2012 Model Update and Validation for 2016 RTP/SCS

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SOUTHERN CALIFORNIA ASSOCIATION of GOVERNMENTS
50 YEARS

Presentation Outline

Overview of SCAG's Modeling Program

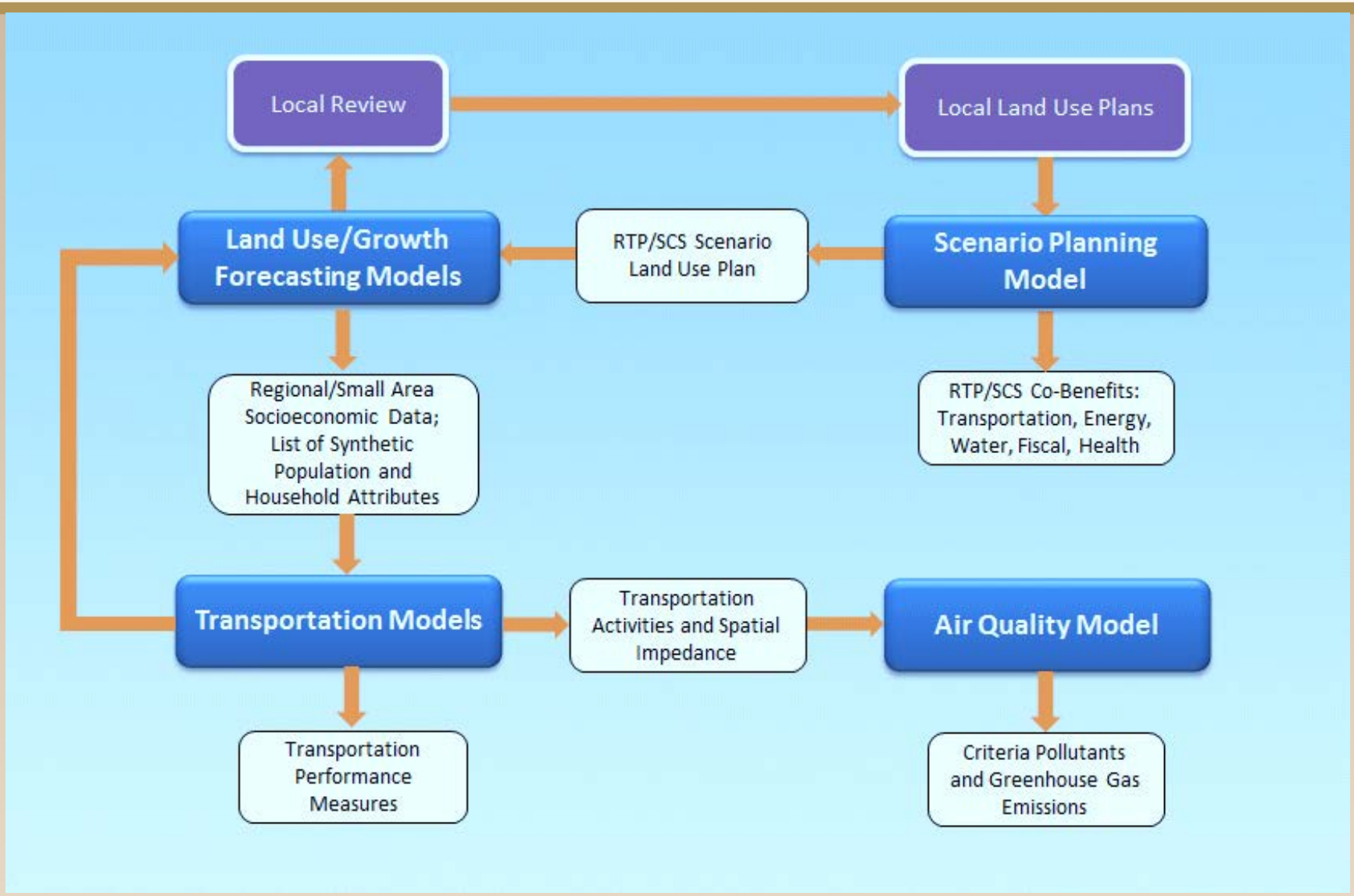
Review of Model Components

2012 Model Update and Validation

2012 Model Update and Validation for 2016 RTP/SCS

Overview of SCAG's Modeling Program

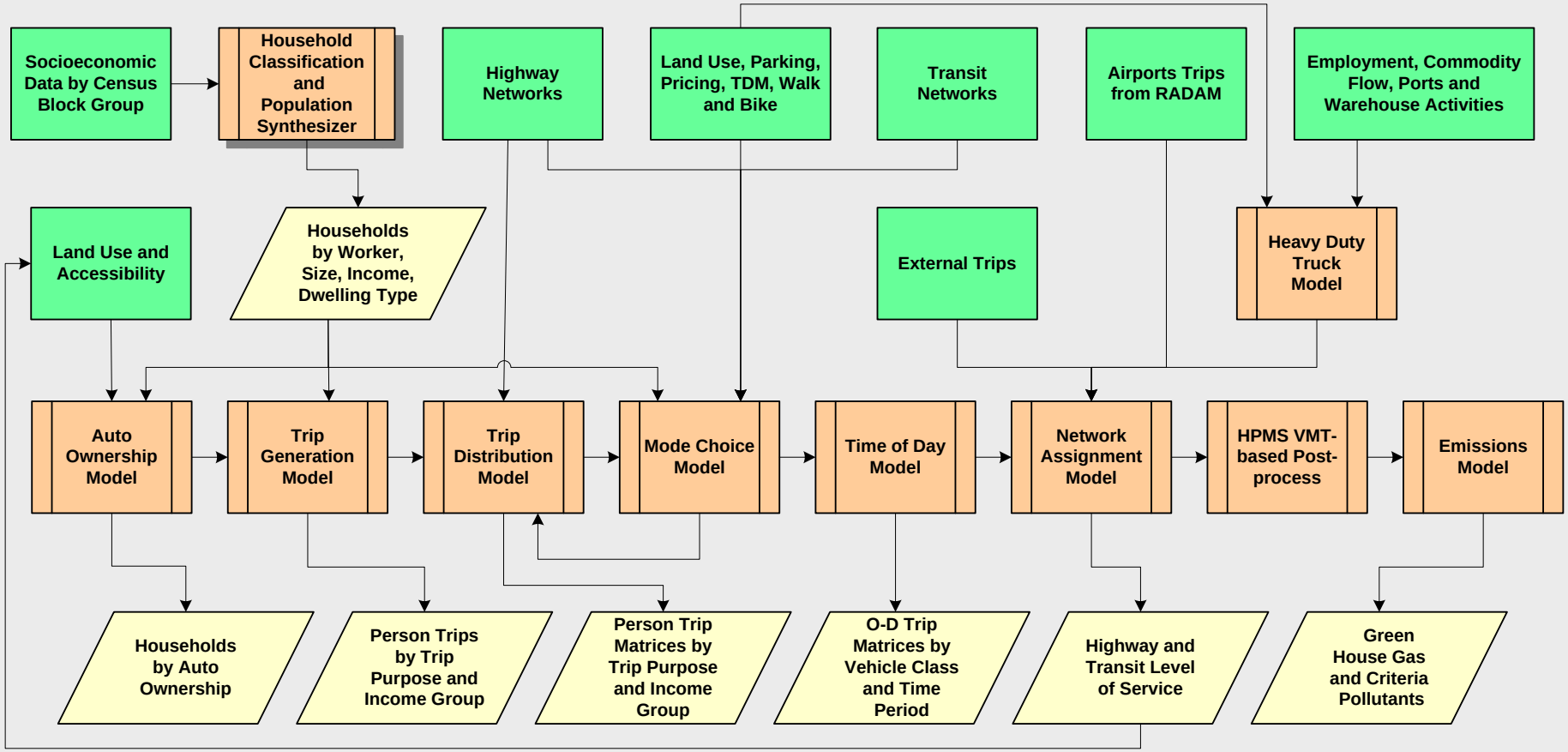
SCAG's Integrated Modeling & Forecasting Framework



