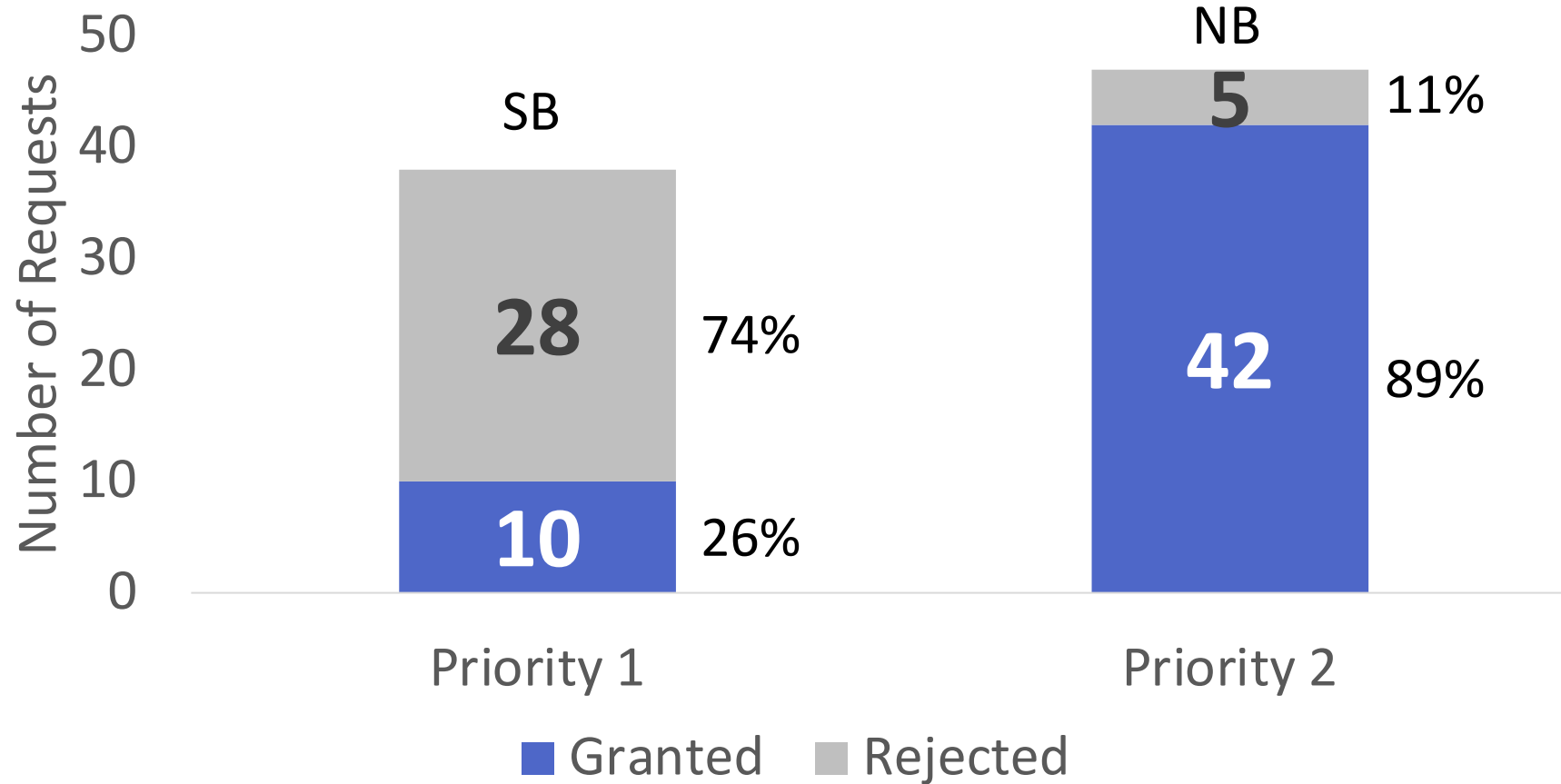
# Data and Questions

- Data Collected:
  - Two days of data was collected 11/16/2021 + 11/17/2021
- Questions to answer:
  - Is the system working?
  - How accurate are our arrival time predictions?
  - How often are buses arriving on green?
  - Are busses arriving on green more than they normally would?
  - If they are getting red, what is that average delay?



