New Generation Large Scale Activity Microsimulation Models (SimAGENT) & Data Needs

Konstadinos (Kostas) G. Goulias-
University of California Santa Barbara
goulias@geog.ucsb.edu
+1-805-284-1597
http://www.geog.ucsb.edu/geotrans/publications.php

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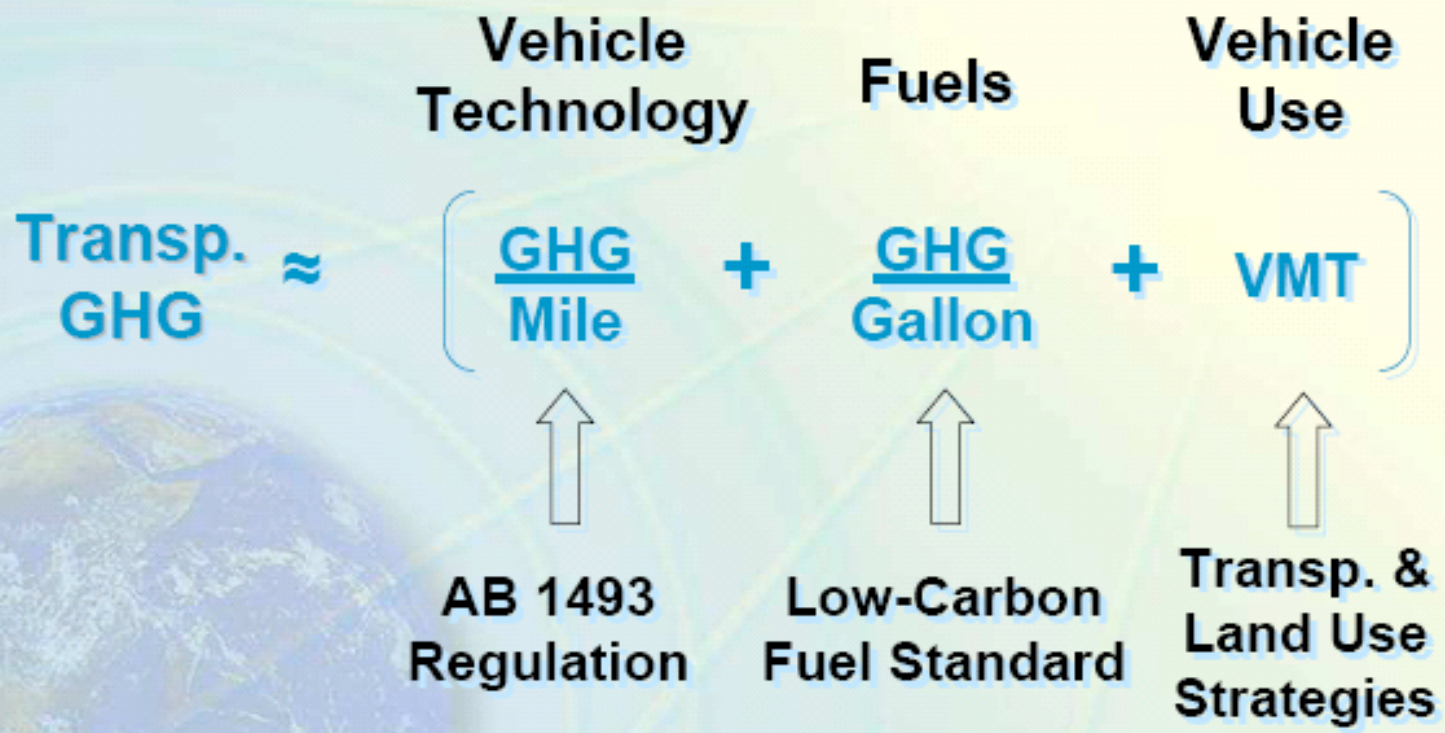
Summer School

THE UNIVERSITY OF TOKYO

Policy Examples & Tools

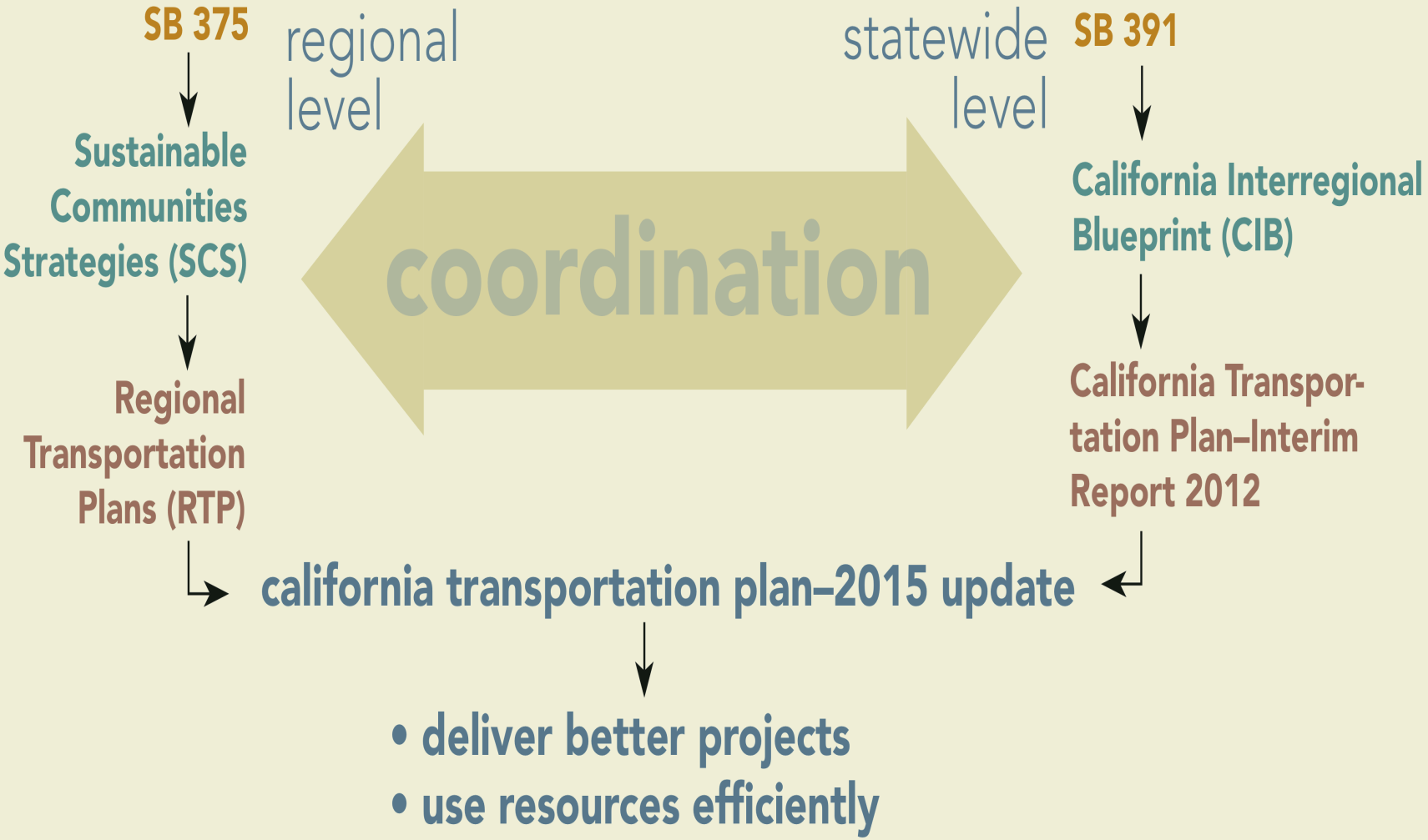
- Policy Context -> DECREASE CO2 Emissions
  - Vehicle Technology
  - Fuel Technology
  - VMT Decrease Using Land Use & Pricing &……..
  - Equity analysis and allocation to small communities
- STATEWIDE & REGIONAL Land Use-Transportation Models
  - PECAS development
  - Travel Model
  - Emissions
- SimAGENT for SCAG
  - Dynamic Microsimulation
  - Year to year
  - Second by second

Overarching Strategies



California Policies but will expand (we hope!)

Reducing Greenhouse Gases: Shared Responsibilities SB 375 (Steinberg) and SB 391 (Liu)



Southern California Association of Governments (SCAG)

SCAG Quick Facts

- US largest Metropolitan Planning Organization (MPO)
- 6 counties, 191 cities and 38,000+ square miles.
- 18 million people (5.8% of US population; 48.5% of California population)
- GRP in 2010: $910 Billion, 16th largest economy in the world
- 10,000 lane miles of freeway; 4 major airports; Nation's global gateway for trade

SimAGENT (Simulator of Activities, Greenhouse Emissions, Networks, and Travel)

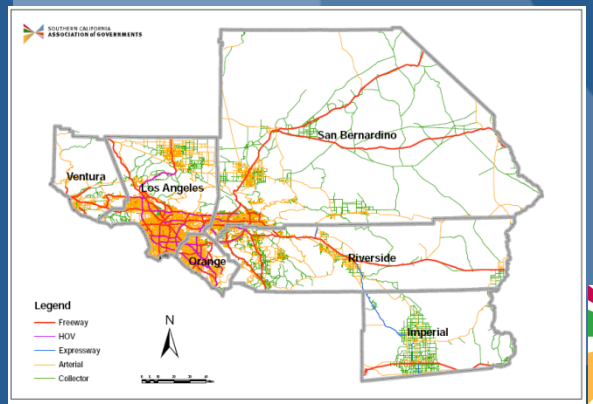
Kostas Goulias
& Yali Chen
+ others in GeoTrans laboratory
University of California
Santa Barbara

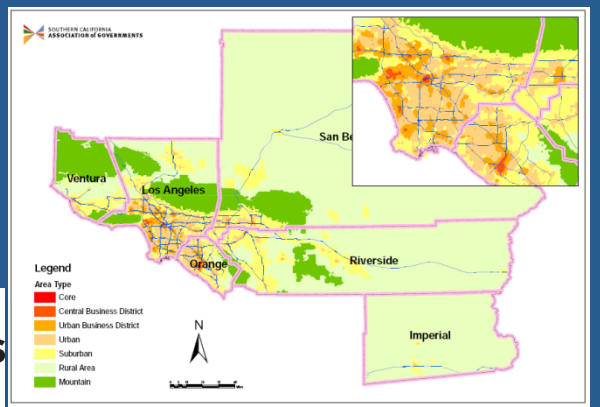
Chandra Bhat
& Rajesh Paleti
+ others
The University of Texas
Austin

Ram Pendyala &
Karthik Konduri
+ others

Arizona State University
Tempe

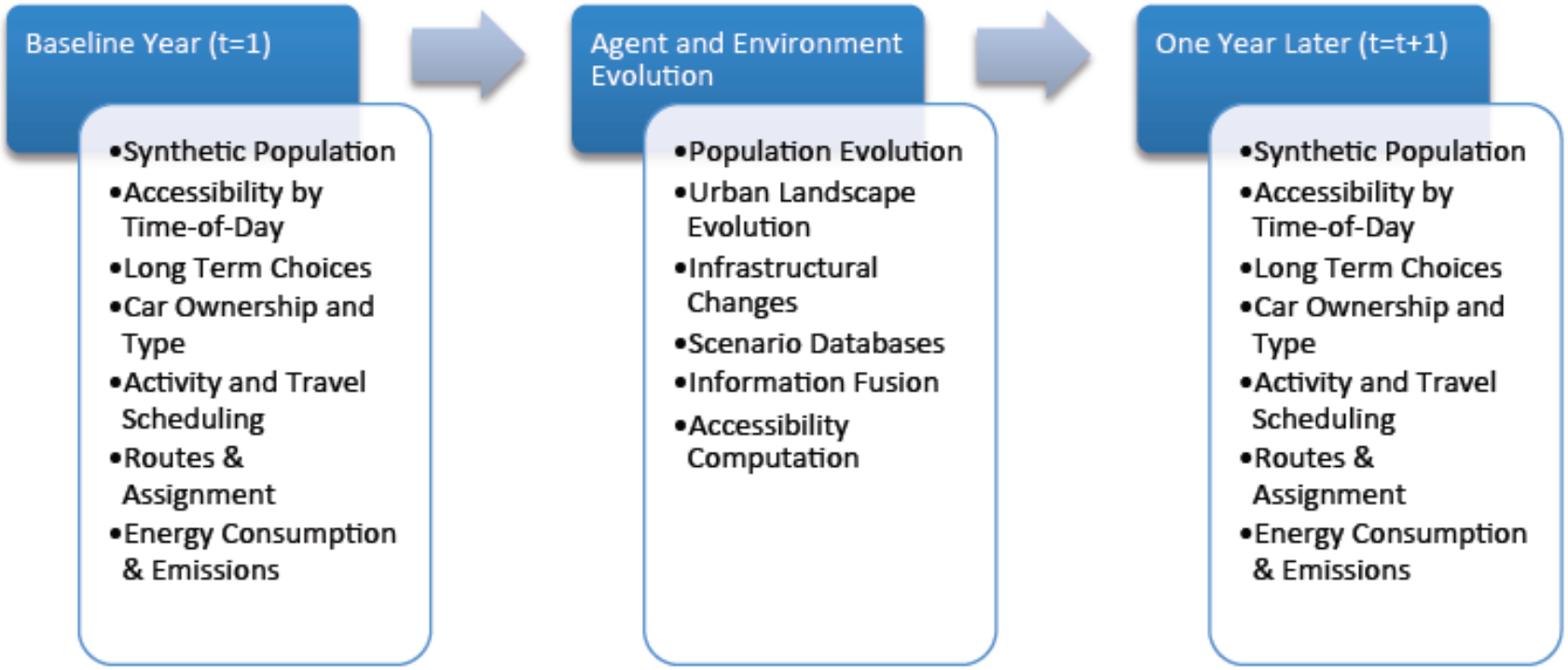
Guoxiong Huang, Hsi-Hwa Hu
+ others
SCAG
Los Angeles+





SOUTHERN CALIFORNIA
ASSOCIATION of GOVERNMENTS

Typical Schema SimAGENT



Some Early Benefits of SimAGENT

- Synergy with SCAG and three Universities
- Motivated SCAG technical partners to develop their own new research applications
- Developed an inventory of the region's characteristics and data availability = many practical applications
- Updated and used older models including the 4-step model -> now 11K zones + synthetic population used
- Designed/Redesigned a large scale (50,000 household survey happening now)
- SCAG first of class pride = job satisfaction, more funding, leadership role in California
- Satisfied my professional curiosity and met challenge of building an ENORMOUS model
- Great education tool
- Students that worked on SimAGENT get very good job offers!

Team

Research Team:

UCSB (prime): *Dr. Kostas Goulias, Dr. Yali Chen, Dr. Seo Youn Yoon, and…*

UT Austin: *Dr. Chandra Bhat, Dr. Rajesh Paleti, and…*

ASU: *Dr. Ram Pendyala, Dr. Karthik Konduri, and …*

See papers for all the names

SCAG:

Program manager: Dr. *Hsi-Hwa Hu*

Model estimation and calibration: *Dr. Bayarmaa Aleksandr*

Software and model operation: *Hao Cheng*

Model validation: *Mana Sangkapichai and Sung Su Yoon*

Travel survey and data: Dr. *Yongping Zhang*

Model Concept

- The Activity-Based Travel Demand Modeling (ABM) is an agent-based modeling in which individuals and their interaction with each other and their environment are explicitly represented.

- Activity-based approaches view travel as a derived demand to pursue activities.
  - It considers link between activity participation behavior and travel behavior,
  - It accommodates the interaction among different activities pursued by an individual and
  - It accommodates the interaction between the temporal and spatial dimensions of activity participation.

Model Purpose

- SCAG ABM will be fully implemented for the **2016 Regional Transportation Plan/Sustainable Community Strategies** – major investment strategies.
- The model will generate **performance indicators**, **conformity analysis**, and **environmental justice analysis**.
- To analyze the impact of infrastructure investment, land use development, pricing policy, active transportation, high speed rail, and travel demand management.

Stage 1
Model Development

Motivation (of the funding agency)

RTP Guideline by California Transportation Commission - the largest four MPOs in California are encouraged to transition

to activity-based travel demand models.

Progress

Oct. 2008

SCAG decided to develop an activity-based model for the region

April 2009

SCAG launched ABM development project

Jan. 2013

End of Stage 1 development

Stage 1 Model Development

A

- **Task 1: Modeling Framework Setup**
  - Based on CEMDAP (UT Austin)

B

- **Task 2: Initial Estimation**
  - Three Core Modules
  - Based on 2001 Travel Survey

C

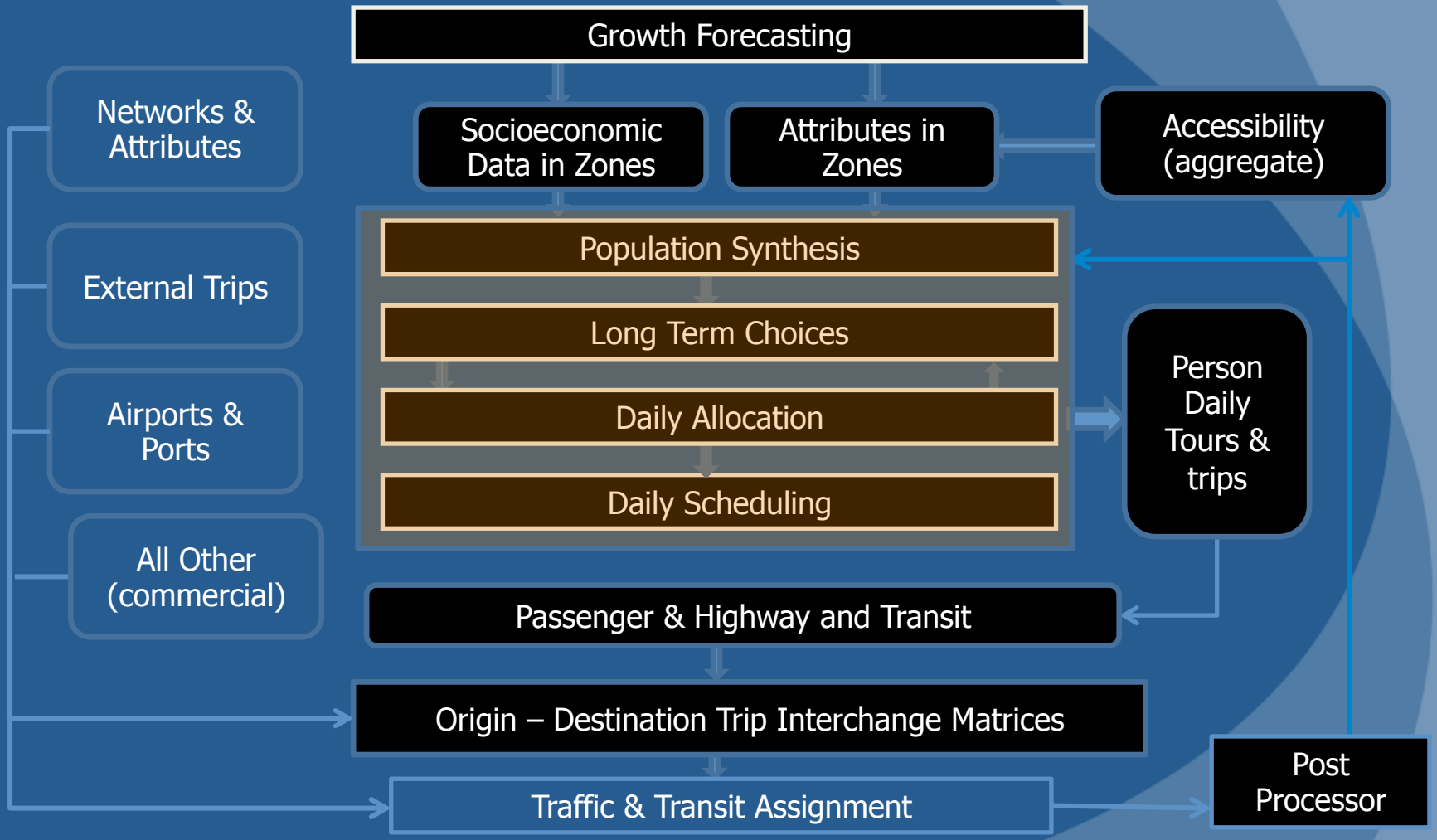
- **Task 3: Initial Calibration**
  - Base Year 2003

OVERVIEW OF SimAGENT for SCAG

SimAGENT

- Creates synthetic household/person and their socioeconomic characteristics.
- Simulates daily activities and travel patterns for each person (18 million +) of SCAG region
- Outcome = every person with a day timer attached to them – just like travel survey
- Model outputs are converted to OD matrix and input to assignment for SCAG
- Model outputs also used as inputs for TRANSIMS and MATSIM experiment

SimAGENT
SCAG version Flowchart



Salient Features of SimAGENT SCAG

- Can be applied to any metropolitan area
- Comprehensively characterizes the activity-travel patterns of all household members
- Incorporates **spatial-temporal dependencies and constraints** in activity-travel patterns between and within individuals of a household.
- Incorporates advanced **vehicle type choice model**, which determines the mix of vehicles in a fleet and naturally impacts mobile-source emissions estimation, energy consumption, and greenhouse gas emissions.

Salient Features of SCAG ABM

- It **facilitates** *environmental justice* (EJ) analyses by having the ability to examine the effects of policies on any defined segment.

- Enables a **holistic assessment of the effects of land-use, built environment, and transportation policies** on entire activity-travel patterns.

- **Accessibility** that is sensitive to time of day, availability of opportunities and variation of transportation level of service, offers increased **behavioral realism and behavioral sensitivity** to the combined impact of land use and level of service improvements.

Salient Features of SCAG ABM

Temporal Resolution

- Continuous time scale
- Level-of-service data can be provided at any temporal resolution

Spatial Resolution

- Allows for any number of zones

Salient Features of SCAG ABM

Software

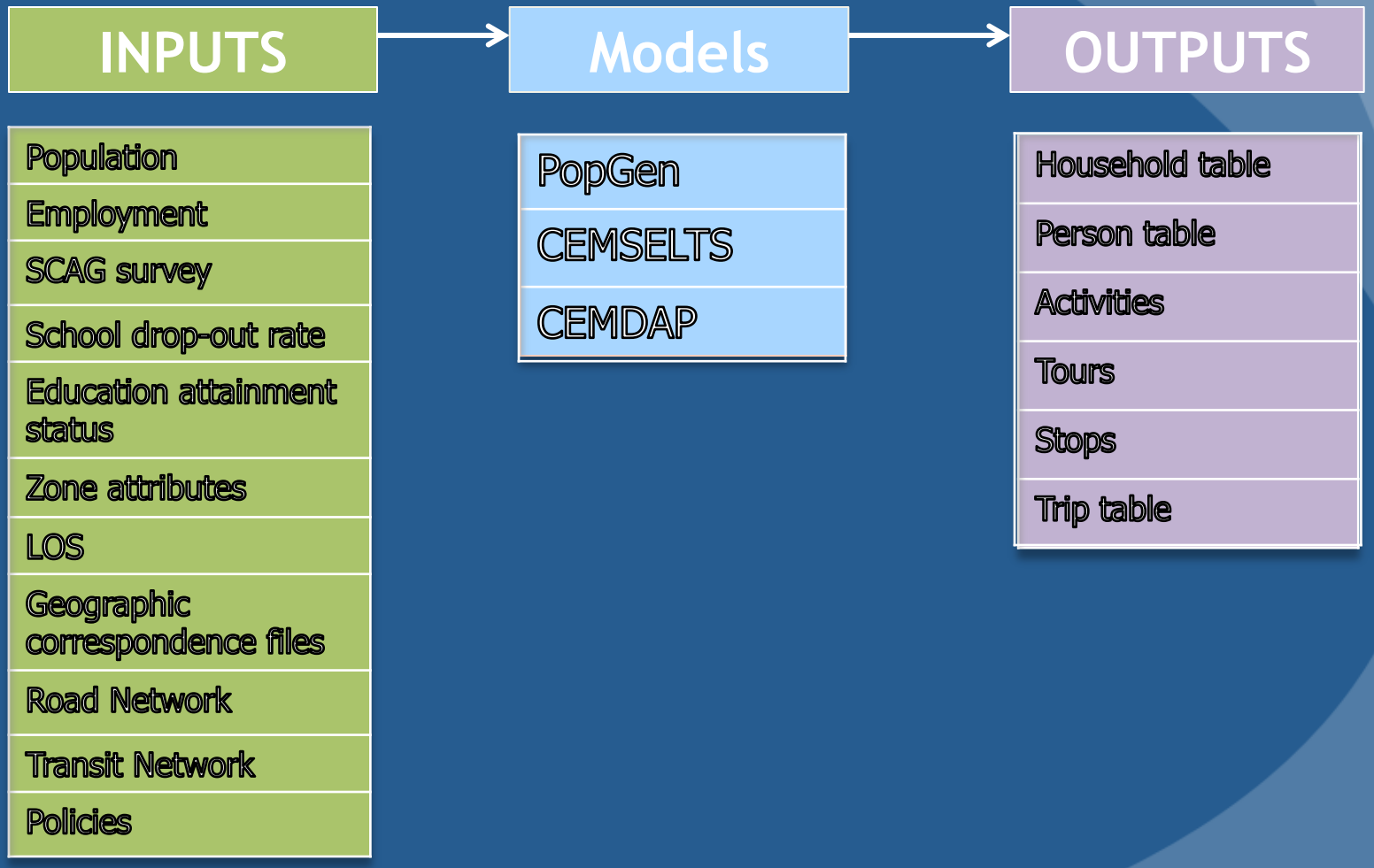
- Involves a portable and flexible object-oriented software architecture design, ensuring data and data processing integrity, parallel processing and multi-threading capability, extensibility and modifiability in structure, and usability.
- Standard Window-based user interface
- Allows user to modify model parameters
- Provides a friendly diagrammatic interface to help the user understand the logic of the system and the underlying models

SCAG ABM framework: SimAGENT

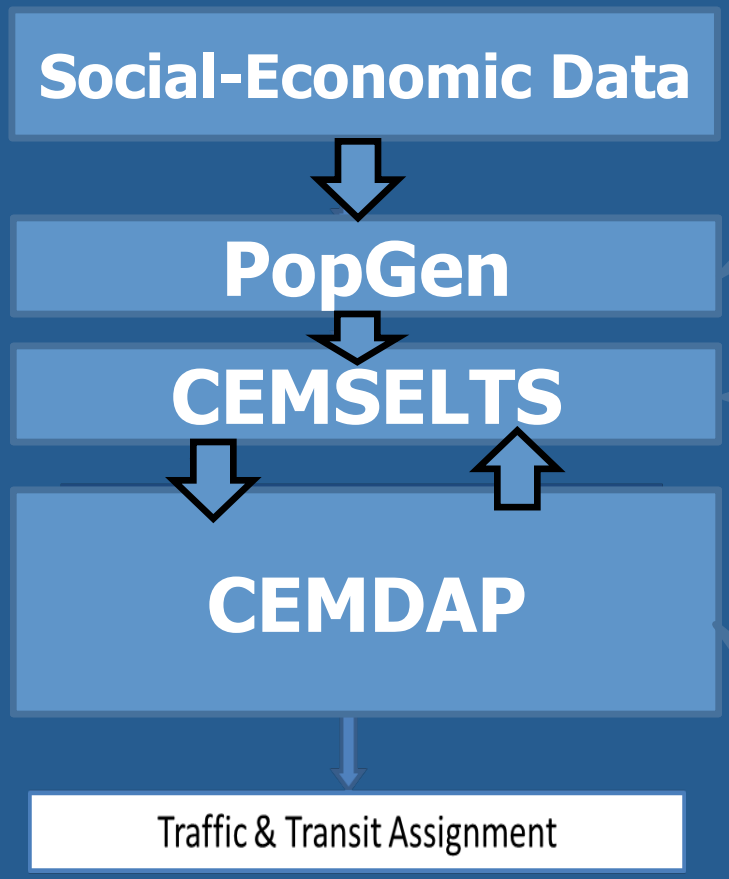
- **SimAGENT** (*Simulator of Activities, Greenhouse Emissions, Networks, and Travel*) is the base framework of SCAG ABM.

- **SimAGENT** is a model system that includes
  - Synthetic population generator,
  - Disaggregated socioeconomic module and work location and vehicle ownership/type modules,
  - Daily activity and travel scheduling module

SimAGENT Model System



SimAGENT Sequence and Modules



PopGen generates eight basic attributes that are not enough to reflect a rich variance in socio-economic characteristics for the region's 18 million population.

CEMSELTS generates additional person and household socioeconomic attributes that fed to CEMDAP to simulate daily activity-travel patterns.

CEMDAP is the core module that simulates activity schedule and travel characteristics for each individual of the region.

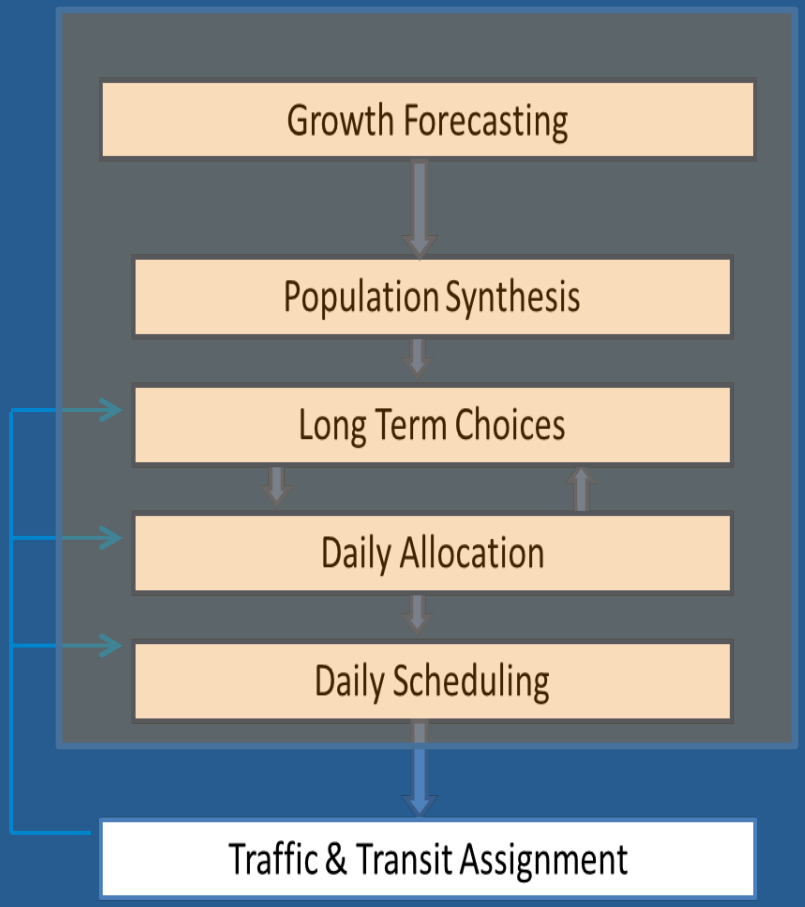
Summary

- PopGen and CEMSELTS modules create the entire population of the region, provide locations for workplaces, and schools for each person, estimates car ownership and type as well as main driver for each vehicle, and provides other key personal and household characteristics.

- CEMDAP module creates a complete description of the activities at locations and movements among locations of each individual over space and time that is congruent with the movements of the rest of the household members.

- In this way, for each person, we have information about the type of activity, when, where, how long, how to travel, with whom, in what sequence, and interrelationships with other persons and locations in the engagement pattern.

Summary cont.



- CEMDAP output is converted to OD matrix as input for assignment
- Using the same assignment module from SCAG Trip-based Model in TransCAD.
- Feedback skim and accessibility till converged.

Current Status

Three Core Modules and Software

- PopGen, CEMSELTS+Household evolution, CEMDAP
- TRANSCAD 4 periods, TRANSIMS

67 Sub-Models

- Estimated Based on 2001 Travel Survey

Research

- Research Papers and Conference Presentations
- Further Work and AnalysesNeeded to Enhance as a Regional Activity-based Travel Demand Model

CORE MODULES

Population Synthesizer

What is PopGen?

- A population synthesizer uses *Iterative Proportional Updating* (IPU) method which can simultaneously control household and person attributes.

- Generates complete synthetic population for base year by expanding the disaggregate sample data to mirror known aggregate distributions of household and person variables of interest.

Why Synthetic Population Data?

- Need to disaggregate household and person socio-economic data for the entire population of SCAG.
- Such data for the entire population is generally not available.
- This leads to the need to synthesize a regional population from known statistical distributions on the population.
- What we have:
  - Disaggregate data for a sample of the population (*PUMS, travel survey)*
  - Marginal distribution for the entire region (*census summary files, agency forecasts*)

Features of PopGen

- Controls for both household and person attributes
- Automatically corrects for zero-marginal and zero-cell problems
- Extendable
- Scalable
- Computationally tractable method implemented in user-friendly Windows and Linux operating systems
- Provides goodness-of-fit measures to assess performance of population synthesis process

Procedure

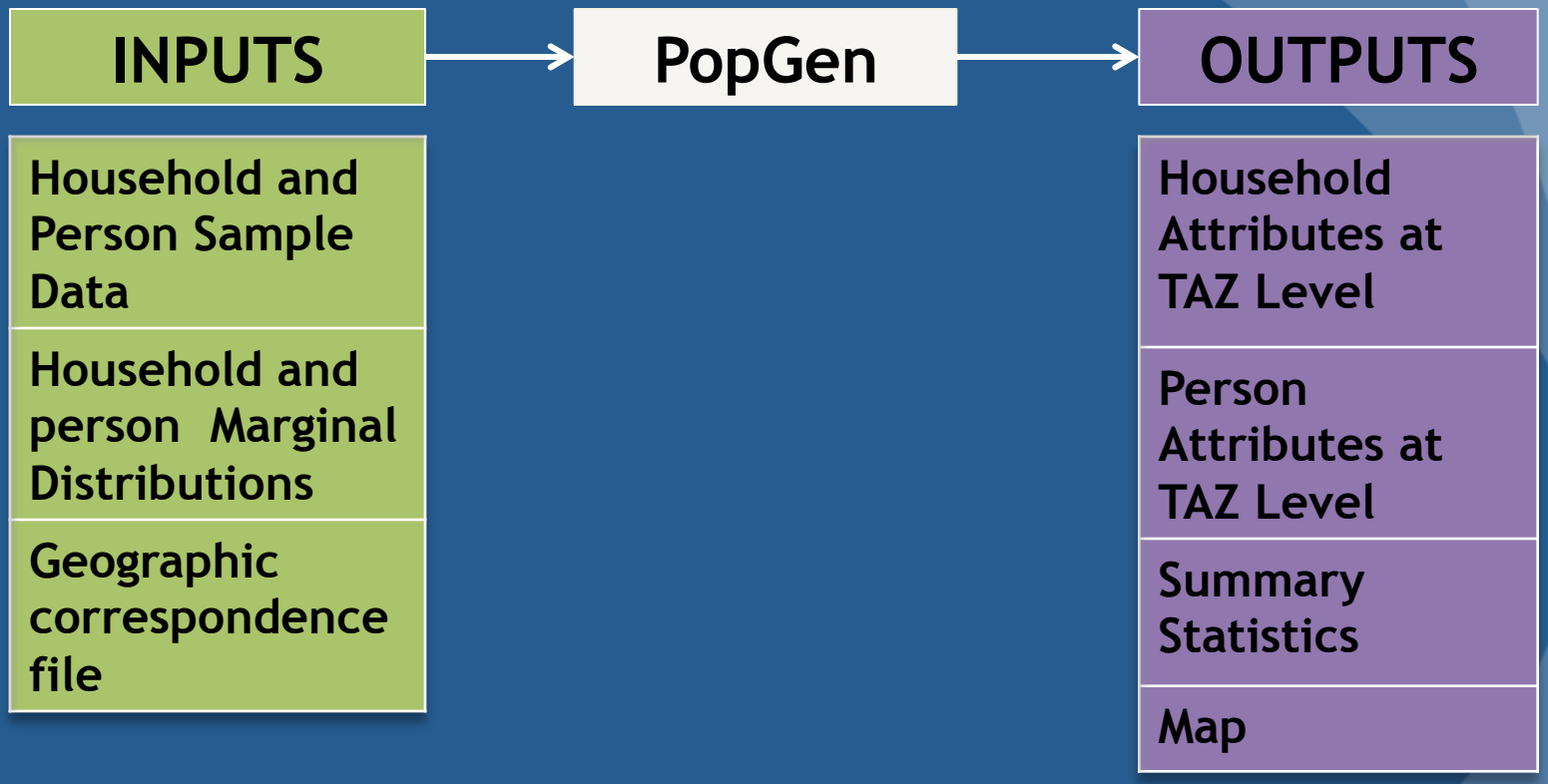
Choose control variables

Obtain the marginal distribution of these variables from census summary file (SF) or agency forecast

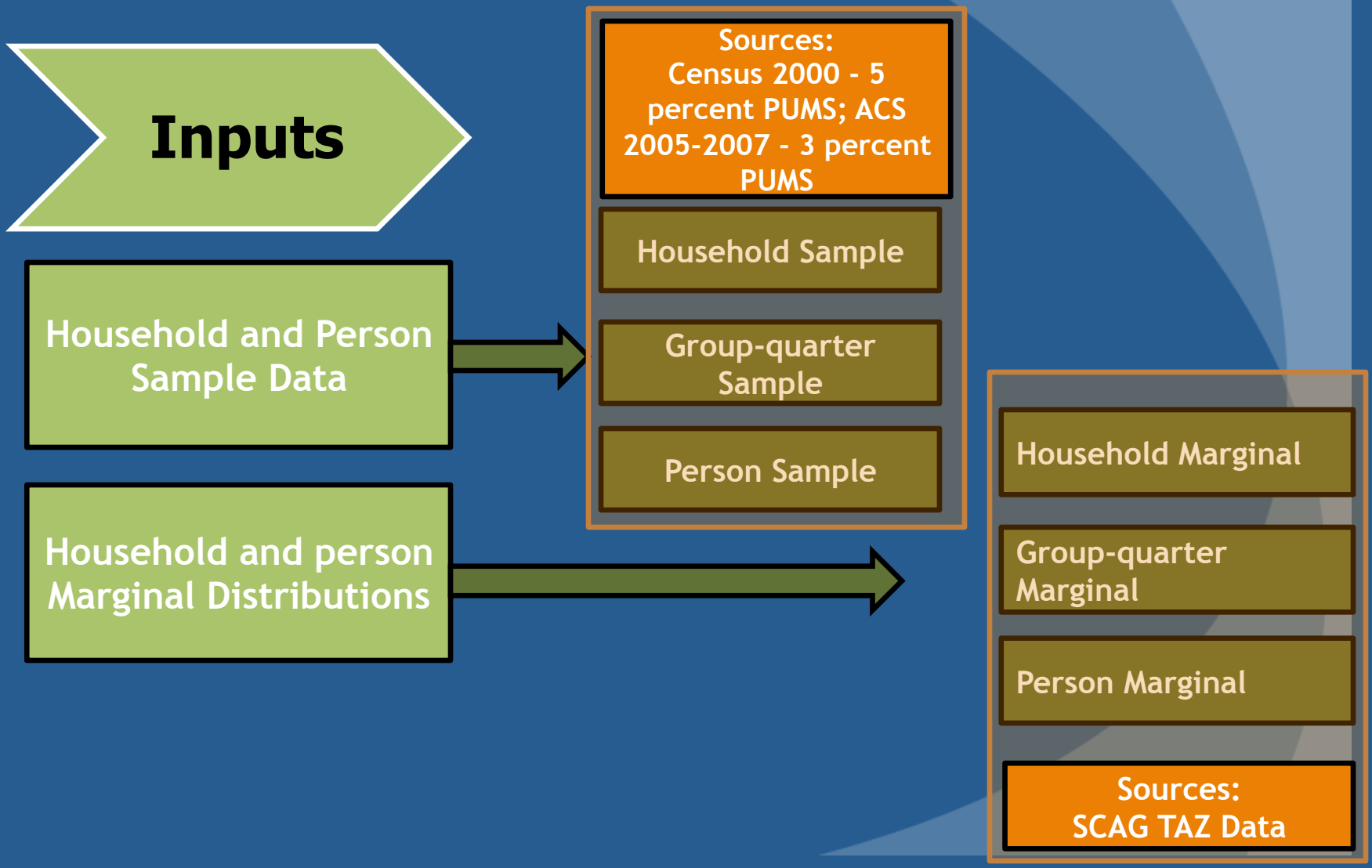
Create a seed matrix of the joint distribution from a microdata sample data set (PUMS, travel survey)

Expand the seed matrix using an IPF procedure to match the given marginal control totals while maintaining the joint distribution implied by the seed matrix

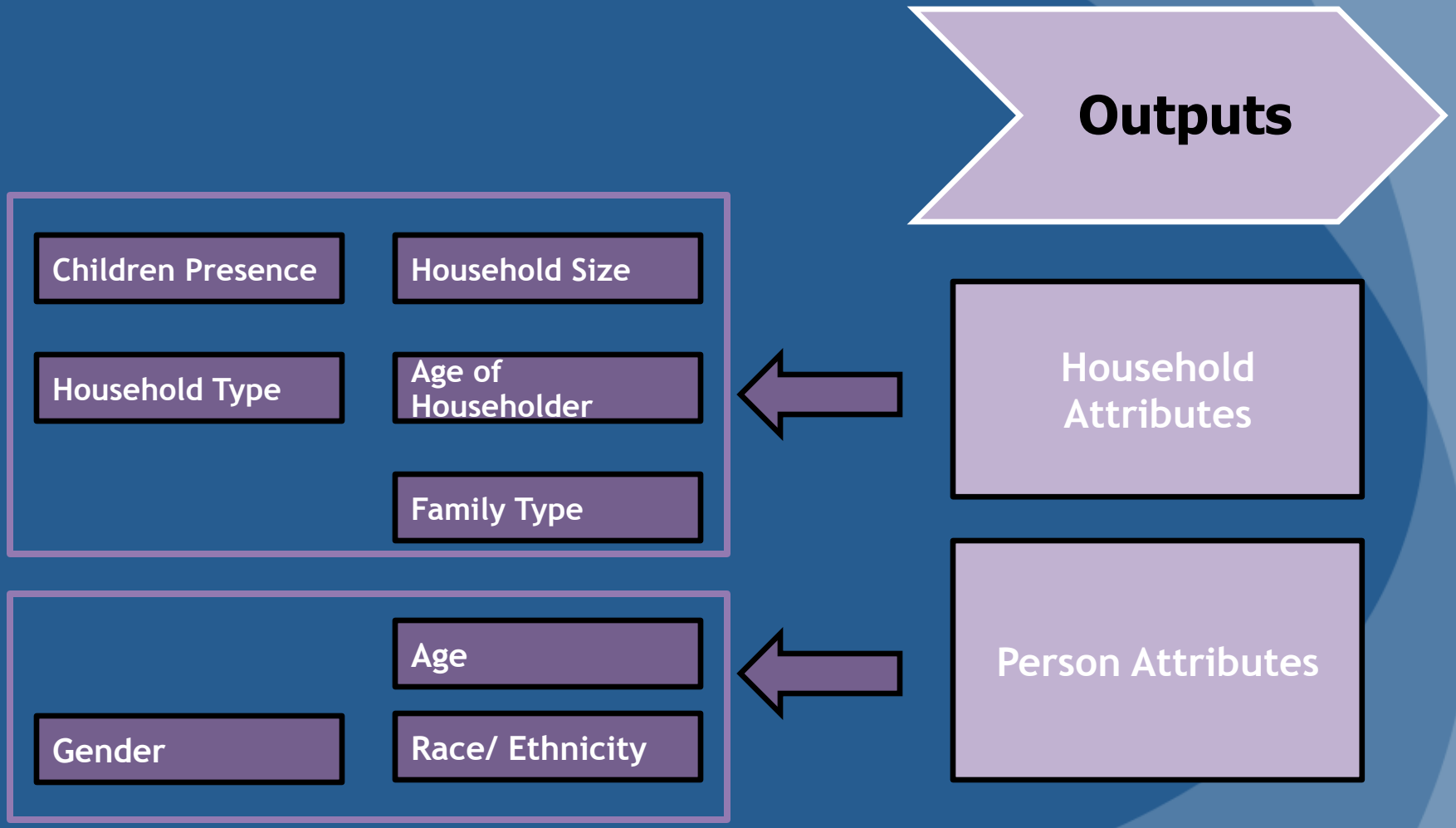
SCAG Population Synthesizer



PopGen Inputs



PopGen Outputs

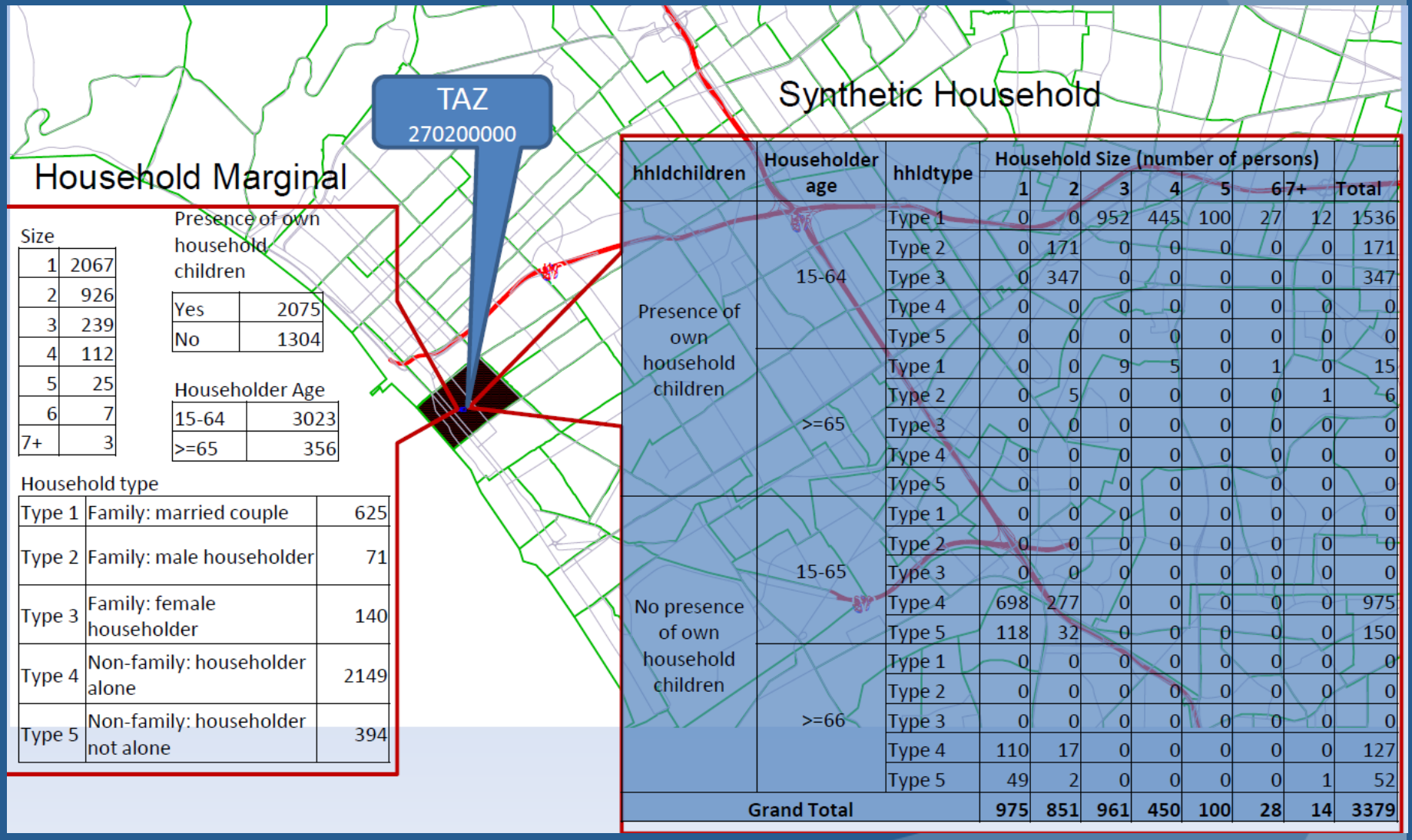


Summary Statistics

- Marginal Totals (for 10,579 TAZs)
  - Household marginal total: 5,812,319
  - Groupquarter marginal total: 336,451
  - Person marginal total: 17,891,482

- Sample Size
  - ACS 2005-2009 PUMS for State of California
  - Household sample size: 628,061 (10.81 percent of HH marginal total)
  - Groupquarter sample size: 34,358 (10.21 percent of GQ marginal total)
  - Person sample size: 1,727,790 (9.66 percent of Person marginal total)

Household Attributes



Household Marginal

Size

1	2067
2	926
3	239
4	112
5	25
6	7
7+	3

Presence of own household children

Yes	2075
No	1304

Householder Age

15-64	3023
>=65	356

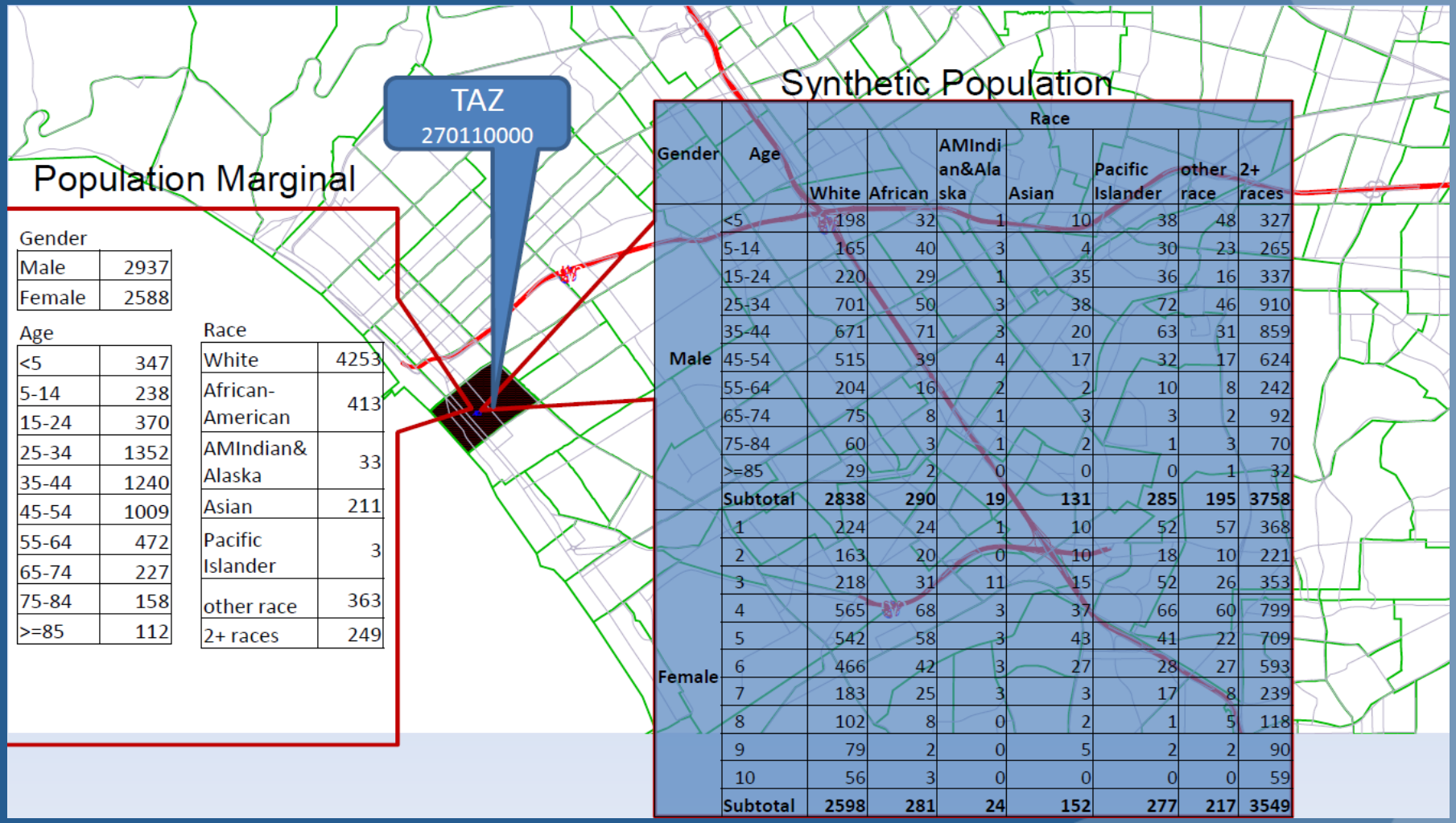
Household type

Type 1	Family: married couple	625
Type 2	Family: male householder	71
Type 3	Family: female householder	140
Type 4	Non-family: householder alone	2149
Type 5	Non-family: householder not alone	394

