



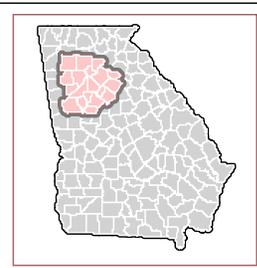
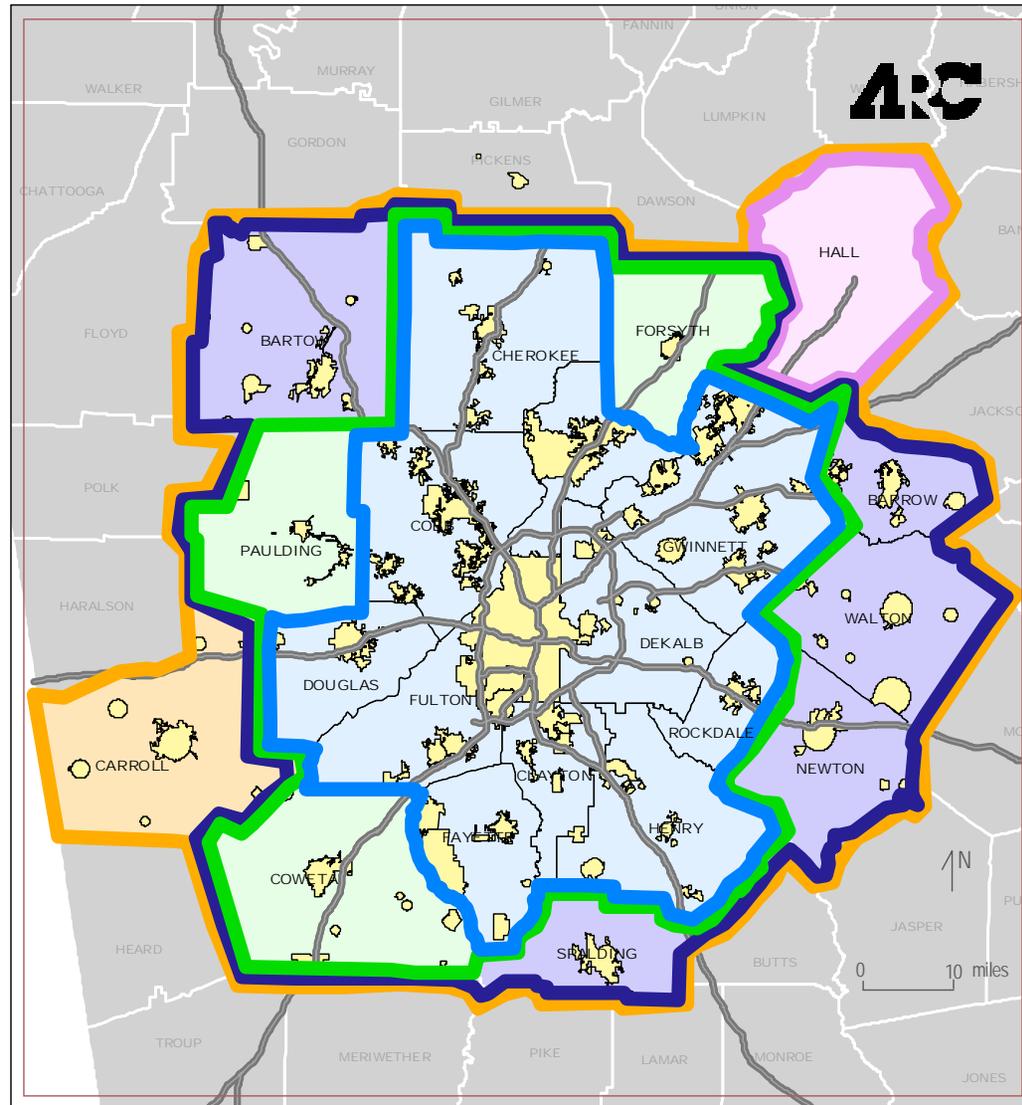
**From Trip-Based To Tour-Based:  
A Systematic & Incremental Way Of Migrating To  
Activity-Based & Tour-Based (ABTB) Modeling:  
The Atlanta Regional Commission (ARC) Experience**

**Guy Rousseau, Modeling Manager, ARC**

# Presentation Outline

- Acknowledgement of Consultants Assistance (PBSJ-Atlanta, PB, AECOM, John Bowman, Mark Bradley, Bill Allen)
- Overview of Atlanta Region: Growth
- 4-Step Trip-Based Aggregate Model
- ABTB Disaggregate Model Development
- Other 2007 Model Activities
- TRANSIMS
- Linking Atlanta's Regional Travel Demand Model with Microscopic Traffic Simulation

ARC's  
 Modeling  
 Domain &  
 Air  
 Quality  
 Status



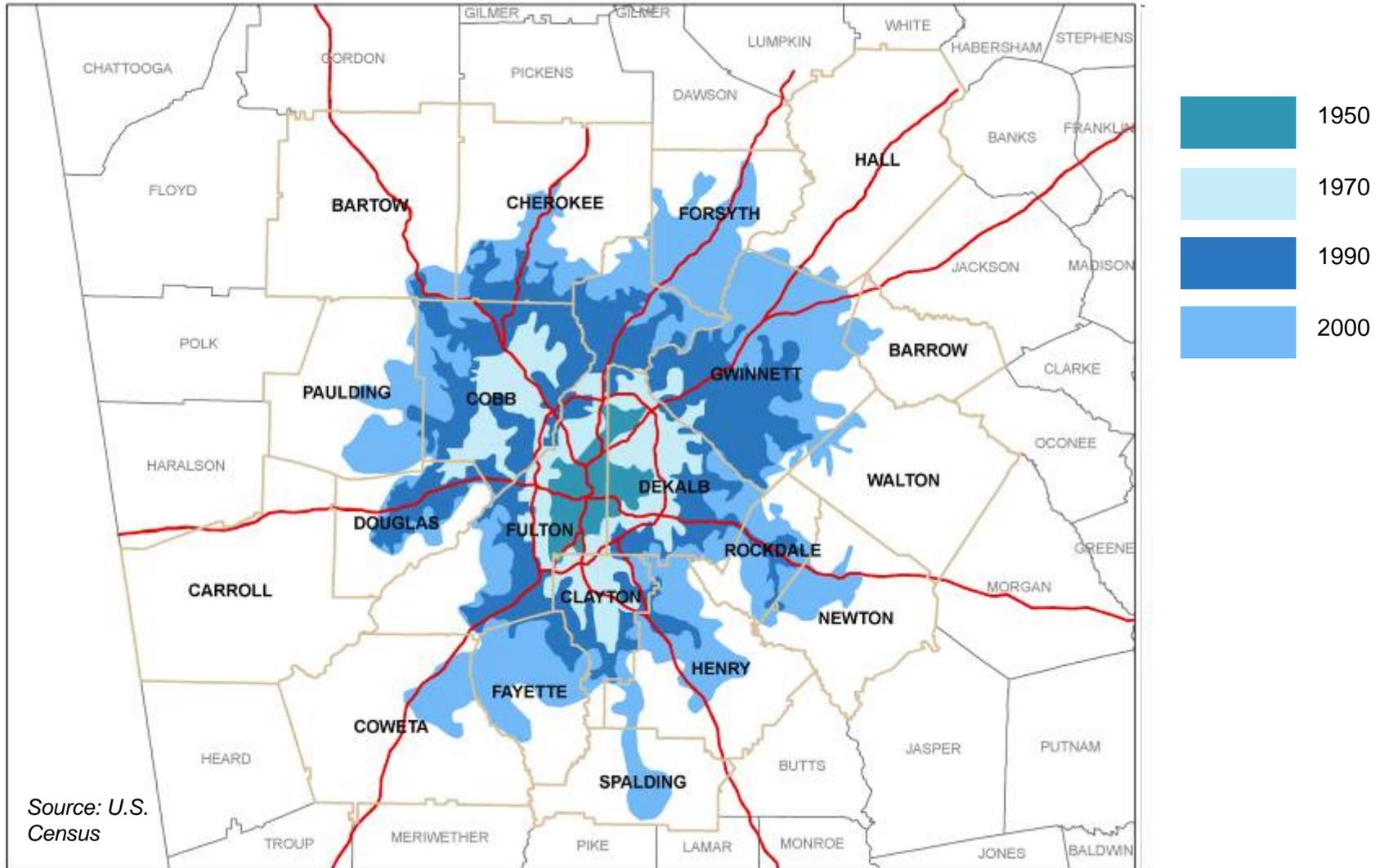
**Planning and Nonattainment Boundaries for the Atlanta Region**

 ARC 10-County Area	 Gainesville - Hall County MPO Transportation Planning Area
 13-County One-Hour Ozone Atlanta Nonattainment Area	 20-County Eight-Hour Ozone Atlanta Nonattainment Area
 ARC MPO Transportation Planning Area - All or portions of 18 Counties	

