Data-Driven Decision-Support Platform for Selection of the Intersections with Adaptive Traffic Control

2023 MassDOT Transportation Innovation Conference

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PRESENTATION OUTLINE

Motivation & Background

Problem Formulation

Methodology

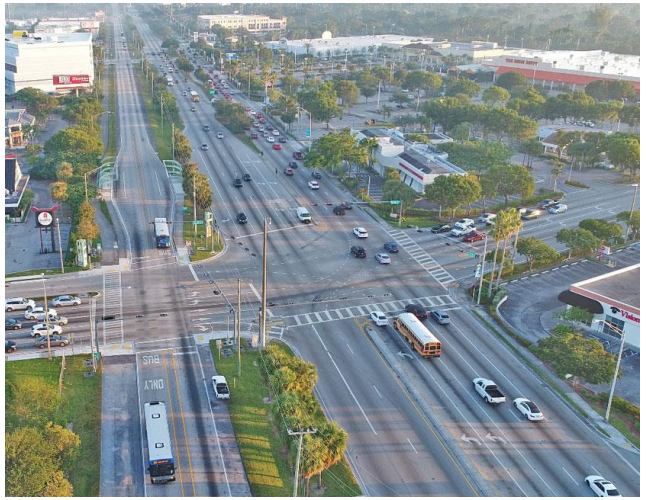
Platform Development

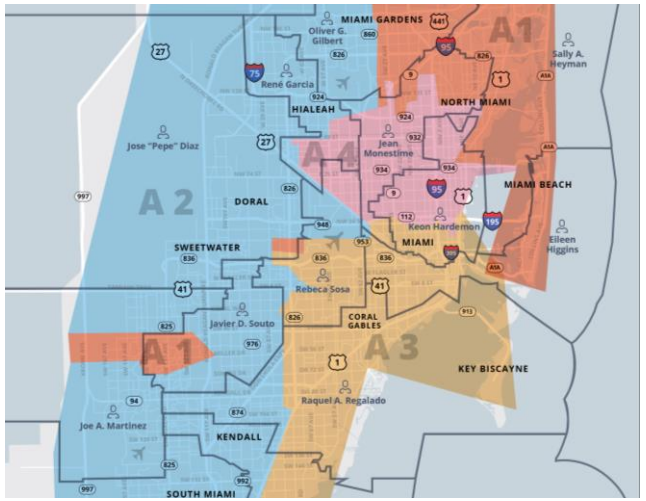
Demonstration

Conclusions & Future Works

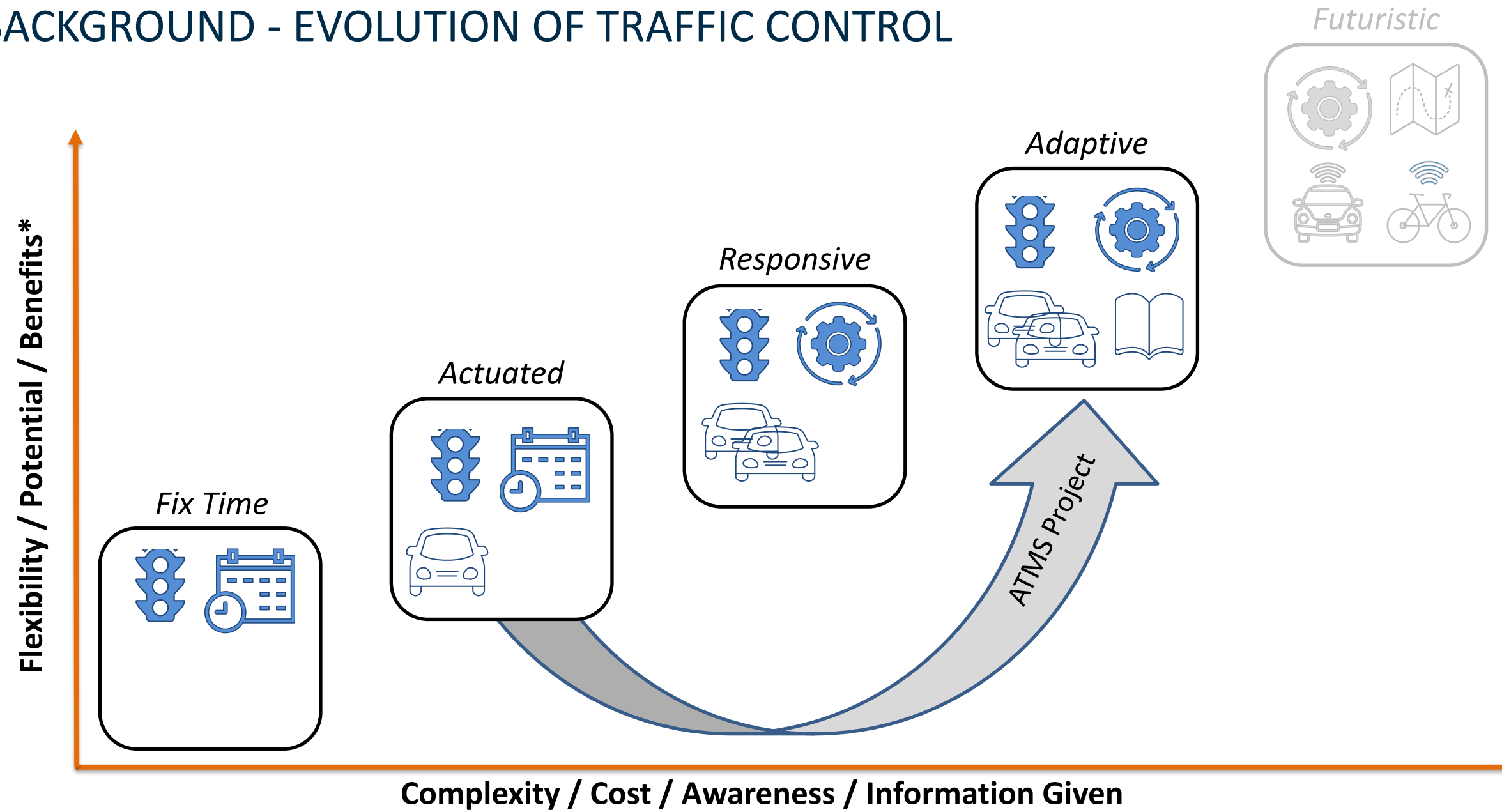
MOTIVATION - MIAMI DADE ATMS PROJECT OBJECTIVE

- Upgrade of ATMS Central Software
- Controller's replacement*
- Installation of new detection
- *<u>Installation of adaptive system</u>*