Synthetic Household

hhldchildren	Householder age	hhldtype	Household Size (number of persons) 1	2	3	4	5	6	7+	Total
Presence of own household children	15-64	Type 1	0	0	952	445	100	27	12	1536
		Type 2	0	171	0	0	0	0	0	171
		Type 3	0	347	0	0	0	0	0	347
		Type 4	0	0	0	0	0	0	0	0
		Type 5	0	0	0	0	0	0	0	0
	>=65	Type 1	0	0	9	5	0	1	0	15
		Type 2	0	5	0	0	0	0	1	6
		Type 3	0	0	0	0	0	0	0	0
		Type 4	0	0	0	0	0	0	0	0
		Type 5	0	0	0	0	0	0	0	0
No presence of own household children	15-65	Type 1	0	0	0	0	0	0	0	0
		Type 2	0	0	0	0	0	0	0	0
		Type 3	0	0	0	0	0	0	0	0
		Type 4	698	277	0	0	0	0	0	975
		Type 5	118	32	0	0	0	0	0	150
	>=66	Type 1	0	0	0	0	0	0	0	0
		Type 2	0	0	0	0	0	0	0	0
		Type 3	0	0	0	0	0	0	0	0
		Type 4	110	17	0	0	0	0	0	127
		Type 5	49	2	0	0	0	0	1	52
Grand Total			975	851	961	450	100	28	14	3379

Person Attributes



Population Marginal

Gender

Male	2937
Female	2588

Age

<5	347
5-14	238
15-24	370
25-34	1352
35-44	1240
45-54	1009
55-64	472
65-74	227
75-84	158
>=85	112

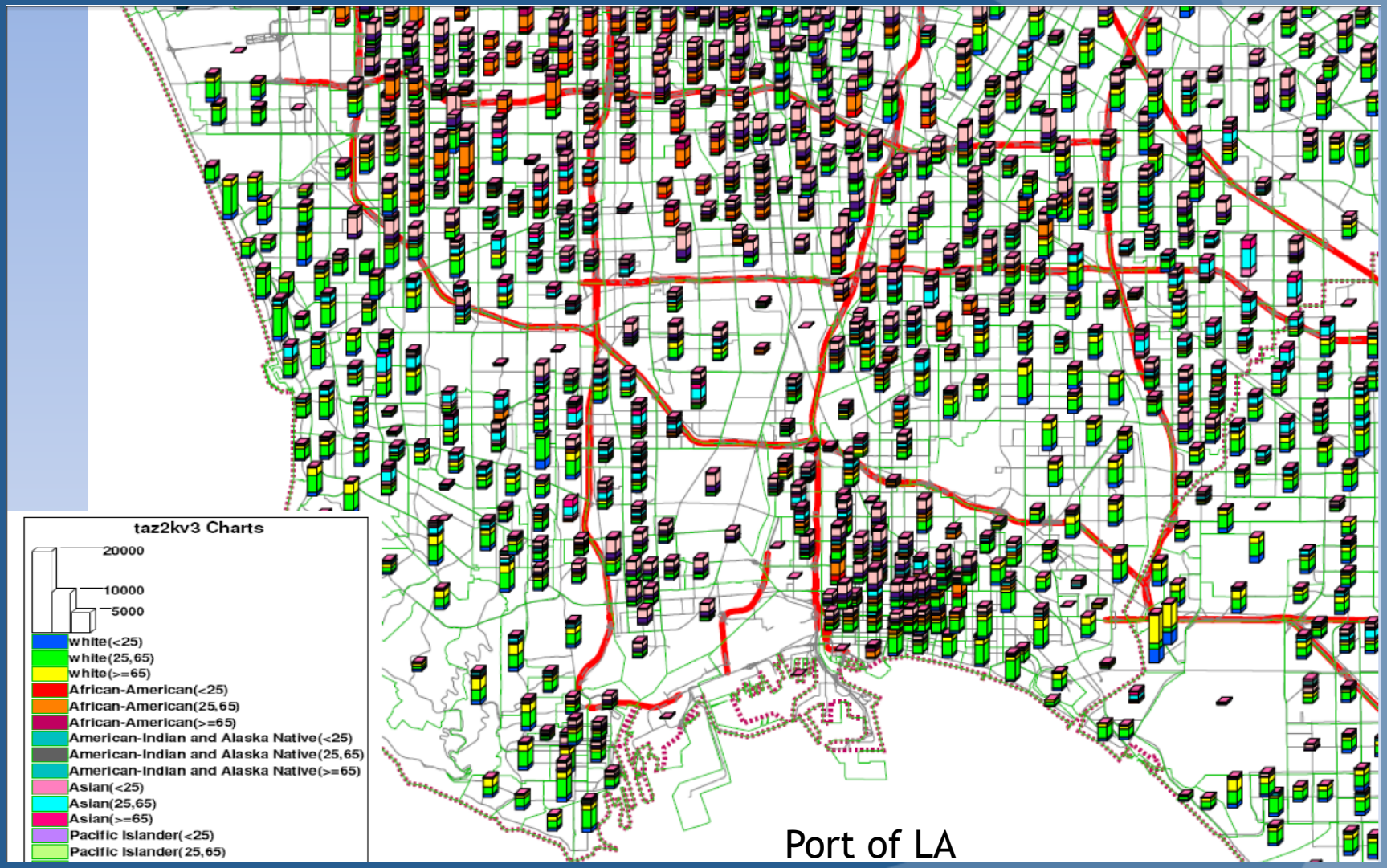
Race

White	4253
African-American	413
AMIndian&Alaska	33
Asian	211
Pacific Islander	3
other race	363
2+ races	249

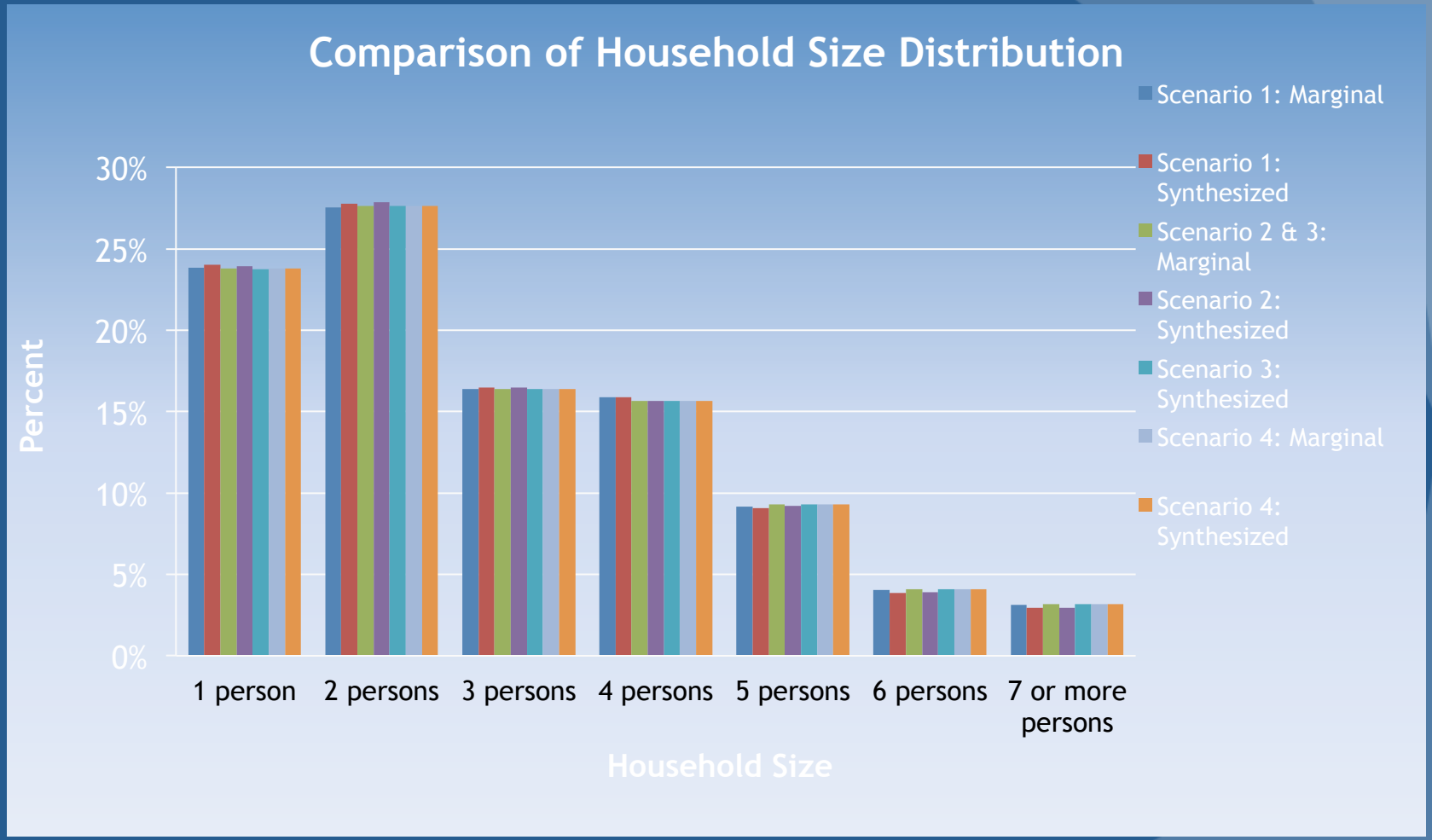
Synthetic Population

Gender	Age	Race						
		White	African	AMIndian&Alaska	Asian	Pacific Islander	other race	2+ races
Male	<5	198	32	1	10	38	48	327
	5-14	165	40	3	4	30	23	265
	15-24	220	29	1	35	36	16	337
	25-34	701	50	3	38	72	46	910
	35-44	671	71	3	20	63	31	859
	45-54	515	39	4	17	32	17	624
	55-64	204	16	2	2	10	8	242
	65-74	75	8	1	3	3	2	92
	75-84	60	3	1	2	1	3	70
	>=85	29	2	0	0	0	1	32
	Subtotal	**2838**	**290**	**19**	**131**	**285**	**195**	**3758**
Female	1	224	24	1	10	52	57	368
	2	163	20	0	10	18	10	221
	3	218	31	11	15	52	26	353
	4	565	68	3	37	66	60	799
	5	542	58	3	43	41	22	709
	6	466	42	3	27	28	27	593
	7	183	25	3	3	17	8	239
	8	102	8	0	2	1	5	118
	9	79	2	0	5	2	2	90
	10	56	3	0	0	0	0	59
	Subtotal	**2598**	**281**	**24**	**152**	**277**	**217**	**3549**

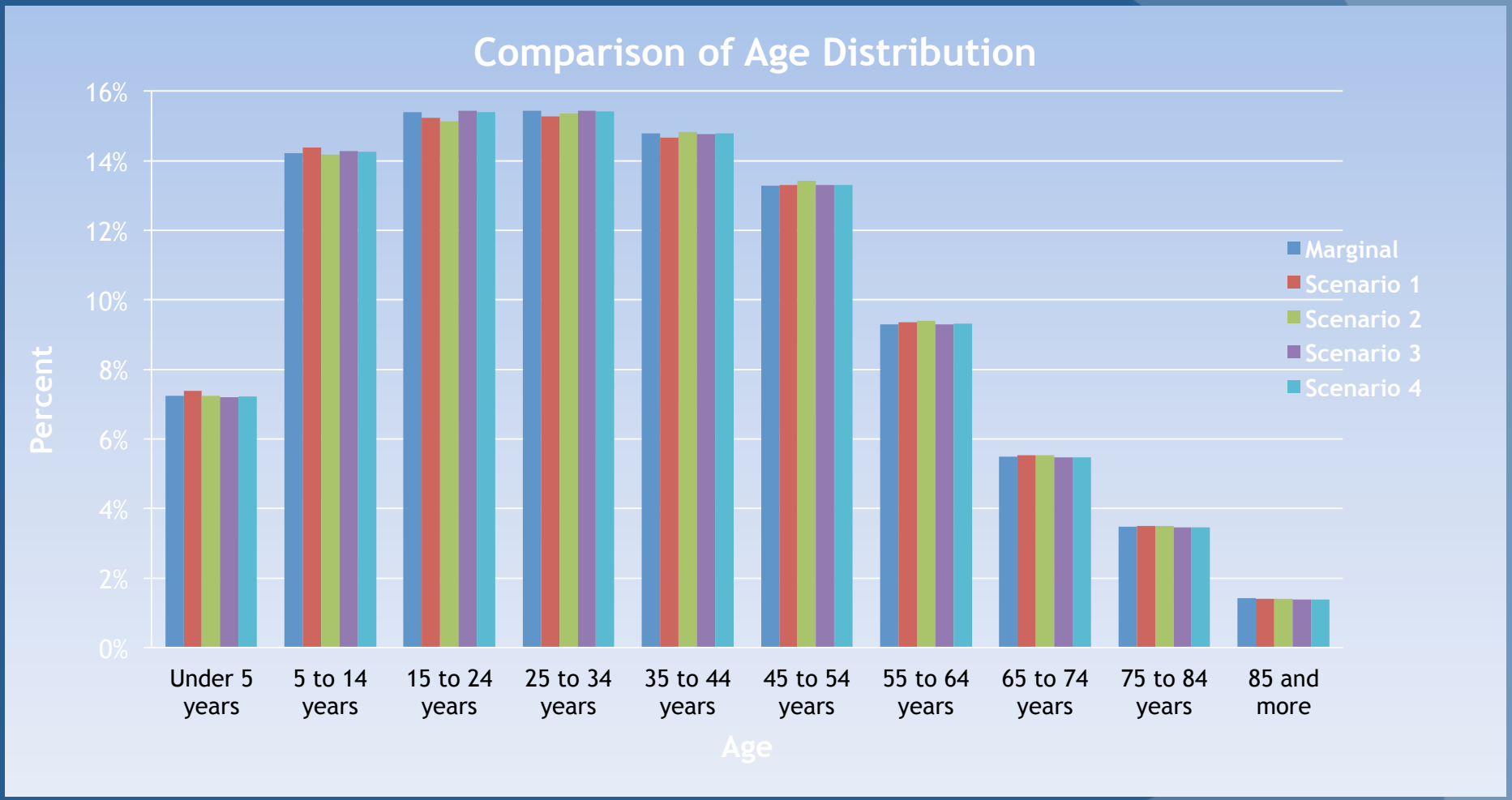
Example of Outputs



Results - Example of Household



Results - Example of Population



Summary

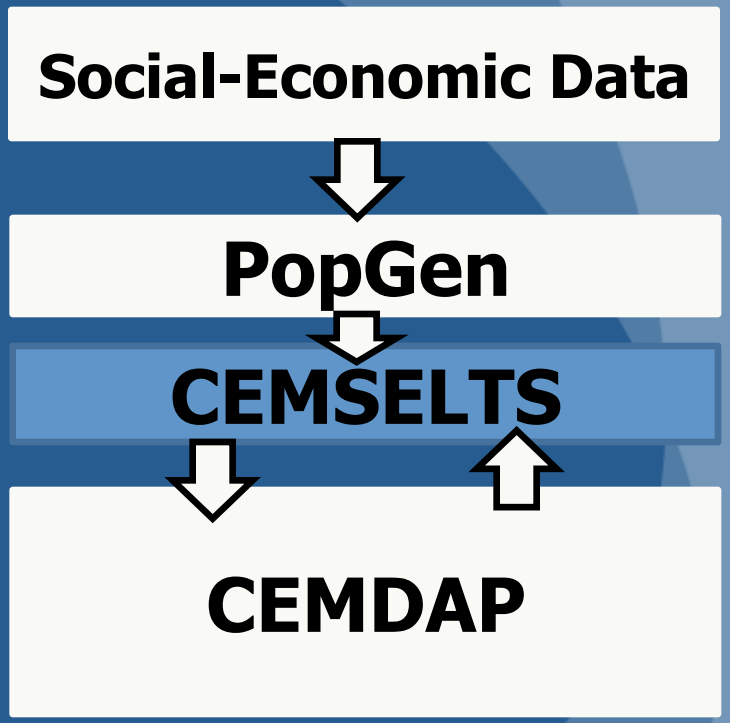
- Synthetic population data for SCAG ABM was created using PopGen (Population Generator) software developed at Arizona State University.

- For the 2003 simulation year:
  - Marginal distributions on control variables were furnished by the SCAG at the level of the traffic analysis zone (TAZ) for a total of 4109 zones.
  - Applied recently to 11,000 zone system

- **Windows Server**
  - 16 cores, 72GB of RAM
  - Effective synthesis model run time = 23 hours

Richer set of inputs is needed

- Synthesizing huge populations (18 million) reduces variances in population characteristics that would be desirable in the context of the ABM model implementation.
- Many key socio-economic attributes that may explain people and household choices are missing.



Next Step

CORE MODULES

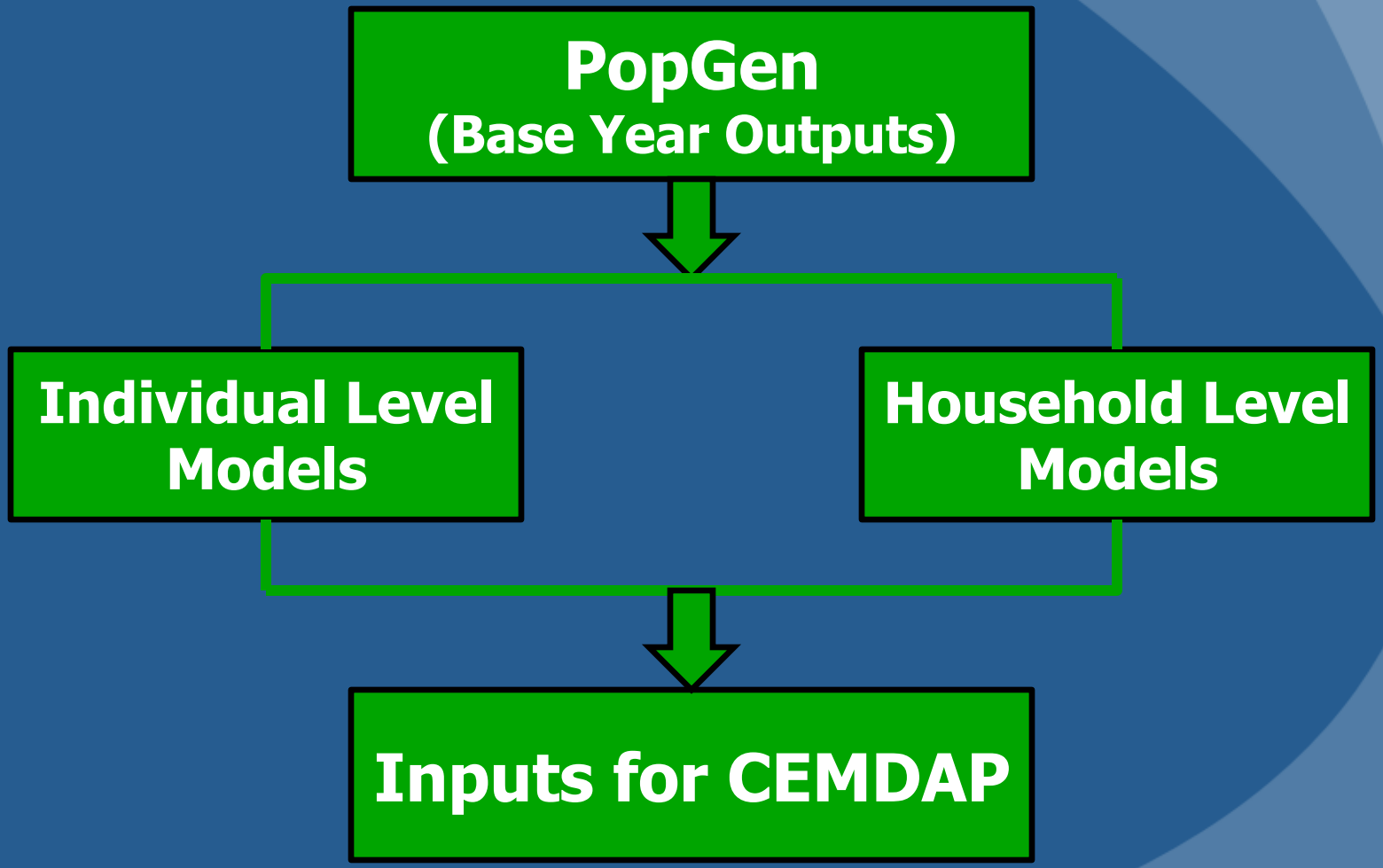
CEMSELTS

***C**omprehensive **E**conometric **M**icrosimulator of **S**ocio-economics, **L**and-use, and **T**ransportation **S**ystem*

CEMSELTS

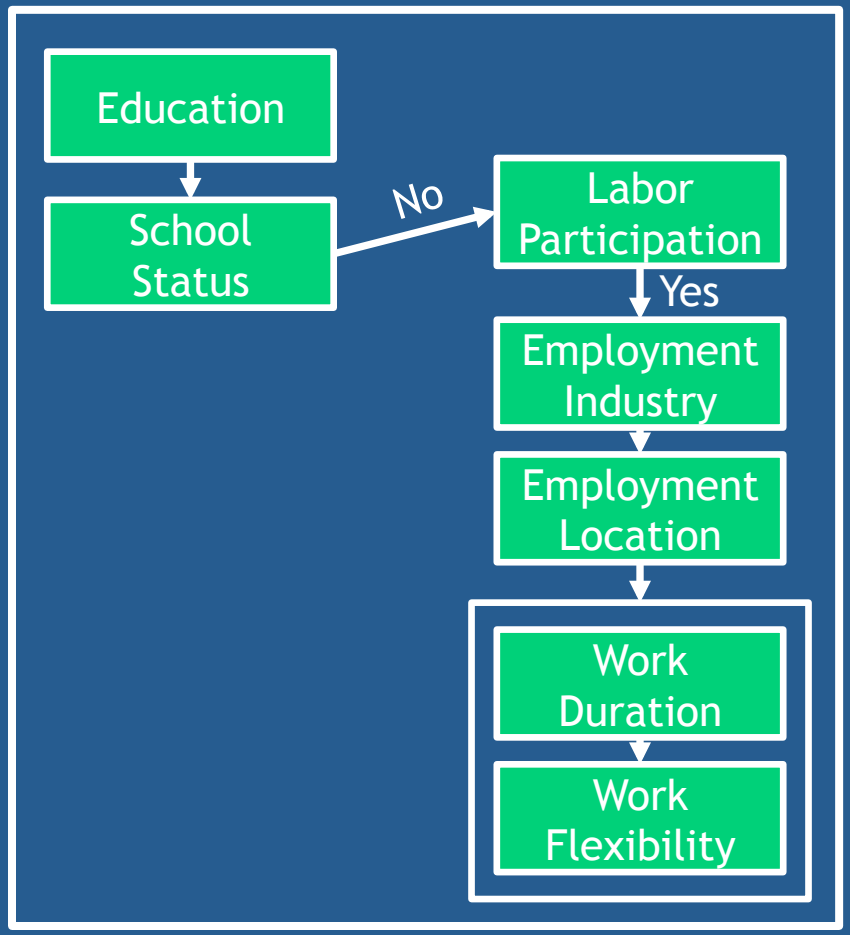
- **Create additional variables for each individual:**
  - Education Attainment
  - Job Status
  - Household Income
  - Housing Type
- **Create Long-Term Choice Variables**
  - Vehicle Ownership & Type
  - Job/School Location Choice

CEMSELTS Sequence

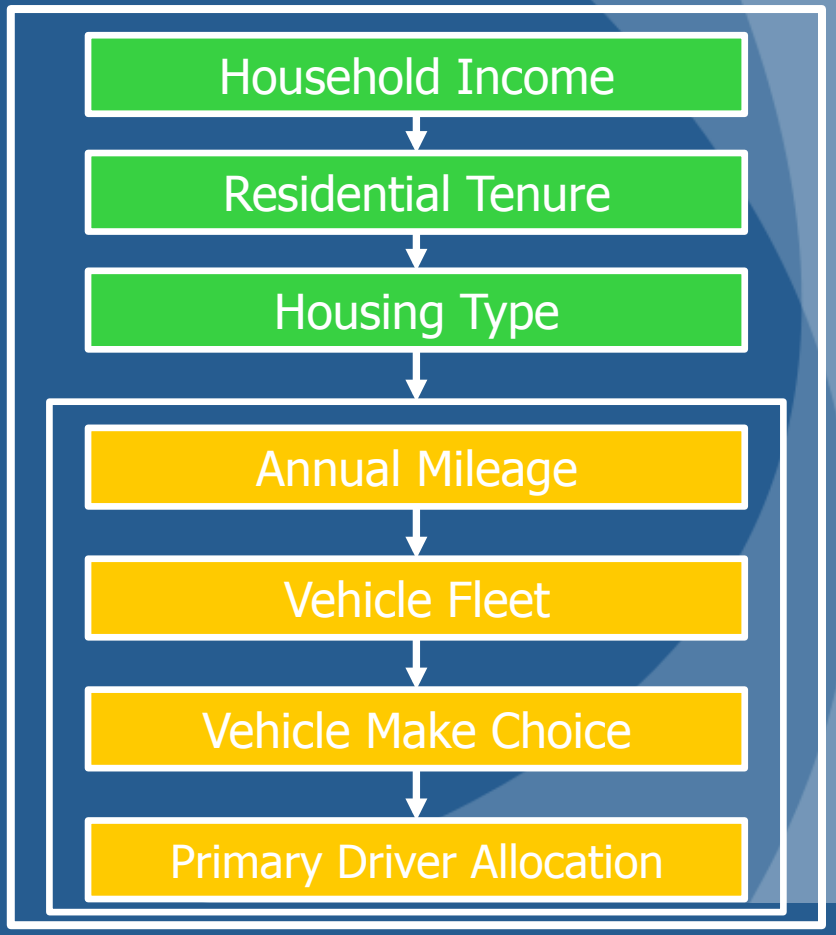


CEMSELTS Models

Individual Level Models



Household Level Models



Vehicle type choice model

- Log-Regression model to predict annual household mileage
- Vehicle Fleet Composition → MDCEV
- 54 Alternatives: Combination of 9 body types and 6 vintage categories
  - Body type: Sub-compact car, Compact car, Medium car, Large Car, Sports car, Medium SUV, Large SUV, Van, Pickup
  - Vintage: New or 1 year, 2-3 years, 4-5 years, 6-9 years, 10 to 12 years, >12 years
  - Plus One non-motorized mileage alternative

CEMSELTS Individual level model output

Comparison with ACS 2003 and Census 2000

Individual Socio-demographics	Values in Percent			Values in Percent		
	ACS 2003	CEMSELTS Predicted	Difference in Percentage	Census 2000	CEMSELTS Predicted	Difference in Percentage
Enrollment of Children (3 to 17 years)						
Preschool - Grade 3	37.07	44.59	7.52	41.17	44.59	3.42
Grade 4 - Grade 8	41.64	42.16	0.52	38.76	42.16	3.40
Grade 9 - Grade 11	21.29	13.25	-8.04	20.07	13.25	-6.82
Educational Attainment (Adults)						
Less than Grade 9	11.58	2.23	-9.35	13.14	2.23	-10.91
Grade 9 - Grade 12 (no diploma)	12.05	8.28	-3.78	14.71	8.28	-6.44
Completed High School	45.70	58.48	12.78	44.00	58.48	14.48
Associate or Bachelors	22.55	22.95	0.41	20.77	22.95	2.18
Graduate Degree (Masters or Ph.D)	8.12	8.06	-0.06	7.37	8.06	0.69
Labor Participation						
Employed	59.47	59.07	-0.40	56.81	59.07	2.26
Unemployed	40.53	40.93	0.40	43.19	40.93	-2.26
Employment Industry						
Construction and Manufacturing	19.92	14.46	-5.46	20.67	14.46	-6.21
Trade and Transportation	4.94	7.32	2.38	4.86	7.32	2.46
Personal, Professional and Financial	50.63	49.42	-1.21	49.34	49.42	0.08
Public and Military	3.94	5.07	1.13	4.04	5.07	1.03
Retail Trade	15.29	10.77	-4.51	15.60	10.77	-4.83
Other	5.28	12.96	7.68	5.49	12.96	7.47

CEMSELTS Household level model output
Comparison with ACS 2003 and Census 2000

Household Socio-demographics	Values in Percent			Values in Percent		
	ACS 2003	CEMSELTS Predicted	Difference in Percentage	Census 2000	CEMSELTS Predicted	Difference in Percentage
Number of Vehicles						
Households with no vehicles	8.29	7.27	-1.02	10.07	7.27	-2.79
Households with 1 vehicle	33.34	31.32	-2.02	34.85	31.32	-3.55
Households with 2 vehicles	37.48	34.71	-2.77	37.16	34.72	-2.44
Households with 3 vehicles	14.10	15.17	1.07	12.59	15.17	2.59
Households with 4 or more vehicles	6.79	11.52	4.74	5.33	11.52	6.19
Number of Workers						
Households with no workers	12.21	16.84	4.63	11.31	16.84	5.53
Households with 1 worker	34.23	36.80	2.58	32.98	36.80	3.82
Households with 2 or more worker	53.57	46.36	-7.21	55.71	46.36	-9.35
Household Income						
$0- $9999	8.08	8.09	0.01	8.98	8.09	-0.89
$10,000-$34,999	28.85	40.45	11.6	29.56	40.45	10.89
$35,000-$49,999	15.05	14.47	-0.58	15.24	14.48	-0.76
$50,000-$74,999	18.53	13.58	-4.95	18.89	13.58	-5.31
$75,000 and more	29.49	23.4	-6.09	27.32	23.40	-3.93
Household Tenure						
Owner	55.74	61.05	5.30	54.78	61.03	6.25
Renter	44.26	38.95	-5.30	45.22	38.97	-6.25
Household Type for Owners						
Single Unit (Attached/Detached)	88.15	93.42	5.27	54.78	61.05	6.27
Other	11.85	6.58	-5.27	45.22	38.95	-6.27
Household Type for Renters						
Single Unit (Attached/Detached)	27.87	50.49	22.62	88.32	93.42	5.10
Apartment	72.13	49.51	-22.62	11.68	6.58	-5.10

CEMSELTS
Work Flow Distribution by Destination

Origin county	Within Origin County			Outside Origin County			Total		
	ACS2003 (%)	CEMSELTS 2003 (%)	Difference	ACS2003 (%)	CEMSELTS 2003 (%)	Difference	ACS2003 (%)	CEMSELTS 2003 (%)	Difference
Los Angeles	52.79	52.63	-0.16	3.86	5.29	1.43	56.65	57.92	1.26
Orange	15.61	14.28	-1.32	3.11	3.45	0.35	18.71	17.74	-0.98
Riverside	6.57	7.65	1.09	3.19	1.85	-1.35	9.76	9.50	-0.26
San Bernardino	6.88	7.58	0.70	3.18	2.60	-0.58	10.06	10.18	0.12
Ventura	3.73	3.67	-0.06	1.09	1.00	-0.09	4.82	4.67	-0.15
Total	85.57	85.81	0.24	14.43	14.19	-0.24	100	100	0.00

CEMSELTS
Vehicle Type Choice Model Results

Body Type	Survey Data	CEMDAP
Sub-compact Car	3.5	2.7
Compact Car	18.2	23.9
Medium Car	22.3	23.9
Large Car	5.7	3.3
Sports Car	5.6	4.1
Medium SUV	9.5	9.9
Large SUV	11.0	8.9
Van	7.0	5.9
Pickup	17.2	17.3

Summary

- CEMSELTS is - software/module that contains a series of choice models estimates for long-term choices & other attributes (14 sub-models).

- Vehicle type choice determines vehicle fleet mix; critical to *energy* and *emission* analysis.

- The resulting richer set of output is then fed to CEMDAP, the core activity-based modeling engine within SimAGENT to simulate complete daily activity-travel patterns for the population of the region.

Household Evolution Model

- A model that progresses resident population year after year using smooth transitions instead of abrupt adjustments based on externally provided demographic data.

- It enables to link demographic transition to behavioral change and demonstrate the market penetration of new technologies and adoption of new behavioral patterns in a realistic and verifiable way.

- The project is almost complete (June, 2013).

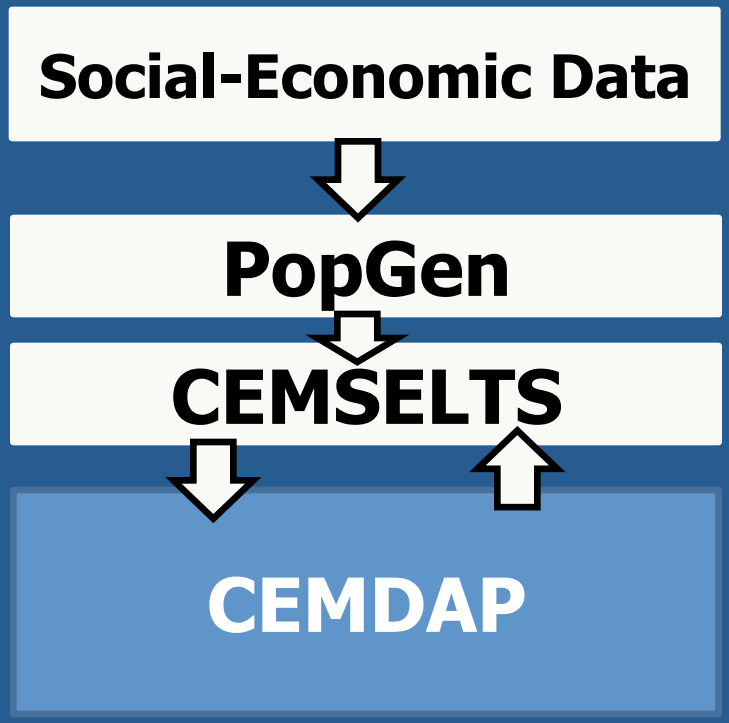
CORE MODULES

CEMDAP

***C**omprehensive **E**conometric Microsimulator of Daily Activity-Travel Patterns*

CEMDAP Module

Comprehensive Econometric Microsimulator of Daily Activity-Travel Patterns



- Simulates activity schedule and travel characteristics for each individual of the region
- Core module of SimAgent
- 52 sub-models.
- Developed by UT Austin with new functions and acessibility.

Features of CEMDAP

- A policy responsive tool
- Continues time scale (1440 minutes in a day)
- Allows any number of zones
- Level of service data can be provided at any temporal resolution (5 time of-day periods for SCAG ABM)
- Explicitly considers time-space constraints
- Changes in the activity-travel pattern of one individual in a household may bring about changes in activity-travel patterns of other household members
- MDCEV approach facilitates modeling activity participation at a household level with joint activity participation incorporated in a simple fashion

Features of CEMDAP

Recognizing Fixities

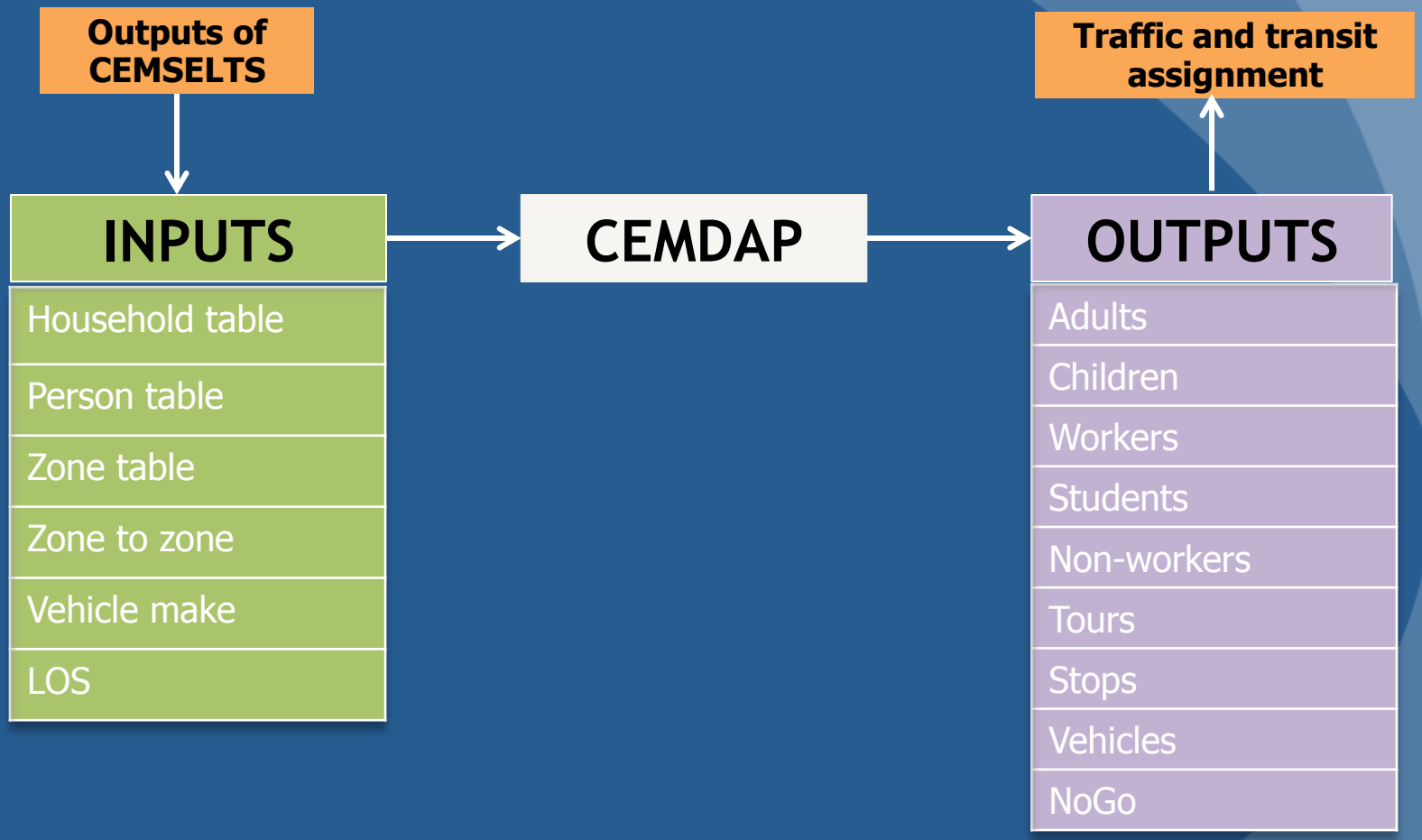
Non-Workers

- No obvious activity with spatial and temporal fixities
- Person more flexible in scheduling his/her activities

Workers

- The “work” activity has spatial and temporal fixities
- Person schedules his/her activities around the work activity

CEMDAP System



Tools for CEMDAP

- CEMDAP includes 52 sub-models

- The econometric structure for each sub-model falls under one of the eight econometric model categories:
  1. Multiple Discrete Continuous Extreme Value (MDCEV),
  2. Fractional split
  3. Binary logit
  4. Multinomial logit
  5. Hazard-duration
  6. Regression,
  7. Ordered probit and
  8. Spatial location choice.

Person type

Population

Workers

-Who goes to work
-Persons aged 16 or older

-Who goes to school
-Persons aged 15 or younger

Non-workers

-Who does not go to work
-Persons aged 16 or older

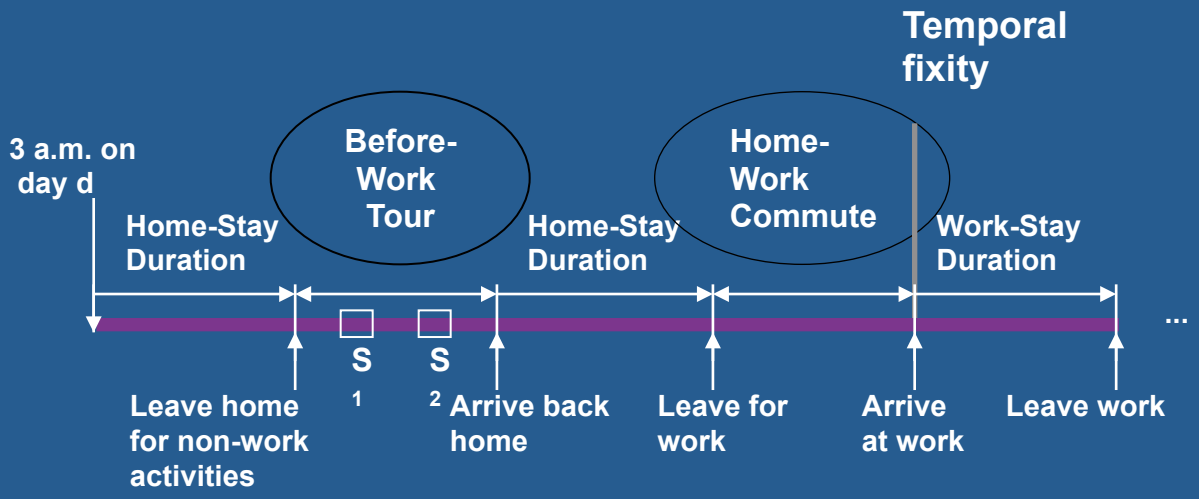
-Who does not go to school
-Persons aged 15 or younger

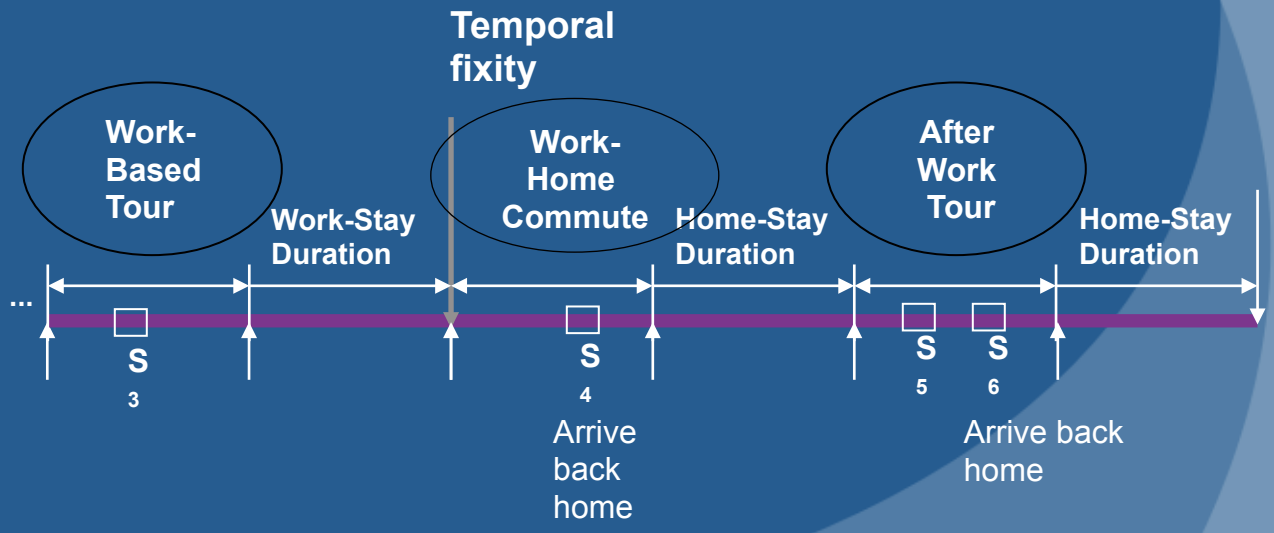
Activity Types/Travel Purposes

- Home
- Mandatory
  - Work
  - School
- Maintenance
  - Drop-off at school
  - Pick-up from school
  - Other serve-passenger
  - Shopping
  - Work-related
  - Household/personal business
- Discretionary
  - Joint discretionary
  - Children discretionary
  - Social recreation
  - Eating out

Representing Activity-Travel Patterns

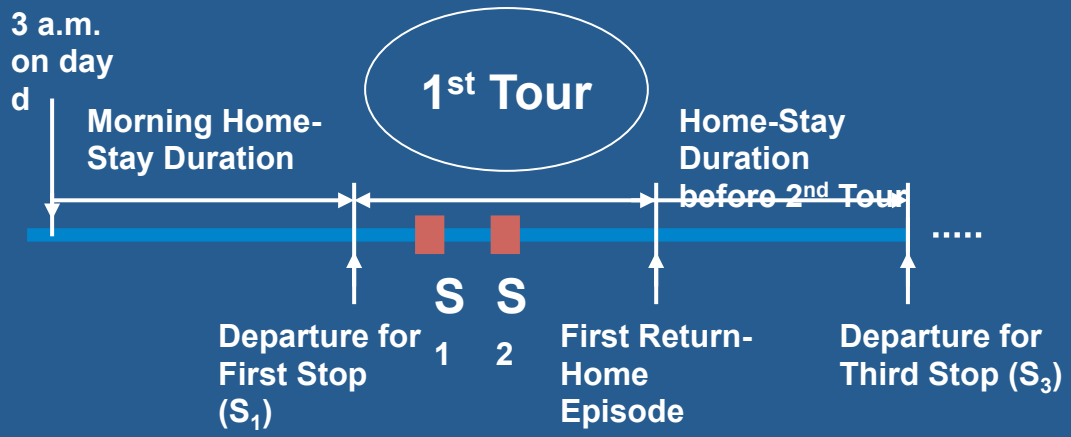
Workers

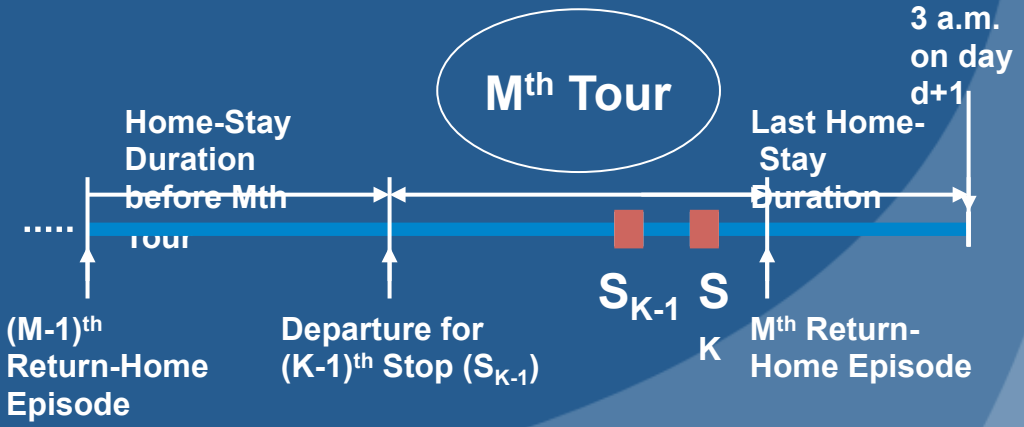




Representing Activity-Travel Patterns

Non-Workers

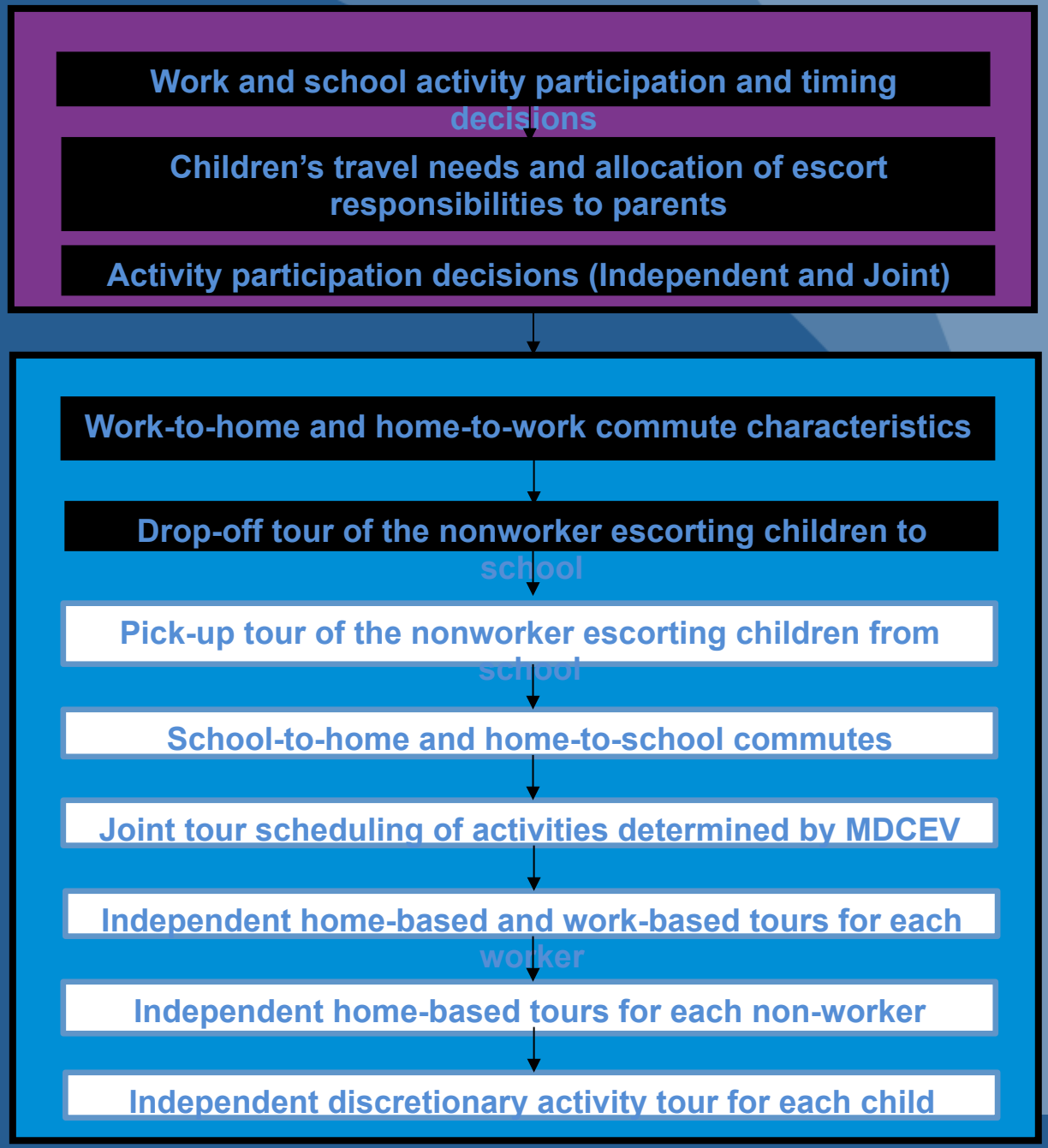




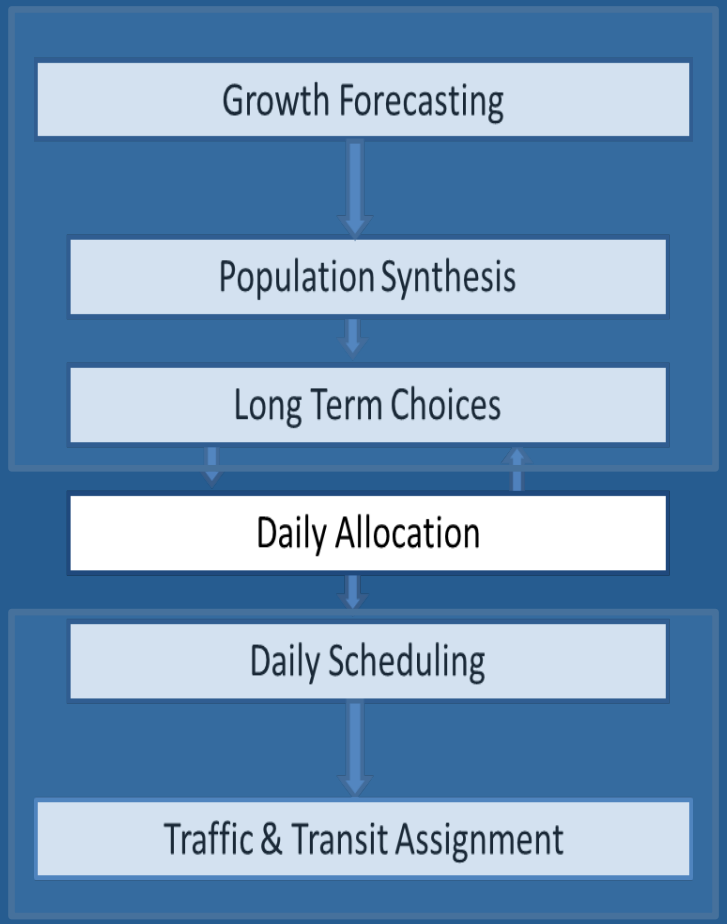
CEMDAP Modeling Framework

Two major steps:

