

How Technology is Driving More Effective Strategies for Dilemma Zone Protection



DOUGLAS TARICO

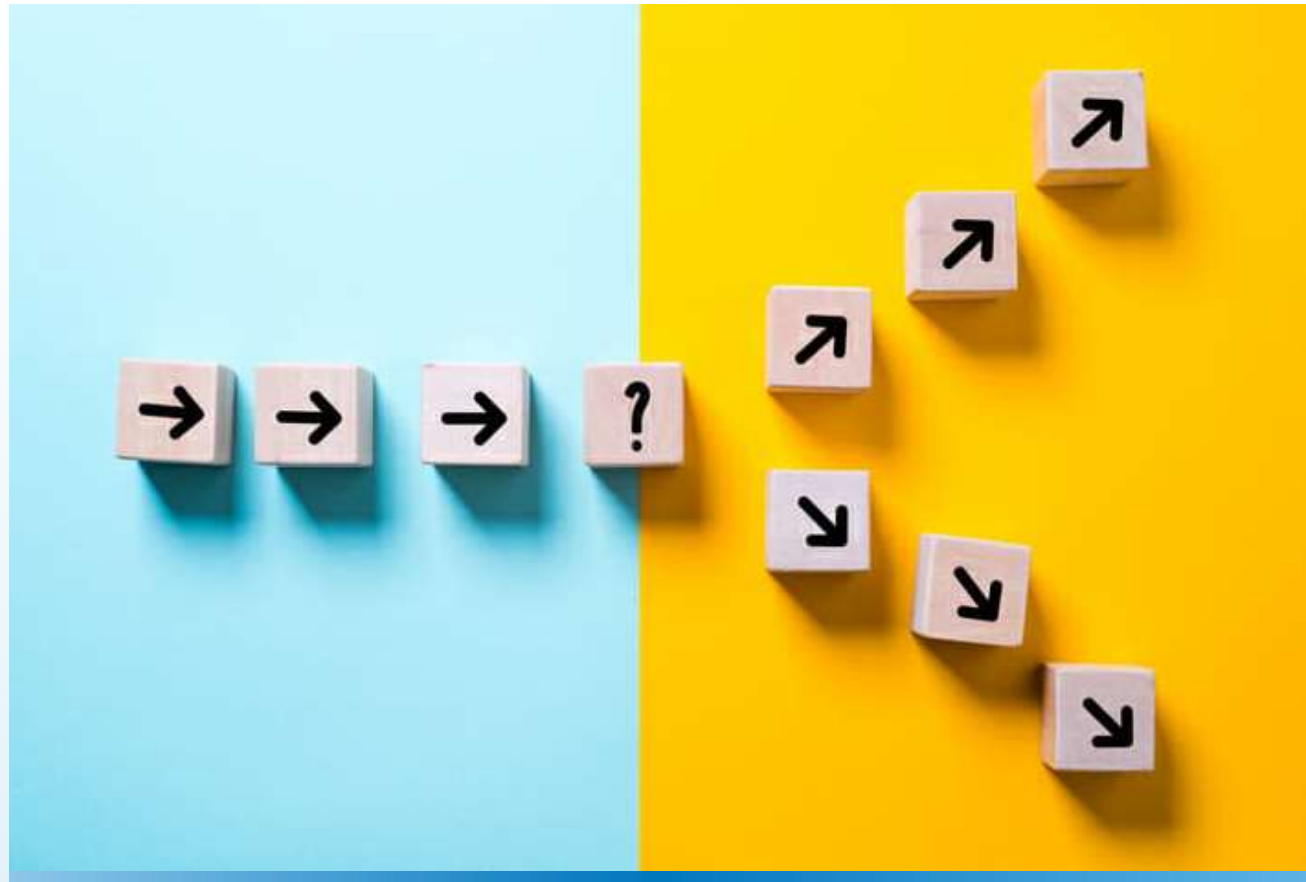
Director, Product Management –
Controllers & Detection



Saving Lives Through Improved Mobility

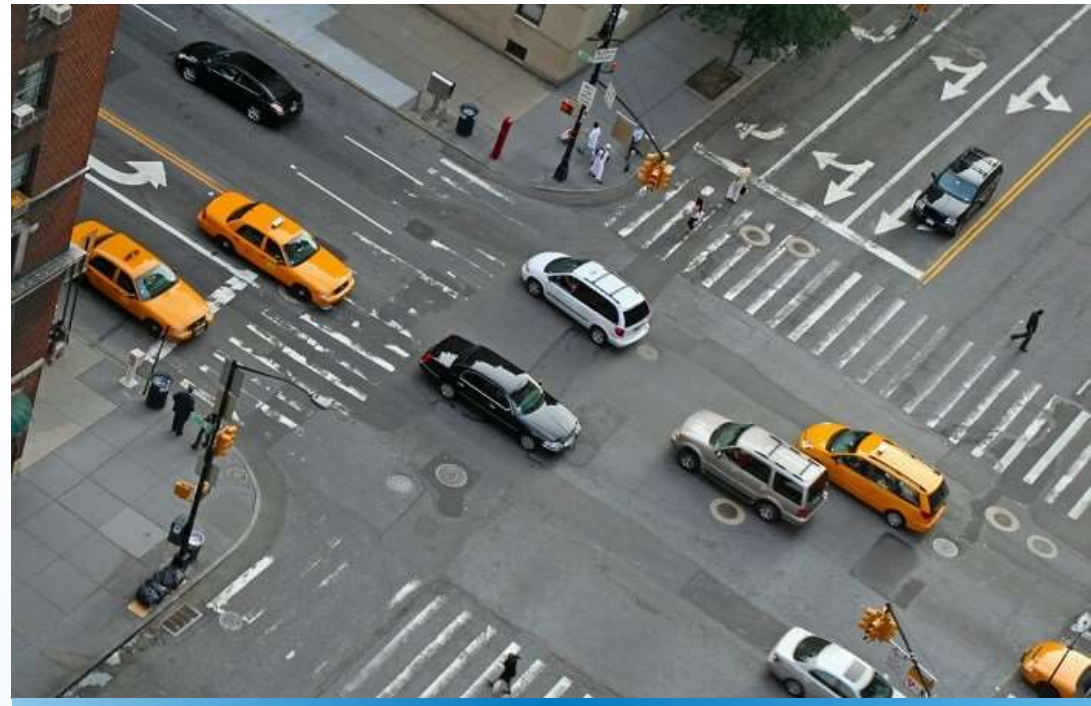
Agenda

- Introduction
- Background and History
- Use of Technology
- Remaining Challenges



