NEW SIGNAL PERFORMANCE ANALYTICS FOR MARYLAND

Leveraging Connected Vehicles to Understand the Performance of Traffic Signals Statewide

BRTB Traffic Signal Subcommittee Meeting

September 15, 2022

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MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

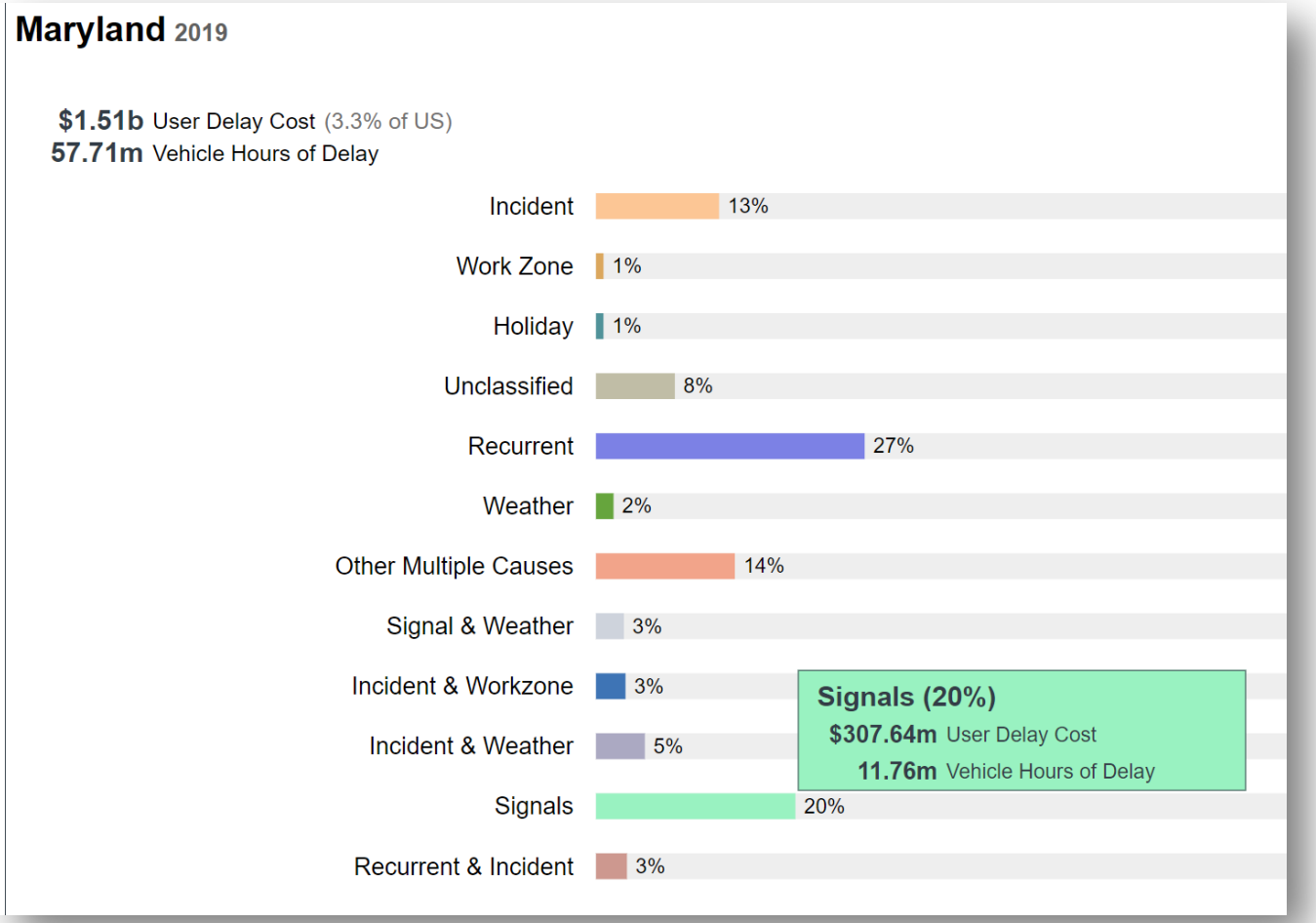
AGENDA

- Signal Analytics Introduction – Why and How Does it Work?
- How Maryland Can Use Signal Analytics to Monitor & Improve Traffic Signal Operations
- Challenges & Next Steps for MDOT

WHY SIGNAL ANALYTICS?

- Signalized intersections contribute to approx. 20% of delay in Maryland (*University of Maryland – CATT Lab*)
- MDOT SHA efforts to improve mobility through efficient signal operations continue
- Signal Analytics is an affordable way to identify and address delay, emissions and economic impacts
- Latest operations strategy added to the MDOT SHA toolbox

DELAYS, EMISSIONS, & ECONOMIC IMPACTS



In 2019, signals contributed to:

- **$300M+ in User Delay Cost**
- **11.7M+ Vehicle Hours of Delay**

Just on the National Highway System in Maryland.

Monitoring these signals is critical to the economy, environment, and quality of life.

BENEFITS OF SIGNAL ANALYTICS

- Issues can be identified quickly
- Proactive instead of reactive response
- More efficient traffic signal operations
- Data to communicate outcomes
- Cost savings

CONCEPT/ HOW DOES IT WORK?

- Intersection Performance Metrics from 3rd Party Connected Vehicle Data
- No roadside infrastructure required
- No server and IT resources required
- Scalable anywhere in the state

CONCEPT/ HOW DOES IT WORK?

The Data

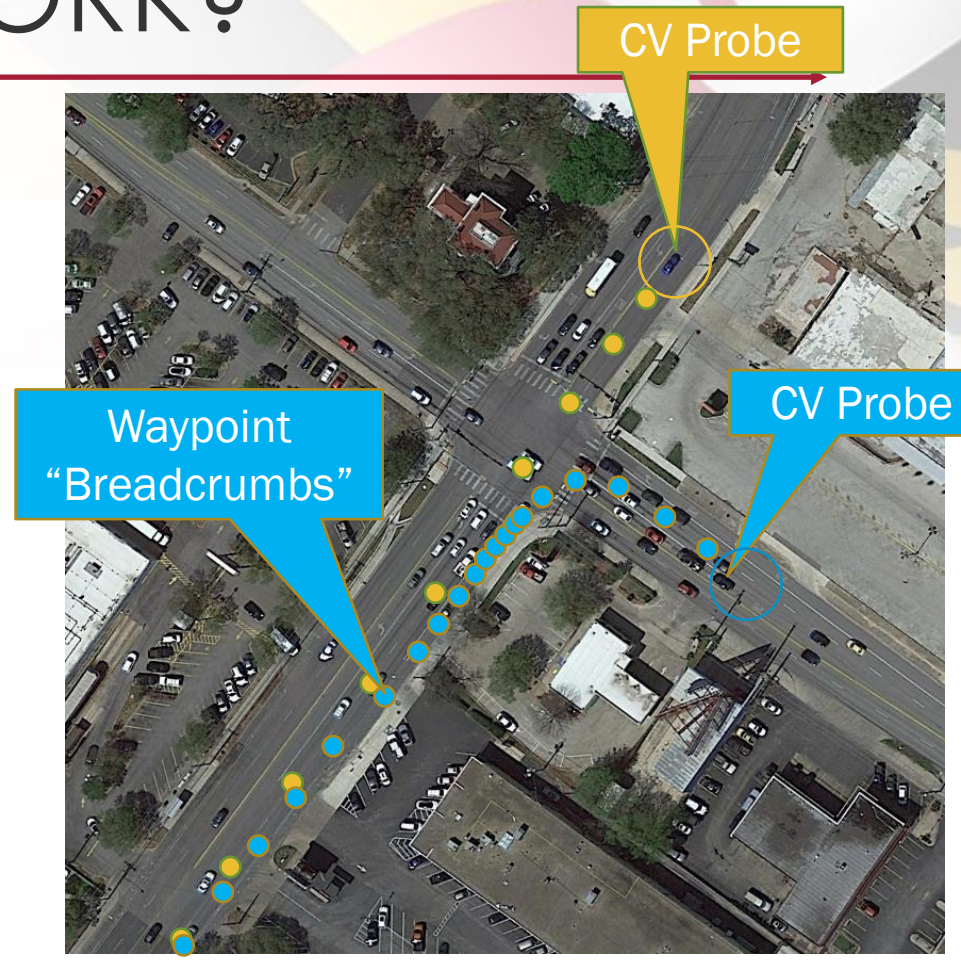
3 to 5 second frequency vehicle waypoints collected from connected vehicles snapped to a free, open, and global map

The Metrics

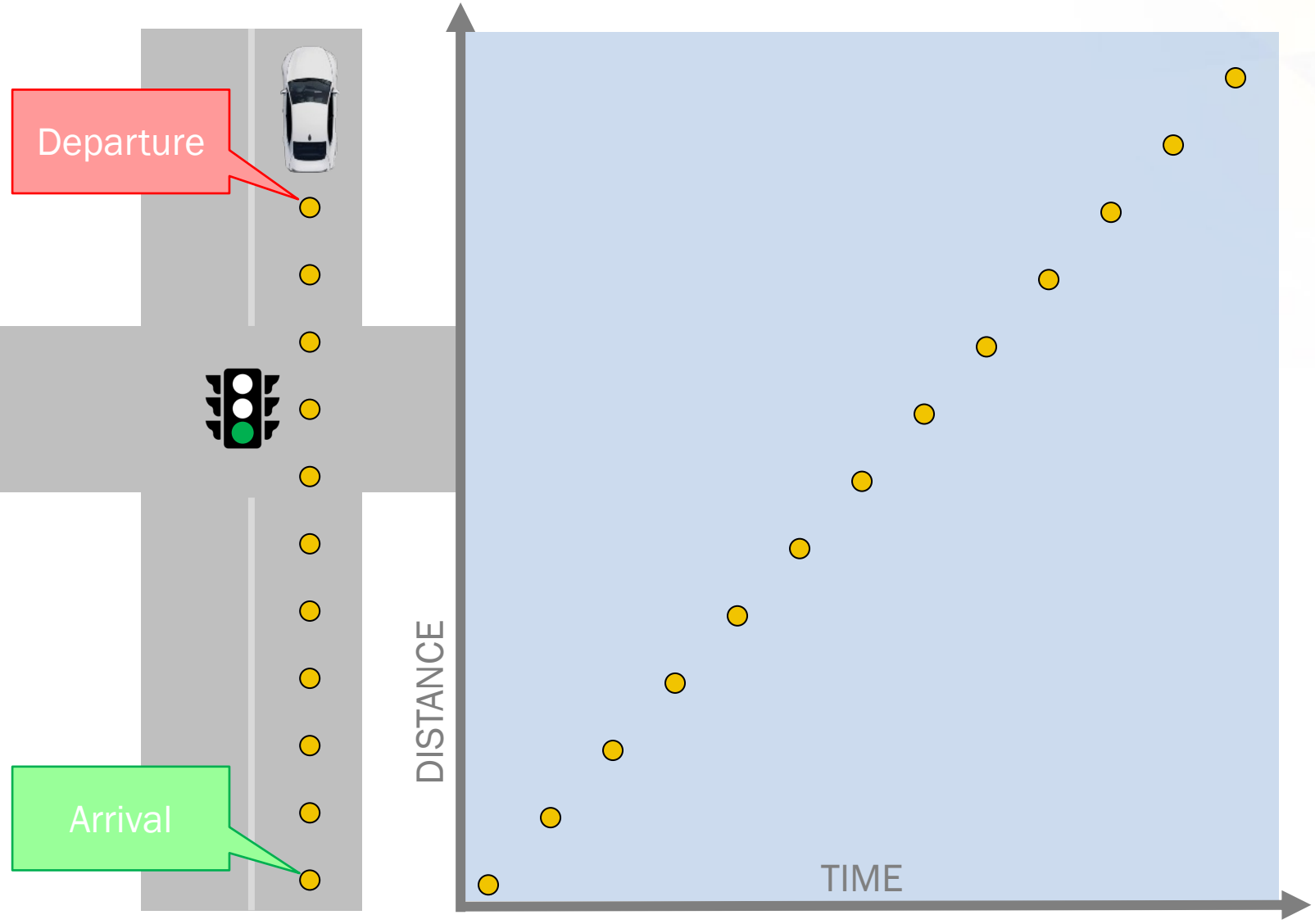
Individual vehicle waypoints are used to determine the travel time of a vehicle moving through an intersection
Other vehicle attributes include turning movement, vehicle stop, approach speed, or vehicle split failure and volume

The Tools

Collaboration between CATT Lab and INRIX
Aggregate the metrics by intersection
Report summary metrics over various time periods



THE METRICS – EACH VEHICLE



Metrics for each vehicle

- Travel Time (TT)
- Approach Speed
- Vehicle Stop
- Vehicle Double Stop
- Movement (Left, Thru, Right)
- Volume