1. **Generation Allocation**
2. **Scheduling**

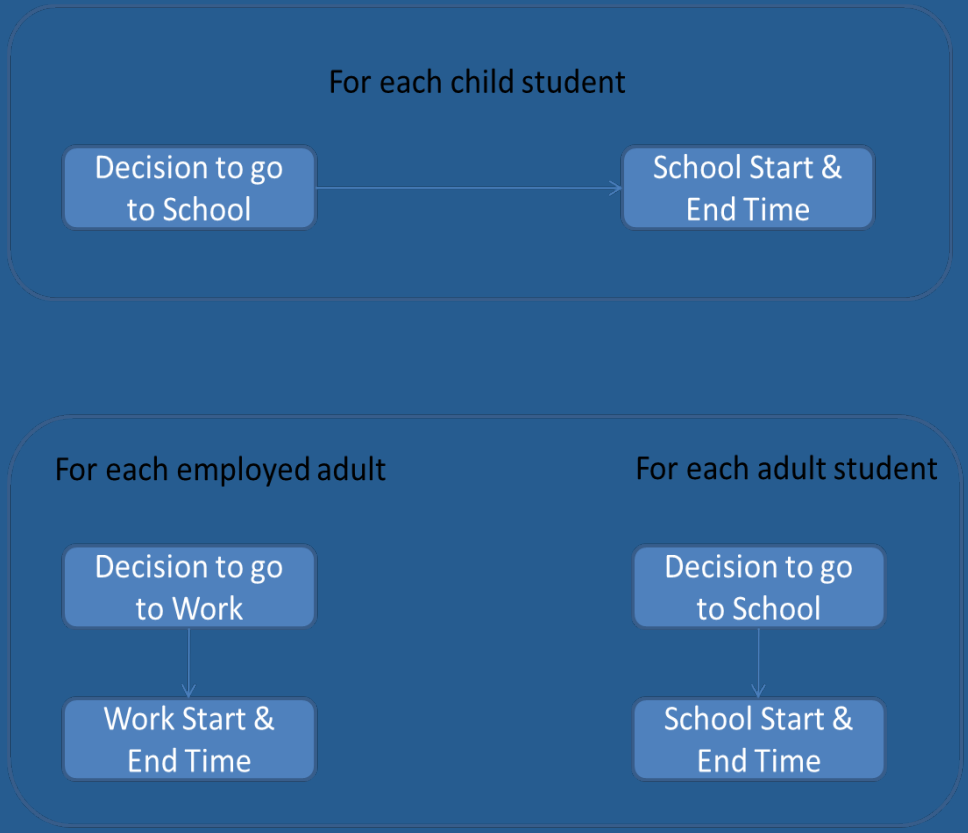


Activity Generation & Allocation



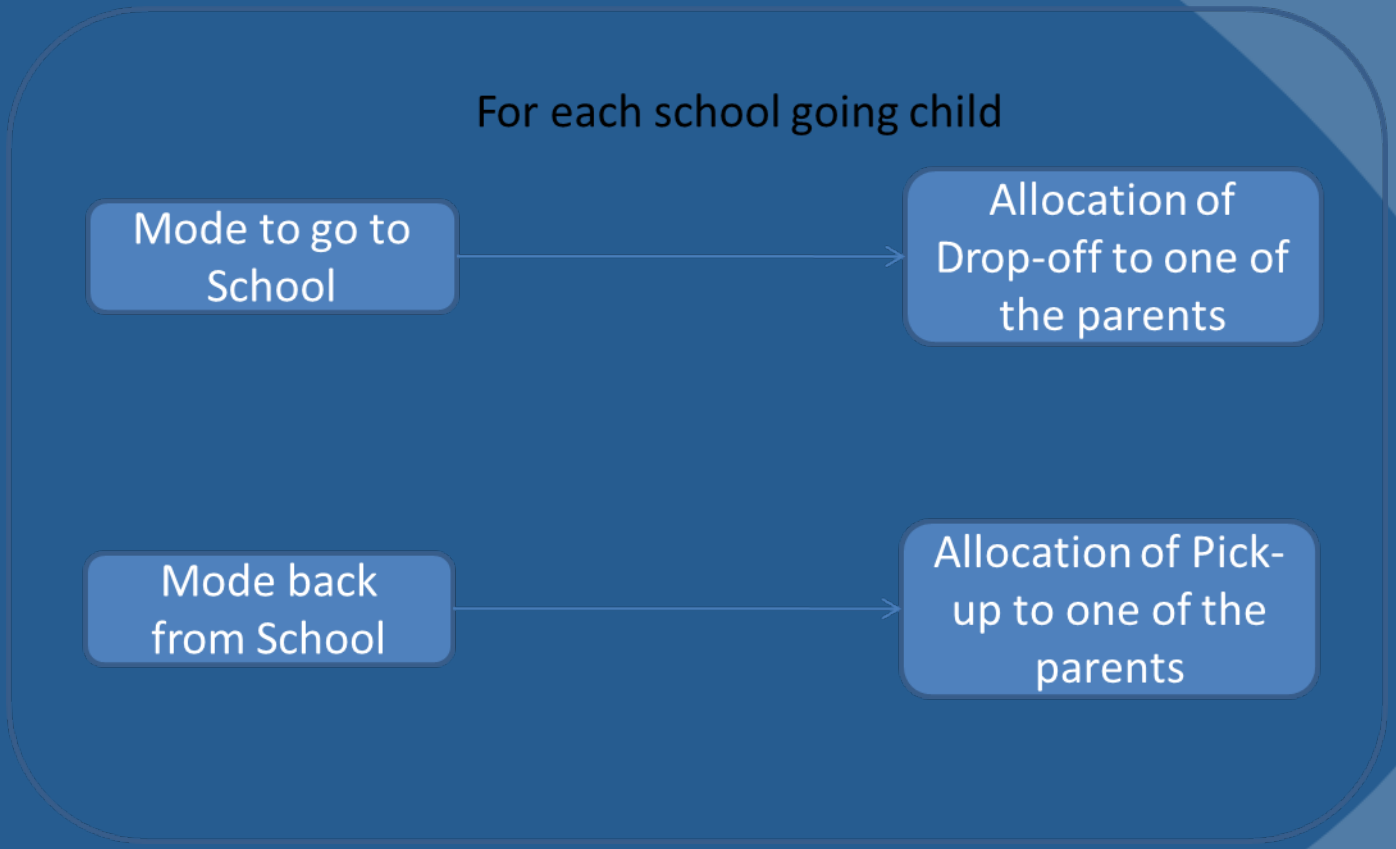
- **Determine each person's decision on daily activities:**
  - Workers: Commute
  - Children: Go to School
  - Non-workers: Non-work Activities
  - Parents: Pick up/Drop off
  - All Household Members: Joint Activity

GA module: Generation of work and school activity participation

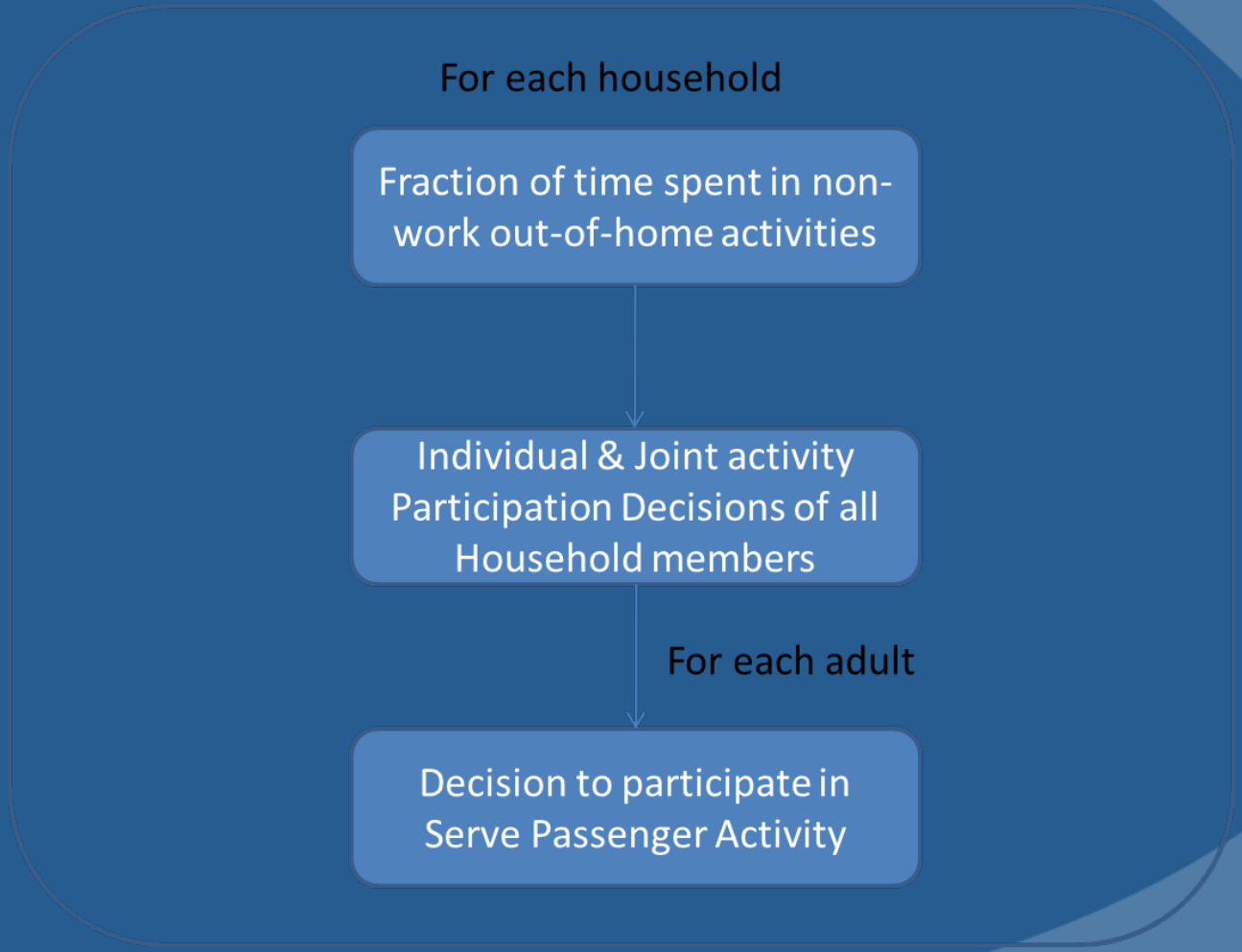


- Work and school activities are the greatest *space-time constraints* for most individuals
- Participation in these activities significantly influences an individual's participation in all other activities during the day

GA Module: Children's Travel Needs & Allocation of Escort Responsibilities



GA Module: Generation of Independent Activities for Personal and Household Needs

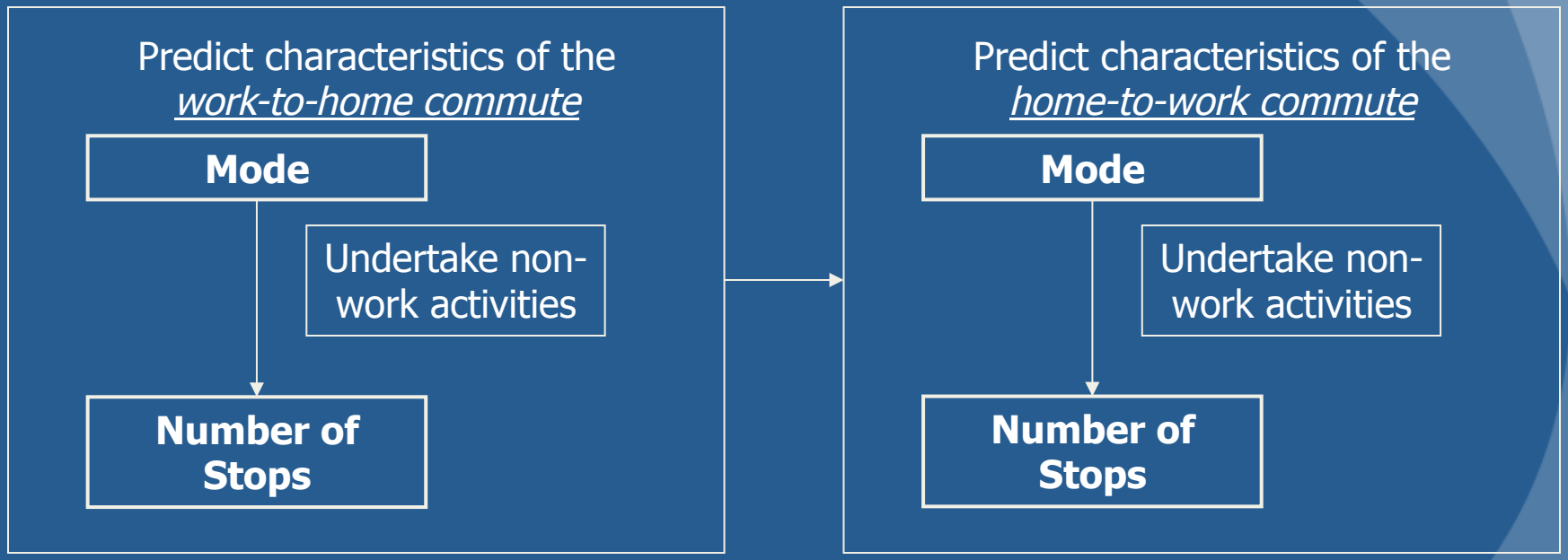


Activity & Travel Scheduling

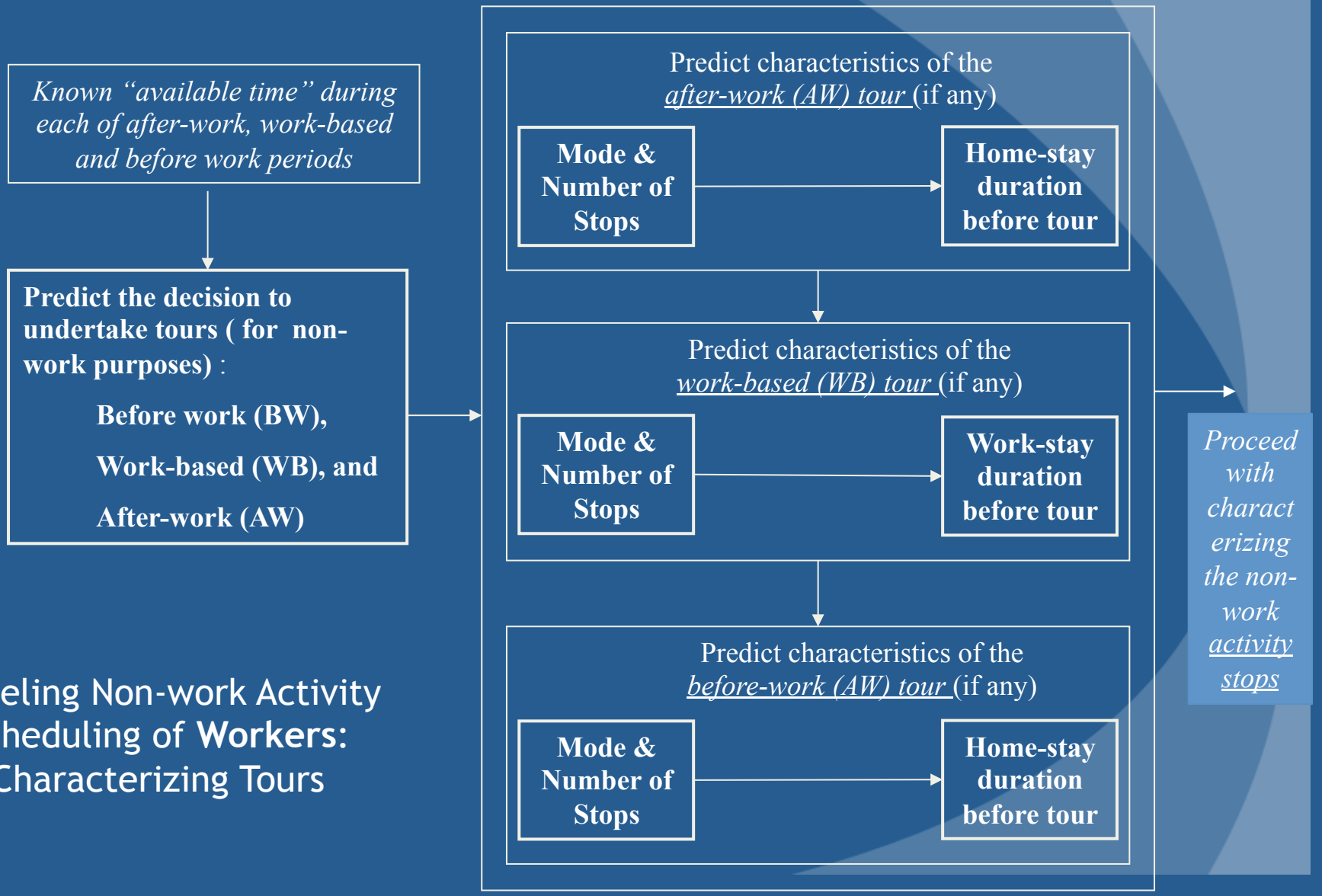
- **Produce:**
  - sequence of activities,
  - with the departure and arrival times,
  - activity duration(s),
  - mode for each trip, and
  - determination of the location of each activity.

Example of scheduling process

For each worker



Example of scheduling process

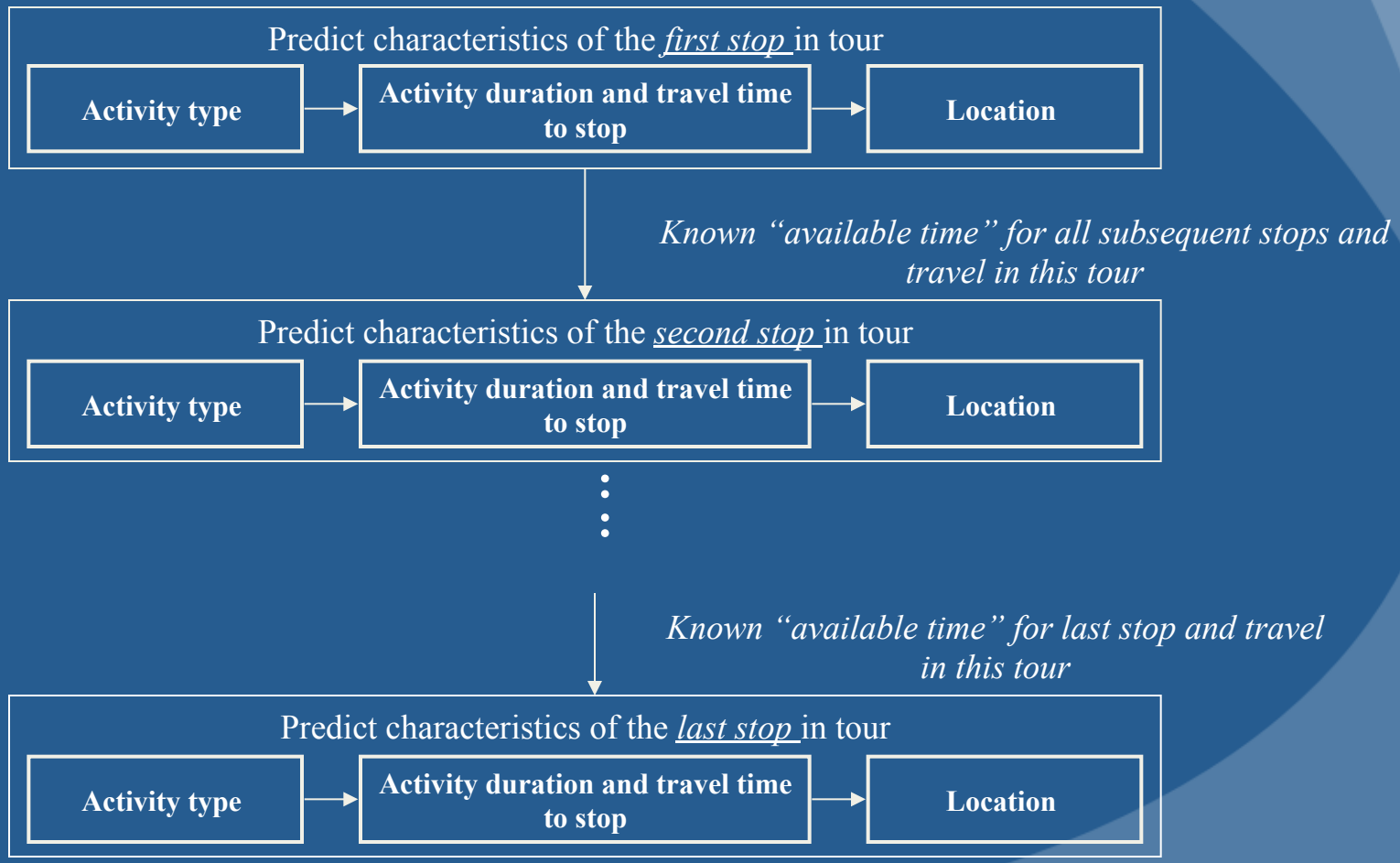


Modeling Non-work Activity Scheduling of **Workers**: Characterizing Tours

Example of scheduling process

Modeling Activity Scheduling of Non Workers
Charactering stops

Known duration and number of stops in this tour



Worker Scheduling Model System

Model ID	Model Name	Econometric Structure	Choice Alternative
WSCH1	Commute mode	MNL	Solo driver, Driver with passenger,
WSCH2	Number of before-work tours	Probit	0 or 1
WSCH3	Number of work-based tours	Ordered probit	0, 1 or 2
WSCH4	Number of after-work tours	Ordered probit	0, 1 or 2
WSCH5	Before-work tour mode	MNL	Solo driver, Driver with passenger,
WSCH6	Work-based tour mode	MNL	Solo driver, Driver with passenger,
WSCH7	After-work tour mode	MNL	Solo driver, Driver with passenger,
WSCH8	Number of stops in a tour	Ordered probit	1,2,3,4, or 5
WSCH9	Home or work stay duration before the tour	Regression	Continuous time
WSCH10	Activity type at a stop	MNL	10 Activity purposes
WSCH11	Activity duration at stop	Regression	Continuous time
WSCH12	Travel time to a stop	Regression	Continuous time
WSCH13	Location of a stop	Spatial Location Choice	Choice alternatives based on estimated travel time

Non-Worker Scheduling Model System

Model ID	Model Name	Econometric Structure	Choice Alternatives
NWSCH1	Number of independent tours	Ordered probit	1, 2, 3, or 4
NWSCH2	Decision to undertake an independent tour before the pick-up or joint discretionary tour	Binary logit	Yes, No
NWSCH3	Decision to undertake an independent tour after the pick-up or joint discretionary tour	Binary logit	Yes, No
NWSCH4	Tour mode	MNL	Solo driver, Driver with passenger, Passenger, and Walk/bike
NWSCH5	Number of stops in a tour	Ordered probit	1, 2, 3 4, or 5
NWSCH6	Number of stops following a pick-up/drop-off stop in a tour	Ordered probit	0 or 1
NWSCH7	Home stay duration before a tour	Regression	Continuous time
NWSCH8	Activity type at stop	MNL	10 Activity purposes
NWSCH9	Activity duration at stop	Regression	Continuous time
NWSCH10	Travel time to stop	Regression	Continuous time
NWSCH11	Stop location	Spatial Location Choice	Choice alternatives based on estimated travel time

Children Scheduling Model System

Model ID	Model Name	Econometric Structure	Choice Alternatives
CSCH1	School to home commute time	Regression	Continuous time
CSCH2	Home to school commute time	Regression	Continuous time
CSCH3	Mode for independent discretionary tour	Binary logit	Drive by other, Walk/bike
CSCH4	Departure time from home for independent discretionary tour (time from 3 a.m.)	Regression	Continuous time
CSCH5	Activity duration at independent discretionary stop	Regression	Continuous time
CSCH6	Travel time to independent discretionary stop	Regression	Continuous time
CSCH7	Location of independent discretionary stop	Spatial Location Choice	Predetermined subset of the 4,109 zones

Joint Discretionary Tour Scheduling Model System

Model ID	Model Name	Econometric Structure	Choice Alternative
JASHCH01	Decision of Joint or Separate Travel	Binary Probit	Yes or No
JASHCH02	Joint Activity Start time	Regression	Continuous
JASHCH03	Joint Activity travel time to stop	Regression	Continuous
JASHCH04	Joint Activity location	Spatial Location Choice	Predetermined subset of the 4,109 zones
JASHCH05	Vehicle Used For Joint Home-Based Tour	MDCEV	Vehicle types based on body type and vintage

- Joint activities of **workers** scheduled in work-to-home commute or After-work period
  - Determined by the Joint Activity Start Time
- For **non-workers** participating in joint activities
  - Decision to undertake independent tour before pick-up or joint tour
  - Decision to undertake independent tour after pick-up or joint tour

CEMDAP Simulation Output

- **CEMDAP** produces *complete activity-travel patterns* for a day for every **individual** in the population of interest
- There are **nine** output files:
  - Adults: decisions to undertake activities of different types for adults
  - Children: decisions to undertake activities of different types for children
  - Workers: pattern-level attributes of the workers' (including adult students)
  - Students: pattern-level attributes of the child students
  - NoGo: list of people who stayed at-home the whole day
  - Non-workers: pattern-level attributes of non-workers
  - Tours: tour-level attributes
  - Stops: stop-level attributes
  - Activities: activity episode attributes

CEMDAP

Initial validation results

Average Number of Trips per Household

Type of Trips	SimAGENT	Survey	SimAGENT (85% Work Scenario)
Home Based Work	1.27	1.33	1.68
Home Based Non-work	5.13	4.90	4.94
Non-home based	2.31	2.59	2.69
Total	8.71	8.82	9.30

Distribution of Number of Tours (Workers)

Number of Tours	Before Work		Work Based		After Work	
	Survey	SimAGENT	Survey	SimAGENT	Survey	SimAGENT
0	94.26	96.69	81.03	76.67	79.48	81.36
1	5.74	3.31	16.59	18.01	17.86	17.17
2	--	--	2.38	5.32	2.66	1.47

Distribution of Number of Tours (Non-Workers)

Number of Tours	Survey	SimAGENT
1	58.81	55.51
2	27.53	24.79
3	9.49	12.55
4	4.17	7.15

Average Number of Stops by Tour Type

Average number of stops	Survey	SimAGENT
Work Based tours	1.37	1.36
Before work tours	1.41	1.34
After work tours	1.40	1.36
Work-to-home commute	0.40	0.35
Home-to-work commute	0.26	0.18
Non-worker tour	1.78	1.66

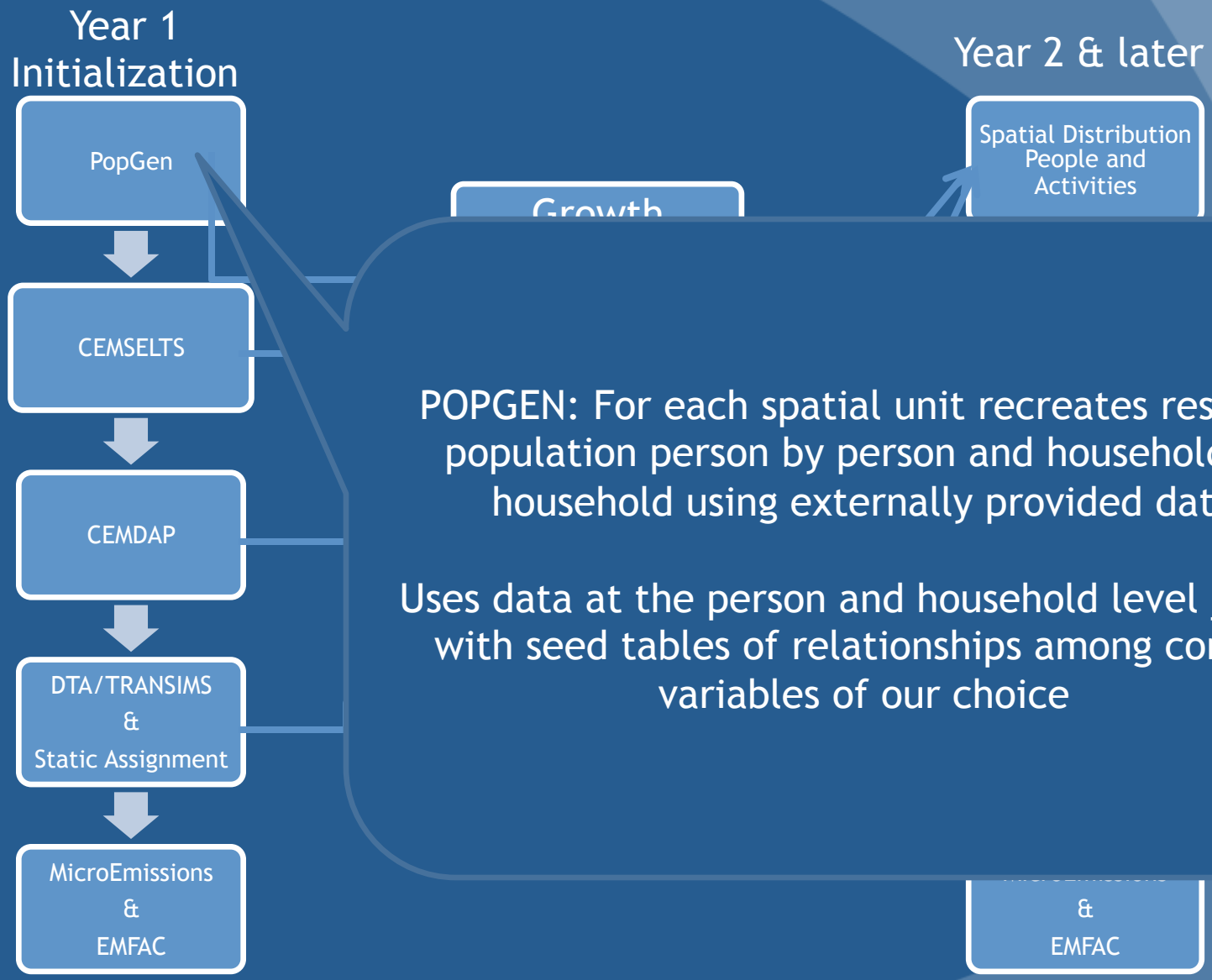
Chaining Propensity

	Survey	SimAGENT
Worker		
Chaining Propensity	0.85	0.86
Non Worker		
Chaining Propensity	0.71	0.76

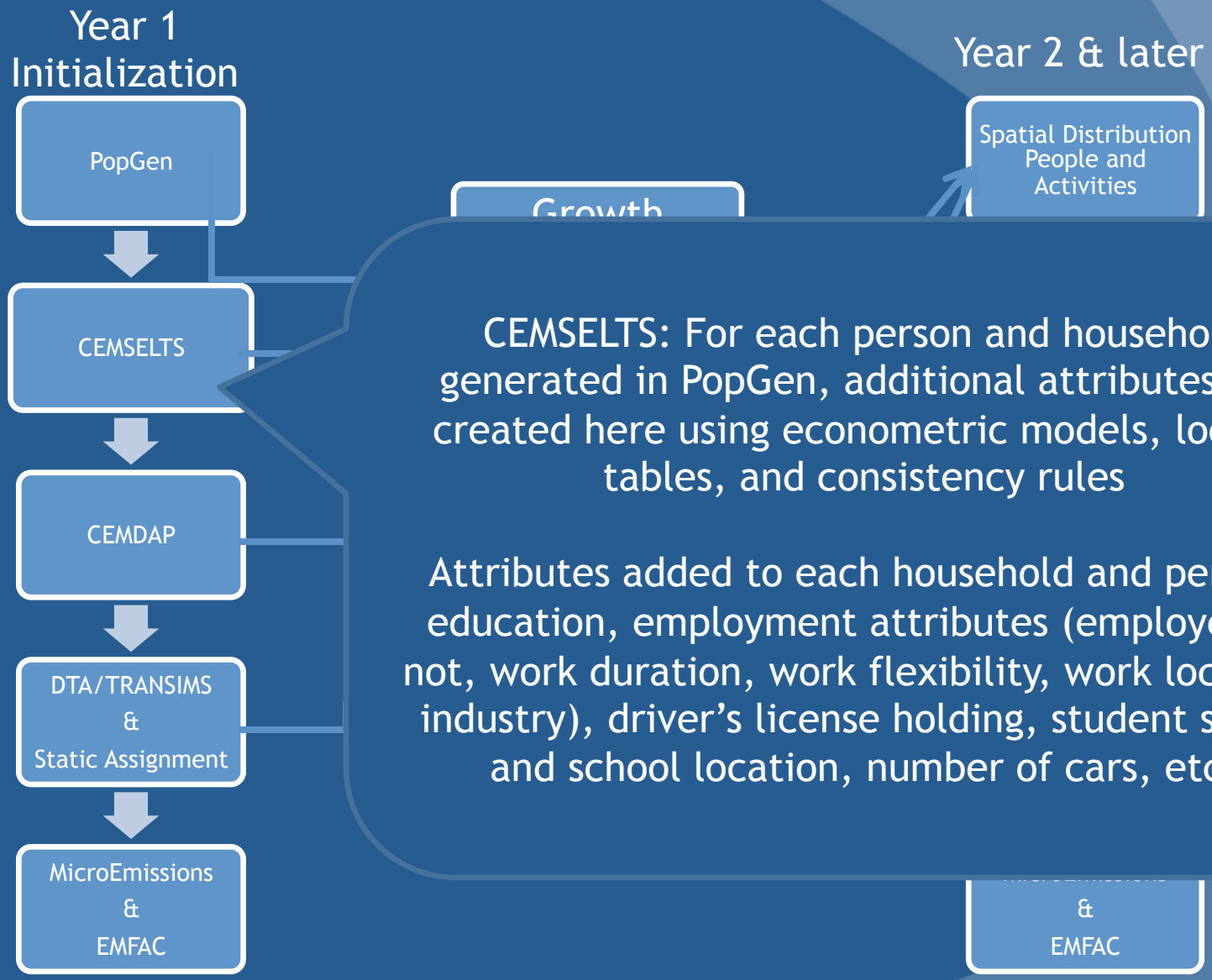
Tour Mode Shares

	Work-to-home		Work based		Before work		After work		Non-Worker	
	ABM	Survey	ABM	Survey	ABM	Survey	ABM	Survey	ABM	Survey
Drive alone	77.7	78.2	64.2	69.3	56.5	44.0	55.0	56.2	51.9	39.8
Drive as passenger	8.9	9.8	15.9	13.8	26.2	39.1	35.3	31.7	28.8	36.7
Shared ride	8.1	6.6	6.0	6.3	4.0	2.5	3.9	5.1	12.2	14.1
Walk or bike	2.7	2.9	13.7	10.1	12.7	13.9	4.9	6.3	5.7	7.5
Transit	2.6	2.5	0.2	0.5	0.6	0.5	0.9	0.7	1.4	1.9

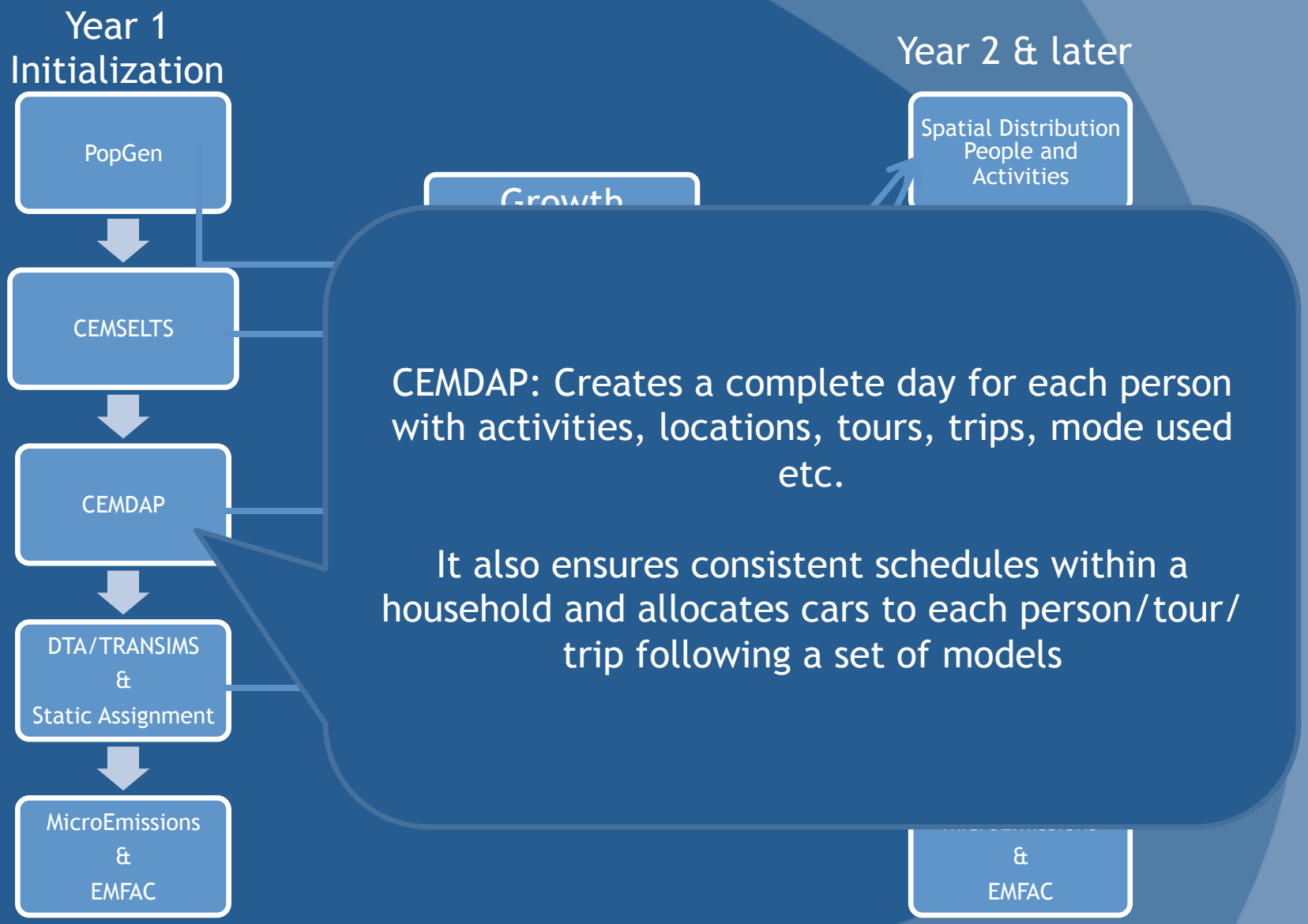
Sequence of SimAGENT Models



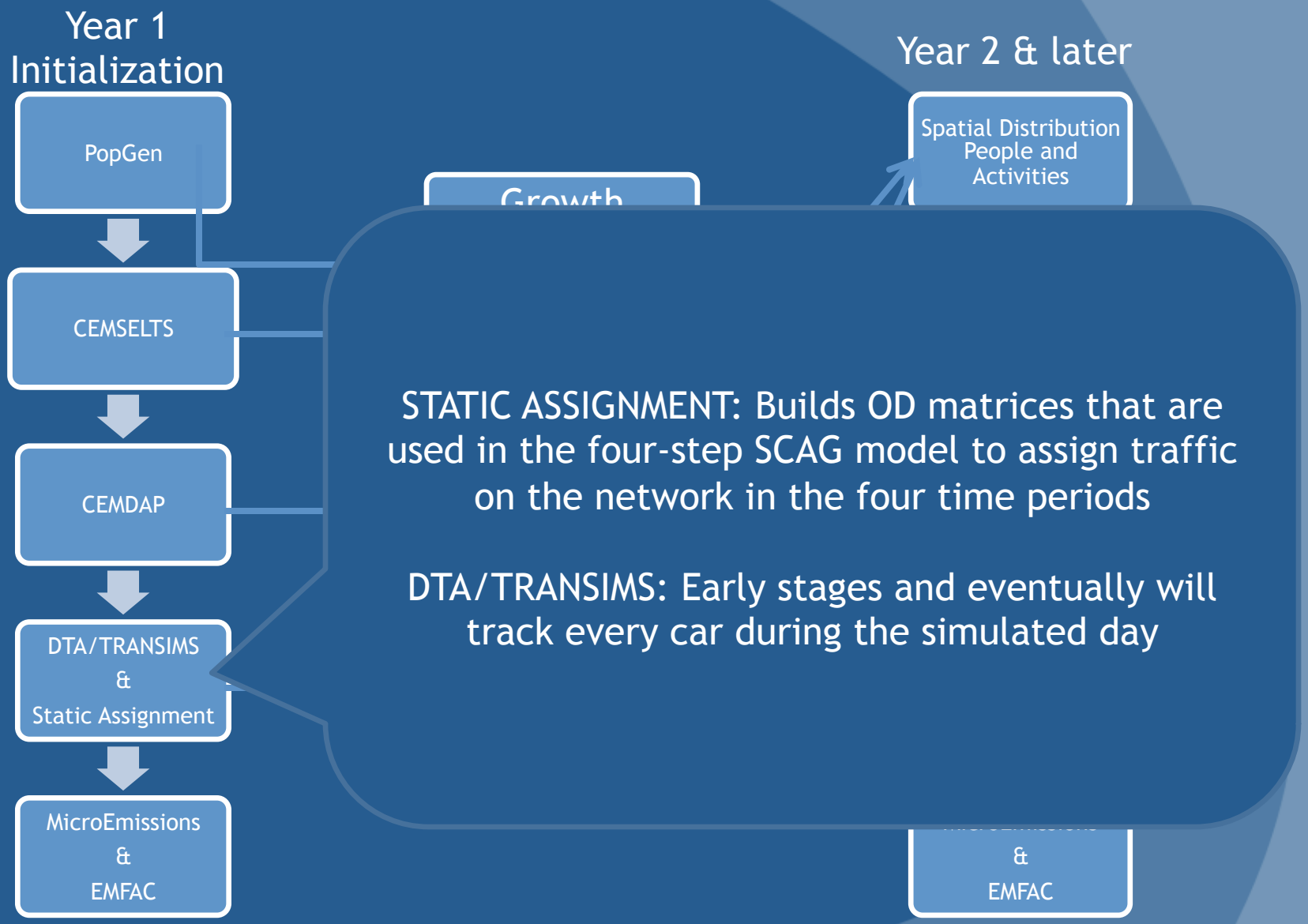
Sequence of SimAGENT Models



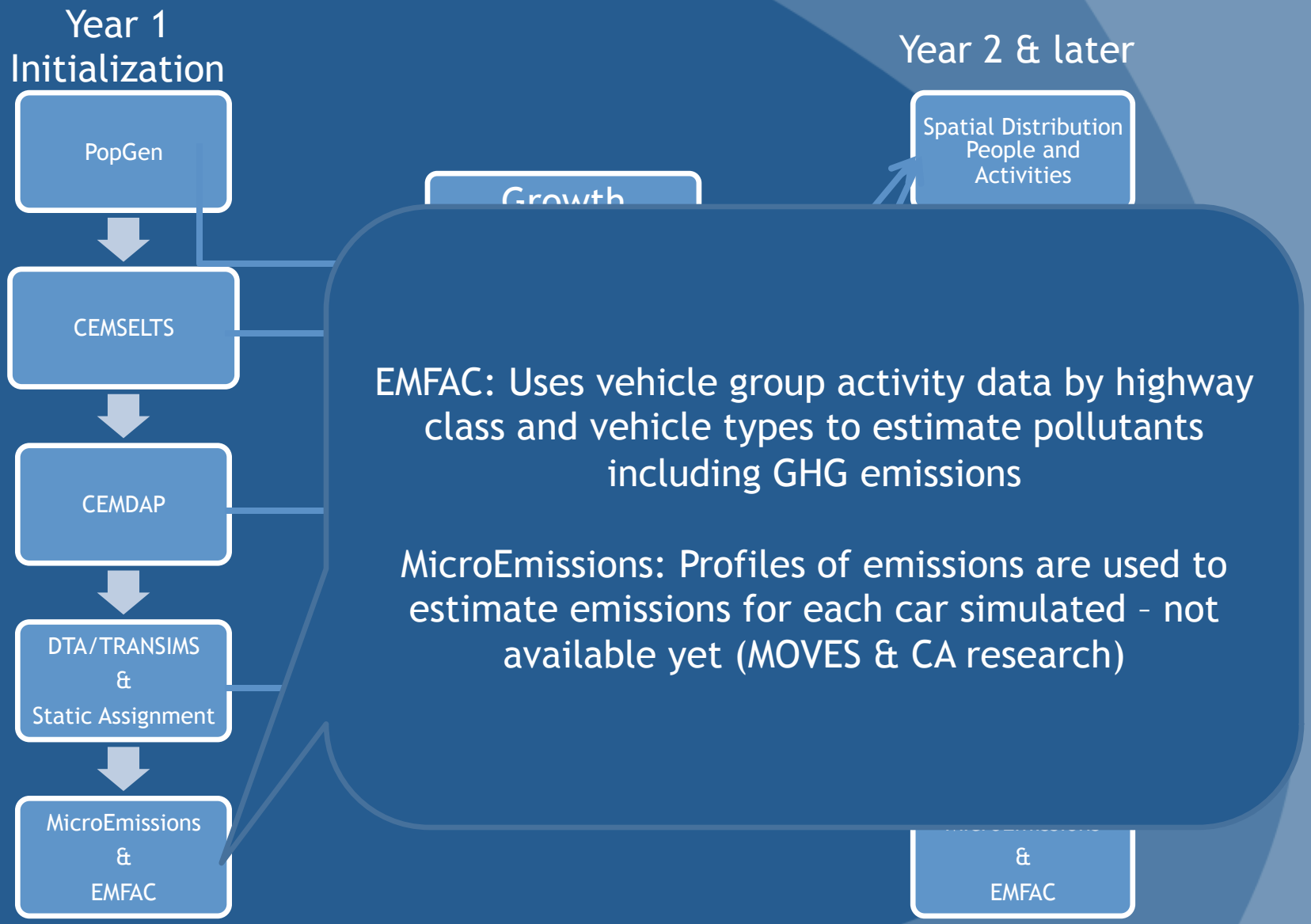
Sequence of SimAGENT Models



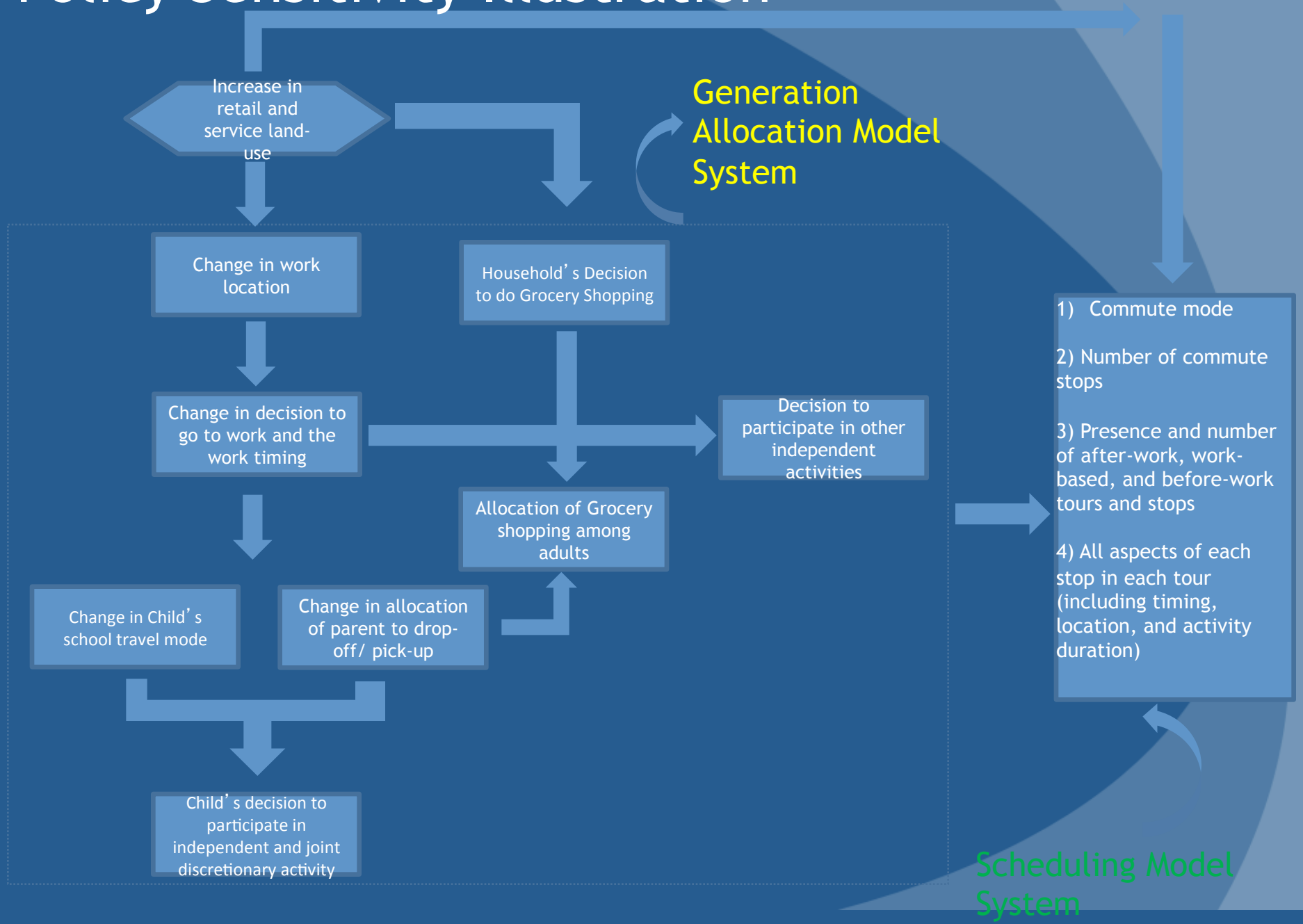
Sequence of SimAGENT Models



Sequence of SimAGENT Models



Policy Sensitivity Illustration



Vehicle Type Choice Simulation Component

- Vehicle type choice determines vehicle fleet mix; critical to energy and emissions analysis

- SimAGENT incorporates joint vehicle type choice and primary driver allocation model which determines:
  - Multiple vehicle holdings
  - Body type (Sub-compact, Compact car, Mid-sized car, Large car, Small SUV, Mid-sized SUV, Large SUV, Van, and Pickup)
  - Age (Less than 2 years old, 2 to 3 years old, 4 to 5 years old, 6 to 9 years old, 10 to 12 years old, Older than 12 years)
  - Use (miles)
  - Primary driver of each vehicle, simultaneously

Multimodal Capabilities

- SimAGENT incorporates full multimodal capabilities
- Explicit consideration of non-motorized transportation mode use for both utilitarian and recreational purposes
- Focus on both the person and the vehicle

Other Salient Features of SimAGENT

Temporal Resolution

- Continuous time scale
- Level-of-service data can be provided at any temporal resolution
- Explicitly considers time-space interactions/constraints
- Enables consideration of time-varying and dynamic pricing policies

Spatial Resolution

- Allows for any spatial resolution, and multi-scale spatial resolution.

