

Role of TSM&O in Improving Freeway Operations



Presented by:
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Presentation Outline

1 What is TSM&O?

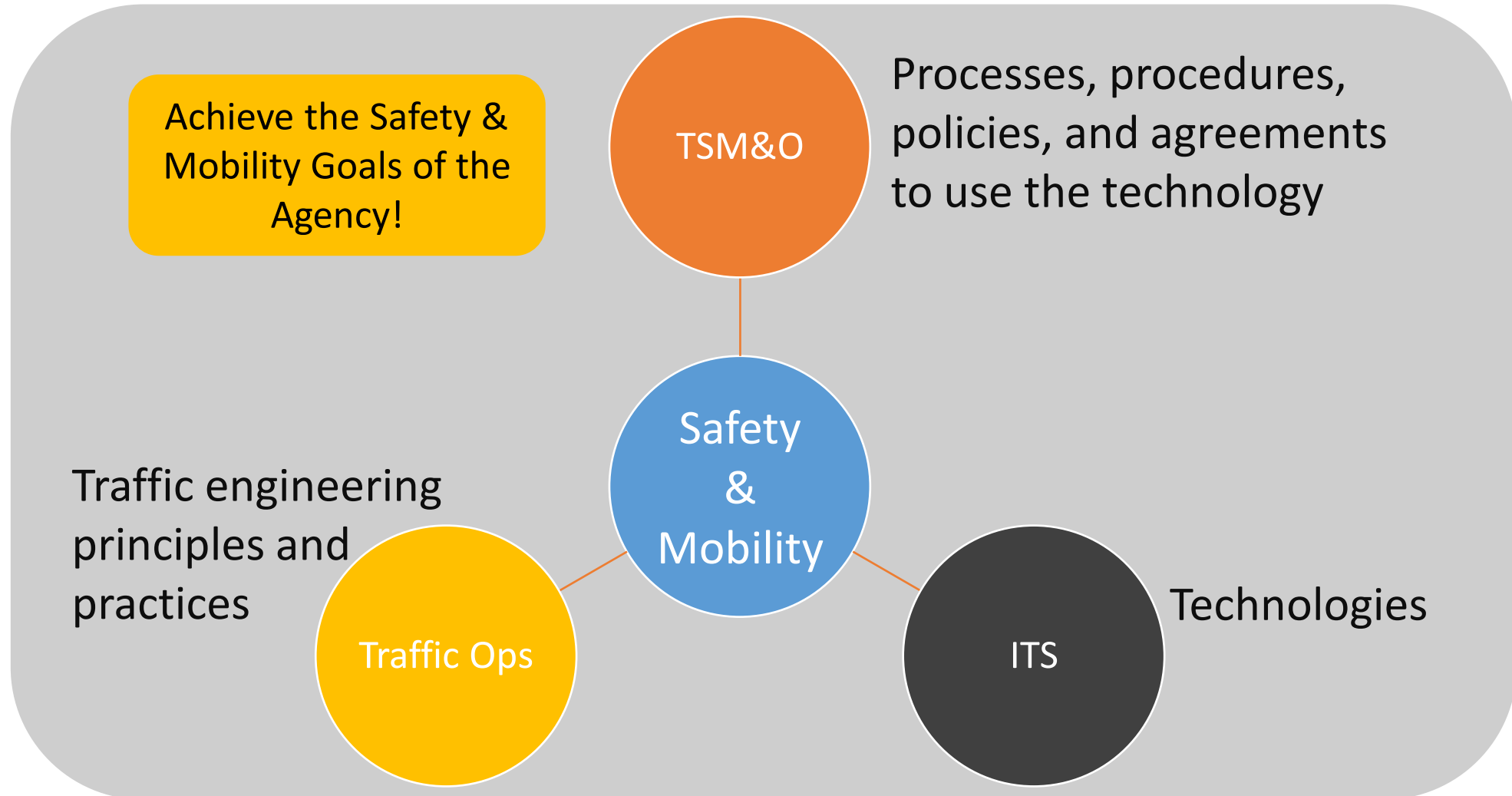
2 Need for TSM&O

3 Ramp Meters

4 Dynamic Message Signs

5 Express Lanes

What is TSM&O?



Conventional Improvements vs. TSM&O Strategies

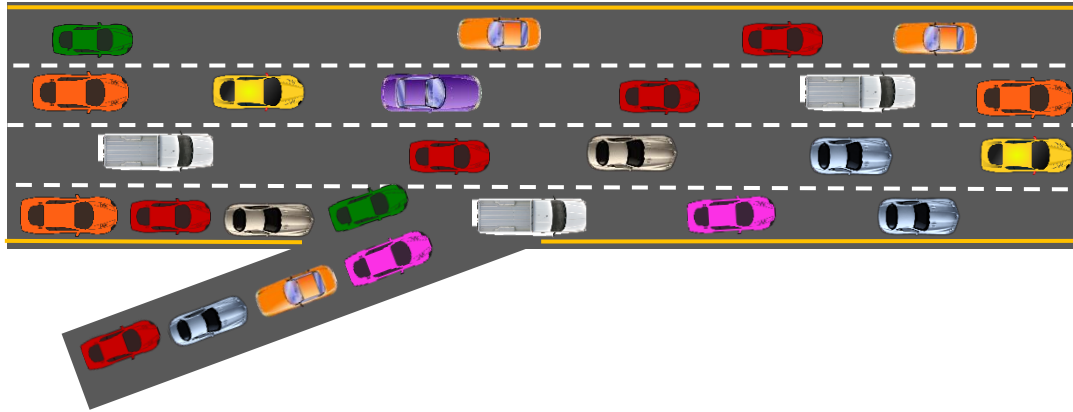


Lets add more lanes!!

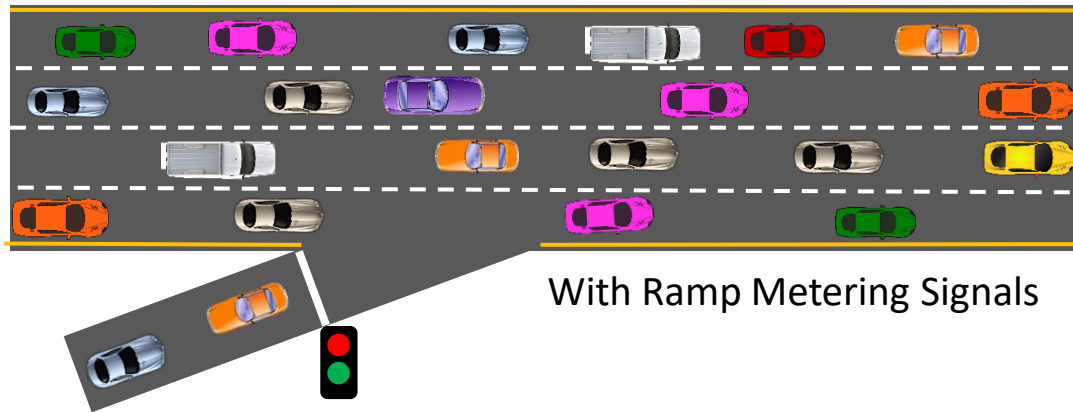


Lets invest in Express Lanes!

Proactive TSM&O Strategies



Lets add more lanes!!



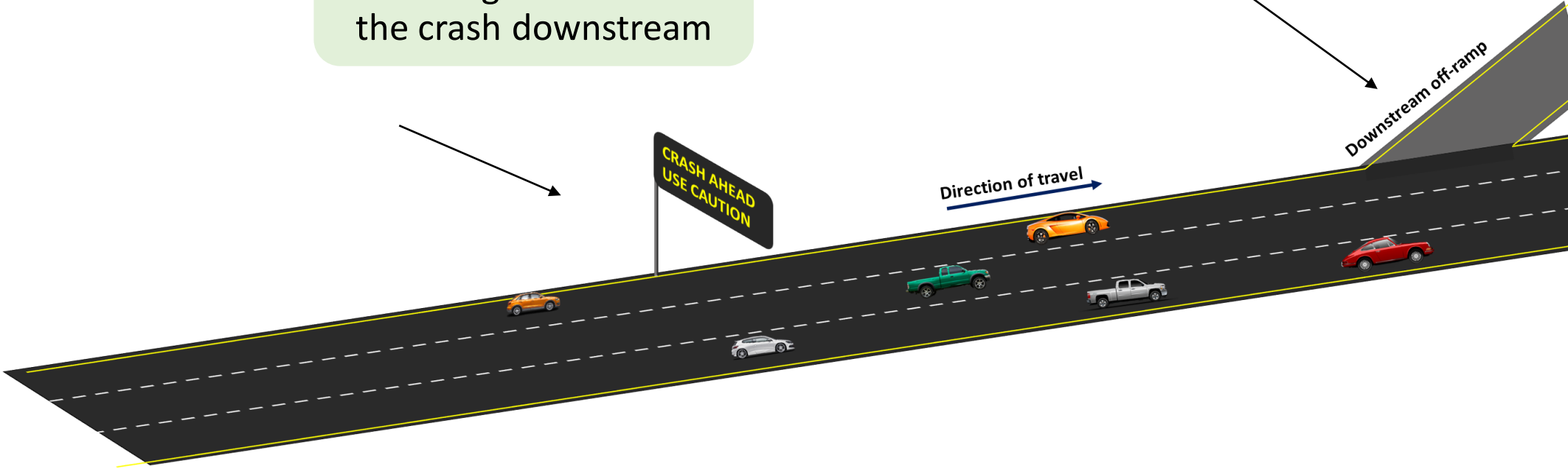
With Ramp Metering Signals

Lets deploy ramp meters!

Proactive TSM&O Strategies

Dynamic Message Sign informing drivers about the crash downstream

Drivers may detour after reading the message



TSM&O Strategies are ...

Integrated

Performance Based

At All Stages

Multimodal



TSM&O Strategies are ...

