



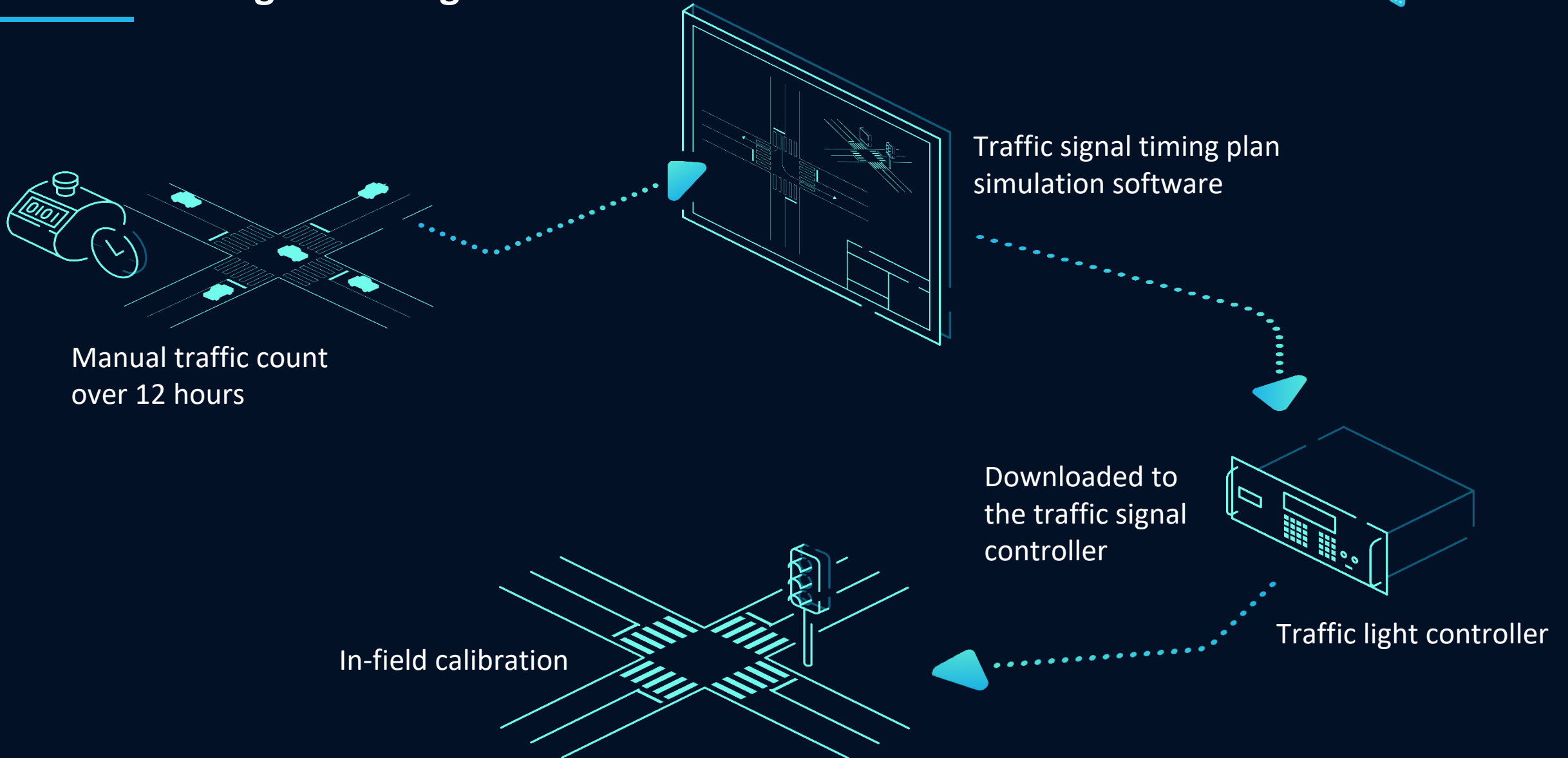
Using Artificial Intelligence in Adaptive Signal Control

OCTOBER 2022

Justin Effinger, PE

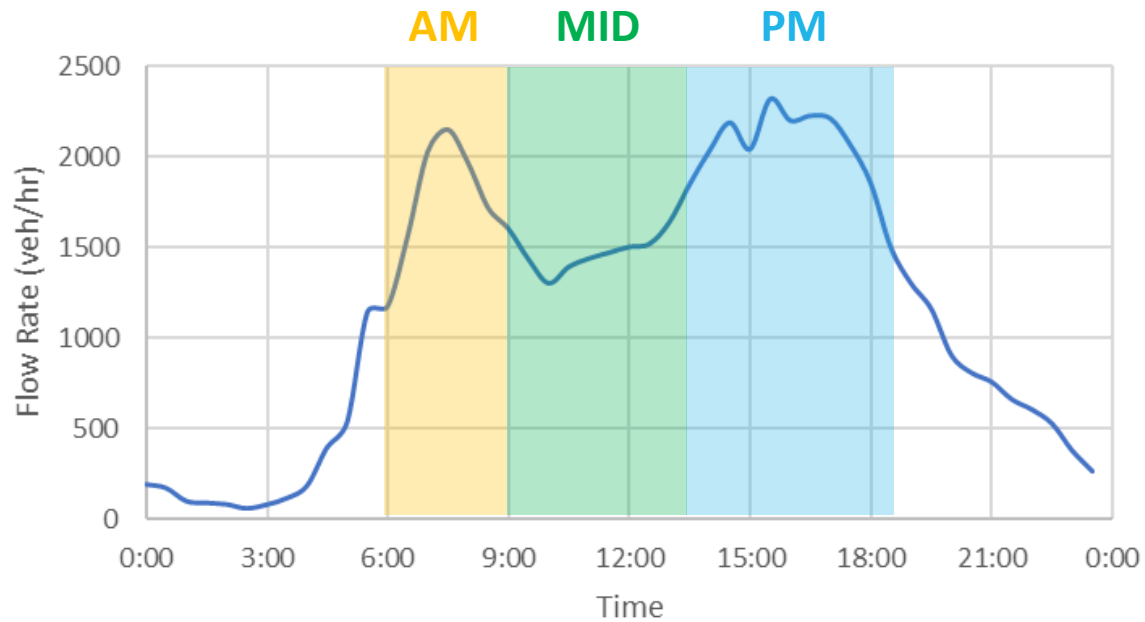
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Traditional Signal Timing



