Connected Corridors
Face-to-Face Meeting

Tuesday, August 6th , 2019
1:30 – 3:30 pm
Pasadena

Agenda

- **1:30 - 2:00 – Program Review**
- **2:00 - 2:20 – Call for Projects Update**
- **2:20 – 2:50 – Cal Poly Presentation**
- **2:50 – 3:20 – Response Plan Metrics**
- **3:20 - 3:30 – Closing**
  - Next Meeting at Monrovia – Tuesday September 17th
  - (Monrovia, Duarte, Caltrans, County, Arcadia, Pasadena)

MAHMOUD HAJJAR - Corridor Manager

Mahmoud graduated with a Bachelor of Science Degree in Civil Engineering from the University of Oklahoma in 1981. After graduation, Mahmoud worked in the private sector as a Geotechnical Engineer.

He began his career with Caltrans District 7 in 1990 in the Division of Construction, where he worked as a Resident Engineer performing Construction Management. He joined the Division of Traffic Operations in 1995 as a lead engineer

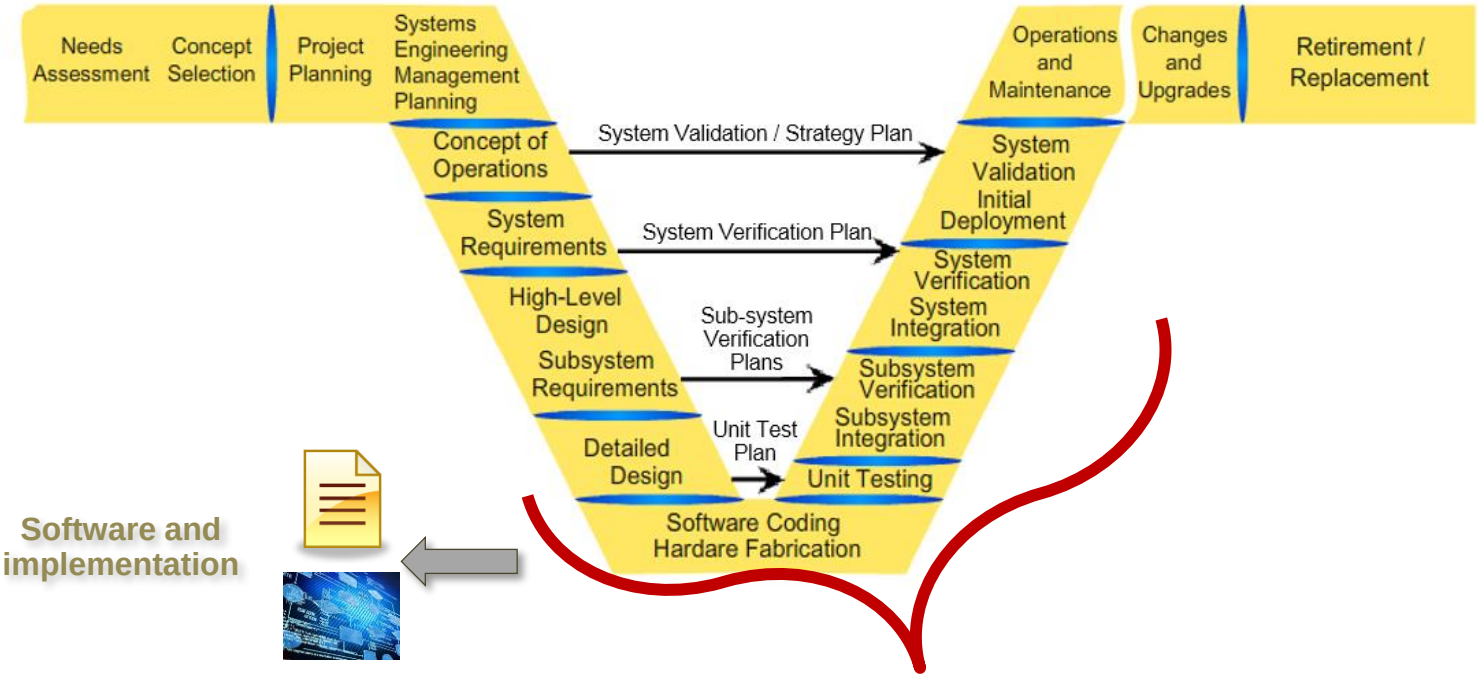
Mahmoud lives in San Dimas with his wife and three daughters.

Schedule Discussion – System Testing

- **We anticipate system launch in the second half of next year**
  - Goal – Ready for the ITS World Congress in LA in October 2020
- **We anticipate system testing starting in January**
  - All C2C interfaces (sans McCain) completed in October
  - ATMS upgrade moved to production end of August
  - Testing of ability to set plans on bench controllers in September
  - Ability to generate response plans in November based on input from ATMS
  - Kapsch initial release ready in December
  - System testing in January
  - Possible production testing on selected routes where ITS elements are available in first/second quarter 2020

Systems Engineering Next Steps

- Design Documents – Details of interfaces and implementations
- Hardware/Software – Building the system
- Integration – Subsystems will come on line this year



Summary

Freeway Data Quality

- **Core I-210 sensor availability recovered from 19-day outage**
- **Great results at this time**

I-210 PM 22.6 - 25
EB 80.0% --- good
WB 92.9% --- great

I-210 PM 25 - 43.25
EB 92.7% --- great
WB 95.8% --- great

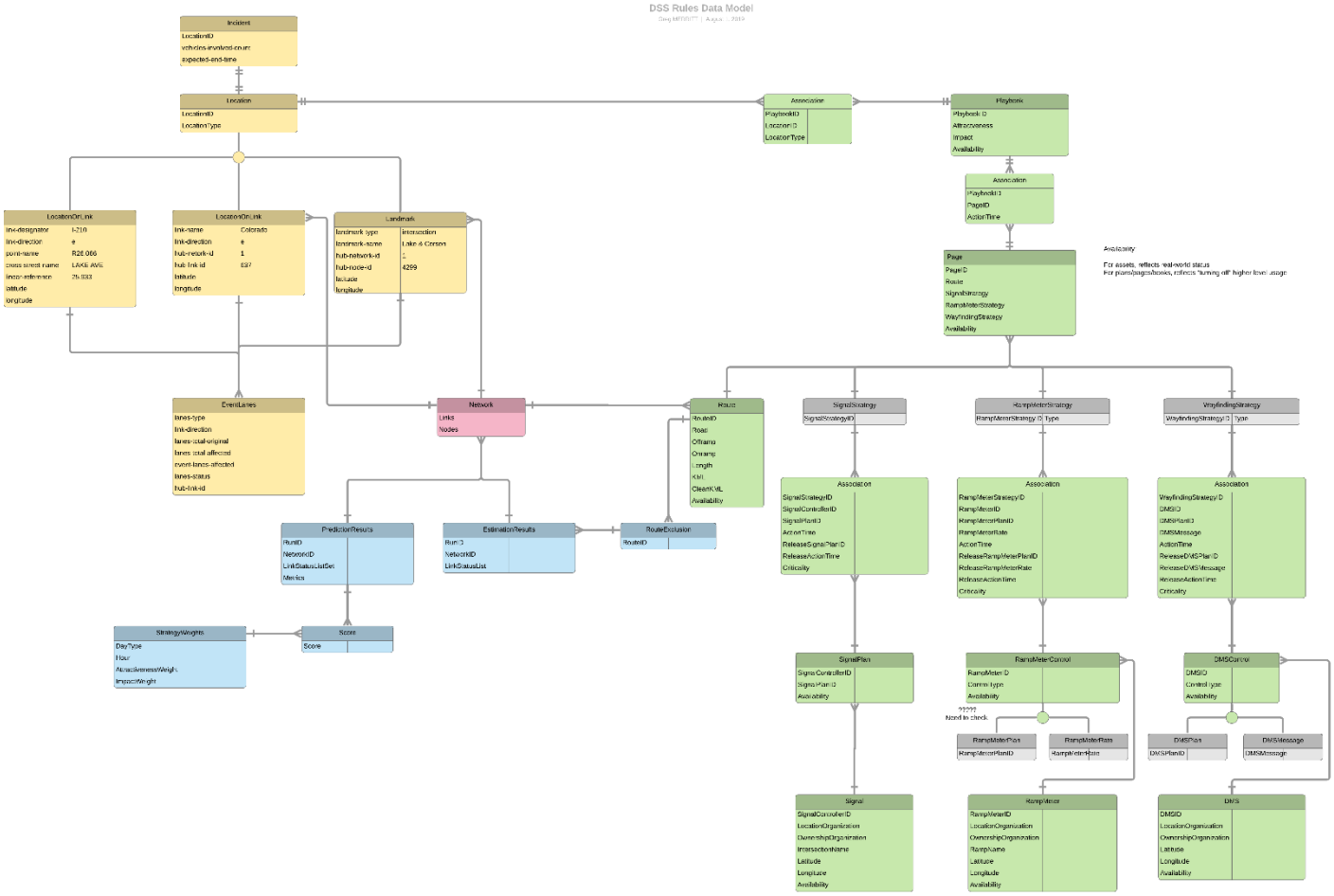
SR-134 PM 11.4 - 13.5
EB 95.9% --- great
WB 96.6% --- great

I-605 PM 22.93 - 28
NB 89.4% --- very good
SB 82.7% --- very good

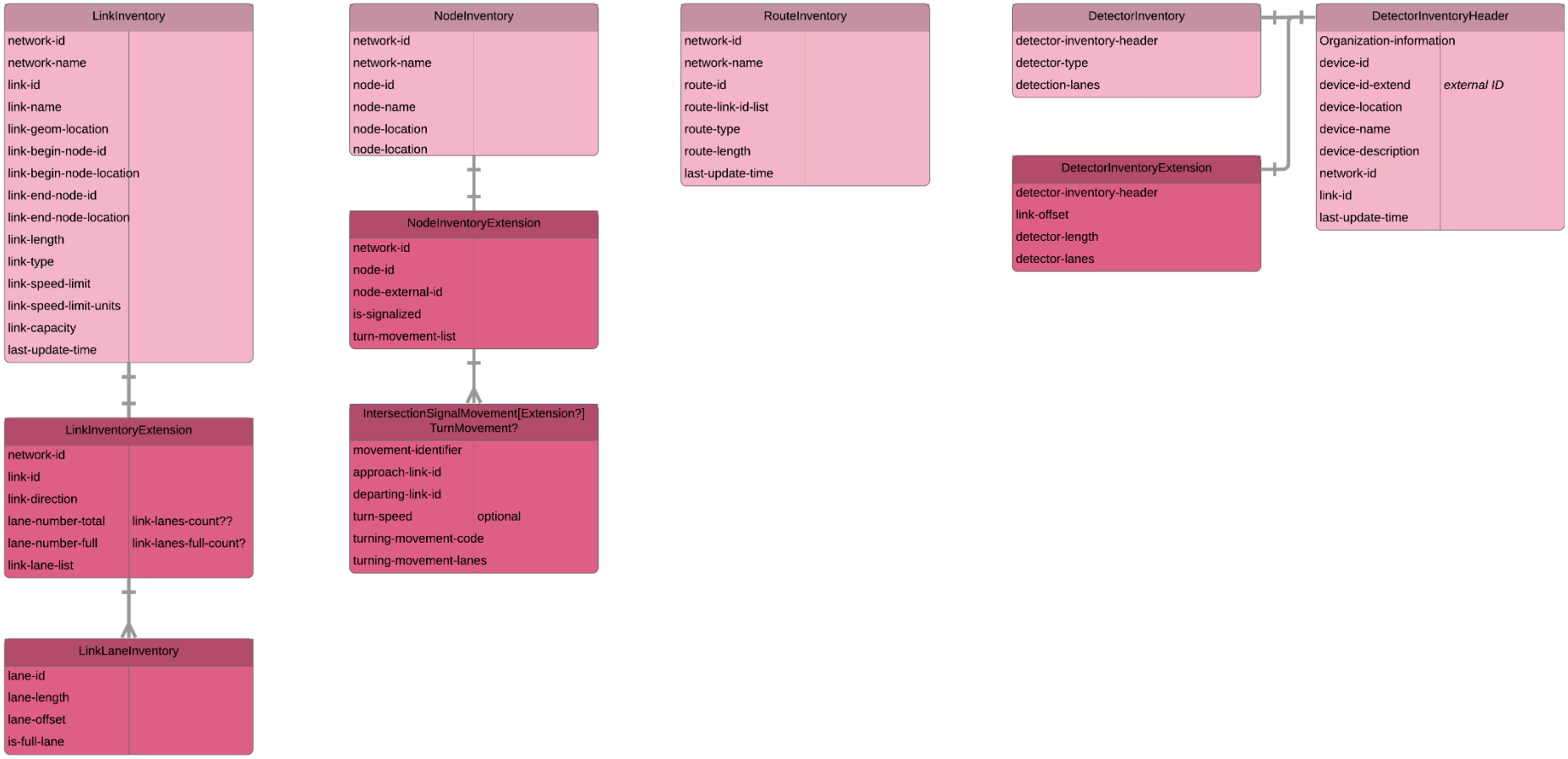
Response Plans

- **Signal plan review and validation**
  - Pasadena has installed plans along Corson and Maple
  - Arcadia and LA County have agreed to begin bench testing of plans
  - Bench testing will check for valid plans
  - We will also bench test ability to set a plan and to return to normal operation
- **New structure for response plan building**
  - Nicely captures multi-route plans in playbooks and pages
  - Reviewing process to generate these playbooks and pages

Response Plan Data Model



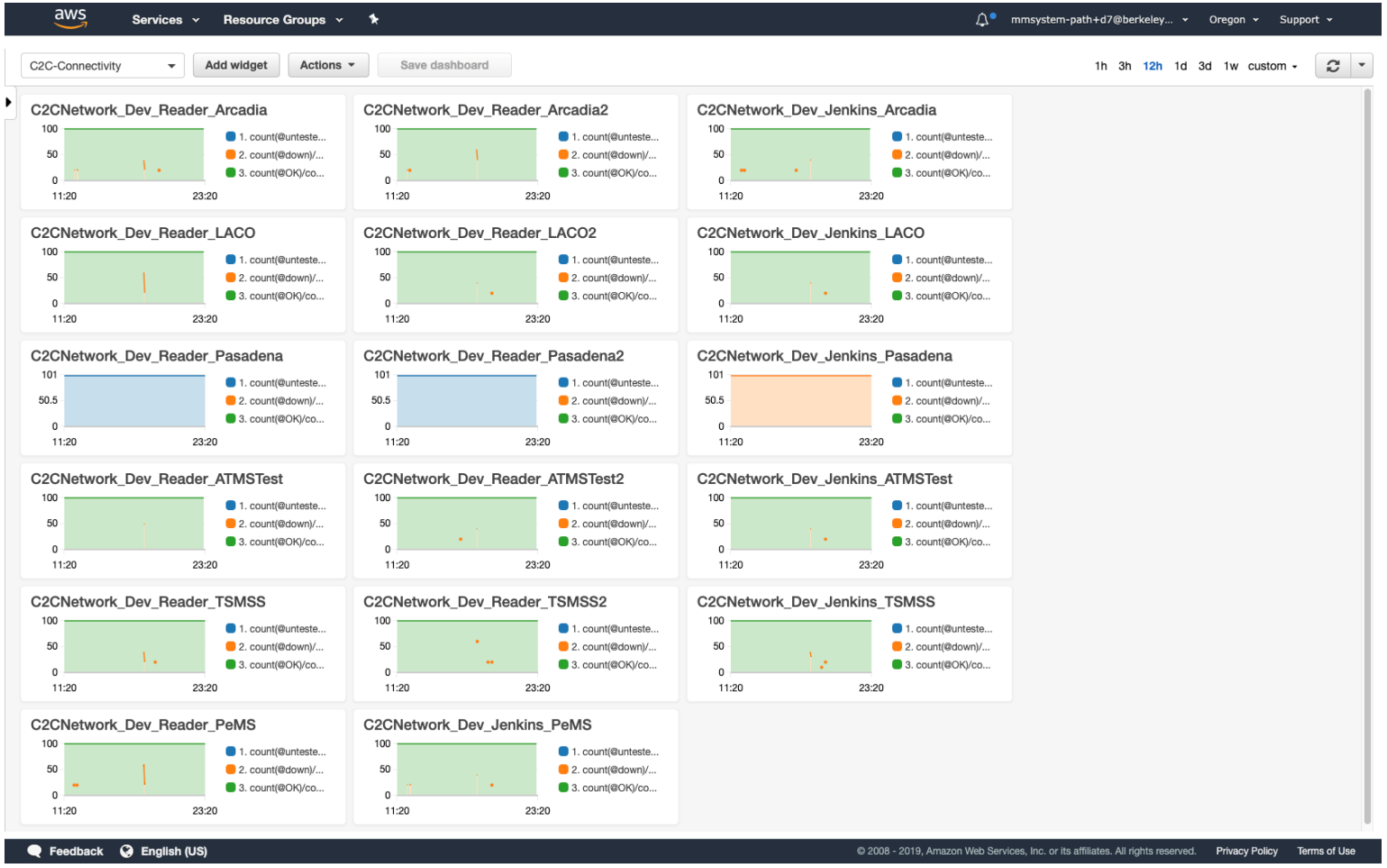
Network Data Model



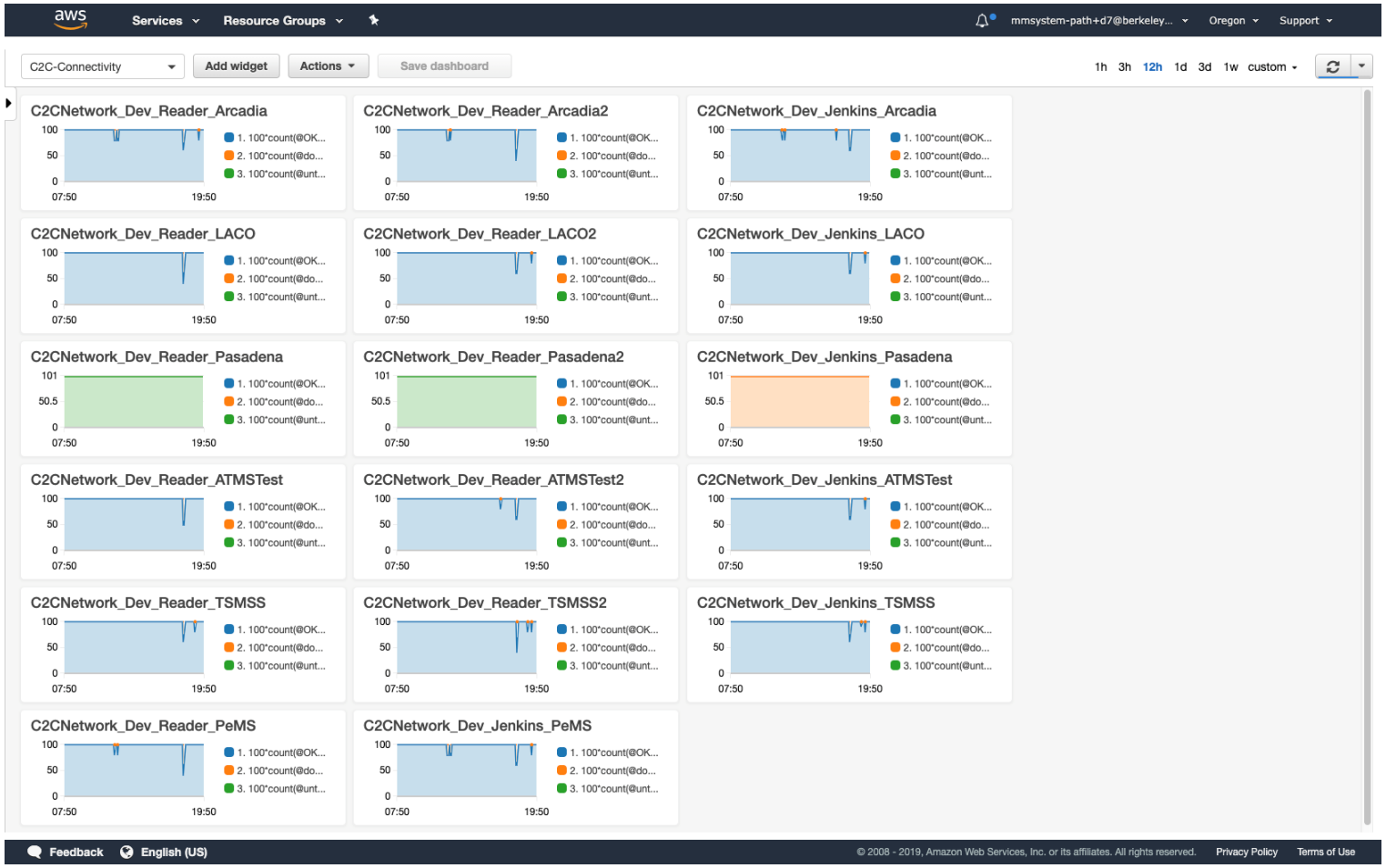
C2C Networking

- We designed, built, and deployed a C2C network connection monitor, including a dashboard. This is running for the Development environment.
- This is very high level and just checks if we can connect from the cloud to each C2C endpoint.
- Several network-related hiccups occurred in July, including some D7 TMC VPN server service interruptions and a RIITS outage. We worked with stakeholder partners on resolution of these issues.
- No progress with D7 TMC IT & RIITS personnel regarding the establishment of secure user access to the ICM application.

High Level Network Monitoring Utility



High Level Network Monitoring Utility



Arterial Data Quality

- **Arcadia's TCS server and the IEN**
  - We continue to collect and process data from these two data sources.
  - A weekly detector health report for Arcadia is sent to the AMS team.
- **KITS**
  - We updated the data quality report on the TMDD messages from LACO
  - We plan to send this report to Kimley Horn this week
- **Data Hub**
  - We are retrieving TMDD Inventory and Status messages 24/7 and save them to a local MongoDB for analysis and modeling purposes.

