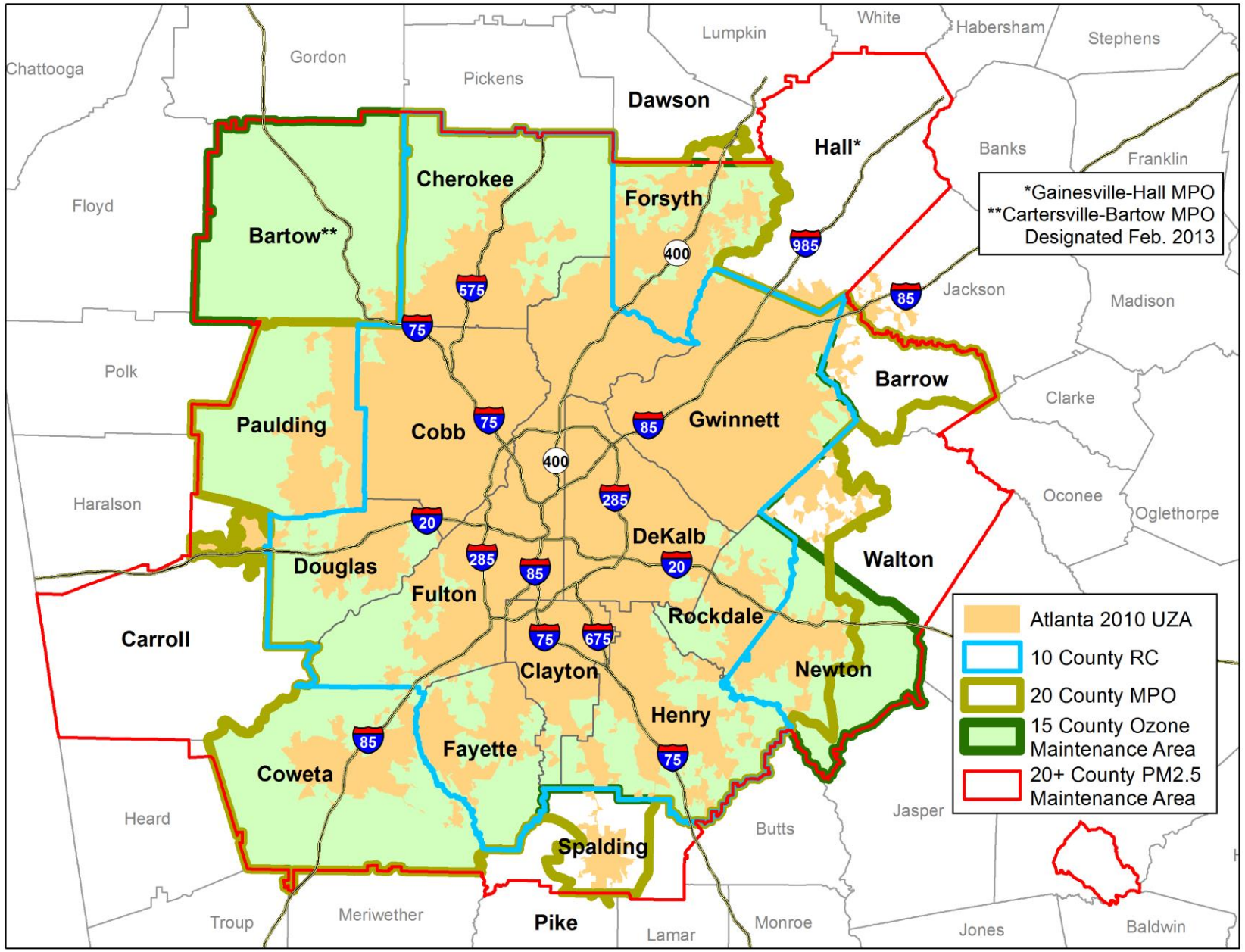
Model Development & Applications at the Atlanta Regional Commission for Transportation Planning

Guy Rousseau, Atlanta Regional Commission

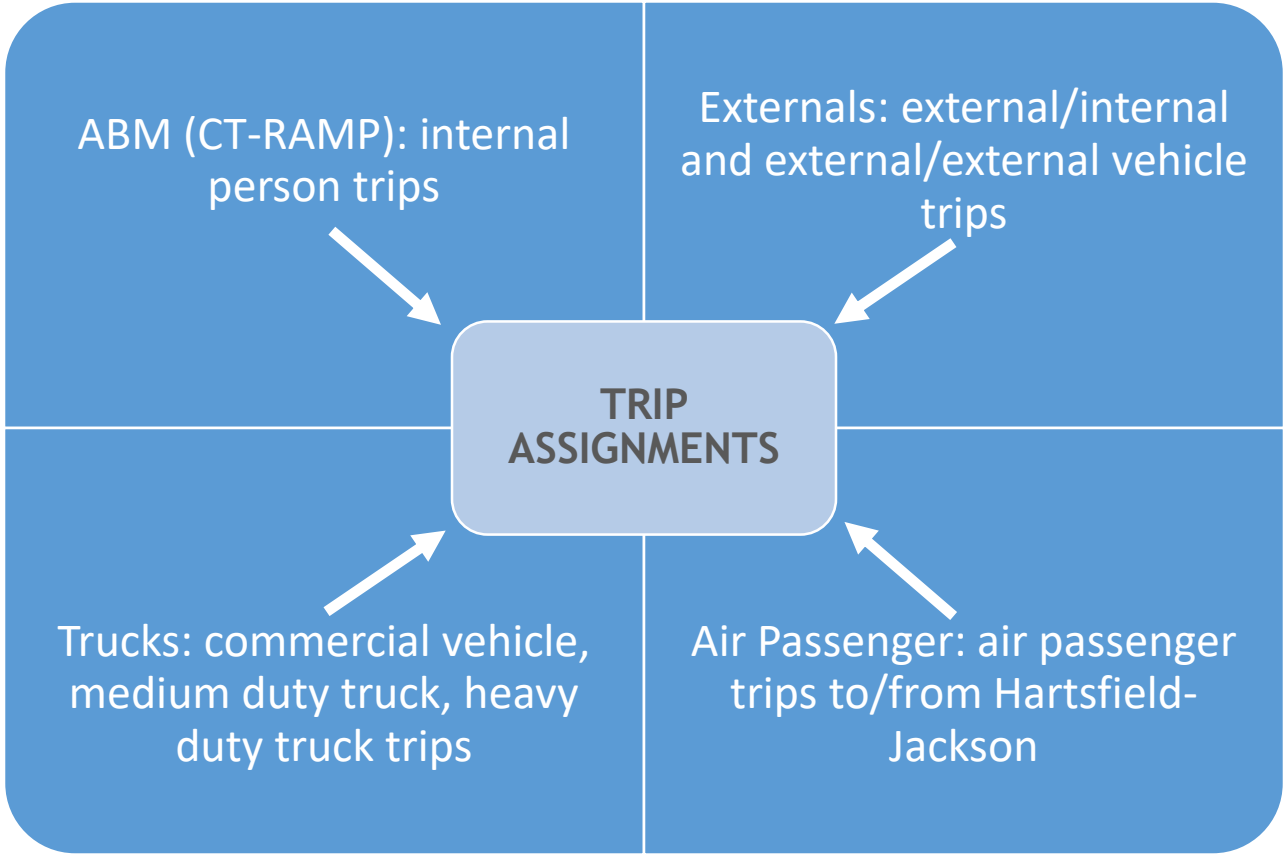
FDOT District 4 Southeast Florida FSUTMS Users Group Meeting

Friday September 14 2018

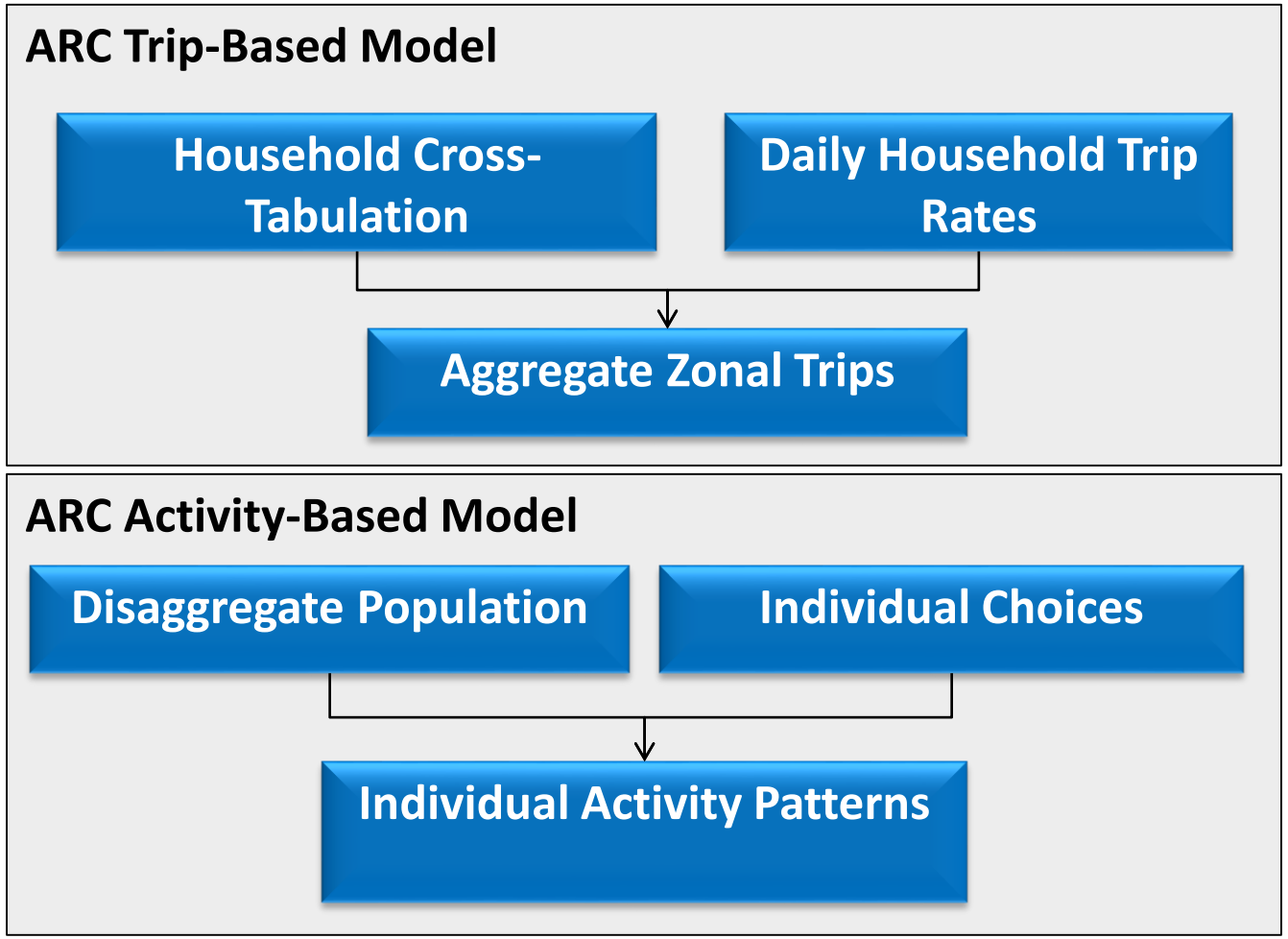
ARC Modeling & Planning Boundaries



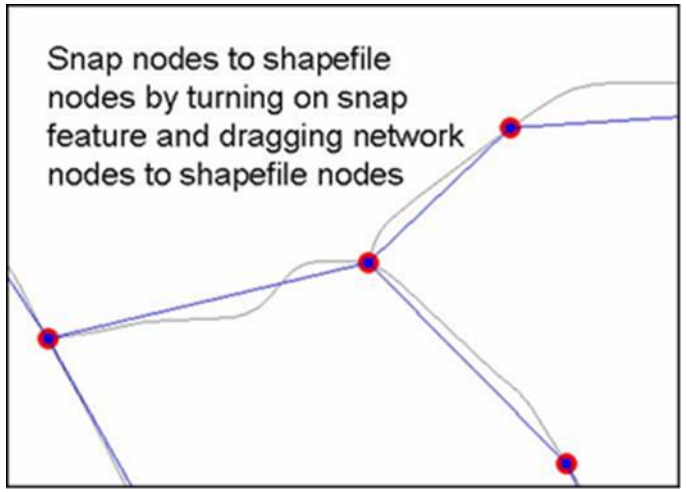
ARC ABM Components

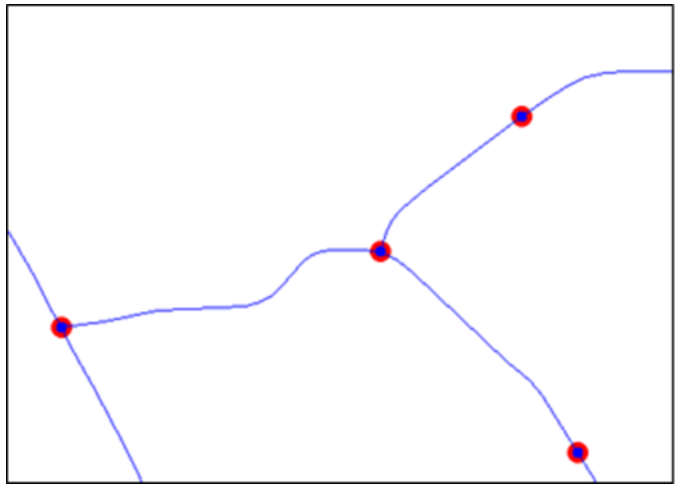


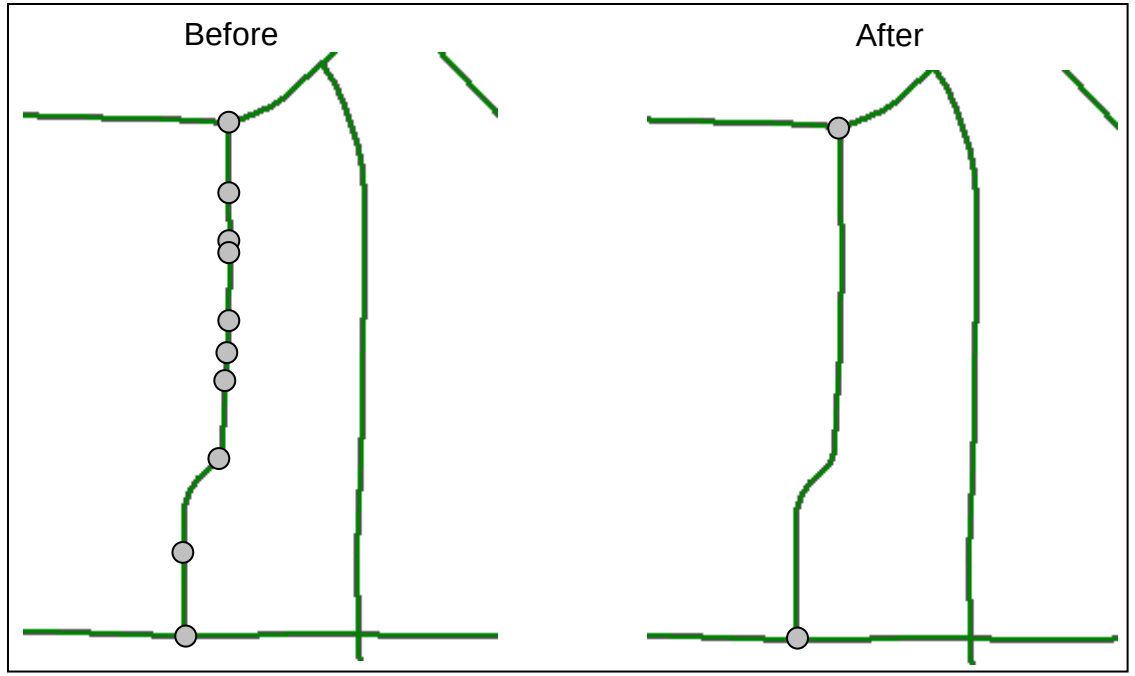
ARC Modeling Evolution for Transportation Planning