# Is the system working?

## TSP Granted/Rejected Requests



# How accurate are arrival time predictions?

## Travel Time – Predicted vs Observed

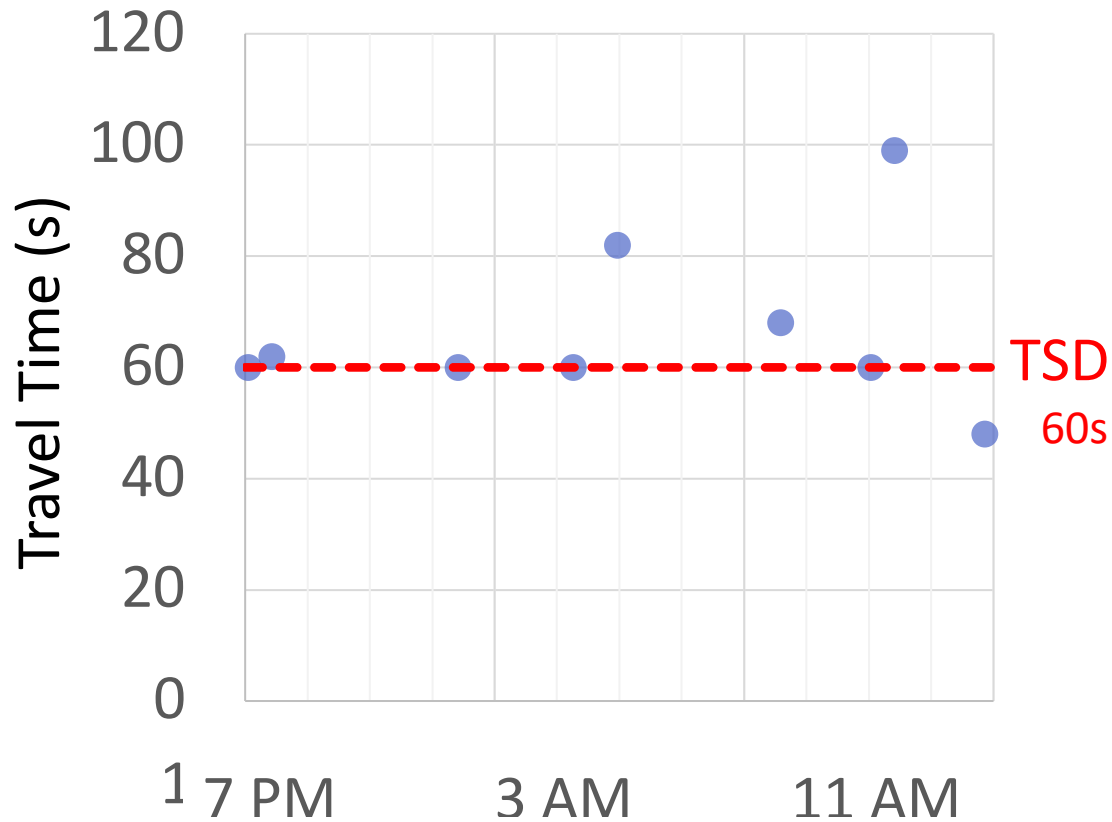
STREET	DIRECTION	SIGNAL PHASE	CONTROLLER PRIORITY	TSD (S)	AVG. FIELD TRAVEL TIME (S)	STD. FIELD TRAVEL TIME	# of Records
HANCOCK ST	SB	Φ 1 & Φ 6	Priority 1	60	67	15	9
HANCOCK ST	NB	Φ 2	Priority 2	75	74	20	25

