A DATA-DRIVEN ARTERIAL CORRIDOR PERFORMANCE EVALUATION METHODOLOGY VIA CORRIDOR RANKING

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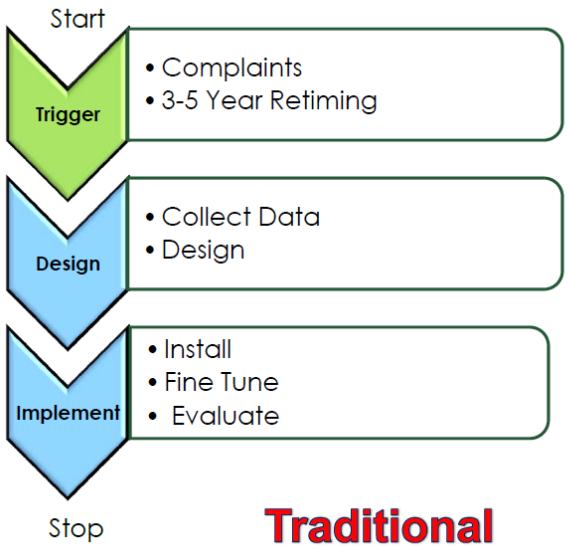
PRESENTATION CONTENT

- Arterial Traffic Signal Operations
- Data-driven Traffic Signal Operations AT Macomb County Depart of Road (MCDR)
  - Arterial Corridor Ranking
- Summary of Findings and Next Steps

ARTERIAL SIGNAL OPERATION GOALS

- Increased Safety
- Improved Mobility
- Improved Operations
- Reduced Maintenance Cost
- Improve Quality of Service
- Reduced Impact on Environment



MACOMB COUNTY, MICHIGAN

- 16 miles outside of Detroit Michigan
- Population of 875,000 (3rd Largest County in MI)
- 27 cities, townships, and villages
- MCDR Manages Over 1,700 Miles of Roads
- Arterial Roads with Over 100,000 Vehicles Per Day
- Notable Industry & Governmental Presence

Ford STELLANTIS GM GENERAL DYNAMICS U.S.ARMY AIR NATIONAL GUARD Circle The Lake Tour Lake St. Clair

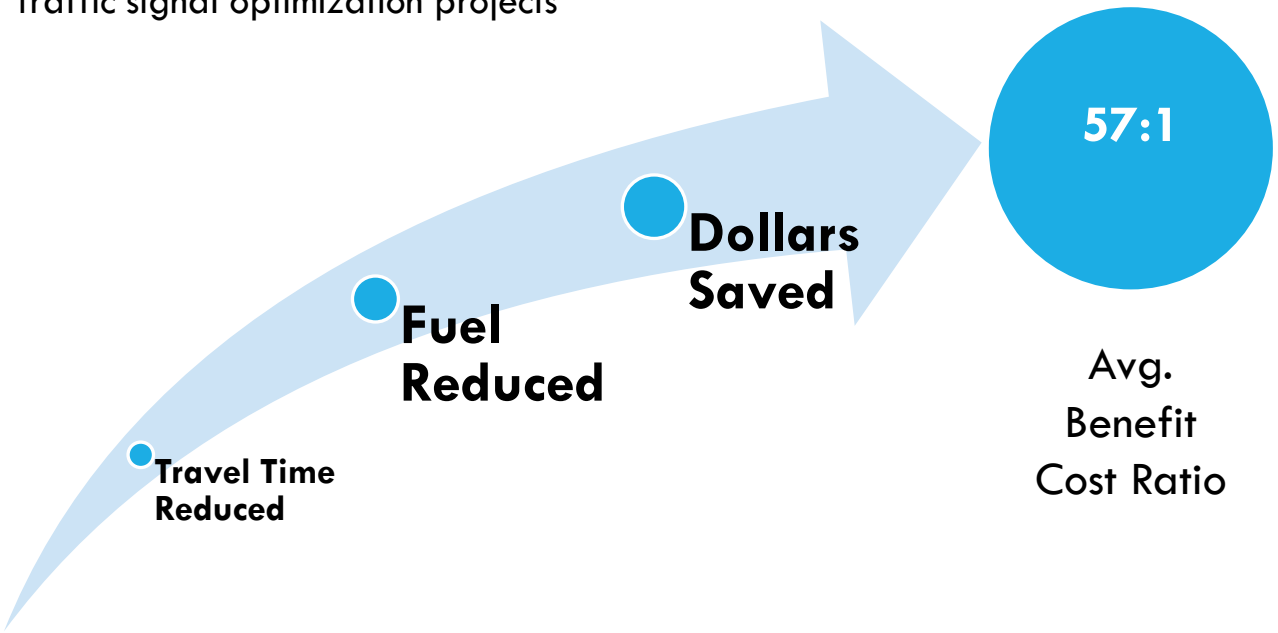
DEMANING OF DATA-DRIVEN OPERATIONS

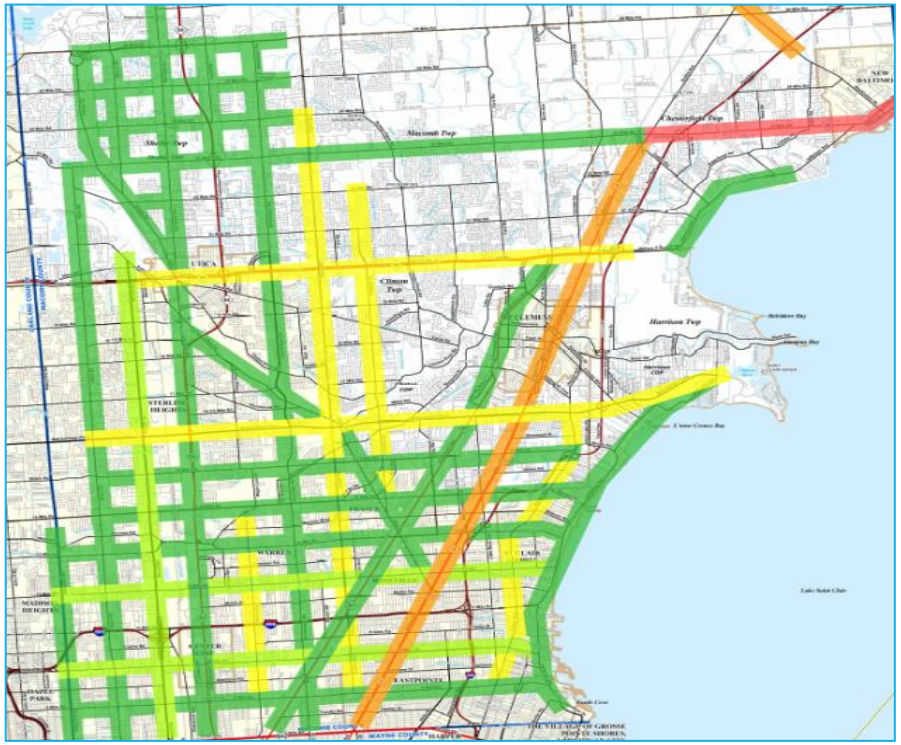
MCDR Traffic Department Planning Considerations

- Short-, mid-, and long-term goals evaluated
- Budget considerations and Federal fund requests granted

80 projects over 10+ years funded with 100% Federal funds:

- Deployment of ITS technologies
- State-of-the-art traffic operation center (TOC)
- Traffic signal optimization projects





Optimized Corridor Map

MCDR ARTERIAL ITS INFRASTRUCTURE

700+ Traffic Signals Connected

300+ Closed Circuit Television (CCTV)

600+ Road - Side Units (RSU's)