2012 Model Update and Validation for 2016 RTP/SCS

Review of Model Components

SCAG Trip-based Regional Travel Demand Modeling Process

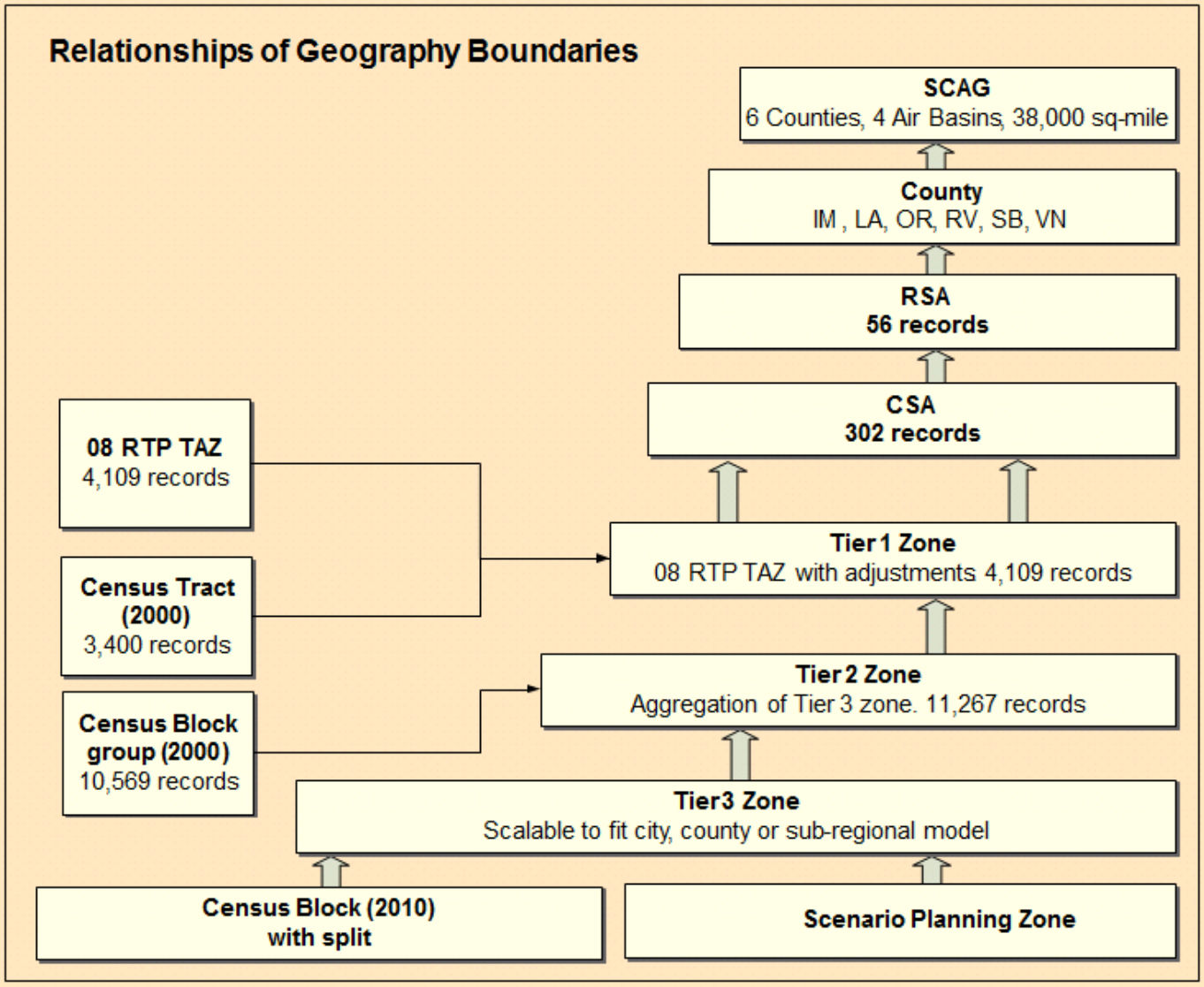


Legend

Input Module Output

Note:
Population Synthesizer (shadowed) is a new component.
All the model modules and input data are updated for 2008 model validation and 2012 RTP analysis.

Tiered Zone System - Structure



Auto Availability Model

Multinomial logit model

Explanatory variables:

- ✓ Household size – 1, 2, 3, 4 or more persons
- ✓ Household income – <35K, 35-75k, 75-150K, 150K+
- ✓ Number of workers in household – 0, 1, 2, 3 or more workers
- ✓ Type of housing unit (single family detached, other)
- ✓ Transit accessibility to employment

$$TrLogsum_p = Ln\left(\sum_q \exp\left(-0.025 * (TransitTime_{pq} - AutoTime_{pq}) + \ln(Emp_q)\right)\right)$$

Where: $TransitTime_{pq}$ is total transit time including a weight of 2 on all out-of-vehicle time components

Auto Availability Model (continued)

- ✓ Mix household, employment and intersection density

Ln {[Int*(Emp*a) * (HH*b)] /[Int + (Emp*a) + (HH*b)]},

Int= Number of local intersections in 1/2 mile of centroid
Emp= Employment within 1/2 mile of centroid
HH= Households within 1/2 mile of centroid
a= average Int / average Emp
b= average Int / average HH

- ✓ Non-motorized accessibility to employment - Number of jobs within a 10 minute walk.

