High-Resolution Performance Monitoring in Managed Lane Evaluation

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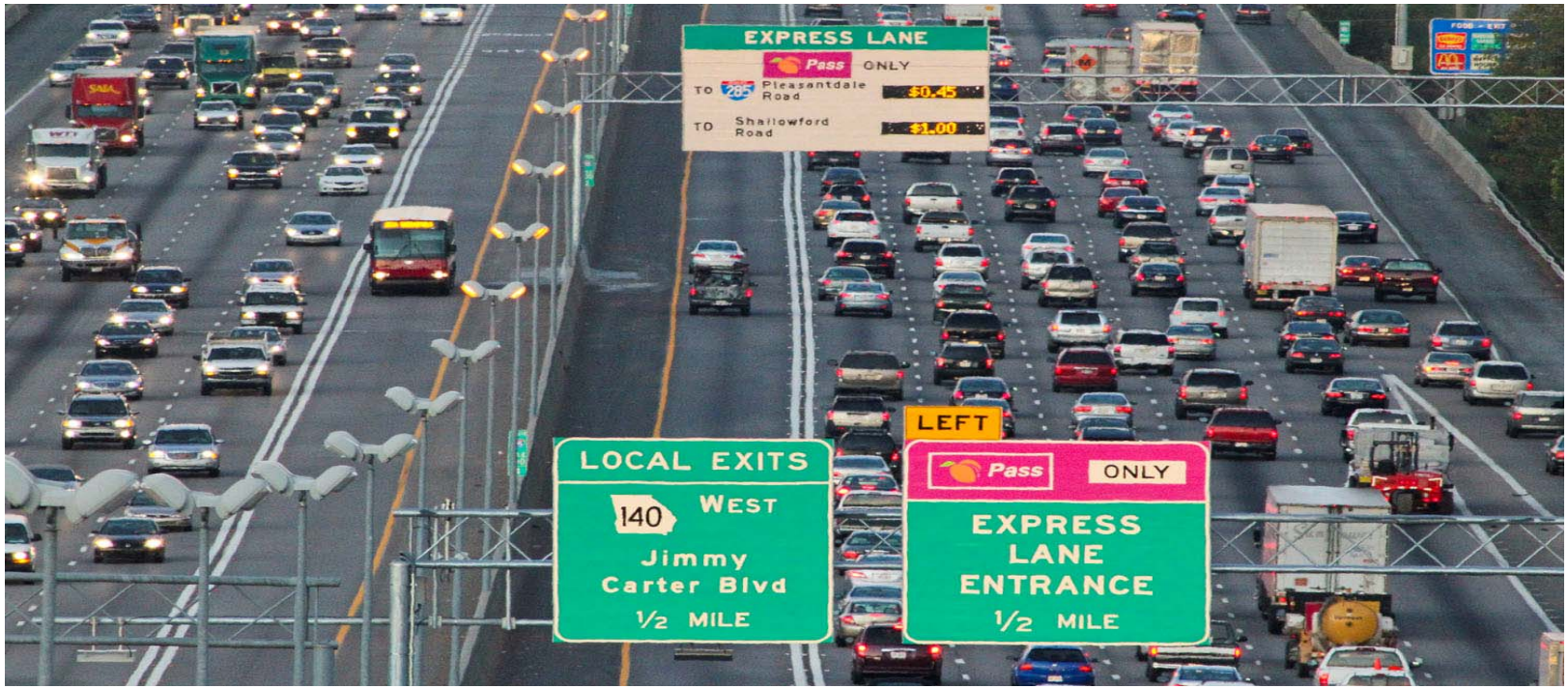
Monitoring Depends on Project Goals

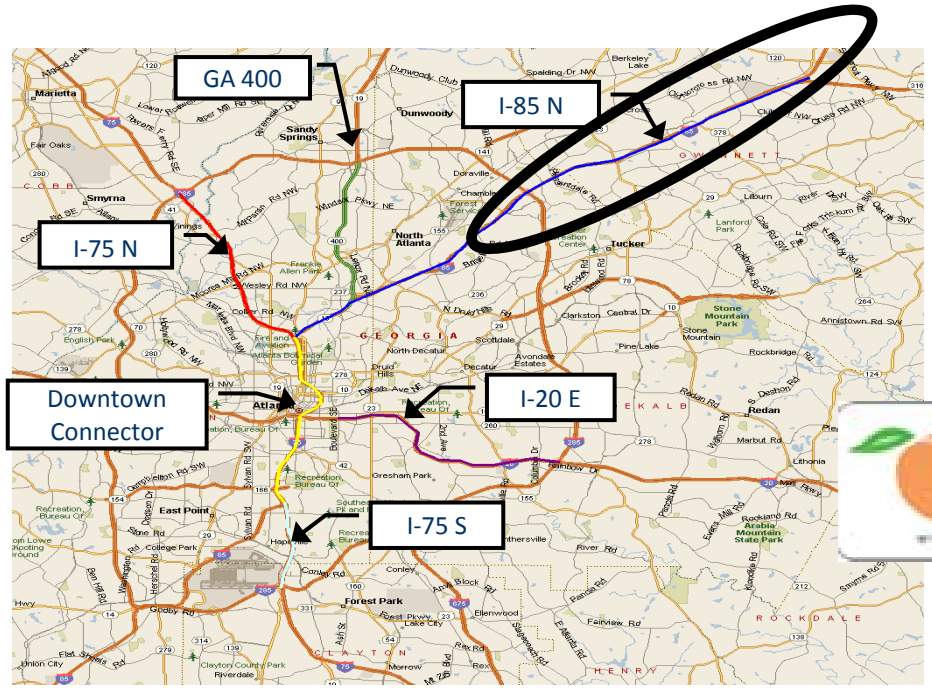
- ***Reducing corridor congestion and travel times***
- ***Improving corridor travel time reliability***
- ***Providing a travel option with guaranteed performance***
- ***Enhancing carpool and transit alternatives***
- ***Maximizing vehicle-throughput on the corridor***
- ***Maximizing person-throughput on the corridor***
- ***Maximizing toll revenues***
- ***Reducing fuel consumption and/or pollutant emissions***
- ***Customer satisfaction, environmental justice, etc.***

