A Framework for Evaluating Dynamic Methods of Multimodal Arterial Traffic Control

Ted Morris[1], John Hourdos[2], Vassilios Morellas[1], and Nikos Papanikolopoulos[1]

[1]Department of Computer Science

[2]Department of Civil, Environmental, and Geo Engineering

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Synopsis

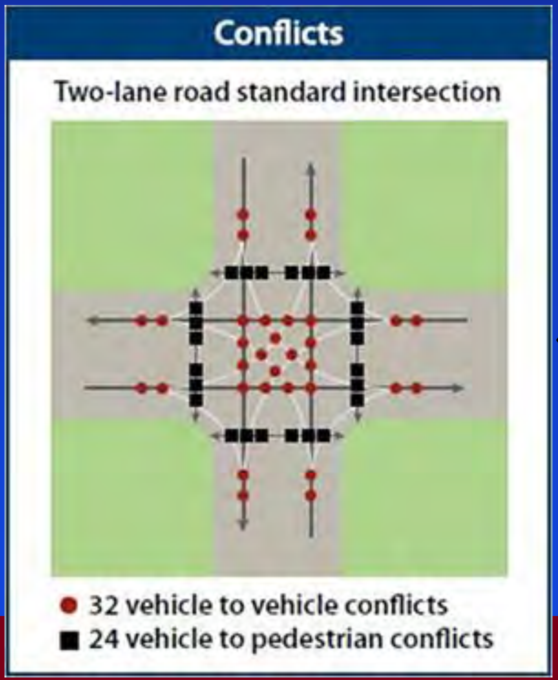
- Project Background and Goals
- Study Area
- Field Deployment and Sensor Acquisition
- Traffic Measurement Strategies
- Traffic Simulation Model
- Future build-out plans and testing

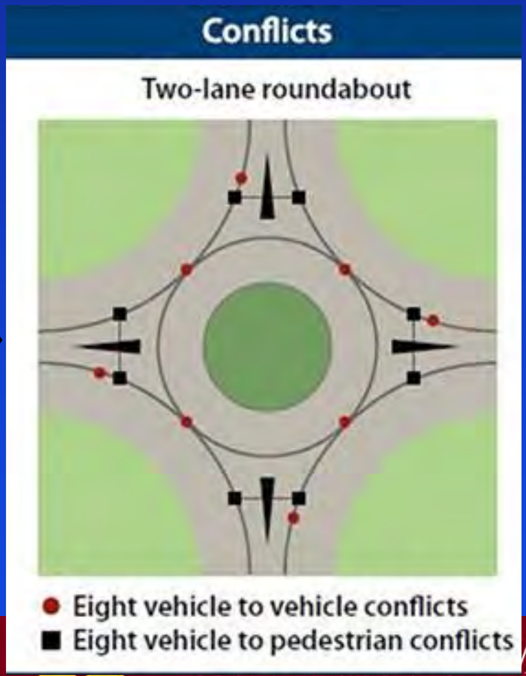
Background

- Significant research has focused on controlling congestion on freeways and major highway networks.
- Traffic control within urban network of streets and arterials presents challenging problems due to varied mode choices, route choice selection, and traffic dynamics.
- Need for creating framework for testing and evaluating new urban traffic control strategies for arterial networks.
- Couple sensor traffic measurements with simulation, to build signal and sensor ‘in-the-loop’ simulation testbed.

Roundabout Utilization for Arterial Traffic Control

- Urban corridor intersection adaptation to roundabouts.
- Lower cost than signalized intersections.
- 16 turning movements.
- Safety benefits – pedestrians & vehicles.
- Integrate with ‘complete street’ designs.