BACKGROUND - EVOLUTION OF TRAFFIC CONTROL



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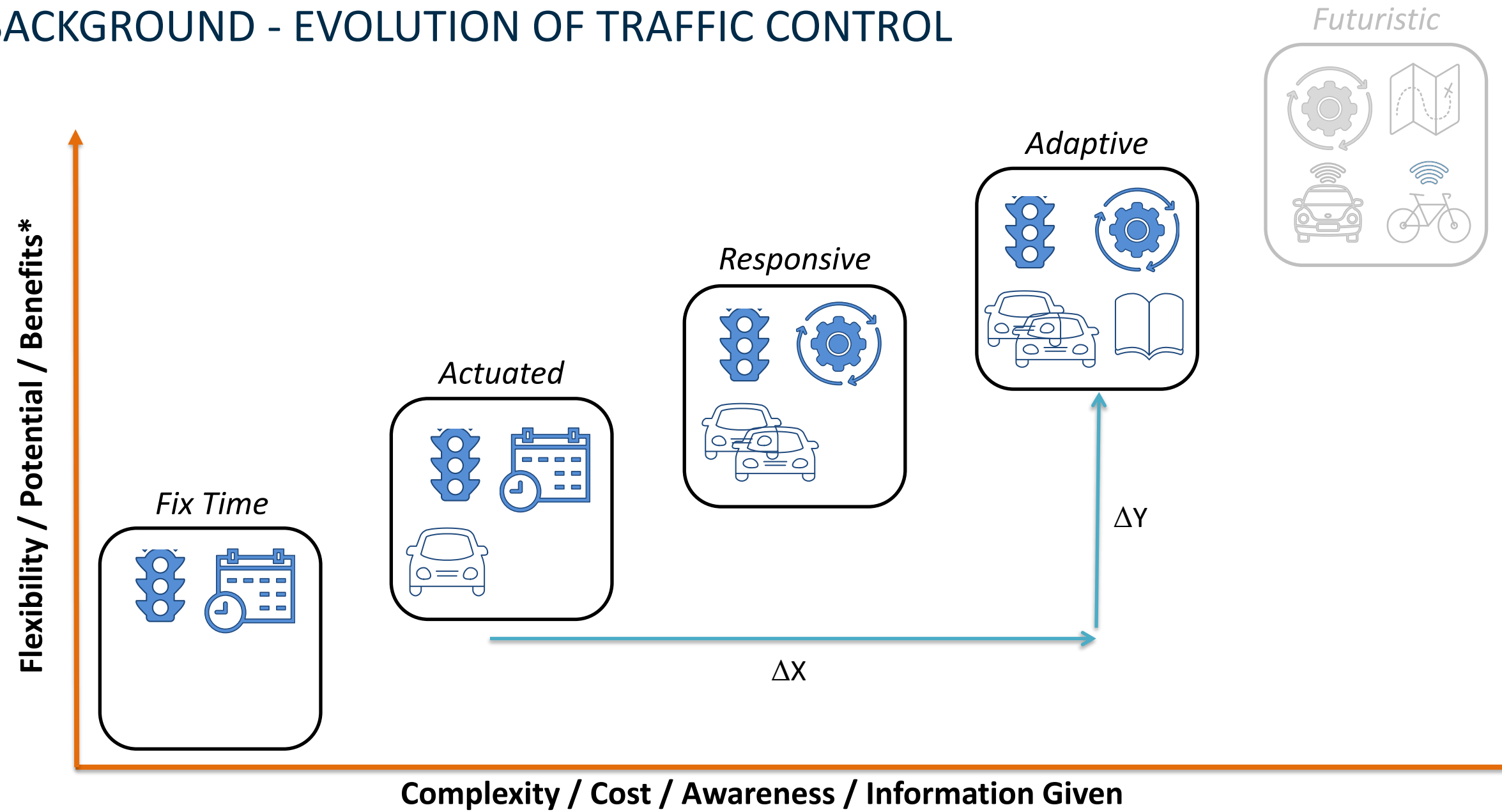
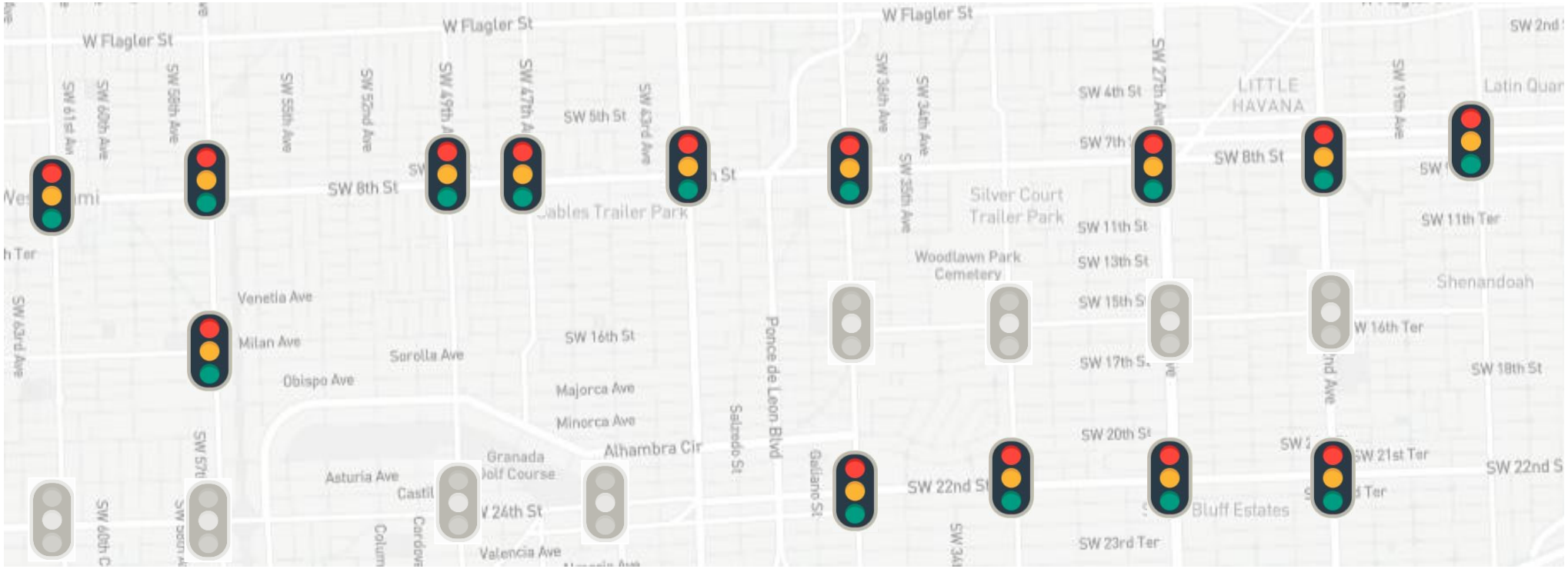


PROBLEM FORMULATION

For given network of *N* facilities, identify those *M (0<M<N)* that *should have new technology / adaptive system deployed*



METHODOLOGY: UNDERLYING PRINCIPLES

- Match (*limited*) *supply* and *demand*, or
- Assign *new technology* to adequate *facilities*, or
- Analyze the **operational attributes** to identify facilities that offer room for *improvement:*
  - Cycle optimization
  - Split optimization
  - Offset optimization
  - Transition mitigation, etc.

OPERATIONAL ATTRIBUTES

Signal Timing Program

1. Number of plans*
2. Number of time-of-day points*
3. Percentage of the time that the signal is running free

Signal Timing Parameters

1. *Number of vehicular phases*
2. *Number of pedestrian phases*
3. *Maximum cycle length*
4. *Minimum cycle length*

