Video Analytics - Proactive Approach to Safety

Presenter:
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AMAG
A Transoft Solutions company

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About Us

TRANSOFT SOLUTIONS

Transoft Solutions develops and supports innovative and timesaving software and services to help professionals plan, design, and operate safe transportation systems.

30+ YEARS
of innovation

50,000 USERS
in 150 countries

13 OFFICES
to serve you globally

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About Transoft

Transoft Solutions provides multiple software products across three business units.

The Transoft Transportation Safety & Operations Group

- Transportation Industry Professionals
- Experts in Road Safety, Computer Vision, and AI
- Research Partnerships
- Active in safety and transportation related professional activities
  - ITE Safety Council
  - TRB Committees and Surrogate Safety Subcommittee
  - ITE Section Board
  - and more!

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Transoft's Video Analytics Solutions

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Major Applications

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Post-processing of video data

Real-time processing and monitoring of video data

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Why Video Analytics?

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Leverage Existing Assets
- Use current cameras / maximize investments
- Extract intelligence out of existing infrastructure

Insights unique to video
- Insights you can't get from other sensors
- Most comprehensive view – 100% sample of objective measures

Exception reporting
- Set and forget
- Configure the AI to alert when things are "abnormal"

Evidence-based Decision-Making
- Objective ***safety and operational*** metrics
- Real-time or near-term analytics
- Saved video clips of key events

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Video-Based Safety Analytics

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- Based on computer vision and artificial intelligence
- Detect and Monitor 13 different road user types
- Identify conflicts between road users to
  - Assess safety risk
  - Identify contributing factors
- Understand what is happening now to prioritize issues to address

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Critical Conflicts ("Near Misses"): Leading Indicator of Safety Risks

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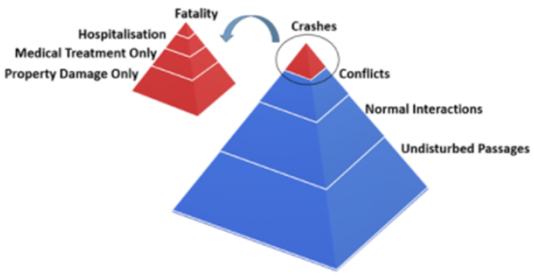
1. Can be objectively measured with video analytics
2. Measured using various metrics
3. Strongest predictor of future crashes
4. Plentiful in sample
5. May involve "evasive actions" but not necessary
6. Severity component measured using Delta-V



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Core Analytics: Reliable, Repeatable, Precisely Measured

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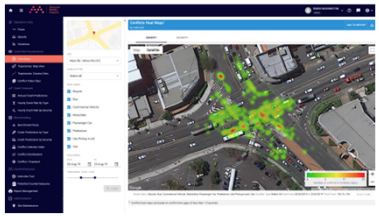

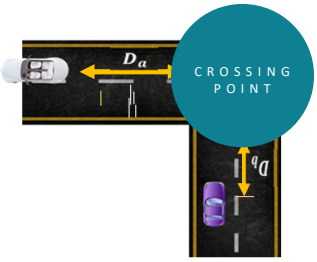

Time to Collision (TTC):
Temporal distance from the collision point
assuming constant velocity

$$TTC = \frac{D_f - D_l}{V_f - V_l}; \qquad V_f > V_l$$

Modified Time to Collision (MTTC):
Temporal distance from the collision point
assuming constant acceleration

$$MTTC = \frac{(V_f - V_l) \pm \sqrt{(V_f - V_l)^2 + 2(A_f - A_l)(D_f - D_l)}}{(A_f - A_l)}; \quad A_f > A_l$$

Deceleration Rate to Avoid Crash (DRAC):

$$DRAC = \frac{(V_f - V_l)^2}{2(D_f - D_l)}$$

$$T_a = \frac{D_a}{V_a}; T_b = \frac{D_b}{V_b}$$

Post-Encroachment Time (PET):
Time elapsed between vehicle '*a*' leaving crossing point and vehicle '*b*' arriving there

$$PET = T_a - T_b$$

Delta-V (ΔV):
Post-Crash change in velocity

$$\Delta V_a = V_{ab} - V_a = \frac{M_b}{M_a + M_b}\sqrt{V_a^2 + V_b^2 - 2V_a V_b \cos\theta}$$