Arterial Configurations - Detectors

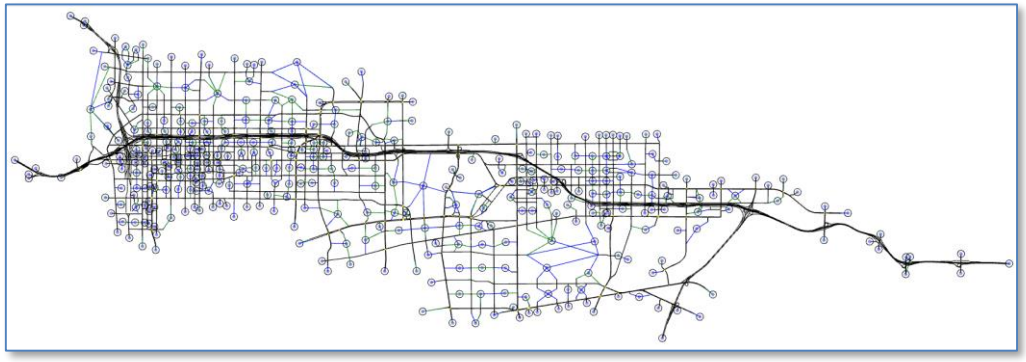
- **Detector configuration update for Arcadia**
  - We found a number of changes had been made since the last update of detector configuration in Mid 2017.
  - We generated the latest detector inventory from the data retrieved from the data hub.
  - We then used it to update/correct the detector configuration file and sent the revised version to the AMS team.
  - We also generated a new set of historical data (24hrs) for the detectors in Arcadia using the data collected in Year 2019 for modeling and calibration purposes.

Keeping track of network changes

- **Network/plan changes happen frequently**
  - New elements
  - Changes sensor configuration
  - New plans
  - Roadway changes
- **Knowing the correct state of the network and the ITS elements is essential to estimation, prediction, data quality determination, response plan generation and visualization**

Aimsun Model

- **Some statistics:**
  - 2579 signal control plans
  - 7312 detectors
  - Over 1000 lane miles of roadway
  - 4242 road sections
  - 1748 nodes
  - 395 trip origin / destination nodes



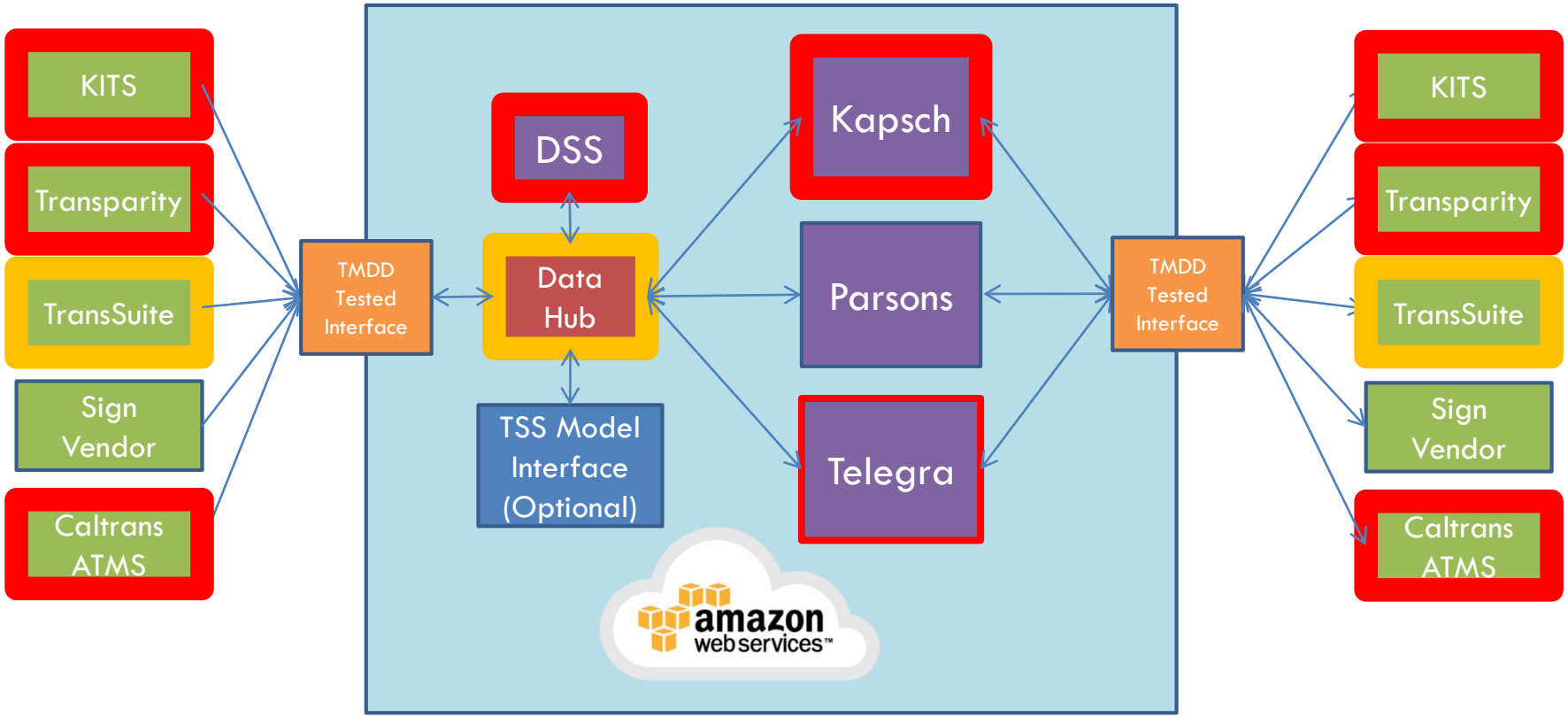
General Model Updates

- **Migrated from Aimsum 8.2.4 to Aimsun 8.4.1**
  - Provides more refined capability for modeling behavior during incidents
  - Fix a few bugs
- **Network geometry**
  - Updated the geometric modeling of metered ramps to improve vehicle behavior under high flows when meter is green balled or off
- **Reference flow data**
  - Updated the PeMS flow data used as reference for calibration (to account for improved detection and detection issues being fixed)
  - February-April 2019 period used as primary source of information

General Model Updates

- **Ramp meters**
  - Updated the timing parameters of meters on San Gabriel, Altadena, Hill and Lake on-ramps on I-210 WB to reflect recent operational changes
    - Changes first noticed through increased flow processed through ramps in PeMS
    - Later confirmed with the reception of new timing sheets from Caltrans
  - Waiting on Caltrans to provide updated timing sheets for rest of corridor
    - Most sheets used for modeling were obtained in 2016
- **New arterial data available for calibration**
  - We use to see how accurate the model has previously been on arterials

C2C Interface Implementations - Status



Systems Integration

- **Arcadia**
  - Data acquisition technical testing completed
  - Data analysis report completed. One important issue found.
  - Determining how to fix this issue.
  - Bench testing planned for completion in September
  - Working on response plan termination process
- **LA County**
  - Data acquisition technical testing completed
  - Data issues report in review. Several items for discussion.
  - Bench testing planned for completion in September
  - Termination process agreed uon
- **Pasadena**
  - Approved high level design. Awaiting updates to detail design, verification plan, test endpoint from McCain.

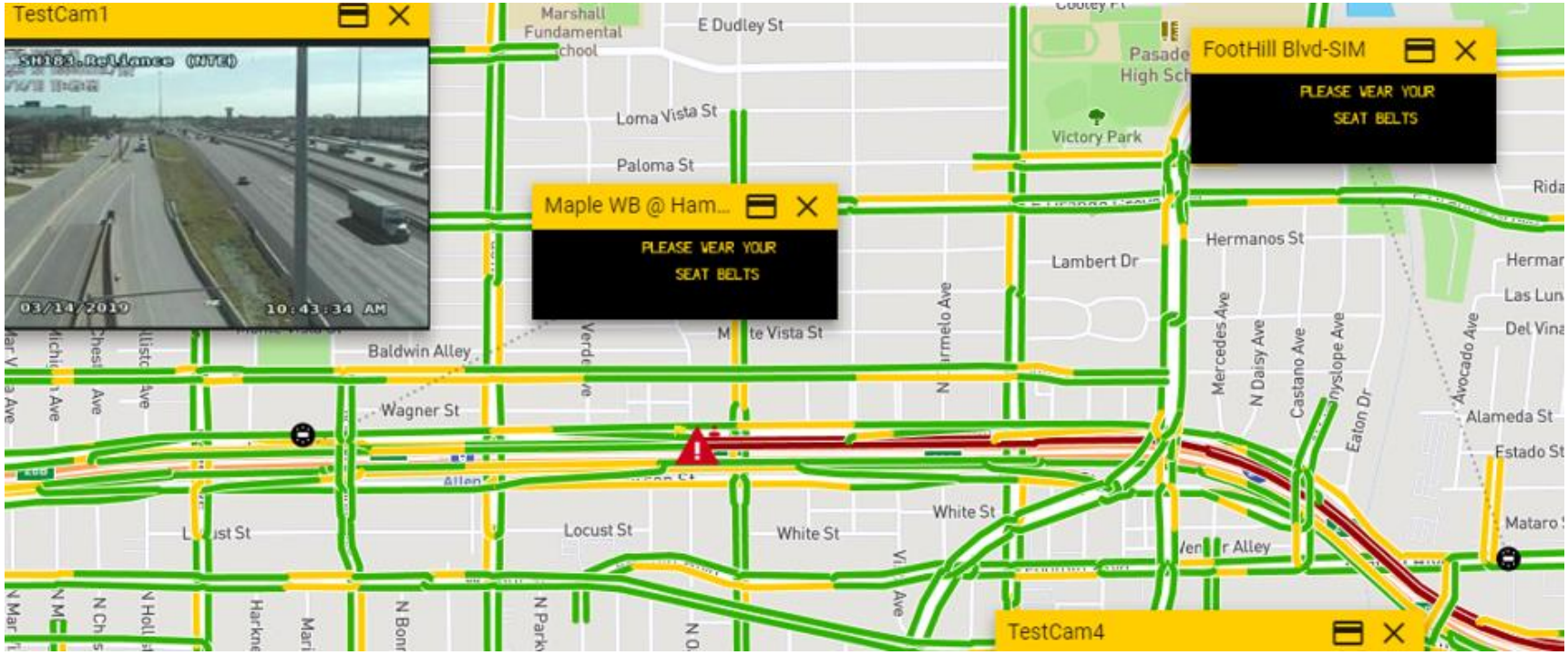
Systems Integration

- **TSMSS**
  - Have tested ability to read data
  - Configuration data should be loaded by end of month
  - Bench testing planned to be completed by end of September
- **ATMS**
  - ATMS modified to support I-210 CC system – May 2019
  - Parsons and PATH working together to support arterial event testing
  - Software updates occurring based on testing
  - Testing is ongoing
  - ATMS needs to be moved to production for us to test with real data
  - Termination process agreed upon for CMS signs, ramp metering in discussion

Systems Development

- **Ongoing system development**
  - Upgraded to MongoDB clusters – data reliability and persistence requirement
  - Improving workflow processing and orchestration (incident lifecycle management workflows, Corridor Management System/Data Hub process communication – should be in test this month
  - Fixed inventory messages structure and fixed an issue with data received without time zone information
- **Improve release frequency – Permits rapid response to problems**
  - Working on allowing release of individual micro-services on demand instead of full subsystems (DH, DSS) every release. Much easier to coordinate and assemble releases.
- **Improve deployment capabilities**
  - Create environment for verifying infrastructure as code, reduce disruption to developers

I-210 Integrated Corridor Management Kapsch Update



Tim O'Leary

August 6, 2019

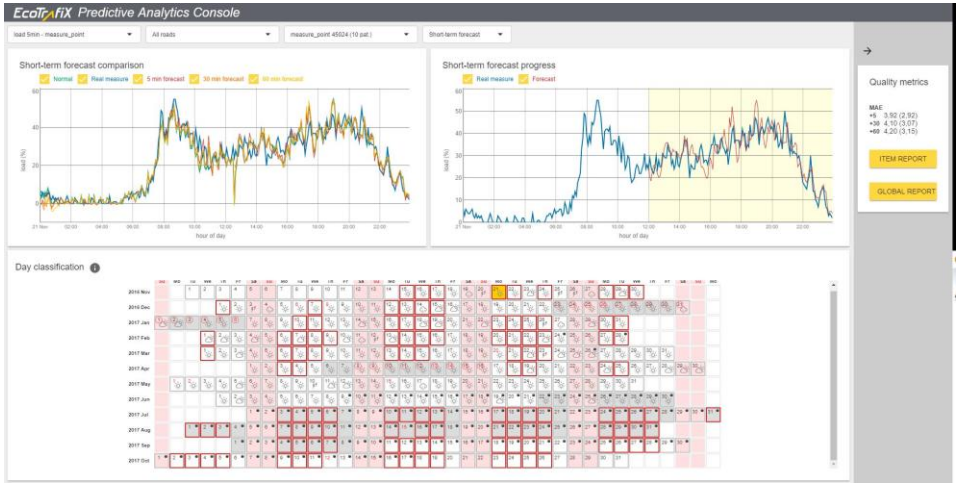
I-210 CALTRANS Pilot

EcoTrafiX

- Product Status
- Interface Status

EcoTrafiX Product Status

- In progress:
  - Provide import/export access to EcoTrafiX Response Plans
  - Align lane status (clear/blocked) with ICM arterial movements
  - Tailor agency Response Plan voting

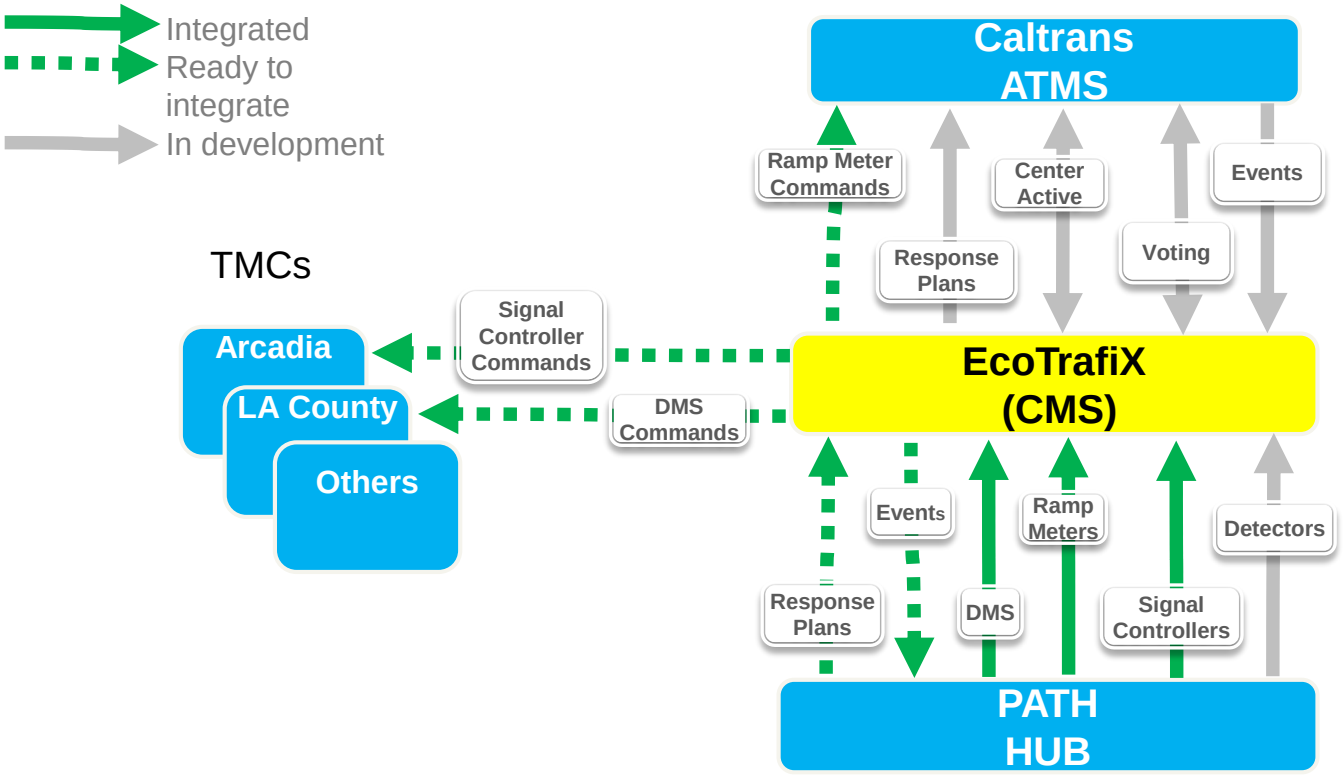


EcoTrafiX Interface Status

- Publish Events to Hub – ready to integrate with DSS
- Receive Events – simulated until ATMS is available in AWS
- Response Plans – ready to receive from DSS
- Traffic Signals live from Arcadia & some LA County signals
- DMS – receiving from Hub
- Ramp Meters – receiving from Hub (simulated from ATMS)
- Response Plan Item Execution – ready to integrate with TMCs

EcoTrafiX Status

Interface



EcoTrafiX Status

Next Steps

- EcoTrafiX send Events to HUB
- Integrate with PATH's Hub
- DSS send Response Plans to EcoTrafiX
- Integrate with CALTRANS ATMS
- ATMS send Events to EcoTrafiX/HUB
- EcoTrafiX exchange Voting with ATMS
- EcoTrafiX send Response Plans to ATMS
- EcoTrafiX exchange Center Active with ATMS

Thank You!

Kapsch TrafficCom

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USA

www.kapsch.us

timothy.oleary@Kapsch.net

I-210 Connected Corridors
Face-to-Face Meeting

City of Pasadena,
Grand Conference Room, 100 N Garfield Avenue,
Pasadena, CA 91101
Tuesday, August 6, 2019
1:30 – 3:30 pm

Agenda

- I-210 CC Arterial Systems Improvement Project System Consulting Services – Scope
- Expected Timeline
- Status of 9 procurement package
- Next Steps

I-210 CONNECTED CORRIDORS ARTERIAL SYSTEMS IMPROVEMENT PROJECT SYSTEM CONSULTING SERVICES

SCOPE OF WORK

August 6, 2019

Project Objective

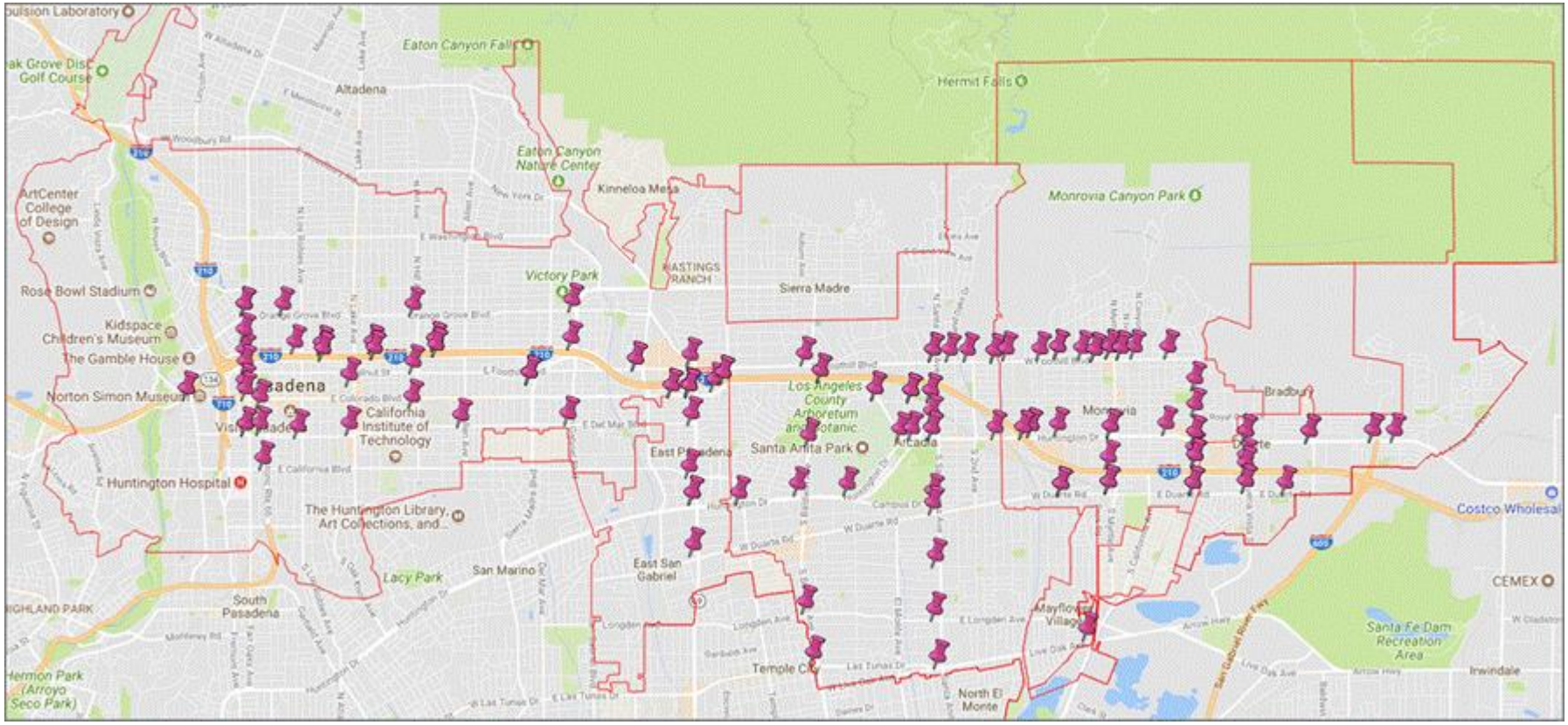
- Assist Caltrans D7 to manage the execution of the 9 arterial ITS improvement projects

#	Package Description	Contract #	Contract Status
1	Bluetooth – Iteris Velocity	07A4470	Completed
2	Bluetooth – BlueToad	07A4477	Awarded, in Progress
3	New Controller Cabinets	07A4603	Under DPAC Review
4	Communication Upgrades	07A4479	Awarded, in Progress
5	Firmware/Timing Plan Updates/Controller Upgrades	07A4480	Awarded, in Progress
6	Video Detection System	07A4481	Awarded, in Progress
7	Data Communication Module and Video Detection Software Upgrade	07A4601	Under DPAC Review
8	Advanced Traveler Information Systems	N/A	DMS – Under DPAC Review Integration - Under DPAC Review Static Signs – Caltrans, in Progress
9	Environmental Stations with Air Quality Sensors and Open Data Systems	07A4388	Awarded, in Progress

Project Area

#	Package Description	Contract #	Metro & Caltrans	City of Pasadena	City of Arcadia	City of Monrovia	City of Duarte	LA County
1	Bluetooth – Iteris Velocity	07A4470	√		√			
2	Bluetooth – BlueToad	07A4477	√	√		√	√	√
3	New Controller Cabinets	07A4603	√	√	√			
4	Communication Upgrades	07A4479	√		√	√	√	√
5	Firmware/Timing Plan Updates/Controller Upgrades	07A4480	√	√	√	√		√
6	Video Detection System	07A4481	√	√	√	√	√	√
7	Data Communication Module and Video Detection Software Upgrade	07A4601	√	√	√	√	√	√
8	Advanced Traveler Information Systems	N/A	√	√	√	√	√	√
9	Environmental Stations with Air Quality Sensors and Open Data Systems (ODS)	07A4388	√					

Project Area (cont.)

