

Transitioning from a Trip-Based Travel Model to an Activity-Based Travel Model: Experiences of the Atlanta Regional Commission (ARC)

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MWCOG TPB Travel Forecasting Subcommittee

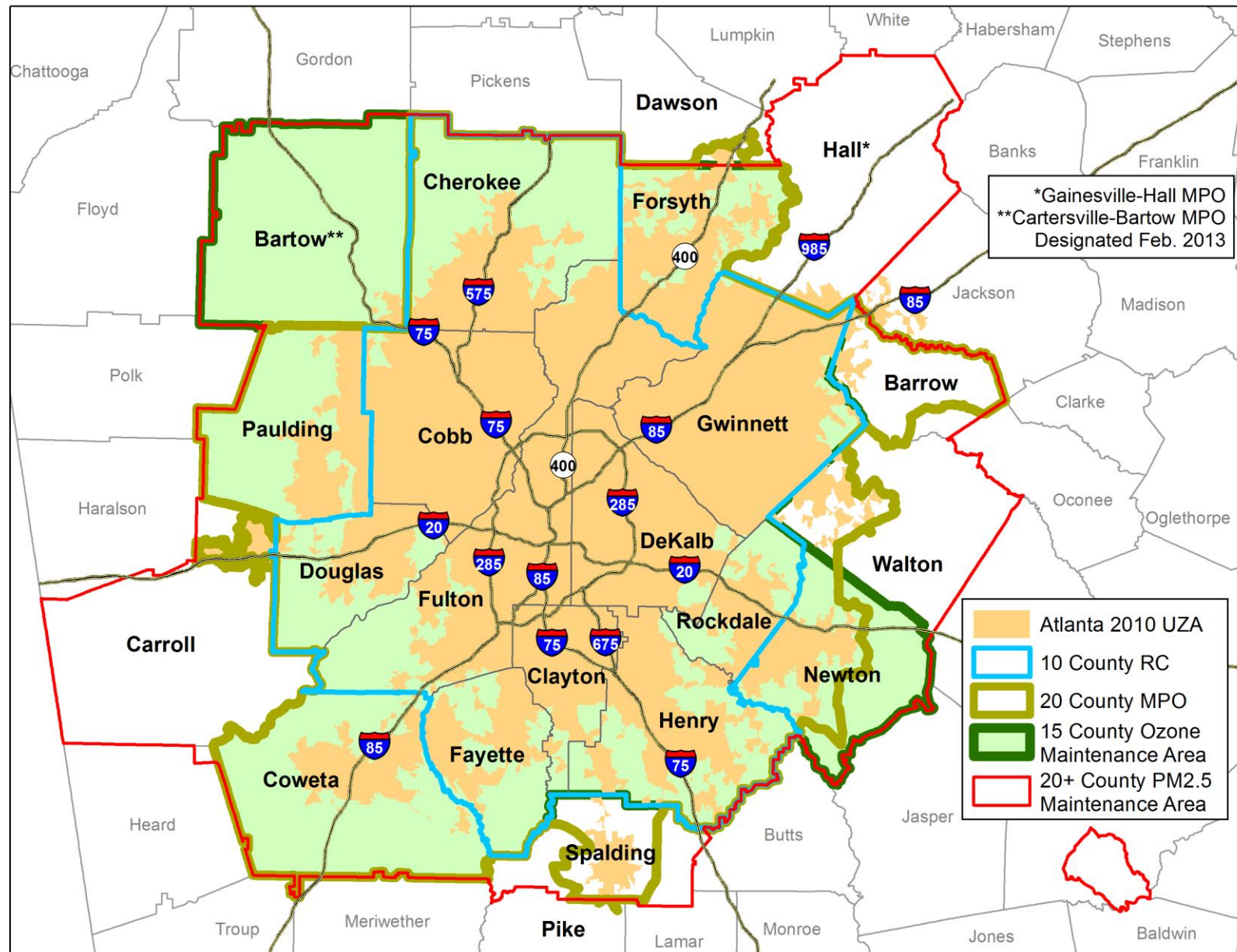
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ARC Modeling & Planning Boundaries

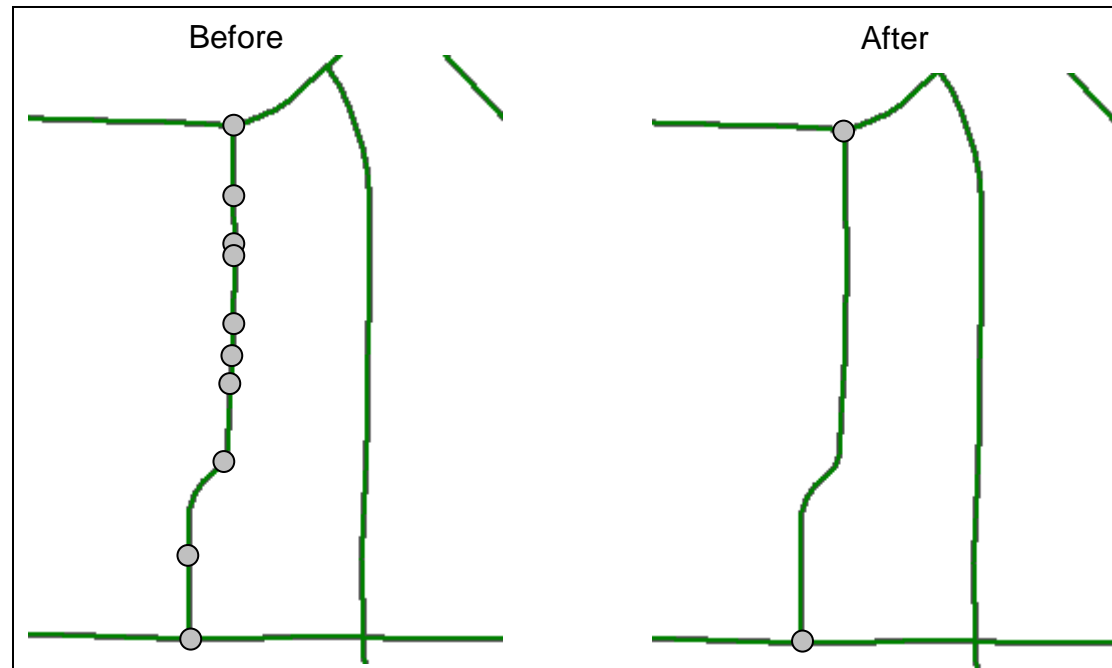
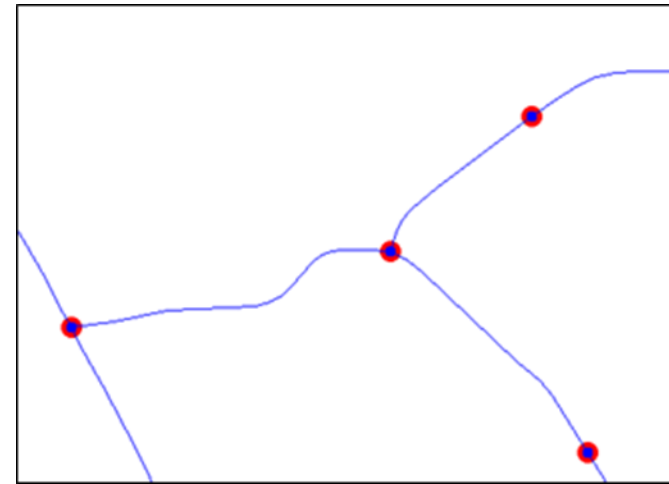
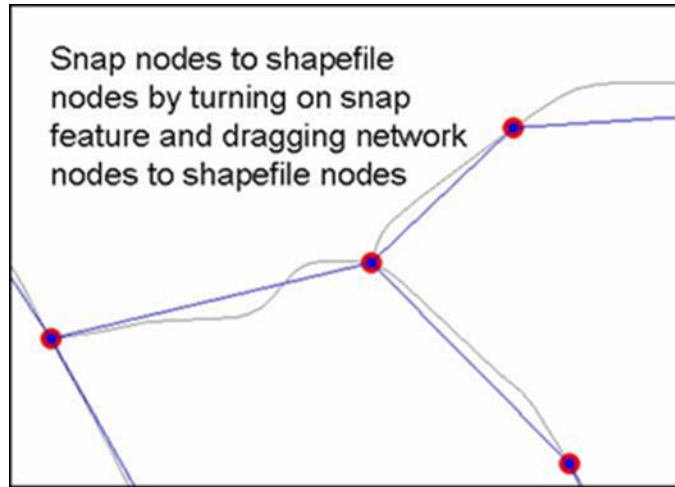
Current Population: Almost 6M