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Proactive Analytics for Safe System Approach

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CURRENT PRACTICE

- Focus on crashes (reactive)
- Deaths and injuries required
- Too late to prevent
- Incomplete data
- Challenging Problem Diagnosis

Interventions based on imperfect and incomplete risk analysis

COMPLEMENTARY ANALYTICS

- Focus on conflicts (proactive)
- No death or injury
- Assesses likelihood of future events
- Full data set: speeds, trajectories, road users, week and time of day, etc.
- Excellent Problem Diagnosis

Interventions based on high quality, objective risk analysis

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The POWER of Critical Conflicts: Identifying Crash Risk Before Injuries

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Granular observation of risky behaviors

Uncovering crash risk patterns through repeated conflicts

Potential to prevent loss of life before crashes occur

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QAQC Process: Challenging to get it Right

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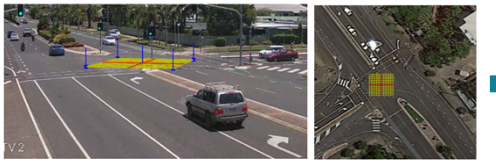
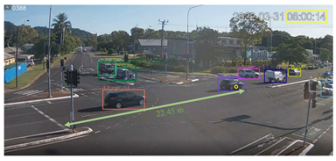


Manual count	Object Detected (OD)	% Compared to Manual	Accuracy	Direction
334	343	97%	97%	Eastbound Through
N/A				Eastbound Left
18	18	100%	100%	Eastbound Right
13	12	108%	92%	Eastbound U-Turn
127	125	102%	98%	Westbound Through
24	21	114%	88%	Westbound Right
3	2	150%	67%	Westbound U-Turn
4	3	133%	75%	Southbound Through
25	23	109%	92%	Southbound Right
61	57	107%	93%	Southbound Left
1	1	100%	100%	Northbound Through
10	4	250%	40%	Northbound Right
3	1	300%	33%	Westbound PED C
N/A				Southbound PED C
623	610	102%	98%	Total



OUR AI VALIDATION AND QA/QC PROCEDURES

1: Road-User Spatial Accuracy Validation
2: Road-User Detection Accuracy Validation
3: Road User Trajectory Quality Validation
4: Road User Flow Validation
5: Road User Speed Validation
6: Critical Conflict Validation

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Screen Shots from SMART SAFETY Platform

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Violation Data

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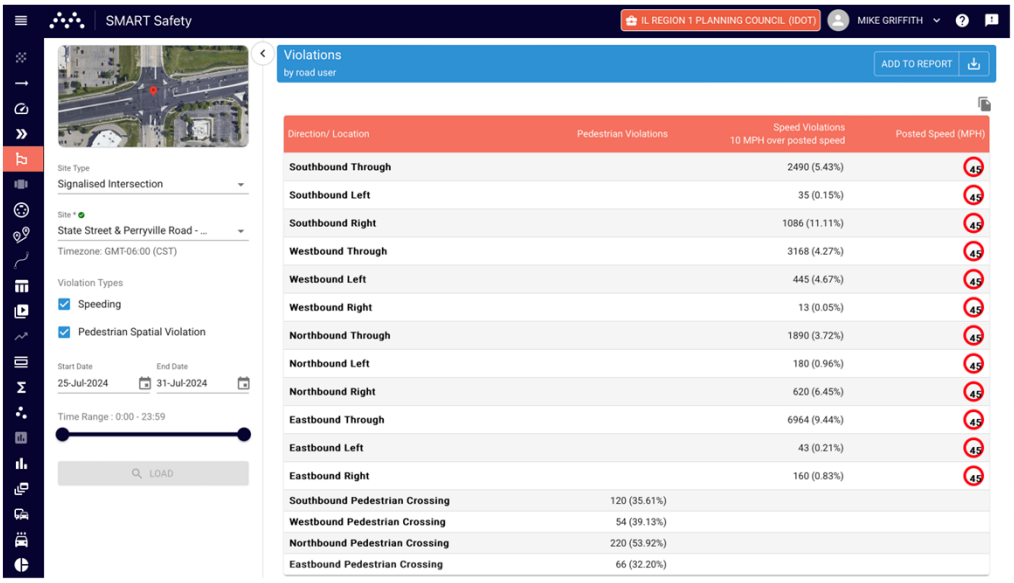