I-85 HOT Corridor



www.ajc.com

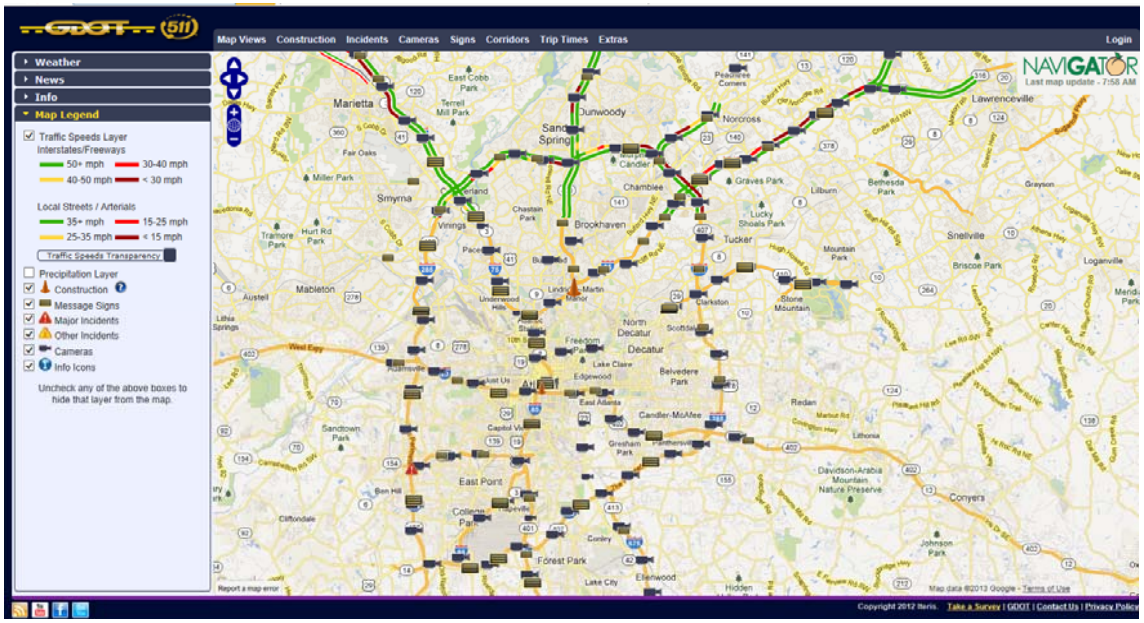
Atlanta's I-85 HOV-to-HOT Corridor Opened October 1, 2011

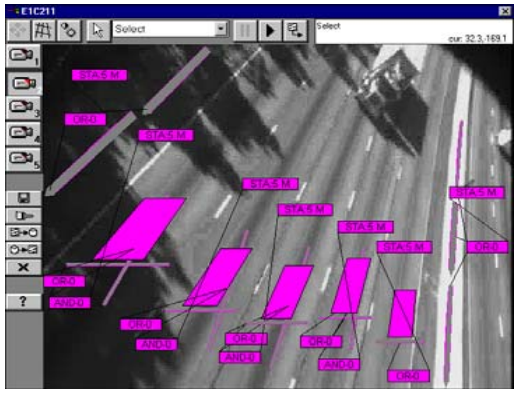


15.5 mile main corridor (plus 1 mile)

Operations Data

- ***State Road and Tollway Authority toll system data***
- ***Georgia Department of Transportation NaviGAtor data***





- ***20-second data by lane***
- ***200+ facility miles***
- ***2000+ VDS cameras***
- ***535 CCTV video cameras***

Speed-Flow Plots

Toll System Data

	2012	2013	2014
Total HOT Detections	78,340,186	94,974,194	108,718,150
Total GP Detections	44,368,481	62,159,534	63,614,769
Average Unique HOT Users/Month	48,476	63,328	73,337
Average Unique GP Users/Month	142,259	176,170	180,515

2.3 stations/mile HOT
0.4 stations/mile GP

Monitoring Corridor Occupancy

Guensler, et al., 2013

- ***Vehicle occupancy (persons/vehicle)***
  - ***Quarterly roadside data collection***
  - ***Netbooks with keypads (vehicle class & occupancy data)***
- ***Parallel license plate data collection (not paired)***

Changes in Vehicle Occupancy

- ***Significant decrease in carpooling***
  - ***HOV2 vehicles decreased from 14.3% to 10.3%***
  - ***HOV3+ vehicles decreased by 0.7% to 0.5%***
    - ***Does not include transit vehicles***

- ***Corridor vehicle throughput dropped by 6.6%***
- ***Corridor person throughput dropped by 9.9%***
- ***Express bus throughput remained constant***
  - ***1.2% of vehicles yields 26% of HOT person-throughput***