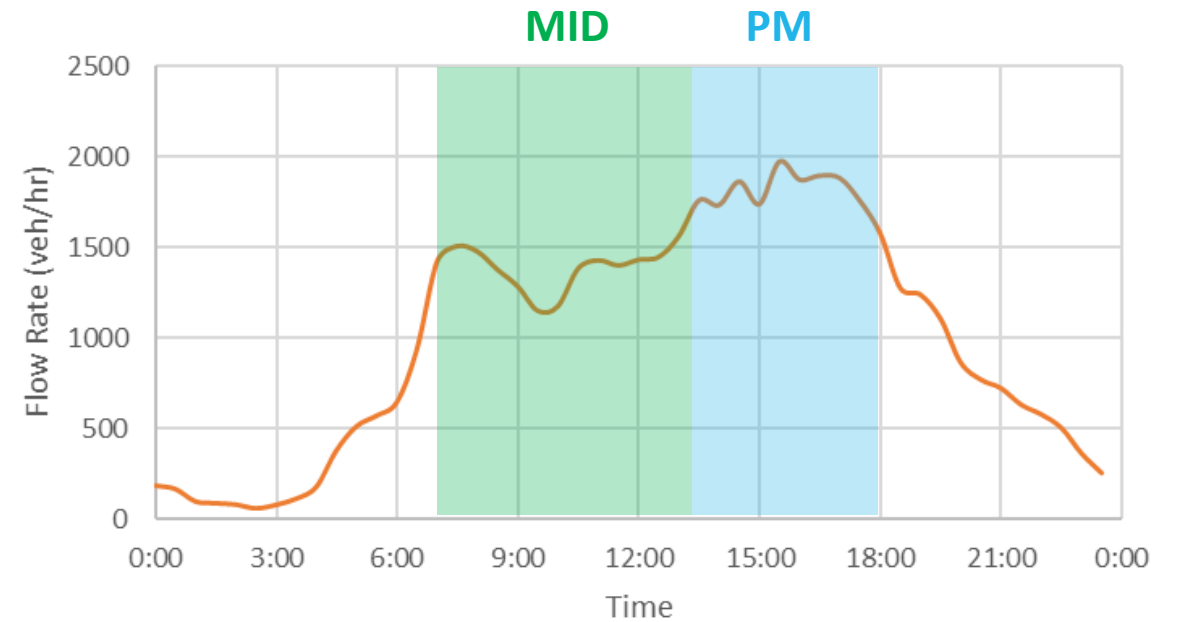
Time of Day Signal Timing

Mainline Flow Rate

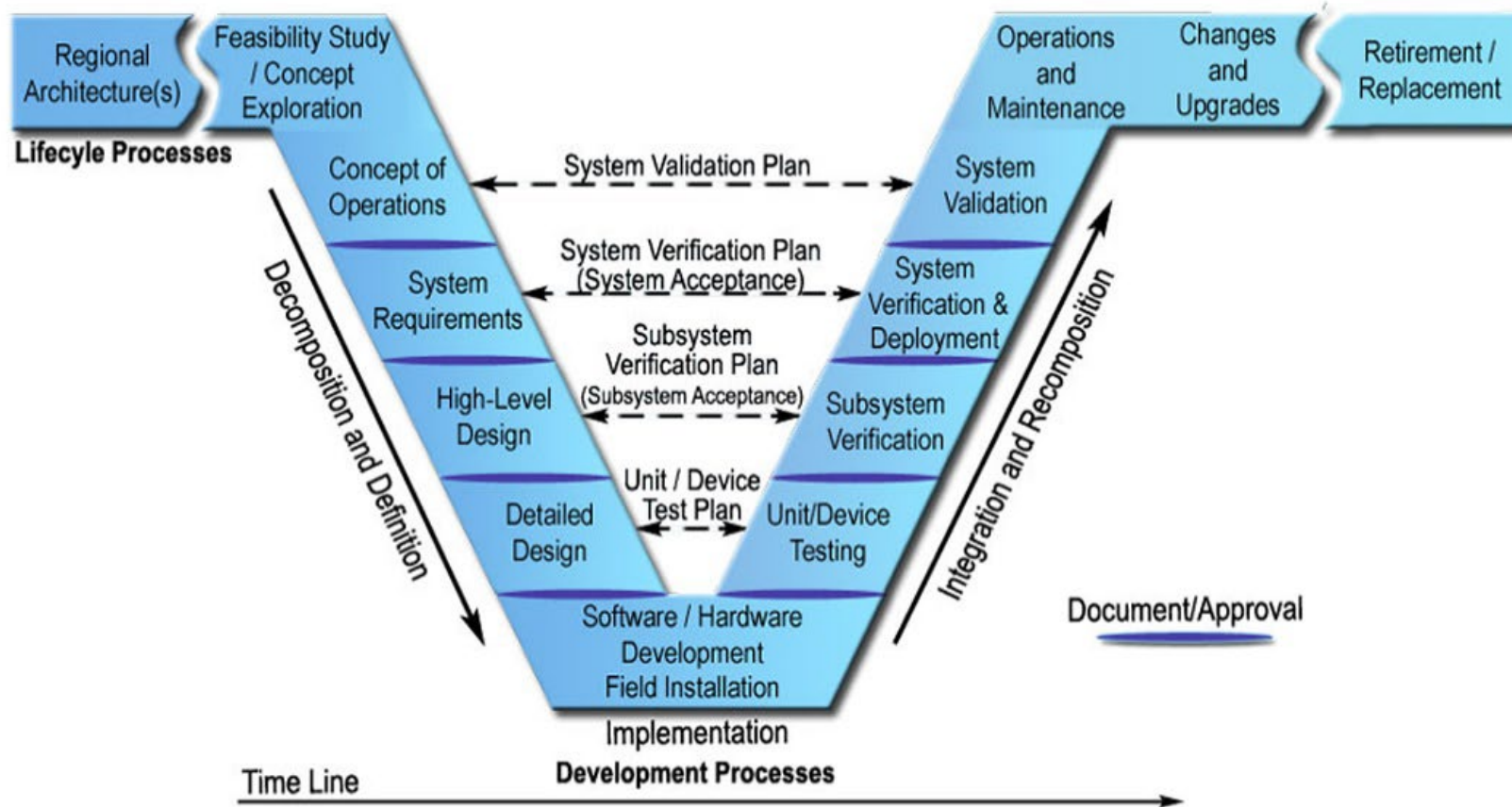


Traffic Responsive

Mainline Flow Rate



Picking pre-determined timing plans based on traffic volumes



Picking Objectives

- › Smooth flow
- › Maximize throughput
- › Access equity
- › Manage queues
- › Variable objectives
- › Linking objectives to circumstances

