

# Advancing TSMO with AI-Powered Video Analytics (AIVA)

*Transforming Existing CCTV Feeds into Proactive, Actionable System-Level Intelligence*



**2026 Traffic Engineering Workshop and Transportation Planning Forum**

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Director of Traffic | Minneapolis | WSB

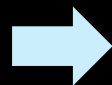




# WSB's AI-Powered Video Analytics (AIVA) Framework

*Enabling multiple TSMO applications from high-resolution, lane-level vehicle trajectories*

Leverages Existing  
Video Assets



- Existing CCTV (RTSP/IP)
- Portable traffic camera
- Drone



I-94 WB at Chicago Avenue – Minneapolis, MN  
Video Quality: SD, 640x480, 30 fps

- ✓ Automated detection & classification
- ✓ Continuous lane-level trajectory tracking
- ✓ High-resolution data extraction using virtual detectors





# I-694 Detector Health Assessment (Jan 2026 – Mar 2027)

*Developing a scalable framework for lane-level detector performance evaluation using existing CCTVs*

## Project Corridor

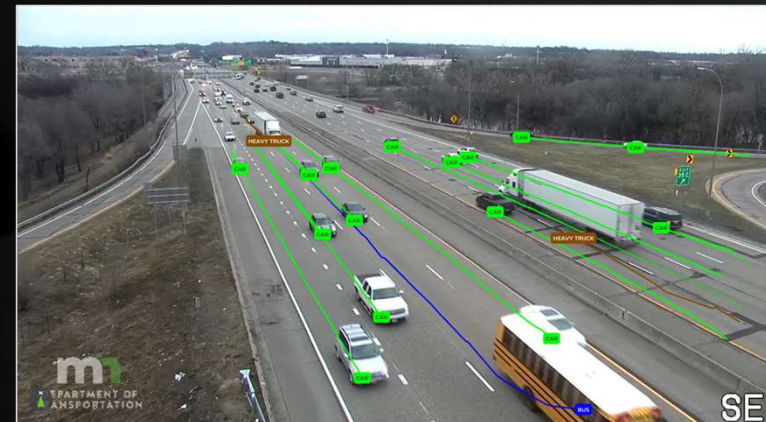
- I-694 : CR 81 (west) to Lexington Avenue (east)
- 125 lane-level detector channels
- 20 PTZ CCTVs

## Project Datasets

- MnDOT PeMS detector data
- AIVA-derived video counts
- Independent 3-party manual reference counts

## Evaluation Metric

- 15-minute lane-level mean absolute percentage difference (MAPD)



Lane-Level Vehicle Trajectory Extraction from MnDOT CCTV  
I-694/I-94 Interchange – Minneapolis  
(RTSP, HD 1920x1080, 30 fps)



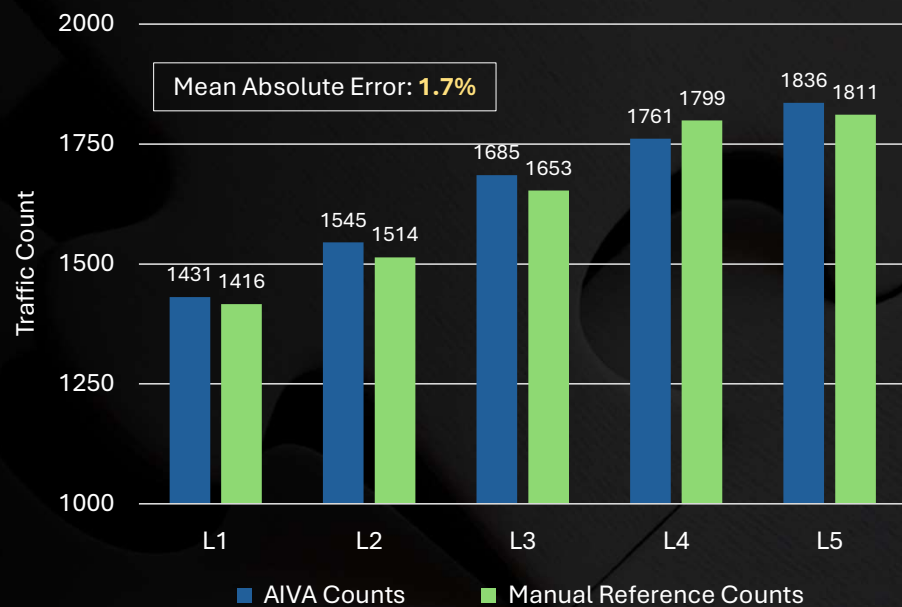
# Lane-Level Detection Accuracy Validation