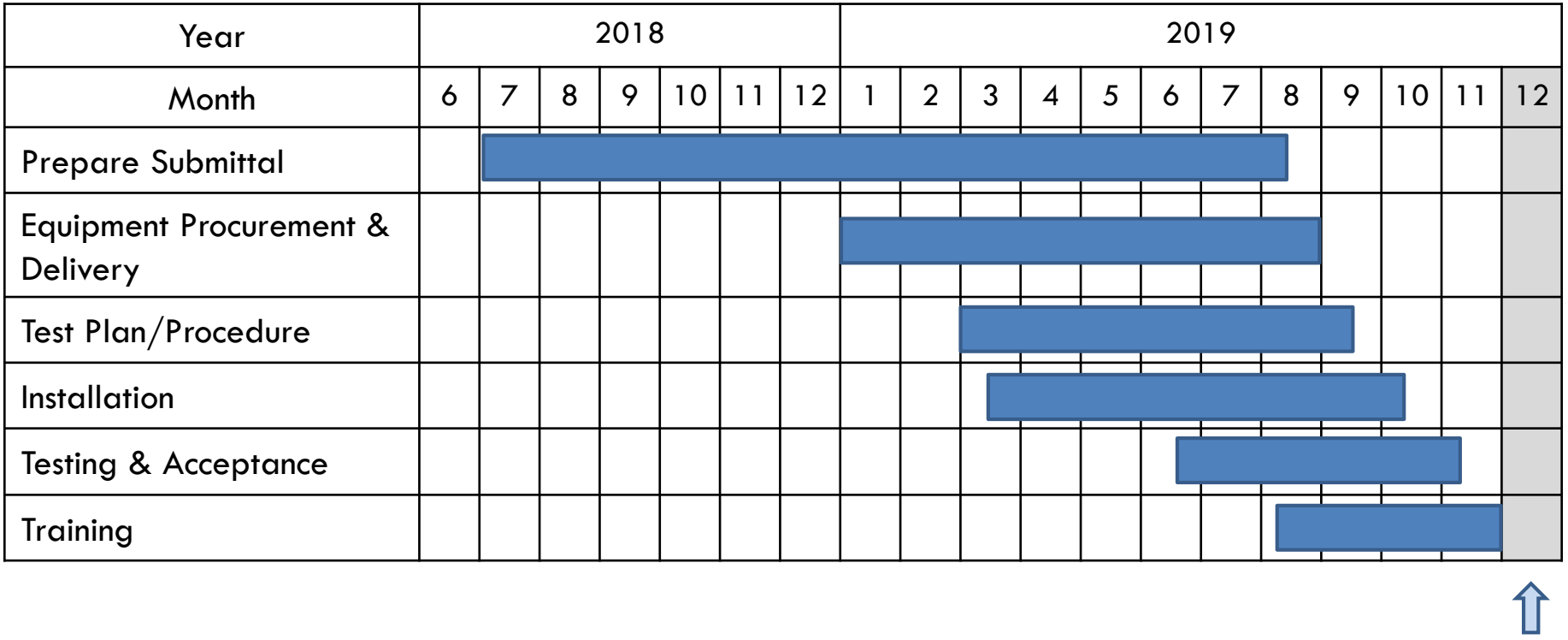


UPDATE ON

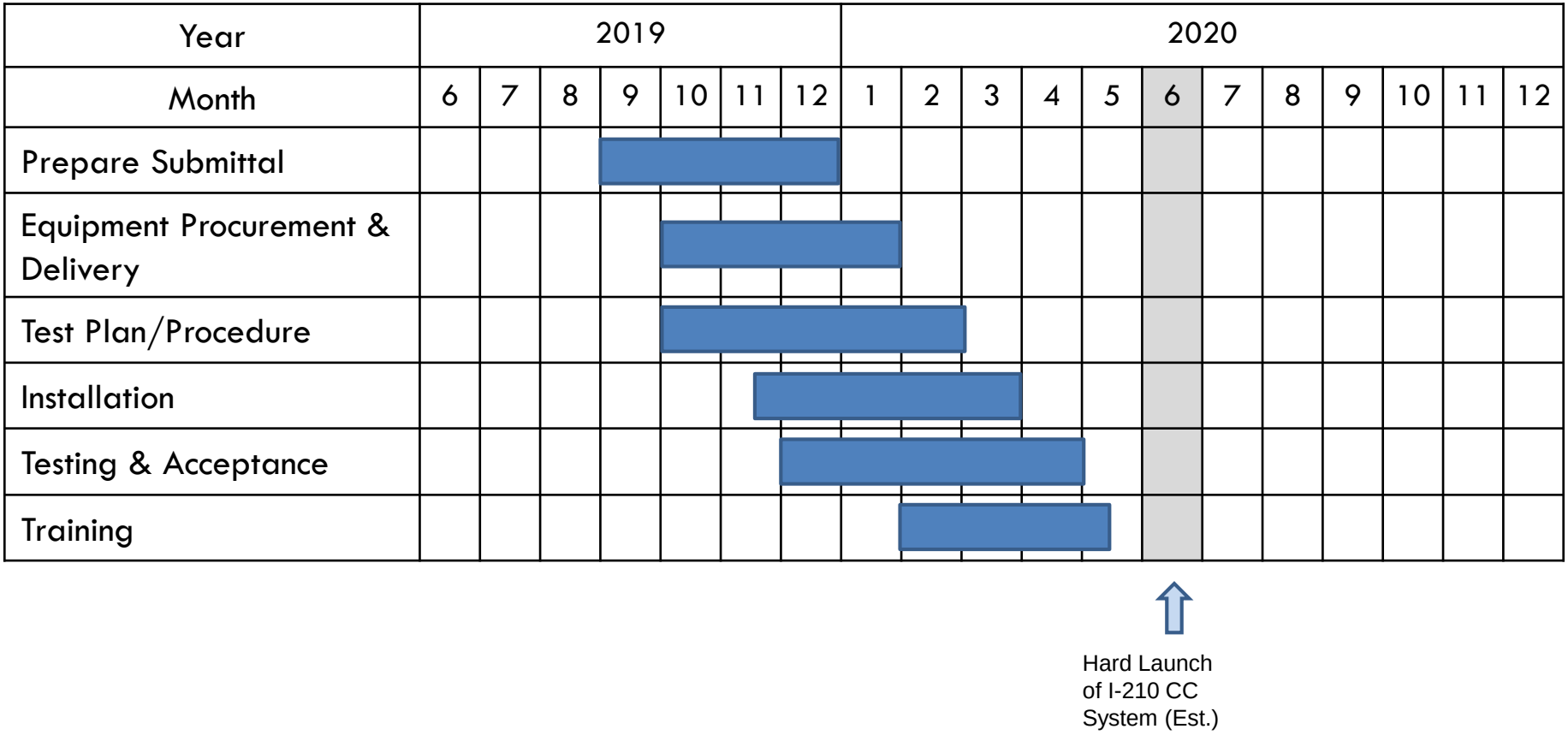
PACKAGES 1-9

June 25, 2019

Target Timeline - 6 awarded Packages



Target Timeline - 3 unawarded Packages



Update on 9 Packages

Pkg. #	Package Name	Contract #	Project Status
1	Bluetooth – Iteris Velocity	07A4470 PTM	• NTP: 7/10/2018 • Kick-off Meeting: 7/30/2018 • Submittal Approved: 8/16/2018 • Installation & Testing Completed on 5/29 & 5/30/2019 • Accepted by Arcadia • Documents Submitted • Completed
2	Bluetooth – BlueToad	07A4477 DBX	• NTP: 7/10/2018 • Kick-off Meeting: 7/30/2018 • Submittal Approved: 10/12/2018 • Installation QC checklist & Test Procedure: Submitted for Stakeholders' Review • LA County: VM server configured on 5/15/2019; scheduling field installation • Pasadena: Physical server to be procured and configured • Expected to be completed: September 2019 (80%)

Update on 9 Packages (cont.)

Pkg. #	Package Name	Contract #	Project Status
3	New Controller Cabinets	07A4603	• Disqualified: Bids came above the SB limit (314k). • Procurement Package revised per Stakeholder comments on Pkg. 5 • Cancelled by DPAC in the week of Mar 15, 2019 • Revised package (reduce reference, service contract not engineering contract) being reviewed by DPAC • Expected to be advertised: Aug, 2019 • Expected to be completed: First Quarter, 2020
4	Communication Upgrades	07A4479 Kanaan Construction	• NTP: 7/13/2018 • Kick-off Meeting: 7/30/2018 • Submittal & RFI Approved: 5/6/2019 • Equipment procured • Installation QC checklist & testing plan being prepared • Installation to be scheduled • Expected to be completed: October 2019 (80%)

Update on 9 Packages (cont.)

Pkg. #	Package Name	Contract #	Project Status
5	Firmware/Timing Plan Updates/Controller Upgrades	07A4480 CPE, Inc	• NTP: 7/17/2018 • Kick-off Meeting: 7/30/2018 • Submittal Reviewed but Required Equipment changed per Stakeholder Comment • Contractor revised price estimate ($115,695.80) lower than original amount ($171,600.00) – being reviewed by stakeholders • To present to DPAC for approval • Expected to be completed: October 2019 (80%)

Update on 9 Packages (cont.)

Pkg. #	Package Name	Contract #	Project Status

6	Video Detection System	07A4481 Traffic Loops Crackfilling, Inc	• NTP: 7/10/2018
			• Kick-off Meeting: 7/30/2018
			• 10/9/2018: Conducted Site Survey
			• 10/18/18: Submittal approved
			• Installation:
			  • 18 out of 22 installations are completed (2 LA County, 5 Monrovia, 3 Arcadia, 8 Pasadena)
			  • 3 locations in Duarte – pull boxes & conduits are full; City will fix
			  • 1 location in Pasadena: conduit too small. Contractor provided cost estimate
			• Expected to be completed: September 2019 (90%)

7	Data Communication Module and Video Detection Software Upgrade	07A4601	• Disqualified: Bids came above the SB limit (314k). • Originally cancelled by DPAC; • Revised Package (service contract not IT contract) being reviewed by DPAC for further consideration • Expected to be awarded: Aug, 2019 • Expected to be completed: First Quarter, 2020

Update on 9 Packages (cont.)

Pkg. #	Package Name	Contract #	Project Status

8	Advanced Traveler Information Systems	N/A	• Divided to 3 parts:
			  • DMS Procurement – being reviewed by DPAC
			  • Integration – being reviewed by DPAC
			  • Static Sign Procurement - ordered by Caltrans Maintenance Group, may take up to 6 months
			• Expected to be awarded: Aug, 2019
			• Expected to be completed: Second Quarter, 2020

9	Environmental Stations with Air Quality Sensors and Open Data Systems (ODS)	07A4388 Cal Poly Pomona	• NTP: 6/29/18
			• Kick-off Meeting: 7/12/18
			• Environmental stations
			  • Roadside study done
			  • Field installation done – 6/7/19
			  • Collect data and analyze data - ongoing
			• ODS
			  • CPP continuously coordinates with PATH
			• Expected to be completed: Dec 2019 (80%)

Next Steps

- Package 2: Review Test Procedure; schedule installation in LA County; Procure & configure server in Pasadena
- Package 3: Tracking status
- Package 4: Prepare documentations
- Package 5: Review revised scope & cost estimate
- Package 6:
  - Follow up with Duarte on the pullbox/conduit fixing progress
  - Review cost estimate (RFI # 4) for 1 location in Pasadena
- Package 7: Tracking status
- Package 8: Tracking status
- Package 9: Support coordination

Thank You and Questions?

ENVIRONMENTAL IMPACT EVALUATION FOR I-210 CONNECTED CORRIDOR PILOT PROJECT

PROGRESS REPORT

XUDONG JIA, PH.D., PE; XINKAI WU, PH.D.; CAL POLY POMONA
ALLEN CHEN, PE; GEROMAR, HASTA; LEILA SY; CALTRANS DISTRICT 7

AUG. 06, 2019

Tasks

- **To evaluate the air quality before and after the deployment of the CC project, the project needs to collect high frequency data including:**
  - Toxic gases (CO, NO, NO2, O3, SO2, CO2);
  - Particulates (PM1, PM2.5, PM10);
  - Meteorological data (temperature and relative humidity); and
  - Potential traffic data (traffic flow, vehicle types, speed, etc.).

- **Other specific features include:**
  - Allow remote access for customized data collection and configuration through Linux system;
  - Support 3G/4G cellular communication through multiple carriers;
  - Low power usage;
  - Support to use solar panel power;
  - An integrated device that supports data collection and transmission;
  - Portable;
  - Provide ready-to-mount for easy implementation;
  - Provide a camera for field condition monitoring;
  - Provide unique feature of traffic data collection (optional); and
  - Low-cost.

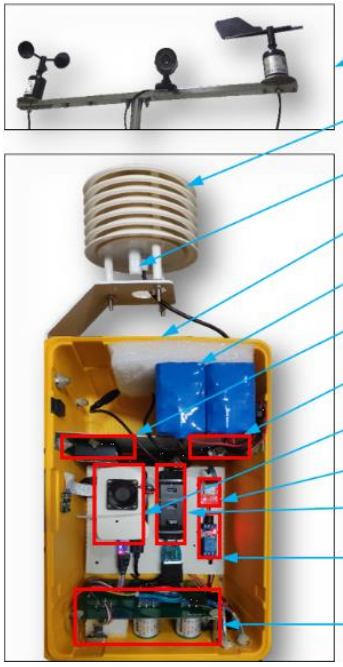
Device: iAQBox

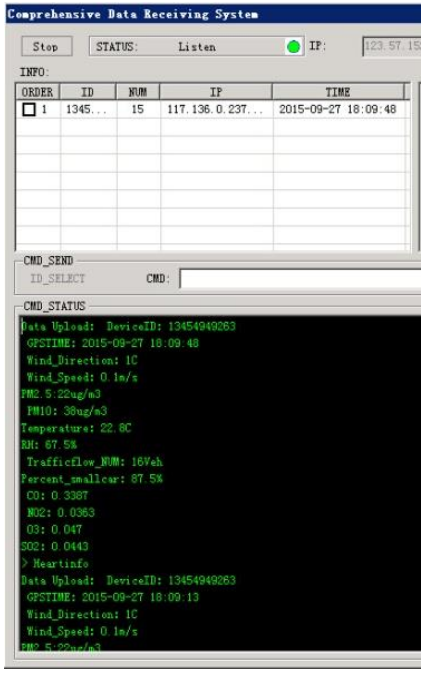
- iAQBox (intelligent Air Quality measure Box)
- A Roadside Air Quality Measurement Device, customized from CLR Analytics Inc.
- Fulfill all required functions
- Portable
- Low-cost
- Solar power supported




Caltrans Metro County of Los Angeles City of Pasadena Incorporated June 1886 California City of Arcadia City of Monrovia 1887 City of Duarte SCAG Pacific Rim Initiative SGVCOG Foothill Transit California PATH

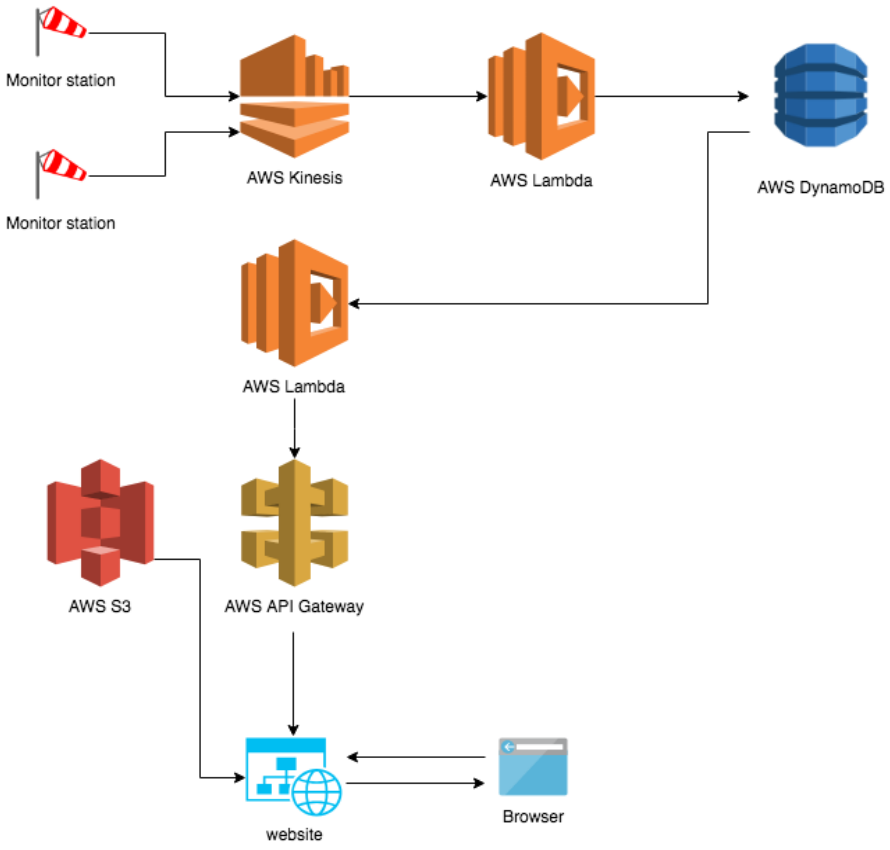
iAQBox: Overview





Database Architecture

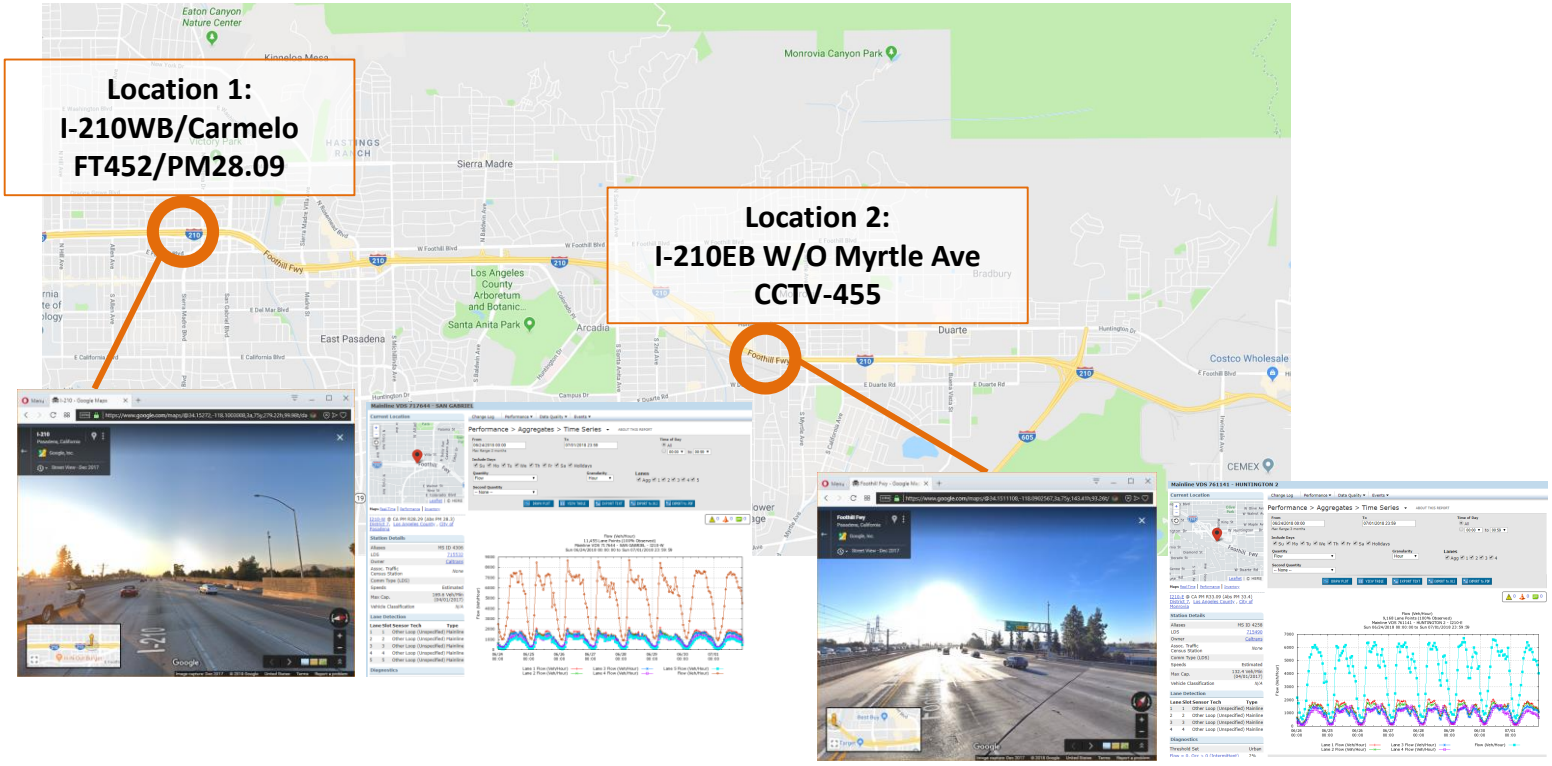
- **Data Collection**
  - iAQBox air quality monitoring station
- **Data Receiving and Processing**
  - AWS Kinesis
  - AWS Lambda function
  - AWS DynamoDB
- **Data Publishing**
  - AWS Lambda function
  - AWS S3
  - AWS API gateway