Road Safety at Signalized Intersections

- ~40k traffic fatalities per year in US
- Intersections are one of the highest risk areas in road networks
 - *“Each year roughly one-quarter of traffic fatalities and about one-half of all traffic injuries in the United States are attributed to intersections” – FHWA*
- Huge national focus on safety at signalized intersections – “Vision Zero”, “Safe System Approach”
- Safety vs. efficiency – Finding the right balance



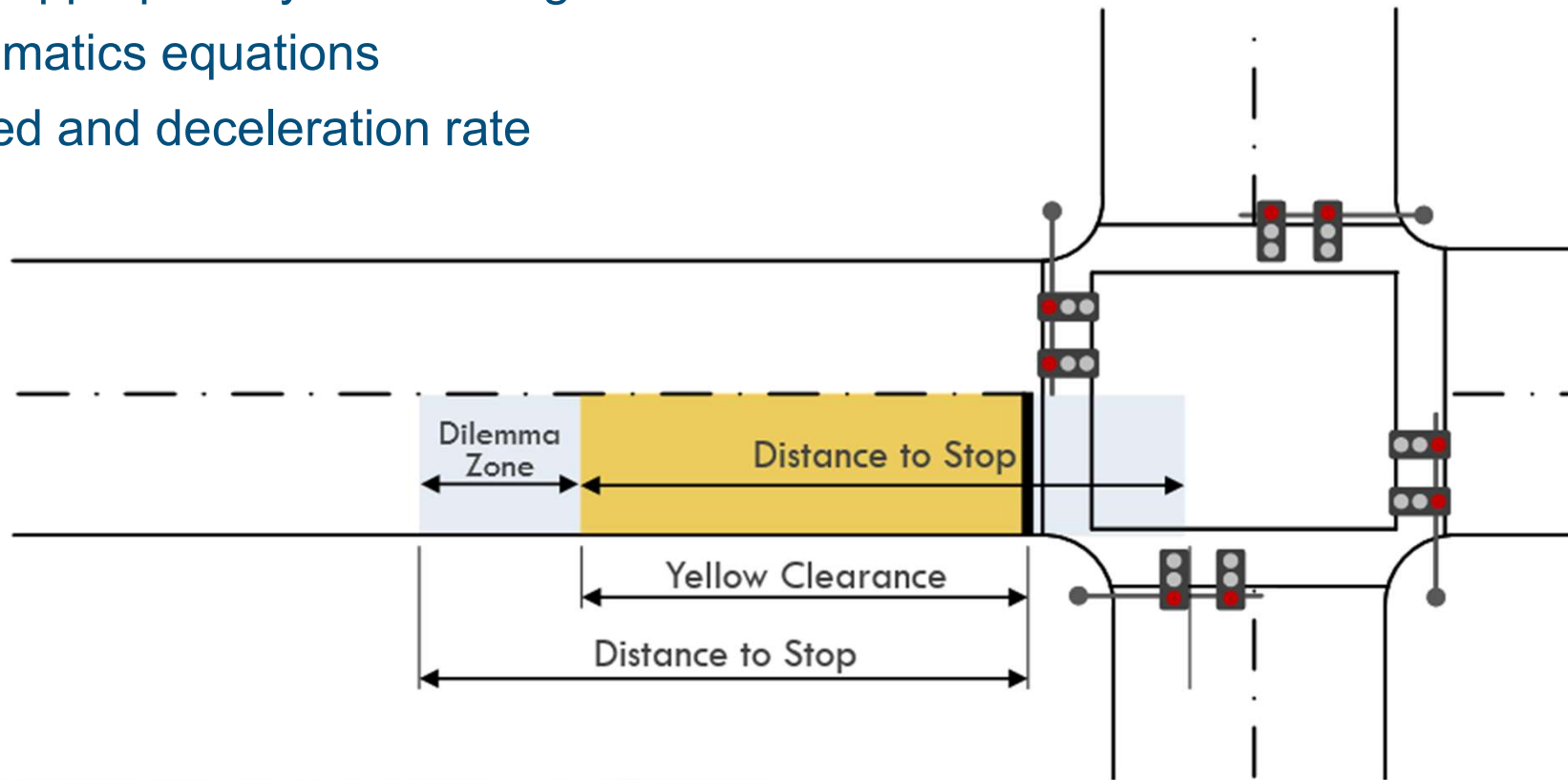
Dilemma Zone - Background and History



- Dilemma Zone vs. Decision Zone
 - Two distinct scenarios of driver behavior
 - Type 1 Dilemma Zone
 - Type 2 Dilemma Zone, aka Decision Zone