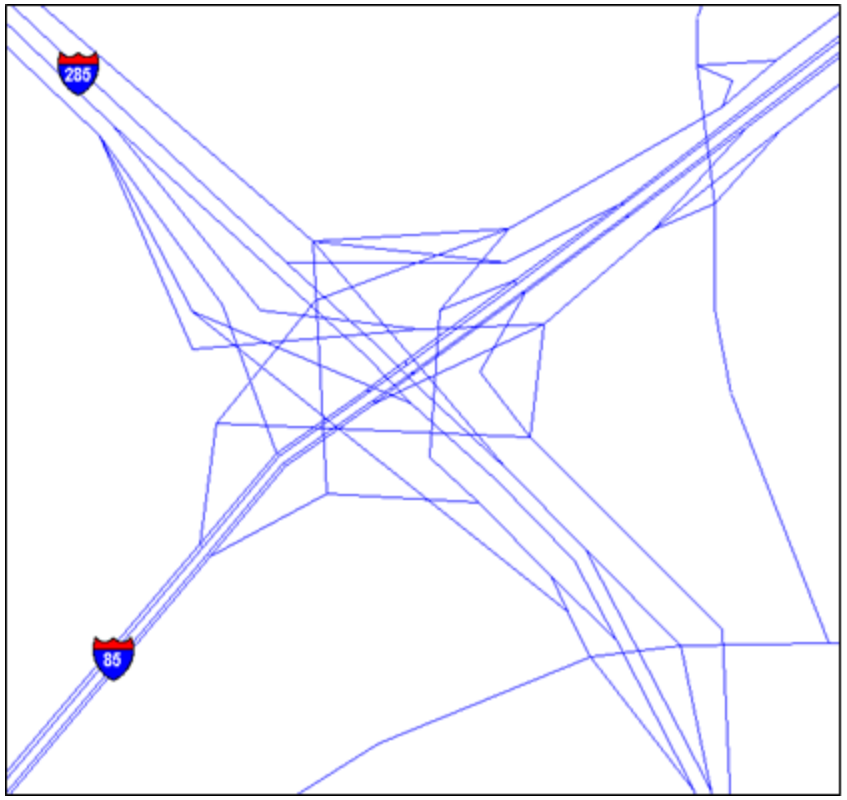
ARC ABM True-Shape Display & Network Conflation

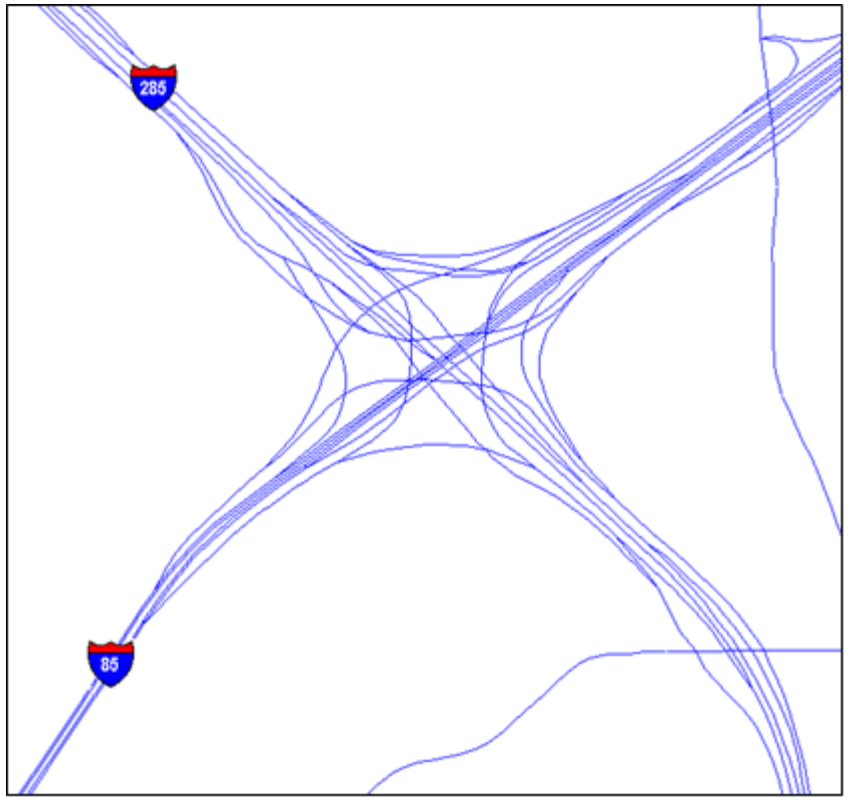






Network Coding Evolution: from a Trip-Based "Stick" Network to an ABM Conflated Network





Server Specs to Efficiently Run the ARC ABM

Server	Physical cores	Logical cores	CPU	RAM	Harddrive Capacity
Main/Node 1	48	96	Intel Xeon E5-4657L v2 @ 2.40GHz	448 GB	1.6 TB
Node 2	48	96	Intel Xeon E5-4657L v2 @ 2.40GHz	192 GB	1 TB

Atlanta's Activity-Based Model (ABM) Person Types

NUMBER	PERSON-TYPE	AGE	WORK STATUS	SCHOOL STATUS
1	Full-time worker	18+	Full-time	None
2	Part-time worker	18+	Part-time	None
3	Non-working adult	18 – 64	Unemployed	None
4	Non-working senior	65+	Unemployed	None
5	College student	18+	Any	College +
6	Driving age student	16-17	Any	Pre-college
7	Non-driving student	6 – 16	None	Pre-college
8	Pre-school	0-5	None	None

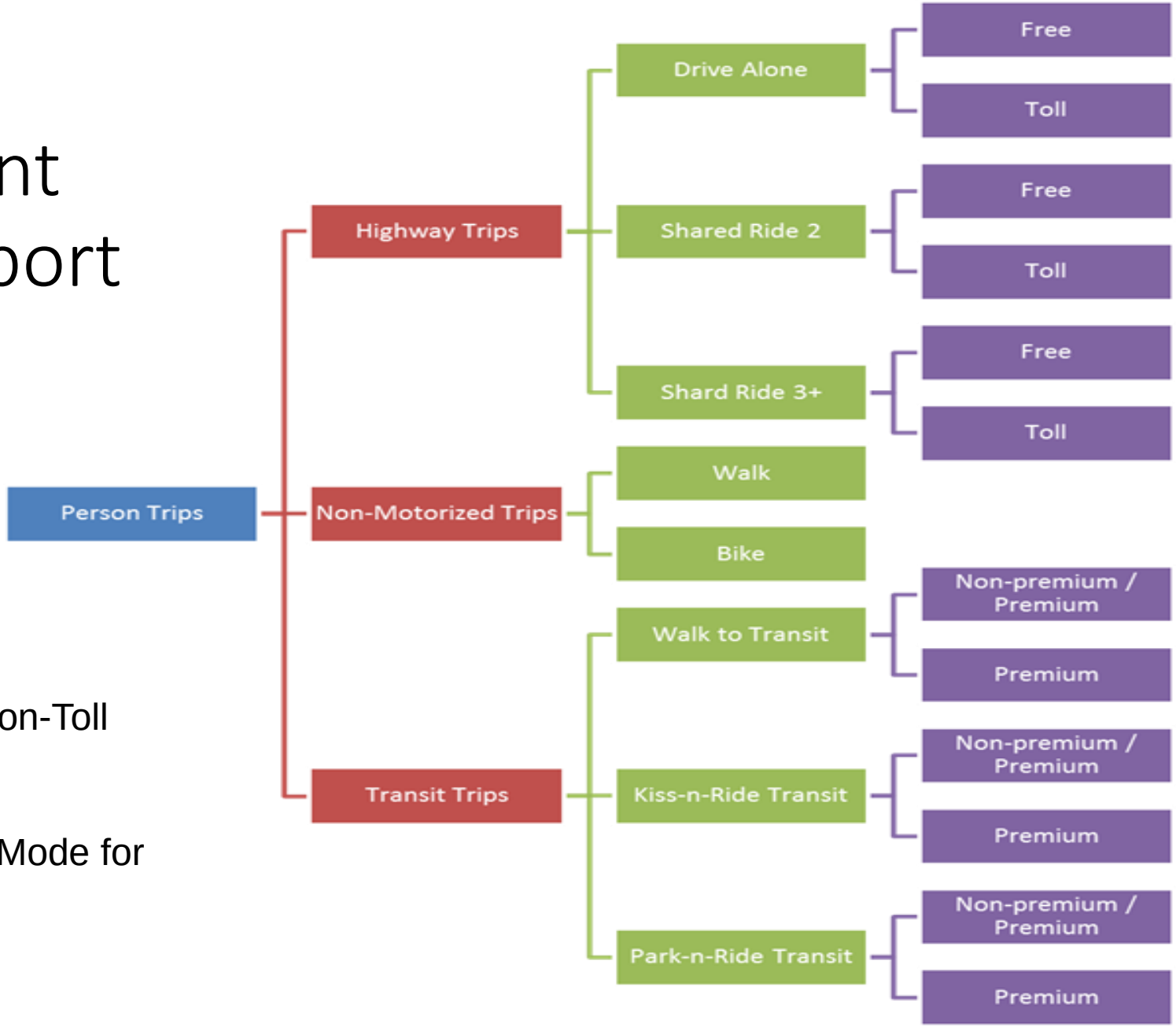
Atlanta's Activity-Based Model (ABM) Activity Types

TYPE	PURPOSE	DESCRIPTION	CLASSIFICATION	ELIGIBILITY
1	Work	Working at regular workplace or work-related activities outside the home.	Mandatory	Workers and students
2	University	College +	Mandatory	Age 18+
3	High School	Grades 9-12	Mandatory	Age 14-17
4	Grade School	Grades K-8	Mandatory	Age 5-13
5	Escorting	Pick-up/drop-off passengers (auto trips only).	Maintenance	Age 16+
6	Shopping	Shopping away from home.	Maintenance	5+ (if joint travel, all persons)
7	Other Maintenance	Personal business/services, and medical appointments.	Maintenance	5+ (if joint travel, all persons)
8	Social/Recreational	Recreation, visiting friends/family.	Discretionary	5+ (if joint travel, all persons)
9	Eat Out	Eating outside of home.	Discretionary	5+ (if joint travel, all persons)
10	Other Discretionary	Volunteer work, religious activities.	Discretionary	5+ (if joint travel, all persons)

Atlanta's Activity-Based Model (ABM) Time of Day Periods

NUMBER	DESCRIPTION	BEGIN TIME	END TIME
1	Early	3:00 A.M.	5:59 A.M.
2	A.M. Peak	6:00 A.M.	9:59 A.M.
3	Midday	10:00 A.M.	2:59 P.M.
4	P.M. Peak	3:00 P.M.	6:59 P.M.
5	Evening	7:00 P.M.	2:59 A.M.