\*TSD: Time of Service Desired

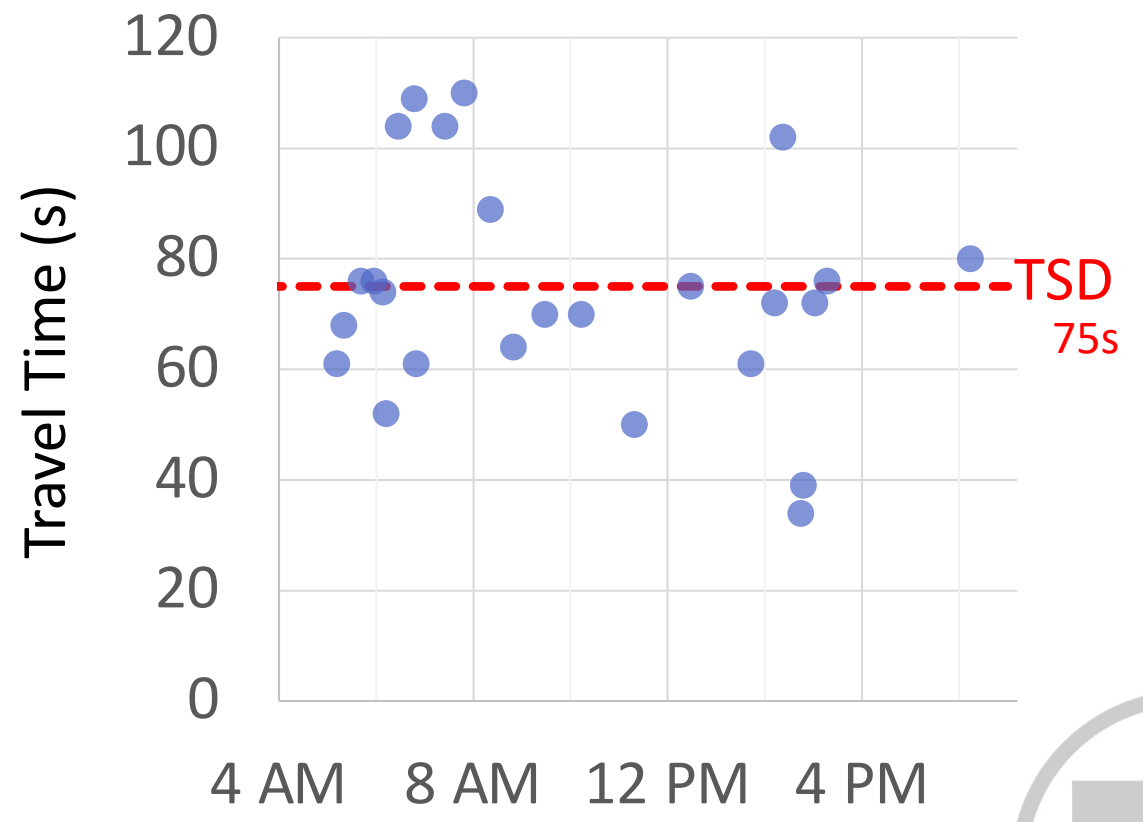


# Travel Time – Predicted VS Observed

## Priority 1 Southbound



## Priority 2 Northbound



\*TSD: Time of Service Desired





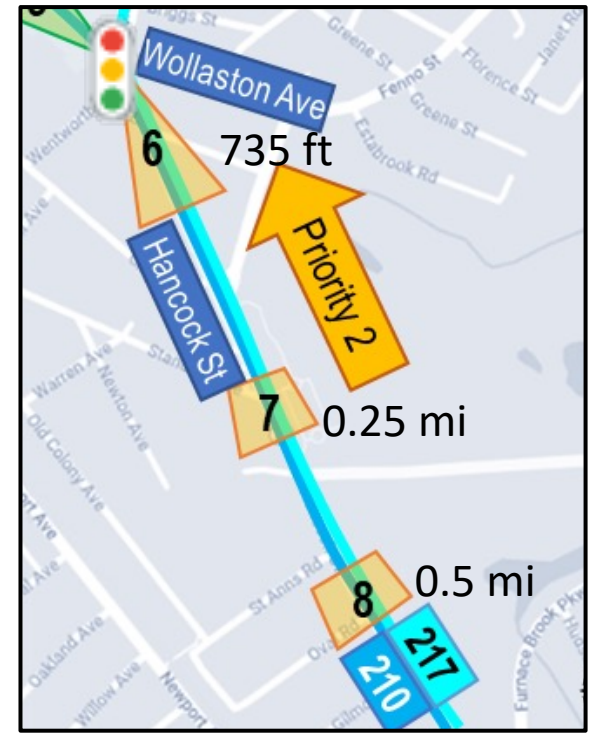
# Arrival on Green – Example 1

The signal changes to green when the bus arrives at the stop bar detector zone

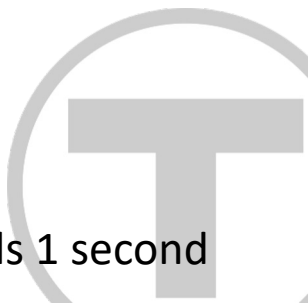
AoG-1

Time	6:19:30	6:19:35	6:19:40	6:19:45	6:19:50	6:19:55	6:20:00	6:20:05	6:20:10	6:20:15	6:20:20	6:20:25	6:20:30
Phase1													
Phase2	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Phase3													
Phase6	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey
Phase7													
Phase8													
Zone8	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
Zone7													
Zone6													