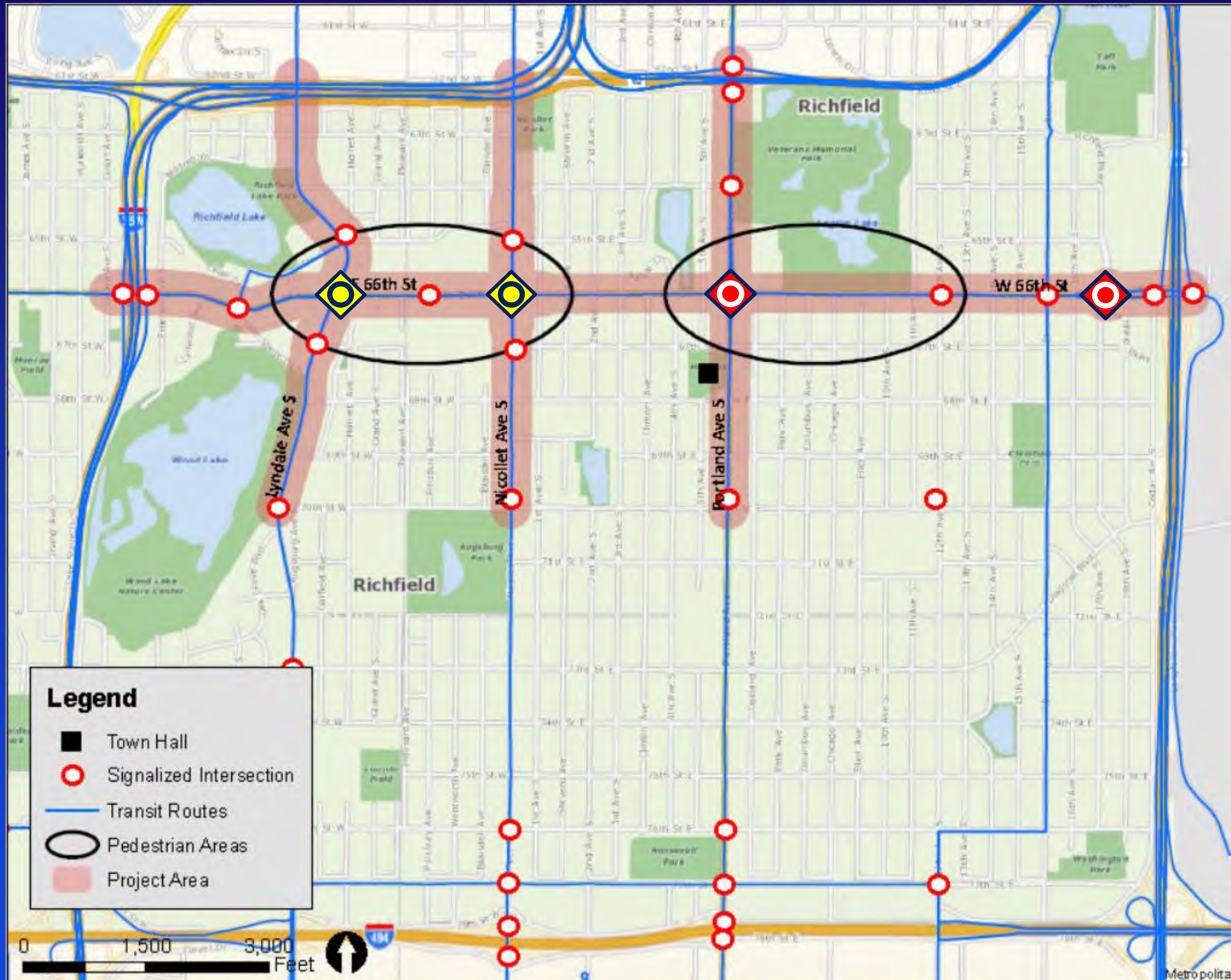




City of Richfield Corridor ‘Test-bed’

2-Lane Roundabouts

Under Construction



Roundabout Capacity & Traffic Control

- Available capacity affected by:
  - ❑Pedestrian crossing events (*Kang & Hideki, 2014, Dahl et. al*)
  - ❑Origin/Destination flow variation through roundabout (Z. Qu et. al, 2014)
  - ❑Heavy vehicle traffic volumes (*Dahl et. al 2012*)
  - ❑Approach vehicle gap selection and follow-up time variation (*Polus et. al, 2003, HCM 2010*)
- Near entrance capacity (> 0.95) creates instabilities (queues). (Z. Qu et. al, 2014)

Roundabout Capacity Control

- Signalize turning movements or rate control an approach leg (Yang et. al 2004, Davies et. al, 1980, SIG-NABOUTS- several deployments in UK and Austrialia: Akcelik, 2003, Akcelik etl al, 1997, 1998)
- Add push-button beacons or signals at pedestrian crossings (Baranowksi, 2005)
- …

General Traffic Control Strategy

- Don’t signalized the roundabout, instead:
- ‘Observe’ roundabout capacity, pedestrian crossing events, and approach traffic volume
- Estimate gap times
- Develop and ‘test’ traffic control laws to extend green phases at adjacent signalized intersections to regulate incoming traffic volumes
- Evaluate intersection total system delay and pedestrian crossing gap opportunities