ARC ABM History & Migration Evolution

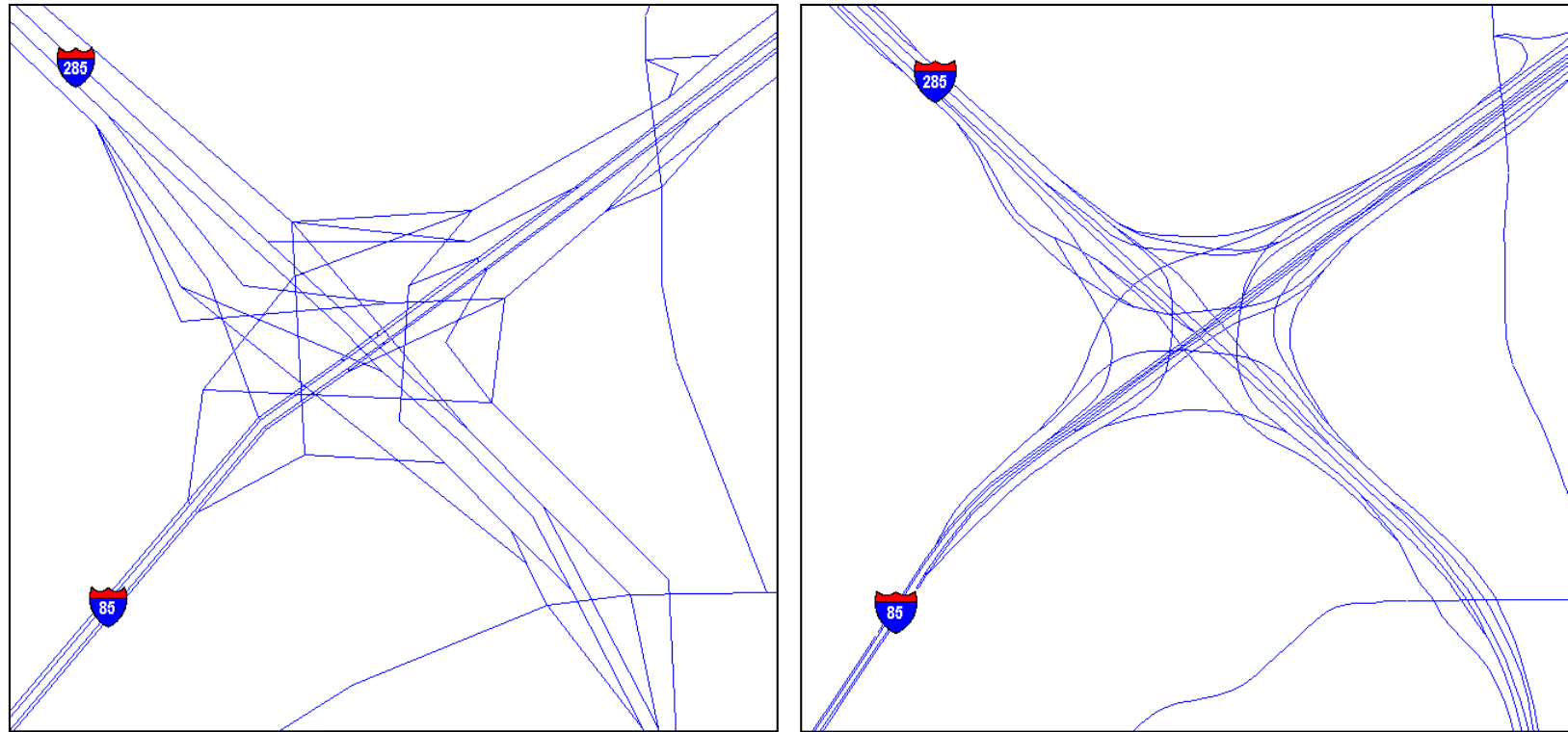
- 2000: Model Peer Review
- 2001: Household Travel Survey (and Transit On-Board Survey)
- 2002: ABM Model Design
- 2003: Population Synthesizer Developed
- 2004: ABM Model Estimation & Model Peer Review
- 2005-2006: Conformity Work Focusing on Trip-Based Model and Expanded Modeling Area (13 to 20 Counties), Population Synthesizer Refined
- 2007-2008: Finished Model Estimation & Implementation
- 2009-2010: Model Calibration & Validation, In-House QA/QC “Look Under the Hood”, Sensitivity Testing, Visualization, Documentation
- 2011: Household Travel Survey (2009 Transit On-Board Survey)
- 2012-2013: ABM Re-Calibration & Re-Validation
- 2014: Use ABM & PECAS for 2016 Plan Update

Transitioning to True-Shape Display via GIS Network Conflation



Transition to Conflated Networks in ABM

- **Finally True Shape Display, No More “Stick Network”!!**
- **Based on street centerline data file**
- **Modify network with roadway shape file**