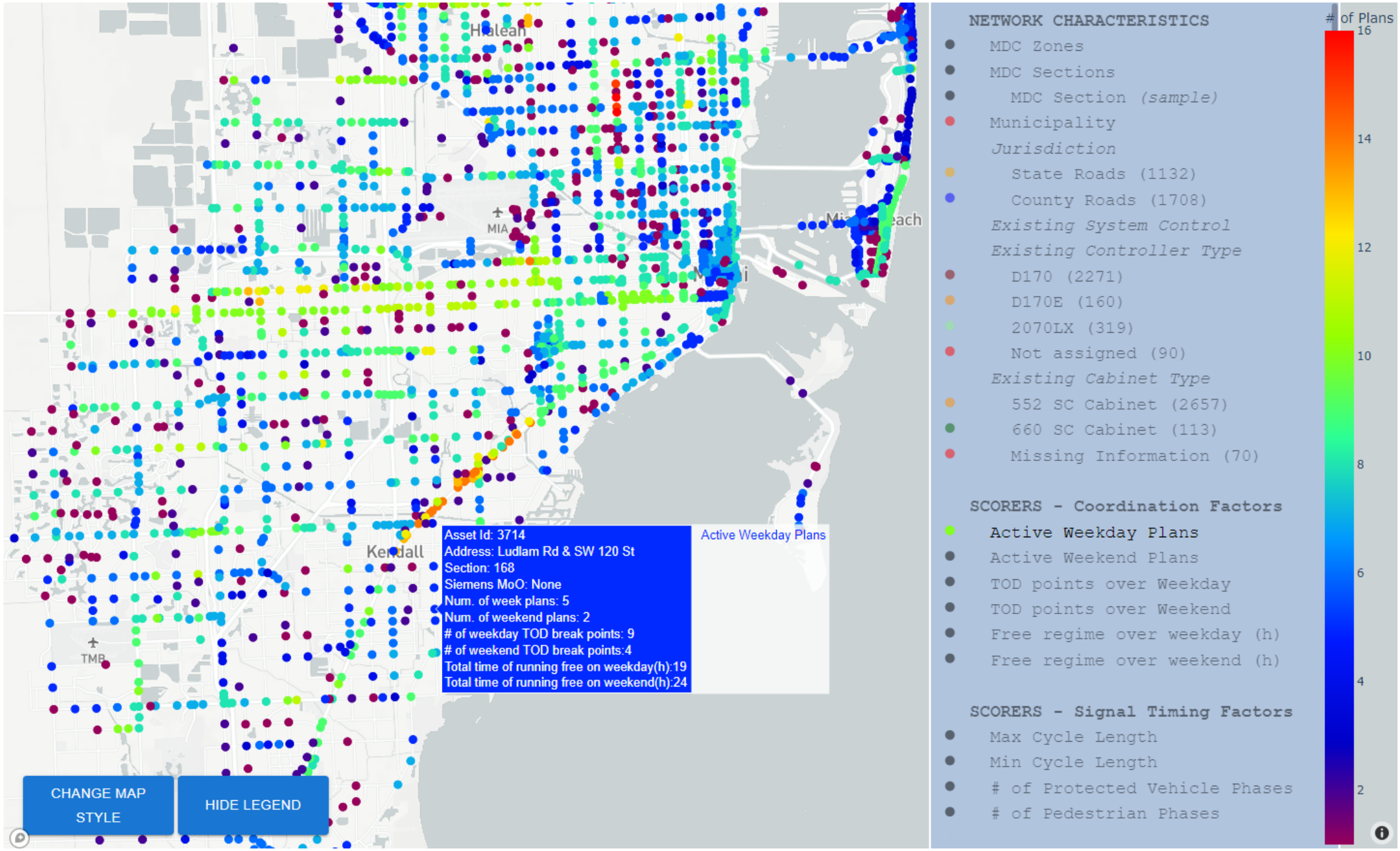
Connectivity

1. Isolated operations
2. Region density
3. Presence of an existing adaptive system
4. Importance of the State roads

Intersection Complexity

1. Presence of special ped. treatment
2. Presence of railroad preemption
3. Presence of overlaps
4. Presence of lead/lag LT operations
5. Presence of nearby freeway ramps

APP VIEW: OPERATIONAL ATTRIBUTES



METHODOLOGY: STEP-BY-STEP

1. Identification of the operational attributes (# of plans, CL)

2. Computation of the intersection's score
   *(for given user inputs and **weights**)*

3. Spatial aggregation (*if any*) of the computed scores

4. Sorting and selection of the top *M* facilities

5. Fine-tunning

USER INPUTS – SPATIAL AGGREGATION

Process

~~*1. Identification of the operational attributes*~~

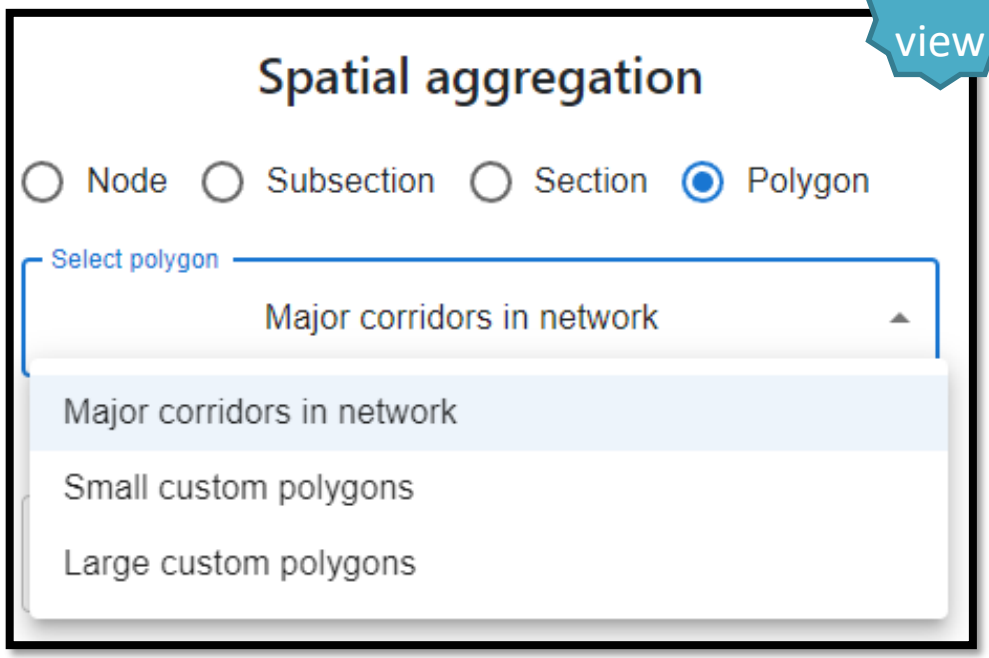
~~2. Computation of the intersection's score~~

3. Spatial aggregation of the computed scores

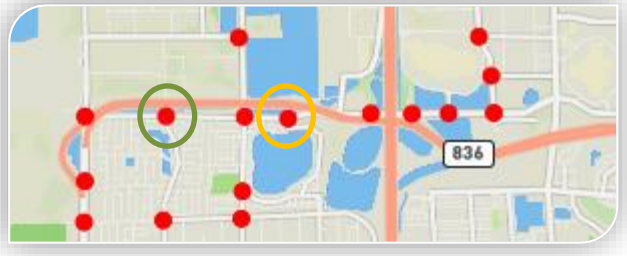
4. Sorting and selection of the top M facilities