- Legend*
- Priority Phase Green
  - Priority Phase Yellow
  - Priority Phase Red
  - Other Phase Green
  - Other Phase Yellow
  - Bus in the Detector Zone



\*Each box equals 1 second



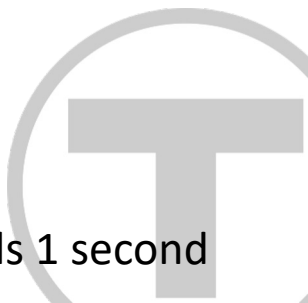
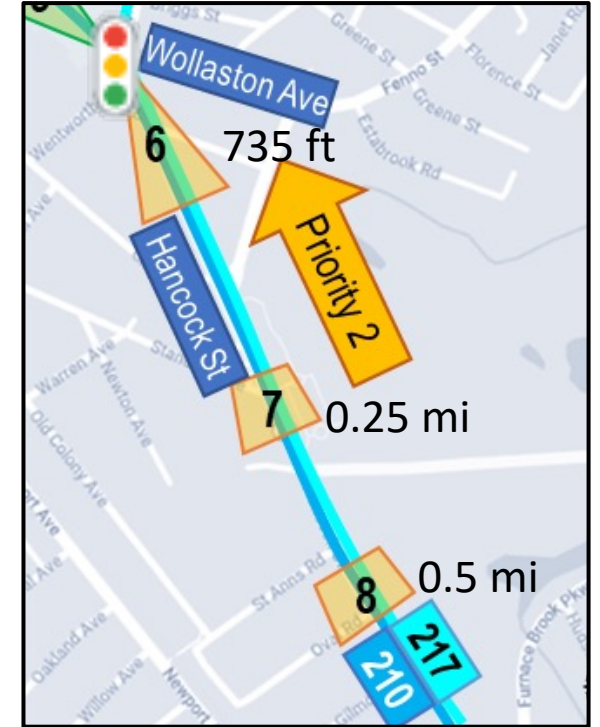
# Arrival on Green – Example 2

The signal is red when the bus arrives at the stop bar detector zone and changes to green before the bus arrives at the stop bar

Time	6:08:20	6:08:25	6:08:30	6:08:35	6:08:40	6:08:45	6:08:50	6:08:55	6:09:00	6:09:05	6:09:10	6:09:15	6:09:20	6:09:25	6:09:30
Phase1															
Phase2	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Red	Red	Red	Red	Red	Green
Phase3										Grey	Grey	Grey	Grey	Grey	
Phase6															
Phase7															
Phase8															
Zone8	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue							
Zone7					Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	
Zone6											Blue	Blue	Blue	Blue	Blue