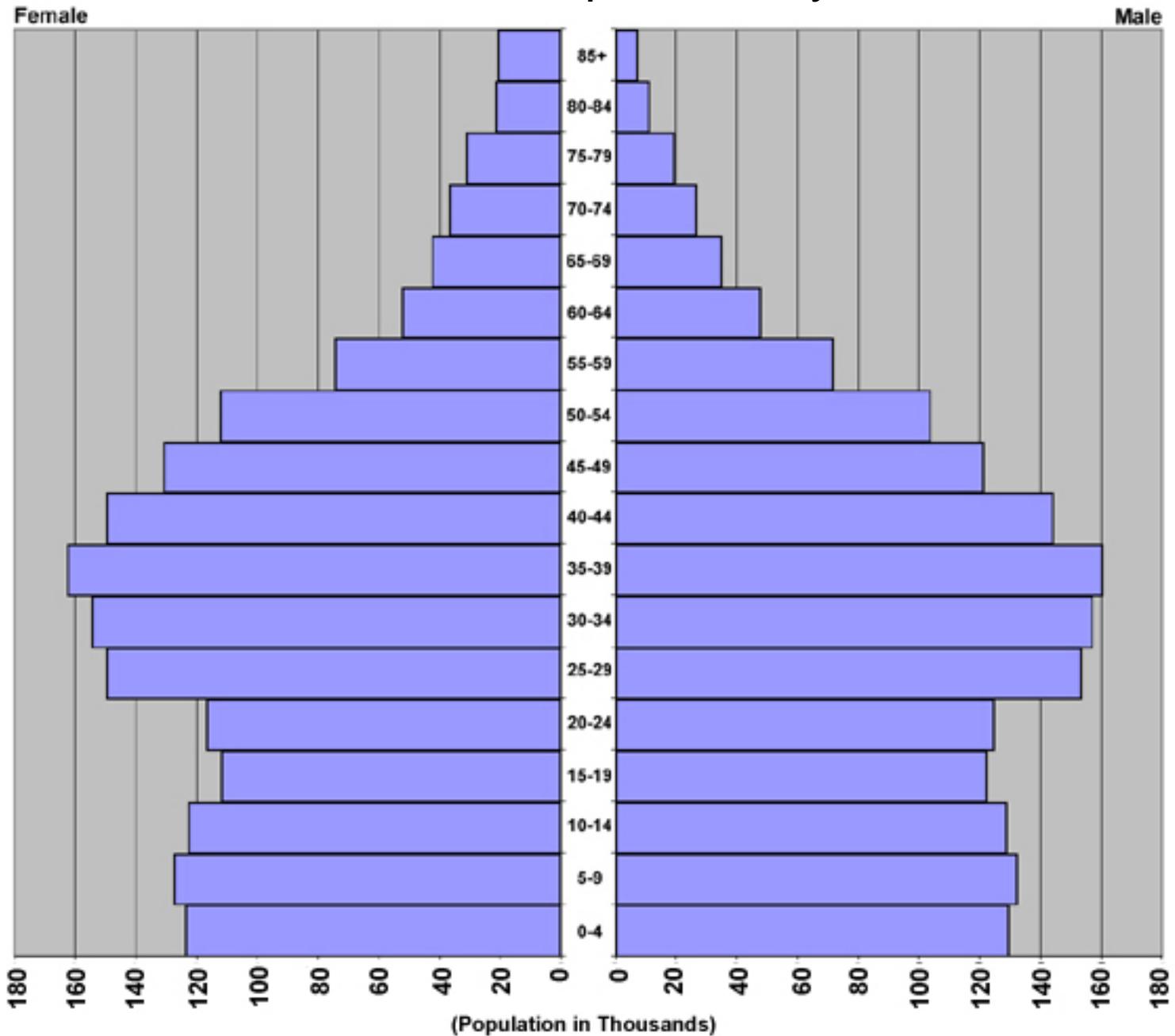
Data Source - ARC 2004

# Growth Over Time

## Atlanta Urbanized Area 1950 - 2000

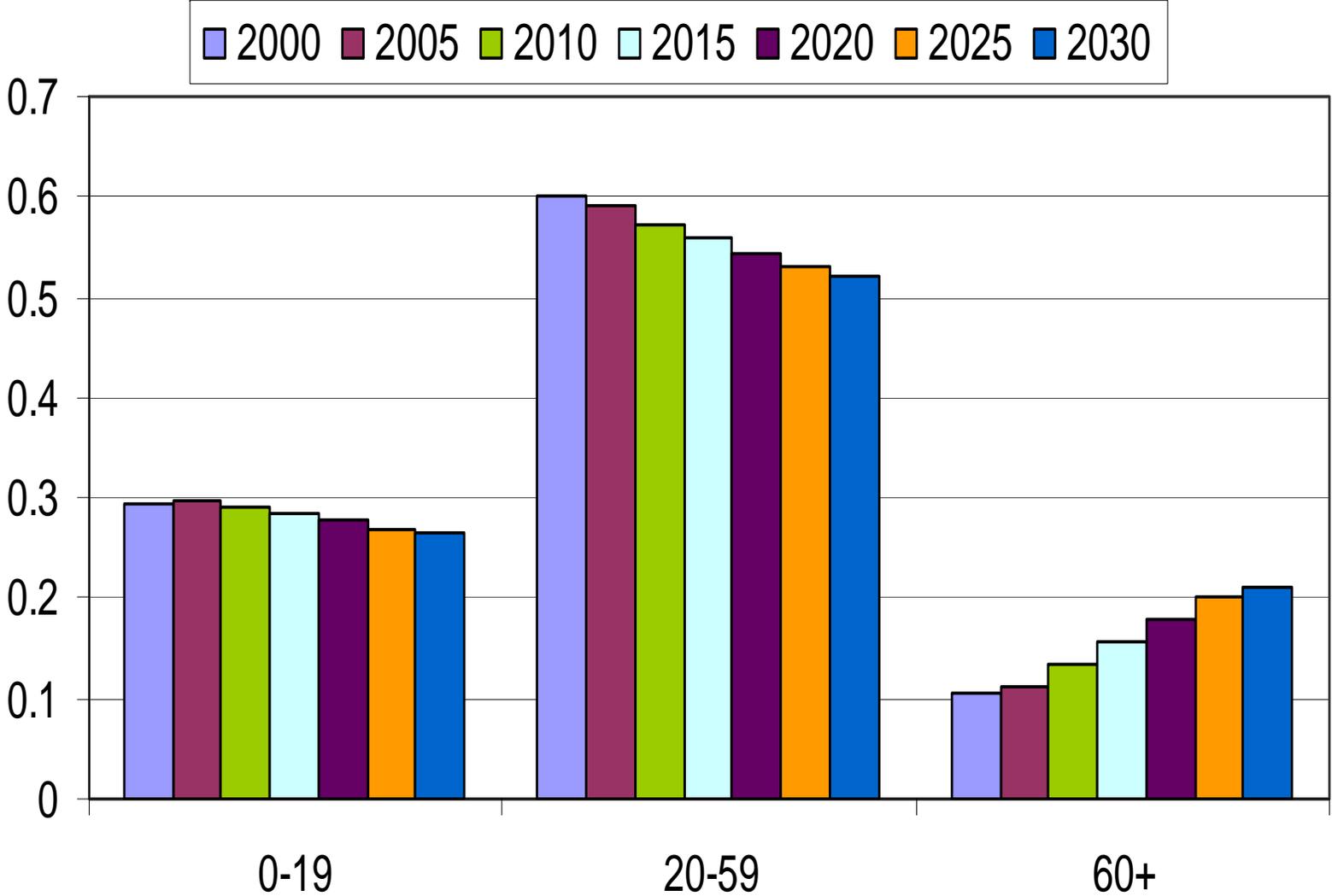


# 2000 Atlanta Population Pyramid



# The Aging of the Population

## ARC 20-County Forecasts



# More “Non-Traditional” Households

<u>Household Type</u>	<u>1970</u>	<u>2000</u>	<u>2030</u>
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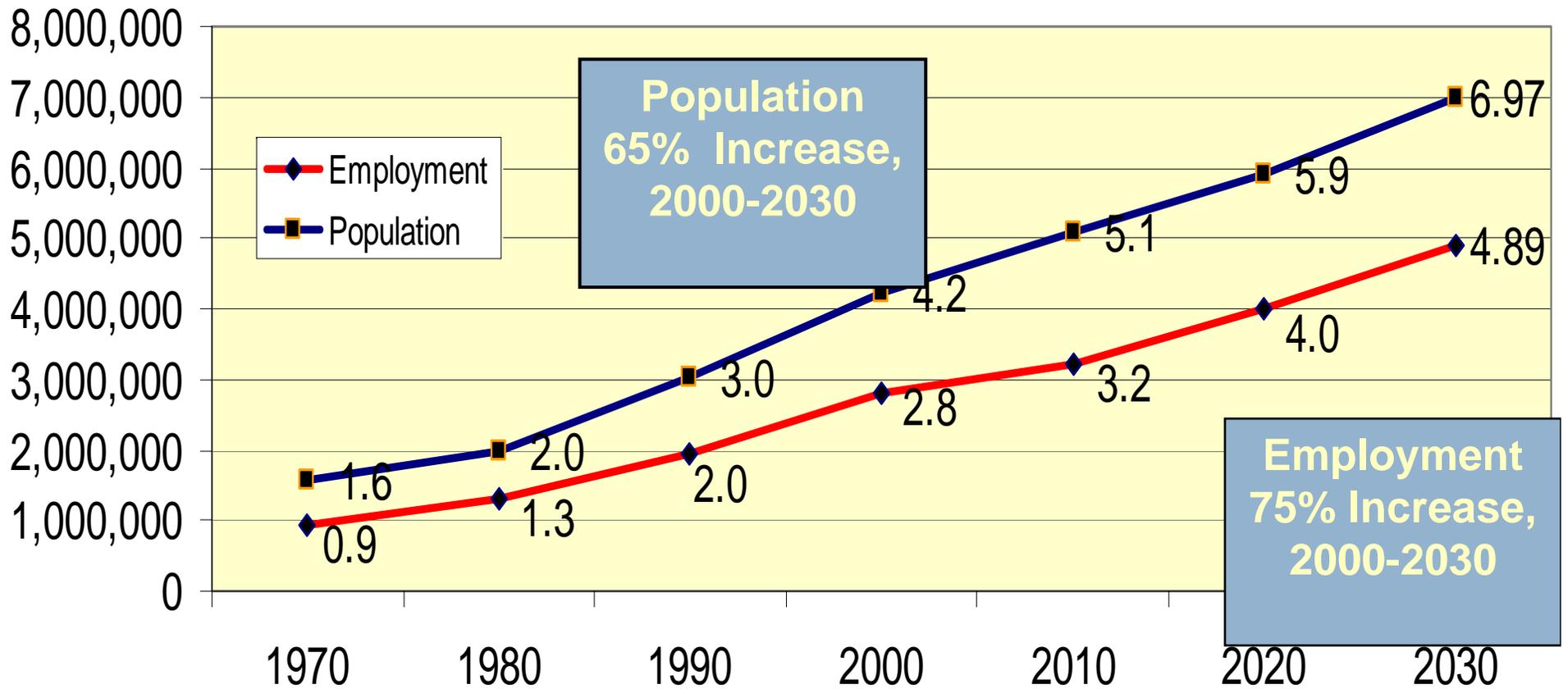
Family HH(2 parent)	81%	69%	65%
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With Children	40%	32%	21%
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Non-family HH	19%	31%	35%
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Living Alone	17%	25%	29%
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# ARC 20-County Forecasts



# Growth? What does this mean?

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2.3 million people is equivalent to adding the metro area of ...



One (1) Portland

OR



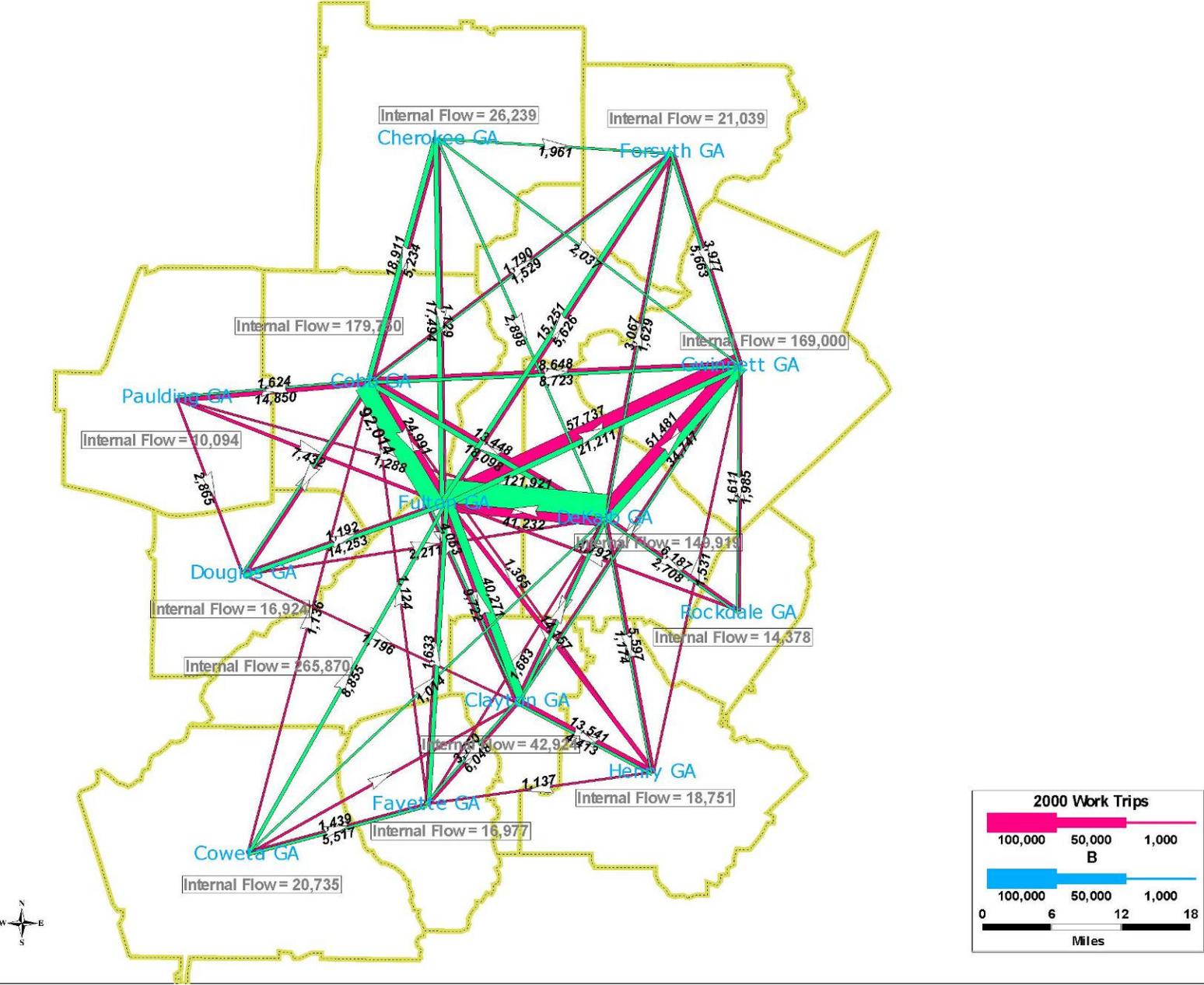
Two (2) Jacksonvilles

OR

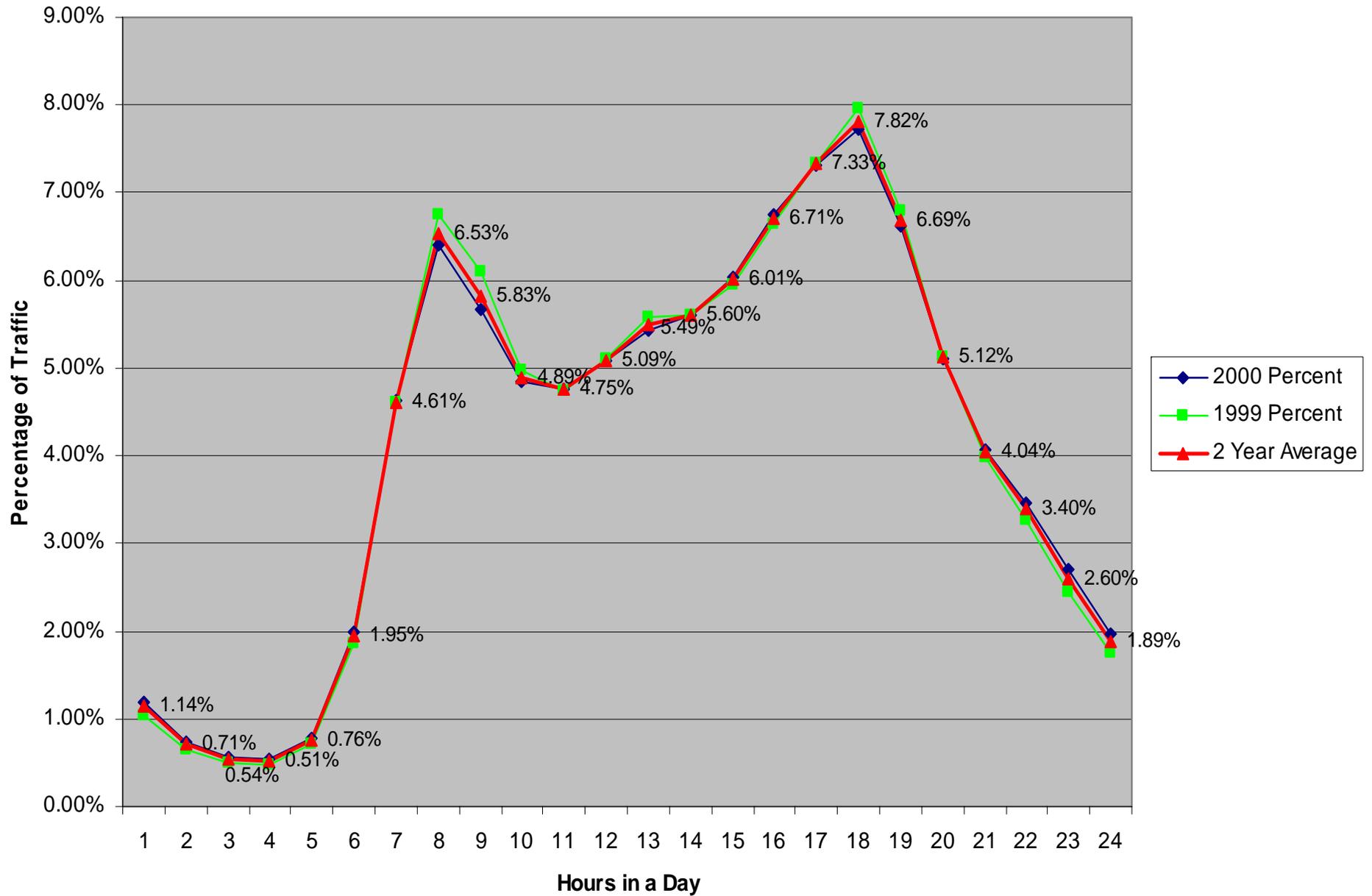


Four (4) Chattanooga

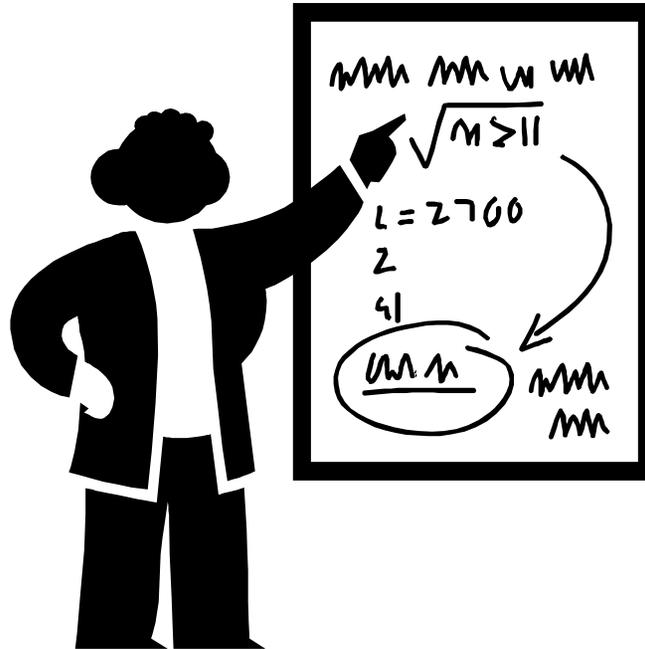
# Atlanta Region Work Trip Flows - 2000 CTPP



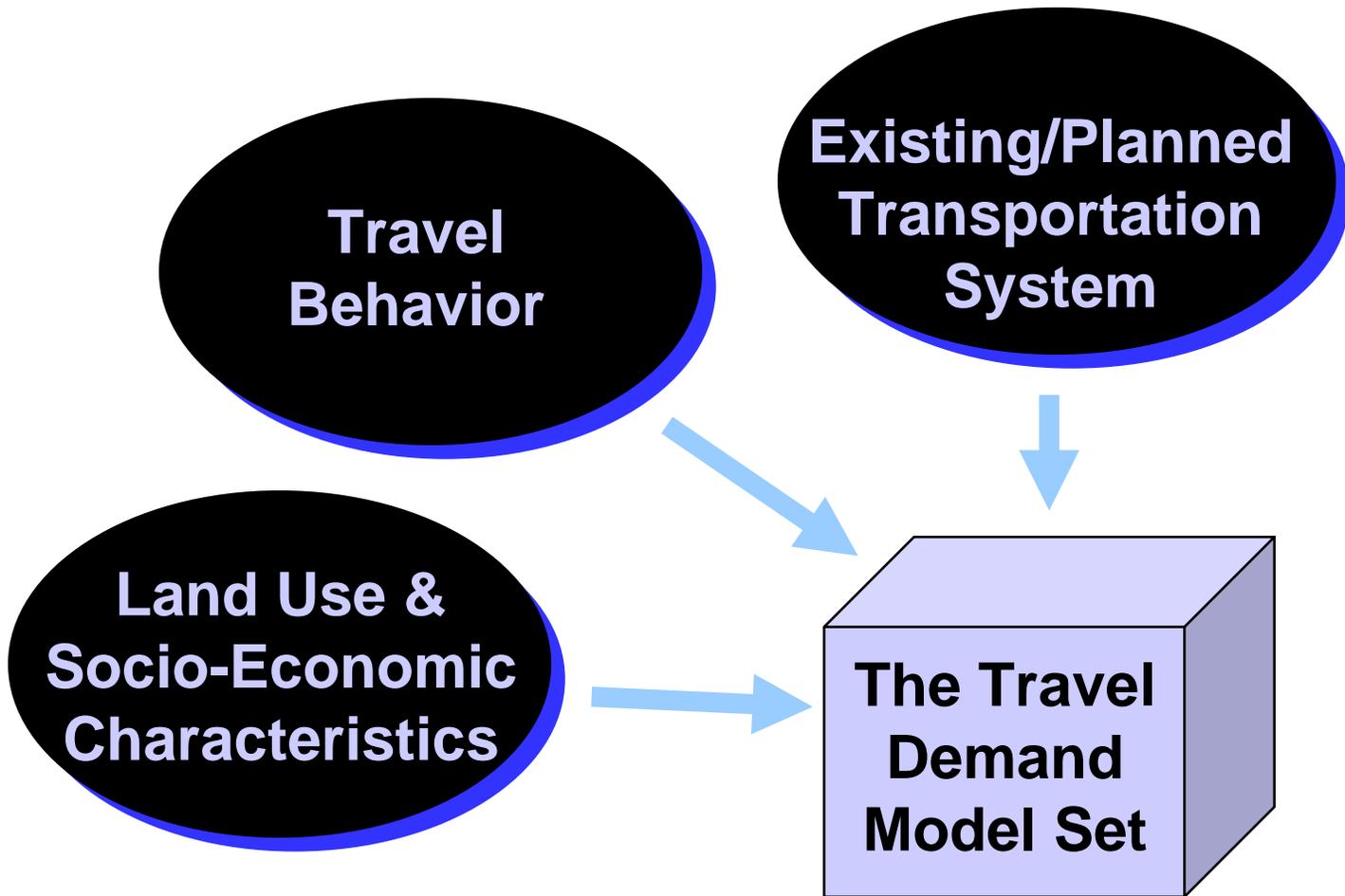
# Diurnal Traffic Distribution By Hour, Emergence of Mid-Day Peak, Time-of-Day Modeling



