



TMIP Webinar Series



Activity-Based Modeling

Session 3: Technical Issues for Managers

The **Travel** Model
Improvement
Program

Speakers: Joel Freedman & Maren Outwater

March 15, 2012

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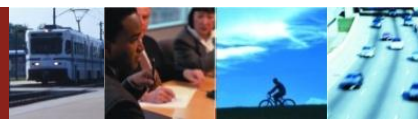
2012 Activity-Based Modeling Webinar Series

Executive and Management Sessions

Executive Perspective	February 2
Institutional Topics for Managers	February 23
Technical Issues for Managers	March 15

Technical Sessions

Activity-Based Model Basics	April 5
Population Synthesis and Household Evolution	April 26
Accessibility and Treatment of Space	May 17
Long-Term and Medium Term Mobility Models	June 7
Activity Pattern Generation	June 28
Scheduling and Time of Day Choice	July 19
Tour and Trip Mode, Intermediate Stop Location	August 9
Network Integration	August 30
Forecasting, Performance Measures and Software	September 20



Session 1: Executive Perspective

- What an activity-based model is and how it may be used in planning and policy analysis
- Practical advantages of activity-based models
- Examples of activity-based models used for policy analysis
- Resource considerations and lessons learned



Session 2: Institutional Topics for Managers

- Typical motivations and concerns of agencies considering an activity-based model
- Familiarity with the evolution of activity-based models in the U.S.
- Development options for migrating from 4-step to activity-based models
- Resources needed to implement an activity-based model program
- Experience with stakeholder acceptance and use



Session 3: Learning Outcomes

By the end of this session, you will be able to

- Discuss the processes used to develop, calibrate, validate, and implement an activity-based model
- Discuss the criteria that agencies should consider when evaluating whether an activity-based model may be right for them
- Discuss high-level model design decisions that will need to be made when embarking on activity-based model project, as well as alternative transitional development paths

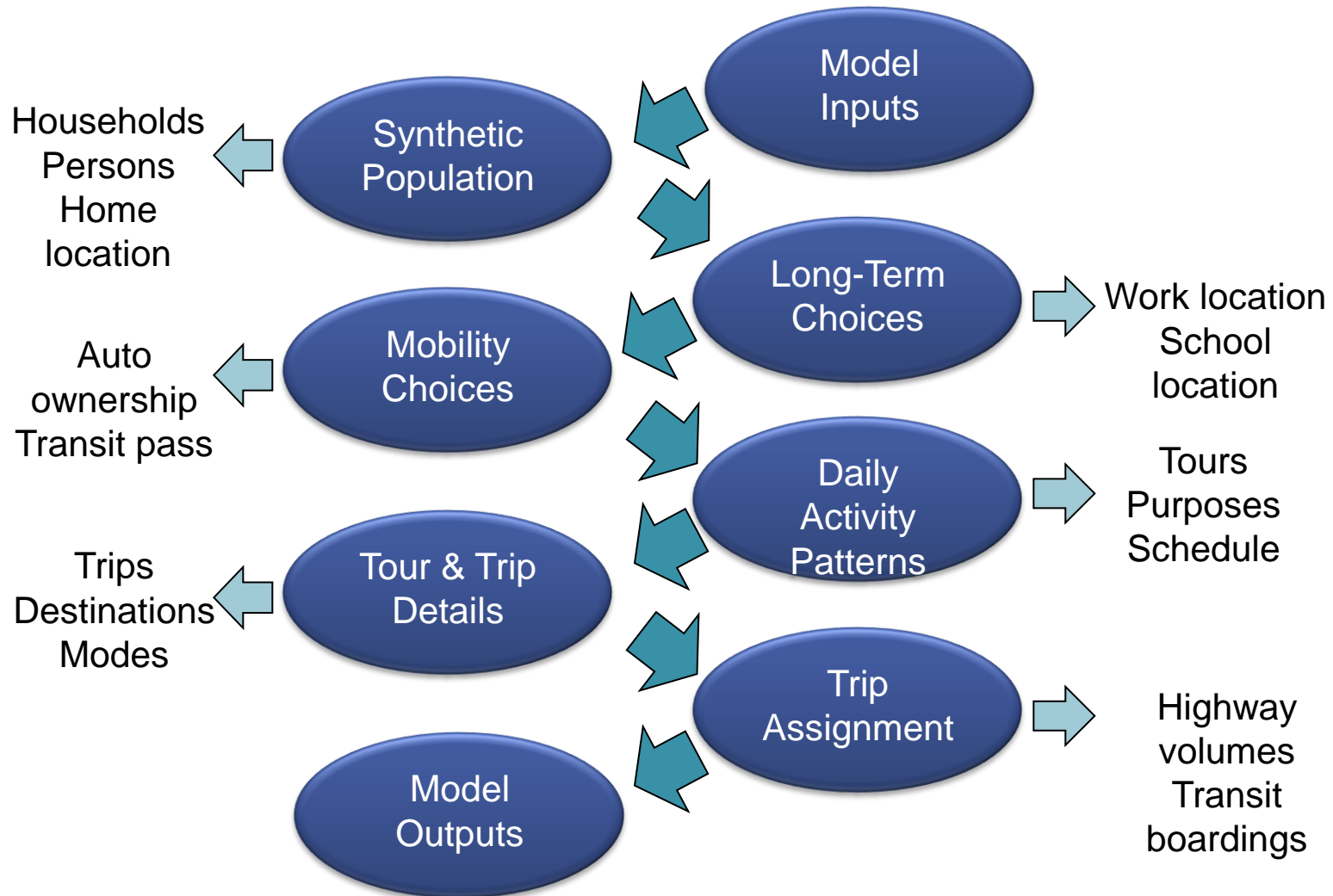


Terminology

- Model development
 - Model estimation
 - Model calibration
 - Model validation
- Model implementation
- Model application



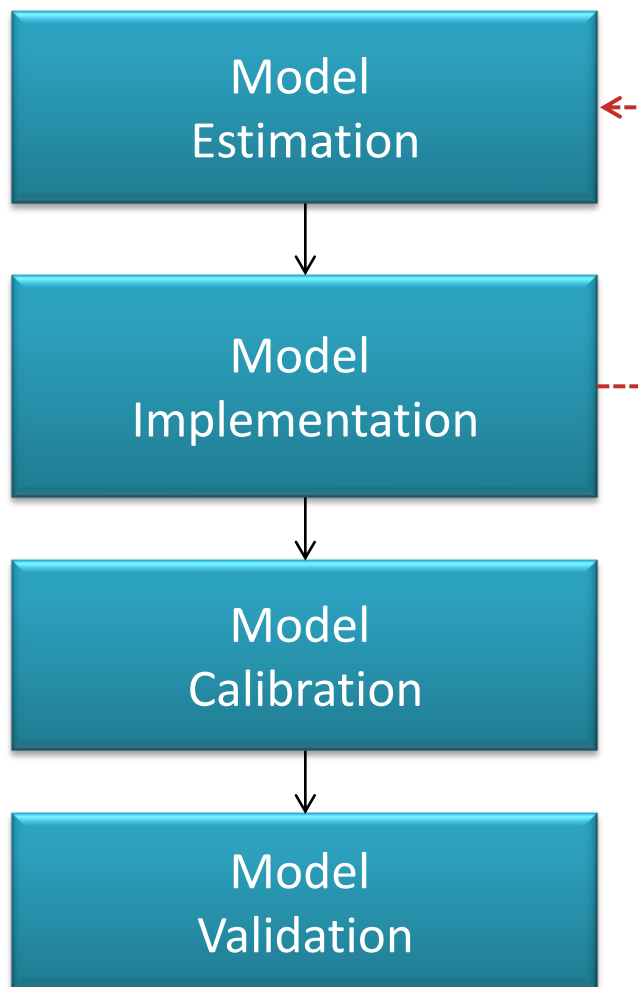
Typical Activity-Based Model Process



Model Development Process

Trip-Based Models:

- Less estimation, more calibration
- All models implemented at once.
- Model validation compares estimates to traffic counts and transit volumes

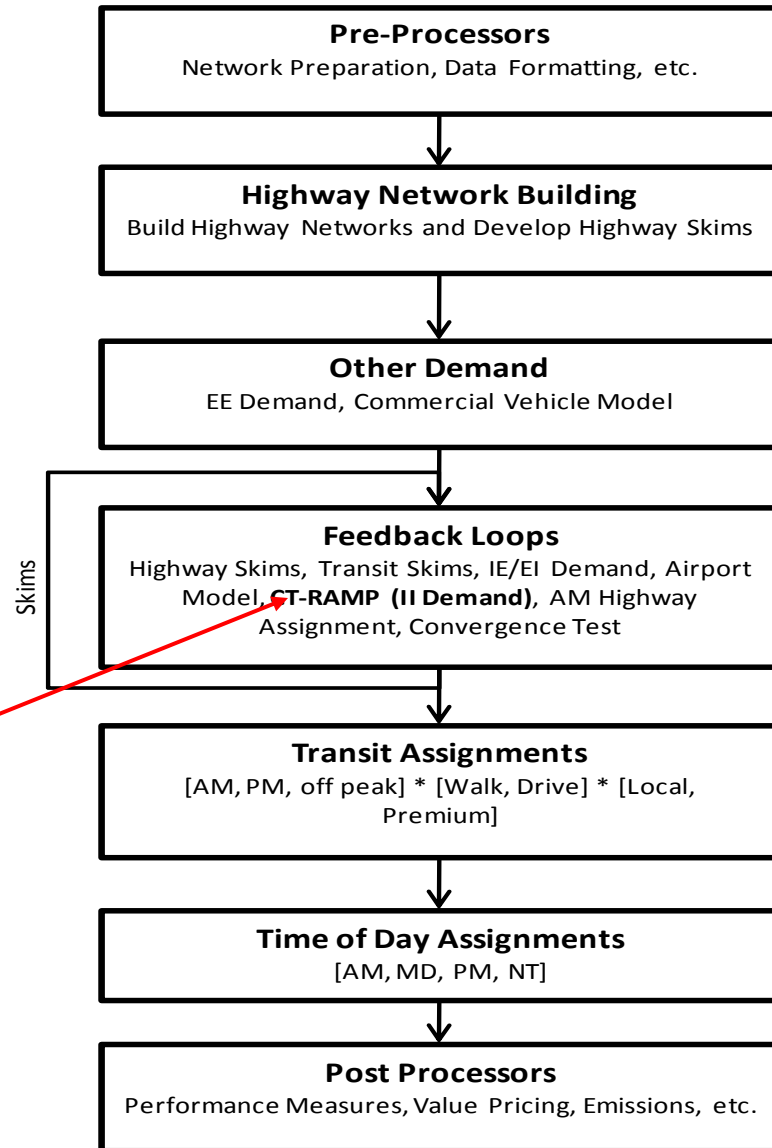


Activity-Based Models:

- More estimation, less calibration
- Last model estimated first, then implemented before next model estimated
- Models can also be validated against observed choices in data

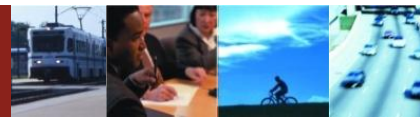
Activity-Based Model System Structure (Atlanta Regional Commission)

Activity-based demand
component (CT-RAMP)



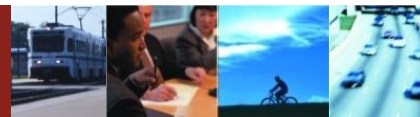
Data for Estimation & Calibration: Surveys

- Household survey
 - Provides complete daily trip diaries for entire household
- On-Board survey
 - Difficult to use for ABM because only trip data is reported
 - Special questions required to construct tours
- Special market surveys
 - Origin-destination
 - Downtown parking
 - Visitors
 - Special events
 - Air passengers
 - Other special markets/populations
- Census data
 - Calibration summaries
 - Synthetic population controls