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Average travel time

Travel time reliability

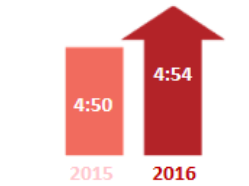
Incident response & clearance time

Total travel delays

Crashes

Secondary crashes

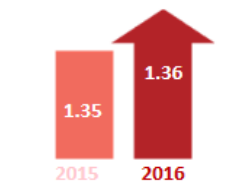
CONGESTED HOURS



+4 minutes

Average duration of daily congestion

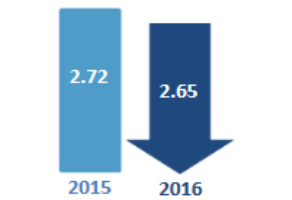
TRAVEL TIME INDEX



+1 points

Peak period vs. off-peak travel times

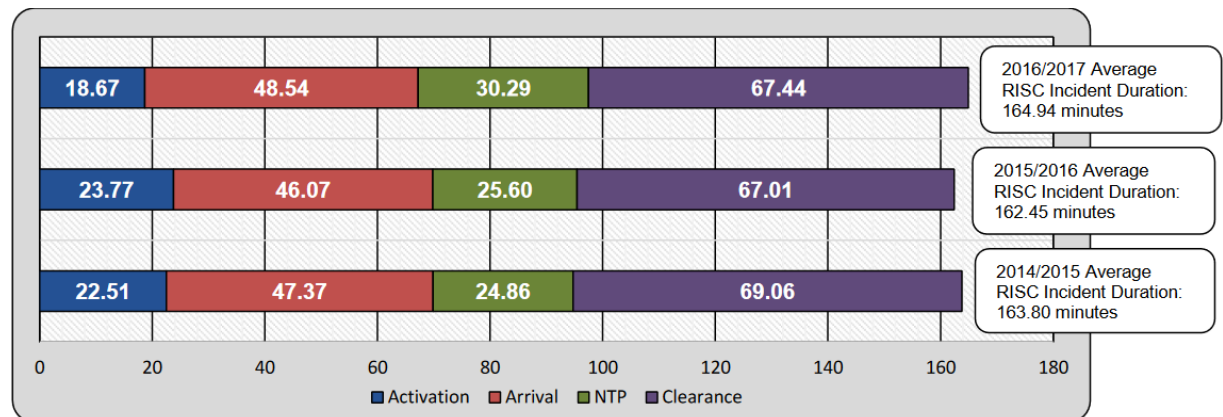
PLANNING TIME INDEX



-7 points

Unreliability (variability) of travel

A Snapshot of Year-to-Year Congestion Trends in the U.S. for October through December 2016



Statewide Average RISC Incident Duration

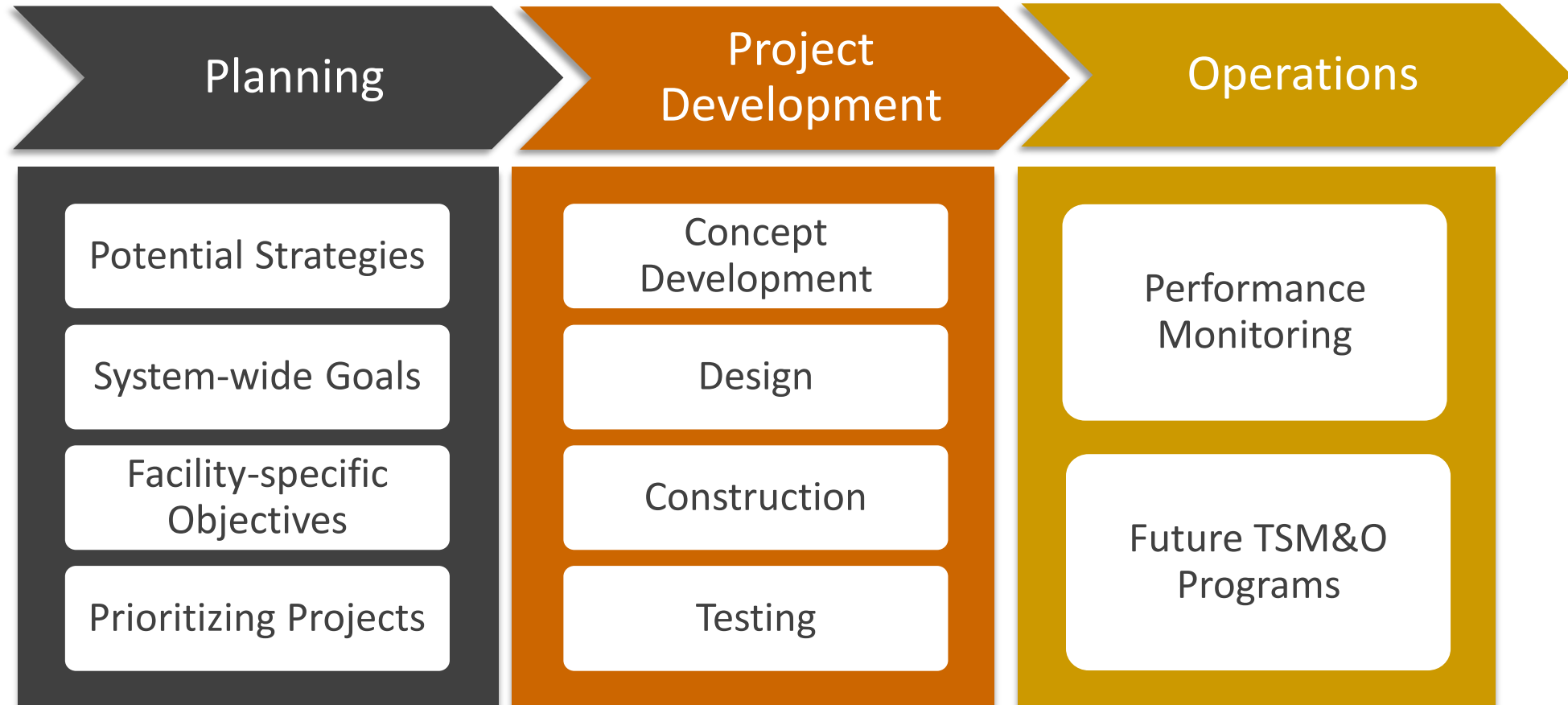
TSM&O Strategies are ...

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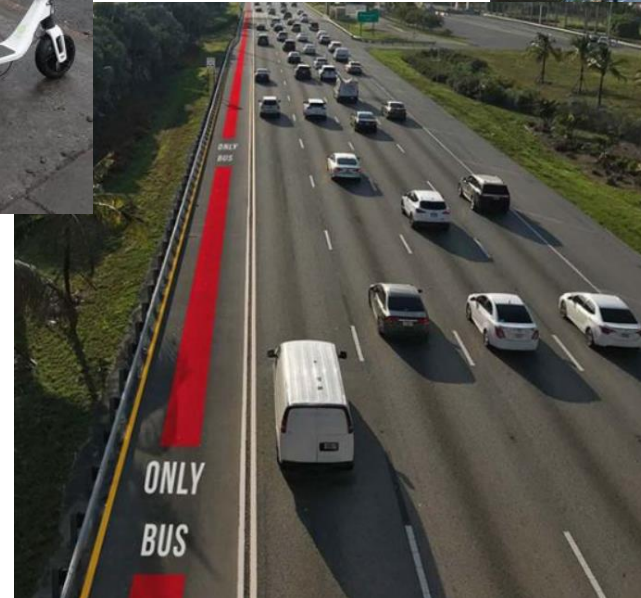
TSM&O Strategies are ...

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At All Stages

Multimodal



TSM&O Strategies ...



Preserve Capacity



Improve Safety



Improve Reliability of
Transportation System

FDOT's 2017 TSM&O Strategic Plan

Vision:

Increase the delivery rate of *fatality-free and congestion-free transportation systems* supporting the FDOT Vision and Florida Transportation Plan Goals.

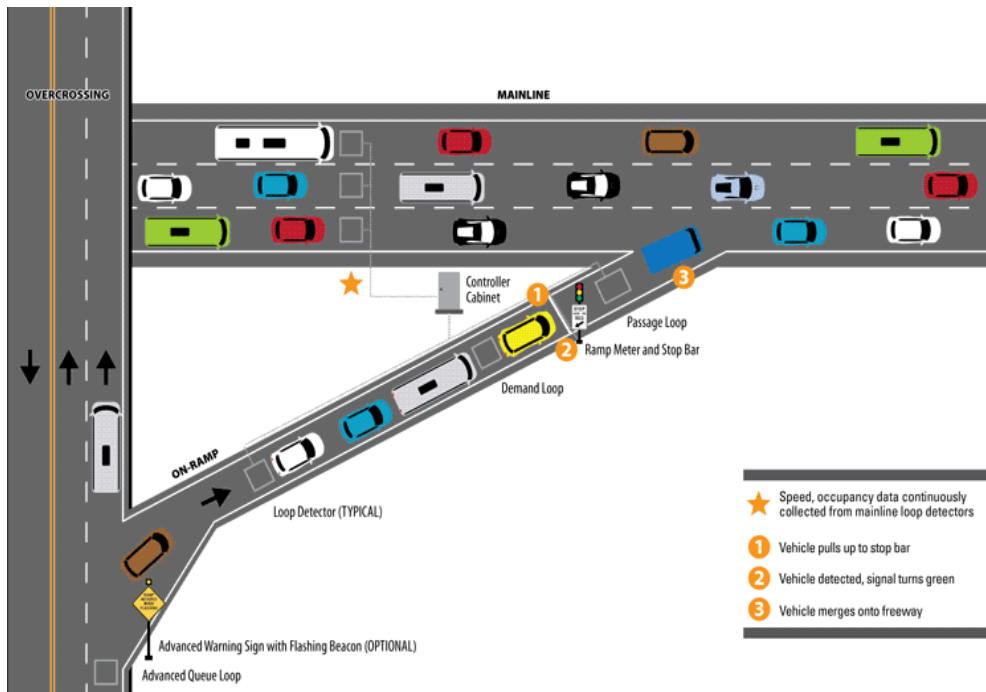
Mission:

Identify, prioritize, develop, implement, operate, maintain, and update **TSM&O** strategies and measure their effectiveness for improved safety and mobility.