# ARC 4-Step Trip-Based Aggregate Model

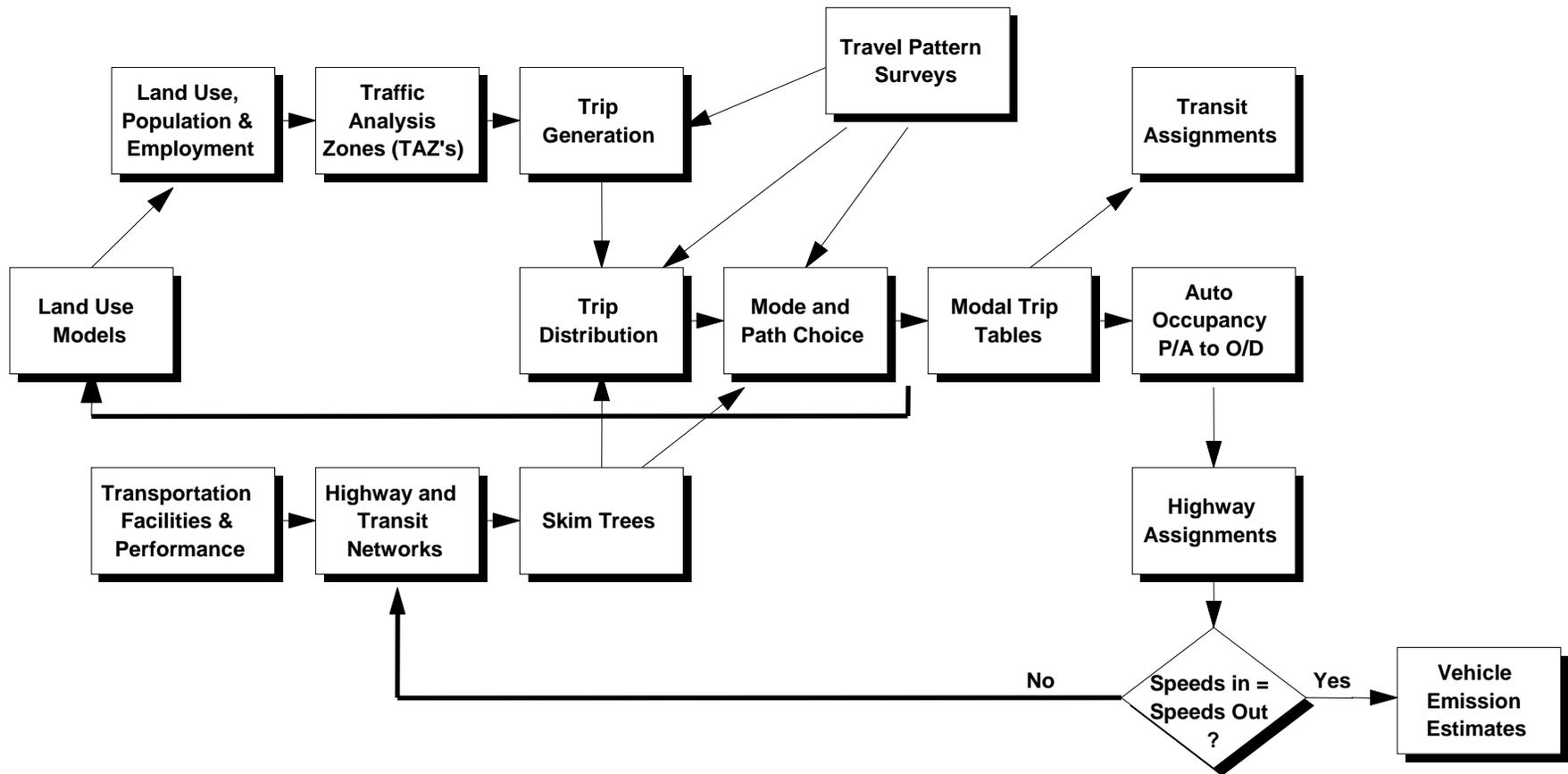


# Traffic Modeling at ARC - Where Do We Start?

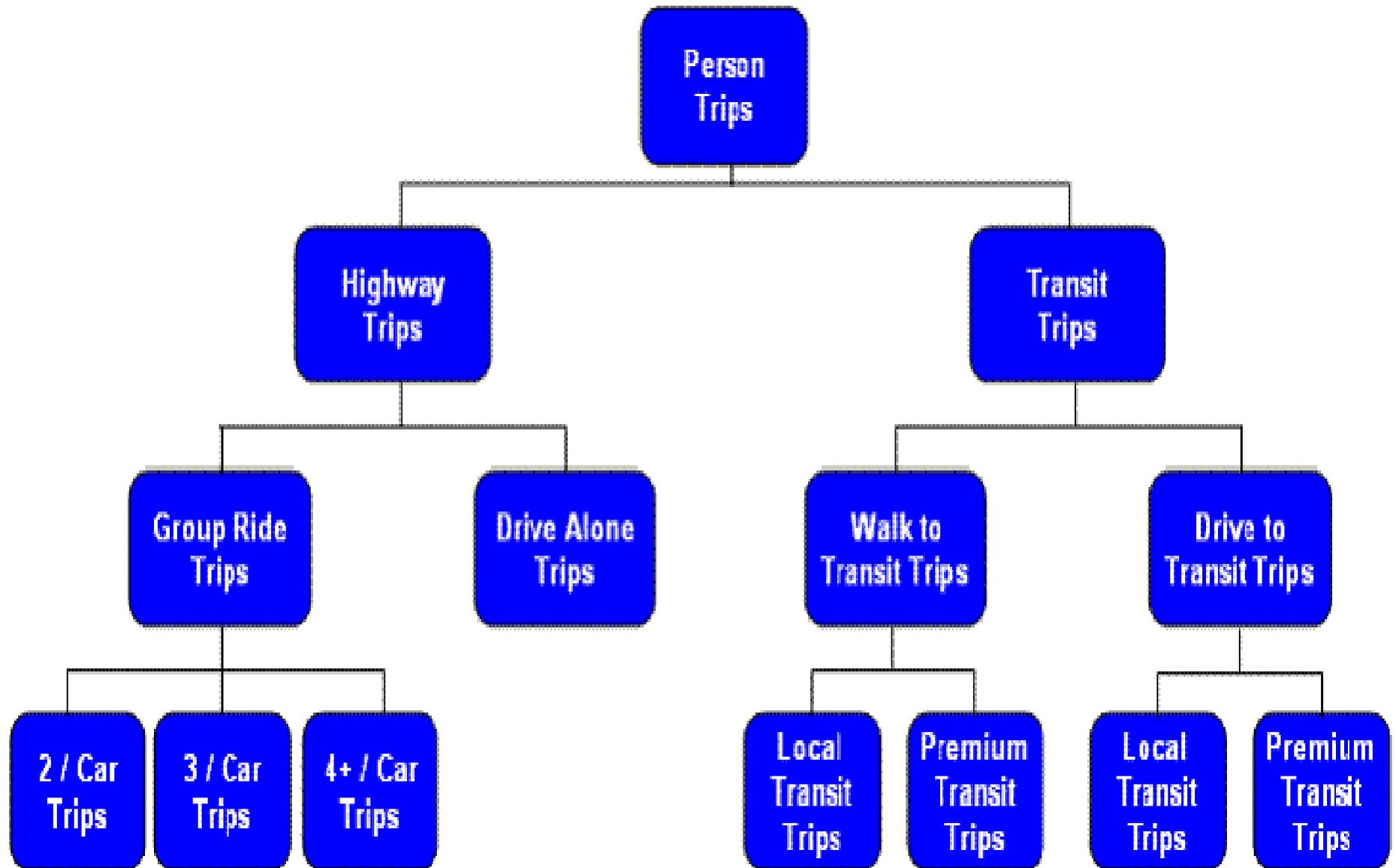


(The “Black Box”, to “demystify”)

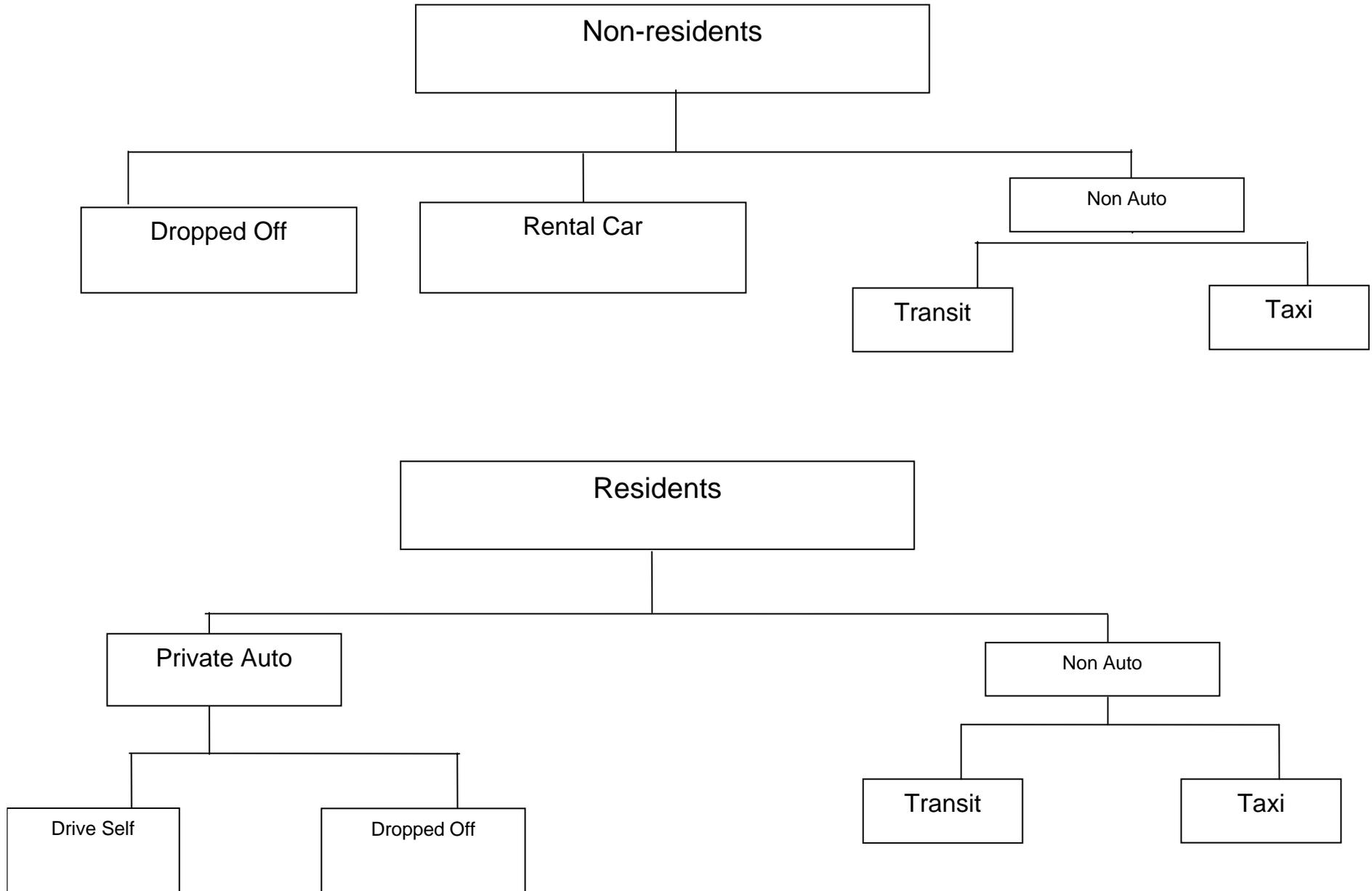
# The 4-Step Process - ARC Travel Demand Forecasting



## ARC Mode Choice Nesting Structure



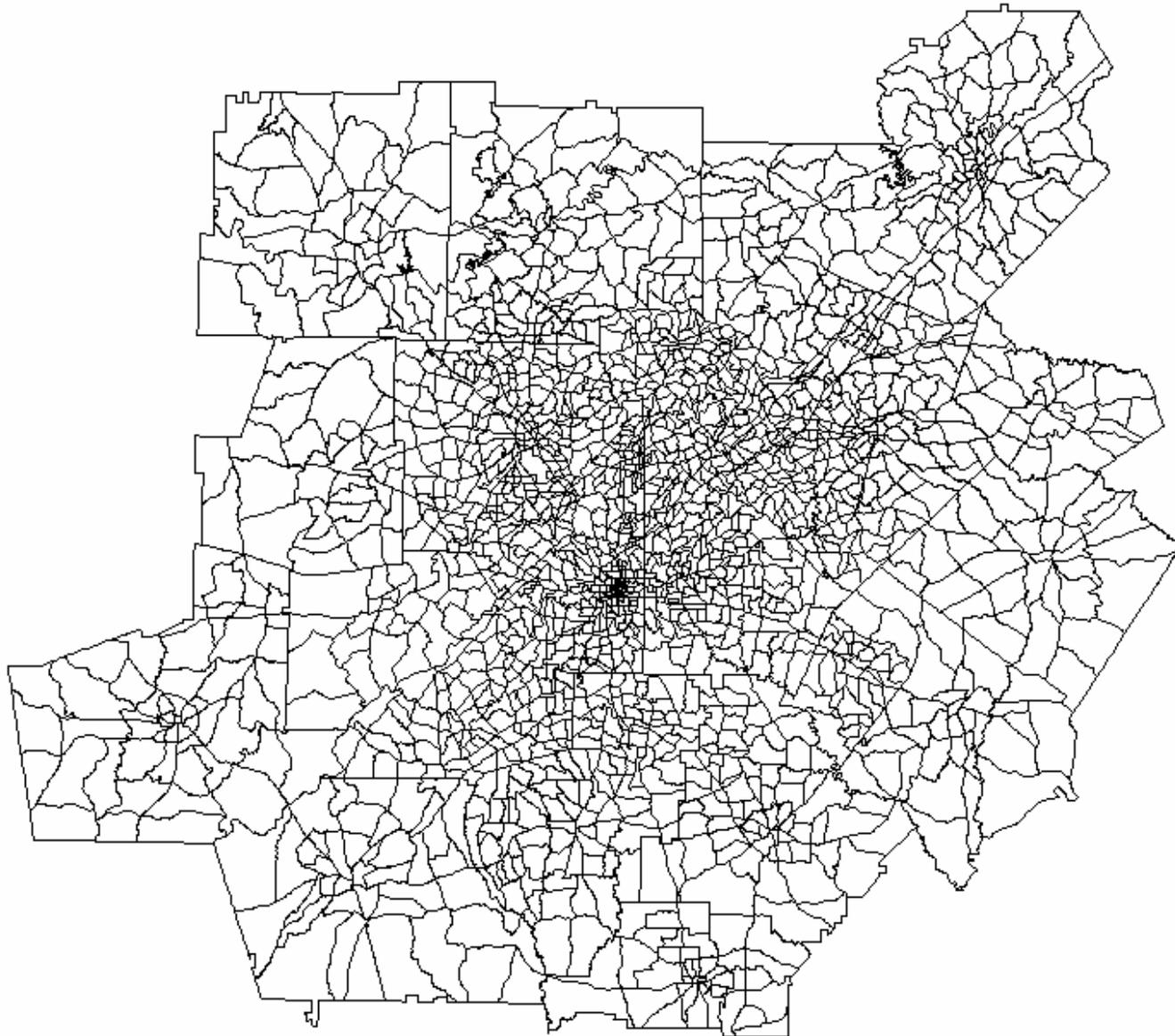
# ARC Air Passenger Mode Choice Structure