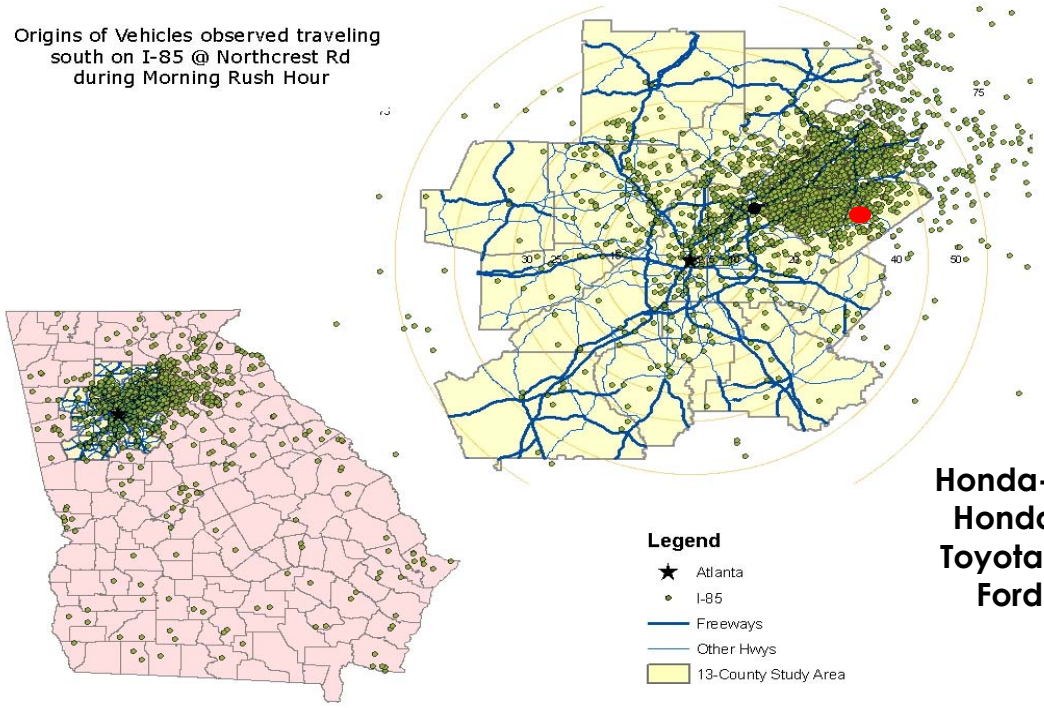
Follow-up Corridor Carpool Survey

- ***About 13% of respondents changed carpool mode***
- ***Carpool break-ups outpaced carpool formation (1.6x)***

n = 540		In 2012, after the Express Lanes opened, how did you usually commute to work?	
		Drove Alone	Carpool
In 2011, before the Express Lanes opened, how did you usually commute to work?	Drove Alone	367 (68%)	27 (5%)
	Carpool	45 (8%)	101 (19%)

About 70% are fampools

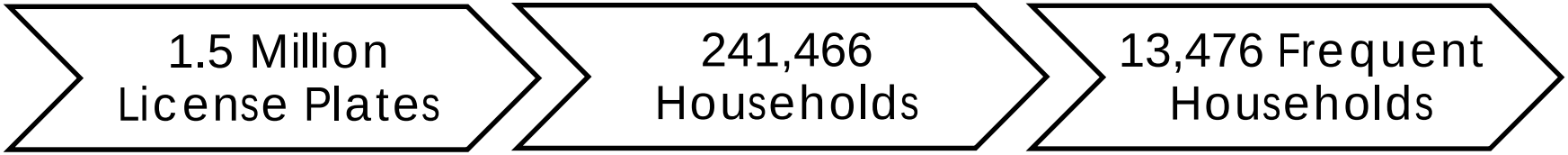
License Plate Studies
User Demographics (I-85 Commutershed)



Honda-Accord
Honda-Civic
Toyota-Camry
Ford-F150

License Plates to Demographics

Khoeini, 2014

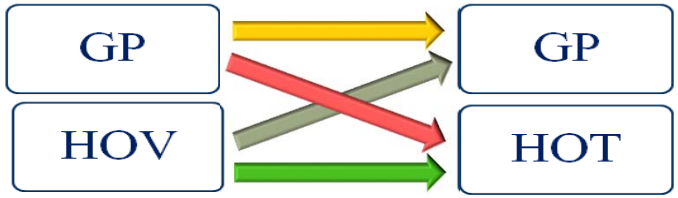


- 10¢ per matched license plate
- Remove out of state (5%)
- Remove out of metro area (8%)
- Remove 7+ vehicle owners
- 5 observation per HH (average)
- 42% of observations
- 20+ observations/frequent HH

