Pedestrian and Bicyclist Traffic Control Technology Evaluation

Georgia ITE/ASHE Winter Workshop

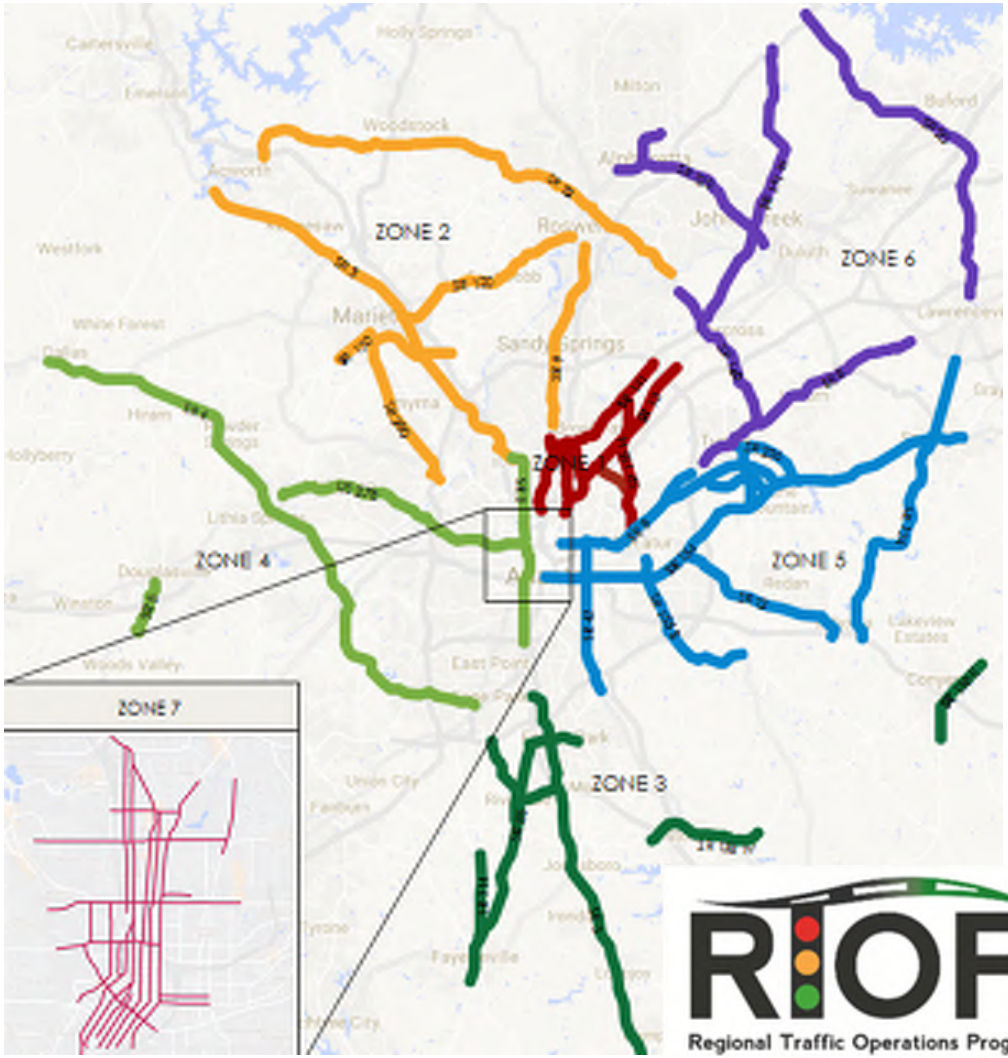
Jack Anninos, GDOT
Leslie Langley, AECOM

Overview

1. Background Research
2. Compliance Evaluation
3. Device Evaluation
4. Alternative Data
5. Device Specification
6. Recommendations

Purpose

RTOP should consider all multimodal needs. This was voiced by many stakeholders.



RTOP
Regional Traffic Operations Program

Goal

Analyze technology applications that improve operations and safety for non-motorized users, in a context sensitive and data-driven manner.

Background Research

Background Research

- Identify existing state or local agency specifications related to bicycle and pedestrian technology.
- Colorado DOT and Minnesota DOT have mature bicycle and pedestrian state wide count programs
- Formalized bicycle and pedestrian counter specifications were not found to be prevalent

Bicycle and Pedestrian Data Collection Guidebooks Reviewed
National Cooperative Highway Research Program (NCHRP)
California DOT (CalTrans)
Colorado DOT (CDOT)
Delaware DOT (DelDOT)
Florida DOT
Minnesota DOT (MnDOT)
Oregon DOT
Portland Bureau of Transportation
San Diego Association of Governments (SANDAG)
Utah Department of Transportation (UDOT)
Washington DOT (WSDOT)

Background Research

Table 3-1. Comparison of common pedestrian and bicycle counting methods: user characteristics and site characteristics.

Characteristic	Passive Infrared	Active Infrared	Pneumatic Tubes	Inductive Loops	Piezoelectric Sensor	Passive IR + Inductive Loops	Radio Beam (One Frequency)	Radio Beam (High/Low Frequency)	Automated Video[1]	Manual Counts[2]
Type of users counted										
All facility users	Yes	Yes				Yes	Yes	Yes	Yes	Yes
Pedestrians only						Yes		Yes	Yes	Yes
Bicycles only			Yes	Yes	Yes	Yes		Yes	Yes	Yes
Pedestrians vs. bicycles						Yes		Yes	Yes	Yes
Bicycles vs. automobiles			Yes	Yes					Yes	Yes
Characteristics collected										
Different user types						Yes				
Direction of travel[3]	Yes	Yes	Yes	Yes	Yes	Yes				
User characteristics[4]										
Types of sites counted										
Multiple-use trail segments	Yes	Yes	Yes	Yes	Yes	Yes				
Sidewalk segments	Yes	Yes				Yes				
Bicycle lane segments			Yes	Yes	Yes					
Cycle track segments		Yes	Yes	Yes	Yes					
Shared roadway segments			Yes	Yes						
Roadway crossings (detect from median)[5]		Yes	Yes	Yes	Yes					
Roadway crossings (detect from end of crosswalk)										
Intersections (identify turning movements)										

Notes: (1) Existing "automated video" systems may not use a completely automated counting process; they may also incorporate manual data checks of automated video processing.
(2) Includes manual counts from video images.
(3) Technologies noted as "Yes" have at least one vendor that uses the technology to capture directionality.
(4) User characteristics include estimated age, gender, helmet use, use of wheelchair or other assistive device, pedestrian and bicyclist behaviors, and other characteristics.
(5) Roadway crossings at medians potentially have issues with overcounting due to people waiting in the median. Median locations were not tested during this project.