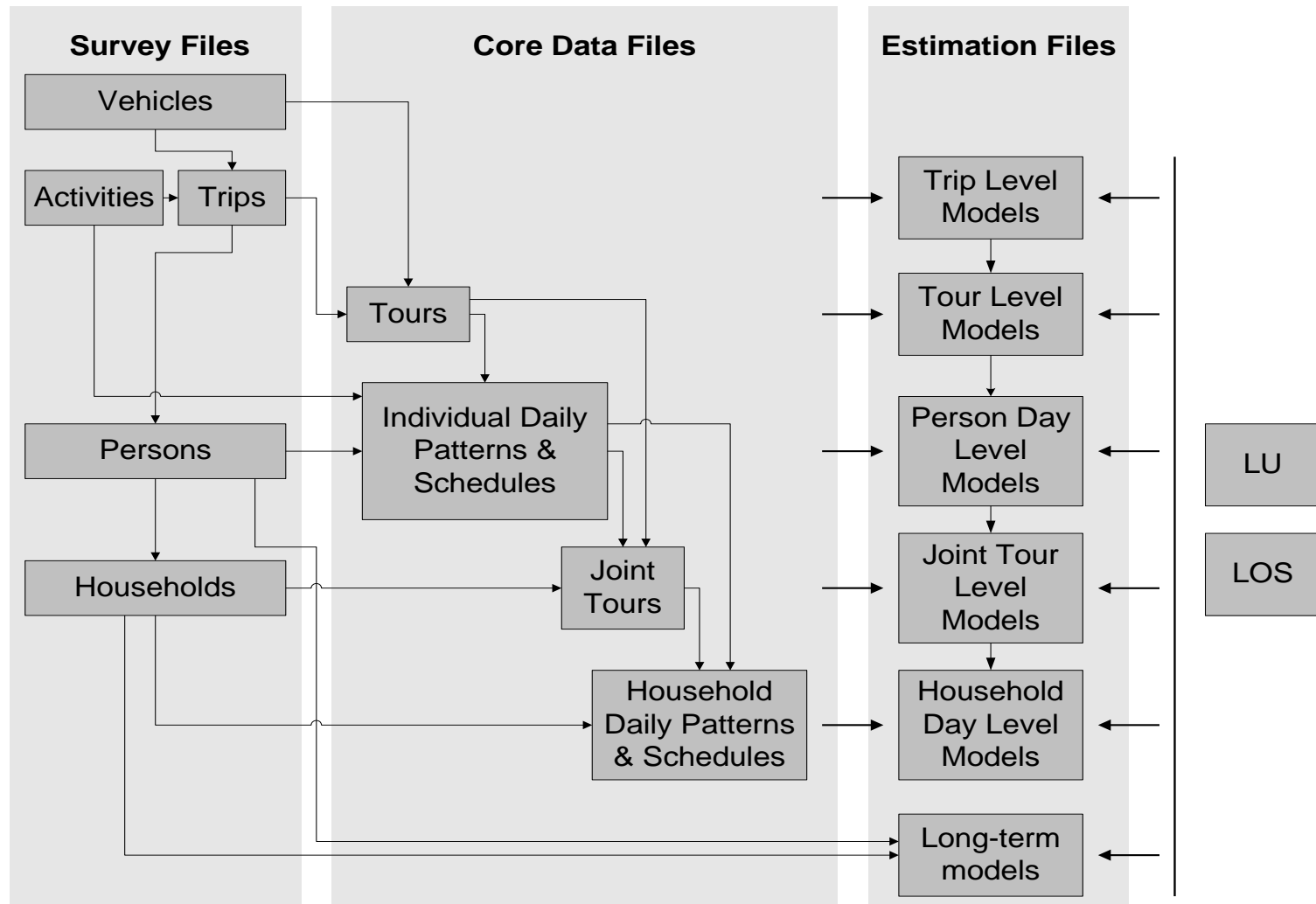


Data for Estimation and Calibration: Land Use and Transportation Supply

- Land use data
 - Housing units
 - Employment and square footage by industry group
 - School enrollment by grade level, college/university
 - Urban form and open space
- Parking supply data
- Need data for model geography
 - TAZ, Micro-TAZ, or parcel
- Transport networks \level-of-service skims
 - Travel times and costs by mode and time period
 - Intersections and transit stops



Coding Household Survey Data

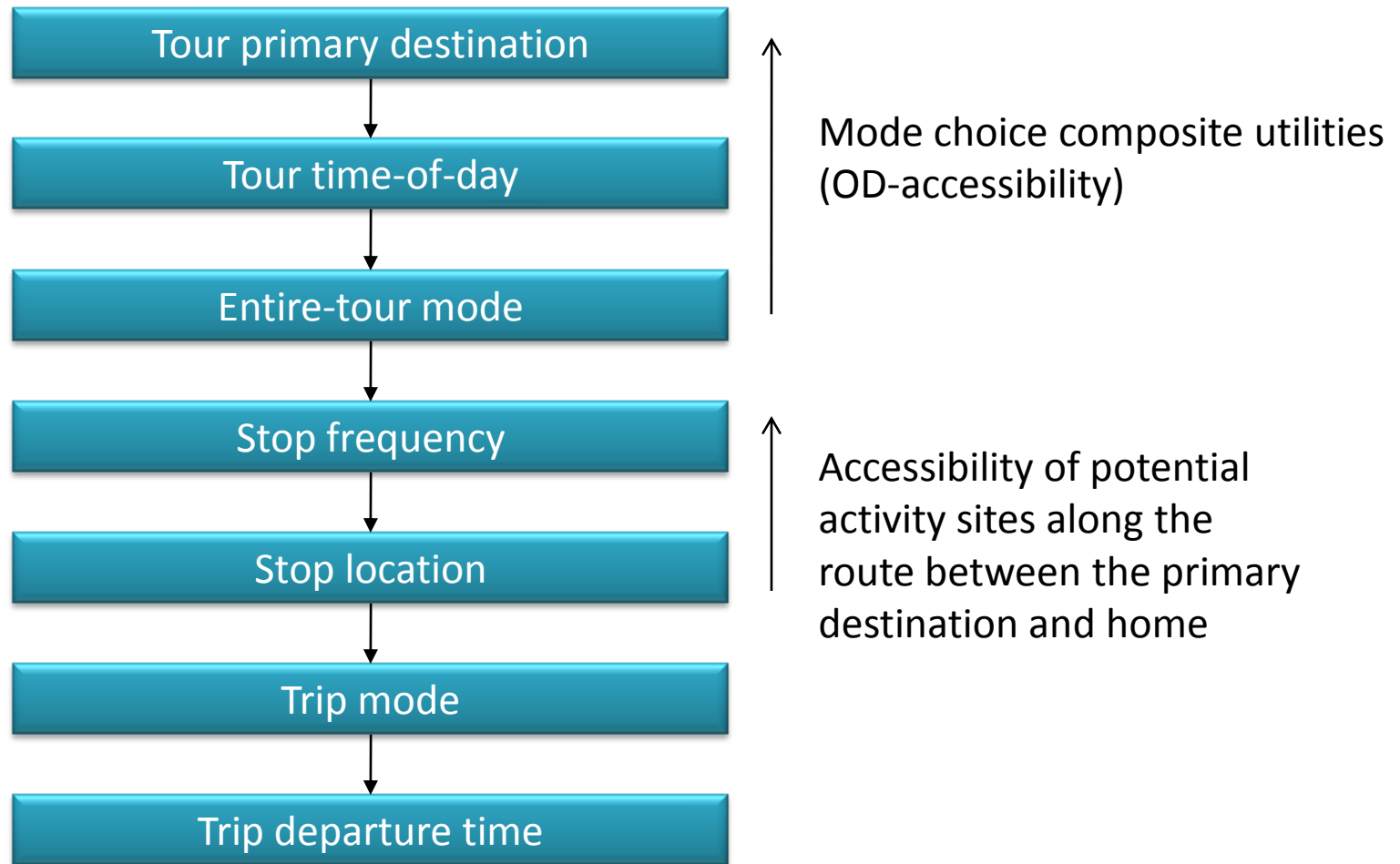


Estimation of an Activity-Based Model

- Model estimation is performed in statistical software (SAS, SPSS, Stata, R, Alogit, NLogit, Biogeme) by an experienced analyst
- Typically models are estimated in order from bottom up; i.e., the last model to be applied is estimated first
- After each model is estimated, it is implemented so that the expected utilities (accessibilities) from the model can be used in upper-level models
- Once all the models have been implemented, the entire system can be calibrated



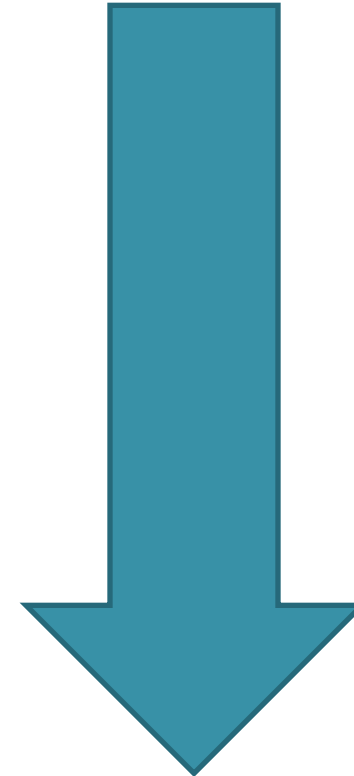
Top Down Application—Bottom Up Estimation



Options for Model Estimation and Calibration

Model Component
Daily Activity Pattern & Tour Generation
Household Auto Availability
Tour and Trip Start and End Times Choices
Usual Workplace and School Location Choices
Tour and Trip Mode Choices
Intermediate Stop Generation
Tour and Trip Destination Choices