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Speed Percentiles by Road User, Directional Movement and Time of Day

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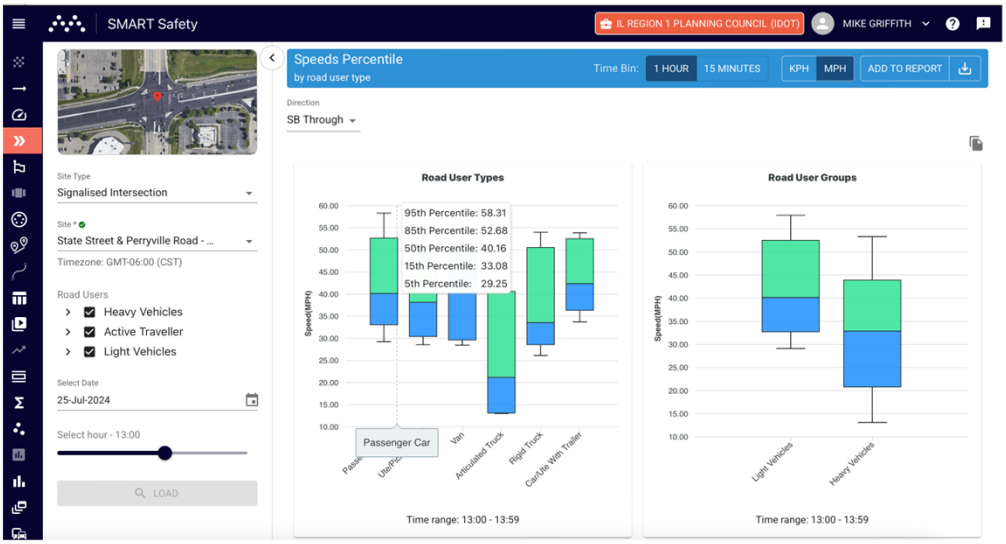

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Crash Predictions

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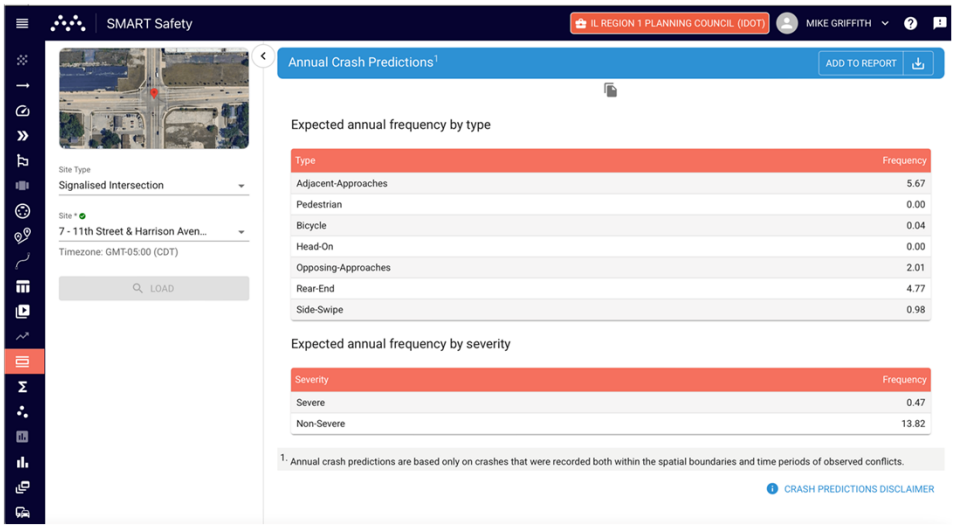