Ramp Metering

Traffic signals along freeway on-ramps to control and regulate the frequency at which vehicles join the freeway mainline

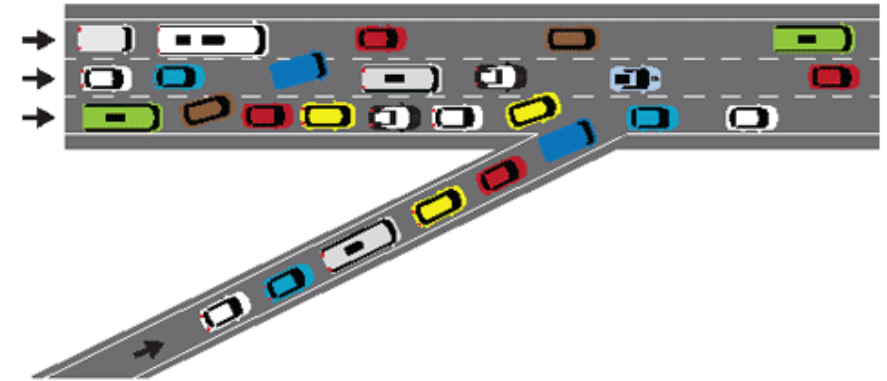


Advantages

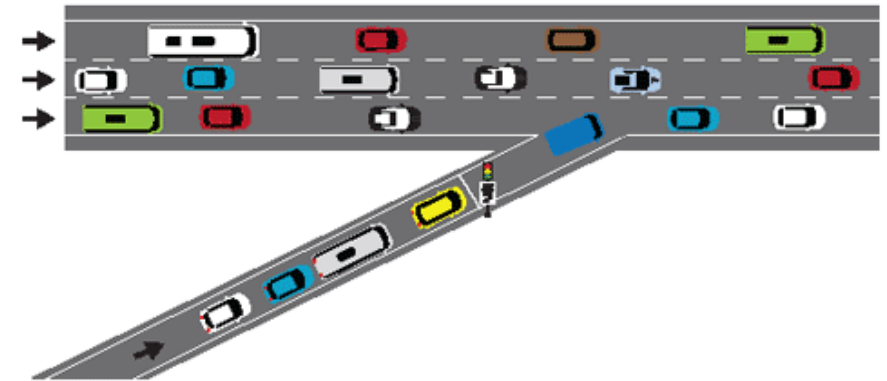
Help manage entrance demand on freeway mainline thereby preventing traffic flow breakdowns

Break up the platoons by controlling the rate at which vehicles enter the mainline from the ramp

Freeway Without Ramp Signaling



Freeway With Ramp Signaling



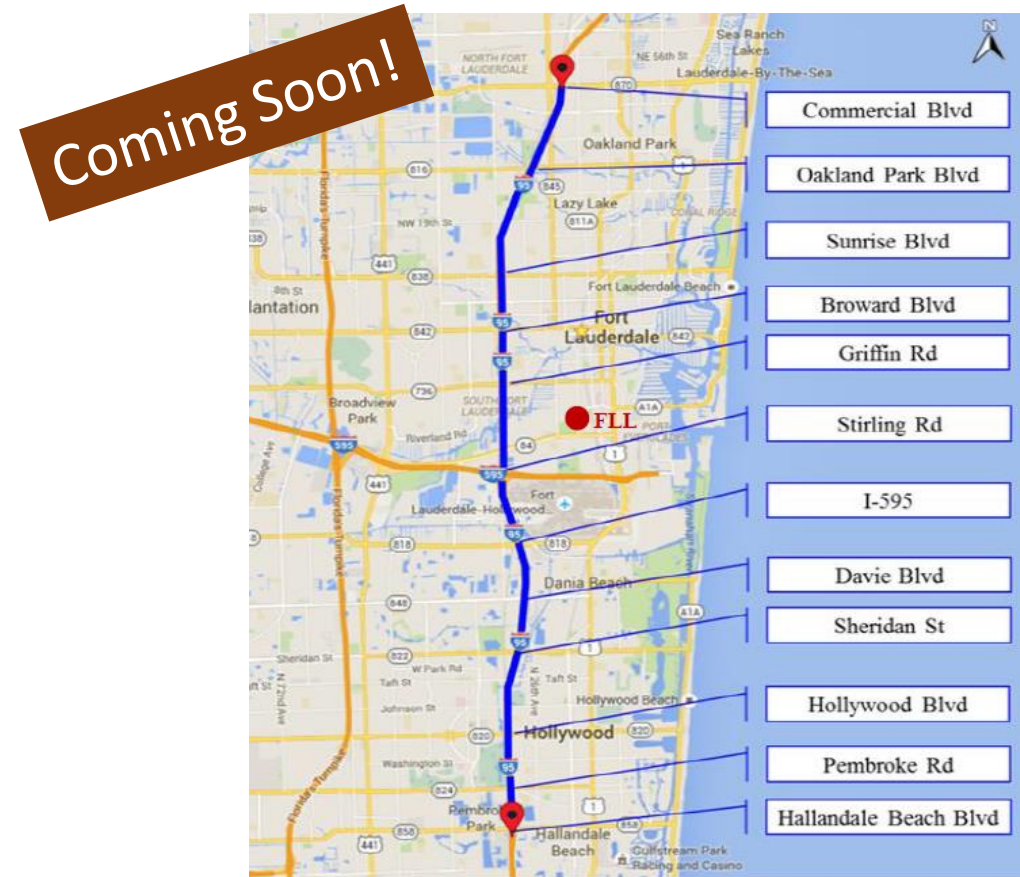
Deployment

I-95 in Miami-Dade County Ives Dairy Road to NW 62nd Street



Source: Zhu et al. 2007

I-95 in Broward County Commercial Blvd to Hallandale Beach Blvd



Source: Hadi et al. 2017

Data

Traffic Data

- RITIS

RMS Operations Data

- FDOT District 6 RTMC

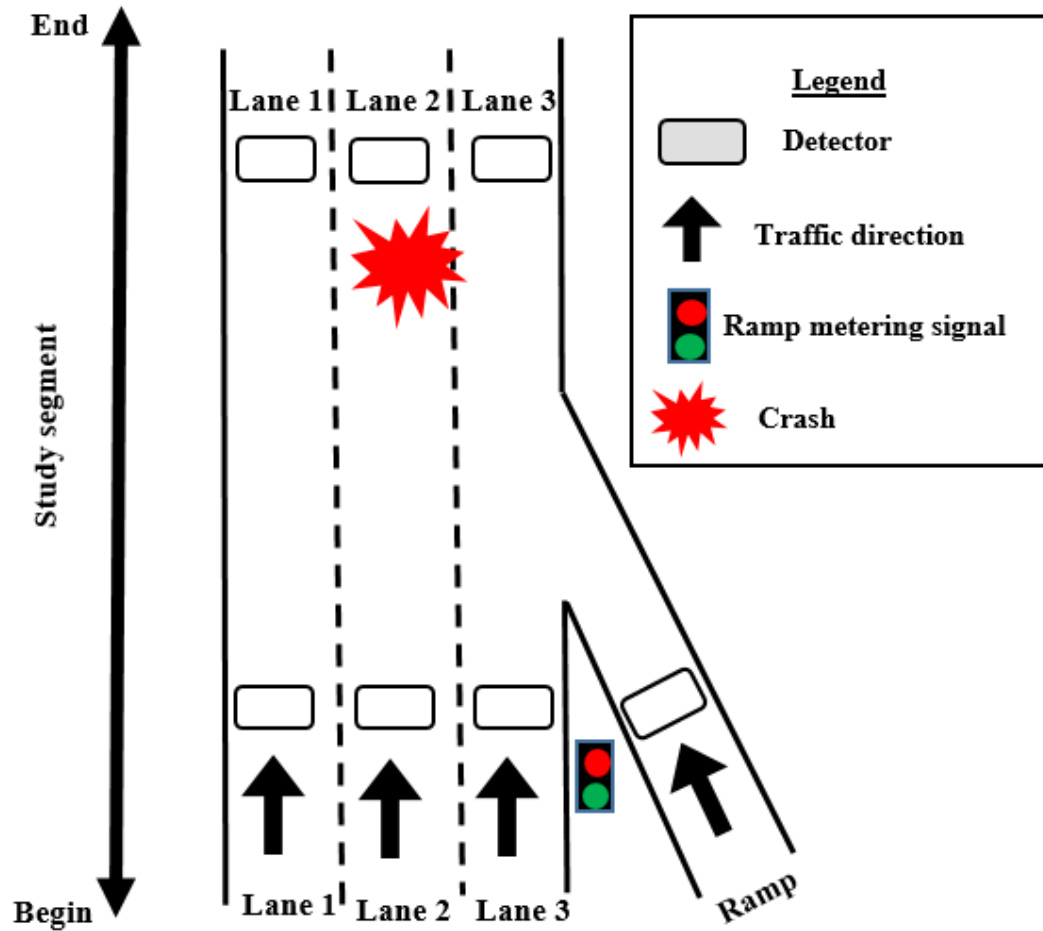
Contextual Data

- Google Maps

Crash Data

- SunGuide[®] Incident Database

Methodology: Safety Benefits



Matched Crash and Non-crash Cases

Crash Precursors

Penalized Logistic Regression

Bootstrap Resampling

Results: Safety Benefits

Ramp metering decreased the crash risk by 41%



Crash Precursors: RMSs OFF

Average downstream volume

Crash Precursors: RMSs ON

Downstream		Average	Coefficient of variation
	Speed	x	x
	Occupancy	✓	✓
	Volume	✓	x