Urban Arterial Redesign

Current

Future (2018)

- Omnidirectional outdoor 9 MP net camera
- Low Cost, single sensor solution
- Avoids multi-cam frame synch issues
- Traditional loops or ‘trip-wire’ sensors cannot be used to solve O/D problem
- Other COTSI Traffic Sensors have closed architecture (GridSmart, Inc.)
- Develop open architecture real-time tracking, calibration, and image stream acquisition

Roundabout sensor field deployment

- Deploy computational hardware at roadside (in cabinet).
- Wireless link to roadside cabinets and adjacent intersections.
- Broadband wired service to UMN.
- ‘Blend in’ with existing infrastructure.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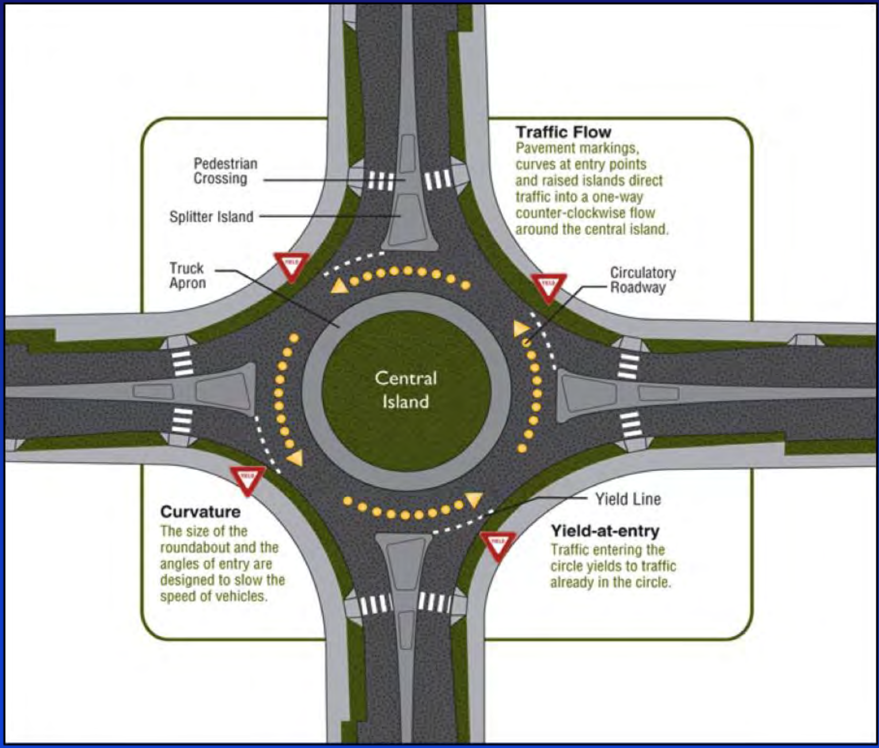
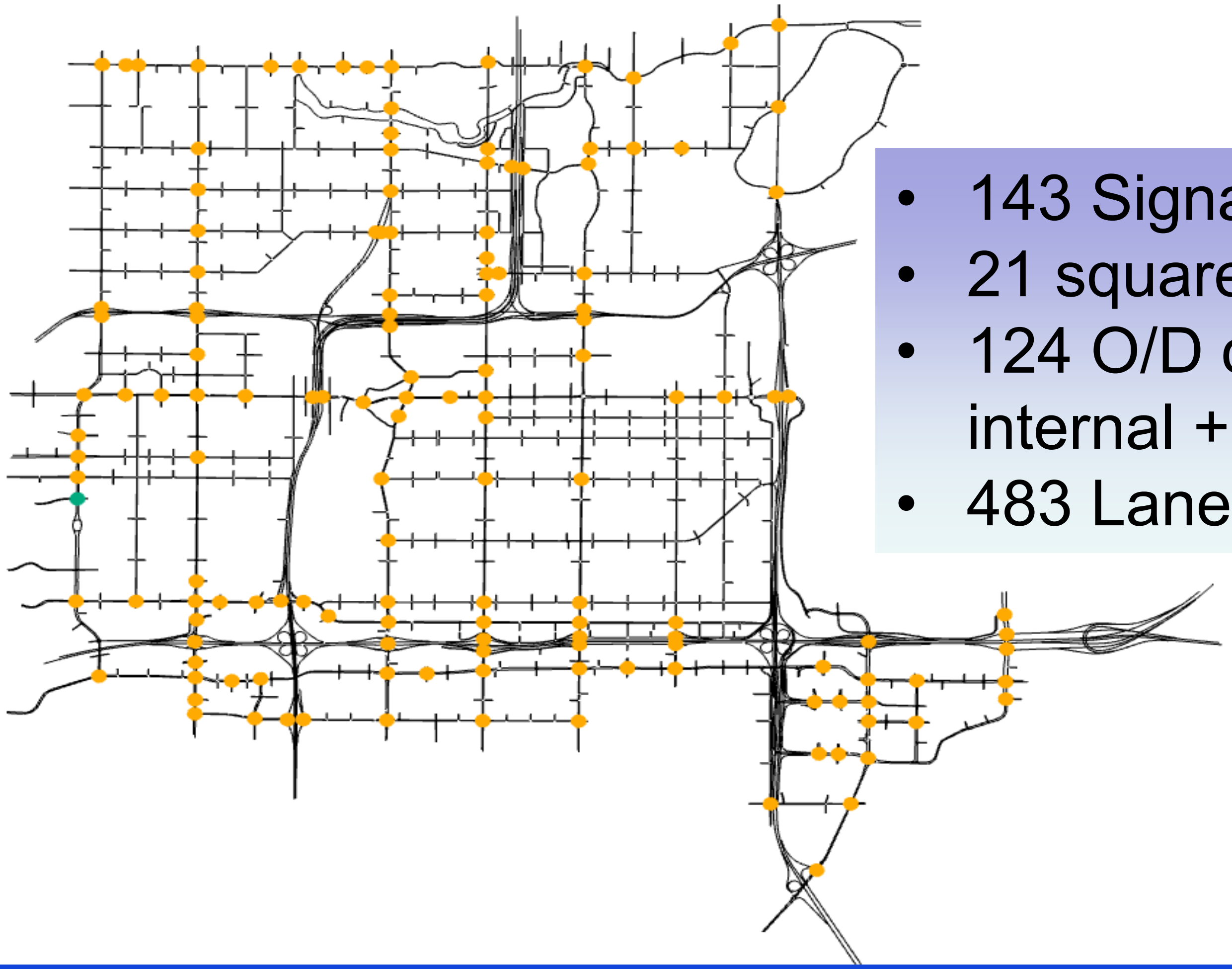
Roundabout Sensor Field Deployment