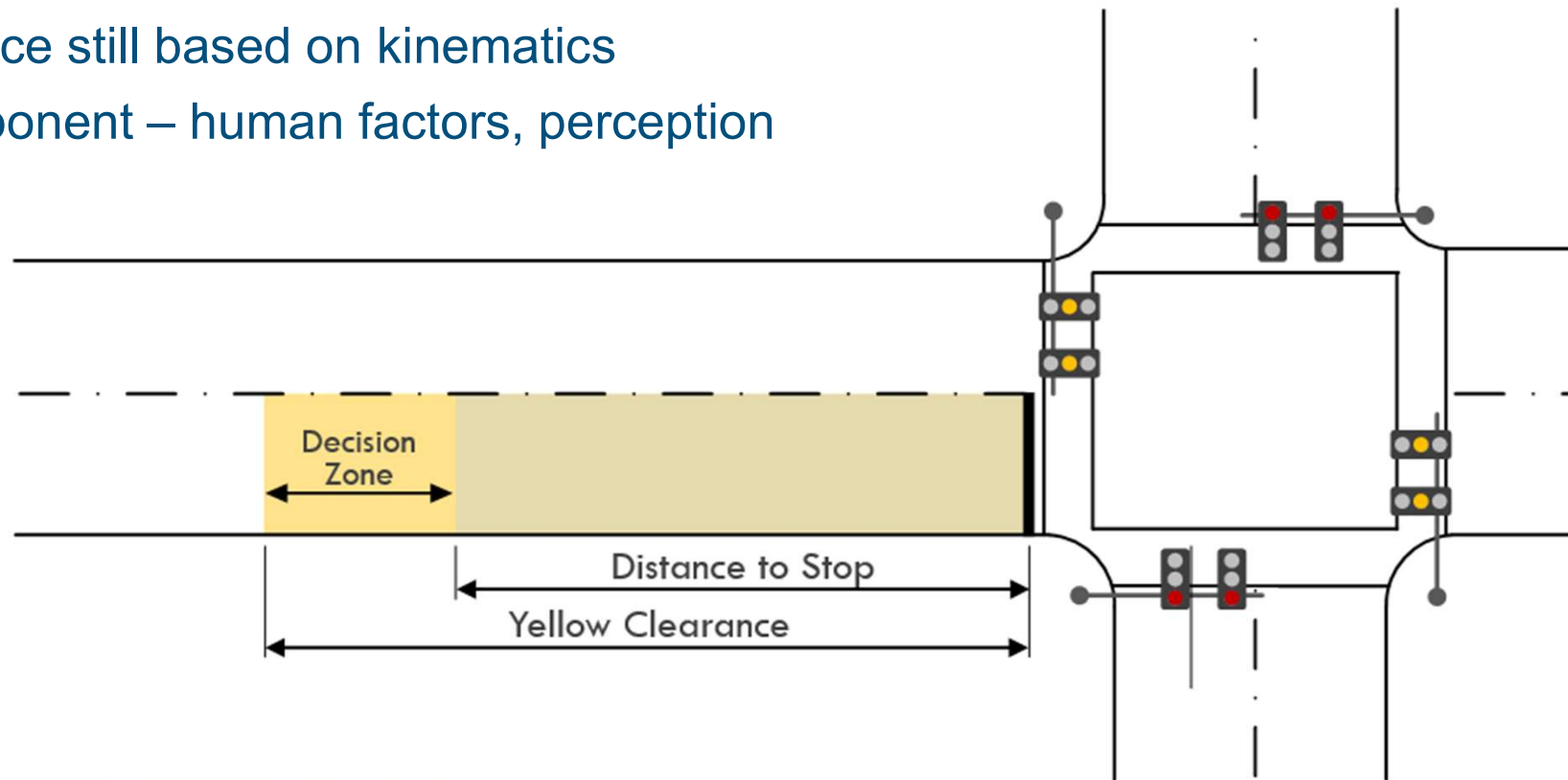
Type 1 Dilemma Zone

- Resolved with appropriate yellow change interval
- Based on kinematics equations
- Assumed speed and deceleration rate



Type 2 Dilemma Zone – aka Decision Zone

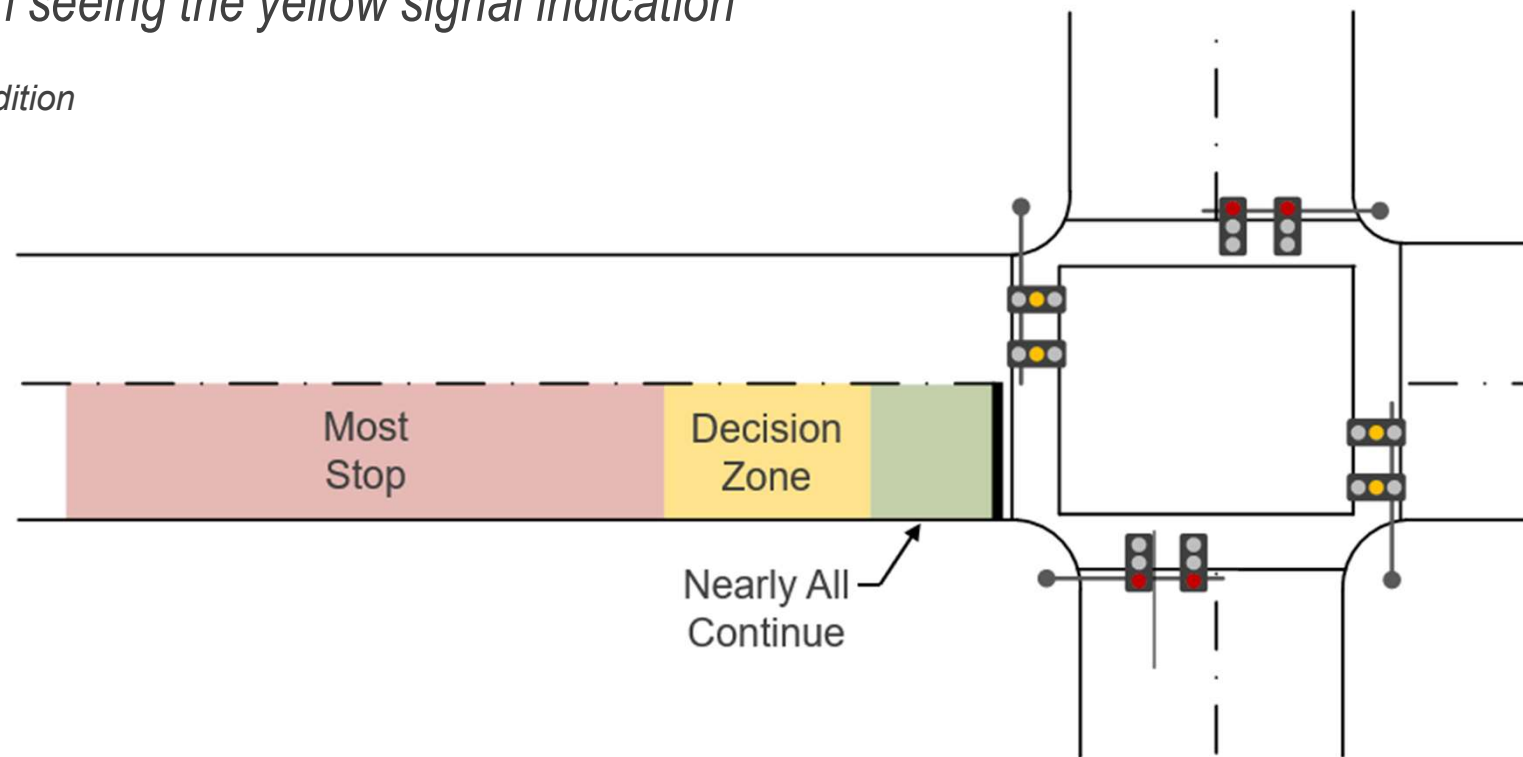
- Yellow clearance > Stopping distance
- Yellow clearance still based on kinematics
- Decision component – human factors, perception



Decision Zone Definition

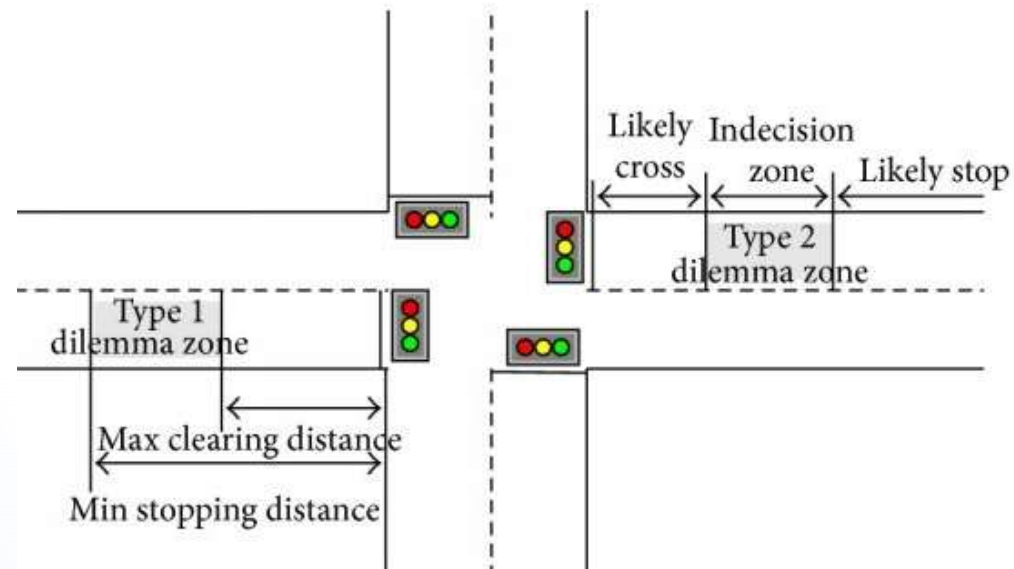
“Length of roadway where each individual driver may make a different decision upon seeing the yellow signal indication”