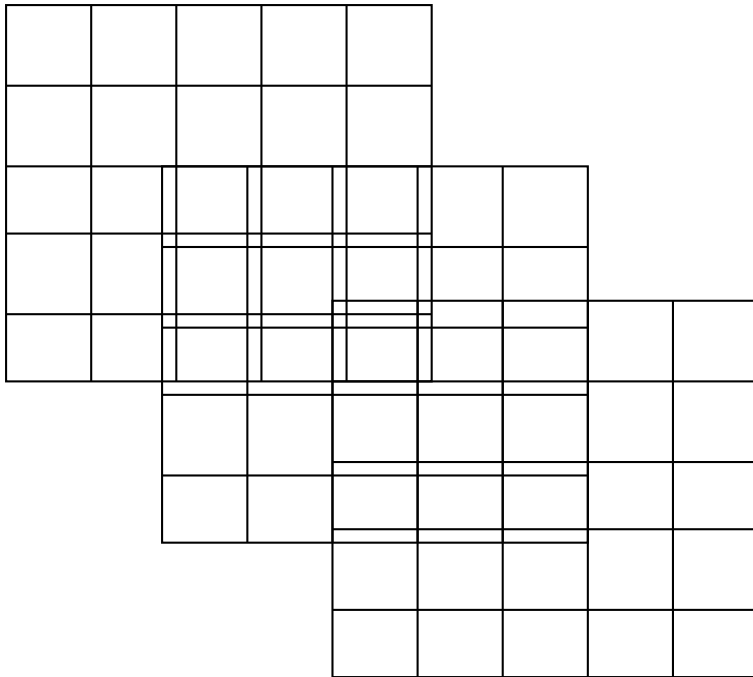
Why ARC Transitioned from Trip-Based Model to ABM?

- Lack of Behavioral Fidelity in Trip-Based Model
 - The only model based on actual decision-making theory is mode choice
- Aggregation Bias in Trip-Based Model
 - No / very little info on non-home-based trips
 - Each additional market segment (socio-economic category, trip purpose, time period) significantly increases model run-time
- Lack of Policy Responsiveness in Trip-Based Model
 - Time-of-day shifts
 - Socio-economic changes
 - Induced Travel / Induced Demand

Activity-Based Model at ARC: Why???

- ARC Travel demand forecasters could no longer ignore critical policy questions (pricing, peak spreading, demographic changes, equity analysis, greenhouse gas emissions, etc.)
- Computational power has caught up with model theory
- Proven successful implementations
- **Key to Success**: Involve all planning partners, stakeholders and local jurisdictions in ABM development steps, especially network coding review, reasonableness checks of model results, etc.

ARC Trip-Based Model



- One set of calculations per cell
- Each market segment = new set of trip tables
- **More markets = more calculations**

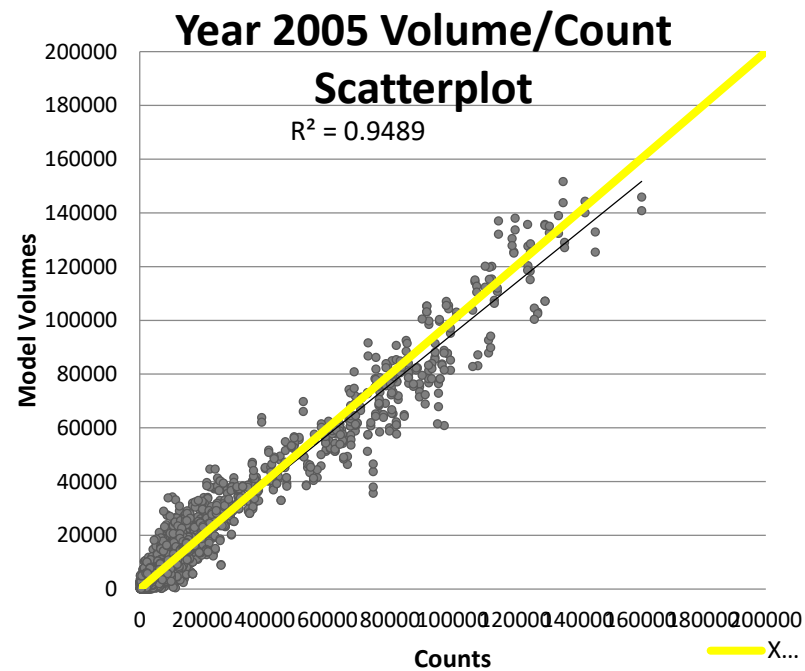
ARC Activity-Based Model

HID	PID	AUT	INC	WRK	GEN	AGE	EMP
1	1	1	3	1	0	24	1
1	2	1	3	0	1	23	0
1	3	1	3	0	1	3	0
2	1	2	4	2	0	32	1
2	2	2	4	2	1	34	1
3	1	3	2	2	0	49	1
3	2	3	2	2	1	47	1
3	3	3	2	2	1	15	0
3	4	3	2	2	0	12	1

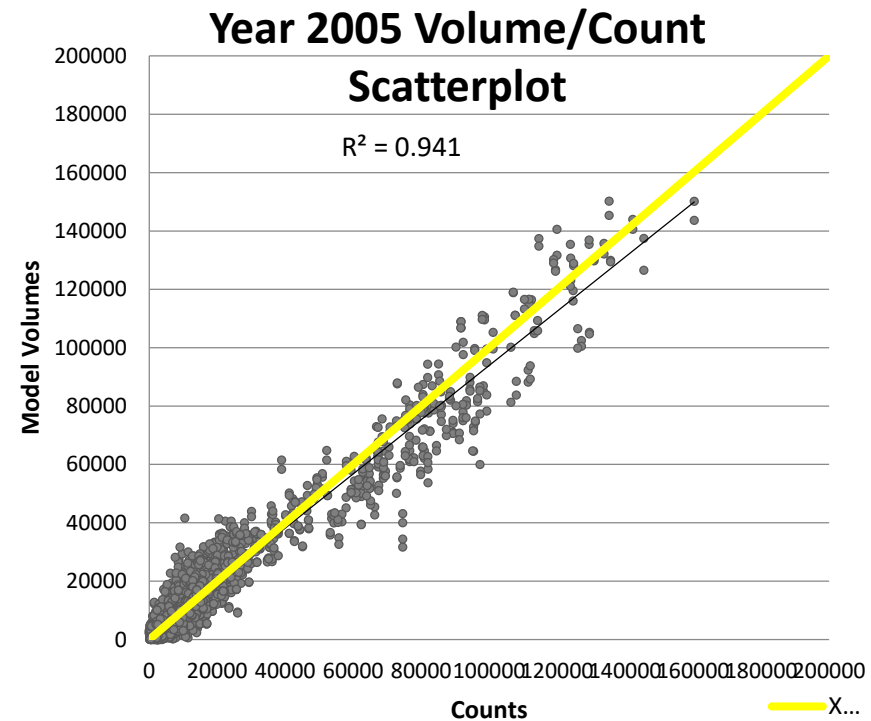
- One set of calculations per agent
- Each market segment = new column
- **More markets = no additional calculations**