Lane-level errors < 2% across all lanes under daylight conditions | 5-lane urban freeway, peak hour



I-10 EB at Washington Avenue - Houston, TX

### Lane Volume Comparison (4 – 5 PM)





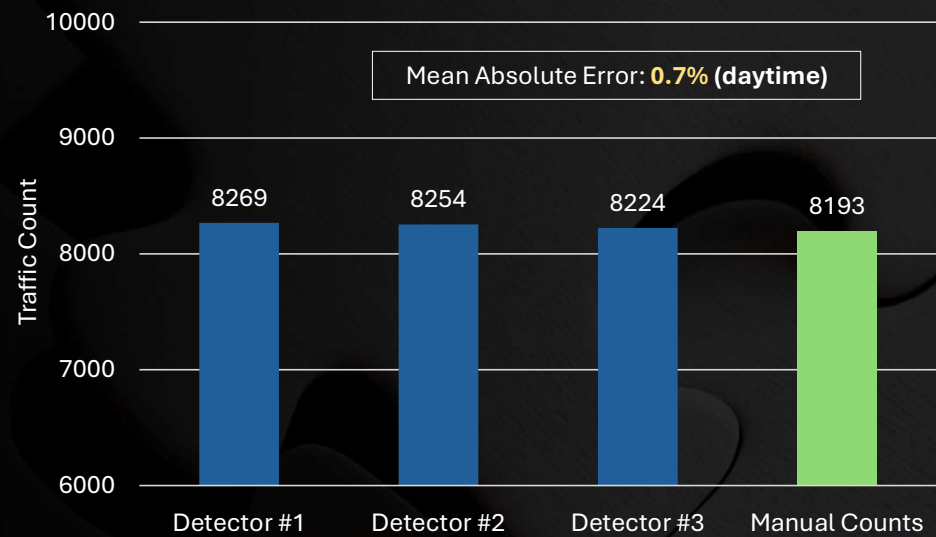
# Detection Accuracy Stability Assessment

Stable detection performance without site-specific calibration



Three Virtual Detector Placements

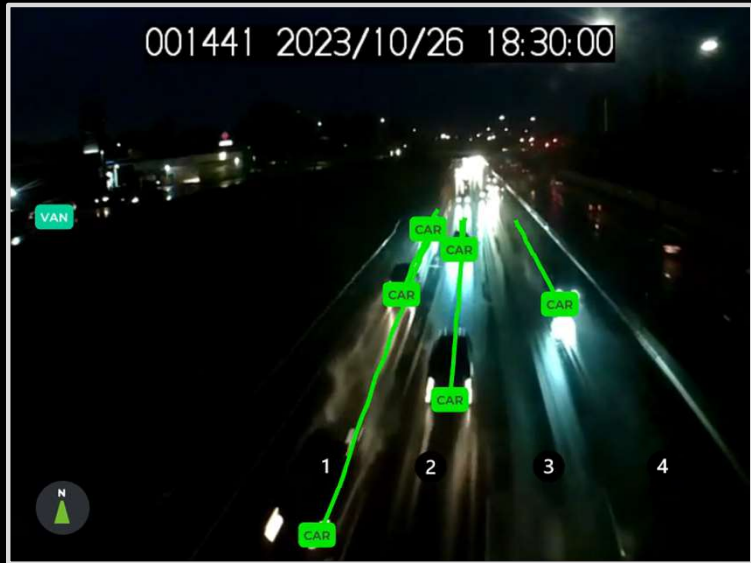
### Link Volume Comparison (4 – 5 PM)