-Signal Timing Manual, 2nd Edition



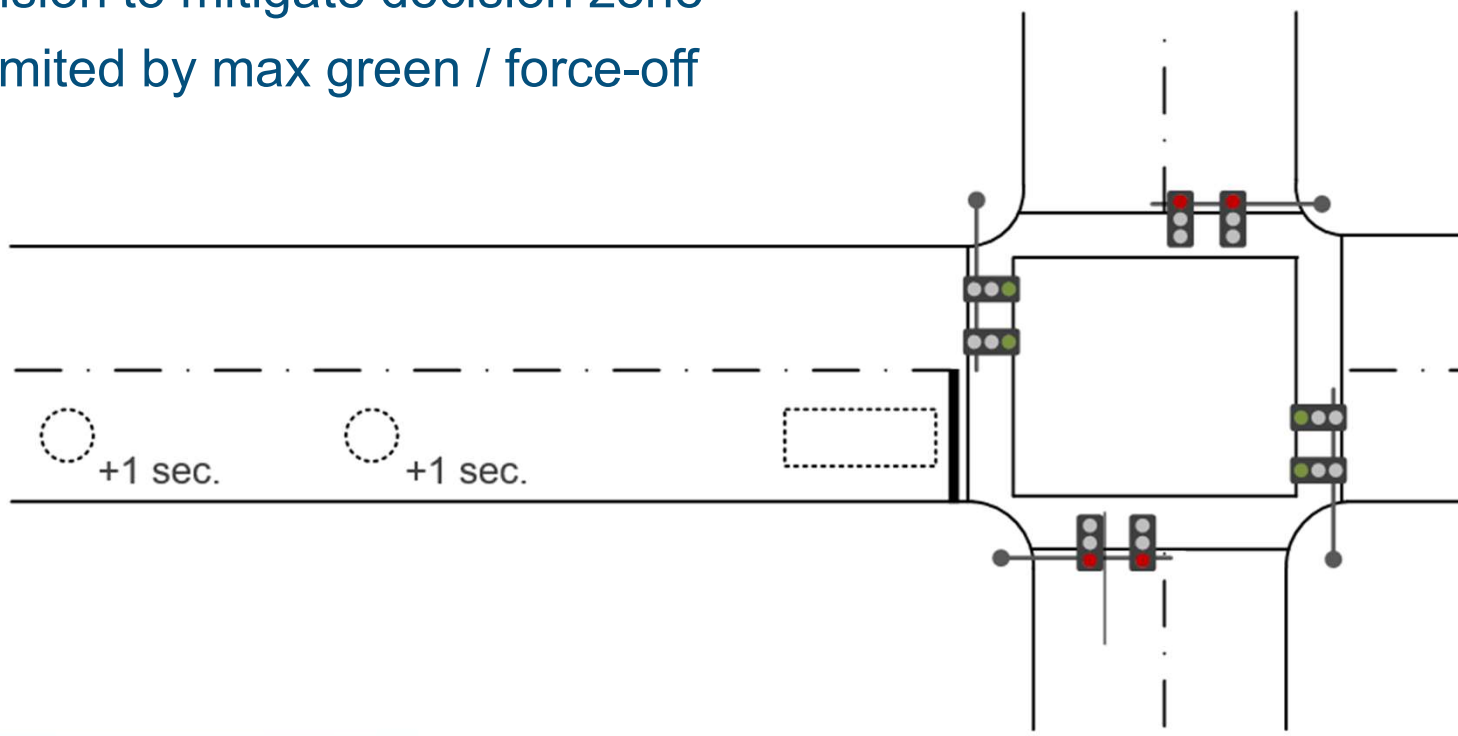
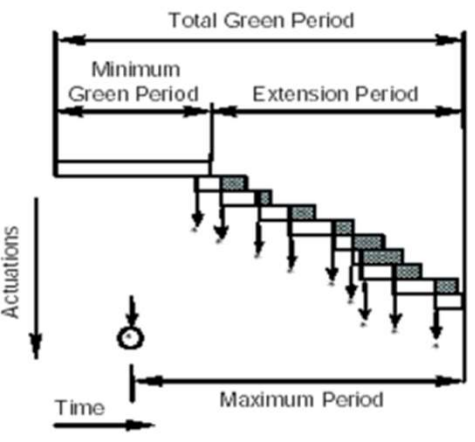
Decision Zone – An Issue for Decades

- Late '70s research
 - Based on a “likely stop” vs. “likely go”
 - Specific to vehicle and driver types
 - Begin zone where 90% of drivers stop; end zone where only 10% of drivers stop
- The '80s
 - Decision zone defined based on travel time
 - 85% of drivers stopped if 3 seconds or more from stop bar
 - Nearly all drivers continued if 2 seconds or less from stop bar
 - Extension detectors installed to mitigate issue