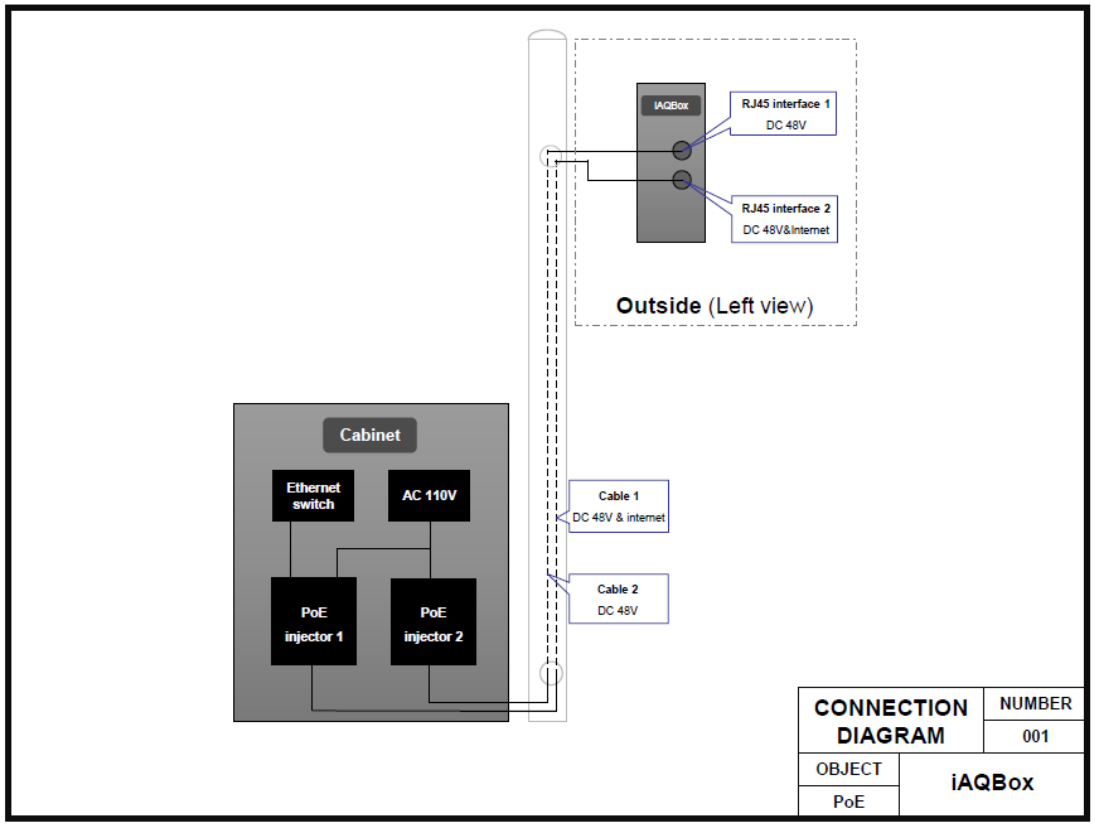
Field Installation – Mounting on CCTV Poles

- ✓ **Electricity Power Support**
- ✓ **Potential Ethernet Support**

Locations: Two CCTV Poles

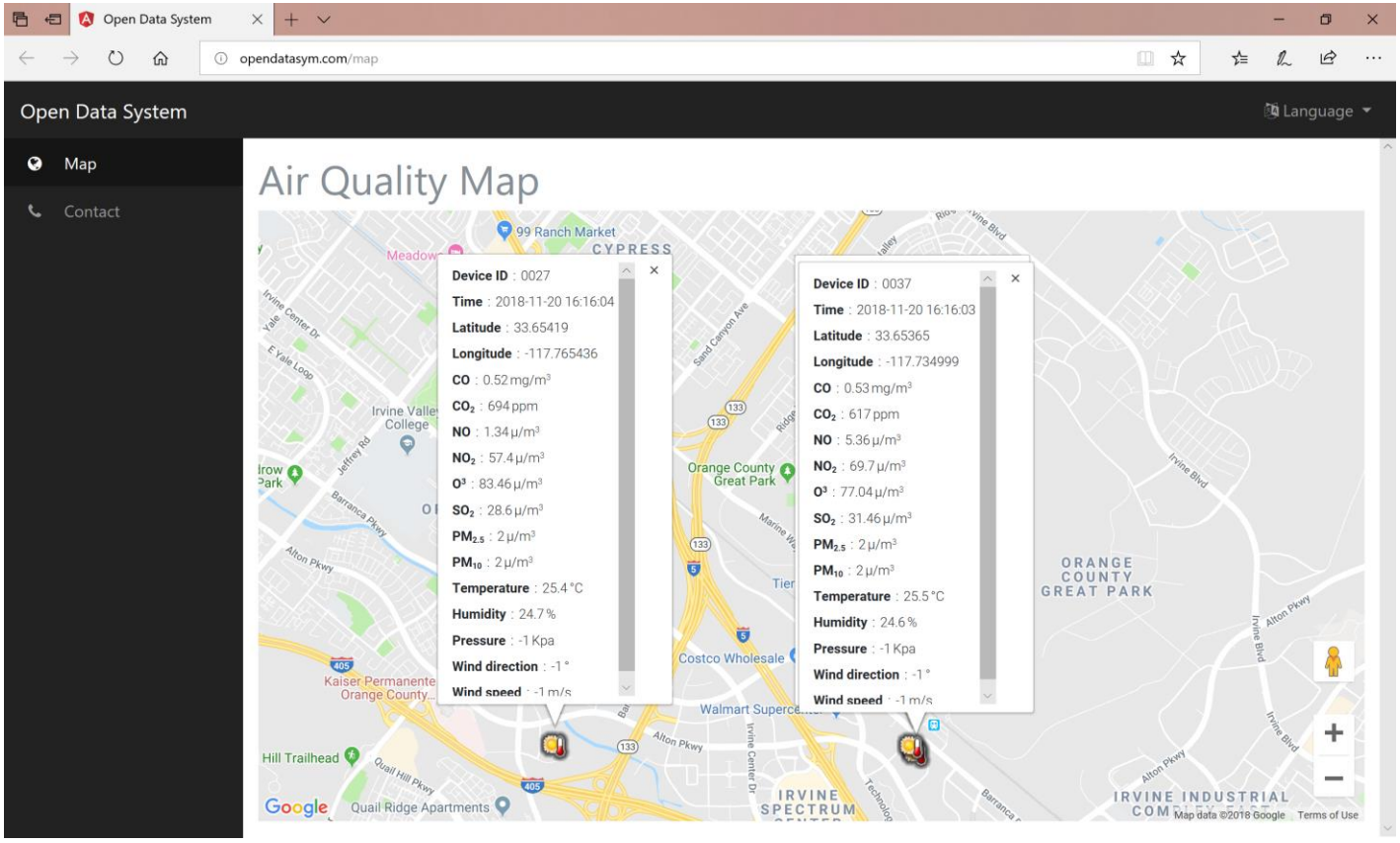


Installation Diagram



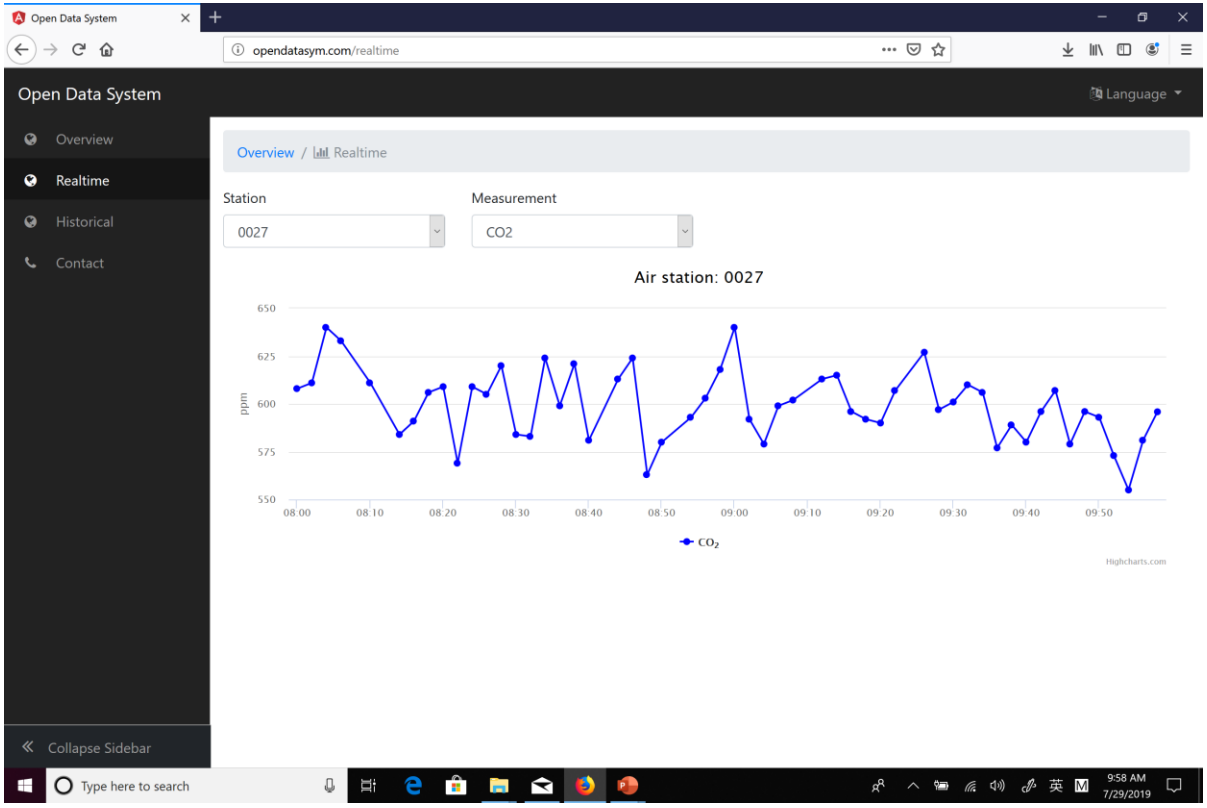
Field Installation - Mounting on CCTV Poles

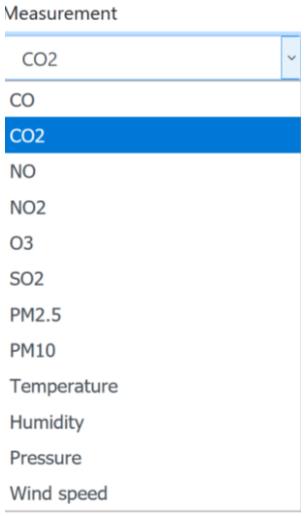
Real-Time Data: opendatasym.com



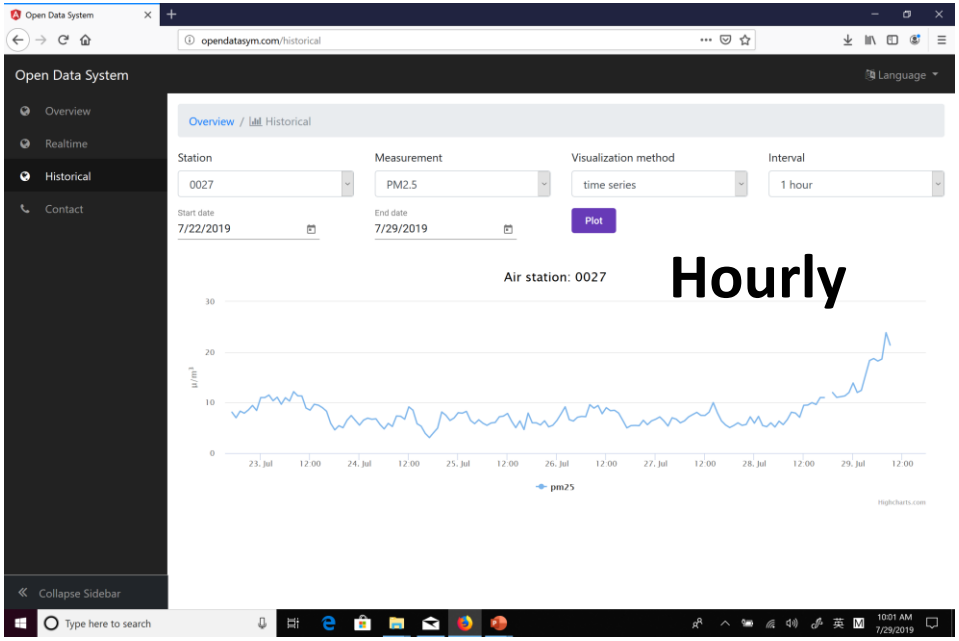
Caltrans Metro

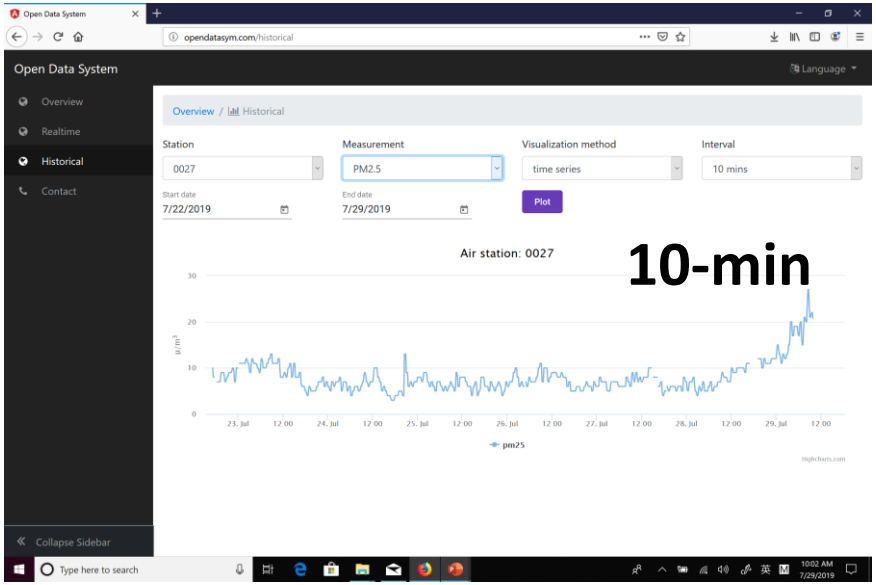
Data Statistics: Real-Time Data



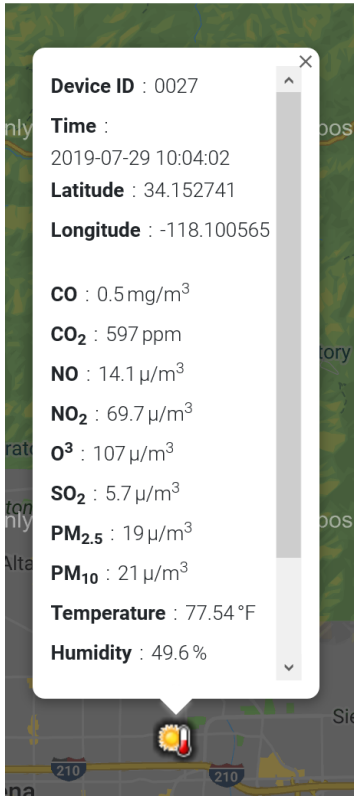


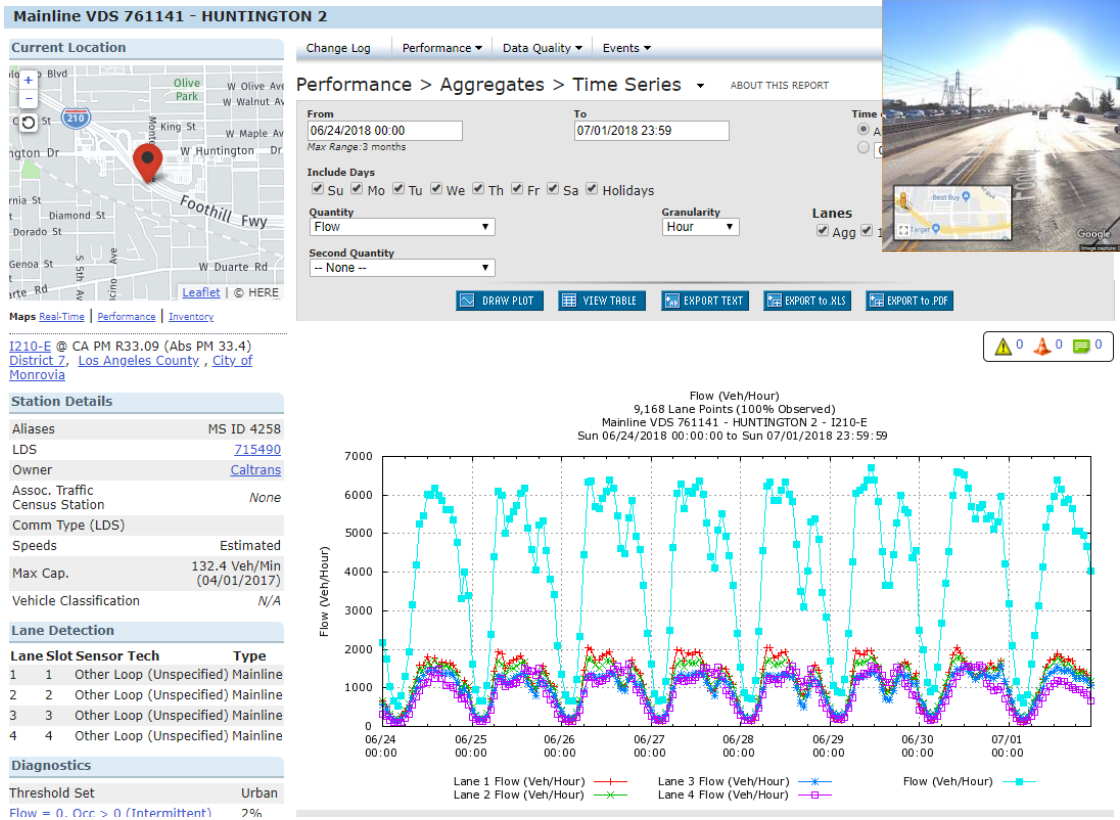
Data Statistics: Historical Data

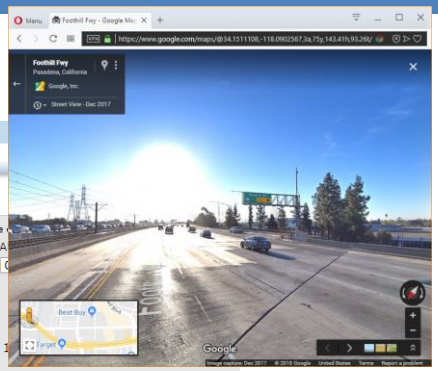




Next Step: Associate with Traffic Data







Caltrans Metro County of Los Angeles California City of Pasadena Incorporated June 1886 City of Arcadia City of Monrovia 1887 City of Duarte SCAG SGVCOG Foothill Transit California PATH

Thank You and Questions?

Response Plan Metrics

Modeling and Evaluation Metrics

- We now have a calibrated model
- We have initial response plans (including signal timing)
- We now what to run these response plans in simulation and compare the before and after metrics
- In order to do so we need to define the metrics we wish to use in evaluating the incidents
- We then need to generate these metrics from the model
- This is a discussion of those metrics, their generation parameters, and an example of running them on a response plan

Response Plan Evaluation Metrics

- **Potential performance metrics**
  - Demand
    - Vehicle-miles traveled (VMT)
  - Mobility
    - Vehicle-hours of travel (VHT)
    - Average delay
    - Average speed
    - Average travel time
    - Length of congestion/queue along a given roadway
    - Congestion period related to incident
  - Productivity
    - Traffic volumes (network, ramps, road sections, etc.)
    - Level of service at intersections
  - Reliability
    - Travel time variability
    - Planning time index
  - Safety
    - Incident data

Response Plan Evaluation Metrics

- **Metrics that can easily be extracted from simulation results**
  - Demand
    - Vehicle-miles traveled (VMT)
  - Mobility
    - Vehicle-hours of travel (VHT)
    - Average delay
    - Average speed
    - Average travel time
    - Length of congestion/queue along a given roadway
    - Congestion period related to incident
  - Productivity
    - Traffic volumes (network, ramps, road sections, etc.)
    - Level of service at intersections
  - Reliability
    - Travel time variability
    - Planning time index
  - Safety
    - Incident data

***Person-based** metrics can also be estimated using assumed vehicle occupancy rates*

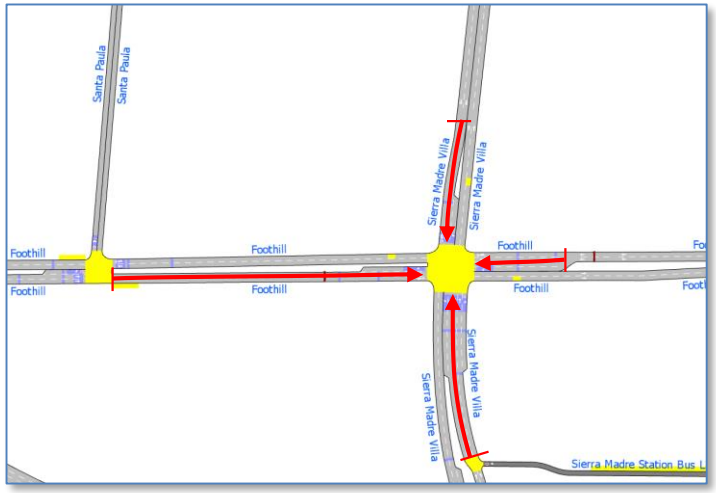
***Statistics variability** can only be measured if executing multiple runs*

Response Plan Evaluation Metrics

- **Issues with remaining metrics**
  - Congestion period related to incident
    - Can be difficult to determine in a network setting through simple mathematical data processing
    - Results may vary depending on section of roadway or area considered
    - How to determine deviation from normality, particularly for incidents occurring during peak periods?
    - How to handle simultaneous incidents at different locations
    - RECOMMENDATION: Warrant further investigation

Response Plan Evaluation Metrics

- **Issues with remaining metrics**
  - Level of service at intersections
    - Average approach delay compiled for each node in Aimsun
    - However, analysis only covers links directly connected to node
      - Issue where length of links differ significantly across approaches
      - Full queue may not be adequately captured on all approaches



    - Possible to fix calculation using data outputs, but may require extensive analysis setup
    - RECOMMENDATION: Inquire with TSS on available options

Response Plan Evaluation Metrics

- **Issues with other metrics leading to their potential exclusion**
  - Planning time index (Time to go from point A to B)
    - Highly correlated to travel time variability
    - Only relevant for specific paths
    - Would need to calculate an index for a specific pair of origin-destination nodes that may not be representative of all traffic
    - RECOMMENDATION: Simply consider travel time variability
  - Incident data
    - Simulation models do not produce accidents
    - Incident risk estimation models can be used, but accuracy would need to be demonstrated
    - RECOMMENDATION: Do not consider safety in response recommendations, unless adequate model can be provided

Extraction of Simulation Metrics

Extraction of Metrics from Simulations

- **Aimsun stores simulated output statistics in a SQL database**
- **Database contains information for specific**
  - Links
  - Nodes
  - Origin/destination nodes
  - Detectors
- **Database can be queried using free SQL analysis tools**

Extraction of Metrics from Simulations

- **Link metrics than can easily be extracted from SQL database**
  - Vehicle input count
  - Vehicle exit count
  - VMT
  - VHT
  - Average speed
  - Average travel time
  - Incurred delay (relative to travel time at speed limit)
  - Number of stops
  - Total time spent stopped
  - Size of virtual queue (*vehicles unable to enter link from an origin node*)
  - Average wait time in virtual queue