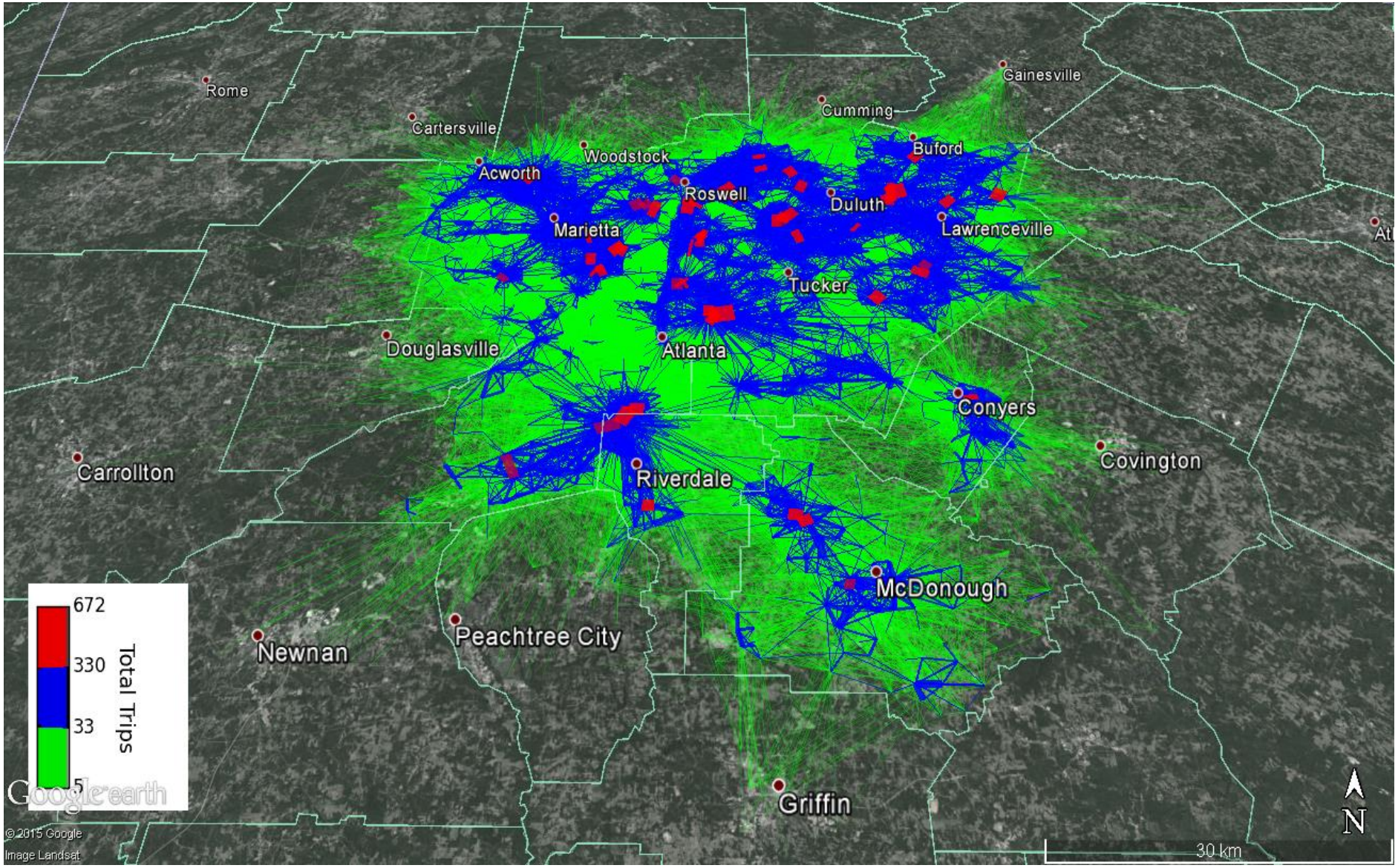
Atlanta's Treatment of Transport Modes



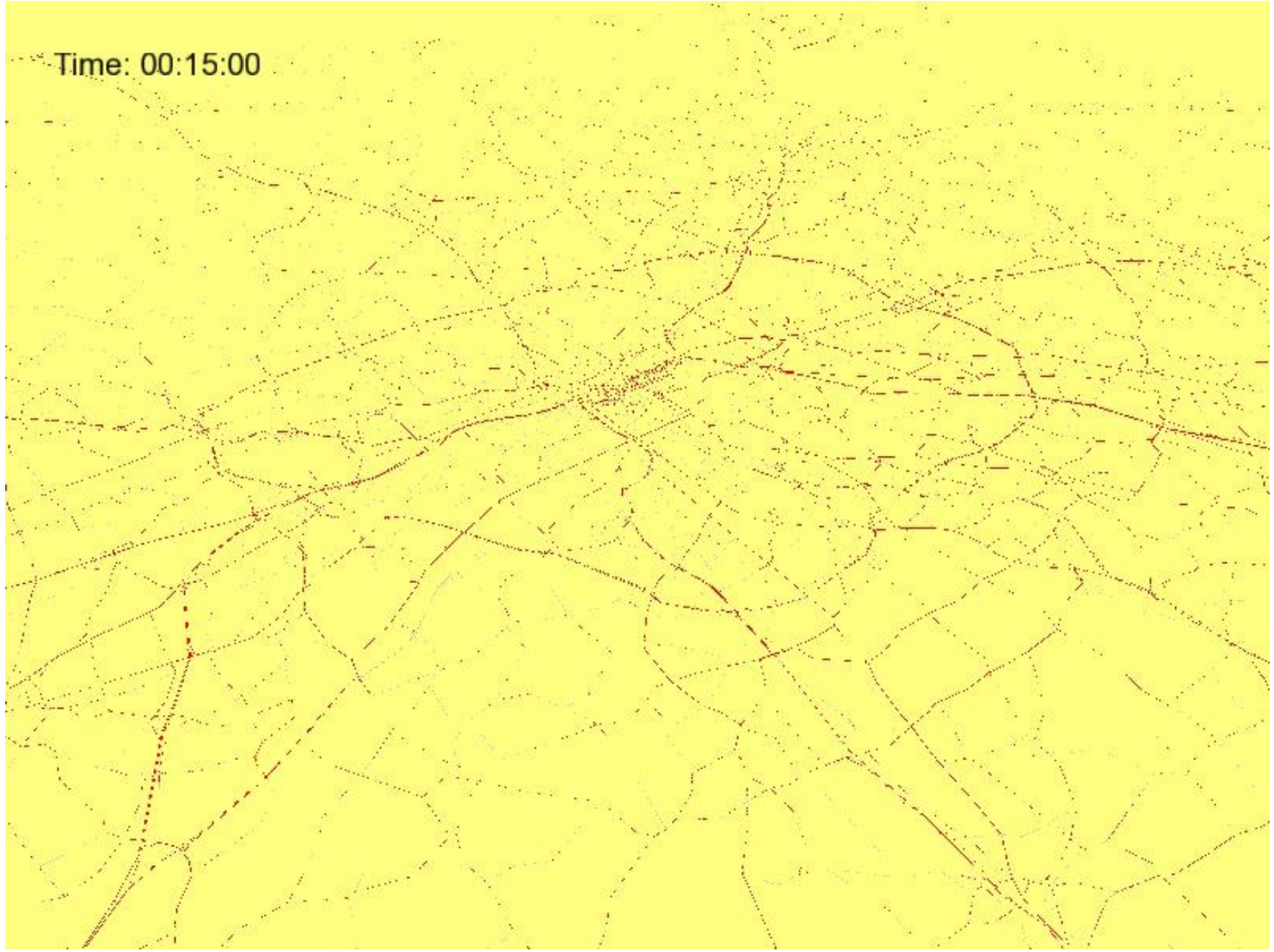
- Explicit Toll versus Non-Toll Choice in Mode Split

- School Bus is a Trip Mode for Traffic Assignment

Atlanta's Single-Occupant Vehicles Origin-Destination Desire Lines



Atlanta’s Traffic Assignment Animation via Transims Router

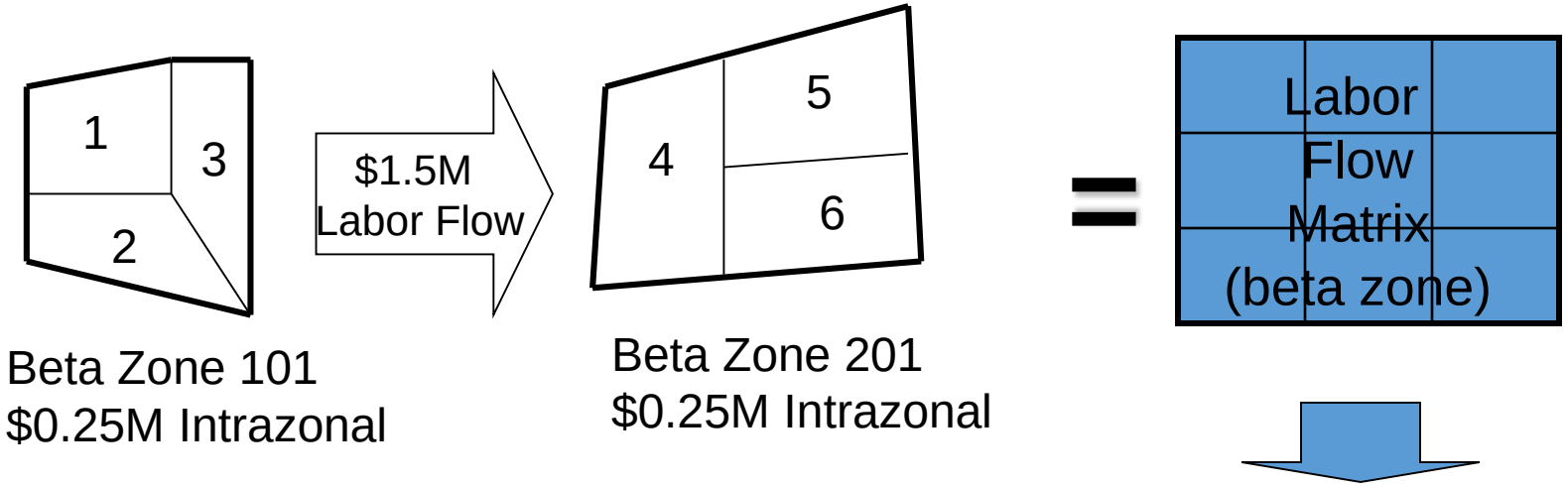


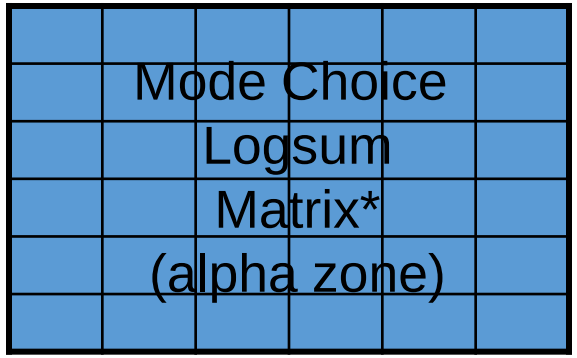
Atlanta's Integrated Transport/Land Use Model

- 2 Types of Linkages:
  - *Connection*: Feeding Land-Use Model Estimates of Population and Employment to ABM
  - *Integration*: Leveraging Labor Flows from Spatial Input-Output Model (PECAS) to Determine Workplace Location Choice

Atlanta's Integrated Transport/Land Use Model

Workplace Location Choice Example





	1	2	3	4	5	6
1	0.06	0.34	0.35	0.19	0.01	0.04
2	0.09	0.17	0.03	0.08	0.34	0.30
3	0.07	0.21	0.16	0.21	0.14	0.20
4	0.11	0.14	0.22	0.21	0.25	0.07
5	0.17	0.07	0.02	0.31	0.18	0.27
6	0.20	0.19	0.21	0.20	0.14	0.06

$ Production (alpha)

$ Consumption (alpha)

*The Mode Choice Logsum matrix take into account the time and cost of travel by all modes of transportation, according to traveler perceptions about the importance of the attributes of each mode, as well as non-included attributes that affect the probability of taking each mode between each origin-destination pair.

Land Use Model (PECAS) to Activity-Based Model (ABM) Integration:

- On the Land Use Side:
  - ABM Takes Employment Projections from PECAS as Part of its Inputs
  - Returns Accessibility Measures to PECAS once it Forecasts Travel Demand

Goals of Land Use Model (PECAS) to Activity-Based Model (ABM) Integration:

- Small Area (TAZ) Land Use Estimates for Use in Destination Choice Models
  - Employment for 20 Industrial Classifications
  - Total Households
- Synthetic Population Control Totals
  - Household by Size and Income (TAZ Control)
  - Workers by Occupation (LUZ Control)

Reality of Land Use Model (PECAS) to Activity-Based Model (ABM) Integration:

- PECAS Small Area Forecasts may be Adjusted due to:
  - Consultation with Local Jurisdictions
  - Forecast Overrides to Correct for Incomplete Base Year Parcel Data

Activity-Based Model (ABM) to Land Use Model (PECAS) Integration:

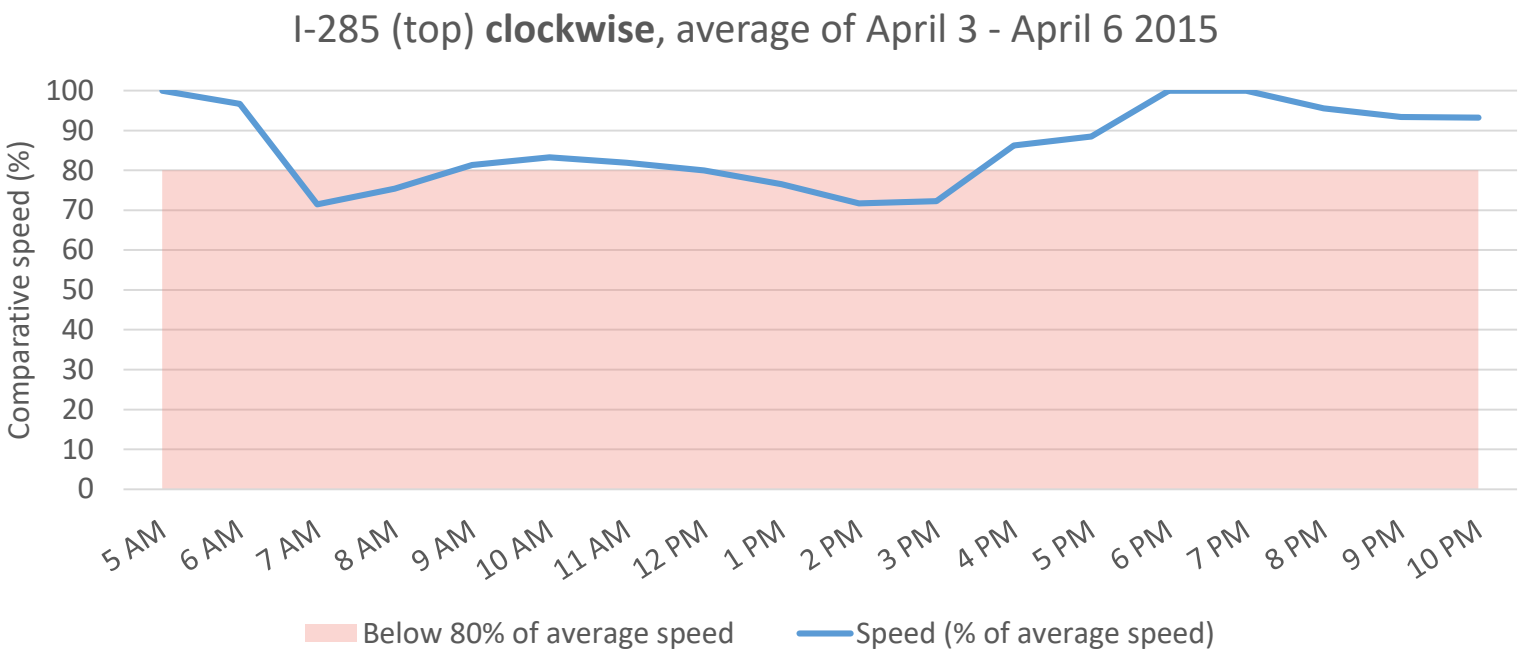
- LUZ (Land Use Zone) to LUZ Accessibilities:
  - Work Location Mode Choice Logsums
  - Impedances (Travel Times, Distances, Tolls)