County-Owned Communications Network

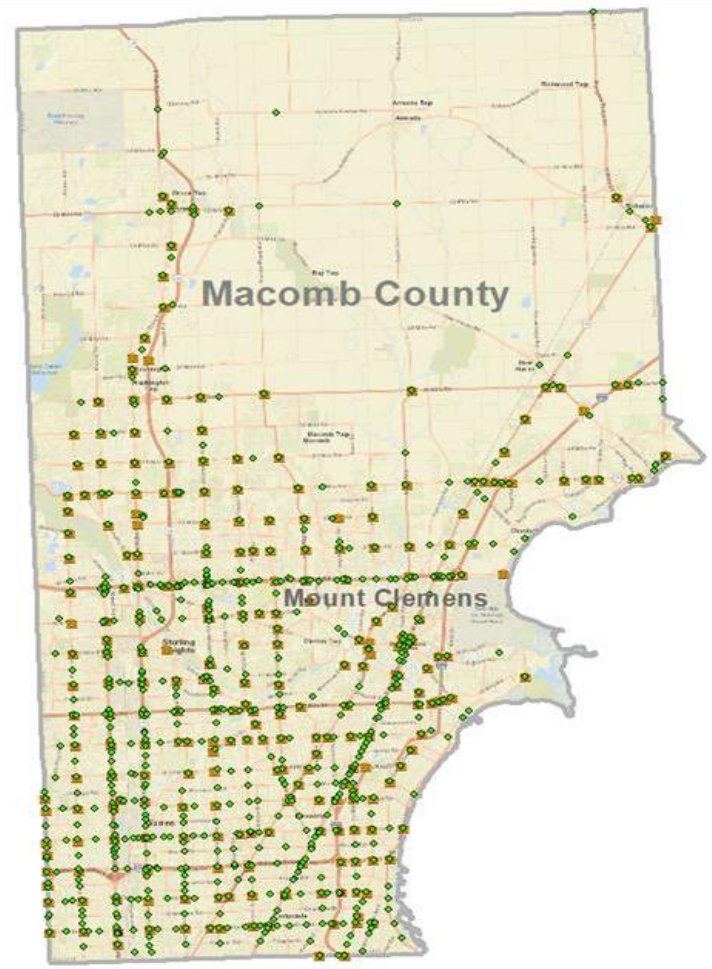
Advanced Traffic Signal Controllers

Advanced Traffic Management System

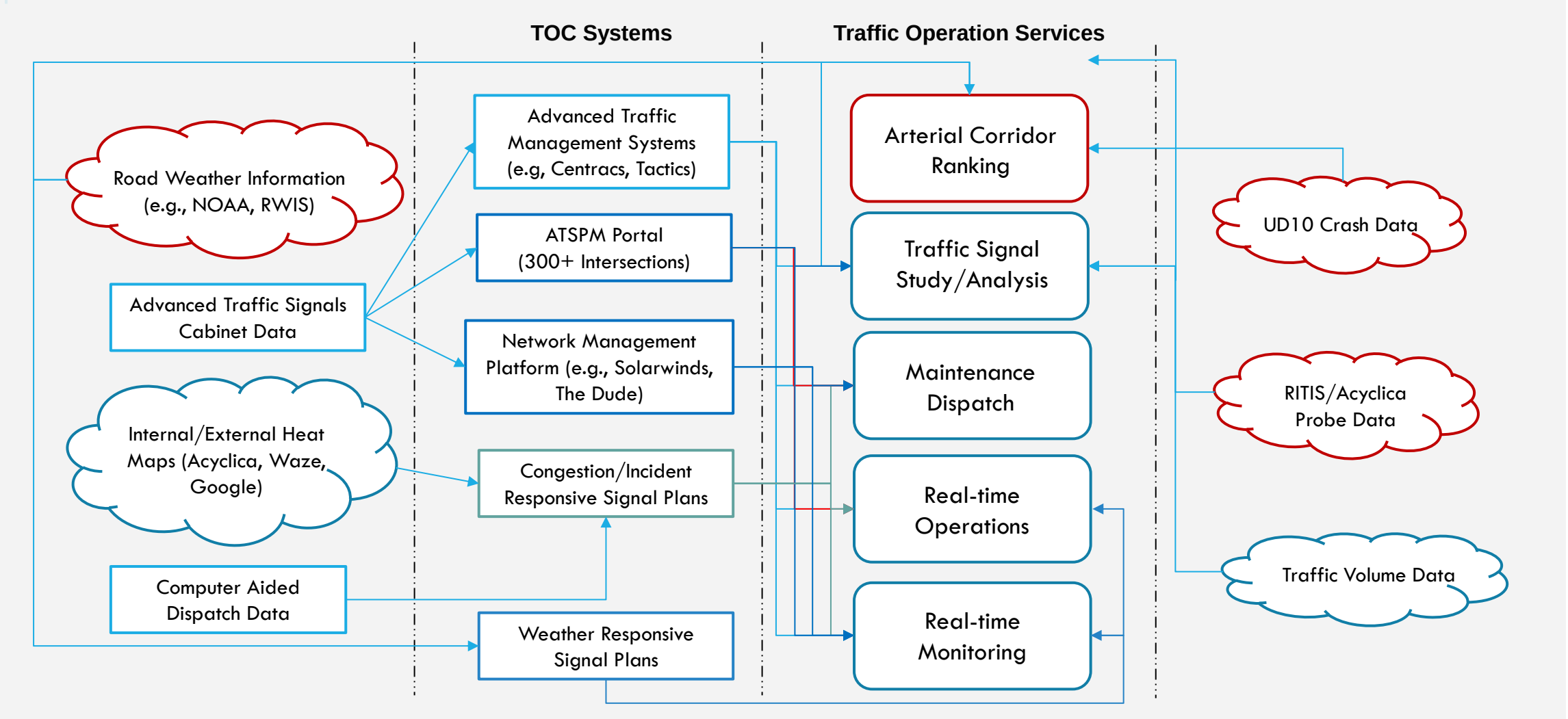
Road Weather Information System (RWIS)