Extraction of Simulation Output Metrics

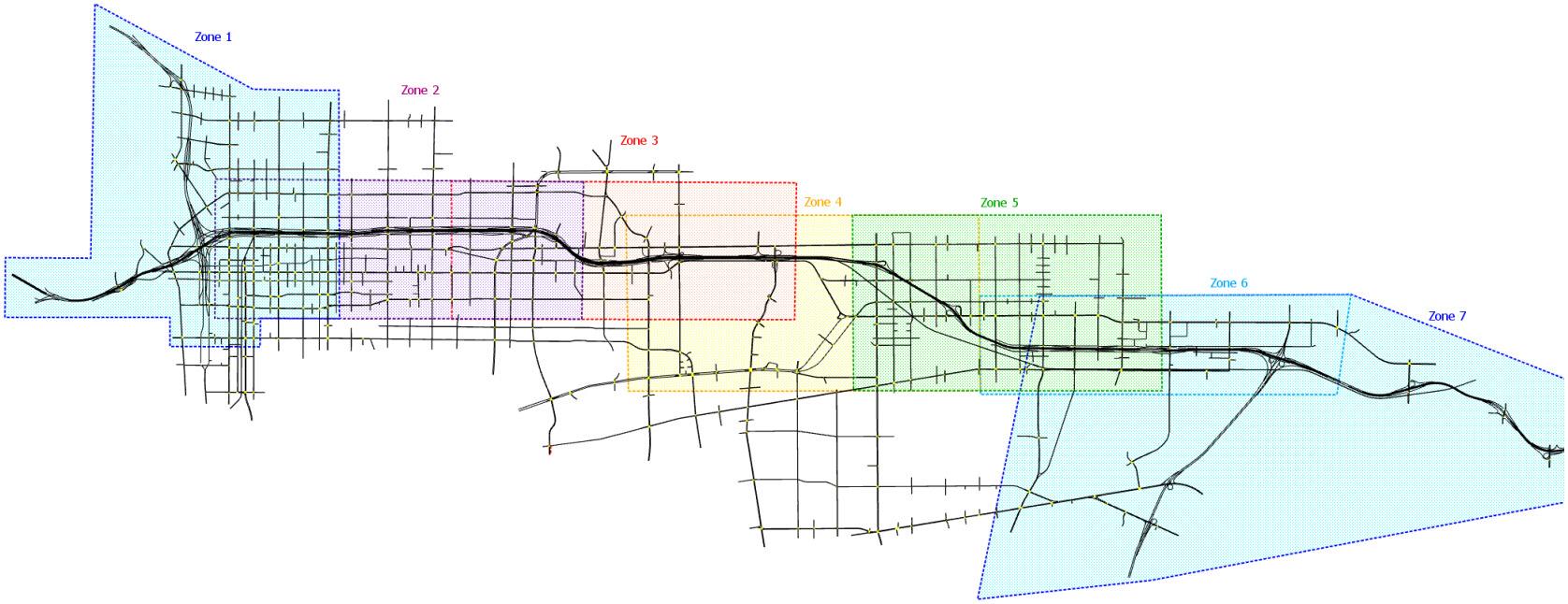
- **Filters can be applied to the stored data to restrict analyses to**
  - Entire network
  - Links belonging to a specific type of roadway (freeway, ramp, local street, etc.)
  - Links/nodes belonging to a specific area
  - Specific type of device (detector, signal, etc.)
- **Filters are simple comma-delimited lists that can be edited in Excel**

Extraction of Simulation Output Metrics

- **Data filters defined so far**
  - Links belonging to freeway network, with the following information associated with each link
    - Freeway association (I-210, SR-134, I-605)
    - Direction of travel (EB, WB, NB, WB)
    - Link type (mainline, HOV, off-ramp, on-ramp, freeway connector)
    - Start milepost
  - Links identifying the start of on-ramps and end of off-ramps, with the following information
    - Ramp type (on-ramp, off-ramp)
    - Milepost associated with start o end of ramp
  - Links belonging to a specific area of network (See zones on next slide)

Extraction of Simulation Output Metrics

- **Defined analysis areas - Zones**

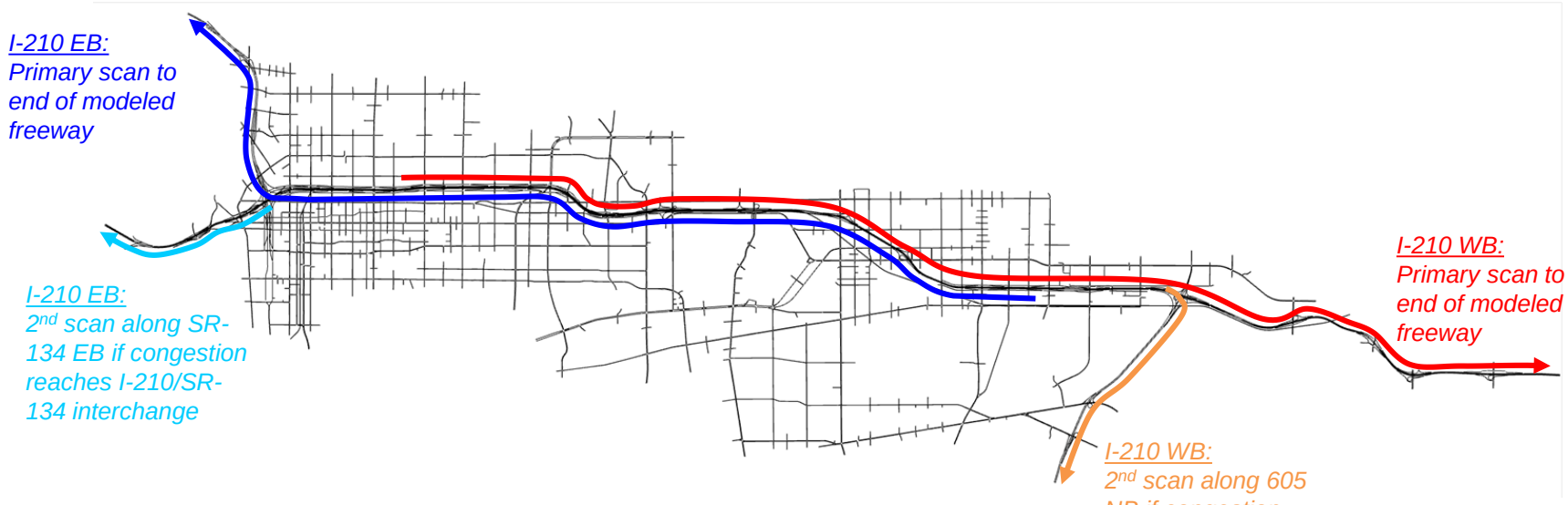


- Area boundaries based on current set of possible detours
- Areas intentionally overlaps – Can be merged in the analysis
- Areas will also be defined to cover each city

Back of Congestion Search

Back of Congestion Search

- **Incident Creator API was modified to search for the back end of congestion upstream of a given location along the I-210**
- **Search paths**



Back of Congestion Search

- **Current search criteria** – *to be changed if needed*
  - Consider a segment to be part of the congestion area is
    - Speed < 30 mph

      OR
    - Density > 90 veh/mile/lane
    - Flow < 1000 veh/hr/lane *(about half of capacity)*

Should we use 25 or 20 mph to focus on areas with high congestion?

  - To account for areas with higher speeds or low density due to shockwaves, short breaks in congested areas are ignored
    - Maximum break between congestion area: 1.0 mile

Should we use 0.75 or 0.50 mile?

Back of Congestion Search

- **Search result examples**

I-210 WB

Starting Point:
I-210 WB between Huntington and Santa Anita

End of Congestion:
I-210 WB just downstream of Buena Vista off-ramp

```
Congestion End Scan - 08:05:0.00 (29100.00)
Start Point: Section 22054 (I-210 WB)
   Section,   Length,  MilePost,    Speed,      Flow,     Density,    Break
                  mi         mi      mph  veh/hr/ln  veh/hr/ln         mi
     22084,    0.249,    33.23,     13.6,       810,      99.3,     0.00
     22088,    0.313,    33.56,     25.6,      1215,      56.6,     0.00
     22089,    0.262,    33.83,     20.1,      1032,      83.6,     0.00
     22410,    0.146,    33.98,     18.9,      1206,      88.6,     0.00
     22406,    0.480,    34.47,     21.5,      1251,      81.6,     0.00
     22402,    0.326,    34.80,     17.2,      1257,      76.8,     0.00
     22398,    0.373,    35.18,     18.1,      1407,      78.2,     0.00
     22102,    0.026,    35.20,     18.1,      1293,      62.9,     0.00
     22100,    0.244,    35.45,     19.9,      1262,      70.9,     0.00
     22379,    0.029,    35.48,     19.3,      1341,      60.8,     0.00
     22383,    0.277,    35.77,     18.7,      1320,      71.7,     0.00
     22367,    0.204,    35.99,     32.5,      1344,      53.8,     0.20
   8017148,    0.183,    36.18,     46.7,      1459,      30.4,     0.39
   7824807,    0.057,    36.27,     62.2,      1232,      17.7,     0.44
     22347,    0.151,    36.43,     67.1,      1359,      17.4,     0.59
     22168,    0.429,    36.87,     67.9,      1338,      18.7,     1.02
     22190,    0.138,    37.02,     68.3,      1371,      15.1,     1.16
***** End of congestion: Section 22383 - Mileposts: 32.43 -> 35.77 (3.33 miles)
```

I-605 NB

Starting Point:
I-605 NB / I-210 WB merge

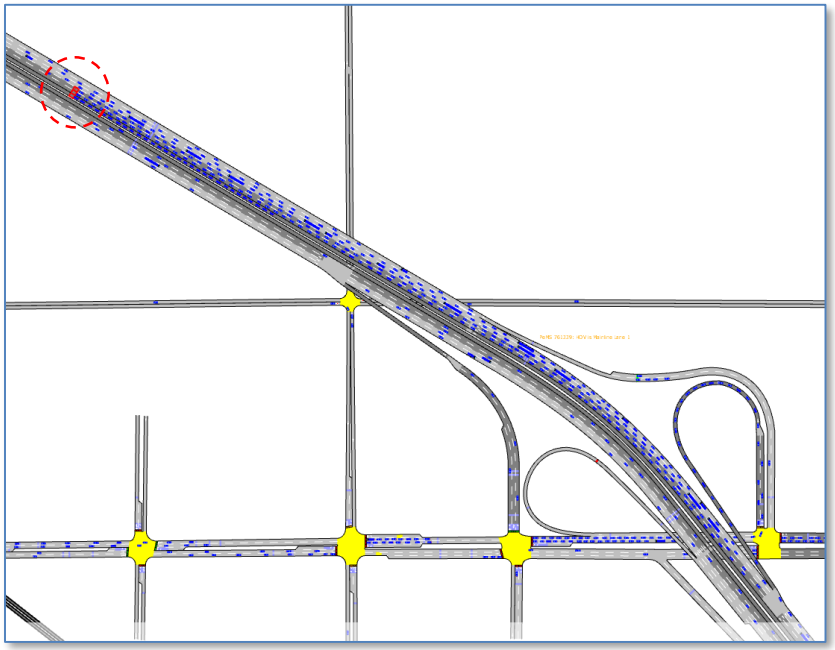
End of Congestion:
Split on connector between I-210 EB and I-210 WB branches

```
Start Point: Section 22343 (I-605 NB)
   8015063,    0.076,    28.02,     11.3,       966,      96.4,     0.00
   8015069,    0.490,    27.53,      9.2,       954,     114.0,     0.00
     22339,    0.130,    27.39,     15.7,       816,      73.2,     0.00
     22332,    0.131,    27.24,     48.0,      1254,      36.2,     0.13
   7996292,    0.518,    26.72,     65.6,      1245,      18.7,     0.65
   8014403,    0.327,    26.39,     66.5,      1188,      18.0,     0.98
   7996286,    0.089,    26.30,     62.4,      1173,      17.8,     1.07
     22803,    0.171,    26.12,     64.9,      1071,      13.9,     1.24
     22317,    0.861,    25.25,     68.5,       993,      14.2,     2.10
     22323,    0.230,    25.00,     70.7,      1194,      16.8,     2.33
***** End of congestion: Section 22339 - Mileposts: 28.10 -> 27.39 (0.71 miles)
```

Evaluation Example 1

Incident

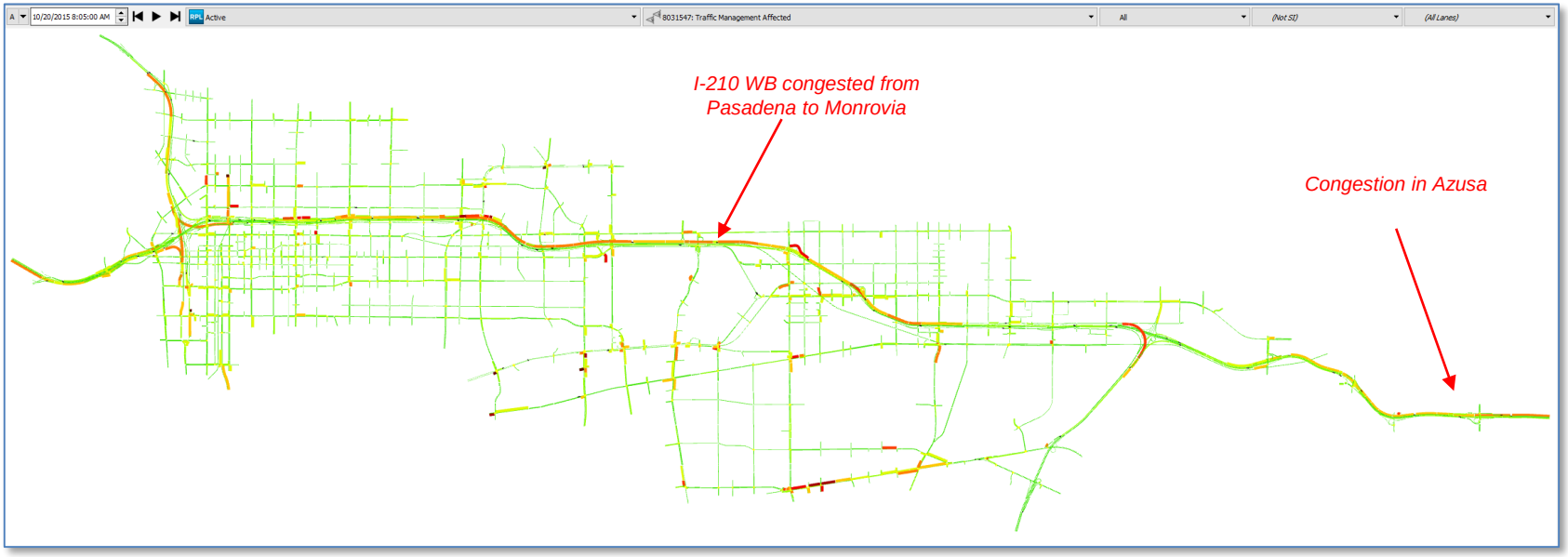
- **Incident blocking 3 lanes on I-210 WB near Huntington**
  - HOV lane
  - 2 left main lanes
- **Occurring at 8:00 AM**
- **Weekday**
- **Duration: 1 hour**



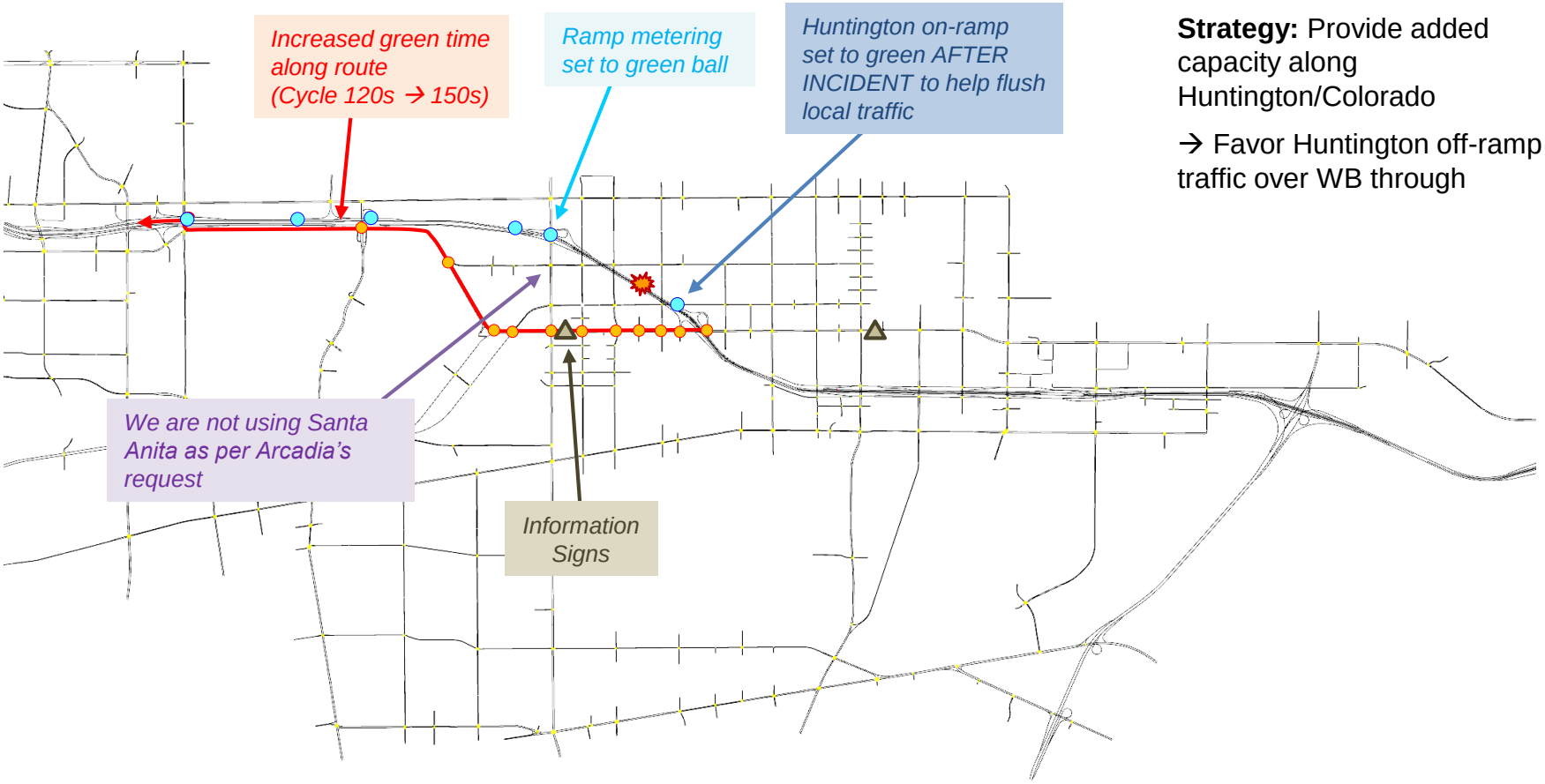
- **Following slides show density**

Incident Evaluation

- **Initial Conditions @ 8 AM**



Incident Response

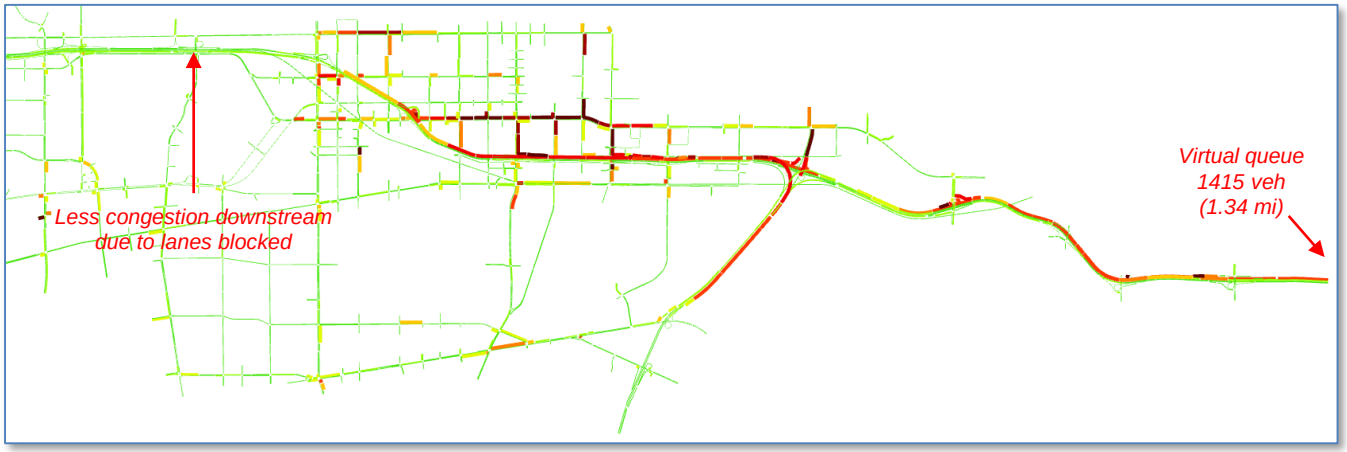


Strategy: Provide added capacity along Huntington/Colorado

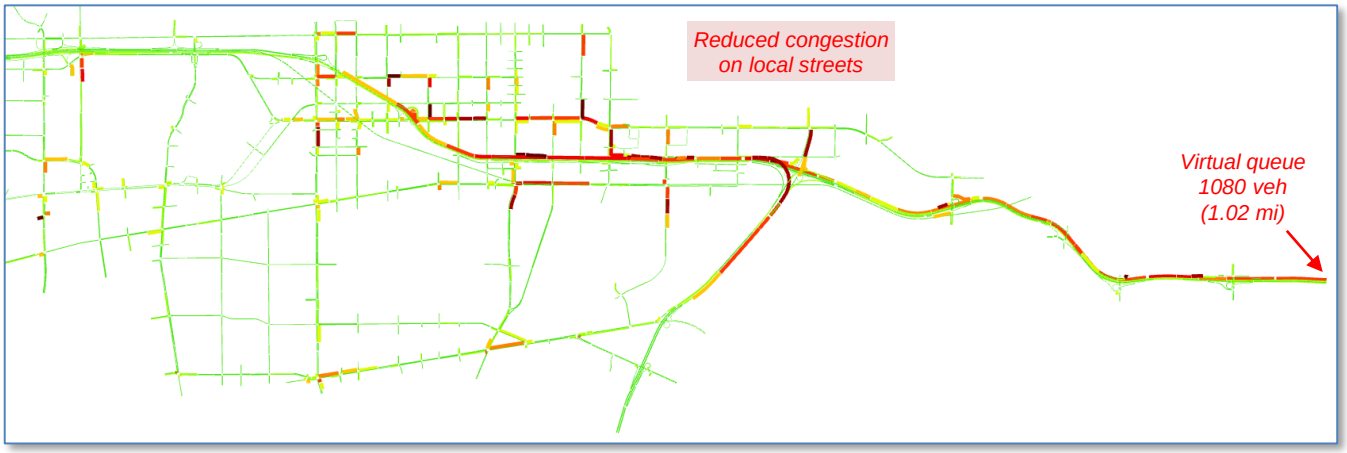
→ Favor Huntington off-ramp traffic over WB through