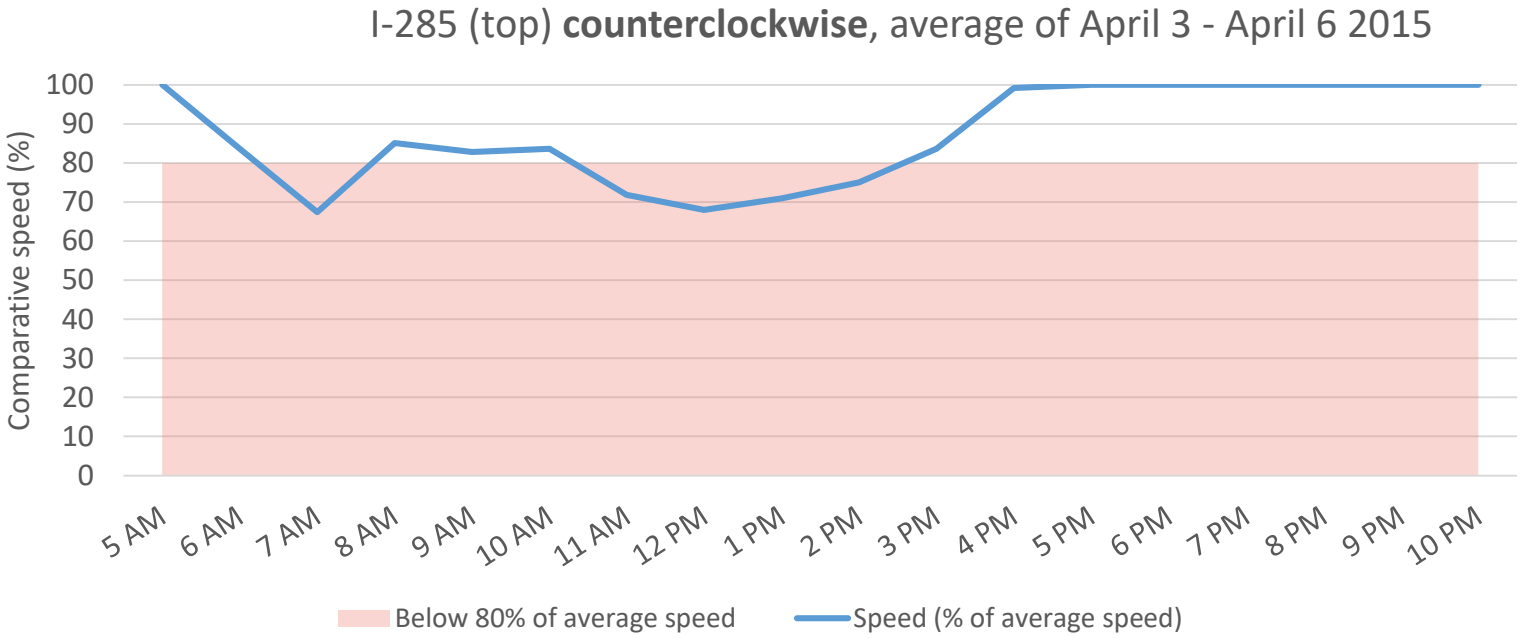
Model Applications and Corridor Analysis Data Tools with INRIX & Data

- Comparative travel speed: measured as a percentage of average speed for that day/time
- Using 2015 INRIX Data
- Freeway Corridors (Interstate and State Routes)
- Regionally Significant Corridors (Arterials)

Corridor: I-285 (top end)

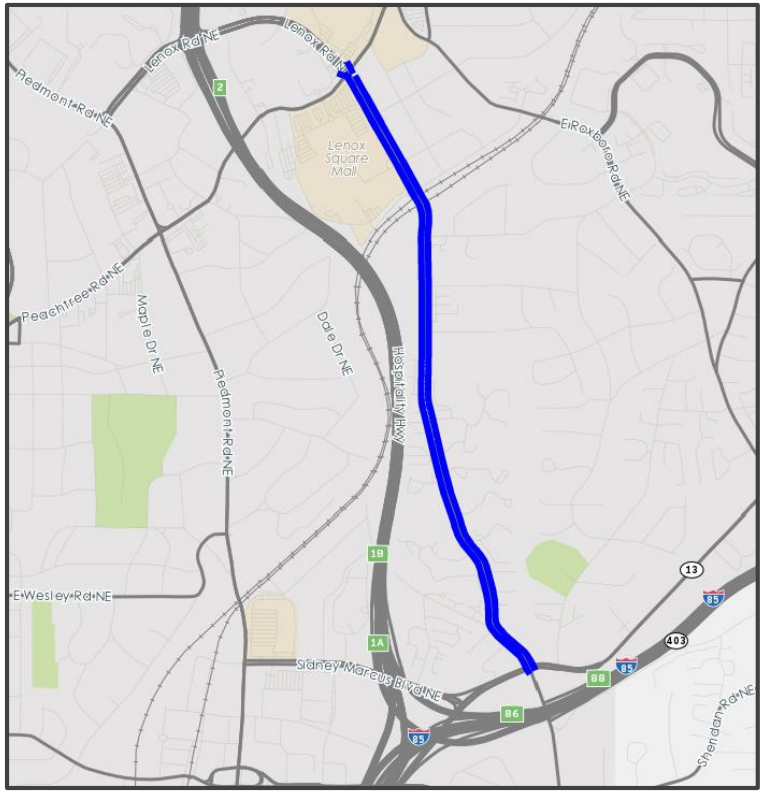
- The **blue line** in the chart shows **comparative speed**, which is the speed of traffic for that time measured as a percentage of historic average speed for that day/time.
- For example, if "normal" traffic speed is 40mph, 100% would represent 40 mph and 50% would represent 20 mph
- The **red area** on the chart highlights where speed has dropped **below 80 percent** of historic average speed.

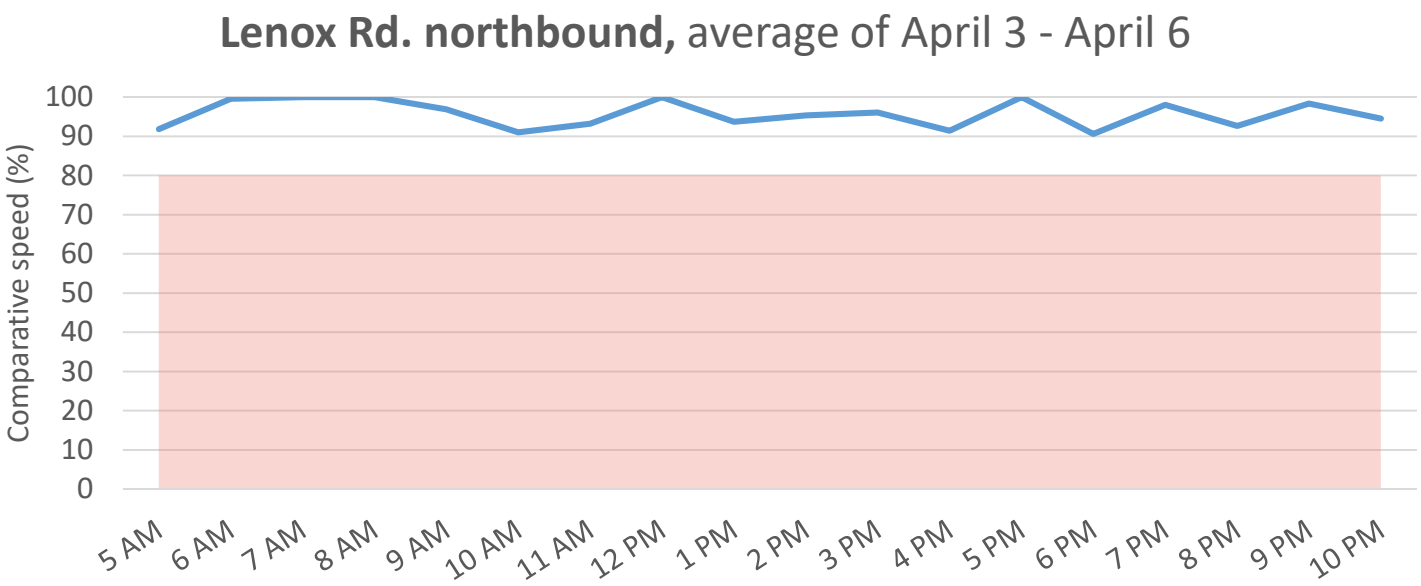


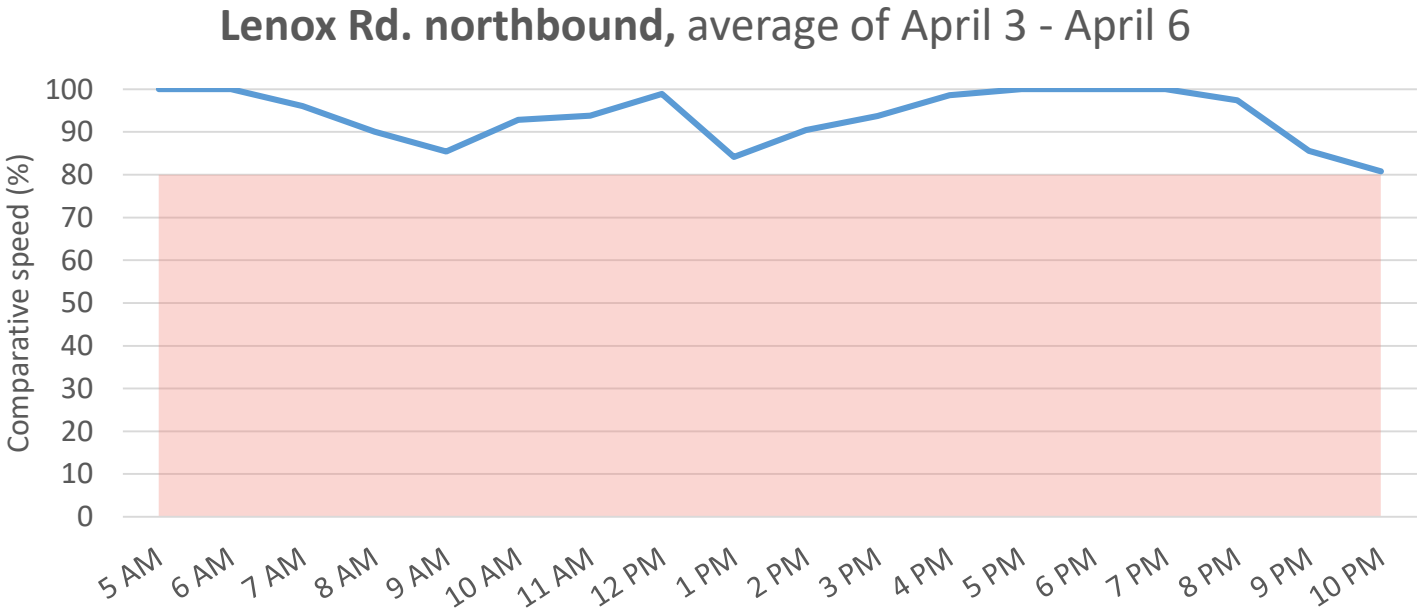


Corridor: Lenox Rd

- The **blue line** in the chart shows **comparative speed**, which is the speed of traffic for that time measured as a percentage of historic average speed for that day/time.
- For example, if “normal” traffic speed is 40mph, 100% would represent 40 mph and 50% would represent 20 mph
- The **red area** on the chart highlights where speed has dropped **below 80 percent** of historic average speed.





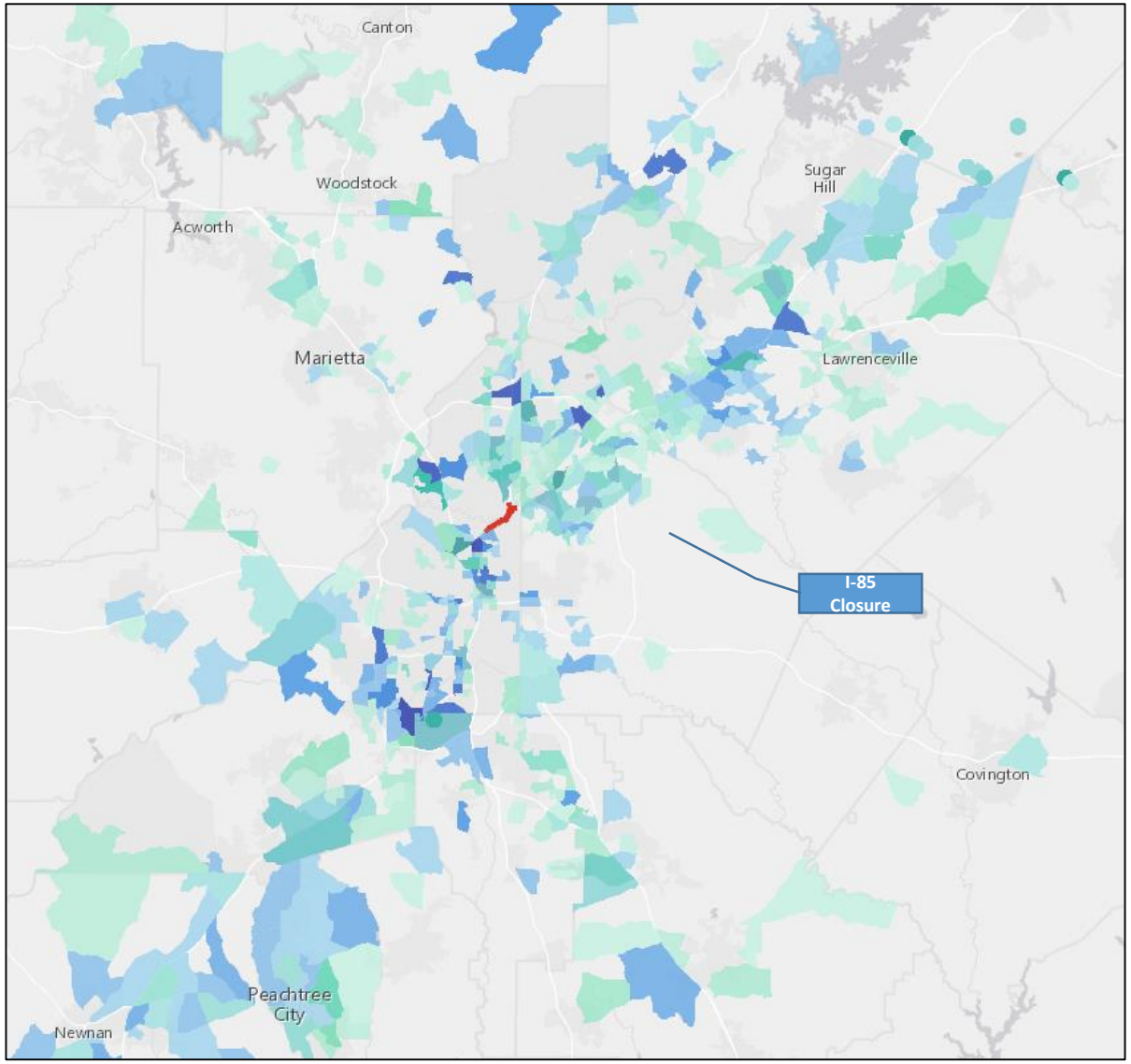


March 30 2017
I-85 Bridge Collapse Travel Patterns Analysis with Streetlytics Data