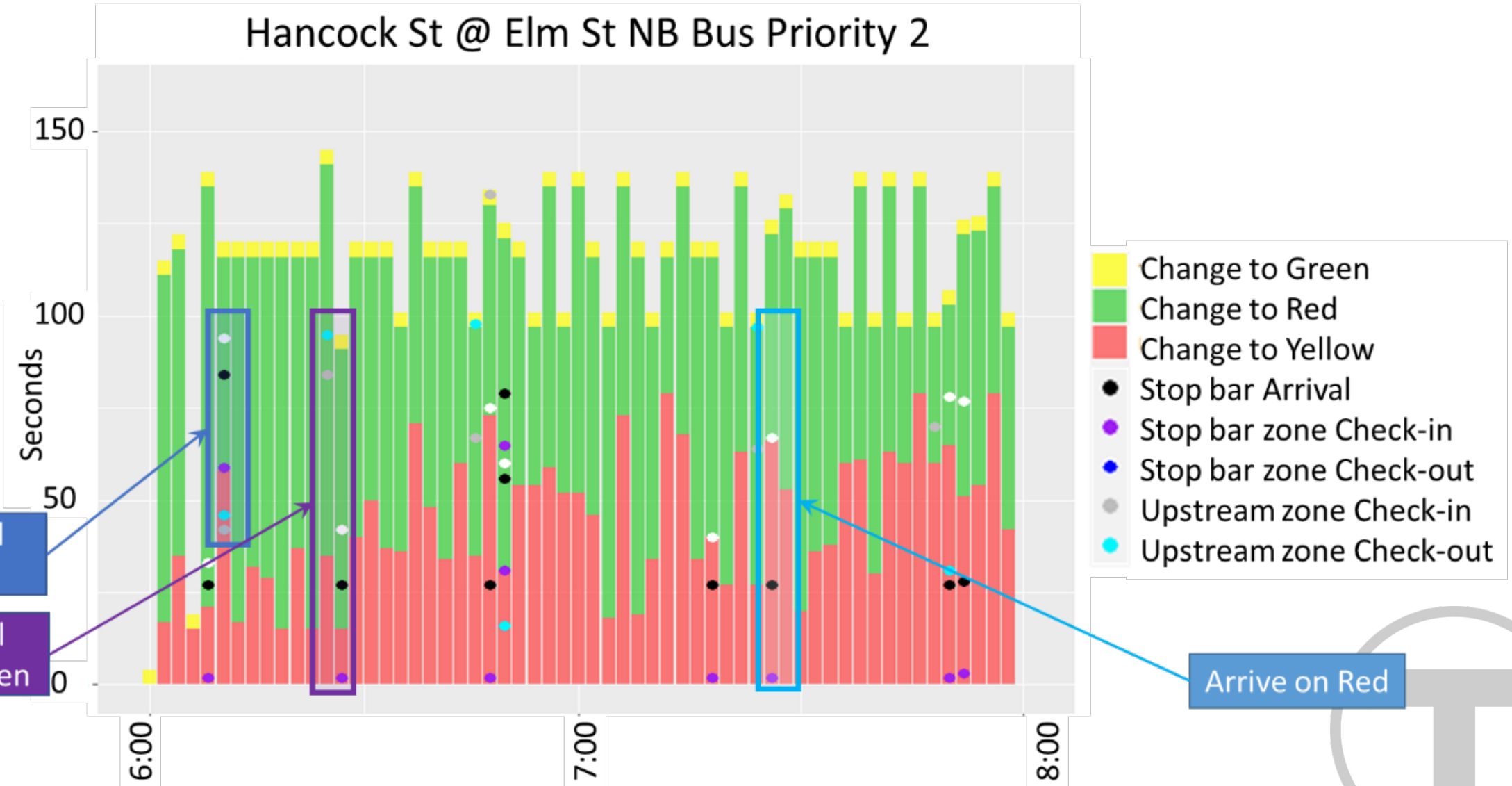
- Legend*
- Priority Phase Green
  - Priority Phase Yellow
  - Priority Phase Red
  - Other Phase Green
  - Other Phase Yellow
  - Bus in the Detector Zone