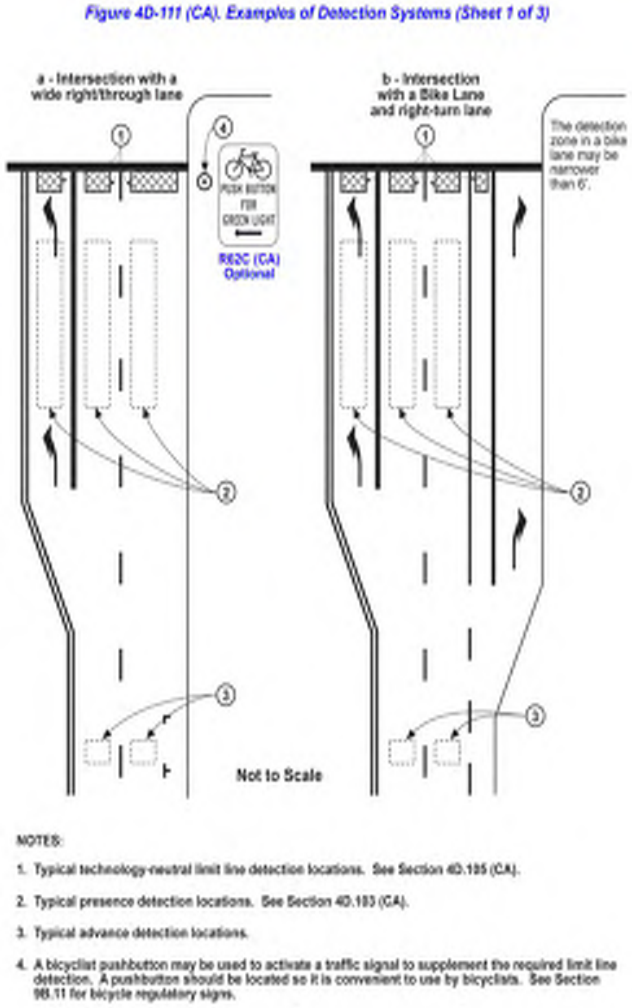
NCHRP 2014 Reports

- *Methods and Technologies for Pedestrian and Bicycle Volume Data Collection*
- *Guidebook on Pedestrian and Bicycle Volume Data Collection*

Background Research

CALTRANS MUTCD

- Minimum Bicycle Signal timing
- Bicycle detection was made a requirement at:
  - New and modified bike path approaches
  - New signalized intersections
- Guidance of detection systems to install
  - Loops
  - Video detection
  - Push button



GDOT
Georgia Department of Transportation

Compliance Evaluation

Mid-Block Crossing Compliance Evaluation

Data collection and analysis focused on:

- Pedestrian crossing location compliance
- Pedestrian crosswalk signal compliance
- Driver crosswalk compliance

Motivating better behavior

Measure the actual outcome associated with the risk for the pedestrian

Goal

Provide recommendations for mid-block crossing treatments and operational parameters to improve compliance

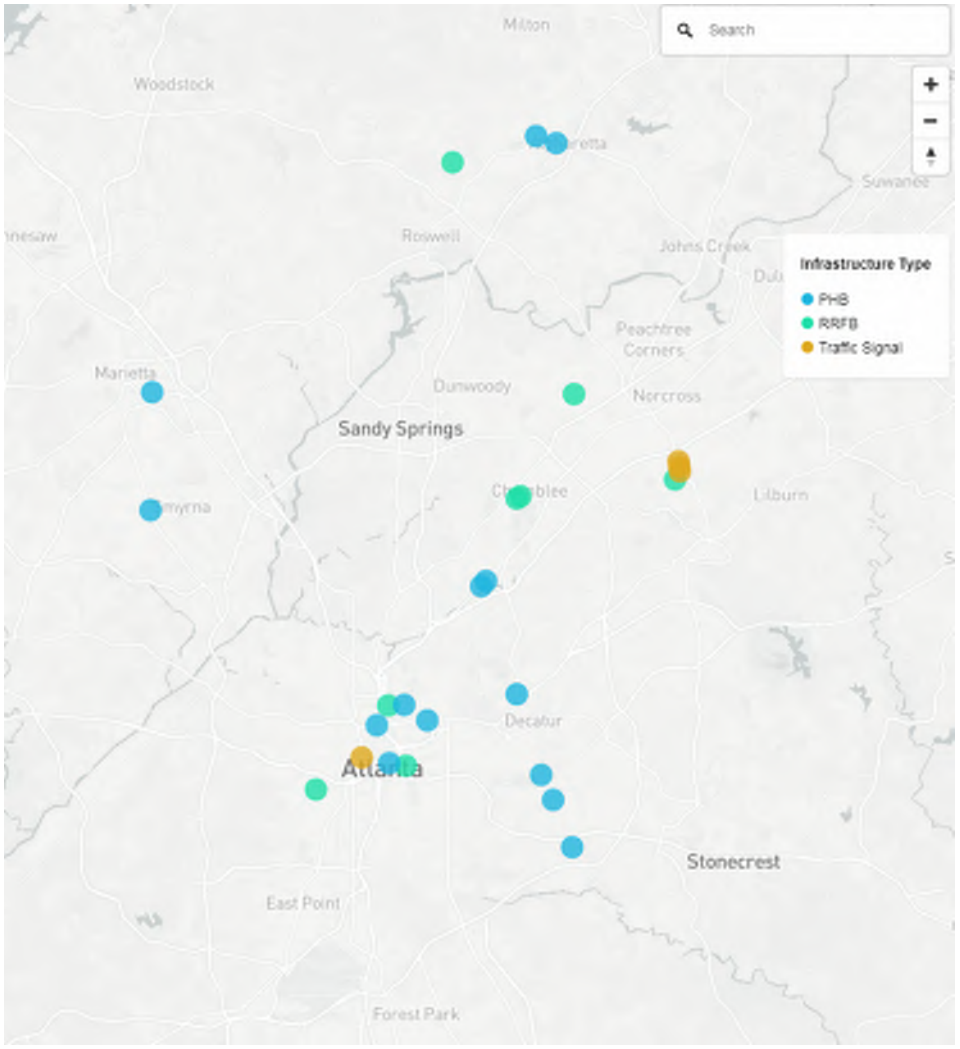
Evaluating Compliance

19 sites

- 12 Pedestrian Hybrid Beacon (PHB)

Source:
Portland Bureau of Transportation

- 7 Rectangular Rapid Flash Beacon(RRFB)



Evaluating Compliance

Observed location characteristics

- Vehicle posted speed
- Roadway width
- Pedestrian refuge area
- Pedestrian daily volume
- Vehicle daily volume
- Distance to nearest ped refuge
- Distance from stop bar to crosswalk

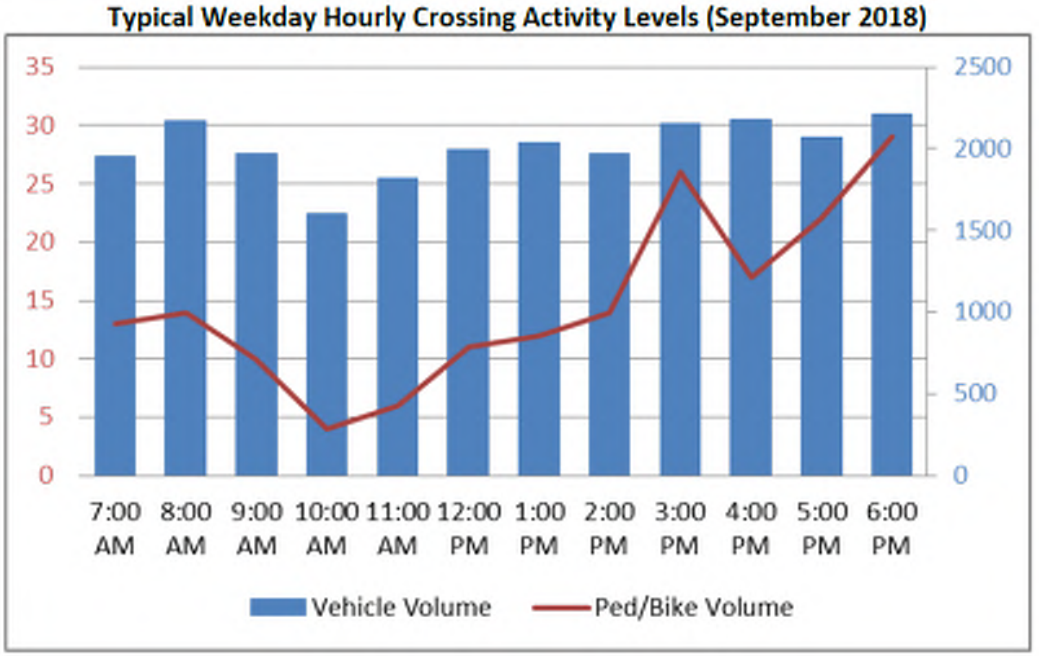
Sample Table

Location	Device Type	Speed Limit (mph)	Weekday 12-hour Pedestrian + Bicycle Volume	Weekday 12-hour Vehicle Volume	Roadway Width (ft)	Number of Lanes
XXXXX Road	PHB or RRFB	X	X	X,XXX	X	X