Traffic Congestion

- **Without response @ 9 AM**

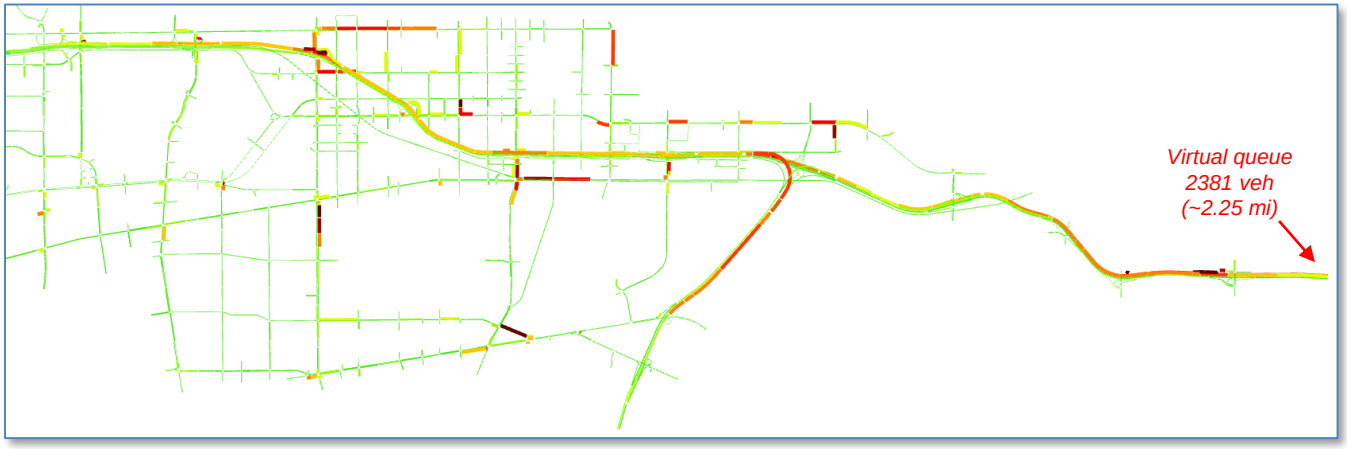


- **With response @ 9 AM**

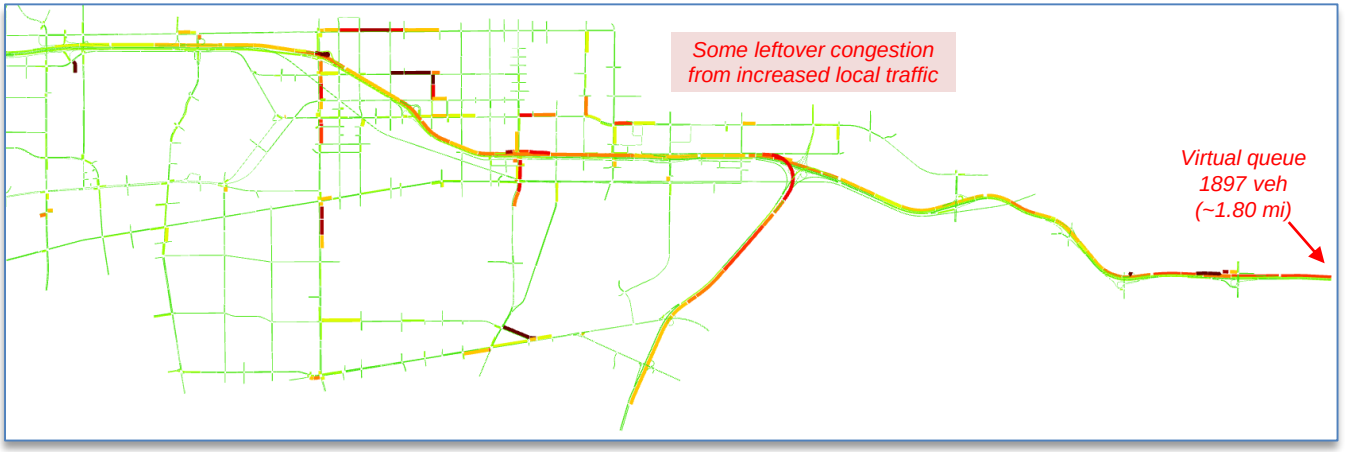


Traffic Congestion

- **Without response @ 9:30 AM**

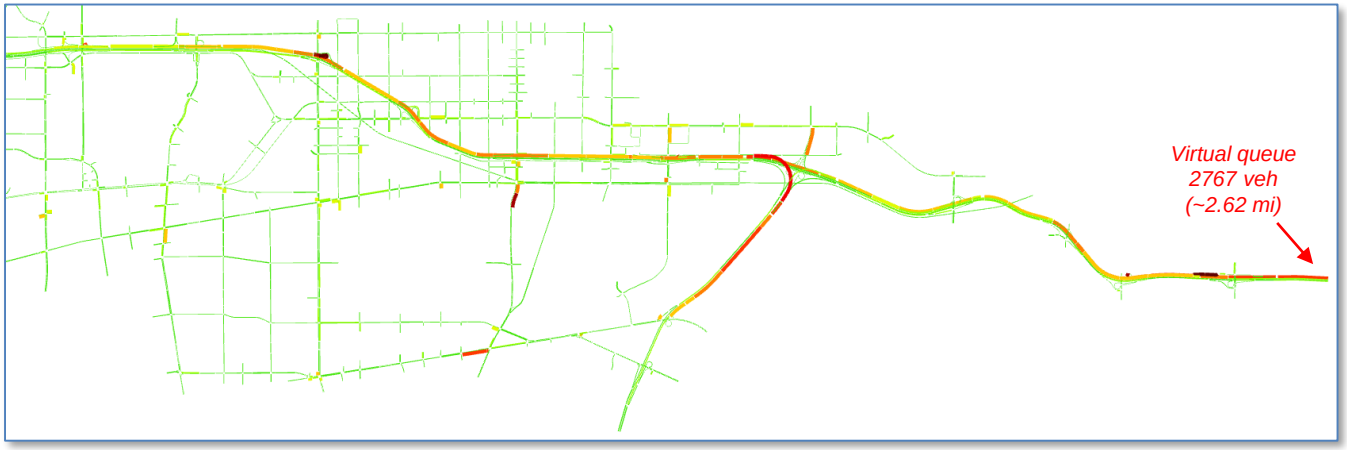


- **With response @ 9:30 AM**

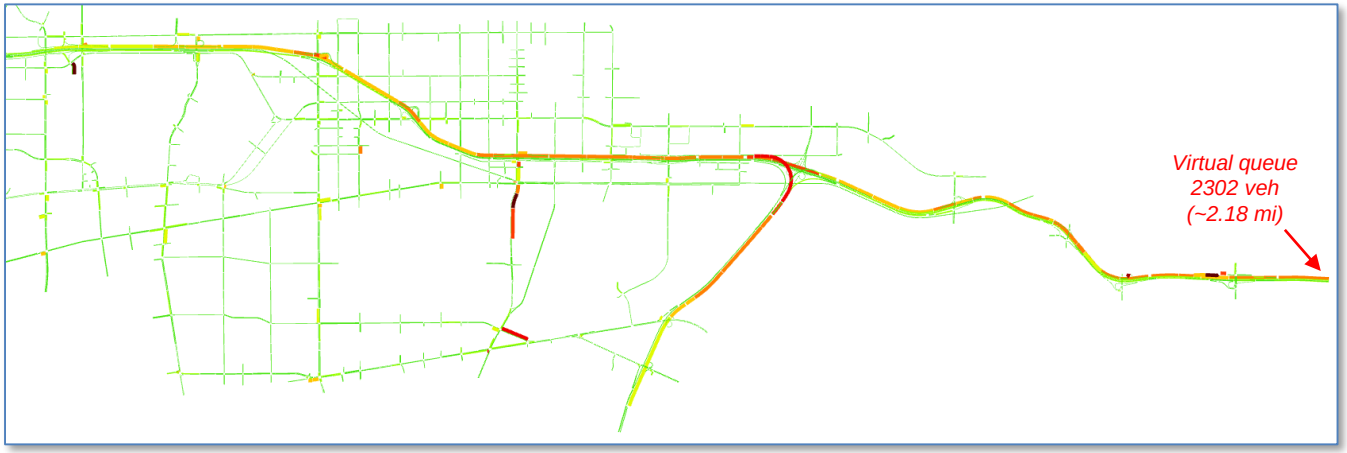


Traffic Congestion

- **Without response @ 10 AM**

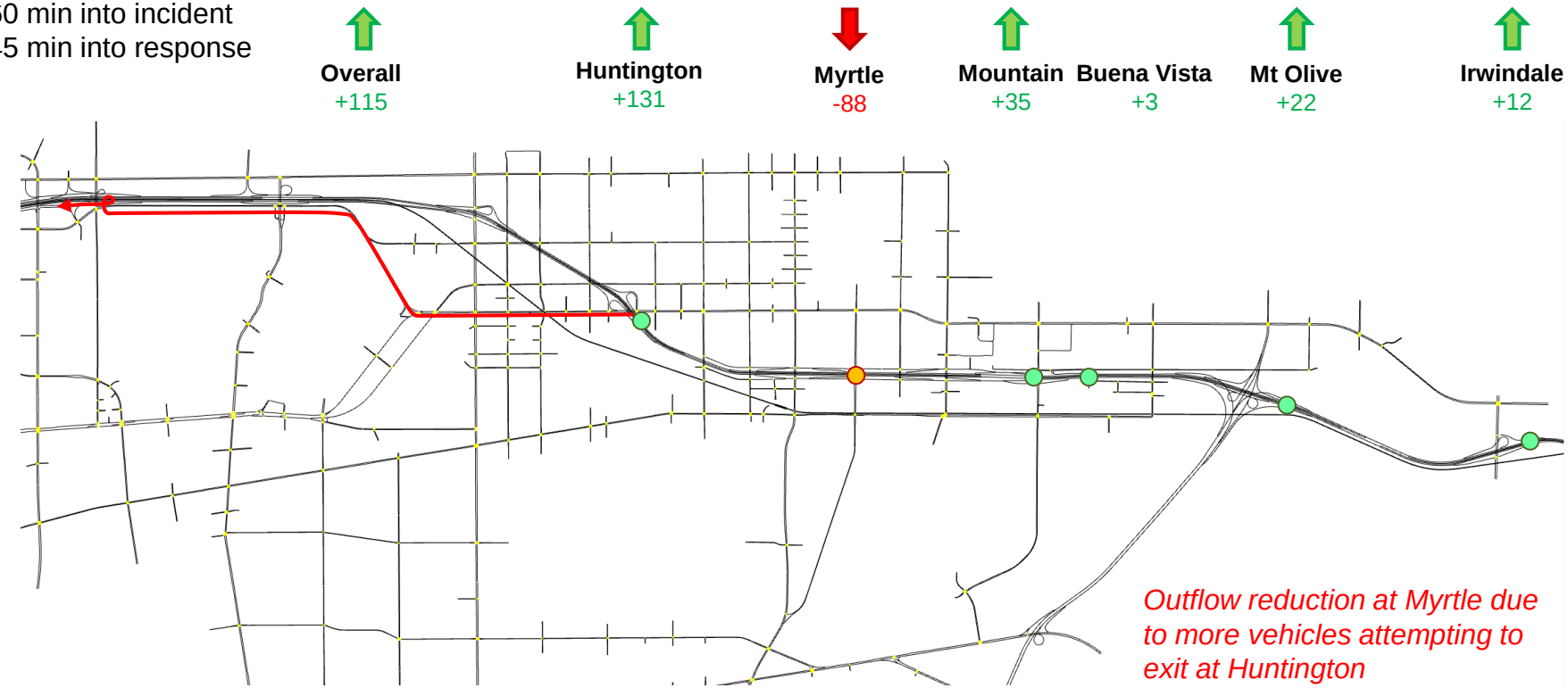


- **With response @ 10 AM**

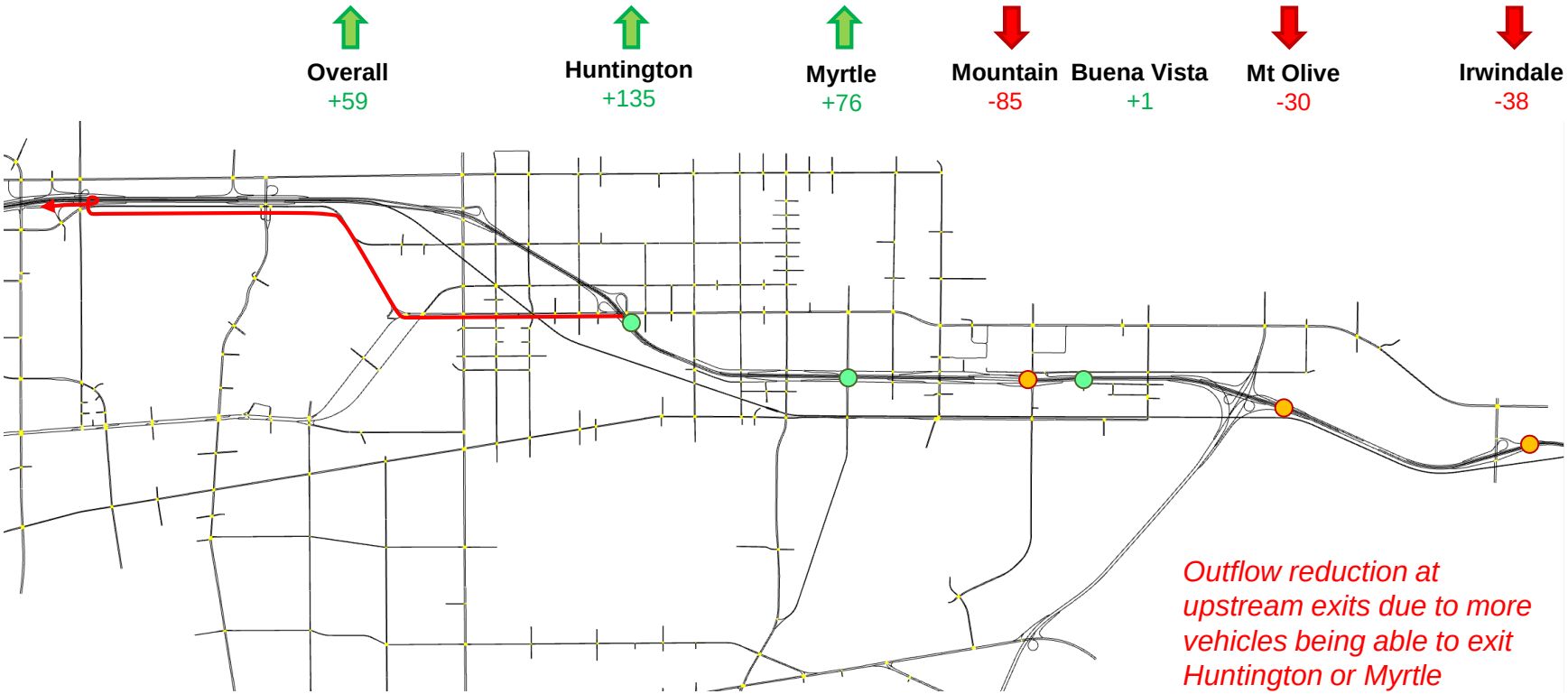


Ramp Count Deltas – End of 1st Hour

60 min into incident
45 min into response



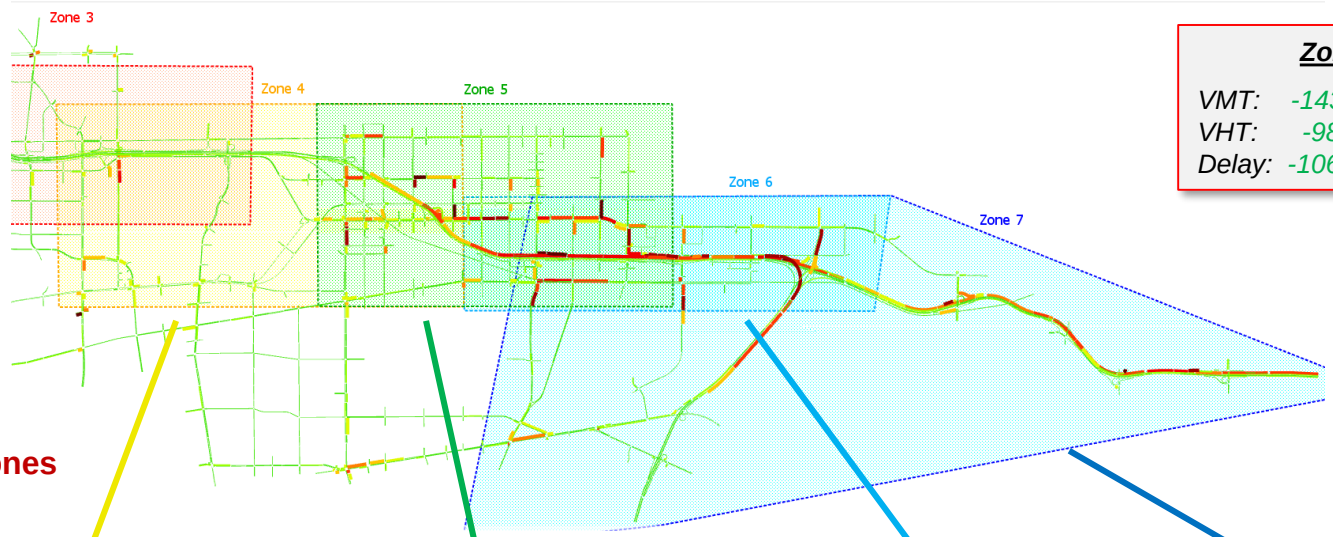
Ramp Count Deltas – End of 2nd Hour



Outflow reduction at upstream exits due to more vehicles being able to exit Huntington or Myrtle

Response Evaluation – End of 1st Hour

- **Impact on VMT, VHT and delay, 8 AM → 9 AM**



Zones 5-6-7

VMT: -143 veh-mi (-0.1%)
VHT: -98 veh-hrs (-1.1%)
Delay: -106 veh-hrs (-2.0%)

NOTE: Zones overlap

Zone 4

VMT: +336 veh-mi (+0.6%)
VHT: -40 veh-hrs (-1.0%)
Delay: -51 veh-hrs (-2.7%)

Zone 5

VMT: +386 veh-mi (+0.8%)
VHT: -90 veh-hrs (-2.2%)
Delay: -111 veh-hrs (-4.2%)

Zone 6

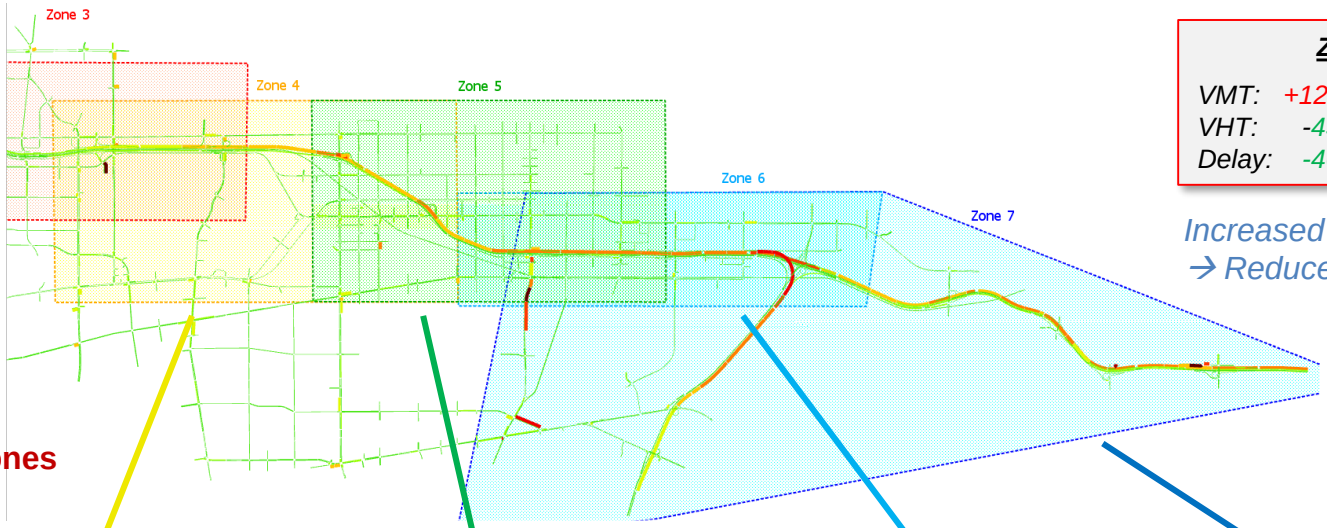
VMT: +145 veh-mi (+0.3%)
VHT: -49 veh-hrs (-1.3%)
Delay: -59 veh-hrs (-2.3%)

Zone 7

VMT: -436 veh-mi (-0.5%)
VHT: -17 veh-hrs (-0.3%)
Delay: -10 veh-hrs (-0.3%)

Response Evaluation – End of 2nd Hour

- **Impact on VMT, VHT and delay, 8 AM → 10 AM**



NOTE: Zones overlap

Zones 5-6-7

VMT: +1262 veh-mi (+0.5%)
VHT: -434 veh-hrs (-2.4%)
Delay: -465 veh-hrs (-4.0%)

Increased VMT, reduced VHT → Reduced congestion

Zone 4

VMT: +1070 veh-mi (+0.9%)
VHT: +153 veh-hrs (+2.2%)
Delay: +123 veh-hrs (+3.4%)

Zone 5

VMT: +456 veh-mi (+0.5%)
VHT: -187 veh-hrs (-2.3%)
Delay: -204 veh-hrs (-3.9%)

Zone 6

VMT: +327 veh-mi (+0.4%)
VHT: -246 veh-hrs (-3.2%)
Delay: -255 veh-hrs (-5.0%)