Upstream		Average	Coefficient of variation
	Speed	x	✓
	Occupancy	x	x
	Volume	x	x

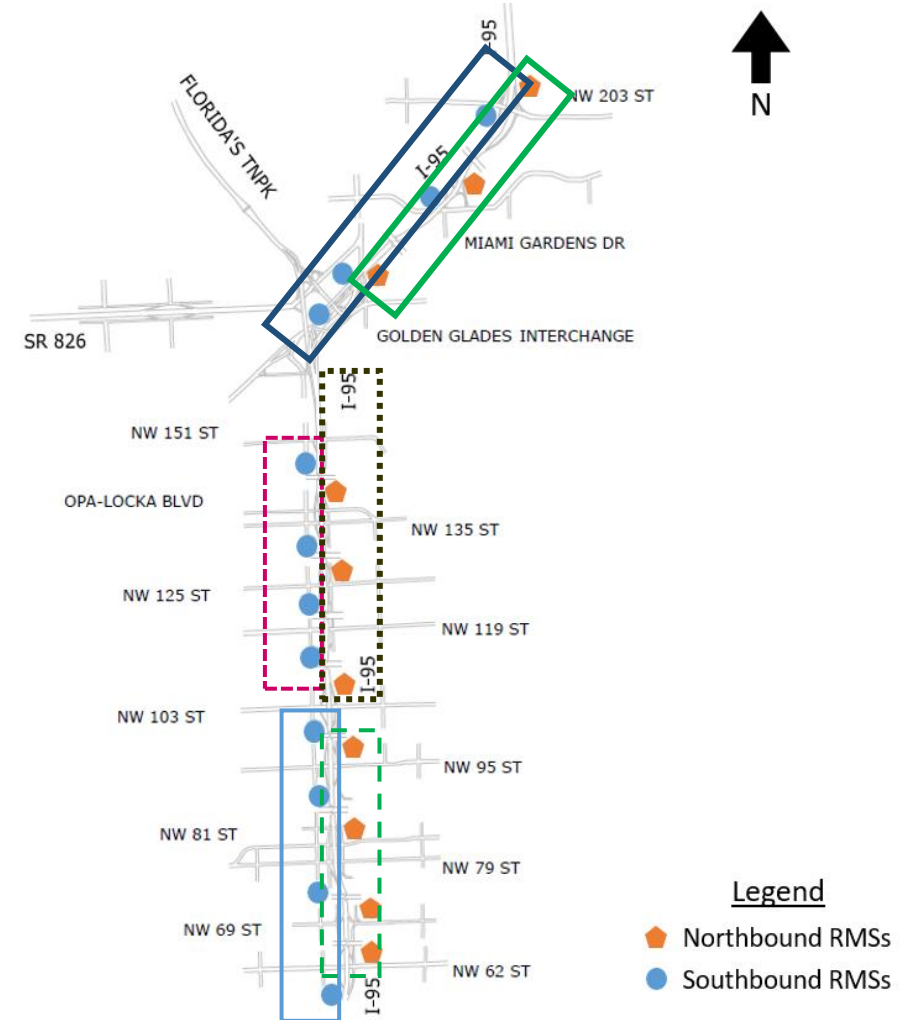
Methodology: Mobility Benefits

RMSs turned ON versus turned OFF

RMS turned ON due to recurrent congestion

RMS turned OFF because of system malfunctioning

operationDate	rmcld	turnOnAt	turnOffAt	turnOnReasonId	eventId	comments
2/9/2009	2	3:04:00 PM	7:00:00 PM	2	0	\N
2/9/2009	3	3:04:00 PM	7:02:00 PM	2	0	\N
2/9/2009	4	3:15:00 PM	7:02:00 PM	2	0	\N
2/9/2009	7	3:30:00 PM	7:03:00 PM	2	0	\N
2/9/2009	8	3:19:00 PM	6:58:00 PM	2	0	\N
2/9/2009	9	3:19:00 PM	6:56:00 PM	2	0	\N
2/9/2009	10	3:19:00 PM	6:49:00 PM	2	0	\N
2/9/2009	11	4:00:00 PM	6:45:00 PM	2	0	\N
4/1/2009	2	3:30:00 PM	6:50:00 PM	2	0	\N
4/1/2009	3	3:30:00 PM	6:50:00 PM	2	0	\N
4/1/2009	4	3:10:00 PM	6:50:00 PM	2	0	\N
4/1/2009	7	3:10:00 PM	6:50:00 PM	2	0	\N
4/1/2009	8	3:05:00 PM	6:50:00 PM	2	0	\N
4/1/2009	9	4:40:00 PM	6:50:00 PM	2	0	\N
4/1/2009	10	4:40:00 PM	6:50:00 PM	2	0	\N
3/31/2009	2	3:00:00 PM	7:30:00 PM	2	0	\N
3/31/2009	3	3:00:00 PM	7:30:00 PM	2	0	\N
3/31/2009	4	2:40:00 PM	7:30:00 PM	2	0	\N
2/21/2009	7	3:40:00 PM	7:20:00 PM	2	0	\N



Mobility Benefits

- Travel time reliability measured using Buffer Index (BI)
- Time cushion that most travelers add to their average travel time when planning trips to ensure on-time arrival

$$BI = \frac{95th\ percentile\ travel\ time - Average\ travel\ time}{Average\ travel\ time}$$

- RMS reduce BI by 22% during moderate congestion
- RMS reduce BI by 30% during severe congestion

Dynamic Message Signs

Programmable electronic signs used for disseminating real-time information to road users



DMSs are Everywhere (Almost)!

~869 DMSs displaying messages on major roadways

Operational 24/7 to convey time-sensitive information to motorists



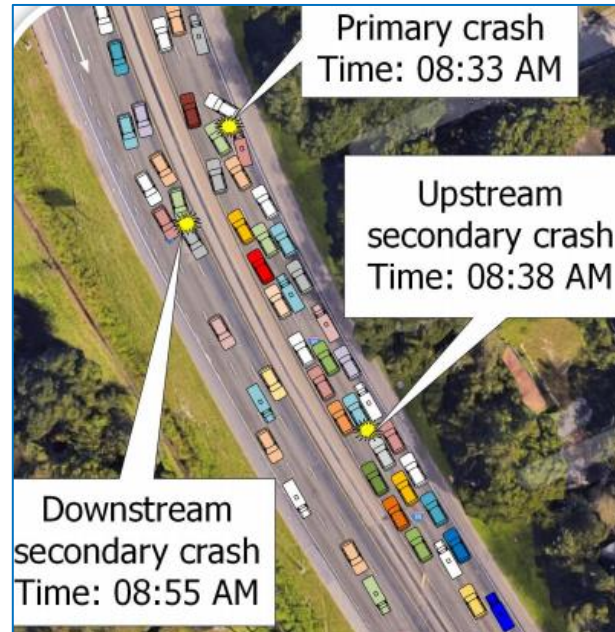
Advantages

Reduce secondary crashes

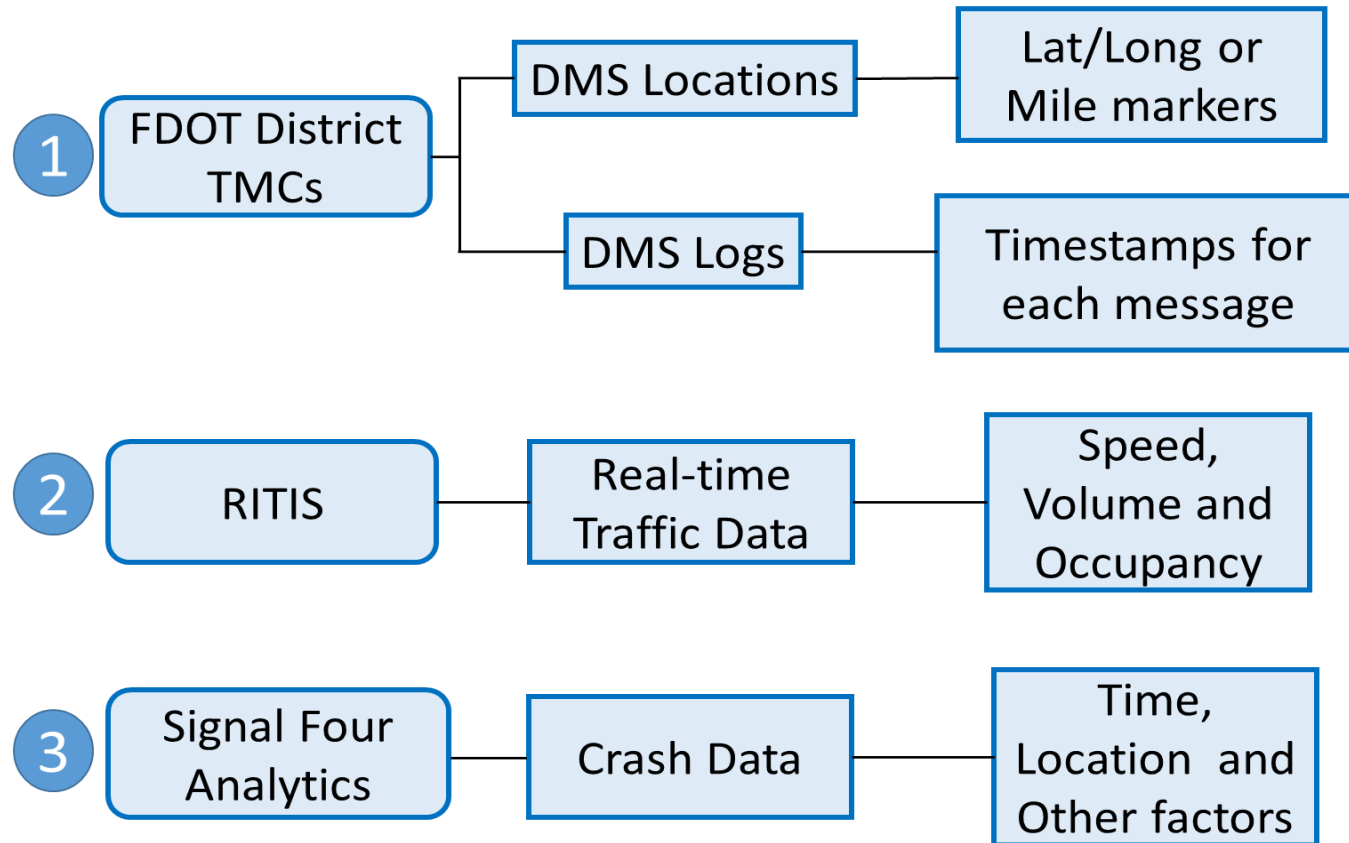
Minimize travel delays

Enable fast and appropriate response to incidents

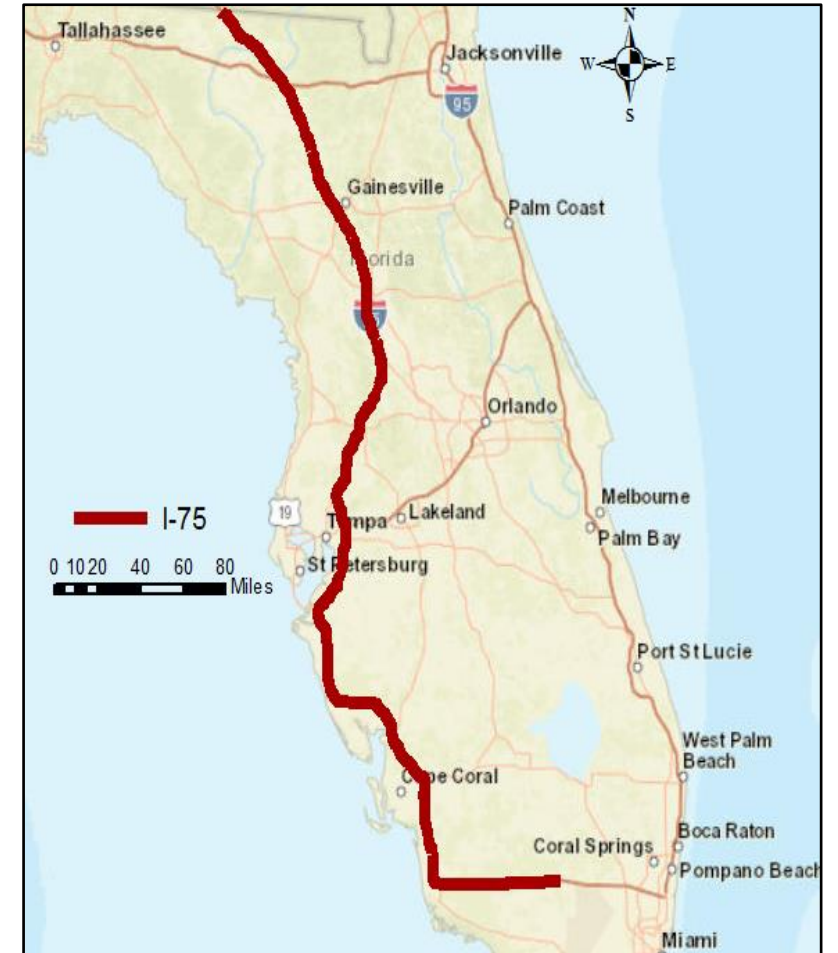
Assist motorists make informed routing decisions