Range of Detection Systems

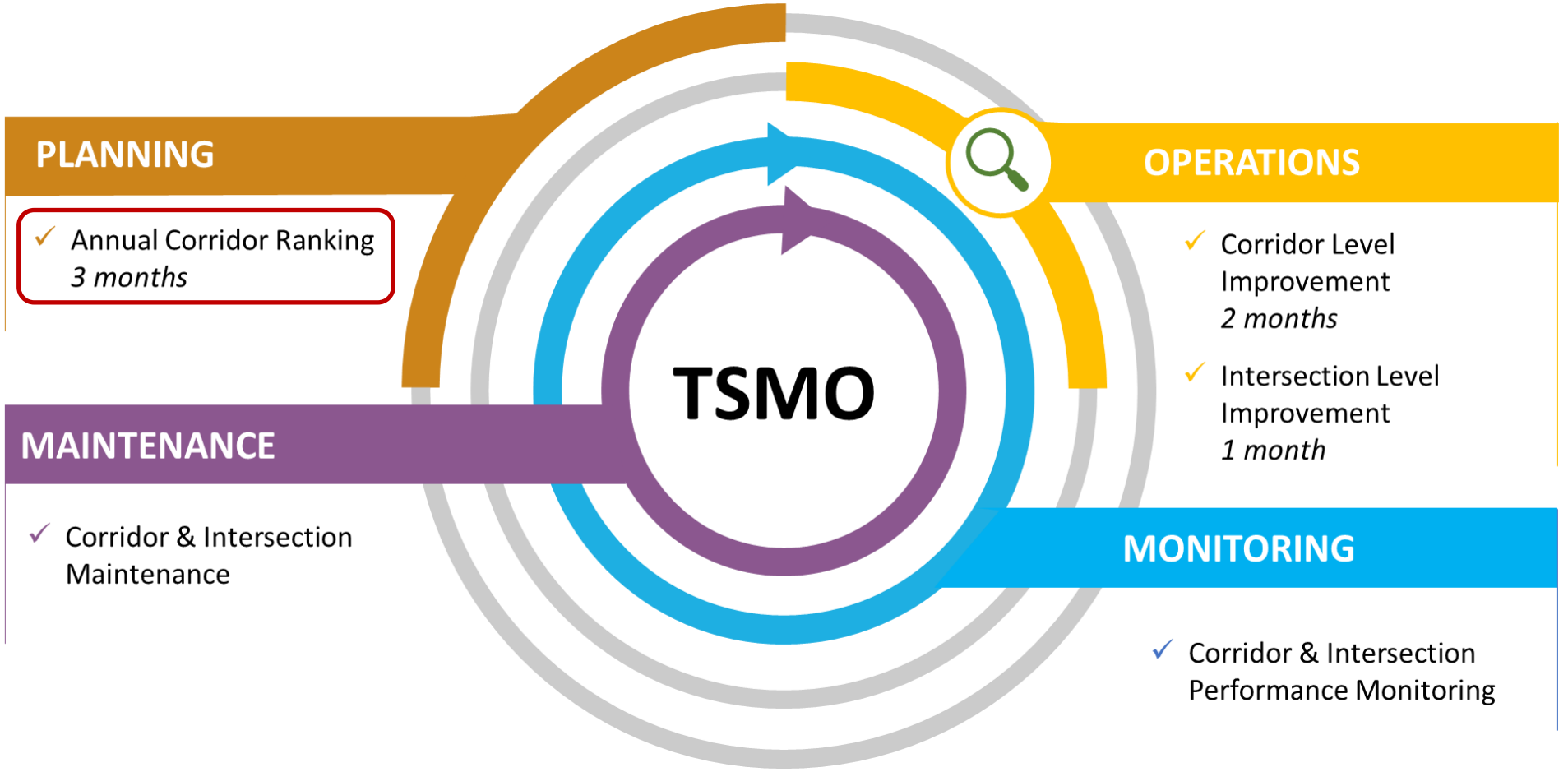
Travel Time sensors



MAJOR DATA SOURCES FOR ARTERIAL OPERATIONS



DATA-DRIVEN TRAFFIC OPERATIONS



ANNUAL CORRIDOR RANKING

Data Sources

- INRIX probe vehicle data
- Inclement weather data
- Crash data

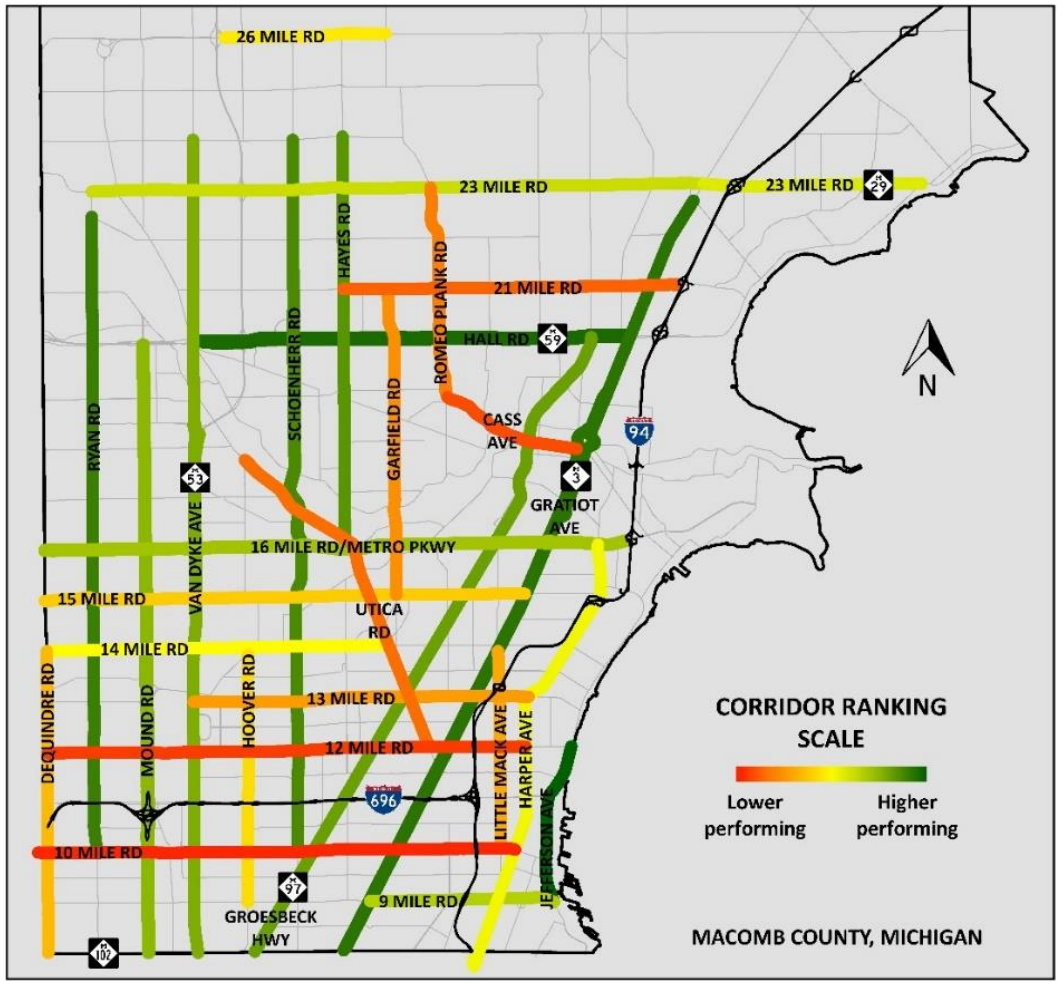
Key Points

- Validation of probe data (I-95 Corridor Coalition study)
- Macro-analysis: performance-based corridor ranking
- Micro-analysis: segments hotspot identification
- Python code to expedite computations (automation)