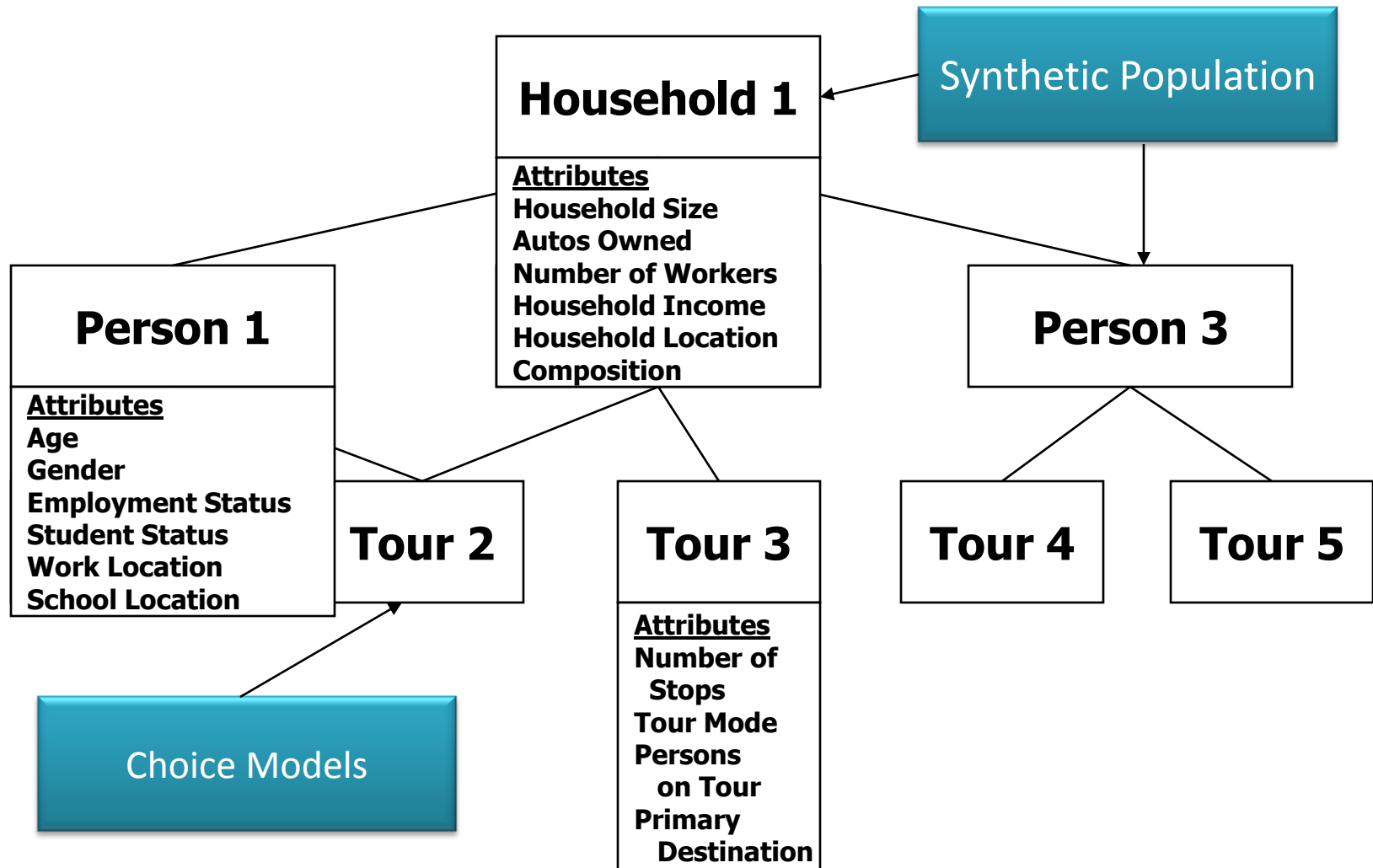
Higher Degree of Transferability



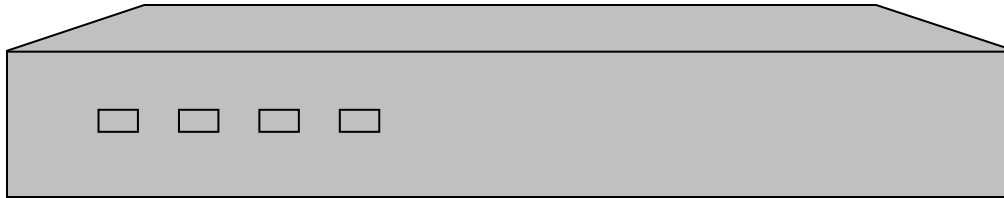
Higher Need for Local
Estimation & Calibration



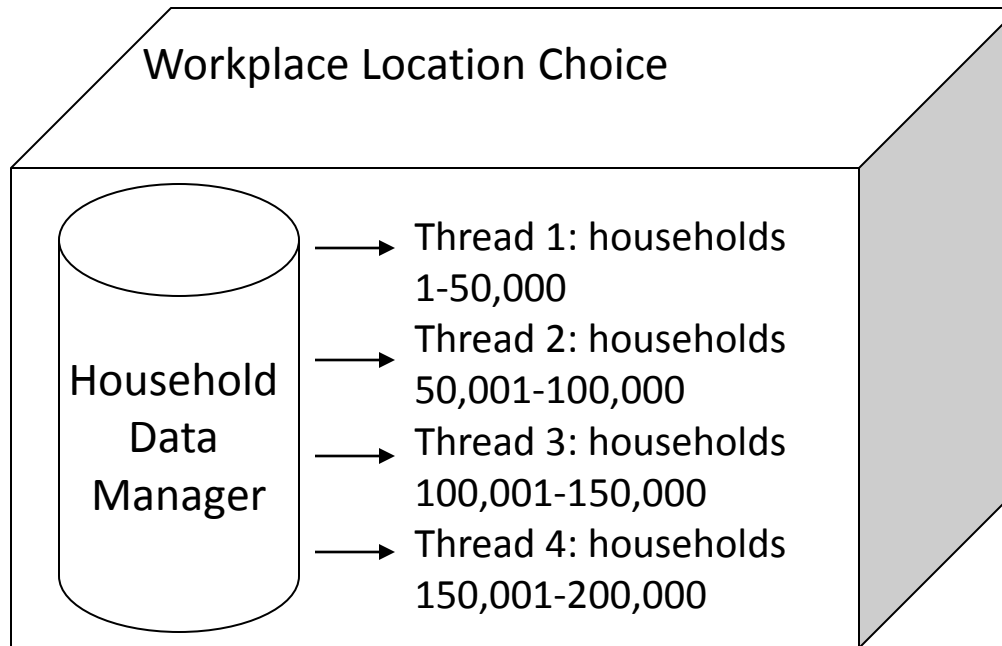
Implementation – Object-Oriented Software



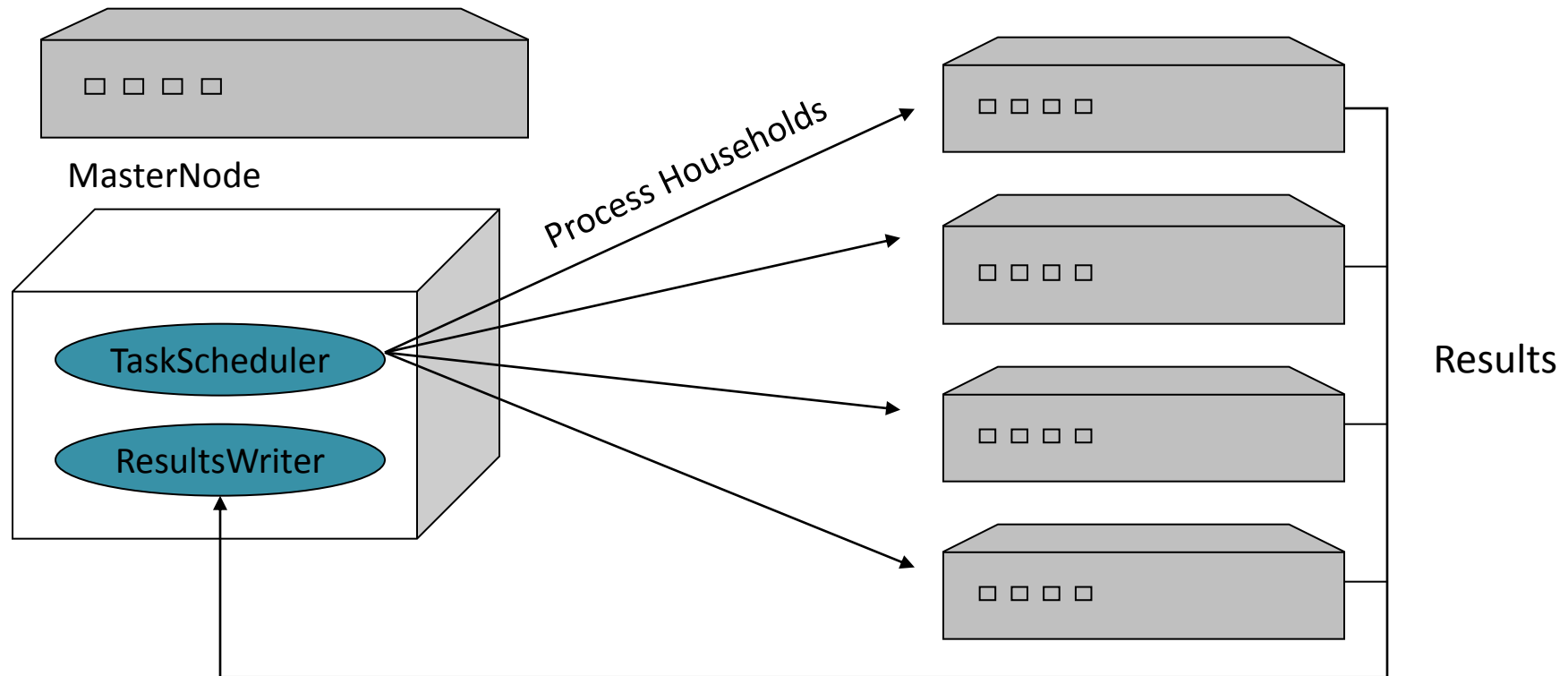
Implementation – Threaded Processes



Quad-core Intel Box with 4 GB RAM per process



Implementation – Distributed Processing



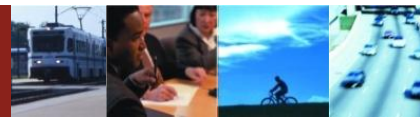
Model Calibration

- Once a model component is implemented, the synthetic population can be run through the software, and the model predictions are compared to expanded data
- Alternatively, household survey data can be run through the software instead of the synthetic population
 - Models can be calibrated in reverse order
 - Upstream model errors can be eliminated from the calibration process
- Model parameters can be adjusted to better match the data
 - Alternative-specific constants
 - Coefficients on distance in destination choice models
- Calibration should focus on meaningful, defensible adjustments