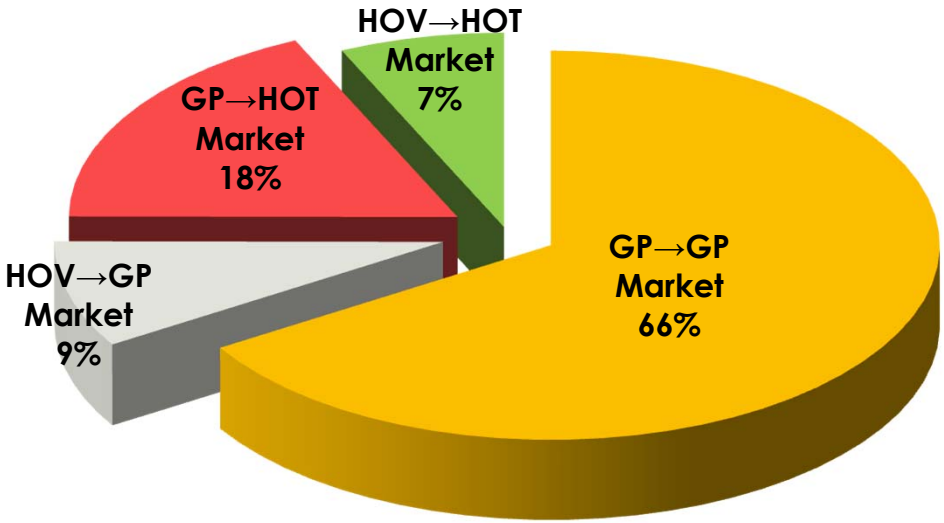
- ***Demographic data***
  - ***Census tract data***
  - ***Census block group data***
  - ***Licensed marketing firm household-level data***

Cluster Analysis of Frequent Commuters

Khoeini, 2014



- n = 13,476 (Frequent HHs)
- 20+ corridor observations
- Hierarchical clustering



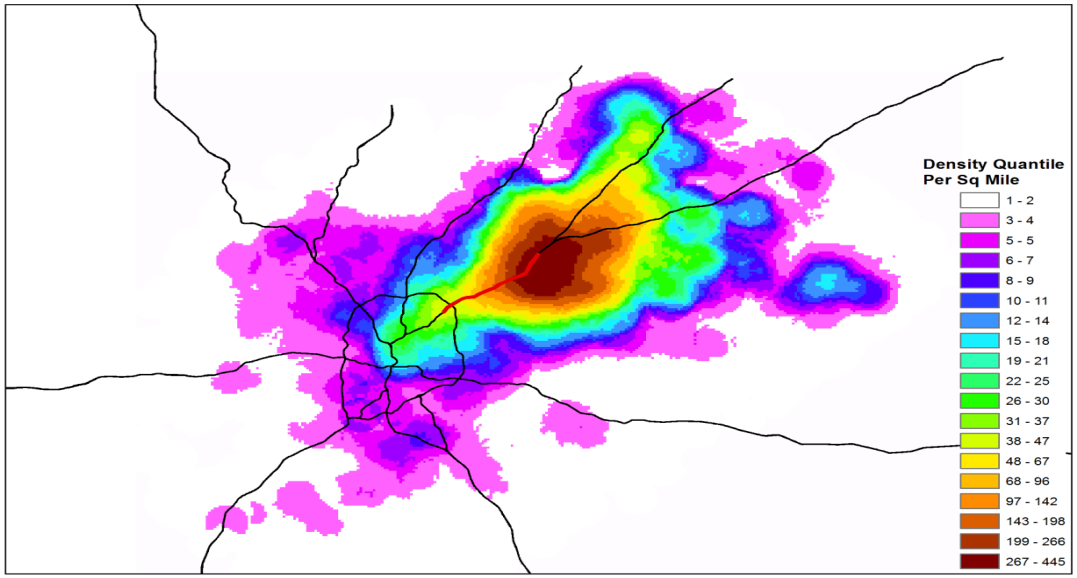
Socioeconomic Attributes across Lanes: Summary of Results

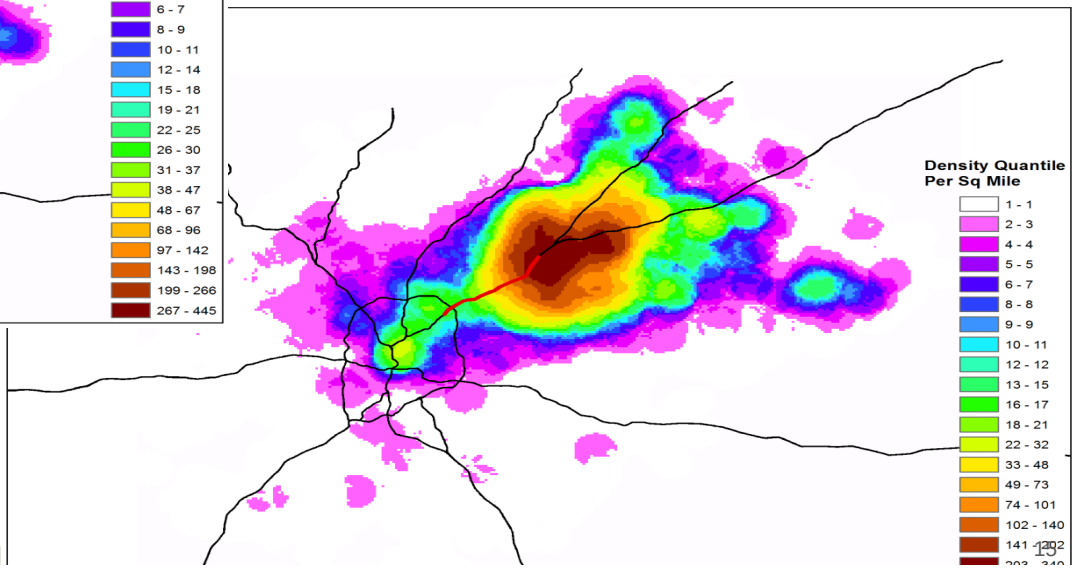
Khoeini, 2014

- ***HOT lane (compared to GP lanes):***
  - ***41% more households with $120,000+ annual income***
  - ***36% more households with 4+ children***
  - ***11% more households with two adults***
  - ***13% more households with Bachelors or more education***
  - ***14% more married HHs***
  - ***9% more households with middle-aged head of HH'***
- ***Logistic regression results in Khoeini (2014)***