Sample of Field Data Collection: Inventory and Activity Levels

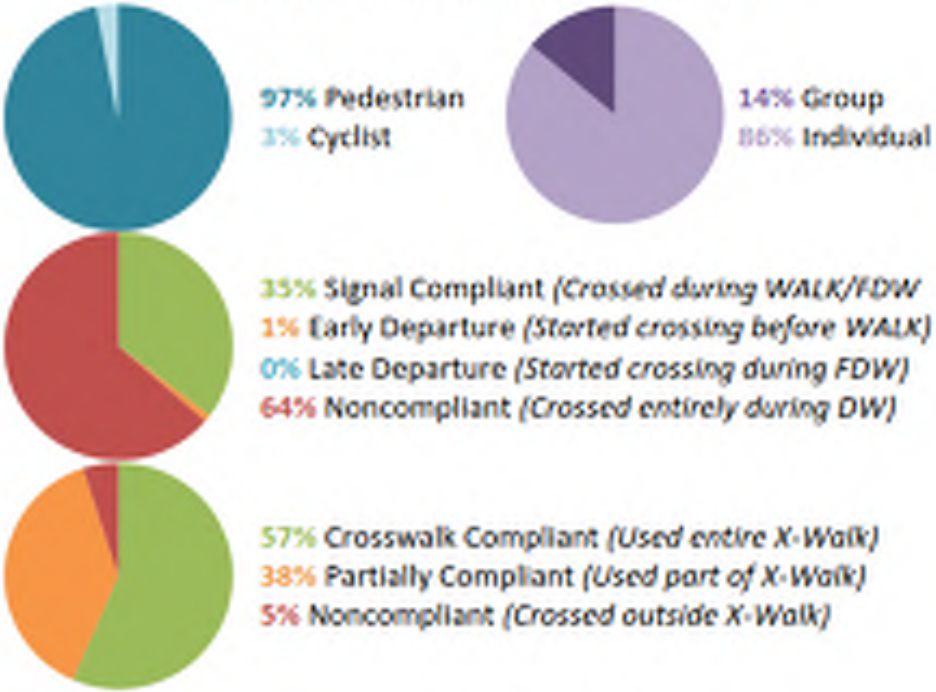
PHB – Atlanta, GA – Ponce de Leon Ave. between Somerset Ter. And Bonaventure Ave.

Speed Limit (mph):	35	Environment:	Urban
Avg. Individual Cross Time (s):	14.3	Crossing Distance (ft):	50
Avg. Wait Time (s):	7.5	Number of Lanes:	4
% Button Activation:	34	Street Lights within 20 ft:	Yes
Weekday 12-hr Ped-Bike Vol:	172	Ped. Detection Type(s):	Passive
Weekday 12-hr Veh. Vol:	24,166	Ped. Service Type(s):	Demand Resp. / Coord.



Sample of Field Data Collection: Pedestrian & Driver Behavior

Crosswalk Users and Behavior



Driver Behavior

Note: This location is a 2-stage crossing but compliance is only measured for one stage. Crossing time is measured across both directions.

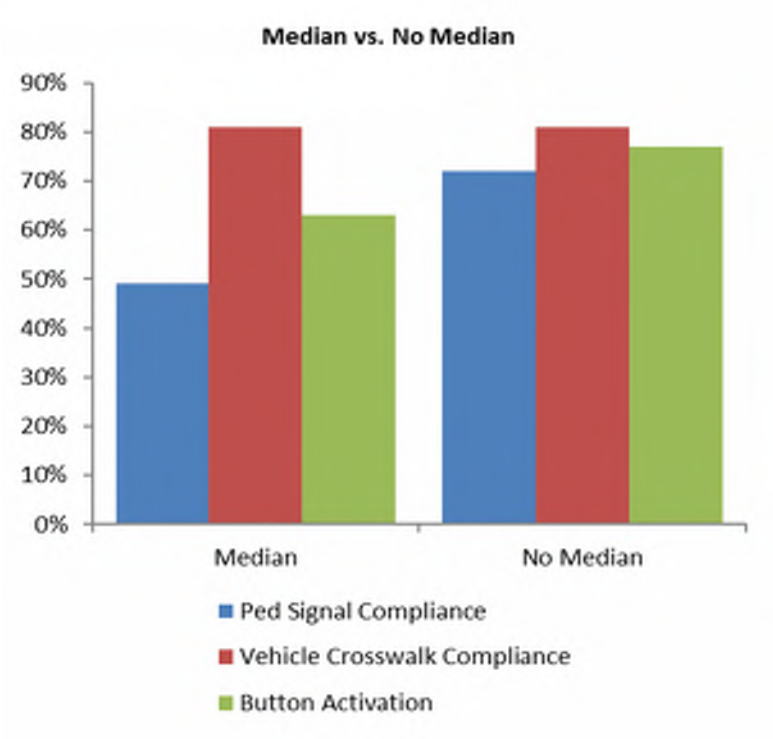
Median Refuge Area

Median refuge areas resulted in a lower rate of pushbutton actuation and pedestrian signal compliance

- Pedestrian signal average compliance: 49% (median) vs 72% (no median)
- Push button activation average compliance: 63% (median) vs 77% (no median)

The **lower** compliance rates represents a **higher** level of pedestrian comfort

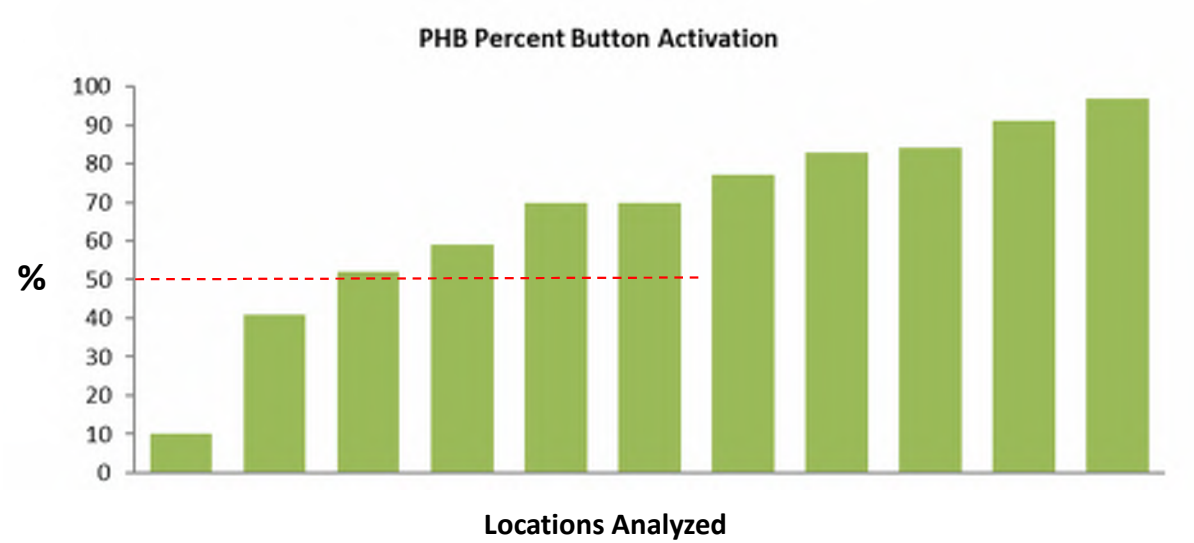
A median is the first treatment for consideration, and provides the primary benefit at a mid-block crossing