ARC Side-by-Side Comparative Analysis: Model Validation

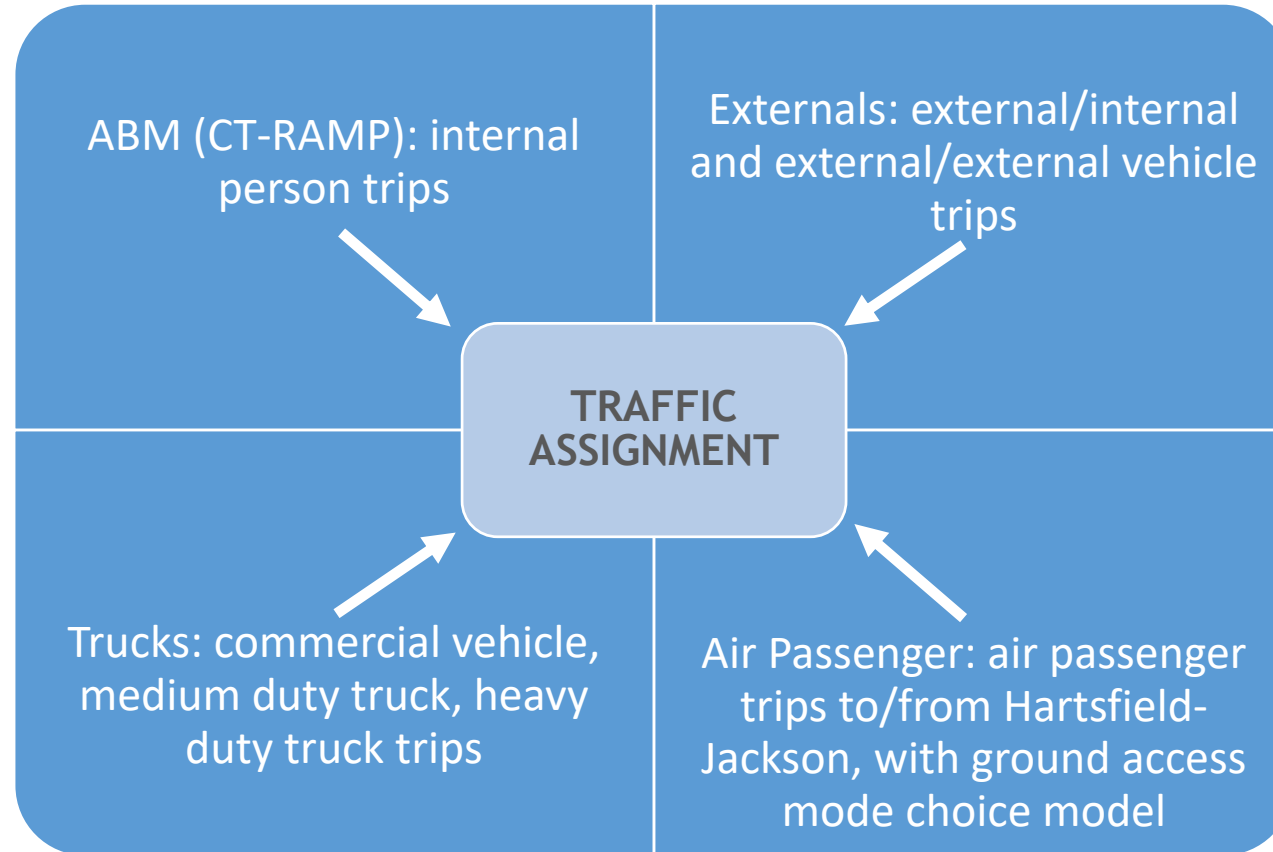
Trip-Based Model



Activity-Based Model



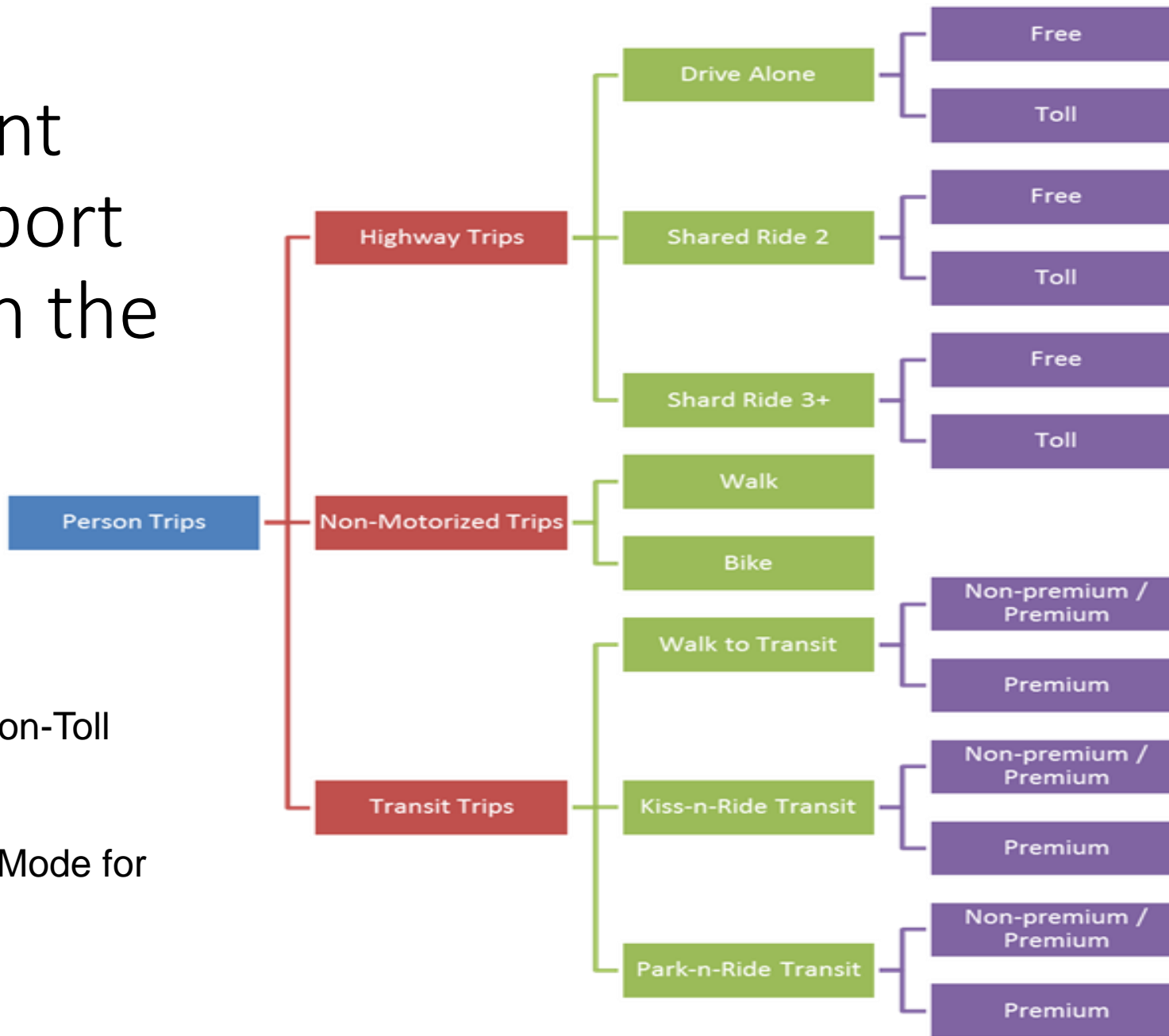
ARC Activity-Based Model Components



DMU = Decision-Making Unit (household)