**Adjustments of coordination settings
(cycles, splits and offsets)**



Human-like Intelligence
To Perform Tasks **Like Us.**



Artificial Intelligence Products

Virtual
Assistant



Smart
Car



Artificial Intelligence



PRIVATE CAR
10MPH



Machine Learning

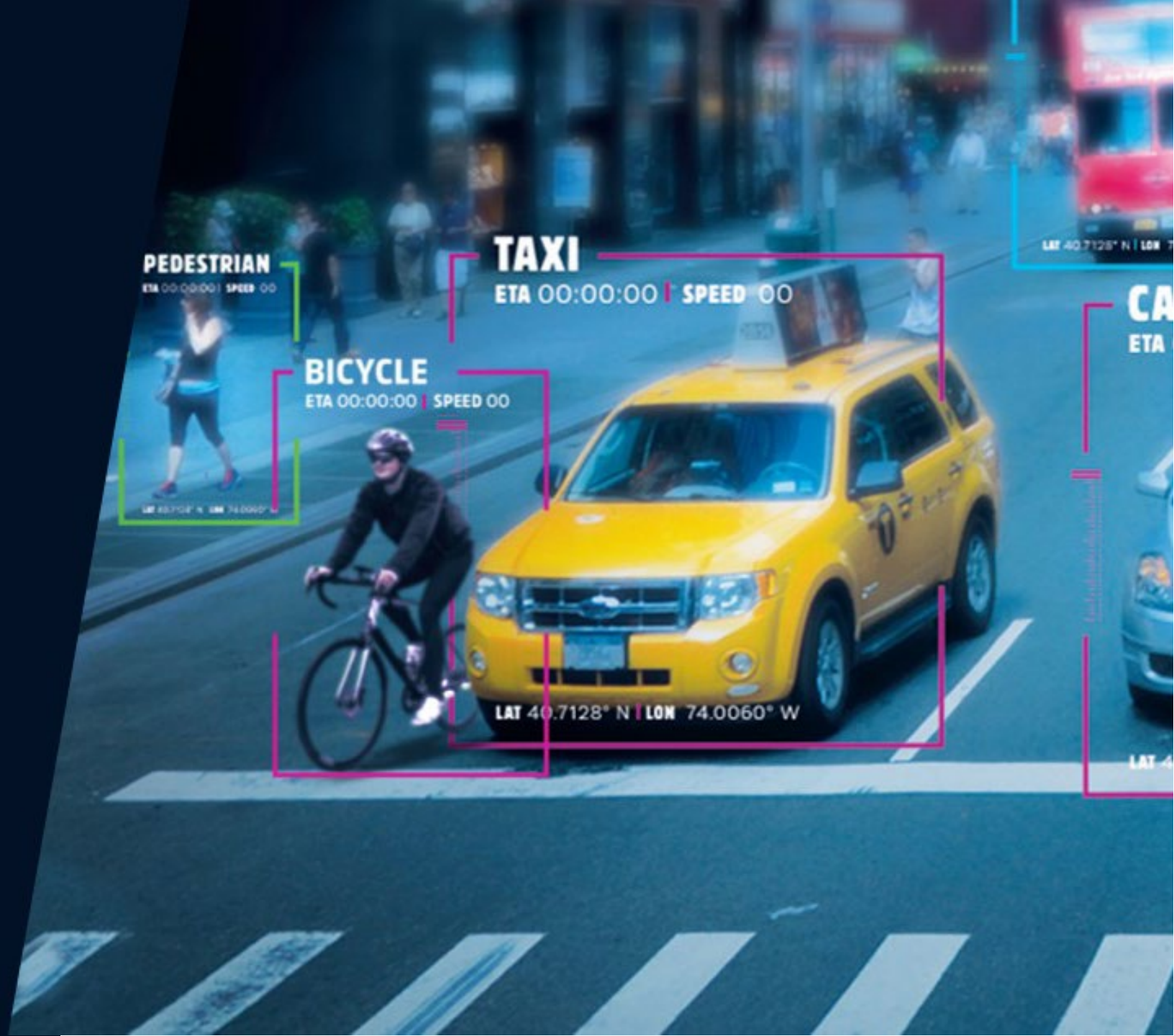
Extracting features.
A technique to achieve AI