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Video-Analytics "In Action"

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Analytics in Action #1:

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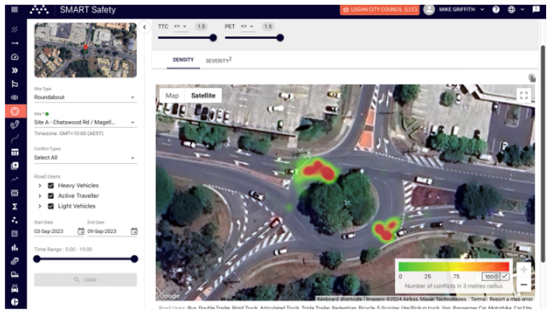
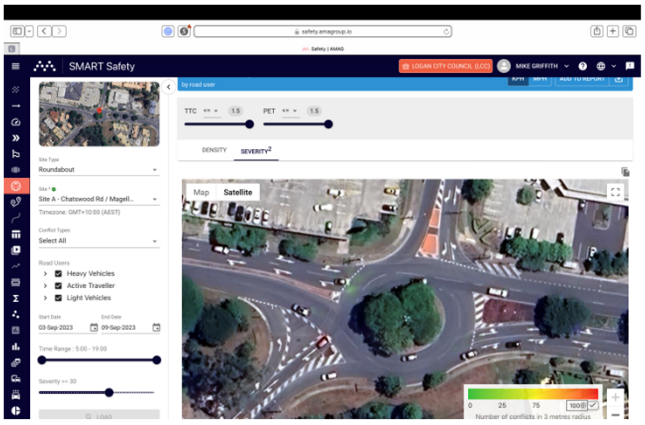
Risk Diagnosis at a Roundabout in Australia

All critical conflicts observed at roundabout



Severe Conflicts at same roundabout



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Analytics in Action #2:

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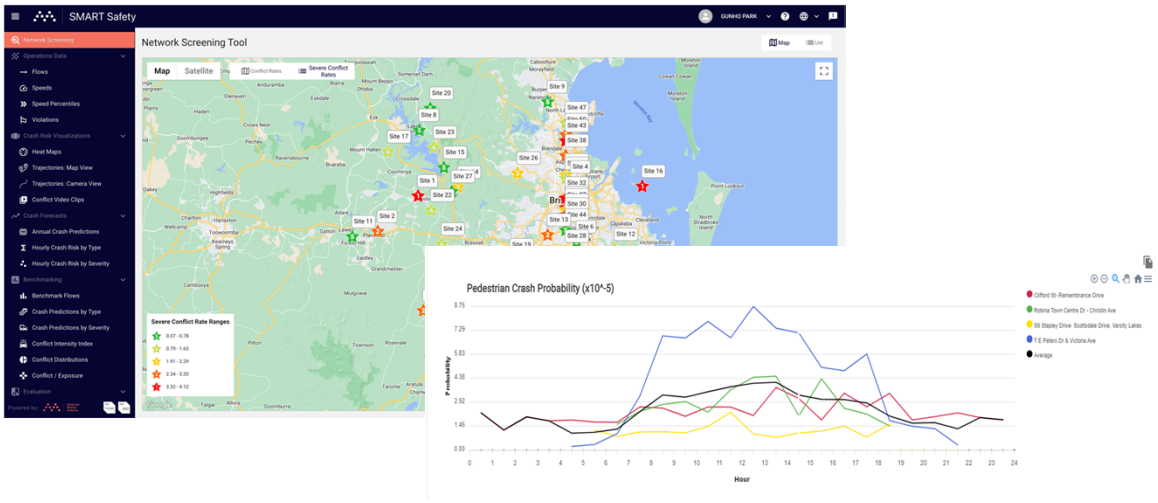
Conflict Rate Network Benchmarking



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Analytics in Action #3:

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Asphalt Art Before-After Evaluation in Bellevue

- Critical conflict rates decreased for all conflict types from 27 percent for pedestrians up to 76 percent for rear-end type.
- There was a 2 percent increase in stop bar compliance from the before to the after period.