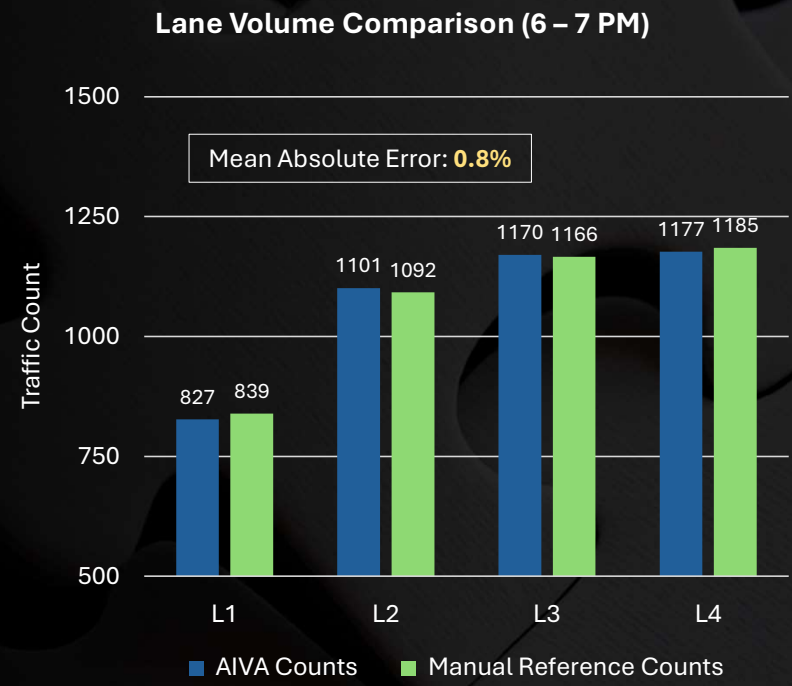


# Robust Lane-Level Detection Accuracy Validation

Lane-level errors < 2% across all lanes under low-light, wet pavement conditions



I-94 WB at 25<sup>th</sup> Avenue – Minneapolis, MN





## Measuring Traffic Flow Instability



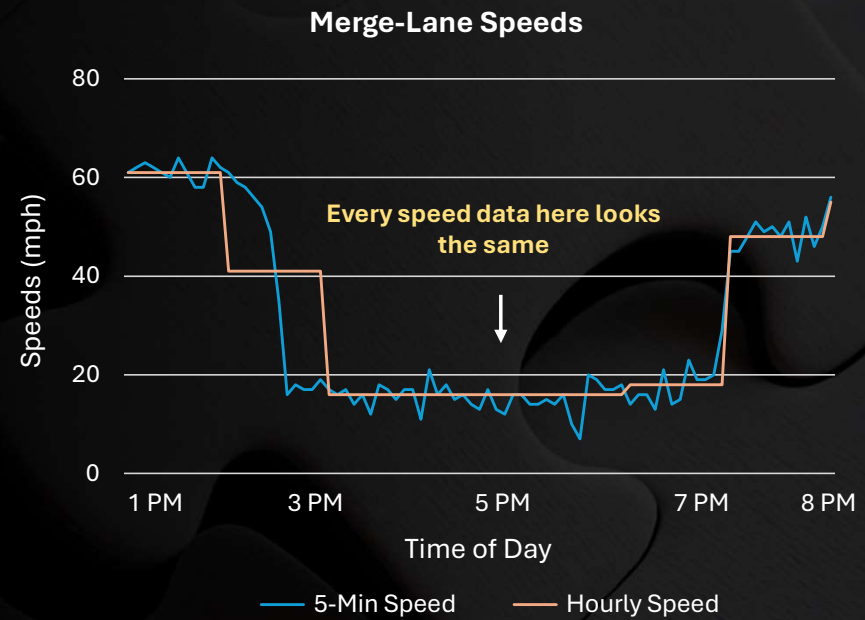


# Measuring Traffic Flow Instability – Merge Operations

*Speeds alone underrepresent instability in congestion – limiting proactive TSMO actions*