5. Fine-tunning

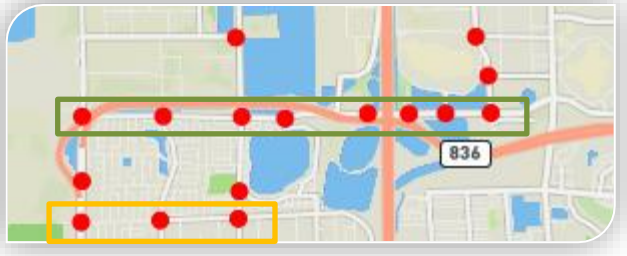
APP view



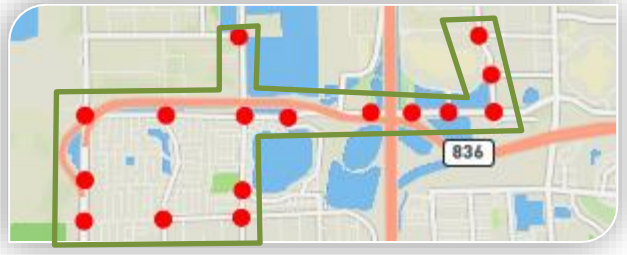
NODE



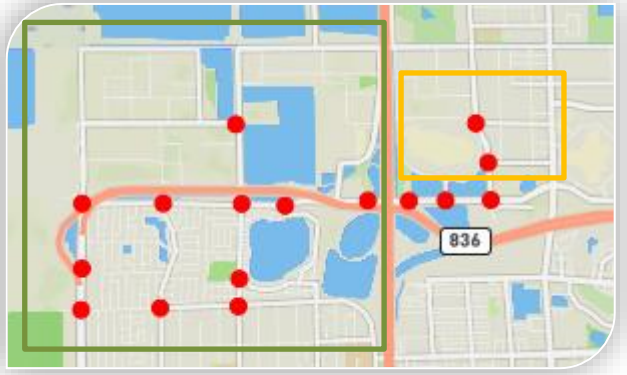
SUBSECTION



SECTION

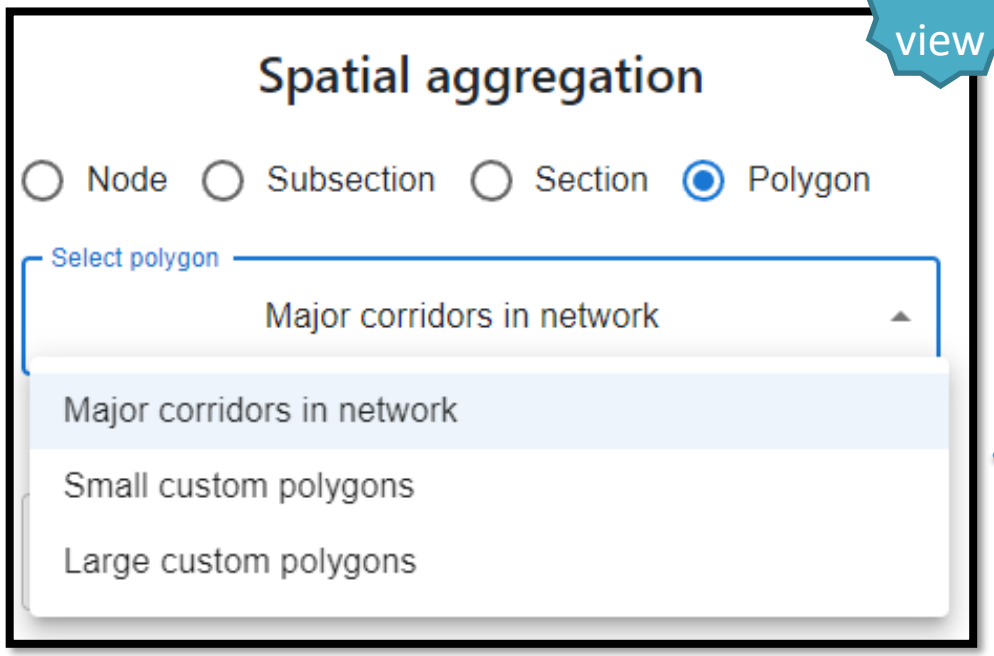


POLYGON

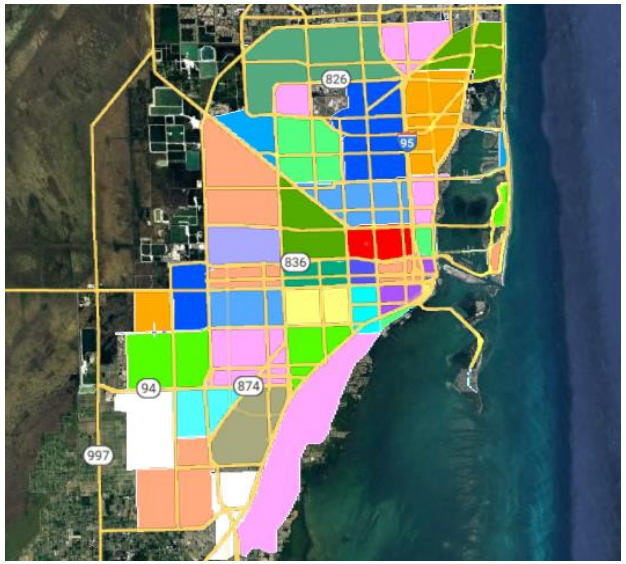


SPATIAL AGGREGATION (CUSTOM POLYGONS)