$$\frac{735 \text{ feet}}{25\text{s}} = 29 \text{ ft/s} = 20 \text{ MPH}$$



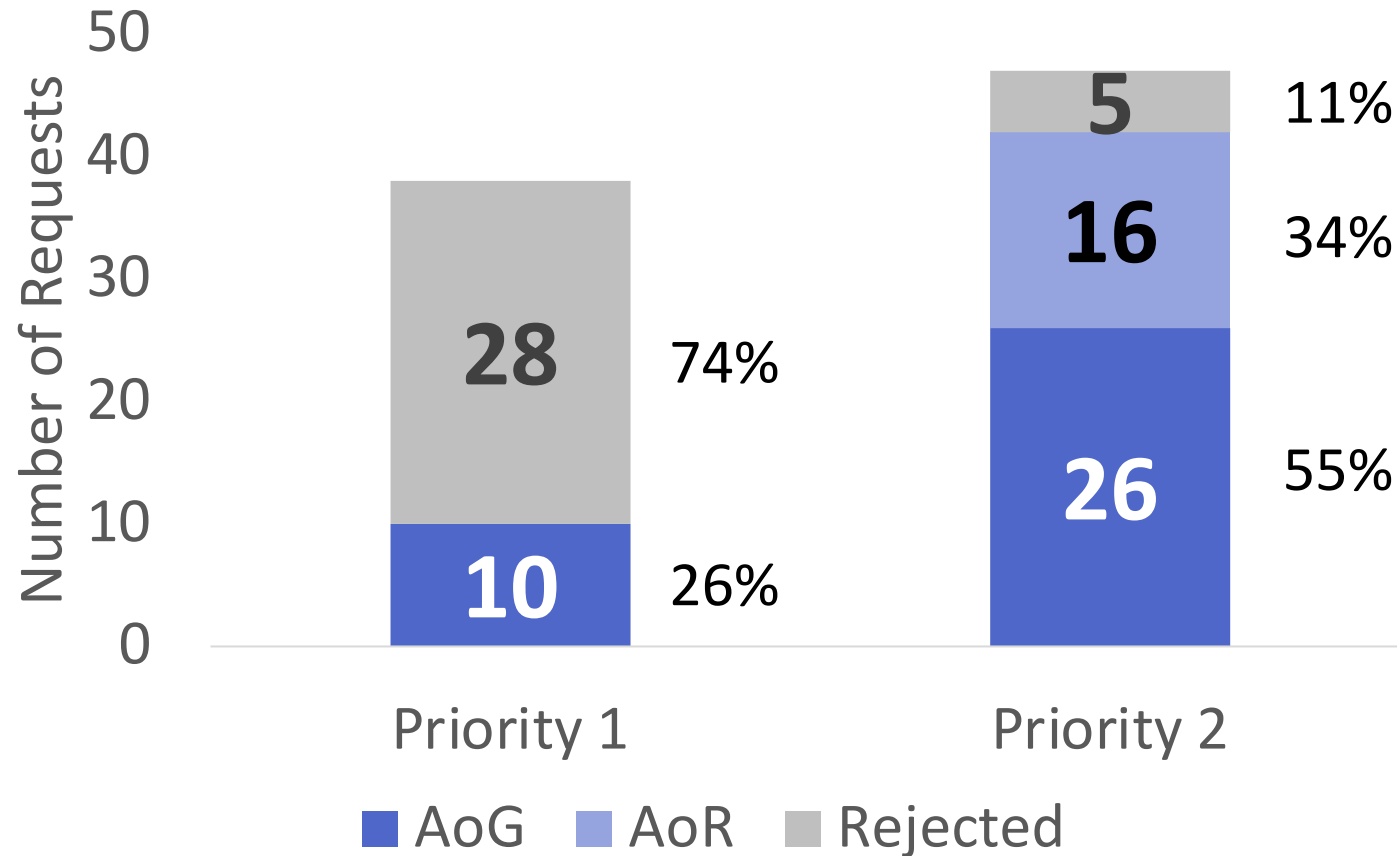
\*Each box equals 1 second

# PCD: Are busses arriving on green?



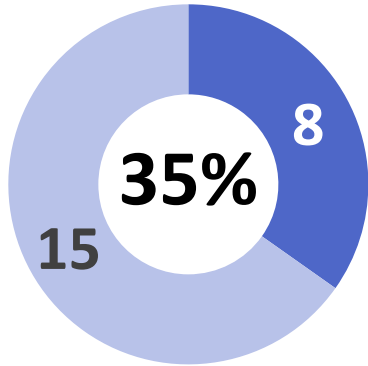
# TSP AoG Summary

## TSP AoG Summary



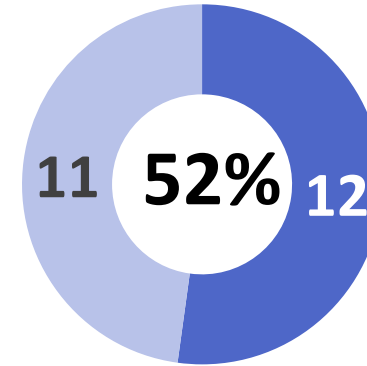
# Hypothetical AoG vs Actual AoG

Priority 2 Hypothetical AoG



■ AoG ■ AoR

Priority 2 Actual AoG



■ AoG ■ AoR