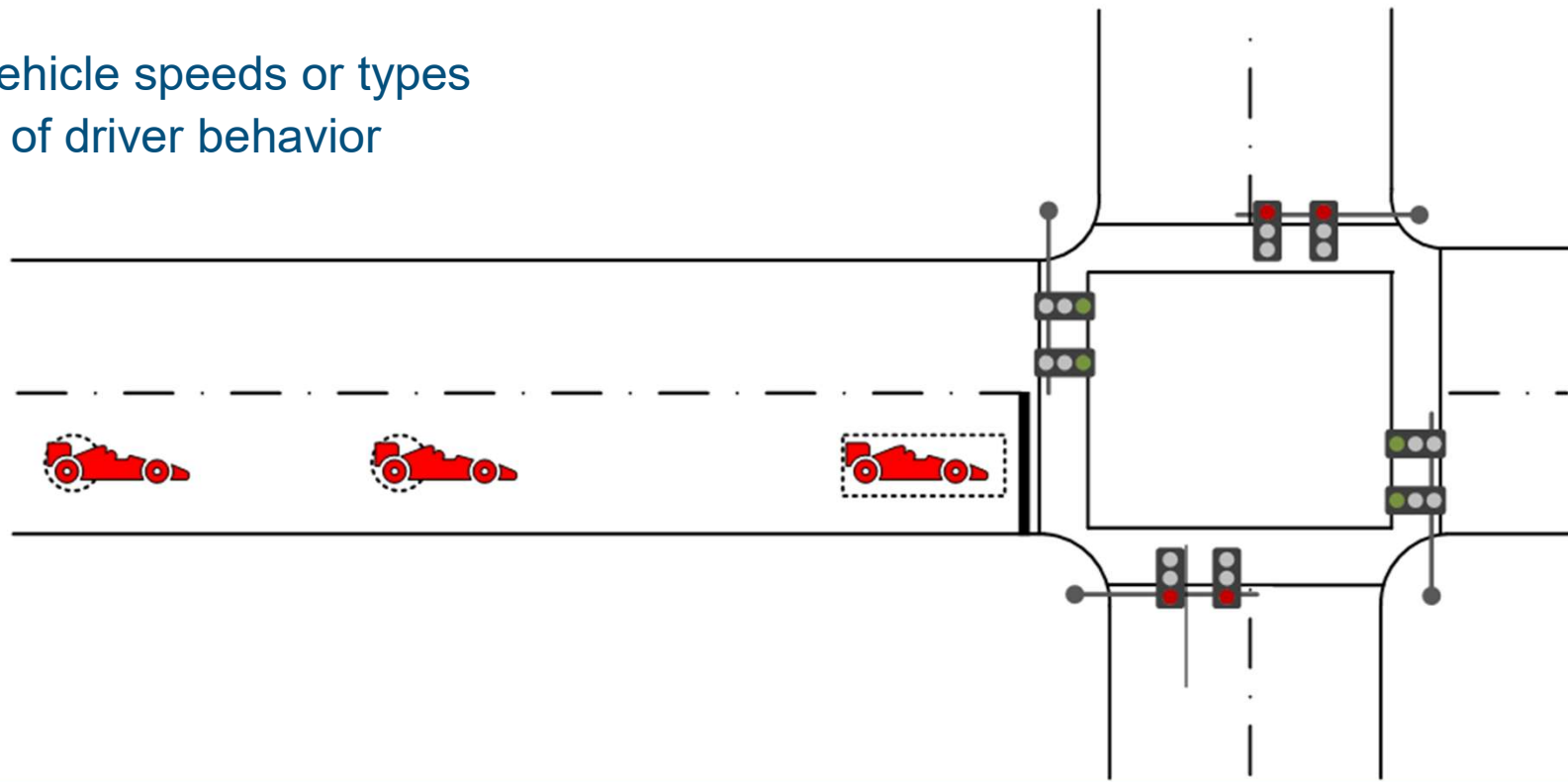
Zone-based Detection

- Traditional green extension to mitigate decision zone
- Can't extend forever, limited by max green / force-off



Zone-based Detection Limitations

- Fixed detection points give limited “vision” of approaching traffic
- No knowledge of vehicle speeds or types
- Limited knowledge of driver behavior



Zone-based Detection Limitations

- Drivers are unique
- Cars are unique
- Road conditions are unique
- Zone-based detection lacks “intelligence” to provide enhanced safety

“Drivers tend to stop at wider intersections but tend to go through at narrower intersections”