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Analytics in Action #4:

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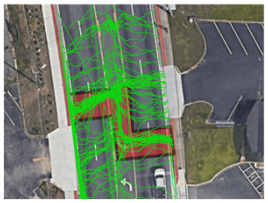
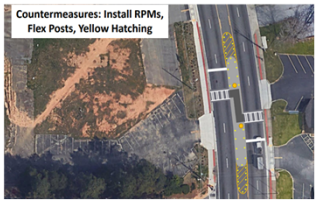
Statewide Safety Decision Support for PHB Design (GA DOT)

- Evaluate the effectiveness of various designs around Pedestrian Hybrid Beacons (PHB)
  - Staggered Z-crossing
  - Size of separation
- Assess the effectiveness of different staging strategies (one or two push button operation)
- Assess the impact of pedestrian wait times on critical conflict metrics





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What is Considered Compliant from a Time Perspective?

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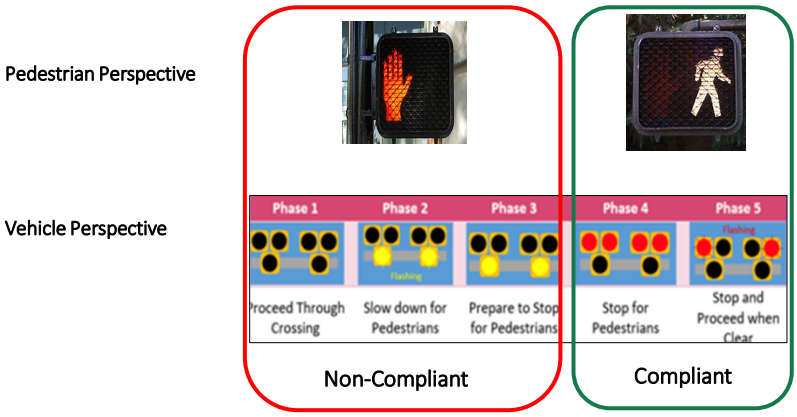
Pedestrians were considered non-compliant if they crossed before PHB gave them the walk phase.



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Question:

Did two-stage crossings affect pedestrians' willingness to wait?

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Signal Modifications in the Study

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Week of Study	Pedestrian Delay Before Yellow Phase (sec)	One or Two Stage Crossing
1	0	One
2		Two
3	20	One
4		Two
5	40	One
6		Two

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One Stage & Two-Stage Crossings

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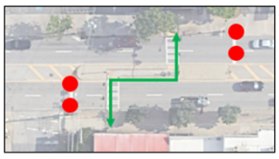
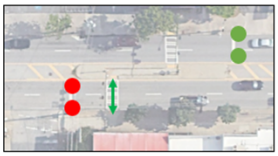
- Two-stage crossings require a pedestrian to hit a second push button in the refuge island.
- A two-stage crossing in condition A stopped vehicular traffic in both directions, while condition B traffic only stops in one direction at a time.

One-stage crossing



Two-stage crossing

(Condition A)



(Condition B)

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Pedestrian Compliance at Two-Stage Crossings in Condition A

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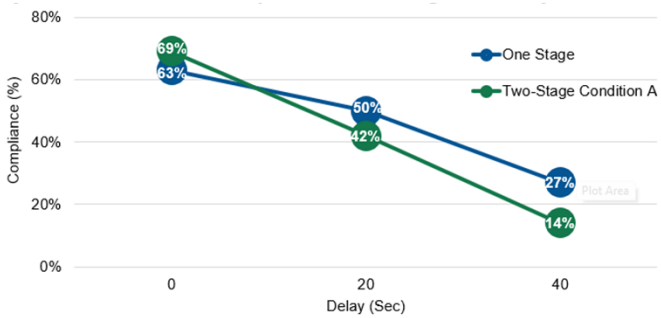
- Similar trends between a one-stage crossing and a two-stage crossing in condition A.
- Two-stage crossings initially had higher compliance at a 0-second delay but had lower compliance at a higher delay.