CT-RAMP = Coordinated Travel – Regional Activity Modeling Platform

Atlanta's Treatment of Transport Modes in the ABM



- Explicit Toll versus Non-Toll Choice in Mode Split

- School Bus is a Trip Mode for Traffic Assignment

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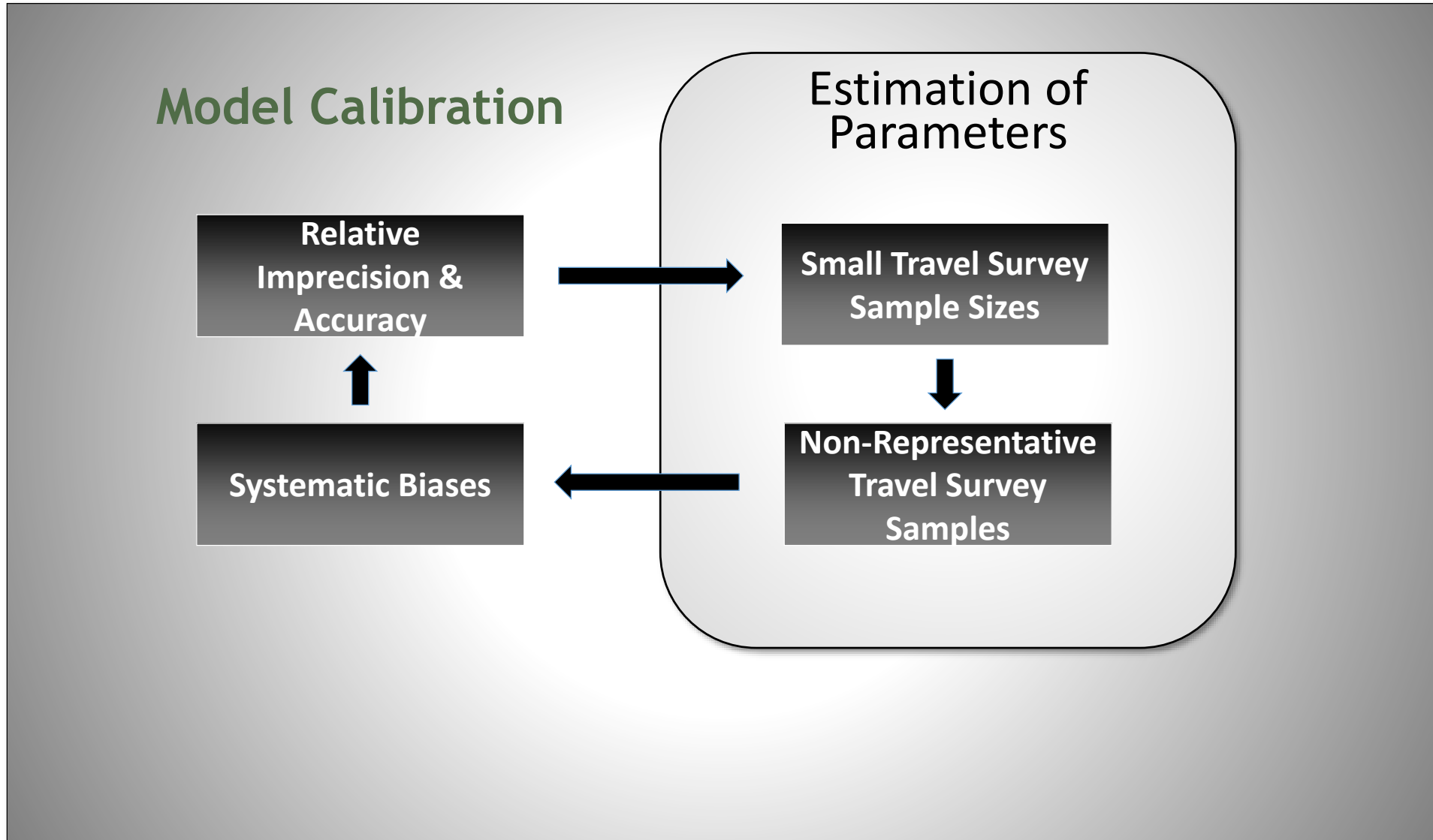
- Travel Model for Base Year 2010
- No-Build 2040
- Regional Plan 2015
- Regional Plan 2017
- Regional Plan 2020
- Regional Plan 2024
- Regional Plan 2030
- Regional Plan 2040
- Regional Plan 2040 minus No-Build 2040
- **2019 Regional Transit On-Board Survey**
- 2019 Regional One-Day Tour Diary Survey

ActivityViz was initially funded by the [Atlanta Regional Commission](#) with additional support from [Oregon Metro](#) and others.