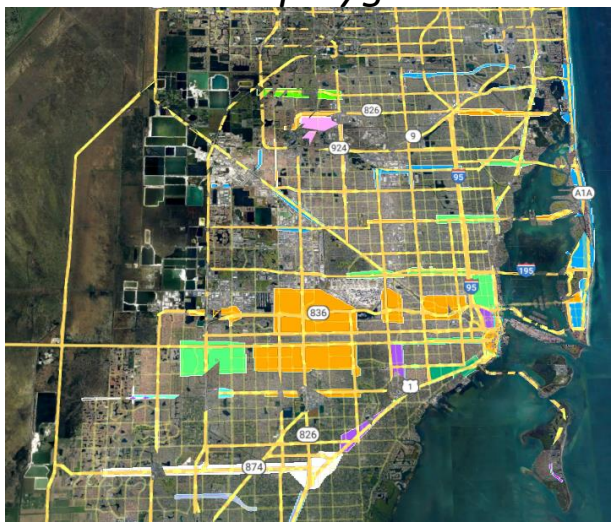
APP view



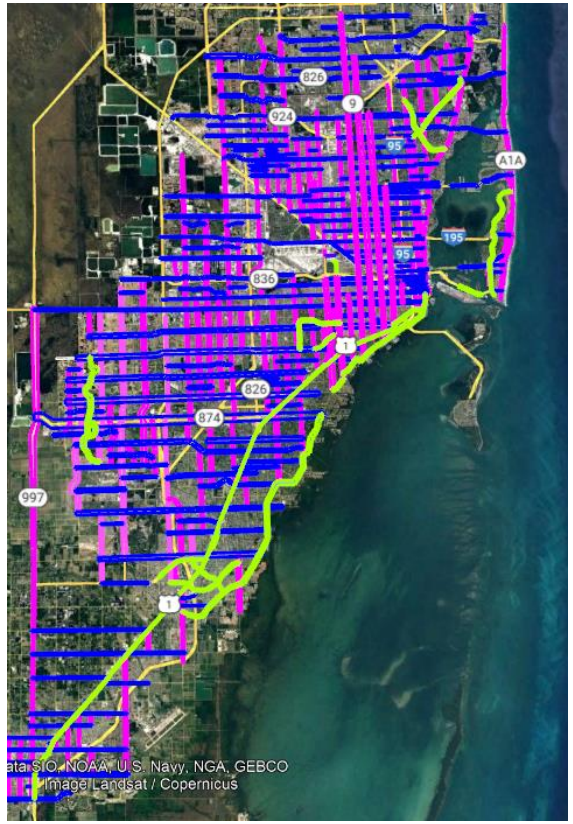
Large polygons



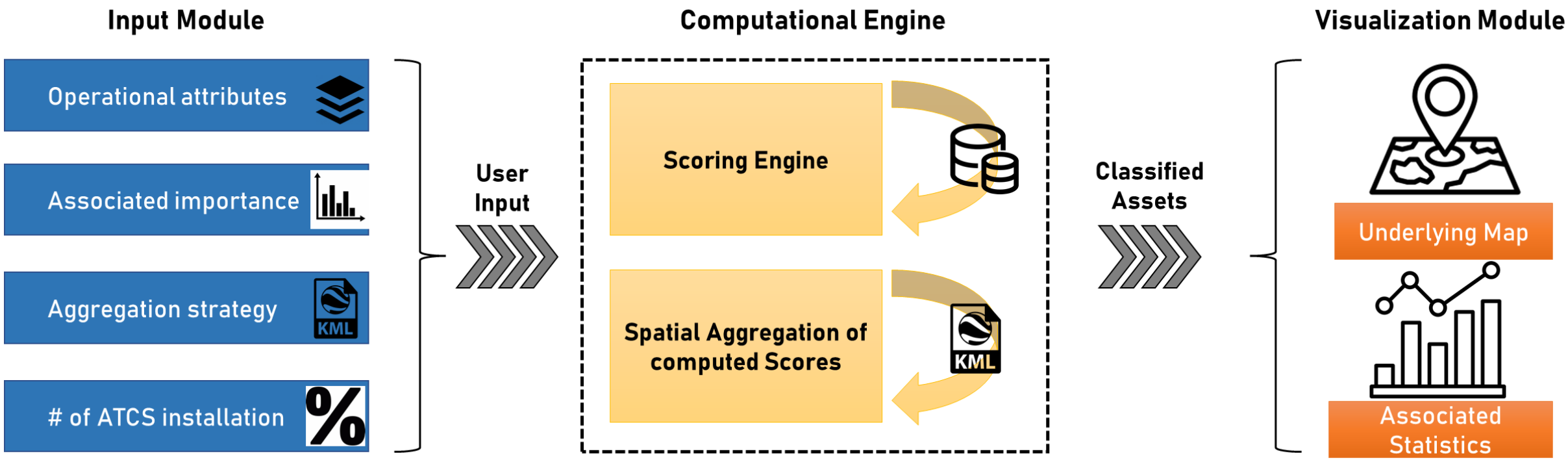
Small polygons



Major corridors



PLATFORM DEVELOPMENT - ARCHITECTURE



Coord-based Signal Timing Parameters

Number of weekday plans
0.67

Number of weekend plans
1.1

Number of Time-Of-Day points over weekdays
0.7

Number of Time-Of-Day points over a weekend
0.9

Weekday - hours that is running free
-0.55

Weekend - hours that is running free
-0.42

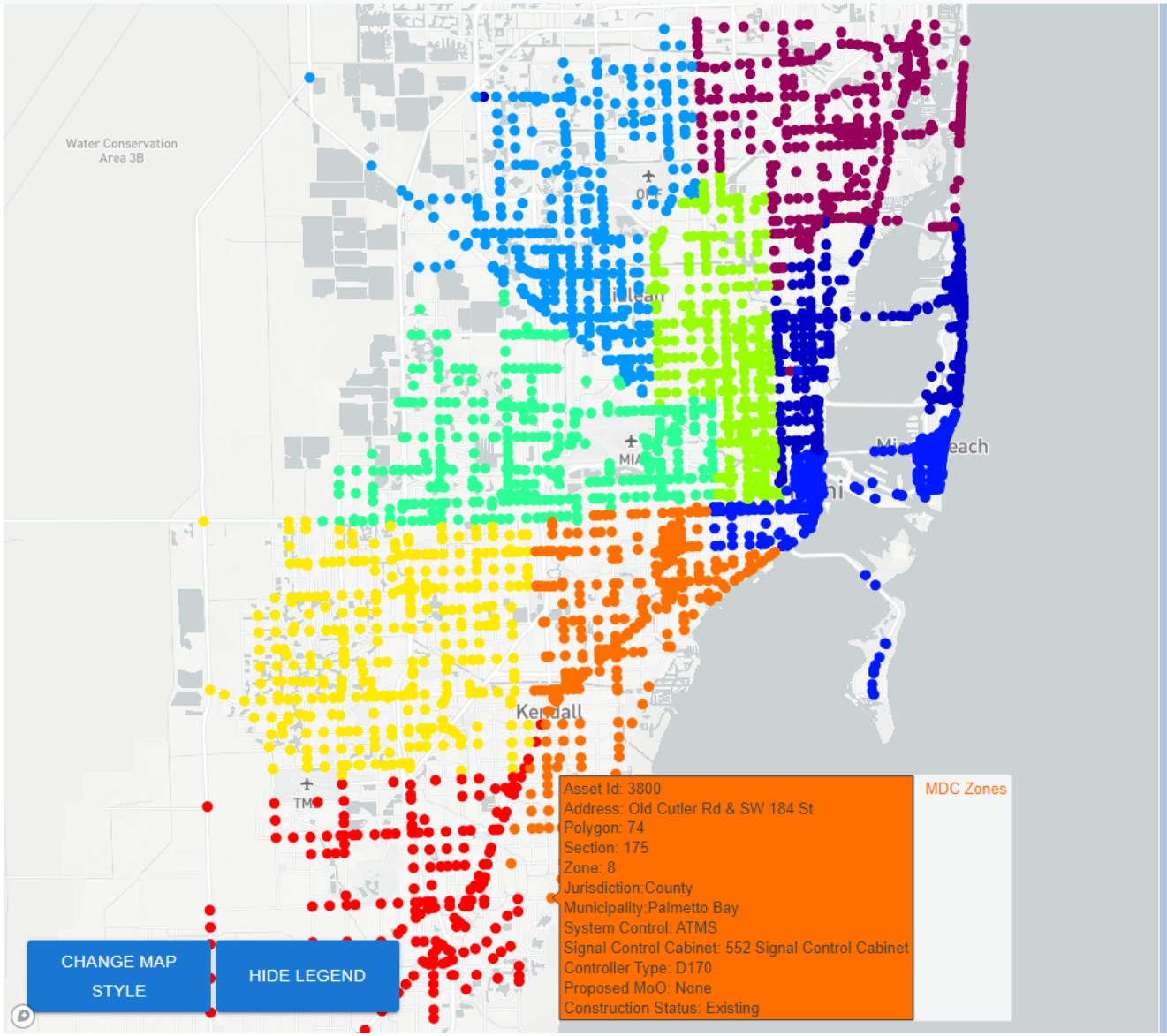
Signal Timing Parameters

Maximum cycle length
0.042

Minimum cycle length
0.7

Number of protected vehicle phases
1.25

Number of pedestrian phases
3.5



NETWORK CHARACTERISTICS
- MDC Zones
- MDC Sections
- MDC Section *(sample)*
- Municipality
- *Jurisdiction*
- State Roads (1132)
- County Roads (1708)
- *Existing System Control*
- *Existing Controller Type*
- D170 (2271)
- D170E (160)
- 2070LX (319)
- Not assigned (90)
- *Existing Cabinet Type*
- 552 SC Cabinet (2657)
- 660 SC Cabinet (113)
- Missing Information (70)

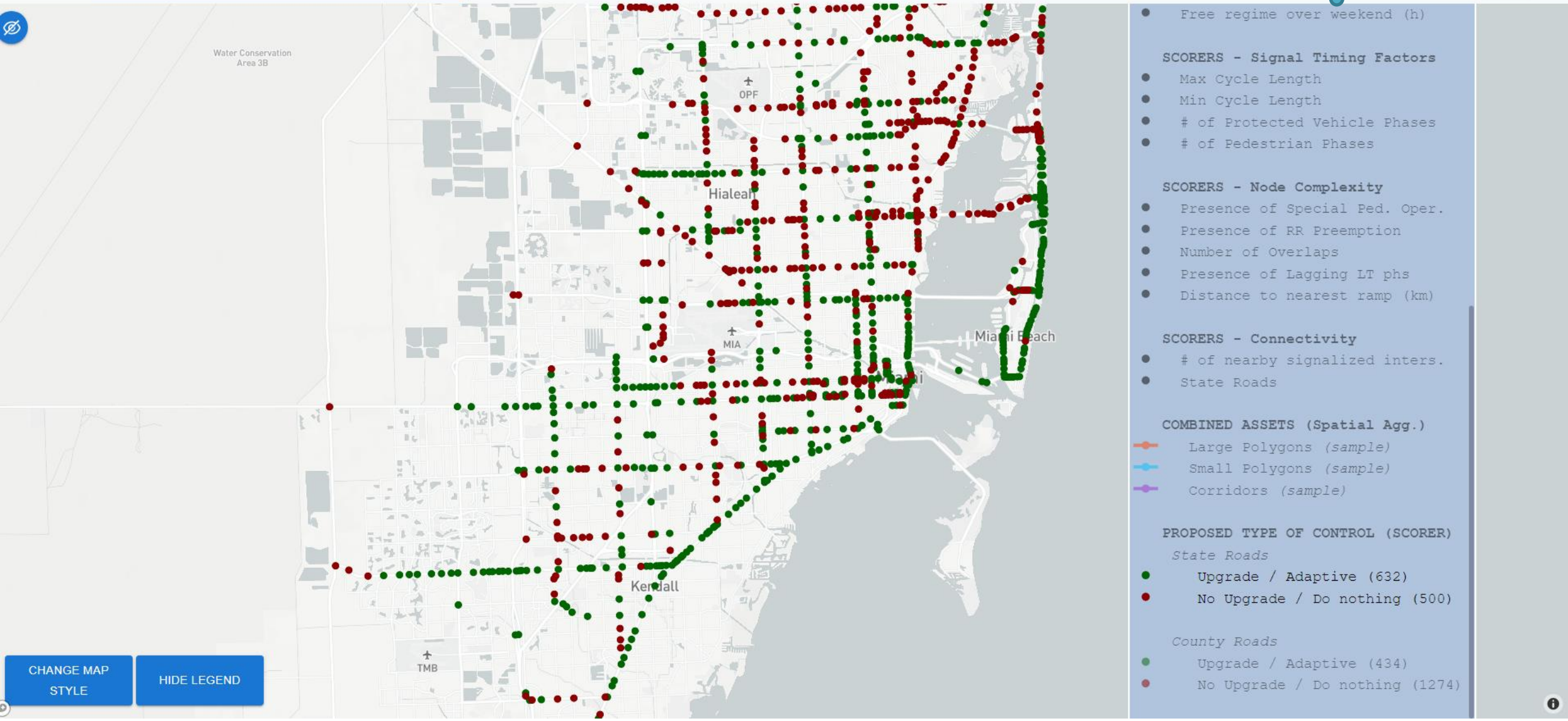
SCORERS - Coordination Factors
- Active Weekday Plans
- Active Weekend Plans
- TOD points over Weekday
- TOD points over Weekend
- Free regime over weekday (h)
- Free regime over weekend (h)