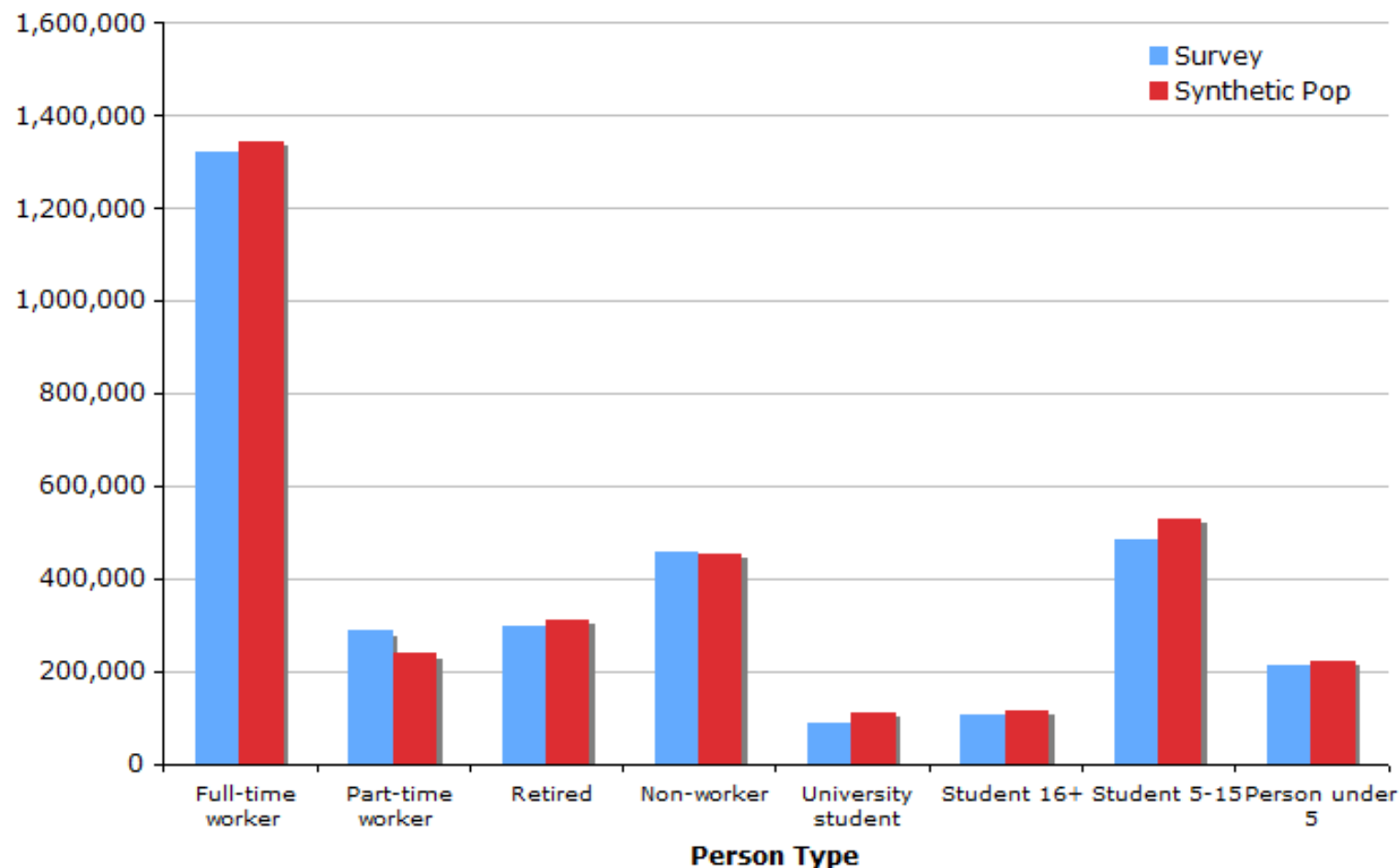


Model Calibration

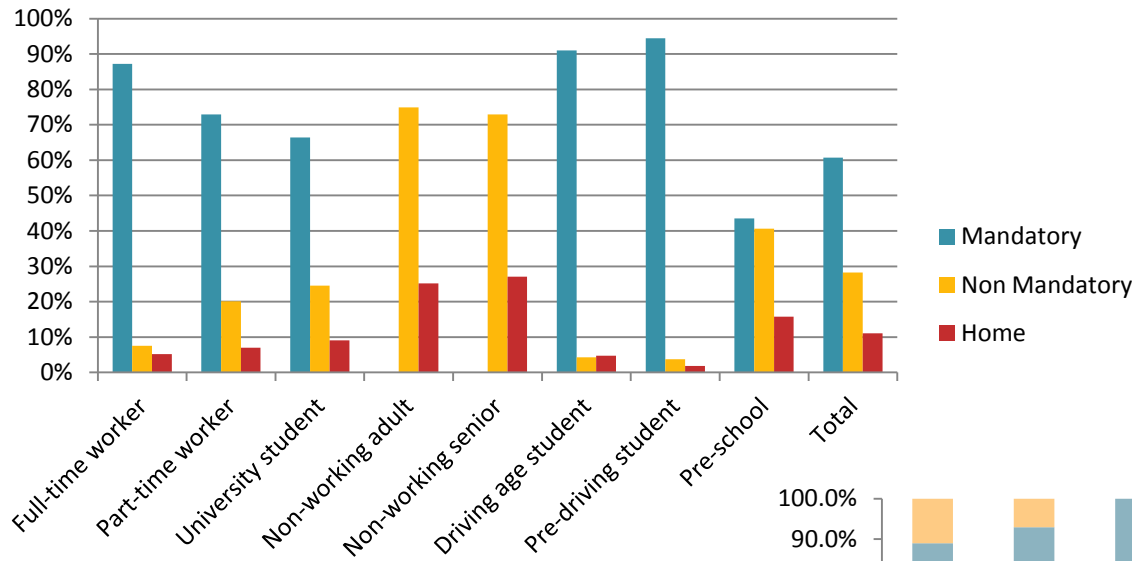
- Similar calibration comparisons as in a trip-based model
 - Trip generation rates -> tours and stops by purpose
 - Trip distribution -> tour destination choice and intermediate stop location choice
 - Mode choice -> tour and trip mode choice
 - HB work trips -> usual workplace (Census JTW data)
- Different model components in an activity-based model
 - Joint travel and mobility models
- Person-level calibration versus aggregate calibration
- Importance of appropriate synthetic population and well-expanded observed data



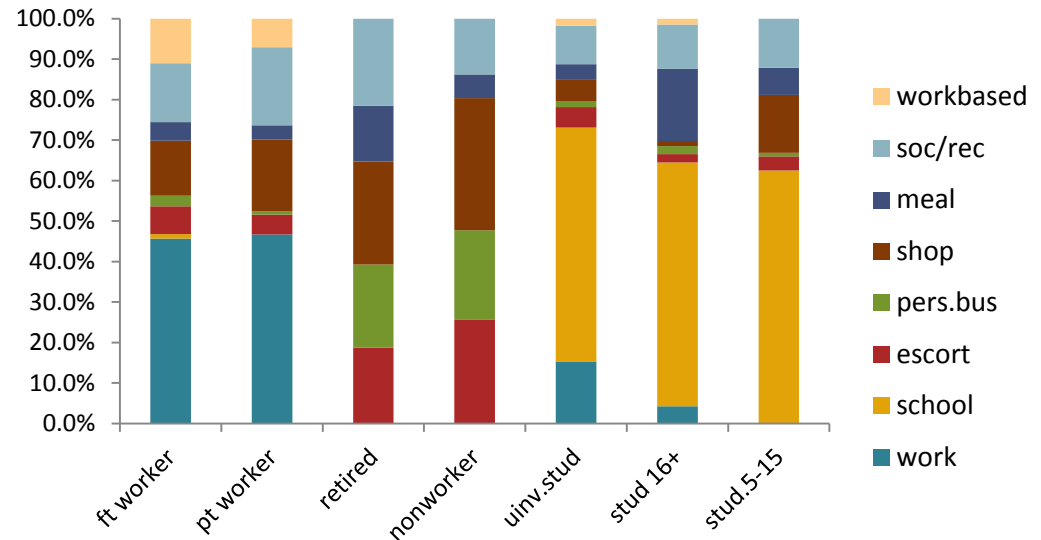
Importance of Household Survey Expansion



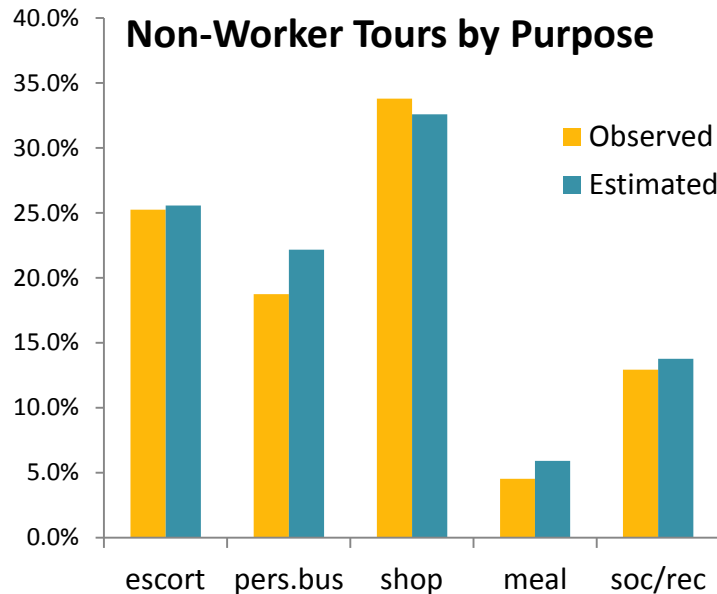
Calibration of Daily Activity Pattern Types



Are the right numbers of daily activity patterns being generated by person-type?

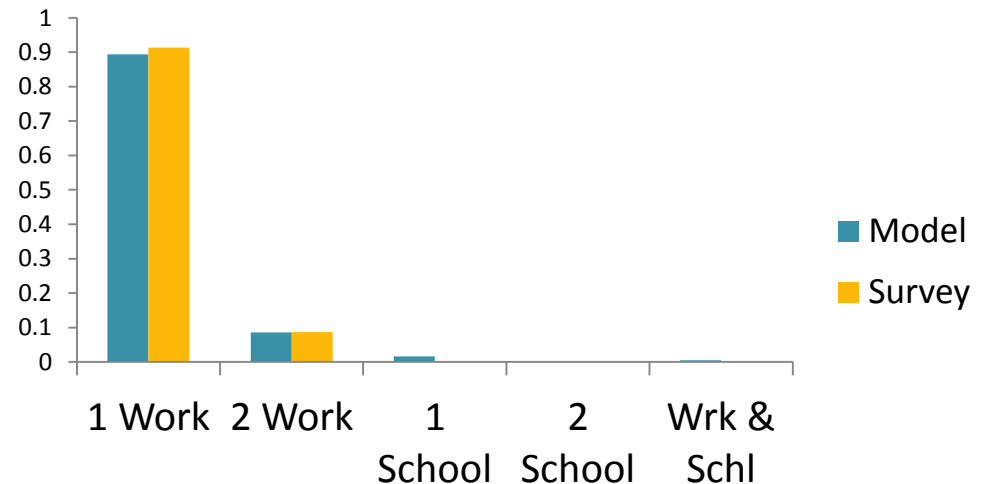


Calibration of Tours



Are the right numbers of tours being generated by person-type?

Estimated versus Observed Mandatory Travel Patterns for Part-Time Workers



Adjustments to Alternative-Specific Constants

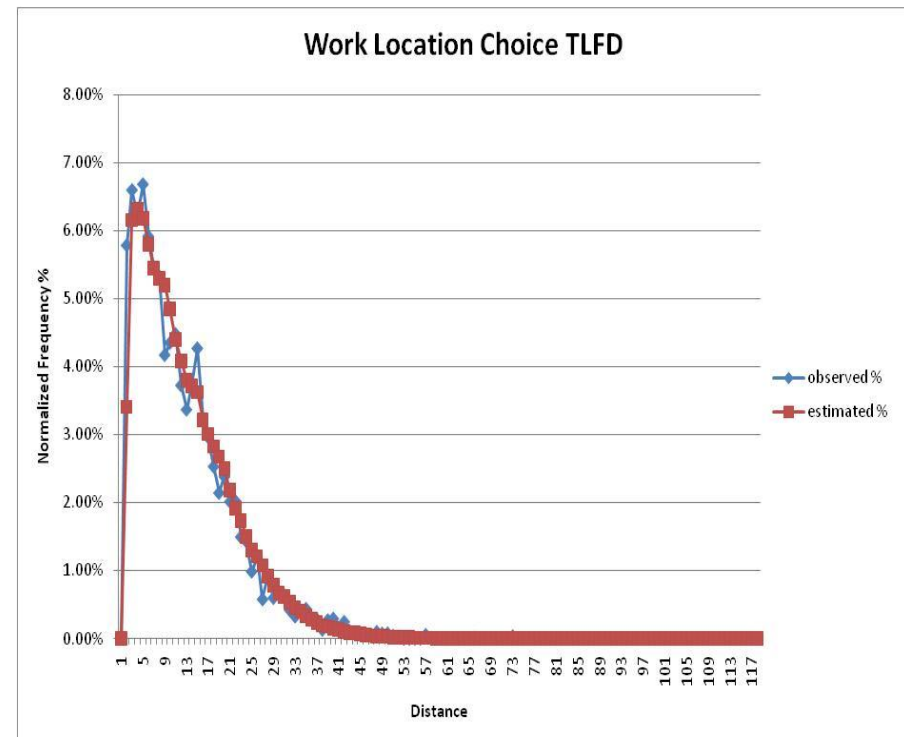
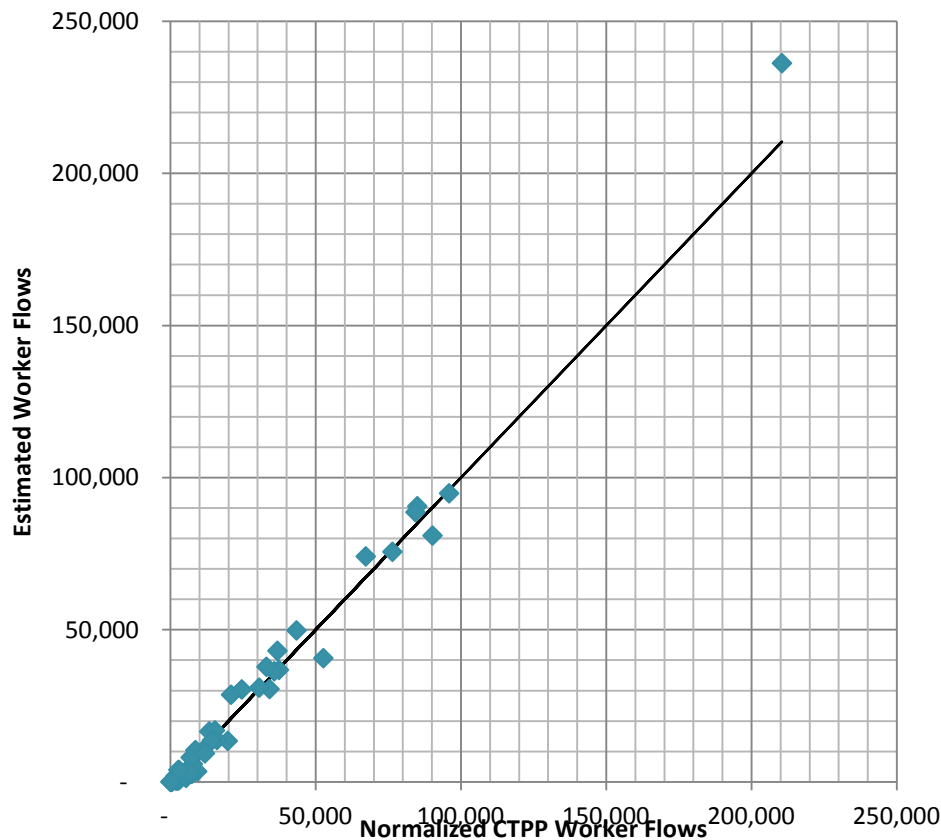
	Estimated	Calibrated
Stay At Home		
Full-time worker	0.0000	-0.3567
Part-time worker	-0.8884	-1.2451
Retired	-0.9572	-1.3139
Non-worker	-0.8739	-1.2306
University student	-1.0212	-1.3778
Student 16+	-0.3650	-0.7217
Student 5-15	-0.4576	-0.8143
Person under 5	-1.1964	-1.5531
Work Tour		
Alternative Specific Constant	1.0705	1.1701
Full-time worker	0.0000	-0.3000
Part-time worker	-1.3157	-1.1157
School Tour		
Alternative Specific Constant	-2.8699	-3.3350
Full-time worker	0.0000	-1.8000
University student	2.2136	0.2136
Student 16+	2.6766	4.6766
Student 5-15	2.5194	3.5194
Person under 5	0.0000	0.3500