Condition A



Note: 217,220 pedestrian crossings on 3 corridors and 12 crosswalks with 7 in condition A

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Assessing Spatial Compliance: Pedestrian Crossings Trajectories (72% non-compliance with pedestrian crosswalk)

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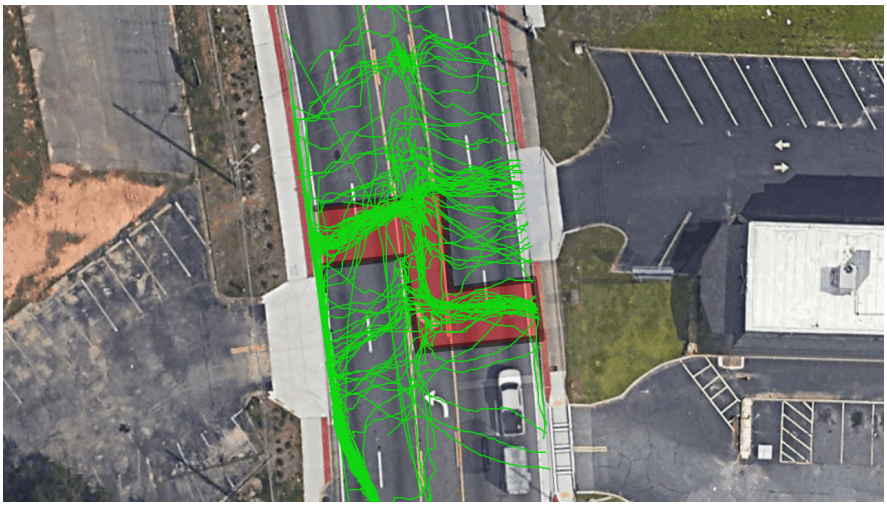

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Analytics in Action #5:

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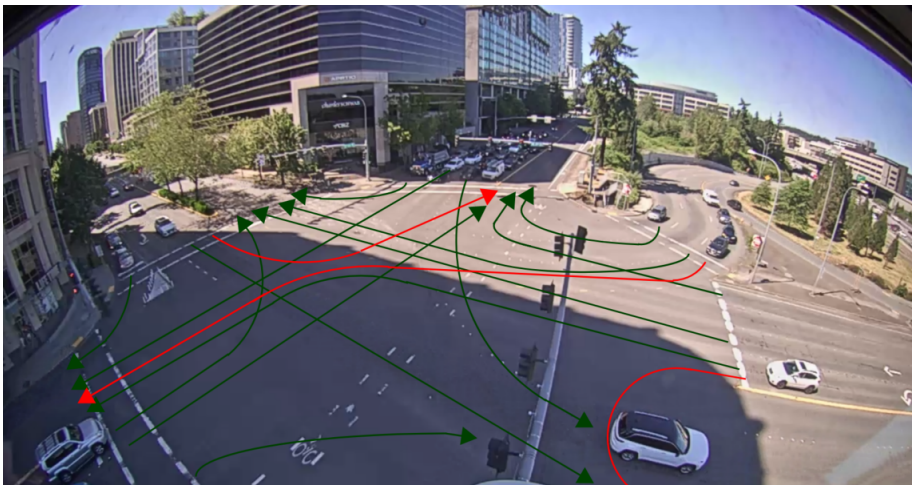
Detection of “Illegal & High Risk” Behaviors: Bellevue



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Analytics Capturing Illegal Turn

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Support Decision-making with Real-time and Continuous Monitoring

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- Industry-leading real-time computer vision and artificial intelligence
- Built to support 24/7/365 monitoring
- Standard and customized alerts (at each site)
- Provides operational data analytics
- Provides added ***safety metrics***
- Comparisons to historical data

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SMART OPERATIONS: Operator Alerts

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- Event and Trend driven
- Customizable for each agency
- Configurable to communicate with ITS devices
- Includes:
  - Speeding
  - Red-light running
  - Wrong-way driving
  - Conflicts (all types)
  - Incidents
  - Flows
  - Avg Speeds
  - Percentile speeds
  - Pedestrian demand
  - Spatial violations
  - Block the box
  - Queues

SMART OPERATIONS

Real-Time Traffic Safety Monitoring

Continuously screen for safety events and trends.