I-85 Bridge Collapse

- ***March 30 2017***: Fire underneath I-85 NB caused the bridge to collapse and altered the commutes for hundreds of thousands of commuters.
- Around ***250,000*** trips go through the impacted area each weekday.
- Eastern half of the I-285 perimeter impacted the most, but travel was impacted all throughout the region, with a minimum of ***30%*** increase in volumes across network.
- Many MARTA stations, especially those in the northern part of the region, have experienced large ***increases*** in ridership after the bridge collapse.
- ***75%*** of the businesses in the area have experienced a loss of customers due to the collapse.
- ***Bridge reopened on May 15, 6 weeks later*** …

Who travels on I-85?



http://arcg.is/0LC1mW

- The affected area on I-85 is a critical link in the transportation network
- In the morning travel period, trips routinely flow from as far south as Newnan and from as far north as Cumming (Data source: Streetlytics)

Trip Origins

- > 1,000 to 2,500
- > 675 to 1,000
- > 325 to 675
- > 200 to 325
- > 150 to 200
- > 100 to 150
- > 50 to 100
- > 25 to 50
- > 8 to 25
- 0 to 8

Trip Destinations

- > 1,000 to 2,500
- > 675 to 1,000
- > 325 to 675
- > 200 to 325
- > 150 to 200
- > 100 to 150
- > 50 to 100
- > 25 to 50
- > 8 to 25
- 0 to 8

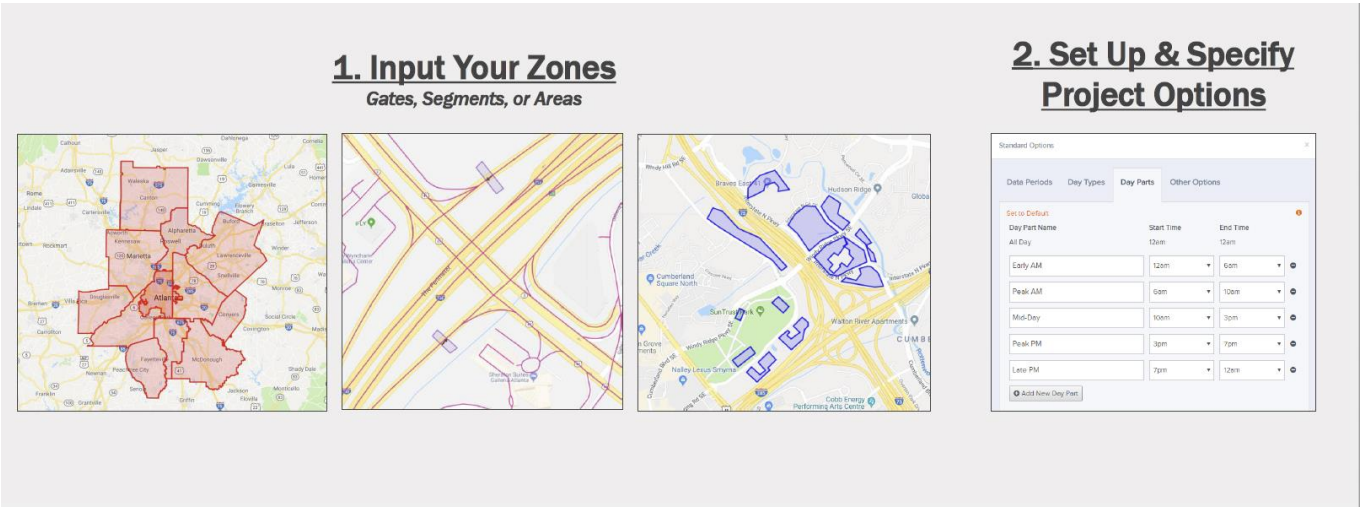
Green = trip origins
Blue = trip destinations

Externals Model Update with Airsage Data

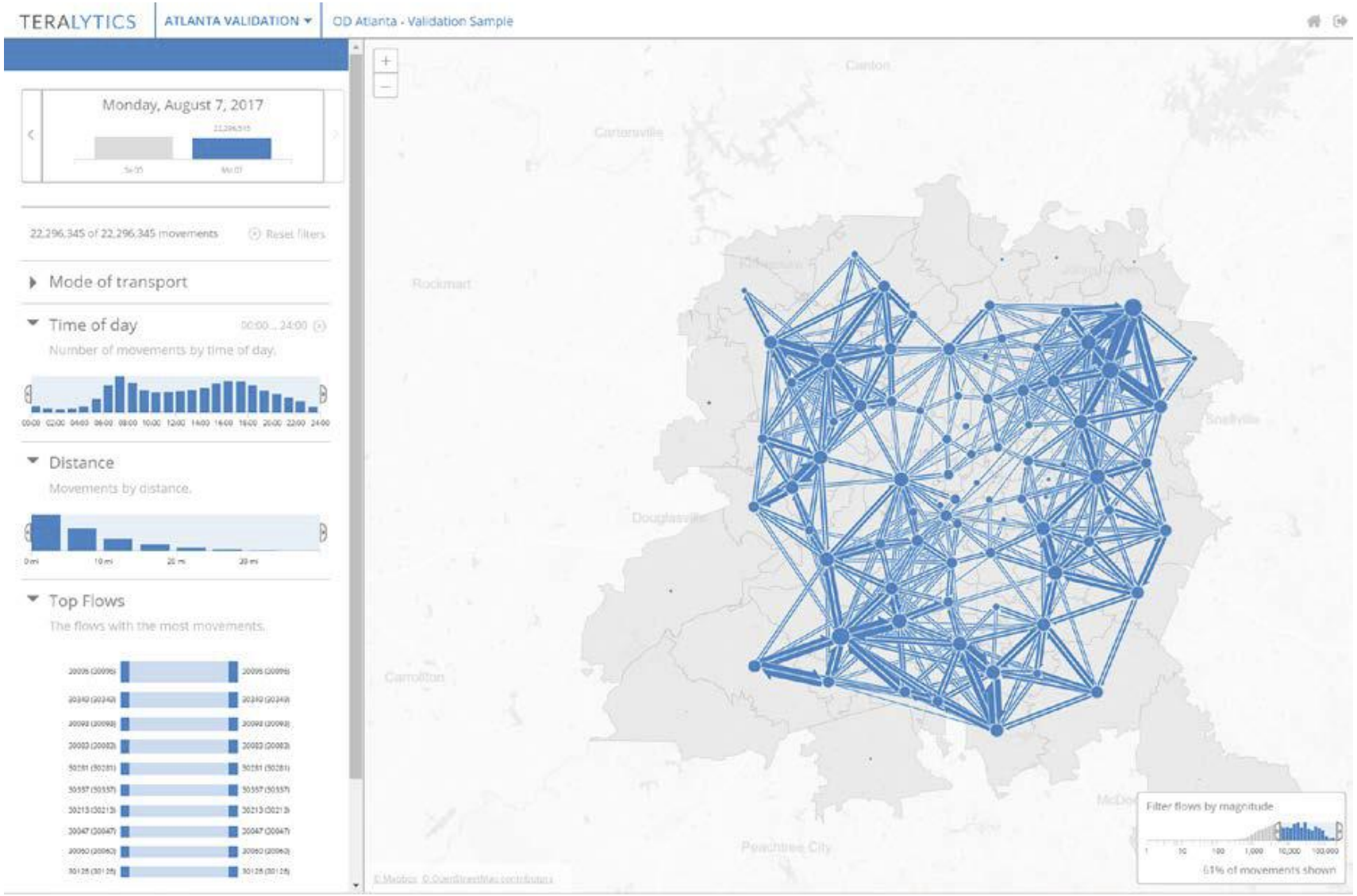
- Work is currently underway
- Airsage Data Processing & External Model Update Methodology
  - Define Zone Structure
  - Create Equivalencies between External Stations and External County Zones (multiple stations will fall within an external county zone)
  - Comparison of OD Trips to Traffic Counts as Validation of Data Integrity
  - Factor External OD Trips to Match Traffic Counts & Verify Travel Patterns
  - Data Disaggregation by Time Period, then Convert from OD to PA Format
  - Assign Disaggregated OD Trips to Highway Network and Perform Additional Validation of Data Integrity
  - Trip Generation & Compute Accessibility Terms to External Stations
  - Trip Distribution & Prepare Average Trip Length Targets & Frequency Curves for Calibration, then Calibrate Friction Factors to Match Observed Trip Lengths & Frequency Curves

I-285 @ GA-400 Interchange Reconstruction Commute Options with Streetlight Data

- Goal: Better Understand Travel Behavior Using Origins and Destinations with Select Links for Different Employment Centers
  - Trip Duration &TLFD
  - Commercial Trips & Personal Trips
  - Provide Alternative Commute Options to Travelers Affected by Interchange Reconstruction

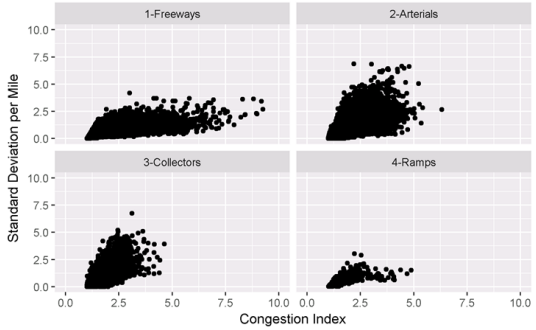


Regional Origin-Destination Analysis with Teralytics Data (Work NOT yet Underway)



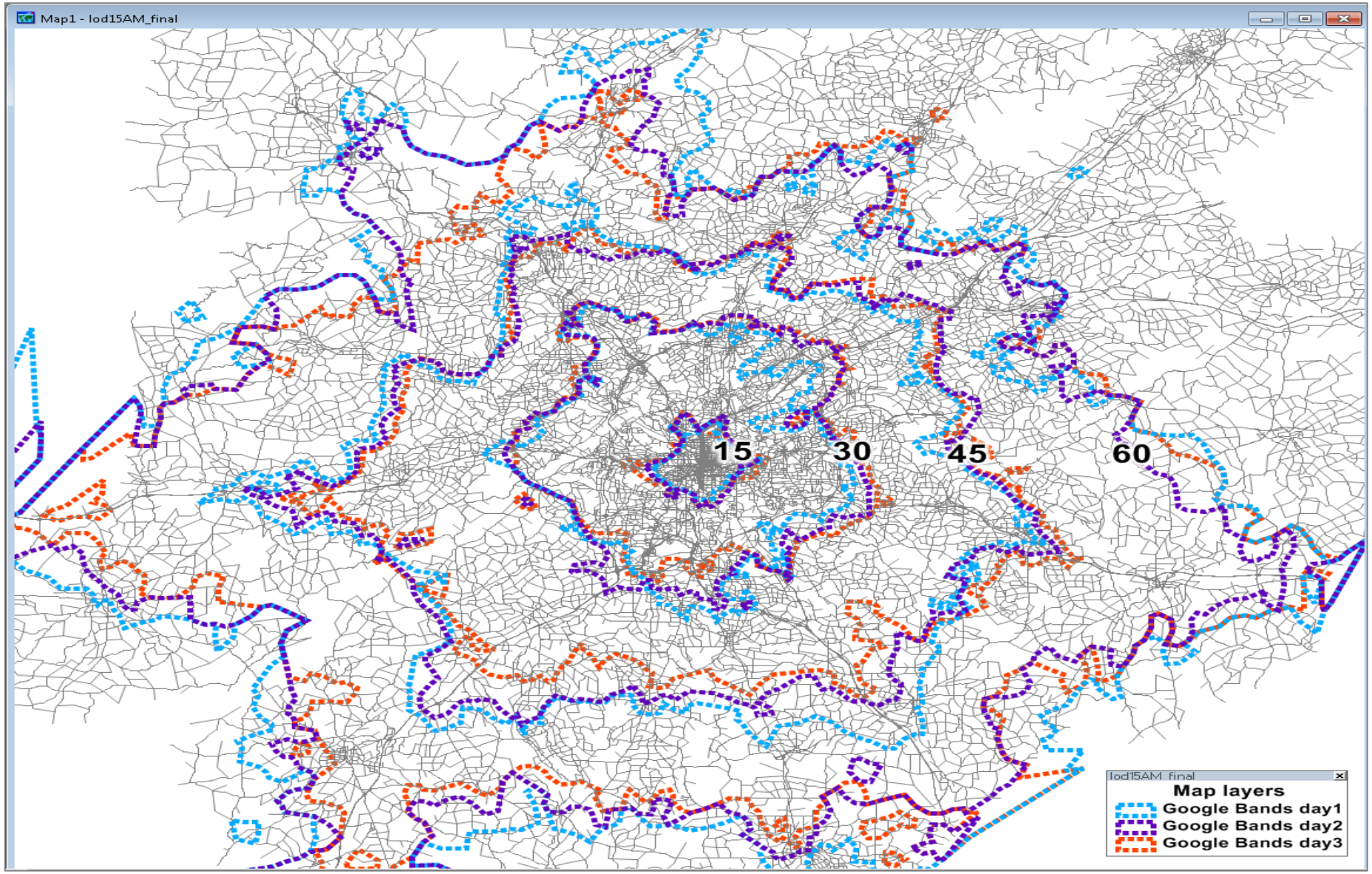
~~VDF~~ Volume-Delay-Reliability Functions (SHRP2 L04) with NPMRDS Data