Low accessibility (<= 500 jobs)
Medium accessibility (500 to 1,000 jobs)
High accessibility (1,000 to 5,000 jobs)
Very high accessibility (> 5,000 jobs)

Auto Availability Estimation Results

	Auto Availibility Choice			
	1 car	2 car	3 car	4 car
	coeff	coeff	coeff	coeff
Constant	2.529	2.333	2.442	2.569
Household income				
Low	-0.465	-1.604	-2.396	-3.032
Medium	1.067	0.766	0.402	0.109
High	1.765	2.126	1.971	1.929
Household size				
2 Person HH	0.126	1.253	0.177	-0.520
3 Person HH	0.081	1.294	1.836	0.947
4 + Person HH	0.112	1.633	2.092	2.306
Workers in HH				
1 Worker HH	1.014	1.497	0.935	0.200
2 Worker HH	0.852	2.902	2.628	2.109
3+ Worker HH	0.889	2.081	3.249	4.617
Multi-family housing	-0.608	-1.516	-2.147	-2.575
Mix eml,hhld. And Int Density	-0.119	-0.141	-0.170	-0.192
Non-motorized accessibility				
Low <500 jobs				
Medium:500-1000 jobs	-0.002	-0.158	-0.161	-0.260
High: 1000-5000 jobs	-0.007	-0.205	-0.328	-0.528
Vhigh: >5000 jobs	-0.368	-0.458	-0.587	-0.787
Transit Accessibility LogSum				
Low: <=10	0.000	0.000	0.000	0.000
Medium: 10-12				
High:12-14	-0.404	-0.662	-0.871	-0.959
Very high:>14	-1.478	-2.490	-2.490	-2.490

Trip Generation Model

- ✓ Enhanced population synthesizer (PopSyn) for detailed joint household distributions
- ✓ HBW by “Direct” and “Strategic” trips
- ✓ Separated by Peak and Off-Peak
- ✓ Trip productions grouped by household income / car sufficiency for downstream models:
  - Zero cars, all income
  - Car competition, all income
  - Car sufficient, low income
  - Car sufficient, medium income
  - Car sufficient, high income

Trip Generation Model – Auto Sufficiency

Trip Market Strata

HBW

- Zero car households, all incomes
- Households with fewer cars than workers, all incomes
- Equal or more cars than workers, low income
- Equal or more cars than workers, medium income
- Equal or more cars than workers, high income

HBNW

- Zero car households, all incomes
- 1 car, 2+ person households, all income
- 1 car, 1 person households or 2+ car household , and low income
- 1 car, 1 person households or 2+ car household , and medium income
- 1 car, 1 person households or 2+ car household , and high income

Trip Distribution Model

- ✓ Gravity models for HBSC and HBCU
- ✓ Destination choice models for all other purposes

$$U_{ijm} = \theta \times L_{ijm} + \sum_k \beta^k D_{ij}^k + \sum_k \delta_m^k N_m^k D_{ij}^k + \sum_k \gamma_m^k M_i^k IZ_j + Ln(A_{jm}) + C_{jm}$$

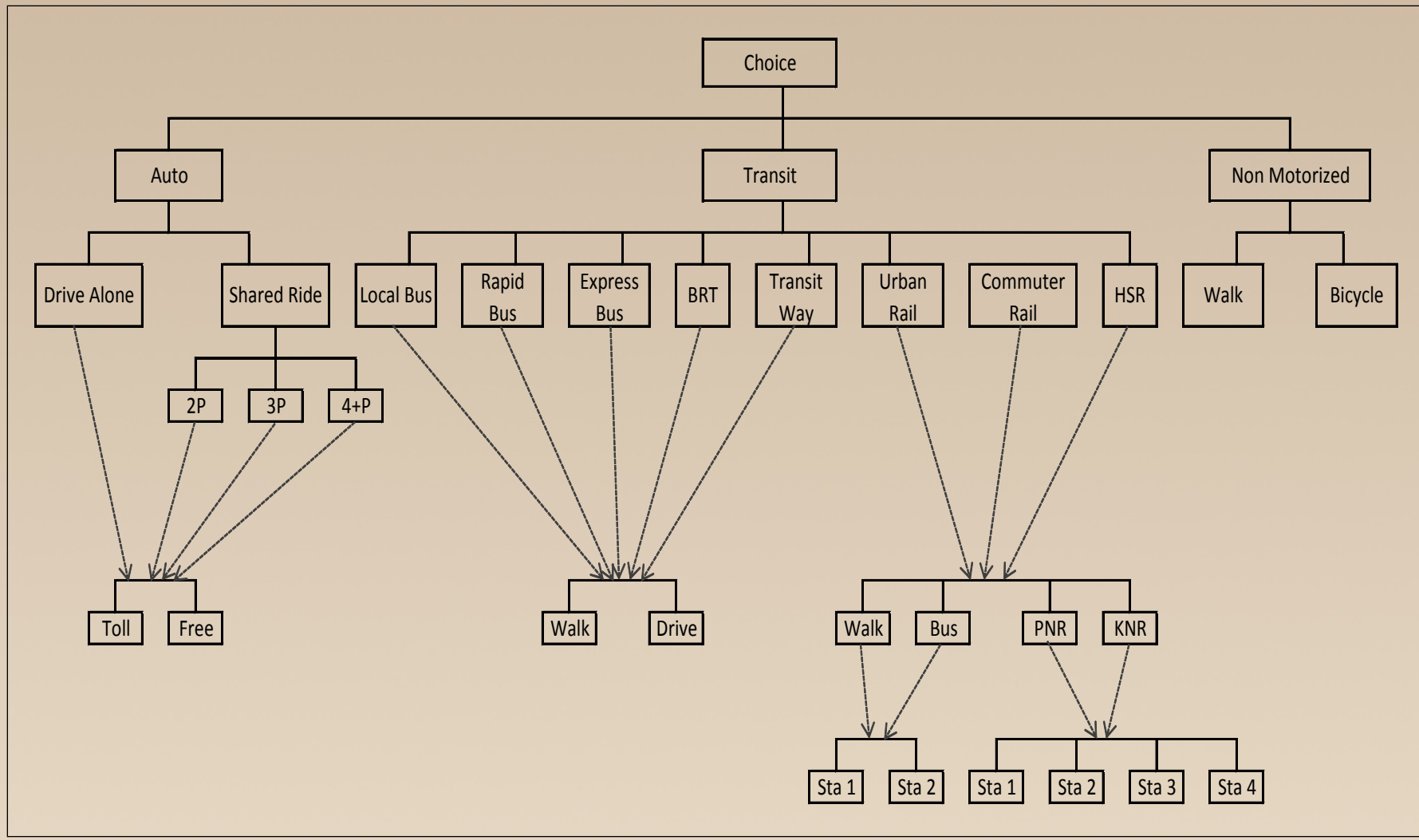
LS = mode choice logsum; D = distance polynomial;
IZ = zonal characteristics; A = size term (attraction).