SCORERS - Signal Timing Factors
- Max Cycle Length
- Min Cycle Length
- # of Protected Vehicle Phases
- # of Pedestrian Phases

Zone 9 8 7 6 5 4 3 2 1

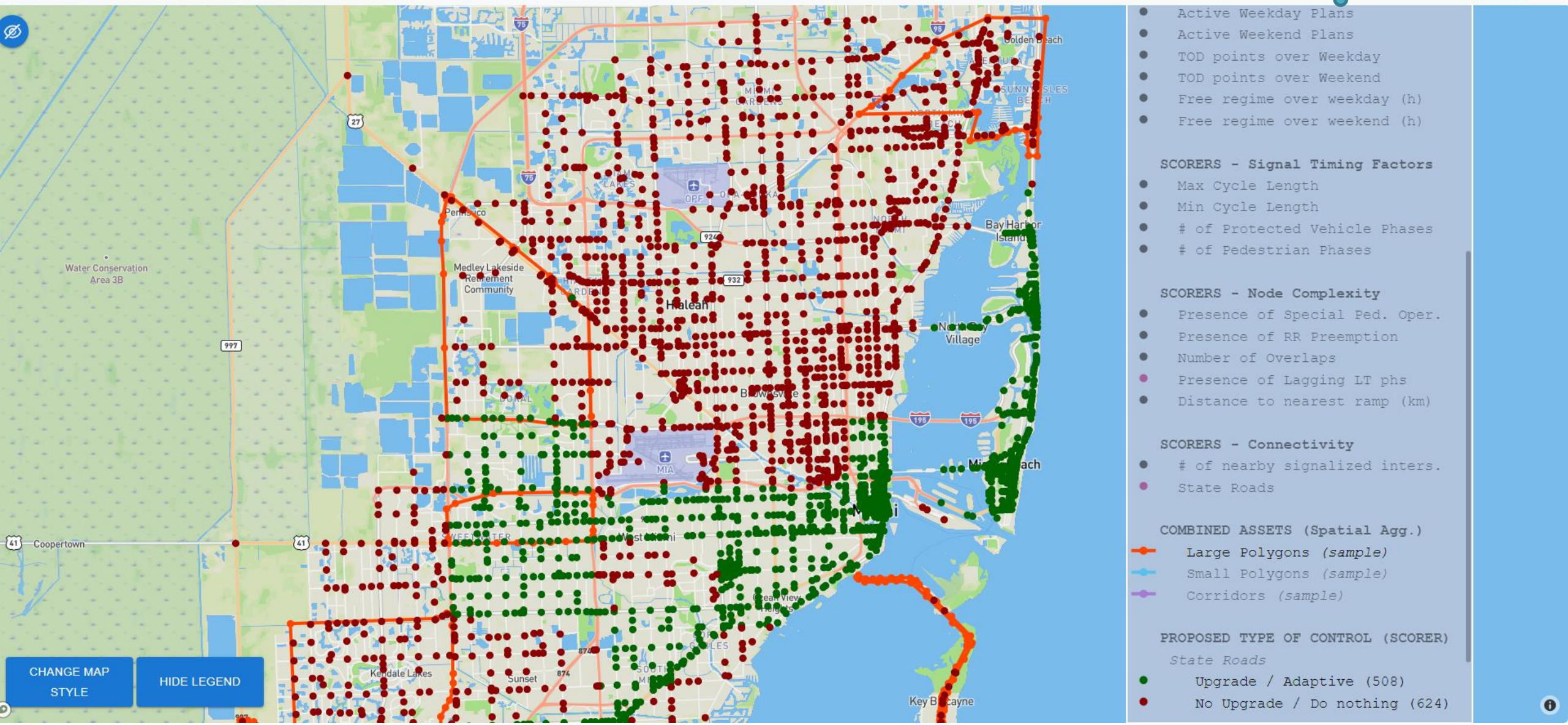
Spatial Integration: Node Level

Selection of the Intersections with Adaptive Traffic Control



Spatial Integration: Polygon Level