	Estimated	Calibrated
Escort Tour		
Alternative Specific Constant	-3.5706	-3.5321
Full-time worker	0.0000	-0.0400
Part-time worker	0.2330	0.3830
Personal Business Tour		
Alternative Specific Constant	-1.9002	-2.0880
Full-time worker	0.0000	-0.0400
Part-time worker	0.1670	0.3170
Shop Tour		
Alternative Specific Constant	-3.1667	-2.9325
Part-time worker	0.3400	0.4900
Meal Tour		
Alternative Specific Constant	-4.9213	-3.8873
Full-time worker	0.0000	-0.0400
Part-time worker	0.0000	0.2000
Social / Recreational Tours		
Alternative Specific Constant	-2.3216	-2.3718
Full-time worker	0.0000	-0.0400
Part-time worker	0.1241	0.2741
Interaction Effects		
Work + Shop	-1.0889	-0.5889
Work + Meal	-0.6221	-0.1221
Personal Business + Shop	-0.2805	-0.0805

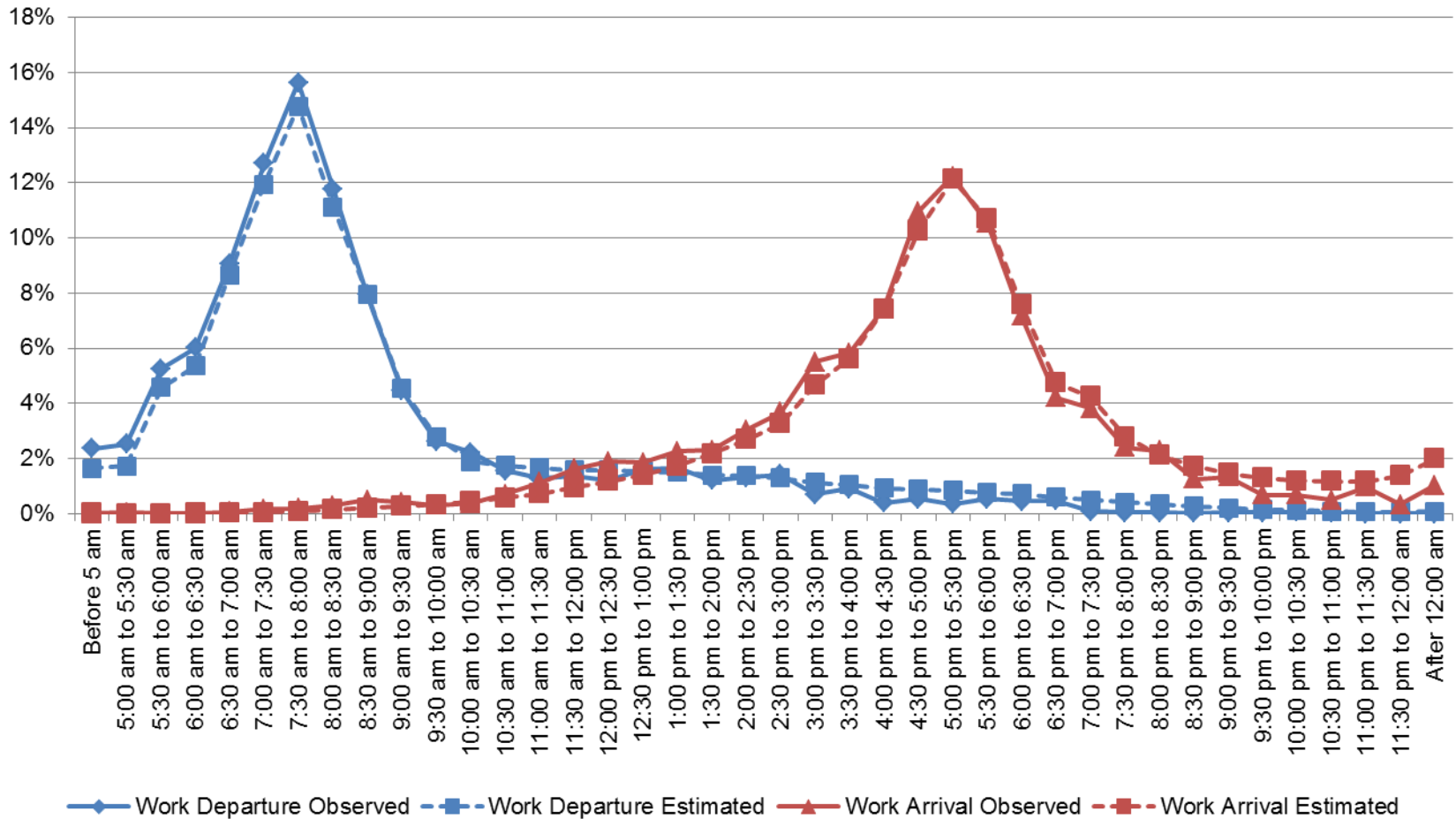


Destination Choice Calibration

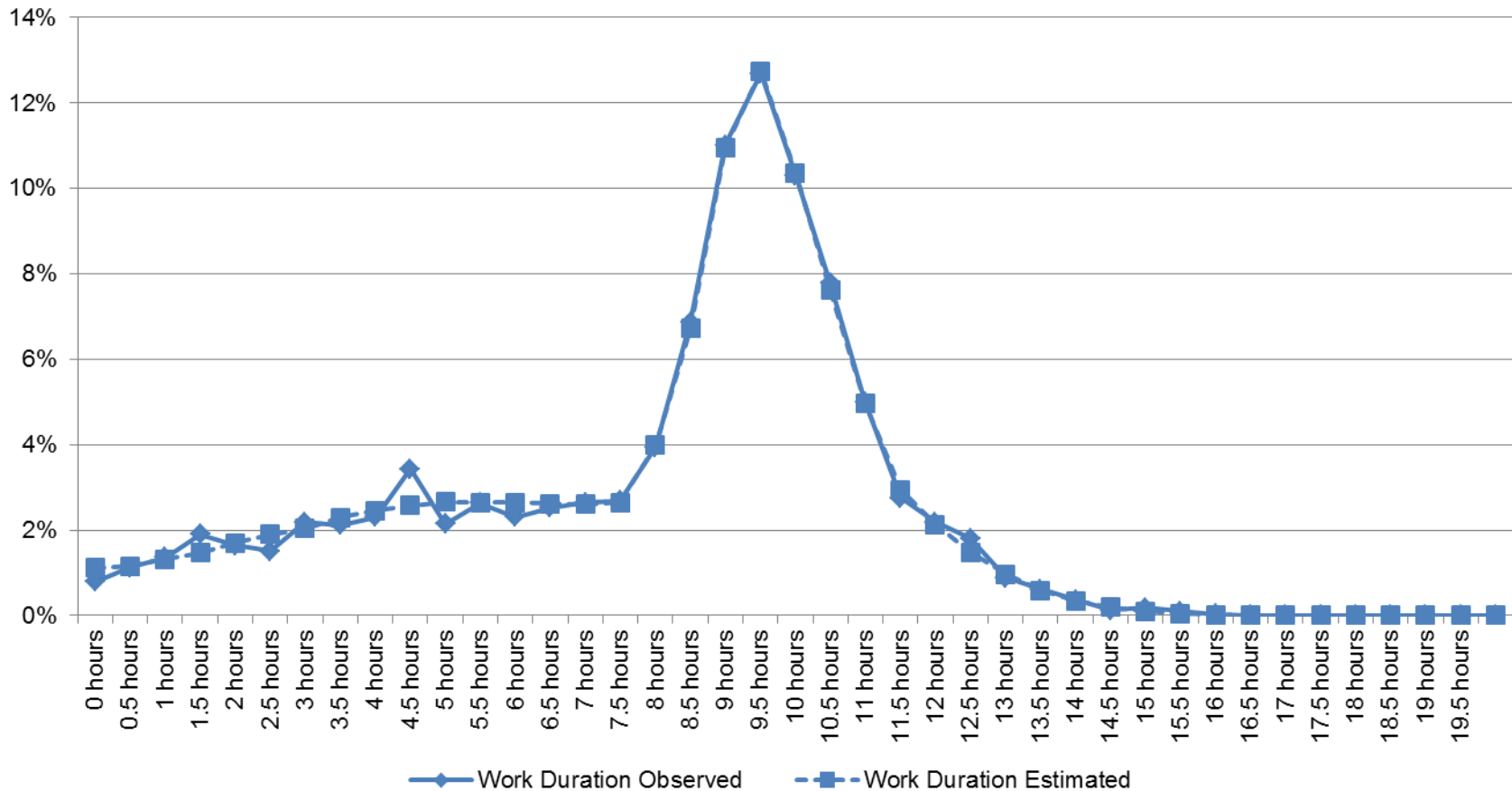
Estimated vs Census Workers By District
of Residence and Workplace