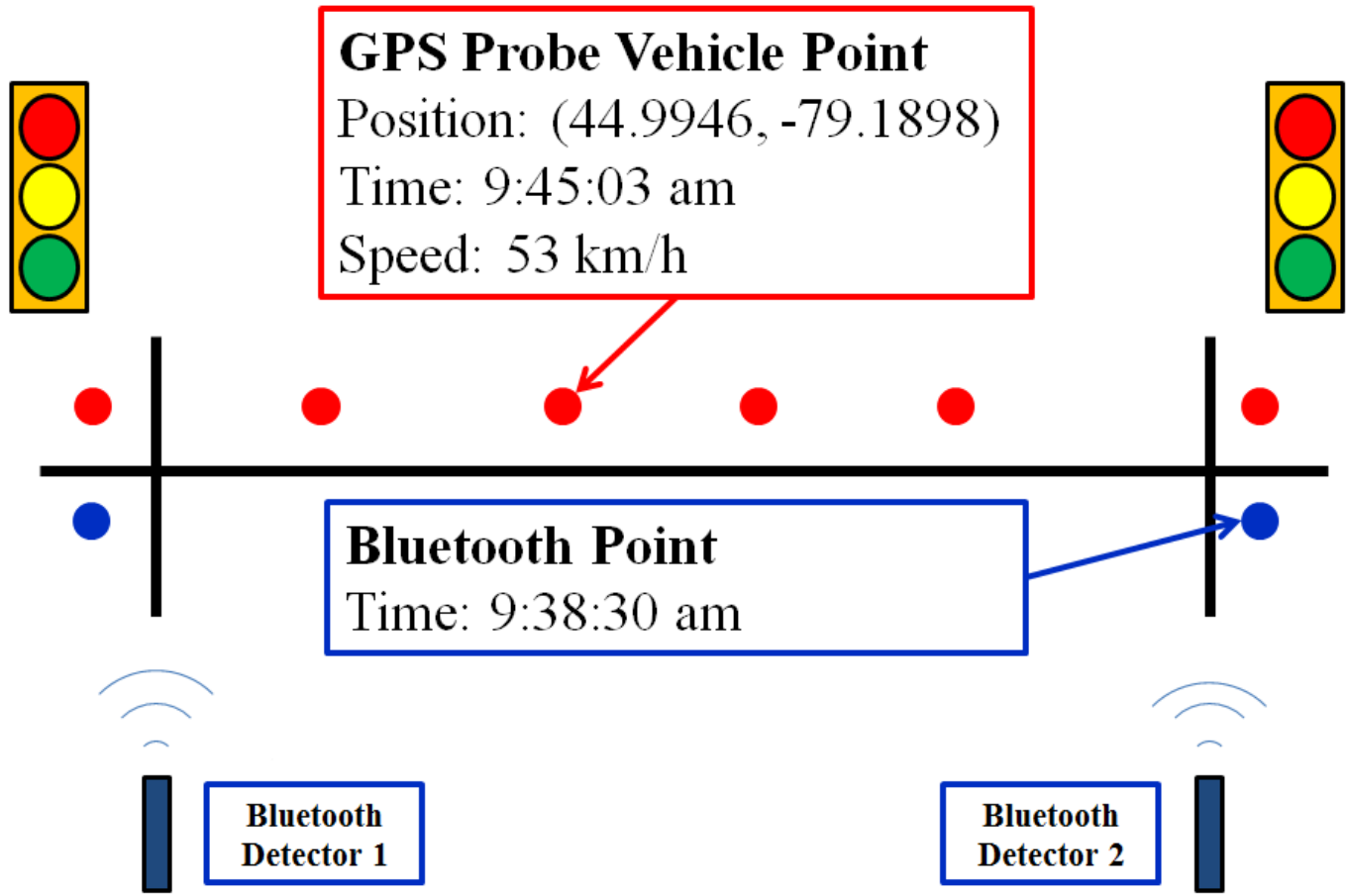
Application

- Helps corridor/site selection for furthering studies and pavement repairs

2021 corridor ranking results Macomb County, Michigan



PROBE DATA AVAILABLE ON THE ARTERAIL ROAD



INRIX

RITIS

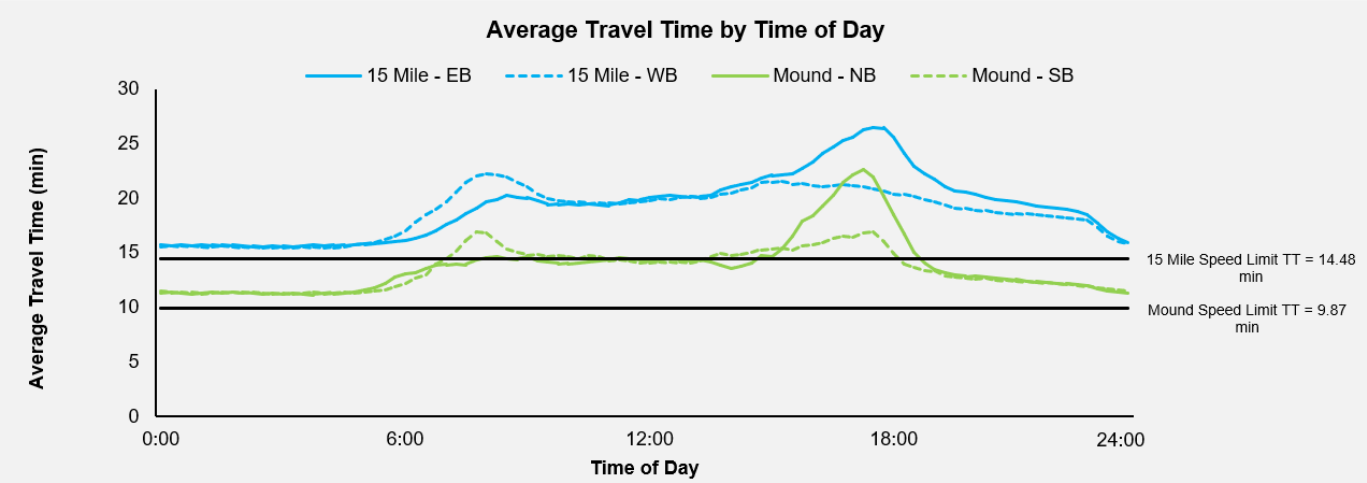
LIMITATION OF PROBE DATA FOR ARTERIAL USAGE

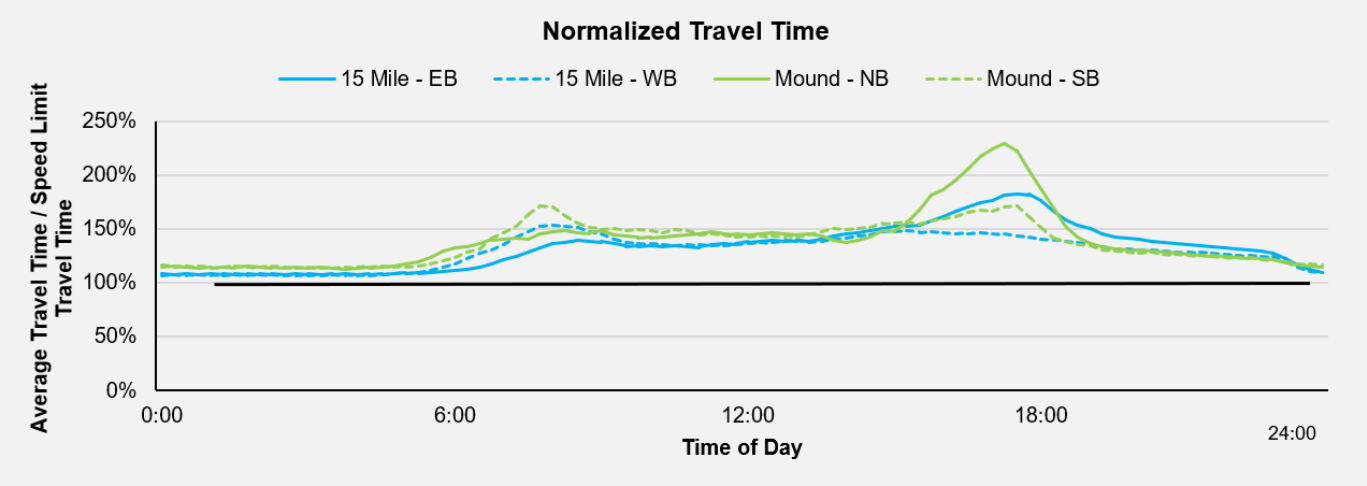
- I-95 coalition study:
  - The arterial should have an AADT of greater than 20,000 vehicles per day.
  - Have a "sparse" density of traffic signals
  - Experience moderate to low midblock friction
  - Through movements should be dominant

Principal Arterials	Minor Arterials	Major Collectors
• AADT > 40,000 vpd (2-way) • 2+ lanes per direction • <= 1 signal per mile • Limited curb cuts **Likely to have accurate probe data…** ✓RECOMMENDED	• AADT 20K to 40K vpd (2-way) • 2+ lanes per direction • <= 2 signals per mile • Moderate number of curb cuts **Possibly accurate probe data…** SHOULD BE TESTED	• AADT < 20K (2-way) - low volume • <= 2 lanes per direction • >= 2 signals per mile • Substantial number of curb cuts **Unlikely probe data is accurate…** ✖NOT RECOMMENDED

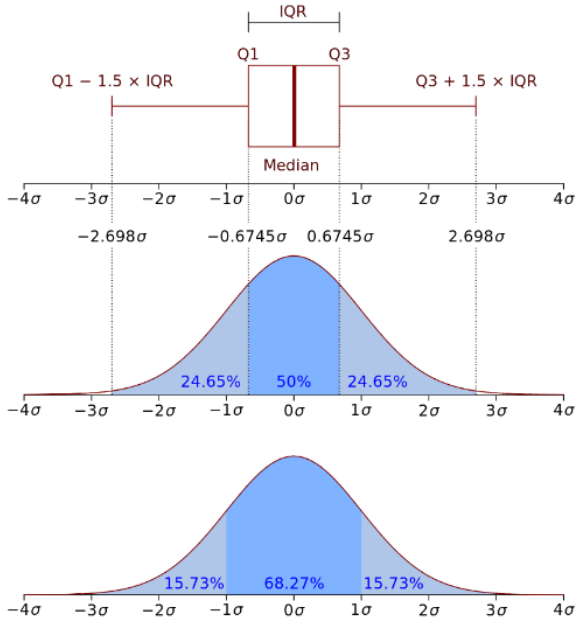
Source: I-95 Corridor Coalition VPP Project.