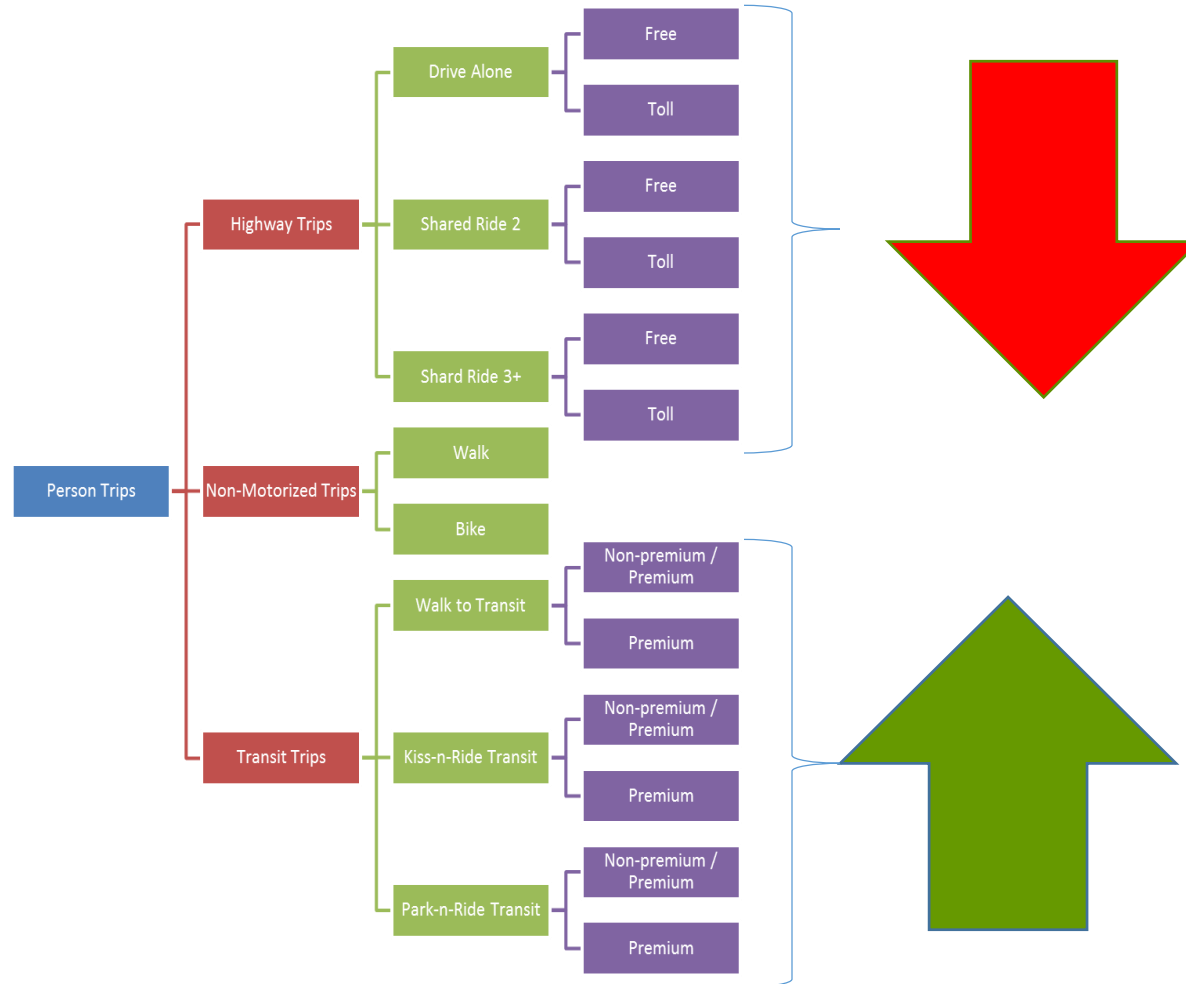


ActivityViz is an interactive travel and activity data visualization tool. It is built with JavaScript technologies and works with various types of travel and activity data - household travel surveys, trip-based model outputs, activity-based model outputs, disaggregate passive data, freight models, on-board surveys, etc. The dashboard features several interactive and customizable visualizations for exploring data, such as 3D maps of trips in time and space, time use by person type and activity, radar charts for performance measure analysis, sunburst diagrams for visualizing mode shares, animated bubble maps, chord diagrams for OD data, point-of-interest maps for transit stop data, truck flow data, etc. ActivityViz is published using [GitHub pages](#) which eliminates most of the administrative backend in traditional systems.

Risk & Uncertainty in ABM

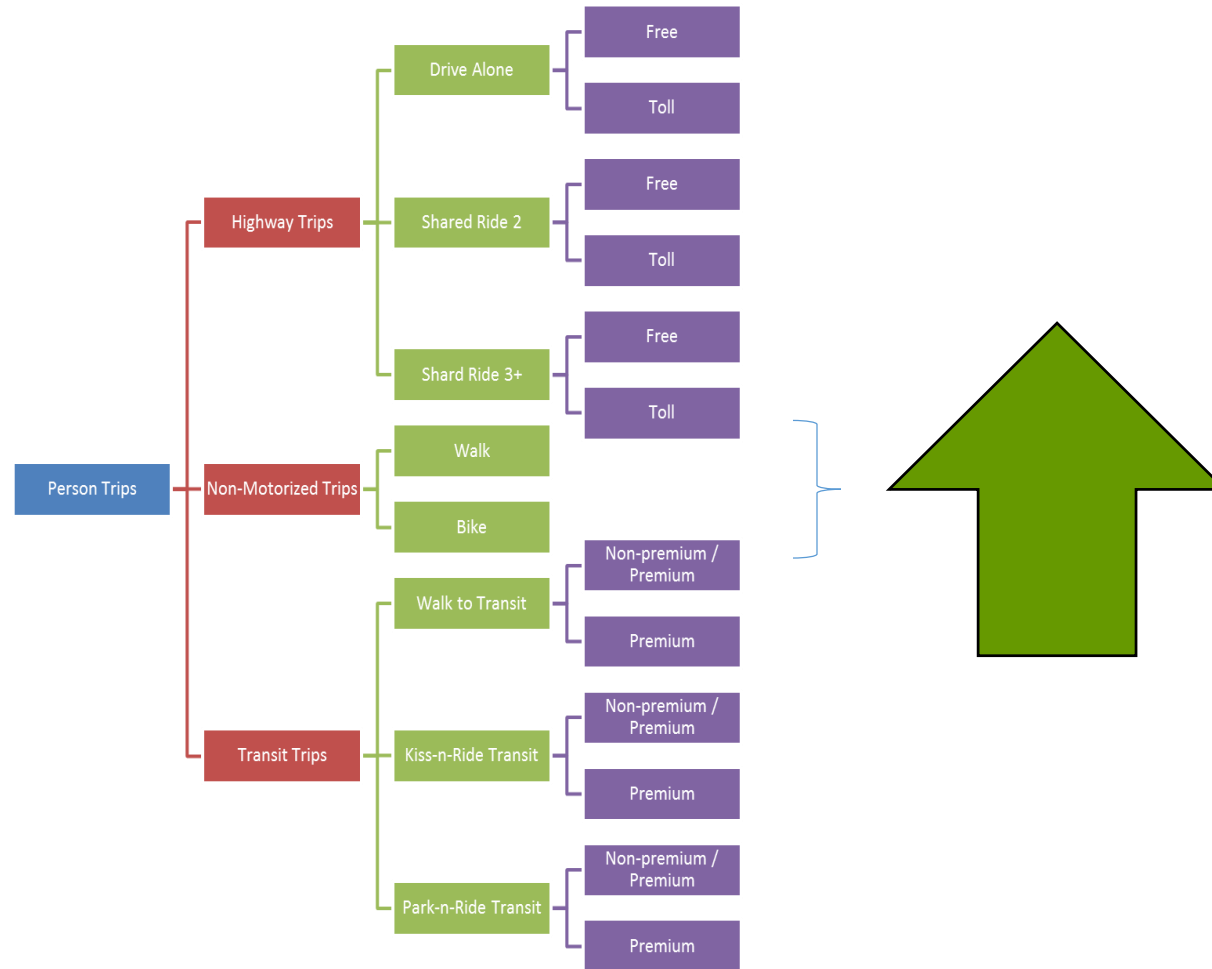


Scenario Modeling for Planning in an ABM: Increase Propensity & Willingness to Use Transit



Adjust transit constants in the UECs, so fewer 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 (Utility Expression Calculations)
- Increased density & land use mix have positive effects on walk & bike

Scenario Modeling for Transportation Planning in an ABM: Managed Lanes, Variable Value Pricing and Express Toll Lanes

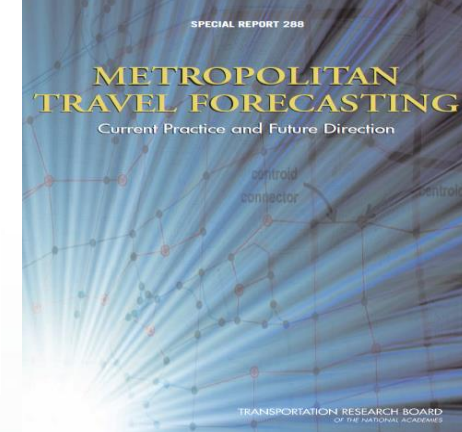
Prohibition	SOV	HOV-2	HOV-3+	Trucks	
1	✓	✓	✓	⊘	No Trucks
2	⊘	✓	✓	⊘	HOV 2+
3	\$	✓	✓	⊘	Managed Lanes - SOV Toll - HOV 2+ Free - No Trucks
4	⊘	⊘	⊘	✓	Truck Only Lanes
5	✓	✓	✓	✓/⊘	I-285 Bypass
6	⊘	⊘	✓	⊘	HOV 3+
7	\$	\$	✓	⊘	Managed Lanes - SOV & HOV2 Toll - HOV 3+ Free - No Trucks
8	\$	✓	✓	\$	Managed Lanes - 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