- ✓ HBW & HBNW stratified by household income /car sufficiency

HBW Destination Choice Estimation Results

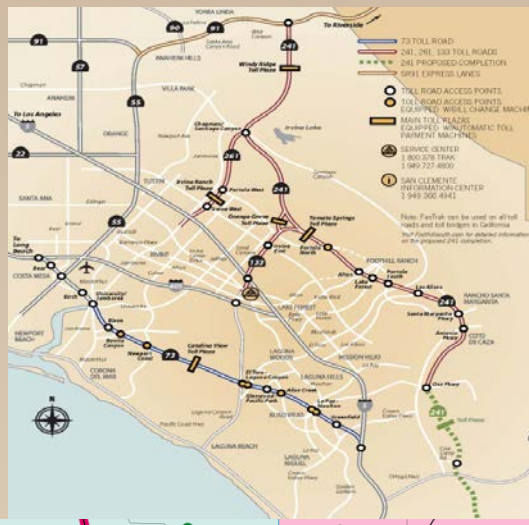
Explanatory Variable	HBWD		HBWS	
	Coefficient	t-Stat	Coefficient	t-Stat
Mode Choice Logsum	0.9	n/a	0.9	n/a
Distance	-0.106965313	-42.29	-0.093875	-19.03
Distance Squared	0.001408705	19.33	0.0014159	8.41
Distance Cubed	-0.00000643	-11.84	-0.0000100	-6.51
Intra-Zonal Indicator	1.007	12.124	-0.052	-0.271
Observations	323340	--	65780	--
Final Log-Likelihood	-56666	--	-24144.2252	--
Rho-Squared (Zero)	0.0986	--	0.0758	--
Rho-Squared (Constants)	0.0956	--	0.0736	--

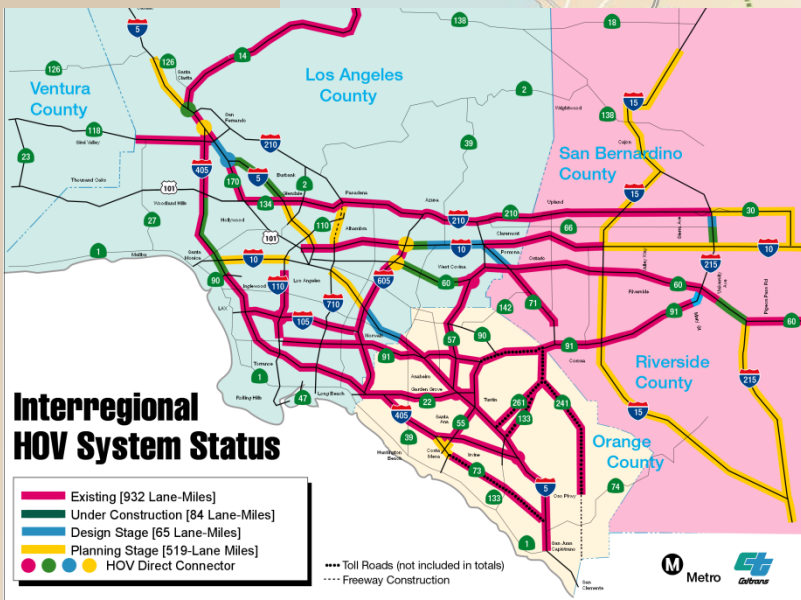
Mode Choice Model - Nest Structure



Mode Choice Model – Highway Choices

- ✓ Over 11,000 lane miles of limited access roadways
- ✓ 900+ lane miles of HOV (2 & 3+ roadways
- ✓ 2 dynamically-priced HOT lanes facilities in 2013
- ✓ Several toll roads





Mode Choice Model – Transit Options

- ✓ Over 70 different transit carriers
- ✓ Wide variety of transit technologies & operations
- ✓ Characterized by trip purpose, trip distance and type of traveler
  - Short distance local & rapid bus, mostly low income
  - Medium distance urban rail (expanding) and various types of express bus service, including transit-way buses & BRT
  - Long distance commuter rail, mostly high income, competing with express buses on some markets