PHB Pedestrian Pushbutton Compliance

Influenced by presence of pedestrian refuge area

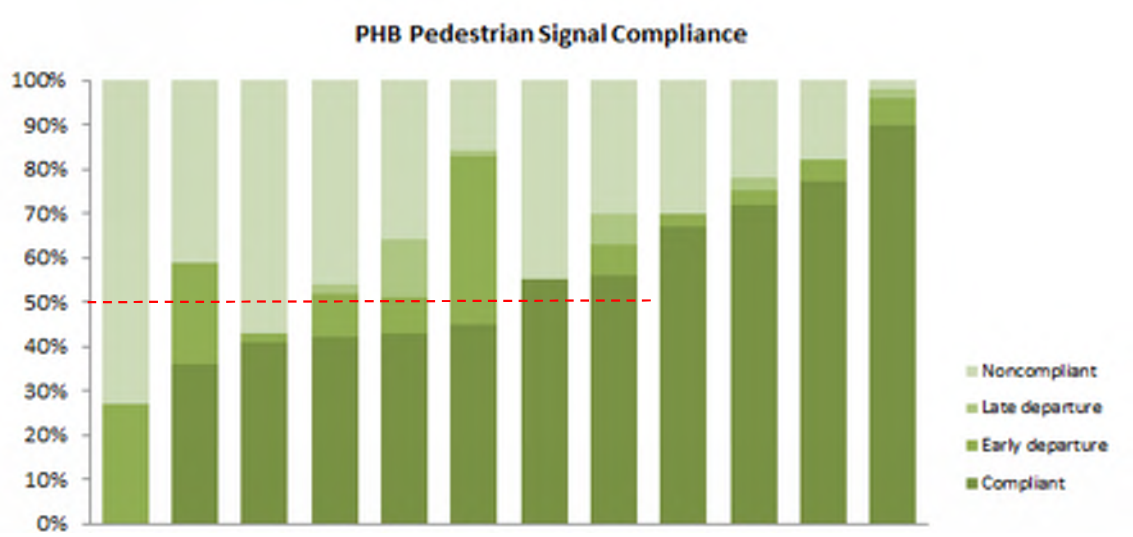
Rule of thumb: compliance at less than 50% should be evaluated further



PHB Pedestrian Signal Compliance

Influenced by presence of pedestrian refuge area

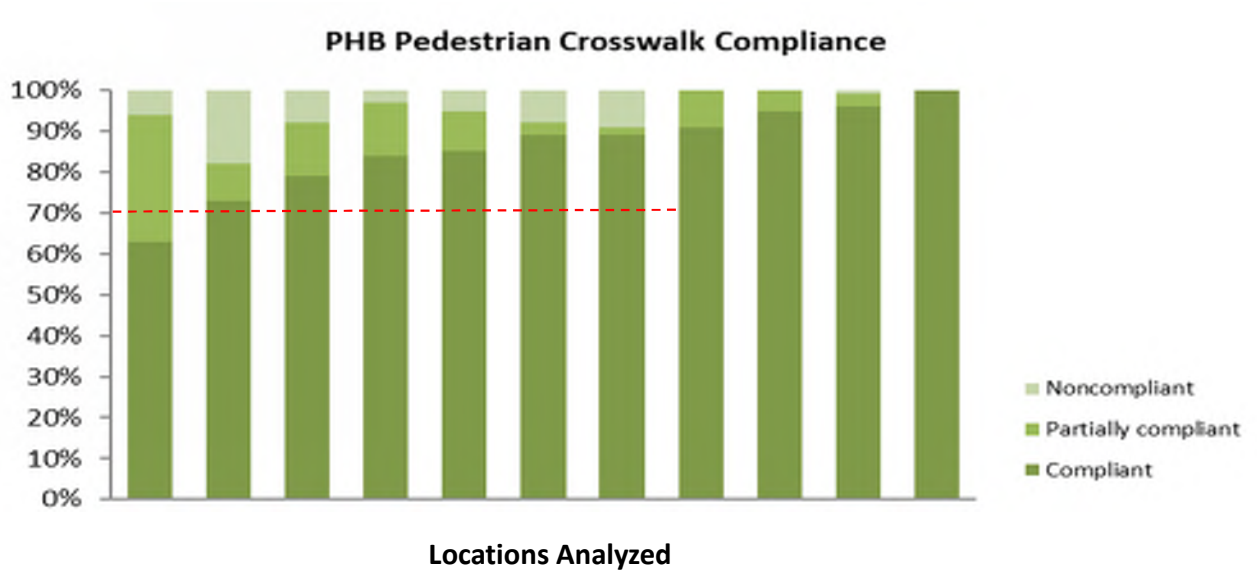
Rule of thumb: compliance at less than 50% should be evaluated further



Locations Analyzed

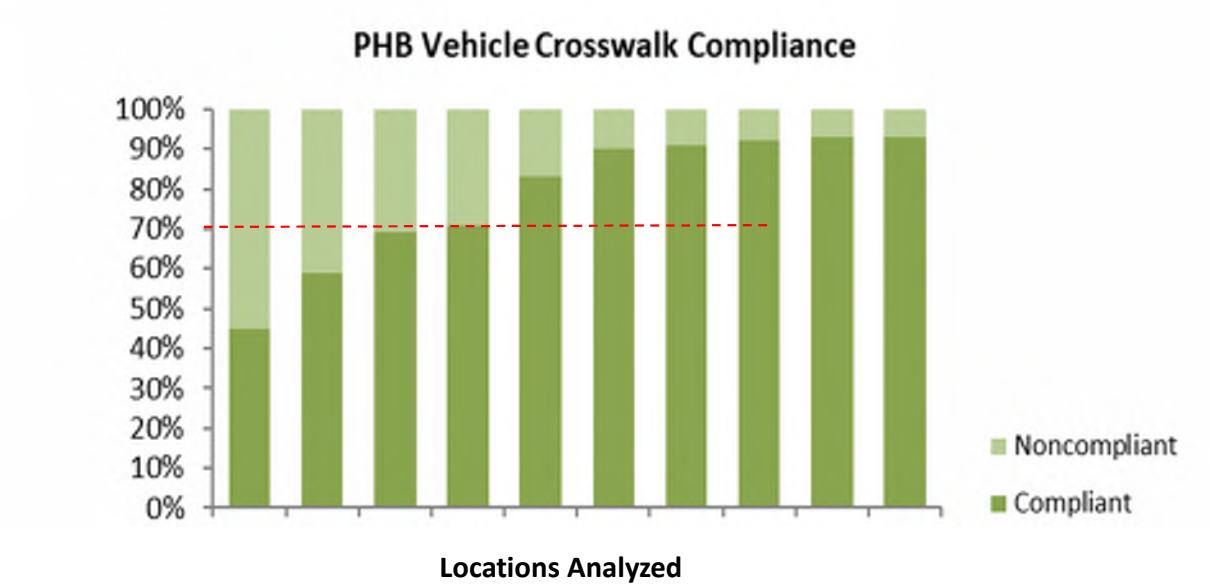
PHB Pedestrian Crosswalk Compliance

Rule of thumb: compliance at less than 70% should be evaluated further



Driver Compliance at Crosswalk

Rule of thumb: compliance at less than 70% should be evaluated further



Correlation Analysis

Field Review

Correlations involving compliance were evaluated based on the following values:

	Pedestrian Compliance	Driver Compliance
Pedestrian Wait Time	X	
Speed Limit	X	X
Average 12-hour Traffic Volume	X	X
Roadway Width	X	
Distance to Nearest Pedestrian Refuge	X	

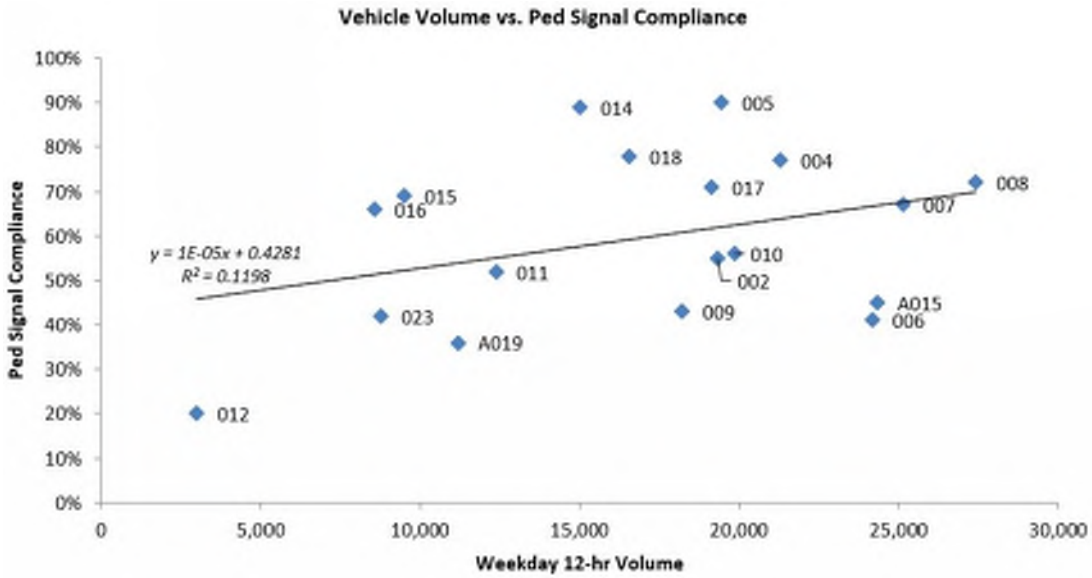
Correlations where the R^2 value exceeded 0.1

Video Data Analysis

Pedestrian or	Timestamp	Individual or	Ped Signal	Ped Signal	Ped Crosswalk	Vehicles	Stop Bar	Vehicl
Pedestrian	11:20:16 AM	Group	Yes	Compliant	Compliant	Present	Compliant	Compliant
Pedestrian	11:22:02 AM	Individual	Yes	Compliant	Compliant	Present	Compliant	Compliant
Pedestrian	11:24:44 AM	Group	Yes	Compliant	Compliant	Present	Compliant	Compliant
Pedestrian	11:28:07 AM	Group	Yes	Compliant	Compliant	Present	Compliant	Compliant
Pedestrian	11:29:42 AM	Group	Yes	Compliant	Compliant	Present	Compliant	Compliant
Pedestrian	12:00:42 PM	Individual	Yes	Compliant	Compliant	Present	Compliant	Compliant
Pedestrian	12:01:33 PM	Individual	Yes	Early Departure	Partially Compliant	Present	Compliant	Compliant
Pedestrian	12:02:29 PM	Group	Yes	Compliant	Compliant	Present	Compliant	Compliant
Cyclist	12:05:13 PM	Individual	Yes	Compliant	Compliant	Present	Compliant	Compliant
Pedestrian	12:07:00 PM	Group	Yes	Compliant	Compliant	Present	Compliant	Compliant
Pedestrian	12:07:11 PM	Group	Yes	Compliant	Compliant	Present	Compliant	Compliant
Pedestrian	12:07:55 PM	Group	Yes	Early Departure	Compliant	Present	Compliant	Compliant
Pedestrian	12:13:54 PM	Group	Yes	Compliant	Compliant	Present	Noncompliant	Noncompli
Pedestrian	12:17:34 PM	Individual	Yes	Compliant	Compliant	Absent	NA	NA
Pedestrian	12:20:15 PM	Group	Yes	Compliant	Compliant	Present	Compliant	Compliant
Pedestrian	12:21:00 PM	Individual	Yes	Compliant	Compliant	Present	Noncompliant	Compliant
Cyclist	12:23:03 PM	Group	Yes	Early Departure	Partially Compliant	Absent	NA	NA
Pedestrian	12:23:34 PM	Individual	Yes	Compliant	Compliant	Absent	NA	NA

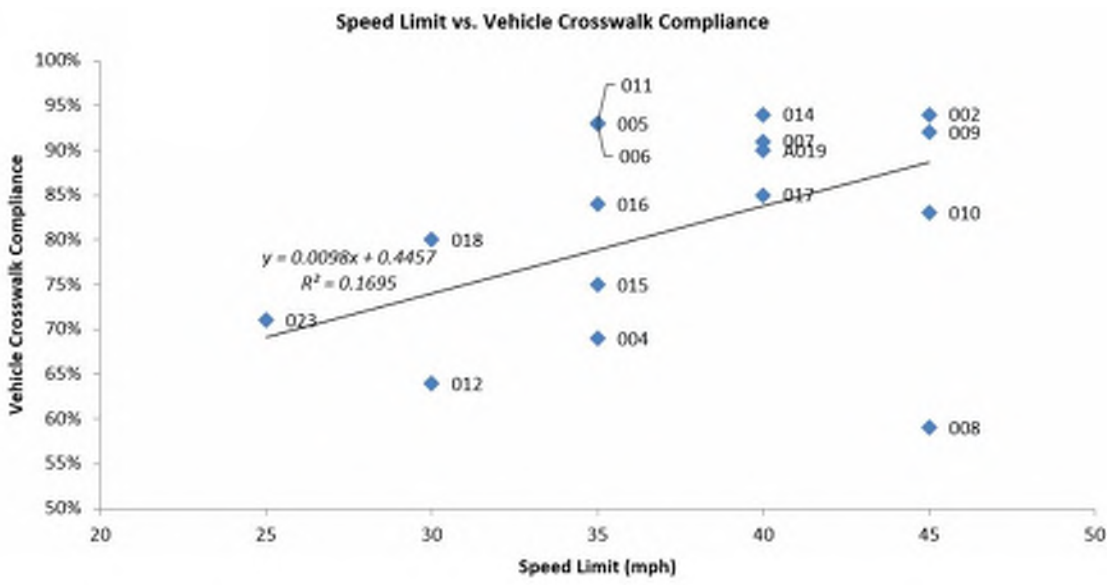
Vehicle Volume and Pedestrian Signal Compliance

- Pedestrians are more likely to wait for the ped signal phase on roads with higher vehicle volume
- Pedestrian signals substantially reduce the risk profile for the pedestrian in a high vehicle volume environment