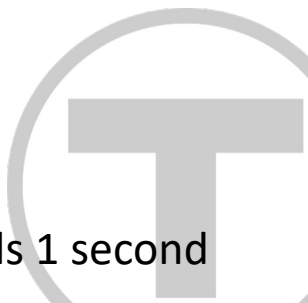
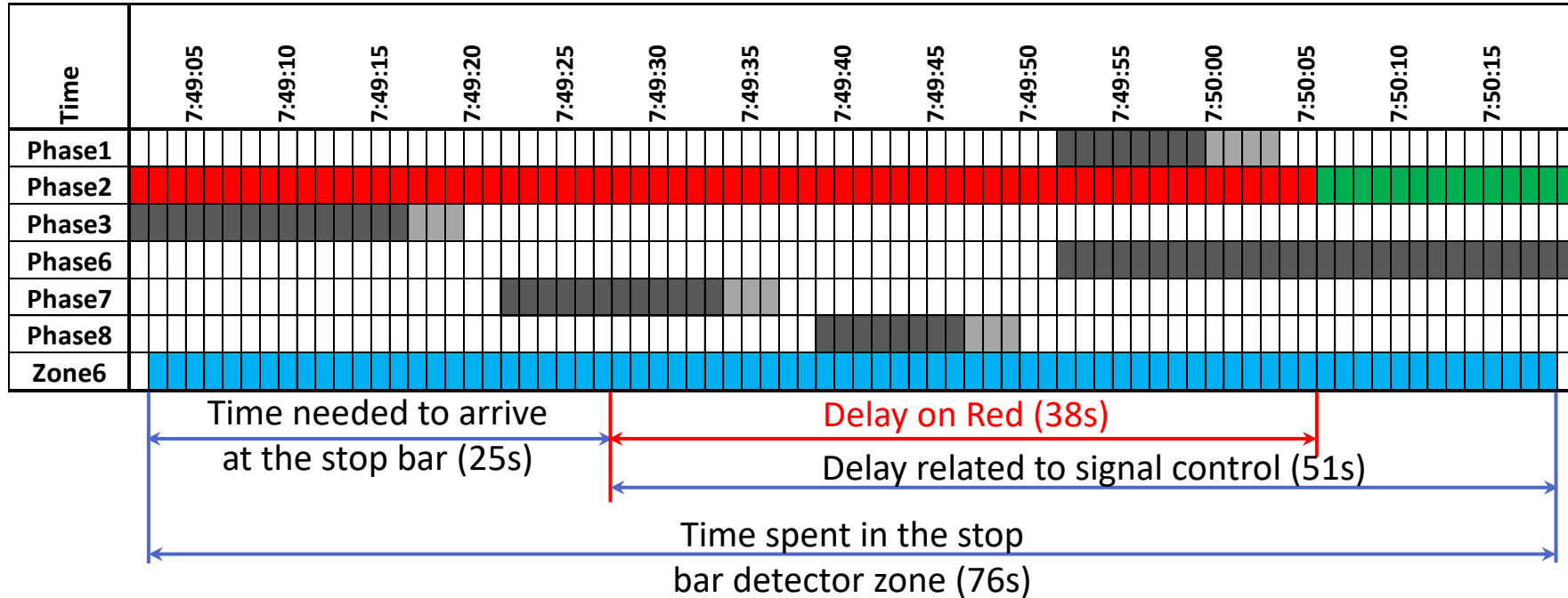
Green Extension

Time	18:42:55	18:43:00	18:43:05	18:43:10	18:43:15	18:43:20	18:43:25	18:43:30	18:43:35	18:43:40	18:43:45	18:43:50	18:43:55
Actual	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Planned	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Zone8	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
Zone7													
Zone6													