Zone 7

VMT: +907 veh-mi (+0.5%)
VHT: -370 veh-hrs (-2.8%)
Delay: -390 veh-hrs (-4.5%)

Response Evaluation – End of 1st Hour

- **Impact on freeway operations, 8 AM → 9 AM**

I-210 WB: I-605 → Incident

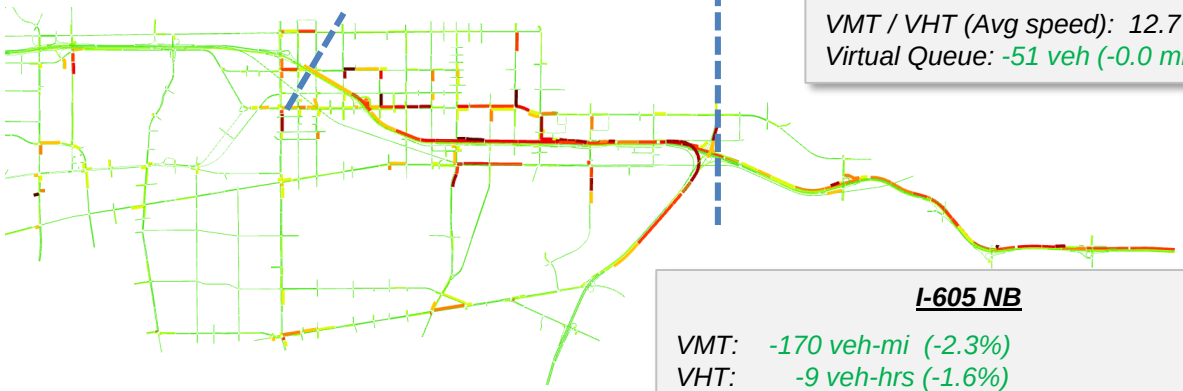
VMT: +142 veh-mi (+1.2%)
VHT: +9 veh-hrs (+0.5%)
Delay: +6 veh-hrs (+0.4%)

VMT / VHT (Avg speed): 6.8 mph → 6.9 mph

I-210 WB: East of I-605

VMT: +40 veh-mi (+0.2%)
VHT: +14 veh-hrs (+0.9%)
Delay: +14 veh-hrs (+1.2%)

VMT / VHT (Avg speed): 12.7 mph → 12.6 mph
Virtual Queue: -51 veh (-0.0 mile)



I-605 NB

VMT: -170 veh-mi (-2.3%)
VHT: -9 veh-hrs (-1.6%)
Delay: -5 veh-hrs (-1.2%)

VMT / VHT (Avg speed): 13.2 mph → 13.1 mph

Increased VMT and VHT, similar speed

→ Delay increase due to freeway processing more vehicles

Response Evaluation – End of 2nd Hour

- **Impact on freeway operations, 8 AM → 10 AM**

I-210 WB: I-605 → Incident

VMT: -332 veh-mi (-1.1%)
VHT: +63 veh-hrs (+1.7%)
Delay: +71 veh-hrs (+2.4%)

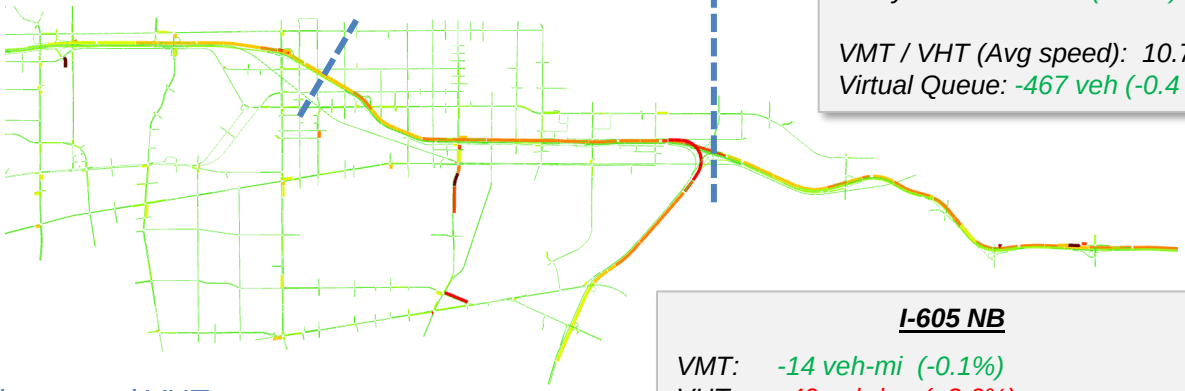
VMT / VHT (Avg speed): 8.3 mph → 8.1 mph

Increased VMT, reduced VHT and virtual queue → Reduced congestion

I-210 WB: East of I-605

VMT: +500 veh-mi (+1.2%)
VHT: -238 veh-hrs (-6.8%)
Delay: -248 veh-hrs (-8.5%)

VMT / VHT (Avg speed): 10.7 mph → 11.6 mph
Virtual Queue: -467 veh (-0.4 mile)



Decreased VMT, increased VHT

→ Increased congestion partly due to measures to flush local traffic

I-605 NB

VMT: -14 veh-mi (-0.1%)
VHT: +49 veh-hrs (+3.6%)
Delay: +50 veh-hrs (+4.6%)

VMT / VHT (Avg speed): 10.1 mph → 9.8 mph

General Observations

- **Overall observation:**
  - Delay Reduction with increased VMT
  - Queue length decreased
  - This is at rush hour so this is a difficult environment
- **Significant benefits typically obtained from continuing response after incident has cleared**
  - Traffic signals along detour kept in operation for 15-30 minutes
  - Ramp meters at key on-ramps set to green to prevent automatic flow reduction while the freeway queue is being processed
- **Allows traffic on local street to get back quicker on freeway**
  - Additional delay savings

General Observations

- **VMT will often go up in corridor up as vehicles are pushed on longer routes**
- **Use of longer routes will tend to increase VHT**
  - Objective: Reduce delay significantly to overcome the increase in VHT
- **Freeway delay savings may be eaten up by delay increase on local streets**
- **VHT and delay increases may simply be the result of more vehicles traveling on a section of road**
  - Need to focus on delay per vehicle
- **VMT and VHT do not measure safety benefits that result from keeping traffic moving better and having shorter queues**
  - Less impatient drivers → Increased safety?

Same Incident – Different Response

- **Strategy: Provide added capacity along Huntington to absorb inflow from Myrtle, Mountain and Mt Olive**
- **Penalize Huntington exit**
- **Does not help left turn onto Huntington**

Response Evaluation – End of 2nd Hour

- **Impact on freeway operations, 8 AM → 10 AM**

VMT Increase, reduced VHT, reduce virtual queue → Reduced congestion

I-210 WB: I-605 → Incident

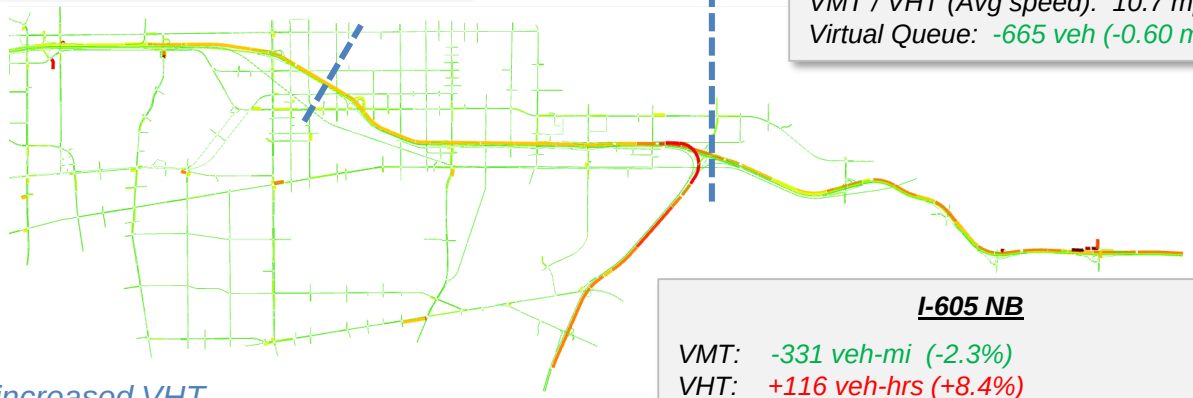
VMT: -191 veh-mi (-0.6%)
VHT: +51 veh-hrs (+1.4%)
Delay: +55 veh-hrs (+1.9%)

VMT / VHT (Avg speed): 8.3 mph → 8.1 mph

I-210 WB: East of 605

VMT: +1311 veh-mi (+3.2%)
VHT: -175 veh-hrs (-4.6%)
Delay: -202 veh-hrs (-7.0%)

VMT / VHT (Avg speed): 10.7 mph → 11.6 mph
Virtual Queue: -665 veh (-0.60 mile)



I-605 NB

VMT: -331 veh-mi (-2.3%)
VHT: +116 veh-hrs (+8.4%)
Delay: +123 veh-hrs (+11.5%)

VMT / VHT (Avg speed): 10.1 mph → 9.1 mph

Decreased VMT, increased VHT

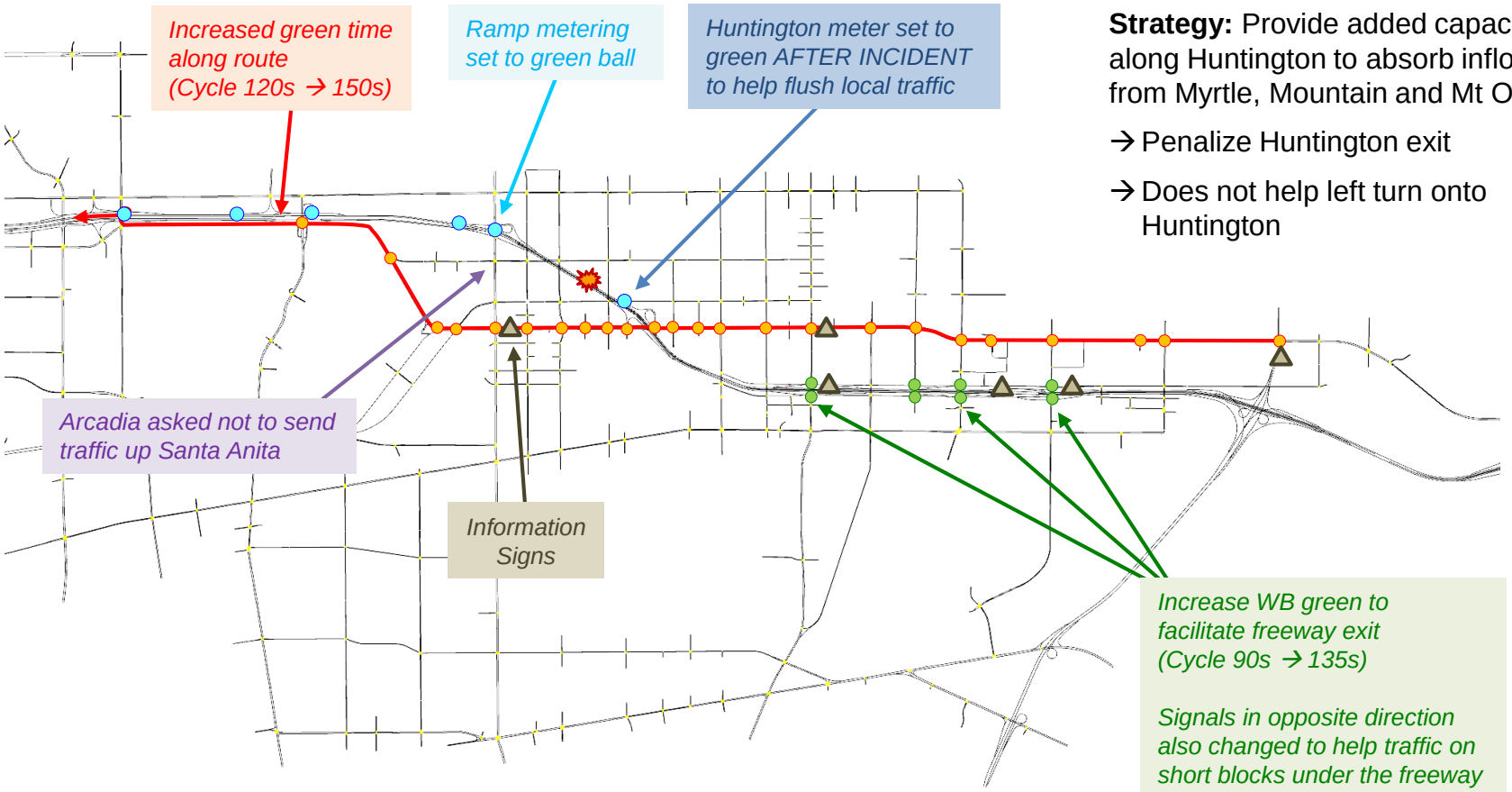
→ Increased congestion partly due to measure to flush local traffic

Evaluation Example 2

Same Incident – Different Response

- **Same Incident**
- **Different Strategy:**
  - Provide added capacity along Huntington to absorb inflow from Myrtle, Mountain and Mt Olive
  - Penalize Huntington exit
  - Does not help left turn onto Huntington

Incident Response – End of 1st Hour



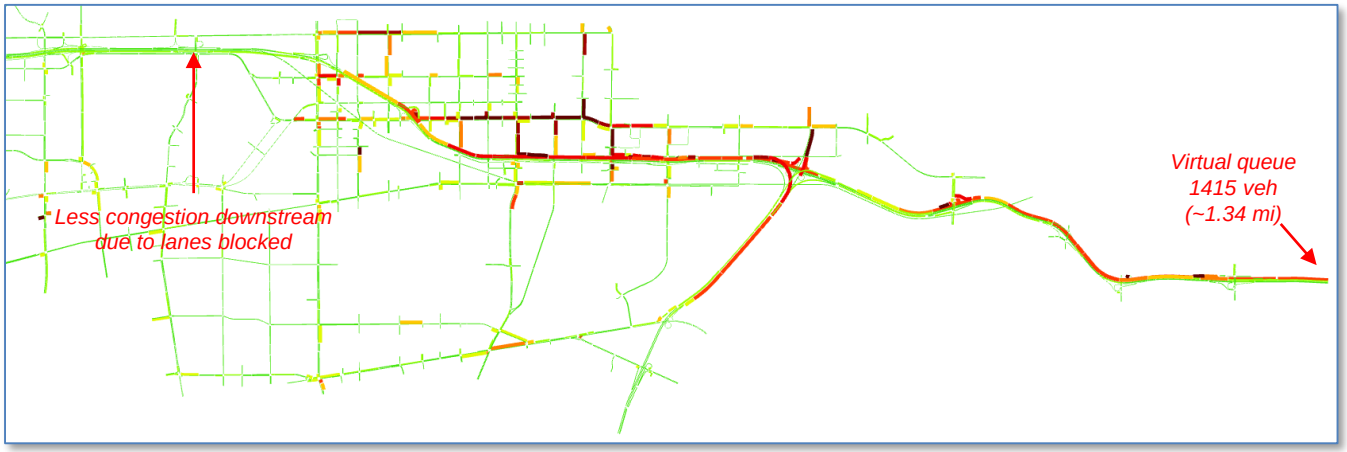
Strategy: Provide added capacity along Huntington to absorb inflow from Myrtle, Mountain and Mt Olive

→ Penalize Huntington exit

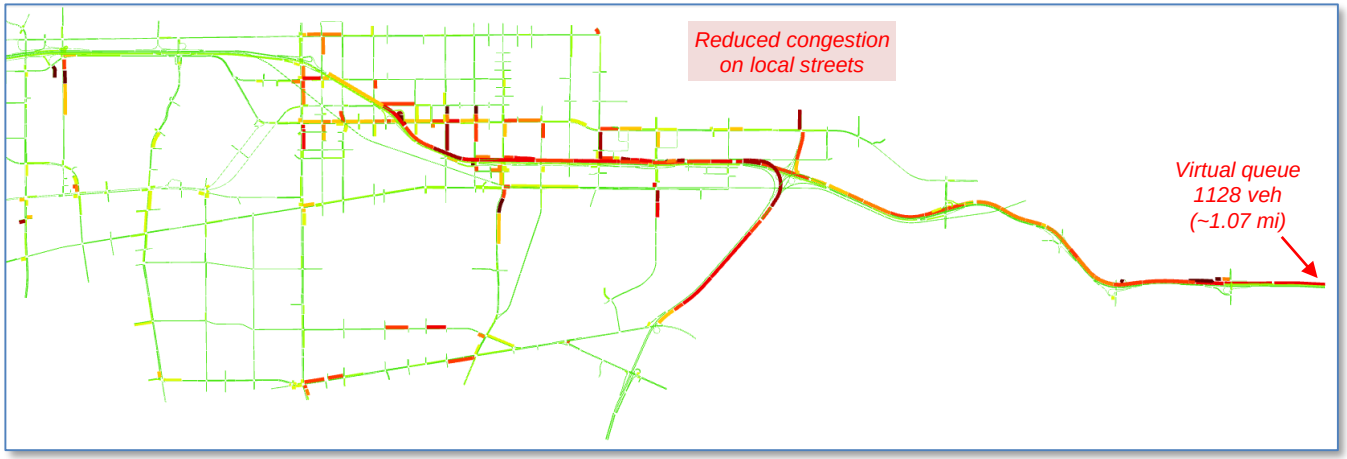
→ Does not help left turn onto Huntington