Merge Lane Operations  
I-94 WB at Chicago Avenue – Minneapolis, MN



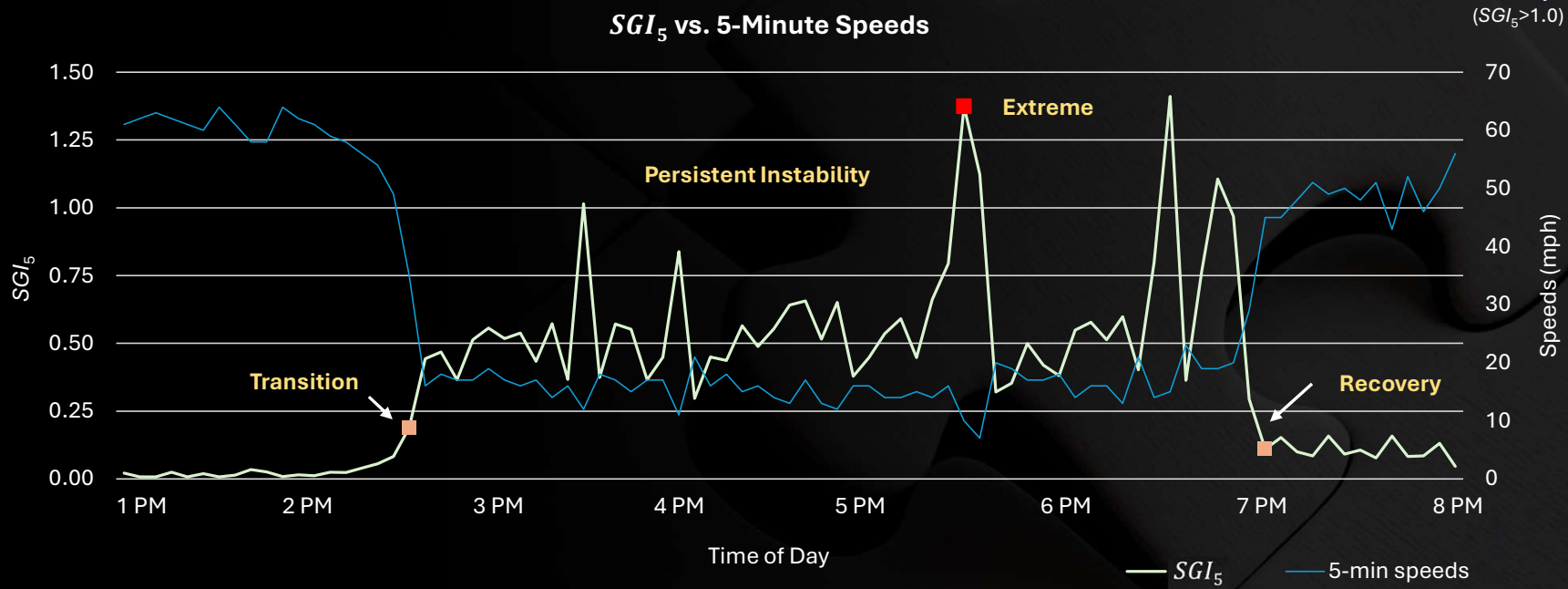


# Stop-and-Go Index (SGI) – Merging Operations

*A lane-level diagnostic measure of traffic flow instability*



Extreme Instability at 5:25 PM (SGI<sub>5</sub>>1.0)