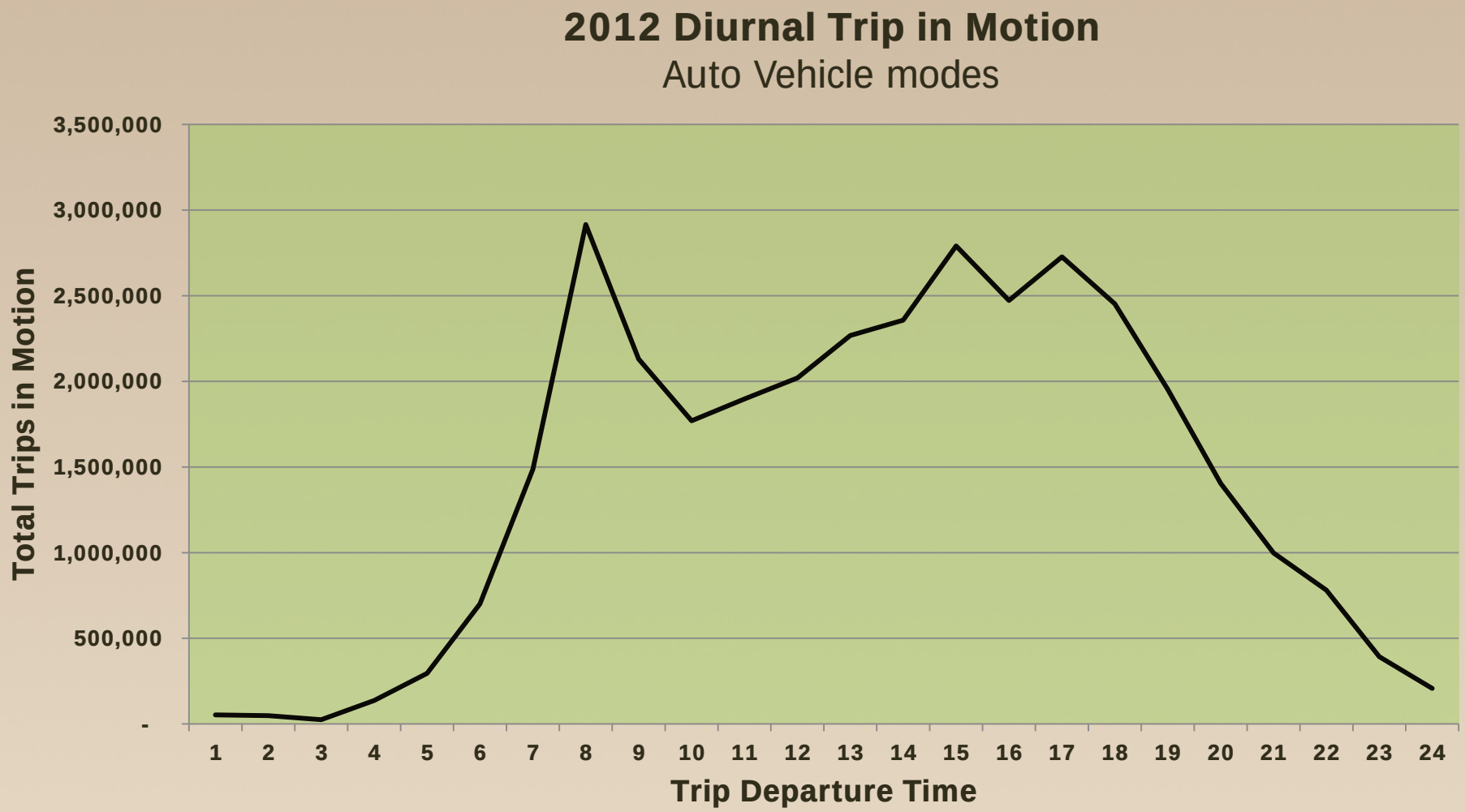
Mode Choice Model – Rail Station Choice

- ✓ 4 sets of paths created to support station choice
  - Zone to station – bus & walk access allowed, no rail
  - Zone to station – only walk allowed, no rail
  - Station to zone – bus & walk access allowed, no rail
  - Station to station – only rail allowed
- ✓ Best paths determined by the mode choice model by minimizing the entire utility of all station-to-station combinations for a given OD

Heavy Duty Truck Model

- ✓HDT trip markets
  - Internal HDT Trips
  - Internal/External & Thru Trips
  - Port Truck Trips
  - Intermodal Terminal Truck Trips
- ✓Weight Classes
  - Light Heavy (8,500 to 14,000 lbs. GVW)
  - Medium Heavy (14,001 to 33,000 lbs. GVW)
  - Heavy Heavy (>33,000 lbs. GVW)

Time of Day Segmentation



Highway Assignment

- ✓ Static biconjugate user equilibrium
- ✓ Generalized cost (time, operation cost, toll/user fee)
- ✓ VOTs stratified by vehicle class and time period
- ✓ Vehicle classes:
  - Drive alone
  - Shared Ride 2: GP lane vs HOV 2+ lane
  - Shared Ride 3+: GP lane vs HOV 3+ lane
  - Heavy Duty Trucks – Light, Medium, Heavy
- ✓ Modified BPR volume-delay functions
- ✓ Built-in HOV and Toll Diversion models

Highway Assignment - HDT

- ✓ Passenger Car Equivalents
  - Function of link length, grade and truck volume
- ✓ Grade and truck link length calculation
  - Point elevation data obtained by polling the USGS website
  - Run grade calculator (custom utility) to compute grade & length

Model Convergence

Travel time feedback to trip generation

- Up to 5 feedback loops performed
- MSA applied to average volumes over loops (1/2 step size)
- User has the option of additional loops to tighten convergence
- Congested times calculated using the averaged volumes
- Peak travel times is based on combined AM & PM peak time

2012 Model Update and Validation

Motivation and Considerations

- ✓ Develop a base year model for the analysis of 2016 Regional Transportation Plan and Sustainable Communities Strategy (RTP/SCS), including conformity analysis and other related programs.

- ✓ Fully utilize the latest available information, especially the data from the statewide household travel survey (CHTS), the 2010 Census and the latest American Community Survey (ACS)

- ✓ Continue with the model framework and setup used for the 2012 RTP/SCS which was peer reviewed in June, 2011

Data Acquisition

- ✓ 2012 CHTS and SCAG Add-on Travel Surveys
- ✓ Highway Network
  - Updates to the 2012 base year network will be carried over to future year networks.
- ✓ Transit Network
  - 2012 TripMaster database for use as the basis for the 2012 base year transit network developed from 2012 TripMaster database.
- ✓ Transit Level of Service Data
  - 2012 Transit LOS data from transit agencies.
- ✓ Year 2012 Screenline Count Database
  - 640 traffic counts on the arterials and 33 video traffic counts on freeways.
- ✓ HPMS Data for estimating regional and sub-air basin VMT
- ✓ HERE / Google data for real-time network speed verification
- ✓ Airsage Data for alternative source of regional travel patterns

CHTS and SCAG Household Travel Surveys

Sample Type	NuStats	SRBI	Total
All Households	24,486	10,563	35,049
Complete households	15,716	3,848	19564
Partially complete households	45	479	524
Only recruit data	8,725	6,236	14,961
Complete and partially complete households	15,716	4,327	20,043
Weekday	67%	71%	68%
Weekend	33%	29%	32%

Population Synthesis

A. Household variables

- Number of household members (continuous)
- Annual household income (continuous)
- Tenure Structure (1=owner, 2= renter)
- Dwelling unit type ((1=SFD, 2=SFA, 3=MF and 4=Other)
- Record type (1=residential, 2=Institutional GQ, 3=Non institutional GQ)