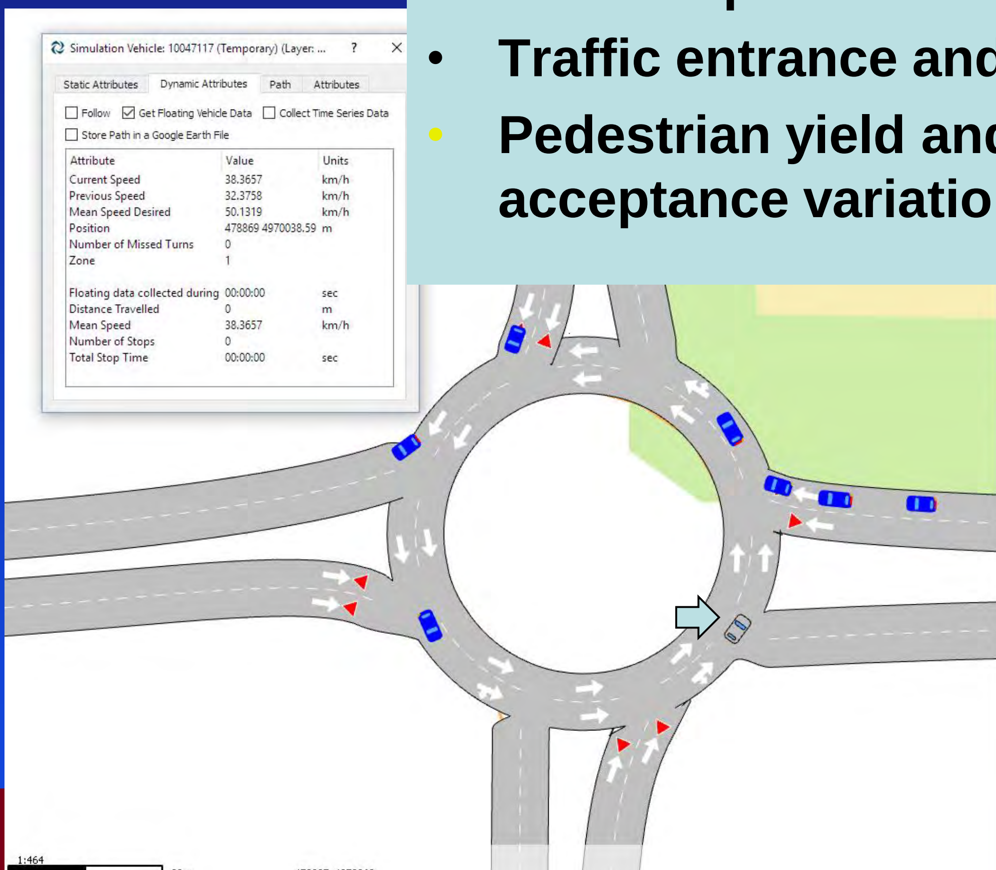
Traffic Simulation Model, Richfield

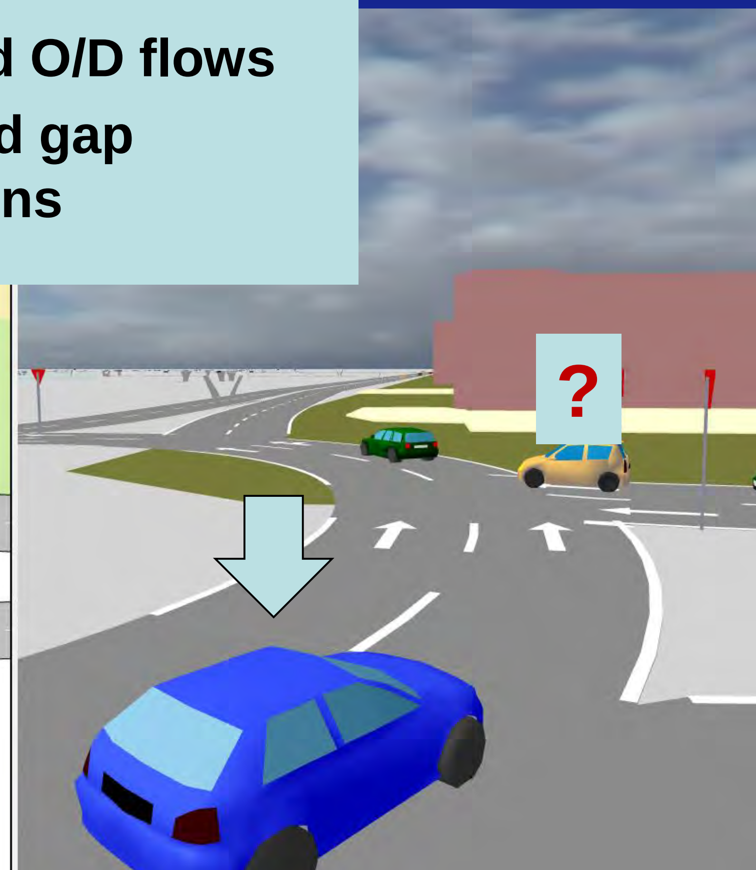


- 143 Signalized Intersections
- 21 square miles
- 124 O/D centroids (33 internal + 91 external)
- 483 Lane miles

Traffic Simulation Model Calibration

- **Quantify approach gap acceptance variations**
- **In-roundabout (conflicting flow) vehicle speeds**
- **Traffic entrance and O/D flows**
- **Pedestrian yield and gap acceptance variations**