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Configurable Violation Alerts

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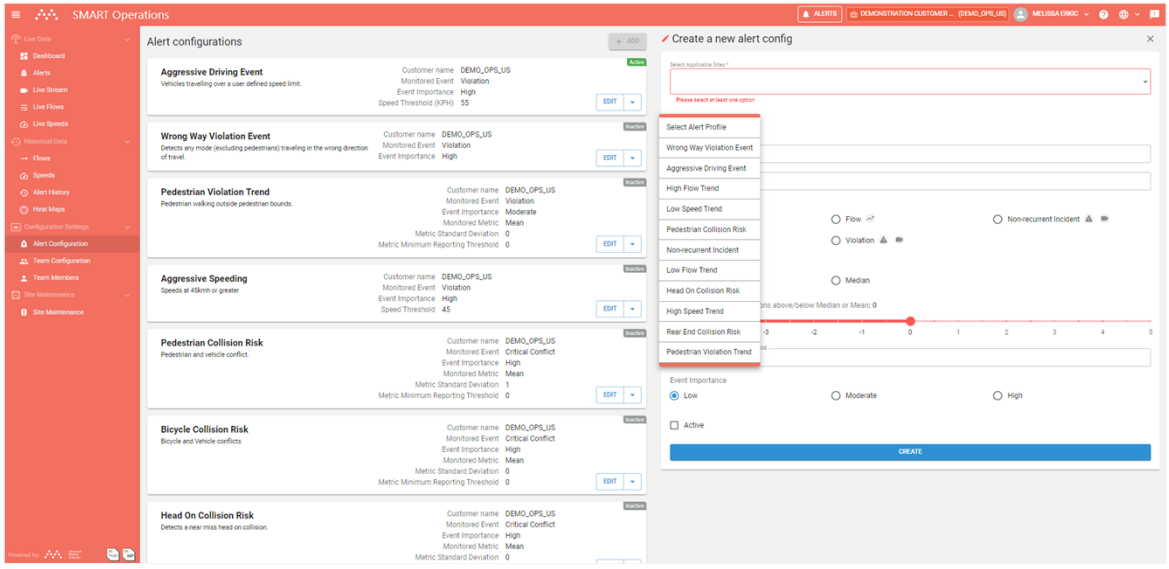

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Wrong-Way Driving Detection

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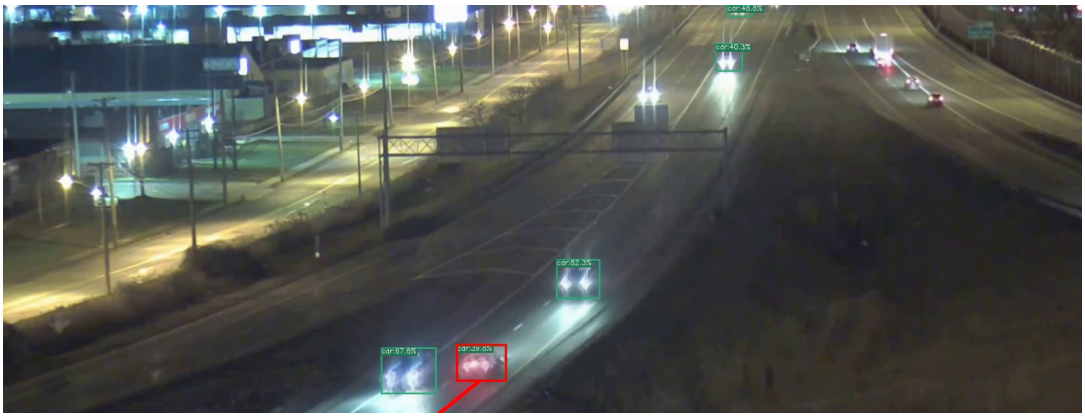