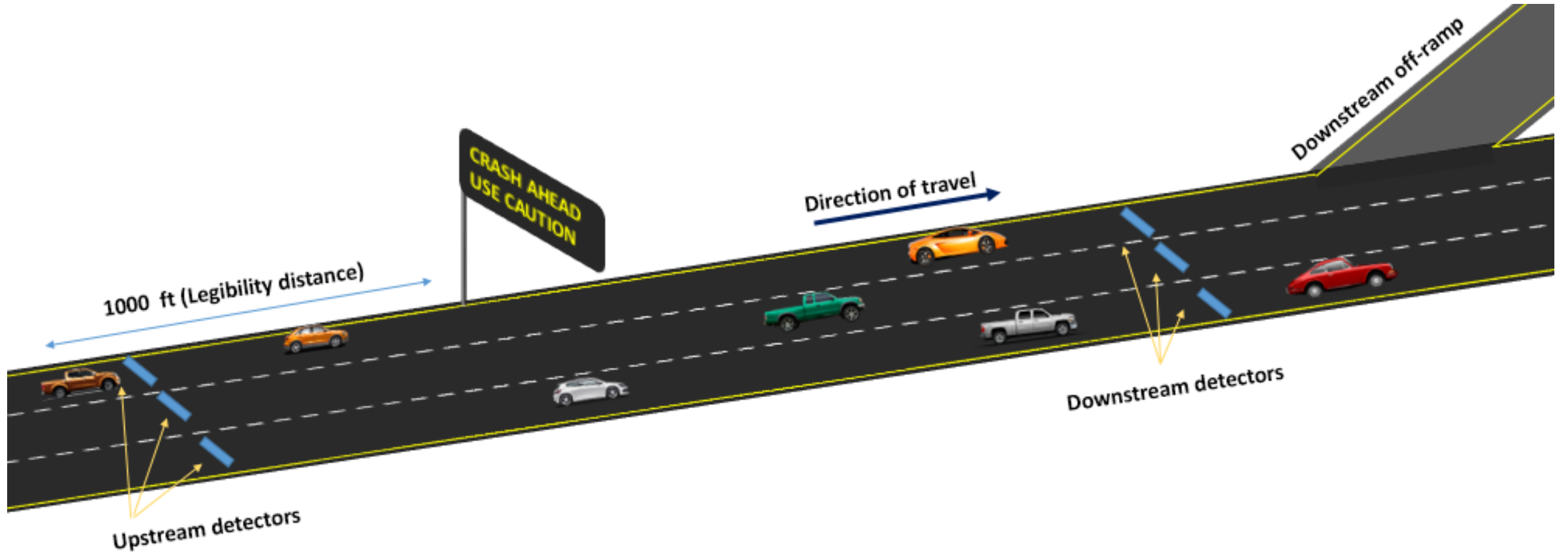
Data



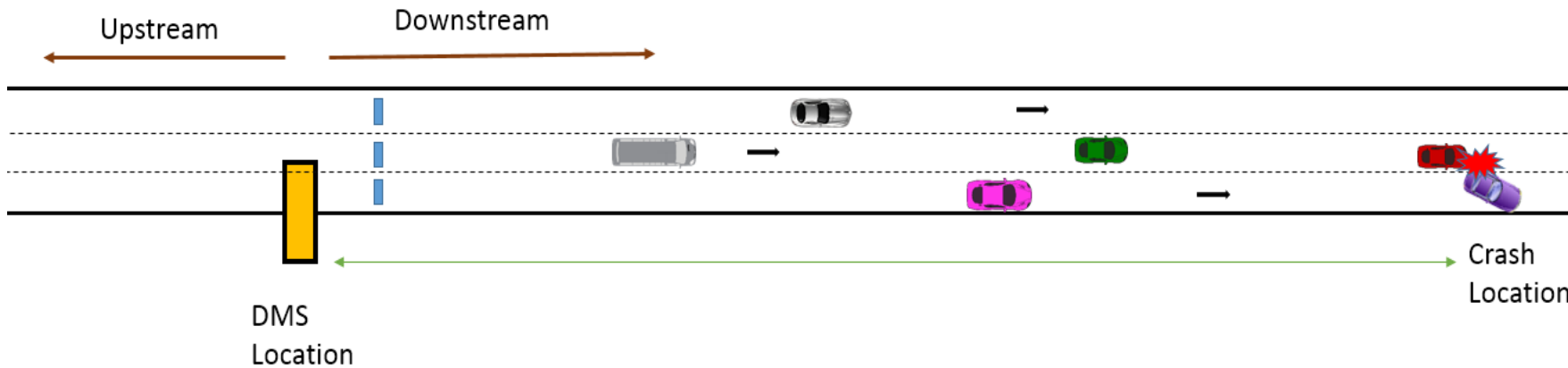
- 23 DMSs along I-75
- Analysis Period: 2016 – 2018



Quantify Benefits



Quantify Benefits



Crash Messages

Convey information about crashes downstream and suggest drivers' reaction

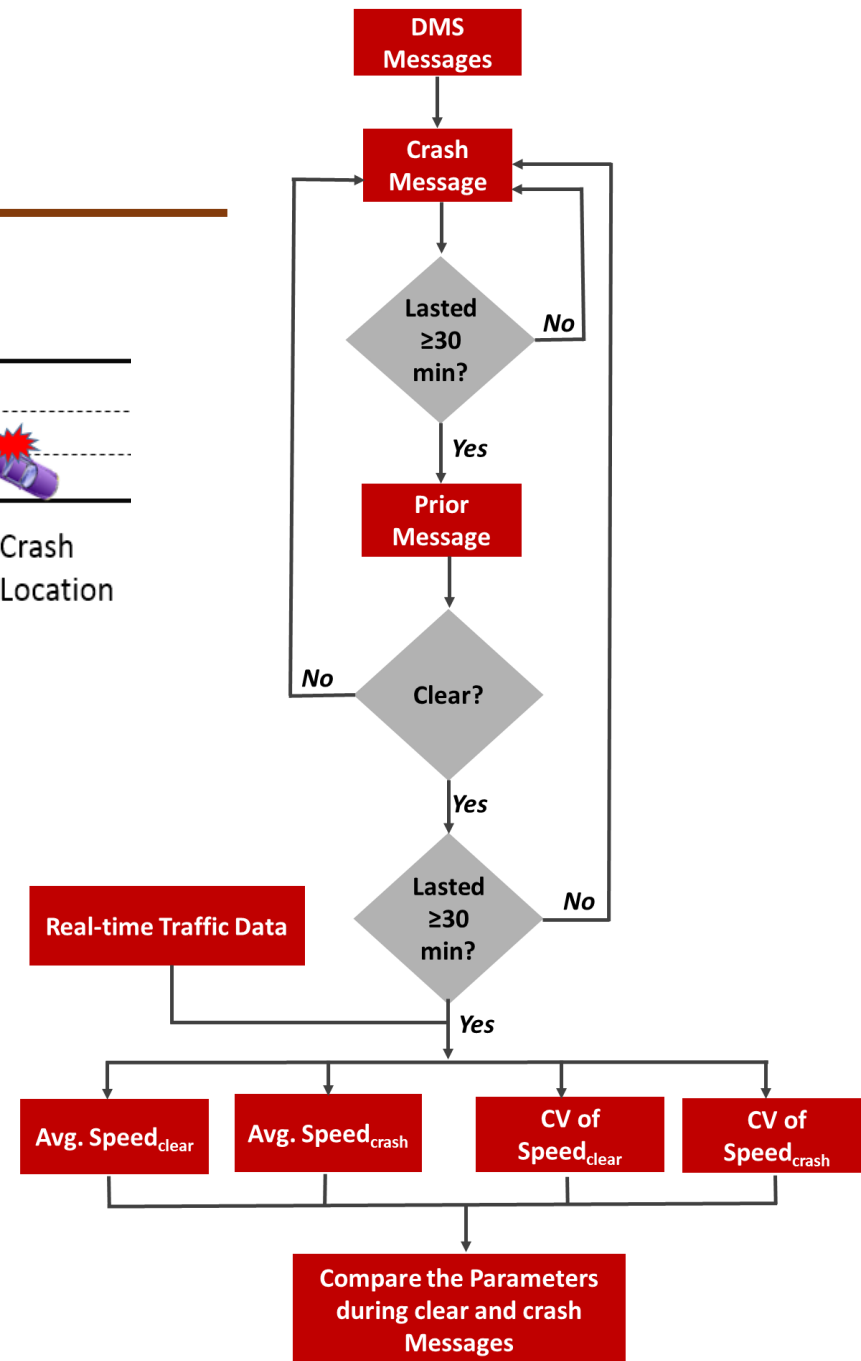
**CRASH
3 MI AHEAD
USE CAUTION**

Clear Messages

Convey general or advisory information that do not require any change in the traffic patterns

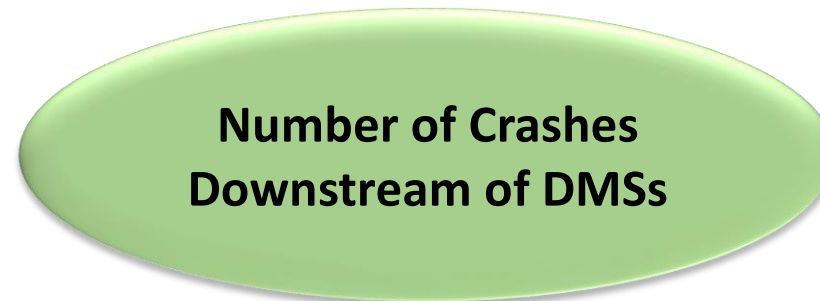
**NO EXCUSES
BUCKLE UP**

**I-75 TO I-4 NO
MAJOR INCIDENTS
REPORTED**



Results - Benefits of Dynamic Message Signs

When *Crash Messages* are displayed on the DMSs



Study Limitations

- The reduction in average speeds observed when the DMSs display *crash messages* may be attributed to other sources of information such as *Waze*, Highway Advisory Radio, etc.
- The analysis did not consider other potential factors such as incidents downstream which may result in speed reduction

Express Lanes

Express lanes are managed toll lanes, separated from general-purpose lanes or general toll lanes within a freeway facility



Deployment

In Operation (~62 miles)