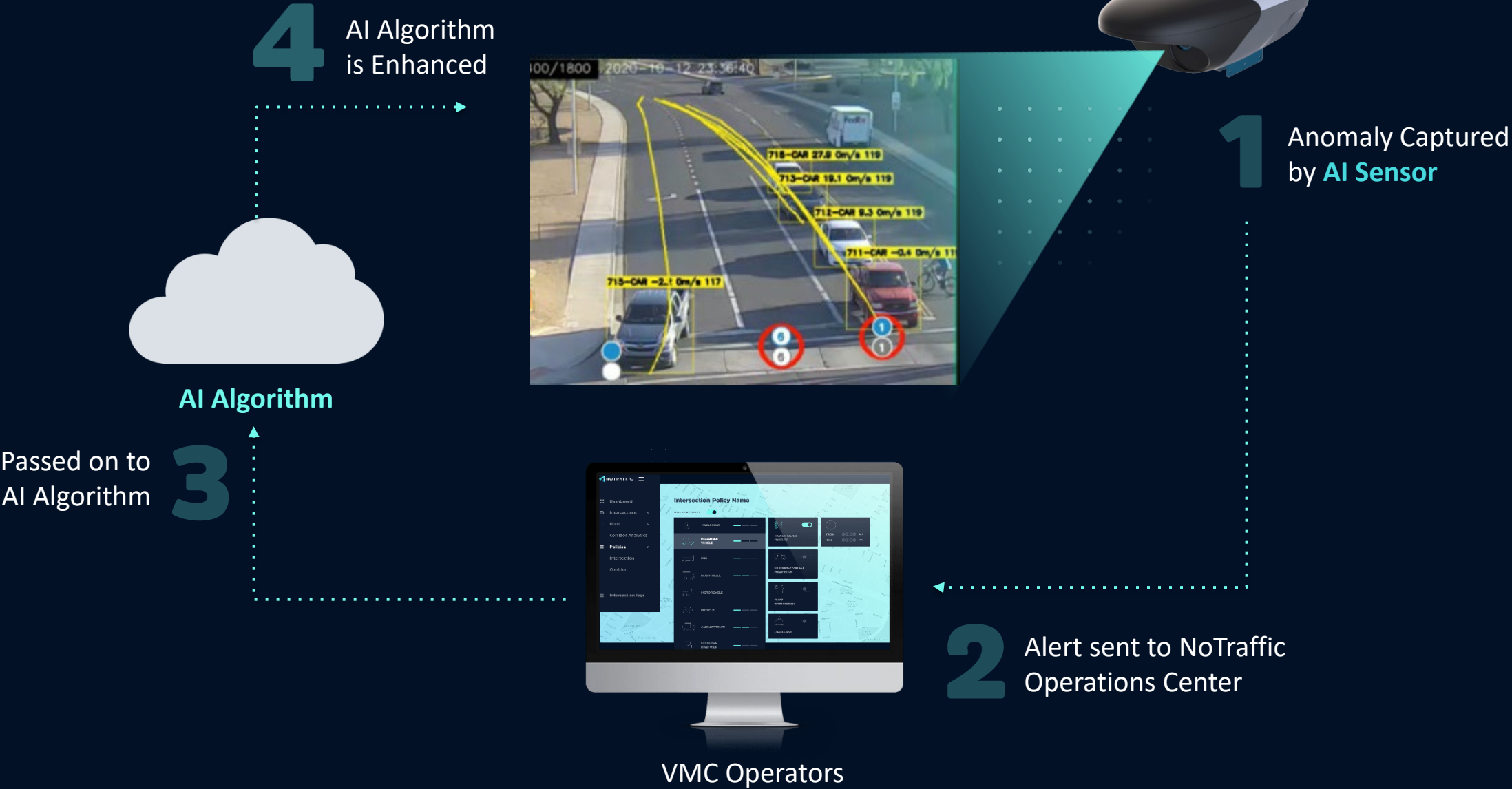
Deep Learning

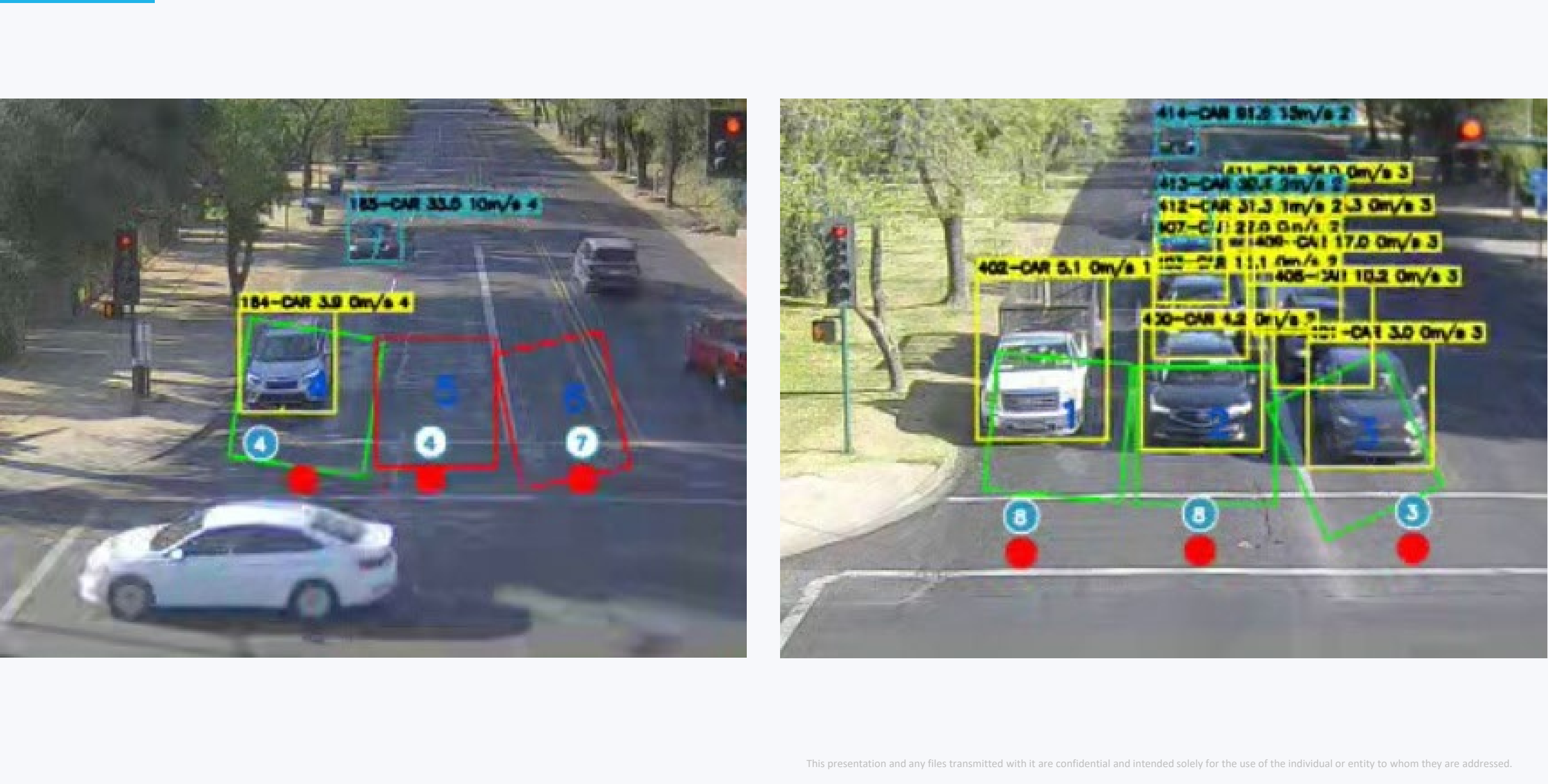
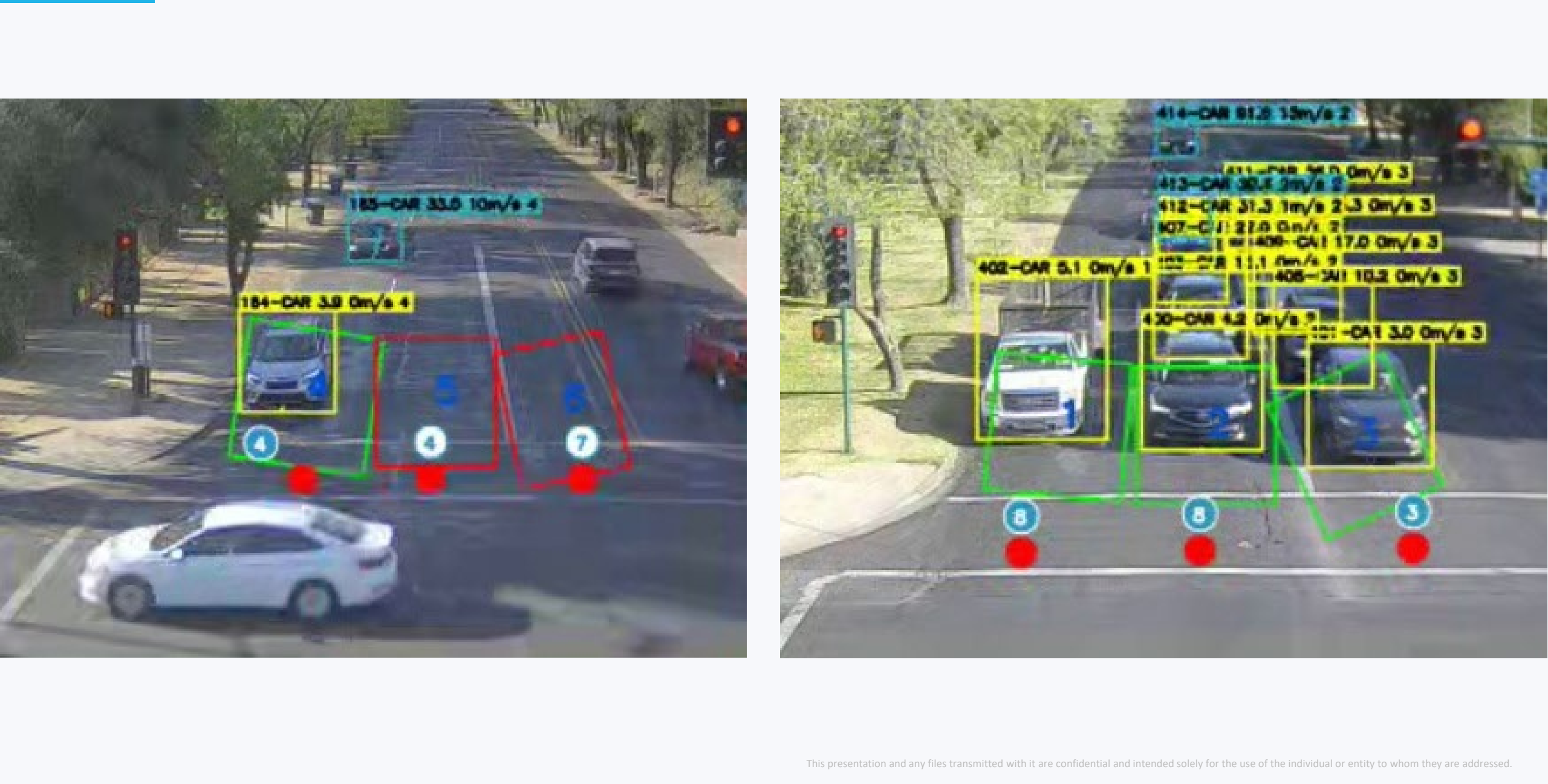
Is a subset of machine learning. System learns all of the features

Natural Language Processing (NLP)

Converting human language to computer language









Optimization

Core Algorithm For Traffic
Lights Grid Digitalization



Local Data

NoTraffic Sensors,
running advance
computer vision
algorithms



Operator's Policy

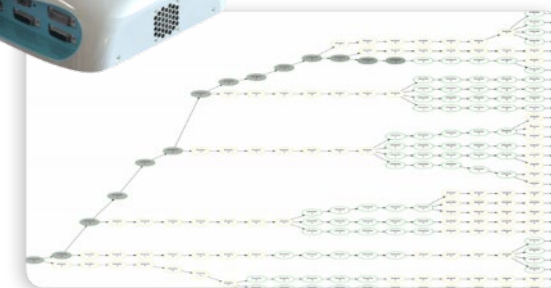


Safety Constraints

(Via cloud based, real-time
meso simulation algorithm)