Selection of the Intersections with Adaptive Traffic Control



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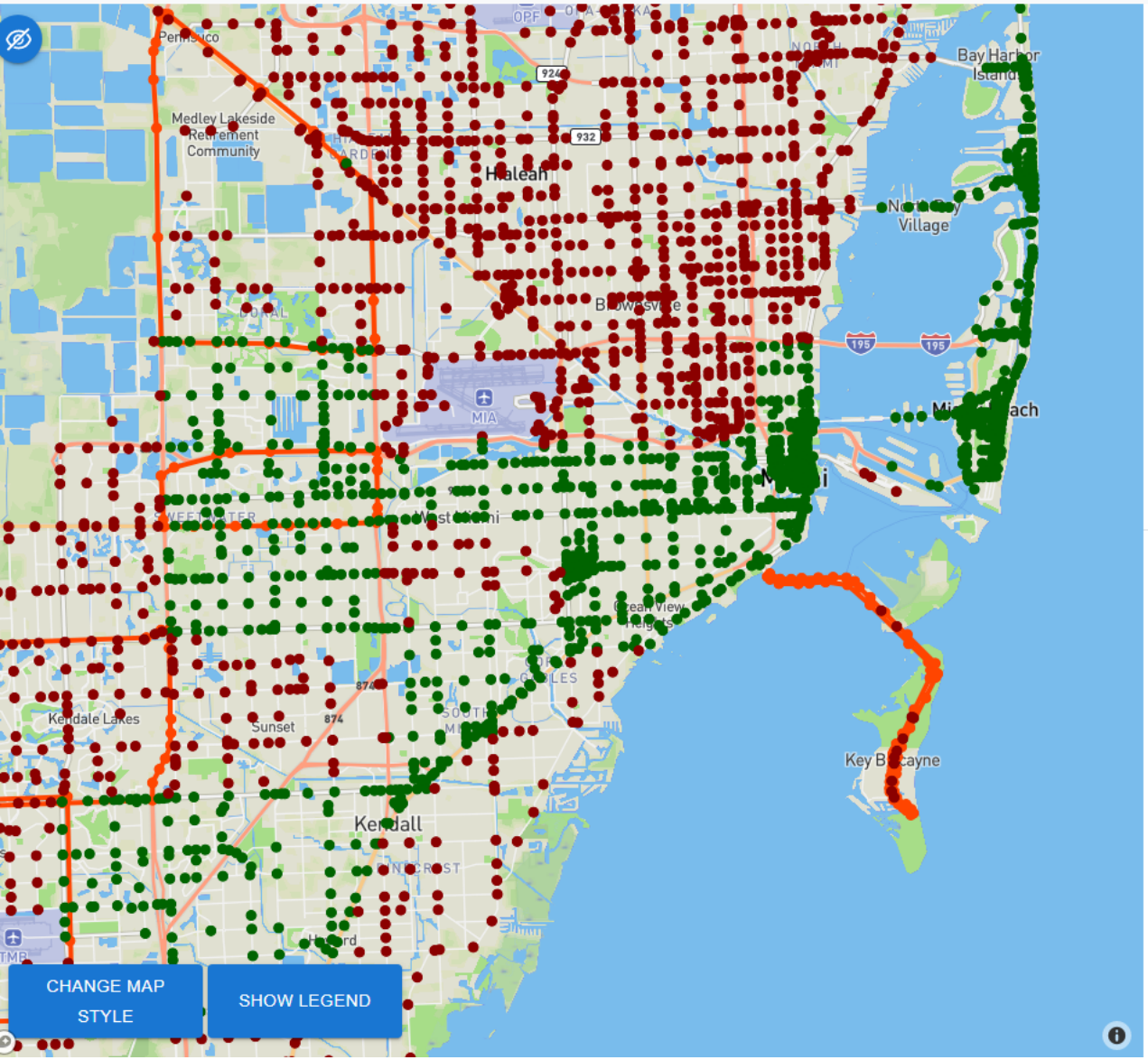
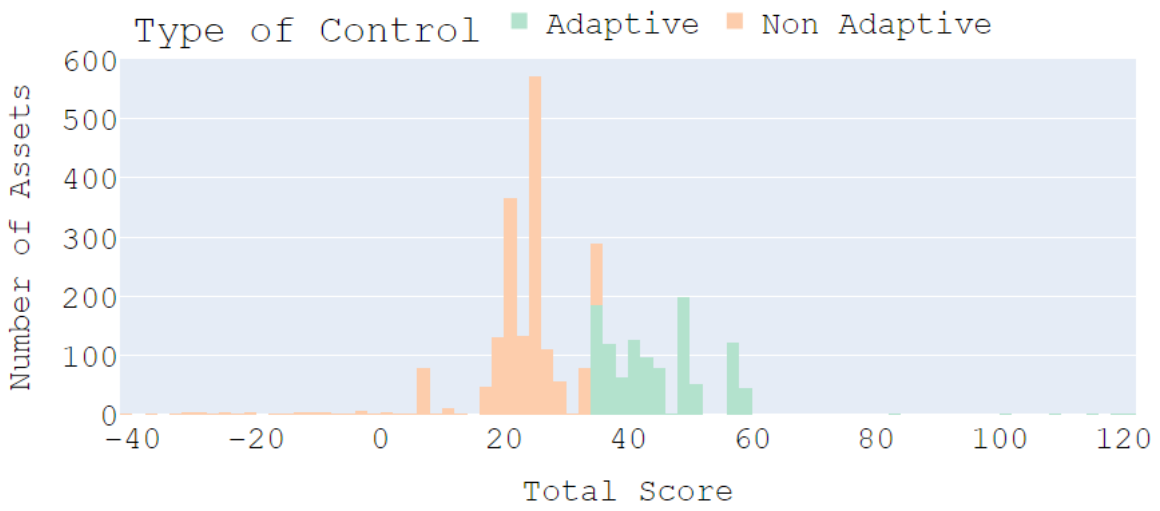
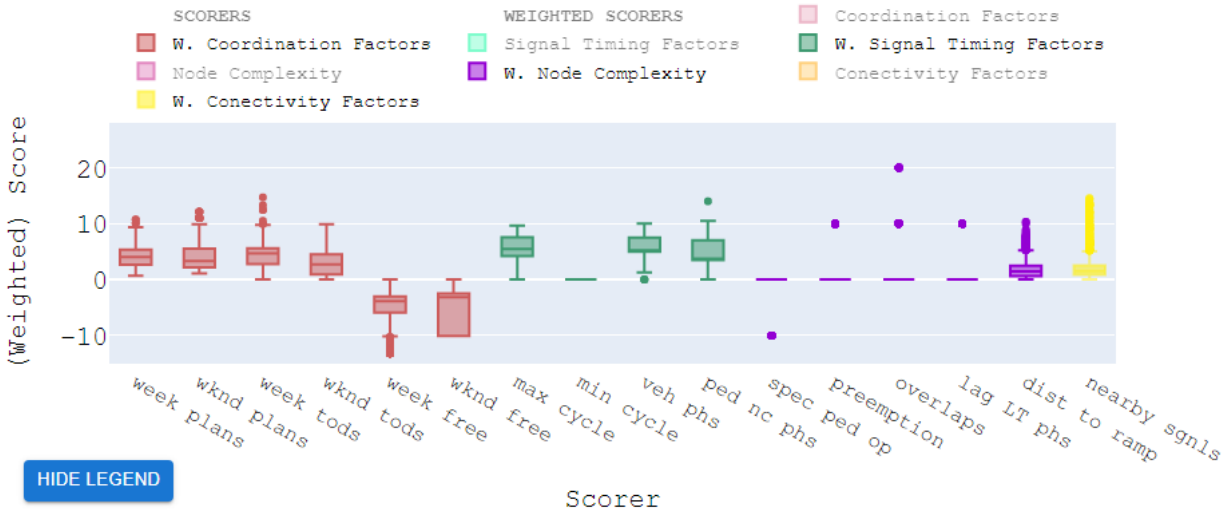






CONCLUSIONS

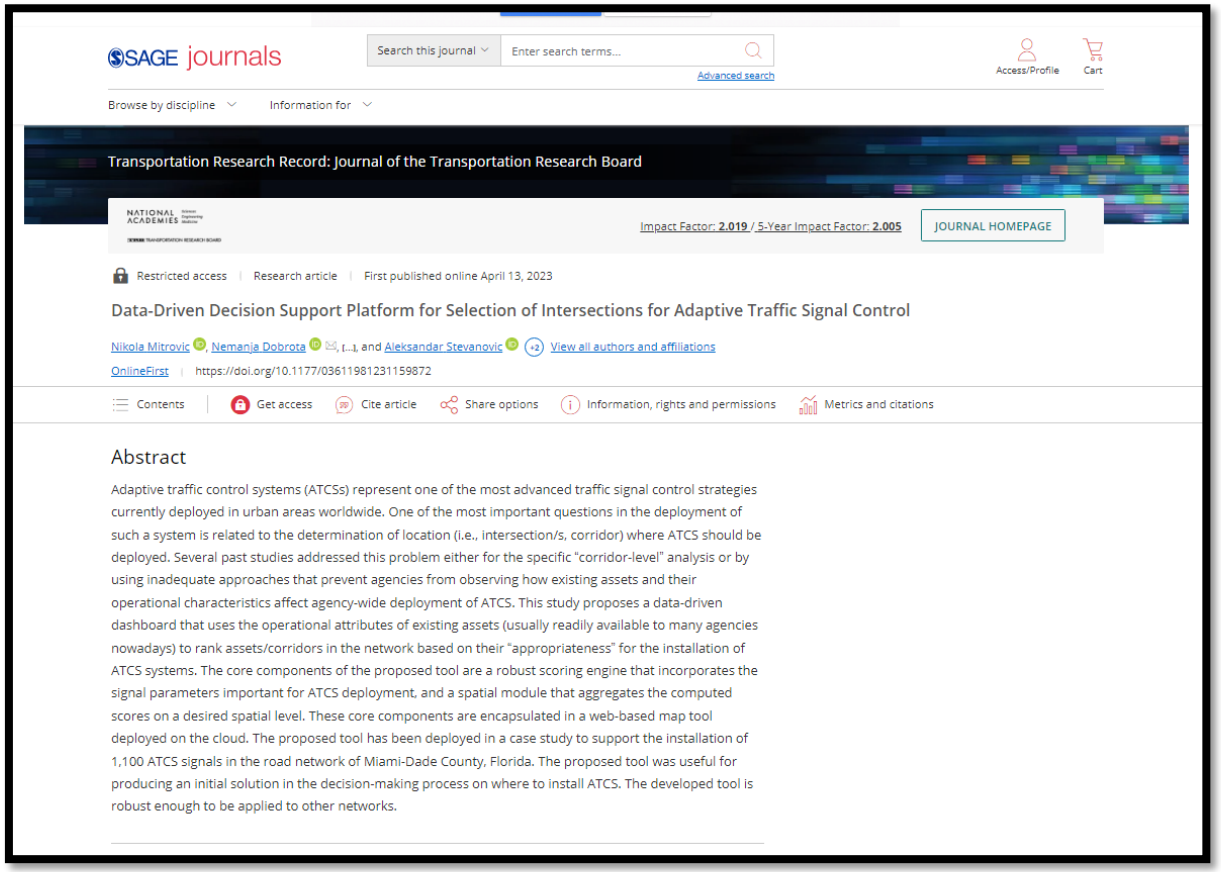
Demonstrated Platform:

- Matches supply *(technology)* and demand *(operational attributes)*
- *Relies on* traditional engineering principles
- Supports decision process by providing (*quick*) initial solution
- Possess robust, flexible & transferable design
- Has been deployed in the Cloud

FUTURE WORK

- Incorporation of **additional operational attributes**
- **Analysis of other use cases** and/or **multiple networks**
- Investigation of **stability** and **robustness** of proposed solutions

TRR PUBLICATION



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Data-Driven Decision Support Platform for Selection of Intersections for Adaptive Traffic Signal Control

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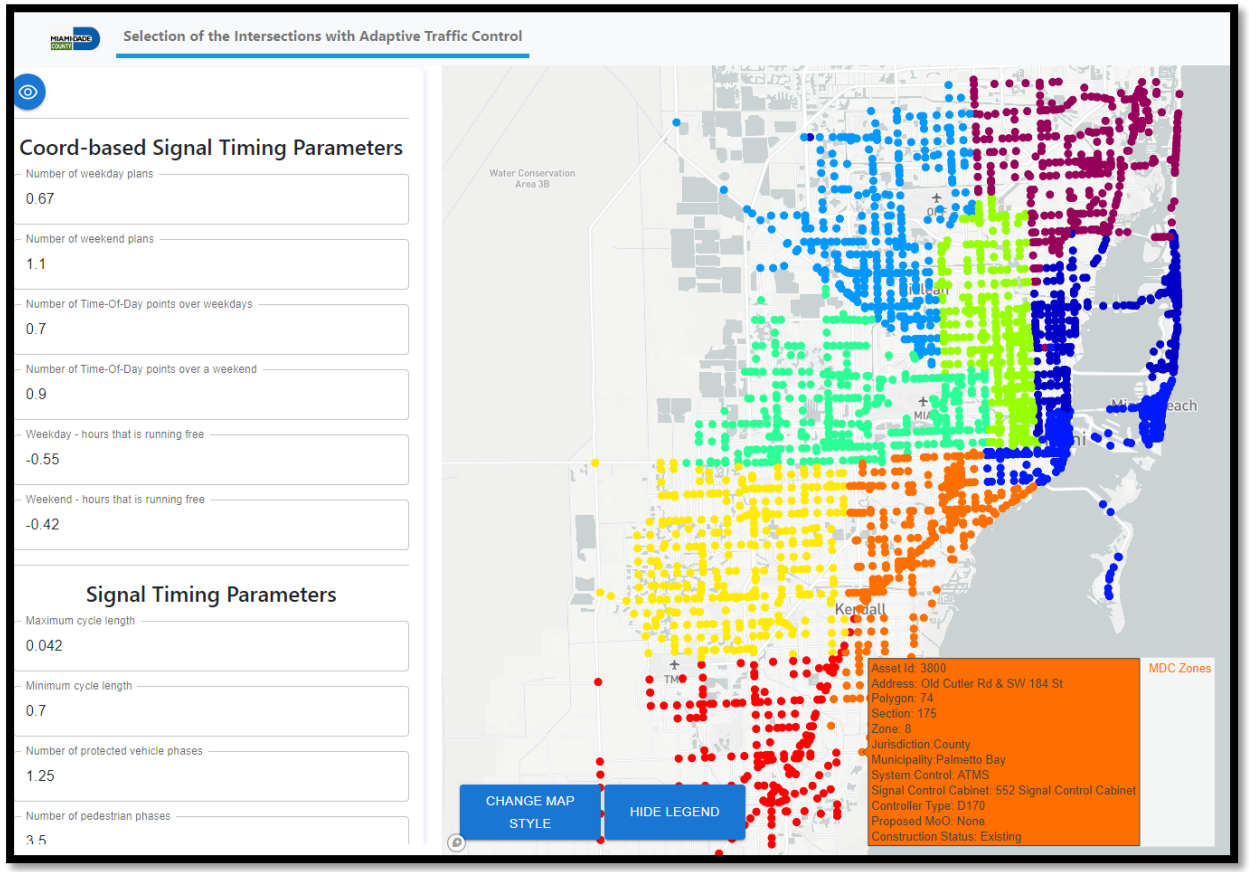
Abstract

Adaptive traffic control systems (ATCSs) represent one of the most advanced traffic signal control strategies currently deployed in urban areas worldwide. One of the most important questions in the deployment of such a system is related to the determination of location (i.e., intersection/s, corridor) where ATCS should be deployed. Several past studies addressed this problem either for the specific "corridor-level" analysis or by using inadequate approaches that prevent agencies from observing how existing assets and their operational characteristics affect agency-wide deployment of ATCS. This study proposes a data-driven dashboard that uses the operational attributes of existing assets (usually readily available to many agencies nowadays) to rank assets/corridors in the network based on their "appropriateness" for the installation of ATCS systems. The core components of the proposed tool are a robust scoring engine that incorporates the signal parameters important for ATCS deployment, and a spatial module that aggregates the computed scores on a desired spatial level. These core components are encapsulated in a web-based map tool deployed on the cloud. The proposed tool has been deployed in a case study to support the installation of 1,100 ATCS signals in the road network of Miami-Dade County, Florida. The proposed tool was useful for producing an initial solution in the decision-making process on where to install ATCS. The developed tool is robust enough to be applied to other networks.

*CLOUD SOLUTION**



Selection of the Intersections with Adaptive Traffic Control

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Weekday - hours that is running free: -0.55

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Signal Timing Parameters

Maximum cycle length: 0.042

Minimum cycle length: 0.7

Number of protected vehicle phases: 1.25

Number of pedestrian phases: 3.5

Water Conservation Area 3B

Kendall

Asset Id: 3800
Address: Old Cutler Rd & SW 184 St
Polygon: 74
Section: 175
Zone: 8
Jurisdiction County
Municipality Palmetto Bay
System Control: ATMS
Signal Control Cabinet: 552 Signal Control Cabinet
Controller Type: D170
Proposed MoO: None
Construction Status: Existing

MDC Zones

CHANGE MAP STYLE | HIDE LEGEND

FOR CREDENTIALS PLEASE CONTACT NMITROVIC@CHACOMPANIES.COM

Thank You!

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BACKGROUND - TMC OPERATIONS

METHODOLOGY -SPATIAL AGGREGATION