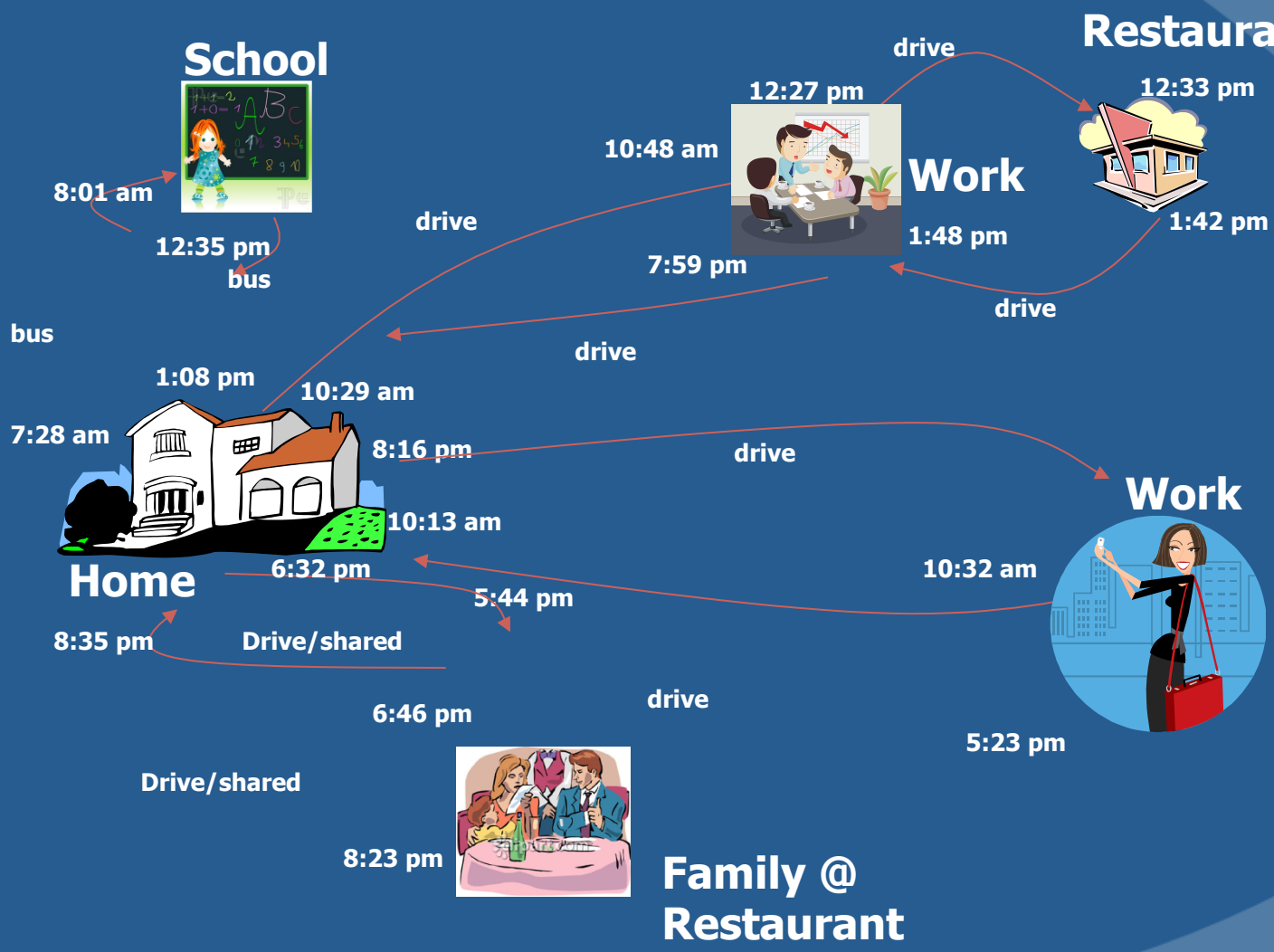
Activity Resolution

- Allows for any purpose resolution, and multiple resolution

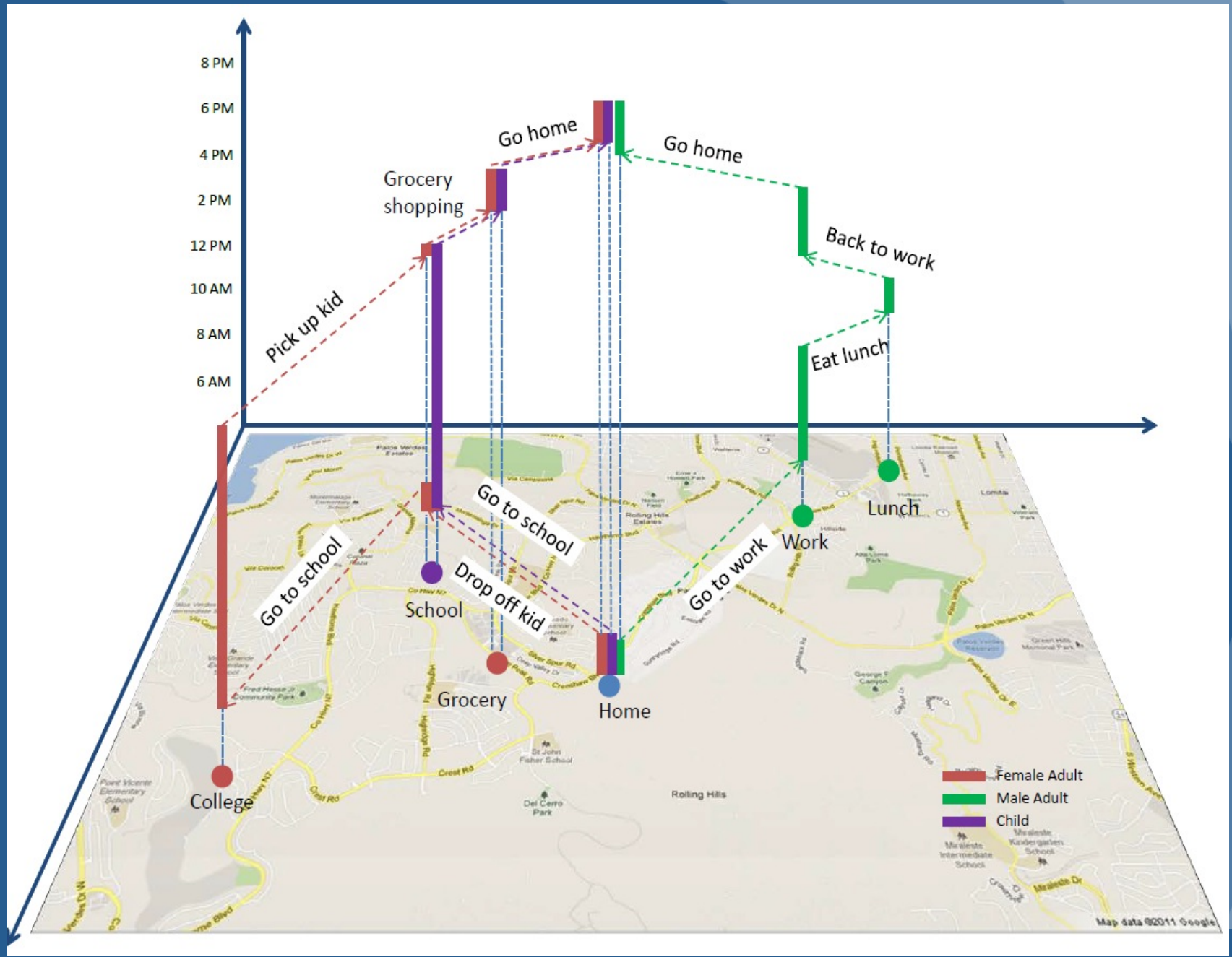
Graphical User Interface

- Standard Windows-based user interface
- Allows user to modify model parameters
- Provides a friendly diagrammatic interface to help the user understand the logic of the system and the underlying models

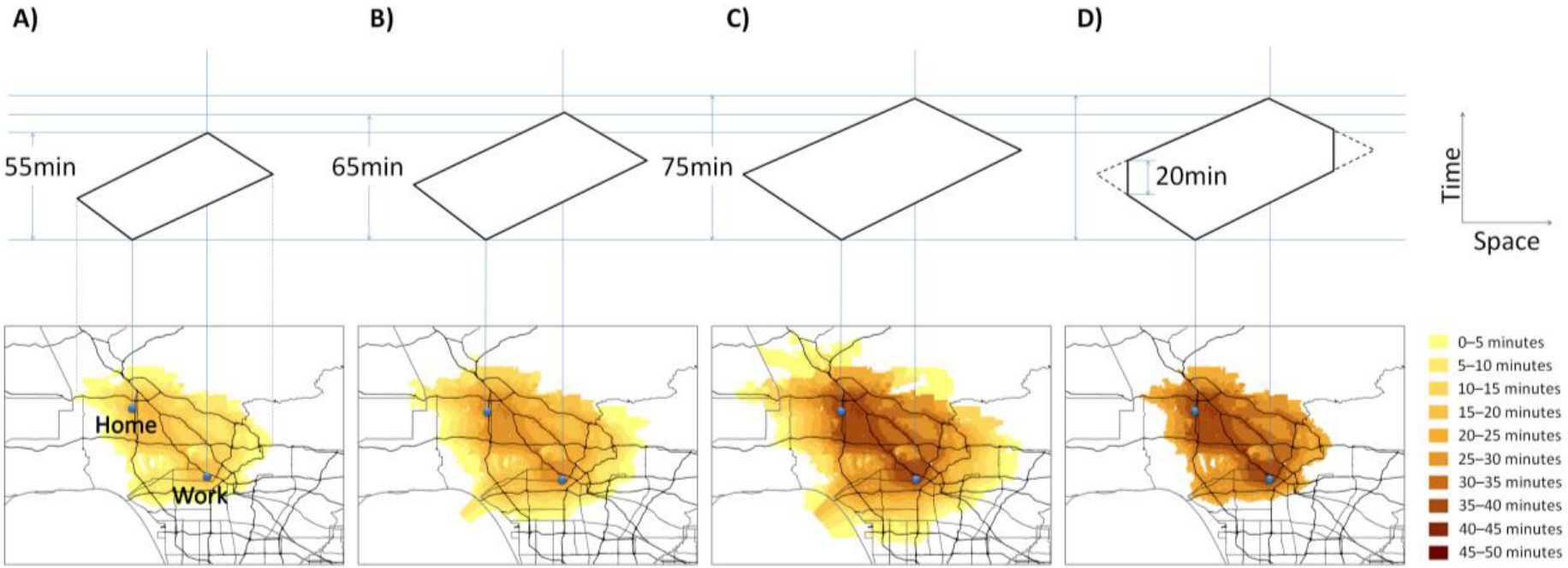
Sample SimAGENT Output: Daily activity-travel undertaken by a household



GEOLOCATED ACTIVITIES



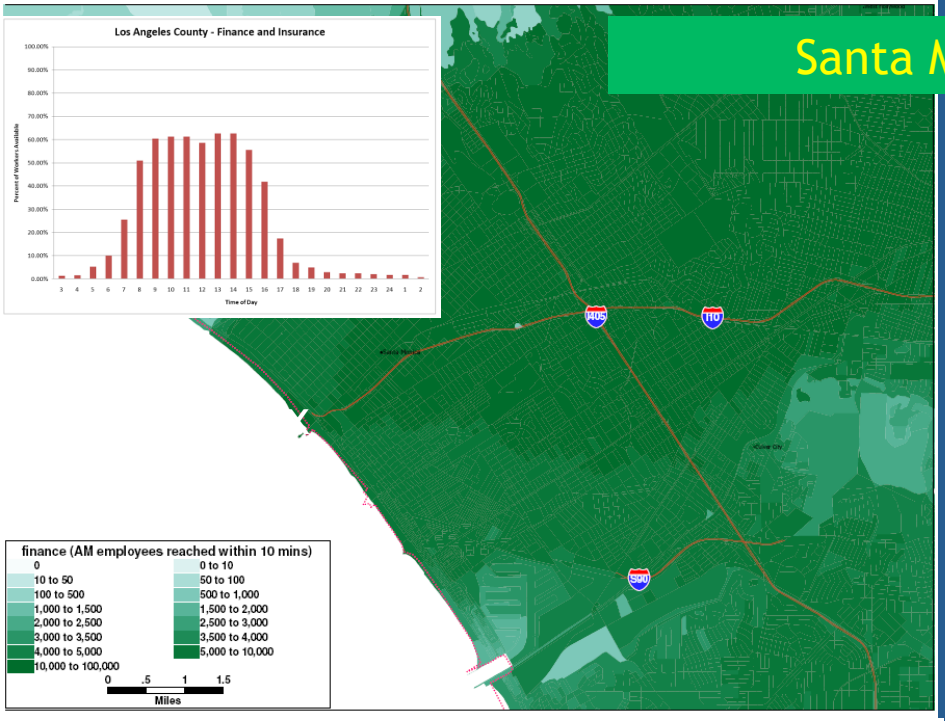
Time-Space Prims

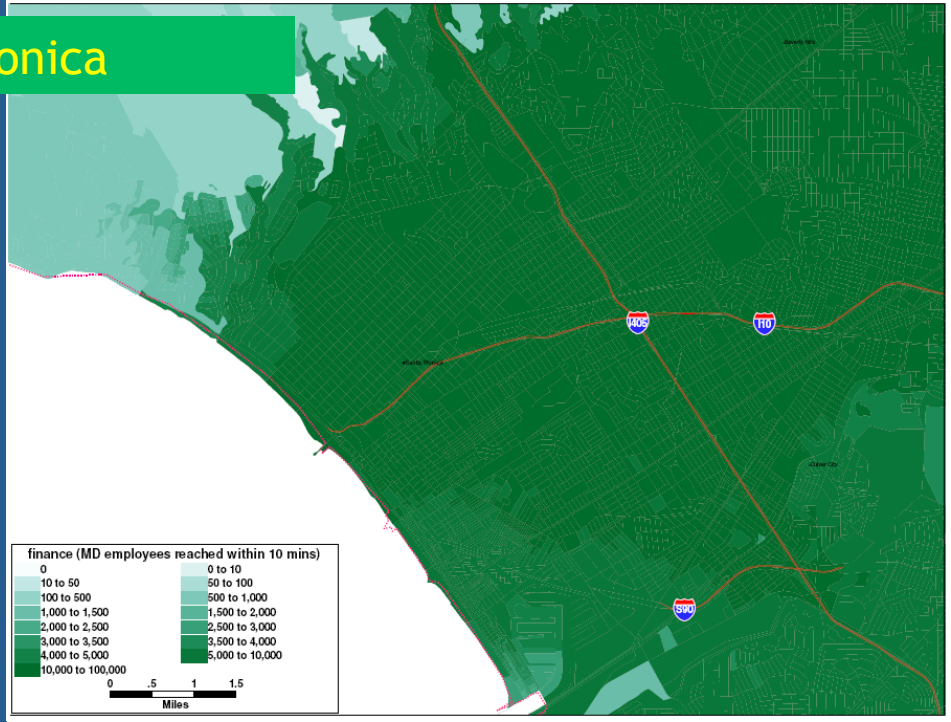


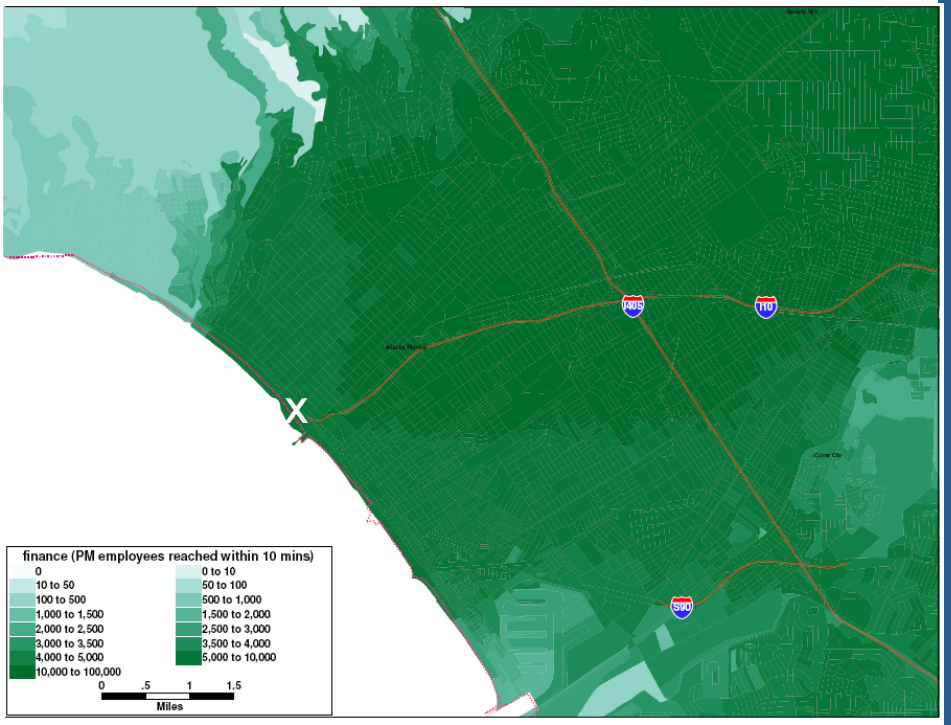
Seo Youn Yoon artwork!

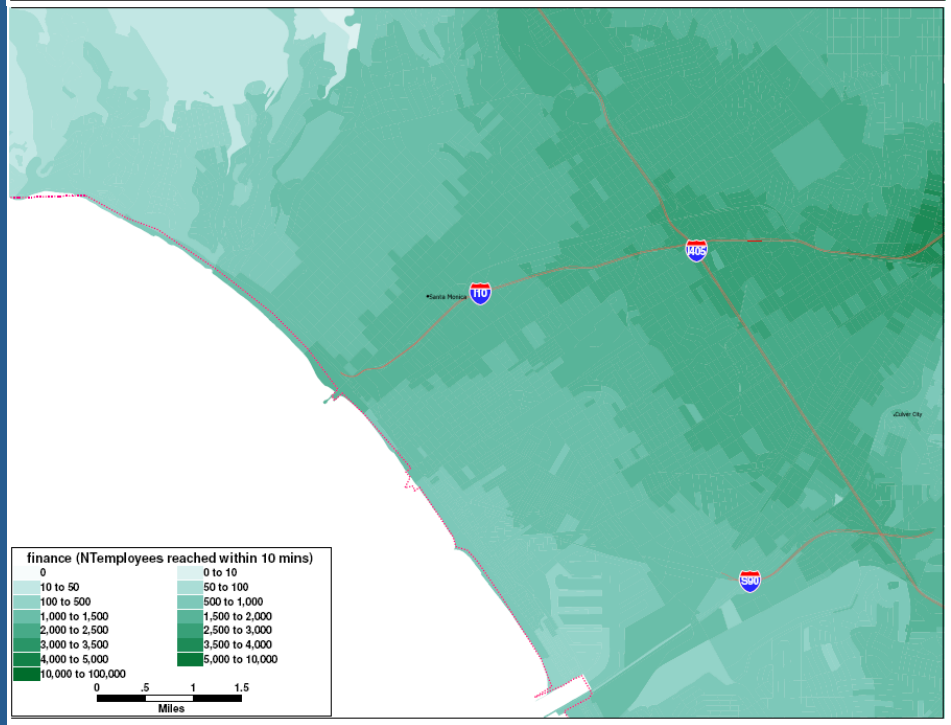
Dynamic Opportunity-based Accessibility is Key Input

Santa Monica

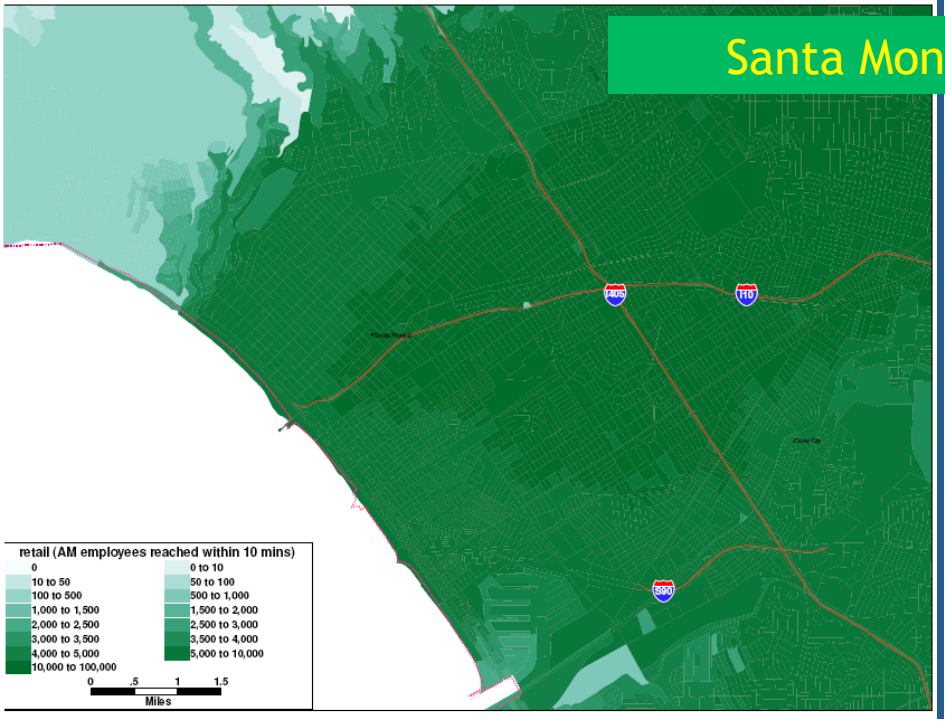


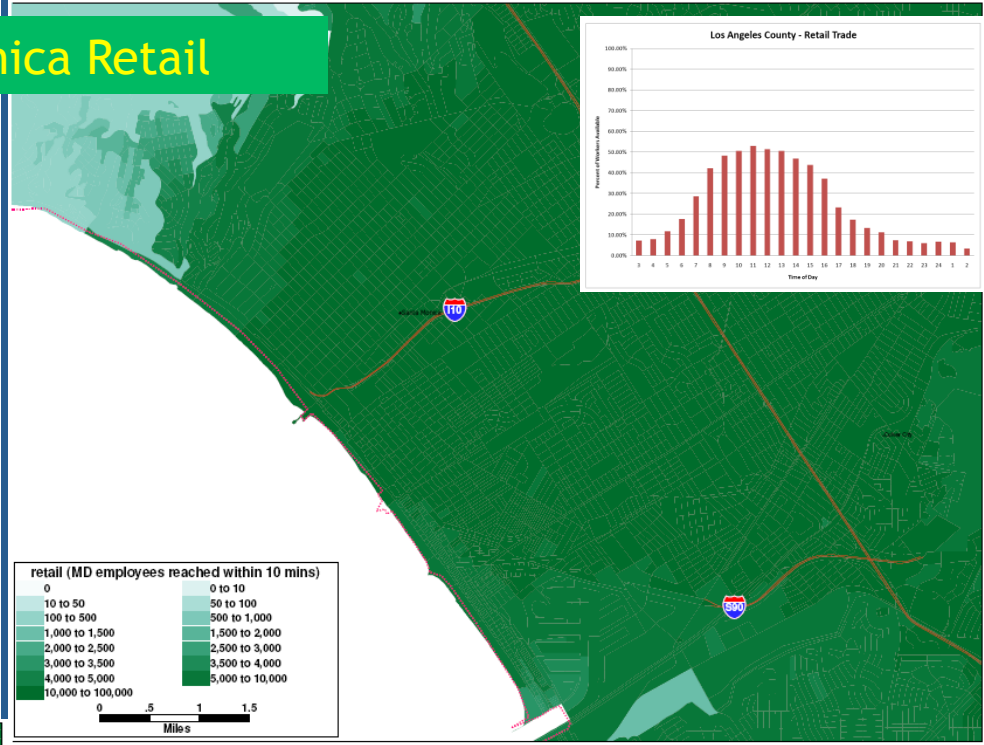


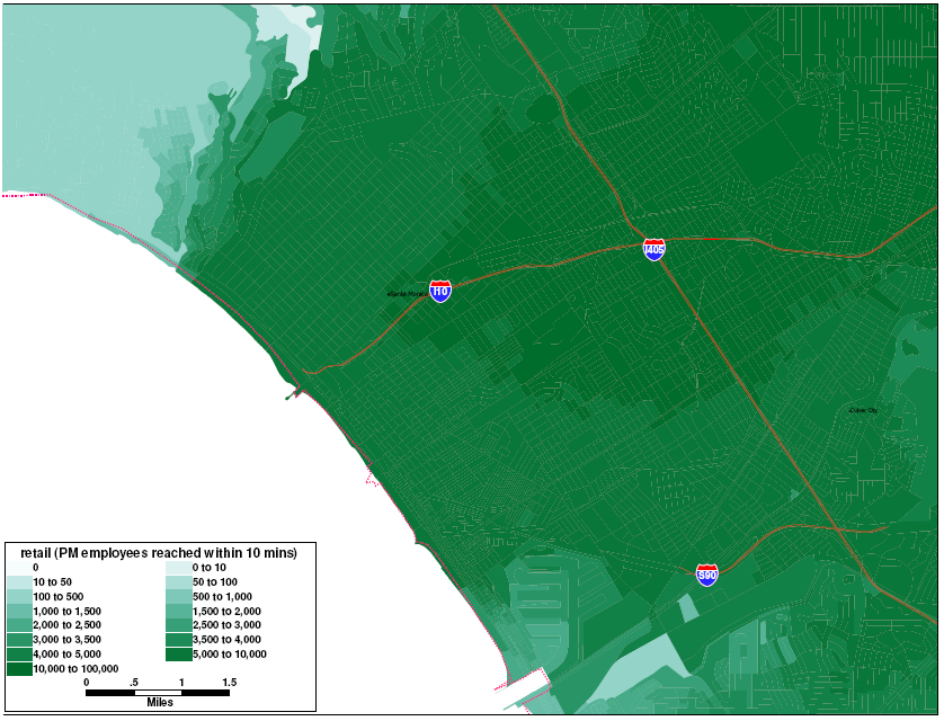


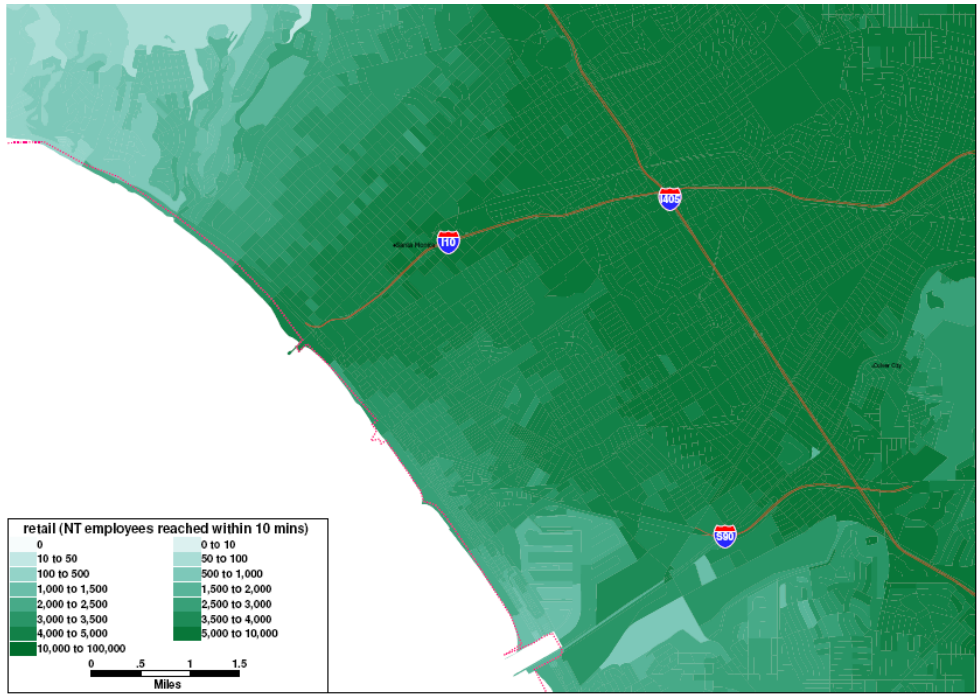


Santa Monica Retail





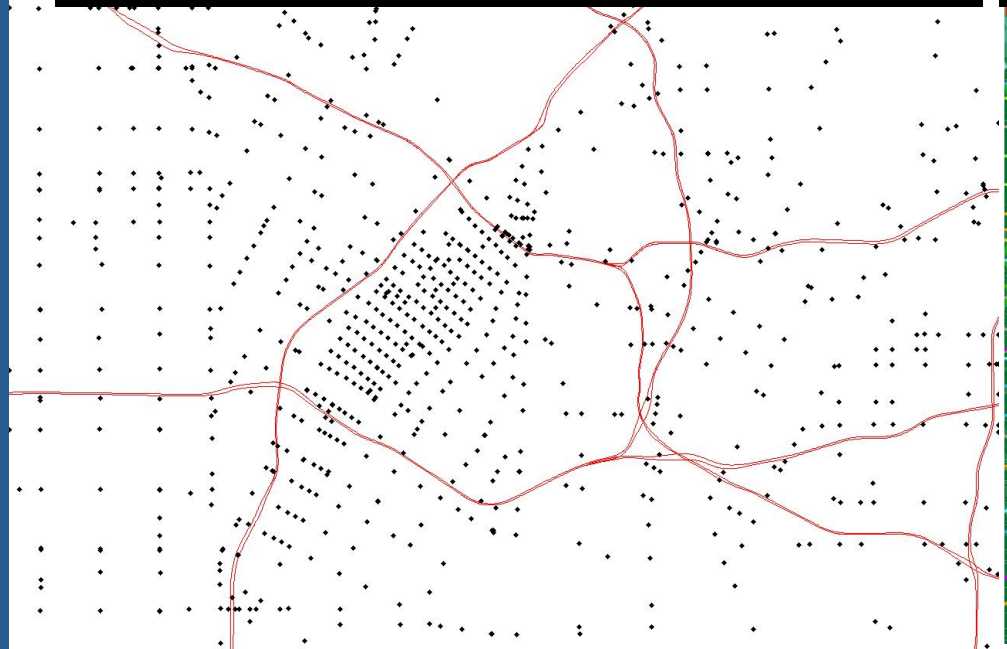




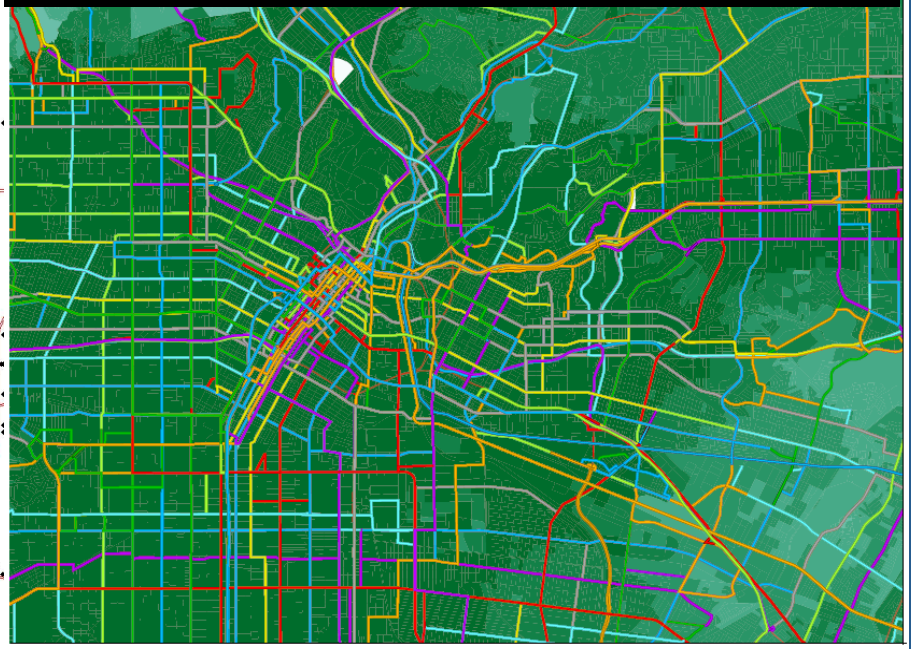
Transit Accessibility

- 60 meters / min walking speed
- 6 min penalty for switching transit lines
- Max time set at 3 hours
- Sparse distance matrix in output
  - Do not report if > 3 hours