DATA PREPARING - NORMALIZATION





KEY ANALYSIS METHODOLOGY



- Travel Time Central Tendency Aggregation and Normalization
  - The **median** of travel times was selected to represent a measure of central tendency.
  - The travel times were normalized to by the speed limit travel time.

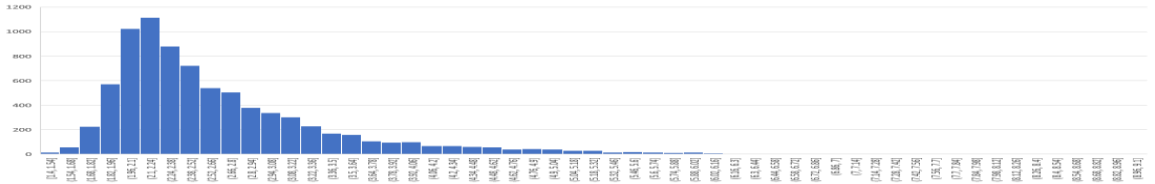
$$Normalized\ Median\ TT = \frac{Median\ TT}{Speed\ limit\ TT}$$

- Travel Time Reliability and Normalization
  - The **interquartile range (IQR)** is used to measure reliability.
  - The corridor IQR calculation is also needed to be normalized by the speed limit travel time.

$$Normalized\ IQR = \frac{(75th\ percentile\ TT - 25th\ percentile\ TT)}{Speed\ limit\ TT}$$

- Integrated Travel Time Index (Composite Index)*

$$Composite\ Index = 100 \times \sqrt{(max\{0, Normalized\ TT - 1\}^2 + (Normalized\ IQR)^2)}$$



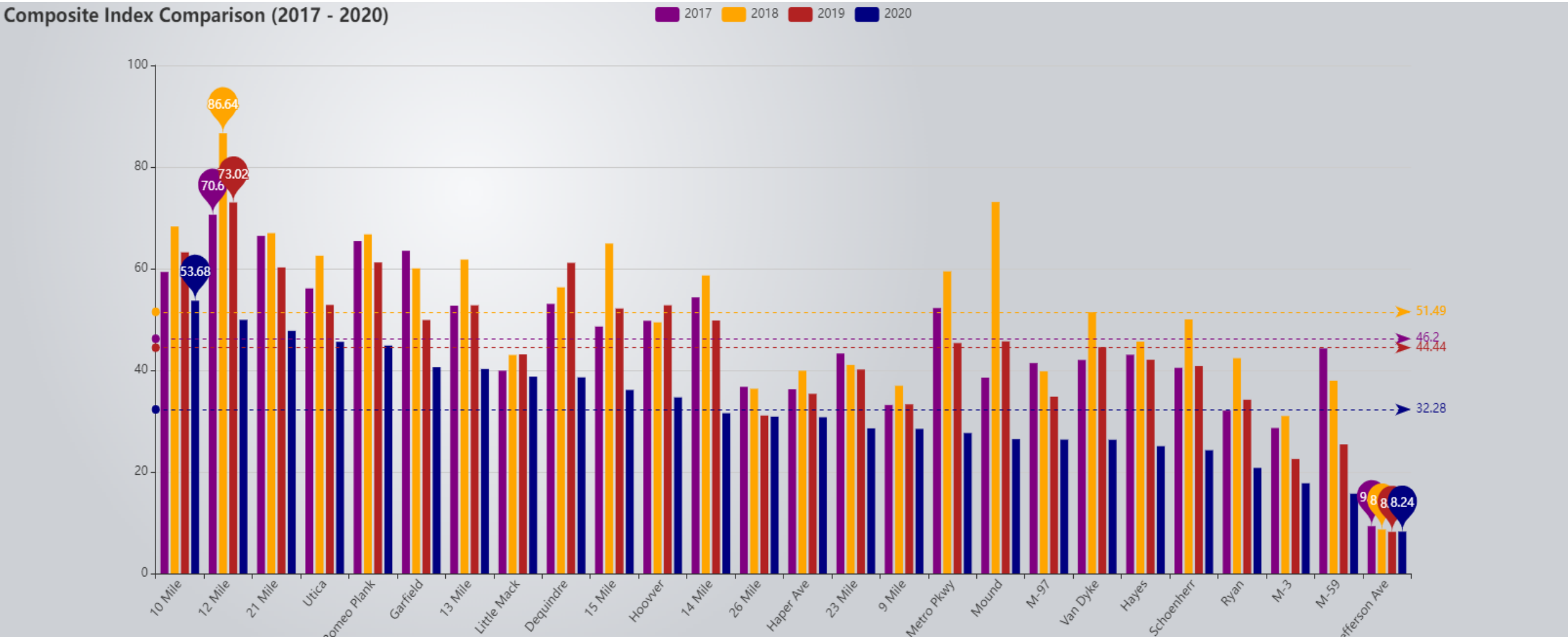
**Reference: Day, C. M., S. M. Remias, H. Li, M. M. Mekker, M. L. McNamara, E. D. Cox, and D. M. Bullock. Performance Ranking of Arterial Corridors Using Travel Time and Travel Time Reliability Metrics. In Transportation Research Record: Journal of the Transportation Research Board, No. 2487, Transportation Research Board of the National Academies, Washington, D.C., 205, pp. 44-54.*

FURTHER DATA FILTERING

- The conditions for a usable day of probe data can be found summarized below:
  - Must be a mid-week day (Tuesday, Wednesday, or Thursday);
  - No inclement weather conditions, and
  - No significant impacts to traffic (incidents, unusual traffic patterns, power outages, etc.).