Point Density Quantiles HOV/HOT Lanes

Khoeini, 2014

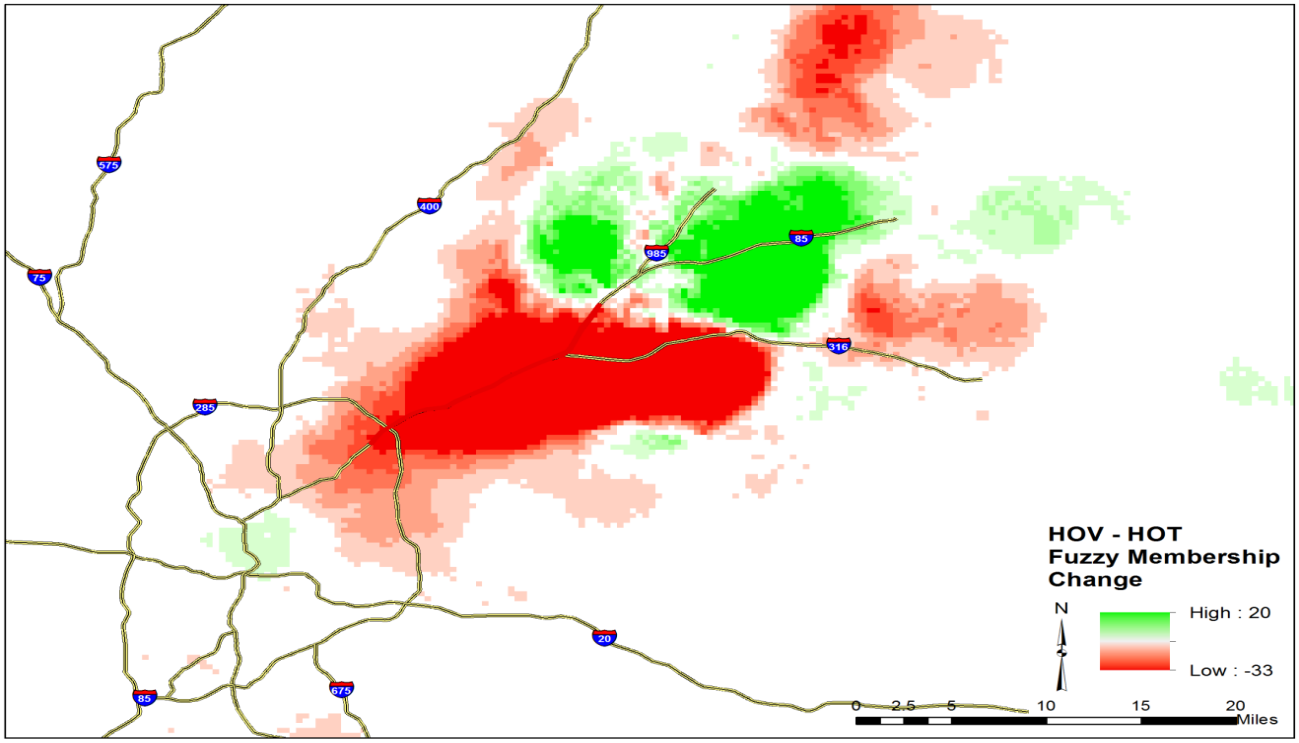




(n = 1,500,000 observations)

Fuzzy Values Difference HOV/HOT Lanes

Khoeini, 2014



Analysis of Toll Response

Sheikh, 2015

- ***Revealed preference data (toll-monitored)***
  - ***HOT and GP lane transponder readings***
  - ***Toll at time of lane-use decision***

- ***Data indicate when the customer chose to pay to use the HOT lane and when they used the GP lanes***

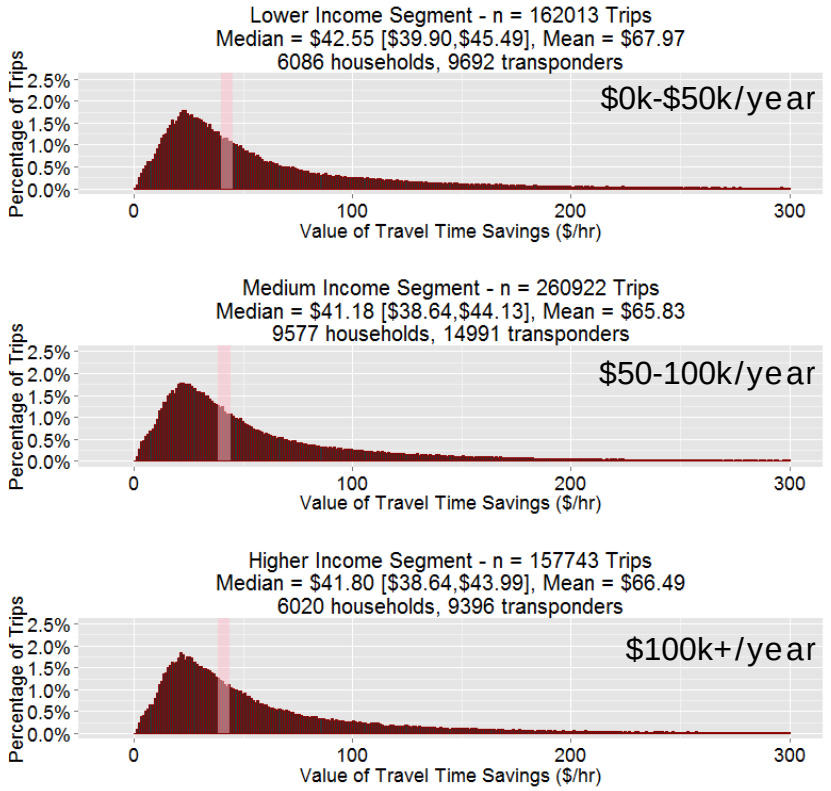
- ***System must collect RFID tag readings in the GP lanes!***