Speed Limit and Vehicle Crosswalk Compliance

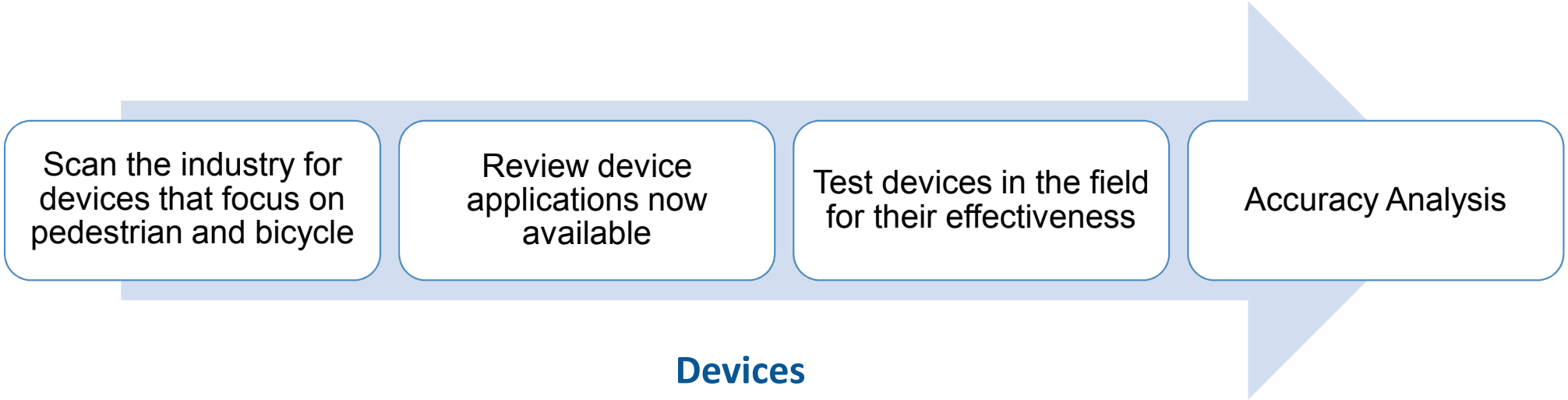
- Corridors with a higher posted speed limit tend to comply more with the crosswalk.
- Pedestrian crossing visibility is a key ingredient for appropriate driver reaction, such as signal heads located over the vehicle lanes



GDOT
Georgia Department of Transportation

Device Evaluation

Device Evaluation



Devices

- Eco-Counter ZELT
- FLIR TrafiOne
- Miovision SmartView 360
- GRIDSMART
- Iteris Vantage Next
- Wavetronix SmartSensor Matrix

Device Demonstration

Multiple vendors were invited to participate in the demonstration.

Two companies agreed to deploy products for evaluation

- Iteris Vantage Next
- GRIDSMART Bell Camera

Vehicle, bicycle, and pedestrian **counting**

Vehicle, bicycle, and pedestrian **detection**

Counting

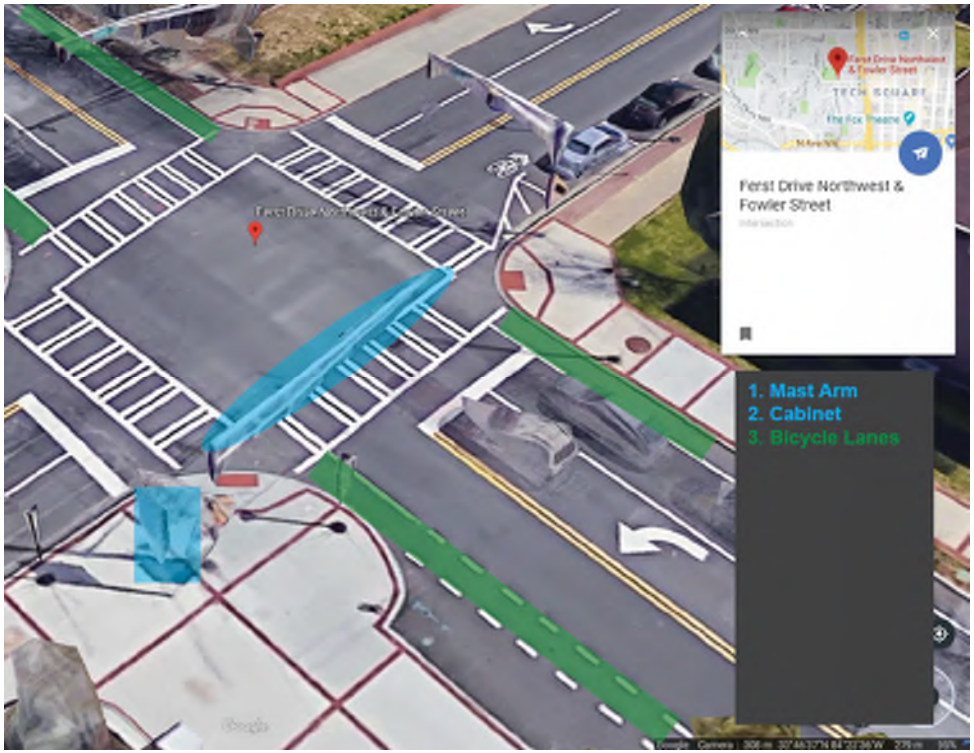
Detecting the number of pedestrians and/or bicyclists in a zone

Detection

Notifies the presence of a pedestrian and/or bicycle and actuates appropriate phase(s) for traffic control device(s) at the intersection

Device Demonstration Sites

GRIDSMART Site

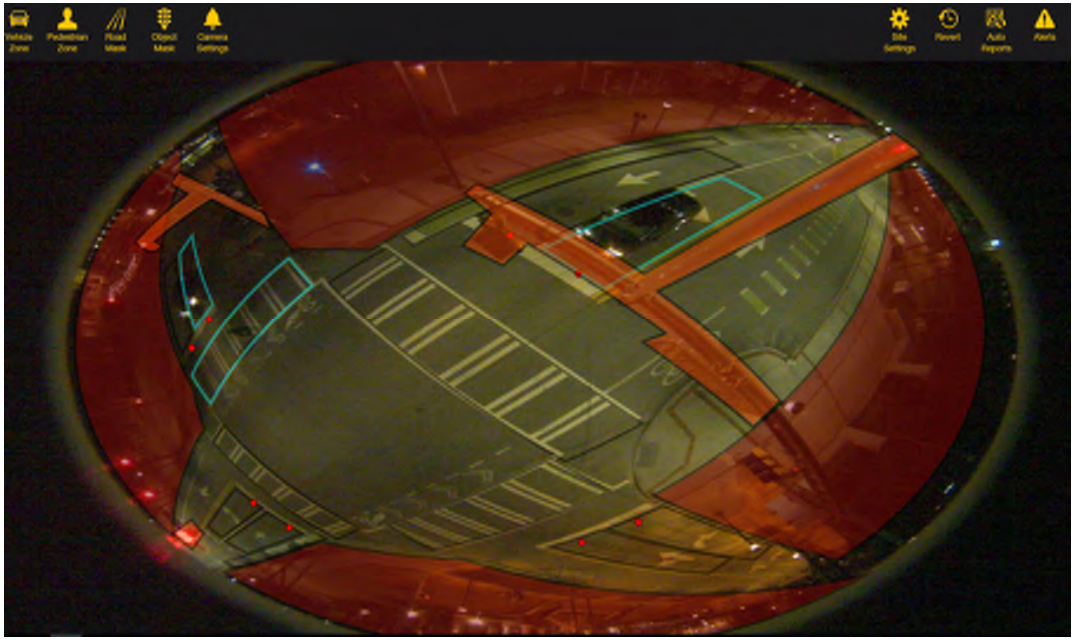


Iteris Site

GRIDSMART Bell Camera System

108° Fisheye Camera

GS2 Processor



Gridsmart Client

Iteris Vantage Next Camera

Vantage Next Camera

SDLC Card and Processor

Vantage Live Interface

Device Functionality

Counting	Detecting
Performance measures	Reporting

	Iteris Vantage Next	GRIDSMART Bell Camera
Counting		
Pedestrians	X	-
Bicyclists	X	X
Vehicles	X	X
Reporting		
Volume by Mode		
5 min intervals		X
15 min intervals	X	X
30 min intervals		X
60 min intervals	X	X
Other Reports		
Turning Movement Count		X
Vehicle Classification		X
Volume		X
Incident*		X
Raw Export		X
Weekly Volume	X	X
Green Occupancy		X
Red Occupancy		X
% Arrivals on Red		X
% Arrivals on Green		X
Speed		X
Export Functionality		
Remote Download	X	X
Automated Reporting		X