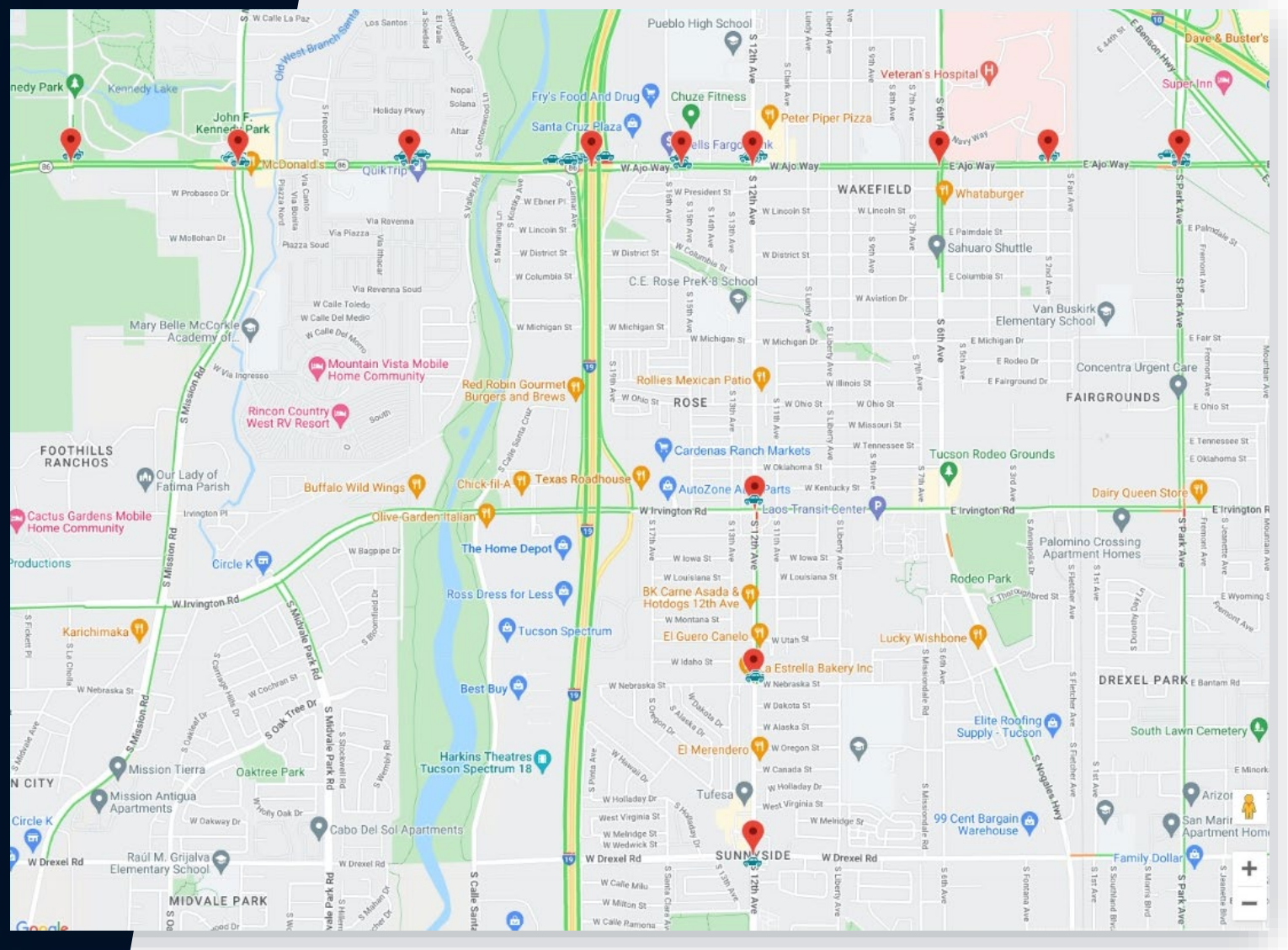


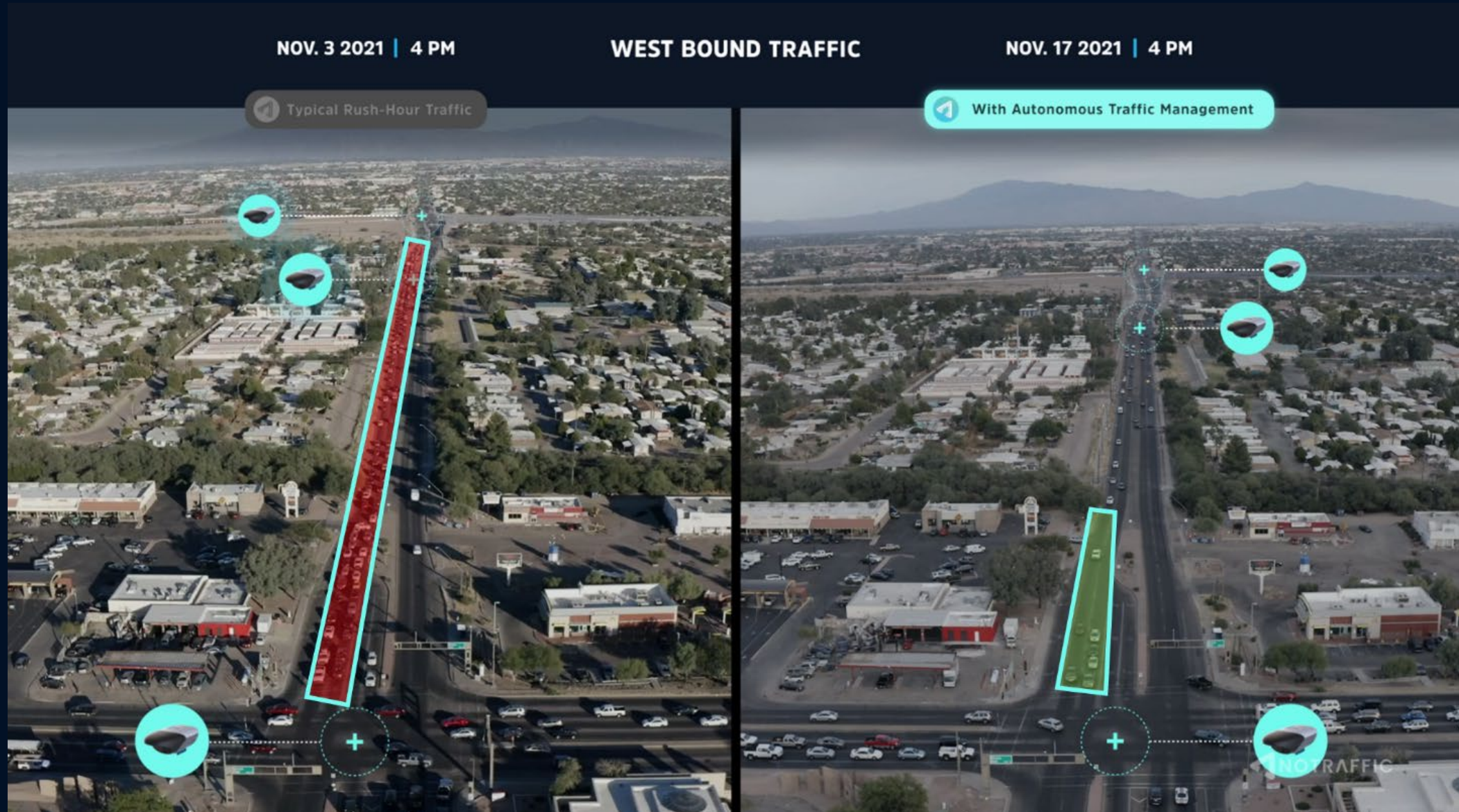
Grid Data



Optimal decision is
sent to the legacy
traffic light controller

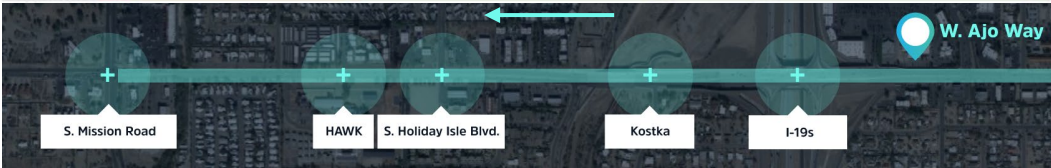
Tucson, AZ





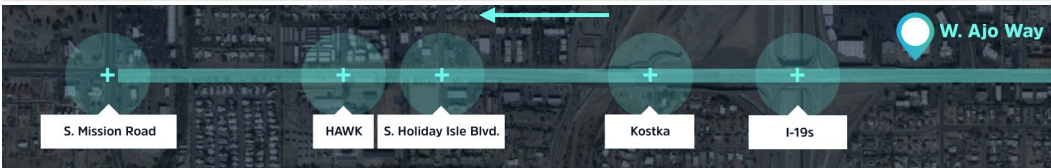
Before Average Queue length
between 3pm and 6:30pm

15:00:00	3	3	1	0	0
15:05:00	3	2	1	0	0
15:10:00	3	3	3	0	0
15:15:00	3	3	2	0	0
15:20:00	3	3	3	0	0
15:25:00	3	3	3	2	0
15:30:00	3	3	3	2	1
15:35:00	3	3	3	2	0
15:40:00	3	3	2	2	0
15:45:00	3	3	3	2	0
15:50:00	3	3	3	2	0
15:55:00	3	3	2	1	0
16:00:00	3	3	3	2	0
16:05:00	3	3	3	2	0
16:10:00	3	3	3	3	0
16:15:00	3	3	3	2	0
16:20:00	3	3	3	3	0
16:25:00	3	3	3	3	0
16:30:00	3	3	3	2	1
16:35:00	3	3	3	2	1
16:40:00	3	3	3	3	0
16:45:00	3	3	3	2	1
16:50:00	3	3	3	3	0
16:55:00	3	3	3	3	1
17:00:00	3	3	3	3	0
17:05:00	3	3	2	2	0
17:10:00	3	3	3	2	1
17:15:00	3	3	2	2	1
17:20:00	3	3	3	2	1
17:25:00	3	3	3	2	1
17:30:00	3	3	3	2	1
17:35:00	3	3	3	3	1
17:40:00	3	3	3	3	1
17:45:00	3	3	3	2	1
17:50:00	3	3	2	1	1
17:55:00	3	3	3	1	1
18:00:00	3	3	3	2	1
18:05:00	3	3	3	1	1
18:10:00	3	3	3	1	1
18:15:00	3	3	2	1	1
18:20:00	3	3	1	1	1
18:25:00	3	2	1	1	1