-MS Chang

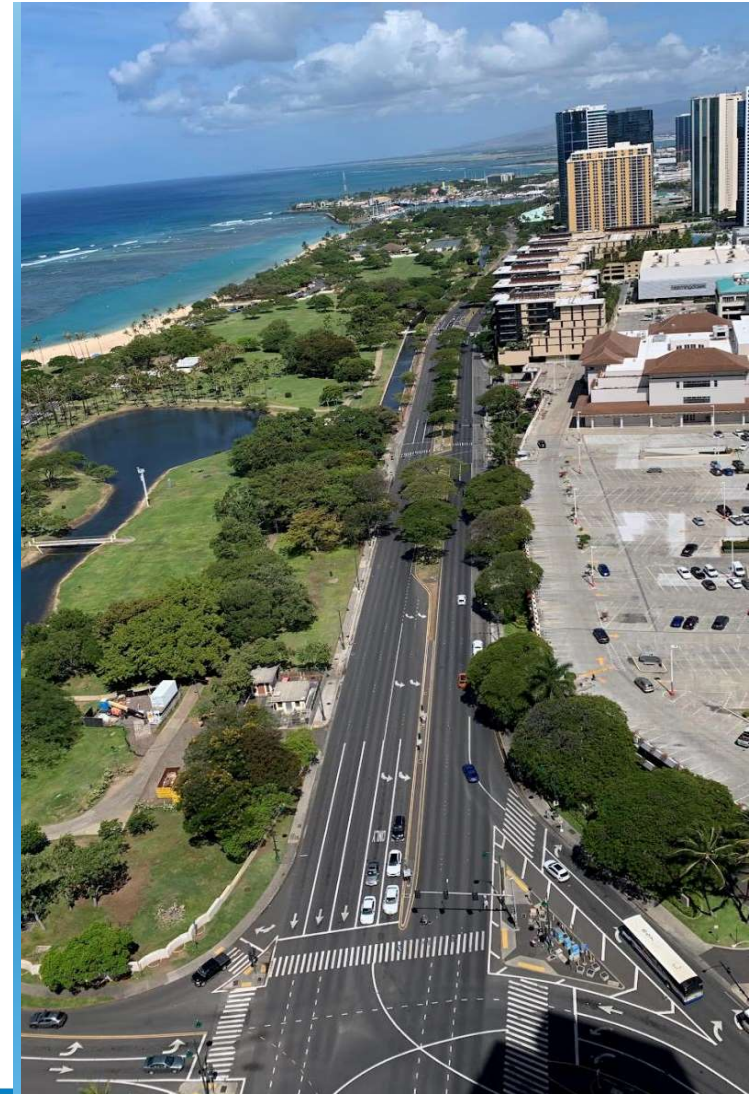
Using New Technology

- More data, less assumptions
- Improved methodology

Trajectory-aware Detection

Advanced Controllers

Data-Driven Evaluation



Trajectory-Aware Detection Technologies



Video and Radar



Track Individual Vehicles

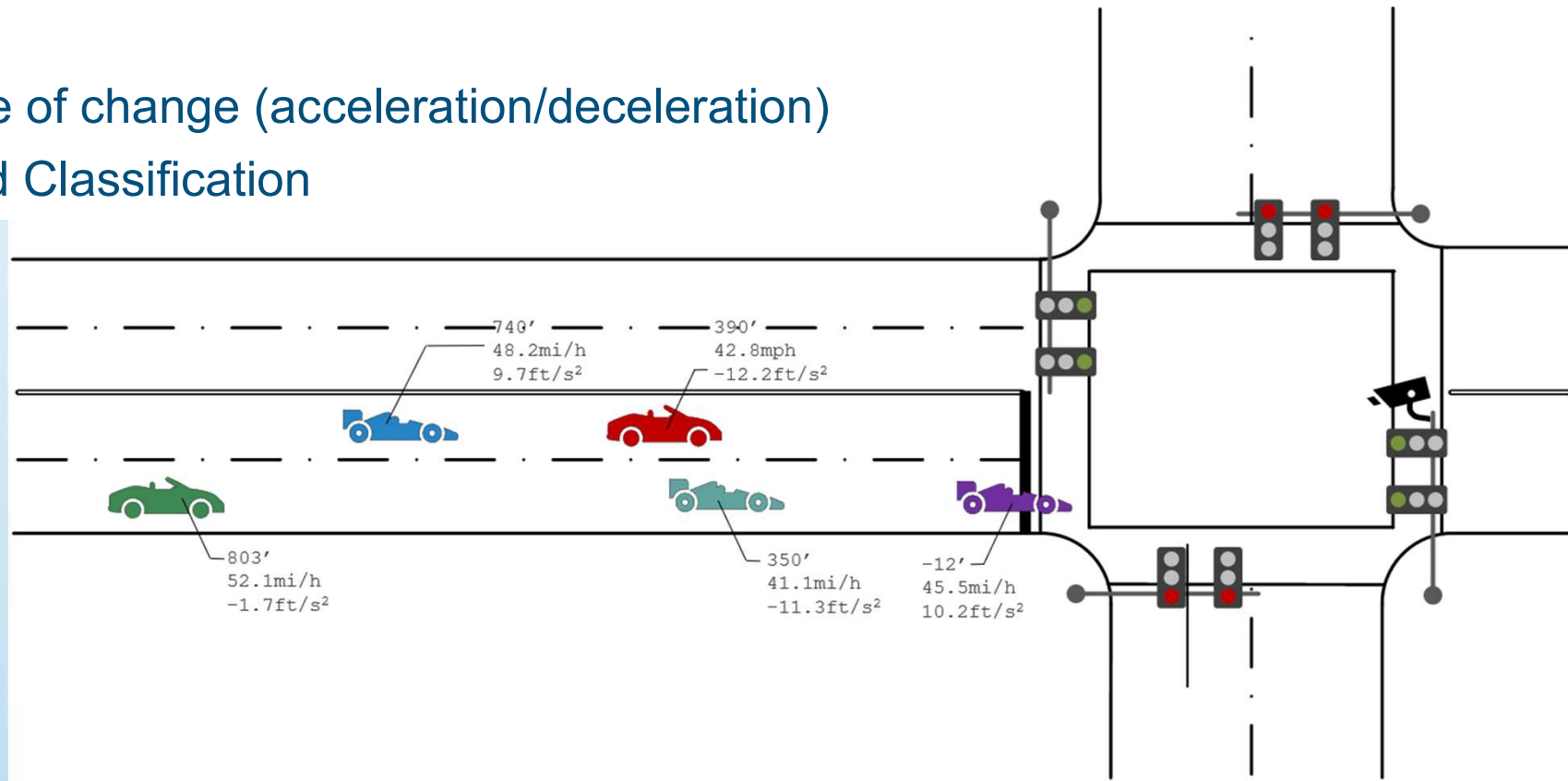


Measure Actual Speeds and Deceleration Rates



Trajectory-Aware Detection Technologies

- Distance
- Speed, rate of change (acceleration/deceleration)
- Counts and Classification