Value of Travel Time Savings By Income Group

Sheikh, 2015

	Lower	Medium	Higher
Median VTTS	$42.55	$41.18	$41.80
Bootstrap Confidence Intervals for Sample Median	$39.90 $45.49	$38.64 $44.13	$38.64 $43.99
Mean VTTS	$67.97	$65.83	$66.49
Bootstrap Confidence Intervals for Sample Mean	$63.60, $72.74	$61.55 $70.21	$61.35 $70.25
25th Percentile	$24.71	$23.94	$24.18
75th Percentile	$80.65	$78.00	$79.03

- *Overlapping confidence intervals*
  - *Mean and median values are not significantly different across groups*
- *Similar in the afternoon northbound*

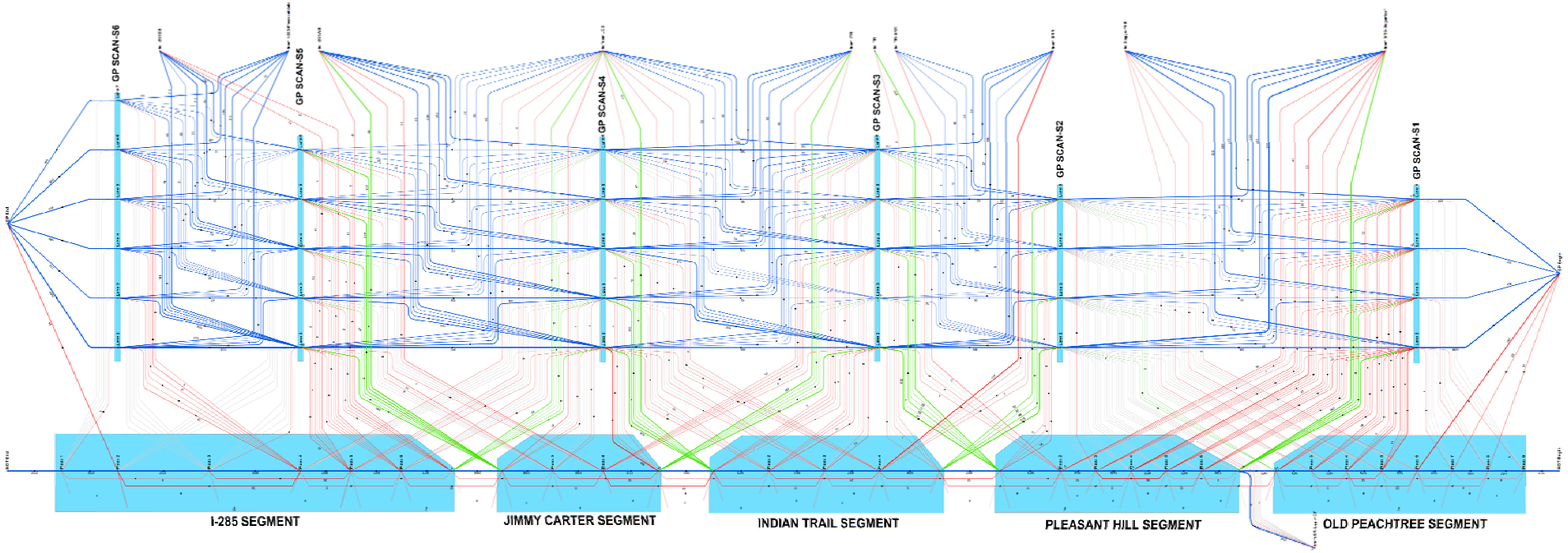


Lane Use and Value of Travel Time Savings

Sheikh, 2015

- ***Lower and higher income households use the HOT lane***
  - ***Both groups are willing to pay similar amounts per trip***
  - ***Higher income users use the lanes more frequently***
- ***Infrequent users saved more travel time and paid less for time savings (more discriminating)***
- ***GP lane congestion and trip length had largest impacts on decisions (much larger than demographics)***
- ***Toll limit in 2013 was $8.50, but users by income may respond differently to higher limits***