- Roadway link-level reliability measures were estimated to establish VDRF functions to replace the standard VDFs in highway assignment
- Functions fully segmented by link function class types
  - Freeways
  - Arterials
  - Collectors/locals
  - Ramps

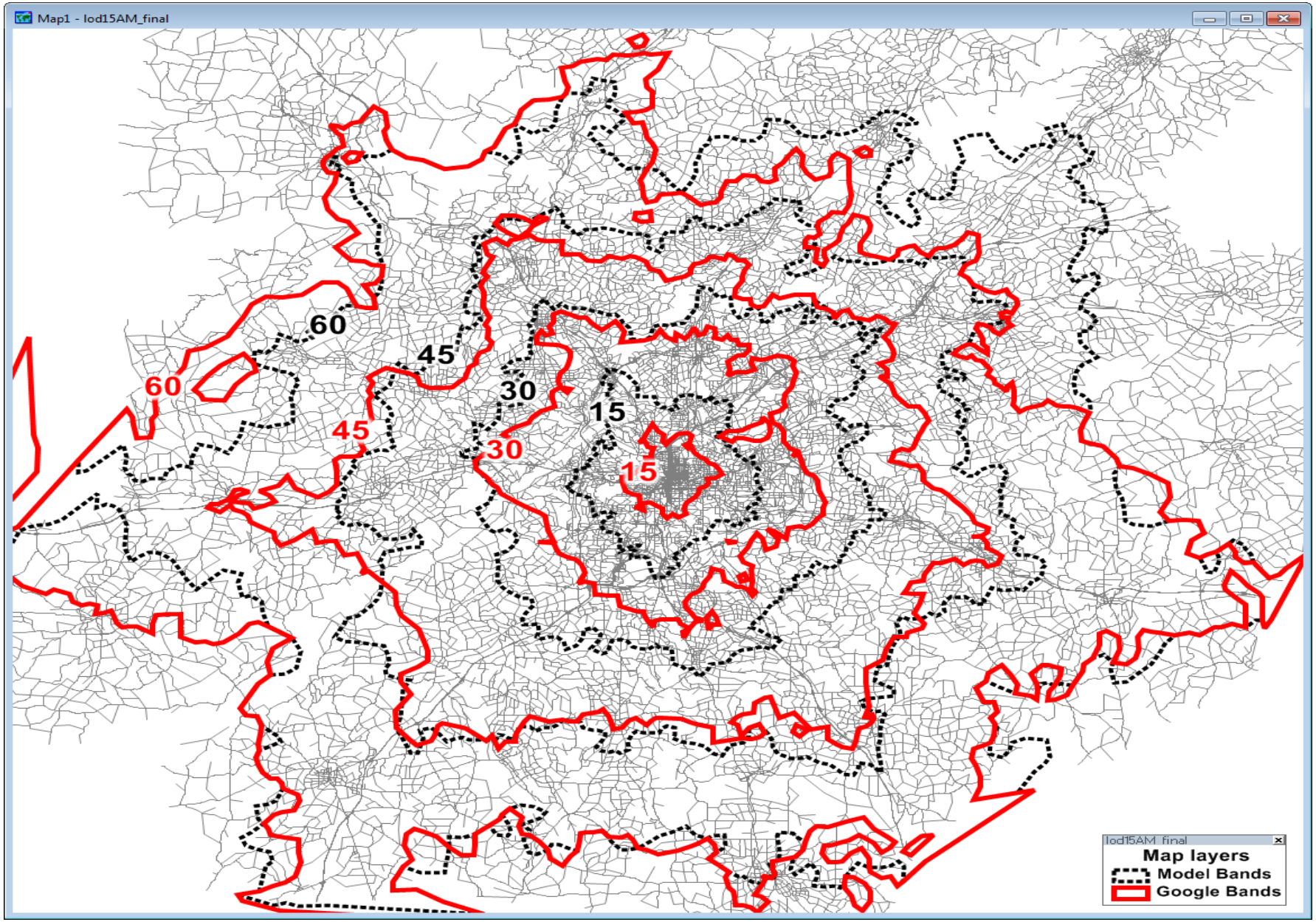


- Standard Deviation (SD) of travel time per mile is the explored dependent variable.
- The main independent (explanatory) variable was Congestion Index (CI) which is a ratio of average travel time to free-flow time

AM Peak Google-Based Travel Times to Atlanta CBD (for 3 different days)



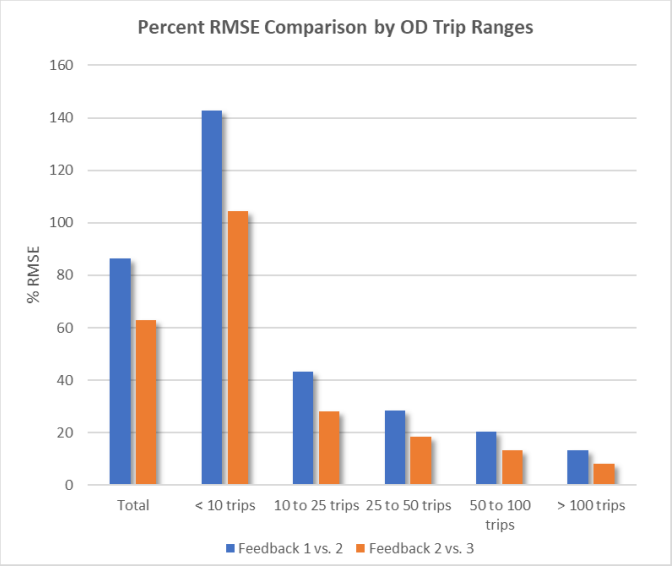
AM Peak Travel Times to Atlanta CBD

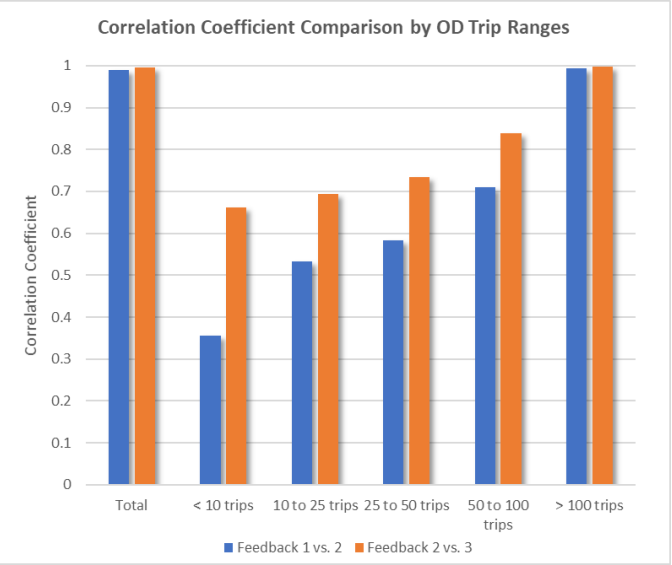


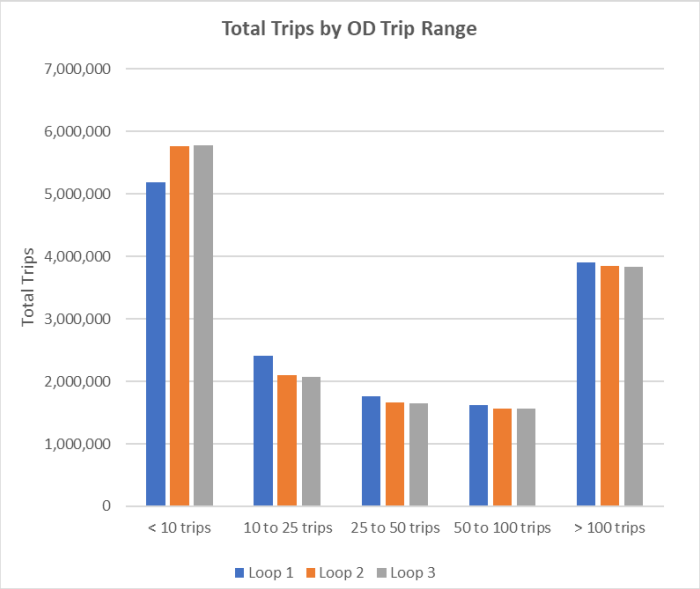
ARC ABM Sensitivity Testing

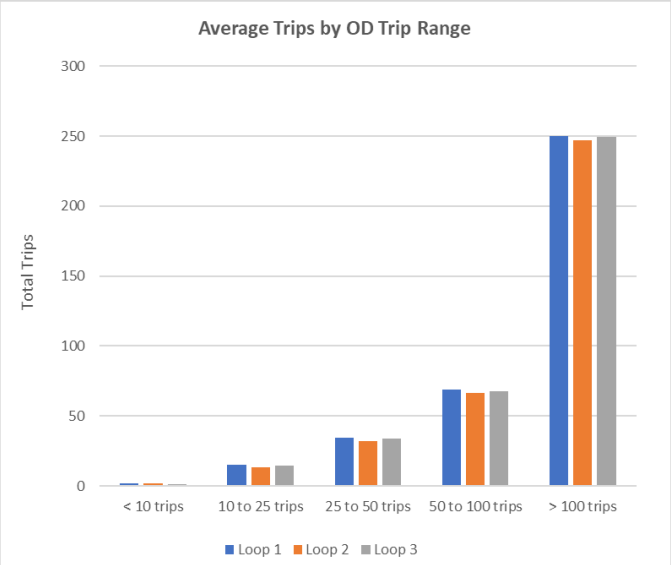
Grouping	No.	Description	Incorporation
Highway Capacity	1	1/2 base capacity	Cube script
	2	Base capacity	
	3	2x base capacity	
Transit Fare	4	No fare	UEC
	5	1/2 base fare	
	6	Base fare	
	7	2x base fare	
Fuel Cost	8	1/2 base fuel cost	UEC / Cube script
	9	Base fuel cost	
	10	2x base fuel cost	
Transit IVTT	11	95% base transit IVTT	UEC
	12	Base transit IVTT	
	13	105% base transit IVTT	

Trip Table Convergence Check





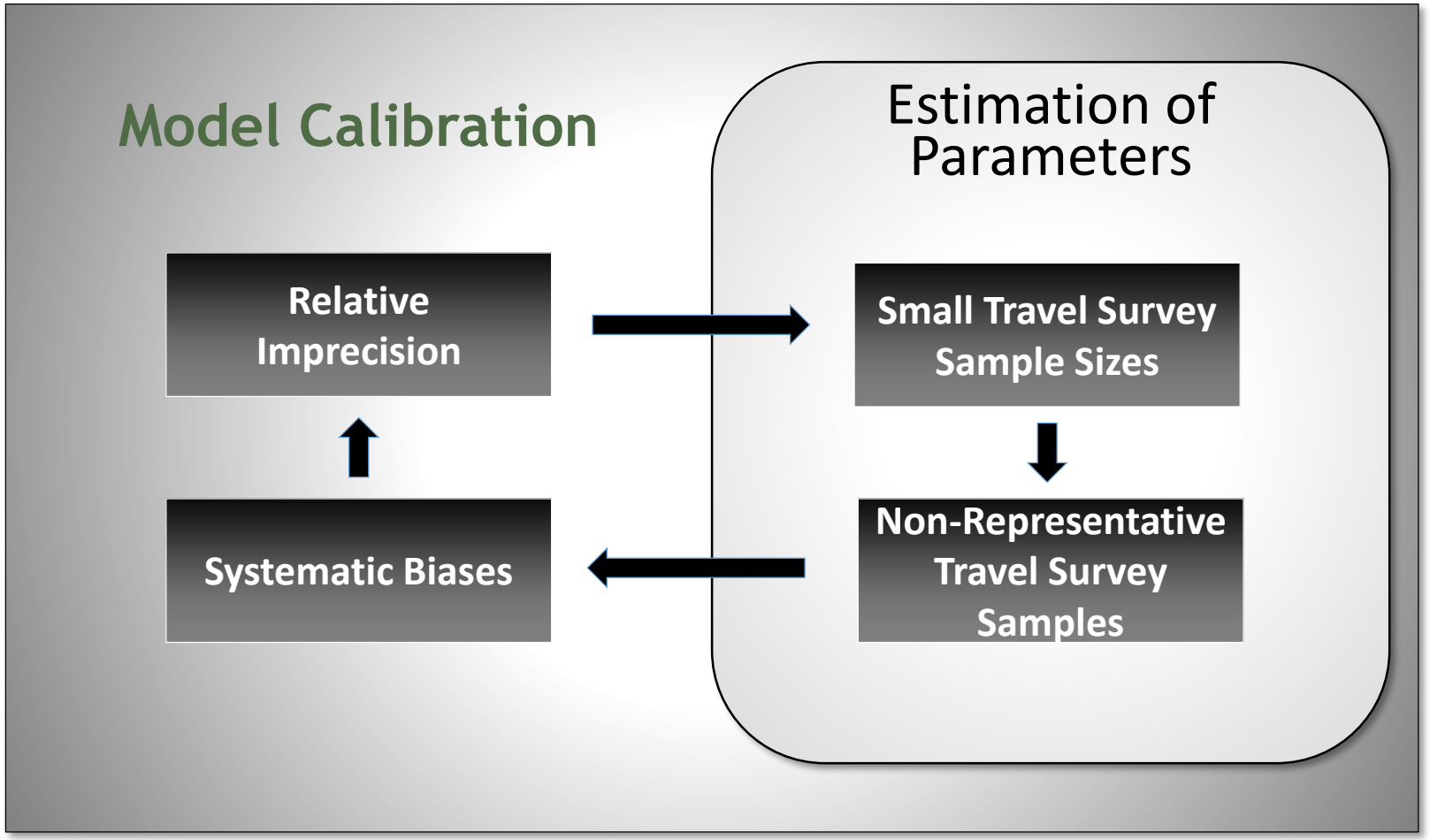




Minimizing Sources of Risk & Uncertainty in ABM

- Some error propagation in a fully integrated transport/land use model:
  - Land use components & uncertainty in demographic inputs / socioeconomic projections
  - Outputs from land use model act as inputs into travel demand model
  - Uncertainty in various model parameters
  - Cumulative effects send shockwaves through an integrated model