B. Person variables*

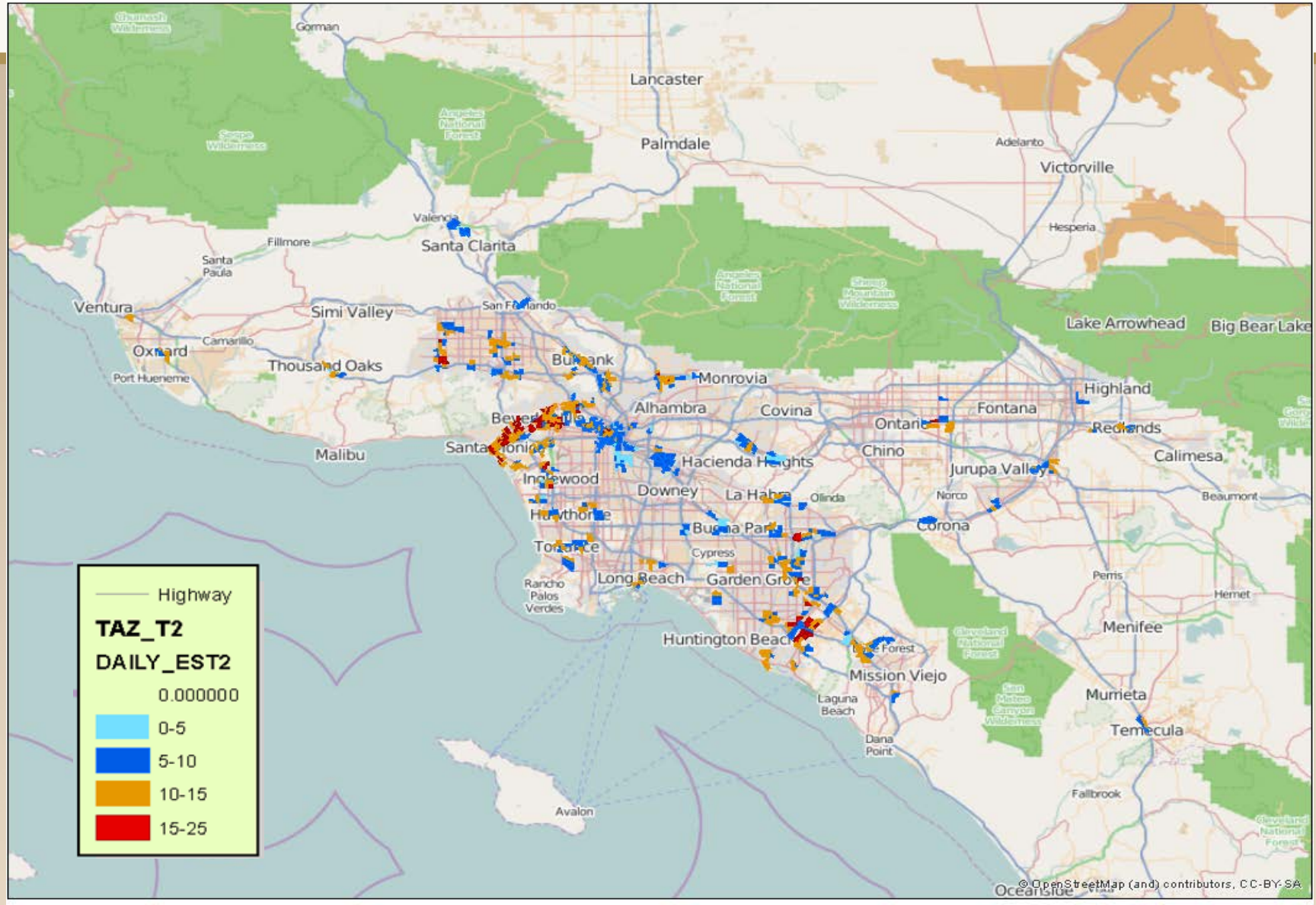
- Age of a person (continuous)
- Gender of a person (1=Male, 2=Female)
- Race/ethnicity of a person (1=HP,2=NHW,3=NHB, 4=NHAI , 5=NHAS and 6=NHO)
- Worker status (1=Employed, 2=Unemployed)
- Worker's industry sector (20 categories)
- Worker's occupation type (24 types)
- Grade of student (1="Nursery school/preschool"; 2="Kindergarten"; 3="Grade 1 to grade 4"; 4="Grade 5 to grade 8"; 5="Grade 9 to grade 12"; 6="College undergraduate"; 7="Graduate or professional school")
- Education Attainment (1="Less than high school"; 2="High school diploma";3="Associate/2-year College degree"; 4="Bachelor degree"; 5="Master's degree +")

* Any person level attribute can be aggregated at household level. For instance: *Number of employed persons in the household*

Model Update

- ✓ Model Data for Auto and Truck Operating Cost and Auto Parking Cost
  - All cost-related variables and parameters updated from 1999$ to 2011$
- ✓ Model Components Updated to 2012 Observed Data
  - Warehouse truck trips
  - Auto ownership and trip rates
  - Trip distribution and mode shares
  - HOV, HOT, and tolls
- ✓ Model Operation
  - Model source code optimization to streamline model flow and reduce runtime

Estimated Parking Costs (Daily Rate)