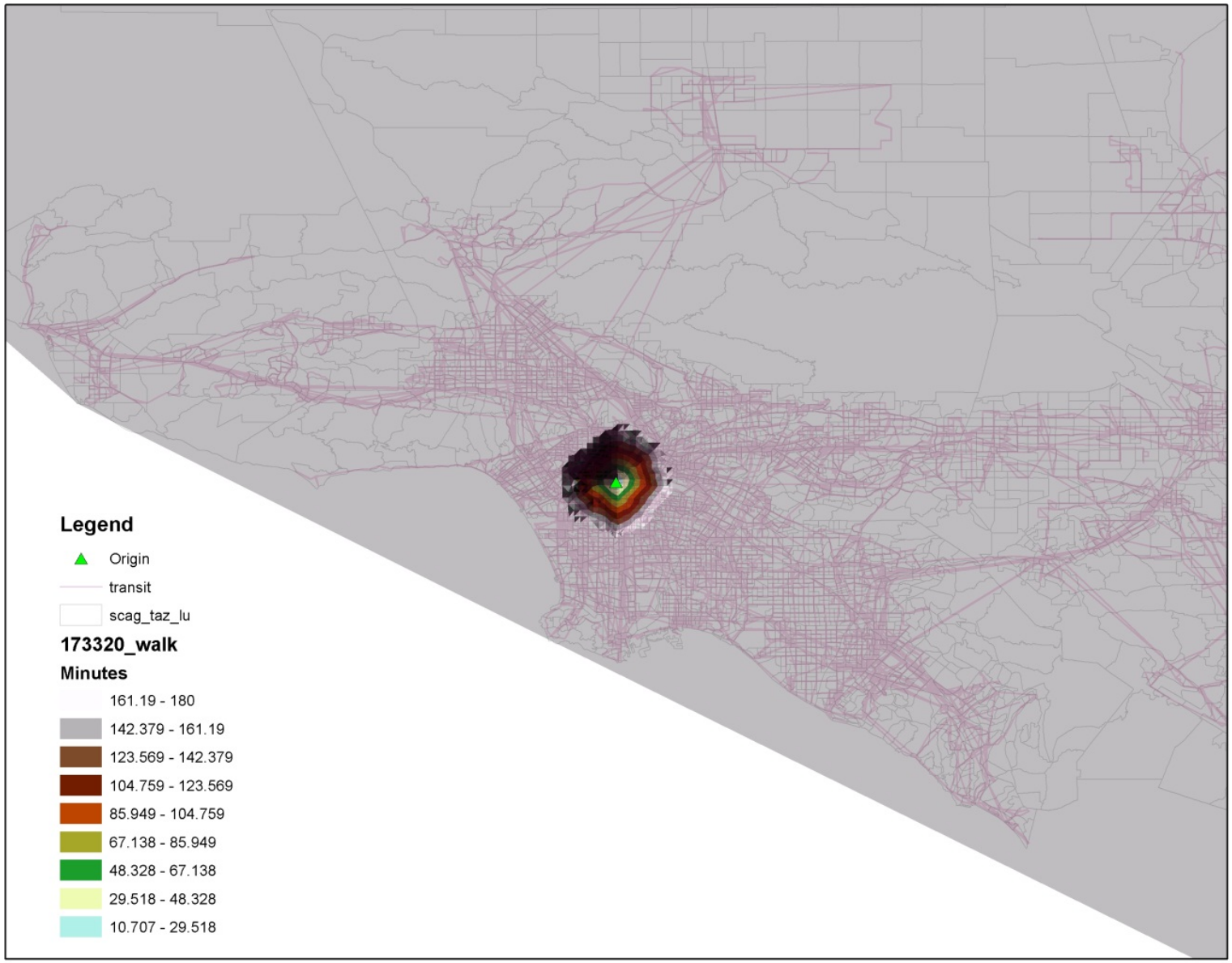
Access Points to Public Transportation



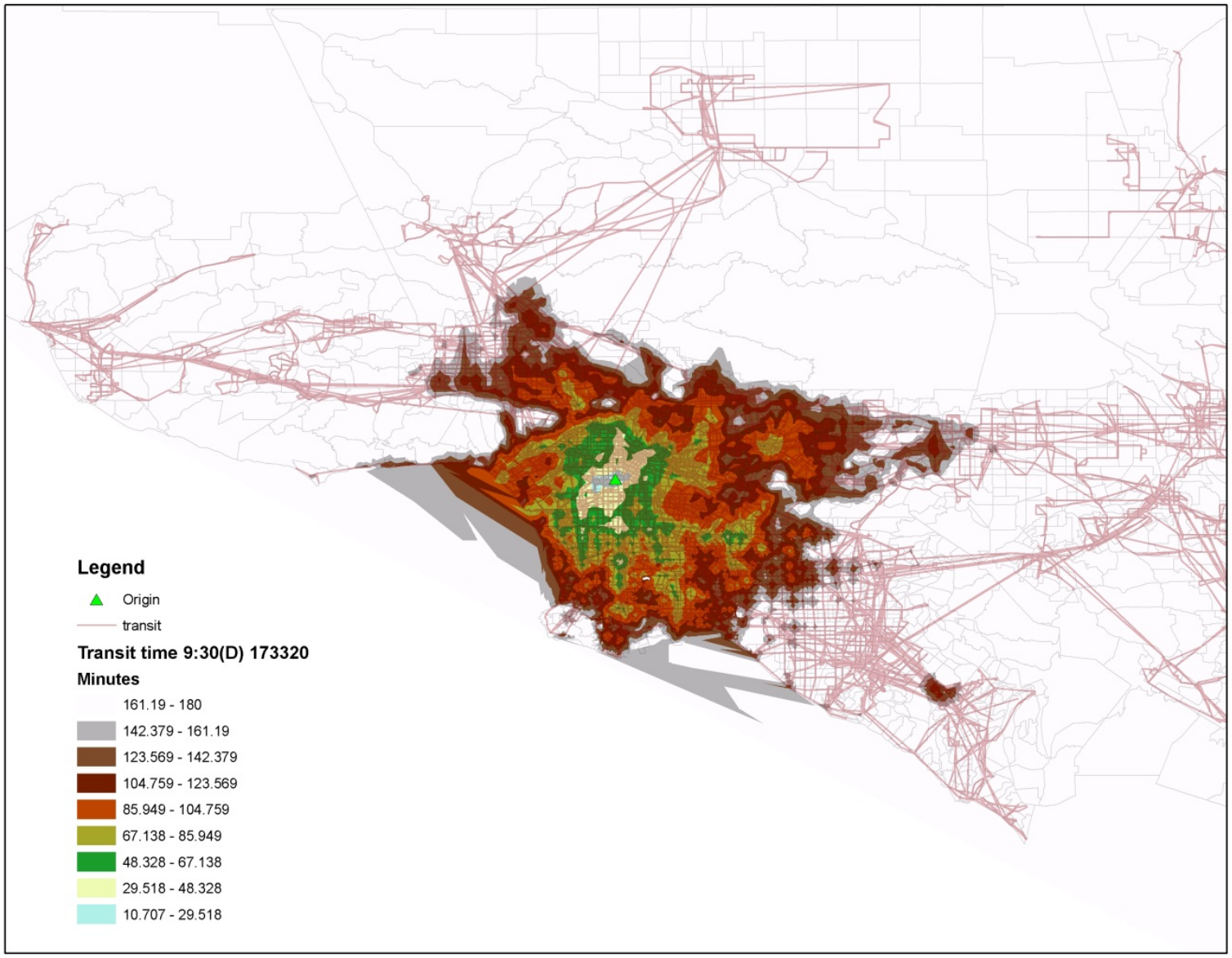
Routes of Public Transportation



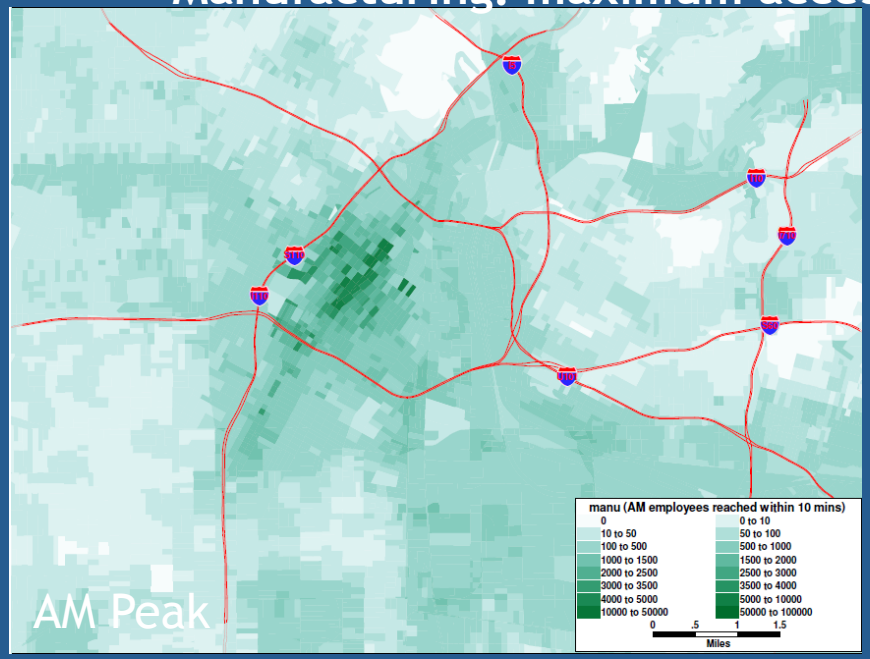
Walk Time Isochrones Example

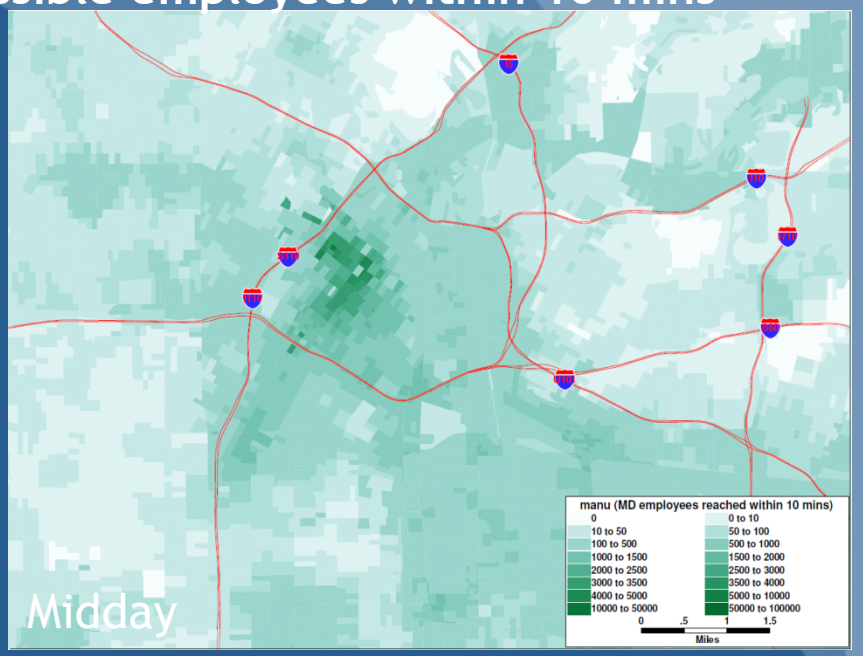


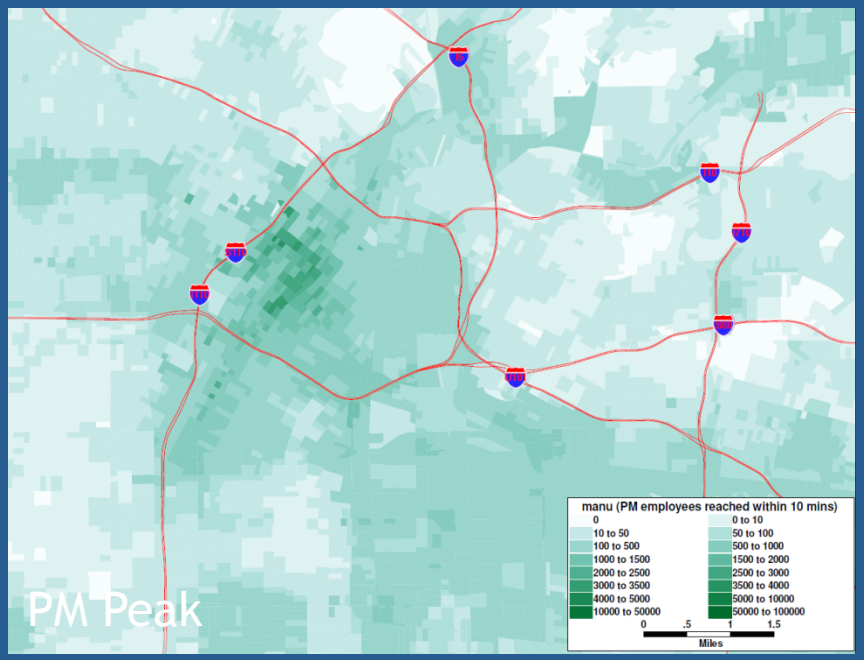
Transit Travel Time Isochrones Example

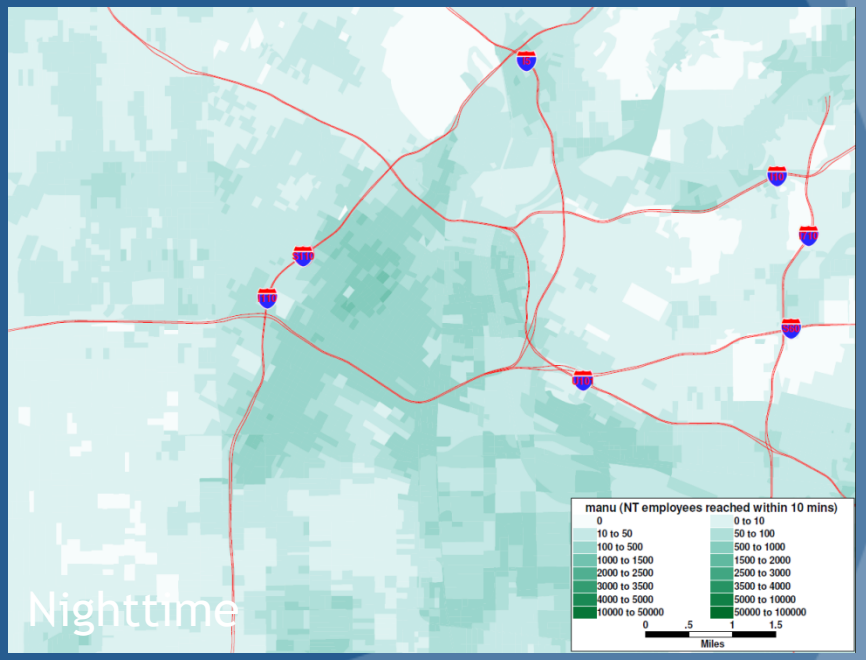


Manufacturing: maximum accessible employees within 10 mins

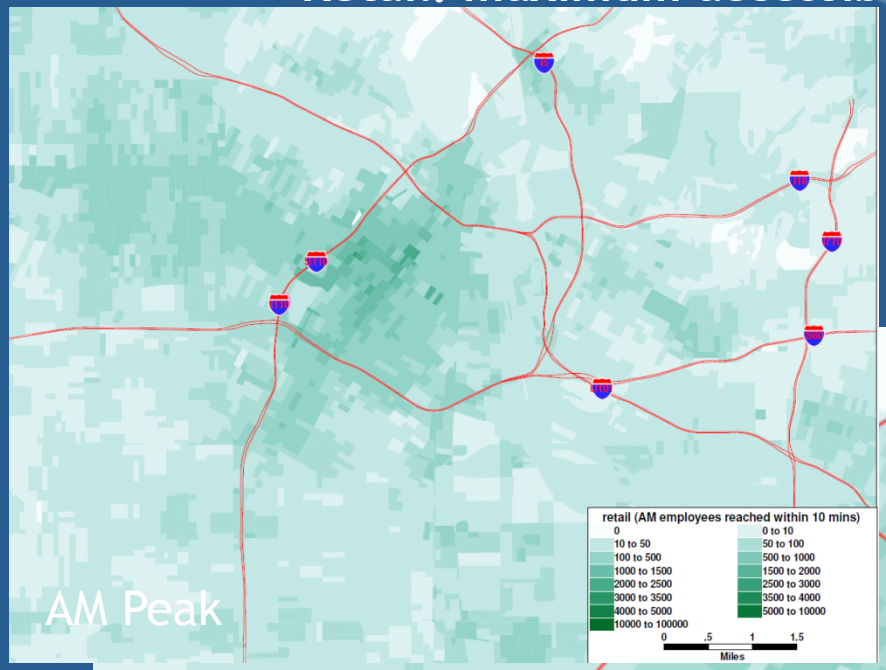


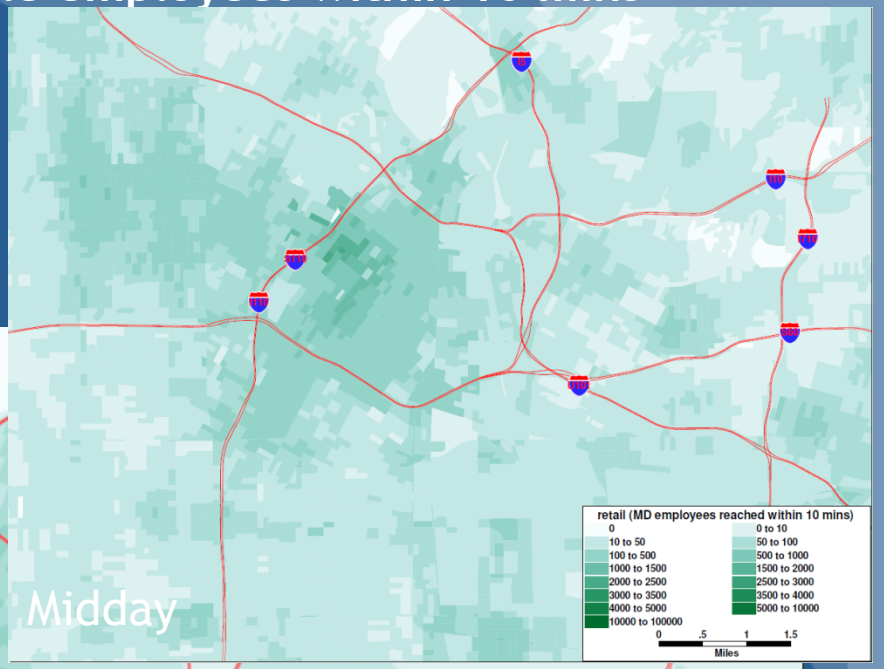


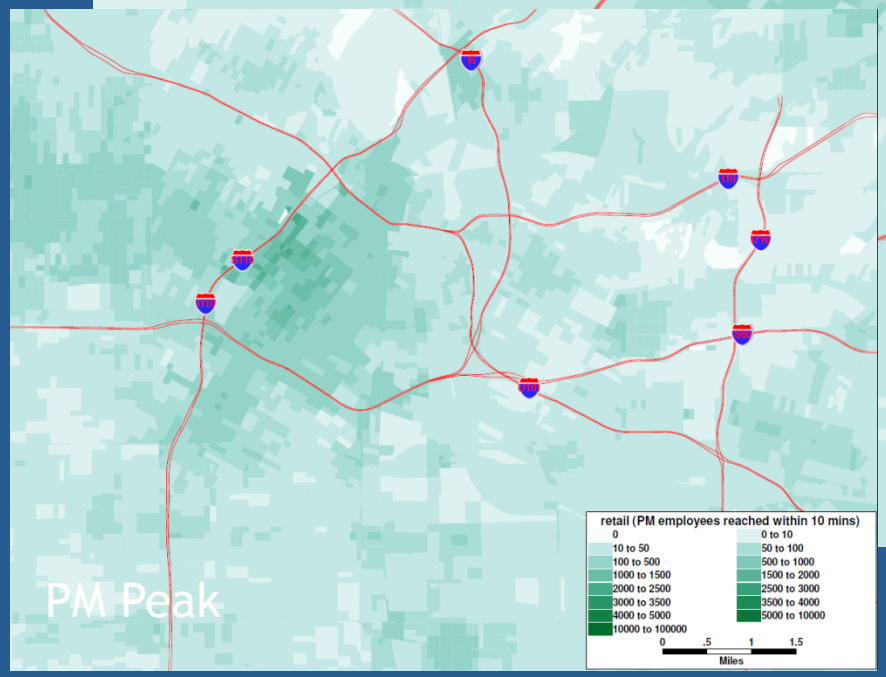


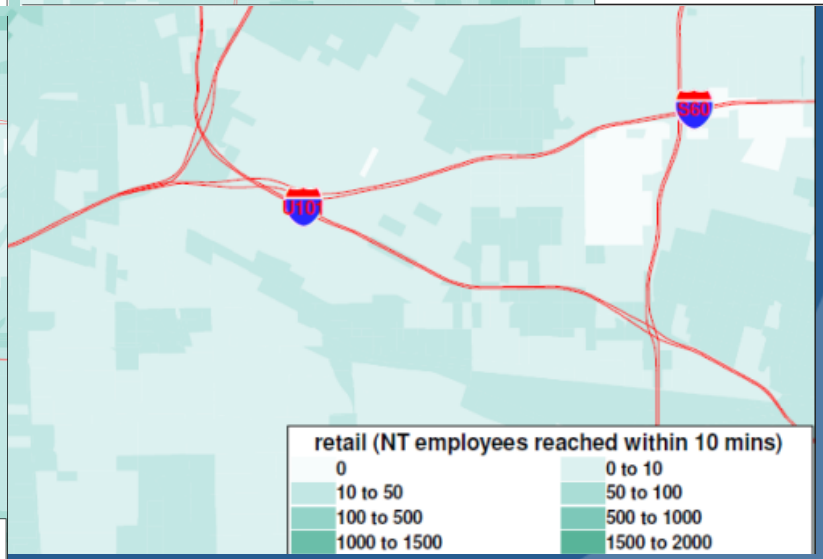


Retail: maximum accessible employees within 10 mins

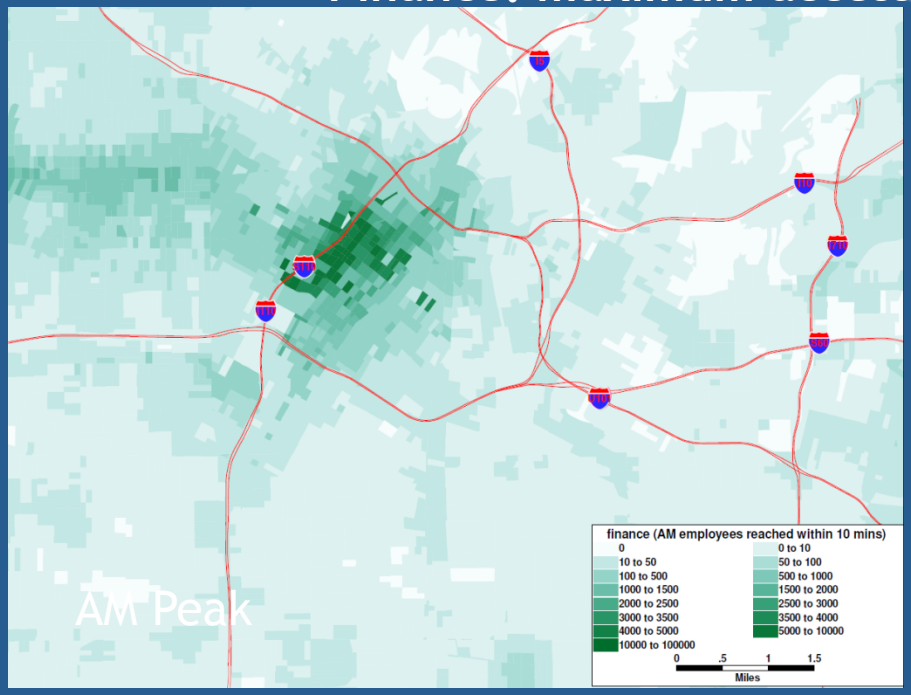


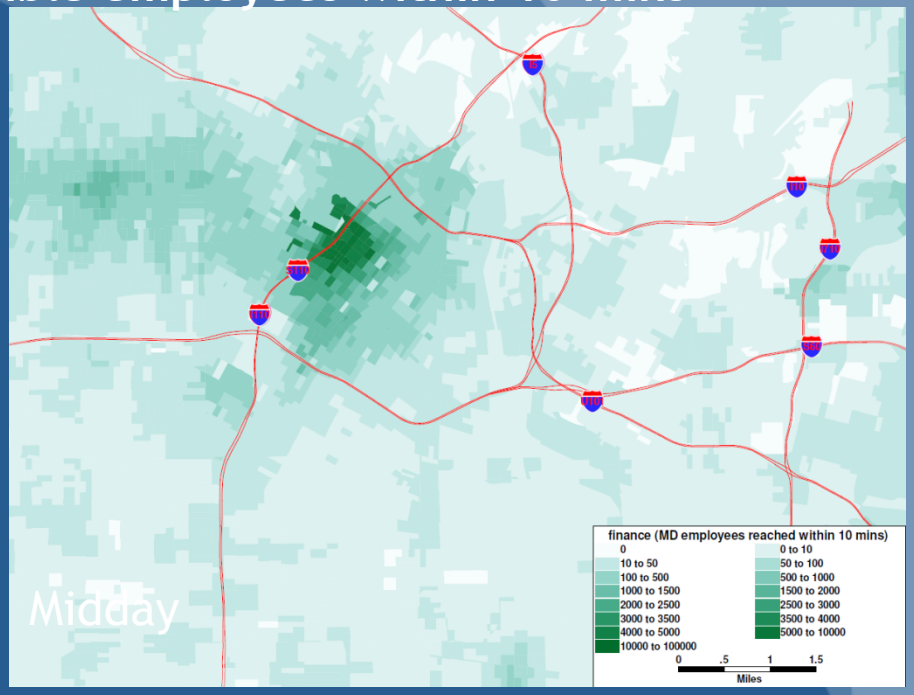


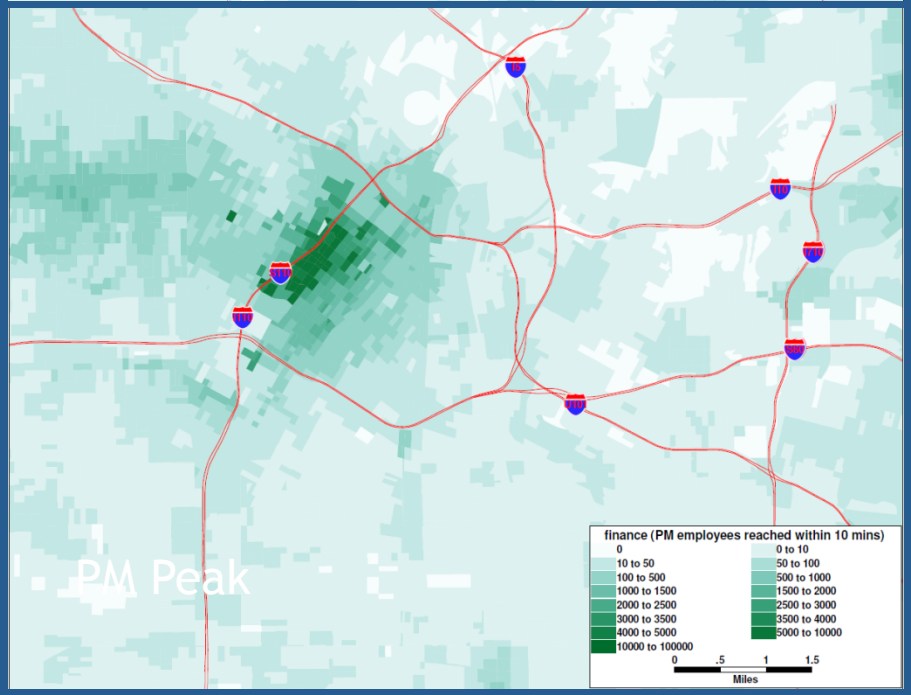


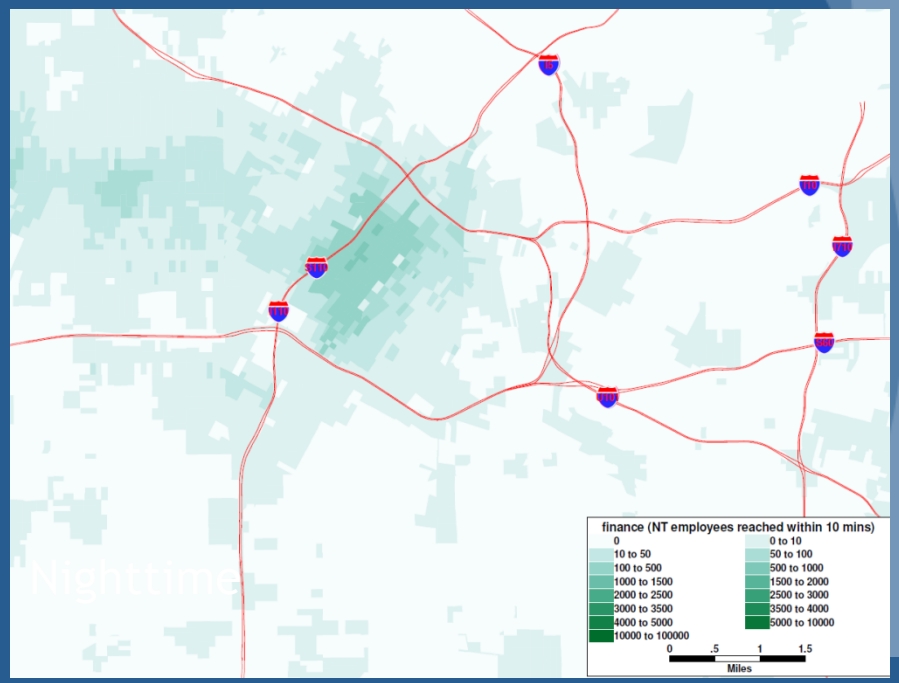


Finance: maximum accessible employees within 10 mins



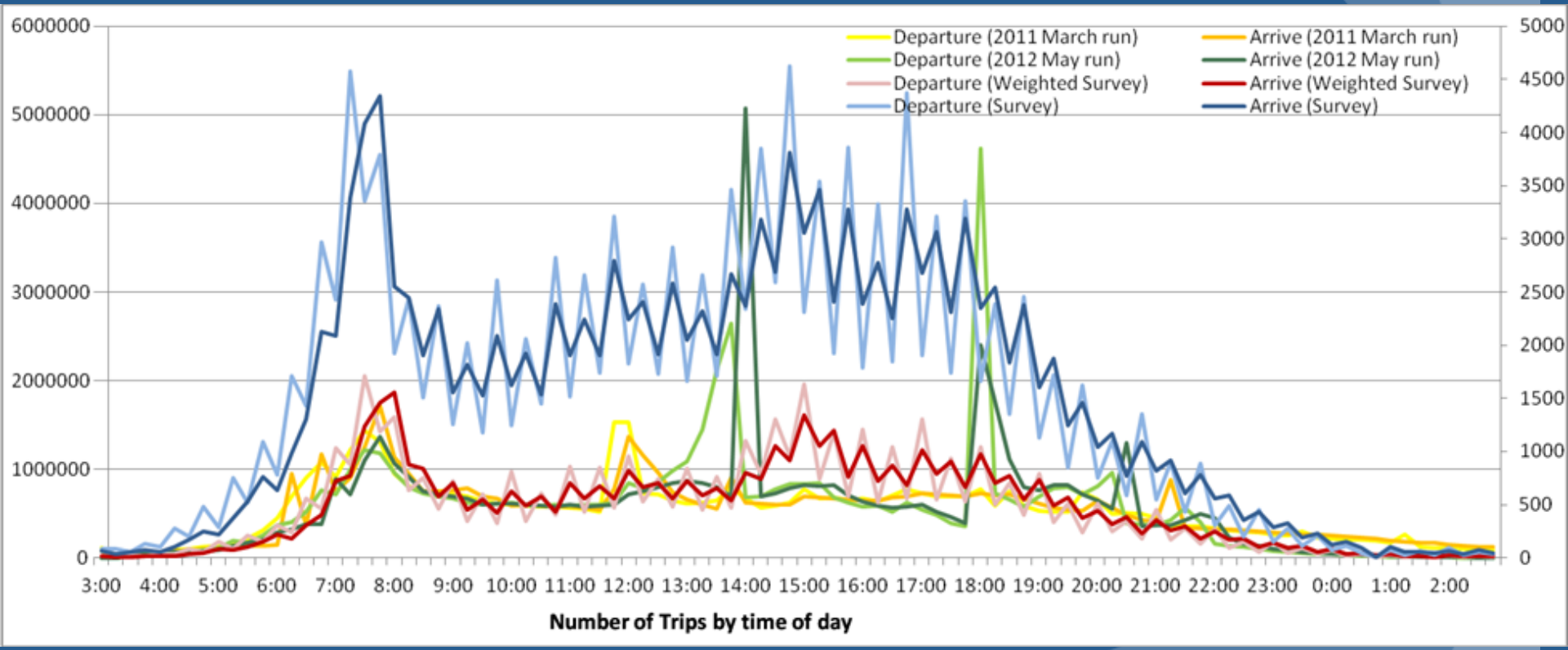




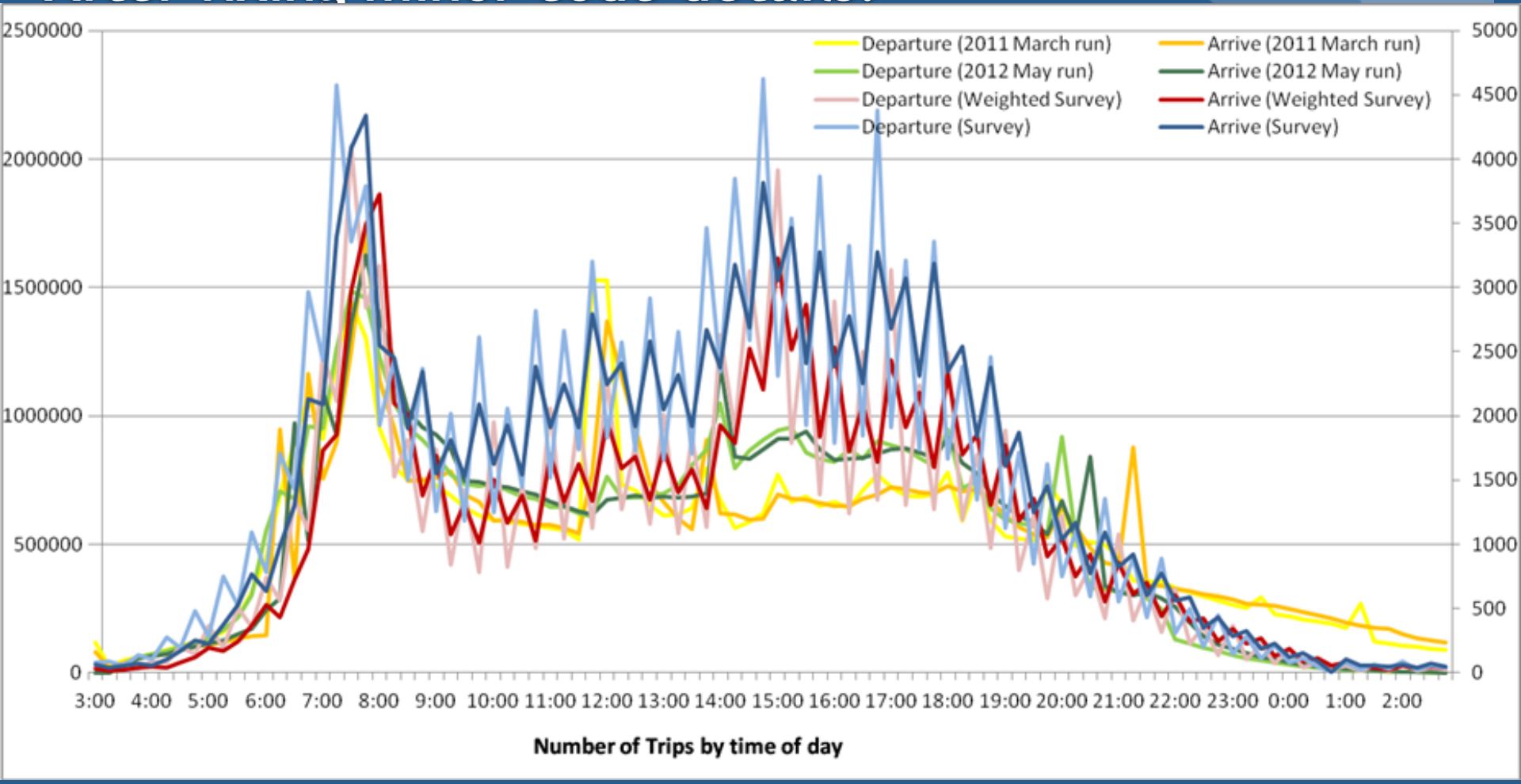


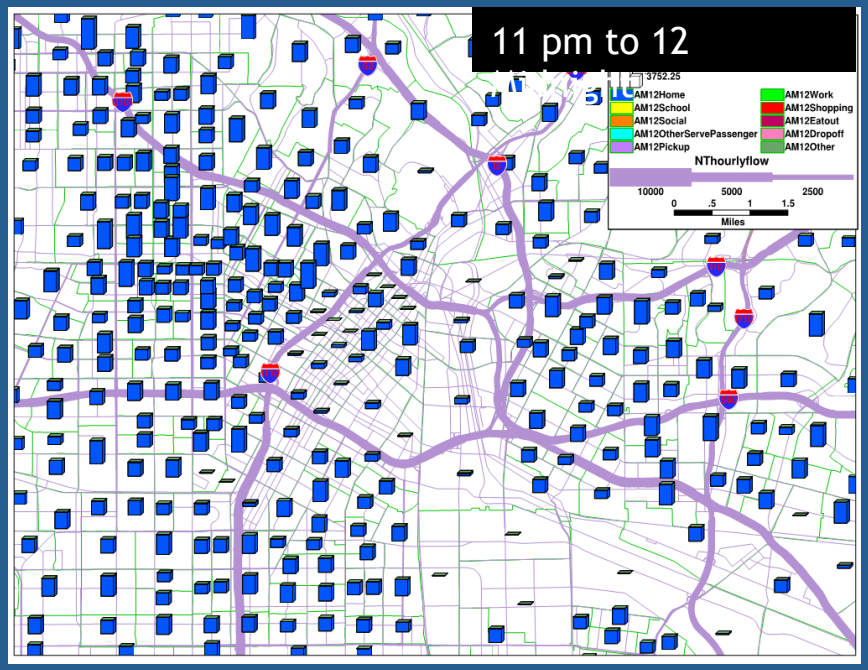
Time of day profiles key in Activity-based models (note the different versions and survey versions)

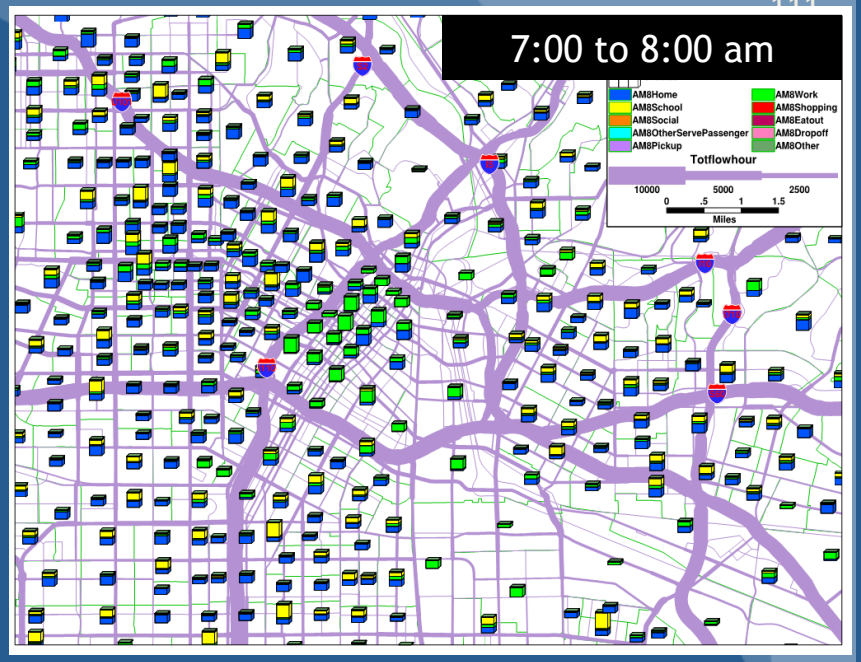
Clearly faulty time of day profiles!!!!



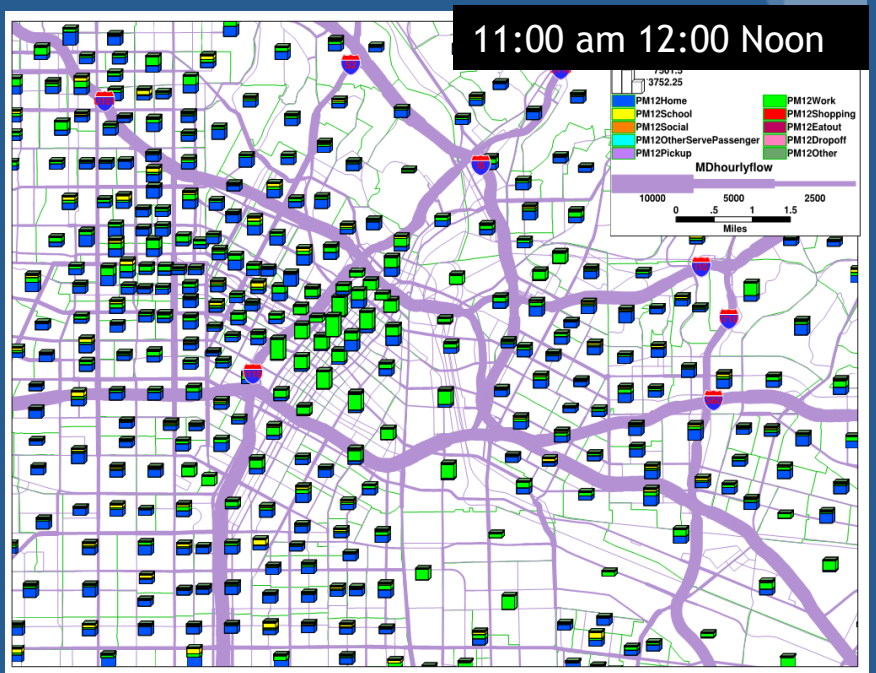
Time of day profiles key in Activity-based models (note the different versions and survey versions)
After fixing minor code details!



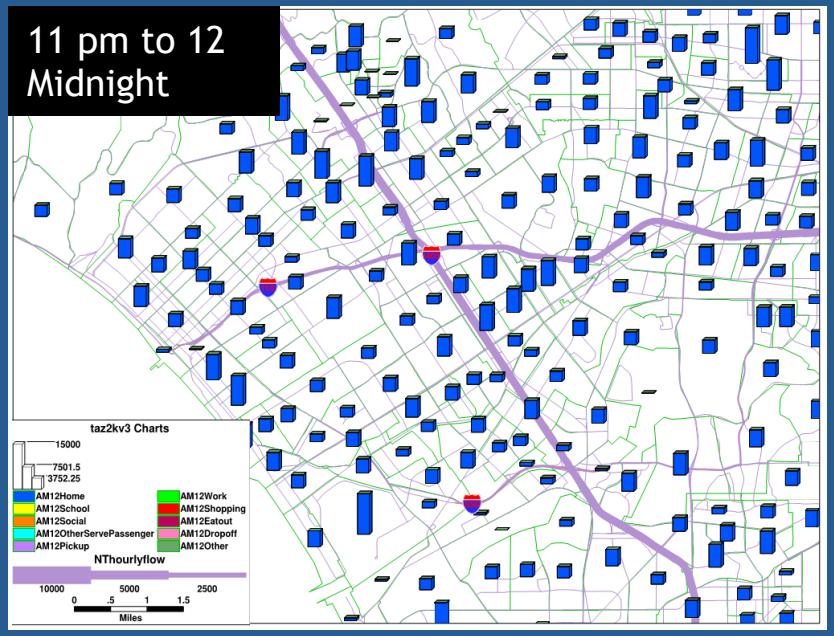




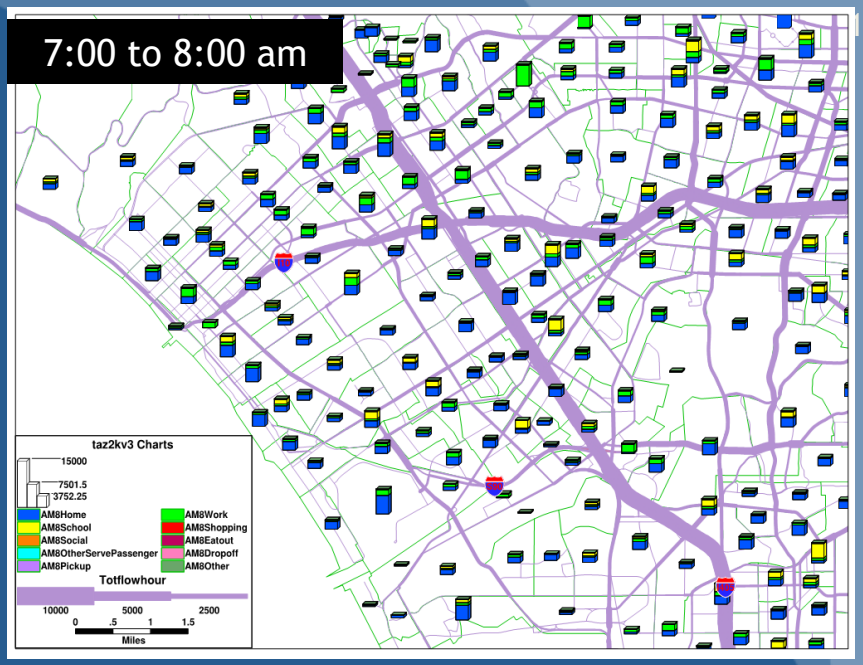
Presence of Persons at Places by Type of Activity



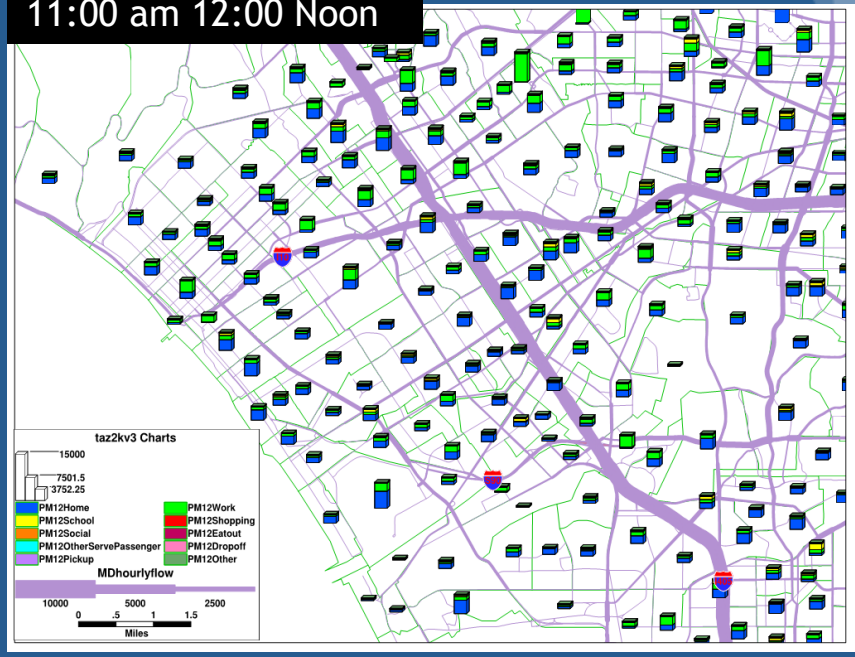
11 pm to 12 Midnight



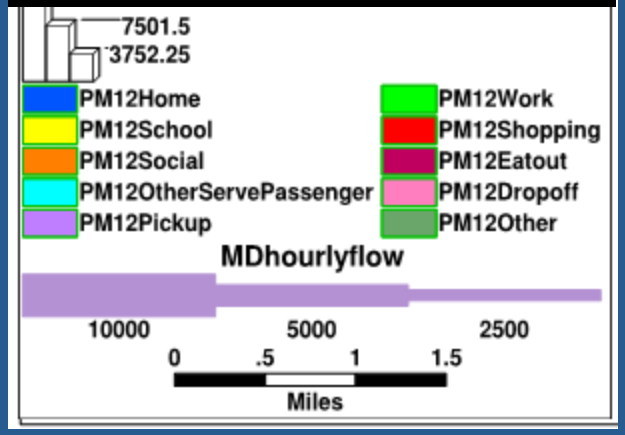
7:00 to 8:00 am



11:00 am 12:00 Noon



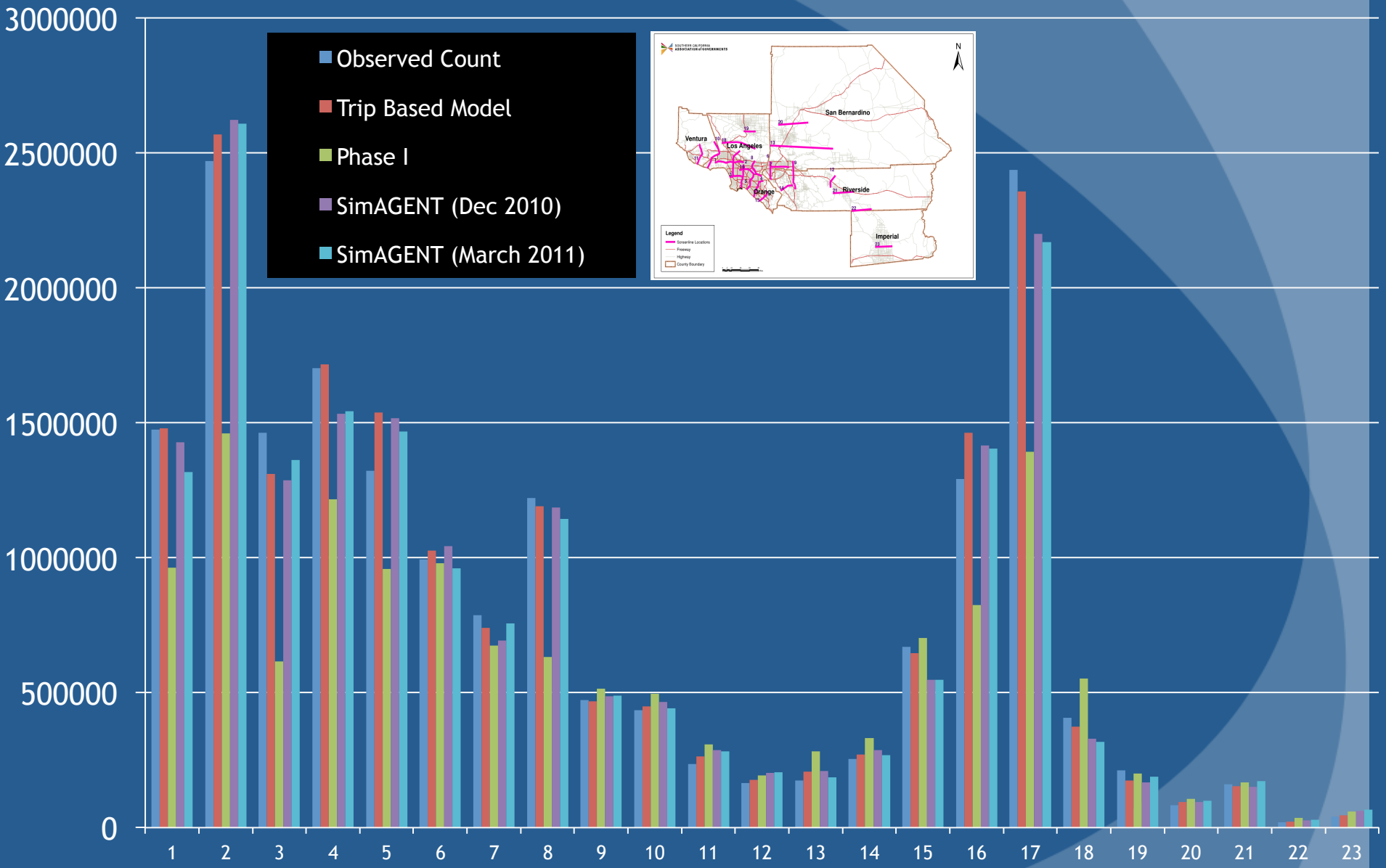
Presence of Persons at Places by Type of Activity



Comparison with 2008 4-step model

Emissions and Fuel Consumption	4-Step Model*	SimAGENT Baseline*
Organic Gases (g/mile)	0.943	0.926
CO (g/mile)	9.498	9.348
NOx (g/mile)	1.929	1.955
CO2 (g/mile)	561.340	543.545
Gasoline (gallons/mile)	0.051	0.050
Gasoline (mile/ gallons)	19.377	20.203
Diesel (gallons/mile)	0.102	0.101
Diesel (mile /gallons)	9.833	9.893
Organic Gases (g/person-day)	22.291	21.333
CO (g/person-day)	224.553	215.388
NOx (g/person-day)	45.606	45.050
CO2 (g/person-day)	13271.790	12524.452
Vehicle Miles Travel/person-day	23.643	23.042

Screenline Counts Comparison



Sample of Scenarios Tested

Difference between GC Baseline and Drive Alone Cost Increase 100%

	ROG	CO	NOx	CO2
L+MDV	-1.85%	-1.83%	-1.74%	-1.97%
HDT	-0.19%	-0.15%	0.06%	-0.08%
Other	0.00%	0.00%	0.00%	0.00%
TOTAL	-1.55%	-1.57%	-0.67%	-1.58%

Difference between GC Baseline and Auto Cost Increase 100%

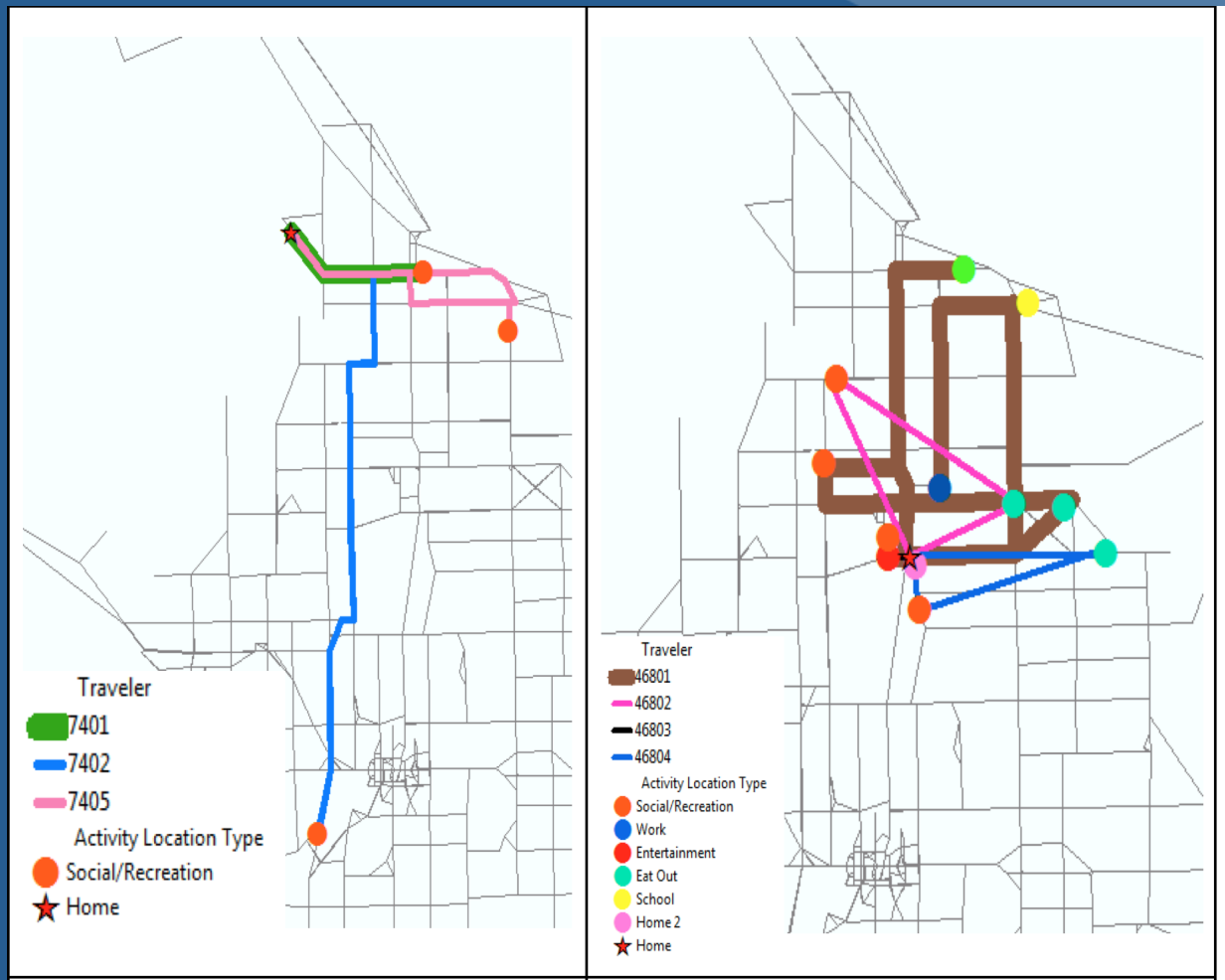
L+MDV	-0.98%	-0.96%	-0.90%	-1.06%
HDT	-0.12%	-0.09%	0.01%	-0.05%
Other	0.00%	0.00%	0.00%	0.00%
TOTAL	-0.83%	-0.83%	-0.36%	-0.85%

Difference between GC Baseline and DA IVTT increase 25%

L+MDV	-11.60%	-11.41%	-11.16%	-11.90%
HDT	-0.67%	-0.39%	0.67%	-0.21%
Other	0.00%	0.00%	0.00%	0.00%
TOTAL	-9.67%	-9.74%	-4.13%	-9.47%

Difference between GC Baseline and Auto IVTT Increase 25%

L+MDV	-11.53%	-11.35%	-11.09%	-11.83%
HDT	-0.66%	-0.38%	0.66%	-0.20%
Other	0.00%	0.00%	0.00%	0.00%
TOTAL	-9.61%	-9.68%	-4.11%	-9.41%

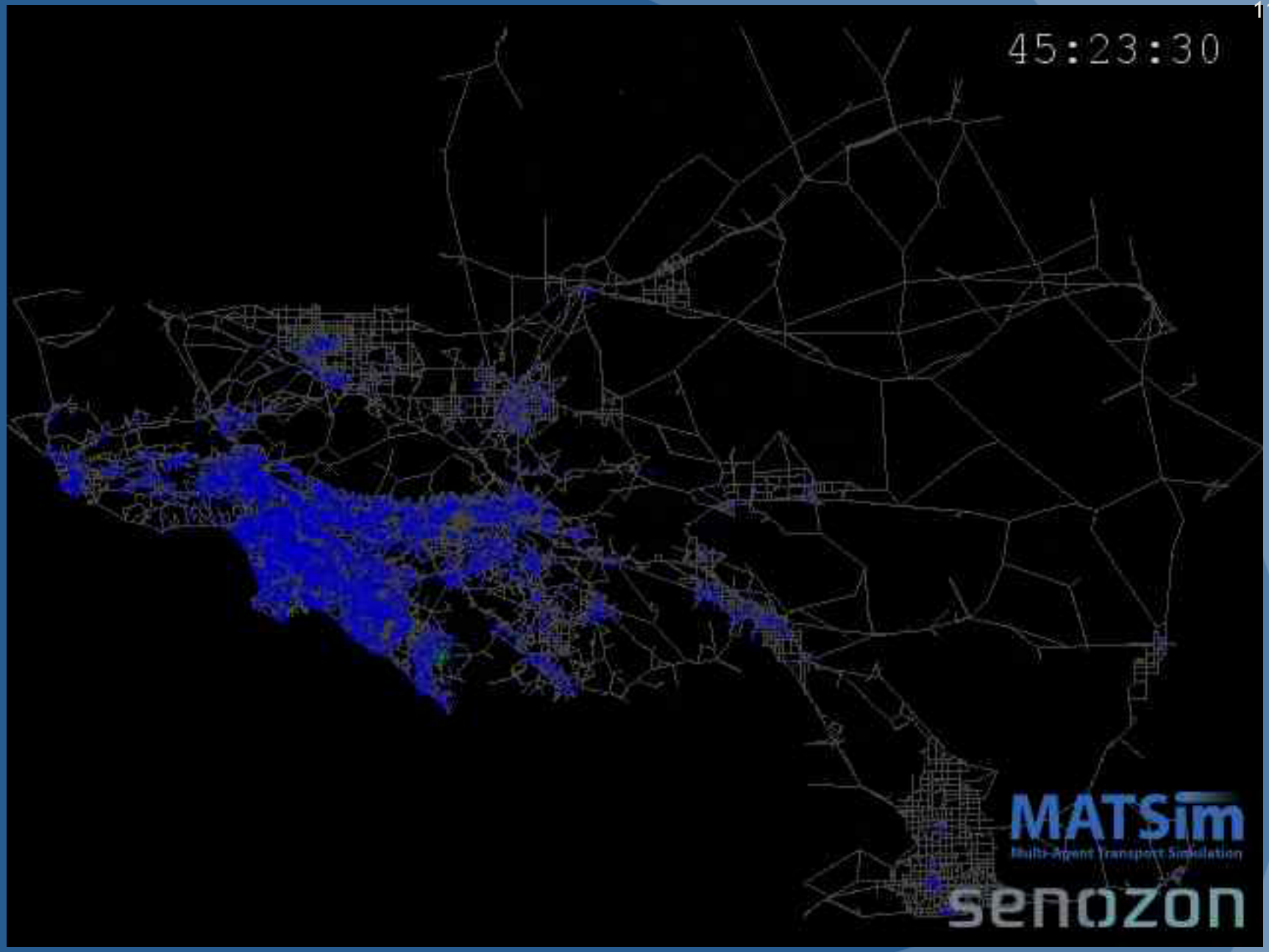


Household "74" Three persons with some overlap of paths	Household "468" Four persons with unassigned trips

Figure 6: Travel Plans for Households 74 and 468

Example output from TRANSIMS


45:23:48
MATSim
Multi-Agent Transport Simulation
senozon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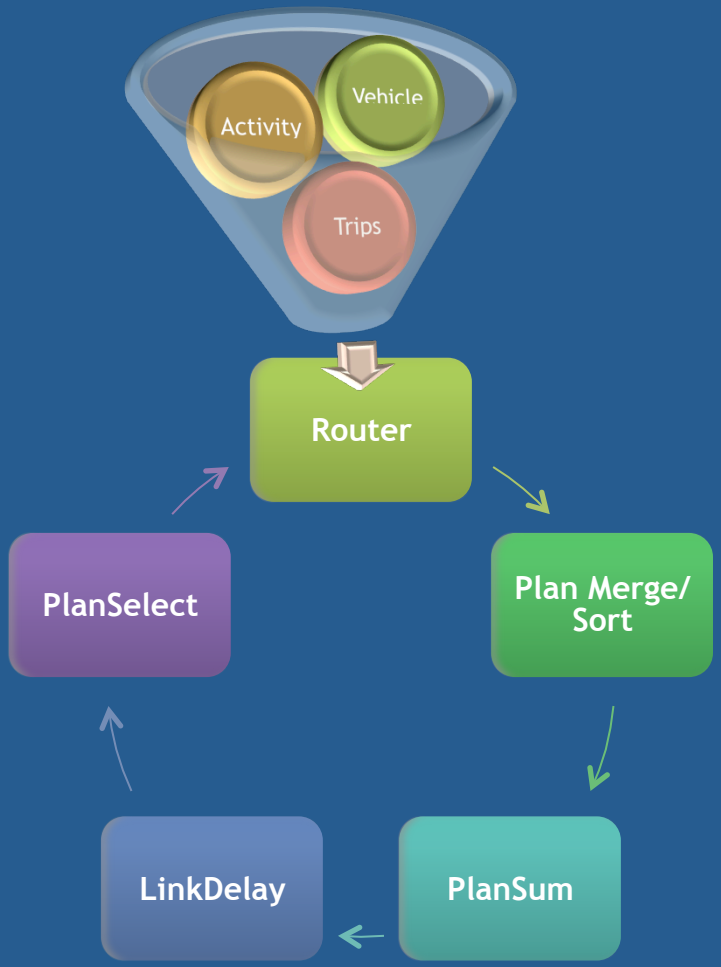
MATSim
Multi-Agent Transport Simulation
senozon

Router & Router Feedback



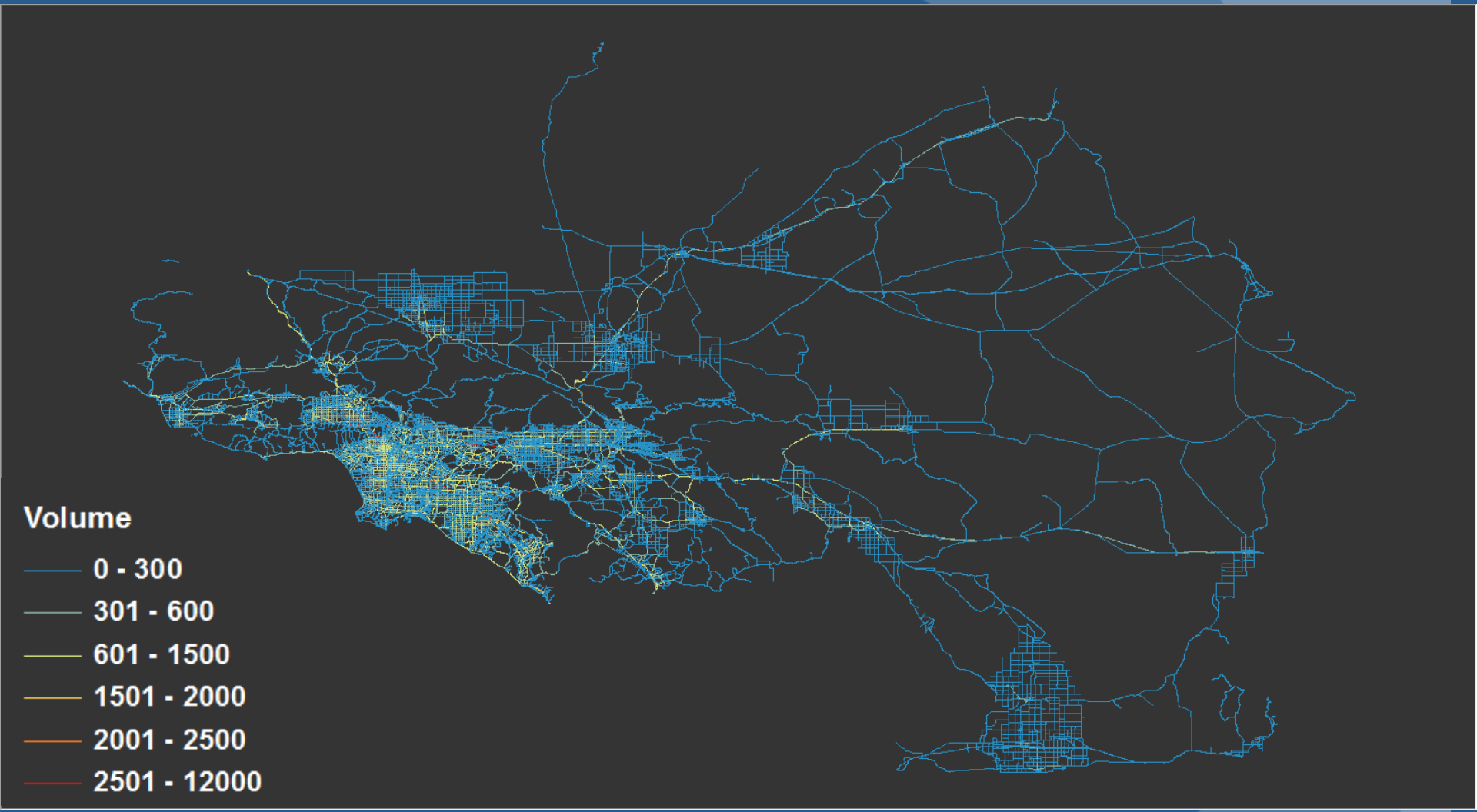
TRANSIMS Router & Feedback Main Processing Flow

Can use activity records and/or trips that are converted into plans of a day

OR

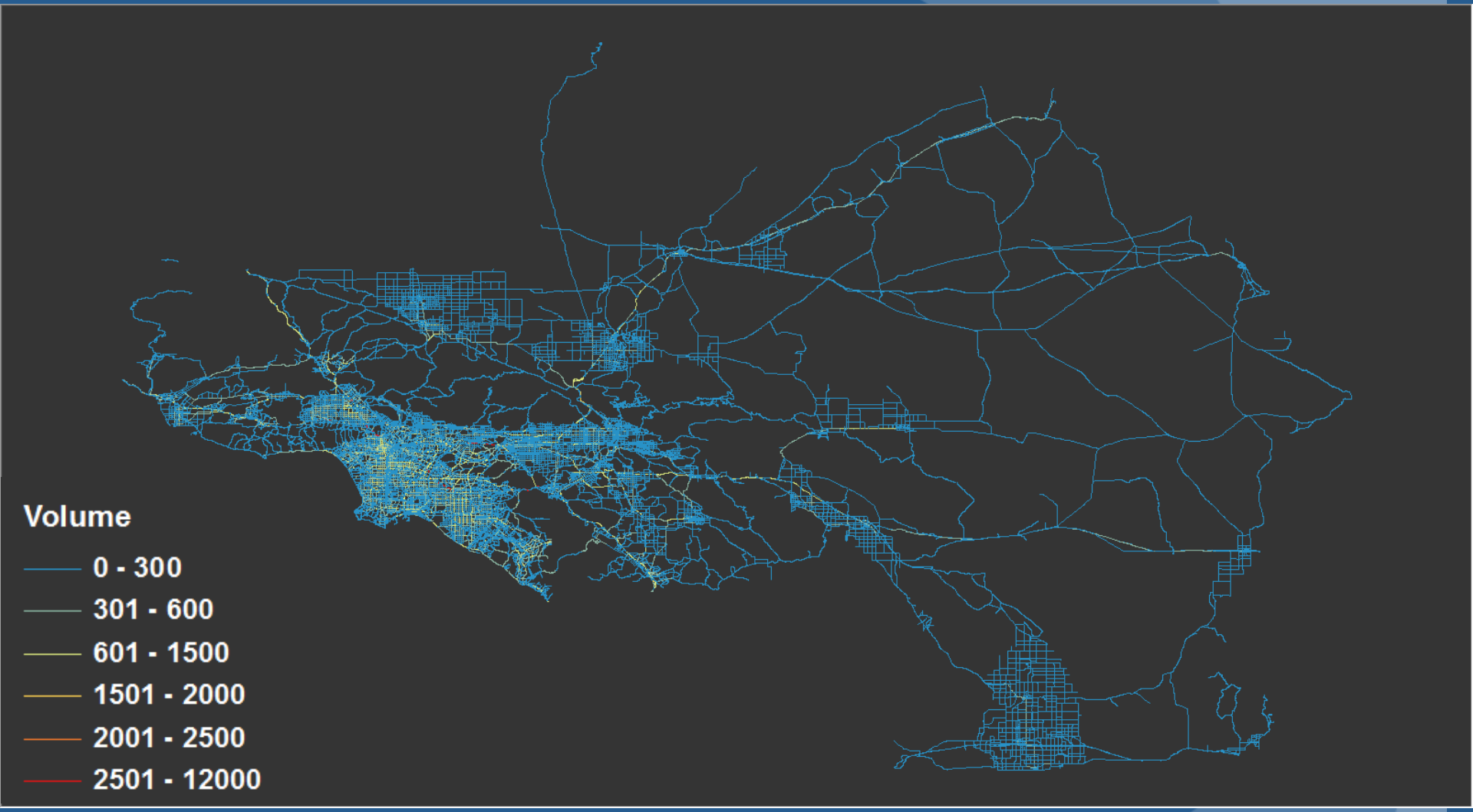
Synthetic surveys!