Calibration: Work Tour Departure & Arrival Periods



Calibration: Work Tour Duration

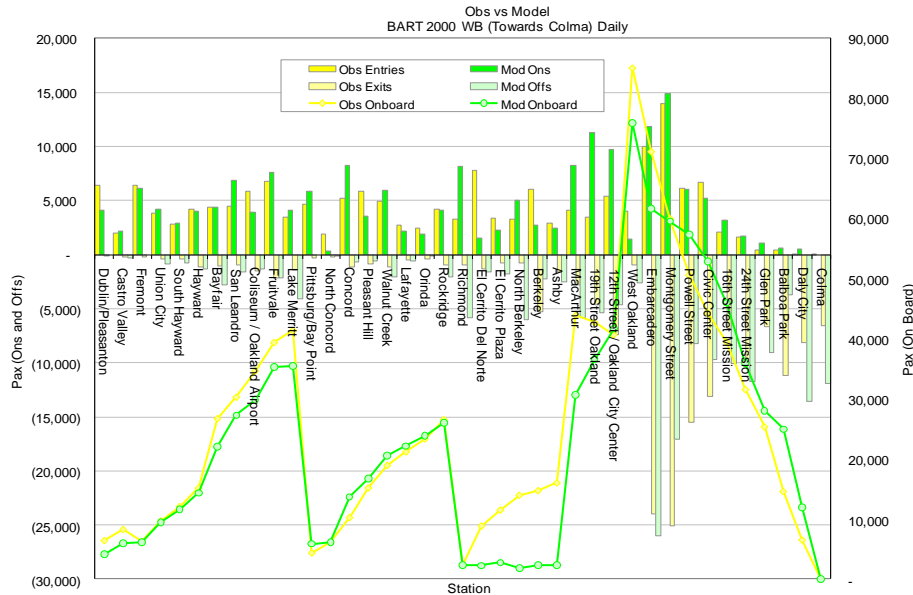


Model Validation

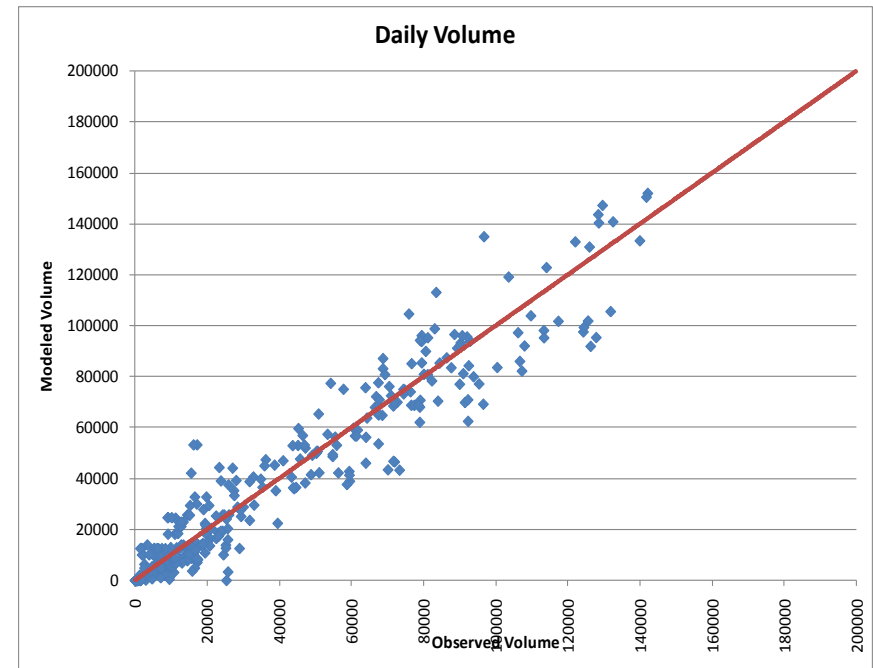
- Check model performance against independent data sources
 - Typically traffic counts (by period) and transit boardings
- Sensitivity testing
 - Change network or land-use data
 - Does model respond appropriately?
- Look for systematic errors
 - Software bug?
 - Illogical coefficients?
 - Missing market segments?
 - Missing variables?



Validating to Count Data: MTC



Transit boardings and alightings by stop

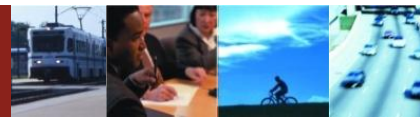


Estimated versus observed traffic volume scatterplot



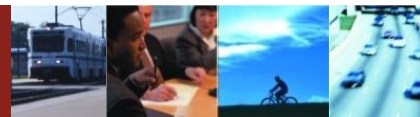
Validation Measures: SACOG

- Households by auto ownership by drivers, by district
- Households by income, by district
- Trip-length frequencies by activity type
- Time-of-day frequency distributions by activity type
- Mode shares by activity type
- Average volume/count ratios by facility type
- VMT by functional class and county
- VMT/HH by Residential Density
- Volume/count scatter plots and correlation
- Screenline count comparisons
- Transit boarding comparisons
- Transit OD comparisons, by mode and purpose
- District-to-District worker flows



Validation Measures: ARC

- Trip length frequency distributions (TLFs) by activity type
- Average distances and percent intrazonal trips for all activity types
- Households by auto ownership, by county and tract
- Frequency of activity types by person type
- Time-of-day frequency distributions by activity type
- Frequency of joint tours
- Tour mode choice results by activity type and auto ownership segments
- Trip mode choice
- Frequency of intermediate stops for round trips by activity type
- TLFs for out-of-direction distance for intermediate stops, by activity type
- Average volume/count ratios by facility type
- Vehicle-miles of travel (VMT) by functional class and county
- Volume/count scatter plots and correlation
- Rail and bus boarding comparisons
- County-level CTPP work flows vs. modeled work tours





Questions and Answers

The **Travel** Model
Improvement
Program

Are Activity-Based Models Right for You?

- Activity-based models are more complex than trip based models
- They produce a richer data set, but that data requires knowledgeable staff to summarize and interpret
- Custom software (and sometimes hardware configurations) are often required to apply them
- Based upon this, are activity-based models right for you?



“Taking the Plunge” Big Picture Questions

(Source: Leta Huntsinger, “Triangle Regional Model Expert Panel Review: Summary Report”, November 17-18, 2011)

- Should the next model update be an **activity-based model**?
- If an activity-based model, what additional investment should be expected in terms of data and consultant support?
- If not an activity-based model, what other model innovations or advances should be considered?
- What innovative data development and management advances should be considered with or without an activity-based model?
- What is the best organization structure to accomplish regional modeling goals (activity based or advanced trip based)?



Whether to “Take the Plunge”: Identifying Indicators of Likely Success

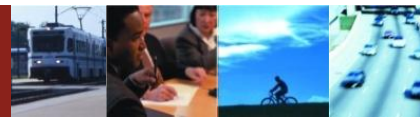
(Source: Leta Huntsinger, “Triangle Regional Model Expert Panel Review: Summary Report”, November 17-18, 2011)

- Have stakeholders historically been actively engaged in travel demand model analysis?
- Has there been a history of resource-based support for travel model development?
- Does the agency staff have the required level of technical expertise to run an activity-based model?
- Are policy makers or the general public advocating policies that require an activity-based model?



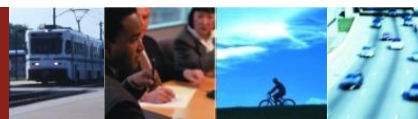
Some Recent TMIP Peer Review Examples

- Delaware Valley Regional Planning Commission
 - Pursue ABM long term due to policy analysis requirements
- Association of Monterey Bay Area Governments
 - Recommended a phased approach to ABM
- Chittenden County Metropolitan Planning Organization
 - Transition to ABM because of increased policy sensitivities
- Omaha-Council Bluffs Metropolitan Area Planning Agency
 - ABM was not discussed
- Arizona Department of Transportation
 - Need more information before recommending ABM
- Southeast Michigan Council of Governments
 - Staged transition to an ABM



Checklist: Staff Expertise

Skill Sets	Need for Activity Model	Need for Trip-Based Model
Facility with simulation programming and outputs	Essential	Not necessary
Knowledge of discrete choice model structures, behavior, utility theory	Essential	Desirable
GIS manipulation of land use parcel data	Essential/Desirable	Desirable
SQL scripting and database manipulation	Essential/Desirable	Not necessary



Checklist: Policy Tests

Policy Tests	Use an Activity Model	Use a Trip Model
Pricing strategies	Yes	Limited
Non-motorized investments	Yes	No
Transit oriented development	Yes	No
Transit schedules	Yes, round trips	Yes, one-way
Transit fare policies	Yes	Limited
Travel demand management programs	Most	No
Transportation systems management	Yes	No
Equity evaluations	Yes	No



Checklist: Impacts of Interest

Impacts of Interest	Use an Activity Model	Use a Trip Model
Induced Demand	Yes	No
Emissions for a Household	Yes	No
Peak spreading	Yes	No
Start/stop emissions by time of day	Yes	No
Vehicle type and choice	Yes	No
Equity by income group	Yes	No



You've Decided to Take the Plunge— Now What? Assembling Resources

Resource Considerations	Activity Model	Trip Model
Staff resources	Training needed	Trained
Executive support	Preferred	Assumed
Quality data	Higher expectations	Reasonable
Cost	Set approach to resources available	Updates required
Approach	Transfer or build	Update
Innovation	Lots of possibilities	More difficult
Development	Consultant support or in-house or hybrid	
Funding	Work program budget or external grants	Work program



You've Decided to Take the Plunge: Now What?—System Design Decisions

- What spatial scale should be used?
- What market segmentation is appropriate?
- What choices should be included?
- How will the activity-based model be integrated into the transportation planning toolkit?
- How should other aspects of transportation be represented?
- How should databases be maintained and used?

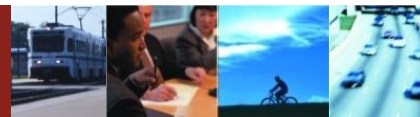


What spatial scale should be used?

	Zones	Microzones	Parcels
Spatial Detail	Heterogeneous Land Uses	Primarily Homogenous Land Uses	Individual Land Use
Data Sources	Existing travel demand model	Census data for households; LEHD or local sources for employment	Tax assessor data combined with Census and local data
Travel times and costs	Aggregate	Use microzones for transit access and non-motorized modes	Use parcels for transit access and non-motorized modes
Measures of Attractiveness	Aggregate	Partially disaggregate	Disaggregate
Level of Effort	Least	Can be automated from available data	Most

How should modes be represented?

- Transit modes
 - Walk access and egress can be developed from parcel or microzone to each stop
 - Transit line-haul can be developed from stop to stop
 - Drive access can be based on a choice of park-and-ride lots and kiss-and-ride can be modeled separately
- Auto modes
 - Drive alone and shared ride modes
 - Toll and non-toll choices with value-of-time classes
- Non-motorized modes
 - Travel times can be developed from parcel or microzone to network
 - Networks can reflect elevation, traffic volumes, turn movements, etc.

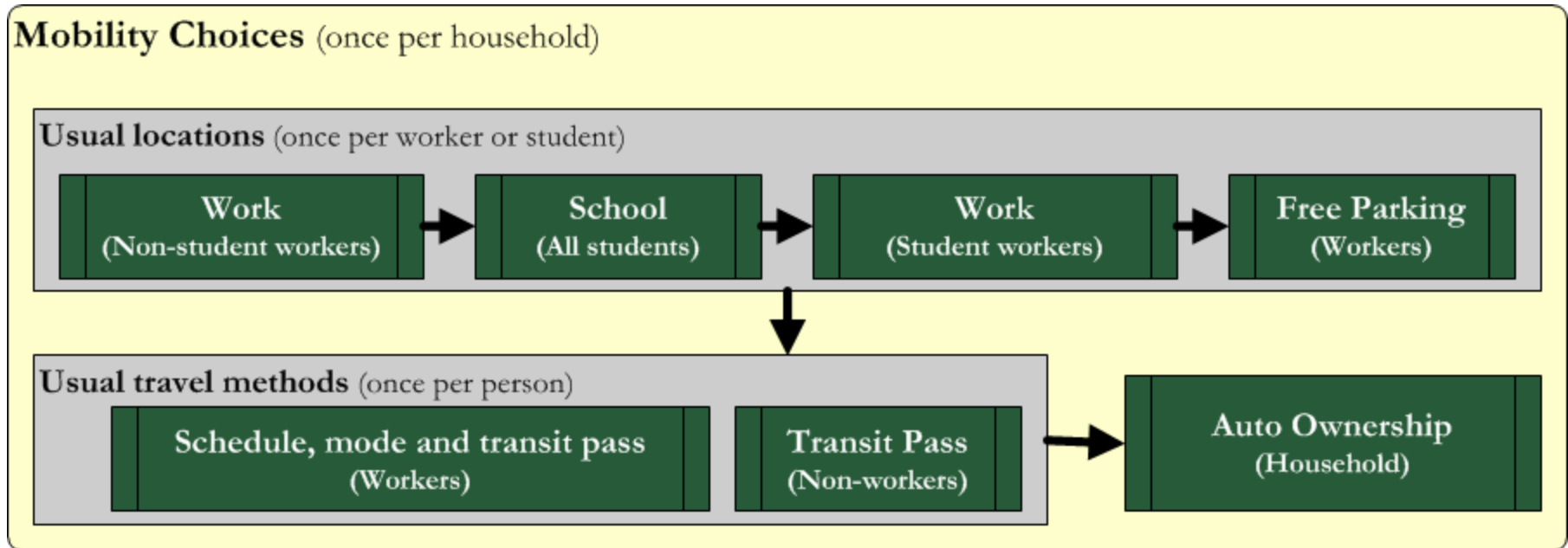


What long term choices should be included?