Possible Sources of Data Uncertainty in ABM



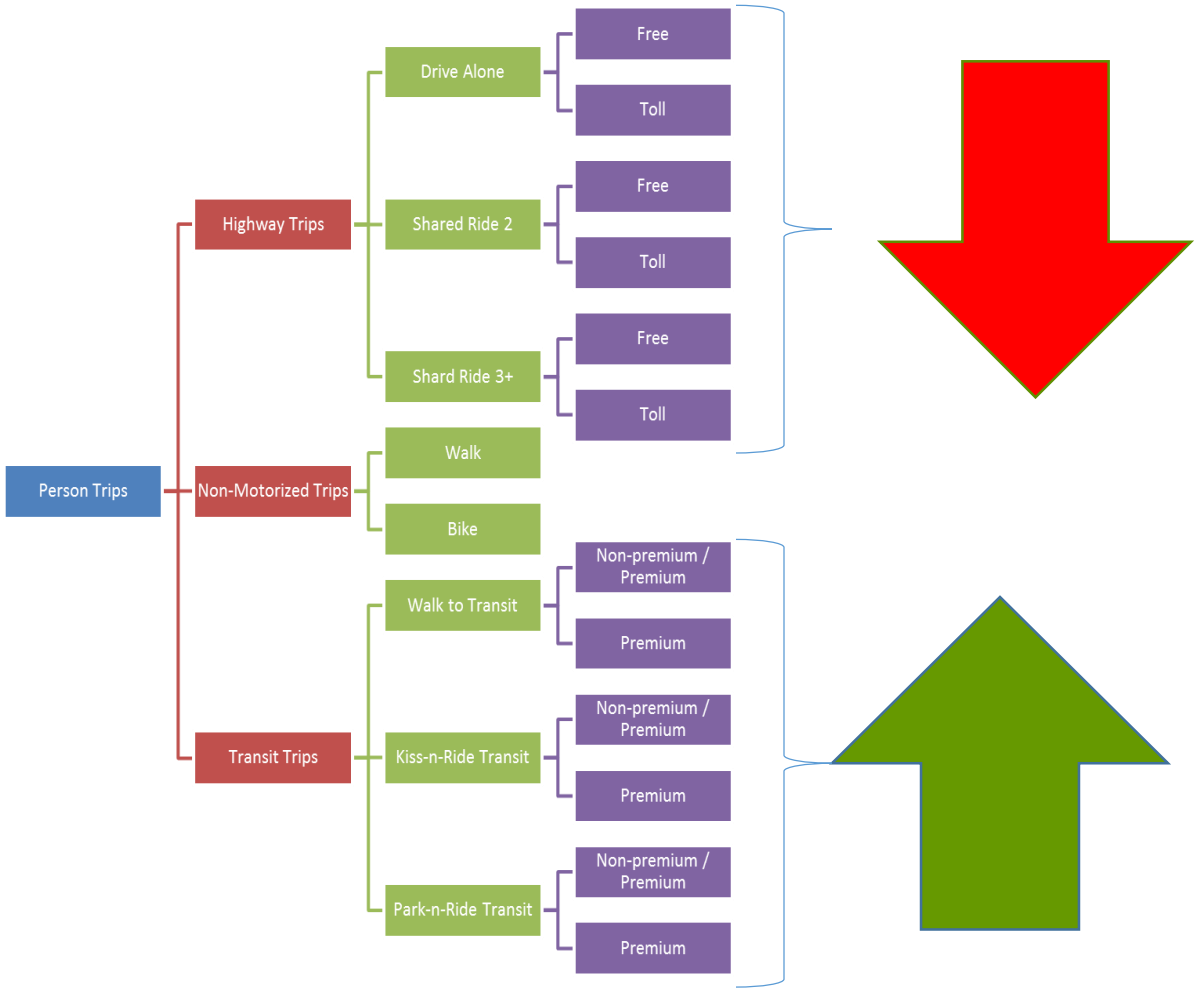
Other Sources of Risk & Uncertainty in ABM

- Monte Carlo random draws in synthetic population
  - Random sampling from inputs distribution
  - Requires large number of samples (PUMS, PUMAS, etc.)
  - Need to allow representation of extremes in probability distribution of outputs

Estimate Uncertainty in Congestion Benefits of Capacity-Adding Projects

- For Road Projects:
  - Differences in observed vs. modeled VMT for certain functional classes
  - % error between observed counts and model estimated counts
  - RMSE should decrease as traffic volumes increase

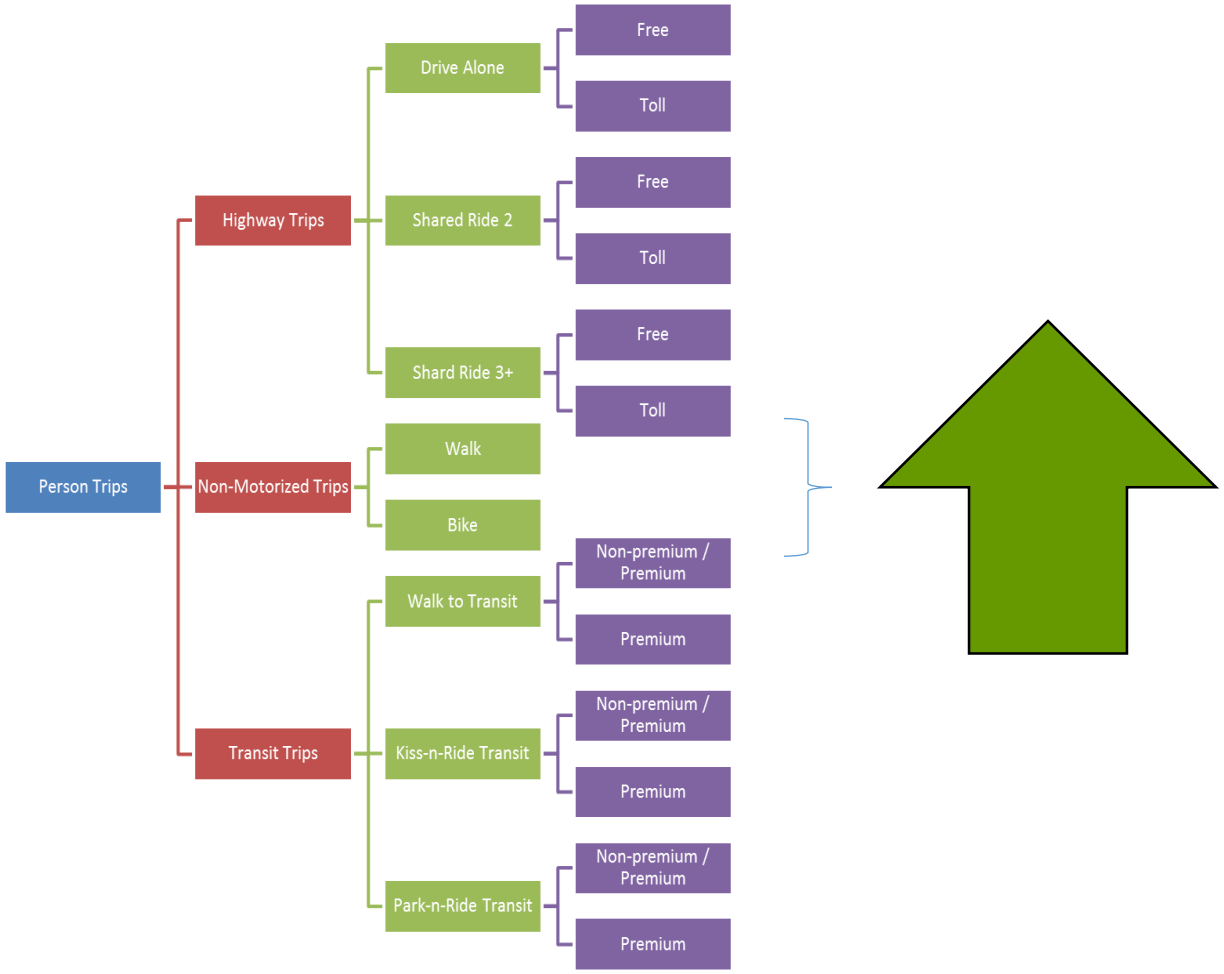
Scenario Modeling for Planning: Increase Propensity to Use Transit



Adjust transit constants – less auto trips

For specific access modes, purposes, market segments, origins/destinations, etc.

Scenario Modeling for Transportation Planning: Testing Active Transportation Modes with the ABM



- Adjust non-motorized constants in ARC's ABM UECs
- Increased density & land use mix have positive effects on walk & bike

Scenario Modeling for Transportation Planning: Managed Lanes & Value Pricing

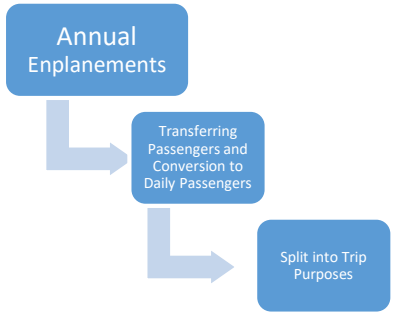
Prohibition	SOV	HOV-2	HOV-3+	Trucks	
1	✓	✓	✓	⊘	No Trucks
2	⊘	✓	✓	⊘	HOV 2+
3	$	✓	✓	⊘	Managed Lanes - SOV Toll - HOV 2+ Free - No Trucks
4	⊘	⊘	⊘	✓	Truck Only Lanes
5	✓	✓	✓	✓ / ⊘	I-285 Bypass
6	⊘	⊘	✓	⊘	HOV 3+
7	$	$	✓	⊘	Managed Lanes - SOV & HOV2 Toll - HOV 3+ Free - No Trucks
8	$	✓	✓	$	Managed Lanes - SOV & Truck Toll - HOV 2+ Free
9	$	$	✓	$	Managed Lanes - SOV, HOV2 and Truck Toll - HOV 3+ Free
10	⊘	⊘	⊘	$	Truck Only Toll
11	⊘	$	✓	⊘	Managed Lanes - HOV2 Toll - HOV 3+ Free - No Trucks or SOV
12	$	$	$	⊘	Managed Lanes - SOV and HOV2+ Toll - No Trucks
13	$	$	$	$	Managed Lanes – SOV, HOV2+ and Trucks Toll

Toll Optimization with Static Traffic Assignment

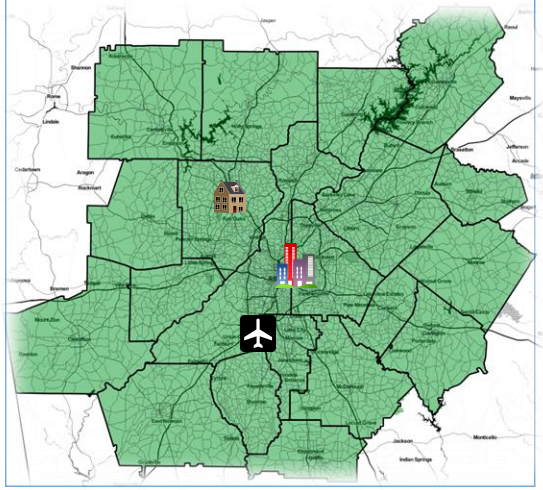
- Facilities with variable pricing require optimizing to ensure consistent results with CT-RAMP and the highway assignment
- Why? Toll/non-toll is part of both mode choice (CT-RAMP) and route choice (highway assignment)
- Optimization occurs in outer (CT-RAMP and other models) and inner (assignment) loops
- Optimization approach seeks to modify the tolls until the generalized cost of the toll lanes and general-purpose lanes are equal for a specific section

Air Passenger Model

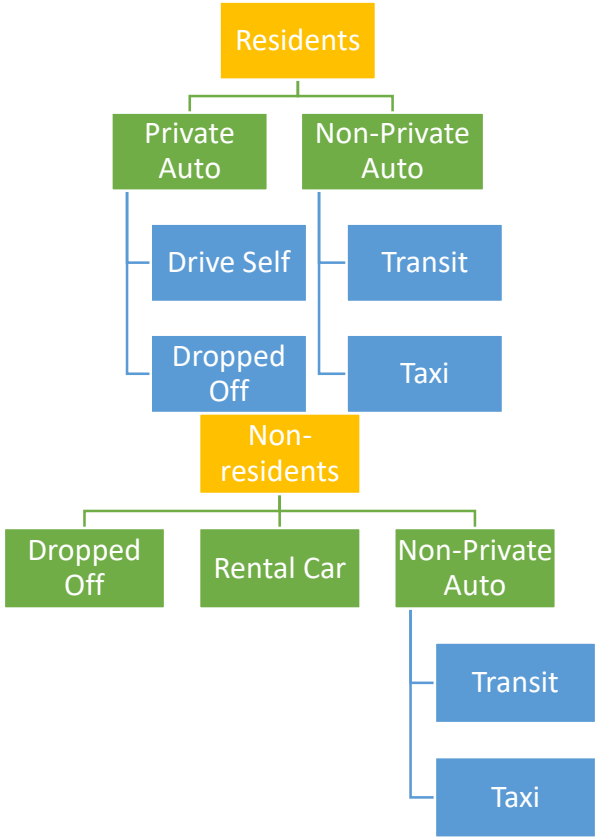
Step One: Estimating Total Airport Passengers



Step Two: Trip End Allocation



Step Three: Mode Choice



Model Applications for Transportation Planning: Autonomous Vehicles Scenario Testing

- Limited to “What-if” scenarios
- Restricted to select factors, while assuming others constant
- Fuel Efficiency based on trends in CAFE standards and annual energy outlook by U.S. Dept. of Energy
- CAFE standards: 54.5 mpg in model year 2025, extrapolated to 2040 for light and heavy duty vehicles
- Additional fuel economy due to efficient operation of autonomous vehicle, resulting in a reduction in overall vehicle operating cost