Accuracy Evaluation

Processing vehicle, bicycle, and pedestrian counts

Weighted Average Percentage Deviation Method

Application to the specification

Weighted Average Percentage Deviation (WAPD)

To account for the low volume bias of the AAPD measure, a volume-weighted accuracy measure is also calculated, as:

$$WAPD = \sum_{t=1}^{n} \left(\left| \frac{A_t - M_t}{M_t} \right| \times \frac{M_t}{\sum_{j=1}^{n} M_j} \right)$$

Alternative Data

Near Collision – Brisk Synergies

From an early but relevant study

- Post Encroachment Time (PET)
  - PET <= 3 second is considered **Near Collision**
- Safety analysis at 3 locations
  - **5th St at Spring St**
  - 10th St at Techwood Dr
  - 13th St and Peachtree St
- All-WALK phase **findings**
  - 75% reduction in pedestrian conflicts
  - Average speed of vehicles increased by approximately 4 mph
  - Bicyclists not moving through the intersection during the pedestrian phase increased from 8% to 20%

From Pedestrian Safety Analysis using Alternative Data Collection Methods
May 2018 Report

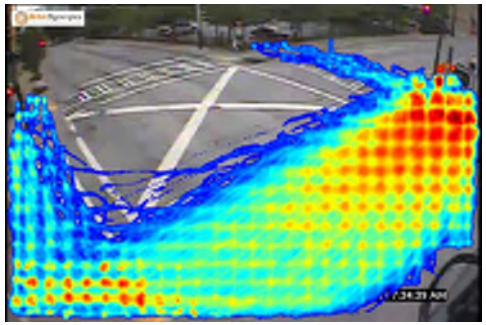


Figure 16. Pedestrian Trajectory Before Condition

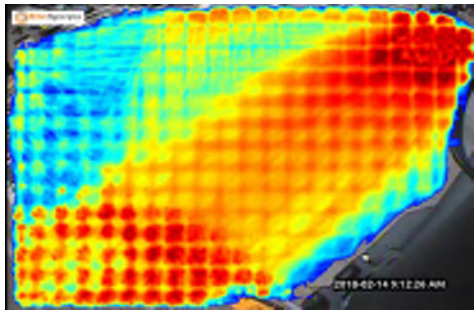


Figure 17. Pedestrian Trajectory After Condition

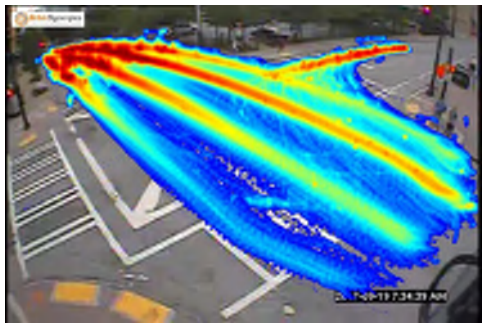


Figure 18. Left Turning and Through Vehicle Trajectory Before Condition

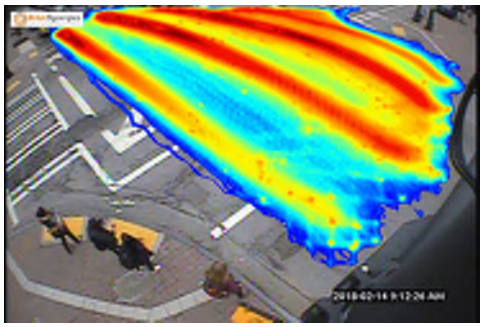
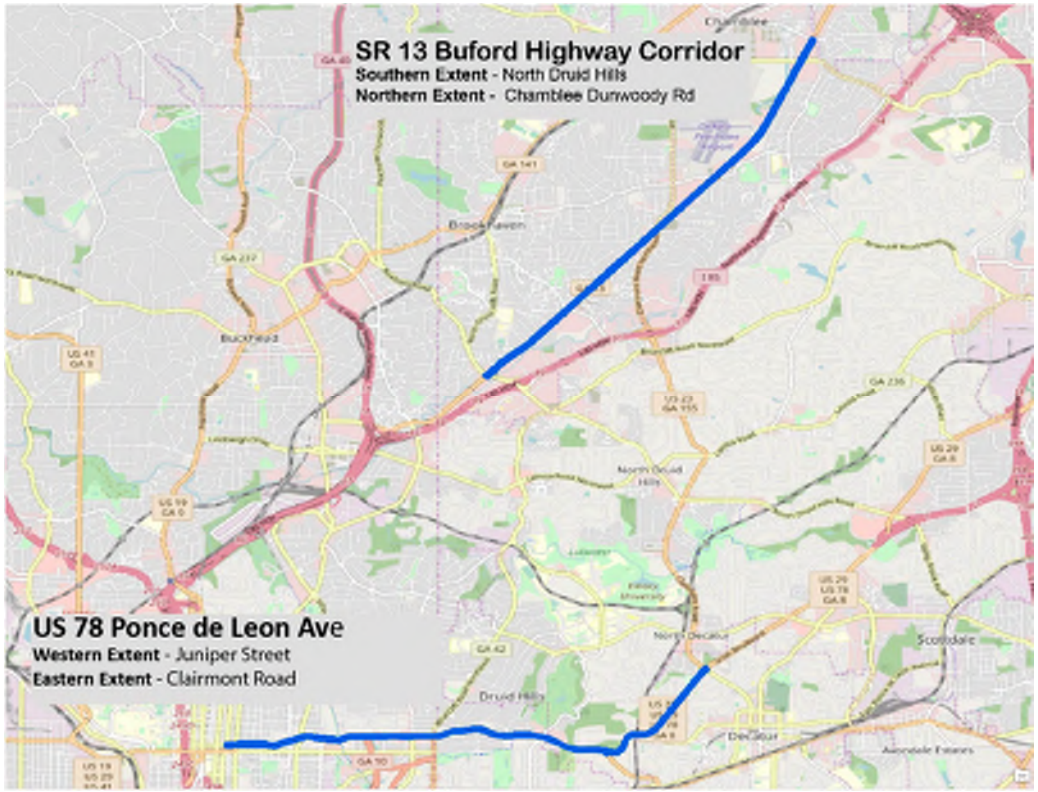