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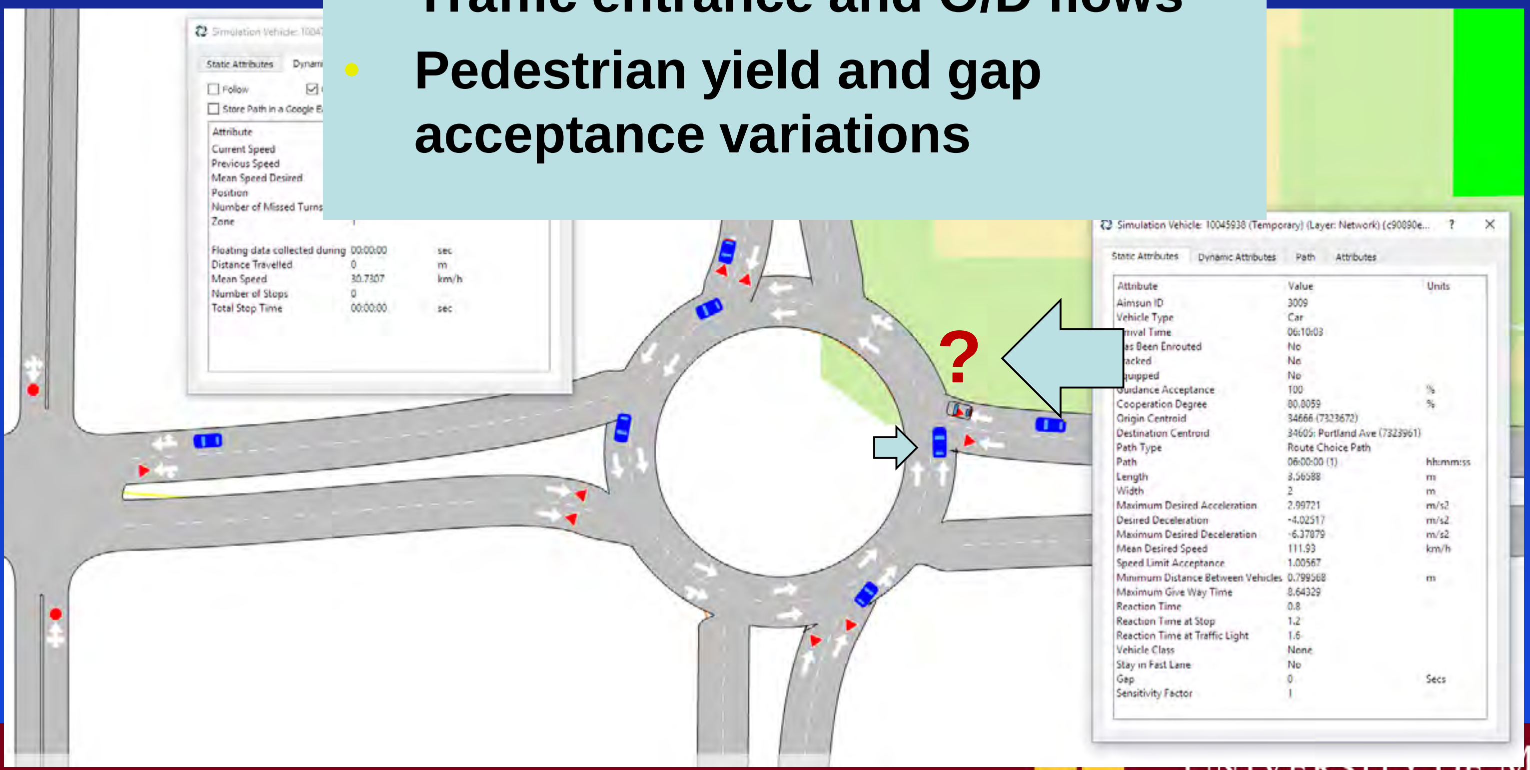
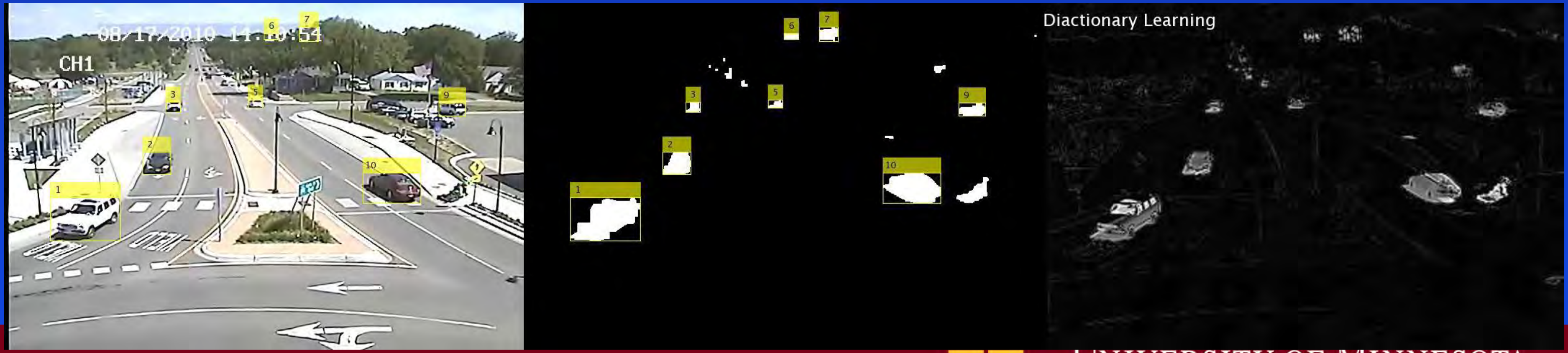


Traffic Simulation

- Need sensor and detection data for Parameter calibration as well as for Real-time traffic control.