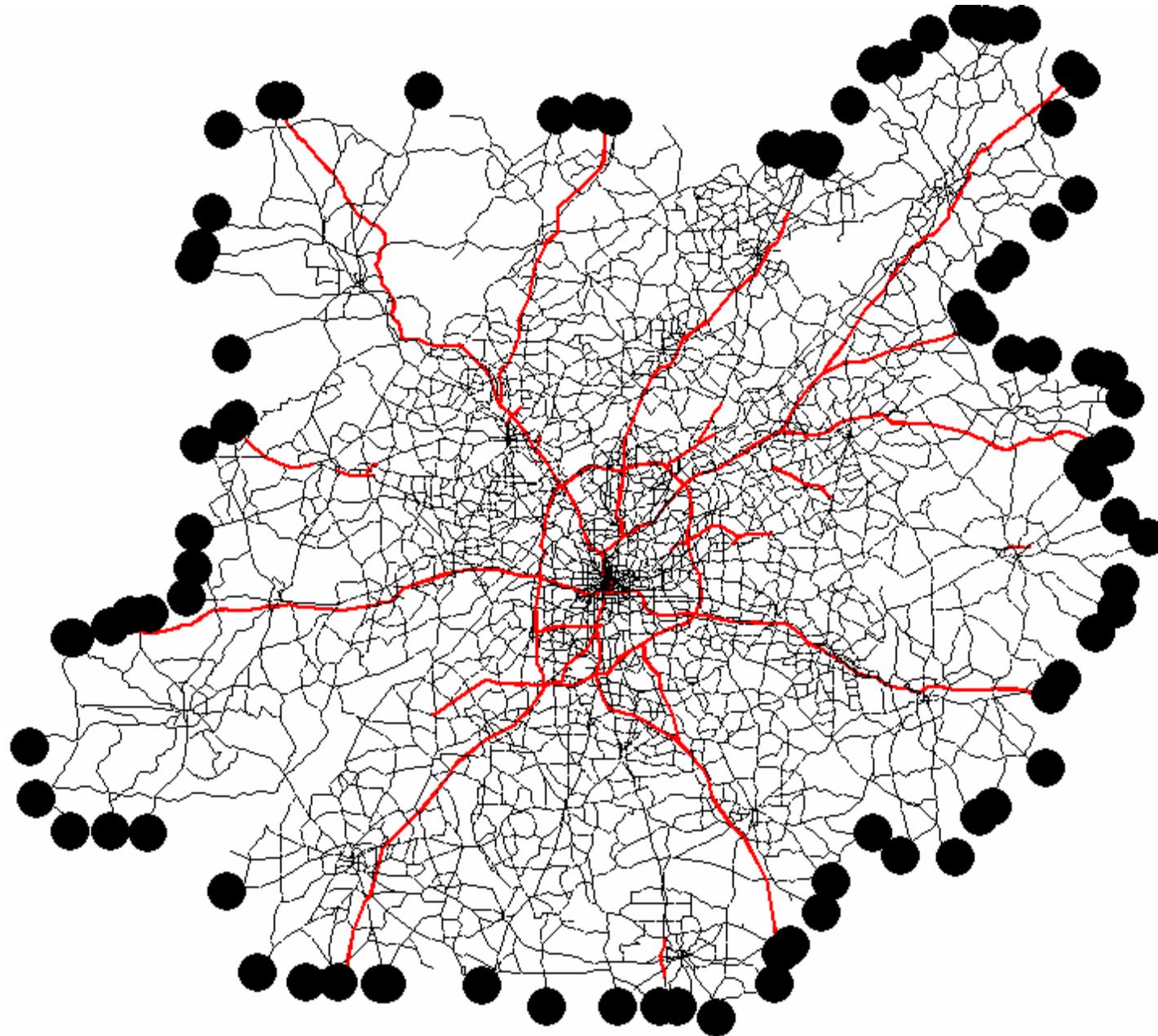
# Model Expansion, Why Expand?

- On December 17, 2004, EPA designated 20 whole counties and two partial counties within the metropolitan Atlanta area as non-attainment under the fine particulate matter (PM 2.5)
- As a result of this non-attainment designation, the ARC initiated the effort to expand the modeling domain from 13 to 20 counties in order to meet the federal requirements for performing conformity analysis
- The addition of the 7 new counties added over 500,000 persons and over 1.5 million acres to the model boundary area

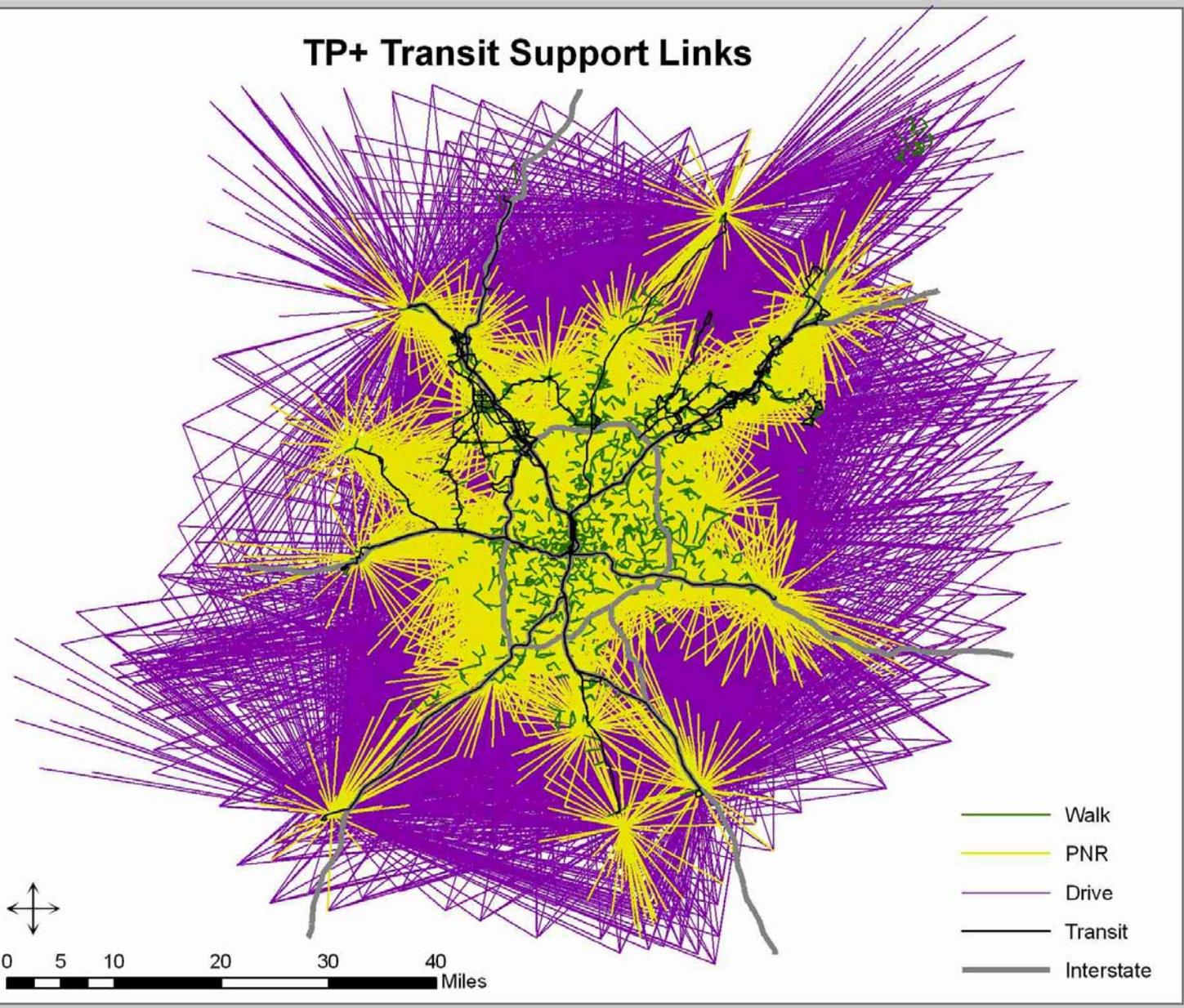
**TAZ for the 20 County Region (2024 internal TAZ, 1683 in old model)**



91 External Stations (2024 + 91 = 2115 total taz, 1740 in old model)



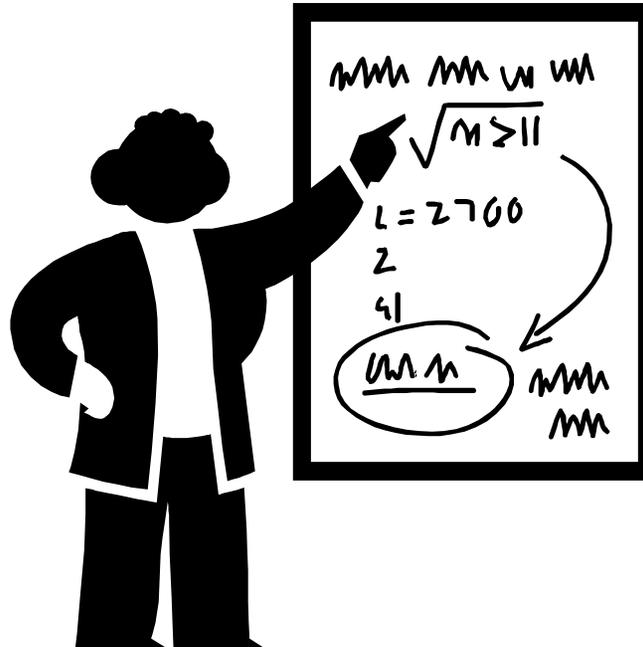
# TP+ Transit Support Links



# Model Domain Statistics

	<b>13 Counties</b>	<b>7 Counties</b>	<b>20 Counties</b>
<b>Total # of Links</b>	<b>38,513</b>	<b>14,955</b>	<b>53,468</b>
<b>Route Miles</b>	<b>18,327</b>	<b>7,273</b>	<b>25,600</b>
<b>Lane Miles</b>	<b>22,855</b>	<b>8,022</b>	<b>30,877</b>
<b>Area in Sq. Mi.</b>	<b>4,028</b>	<b>2,374</b>	<b>6,402</b>
<b>2005 VMT</b>	<b>130M</b>	<b>N.A.</b>	<b>150M</b>
<b>2030 VMT</b>	<b>190M</b>	<b>N.A.</b>	<b>225M</b>

# ARC ABTB Disaggregate Model



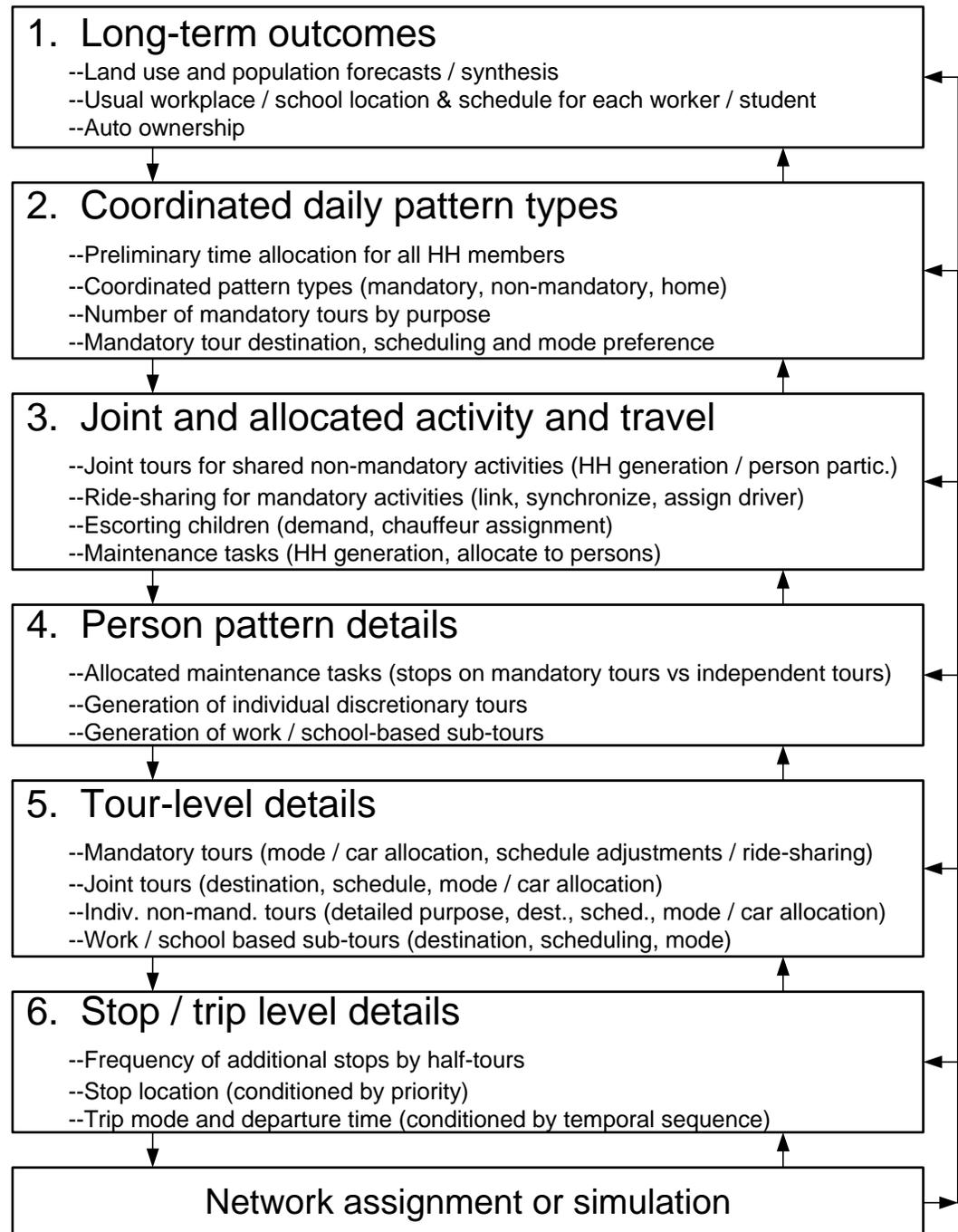
# Historical Context Of ABTB

- 2001: system design for 13-county model domain:
  - Land use, household formation, activity travel
- 2002: preparatory work:
  - Analysis of 2001 SMARTRAQ household travel survey data (2-day diary survey format)
  - Problems identified and corrected with data (some missing/incomplete diaries)
  - Survey deemed adequate for model system design
  - Results analysis: variety & complexity of activity & travel patterns throughout the Atlanta region
  - Key motivation for proposed activity & tour based design

# ABTB Model Design Highlights

- Combination of most attractive & realistic features of previously developed ABTB models (SF, NY, MORPC)
- Open architecture & modular design allows to add features
- Special emphasis on integrity of model system components (not a simple sequence of models!) through:
  - Time-space constraints (feasible activity patterns)
  - Intra-household interactions
  - Accessibility impacts at all decision-making stages (activity generation, tour formation, location, schedule)
  - Global equilibrium framework
- Vision of model structure in place
- Only population synthesizer has currently been implemented

# Main Sub-Models (All Estimated)



# Historical Context (Cont.)

- 2003: debut of population synthesizer (birth of “PopSyn”) given the existing DRAM/EMPAL land use model outputs
- Developed procedures to validate resulting synthetic population (base-year population & forecast population)
  - Synthesized base year 2000 population
  - Used 1990 census data to emulate land use Backcasts to 1990
  - Used land use Backcasts to synthesize 1990 population
  - Compared 1990 synthetic population to 1990 census summary tables: successful comparison, mission accomplished!