THE METRICS

42 sec

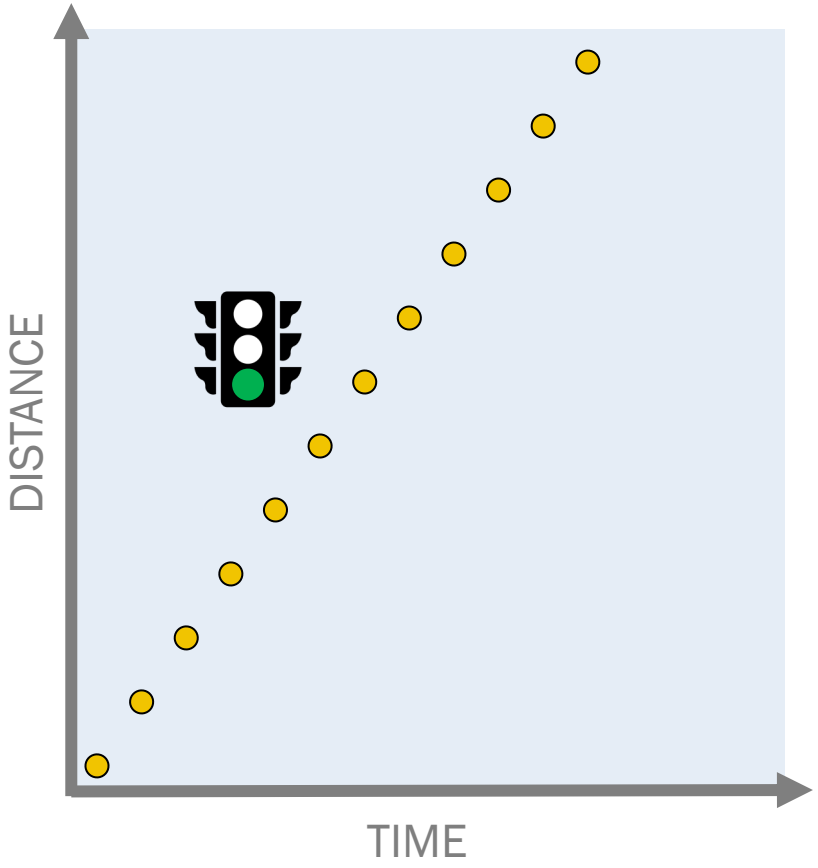
ARRIVAL ON GREEN

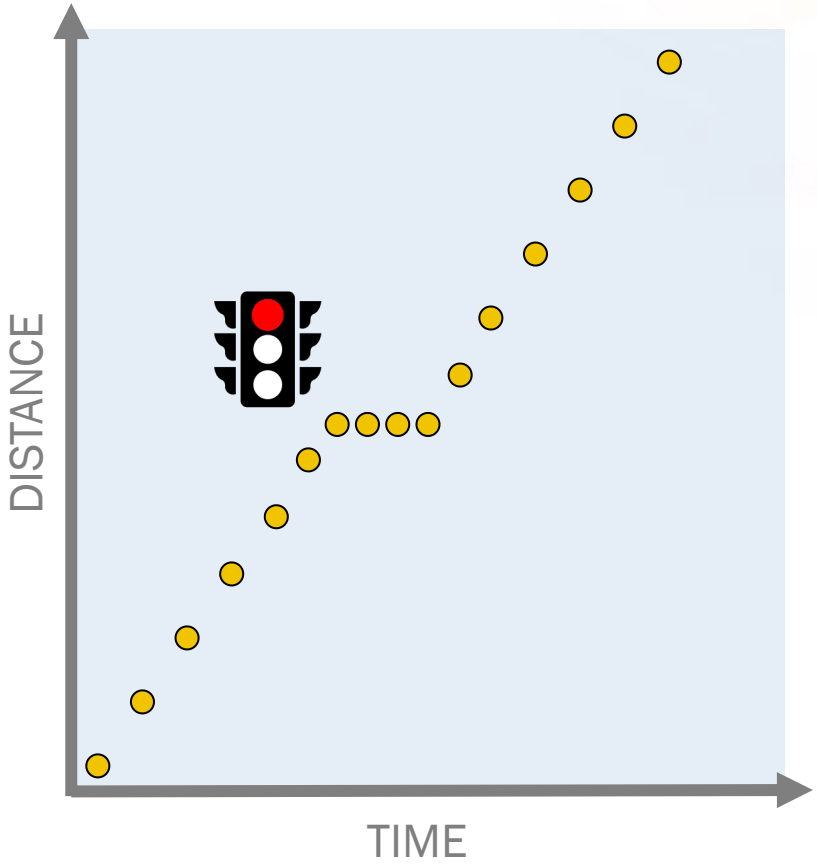
61 sec

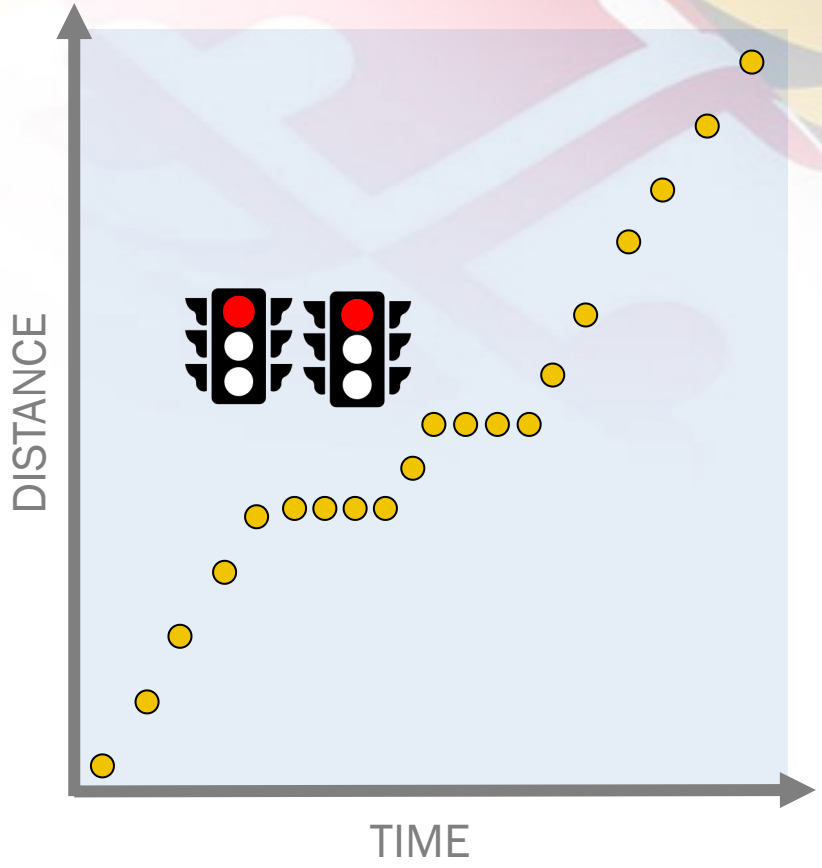
ARRIVAL ON RED

100 sec

SPLIT FAILURE



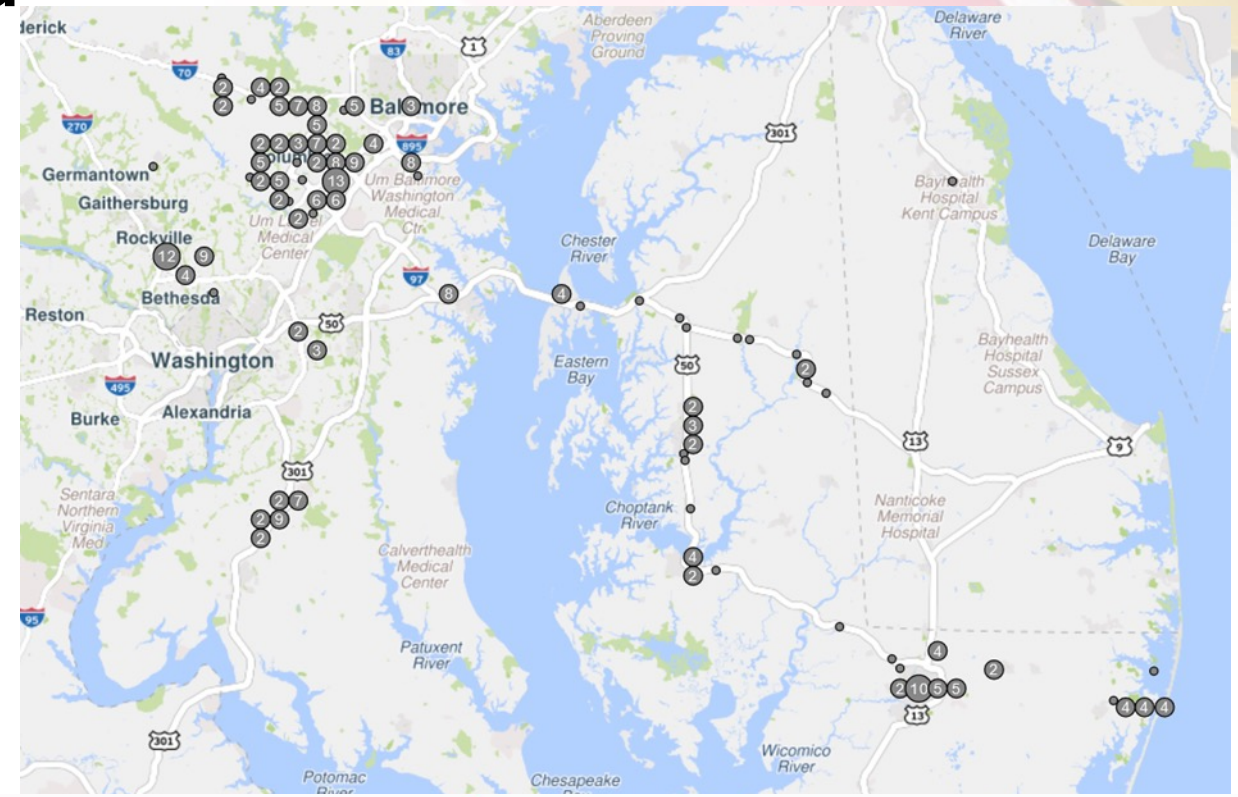




COVERAGE & RESOURCES

289 Intersections currently funded

- Data available from Jan 2020 – present
- Accessible to authorized users through:
  - INRIX IQ (https://iq.inrix.com/)
  - RITIS (https://signals.ritis.org)
- Can be used to identify:
  - Where signal timing can be improved
  - Impacts of signal retiming



INRIX IQ Signal Analytics

RITIS | Transportation System Status | Data Archive | Personal Traffic Alerts

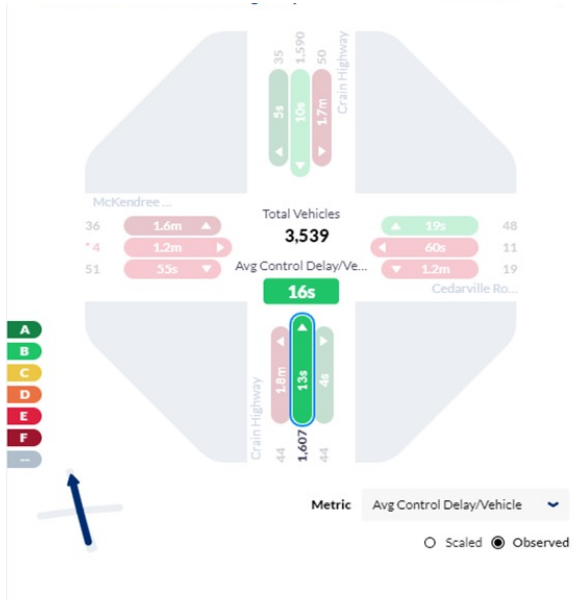
Event Query Tool | Detector Tools | Congestion Causes | Probe Data Analytics | NPMRDS Analytics | Signals Analytics

USE-CASE 1: HOW ARE THE SIGNALS IN MD PERFORMING?

"Is there a way that I can rank the performance of my traffic signals across the entire state?"