Volume on Network



1:00 AM

Volume on Network



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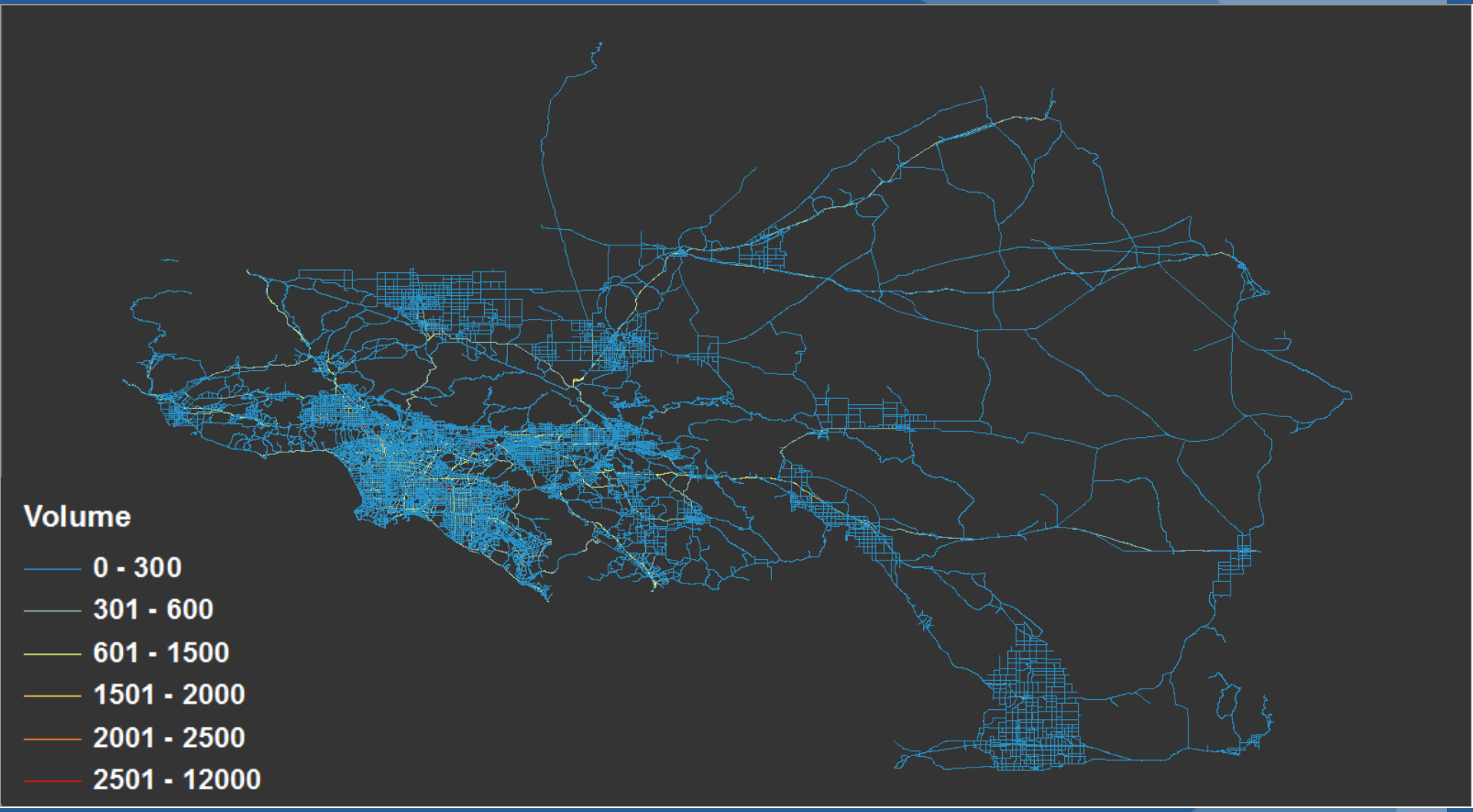

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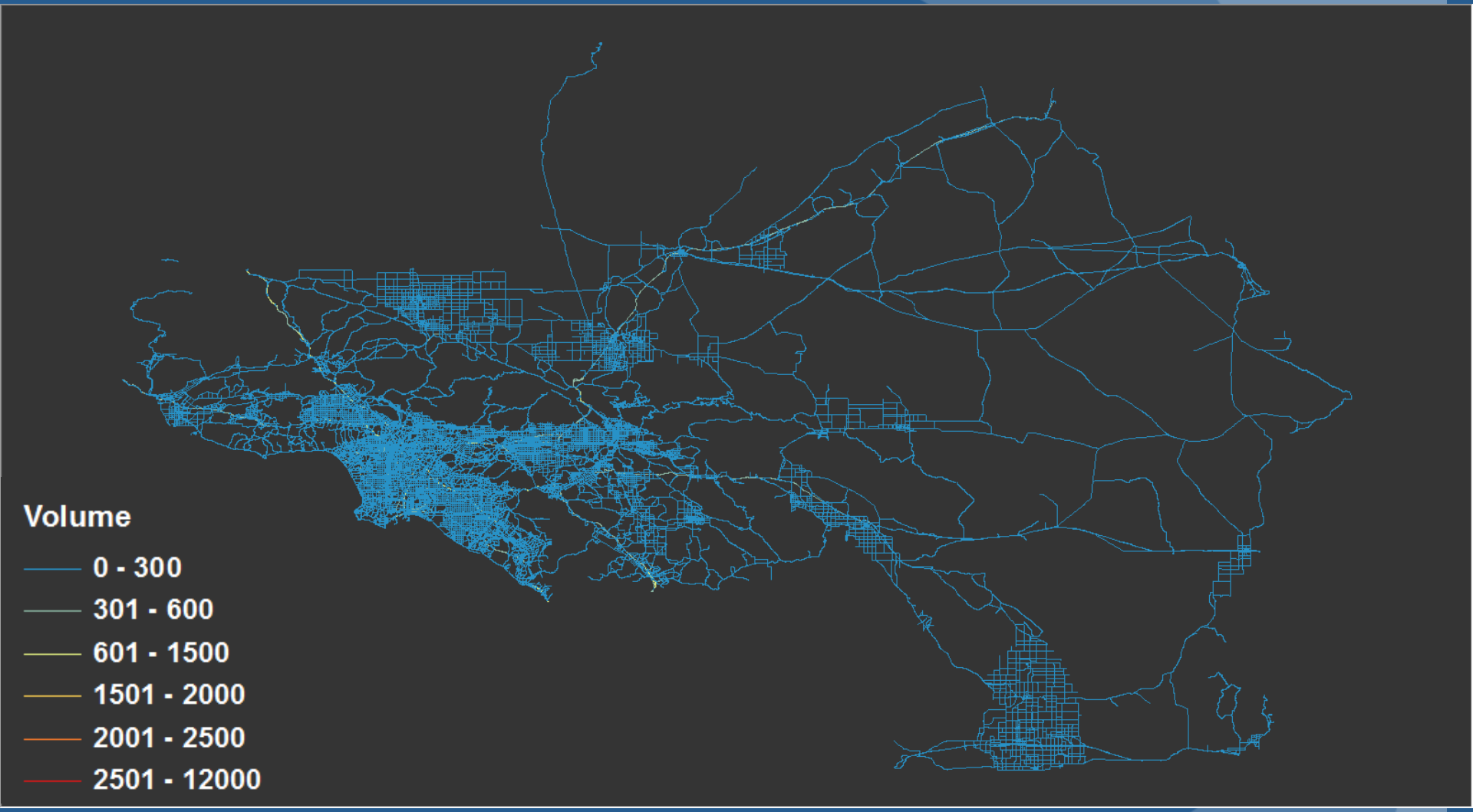

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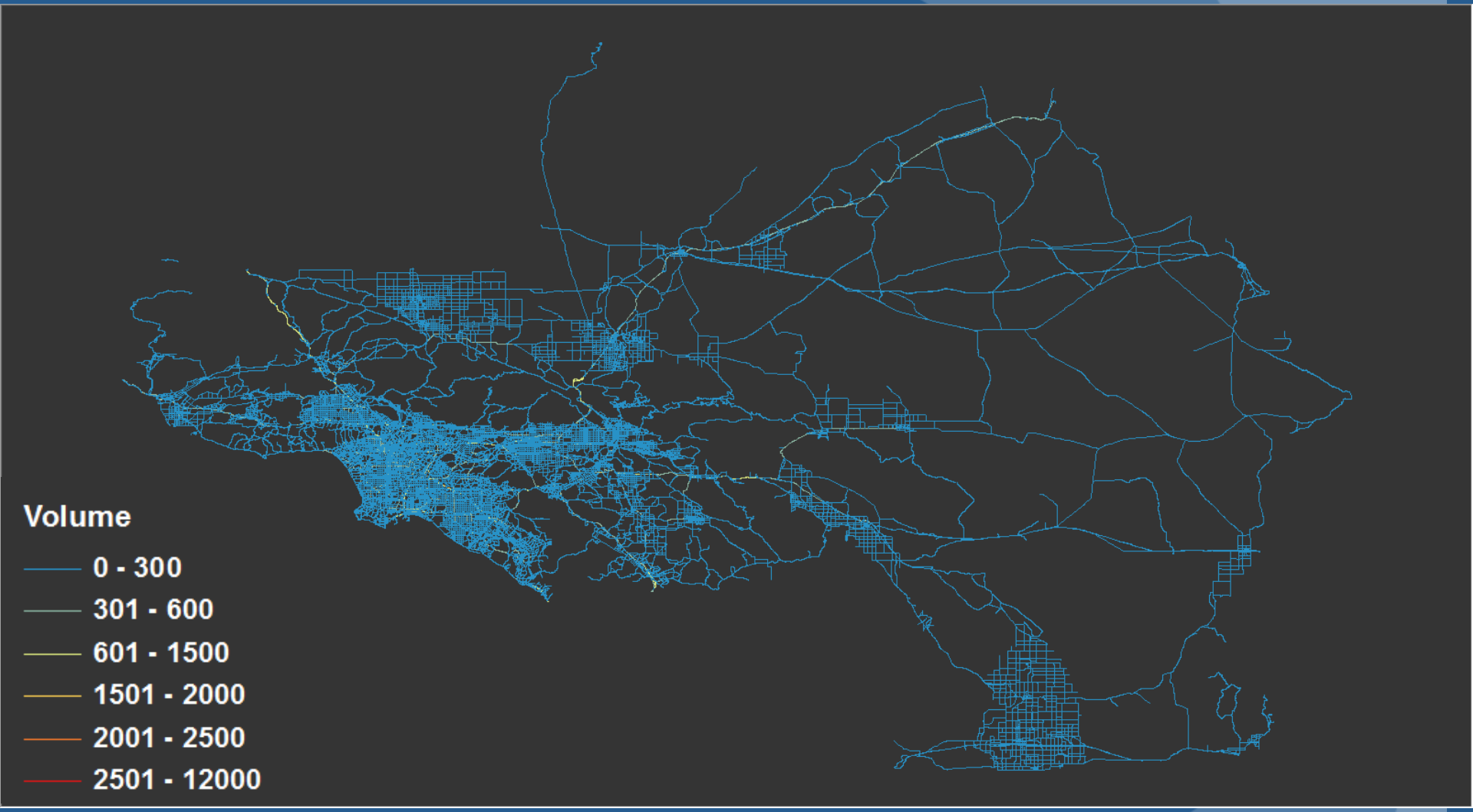

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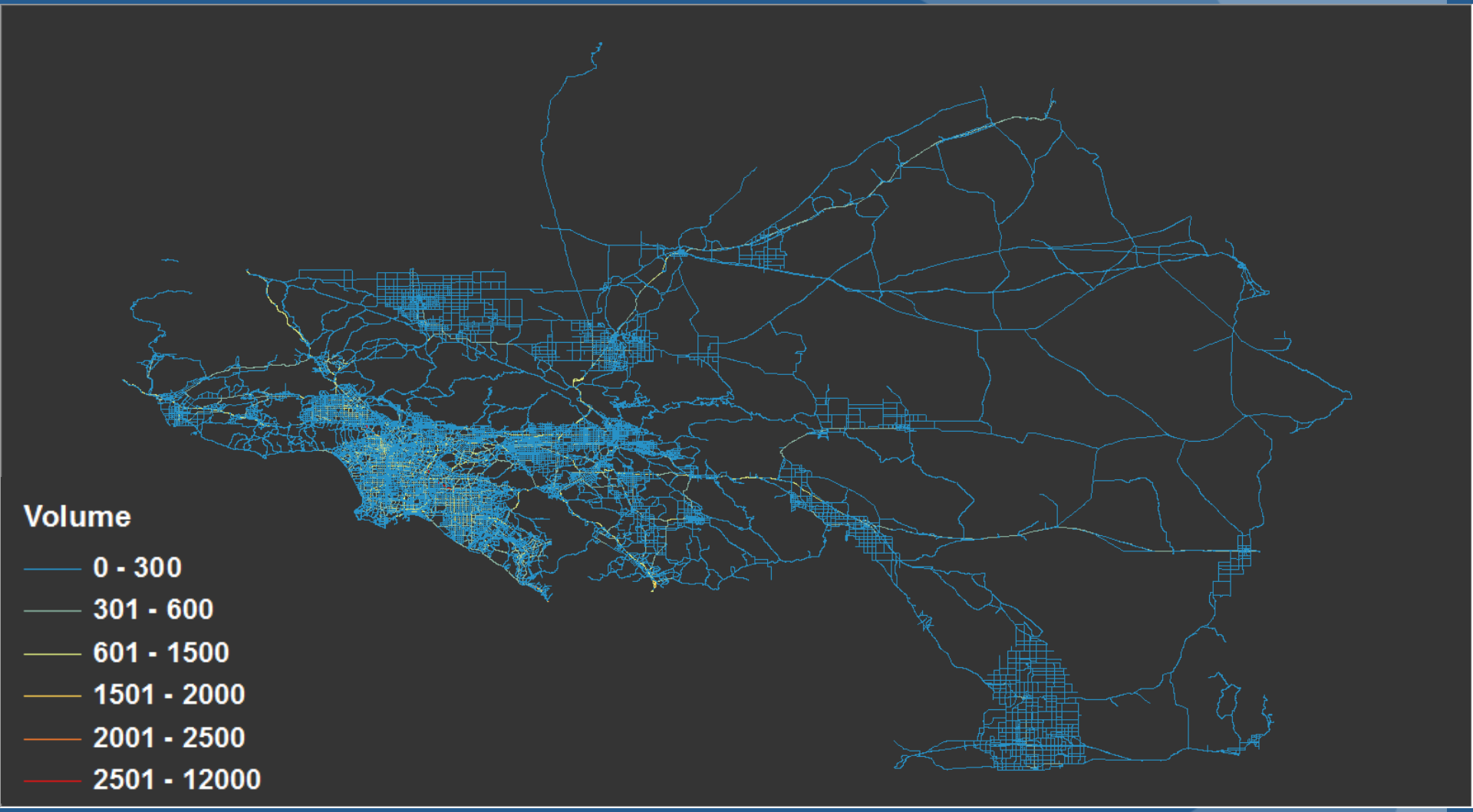

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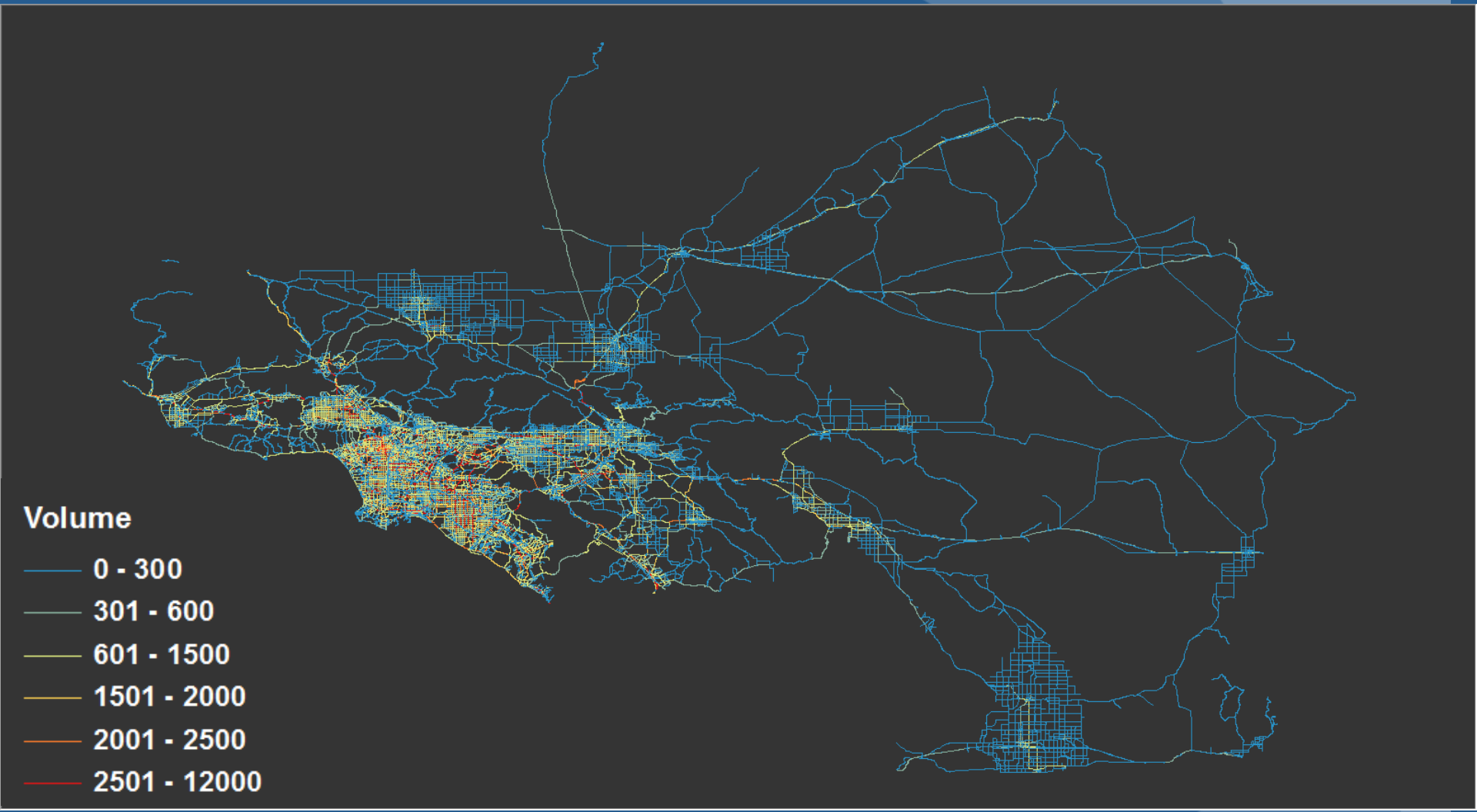

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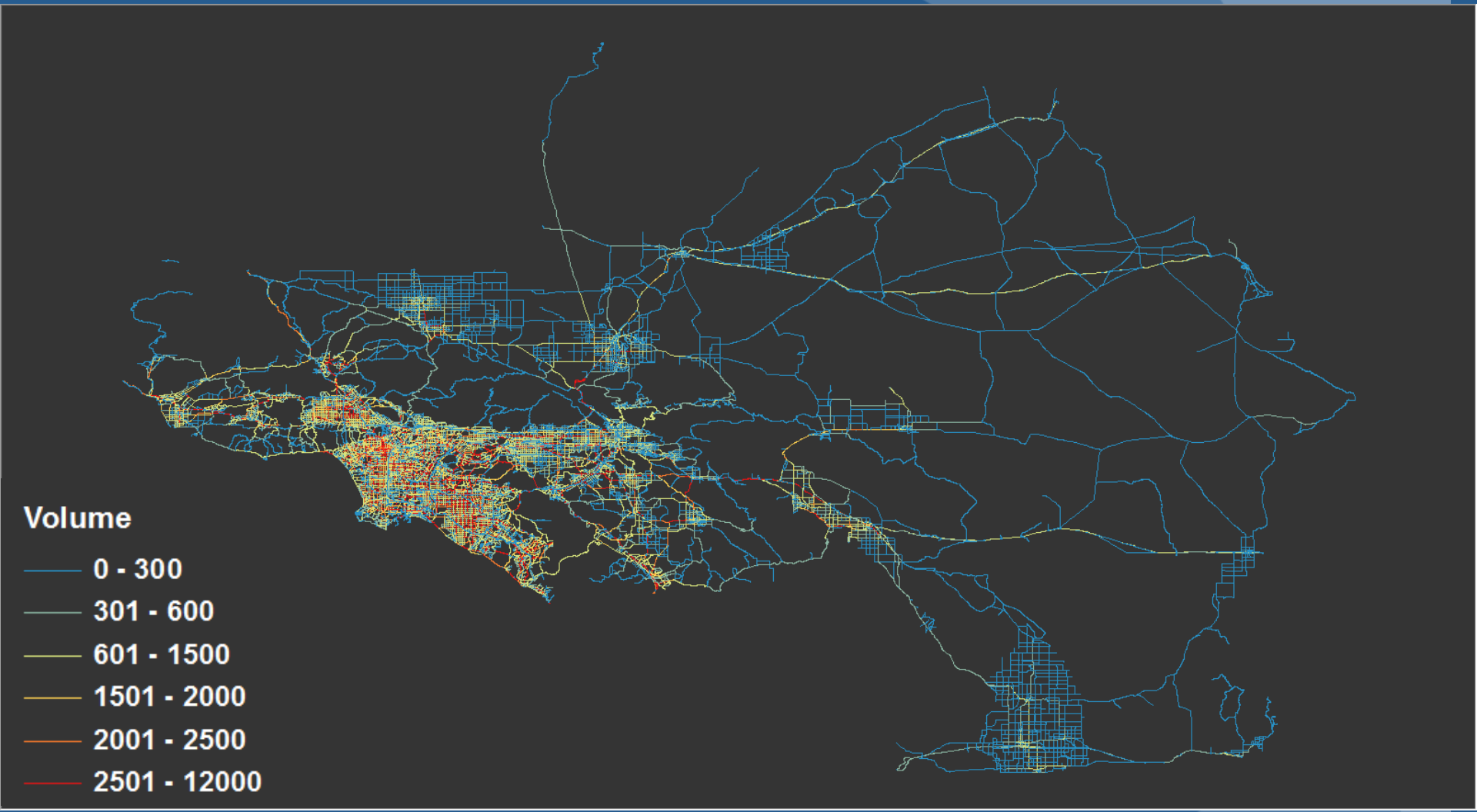

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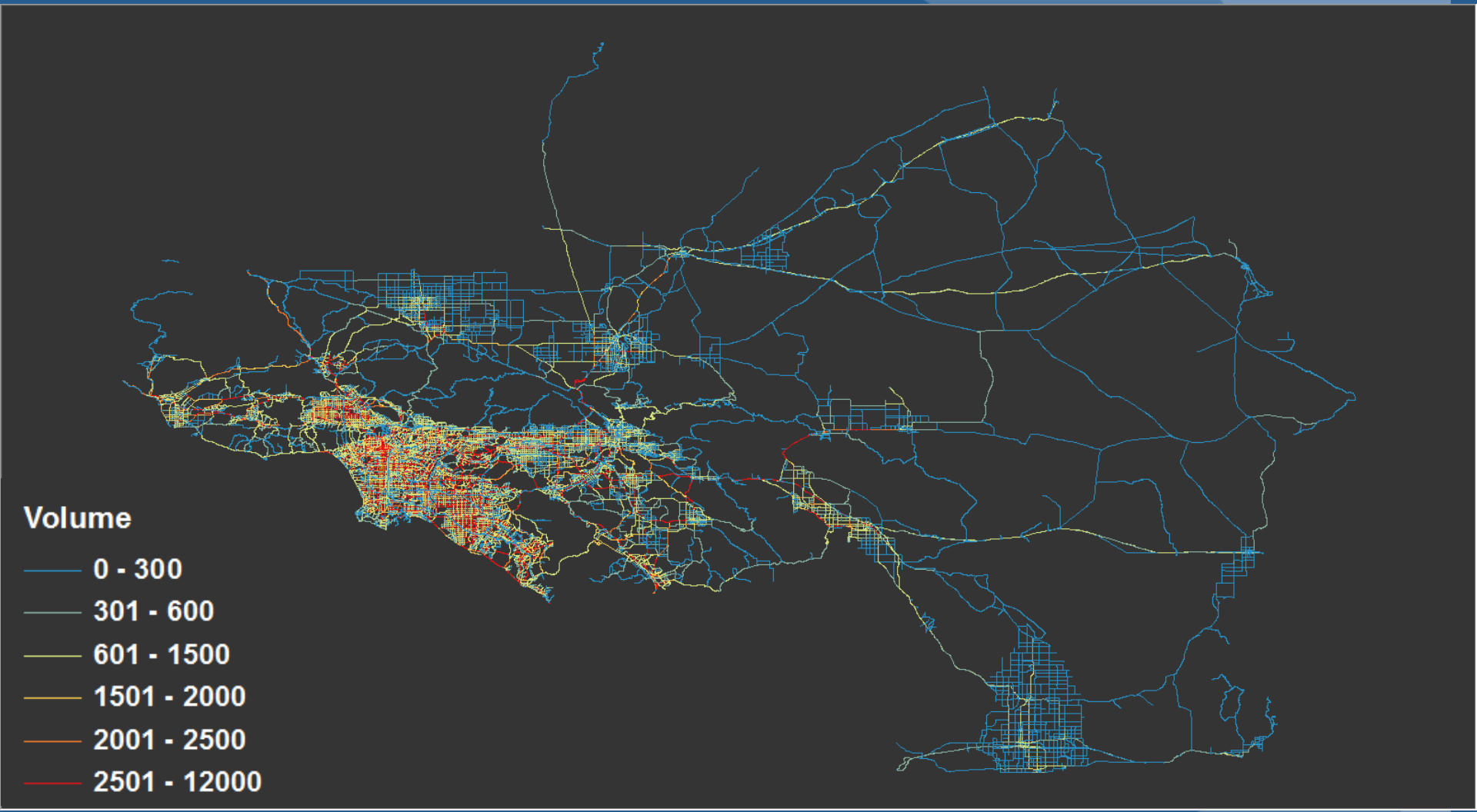
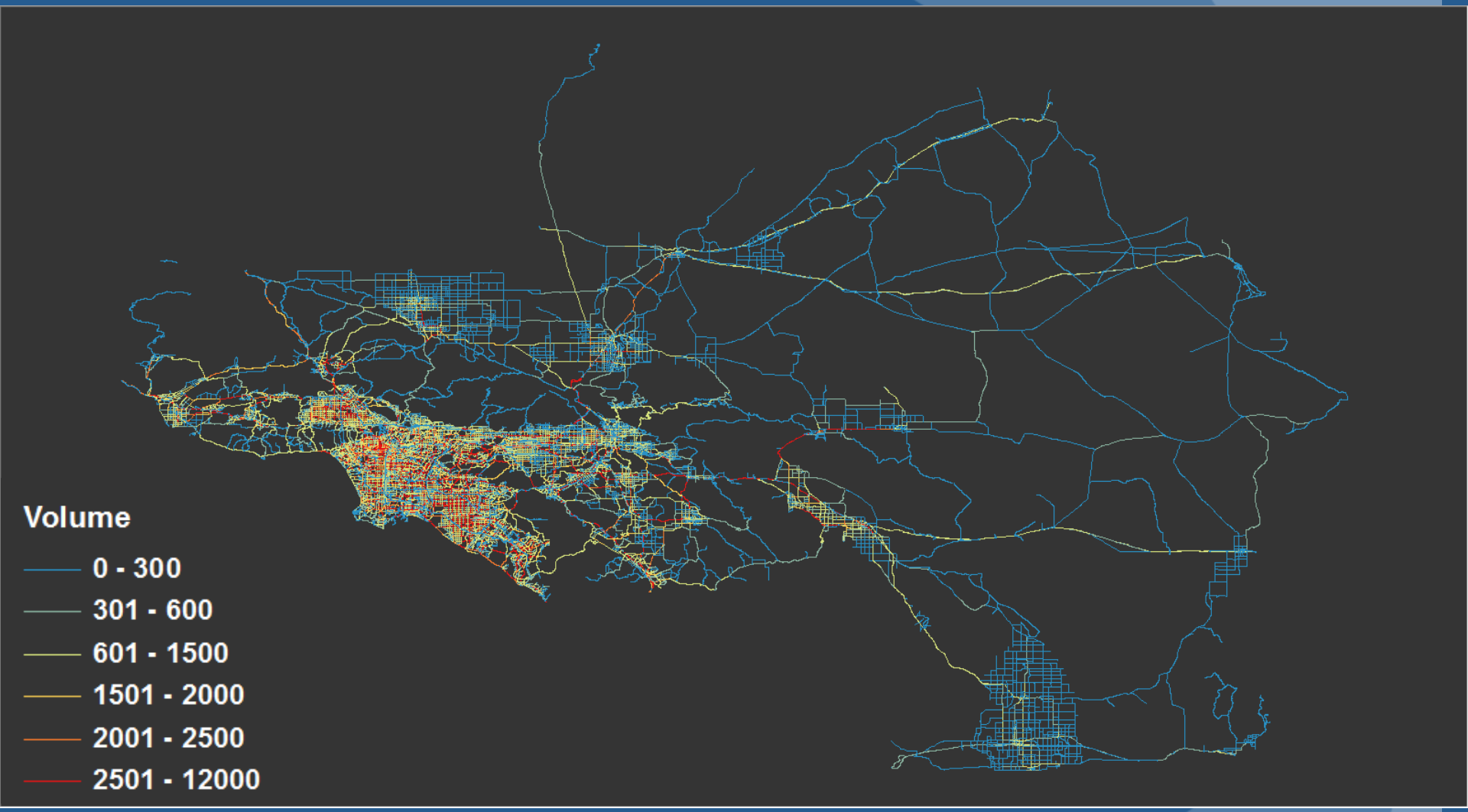
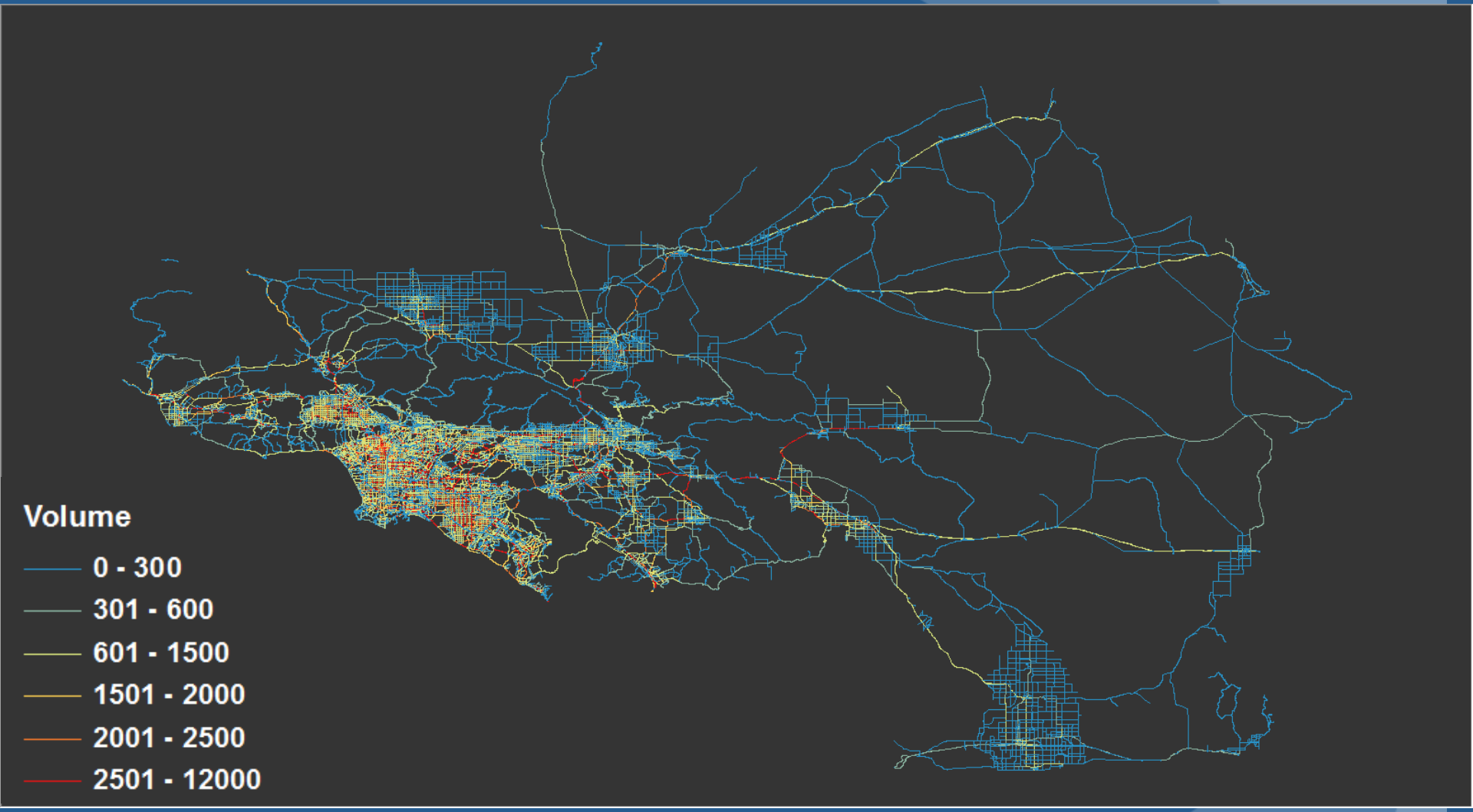


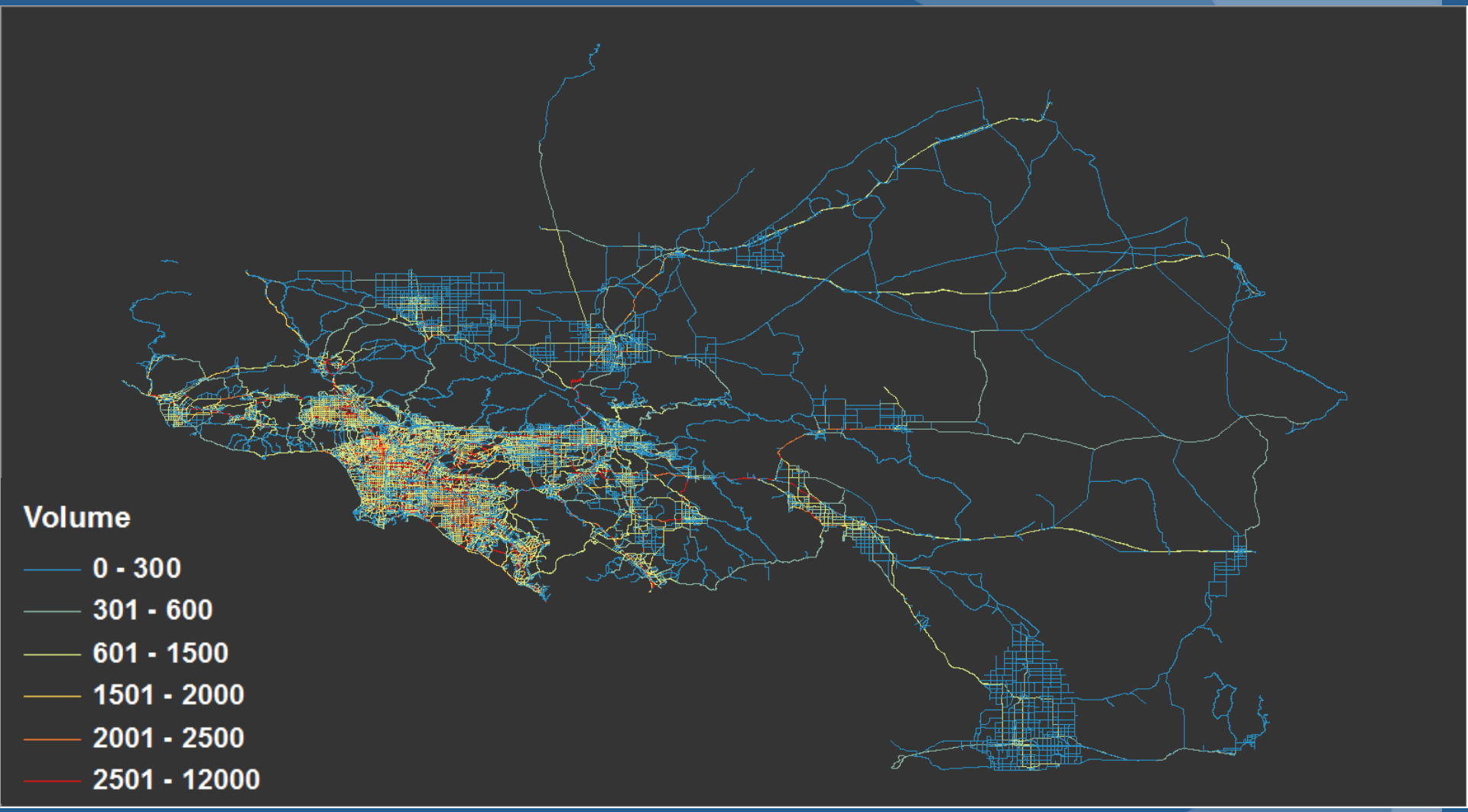
9:00 AM



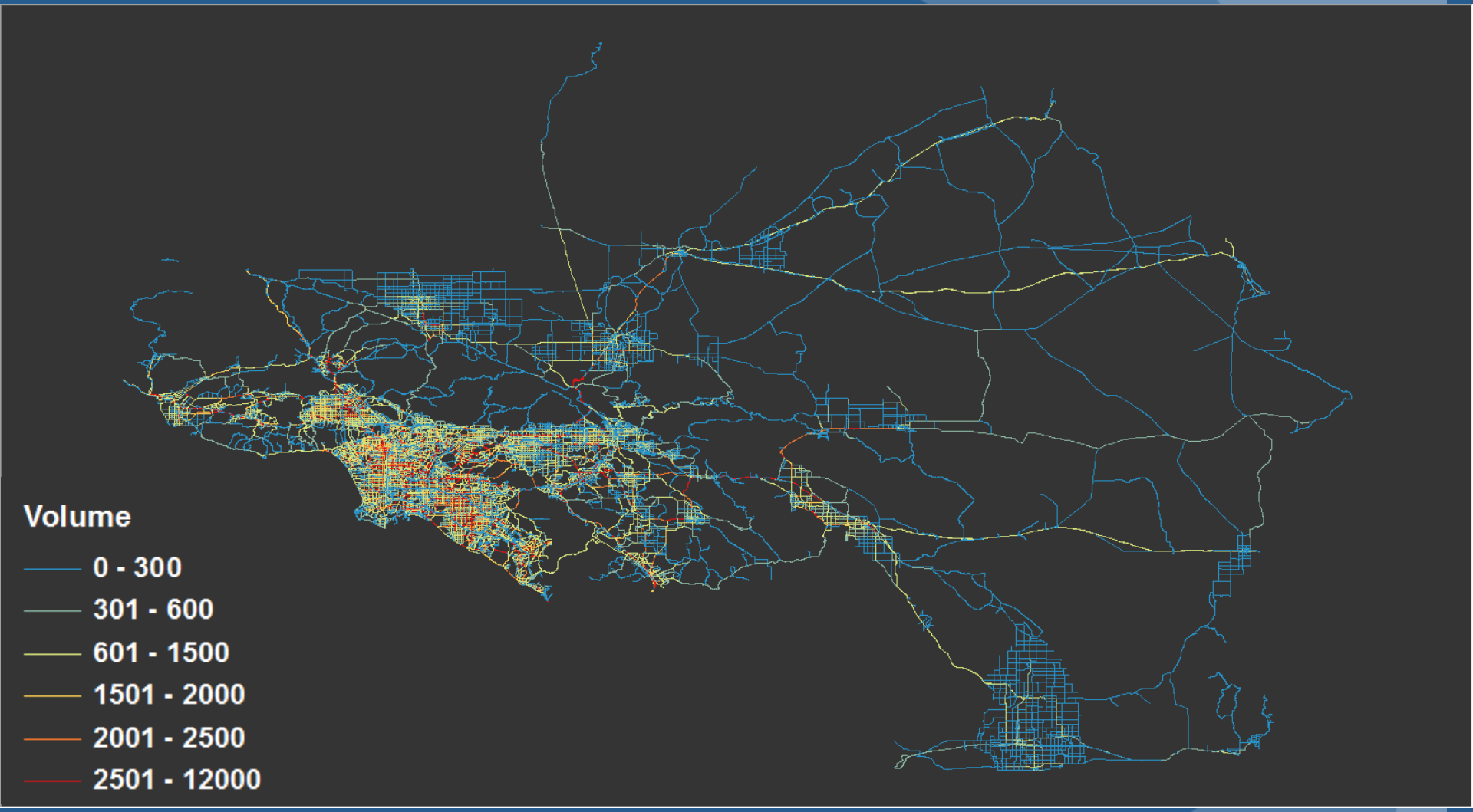
10:00 AM



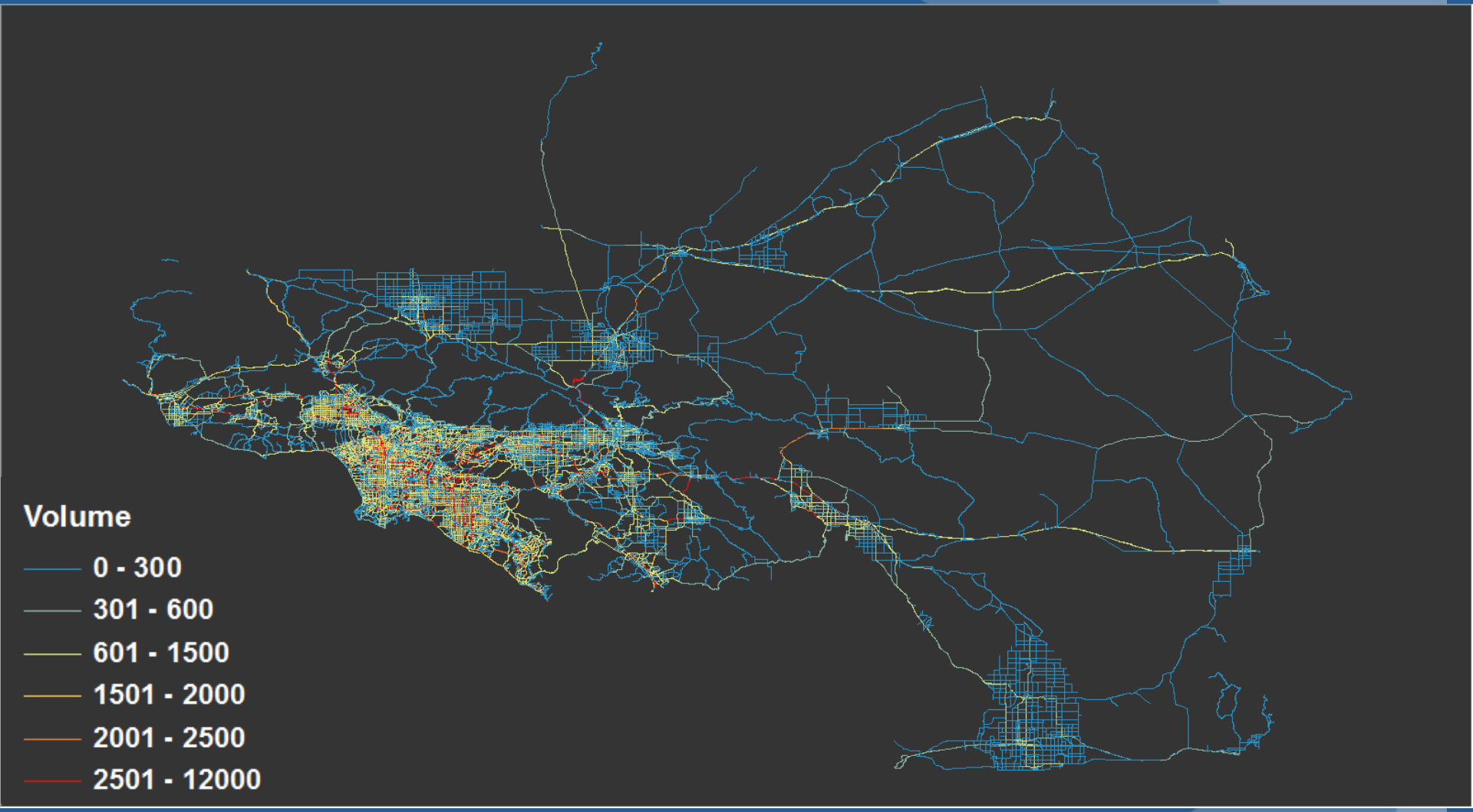
11:00 AM



12:00 PM



1:00 PM



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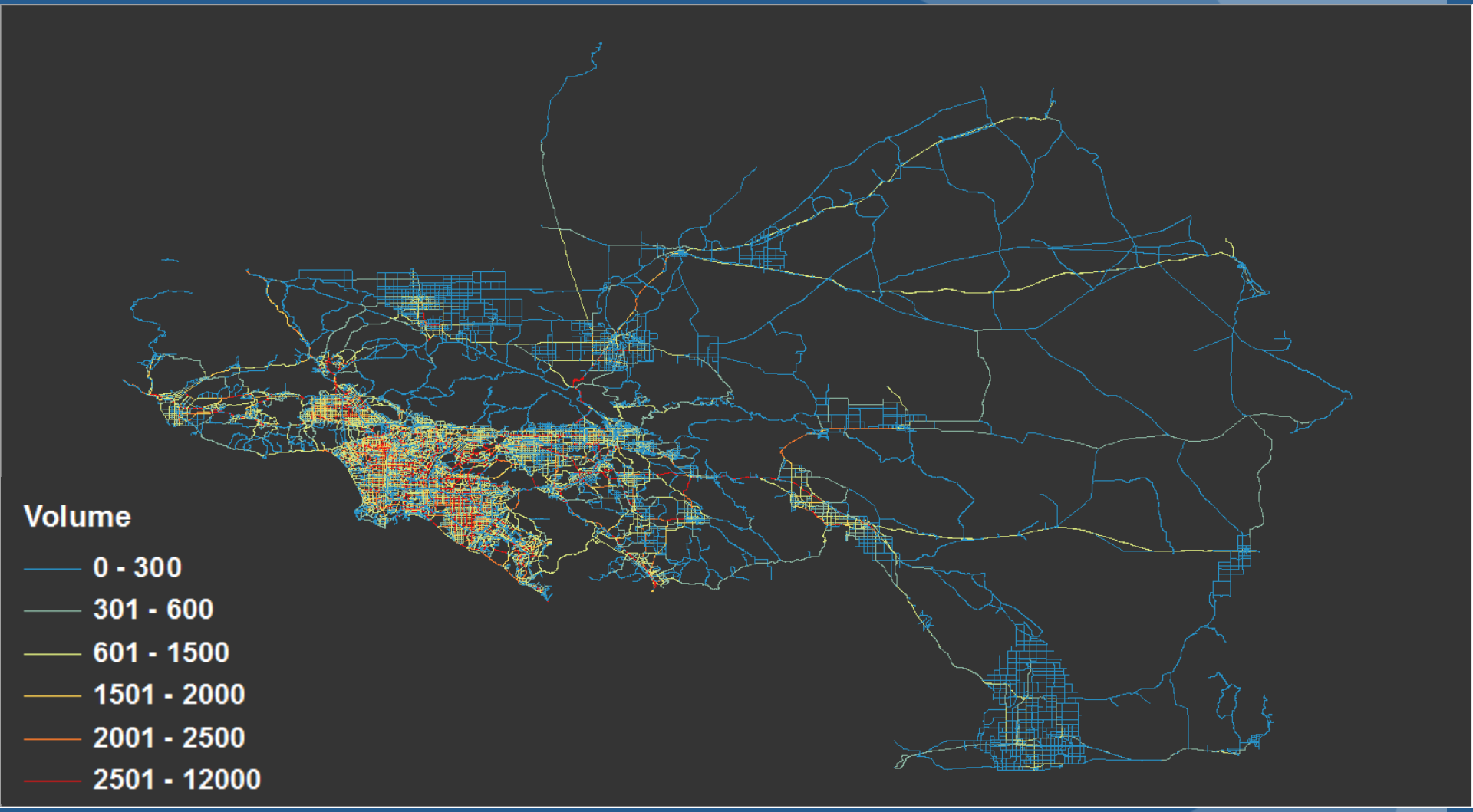

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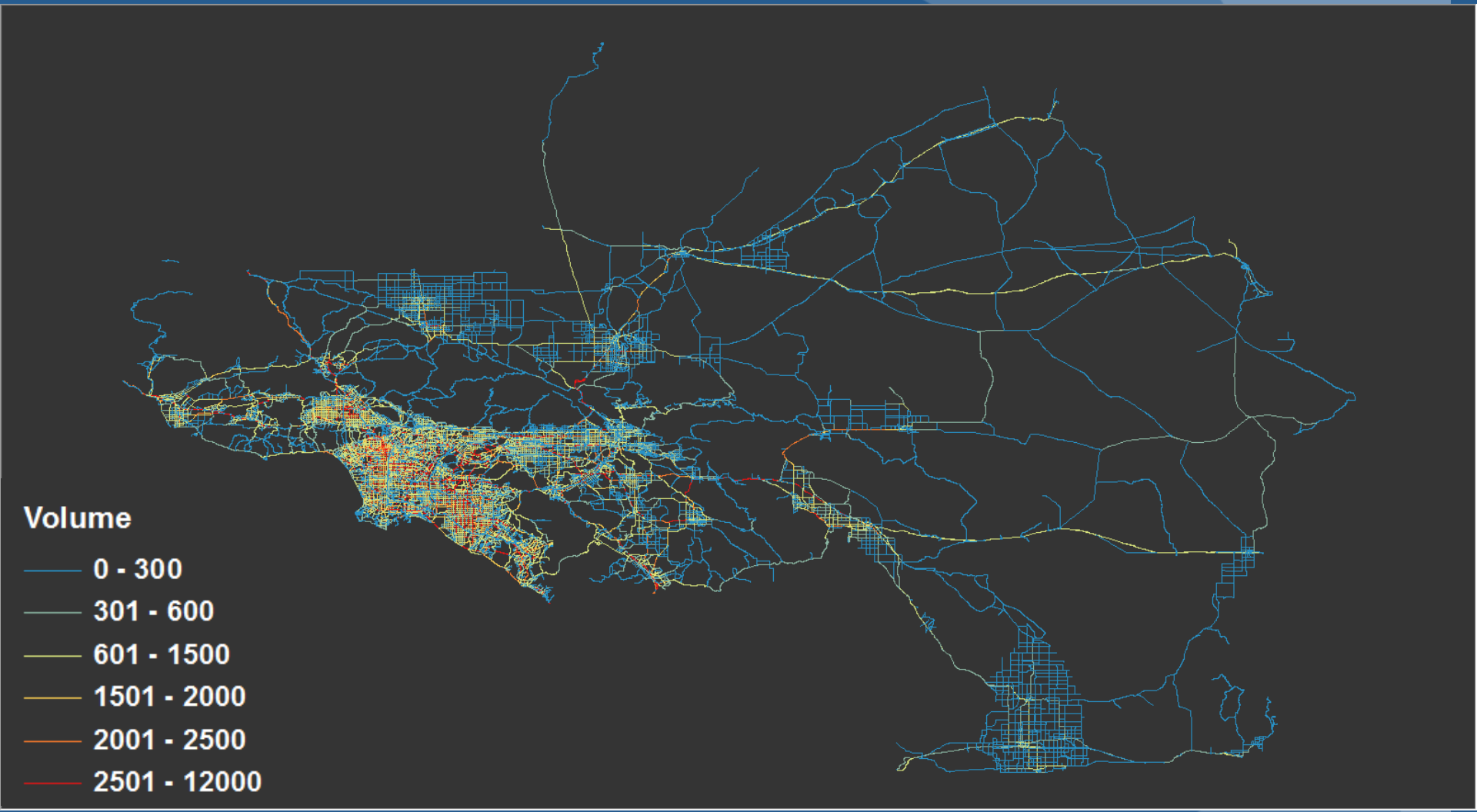

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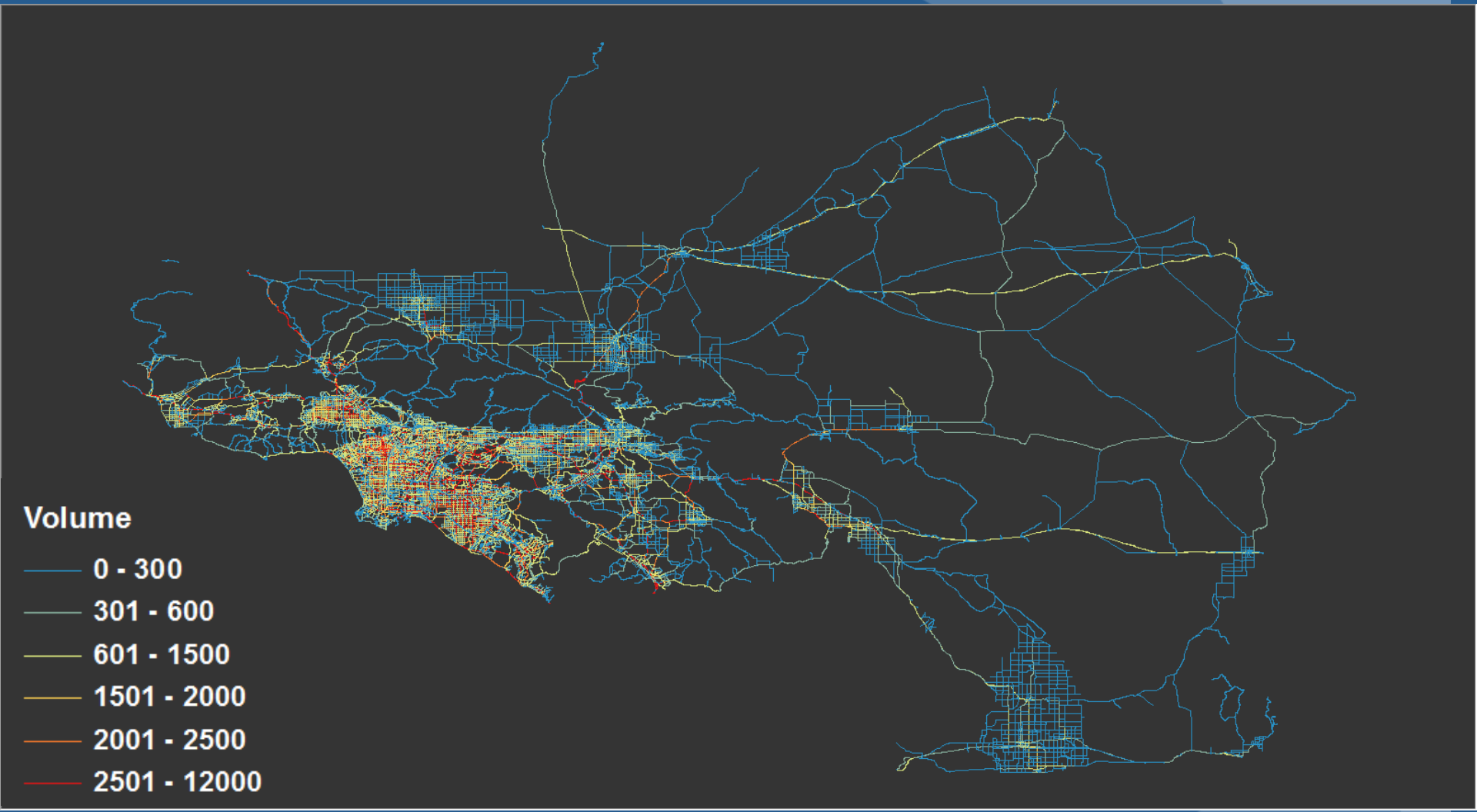