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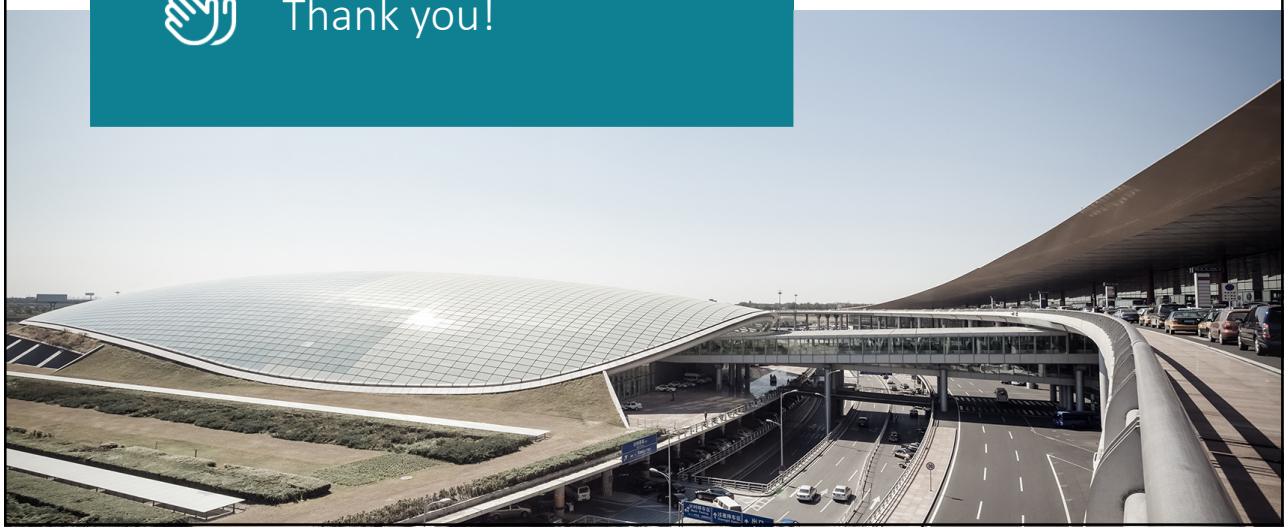
Thank you!



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Contact

Contact me to learn more:
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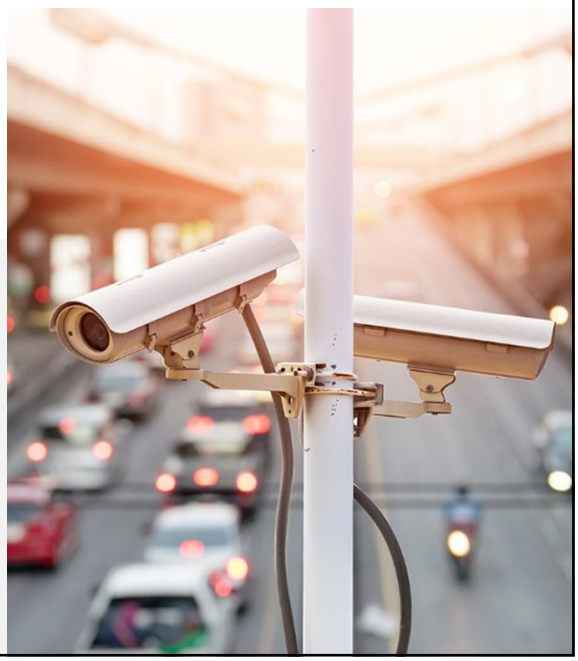
Scan the QR code below to receive a copy of the slides.



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