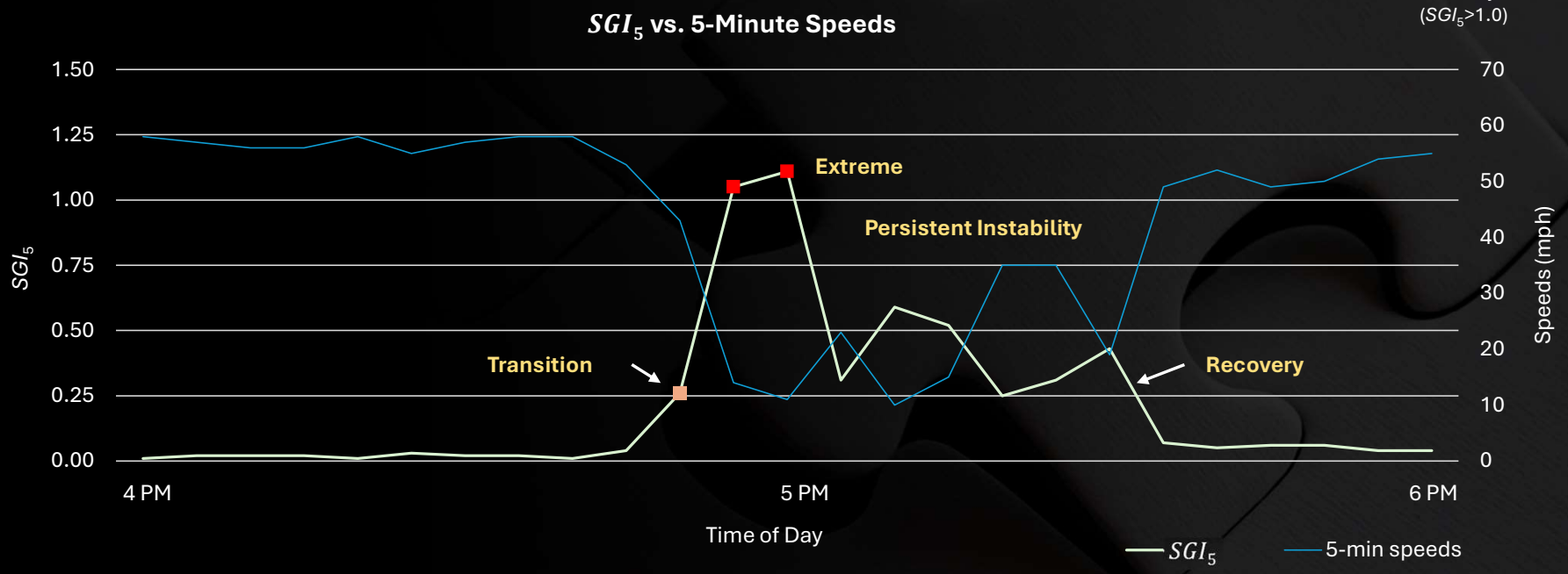


# Stop-and-Go Index (SGI) – Weaving Operations

Tracking freeway weaving lane during PM peak hours



Extreme Instability at 5:00 PM (SGI<sub>5</sub>>1.0)