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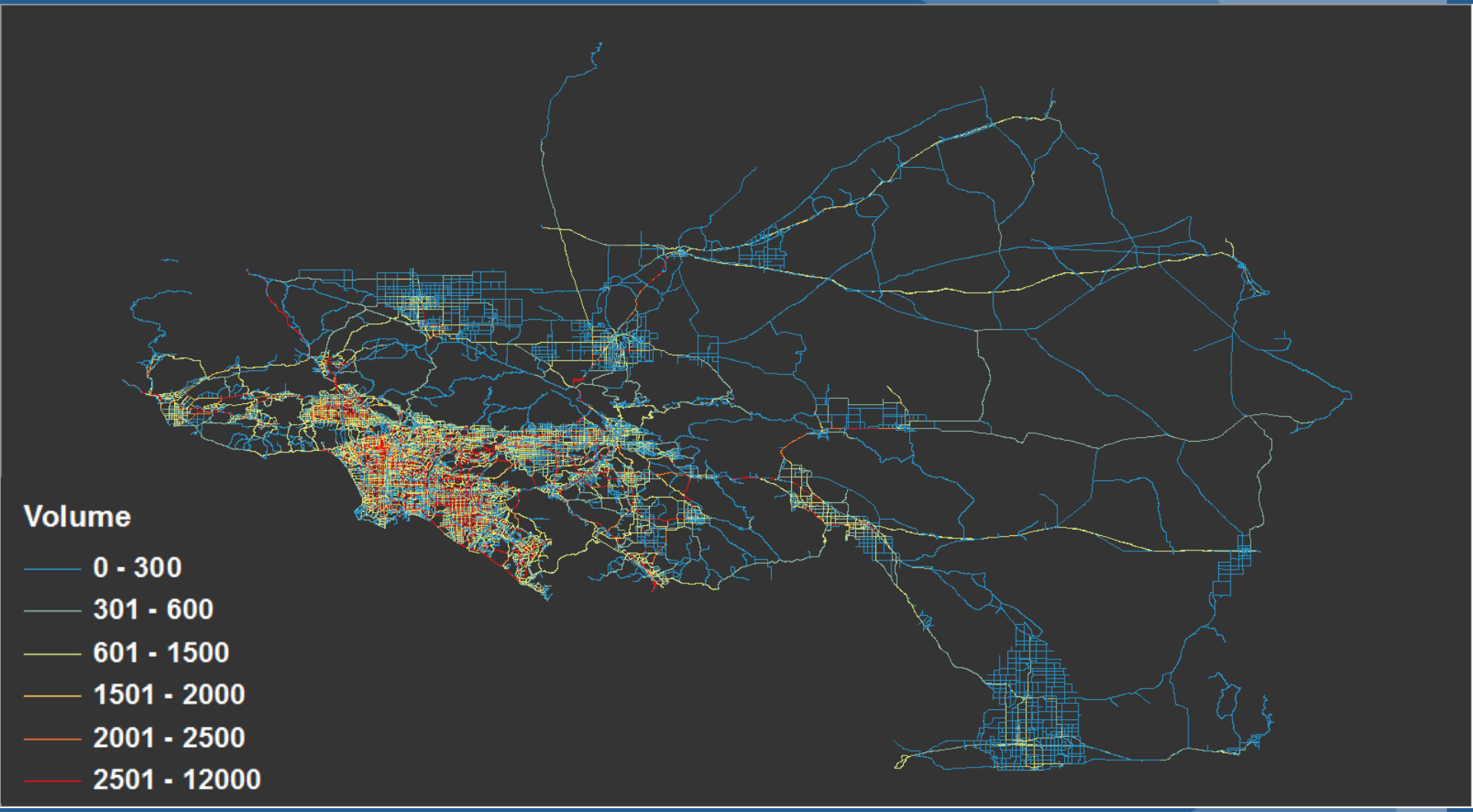

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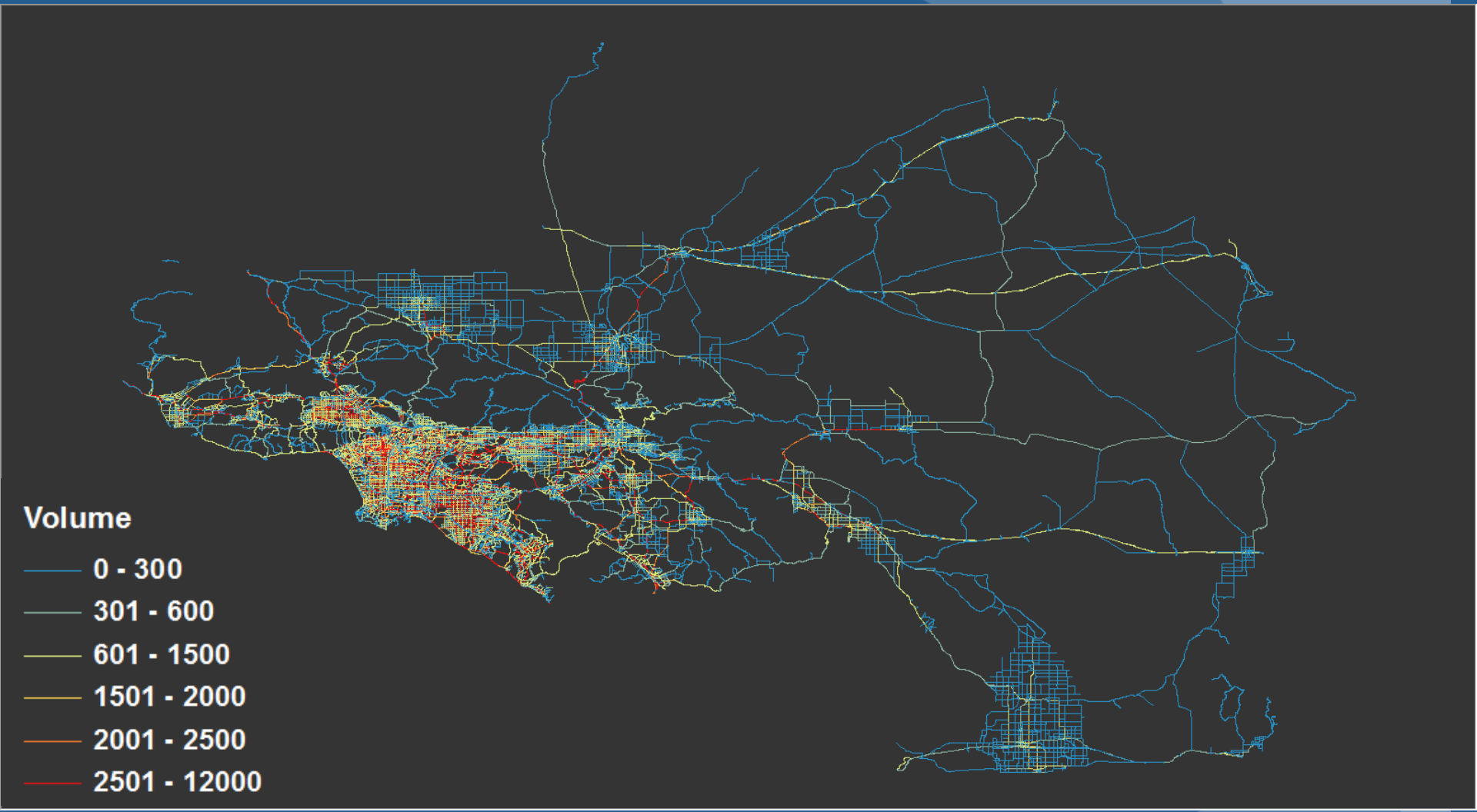
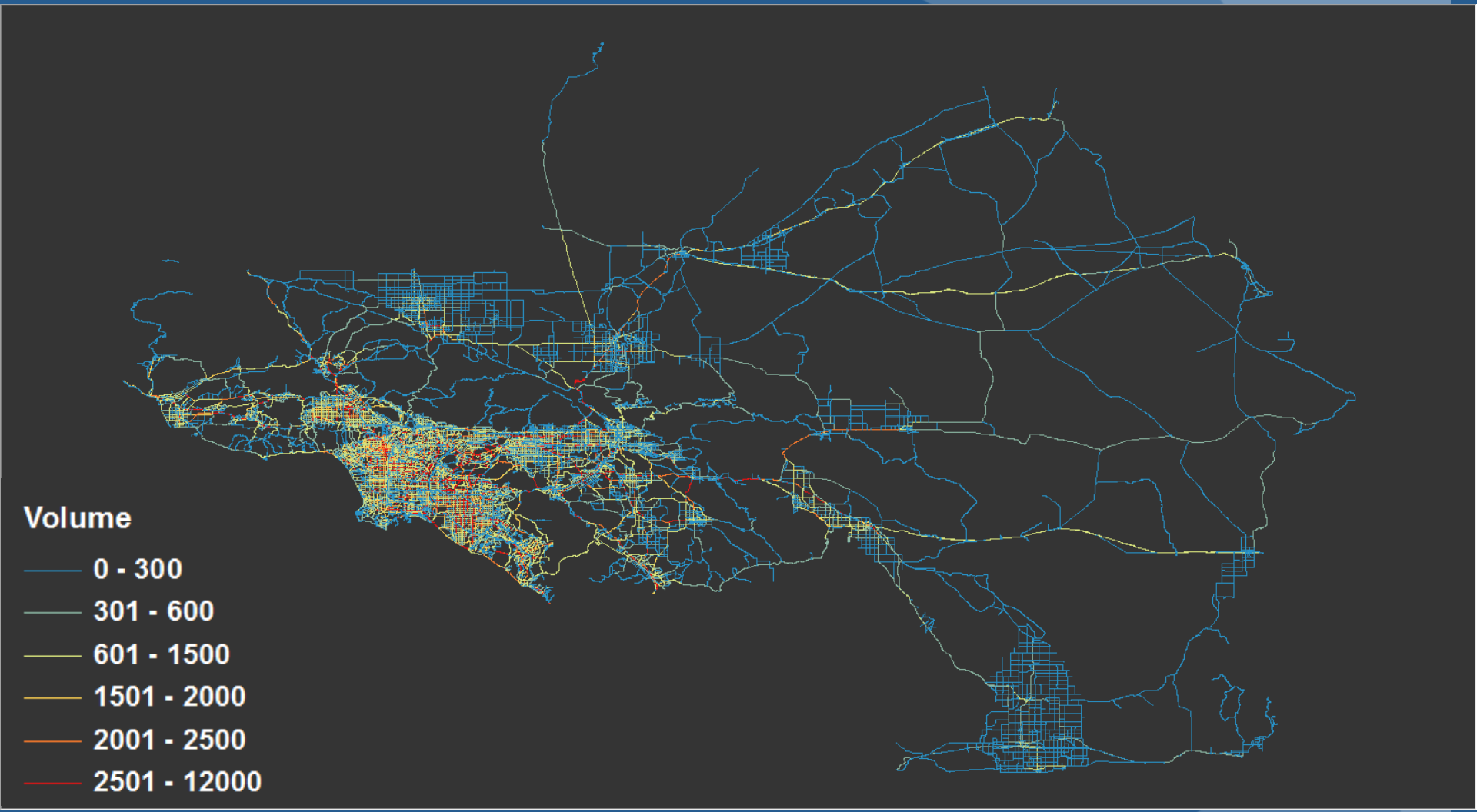
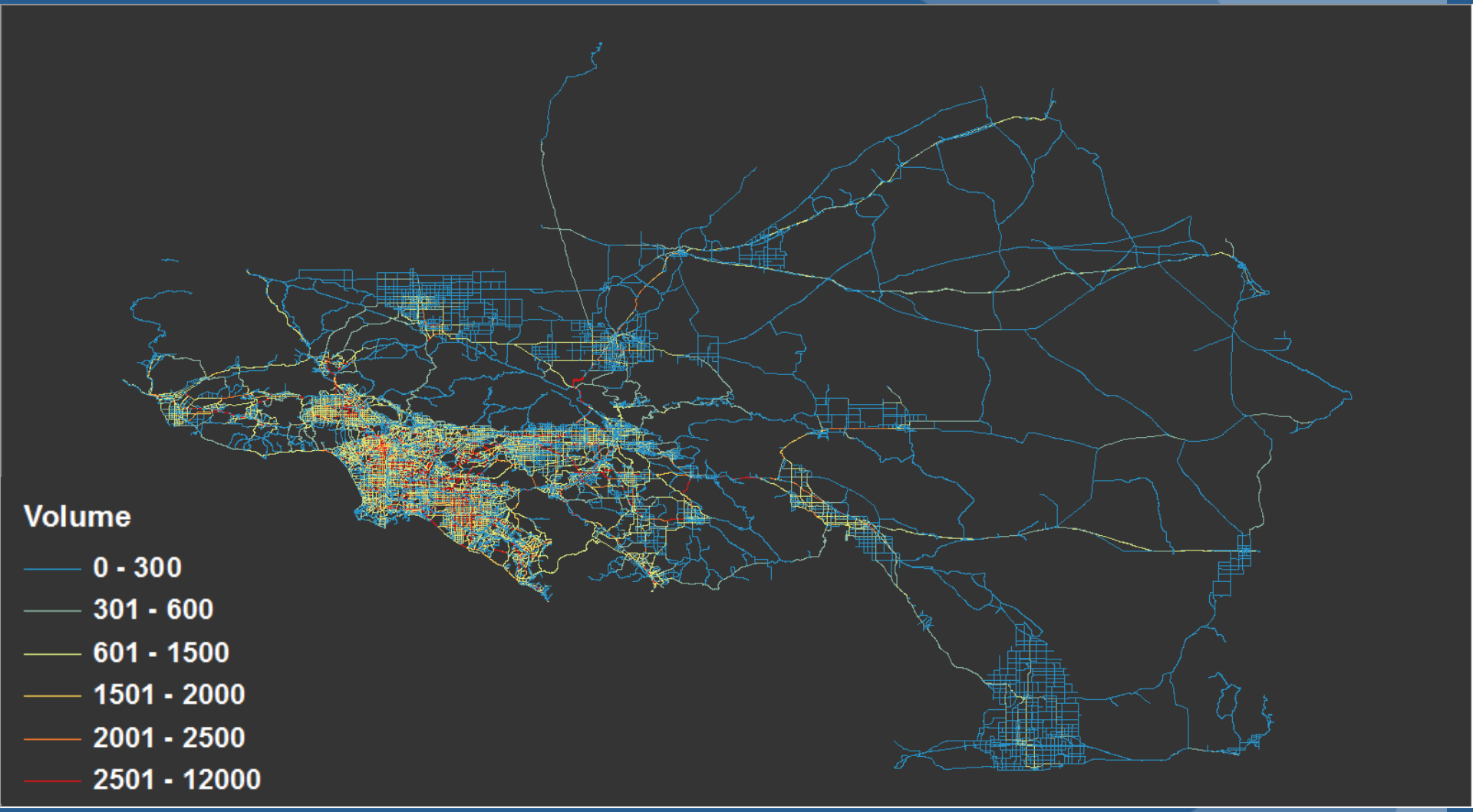


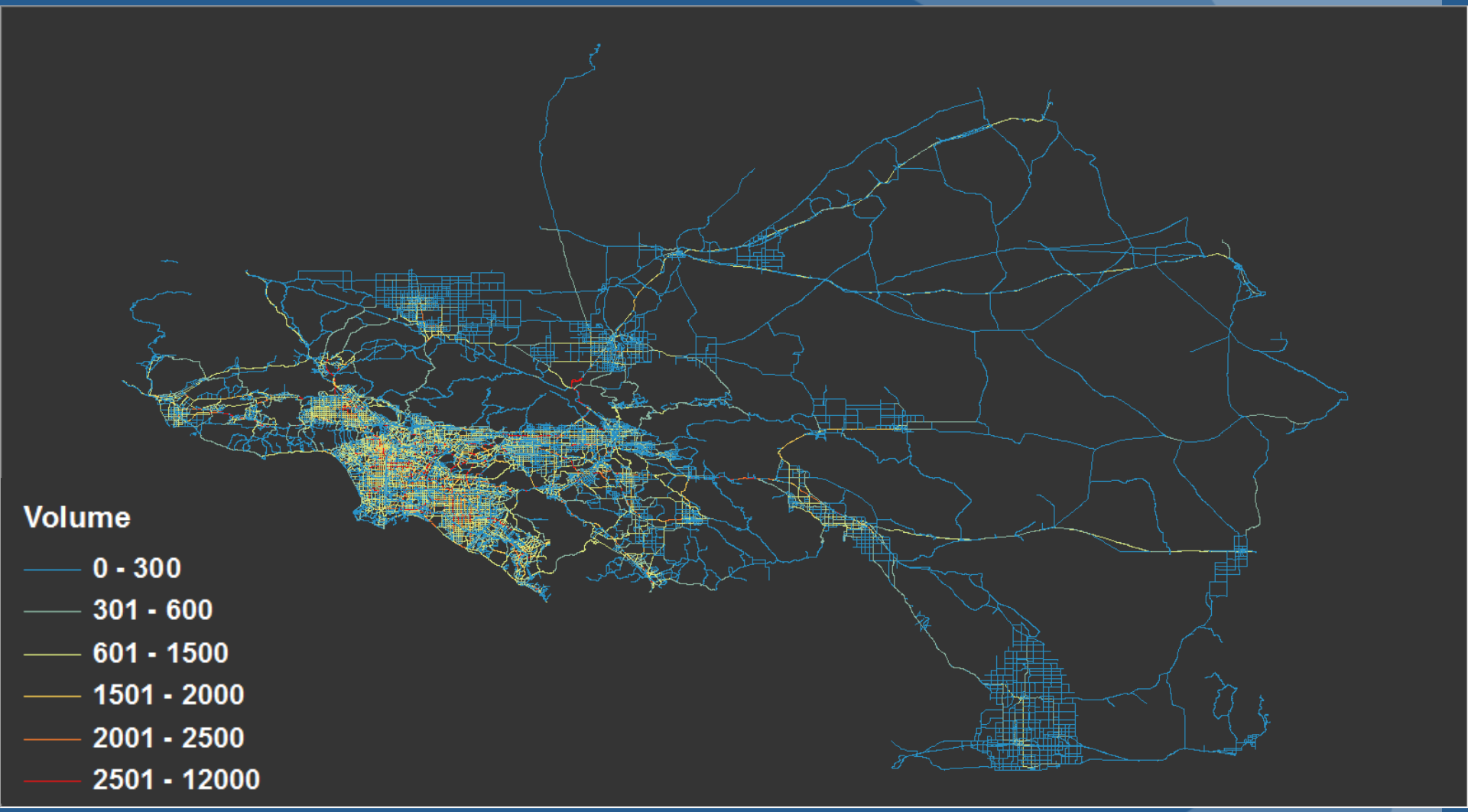
7:00 PM



8:00 PM



9:00 PM



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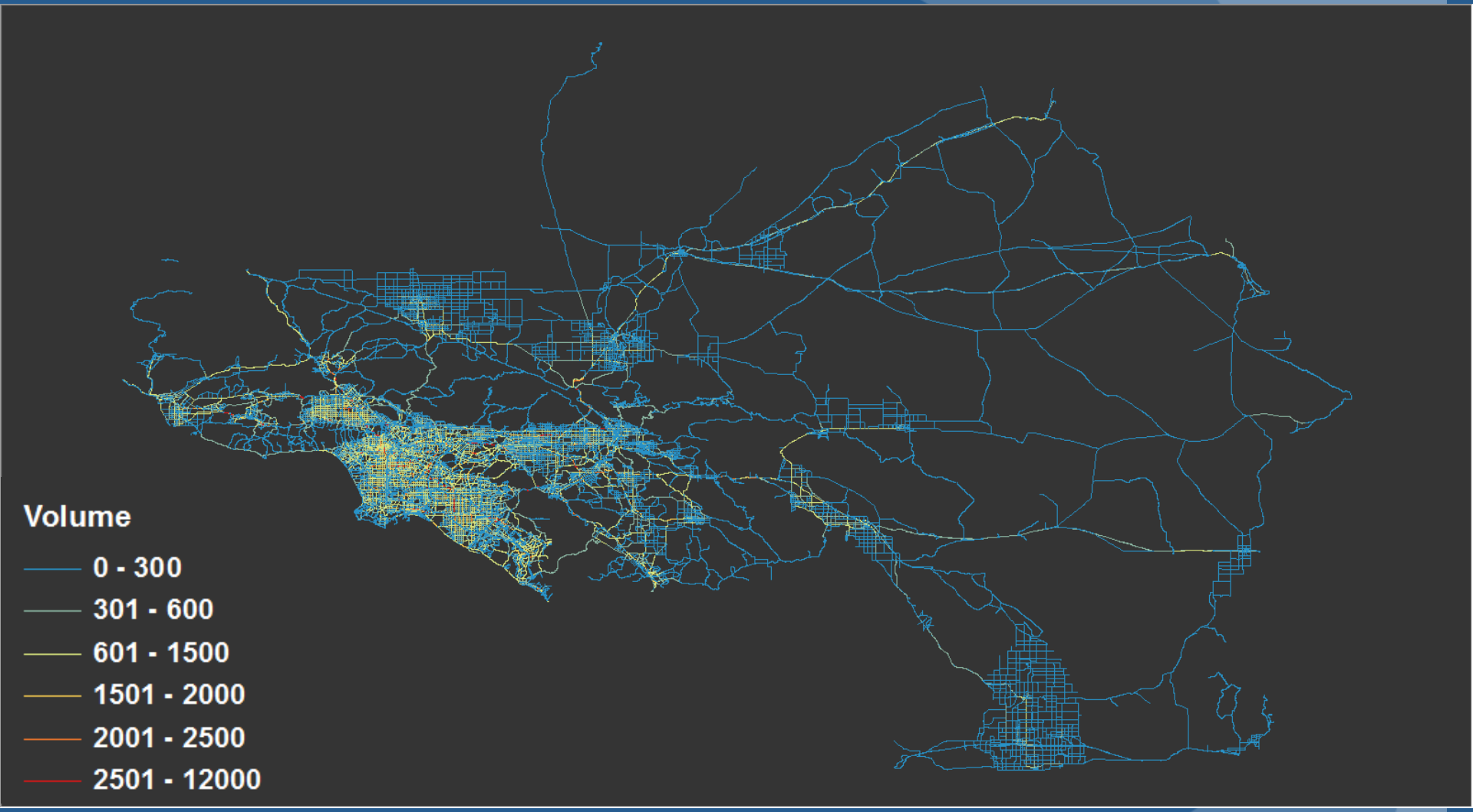
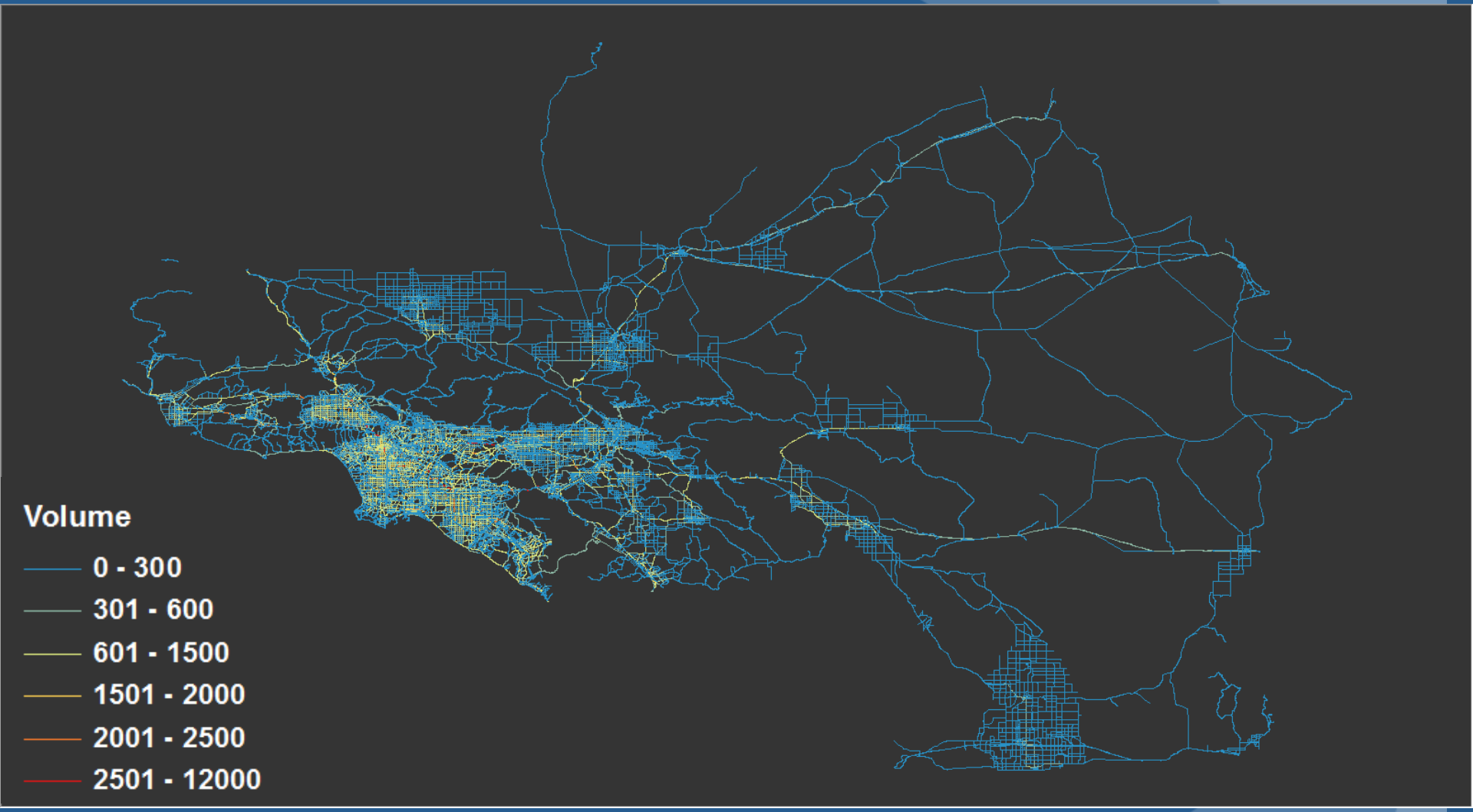


11:00 PM

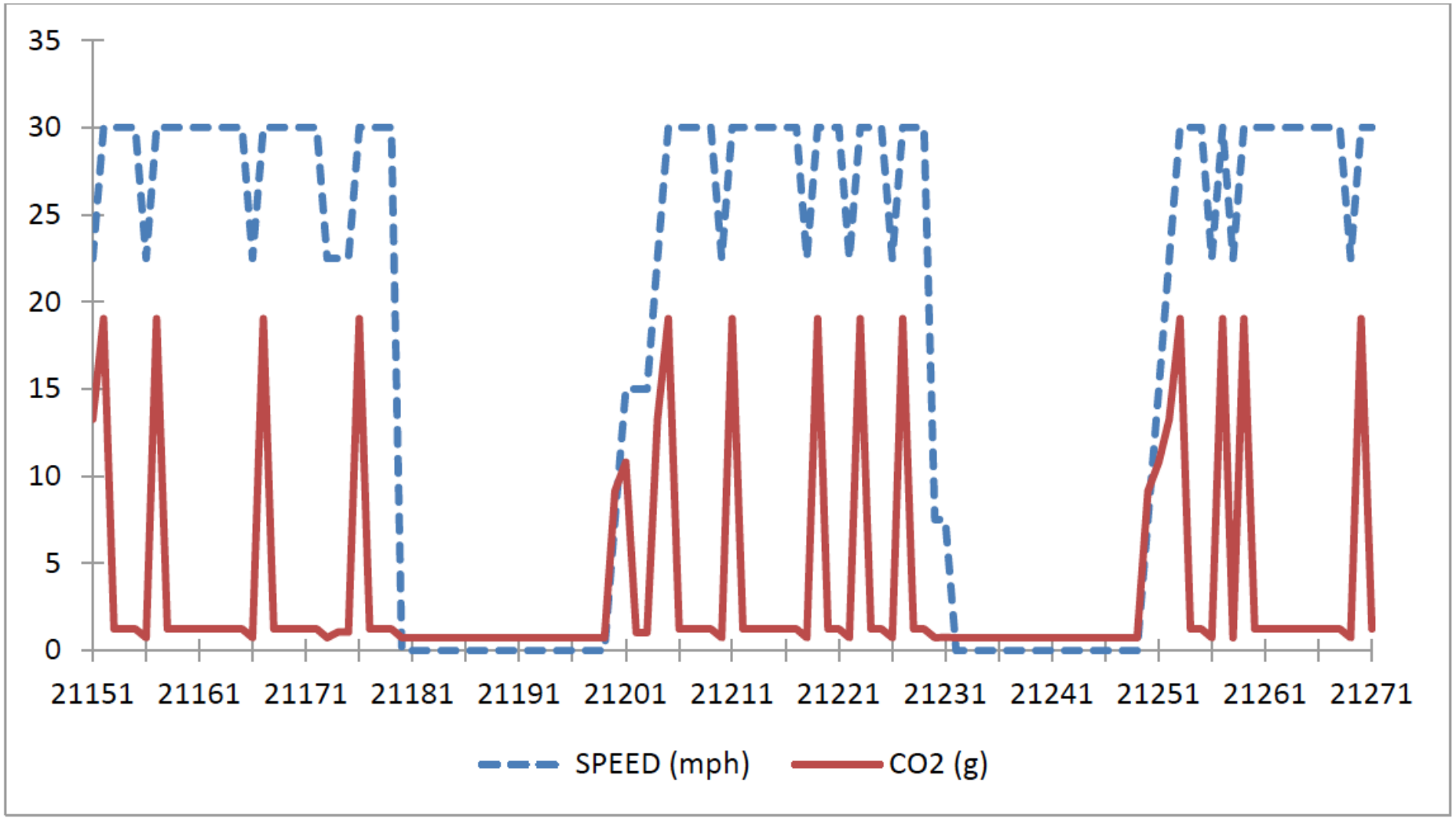


12:00 AM

Second by second emissions and fuel consumption

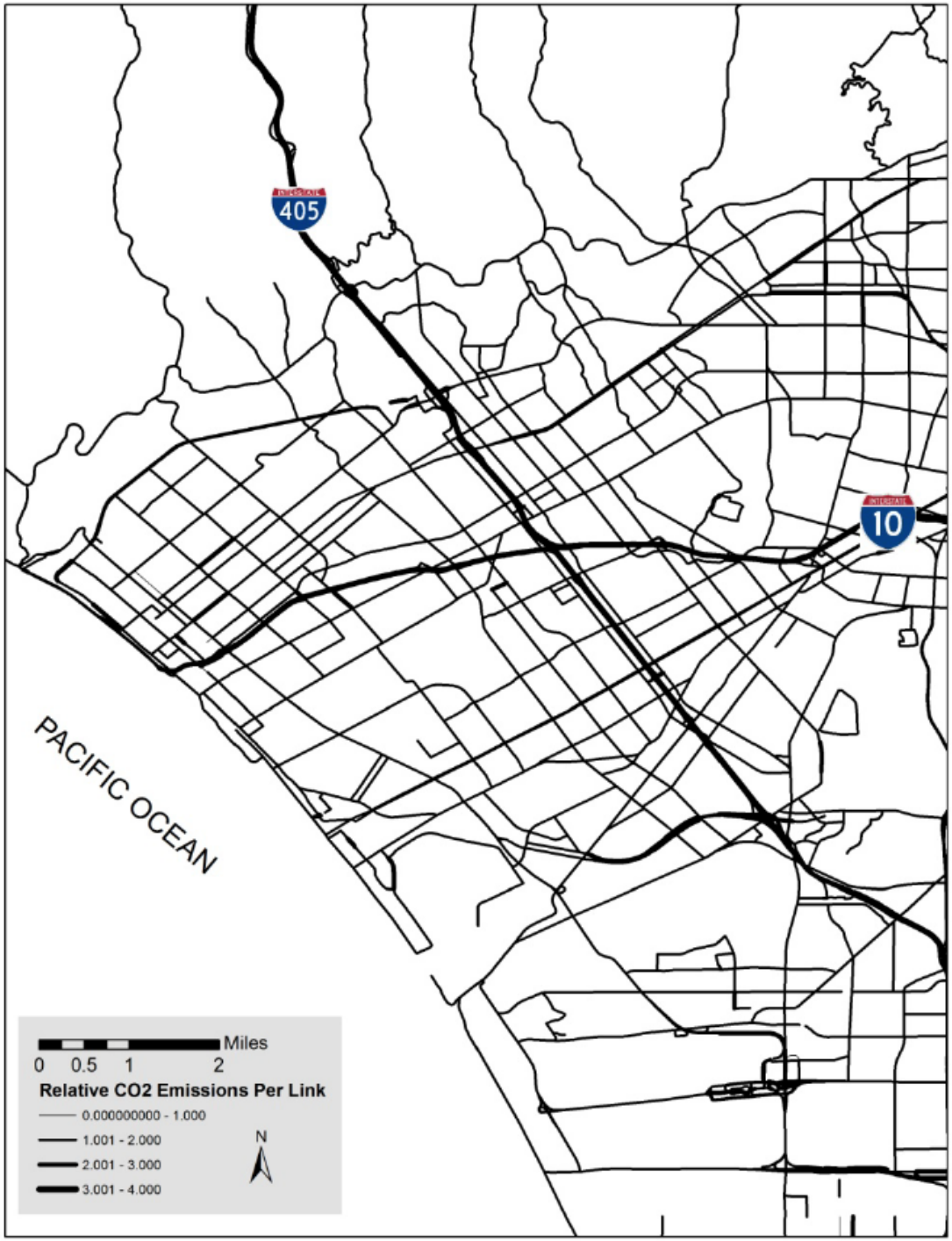
Table X Example of TRANSIMS Vehicle Trajectory Merged with CMEM Emissions

VEHICLE_ID	SPEED	HC	CO	NOX	FUEL	CO2	ACCEL	LINK	DIR	LANE	OFFSET	VEH_TYPE	DRIVER	PASSENGERS
11305071	25	0.000082	0.000155	0	0.375458	1.190549	0	107661	0	3	725	4	1132	0
11305071	20	0	0.000063	0	0.231856	0.735419	-5	107661	0	3	745	4	1132	0
11305071	20	0.000068	0.000101	0	0.29839	0.946199	0	107661	0	3	765	4	1132	0
11305071	25	0.000739	0.009735	0.015031	3.196576	10.12274	5	107661	0	3	790	4	1132	0
11305071	5	0	0.000063	0	0.231856	0.735419	-20	107661	0	3	795	4	1132	0
11305071	10	0.00045	0.004289	0.005936	2.102081	6.660199	5	107661	0	3	805	4	1132	0
11305071	0	0	0.000063	0	0.231856	0.735419	-10	107661	0	3	805	4	1132	0
11305071	0	0.000056	0.000063	0	0.231856	0.735228	0	107661	0	3	805	4	1132	0
11305071	0	0.000056	0.000063	0	0.231856	0.735228	0	107661	0	3	805	4	1132	0
11305071	5	0.000406	0.003592	0.00482	1.91963	6.082653	5	107661	0	3	810	4	1132	0
11305071	10	0.00045	0.004289	0.005936	2.102081	6.660199	5	107661	0	3	820	4	1132	0
11305071	15	0.00052	0.005486	0.007883	2.383786	7.551737	5	106918	0	2	10	4	1132	0
11305071	15	0.000072	0.000115	0	0.321168	1.018419	0	106918	0	2	25	4	1132	0
11305071	20	0.000614	0.007223	0.010771	2.743976	8.691325	5	106918	0	2	45	4	1132	0
11305071	25	0.000739	0.009735	0.015031	3.196576	10.12274	5	106918	0	2	70	4	1132	0



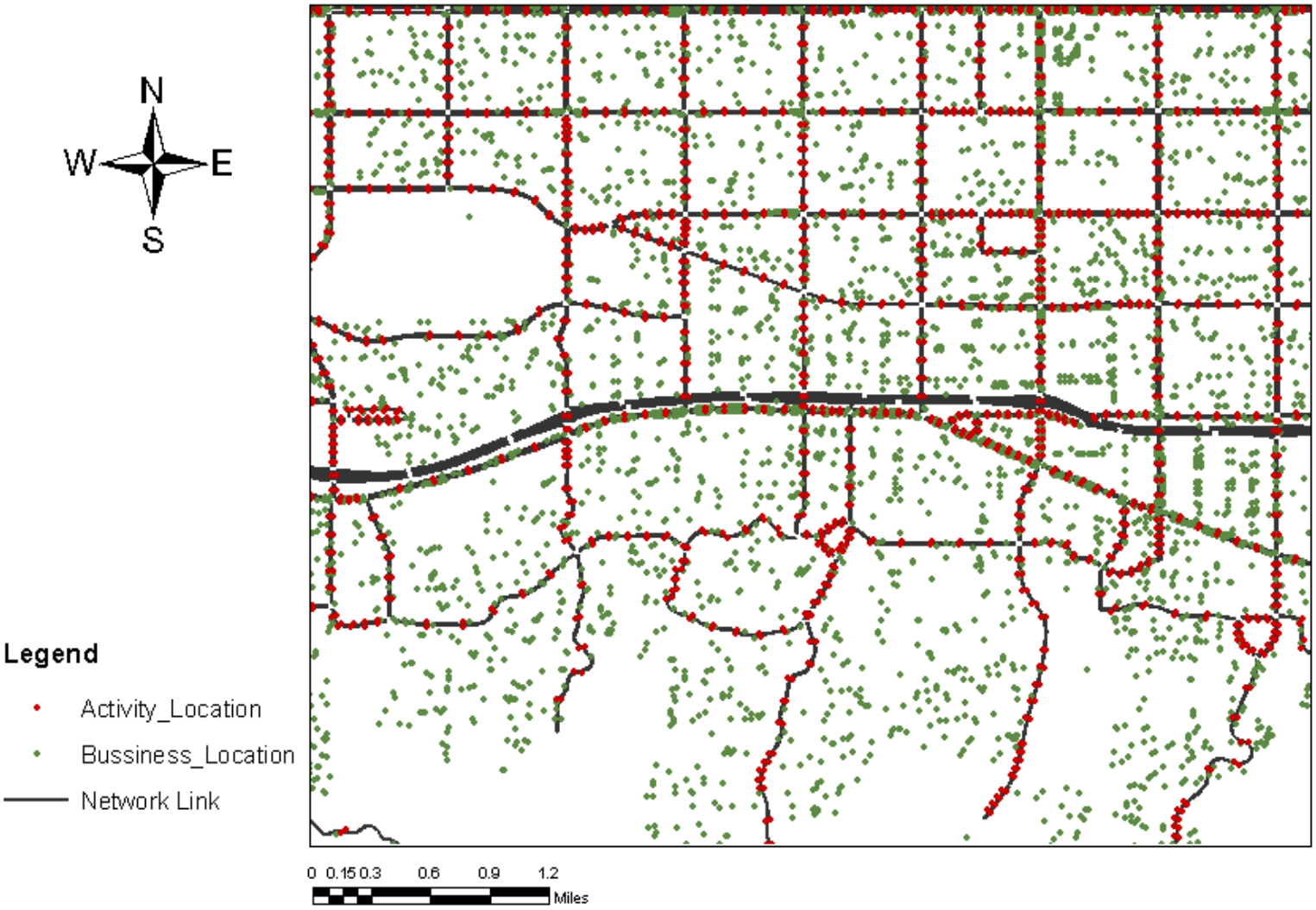
X-axis is second by second of a vehicle

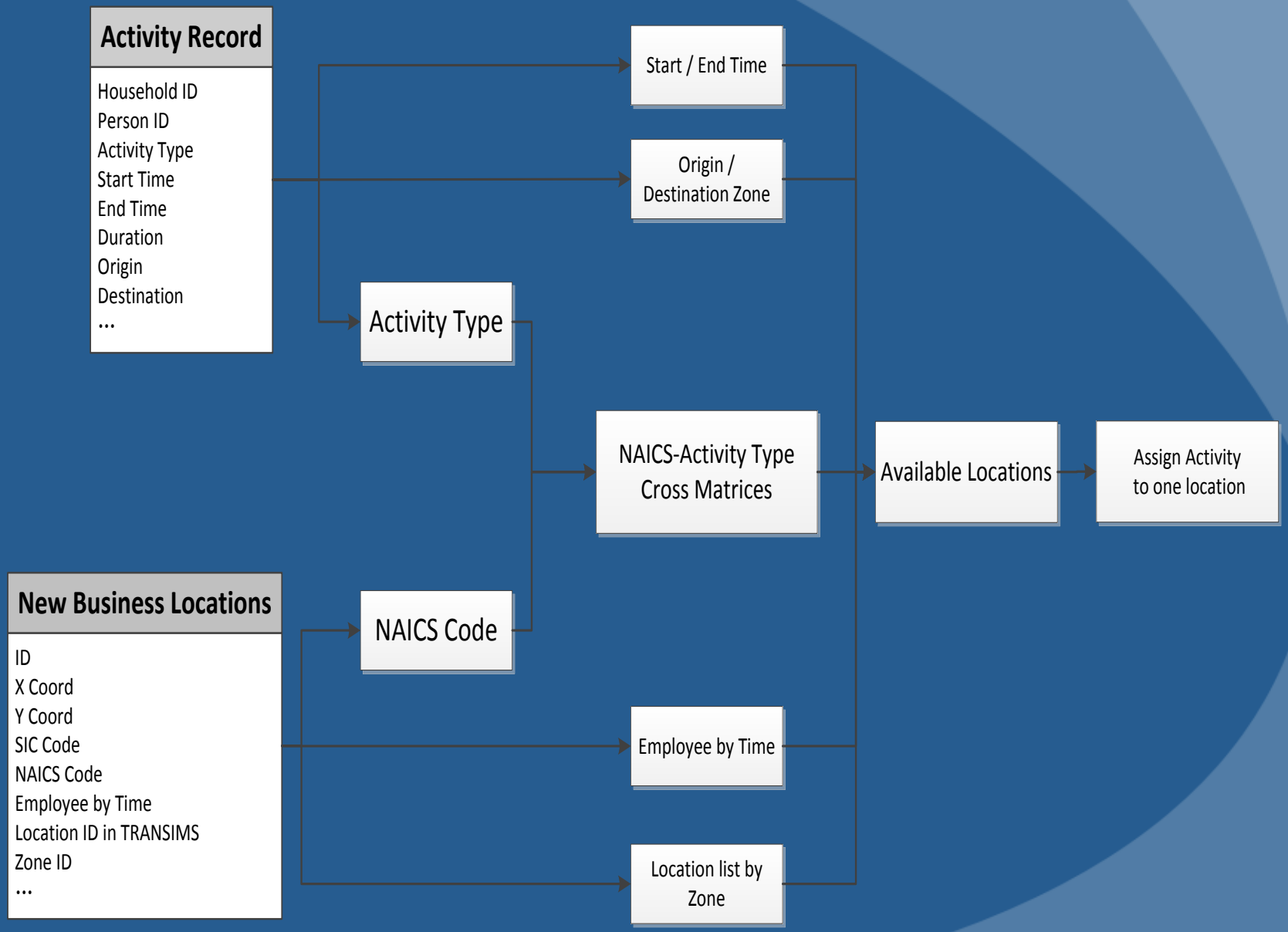
Grams per vehicle in one second

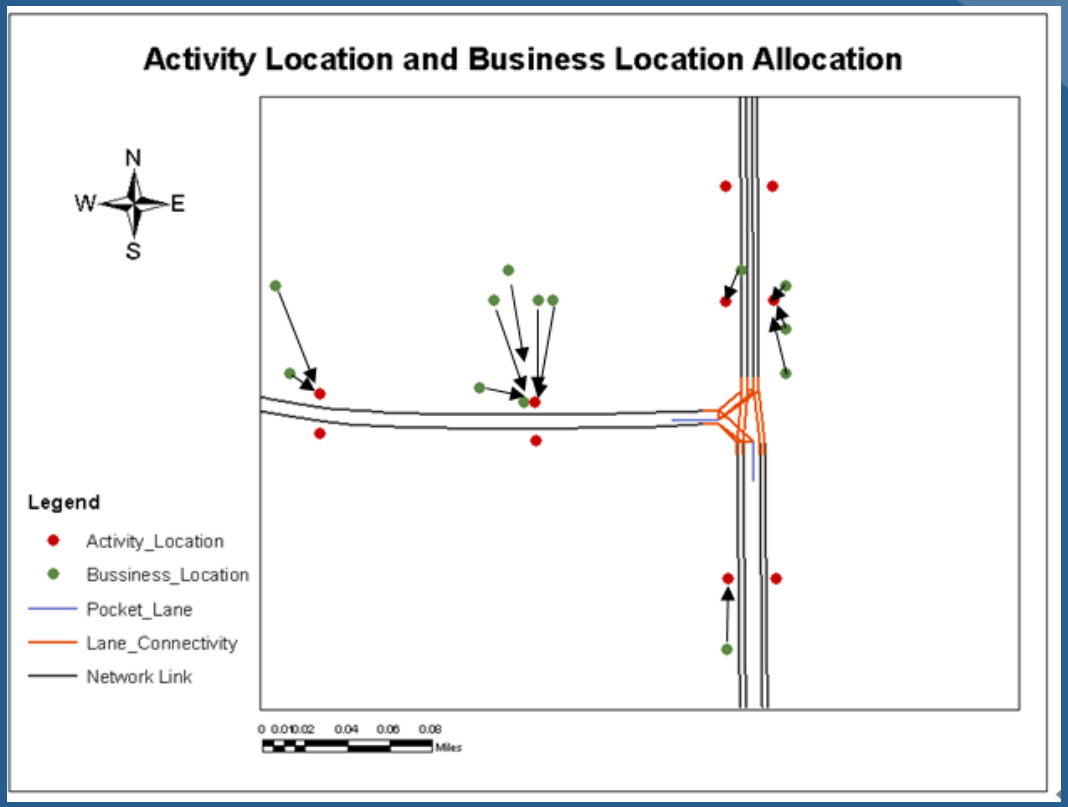


Activities to Business Locations

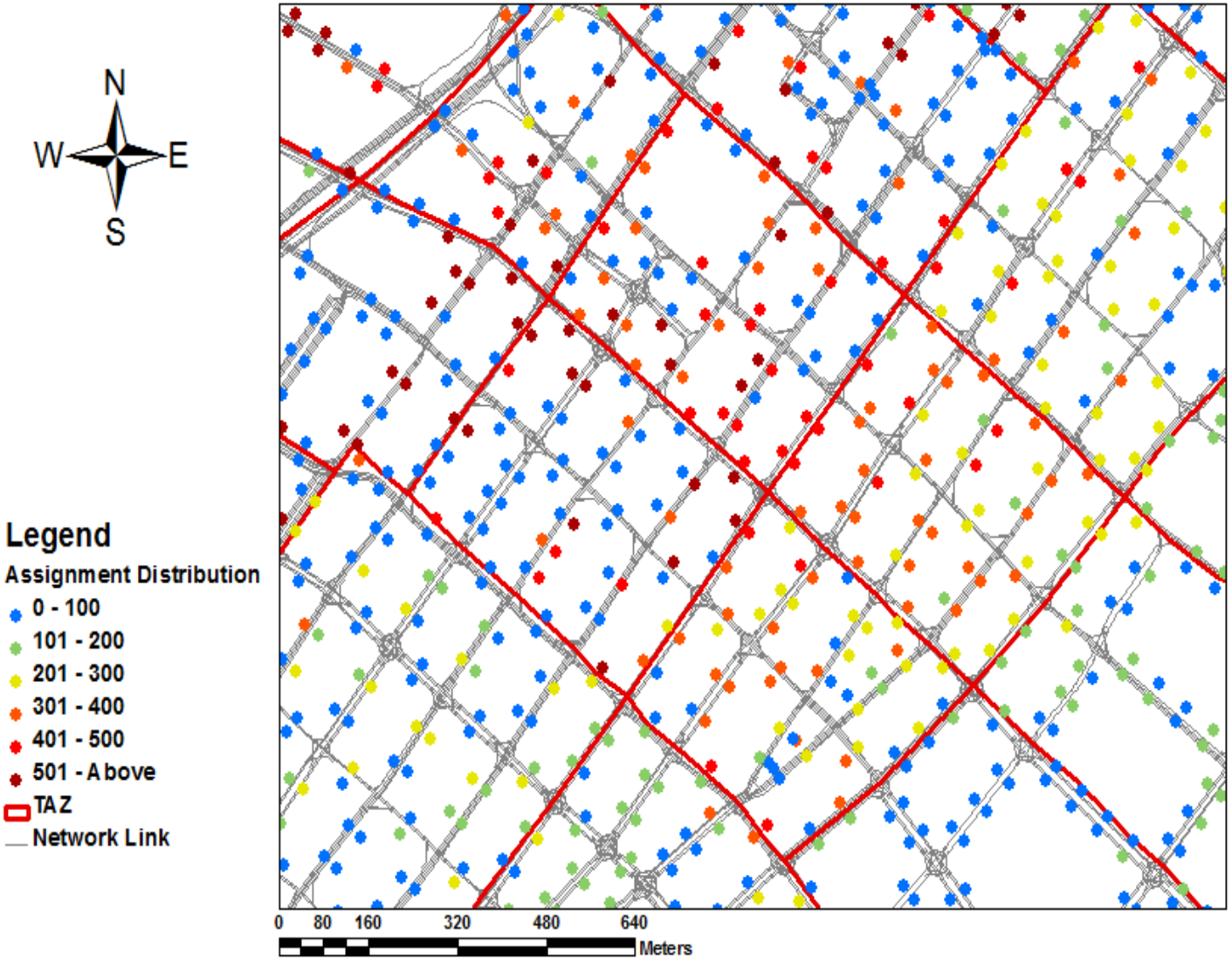
Activity Location and Business Location Distribution




Activity Record
Household ID
Person ID
Activity Type
Start Time
End Time
Duration
Origin
Destination
...
Start / End Time
Origin / Destination Zone
Activity Type
NAICS-Activity Type Cross Matrices
Available Locations
Assign Activity to one location
New Business Locations
ID
X Coord
Y Coord
SIC Code
NAICS Code
Employee by Time
Location ID in TRANSIMS
Zone ID
...
NAICS Code
Employee by Time
Location list by Zone


Activity Location and Business Location Allocation
N
W
E
S
Legend
Activity_Location
Bussiness_Location
Pocket_Lane
Lane_Connectivity
Network Link
0 0.010.02 0.04 0.06 0.08
Miles