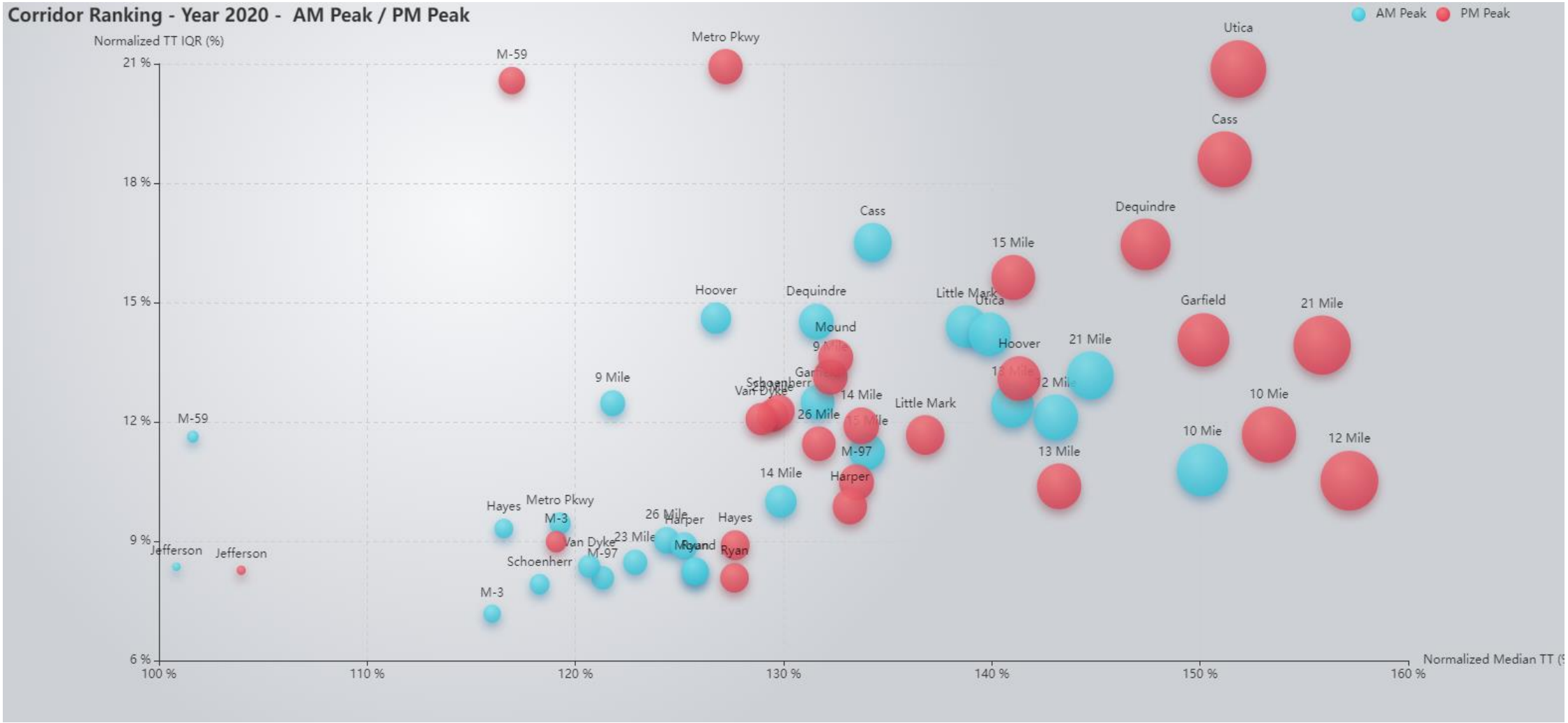
Corridor	Composite Index (%)				2020-2019 Change		2019-2018 Change		2018-2017 Change	
	2020	2019	2018	2017	Rank	%	Rank	%	Rank	%
10 Mile Rd	54%	63%	68%	59%	↑ 1	15%	↑ 1	7%	↑ 2	15%
12 Mile Rd	50%	73%	87%	71%	↓ 1	32%	0	16%	0	23%
21 Mile Rd	48%	60%	67%	66%	↑ 2	21%	↓ 1	10%	↓ 2	1%
Utica Rd	46%	53%	63%	56%	↑ 2	14%	↑ 1	15%	↓ 1	11%
Cass Ave & Romeo Plank Rd	45%	61%	67%	65%	↓ 1	27%	↑ 1	8%	↓ 2	2%
Garfield Rd	41%	50%	60%	64%	↑ 4	19%	↓ 1	17%	↓ 5	5%
13 Mile Rd	40%	53%	62%	53%	0	24%	↑ 1	15%	↑ 1	17%
Little Mack Ave	39%	43%	43%	40%	↑ 7	10%	↑ 2	0%	↑ 2	8%
Dequindre Rd	39%	61%	56%	53%	↓ 6	37%	↑ 9	9%	↓ 4	6%
15 Mile Rd	36%	52%	65%	49%	↓ 1	31%	↓ 3	20%	↑ 6	34%
Hoover Rd	35%	53%	49%	50%	↓ 3	34%	↑ 7	7%	↓ 4	1%
14 Mile Rd	32%	50%	59%	54%	↓ 1	37%	0	15%	↓ 4	8%
26 Mile Rd	31%	31%	36%	37%	↑ 10	1%	↑ 1	15%	↓ 3	1%
Harper Ave	31%	35%	40%	36%	↑ 5	13%	↑ 1	11%	↑ 2	10%
23 Mile Rd (M-29)	29%	40%	41%	43%	↑ 3	29%	↑ 1	2%	↓ 5	5%
9 Mile Rd	28%	33%	37%	33%	↑ 6	15%	↑ 1	10%	0	11%
16 Mile Rd (Metro Pkwy)	28%	45%	59%	52%	↓ 4	39%	↓ 3	24%	0	14%
Mound Rd	26%	46%	73%	39%	↓ 6	42%	↓ 10	38%	↑ 18	90%
Groesbeck Hwy (M-97) & North Ave	26%	35%	40%	41%	↑ 1	24%	↑ 1	13%	↓ 4	4%
Van Dyke Ave (M-53)	26%	45%	51%	42%	↓ 6	41%	↓ 1	13%	↑ 3	22%
Hayes Rd	25%	42%	46%	43%	↓ 5	40%	0	8%	↓ 1	6%
Schoenherr Rd	24%	41%	50%	40%	↓ 5	41%	↓ 3	19%	↑ 4	24%
Ryan Rd	21%	34%	42%	32%	↓ 2	39%	↓ 3	19%	↑ 6	32%
Gratiot Ave (M-3)	18%	23%	31%	29%	↑ 1	21%	0	27%	0	8%
Hall Rd (M-59)	16%	25%	38%	44%	↓ 1	38%	↓ 2	33%	↓ 9	14%
Jefferson Ave	8%	8%	9%	9%	0	1%	0	5%	0	7%