C/AV Modeling Scenarios with an ABM

Incremental Approach

		Scenario			
2040 NB	C	CT	CTO	CTOP	
baseline	<ul style="list-style-type: none"> capacity increase 	<ul style="list-style-type: none"> capacity increase 	<ul style="list-style-type: none"> capacity increase 	<ul style="list-style-type: none"> capacity increase 	
		<ul style="list-style-type: none"> decrease in travel time disutility 	<ul style="list-style-type: none"> decrease in travel time disutility 	<ul style="list-style-type: none"> decrease in travel time disutility 	
			<ul style="list-style-type: none"> reduction in vehicle operating cost 	<ul style="list-style-type: none"> reduction in vehicle operating cost 	
				<ul style="list-style-type: none"> reduction in parking cost 	

ActivitySim



- Why ActivitySim?

Notable Quote from Special Report 288 (pages 14-15)

“Because models must suit local needs and contexts, it is important for MPOs to take a leadership role in their development, testing, verification, and application. Large costs are involved in both improving current and developing more advanced models. **Rather than having these costs duplicated at each MPO, it would be beneficial to pool resources** for such activities as enhancement of existing models, development of new models, implementation procedures, and staff training programs.”

2007: ARC & MTC started collaborating on a joint Java version of CT-RAMP (with PB) code-named “baylanta”

Origins of ActivitySim: <https://www.ampo.org/wp-content/uploads/2014/10/AMPORF.pptx>

- ARC Prototype Goals

Based on a full implementation of ActivitySim & associated model performance results, identify pros & cons and effectiveness of the ARC ActivitySim model application.

Once ARC determines that the ActivitySim model better fits ARC’s forecasting needs, start developing a production-ready model by incorporating additional model components.



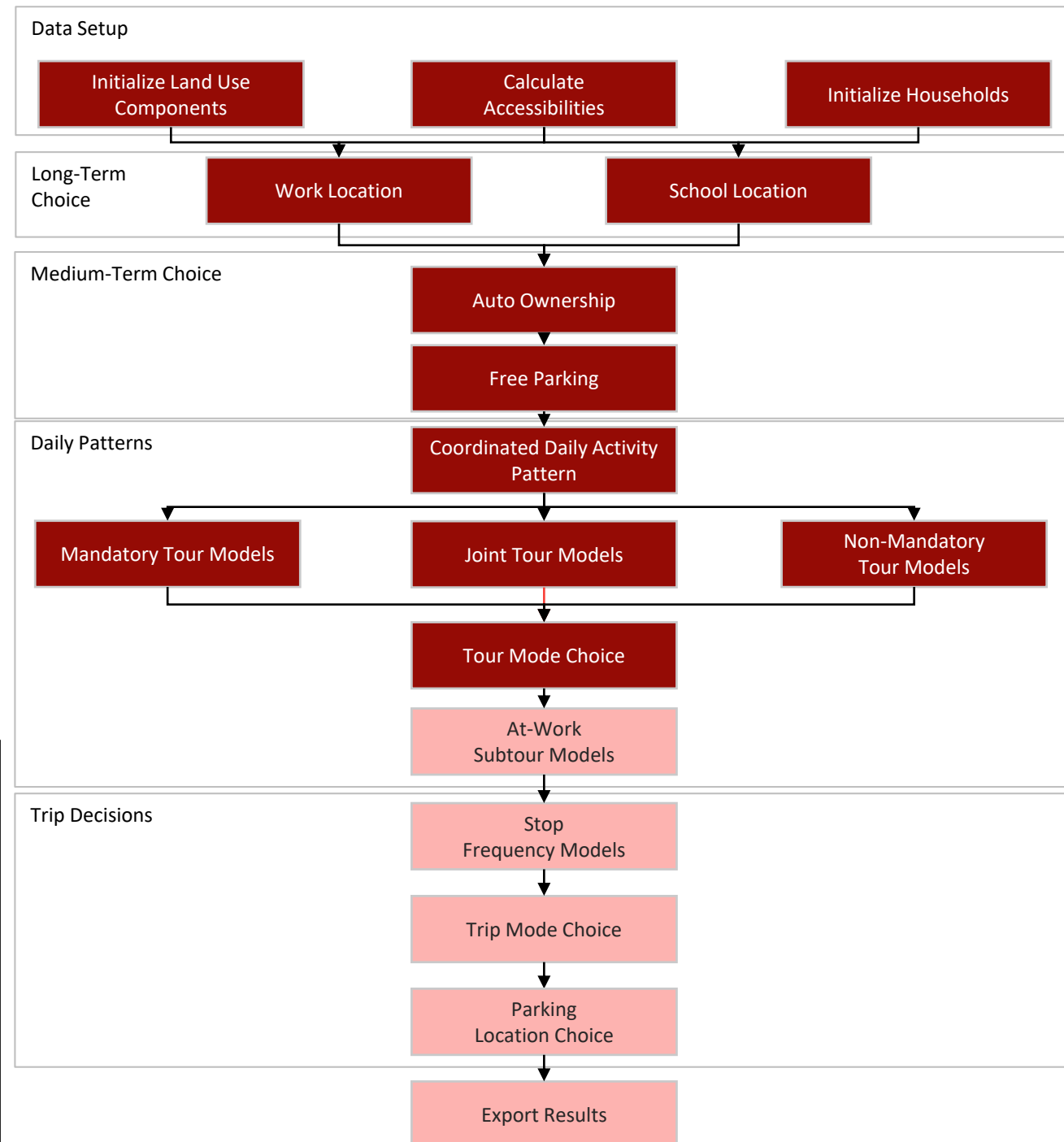
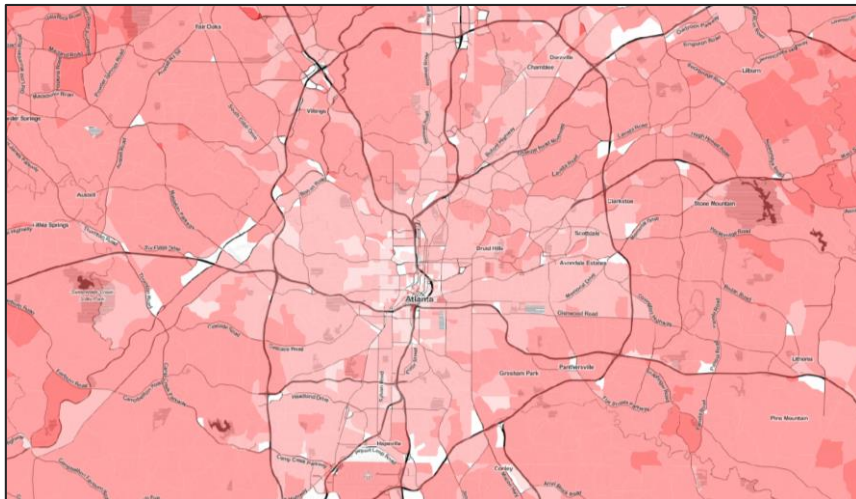
regional impact + local relevance