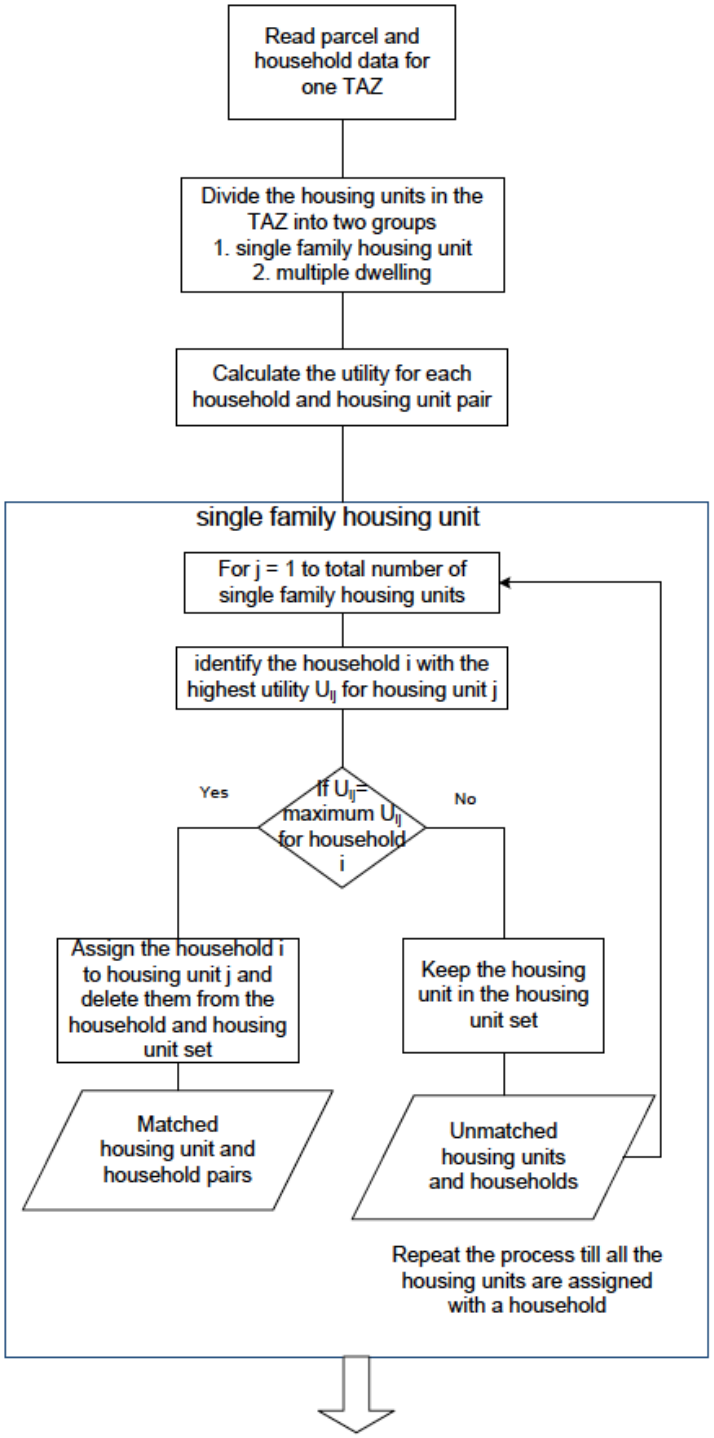
Distribution of Activity Assignment in Downtown LA

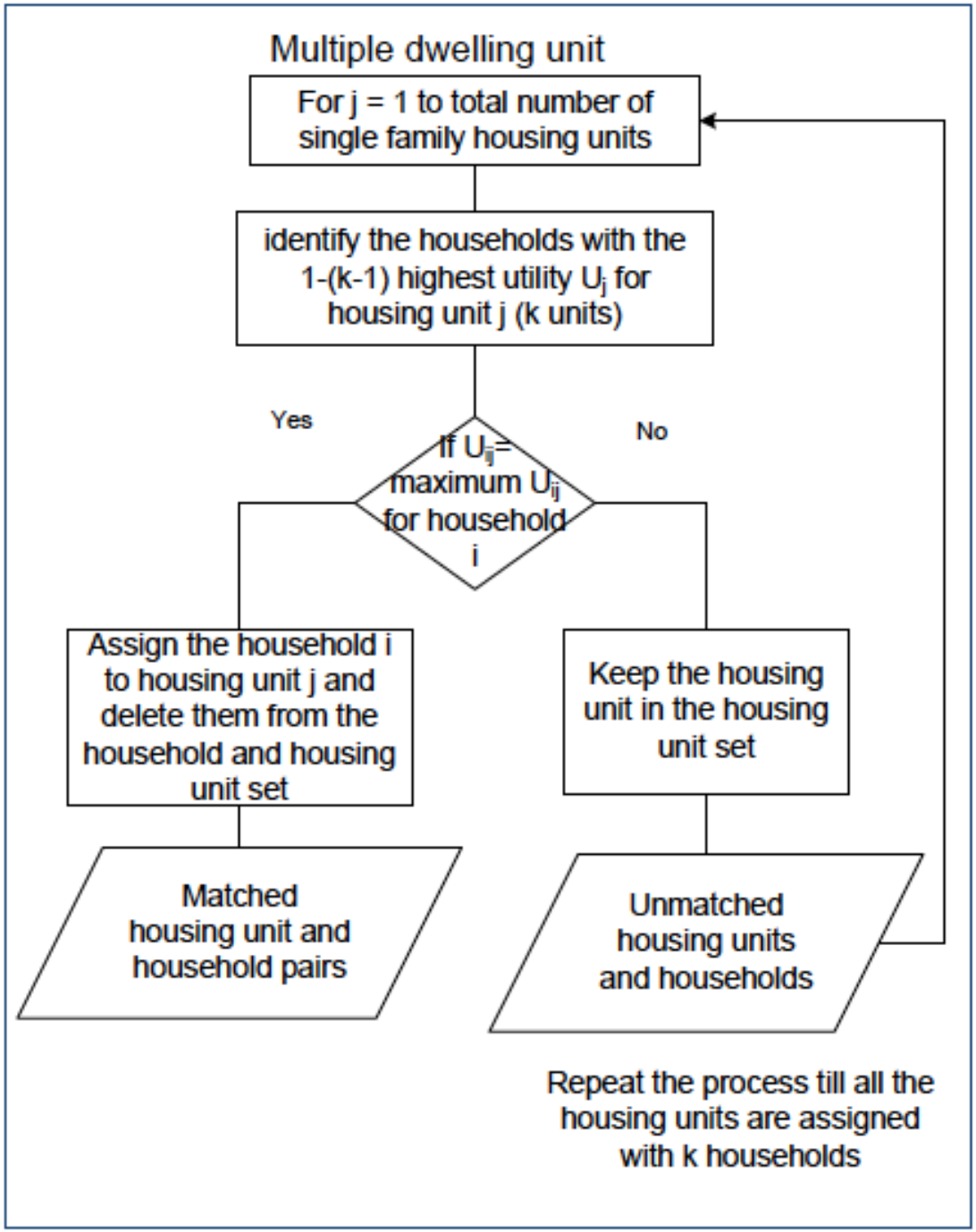


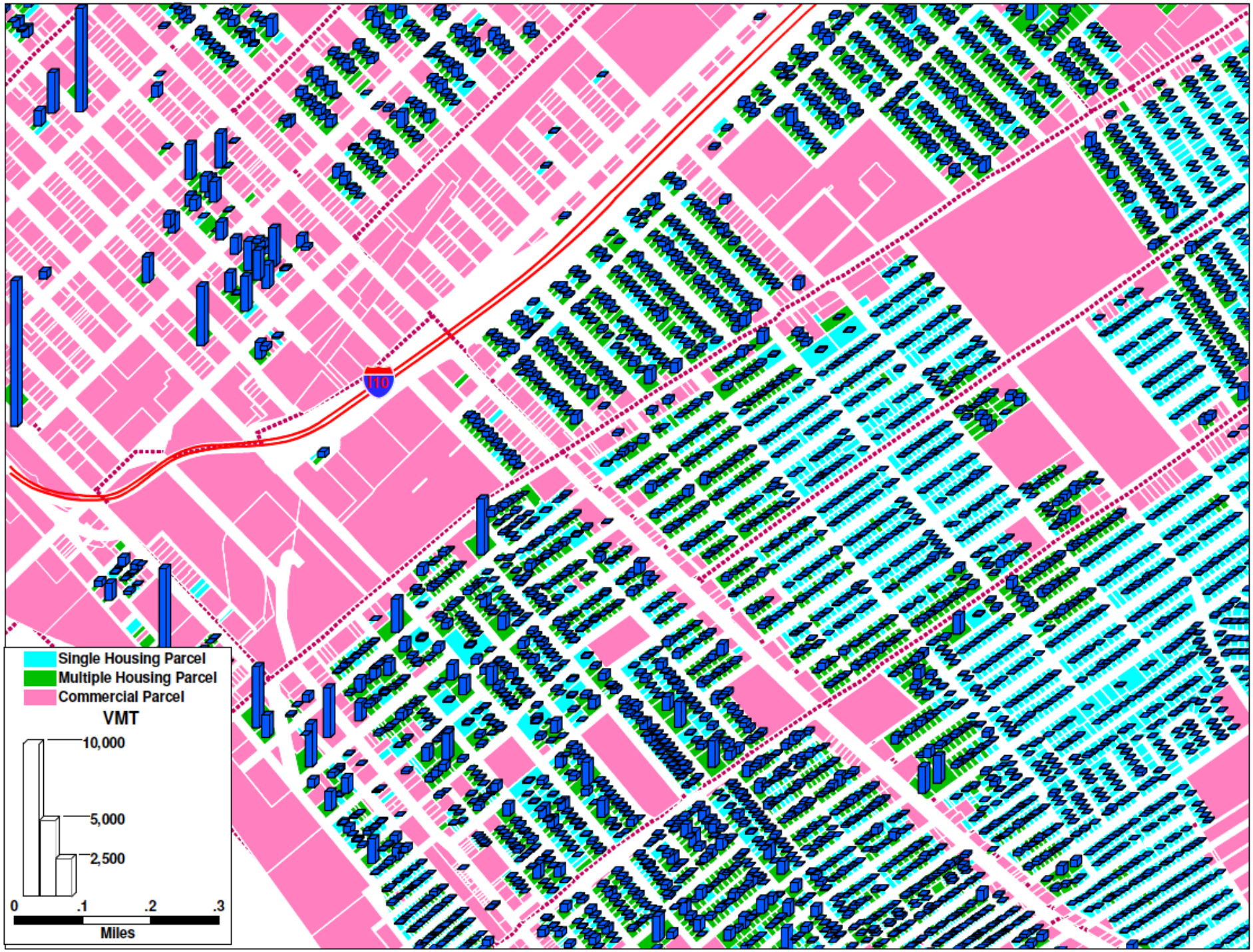
VMT of households in parcels of land

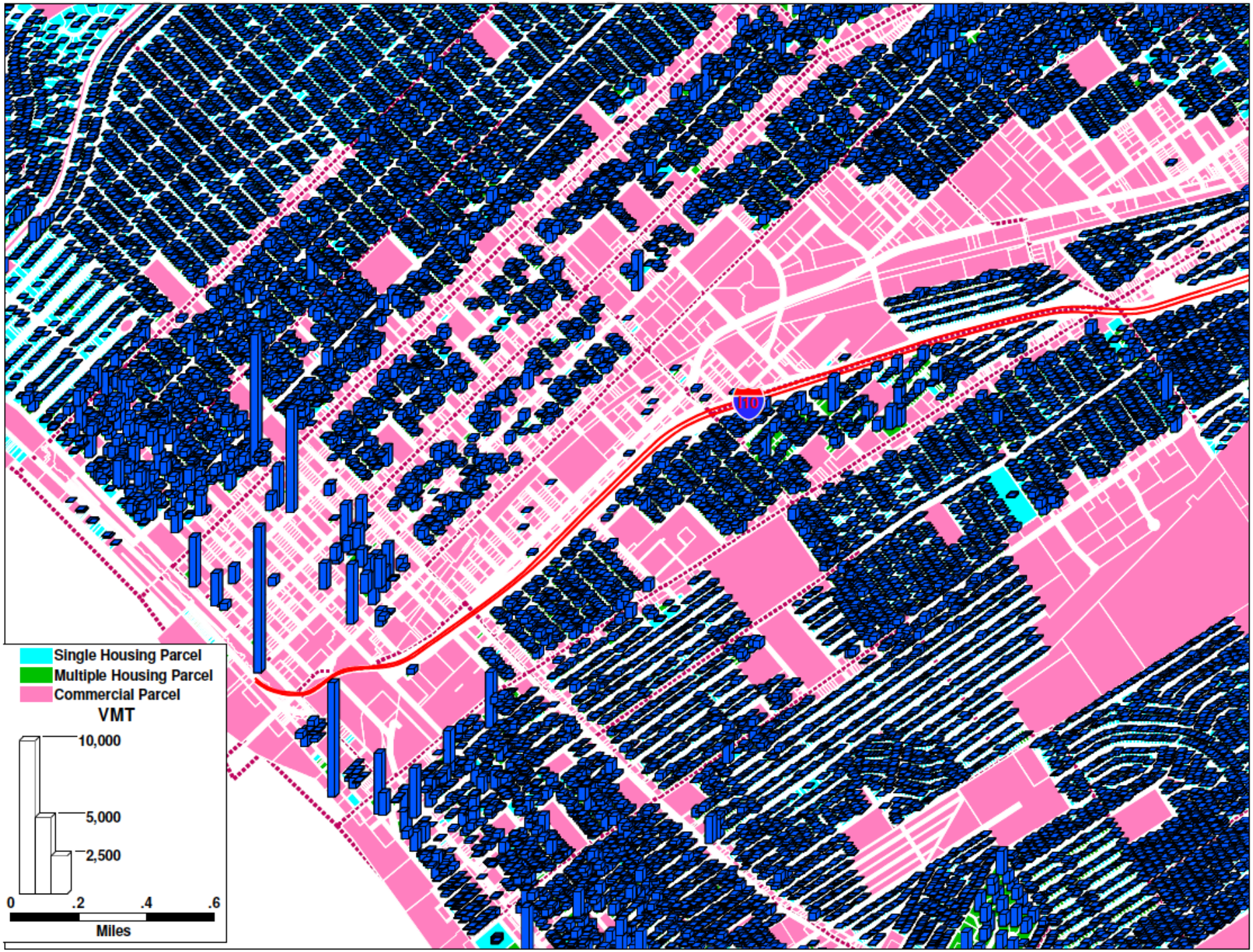
VMT=vehicle miles travelled

Easily by time of day and person of household

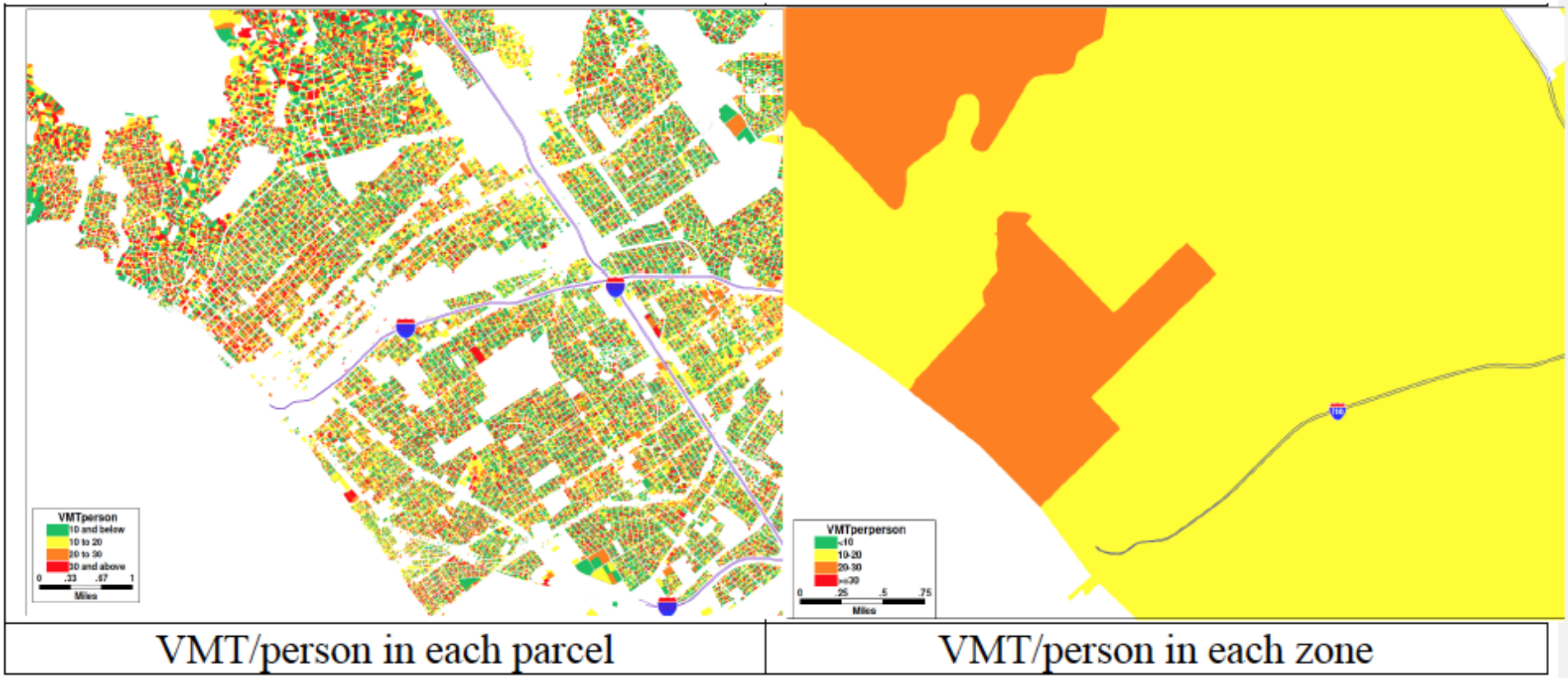

Read parcel and household data for one TAZ
Divide the housing units in the TAZ into two groups
1. single family housing unit
2. multiple dwelling
Calculate the utility for each household and housing unit pair
single family housing unit
For j = 1 to total number of single family housing units
identify the household i with the highest utility U_{ij} for housing unit j
Yes
If U_{ij} = maximum U_{ij} for household i
No
Assign the household i to housing unit j and delete them from the household and housing unit set
Keep the housing unit in the housing unit set
Matched housing unit and household pairs
Unmatched housing units and households
Repeat the process till all the housing units are assigned with a household


Multiple dwelling unit
For j = 1 to total number of single family housing units
identify the households with the 1-(k-1) highest utility U_j for housing unit j (k units)
Yes
If U_{ij}= maximum U_{ij} for household i
No
Assign the household i to housing unit j and delete them from the household and housing unit set
Keep the housing unit in the housing unit set
Matched housing unit and household pairs
Unmatched housing units and households
Repeat the process till all the housing units are assigned with k households


10
Single Housing Parcel
Multiple Housing Parcel
Commercial Parcel
VMT
10,000
5,000
2,500
0
.1
.2
.3
Miles


110
Single Housing Parcel
Multiple Housing Parcel
Commercial Parcel
VMT
10,000
5,000
2,500
0
.2
.4
.6
Miles


110
Single Housing Parcel
Multiple Housing Parcel
Commercial Parcel
VMT
10,000
5,000
2,500
0
.05
.1
.15
Miles



VMT/person in each parcel | VMT/person in each zone

Illustration of the Modifiable Area Unit Problem

In Closing

- This is still not enough!
- Business Establishments – spatial distribution of opportunities, time of day availability, commodity flows and trucks/commercial vehicles
  - Firmographics to parallel Demographics
- Deliveries to households (UPS/FEDEX, DHL, Postal, Gardeners, Maintenance)
- See recent supply chain simulation models

Some Publications

1. Goulias K.G., C. R.Bhat, R.M. Pendyala, Y. Chen, R. Paleti, K. Konduri, G. Huang, and H. Hu (2012) Simulator of Activities, Greenhouse Emissions, Networks, and Travel (SimAGENT) in Southern California. Paper 12-0845 presented at the January 2012 *91st Annual Meeting of the Transportation Research Board, Washington, D.C.,* January 22-26, 2012.
2. Lei T., Y. Chen, and K. G. Goulias (2012) Opportunity-Based Dynamic Transit Accessibility in Southern California: Measurement, Findings, and Comparison with Automobile Accessibility. Paper 12-3813 presented at the January 2012 *91st Annual Meeting of the Transportation Research Board, Washington, D.C.,* January 22-26, 2012. (in press)
3. Bhat C. R., K.G. Goulias, R.M. Pendyala, R. Paleti, R. Sidhartan, L. Schmitt, and H. Hu (2012) A Household-Level Activity Pattern Generation Model: Simulator of Activities, Greenhouse Emissions, Networks, and Travel (SimAGENT) System in Southern California. Paper 12-4226 presented at the *91st Annual Meeting of the Transportation Research Board, Washington, D.C.,* January 22-26, 2012.
4. Vyas G., R. Paleti, C.R. Bhat, K.G. Goulias, R. M. Pendyala, H. Hu, T. J. Adler, A. Bahreinian (2012) A Joint Vehicle Holdings (Type and Vintage) and Primary Driver Assignment Model with an Application for California. Paper 12-3701 presented at the *91st Annual Meeting of the Transportation Research Board, Washington, D.C.,* January 22-26, 2012. (in press)
5. Seraj S., R. Sifhartan, C.R. Bhat, R.M. Pendyala, and K.G. Goulias (2012) Parental Attitudes Toward Children Walking and Bicycling to School: Multivariate Ordered Response Analysis. Paper 12-3675 presented at the *91st Annual Meeting of the Transportation Research Board, Washington, D.C.,* January 22-26, 2012. (in press)
6. Pendyala R.M., C.R. Bhat, K.G. Goulias, R. Paleti, K.C. Konduri, E. Sidhartan, H. Hu, G. Huang, and K. P. Christian (2012) The Application of Socioeconomic Model System for Activity-Based Modeling: Experience from Southern California Paper 12-2186 presented at the *91st Annual Meeting of the Transportation Research Board, Washington, D.C.,* January 22-26, 2012.
7. Goulias K.G., C. R. Bhat, R. M. Pendyala, Y. Chen, R. Paleti, K. C. Konduri, G. Huang, and H. Hu (2011) Simulator of Activities, Greenhouse Emissions, Networks, and Travel (SimAGENT) in Southern California: Design, Implementation, Preliminary Findings, and Integration Plans. Paper in proceedings of the Institute of Electrical and Electronics Engineers (IEEE) Forum on Integrated and Sustainable Transportation System, Vienna, Austria, June 29 to July 1, 2011, pp. 164-169.
8. Goulias K.G., R.M. Pendyala, and C.R. Bhat (2011) Total Design Data Needs for the New Generation Large Scale Activity Microsimulation Models. Keynote paper presented at the plenary of the 9th International Conference on Travel Survey Methods, Chile, Nov. 14-18, 2011
9. Chen, Y., S. Ravulaparthy, K. Deutsch, P. Dalal, S.Y. Yoon, T. Lei, K.G. Goulias, R.M. Pendyala, C.R. Bhat, and H-H. Hu (2011) Development of Indicators of Opportunity-based Accessibility. *Transportation Research Record: Journal of the Transportation Research Board, No. 2255,* Transportation Research Board of the National Academies, Washington D.C., 2011, *pp.58-68.*
10. Paleti, R., N. Eluru, C.R. Bhat, R.M. Pendyala, T.J. Adler, and K.G. Goulias (2011) The Design of a Comprehensive Microsimulator of Household Vehicle Fleet Composition, Utilization, and Evolution. *Transportation Research Record: Journal of the Transportation Research Board, No. 2254,* Transportation Research Board of the National Academies, Washington D.C., 2011, *pp.44-57.*
11. Sidharthan, R., C.R. Bhat, R.M. Pendyala, and K.G. Goulias (2011) Model of Children's School Travel Mode Choice Behavior Accounting for Effects of Spatial and Social Interaction. *Transportation Research Record: Journal of the Transportation Research Board, No. 2213,* Transportation Research Board of the National Academies, Washington D.C., 2011, *pp.78-86.*

Reports (http://www.scag.ca.gov/modeling/)

- Goulias, K.G., C. R. Bhat, R. M. Pendyala, Y. Chen, R. Paleti, K. Konduri, S. Y. Yoon, and D. Tang (2012). Simulator of Activities, Greenhouse Emissions, Networks, and Travel (SimAGENT) in Southern California. SimAGENT Overview. Phase 2 Final Report 1 Submitted to SCAG, March 31, 2012, Santa Barbara, CA.

- Goulias, K.G., C. R. Bhat, R.M. Pendyala, Y. Chen, T. Lei, S. Ravulaparthy, K. Deutsch, P. Dalal, and S. Y. Yoon (2012). Opportunity-Based Dynamic Accessibility Indicators in SimAGENT Phase 2 Final Report 2 Submitted to SCAG, March 31, 2012, Santa Barbara, CA.

- Pendyala, R.M. , C. R. Bhat, K. G. Goulias, R. Paleti, K. Konduri, R. Sidharthan , and K. P. Christian. (2012) SimAGENT Population Synthesis. Phase 2 Final Report 3 Submitted to SCAG, March 31, 2012, Santa Barbara, CA.

- Bhat, C. R., R. Paleti, R. M. Pendyala, and K. G. Goulias.(2012) SimAGENT Activity-Based Travel Demand Analysis: Framework, Behavioral Models, and Application Results. SimAGENT Core Models. Phase 2 Final Report 4 Submitted to SCAG, March 31, 2012, Santa Barbara, CA.

- Goulias, K. G., N. A. Isbell, D. Tang, M. Balmer, Y. Chen, C. R. Bhat, and R. M. Pendyala (2012) TRANSIMS and MATSIM Experiments in SimAGENT. Phase 2 Final Report 5 Submitted to SCAG, March 31, 2012, Santa Barbara, CA.

Thank you!

Domo Arigatou Gozaimasu
どうも 有難う 御座います

Data Needs

- Core Behavior and Household Characteristics
  - Other aspects – policy dependent (cars and costs, long term choices and lifestyle, attitudes)
- Other agents (firms, institutions, plans, and so forth)
- Landscape/Environment/Context
  - Activity locations
  - Homes/Jobs/Schools
  - Availability over time

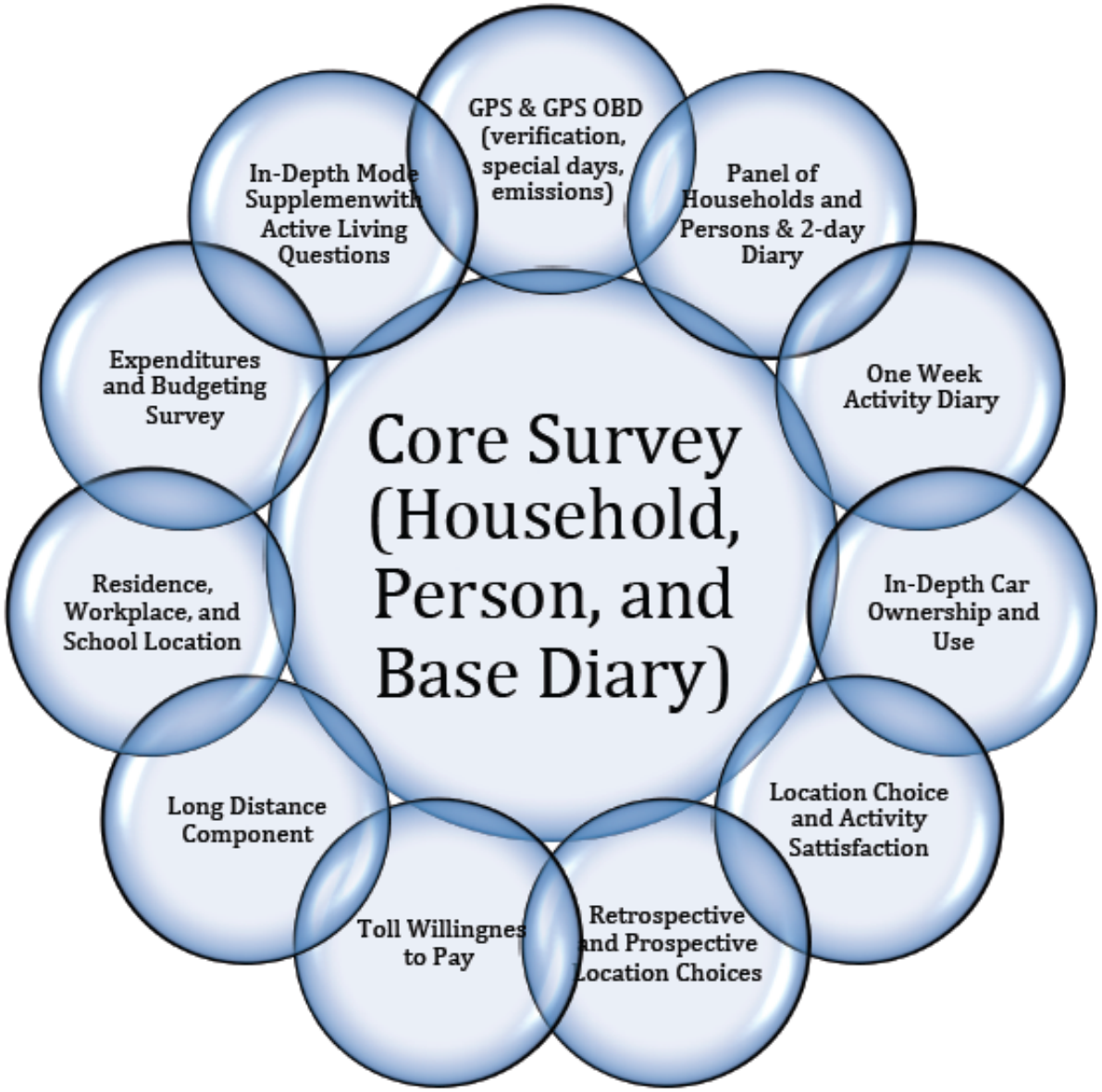


Figure 4 The Data Collection Overall Scheme

One Week Activity and Travel Diary

- Account for day-to-day variation in activity scheduling and travel and attempt to
- Identify shifting of tasks and activities from one day of the week to the next.
- Design to capture the behavioral processes of scheduling activities, and planning and subsequent re-scheduling modifications (see the Toronto tradition).
-

Toll Willingness to Pay

- Attitudes and willingness to pay for tolls on highways
- Develop behavioral equations of the willingness to pay
- Large scale regional simulation models to develop pricing strategies

(Bhat and Castellar, 2002; Bhat and Sardesai, 2006).

GPS and GPS OBD

- Develop a database to correlate destinations to routes and identify a typology of different types of routes and stop making patterns;
- Develop a route choice model;
- Estimate the level and nature of misreported trips by different modes of the main two-day activity diary;
- Verify day-to-day behavioral change in other survey components and day of the week effects; and
- Provide detailed operating characteristics of the household vehicles.
- NOTE: This component for persons carrying GPS devices (wearable GPS) can also be supplemented with an online diary and vehicle-mounted GPS (week long to capture day to day variation) and
- On-Board Diagnostics devices (to identify driving patterns and correlate/link them with emissions models).

Mode Supplement

- Reasons for not using specific modes, including non-motorized modes for active living studies.
- The survey objective is to identify situational constraints, attitudes, and predispositions in favor or against modes such as walk, bike and public transportation.
- Create models to study policy actions that go beyond the time-cost-comfort analysis.
- Add a stated choice, intentions, and preference component to this module.
- Emphasis on collecting data about walking and biking either as a main mode for each trip or as an access mode to another main mode (e.g., walking from a parking lot to an office, biking to a bus stop and then taking the bus).

Residence, Workplace, and School Location Choice:

- Critical survey component for behaviorally integrated land use travel demand models!
- In-depth survey to identify the determinants for each of the residential, workplace, and school choices (see Kortum et al., 2012).
- Both primary locations and secondary locations should be examined in more detail than typical household surveys and data collected to estimate choice models for each facet.
- Examine behavior retrospectively and prospectively.
- Possibly add questions about personal biography of each household member using techniques that are not used by typical household surveys (e.g., ethnography).

In Depth Car Ownership Change and Car Assignment

- Identify the determinants for each of the car ownership, car type (e.g., new/used, model, make, and fuel type), and car assignment decisions.
- In the car assignment data collection, both the primary and secondary drivers should be identified.
- Identify determinants of changes in car ownership, type, and assignment of cars to household members.
- Particular emphasis should be given to policy controlled determinants (e.g., taxation, incentives). One approach to study this latter part is using combinations of revealed and stated preference surveys.

Activity Satisfaction Survey

- Provide a benchmark for the diary instrument; and
- Create an assessment of activities (including trips) and subjective experiences that is able to capture preferences, satisfaction, and perceived quality of life.
- This second set of objectives will enable estimation of choice models with latent variables and classes that are by far richer and more informative than their counterpart observed variable discrete choice models (see the “happiness literature”).

Destinations & Perceptions

- We know that places have symbolic and other meanings that travel behavior models neglect.
- This component identifies how destinations are perceived and what role these perceptions play in their selection.
- Major aspects = mental maps and sense of place

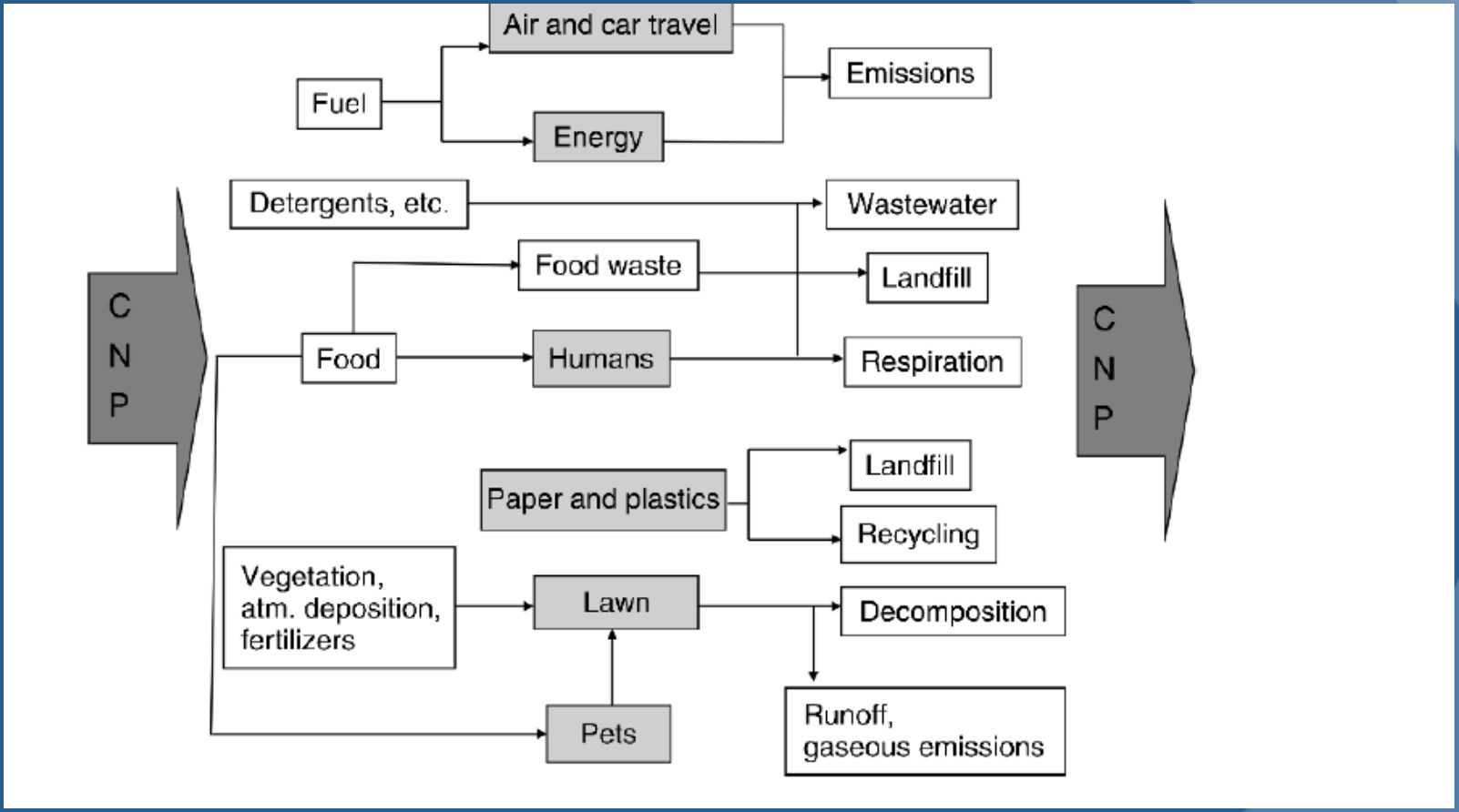
Panel of Households and Persons and Multi-Day Activity

- Undecided: would like a Mobidrive (6 weeks)
- Would also like year to year evolutionary measurement
- Most likely a rotating panel of longer than one week duration

Energy Use and Expenditures

- Link housing to transportation demand.
- Develop more complete household Greenhouse footprints
- Develop models of comprehensive accounting of energy demand.
  - Annual, monthly, or even weekly expenditures for activity participation, travel, and vehicles and housing units maintenance ownership and energy consumption are not collected in typical travel surveys.
  - This component will provide the data needed to enable a direct association between travel and at home energy consumption to eventually create models of the type in Fissore et al. (2011).

Carbon, Nitrogen, Phosphorous by Households/Housing Unit

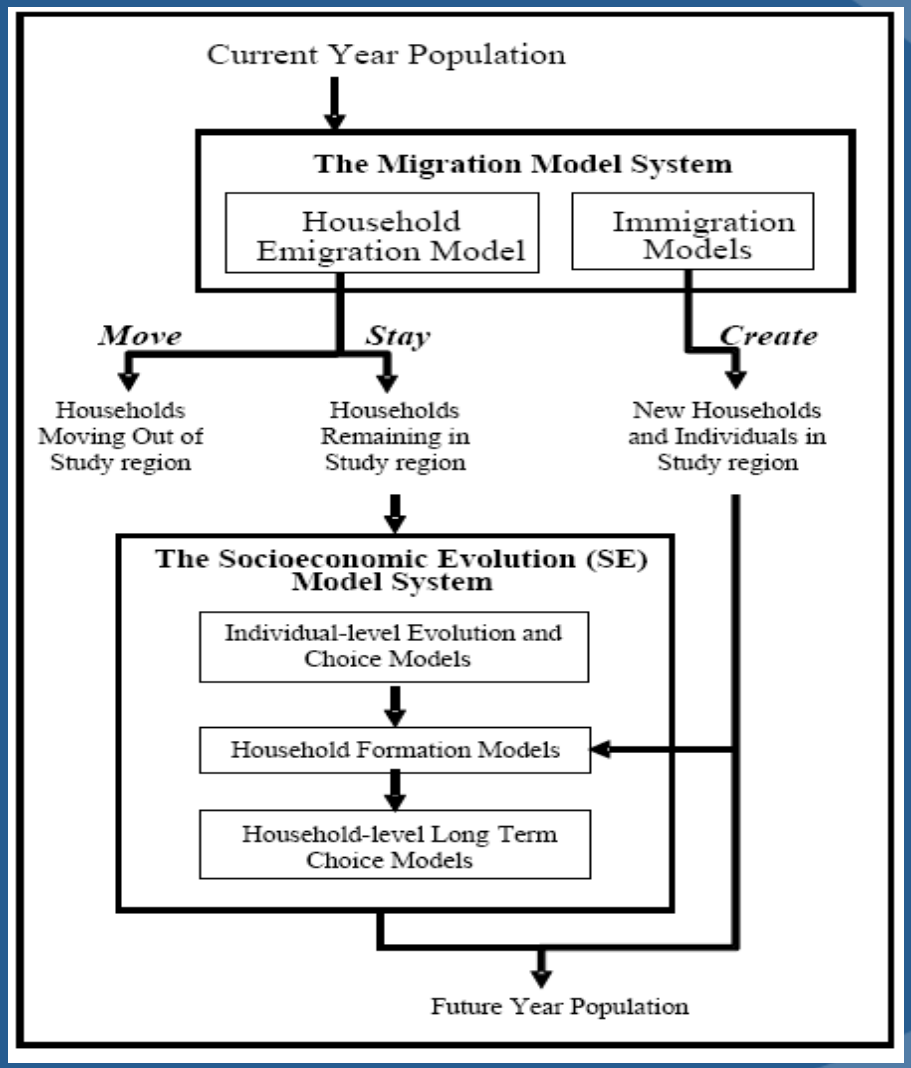


Long Distance Travel

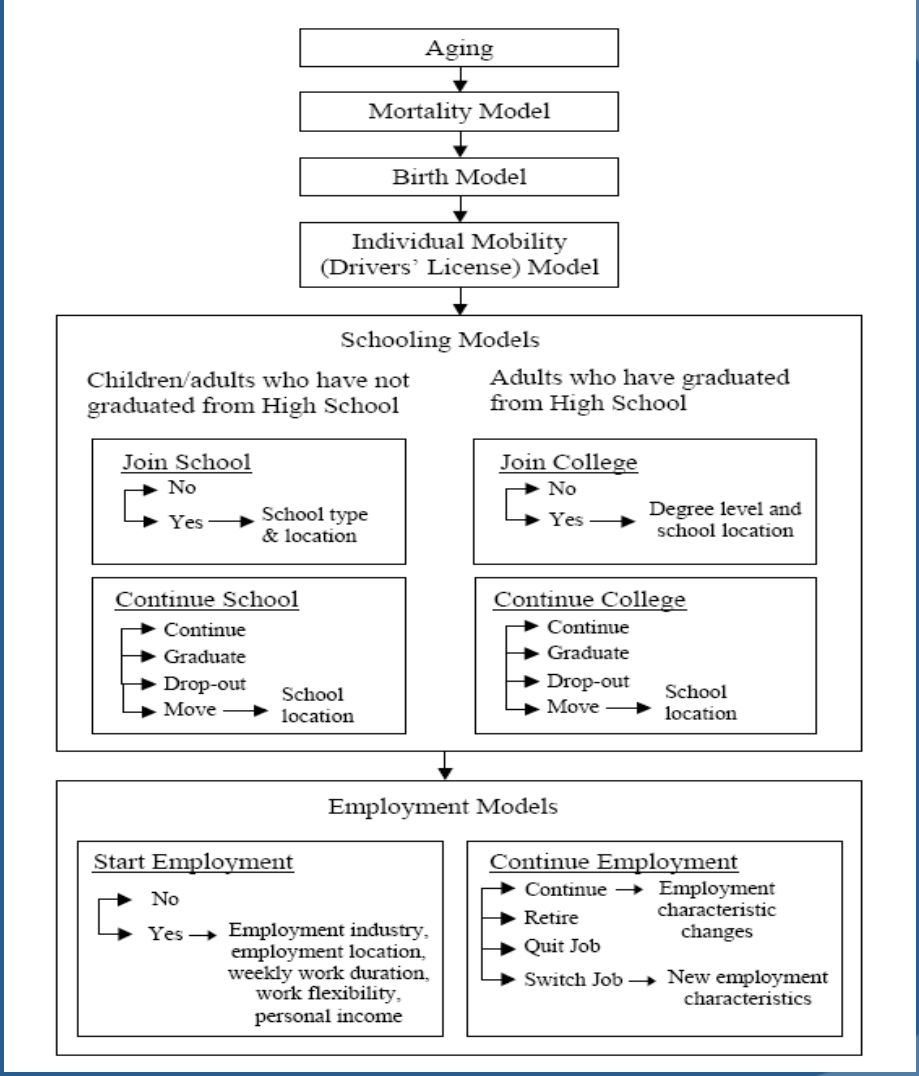
- Travel models in Mega regions and statewide applications also need models that are able to capture what is called interregional travel and long-distance travel.
- Many of the trips in this class are business related, leisure related, or simply long commutes.
- Maybe also study trade-offs people make when they engage in travel that, for example, requires an overnight stay outside the home base.

CEMSELTS EVOLUTION

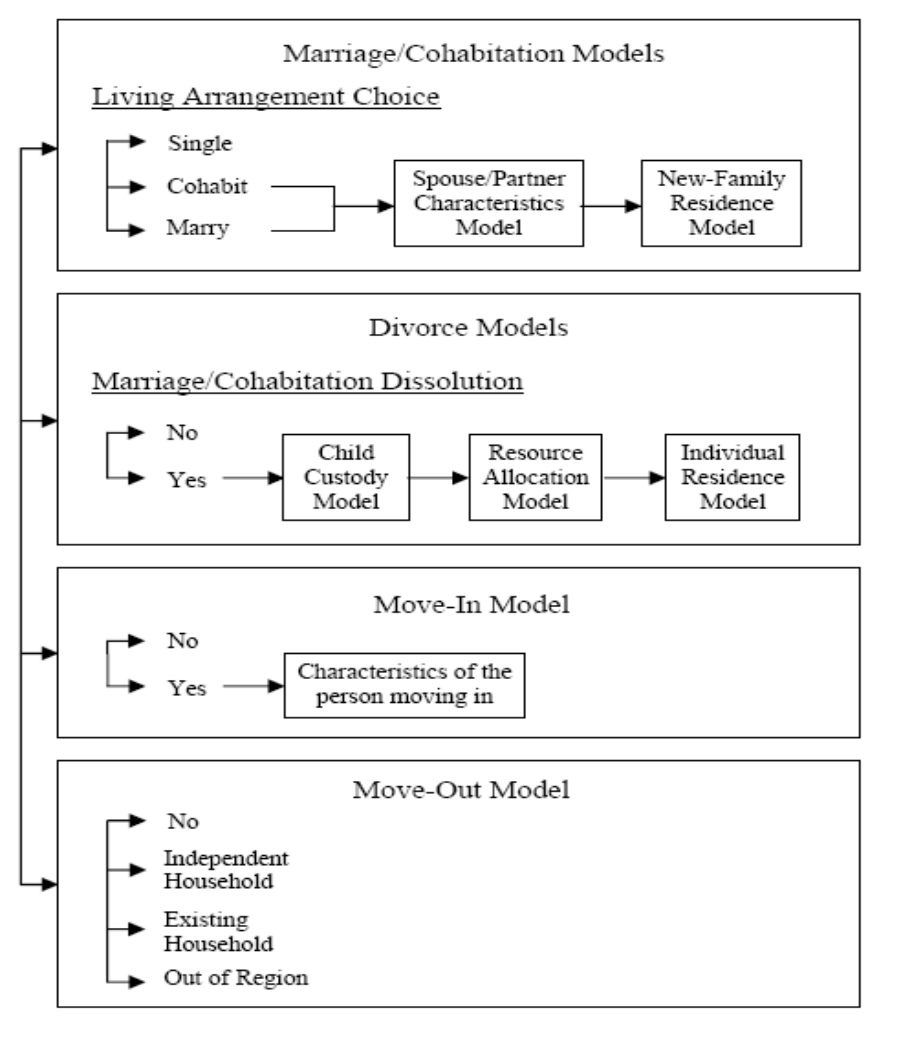
Overview of Evolution Framework



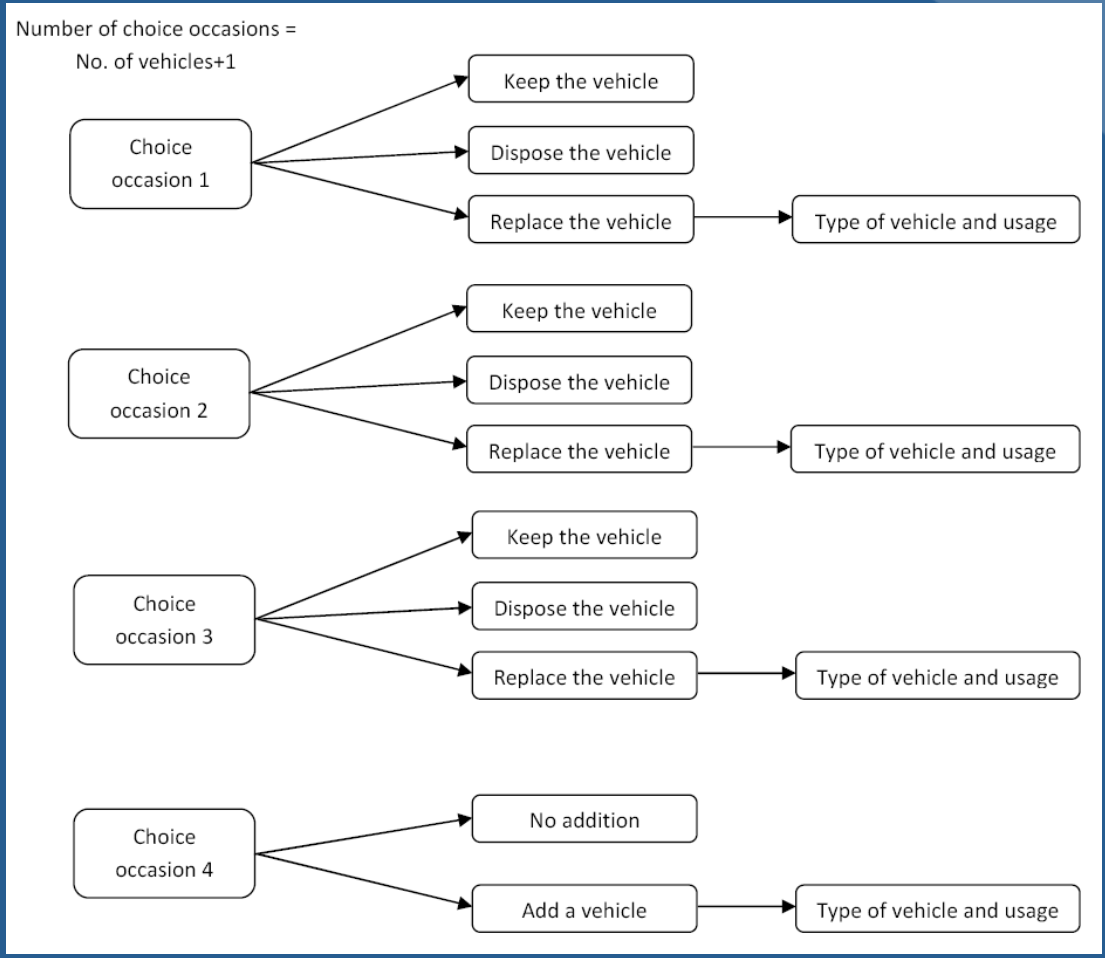
Individual Level Evolution Models



Household Formation Models



Vehicle Evolution Framework



CEMSELTS Evolution Module: *Individual Models*

Sl. Num.	Model Description	Model Type	Current Data Source	Comment
Individual Models: Demographics & Mobility				
1	Mortality Model	Binary Logit	California Department of Public Health	
2	Birth Model	Binary Logit	California Department of Public Health	
3	Base Year License Model	Binary Logit	FHWA	
4	Obtain License Model	Binary Logit	Highway Statistics 2010 FHWA (California)	
5	Maintain License Model	Binary Logit	*Rule Based*	
Individual Models: Schooling Models				
6	School location model	Multinomial Logit	SCAG Survey 2003	
7	College location model	Multinomial Logit	SCAG Survey 2003	
8	Base Year Dropout Rate Model	Binary Logit	SCAG Survey 2003	
9	Base Year Education Attainment Model	Multinomial Logit	SCAG Survey 2003	
Individual Models: Employment Models				
10	Labor Participation Model	Binary Logit	SCAG Survey 2003	
11	Start Employment Model	Binary Logit	SCAG Survey 2003	
12	Employment Industry Model	Multinomial Logit	SCAG Survey 2003	
13	Work Flexibility Model	Ordered Probit	SCAG Survey 2003	
14	Work Duration Model	Multinomial Logit	SCAG Survey 2003	
15	Continue Employment Model	Multinomial Logit	Bureau of Labor Statistics 2012	Currently a very simple constants only model is used. It is preferable to have a more comprehensive model based on survey data.
16	Household Income Model	Ordered Probit	SCAG Survey 2003	
17	Work location model	Multinomial Logit	SCAG Survey 2003	

CEMSELTS Evolution Module: *Household Formation Models*

Sl. Num.	Model Description	Model Type	Current Data Source	Comment
18	Marriage Model	Binary Logit	National Survey of Family Growth - CDC (2006-2010)	
19	Divorce Model	Binary Logit	National Survey of Family Growth - CDC (2006-2010)	
20	Child Custody Model		*No Data*	Need data to estimate model
21	Resource allocation Model		*No Data*	Need data to estimate model
22	Move In Model	Binary Logit	*No Data*	Need data to estimate model - ignoring the move-in process can potentially lead to over-estimation of single person households.
23	Husbands Age Model	Multinomial Logit	National Survey of Family Growth - CDC (2006-2010)	
24	Move In Age Model	Multinomial Logit	*No Data*	Same as Move-in model
25	Move out Model	Multinomial Logit	Pew Research Center 2011	Currently a very simple constants only model is used. It is preferable to have a more comprehensive model based on survey data.
26	Move In Gender Model	Binary Logit	*No Data*	Same as Move-in model
27	Husbands Race Model	Multinomial Logit	National Survey of Family Growth - CDC (2006-2010)	
28	Husbands Educ Attainment Model	Multinomial Logit	National Survey of Family Growth - CDC (2006-2010)	

CEMSELTS Evolution Module: *Household-level long term choice models*

29	Residential Mobility Model	Binary Logit	Rate based model (using data from London, UK)	We need data specific to LA (or California)
30	Residential Tenure Model	Binary Logit	SCAG Survey 2003	
31	Housing Type for Owners Model	Multinomial Logit	SCAG Survey 2003	
32	Housing Type for Renters Model	Multinomial Logit	SCAG Survey 2003	
33	Vehicle Type Choice and Vehicle Transaction Models	MDCEV, Binary logit models	CEC Data	
34	Residential location model	Multinomial Logit	SCAG Survey 2003	
35	Emigration Model	Binary Logit	US Census Bureau 2009	We currently have a simple rate based model to predict net immigration rate (Immigration rate-Emigration rate). It is preferable to have a more comprehensive model based on household demographics for both emigration and immigration.
36	Immigration Model for non-single households	Binary Logit	US Census Bureau 2009	
37	Immigration Model for single households	Binary Logit	US Census Bureau 2009	