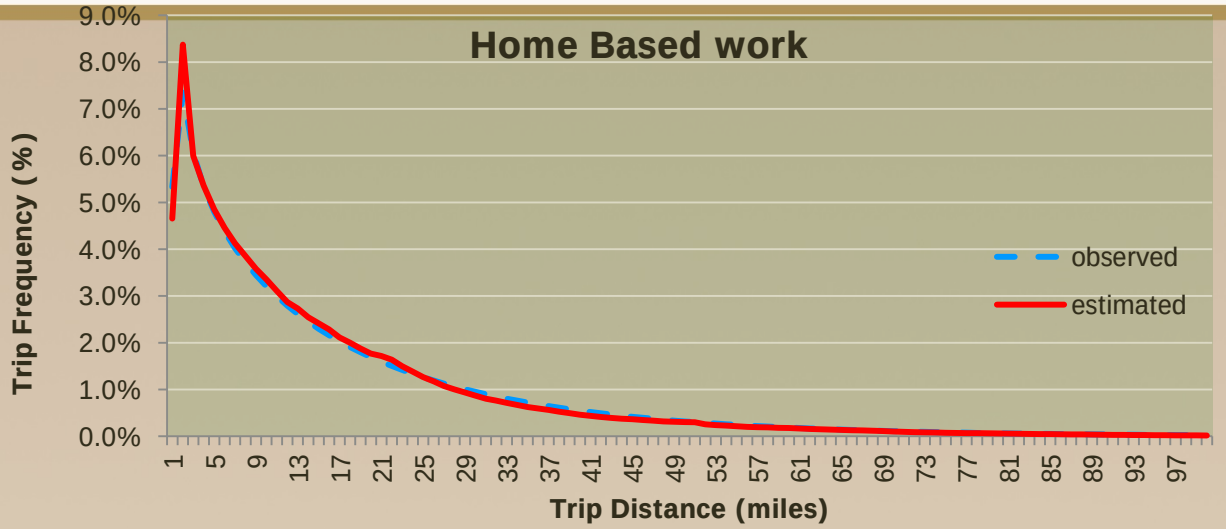


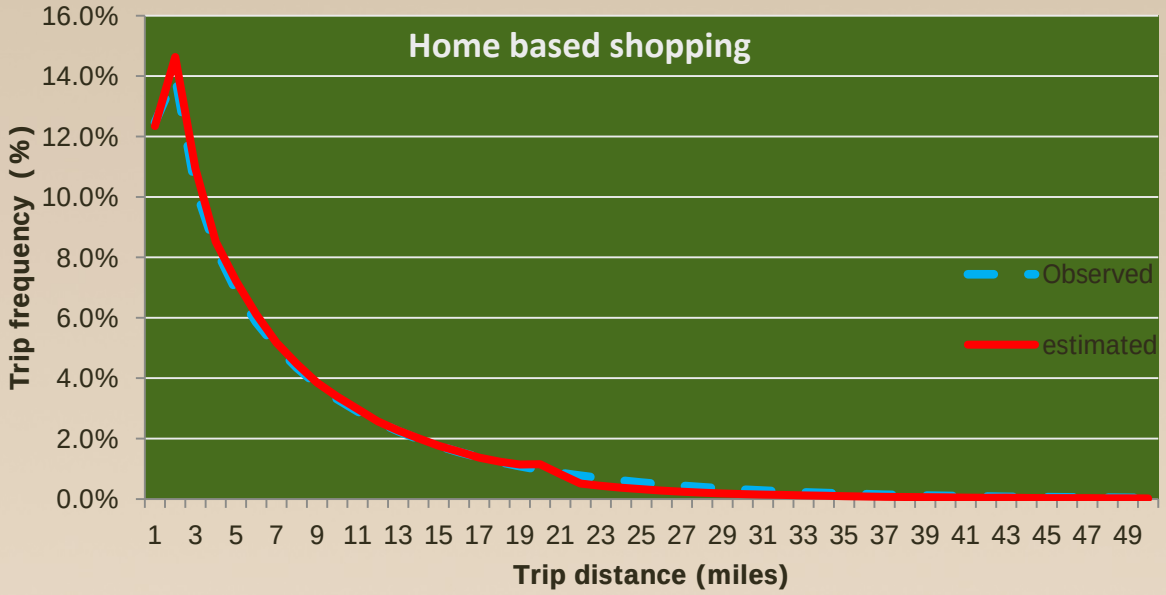
Trip Productions Validation

Trip Purpose	2012 Household Survey	2012 Model Estimate	% Difference
HBWD	8,960,693	9,220,900	3%
HBWS	1,884,606	1,939,400	3%
HBSc	4,718,142	4,581,800	-3%
HBU	699,938	672,600	-4%
HBSh	4,897,836	4,803,000	-2%
HBSR	7,409,153	7,380,500	0%
HBO	10,575,864	10,456,900	-1%
HBSP	6,433,085	6,541,400	2%
OBO	14,579,200	14,565,800	0%
WBO	3,372,527	3,221,700	-4%
Total	**63,531,045**	**63,384,000**	**0%**

Trip Distribution Calibration

Trip Purpose	Coincidence Ratio
HBW	0.88
HBSH	0.90
HBSR	0.88
HBSP	0.83
HBO	0.82
HBSC	0.76
WBO	0.90
OBO	0.92
All Purposes	**0.89**





Trip Distribution Validation – Worker Flow

Worker Flows (ACS 2006-2010)								
		25	37	59	65	71	111	SCAG
25	Imperial	51,070	123	58	1,235	100	10	52,596
37	Los Angeles	197	4,049,070	180,799	15,160	57,039	36,538	4,338,803
59	Orange	25	178,031	1,178,730	15,171	12,110	534	1,384,601
65	Riverside	654	50,875	66,986	585,391	89,406	578	793,890
71	San Bernardino	100	126,465	34,918	64,978	569,504	831	796,796
111	Ventura	25	66,683	1,174	237	439	294,158	362,716
	SCAG	**52,071**	**4,471,247**	**1,462,665**	**682,172**	**728,598**	**332,649**	**7,729,402**

Forecast Difference (%), Trips vs. Worker Flow, County Normalized								
		25	37	59	65	71	111	SCAG
25	Imperial	-1.3%	0.2%	0.2%	0.8%	0.2%	0.0%	0.0%
37	Los Angeles	0.0%	-4.4%	3.5%	0.1%	0.4%	0.4%	0.0%
59	Orange	0.0%	6.4%	-7.6%	0.4%	0.9%	0.0%	0.0%
65	Riverside	0.1%	4.4%	5.4%	-13.7%	3.9%	0.0%	0.0%
71	San Bernardino	0.0%	5.7%	5.1%	2.3%	-13.2%	0.1%	0.0%
111	Ventura	0.0%	11.7%	0.4%	0.0%	0.1%	-12.2%	0.0%
	SCAG	**0.0%**	**-0.3%**	**1.7%**	**-0.7%**	**-0.5%**	**-0.3%**	**0.0%**

HBW Mode Share Comparison

HBW Peak Estimated Mode Shares							
Household Segment	Drive Alone	Shared Ride 2	Shared Ride 3	Shared Ride 4+	Transit	Non-Motorized	Total
No Cars	1.6%	18.0%	9.5%	6.6%	47.0%	17.3%	100%
Car Competition	41.5%	20.2%	8.3%	4.7%	12.5%	12.8%	100%
Income 0-35K	54.6%	8.9%	6.0%	5.8%	18.6%	6.1%	100%
Income 35-75K	81.2%	6.9%	3.4%	2.3%	1.9%	4.3%	100%
Income over 75K	92.1%	3.9%	0.9%	0.3%	0.6%	2.3%	100%
Total	77.0%	7.4%	3.2%	2.1%	5.6%	4.8%	100%