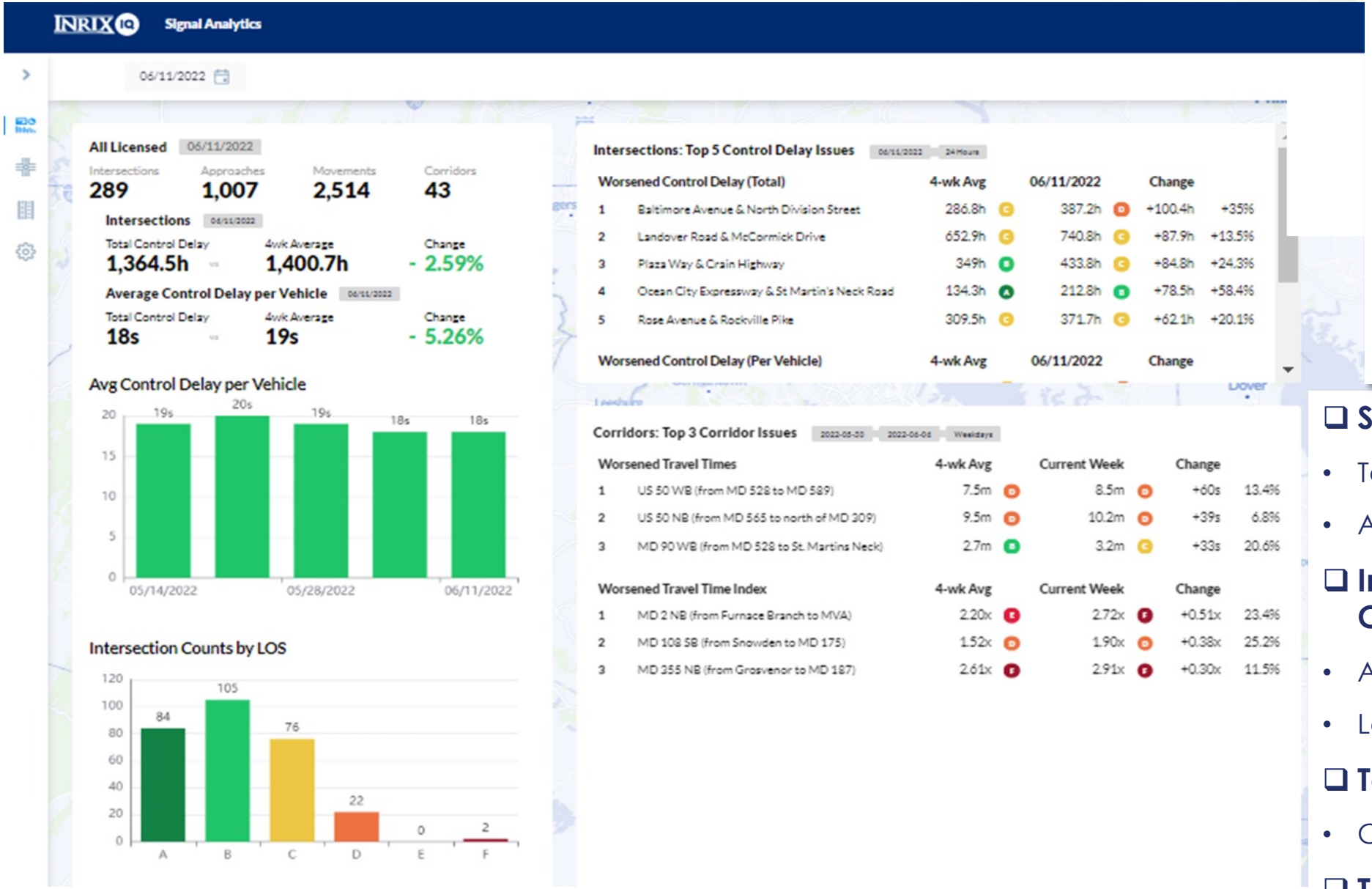
Solution:

- Use INRIX IQ Signal Analytics or RITIS Intersection Analysis Tool to rank intersections
- Consider ranking by control delay, percent arrivals on green, or split failures, etc.



SIGNAL ANALYTICS – Daily Reports

Updated automatically each morning



Agency defined:

- Intersections
- Peak period times

Metrics at a glance:

- Top ranked TT for corridors
- Delay per vehicle stats
- Top ranked control delay variations

❑ System Summary Stats

- Total Control Delay
- Average per Vehicle

❑ Intersection Performance Counts by Metric

- Arrival on Green
- Level of Service

❑ Top Five (5) Intersections

- Change in Delay

❑ Top Three (3) Corridor Summary

Performance Report

INRIX IQ Signal Analytics

Intersection_Performance_Reports_Maryland-State-Highway-Administration_2022-01-28_to_2022-01-29 2022-01-28 **Time Range Display** 24 Hours **Filter** Enter Keyword Observed Scaled Edit Columns Download

	Intersection	ID	POG	Total Count	Throughput
○	Chadds Ford Drive & Crain Highway	38.6747_-76.8760	77.9%	3,578	2,788
◉	McKendree Road & Crain Highway	38.6641_-76.8747	73.5%	3,539	2,601
○	Crain Highway	38.6264_-76.9106	42%	2,993	1,257
○	Clymer Drive & Crain Highway	38.6714_-76.8761	73.2%	2,897	2,120
○	North Salisbury Boulevard	38.4100_-75.5676	46.2%	2,522	1,165
○	Crain Highway	38.6557_-76.8769	70%	2,287	1,600
○	Crain Highway & Acton Lane	38.6395_-76.8973	65.2%	2,280	1,487
○	Crain Highway	38.6116_-76.9257	47.6%	2,249	1,071
○	Crain Highway & VFW Road	38.6473_-76.8881	70.7%	2,224	1,572
○	West North Point Drive & North Salisbury Boulevard	38.4160_-75.5662	58.1%	2,151	1,250

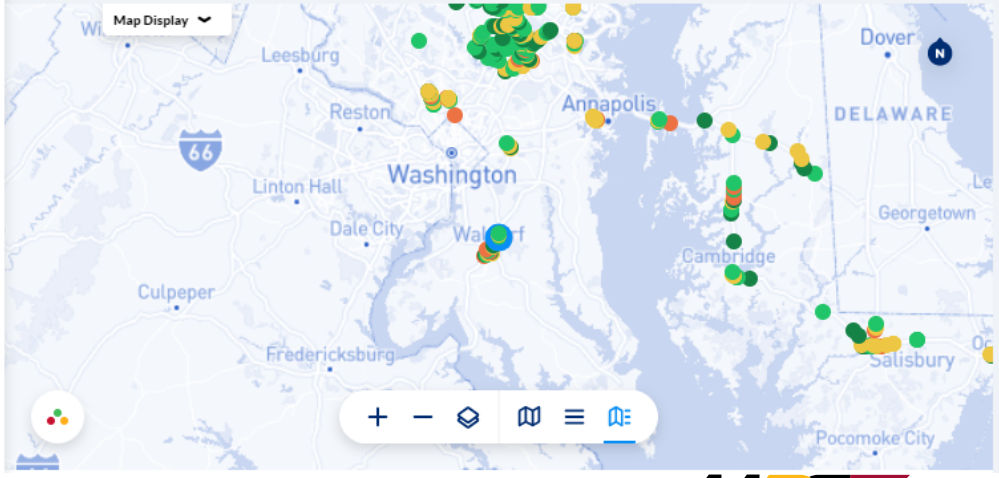
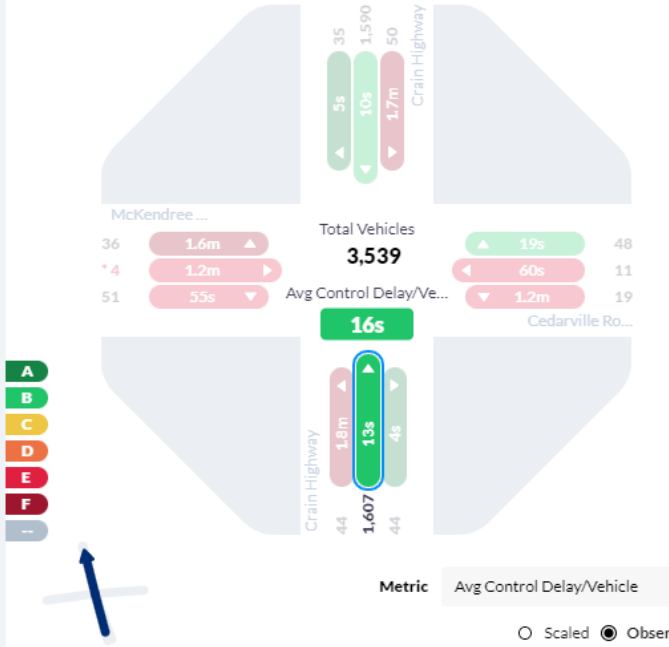


Diagram List Approaches Movements

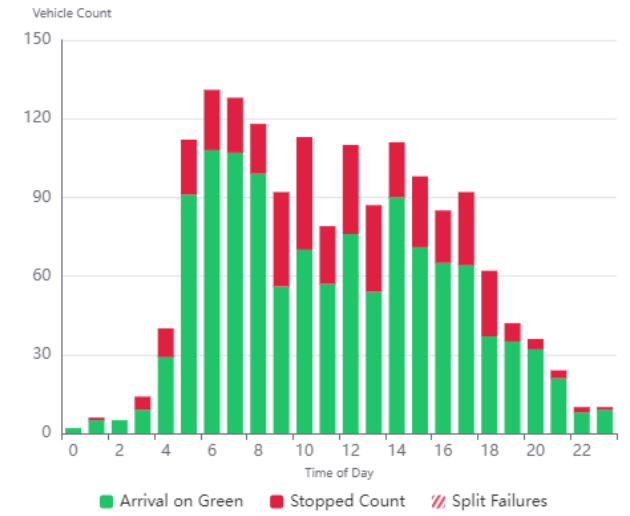
McKendree Road & Crain Highway



Count Stats Time Stats

Percent on Green	75 %	vs	4wk Average	77 %	Change - 3.33%
Split Failures	0	vs	4wk Average	0.0	Change 0%
Vehicle Count	1,607	vs	4wk Average	1,522.0	Change + 85
Stopped Count	407	vs	4wk Average	345.0	Change + 62

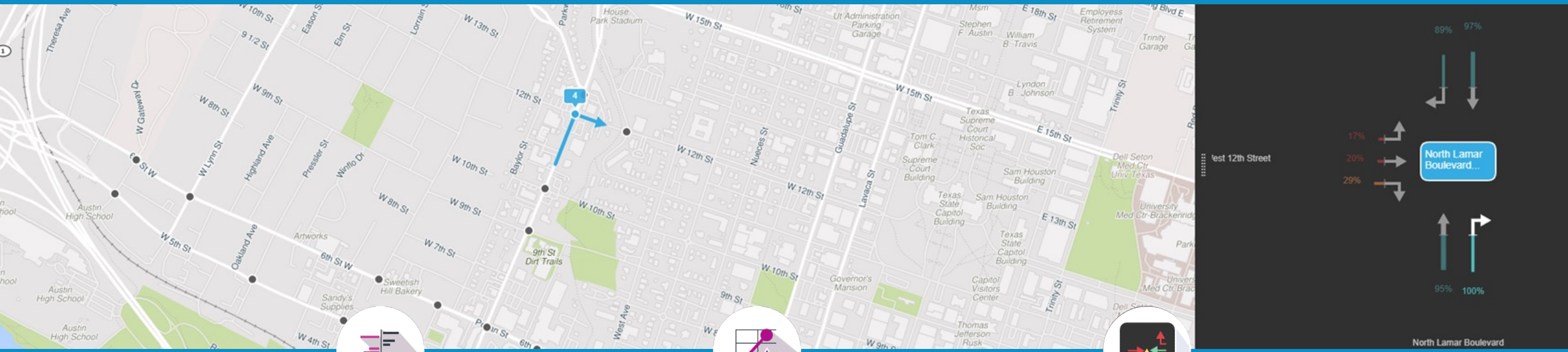
Resolution: Hourly



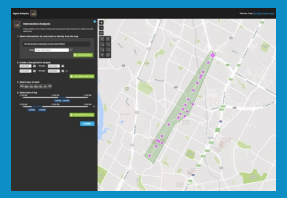
MDOT MARYLAND DEPARTMENT OF TRANSPORTATION

SIGNAL ANALYTICS – **RITIS DEEP DIVE INTERSECTION ANALYSIS**

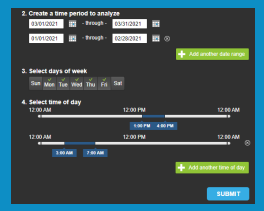
Deep Dive Analysis of Key Performance Indicators for Signalized Intersections