- Auto ownership/Vehicle availability
 - Should drivers should an individual vehicle for each trip?
 - Should vehicle type and vintage be modeled?
- Transit pass ownership
- Drivers licenses
- Parking subsidies
- Usual work and school choices
 - Locations
 - Modes
 - Schedules



Long Term Choice Model Example - DaySim

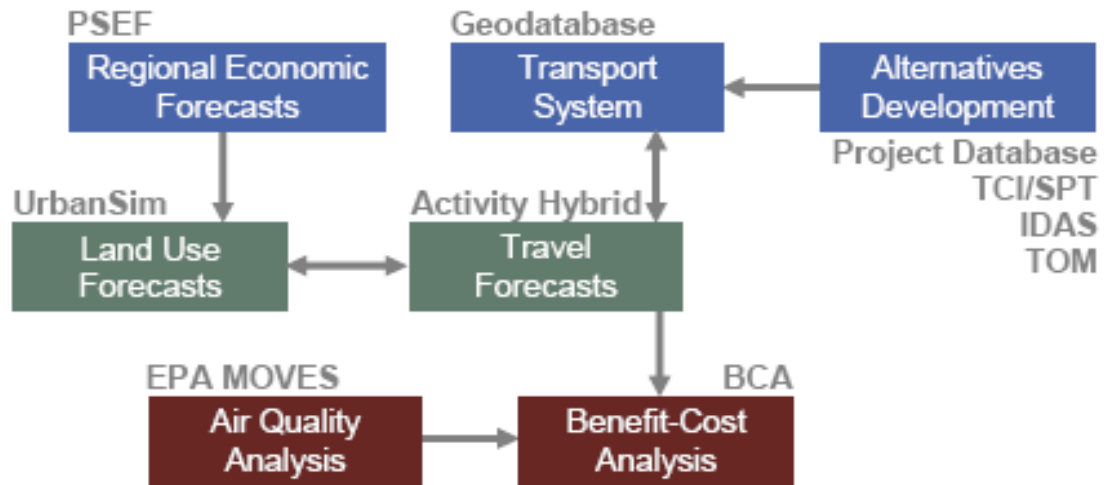


Model Integration

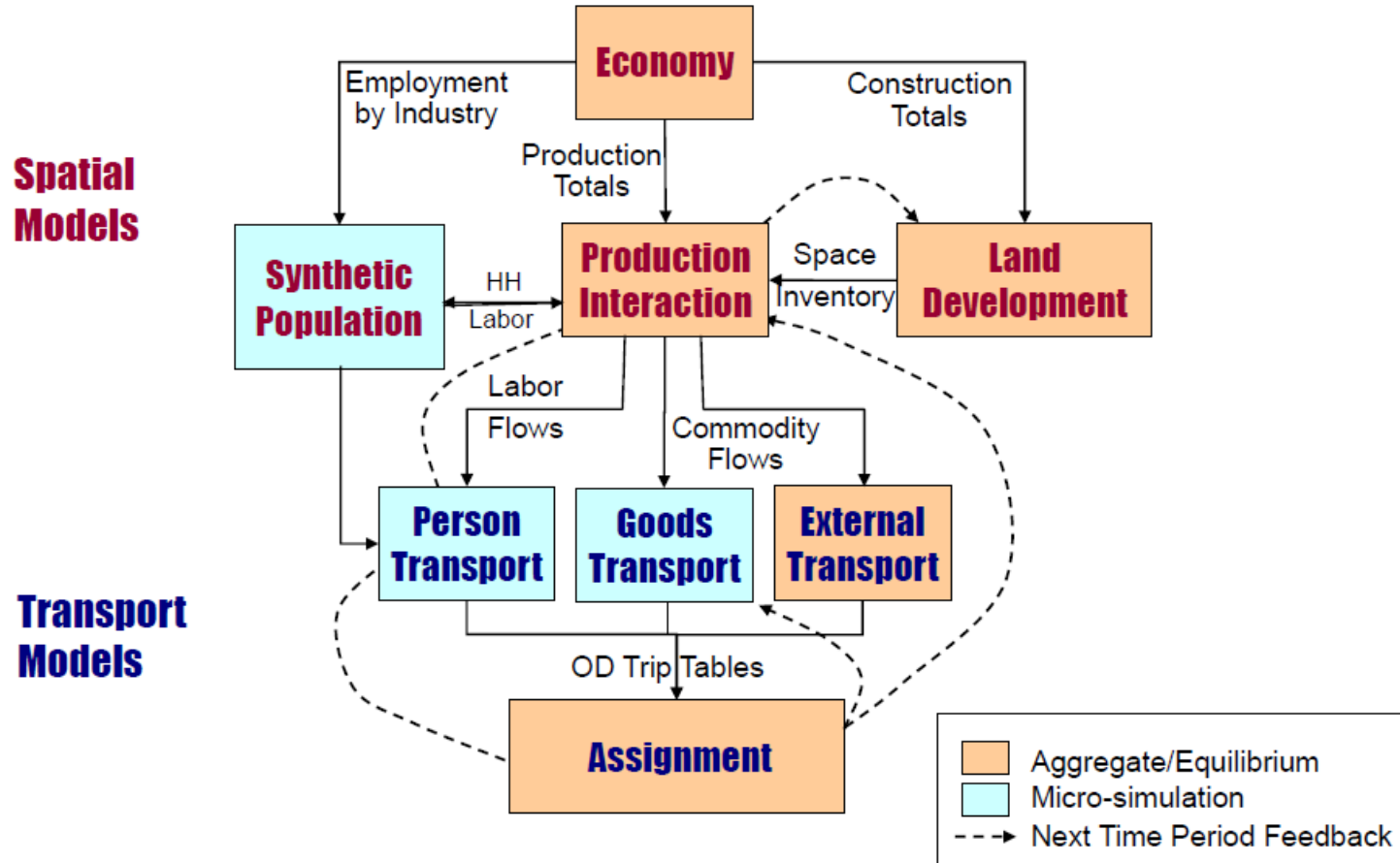
- Should ABM be integrated with other models?
 - Economic models
 - Land use models
 - Dynamic traffic assignment models
 - Air quality models (EPA MOVES)
 - Transit benefits (SUMMIT)
- How should ABM be integrated with skimming and assignment processes?
 - Binary integration provides a faster process
 - “On-the-fly” use of skims in ABM still being considered

Integrated Modeling at PSRC

- Economics
- Land Use
- Geodatabase
- Transit
- ITS
- Toll Optimization
- Activity-based Passenger Travel
- Freight Travel
- Emissions
- Benefit-Cost



Oregon Statewide Integrated Model



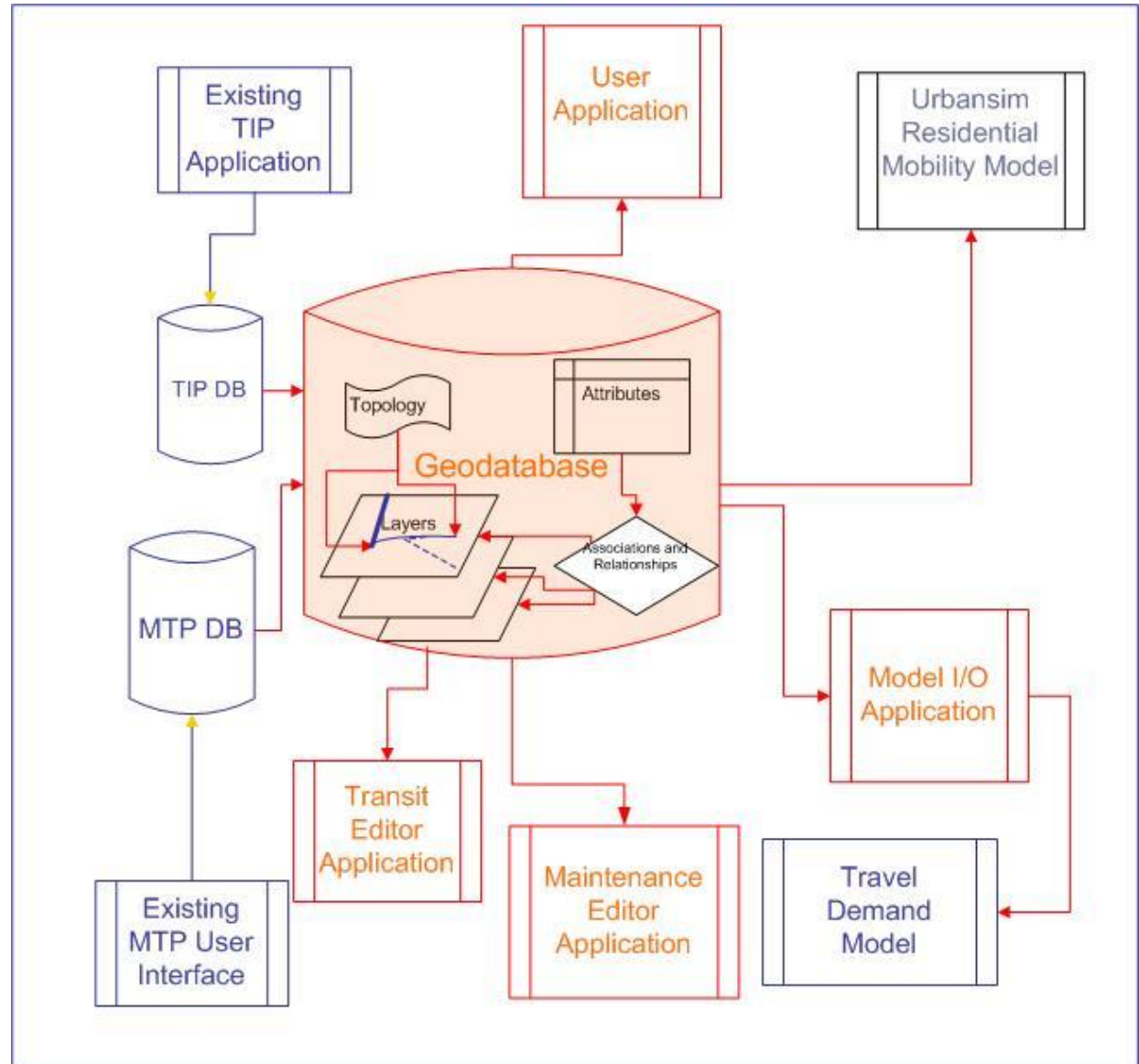
How will other travel be estimated?

Auxiliary Travel	Type	Method
Long distance	Airport	Airport models, long distance models or special generators
	External	Long distance models or externals
Non-resident	Visitor	Visitor models, long distance models or special generators
Commercial vehicles	Trucks, freight and goods	Commodity flow and vehicle touring models
	Taxis, shuttles, rentals	Vehicle touring or simple 4-step
	Service	Vehicle touring models or simple 4-step