## Historical Context (Cont.)

- Early 2004: TMIP model peer review recommended early deployment of population synthesizer
- Late 2004: EPA designated 20 whole counties & 2 partial counties within Metro Atlanta as non-attainment under PM 2.5 (fine particulate matter)
- Result of this non-attainment designation:
  - ARC initiated effort to expand 4-step trip-based model from 13 to 20 counties in order to meet federal requirements for performing conformity analysis
- Addition of 7 new counties added:
  - 500,000 persons
  - 1.5 million acres to the model boundary area

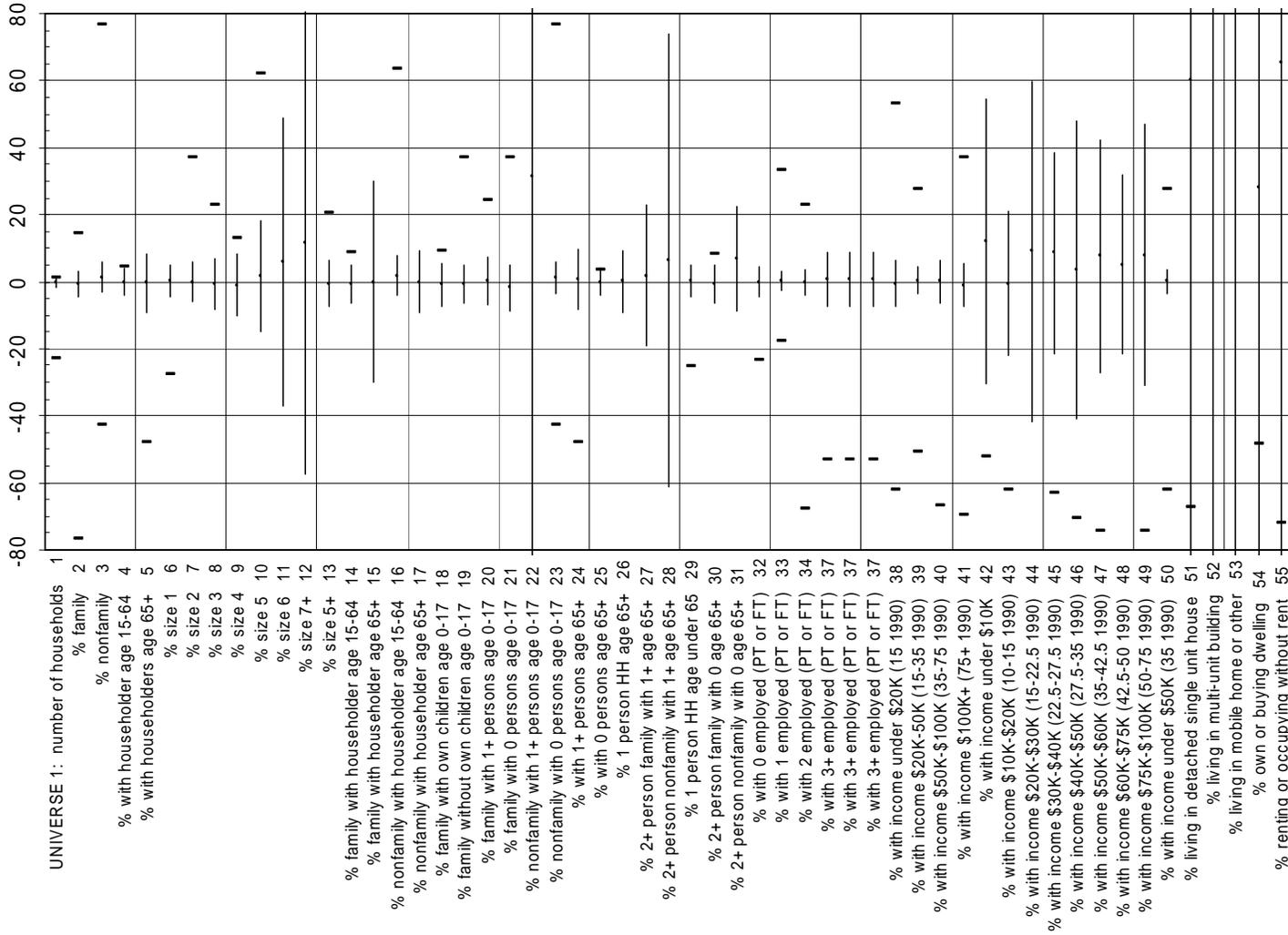
# Historical Context (Cont.)

- 2005: expansion & calibration/validation of 4-step trip-based model
  - ABTB model development slowed down
  - ABTB efforts dispersed
  - ABTB progress impacted
- 2006: expanded 13-county population synthesizer to 20-county model architecture
  - 13-county PopSyn presented at may 2006 TRB Austin conference

# PopSyn Validator Graphical Output

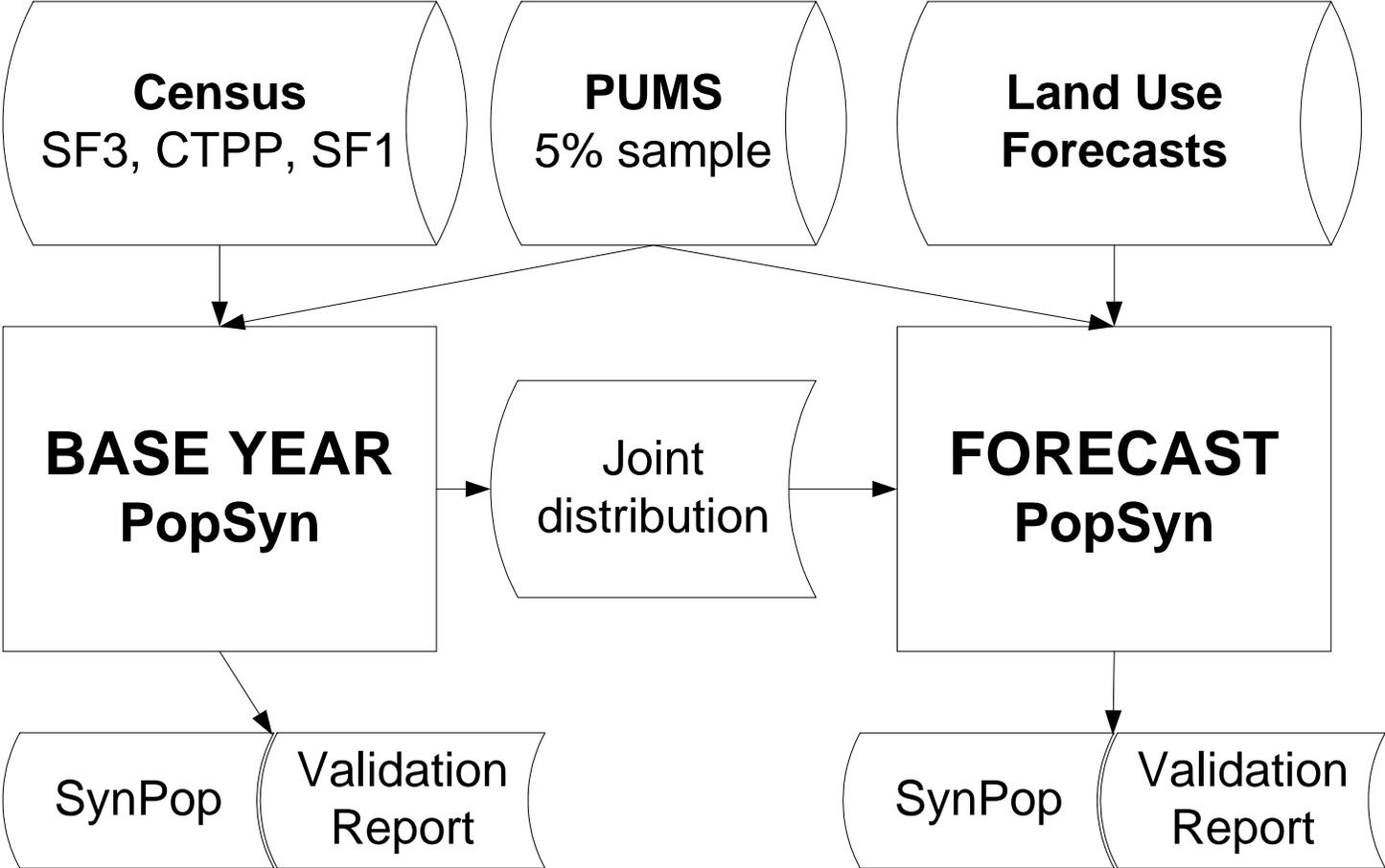
Design: 316 HH, 20-County, 2000 Base Year, Census Tracts

Synthetic Population vs Census Tables  
Household Characteristics

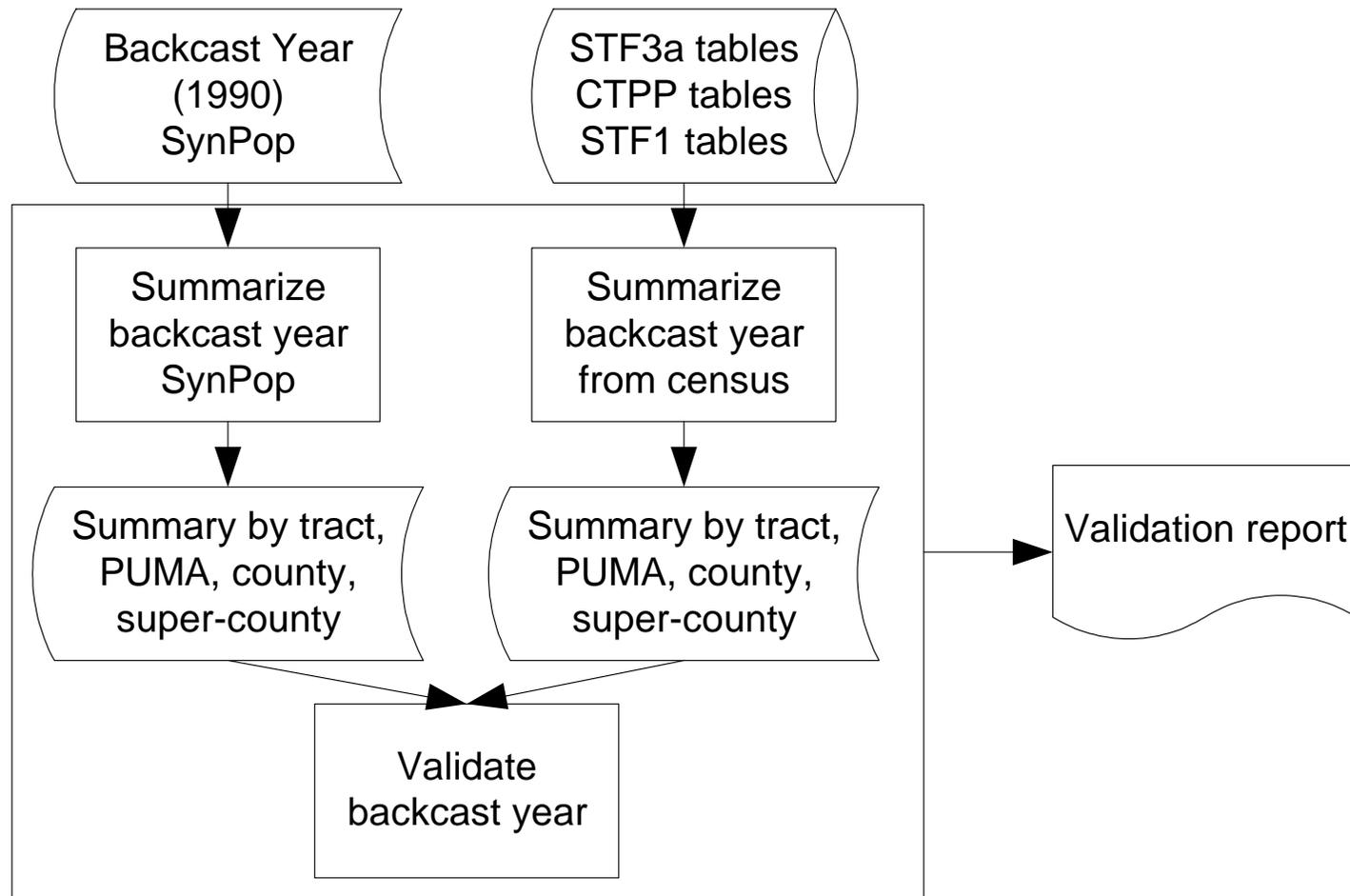


- Max % Difference · Mean % Difference (plus/minus one standard deviation) - Min % Difference

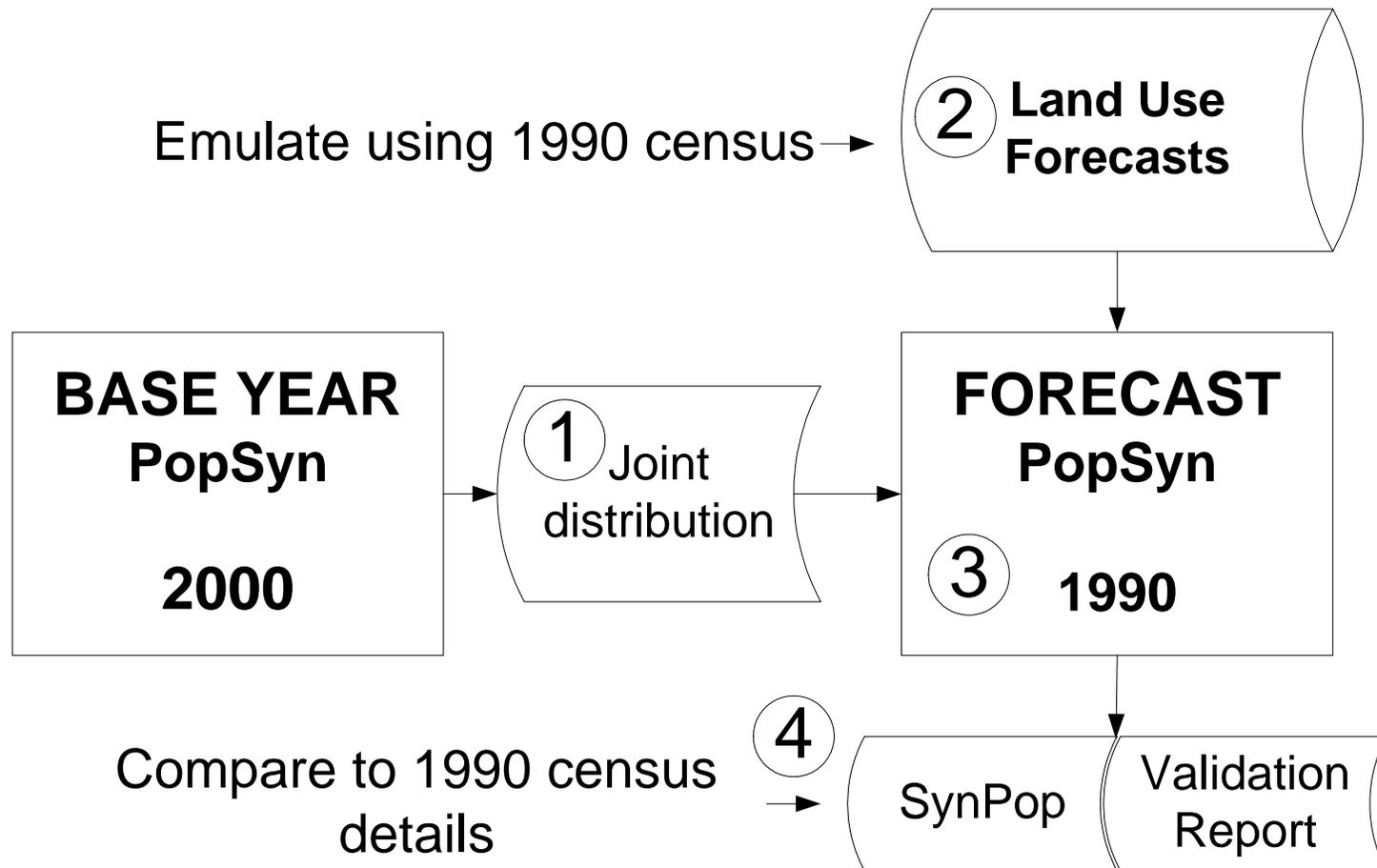
# PopSyn Operation



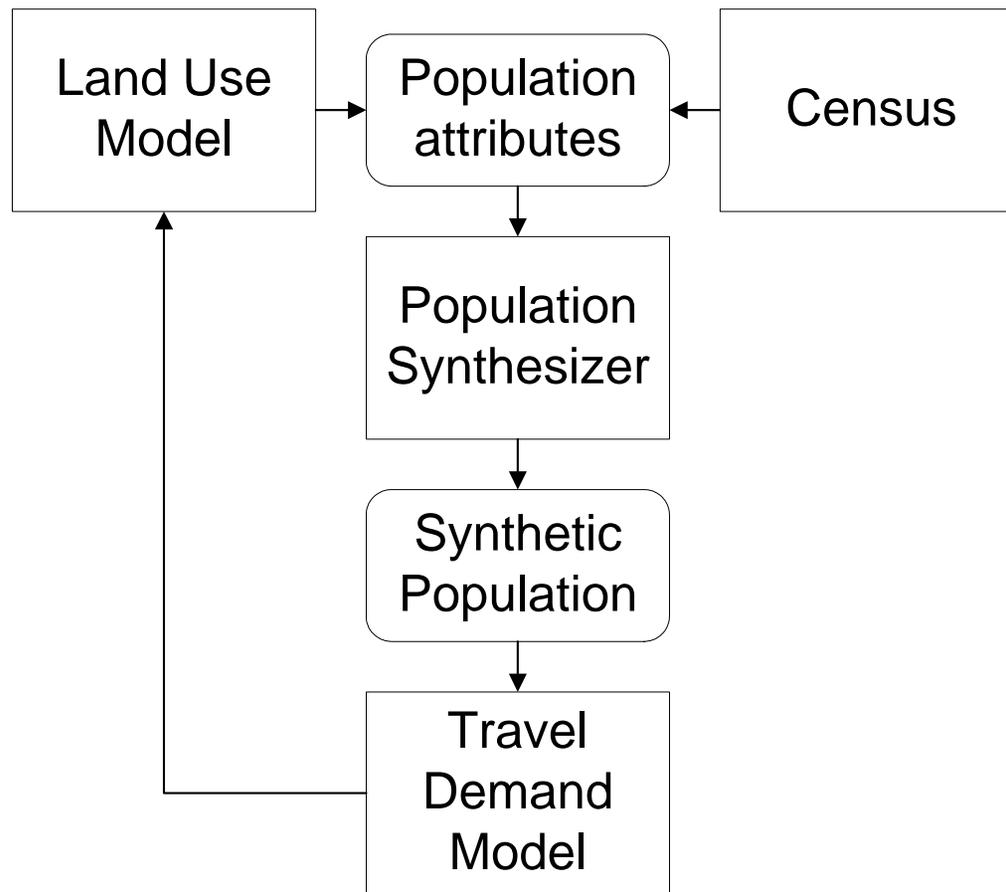
# PopSyn Validation Procedure



# PopSyn Forecast Year Validation



# PopSyn Model System



# Potential Enhancement to Population Synthesizer to Integrate ACS Data????

- Use ACS data to provide control data
- Synthetic population could be generated for any year for which ACS data is available
- Use ACS PUMS to supply the households in the synthetic population
- Use 2006 distribution of the 2005 ACS data & a combo of county and PUMA level data, since tract-level is not expected until 2010
- Modify the PopSyn balancer to handle controls at the 2005 ACS level of geography, by simultaneously using TAZ, ACS and regional control totals
- The population synthesizer's drawer could draw households from 2000 PUMS or ACS PUMS