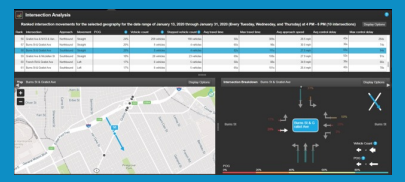
Detailed Spatial Selection



Date/Time Range Filters

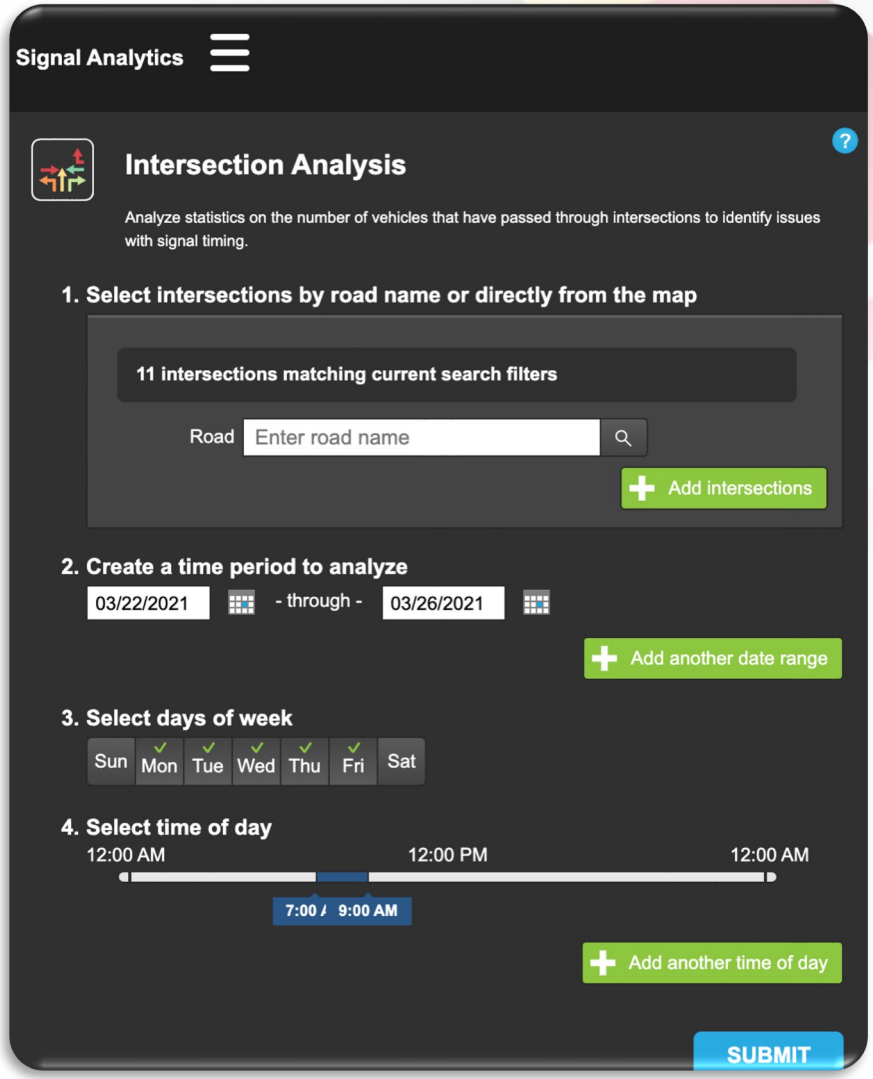


Turning Movement PMs

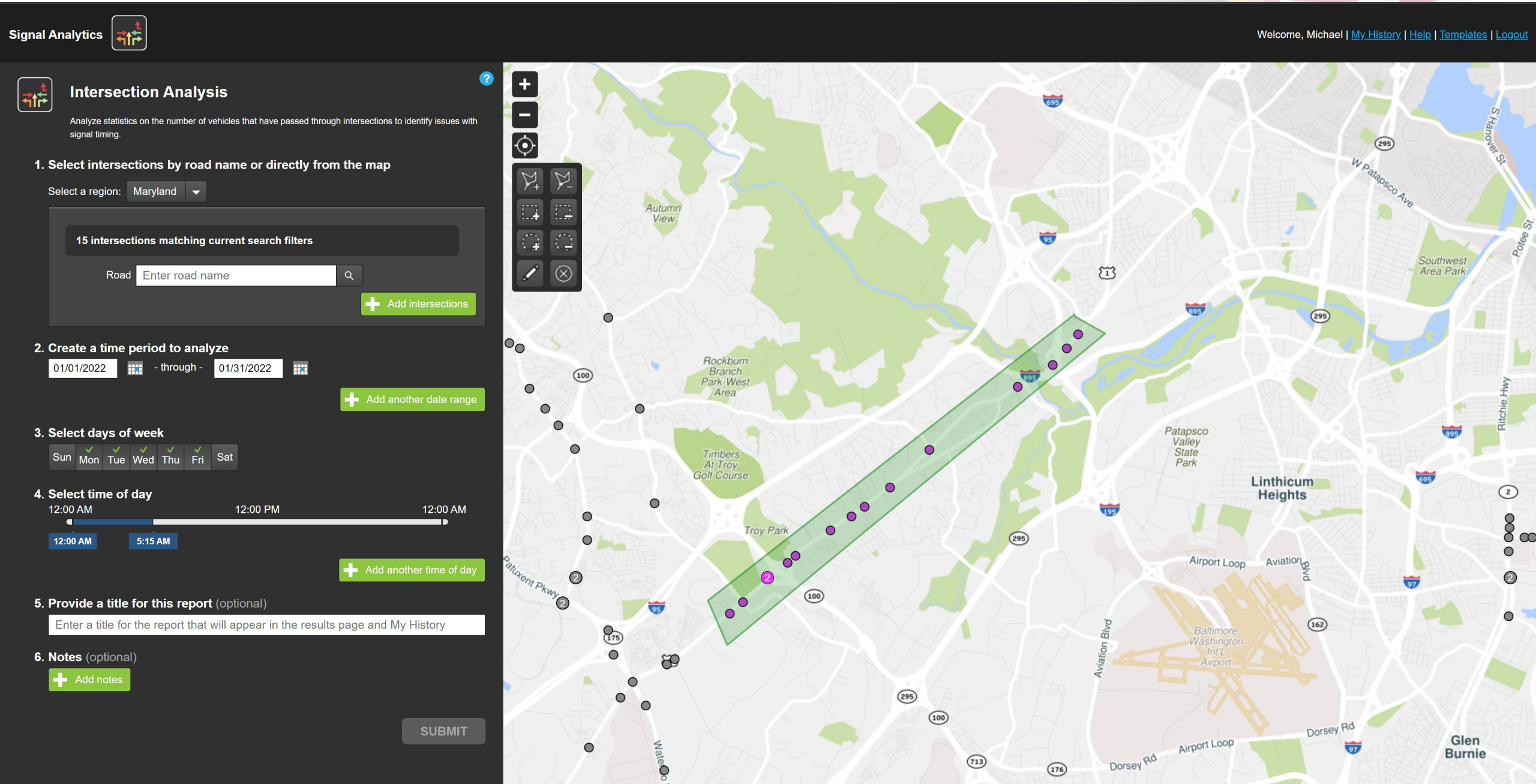


INTERSECTION ANALYSIS – ADVANCED HISTORIC QUERIES

- Custom Spatial Selection Tools
  - Choose individual intersections
  - Select custom corridors for analysis
- Historic Comparisons
  - Analyze historic KPIs for selected intersections
  - Focus analysis on specific days of the week
- Custom Configure Peak Period Analysis

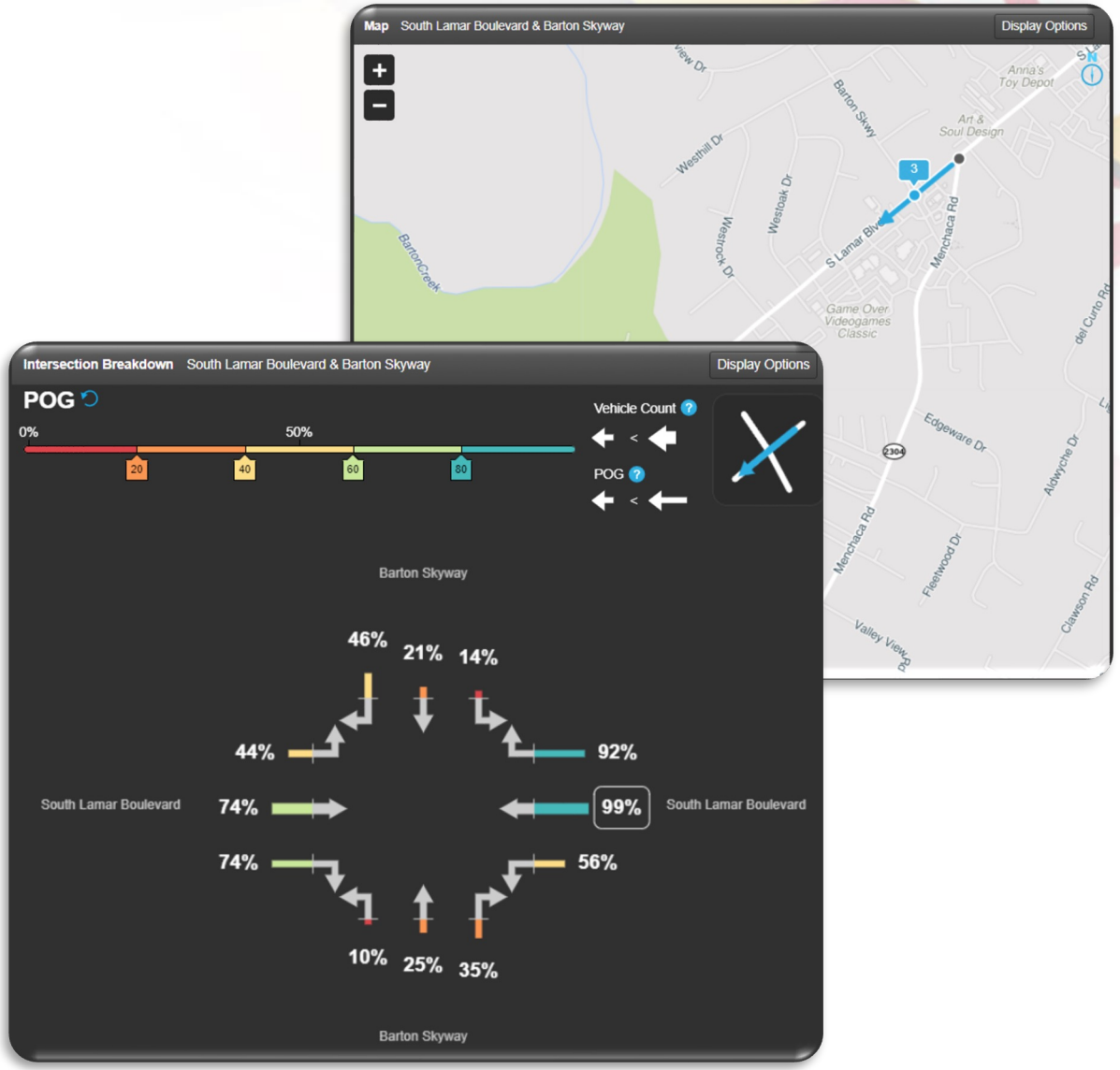


SIGNAL ANALYTICS – ADVANCED INPUT QUERY OPTIONS



INTERSECTION ANALYSIS – DATA VISUALIZATIONS AND KPIS

- Dynamic and Interactive Maps, Tables and Data Visualizations
- Historic Comparisons
  - Analyze historic KPIs for selected intersections
- KPIs for Every Signalized Intersection
  - POG
  - Vehicle count
  - Stopped vehicle count
  - Avg/Max travel time
  - Avg/Max approach speed
  - Avg/Max control delay
  - Split failure count



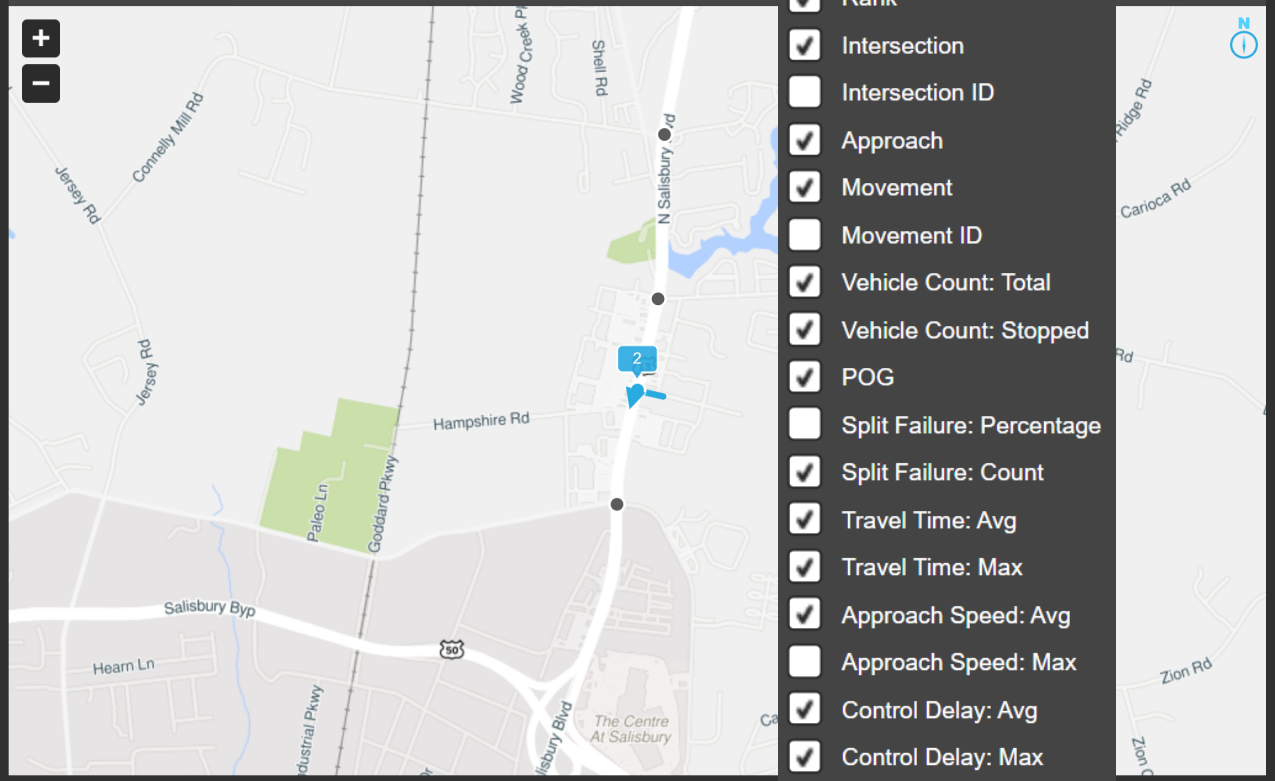
Intersection Analysis

Ranked intersection movements for 286 intersections from January 01, 2022 through January 31, 2022 (Every weekday)