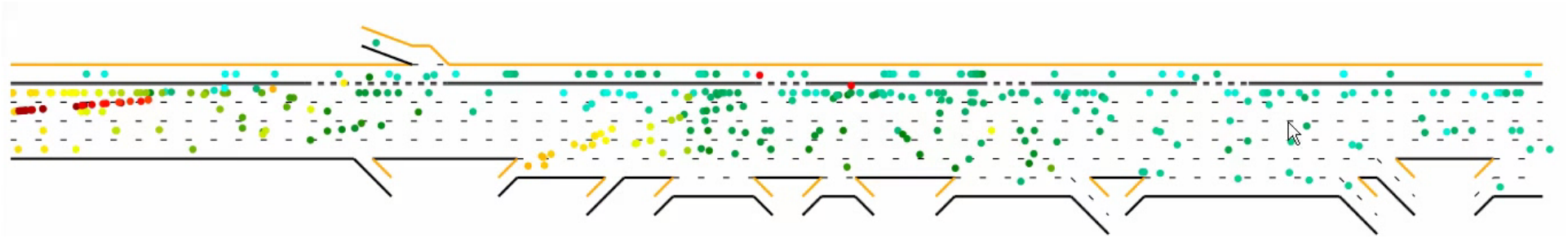
O-D Patterns, Legal and Illegal Weaving RFID Tag Reads



I-85 SOUTHBOUND EXPRESS LANES
PEACH PASS RFID TAG READS 10/24/12 6-10AM

I-85 Operations via RFID Tag Detection

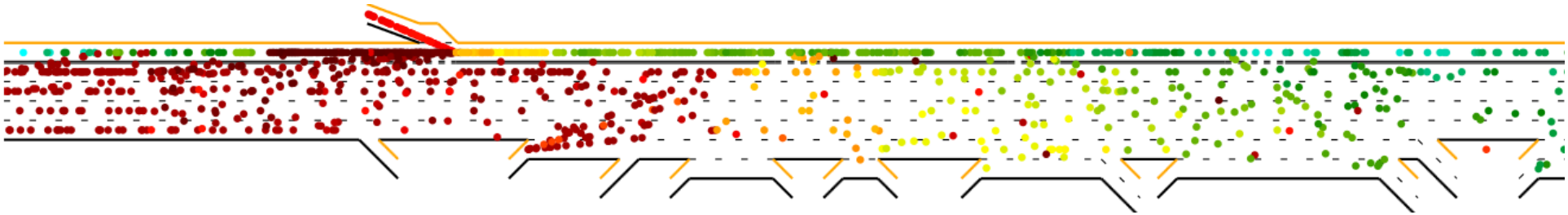
Toth, 2014



Color scale:
black - 0mph
red - 20mph
yellow - 40mph
green - 60mph
cyan - 80mph

I-85 RFID Incident Example

Toth, 2014



Color scale:
black - 0mph
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Data for Managed Lane Assessments

- ***Vehicle flow by lane (by origin-destination pair)***
- ***Speeds and travel times by lane***
- ***Variability in travel times by lane***
- ***Tolling data linked to operations data***
- ***Vehicle occupancy (person throughput)***
- ***Origin-destination patterns***
- ***User demographics (elasticities and equity considerations)***
- ***Microscale facility performance (weaving impacts)***
- ***Speed and acceleration conditions (energy and emissions)***

ARPA-E TRANSNET Project (2016-2019) High-Resolution Agent Monitoring

- ***Develop advanced systems model (simulation) to better predict energy consumption of transportation alternatives***
- ***Implement a control architecture designed to minimize surface transportation energy consumption***
  - ***Estimate energy consumption, time, and cost tradeoffs for alternative departure times, modes, and routes***
  - ***Deliver tailored messages to participants to support travel planning and demand-responsive decision making***
- ***Assess energy savings resulting from improved efficiency***