## Arc's Strategy: Staging Transition From 4-step Trip-based To ABTB

- How does ARC intend to get from where we're at now to full implementation and use of activity-based model system?  
Implement a simulator in stages
- At each stage ARC ends up with a working simulator; not one that simulates whole output, but at each stage, more and more of output is generated
- Stage 1: population synthesizer
- Stage 2: population synthesizer plus long term model improvements
- Stage 2.1: connect partial simulator to existing 4-step trip-based model system
- Stage 3: add day-tour-trip simulator
- Stage 4: integration with traffic assignment

## 2007: Use PopSyn In Arc's Trip-based 4-step Model Via Trip Generation

- Re-run population synthesizer
- Create synthetic population of persons in households
- Aggregate results into matrix of households by income & size
- Incorporate synthesizer & aggregator into model job stream
- Concrete step toward implementing ABTB modeling by incorporating front-end into model

# What Else in 2007 for ABTB

- Complete workplace / school location model
- Complete car ownership model
- Then this becomes next set of ABTB models, following population synthesizer
- ARC purchased special tabulations from census that allows using auto ownership as control variable in validating base year
- Over time we will:
  - Attach entire “day-tour-trip” section in 2008
  - Attach that to assignment portion possibly using cube voyager
  - By end of 2008, have complete activity based model system running for analysis

# What's On Tap For ARC In 2008?

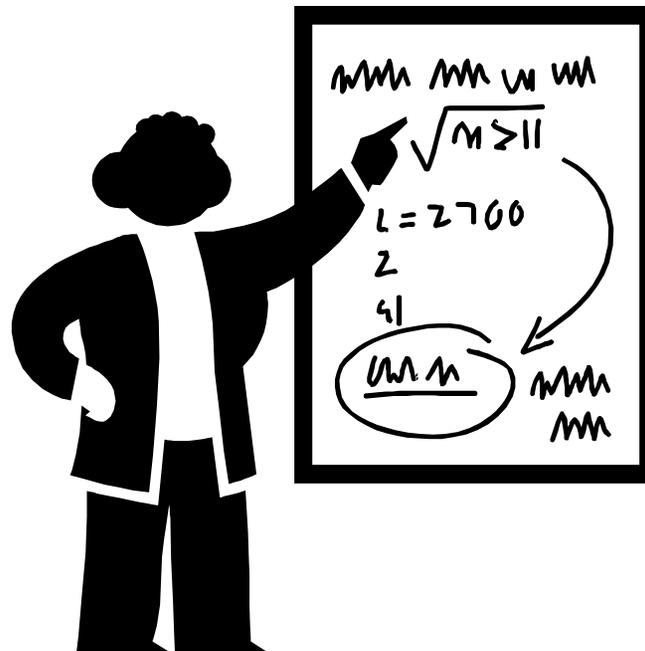
## Core Choice Models

- Coordinated daily activity pattern type: all households
- Joint travel / activity, including generation and participation sub-models
- Individual travel generation / tour formation for all households
- Tour destination choice for all travel purposes
- Tour time-of-day choice for all travel purposes
- Tour mode choice for all travel purposes
- Stop frequency for all tour types
- Stop-location for all tour types
- Trip mode choice for all tour types
- Trip departure time for all tour types, trip purposes, and trip placement in tour chain
- Parking choice for auto trips to CBD

## 2009: Final Calibration, Validation & Training

- Zonal & network data, assignment & skimming for highway & transit
- Model shell application for PopSyn, core models & auxiliary models (trucks, externals, special generators)
- Structural calibration targets sources: household survey, traffic counts, CTPP, transit ridership
- Validation & comparisons to existing 4-step model
- Software & custom hardware with distributed cluster processing

# Other 2007 Model Activities



# Model Management

- Import 20-county model TP+ script into Cube Voyager applications manager
- Incorporate Cube cluster to distribute and accelerate model processing
- Integrate performance measures in Cube reports
- Develop additional QA/QC checks

# Trip Distribution

- Evaluate destination choice model developed in 2006
- Compare performance of 2006 destination choice model against existing gravity model
- Based on evaluation, may replace trip distribution model

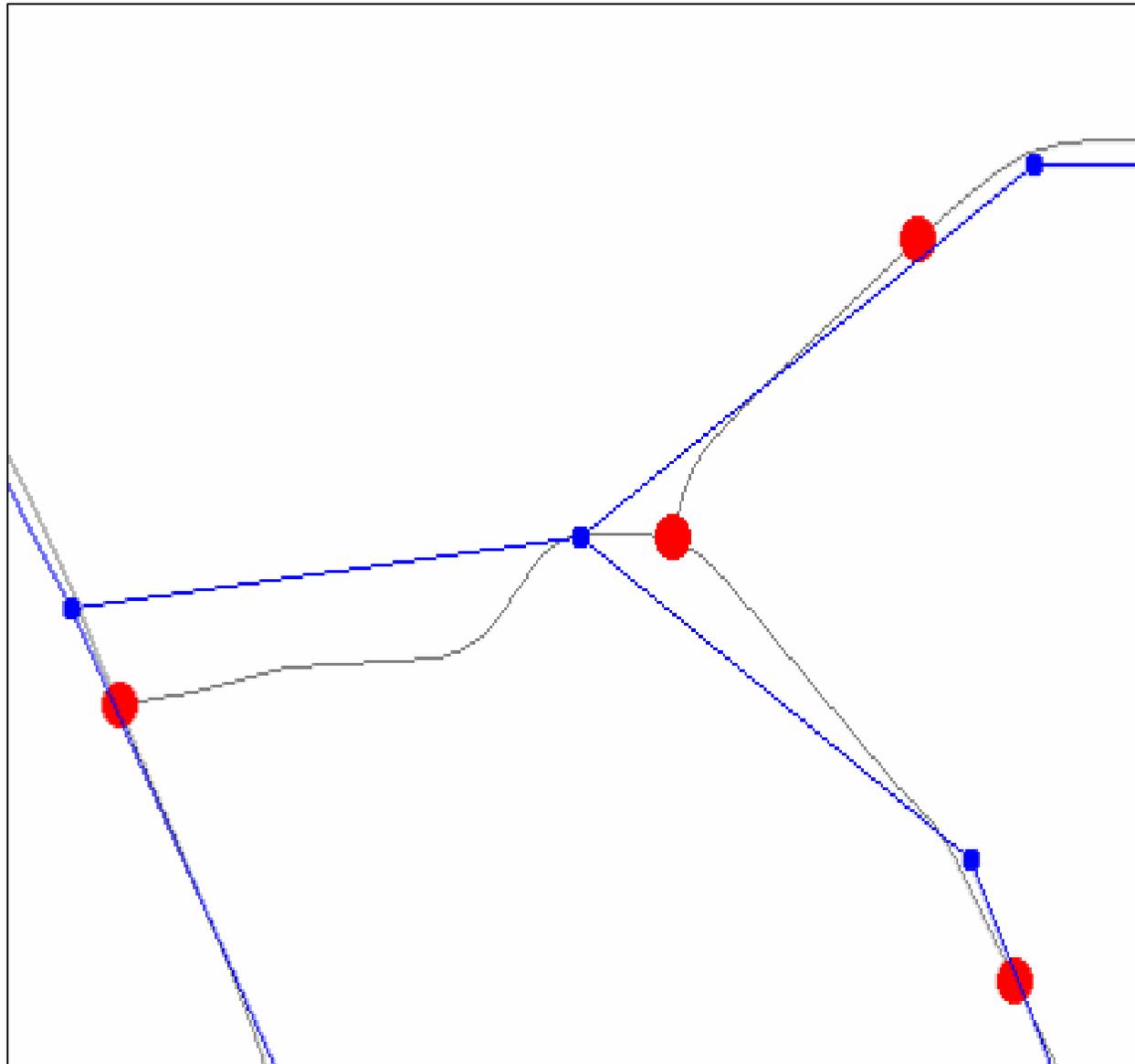
# GIS-T Data Disaggregation

- Develop GIS-T based methods to allocate SE data from Dram/Empal “districts” (census tracts or other) to TAZ
- Identify growth allocation criteria and related algorithms
- Develop, test and deploy the new zapping methods

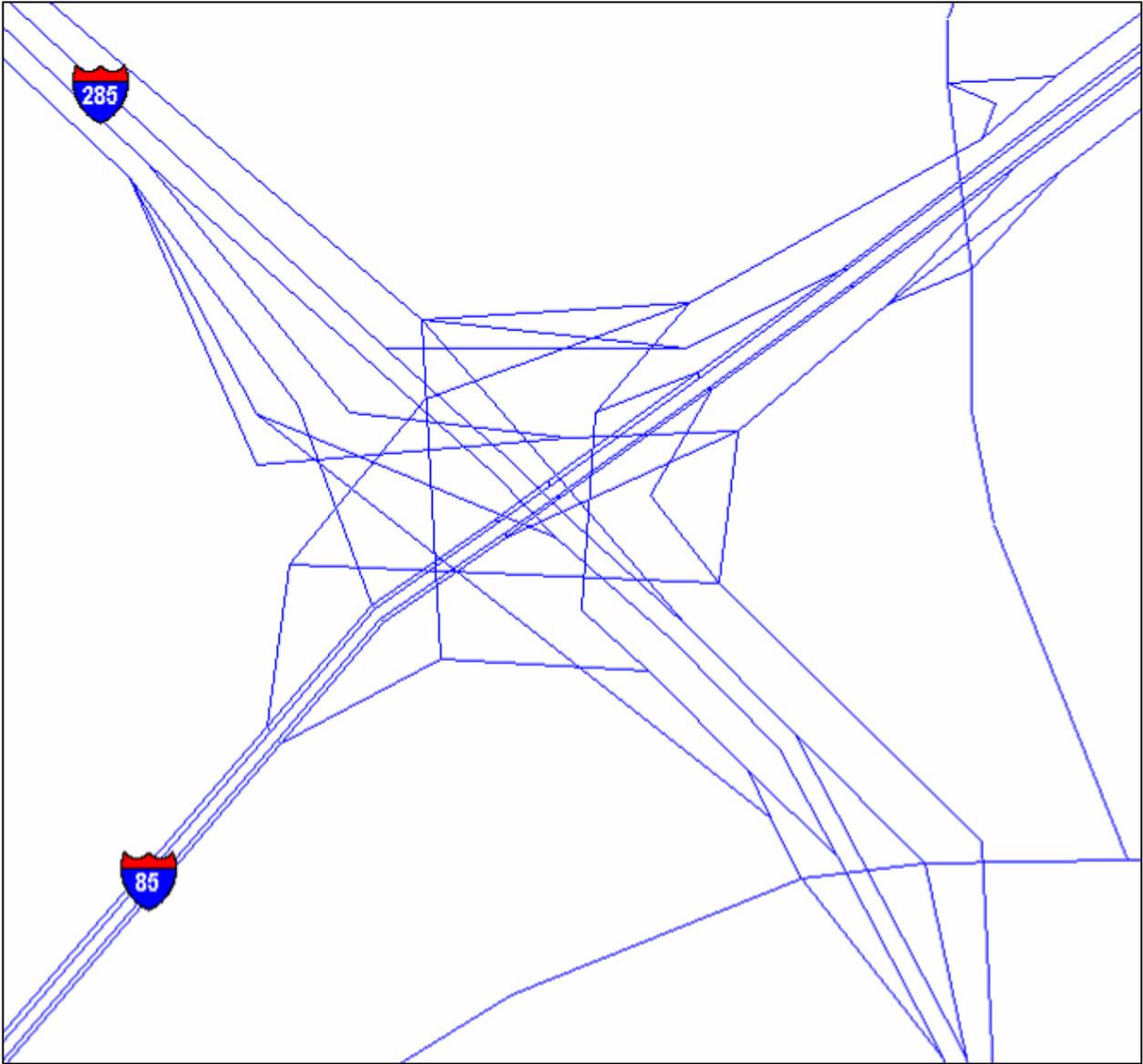
# GIS-T Network Topology

- Conflate highway network to NAVTEQ street centerline file
- Why: to ensure spatial accuracy of highway network (link distances, # of lanes, etc...)
- Conceptualize multi-year network coding, and eventually build networks from shape files

# Network Conflation to NAVTEQ Street Centerline File



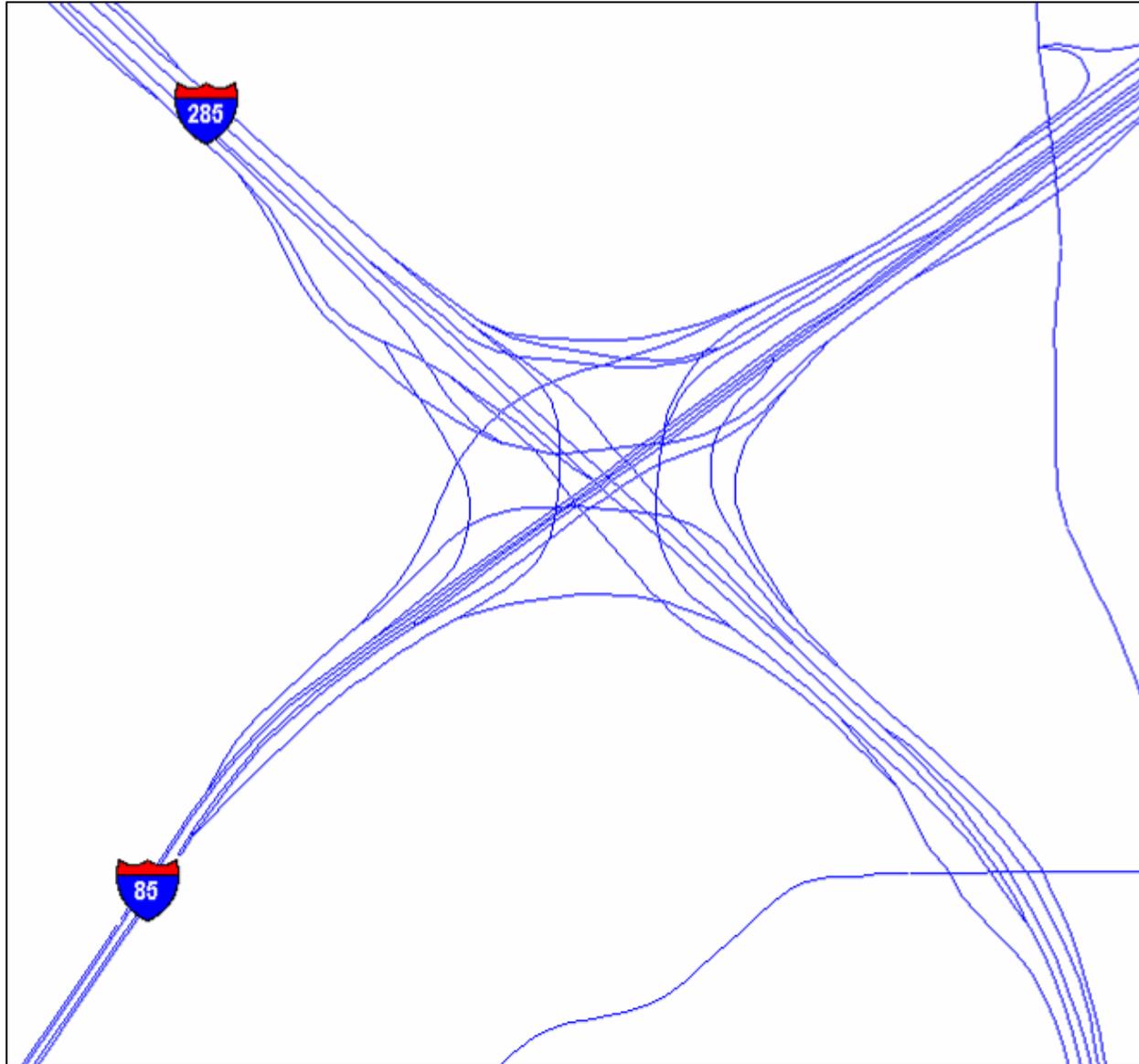
# Spaghetti Junction in Original “Stick” Network