Filter | Display Options

Rank	Intersection	Approach	Movement	Vehicle Count: Total	Vehicle Count: Stopped	POG	Split Failure: Count	Travel Time: Avg (sec)	Travel Time: Max (sec)	Approach Speed: Avg (mph)	Control Delay: Avg (sec)	Control Delay: Max (sec)
1	Ocean Gateway	Northbound	Through	2187	1849	15%	264	65	139	21	47	121
2	West North Point Drive & North Salisbury Boulevard	Westbound	Left	1328	1220	8%	213	93	295	21	74	276
3	Ocean Gateway	Northbound	Left	576	500	13%	167	68	139	22	48	119
4	Landover Road & Mccormick Drive	Eastbound	Left	4727	4083	14%	132	65	282	28	51	268
5	Clymer Drive & Crain Highway	Westbound	Left	1841	1708	7%	92	152	522	25	138	508
6	North Salisbury Boulevard & Winner Boulevard	Eastbound	Left	386	362	6%	88	84	414	24	66	396
7	Washington Boulevard & Dorsey Road	Westbound	Left	2293	1490	35%	64	51	413	30	37	398
8	West North Point Drive & North Salisbury Boulevard	Westbound	Through	322	296	8%	55	100	257	21	80	237

Map | West North Point Drive & North Salisbury Boulevard



Display Options

- [x] Rank
- [x] Intersection
- [ ] Intersection ID
- [x] Approach
- [x] Movement
- [ ] Movement ID
- [x] Vehicle Count: Total
- [x] Vehicle Count: Stopped
- [x] POG
- [ ] Split Failure: Percentage
- [x] Split Failure: Count
- [x] Travel Time: Avg
- [x] Travel Time: Max
- [x] Approach Speed: Avg
- [ ] Approach Speed: Max
- [x] Control Delay: Avg
- [x] Control Delay: Max

Intersection Breakdown | West North Point Drive & North Salisbury Boulevard

Display Options

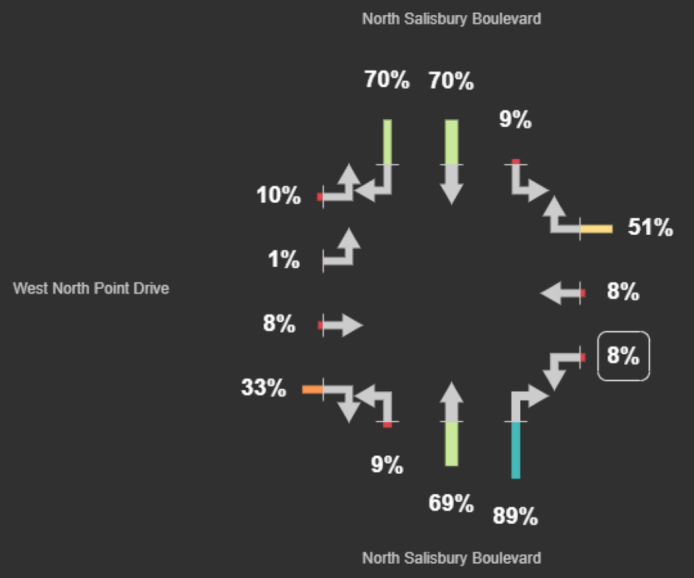
Percent on Green

0% 50%

20 40 60 82

Vehicle

POG



Length of arrows
- (•) POG
- ( ) Split Failure: Count
- ( ) Split Failure: Percentage
- ( ) Travel Time: Max
- ( ) Travel Time: Avg
- ( ) Control Delay: Max
- ( ) Control Delay: Avg
- ( ) Approach Speed: Max
- ( ) Approach Speed: Avg

Width of arrows
- (•) Vehicle Count: Total
- ( ) Vehicle Count: Stopped

SORTING THE RANKED INTERSECTION MOVEMENT TABLE BY SPLIT FAILURES

Signal Analytics

Welcome, Charles | My History | Help | Templates | Logout

Intersection Analysis

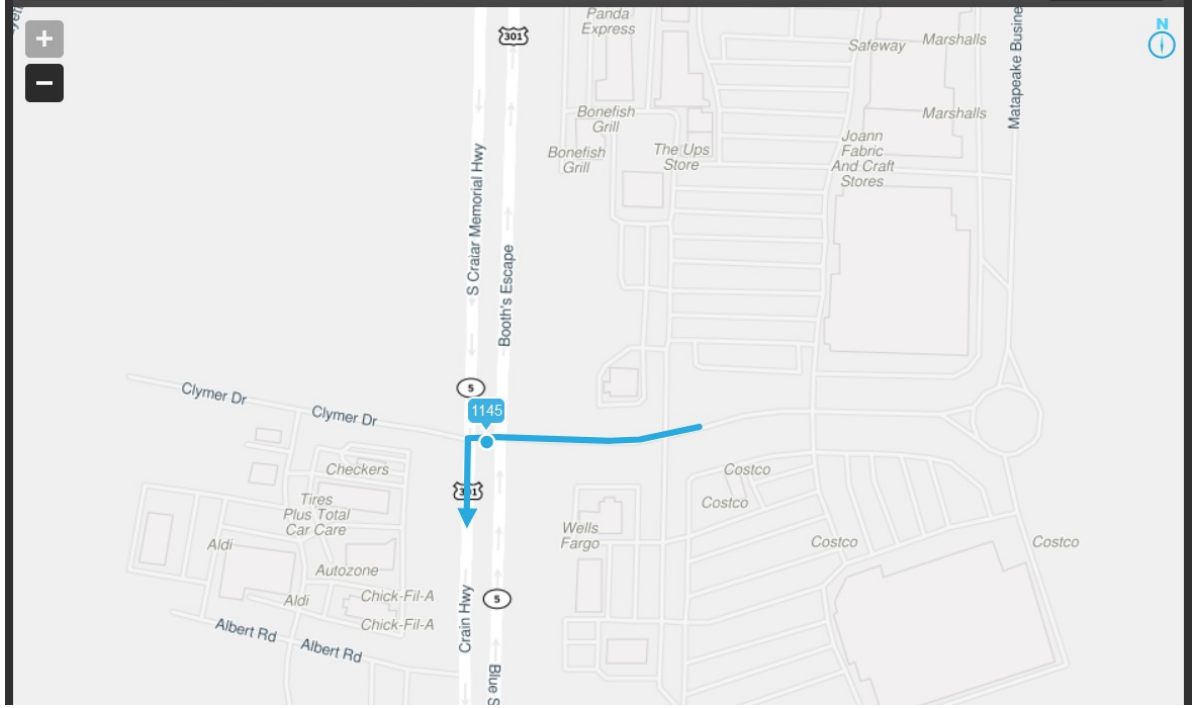
Maryland Statewide Mar 2022

Ranked intersection movements for 289 intersections from March 01, 2022 through March 31, 2022 (Every weekday) from 4 PM to 7 PM

Filters (0) | Display Options

Rank	Intersection	Approach	Movement	Vehicle Count: Total	Vehicle Count: Stopp...	POG	Split Failure: Percent...	Split Failure: Count ▼	Travel Time: Avg (sec)	Travel Time: Max (sec)	Approach Speed: Av...	Control Delay: Avg (...	Control Delay: Max (...
1	Ocean Gateway	Northbound	Through	560	466	17%	12%	66	63	129	22	45	111
2	West North Point Drive & North Salisbury Boulevard	Westbound	Left	340	315	7%	19%	64	95	476	20	76	457
3	Leonardtown Road & Old Washington Road	Westbound	Through	2045	951	53%	2%	47	47	261	0	36	250
4	Clymer Drive & Crain Highway	Westbound	Left	745	711	5%	6%	42	170	523	24	155	508
5	Ocean Gateway	Northbound	Left	173	143	17%	21%	37	69	130	23	49	110
6	Berry Road & Western Parkway	Eastbound	Left	704	669	5%	4%	29	91	360	26	76	345
7	Romancoke Road & Business Parkway	Southbound	Left	922	499	46%	3%	26	38	123	24	25	110
8	West Salisbury Parkway & North Division Street	Northbound	Left	171	137	20%	15%	25	73	172	19	50	149

Map | Clymer Drive & Crain Highway | Display Options



Intersection Breakdown | Clymer Drive & Crain Highway | Display Options

Split Failure: Count

EXAMPLE: INTERSECTION DIAGRAM BERRY RD. & WESTERN PKWY…

Signal Analytics

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Intersection Analysis

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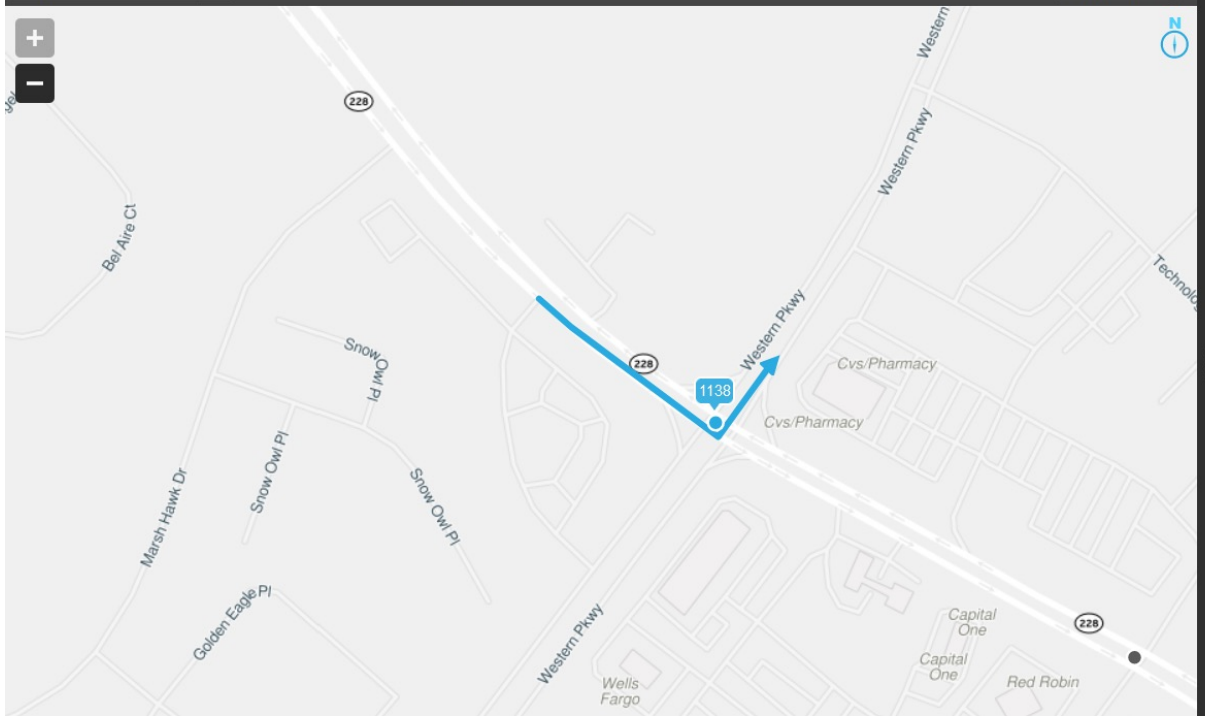
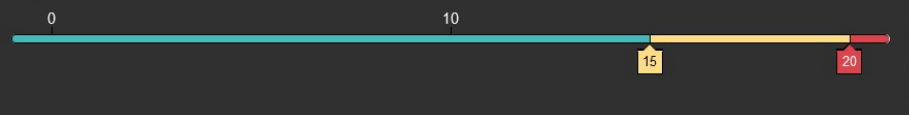
Map | Berry Road & Western Parkway | Display Options