HBW Peak Target Mode Shares							
Household Segment	Drive Alone	Shared Ride 2	Shared Ride 3	Shared Ride 4+	Transit	Non-Motorized	Total
No Cars	4.9%	14.8%	8.7%	5.7%	51.4%	14.5%	100%
Car Competition	41.3%	18.3%	8.5%	4.5%	19.5%	7.9%	100%
Income 0-35K	64.1%	7.8%	4.0%	2.4%	18.0%	3.8%	100%
Income 35-75K	82.9%	6.9%	3.5%	1.7%	2.3%	2.7%	100%
Income over 75K	91.2%	3.7%	1.8%	0.7%	1.2%	1.3%	100%
Total	**79.2%**	**6.7%**	**3.3%**	**1.6%**	**6.3%**	**2.9%**	**100%**

Mode Choice Model Validation

HBW Off-Peak Estimated Mode Shares							
Household Segment	Drive Alone	Shared Ride 2	Shared Ride 3	Shared Ride 4+	Transit	Non-Motorized	Total
No Cars	1.8%	11.3%	10.0%	5.9%	52.5%	18.4%	100%
Car Competition	41.9%	20.4%	8.5%	5.0%	12.4%	11.8%	100%
Income 0-35K	55.3%	8.2%	5.1%	4.7%	19.6%	7.0%	100%
Income 35-75K	80.9%	6.8%	3.3%	2.3%	2.6%	4.3%	100%
Income over 75K	92.0%	3.9%	0.9%	0.3%	1.0%	1.9%	100%
Total	**76.9%**	**7.1%**	**3.1%**	**2.0%**	**6.2%**	**4.7%**	**100%**

HBW Off-Peak Target Mode Shares							
Household Segment	Drive Alone	Shared Ride 2	Shared Ride 3	Shared Ride 4+	Transit	Non-Motorized	Total
No Cars	5.0%	11.6%	9.0%	6.3%	51.5%	16.6%	100%
Car Competition	43.1%	18.8%	9.0%	4.8%	16.3%	8.1%	100%
Income 0-35K	66.2%	8.1%	4.3%	2.6%	14.6%	4.1%	100%
Income 35-75K	82.7%	7.0%	3.7%	1.8%	1.8%	3.0%	100%
Income over 75K	91.1%	3.7%	2.0%	0.8%	0.7%	1.8%	100%
Total	**79.5%**	**6.7%**	**3.5%**	**1.7%**	**5.2%**	**3.3%**	**100%**

Highway Assignment vs HPMS VMT

County		VC SCCAB		SCAB		MDAB		SSAB		Total		County Total
		Auto	Truck	Auto	Truck	Auto	Truck	Auto	Truck	Auto	Truck	
Imperial	Model	-	-	-	-	-	-	4,221	520	4,221	520	4,740
	HPMS							4,466	796	4,466	796	5,261
Los Angeles	Model	-	-	202,103	12,867	7,261	349	-	-	209,364	13,216	222,580
	HPMS			204,952	11,581	8,470	605			213,422	12,186	225,608
Orange	Model	-	-	70,000	3,468	-	-	-	-	70,000	3,468	73,469
	HPMS			73,180	3,366					73,180	3,366	76,546
Riverside	Model	-	-	45,058	2,840	1,404	750	9,504	1,248	55,965	4,838	60,802
	HPMS			41,253	3,496	1,495	632	9,636	1,697	52,383	5,824	58,208
San Bernardino	Model	-	-	35,153	2,416	19,159	3,612	-	-	54,312	6,028	60,340
	HPMS			36,584	3,396	18,424	3,909			55,007	7,306	62,313
Ventura	Model	16,951	1,407	-	-	-	-	-	-	16,951	1,407	18,358
	HPMS	18,719	954							18,719	954	19,673
Total	**Model**	**16,951**	**1,407**	**352,314**	**21,591**	**27,824**	**4,711**	**13,724**	**1,767**	**410,813**	**29,476**	**440,289**
	HPMS	**18,719**	**954**	**355,969**	**21,839**	**28,388**	**5,146**	**14,101**	**2,492**	**417,178**	**30,431**	447,609
	Ratio	**0.906**	**1.475**	**0.990**	**0.989**	**0.980**	**0.915**	**0.973**	**0.709**	**0.985**	**0.969**	**0.984**

Highway Assignment – Screenline by Volume Group

Volume Group By Facility	Daily Vehicle Volumes				Daily Vehicle Volumes				Daily Vehicle Volumes		
	LM				HDT				TOTAL		
	Model	Count	Ratio	RMSE	Model	Count	Ratio	RMSE	Model	Count	Ratio
0 - 4,999	652,864	355,779	1.84	221.21	18,576	35,908	0.52	121.65	673,073	391,687	1.72
5,000 - 24,999	5,839,808	4,880,627	1.20	58.84	224,396	332,581	0.67	99.53	6,085,202	5,213,208	1.17
25,000 - 49,999	4,402,165	4,005,656	1.10	37.83	241,319	339,376	0.71	65.68	4,659,195	4,345,032	1.07
50,000 - 99,999	5,477,728	5,326,238	1.03	20.18	539,628	531,663	1.01	47.70	6,018,988	5,857,901	1.03
100,000 - 199,999	7,032,600	6,654,035	1.06	20.10	622,011	478,906	1.30	56.32	7,655,817	7,132,941	1.07
200,000 or More	186,566	180,946	1.03	3.11	19,140	6,294	3.04	204.10	205,706	187,240	1.10
Total	**23,591,731**	**21,403,281**	**1.10**	**39.91**	**1,665,069**	**1,724,728**	**0.97**	**90.19**	**25,297,980**	**23,128,009**	**1.09**

Transit Assignment Validation

Transit Mode	2012 Estimated Boarding	2012 Actual Boarding	Ratio
Commuter Rail	46,077	44,472	**1.04**
Urban Rail	373,547	356,648	**1.05**
MTA Bus *	1,241,911	1,190,314	**1.04**
Other Transit **	947,390	763,648	**1.24**
Total Boarding	**2,608,925**	**2,355,082**	**1.11**

** MTA Bus: Local bus, Rapid bus, Express bus operated by LACMTA*

*** Other Transit: Local bus, Rapid bus, Express bus operated by other transit carriers in SCAG region*

Thank You!

SOUTHERN CALIFORNIA ASSOCIATION of GOVERNMENTS
50 YEARS