Figure 19. Left Turning and Through Vehicle Trajectory After Condition

Alternate Data Collection

AirSage Data

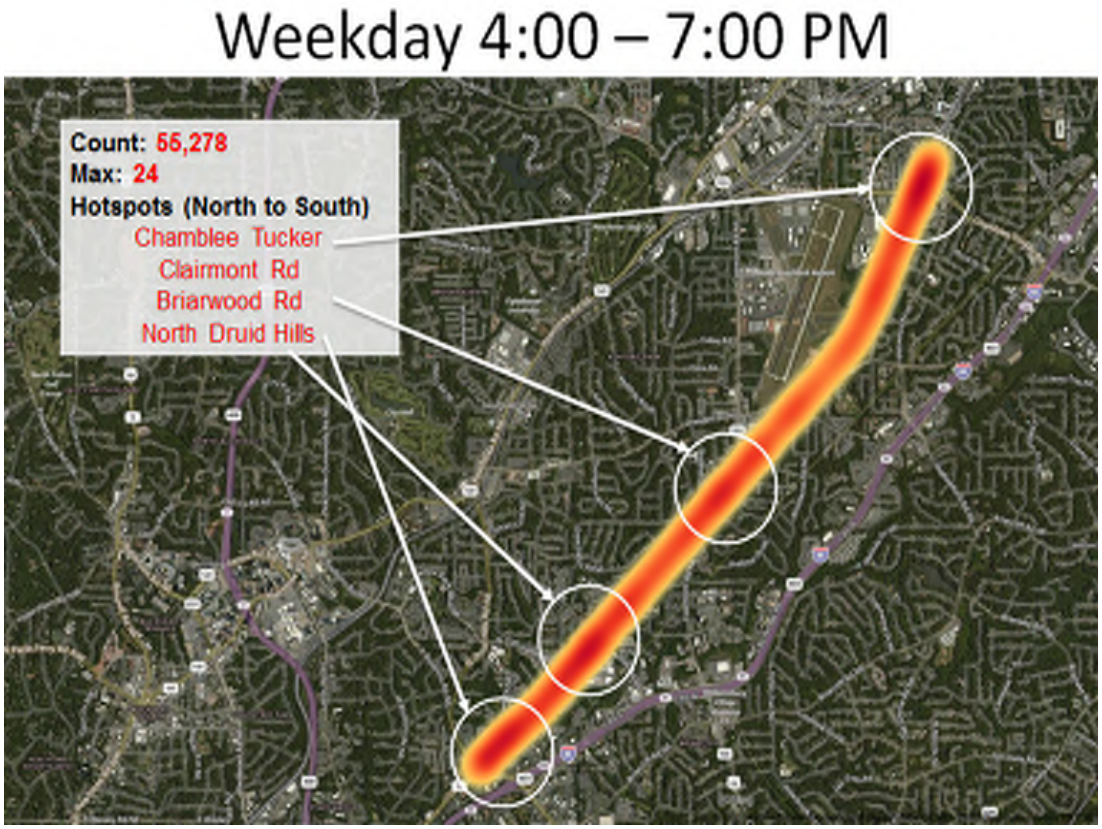
- AirSage Activity Density Pedestrian Identification (ADPI) Data
- Data sets evaluated were for September 2018 and May 2017



Passive Data Collection

Insights

- Weekdays, Saturday, or Sunday per hour block of time.
- Counts are not defined as individual sightings but rather an extrapolated (weighted) number of people passing by at slow speeds

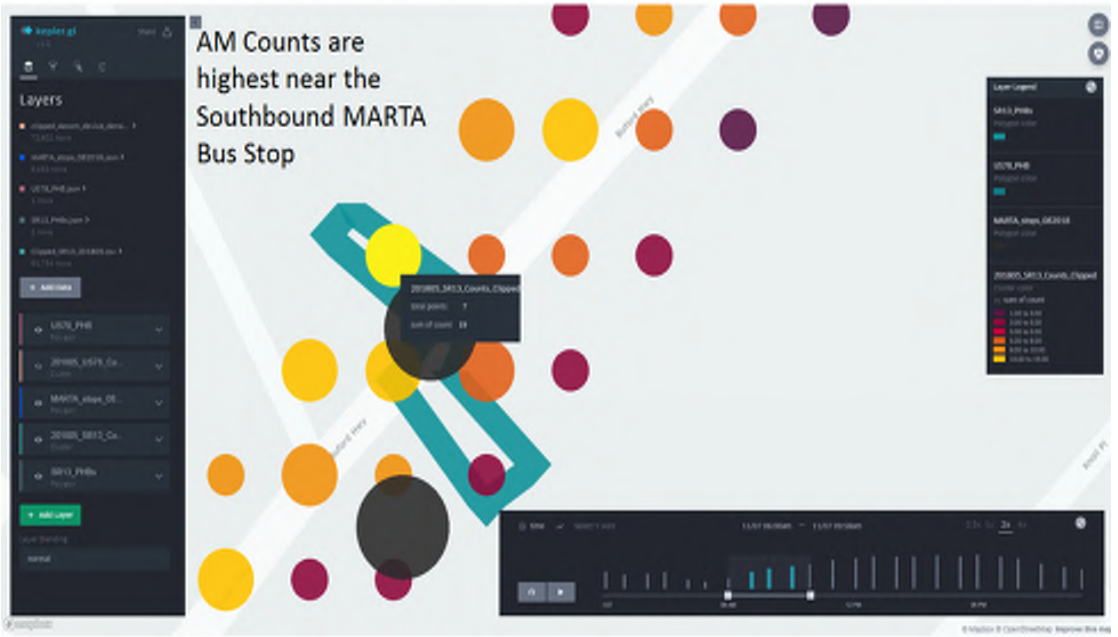


Passive Data Collection

Lessons Learned

- Check for accuracy
- ADPI data set is currently best suited for corridor analysis, not intersection analysis, as shown in the map here

Transit check



GDOT
Georgia Department of Transportation

Device Specification

Specification Components

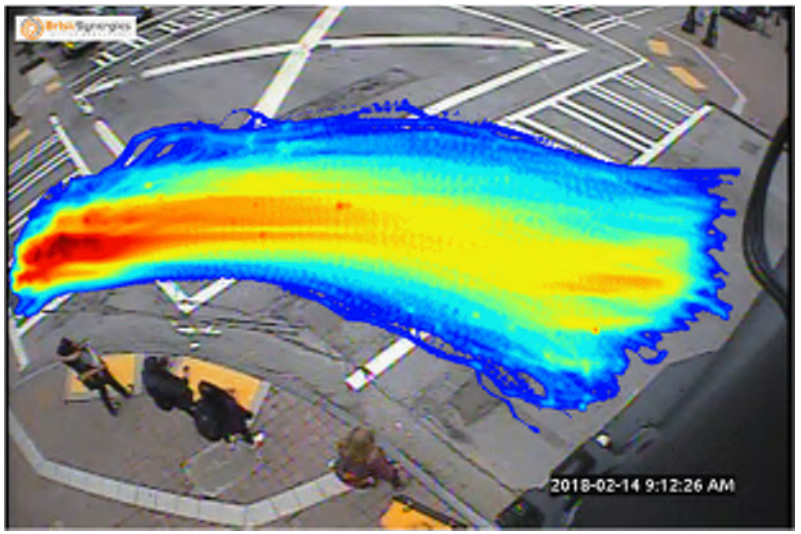
Primary Features

Performance-based approach	Accuracy requirements	Invasive and non-invasive
Software	Installation (on existing structures)	Cabinet requirements

Specification for Pedestrian and Bicycle Technology

Device options under development

Passive pedestrian and bicycle detection	Pedestrian and bicycle counting
Travel time	Near conflicts



Device Technology

Technology options that may be used by devices

Connected Vehicle	GPS	Inductive Loop	Lidar
Piezo	Radar, Aerial-based	Radar, Pavement-base	Video, Thermal
Video, Conventional	Video, Stereo	Wireless Re-Identification	

Recommendations

Recommendations (under development)

Mid-block crosswalks

- Operational parameters
- Visibility guidance
- Behavior thresholds

Devices

- Specification

Programming

- Performance measures
- State-wide program

Source: https://www.litro.co.uk/2013/10/a-monster-fed-by-money-frieze-art-fair-2013/

GDOT
Georgia Department of Transportation

Questions?

Thank you!

Jack Anninos
State Bicycle and Pedestrian Engineer
Traffic Operations
Georgia Department of Transportation
Janninos@dot.ga.gov

Leslie Langley
Smart Cities and Mobility Technology Specialist
Transportation
AECOM
Leslie.Langley@AECOM.com