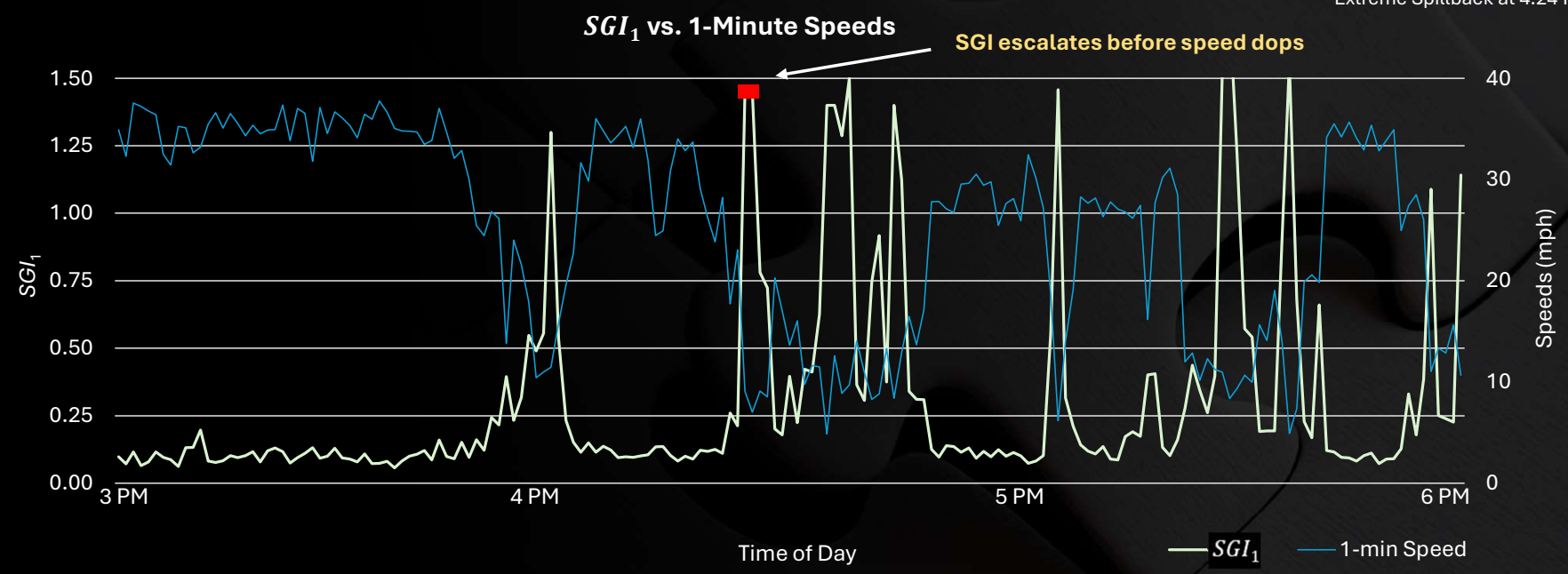


# Stop-and-Go Index (SGI) – Off-Ramp Operations

One-minute SGI enables proactive spillback detection for operational risks



Extreme Spillback at 4:24 PM



Note: SGI values above 1.5 truncated for visualization clarity