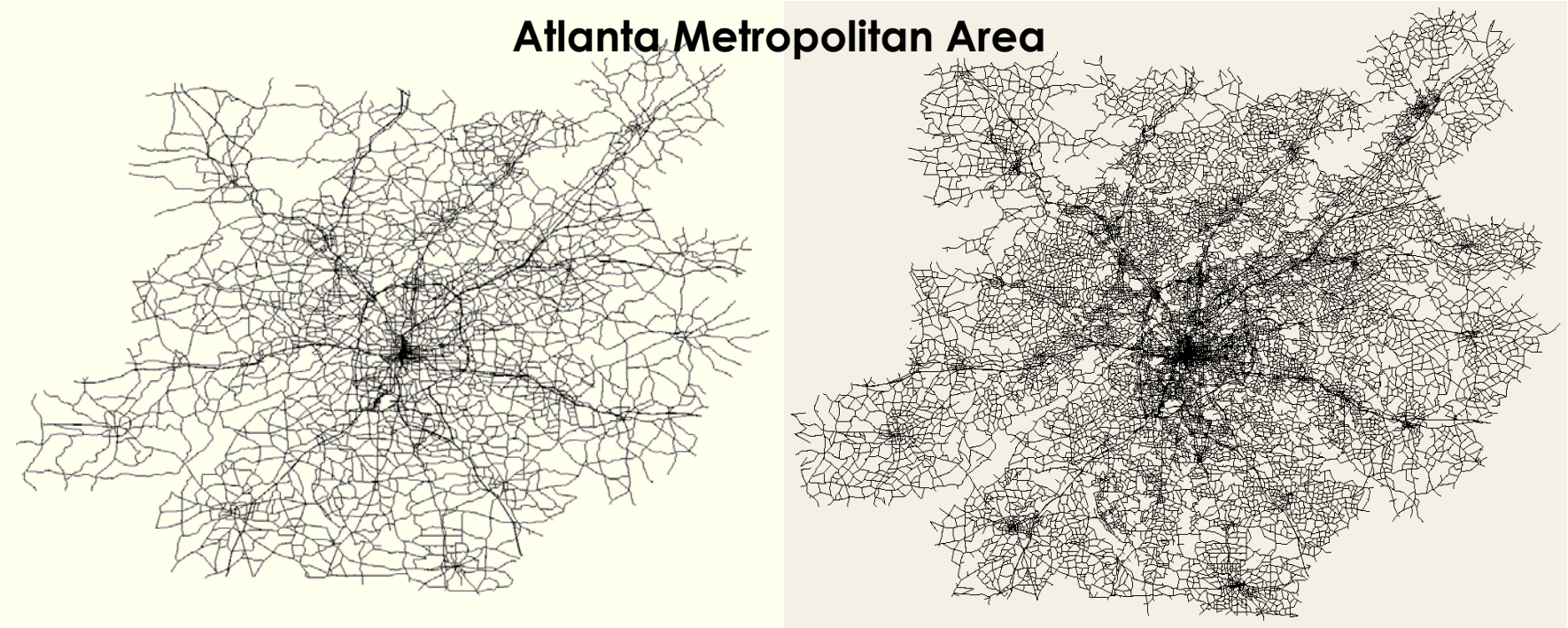
Agent Advising

- ***Present energy consumption, travel times, and costs for home-to-work peak-period Commute Alternatives***
- ***Phase I***
  - ***Alternative modes, off-peak travel, and ecodriving***
- ***Phase II***
  - ***Alternative routes using distributed simulation***
  - ***Large-scale travel demand scenarios likely to affect regional travel and congestion patterns***

Data-Driven Project

- ***Real-time, lane-specific operations data***
  - ***NaviGAtor***
  - ***Toll system data***
  - ***Transit data***
- ***Revealed origin-destination patterns and arterial speeds from AirSage cell phone tower data***
- ***Second-by-second real-time position/speed data from 40,000 volunteers via Commute Warrior smartphone app***
  - ***Recruit I-85, I-75, MARTA, and Xpress Bus Commuters***

DTA Platform Development

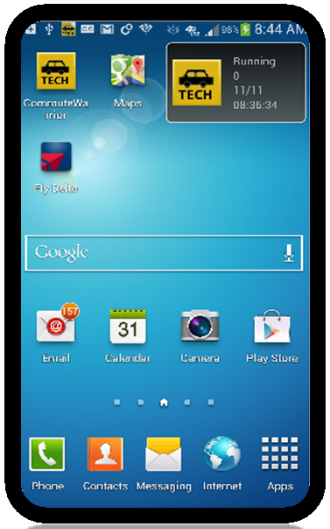


Separate regional transit simulator

Abdelghany (2016)

Commute Warrior

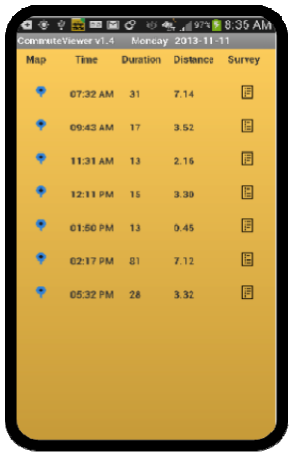
- *Background recording of travel data*
  - *Activated by acceleration sensors*
  - *Trips tracked by GPS*
  - *Sec-by-sec speed and position (real-time)*
- *Interactive surveys*
  - *Trips displayed on smartphone and Commute Warrior website*
  - *Embedded surveys for trip purpose, reasons for route choice, etc.*



Commute Warrior Travel Journal

- *Calendar view*
- *List of trips by day*
  - *Map*
  - *Time*
  - *Travel Time*
  - *Distance*
- *Map view shows trip animation with GPS speed data*

Calendar View



Trip View

Map View

Agent Monitoring and Interaction

- ***Monitored second-by-second activity***
  - ***Revealed travel behavior and O-D patterns***
  - ***Monitoring all modes***
  - ***Speed/acceleration conditions (system performance)***
- ***Observed responses to congestion, tolls, and messaging***
- ***Stated preference surveys for requested days***
- ***Generating linkages across a variety of data sources***
  - ***NaviGAtor ITS, tolling, AirSage, Commute Warrior***

Future Managed Lane Evaluation

- ***High-resolution performance monitoring data will be available to further evaluate managed lane performance in Atlanta beginning in late 2016***
- ***New data will allow the research team to assess commuter response to congestion, pricing, and agent advising***
  - ***Second-by-second system performance***
  - ***Revealed preference data***
  - ***Stated preference surveys***
- ***Simulated case studies of widespread incentives***

Takeaway Suggestions

- ***Issue free user accounts and RFID tags***
- ***Install general purpose lane RFID tag readers***
- ***Place tag readers at key locations for O-D observation***
- ***Monitor and archive corridor operations data by lane***
- ***Monitor for destructive weaving patterns and respond***
- ***Conduct license plate studies***
- ***Review toll database structures (for use in analyses)***
- ***Consider monitoring volunteers for travel activity***
- ***Conduct stated preference studies***

Sources for Today's Presentation

- ***Primary Before-After Assessment:***
  - ***Guensler, R., et al. (2013). Atlanta I-85 HOV-to-HOT Conversion: Analysis of Vehicle and Person Throughput. Prepared for the Georgia Department of Transportation***

- ***Georgia Tech Dissertations:***
  - ***Sheikh, A. (2015). Consumer Response to Road Pricing: Operational and Demographic Effects***
  - ***Toth, C. (2014). Empirical Study of the Effect of Off-ramp Queues on Freeway Mainline Traffic Flow***
  - ***Khoeini, S. (2014). Modeling Framework for Socio-economic Analysis of Managed Lanes***