Traffic Congestion

- **Without response @ 9 AM**

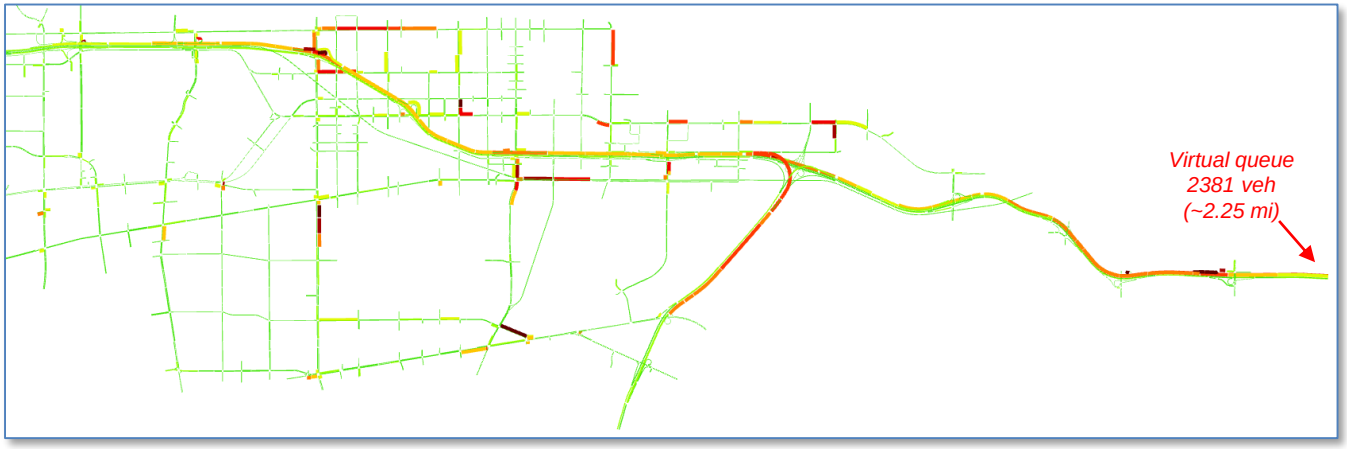


- **With response @ 9 AM**

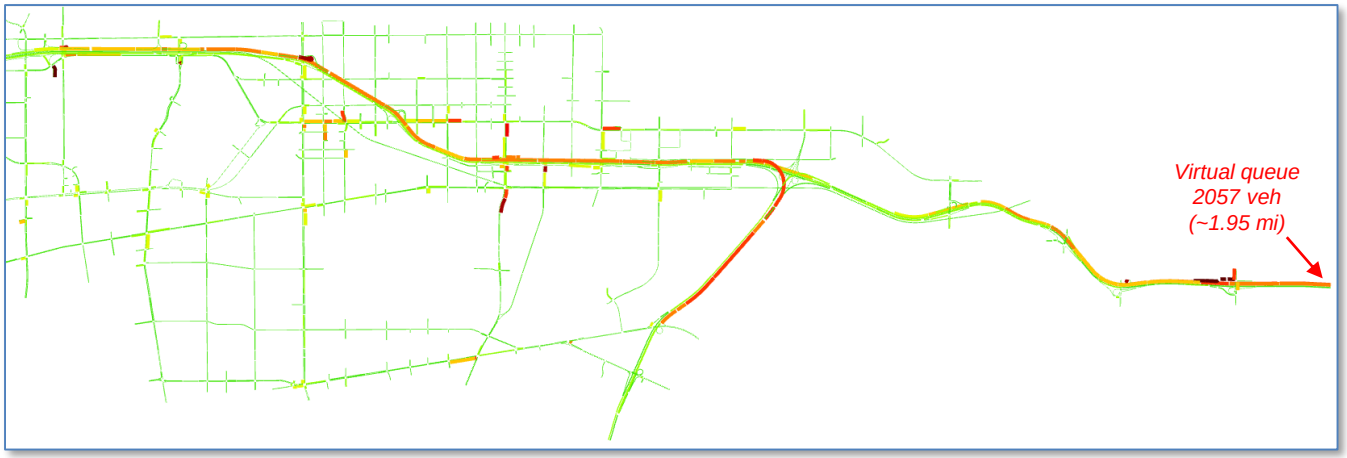


Traffic Congestion

- **Without response @ 9:30 AM**

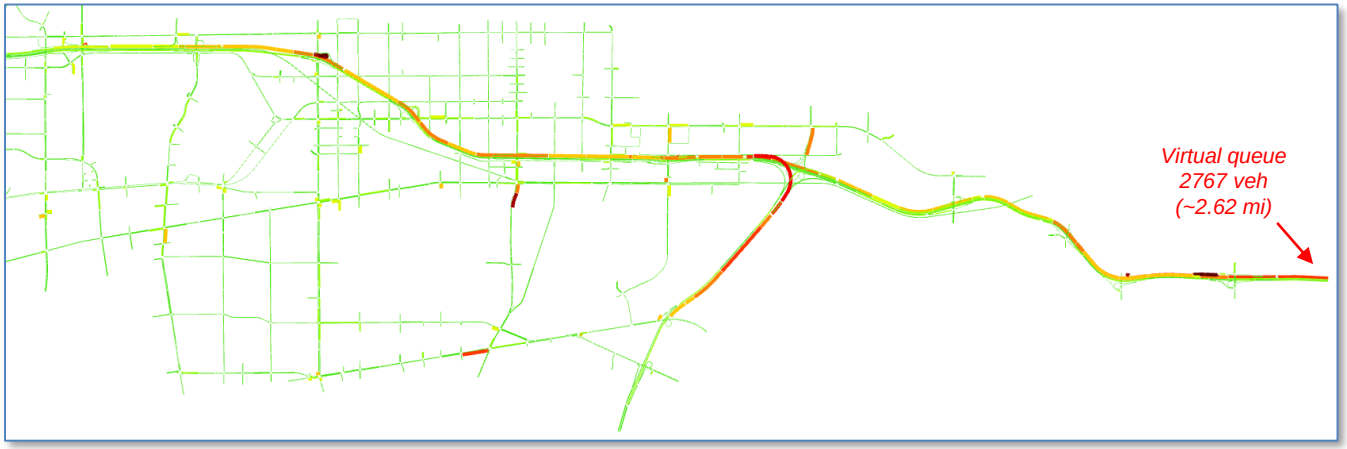


- **With response @ 9:30 AM**

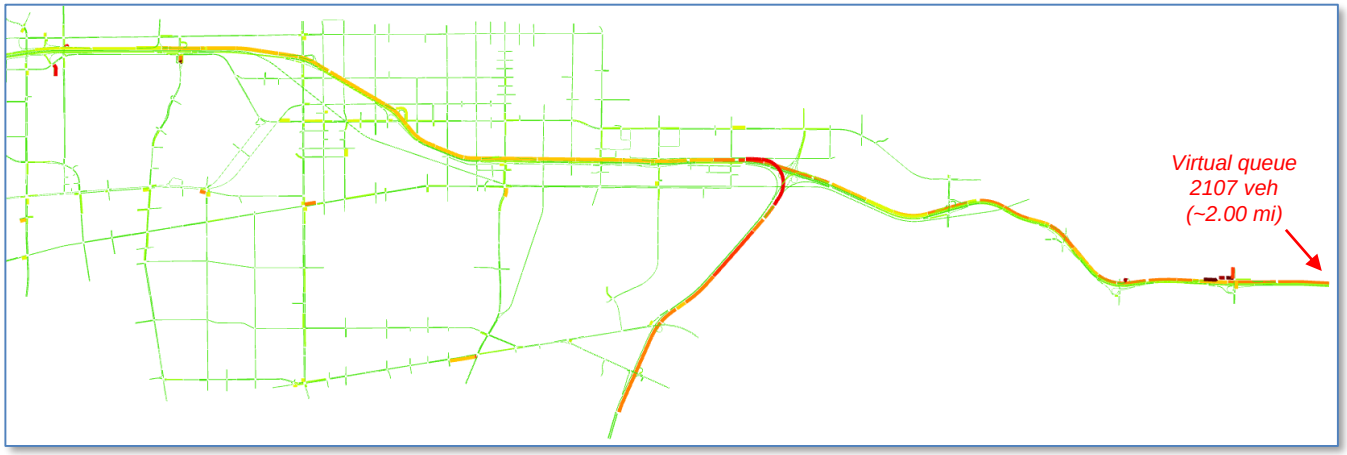


Traffic Congestion

- **Without response @ 10 AM**

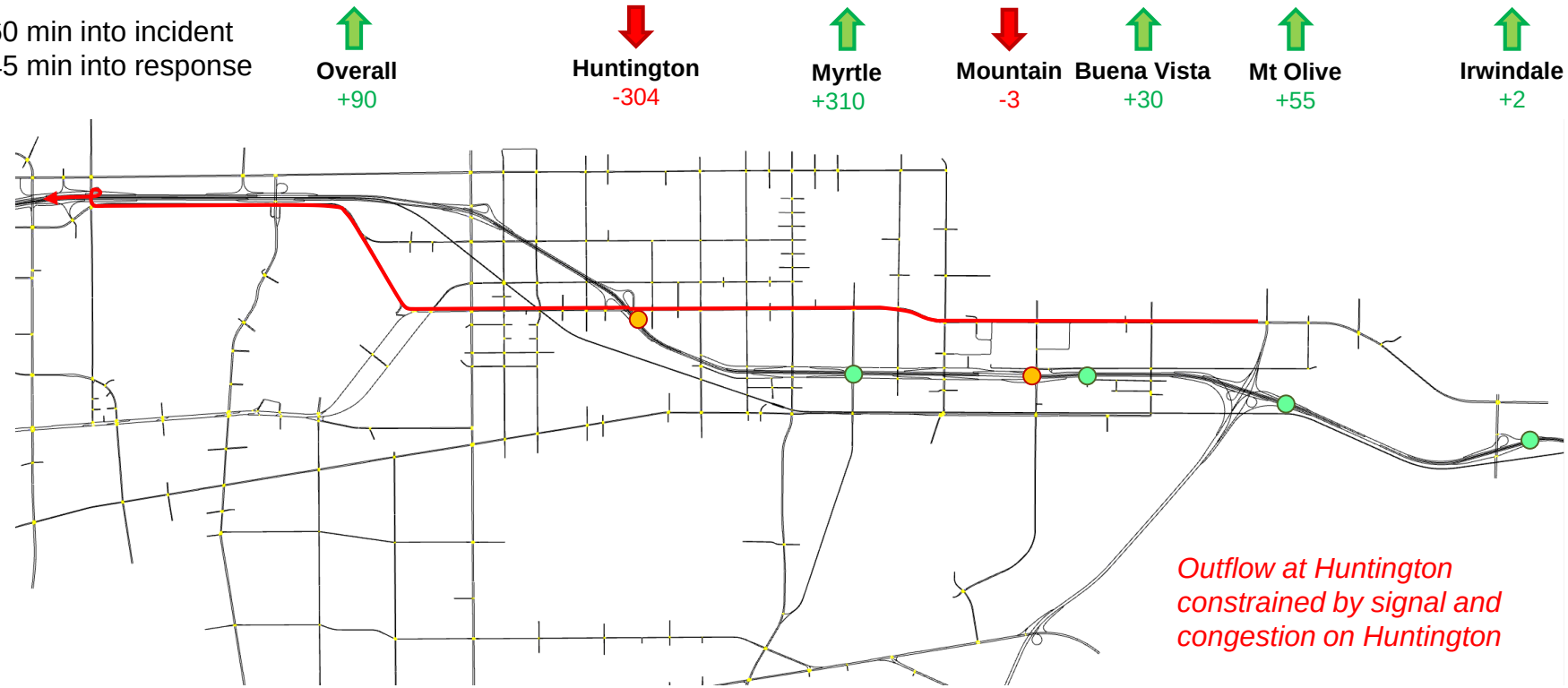


- **With response @ 10 AM**

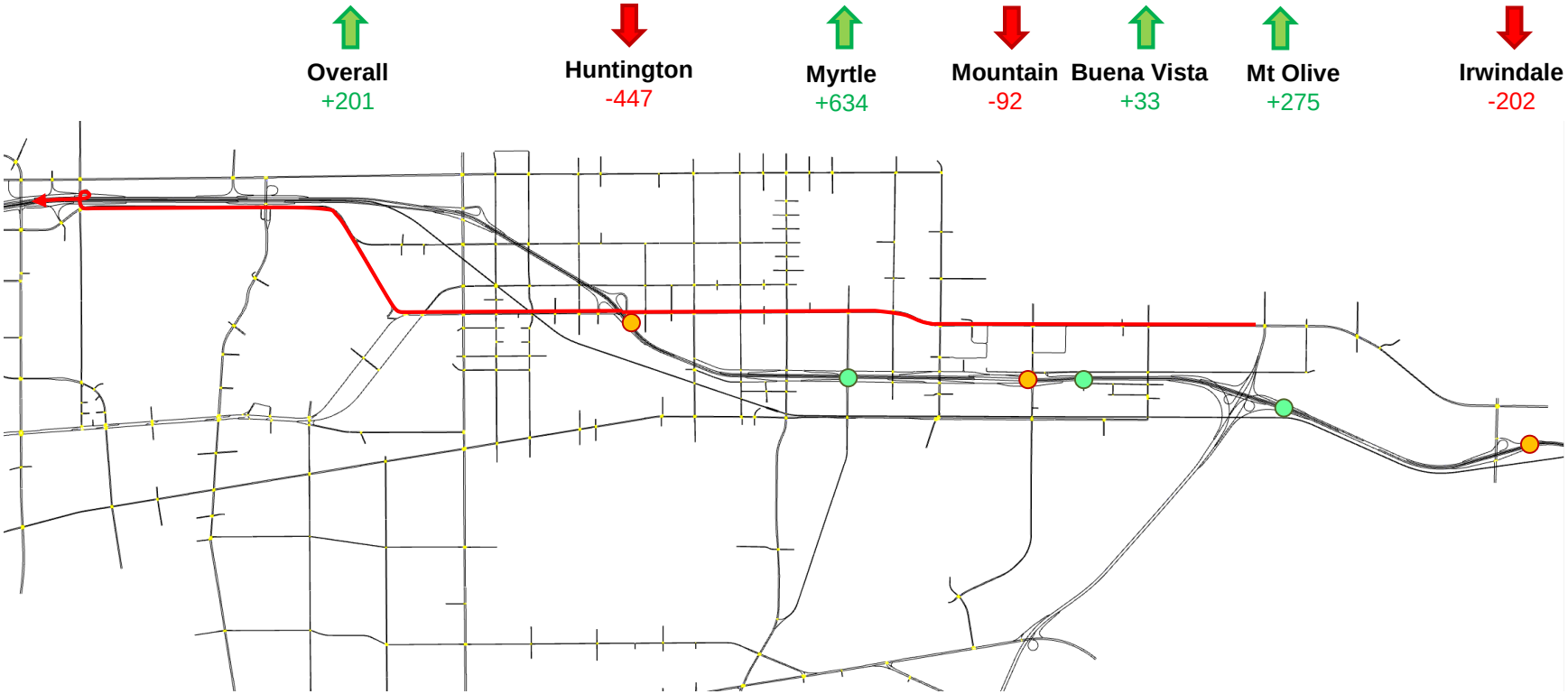


Ramp Counts – End of 1st Hour

60 min into incident
45 min into response

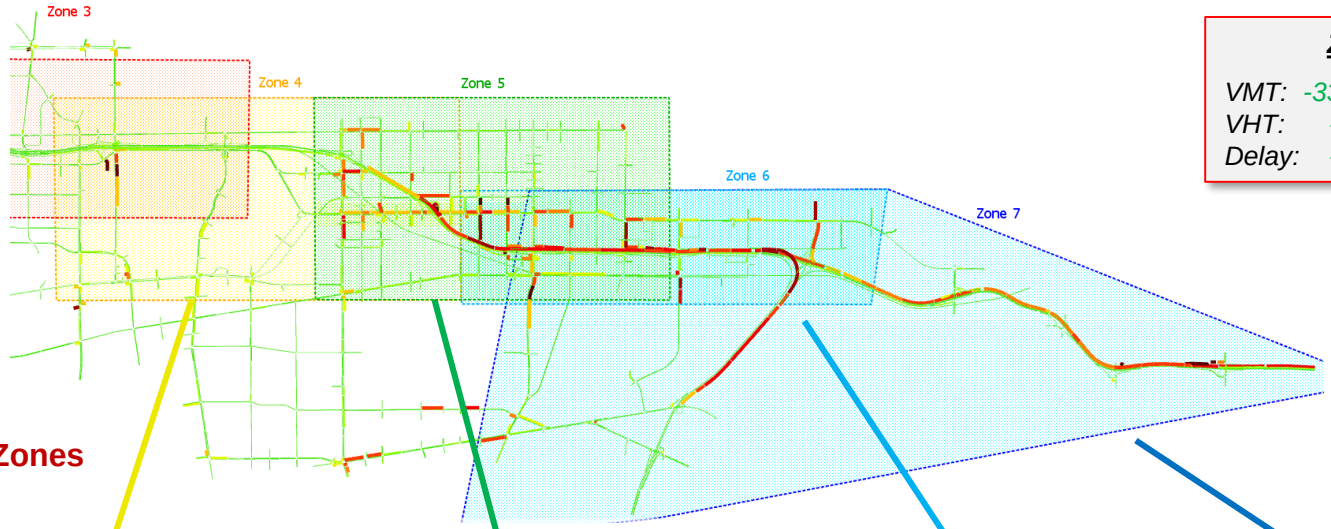


Ramp Counts – End of 2nd Hour



Response Evaluation – End of 1st Hour

- **Impact on VMT, VHT and delay, 8 AM → 9 AM**



NOTE: Zones overlap

Zones 5-6-7

VMT: -335 veh-mi (-0.3%)
VHT: -4 veh-hrs (-0.1%)
Delay: -6 veh-hrs (-0.1%)

Zone 4

VMT: +287 veh-mi (+0.5%)
VHT: +79 veh-hrs (+2.2%)
Delay: +65 veh-hrs (+3.4%)

Zone 5

VMT: +212 veh-mi (+0.5%)
VHT: +35 veh-hrs (+0.9%)
Delay: +22 veh-hrs (+0.8%)

Zone 6

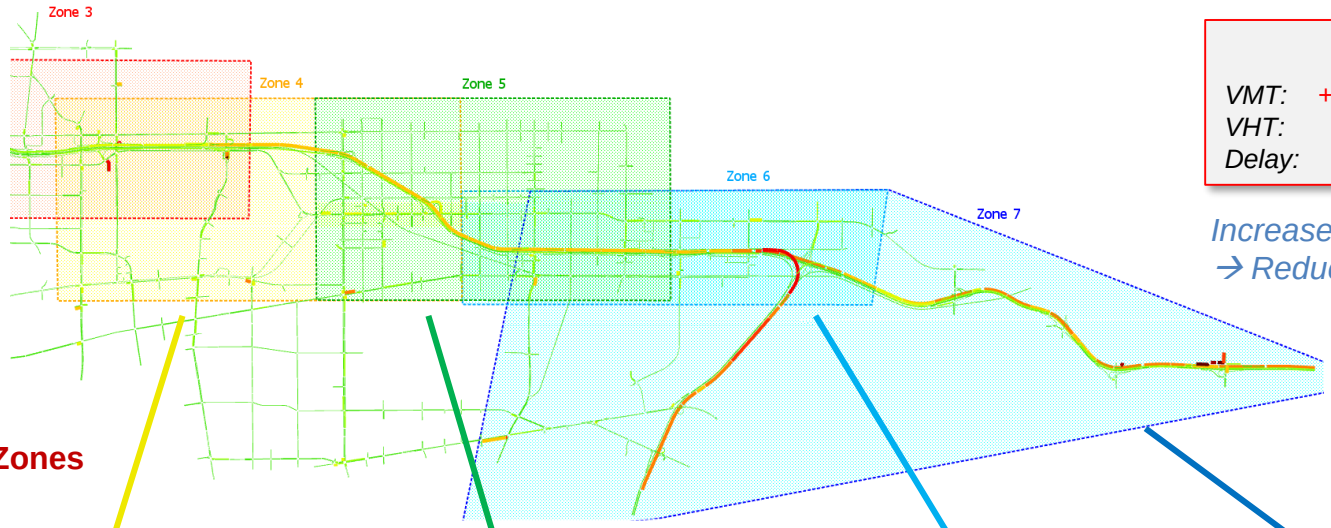
VMT: +129 veh-mi (+0.3%)
VHT: +23 veh-hrs (+0.6%)
Delay: +13 veh-hrs (+0.5%)

Zone 7

VMT: -428 veh-mi (-0.4%)
VHT: -4 veh-hrs (-0.1%)
Delay: +2 veh-hrs (+0.1%)

Response Evaluation – End of 2nd Hour

- **Impact on VMT, VHT and delay, 8 AM → 10 AM**



Zones 5-6-7

VMT: +2260 veh-mi (+0.9%)
VHT: -569 veh-hrs (-3.1%)
Delay: -634 veh-hrs (-5.5%)

Increased VMT, reduced VHT → Reduced congestion

NOTE: Zones overlap

Zone 4

VMT: +1288 veh-mi (+1.6%)
VHT: +173 veh-hrs (+2.6%)
Delay: +113 veh-hrs (+3.1%)

Zone 5

VMT: +1033 veh-mi (+1.1%)
VHT: -331 veh-hrs (-4.1%)
Delay: -373 veh-hrs (-7.2%)

Zone 6

VMT: +1364 veh-mi (+1.5%)
VHT: -299 veh-hrs (-4.0%)
Delay: -344 veh-hrs (-6.7%)

Zone 7

VMT: +1722 veh-mi (+0.9%)
VHT: -439 veh-hrs (-3.3%)
Delay: -481 veh-hrs (-5.6%)

Response Evaluation – End of 1st Hour

- **Impact on freeway operations, 8 AM → 9 AM**

I-210 WB – Incident to I-605

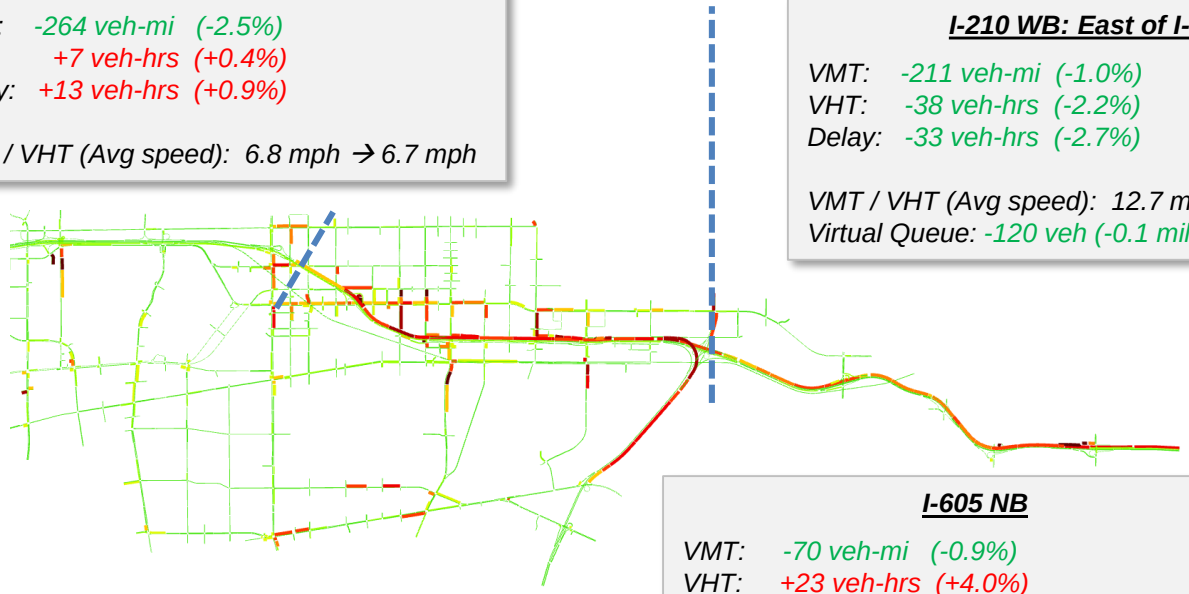
VMT: -264 veh-mi (-2.5%)
VHT: +7 veh-hrs (+0.4%)
Delay: +13 veh-hrs (+0.9%)

VMT / VHT (Avg speed): 6.8 mph → 6.7 mph

I-210 WB: East of I-605

VMT: -211 veh-mi (-1.0%)
VHT: -38 veh-hrs (-2.2%)
Delay: -33 veh-hrs (-2.7%)

VMT / VHT (Avg speed): 12.7 mph → 12.9 mph
Virtual Queue: -120 veh (-0.1 mile)



I-605 NB

VMT: -70 veh-mi (-0.9%)
VHT: +23 veh-hrs (+4.0%)
Delay: +25 veh-hrs (+6.1%)

VMT / VHT (Avg speed): 13.2 mph → 12.6 mph

Response Evaluation – End of 2nd Hour

- **Impact on freeway operations, 8 AM → 10 AM**

VMT Increase, reduced VHT, reduce virtual queue → Reduced congestion

I-210 WB: I-605 → Incident

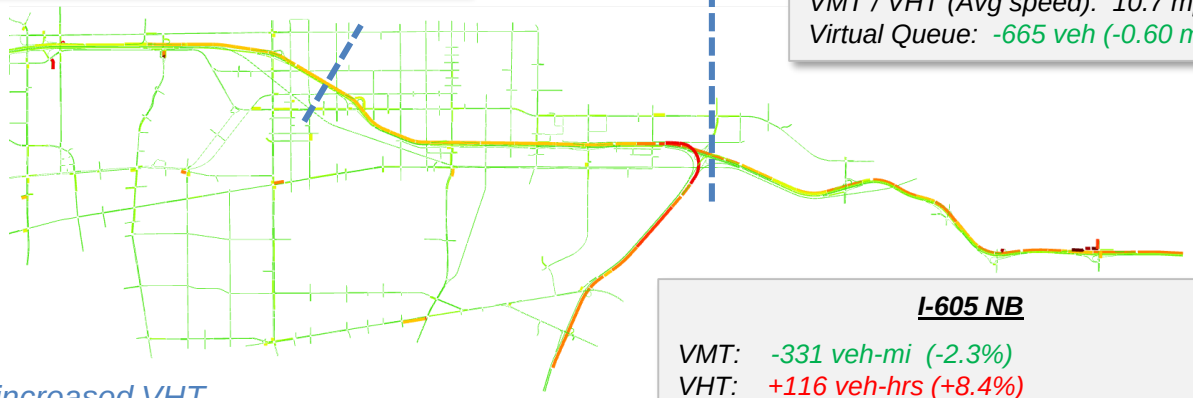
VMT: -191 veh-mi (-0.6%)
VHT: +51 veh-hrs (+1.4%)
Delay: +55 veh-hrs (+1.9%)

VMT / VHT (Avg speed): 8.3 mph → 8.1 mph

I-210 WB: East of 605

VMT: +1311 veh-mi (+3.2%)
VHT: -175 veh-hrs (-4.6%)
Delay: -202 veh-hrs (-7.0%)

VMT / VHT (Avg speed): 10.7 mph → 11.6 mph
Virtual Queue: -665 veh (-0.60 mile)



I-605 NB

VMT: -331 veh-mi (-2.3%)
VHT: +116 veh-hrs (+8.4%)
Delay: +123 veh-hrs (+11.5%)

VMT / VHT (Avg speed): 10.1 mph → 9.1 mph

Decreased VMT, increased VHT

→ Increased congestion partly due to measure to flush local traffic

Thank You
and
Next Meeting
(Suggest Tuesday September 17th at Monrovia)