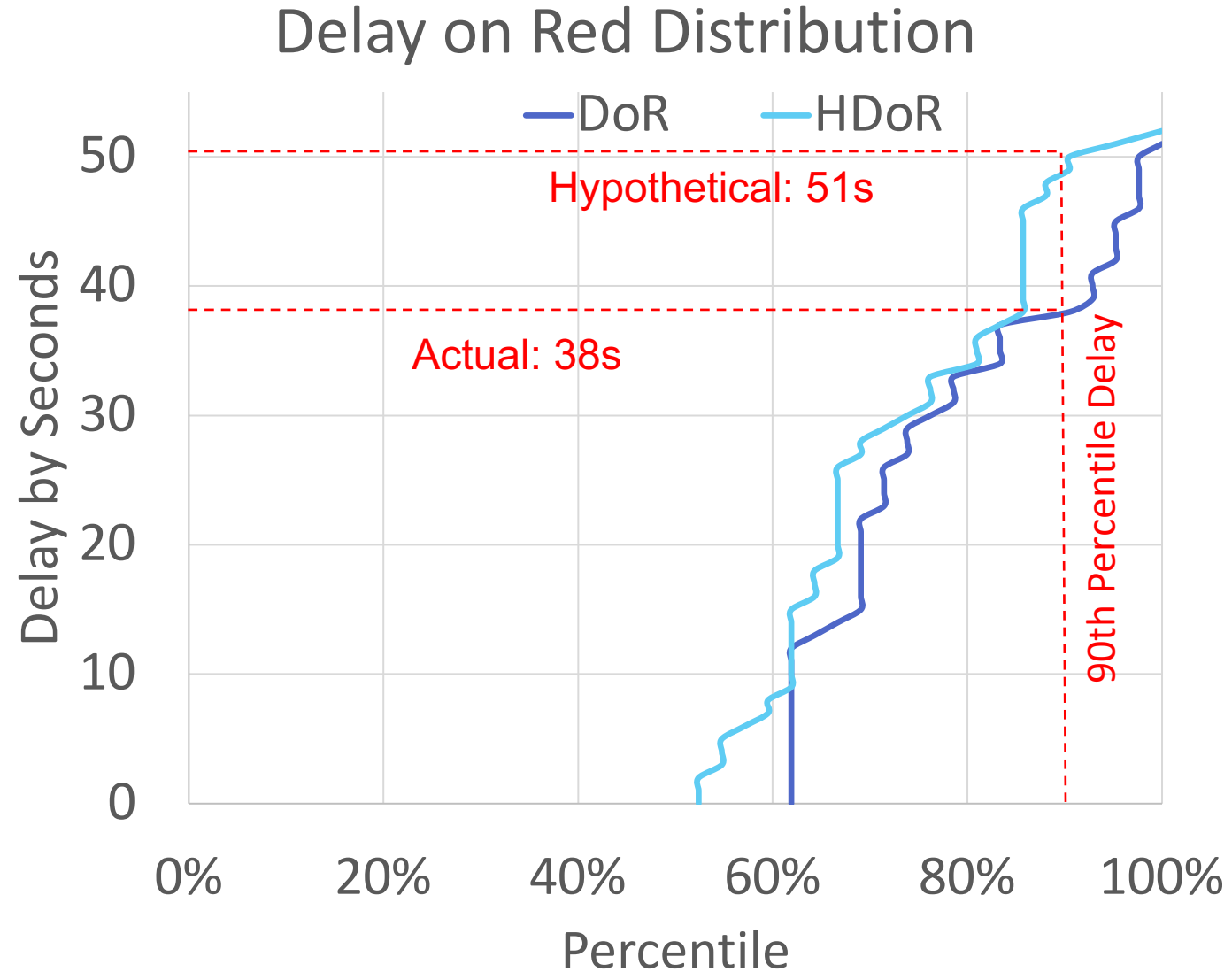
Extra 7s served



# Delay on Red



# Delay on Red Distribution



# Next Steps

## Improvement Iterations

- Developing a TSP dashboard to monitor results
  - System health and operations
  - ETA accuracy
  - TSP effectiveness
  - Queue delay
- Alerts
  - Technical issues (detector, comm)
  - TSP functionality (ETA, malfunction)





## The Socials



@MBTA



@MBTAGM



@TheMBTA



@TheMBTA



@TheMBTA





# Thank you!

Questions?

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# Transit-specific Signal Performance Measures (T-SPMs)

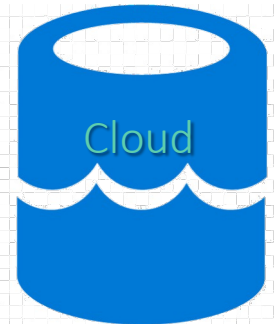
Based on FHWA ATSPM



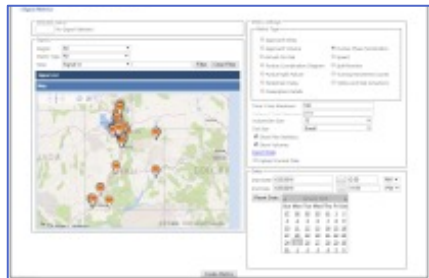
High-resolution Controller



Communications



Cloud



Dashboard



Bus Detection