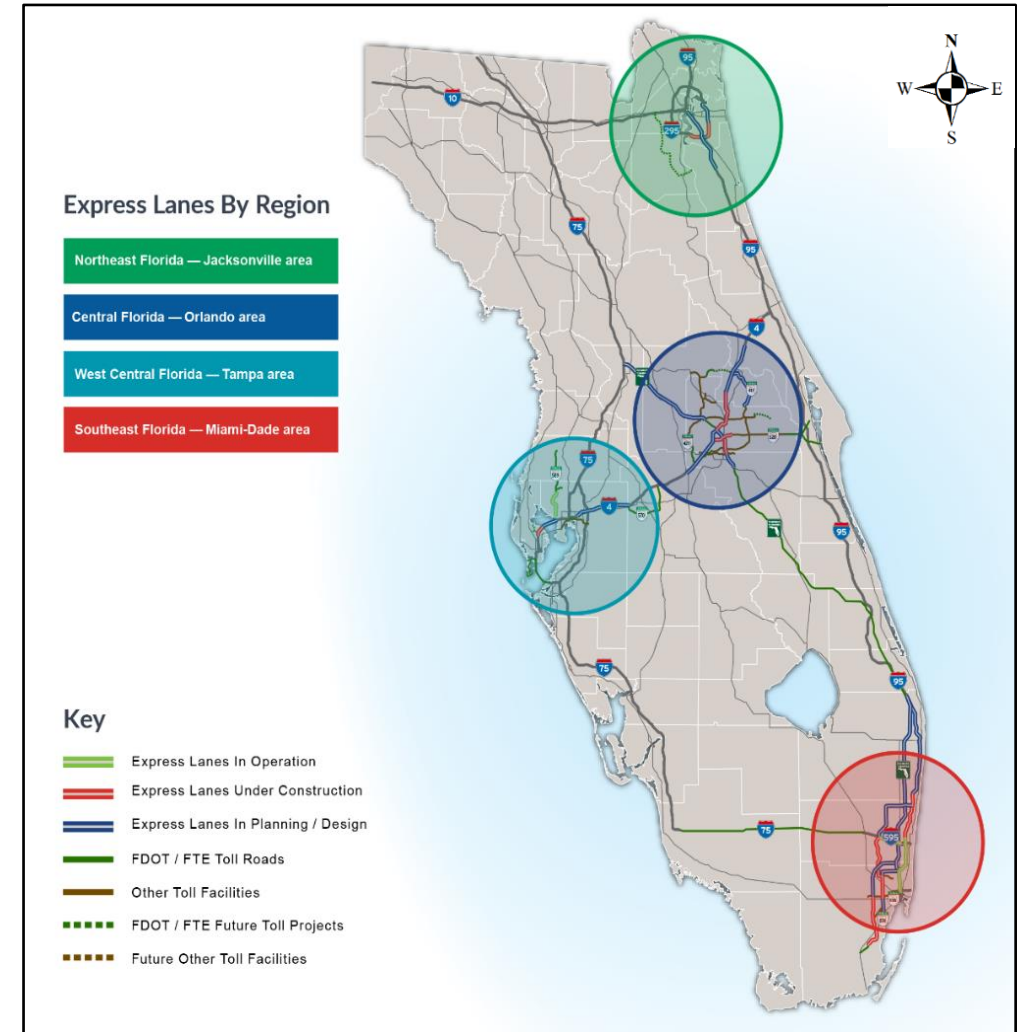
I-95
I-595
I-75
Veterans Expressway / SR 589

Under Construction (~99 miles)

Turnpike Extension (HEFT)
I-95
Palmetto Expressway / SR 826
I-295
Beachline West Expressway / SR 528
Turnpike Mainline
I-4
I-275

In Planning/Design (~298 miles)

Turnpike Mainline
I-95
Sawgrass Expressway / SR 869
Palmetto Expressway / SR 826
I-295
I-95
Turnpike Mainline
I-4
Seminole Expressway / SR 417

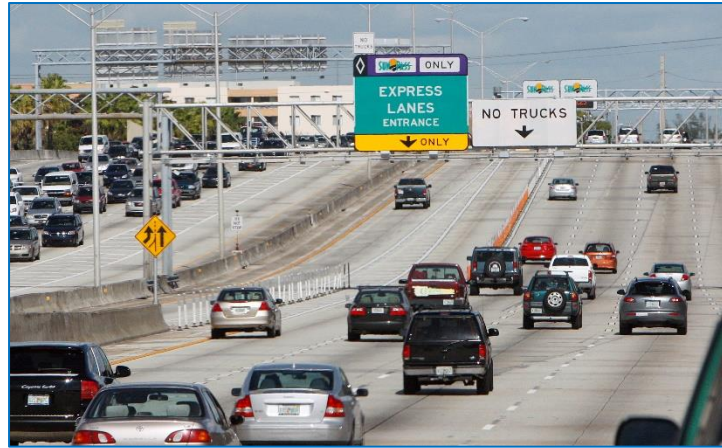


Advantages

Reduce overall traffic congestion

Provide a safe and predictable trip in terms of travel time

Increase the capacity of the highway



Mobility Benefits of Express Lanes

Quantify the mobility benefits of Express Lanes by comparing:

The performance of ELs
with that of their adjacent
GPLs

The performance of GPLs when:

- ELs were operational versus
- ELs were closed

Data

Traffic data

- RITIS

Contextual data

- Google maps

Express Lanes

Operations Data

- FDOT District 4 and 6

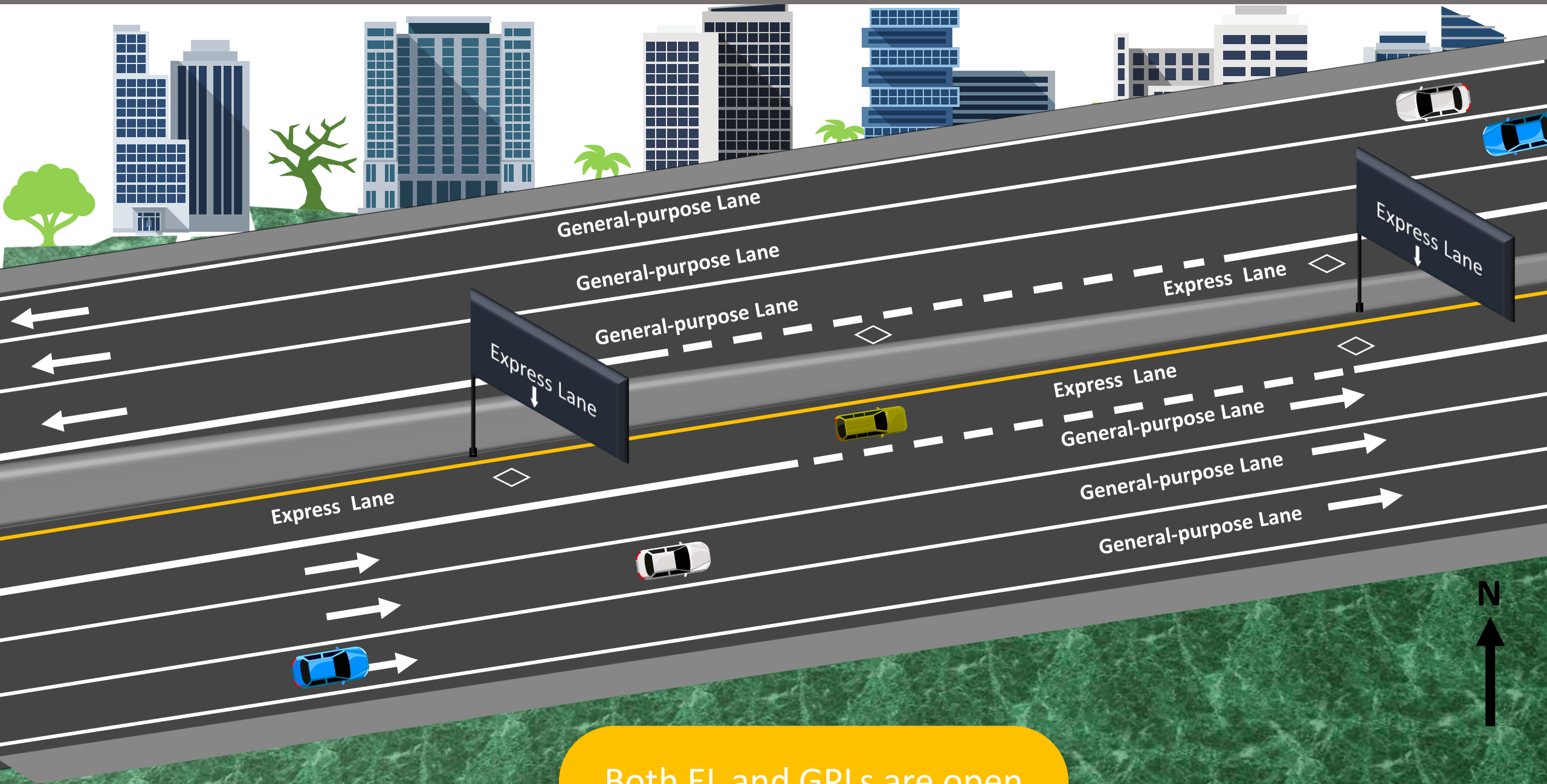
Mobility Benefits of Express Lanes

Two years of travel time data aggregated into 5-minute intervals

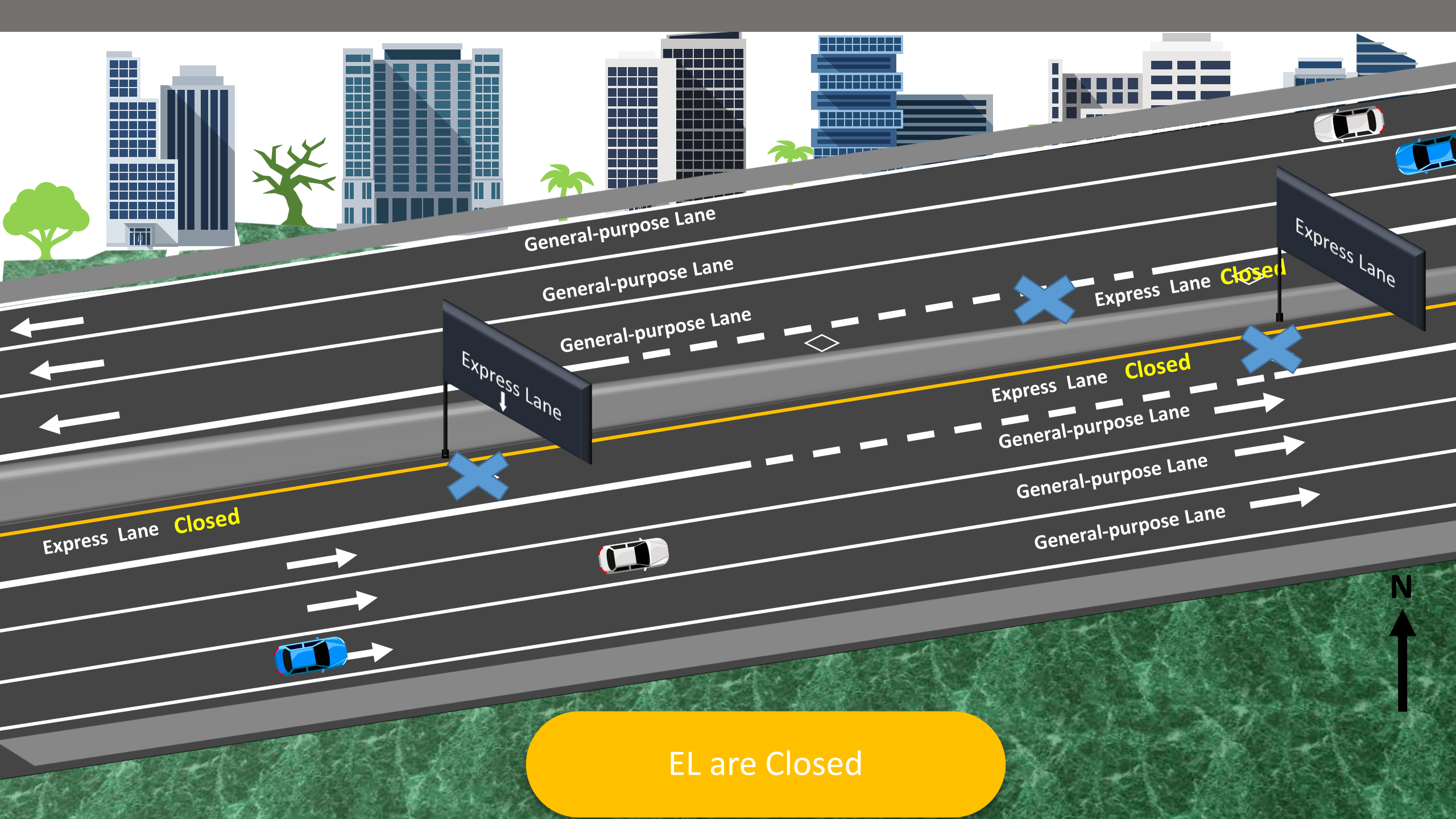
Typical weekday travel time data aggregated into 5-minute intervals