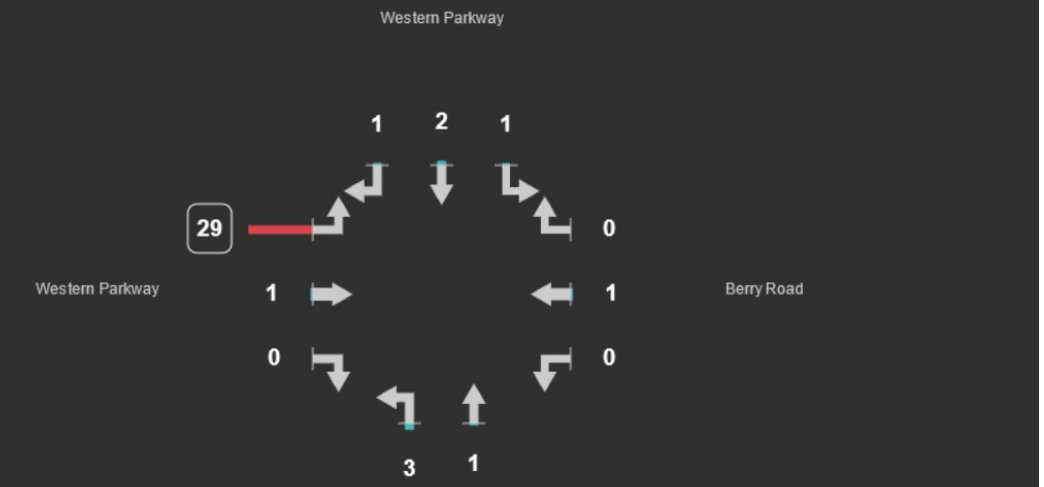
Intersection Breakdown | Berry Road & Western Parkway | Display Options

Split Failure: Count



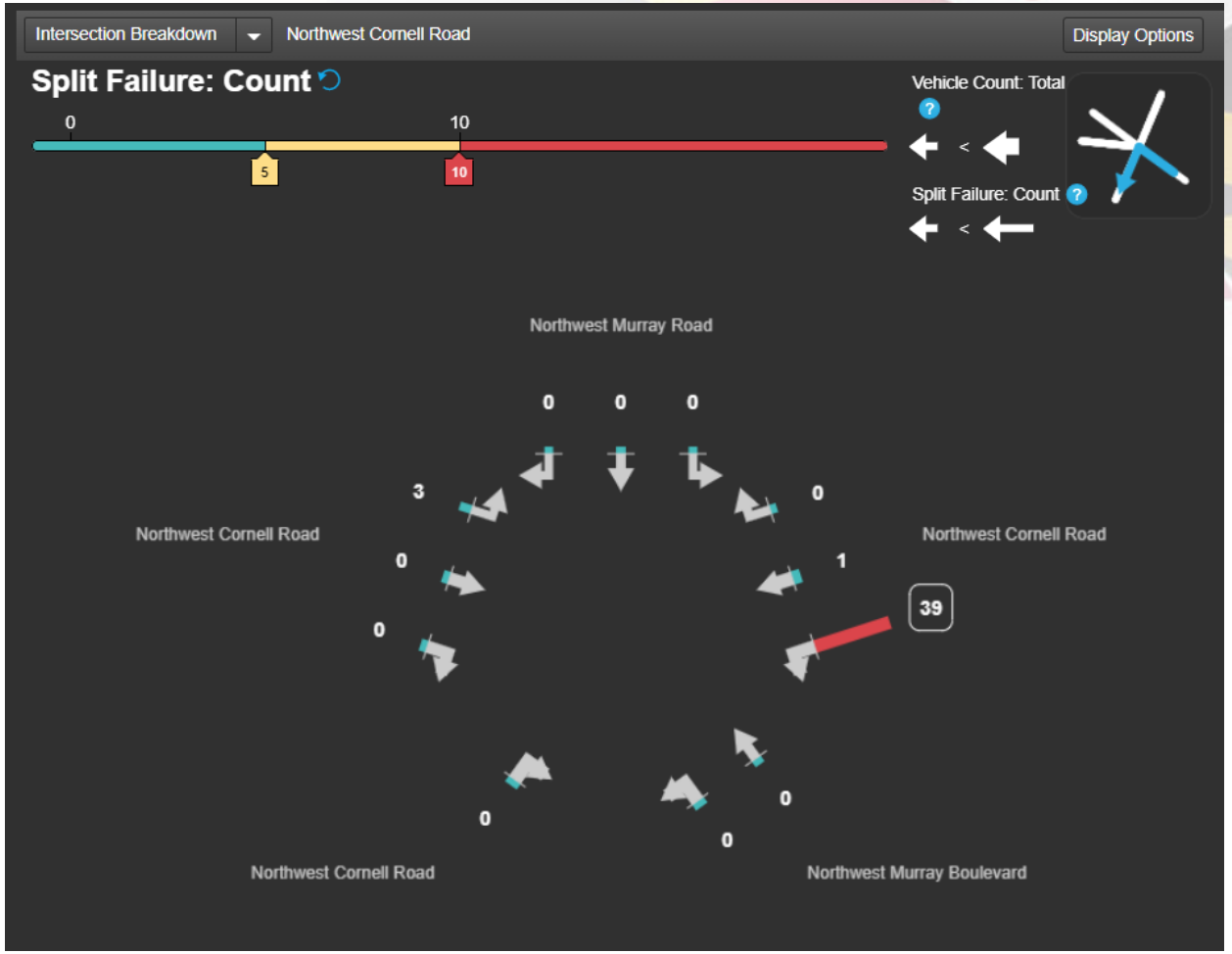
Vehicle Count: Total

Split Failure: Count



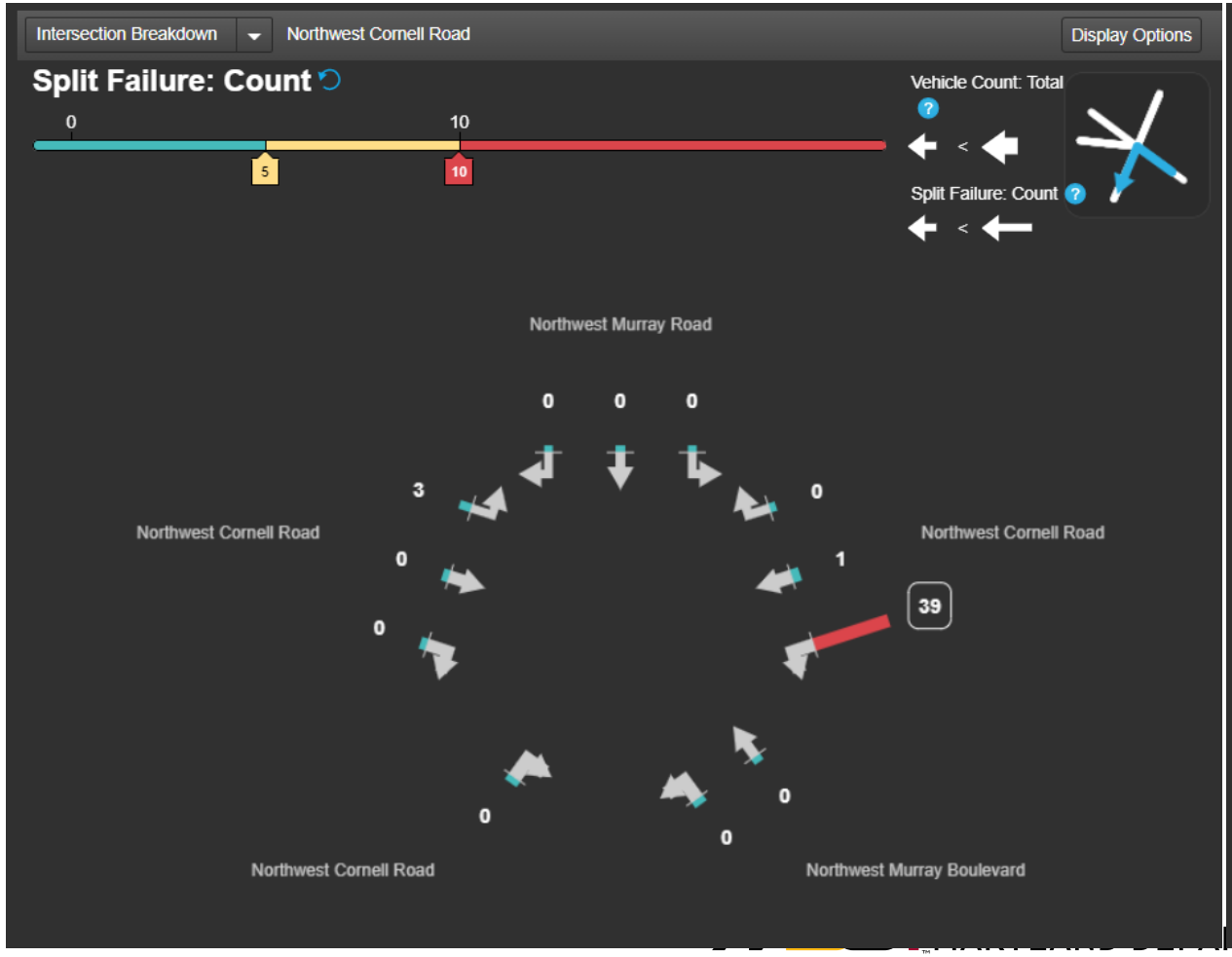
EXAMPLE CASE: WASHINGTON COUNTY, OR - SIMILAR ISSUE. HOW DID THEY HANDLE IT?

- High number of split failures on one left-hand turn movement
- Very low number of split failures on other movements
- Signal Engineer gave more time to the left-turn movement without degrading the other movements

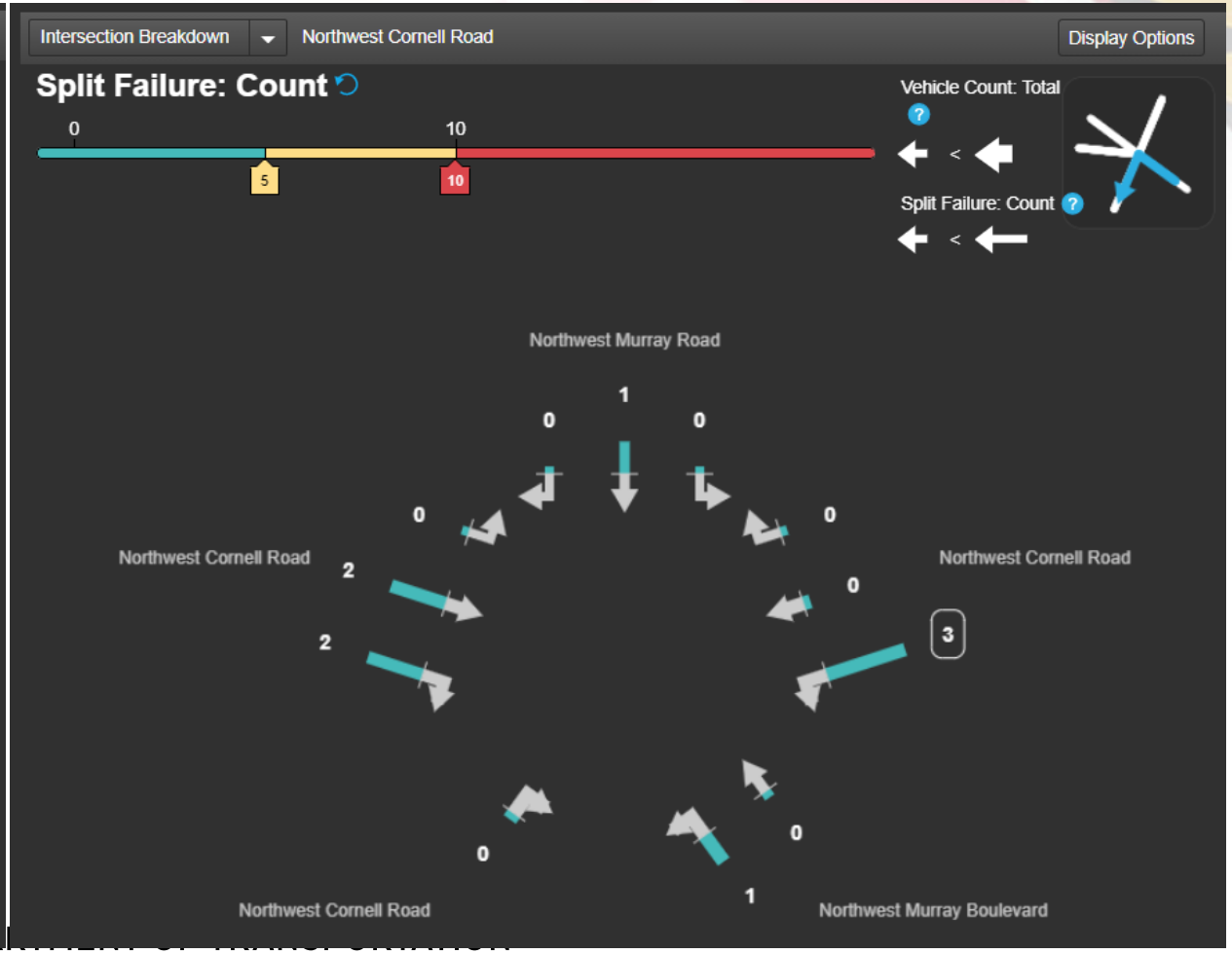


EXAMPLE CASE: WASHINGTON COUNTY, OR - SIMILAR ISSUE. HOW DID THEY HANDLE IT?

Before
(Jul. 22 – Aug. 11)



After
(Aug. 13 – Sep. 2)



USE-CASE 2: HOW DO I COMPARE CONDITIONS BEFORE AND AFTER A SIGNAL TIMING CHANGE?

"How can I measure changes to intersection performance if I don't have detection on all my approaches?"