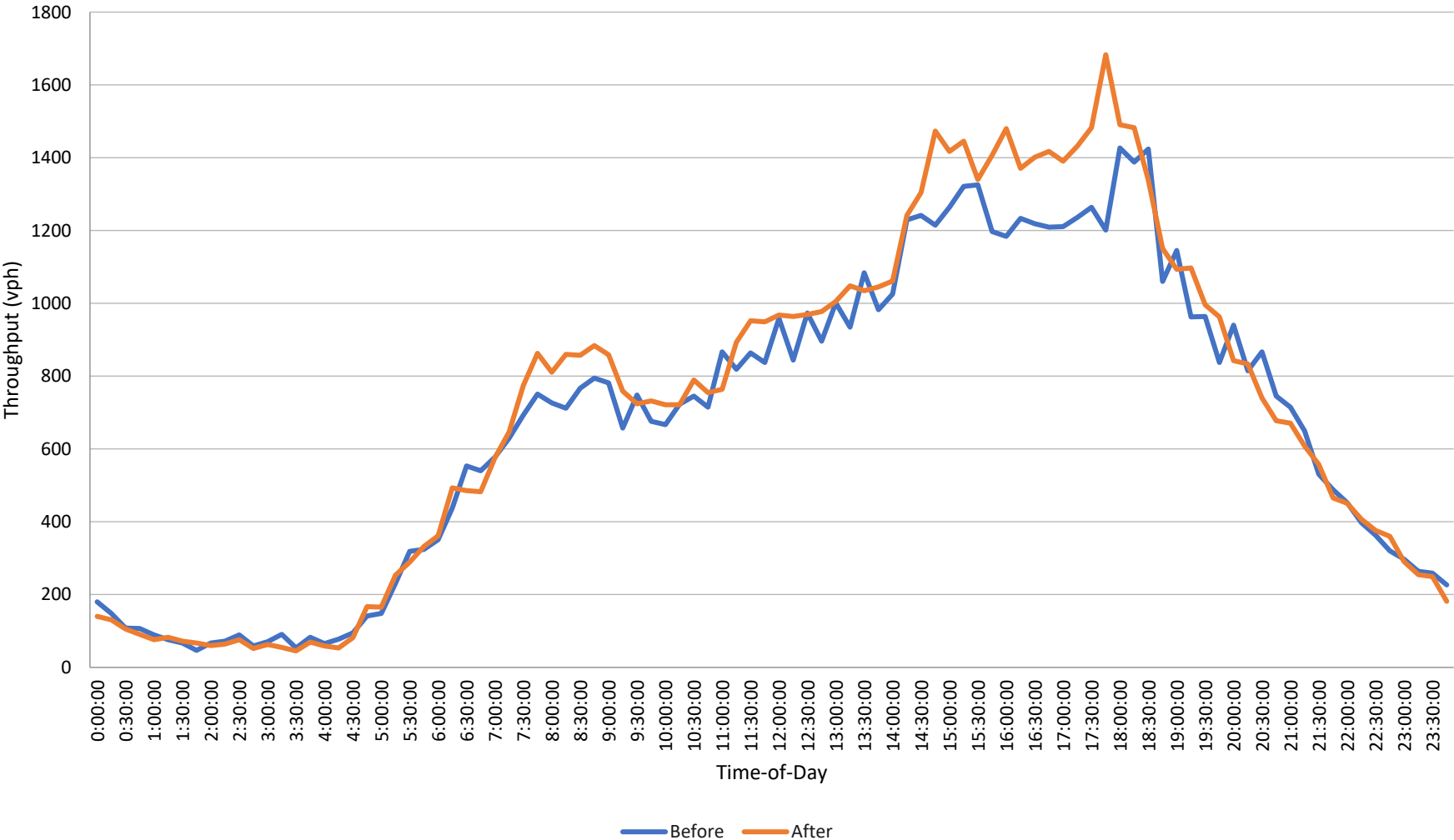


After Average Queue length
between 3pm and 6:30pm

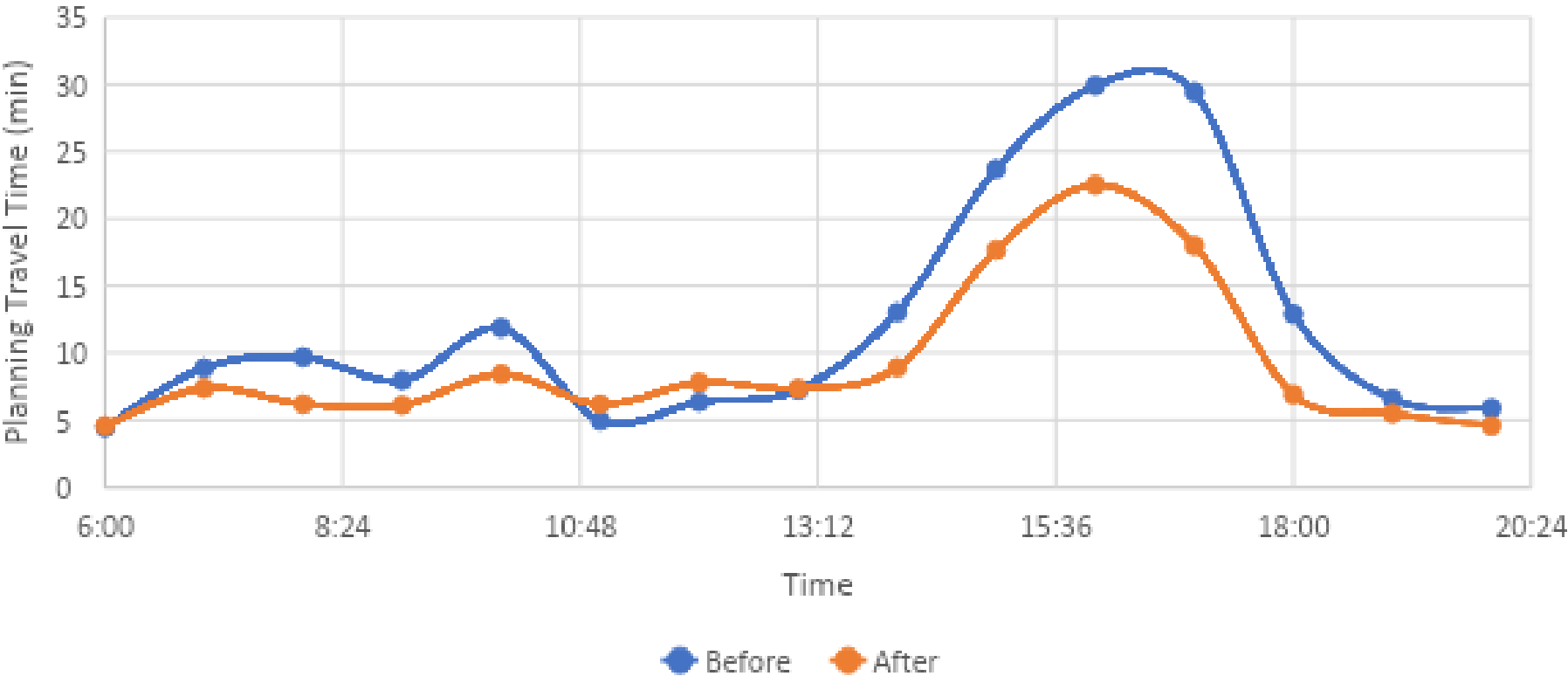
15:00:00	3	1	0	0	0
15:05:00	3	1	0	0	0
15:10:00	3	1	1	0	0
15:15:00	3	2	1	0	0
15:20:00	3	3	1	0	0
15:25:00	3	2	2	0	0
15:30:00	3	3	3	1	0
15:35:00	3	2	1	1	0
15:40:00	3	3	1	1	0
15:45:00	3	3	1	1	0
15:50:00	3	3	3	1	0
15:55:00	3	2	2	1	0
16:00:00	3	2	1	0	0
16:05:00	3	2	2	0	0
16:10:00	3	2	2	0	0
16:15:00	3	3	2	0	0
16:20:00	3	2	2	0	0
16:25:00	3	2	1	0	0
16:30:00	3	2	2	0	0
16:35:00	3	2	2	1	0
16:40:00	3	2	1	1	0
16:45:00	3	2	1	1	0
16:50:00	3	2	2	0	0
16:55:00	3	2	1	1	0
17:00:00	3	2	2	1	0
17:05:00	3	2	2	0	0
17:10:00	3	2	2	0	0
17:15:00	3	2	1	0	0
17:20:00	3	2	1	0	0
17:25:00	3	2	1	0	0
17:30:00	3	3	3	1	0
17:35:00	3	3	3	2	0
17:40:00	3	3	2	1	0
17:45:00	3	3	2	0	0
17:50:00	3	2	1	0	0
17:55:00	3	1	0	0	0
18:00:00	3	1	0	0	0
18:05:00	3	0	0	0	0
18:10:00	2	0	0	0	0
18:15:00	3	0	0	0	0
18:20:00	2	0	0	0	0
18:25:00	2	0	0	0	0



Throughput, WB Full Approach



Corridor 1: WB Planning Travel Time



Summary at Ajo/Mission:

- › Decreased delay
- › Increased throughput
- › Decreased travel time
- › Decreased queue length



PM PEAK:

**63% Delay
Decrease**



**Annualized Hours
of Delay Reduction:**

57,947



**Annualized
Economic Benefits:**

\$1.5M



**Annualized Enviromental
Benefits:**

**952 Metric Tons
CO₂ Reduced**



**Benefits to Cost
Ratio:**

27 to 1



Thank You

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