RANKING OF CORRIDORS BY COMPOSITE INDEX



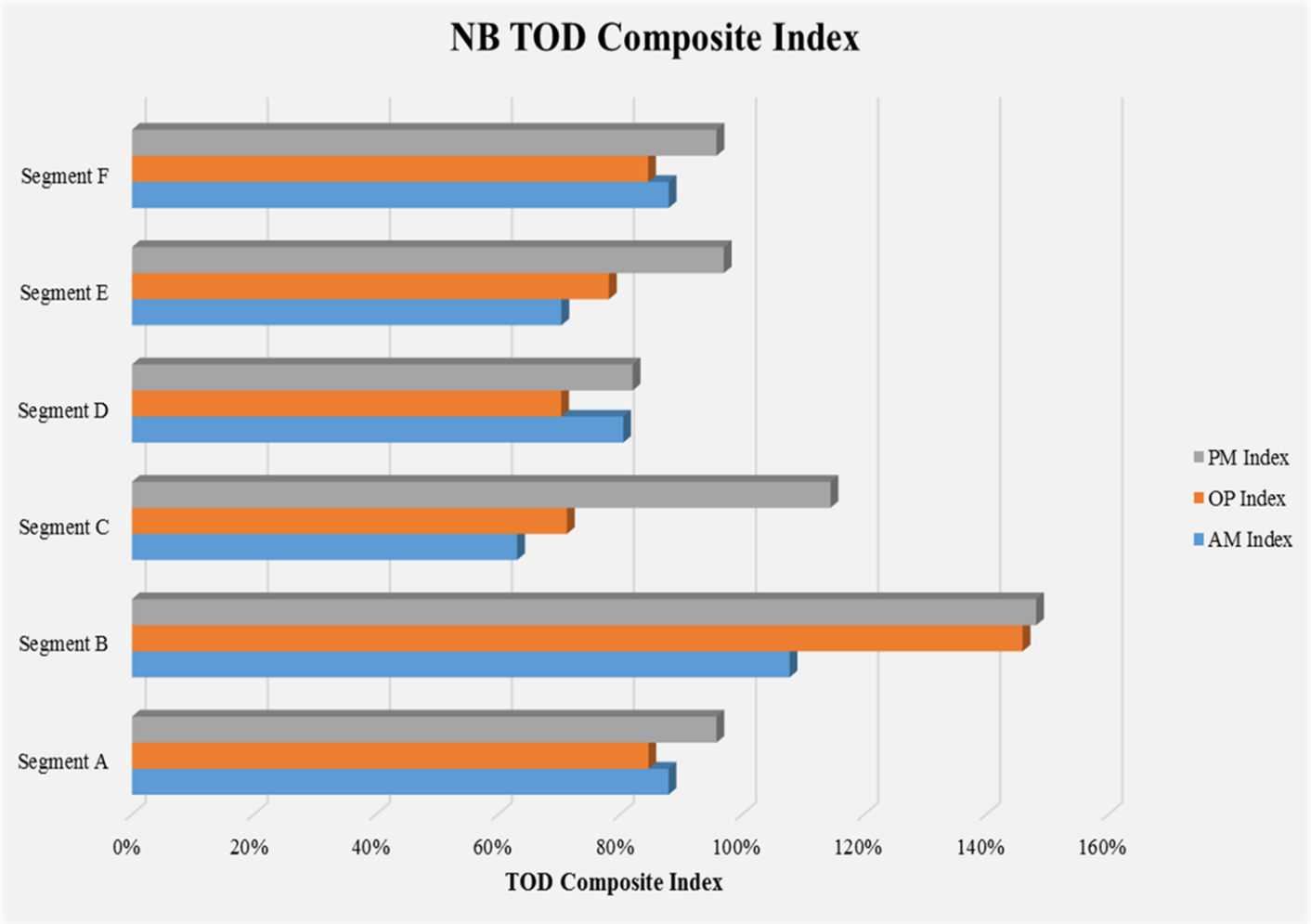
CORRIDORS TRAVEL TIME PERFORMANCE COMPARING

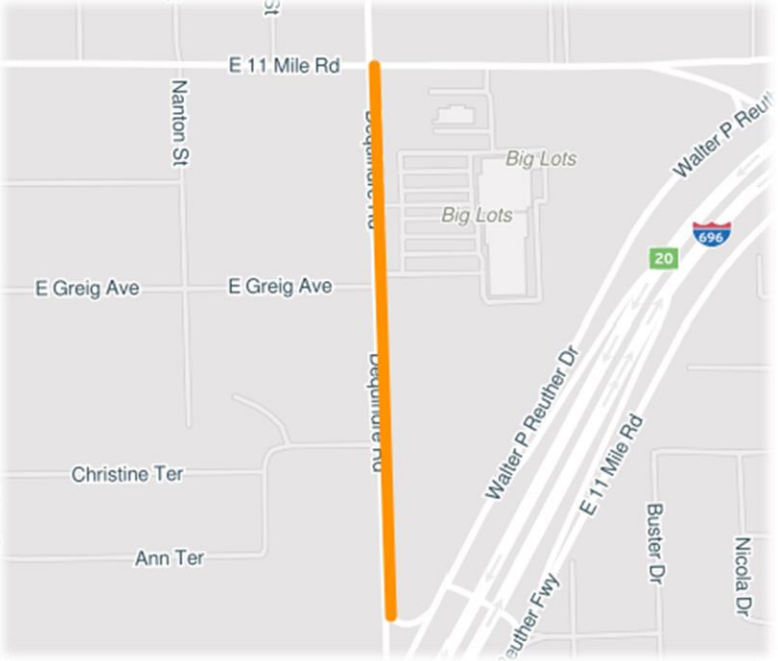
MEDIAN TRAVEL TIME VS TRAVEL TIME RELIABILITY



CASE OF MICRO-LEVEL ANALYSIS

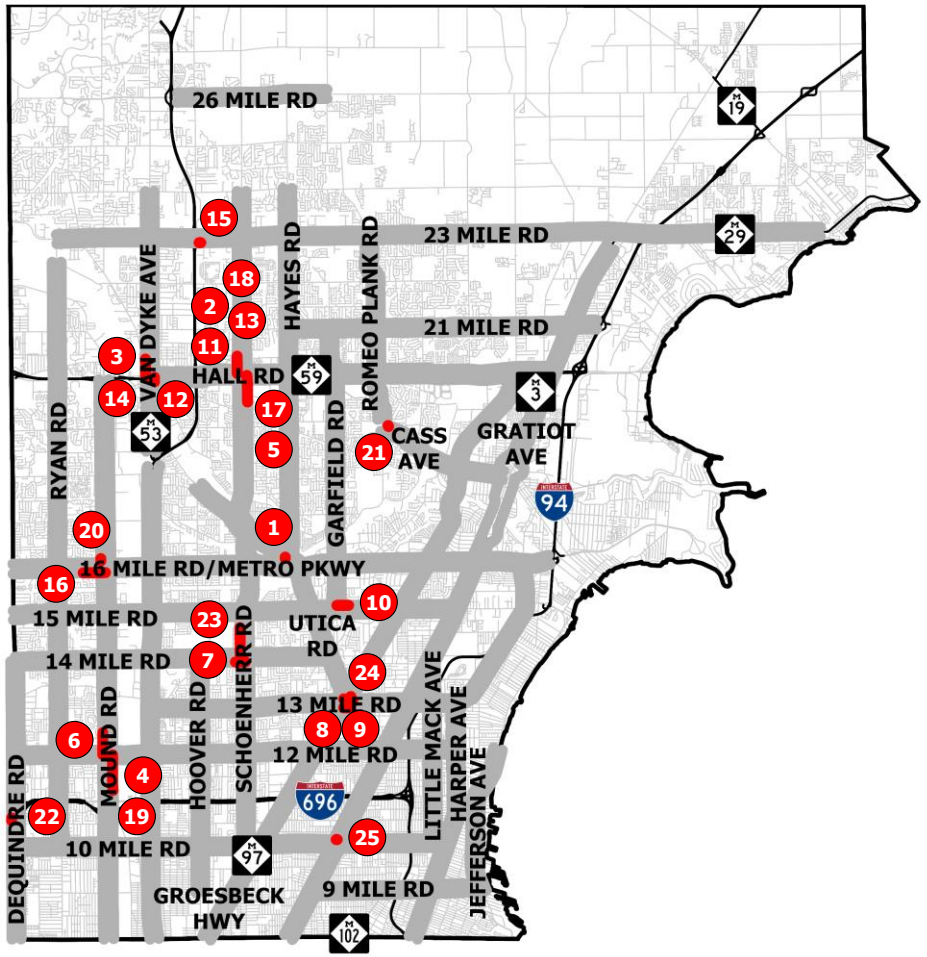
NB DEQUINDRE





- High index value for segment B
- Located at the off-ramp of I-696 freeway
- Sporadic and high traffic volumes acquired from free way (no traffic control devices on I-696)