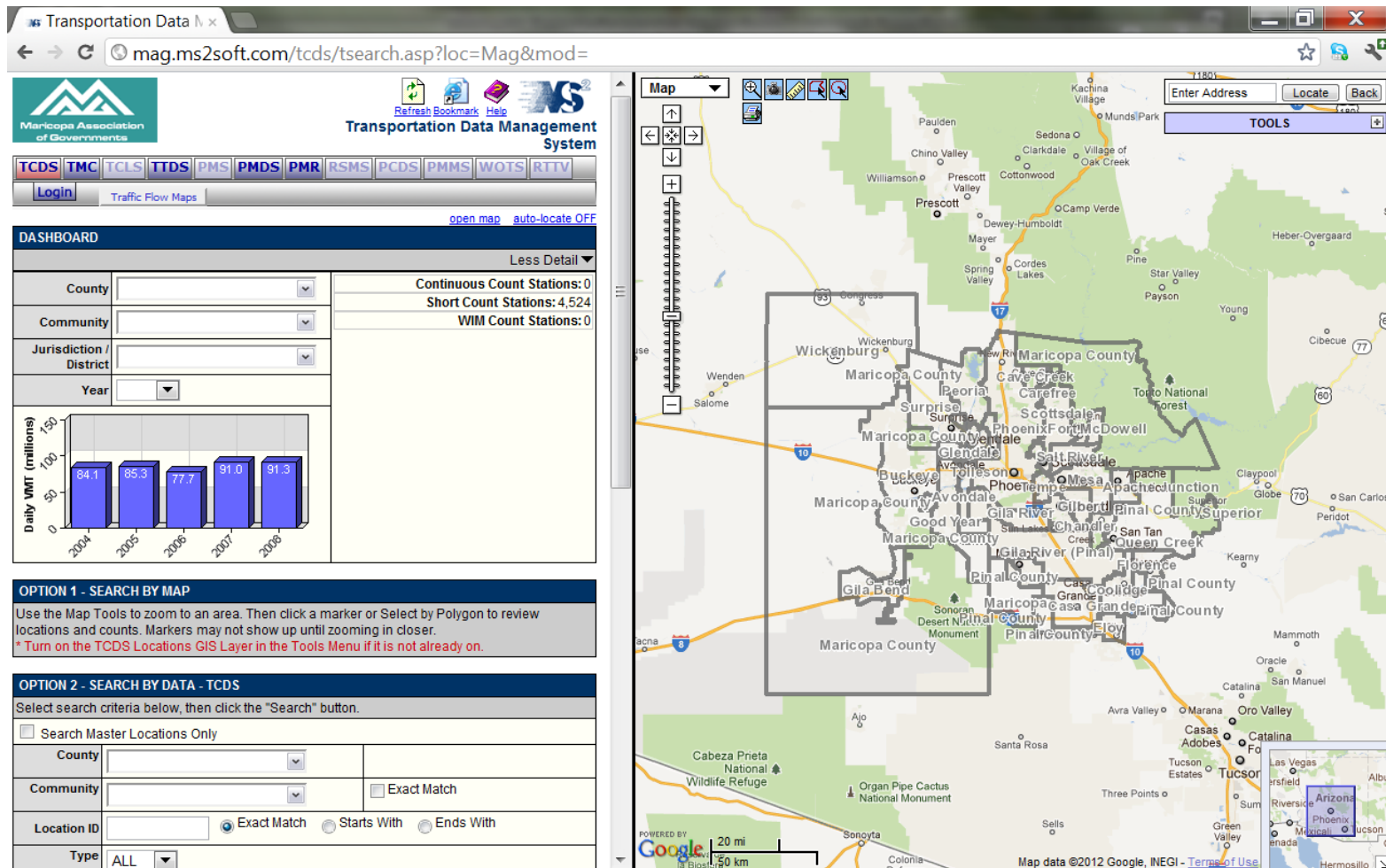
How will data be maintained and used?

- Networks
 - Geodatabase or master network with base and future scenarios
 - All streets networks or limited
- Land uses
 - Building permits to track changes
 - Supplemental surveys for government, schools and major employers
- Counts (Traffic, Transit, Bikes, Pedestrians)
- Parking Inventories

Geo- database at Puget Sound Regional Council



Transportation Data Management System at Maricopa Association of Governments



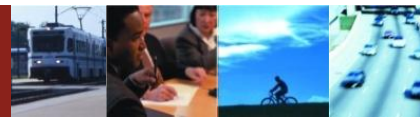
Stepping Away from the Edge: Postponing Activity-Based Model Development

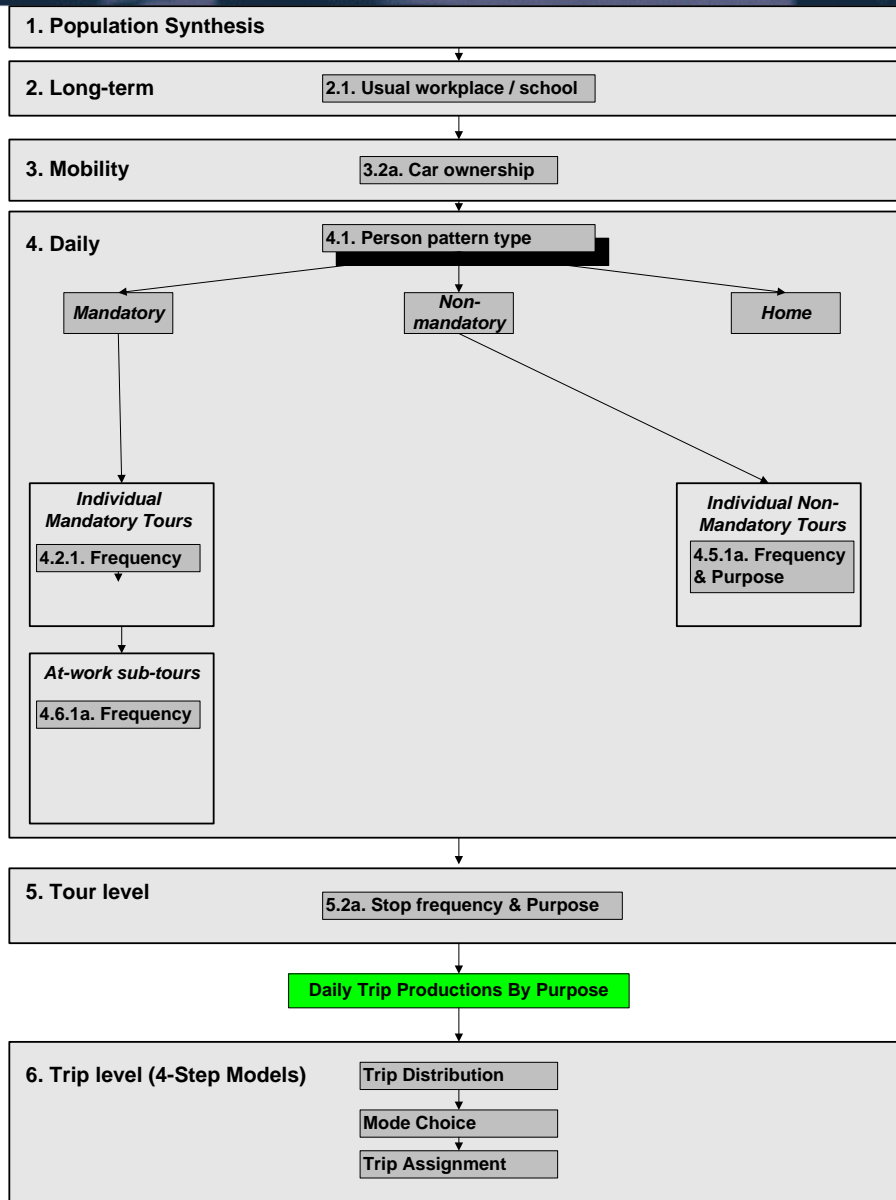
- If the time is not right...
 - Consider a gradual transition to a hybrid system
 - Stakeholders should take the time to prioritize “wants” versus “needs”
 - Begin to acquire additional data to upgrade your trip-based model system
 - Highway system volume and speed data (INRIX, AirSage)
 - Transit data
 - University, visitor/airport surveys
 - Land use and socioeconomic forecasting methods



Transitional Model Development

- Population Synthesizer
- Auto Ownership/Availability (if not already present)
- Usual Workplace and School Location Choices
- Activity Generation to replace Trip Productions
- Destination Choice to replace Gravity Models
- University models, visitor models, airport models



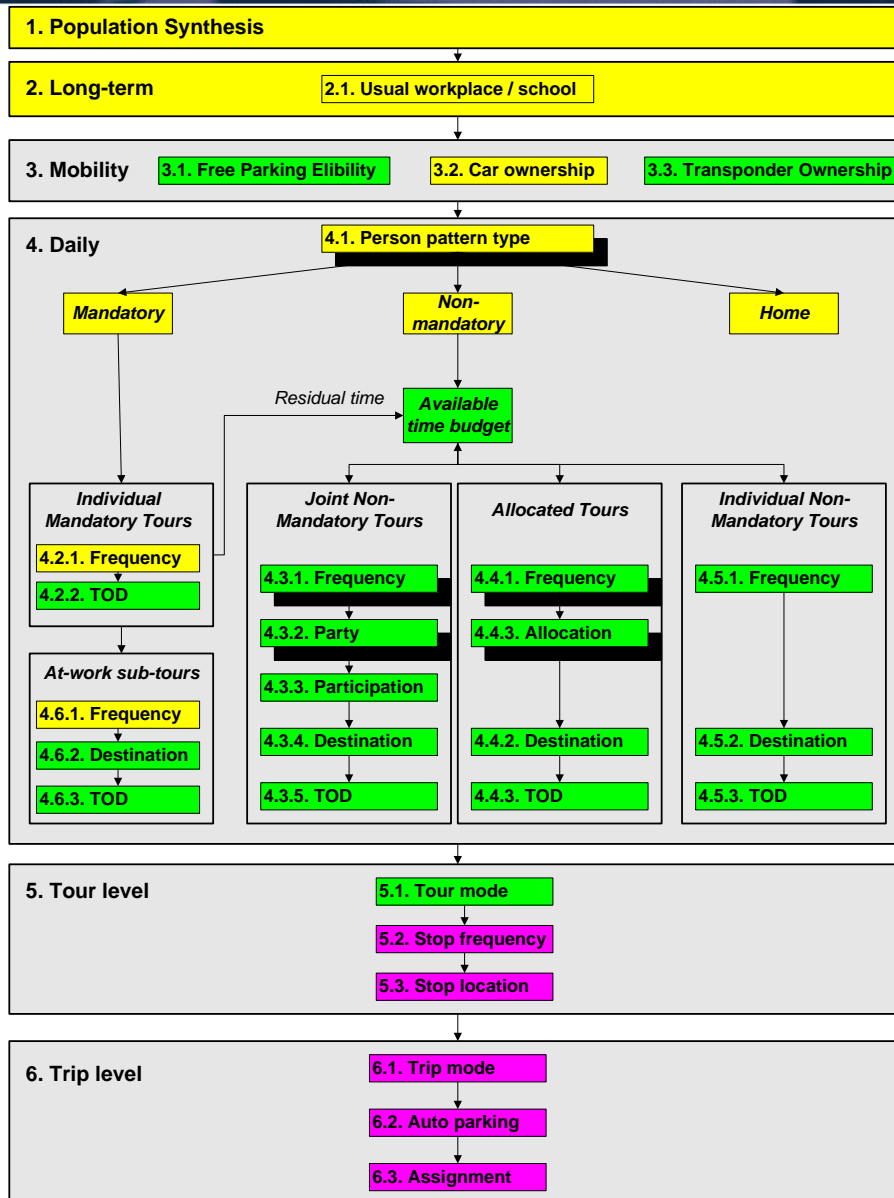


Simplified Activity-Based Model for SANDAG

Year 1 (2009):

Simplified activity-based travel generation models estimated, implemented, and calibrated





SANDAG Development Schedule

Year 1

- Pop Synthesis & Long-Term Models
- Coordinated Daily Activity Pattern
- Simplified Tour Frequency Models
- 4-Step Integration and Testing

Year 2

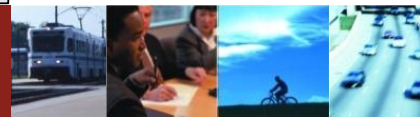
- Remaining Tour Frequency Models
- Remaining Mobility Models
- Joint & Allocated Tours
- Destination and Tour Mode Choice

Year 3

- Stop Frequency
- Stop Location Choice
- Trip Mode Choice
- Parking Location Choice

Year 4

- System Calibration & Validation
- Special Market Models
- Full PECAS Integration
- Sensitivity Testing



Review: Learning Outcomes

- Discuss the process used to develop, calibrate, validate, and implement an activity-based model
- Discuss the criteria that agencies should consider when evaluating whether an activity-based model may be right for them
- Discuss high-level model design decisions that will need to be made when embarking on activity-based model project, as well as alternative transitional development paths





Questions and Answers

The **Travel** Model
Improvement
Program

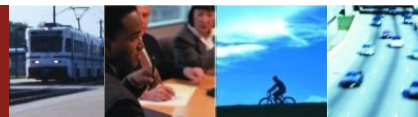
2012 Activity-Based Modeling Webinar Series

Executive and Management Sessions

Executive Perspective	February 2
Institutional Topics for Managers	February 23
Technical Issues for Managers	March 15

Technical Sessions

Activity-Based Model Basics	April 5
Population Synthesis and Household Evolution	April 26
Accessibility and Treatment of Space	May 17
Long-Term and Medium Term Mobility Models	June 7
Activity Pattern Generation	June 28
Scheduling and Time of Day Choice	July 19
Tour and Trip Mode, Intermediate Stop Location	August 9
Network Integration	August 30
Forecasting, Performance Measures and Software	September 20



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