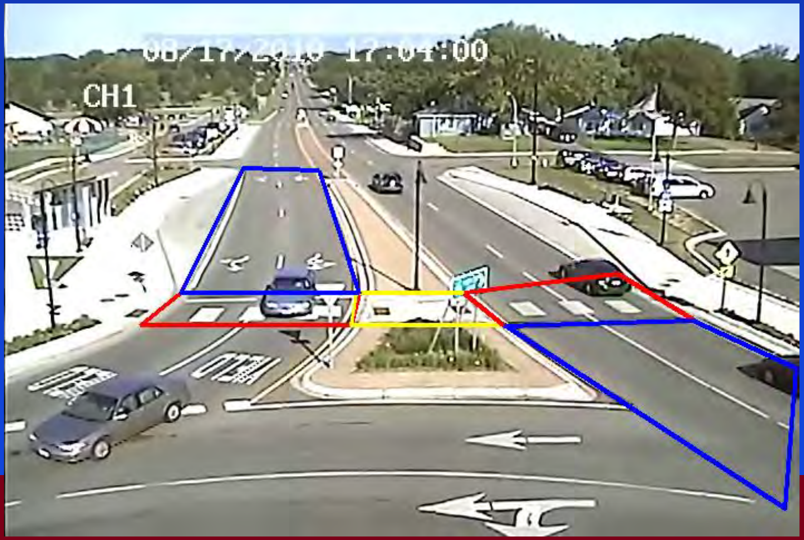
Real-time track vehicles and pedestrians

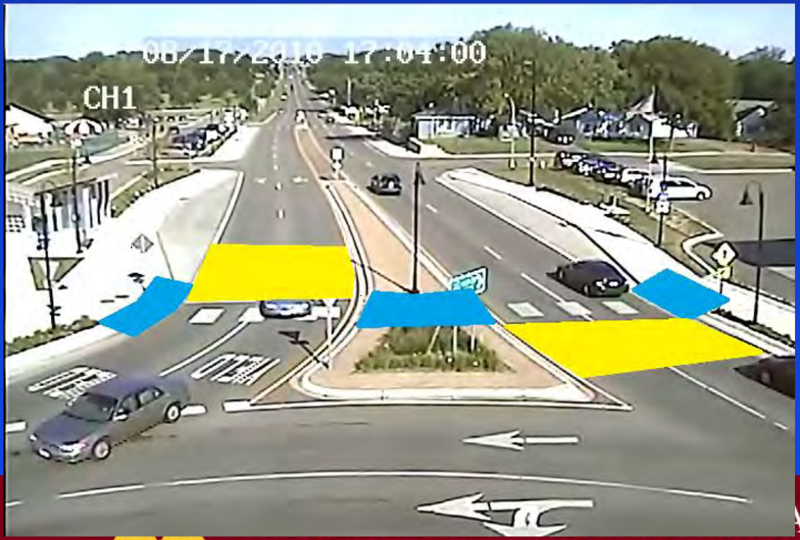
- Accurate manual extraction of measurements for calibration, and real-time O/D flow extraction is a challenging problem.
- Pedestrian crossing events.
- Origin/destination traces.
- Quantify gap selection and follow-up times.
- Quantify travel time/speed of conflicting flow vehicles.



Event and Measurement Extraction

- Define intersection regions of interest (ROI) to classify events and extract measurements
  - At exit/entrance boundary of each approach
  - Crosswalk regions
  - Internal roundabout





Future Framework Development Efforts

- Deploy sensors at signalized adjacent intersections to measure traffic volume data from cross-arterial adjacent intersections
- Transfer 66th and Portland roundabout sensor design for reconstructed intersections.
- Refine real-time extraction of vehicle and computer vision pedestrian track algorithms for spherical panoramic vision sensors
- Calibration of Roundabout traffic dynamics
- Incorporate timing phase plans at signalized simulation intersection

Thanks for listening!

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