Buffer Index measures calculated

Performance of ELs and GPLs was compared



Both EL and GPLs are open



Express Lane **Closed**

Express Lane

Express Lane **Closed**

Express Lane **Closed**

Express Lane

General-purpose Lane

General-purpose Lane

General-purpose Lane

General-purpose Lane

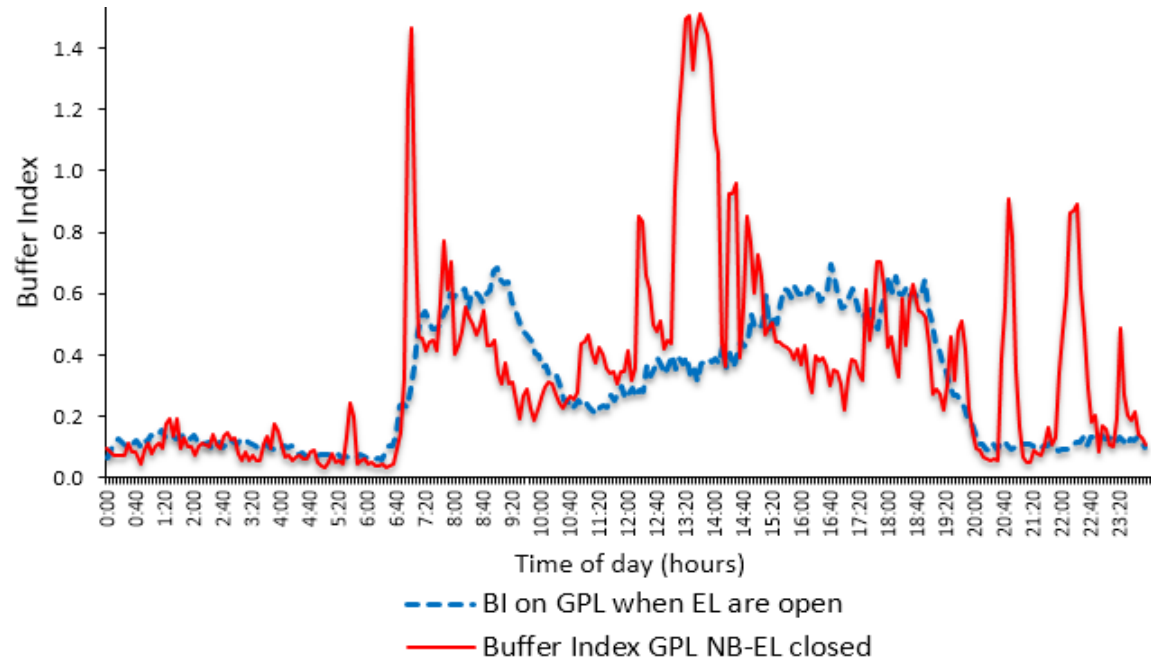
General-purpose Lane

General-purpose Lane

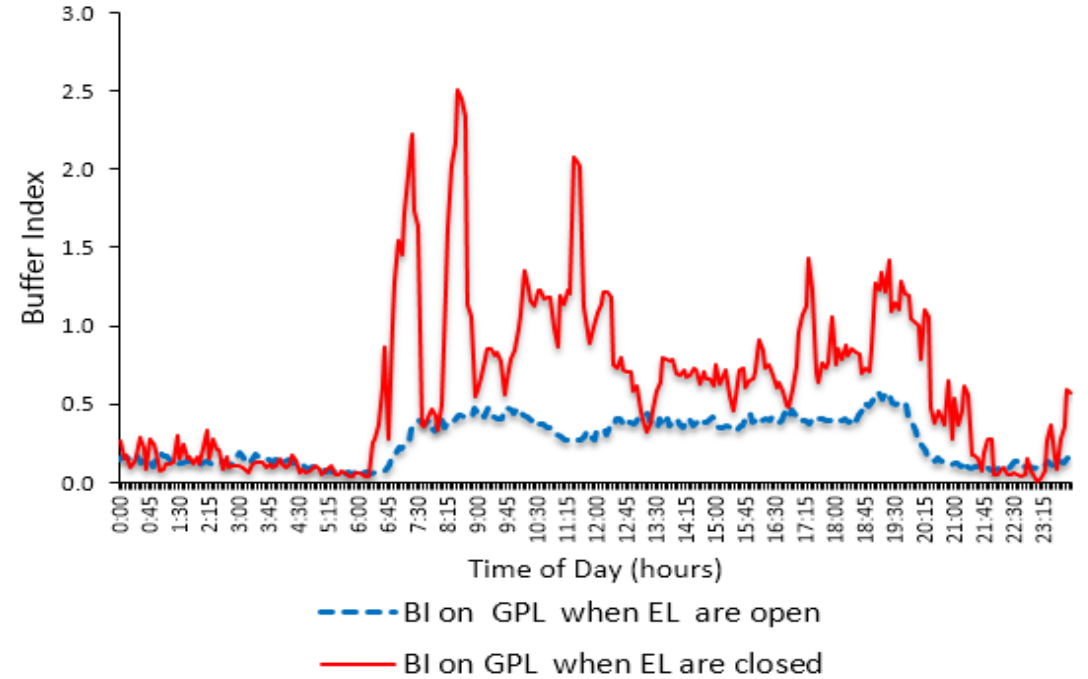
EL are Closed



Performance of GPLs

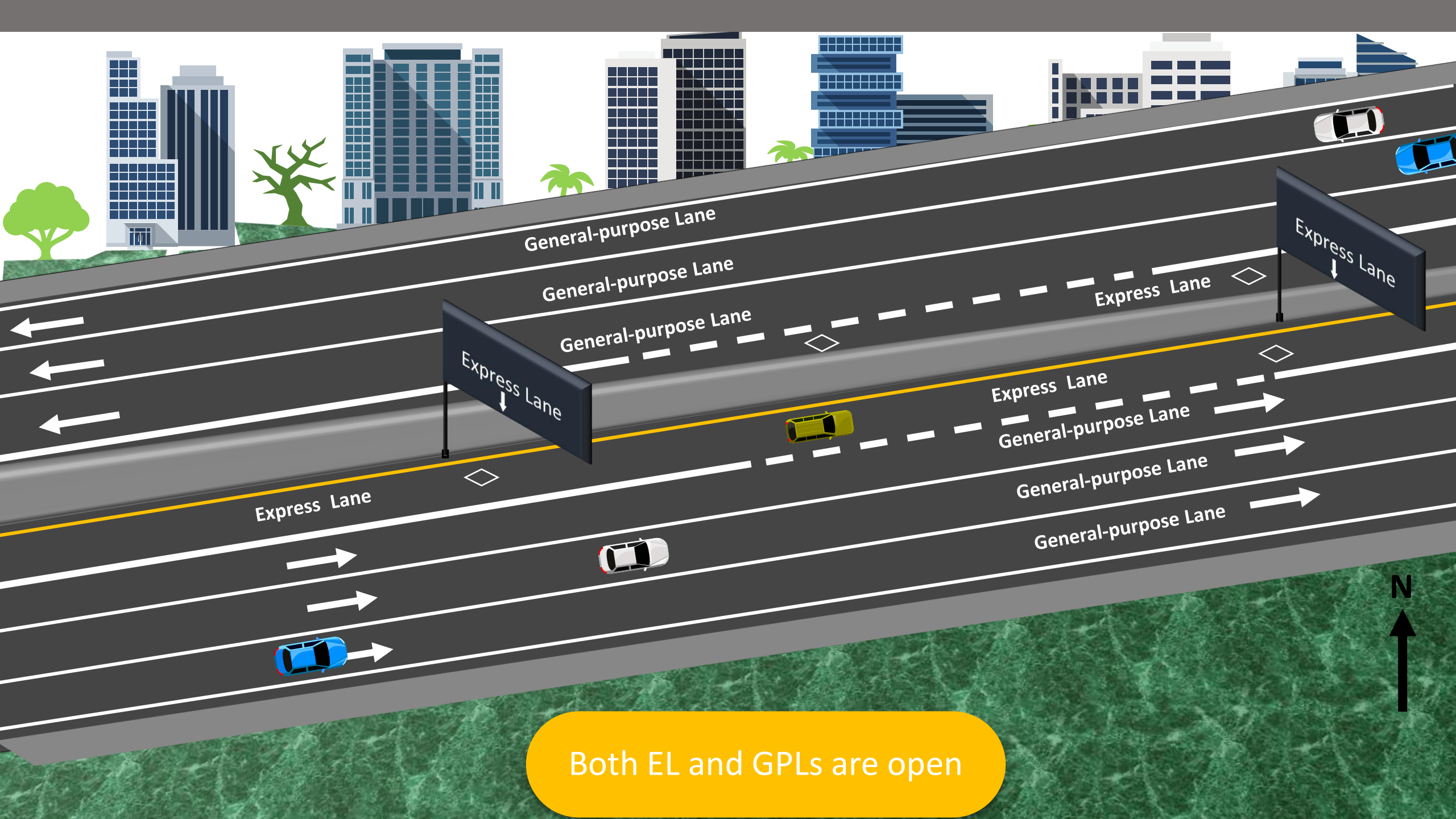


Buffer Index for Northbound GPLs



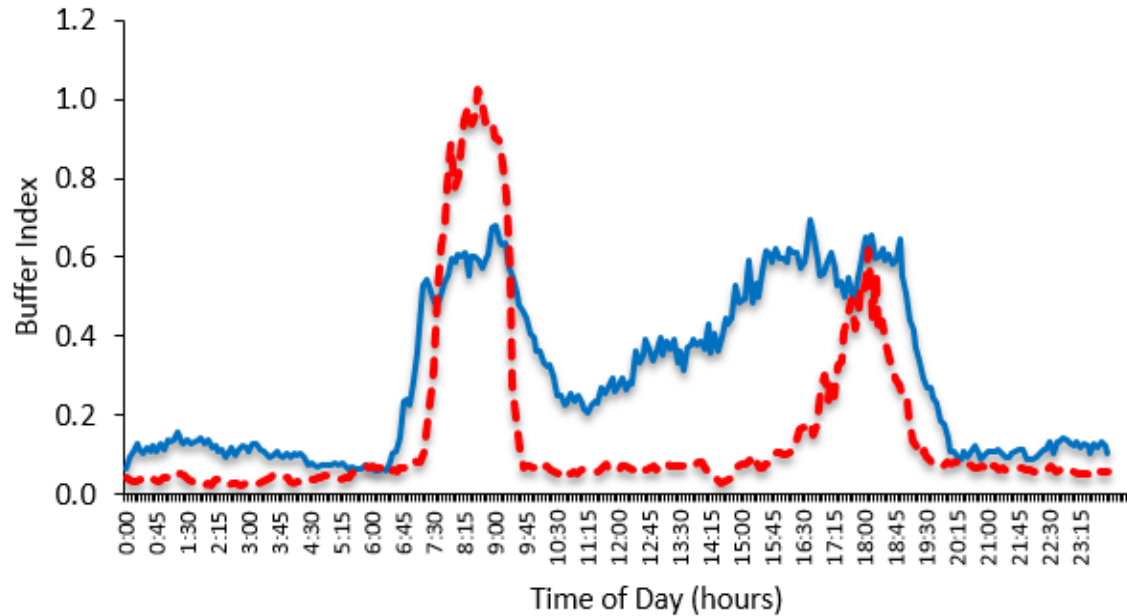
Buffer Index for Southbound GPLs

Statistical Test: Welch's t-test (unequal variance t-test) was used to determine if there was a statistically significant difference in the Buffer Indices (BIs)

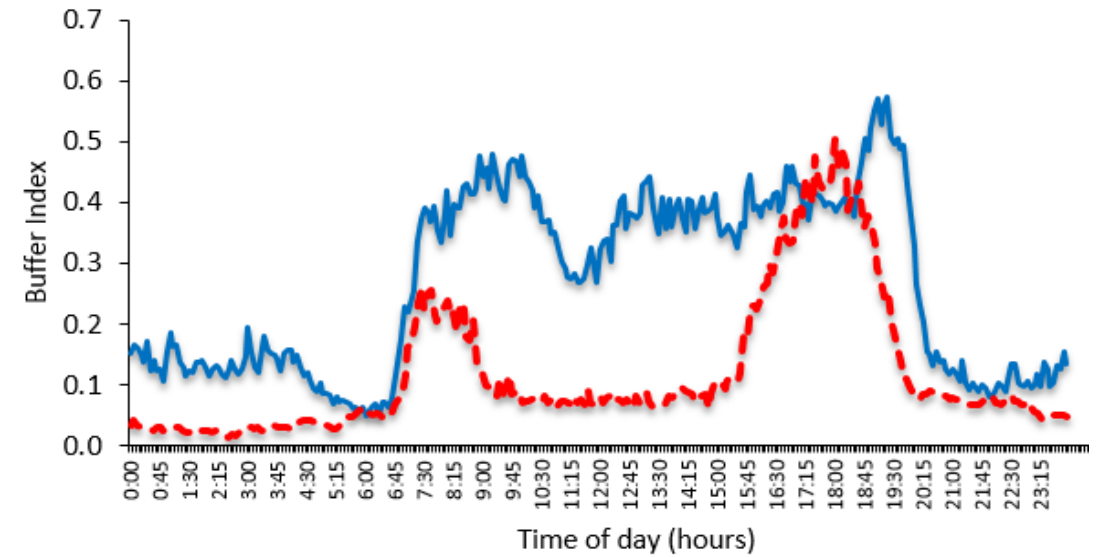


Both EL and GPLs are open

Performance of EL Facilities



Buffer Index for Northbound



Buffer Index for Southbound

Statistical Test: Welch's t-test (unequal variance t-test) was used to determine if there was a statistically significant difference in the Buffer Indices (BIs)

Results –Mobility Benefits

- When the ELs were operational, the performance of the adjacent GPLs improved
- In general, both the ELs and the GPLs performed better when the ELs were operational

Safety Analysis of Express Lanes... Ongoing!

Goal: Quantify the effects of separation types on the safety performance of managed lanes facilities

Objective #1

Develop SPFs under specified base conditions

Objective #2

Develop CMFs for different separation treatments and other geometric attributes (other than the base conditions)

Objective #3

Develop SDFs to estimate the expected crash frequency for different crash severity levels

Expected Project Benefits - Quantitative

Project Requirements

- SPFs
- CMFs
- SDFs

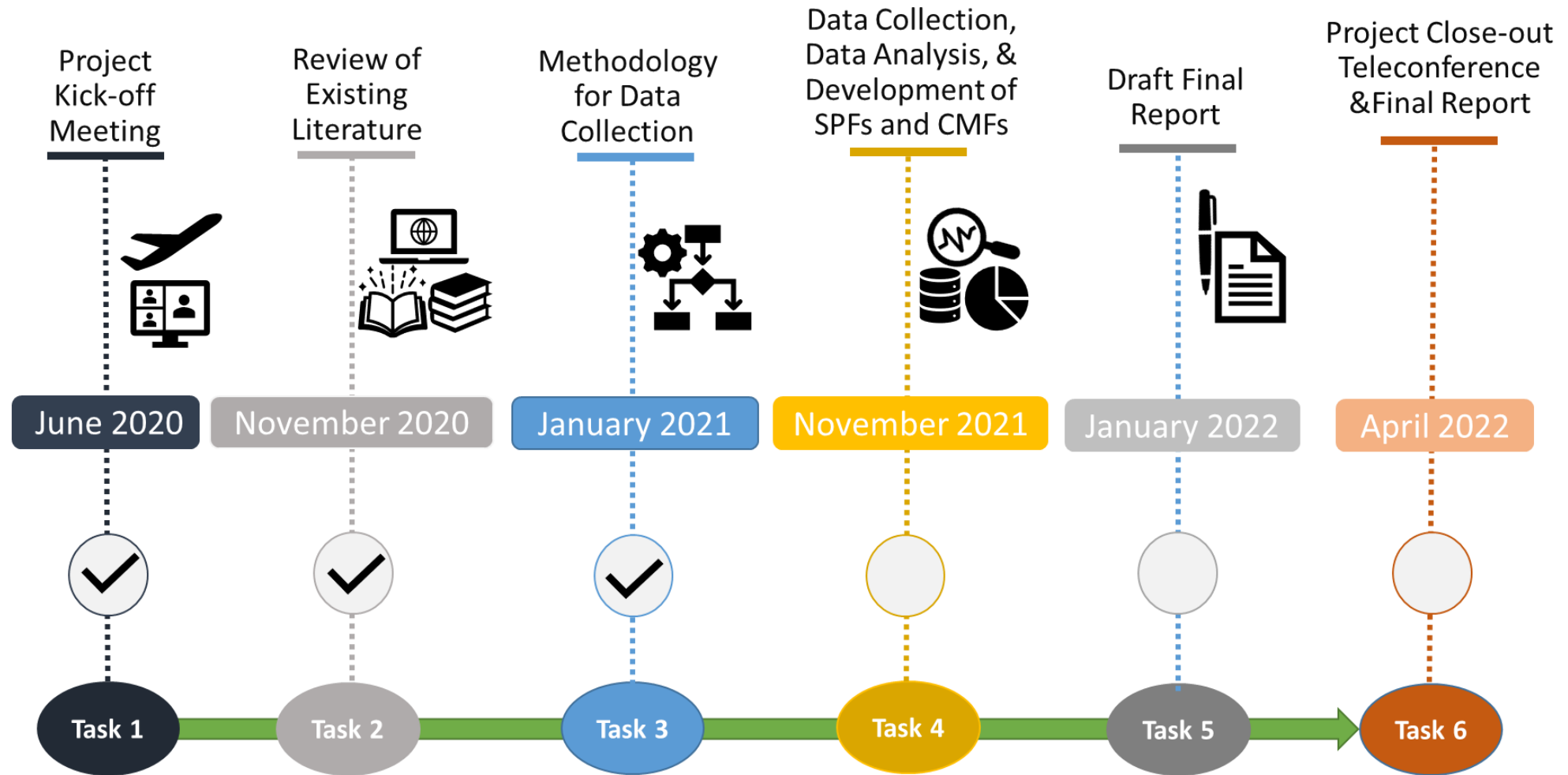
Other By-products

- A spreadsheet application
- A GIS inventory of managed lanes in Florida
- One-page summaries
- A one-hour recorded webinar
- A set of sample problems

Managed Lanes Separation Treatments



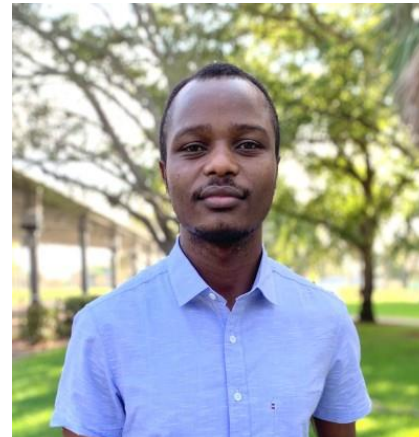
Project Milestones



In Summary

- TSM&O strategies are proven to improve safety and mobility of the our transportation network.
- The safety and operational benefits are unique to the strategy.
- While some strategies provide direct quantifiable benefits, it is difficult to measure the impacts of some strategies.
- TSM&O strategies provide feasible alternatives to achieve the safety and mobility goals of the agencies.

Research Team



Thank You!

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