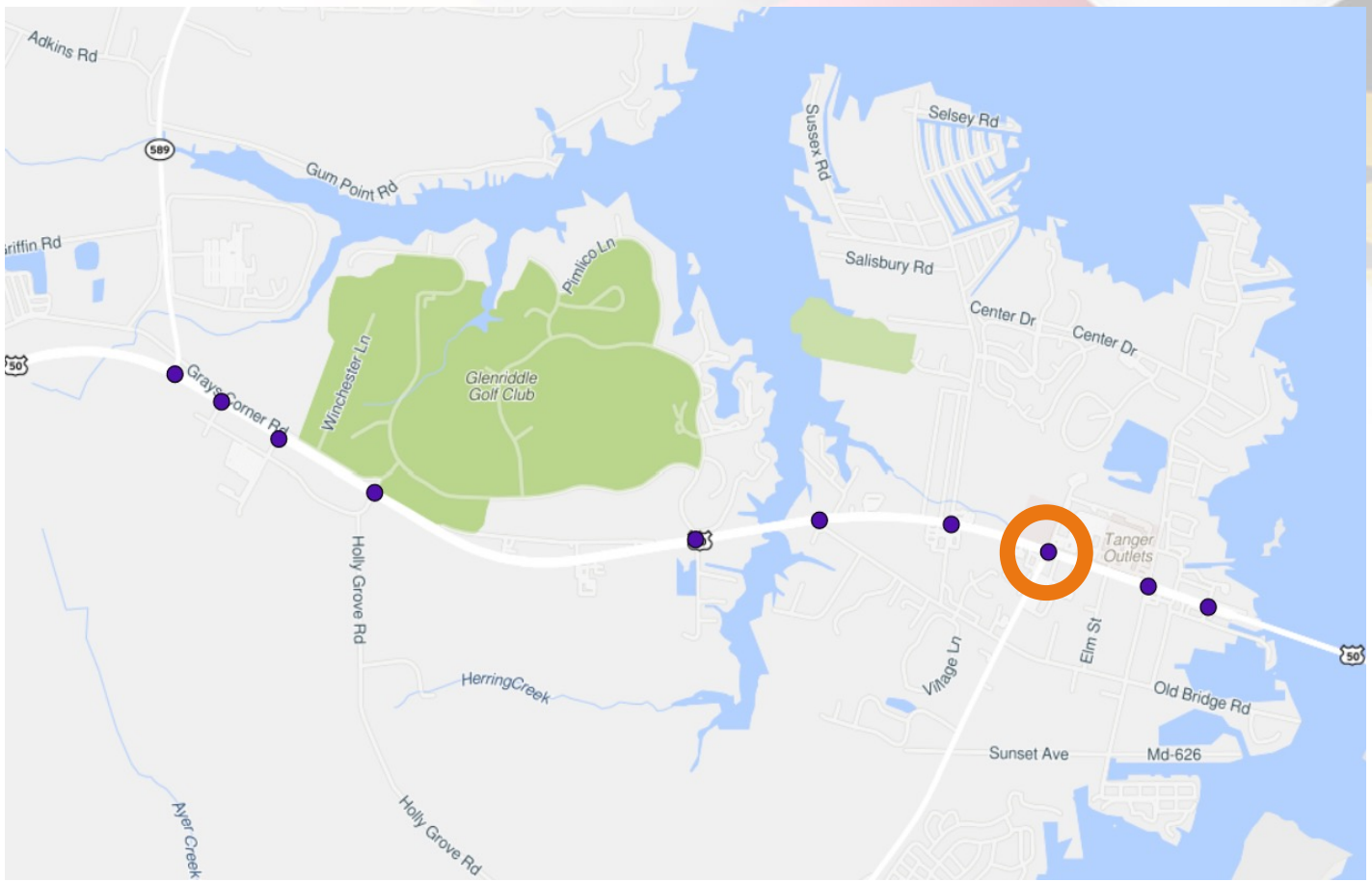
"Using corridor travel times to measure signal timing improvement can be good, but sometimes it seems they don't tell the whole story. Are there additional measures I can use?"

Solution:

- Use the Signal Analytics to compare split failures, control delay, and percent on green over time

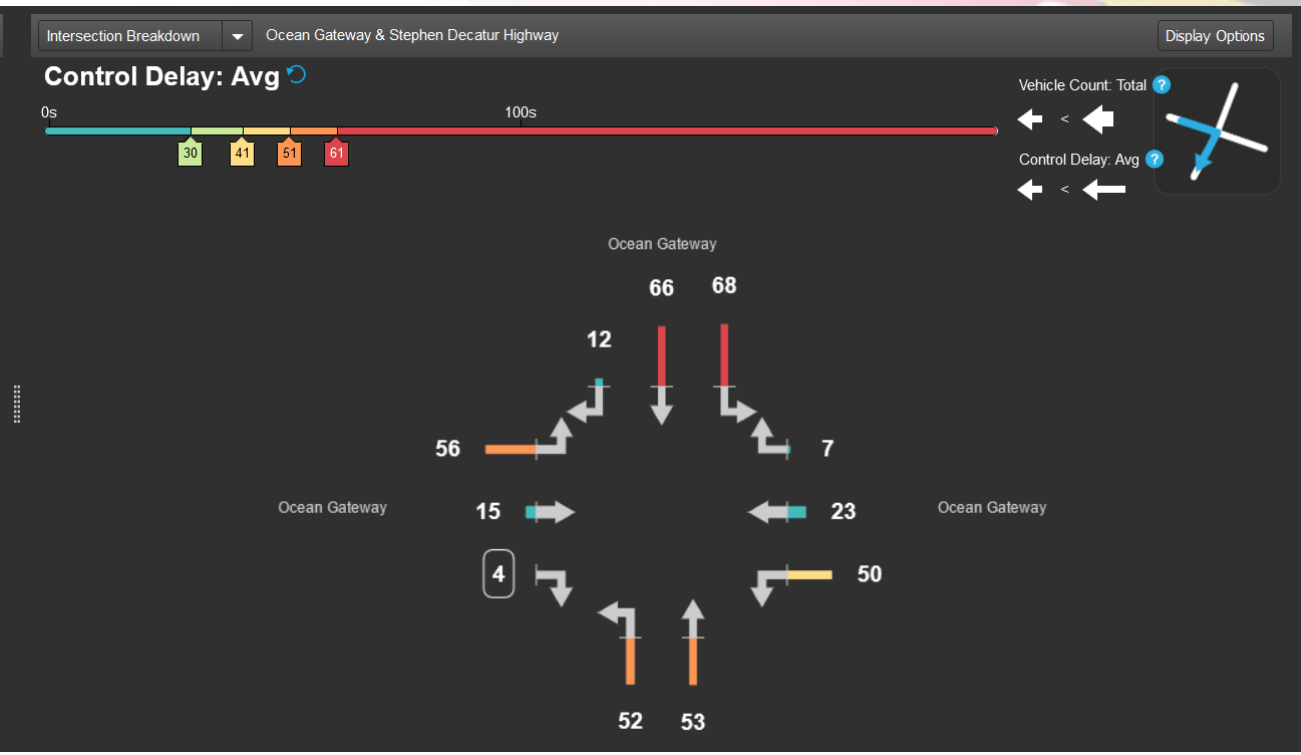
US 50 WEST (OCEAN CITY): 10 INTERSECTIONS – INLET ISLE TO MD 589

- Ten (10) Intersections from Inlet Isle to MD 589 retimed in Dec 2021
- Looking at one month before (Nov 2021) and one month after (Jan 2022)
- Using Ocean Gateway and Stephen Decatur Highway – Circled Intersection