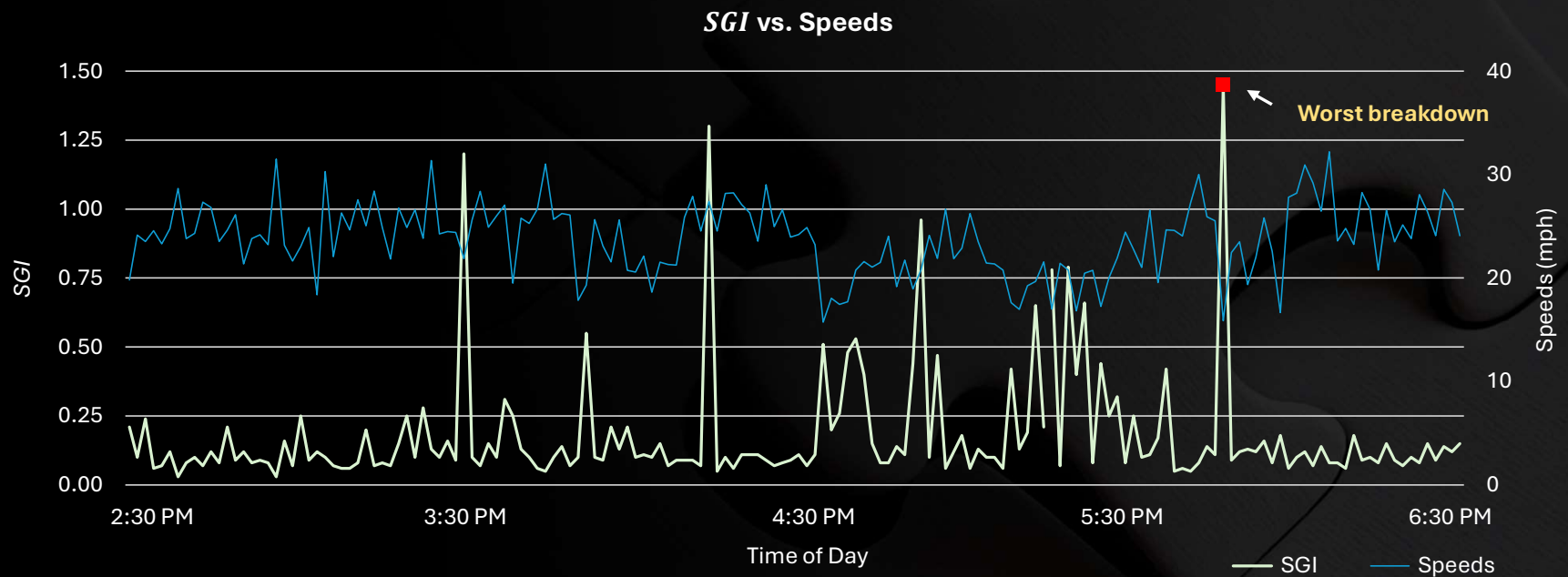


# Stop-and-Go Index (SGI) – Ramp Junction Operations

Same SGI framework, aggregated at the signal-cycle level



Worst Breakdown at 5:50 PM



Note: Each data point represents a signal cycle and SGI value above 1.5 truncated for visualization clarity