**“Spaghetti Junction” (I-85 @ I-285)**



# Spaghetti Junction in Conflated Network



# Mode Choice & Transit

- Enhance parking cost component of mode choice model
- Coordinate with FTA on model refinements for new starts applications
- Investigate TOD transit modeling
- Compare PT and TRNBUILD

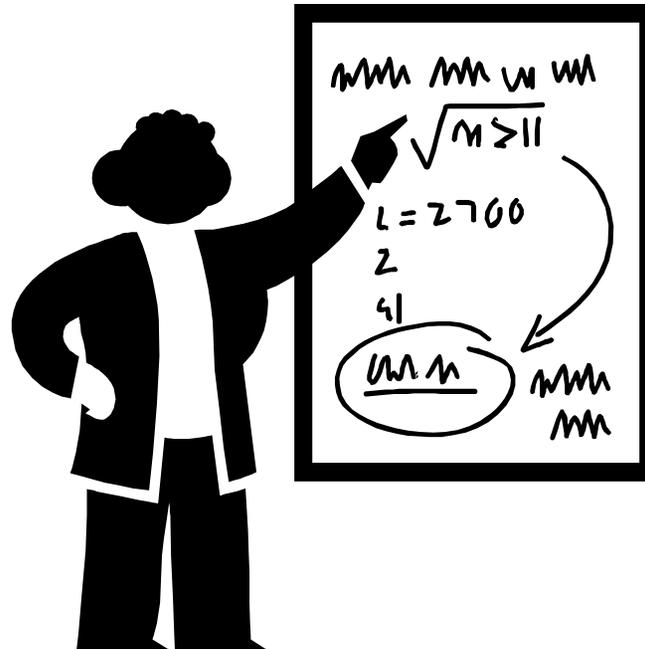
# Highway Assignment

- Revisit the VDF curves
- Enhance managed lanes & toll modeling capabilities (i.e., VOT)
- Evaluate DTA for corridor analysis
- Perform model sensitivity analyses

# Freight Modeling

- Integrate data from freight modeling action plan
- Design a multi-modal commercial vehicle model
- Evaluate cube cargo
- Develop separate growth models for I-E and E-E, and validate against station counts

# TRANSIMS in Atlanta?



# Why?

- AECOM providing guidance to GRTA, EPD & ARC for:
  - Developing a rapid, low cost, limited proof-of-concept implementation of TRANSIMS for Atlanta
  - Performing a hands-on assessment of the potential advantages, disadvantages and feasibility of implementing TRANSIMS
- Determine if TRANSIMS will provide a more accurate assessment of:
  - Spatial and temporal distribution of people
  - Mobile source emissions
- Capture micro-scale interactions between:
  - Land use
  - Transportation system

# Why? (Cont.)

- Goals:
  - Assess feasibility of implementing TRANSIMS in Atlanta
  - Evaluate functionality and advantages/disadvantages of TRANSIMS for transportation & air quality
  - Determine resources needed to implement and maintain TRANSIMS
  - Gain knowledge, skills & abilities needed to implement TRANSIMS
  - Evaluate TRANSIMS population synthesizer and activity generator compared to ARC's PopSyn

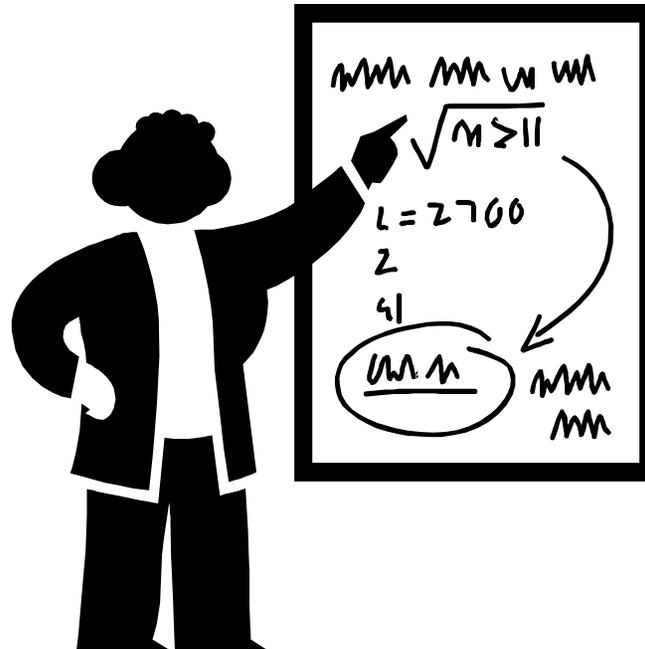
# How?

- Determine which version of TRANSIMS (open source or commercial) is most appropriate
- Obtain, compile, and execute TRANSIMS utilities using test data.
- Determine appropriate portion(s) of Atlanta to model (e.g., entire 20-county region, 5-county core, one county, activity center, NW)
- Convert ARC highway & transit networks to TRANSIMS

## How? (cont.)

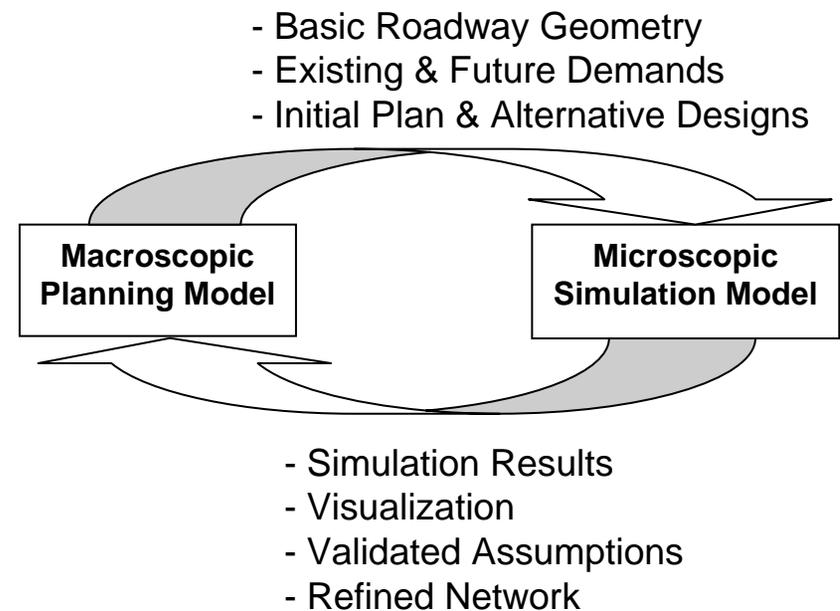
- Disaggregate ARC trip tables into TRANSIMS
- Apply diurnal distributions to trips
- Run TRANSIMS router to load trips on network
- Run TRANSIMS traffic micro-simulator
- Evaluate and visualize the effect of actual and hypothetical congestion mitigation projects and policies on congestion

# Linking Atlanta's Regional Travel Demand Model with Microscopic Traffic Simulation

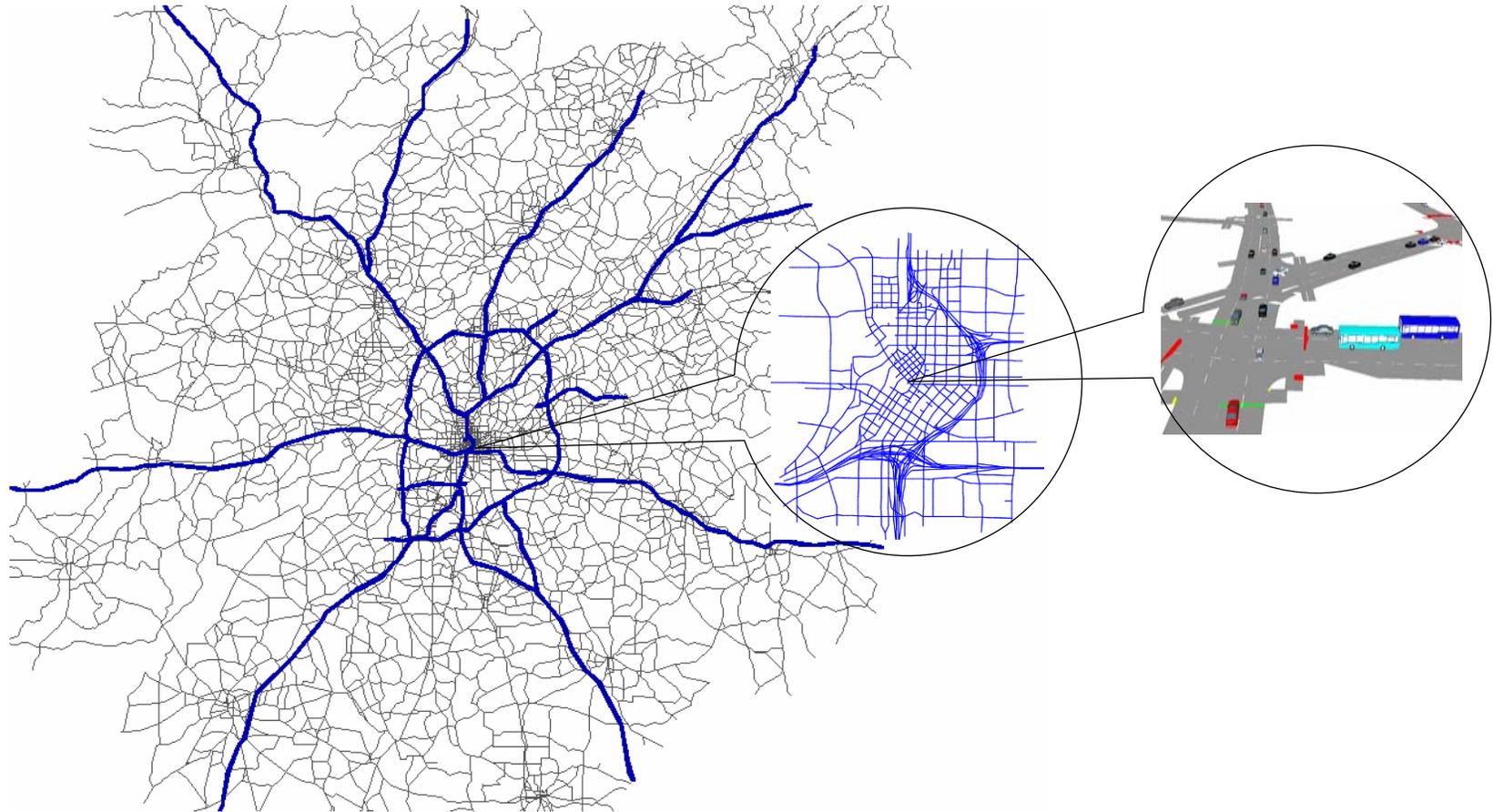


# Needs for Macro-Micro Integration

- Complementary Tools
- Model Development/Refinement
- Consistency of Data/Model Structure
- Better Communication
- Consistency of Analysis
- Use VISUM/VISSIM

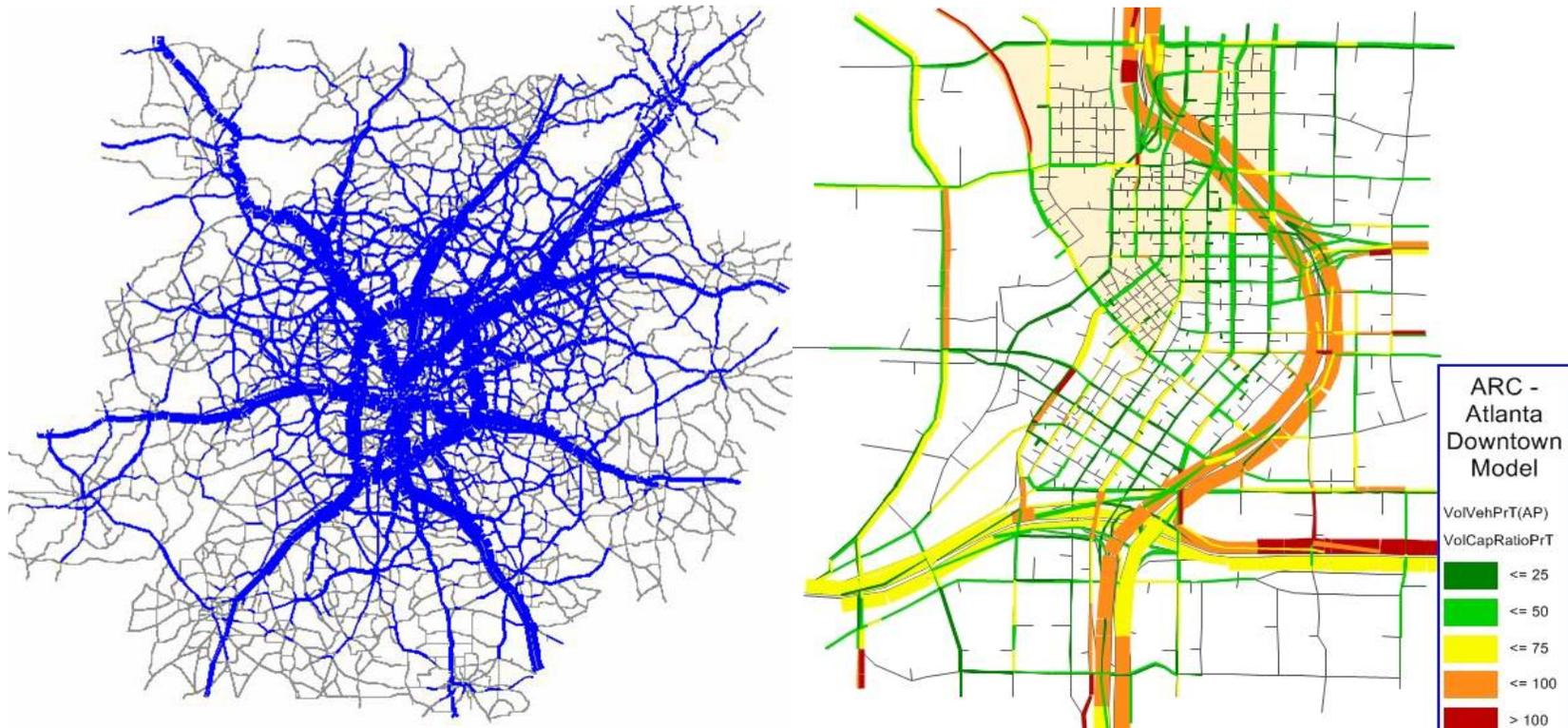


# Integrated Subarea Model



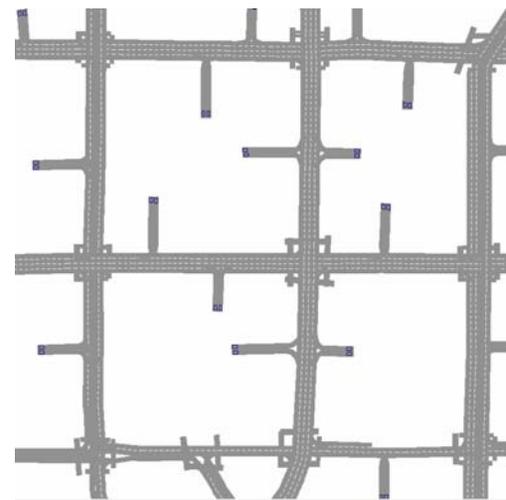
# Method for Integrated Subarea Analysis