OCEAN GATEWAY AND STEPHEN DECATUR HIGHWAY

BEFORE RETIMING



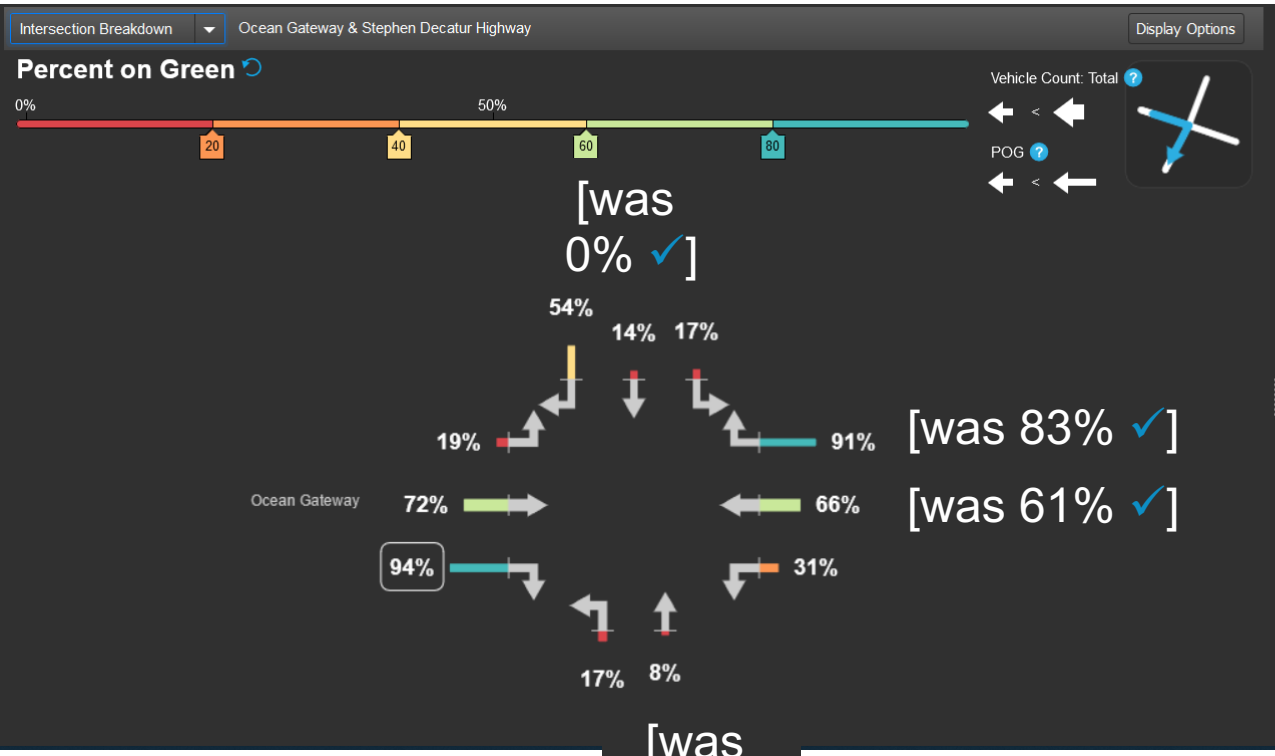
PEAK DIRECTION

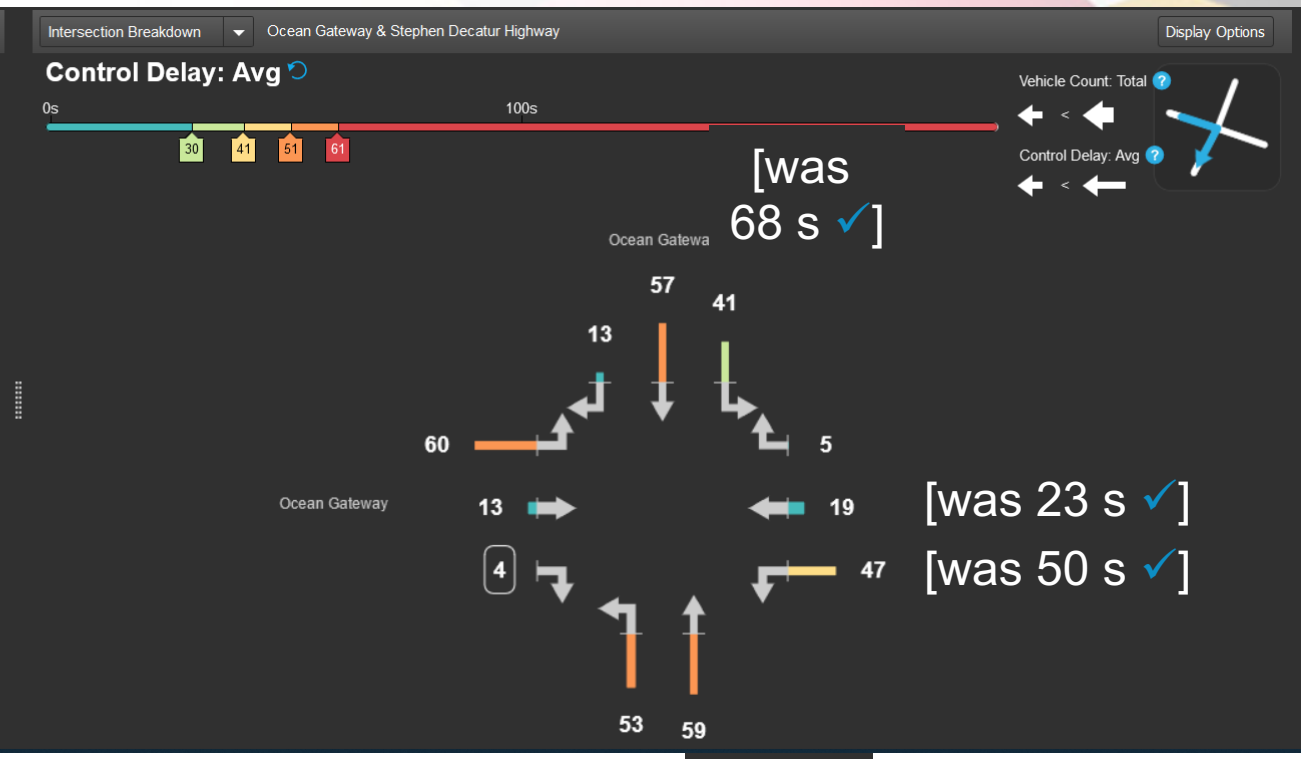
PEAK DIRECTION

MARYLAND DEPARTMENT OF TRANSPORTATION

OCEAN GATEWAY AND STEPHEN DECATUR HIGHWAY

AFTER RETIMING



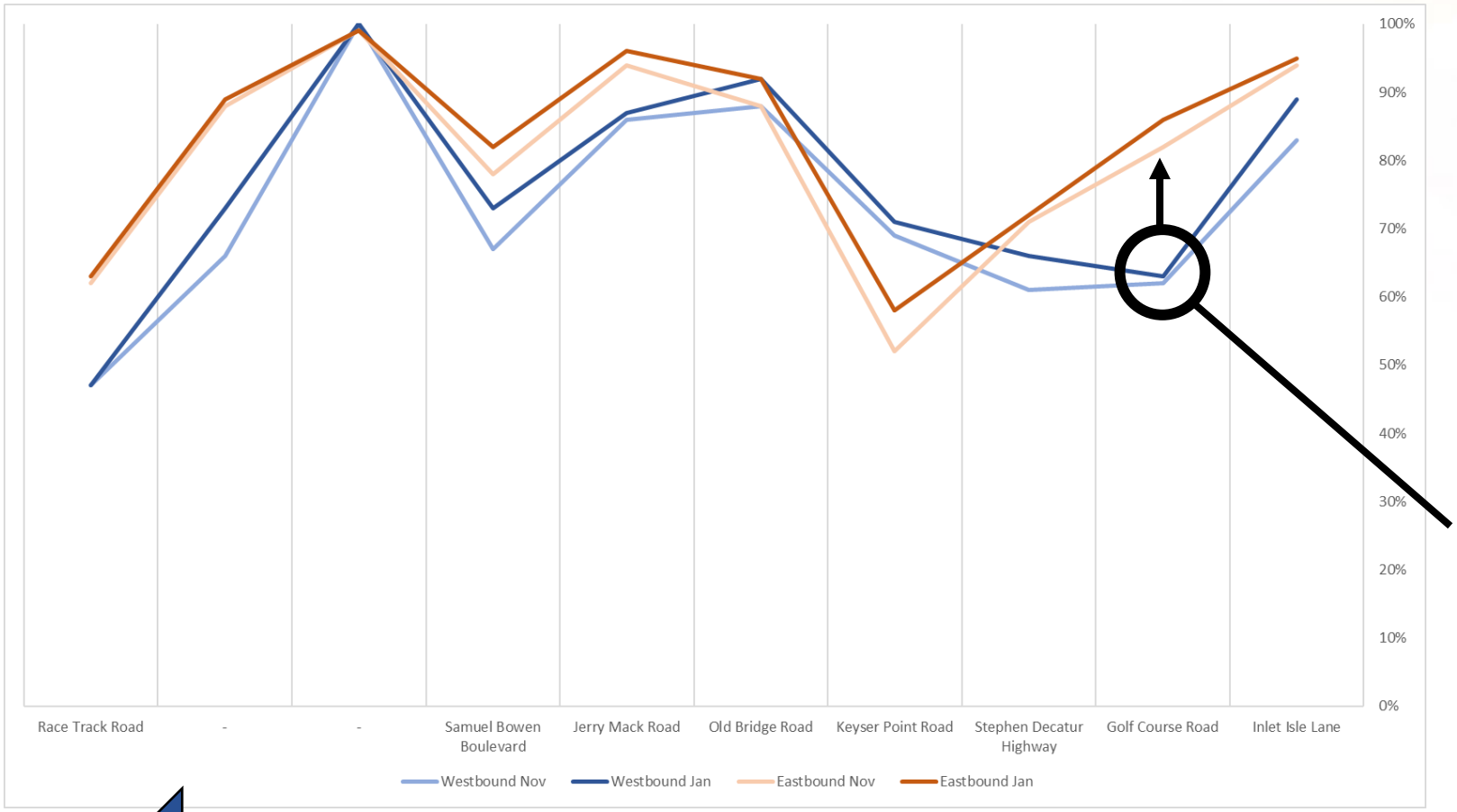


PEAK DIRECTION

PEAK DIRECTION

COMPARING INTERSECTIONS WITH DOWNLOADED DATA

Through Movement, Major Street: Percent on Green (PM Peak)



AFTER

BEFORE

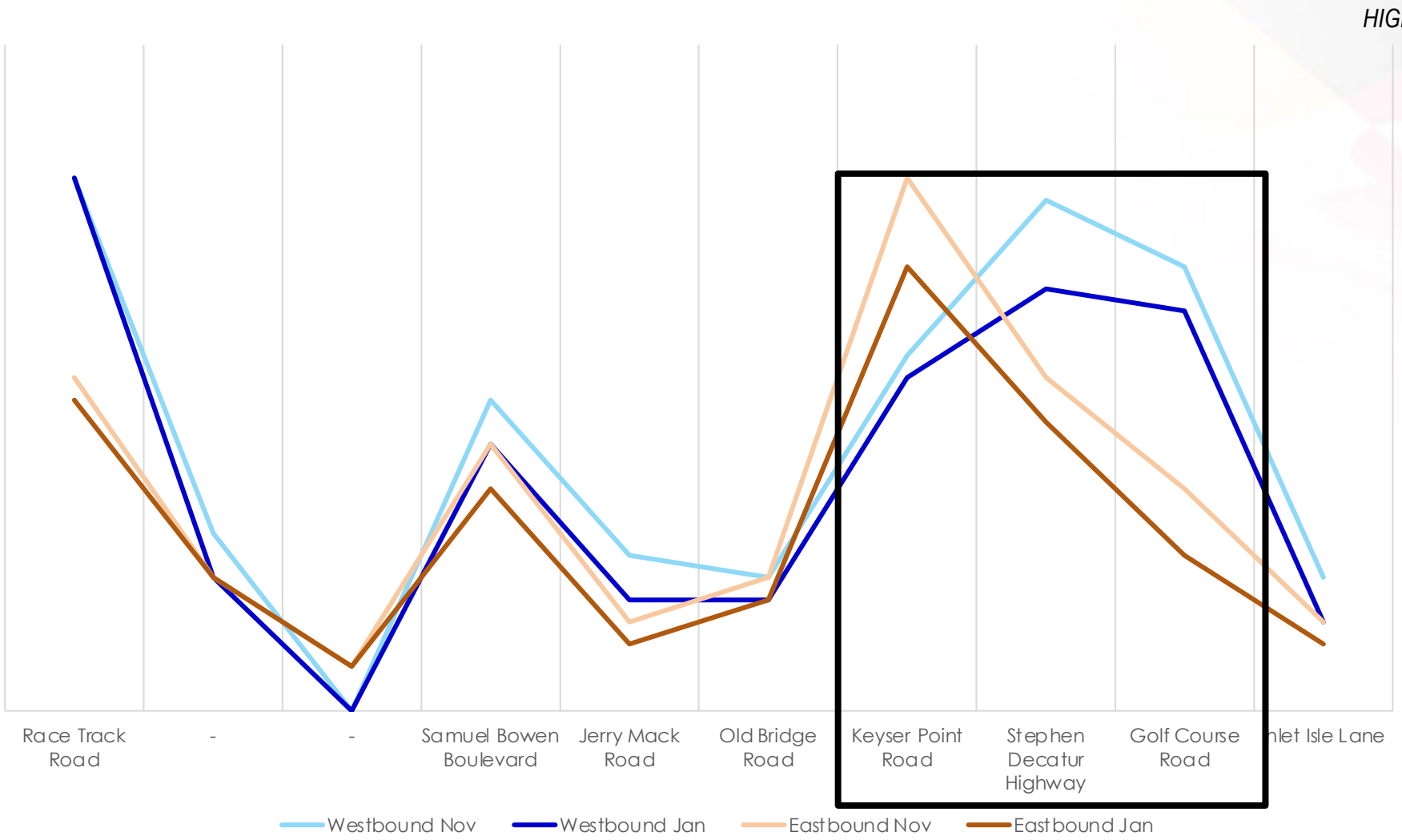
Percent on green for major through movement improved or remained the same all along the corridor

Room for improvement: low progression

PEAK DIRECTION

MARYLAND DEPARTMENT OF TRANSPORTATION

COMPARING INTERSECTIONS WITH DOWNLOADED DATA



BEFORE

AFTER

Control delay for major through movement improved or remained the same all along the corridor

Highest westbound control delay between Golf Course Rd. and Keyser Point Rd.

PEAK DIRECTION

CHALLENGES & NEXT STEPS

Challenges:

- Monitoring data availability and connected vehicle sample size
- Addressing intersections of concern and problem corridors

Next Steps:

- Looking more closely at corridor performance
- Expanding the coverage area

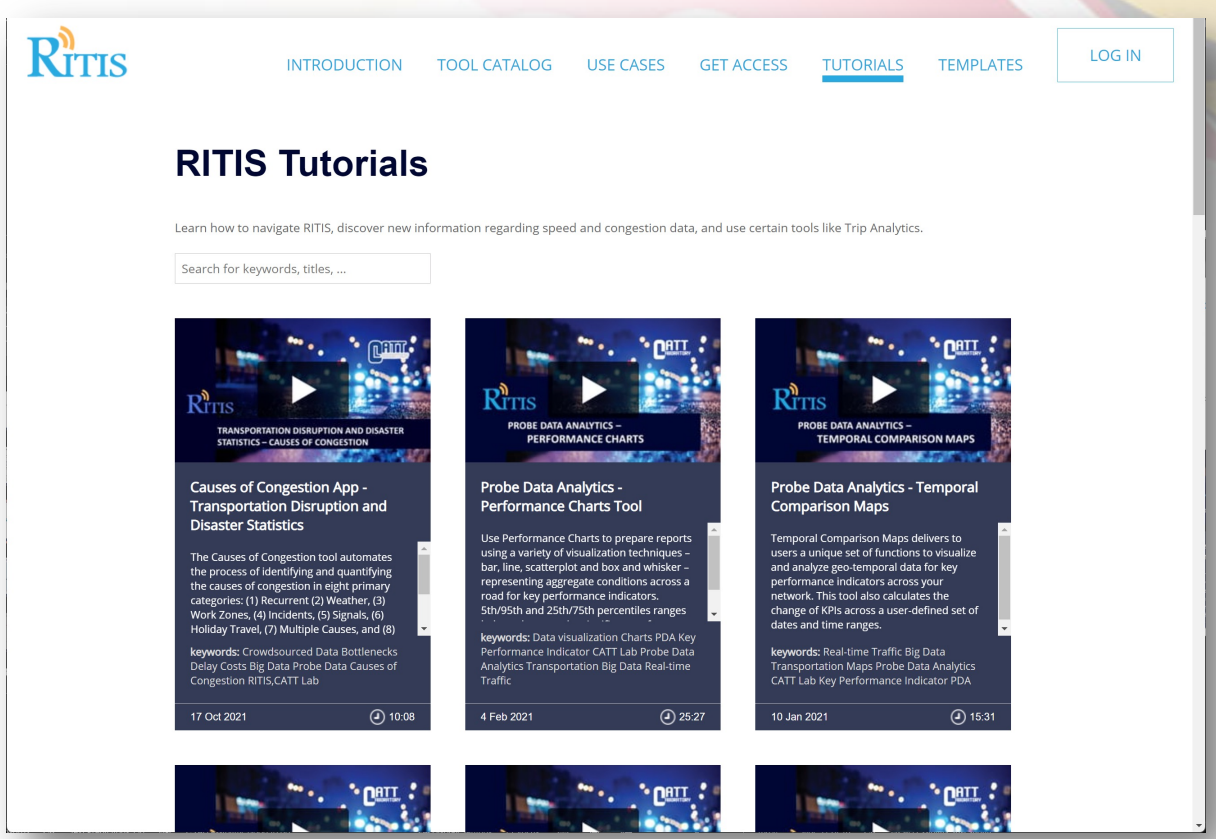
ACCESS & TRAINING

Access

www.ritis.org or www.signals.ritis.org
and
https://iq.inrix.com/

Training

- **Online**: webinars can be scheduled for small or large groups support@ritis.org
- **In-person**: let us know, and we'll come to you support@ritis.org
- **On-demand**: training videos available at https://www.ritis.org/tutorials/



Questions?

Thank You!