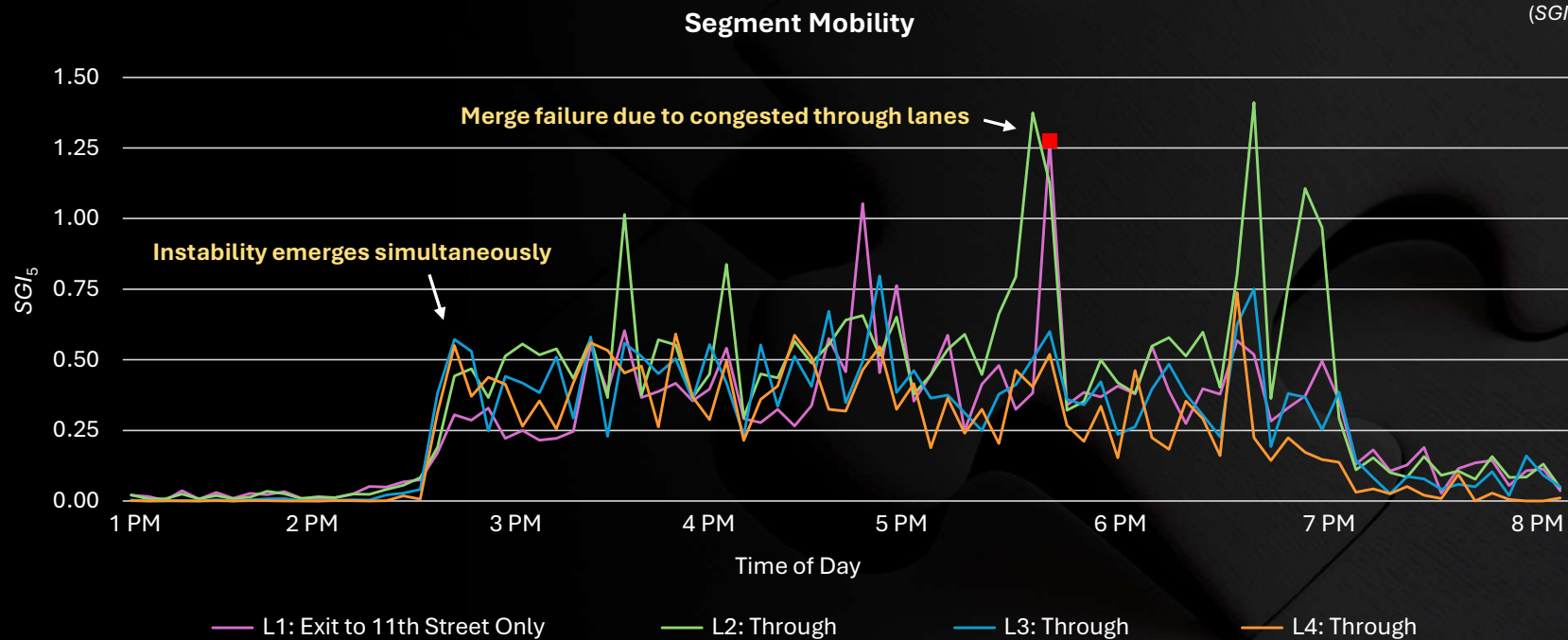


# Measuring Segment Instability

Identifies potential operational risk under uneven lane-level performance



Exit lane instability at 5:30 PM  
( $SGI_5 > 1.0$ )





# Turning Existing CCTV into Powerful Traffic Sensors

*Any roadway, any location with wide-area, high-resolution views*



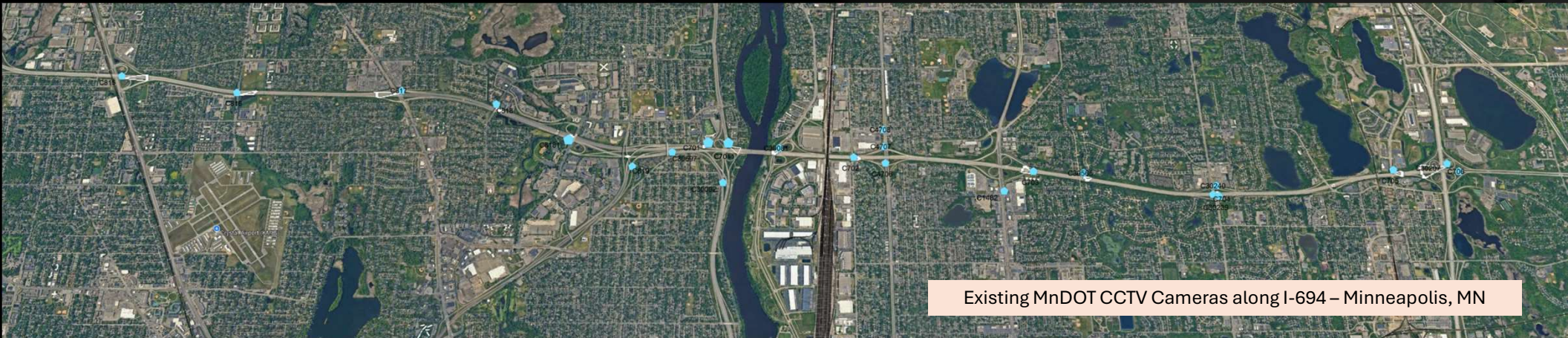
I-694/I-94 Interchange



I-694/Brooklyn Blvd Ramp Junction

## Scaling to Corridor Instability Diagnosis

- *> 98% lane-level detection accuracy without calibration*
- *Applicable to any roadway segment*
- *Applicable at any time interval and comparable across time scales*
- *Scalable using existing high-resolution CCTV infrastructure and portable cameras*



Existing MnDOT CCTV Cameras along I-694 – Minneapolis, MN



Thank You  
Questions?



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