- Identify subarea boundary
- Cut subarea network and traversal matrix

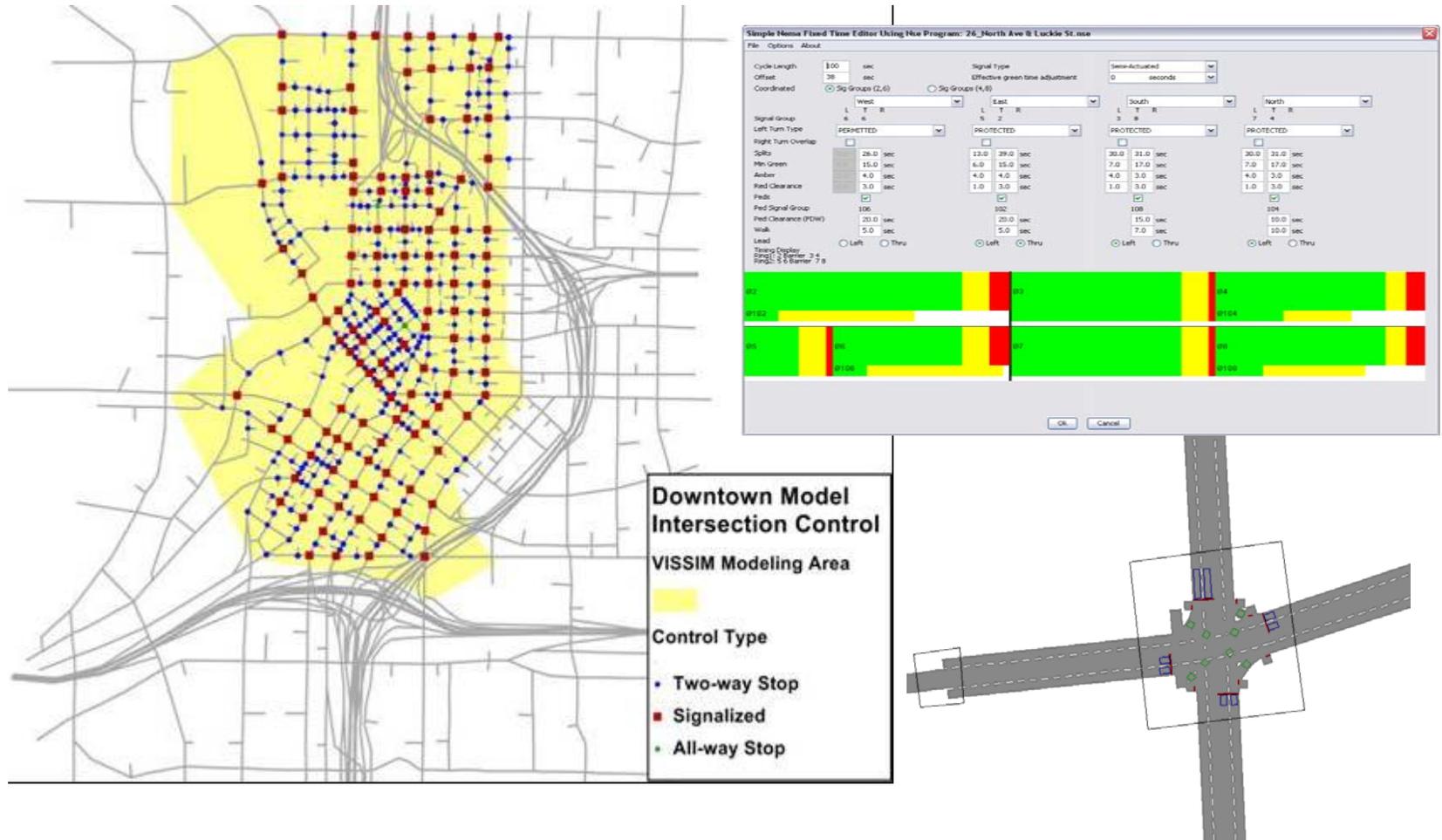


# Method for Integrated Subarea Analysis

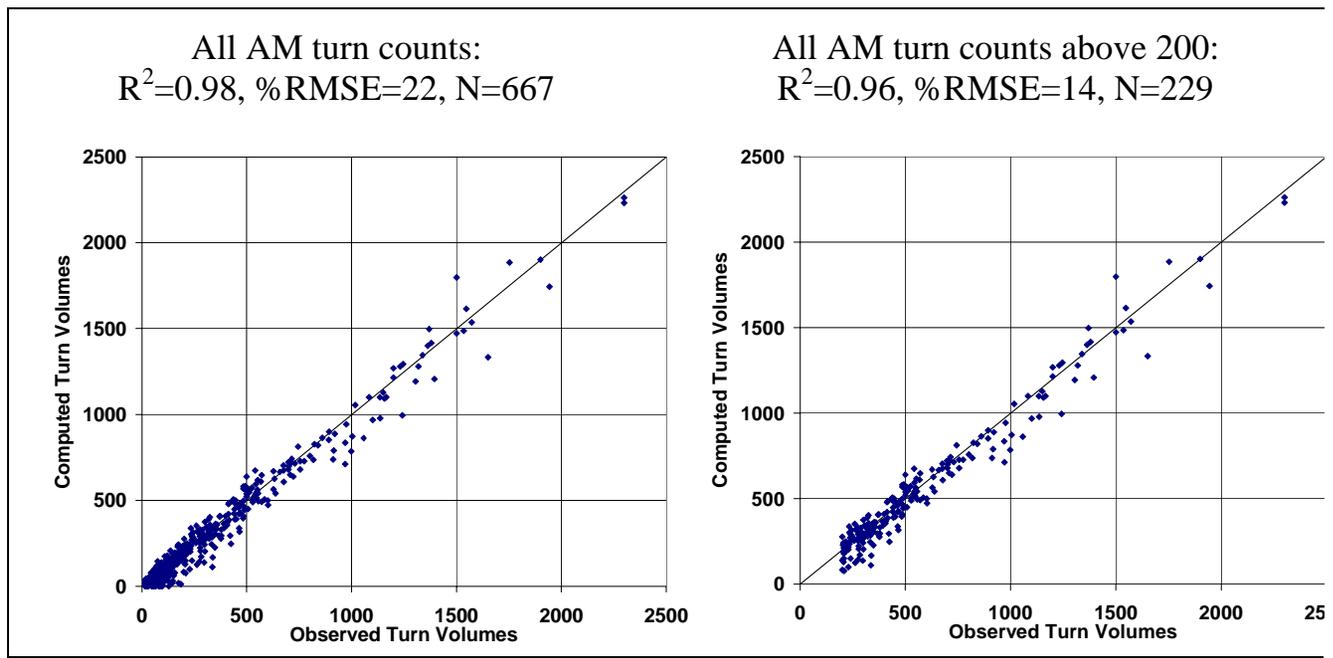
- Identify subarea boundary
- Cut subarea network and traversal matrix
- Refine subarea network
  - Node-link network (e.g. NAVTEQ tile, aerial photos)
  - Zone-connector structure (e.g. driveways and parking facilities)



# Method for Integrated Subarea Analysis

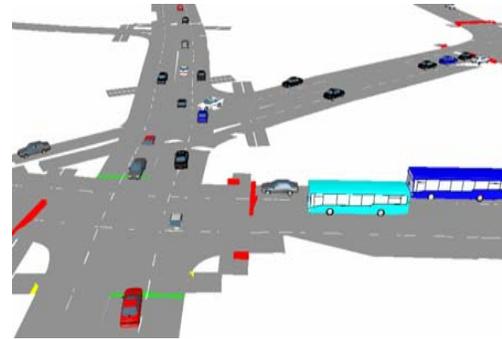
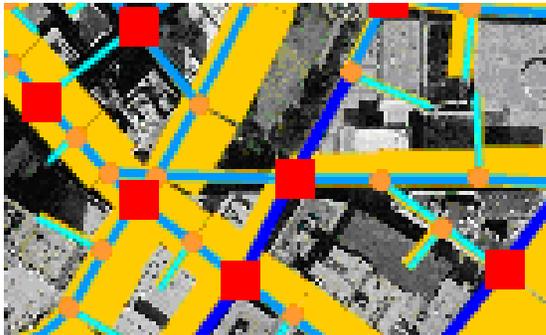


# Method for Integrated Subarea Analysis



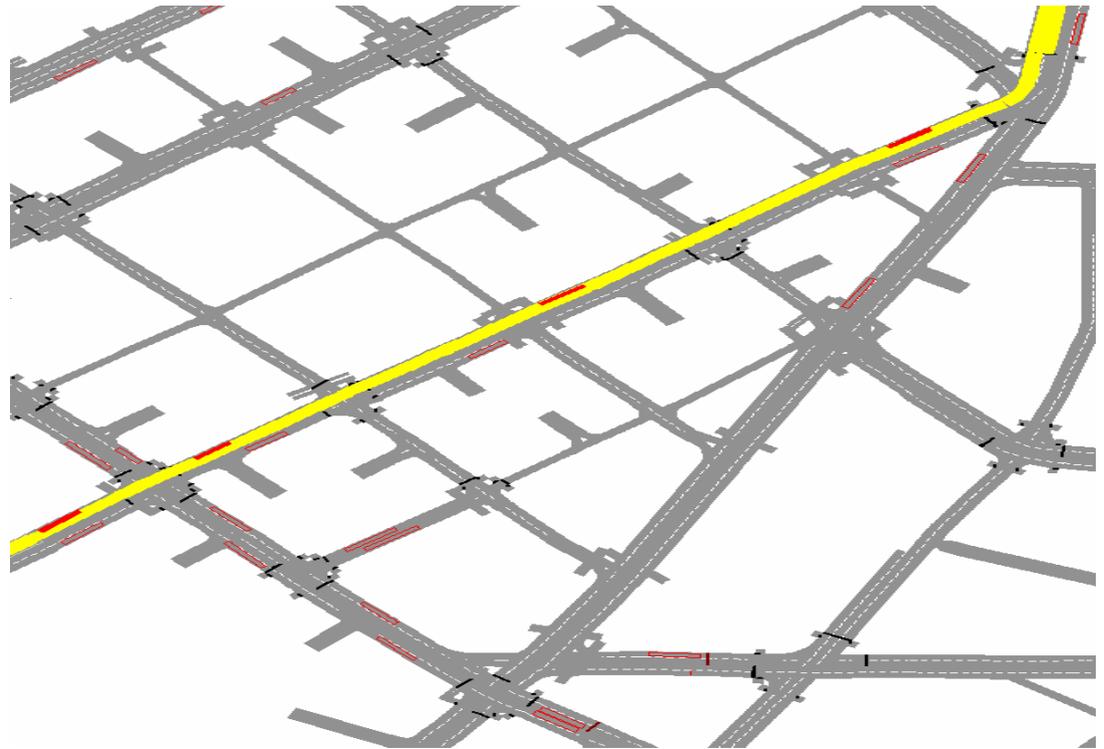
# Method for Integrated Subarea Analysis

- Identify subarea boundary
- Cut subarea network and traversal matrix
- Refine subarea network
- Add intersection data (geometry and control)
- Calibrate flow (assignment and OD matrix)
- Export to micro-simulation



# Method for Integrated Subarea Analysis

- Travel time
- Volume
- Intersection
- Driver behaviors



# Conclusions

- A general methodology for integrated subarea analysis has emerged over the last 10 years and has been applied in many urban areas.
- In recent years ARC has been increasingly involved with microscopic traffic simulation projects.
- ARC's major challenge is to make sure that the data and assumptions used in such studies are consistent with the regional model.
- ARC has found that the integrated approach of linking its macroscopic model with microscopic ones has helped to address that challenge.
- Maintain integrated models like the Atlanta downtown model, and keep them updated to contribute to integrated and consistent micro analysis in the region.

# Where Are All The Models Headed?

- DTA (dynamic traffic assignment)???, As compared to static network equilibrium traffic assignment
- Enhanced visualization and traffic animation for public involvement
- Allow traffic engineers to anticipate problems before they occur rather than simply reacting to existing conditions

# Conclusions

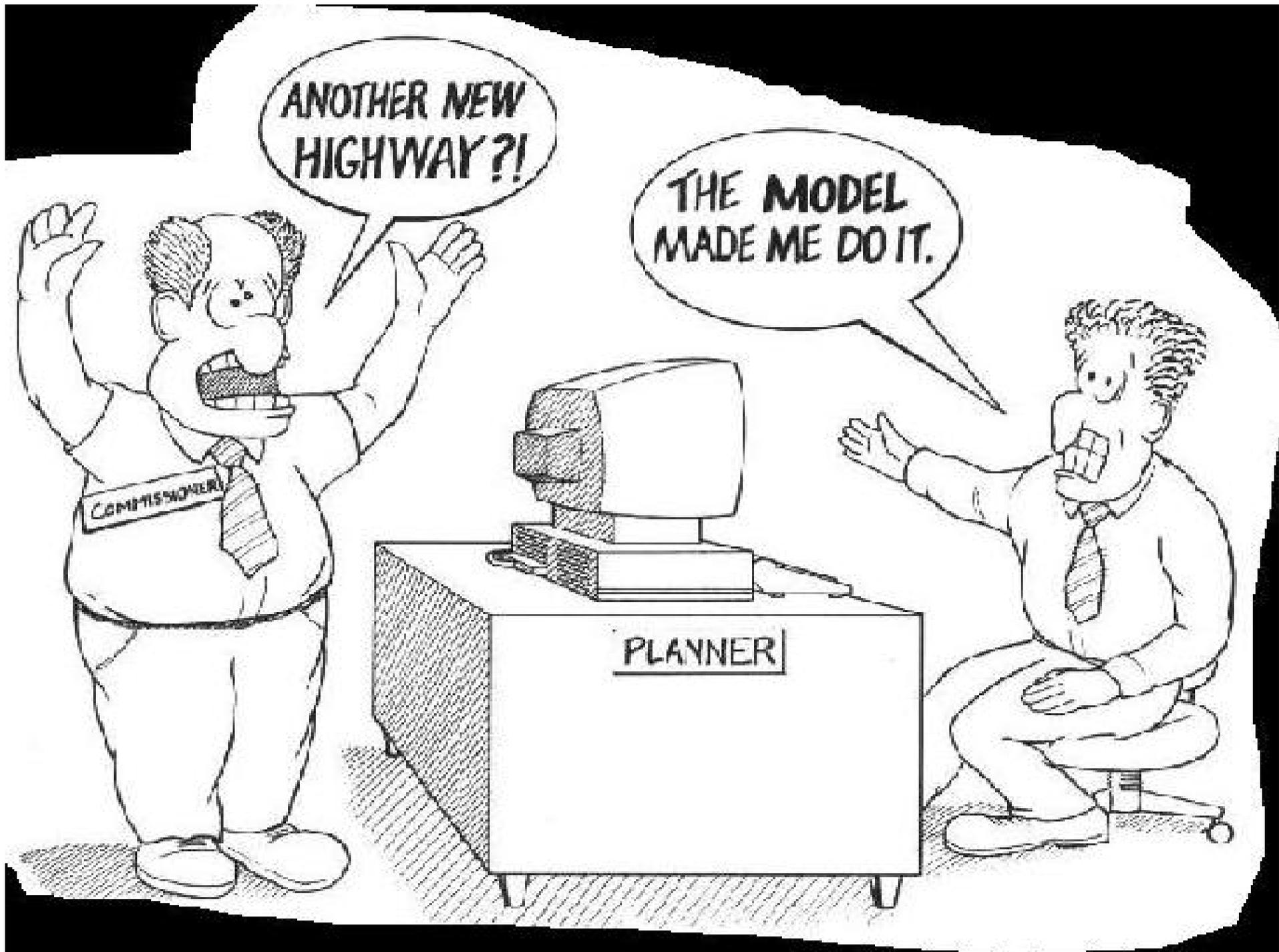
- Aim for a seamless integration between regional travel demand models, mesoscopic models, and microscopic traffic simulation models
- Better capture and account for temporal effects of congested networks, and recurring urban traffic congestion

# Lessons Learned

- ABTB requires detailed QA/QC data
- Design & conceptualize surveys with an ABTB model system in mind
- Maintain a parallel model development track with 4-step trip based models
- Like anything else, ABTB requires lots of:
  - Dedicated staff resources & on-going training
  - Consultants assistance
  - \$,\$\$\$,\$\$\$.\$\$\$

# Atlanta's Most Crucial Step: Moving ARC's ABTB Model to Practice

- So far ABTB models have been developed and applied in regions where 4-step model had been abandoned or never developed
- Rigorous practical testing and cross-comparisons of ABTB model and 4-step trip-based model (both in good shape!) Will be finally possible in Atlanta



# Questions/Comments

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