C/AV Planning Assumptions for Modeling

- Perceived travel time disutility
  - Less onerous in-vehicle travel time
  - In-vehicle productivity: Reduced disutility
  - Affects tour/trip mode choice utilities
- Parking cost
  - Driverless cars significantly reduce the need for paid parking
    - Work and non-work trips
- Increased Roadway Capacity
- NHTSA Level 4 - 100% market penetration in 2040

C/AV Modeling Methodology

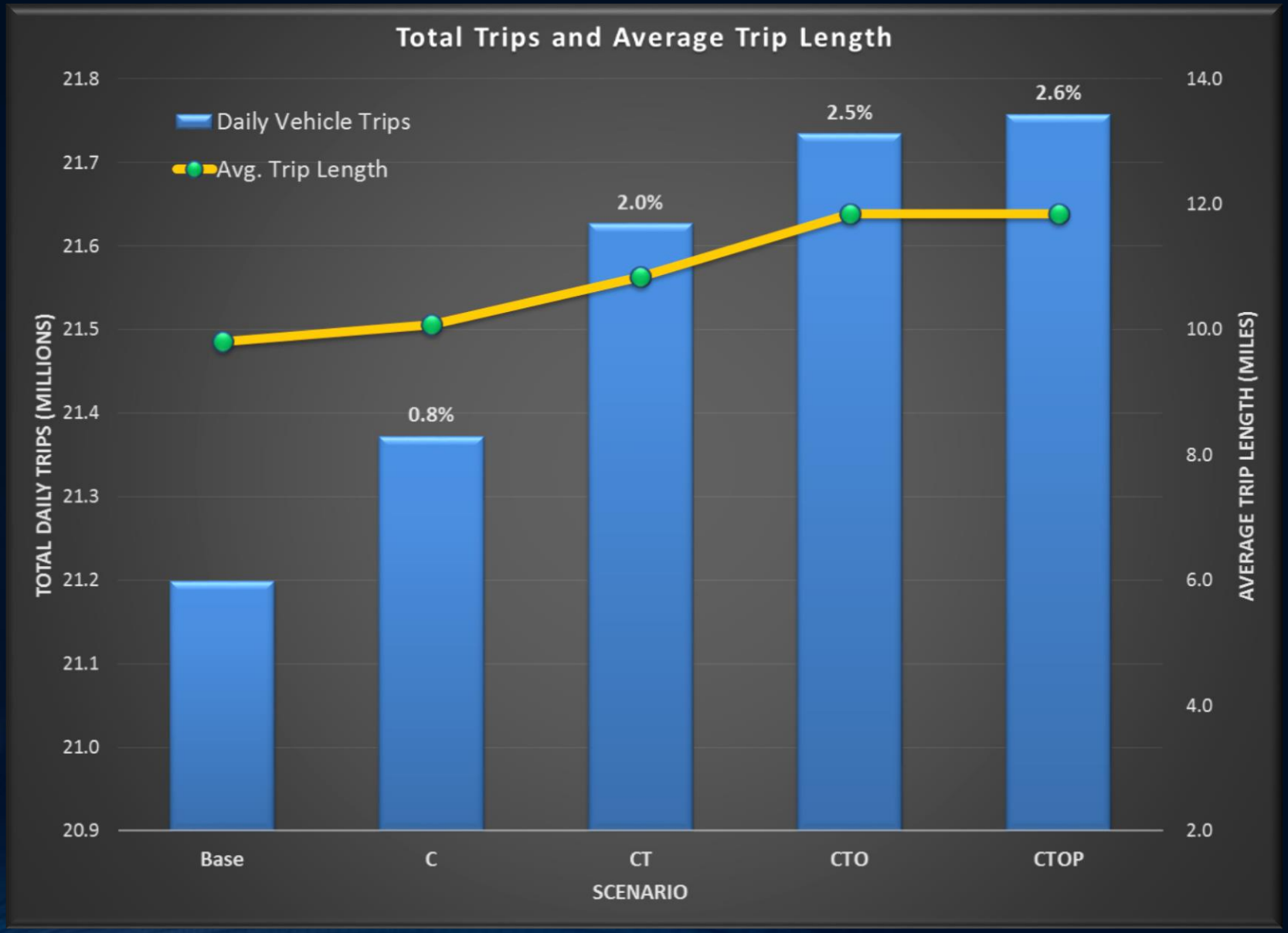
- Tour and Trip Mode Choice Utility Expression Calculators (UECs)
  - AV_Perc_Factor: Reduce In-Vehicle Travel Time (IVTT) coefficients for autos by 50%
  - Increase fuel efficiency in operating cost
    - 70% reduction in vehicle operating cost from present
  - Parking costs at primary destinations set to zero
- Generalized cost in highway assignment
  - Reduce auto and truck operating costs
- Increase roadway capacity by 50%
- 0-Car Households have access to Single-Occupant Vehicles with Autonomous Vehicles scenario

C/AV Modeling Scenarios

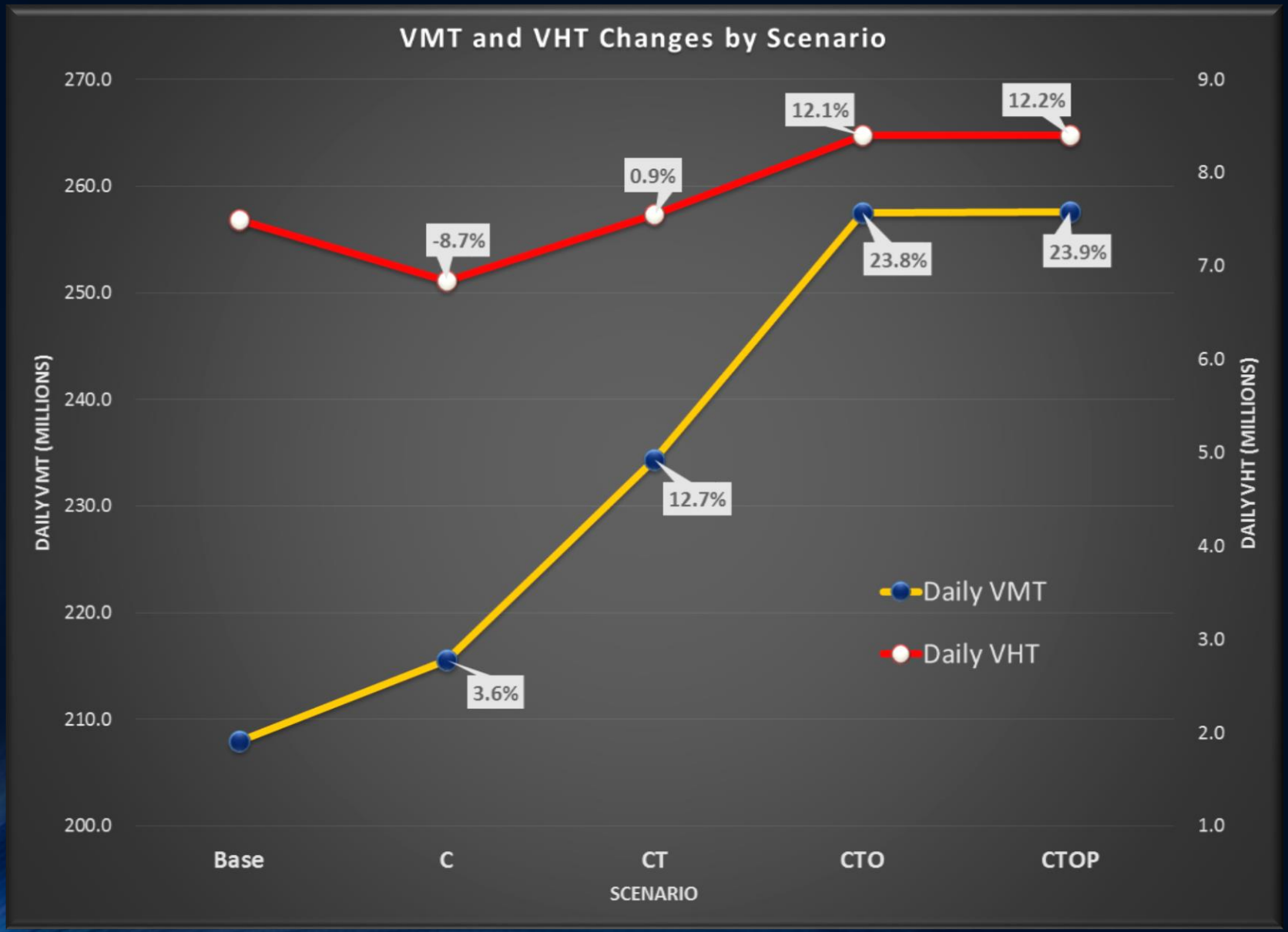
- Incremental Approach

Scenario				
2040 NB	C	CT	CTO	CTOP
baseline	• capacity increase	• capacity increase	• capacity increase	• capacity increase
		• decrease in travel time disutility	• decrease in travel time disutility	• decrease in travel time disutility
			• reduction in vehicle operating cost	• reduction in vehicle operating cost
				• reduction in parking cost

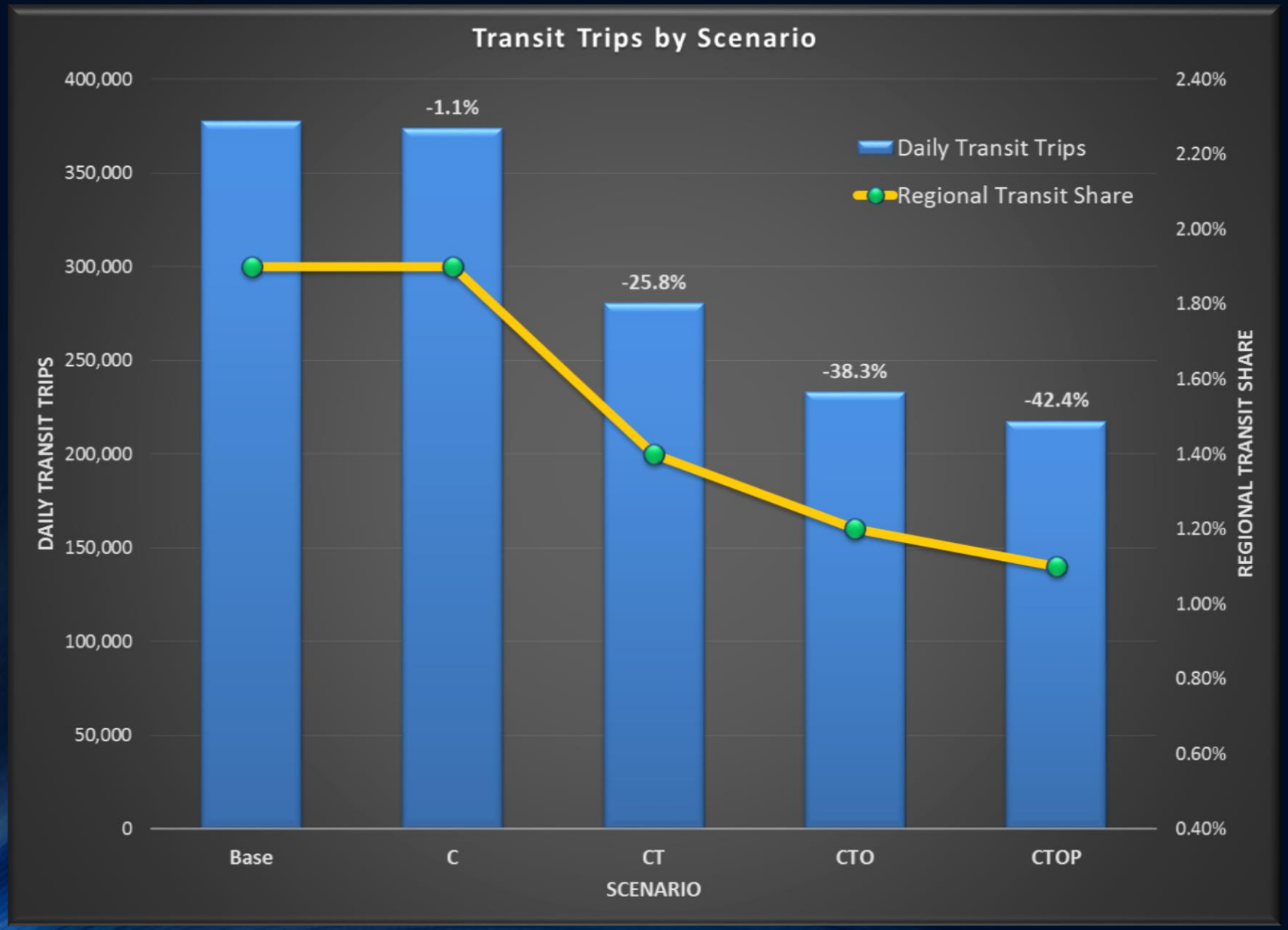
C/AV Model Results



C/AV Model Results



C/AV Model Results



ABM Lessons Learned at ARC

- ABM Requires Detailed & Thorough QA/QC

- Design & Conceptualize your Household Travel Survey with an ABM Model System in Mind

- Need to Visualize ABM Results: http://atlregional.github.io/ABMVIZ/

- Like Anything Else, ABM Requires *Lots* of:

  - Dedicated Staff Resources & On-Going Training
  - DATA (Travel Surveys and/or "AirSage" O-D types)
  - Computer Resources (Servers or Cloud Computing?)
  - Consultants Assistance
  - Programming Expertise (Java, Python, R, Stata, etc.)
  - GIS & a True Geo-Database for Enhanced Network Coding and Project-Level Planning
  - $,$$$,$$$.$$

Atlanta's Most Crucial Step: Moving ARC's ABM into Practice & Official Production Mode for Regional Transportation Planning

- Thus far ABMs are being Developed and Applied mostly in Regions where 4-step Models had been Abandoned or never Developed

- Rigorous Practical Testing and Cross-Comparisons of ABM & 4-Step Trip-Based Model (both in good shape!) is Finally Possible in Atlanta

Thanks!

Guy Rousseau
Travel Surveys & Transportation Model Development Manager
Atlanta Regional Commission
229 Peachtree St NE, Suite 100
Atlanta, Georgia 30303
P | 470.378.1565
M| 678.986.4344
grousseau@atlantaregional.com
atlantaregional.com