Detection Applications

- Green and red extension zones with video

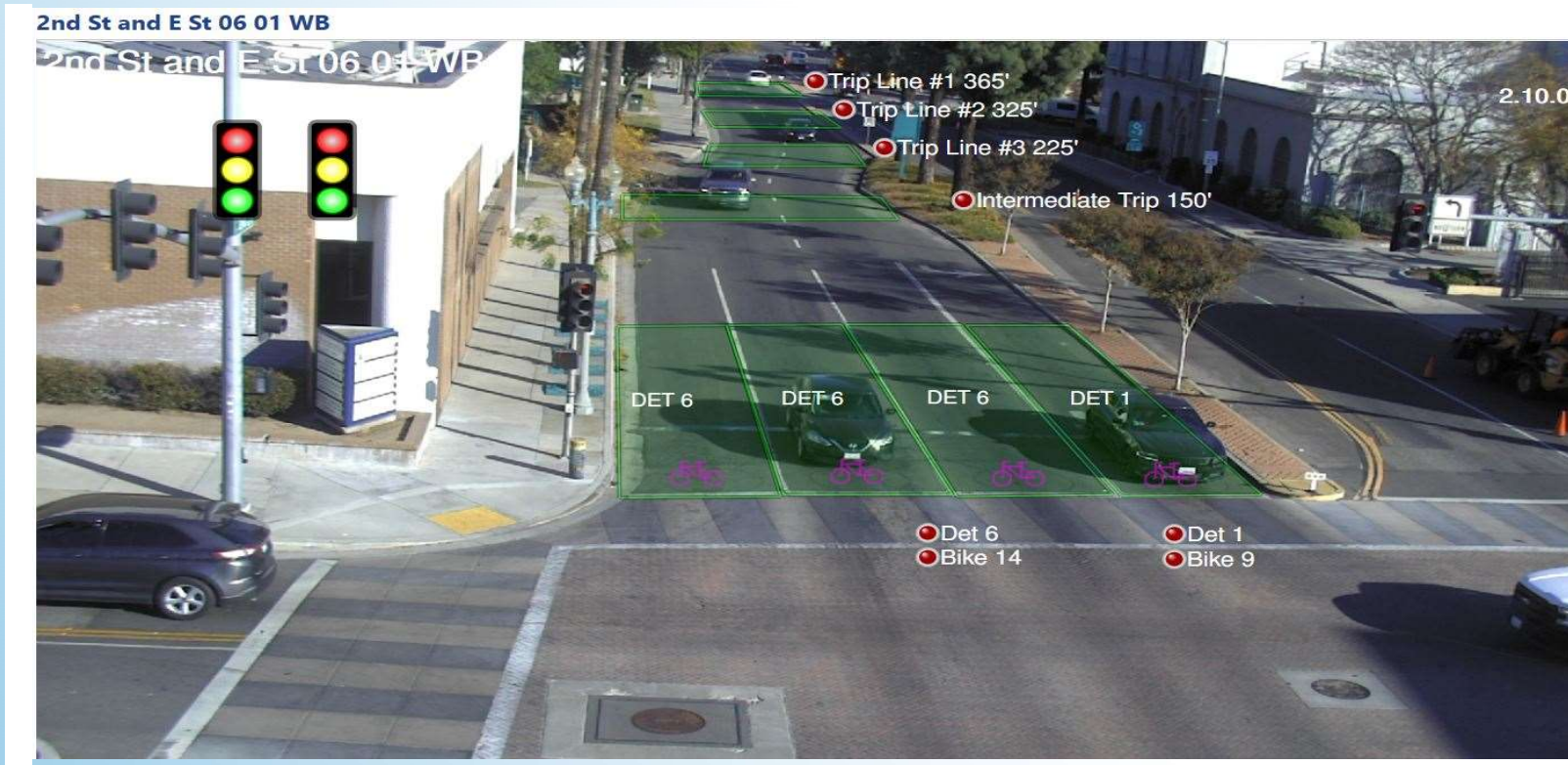


Advance Green
Extension Zone

Red Extension Trigger
Zone – Vehicles
Traveling > 50 MPH

Detection Applications

- Speed conditional detection with video

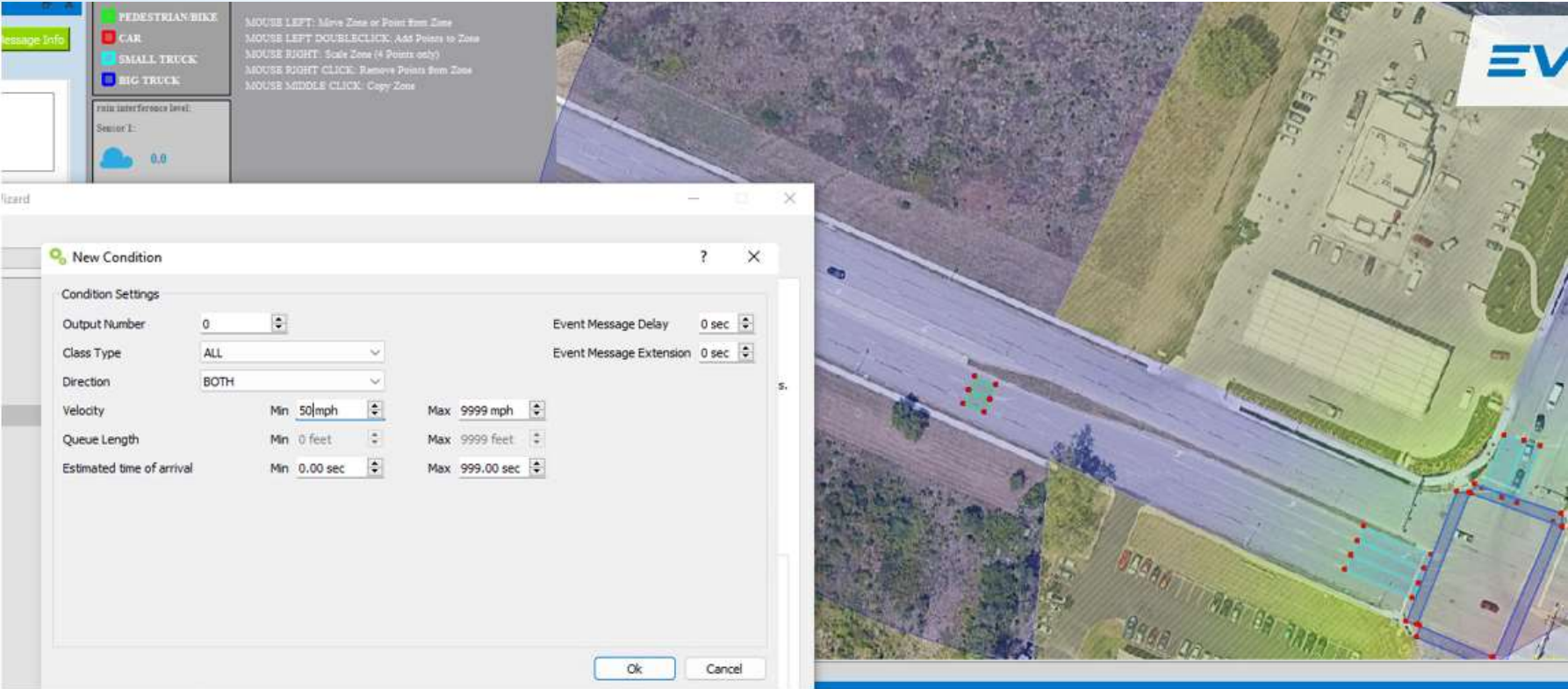


ZONES EXPLORER

- 225 FT Speed DZ**
 - Vehicle Presence in 225 FT Speed
 - Display Zone
 - Trip Line #3 225' mph > 30
 - Det
- 150 FT Speed DZ**
 - Vehicle Presence in 150 FT Speed
 - Display Zone
 - Intermediate Trip 150' mph > 30
 - Det
- 325 FT Speed DZ**
 - Trip Line #2 325' mph > 30
 - Det
 - Vehicle Presence in 325 FT Speed
 - Display Zone
- 365 FT Speed DZ**
 - Vehicle Presence in 365 FT Speed
 - Display Zone
 - Trip Line #1 365' mph > 30

Detection Applications

- Speed conditional detection with radar



EVO

Advanced Traffic Controllers

- Utilize the power and features of Advanced Traffic Controllers (ATC)



GREEN AND RED EXTENSION



EXTENSION BASED ON VEHICLE APPROACH TRAJECTORIES



ADDITIONAL CUSTOM SAFETY MEASURES (PROGRAMMABLE LOGIC)



ADVANCED COORDINATION ALGORITHMS

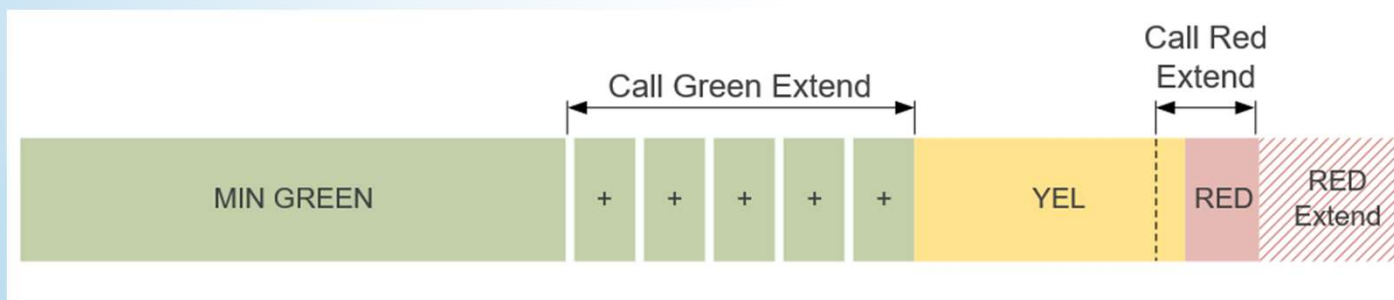


Traffic Controllers: Extending All-Red

- Monitor speed thresholds / filtering
- Trigger red extension
 - Near end of yellow
 - During red clearance