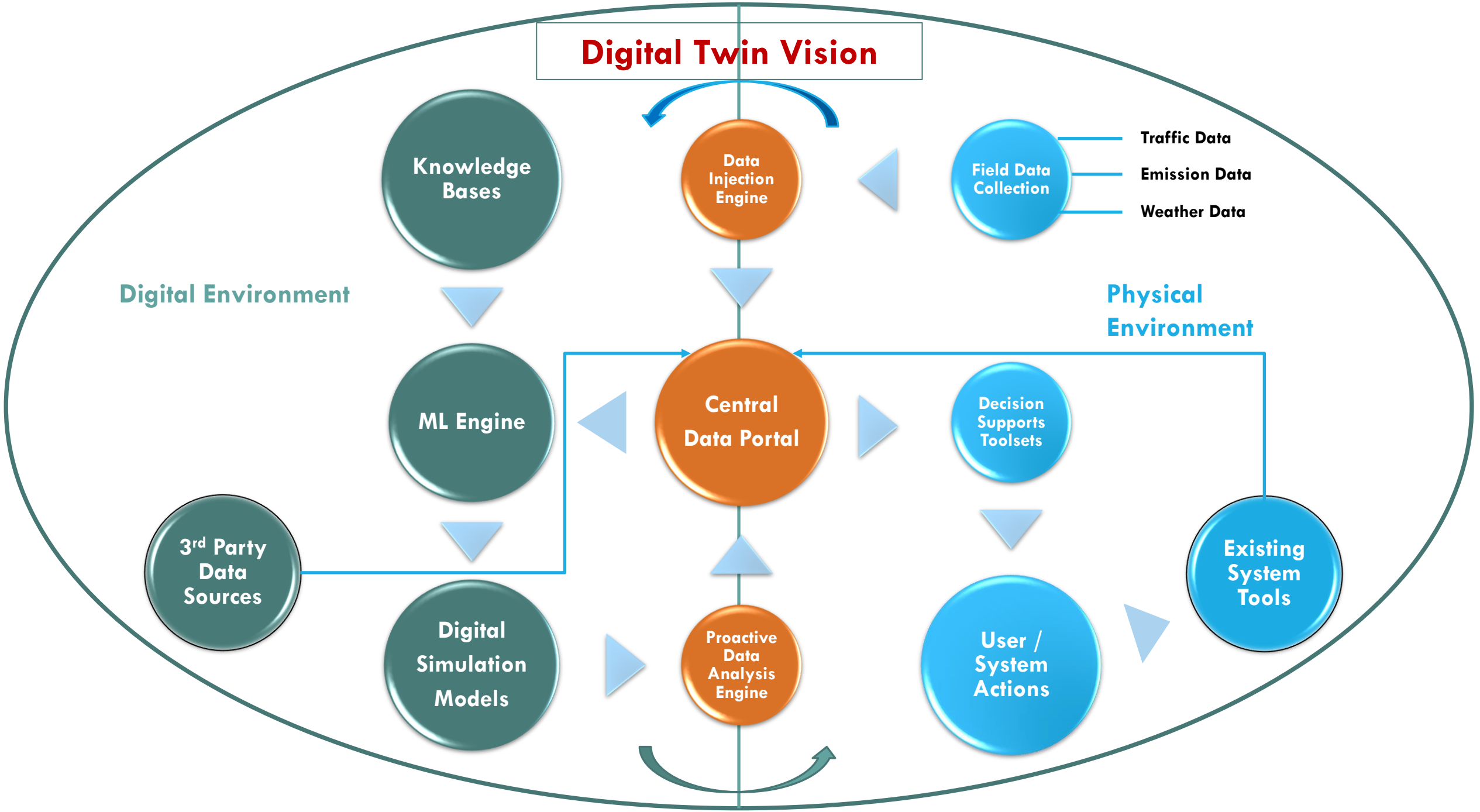
RANKING OF ROAD SEGMENTS BY 2023 CONGESTION INDEX



Rank	Corridor	Direction	Intersection Description	Notes
1	Hayes Rd	SB	Hayes Road and Utica Road (#504)	Designated stop for SB vehicles approaching Utica Road. Meters traffic to 16 Mile Rd/Metro Pkwy and prevent queues from blocking intersection. Corridor signal timing review.
2	Schoenherr Rd	SB	SB Schoenherr Rd and X-Over north of Hall Rd/M-59 (#784)	Capacity analysis
3	Van Dyke Ave	SB	Van Dyke Ave and Hall Rd/M-59 (#212)	Capacity analysis
4	Mound Rd	NB	Mound Rd and 12 Mile Rd (#10)	2023 Innovate Mound Project
5	Schoenherr Rd	NB	NB Schoenherr Rd and X-Over south of Hall Rd/M-59 (#785)	Capacity analysis
6	Mound Rd	SB	SB Mound Rd and 12 Mile Rd (#10)	2023 Innovate Mound Project
7	14 Mile Rd	EB	14 Mile Rd and Schoenherr Rd (#339)	Corridor signal timing review
8	13 Mile Rd	WB	13 Mile Rd and Groesbeck Hwy/M-97 (#203)	Designated stop for WB vehicles approaching Groesbeck Hwy/M-97. Corridor signal timing review.
9	13 Mile Rd	EB	13 Mile Rd and Utica Rd (#315)	Designated stop for EB vehicles approaching Utica Rd. Corridor signal timing review.
10	15 Mile Rd	WB	15 Mile Rd and Garfield Rd (#342)	Corridor signal timing review
11	Schoenherr Rd	SB	Schoenherr Rd and Hall Rd/M-59 (#207)	Capacity analysis
12	Van Dyke Ave	NB	Van Dyke Ave and Hall Rd/M-59 (#212)	Capacity analysis
13	Schoenherr Rd	SB	SB Schoenherr Rd and X-Over north of Hall Rd/M-59 (#784)	Capacity analysis
14	Van Dyke Ave	SB	Van Dyke Ave and Hall Rd/M-59 (#212)	Capacity analysis
15	23 Mile Rd/M-29	EB	23 Mile Rd/M-29 and Corporate Dr (#875)	Random arrivals from NB M-53 off ramp cause long queues for EB vehicles approaching Corporate Dr. Corridor signal timing review.
16	16 Mile Rd/Metro Pkwy	EB	16 Mile Rd/Metro Pkwy and Mound Rd (#277)	2022-2023 16 Mile Rd/Metro Pkwy construction
17	Schoenherr Rd	NB	Schoenherr Rd and Hall Rd/M-59 (#207)	Capacity analysis
18	Schoenherr Rd	SB	SB Schoenherr Rd @ Northpointe Blvd (#905)	Capacity analysis
19	Mound Rd	NB	NB Mound Rd and X-Over south of Heathdale Ave (#572)	2023 Innovate Mound Project
20	Mound Rd	SB	SB Mound Rd and X-Over north of 16 Mile Rd/Metro Pkwy (#723)	2023 Innovate Mound Project
21	Cass Ave	WB	Cass Ave and Romeo Plank Rd	This is a roundabout location.
22	Dequindre Rd	SB	Dequindre Rd and WB I-696 service drive (#438)	Corridor signal timing review
23	Schoenherr Rd	SB	Schoenherr Rd and 14 Mile Rd (#339)	Corridor signal timing review
24	Utica Rd	NB	Utica Rd and Groesbeck Hwy/M-97 (#205)	Designated stop for NB vehicles approaching Groesbeck Hwy/M-97. Corridor signal timing review.
25	10 Mile Rd	WB	10 Mile Rd and Gratiot Ave/M-3 (#180)	Corridor signal timing review

NEXT STEP OF ENHANCEMENTS

- To improve the quality of this analysis, the following will be looked into for future studies:
  - Include reliable construction data
  - Incorporate some type of traffic volume data (representing demands)
  - Use INRIX XD (eXtreme Definition) road segments
- Additional topics to be analyzed include:
  - The influence of inclement weather, crashes, and work zones on corridor travel times
  - Merging probe vehicle data with Automated Traffic Signal Performance Measure (ATSPM) data to obtain an overall assessment of mobility performance
  - Incorporating Safety/Crash data (using the filtered out crash data)


Digital Twin Vision
Knowledge Bases
Data Injection Engine
Field Data Collection
Traffic Data
Emission Data
Weather Data
Digital Environment
Physical Environment
ML Engine
Central Data Portal
Decision Supports Toolsets
3rd Party Data Sources
Existing System Tools
Digital Simulation Models
Proactive Data Analysis Engine
User / System Actions

QUESTIONS ?

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