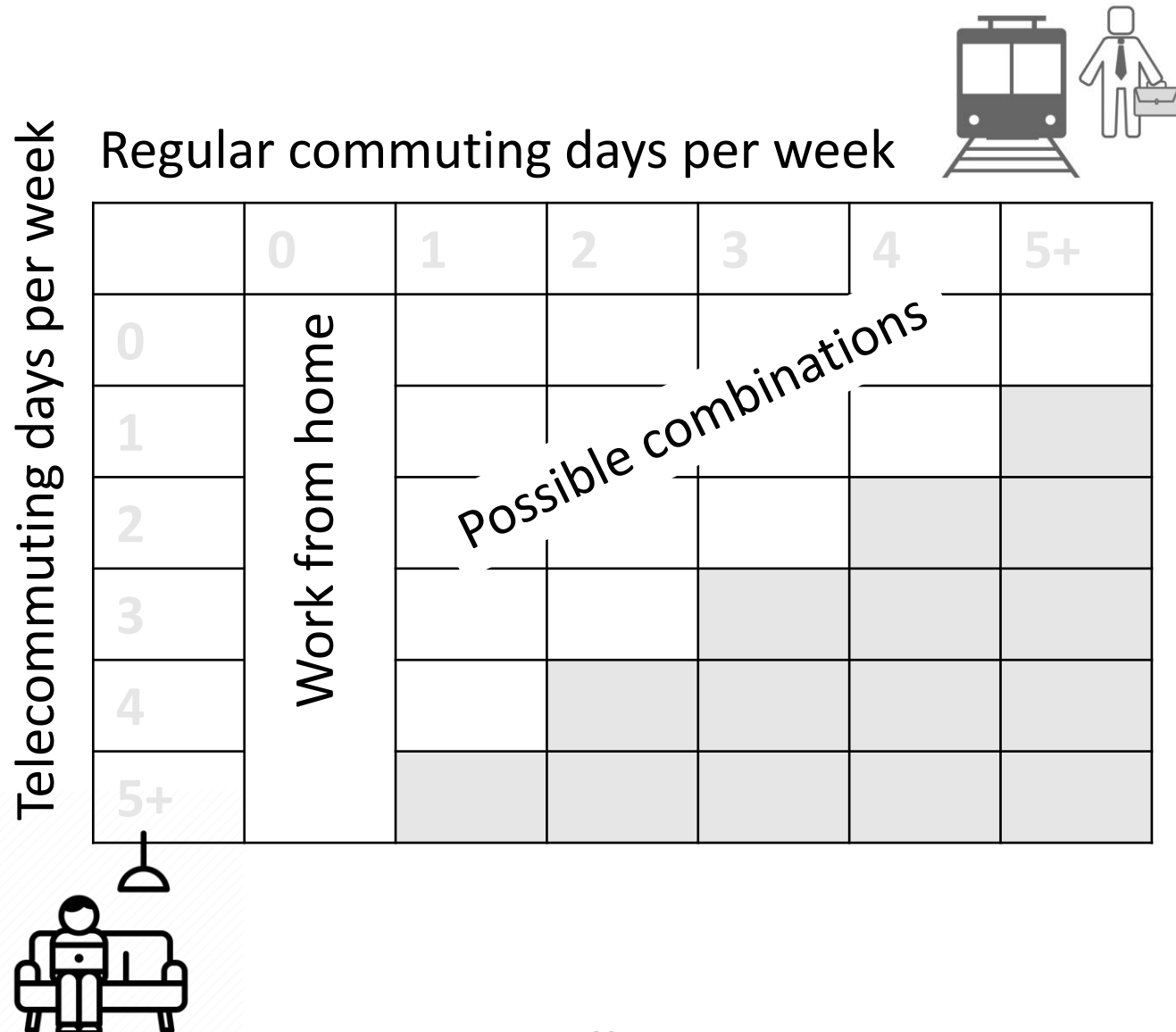
www.activitysim.org

- CT-RAMP to ActivitySim
- 16 of 16 Models Complete
Some models contain more than one model
- Many Pull Requests

Sample ARC ActivitySim Auto Ownership Results
(Mean Vehicles / HH)



Post-Pandemic Travel Behavior / Telemobility Modeling with an ABM: New commuting/telecommuting frequency model



Main factors defining commuting/telecommuting frequency:

- Full-time or part-time
- Industry/occupation
- Distance to work
- Worker's Age
- Worker's Income
- Worker's Gender
- Presence or absence of children within the household

ABM Transition: Lessons Learned at ARC

- Maintain a Temporary Dual / Parallel Track for Model Development with Trip-Based Model before Declaring Victory with the ABM
- ABM Requires Detailed & Thorough QA/QC
- Transparent ABM Documentation https://atlregional.github.io/ARC_Model/index.html
- Design your Travel Surveys with an ABM System in Mind
- Model Sharing: Network-Attached Storage [Activity Based Model - ARC \(atlantaregional.com\)](http://atlantaregional.com)
- Need to Visualize ABM Results: <http://atlregional.github.io/ABMVIZ/>

- Like Anything Else, ABM Requires Lots of:
 - Time: “When you Think you’re done, it’s Time to do it all over again!”
 - Dedicated Staff Resources & On-Going Training
 - DATA (Travel Surveys and/or “Big Data” O-D types)
 - Computer Resources (Servers and/or Cloud Computing)
 - Consultants Assistance
 - Programming Expertise (Java, Python, R, Stata, etc.)
 - GIS & a True Geo-Database for Enhanced Network Coding
 - \$,\$\$\$,\$\$\$.\$\$

- In Hindsight: Develop a Quick-Response ABM for Project level Evaluation

The ARC CT-RAMP ABM Cluster: "IT is your Best Friend!"



Moving to an ABM: Benefits & Challenges

- Enhanced Transport / Land Use Model Integration & Data Exchange
- “Big Data” and Origin-Destination Trajectories Analysis
- Travel Time Reliability, VDF & VDRF in Static Traffic Assignment
- Enhanced Transport / Air Quality (EPA MOVES3) Model Integration
- Machine Learning & Artificial Intelligence for Dynamic Calibration (ITS data)
- Macro-Meso-Micro & Regional DTA
- Modeling for Autonomous, Connected, Electric, Shared (A.C.E.S.) Vehicles
- Work-from-Home / Telecommuting Frequency Models
- On-Demand Micro Mobility Transit and MaaS
- ActivitySim, Open-Source Models & Pooled Funding Efforts

Thanks!

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