TIMING PLAN [1]								
CLEARANCE								
PHASE	1	2	3	4	5	6	7	8
PRECLEAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
YELLOW	3.0	4.5	3.0	4.5	3.0	4.5	3.0	4.5
RED	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
REVERT	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

MAX EXTENSION								
PHASE	1	2	3	4	5	6	7	8
RED	0.0	3.0	0.0	3.0	0.0	3.0	0.0	3.0



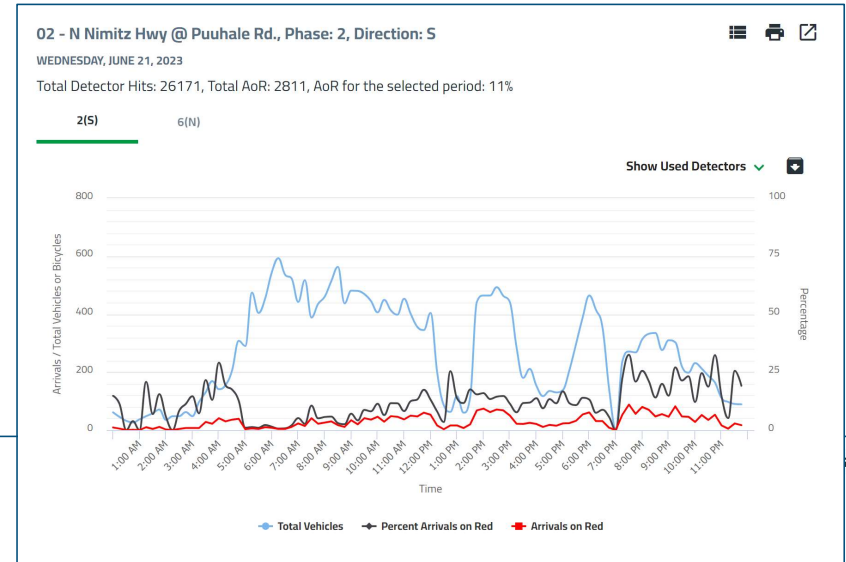
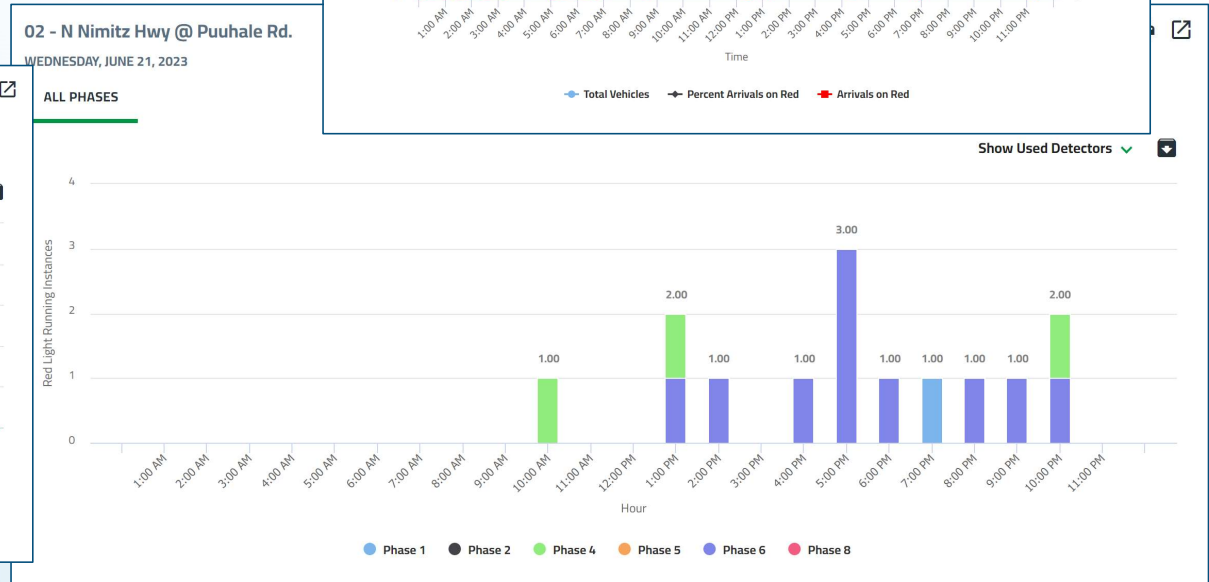
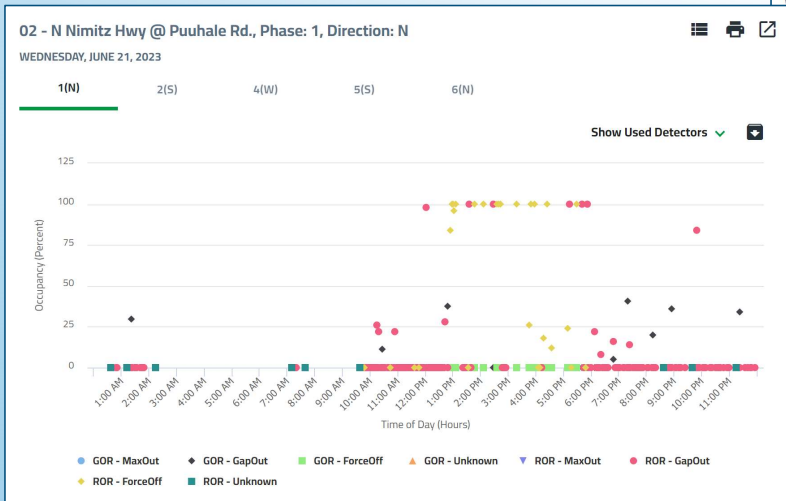
Other Mitigation Techniques: Advance Warning Flashers

- Early warning to reduce inappropriate “go” decisions made in the decision zone
- Useful for intersections with limited sight distance
- May increase red light running as drivers accelerate to “beat the yellow” when flasher activates



Data-driven Evaluation

- Signal Performance Measures
 - Red light running
 - Actuations on red
 - Red extensions
 - Phase terminations



Remaining Challenges



RESTRICTIONS



STANDARDIZATION



CONNECTED VEHICLES

TECHNOLOGY IS DRIVING MORE EFFECTIVE STRATEGIES FOR DILEMMA ZONE PROTECTION

Questions?

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