SERPM 8.0 Model Update

Model Design Plan

approved

plan

prepared for

RTTAC-MS

prepared by

Cambridge Systematics, Inc.

with

Connetics Transportation Group

Gannet Fleming

February 15, 2017

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report

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1.0 Overview

This document presents the plan for the update to the Southeast Florida Regional Planning Model (SERPM). This model update will represent version 8.0 of the SERPM model. This model update project is being led by a consultant team consisting of Cambridge Systematics, Inc. (CS), Gannett Fleming (GF), and Connetics Transportation Group (CTG).

SERPM 7 is calibrated to a 2010 base year and 2040 forecast year. The model structure and parameters were transferred from San Diego Association of Governments (SANDAG) and the constant terms were calibrated using NHTS over-sample data, where available. SERPM 7 was the first activity-based model developed for the region.

Beginning in 2018, the MPOs in the SERPM region will prepare the 2045 LRTP that will use a 2015 base year. In addition to supporting the new LRTP, the model update will serve a variety of county and regional transportation plans, project development and environmental (PD&E) planning, multimodal corridors studies, freight studies, and toll studies among others.

There are several challenges to modeling transportation in the SERPM region, including:

- Expanding managed lane facilities with dynamic tolls;
- Varied resident population with strong retirees and young immigrant households;
- Large tourist industry;
- Multiple transit operators and modes; and
- An oblong geography with several urban centers.

These challenges were met to some degree by SERPM model, but the SERPM 8.0 model update will take the next step to 'tune up' and improve the model accuracy as well as to make the model easier to use for the various plans, projects, and studies.

This report describes the overall model structure and the components of the model that will be developed by the CS team. The report is organized as follows:

- **Section 1.0 – Overview**: describes the high-level model structure, model update purpose and needs, and a summary of the key stakeholder and model user surveys;
- **Section 2.0 – Model Input Data Requirements**: describes the exogenous data needed to run the model including the socio-economic / land-use data, highway and transit networks, and travel behavior data.
- **Section 3.0 – Demand Components**: reviews the aggregate and disaggregate demand components, describes the current model operation and identifies aspects that will be updated for SERPM 8.0.
- **Section 4.0 – Assignment**: describes the highway and transit assignment process.

The model design plan is complemented by three other reports:

- **Model Validation Plan**: describes the validation process, validation tests to be executed, and the data sets to be utilized.
- **Model Usability Plan**: describes the planned improvements to the SERPM usability, including the installation process, model interface and folder organization, Cube Catalog design, scenario support, and reporting features.
- **Model Training and Documentation Plan**: describes the documentation coverage and medium as well as the training approach around webinars, tutorials, and case-study driven self-learning modules.

1.1 Overall Model Structure

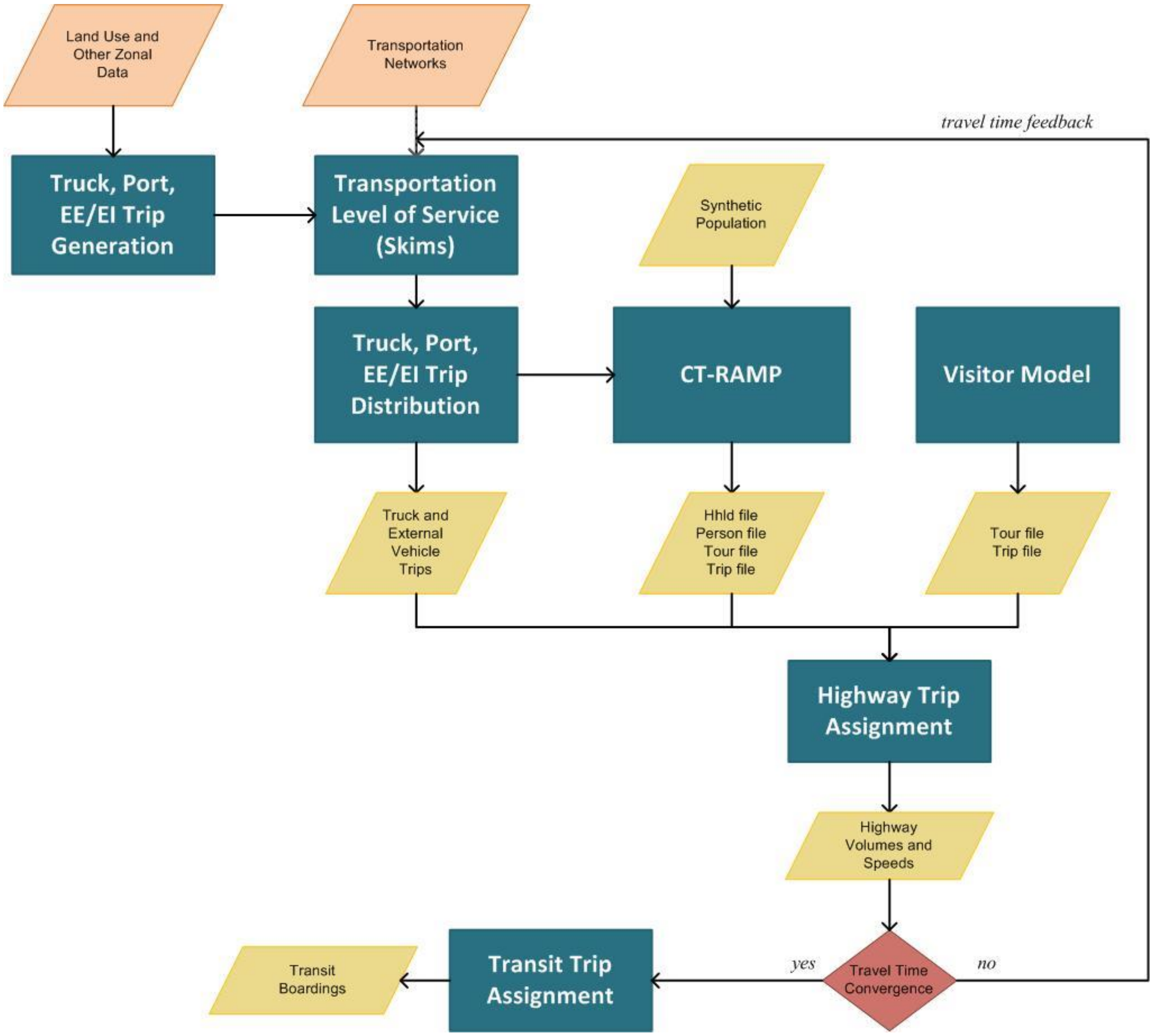
The SERPM 8.0 overall model structure will be highly similar to the current SERPM 7 model structure, shown in Figure 1-1.

Visitor and resident travel that is internal to the region is simulated disaggregately. Figure 1-1 shows these as two separate components although both are implemented in the CT-RAMP software program.

Truck, external (external-external / external-internal / internal-external), and special generator trips at port locations are simulated aggregately at the zonal level. Generation is independent of network conditions, distribution is sensitive to networks.

Auto and truck trips are assigned to the highway network on each iteration until the model has converged. Once convergence is reached, the transit trips are assigned.

Figure 1-1: SERPM 7 Overall Model Flow



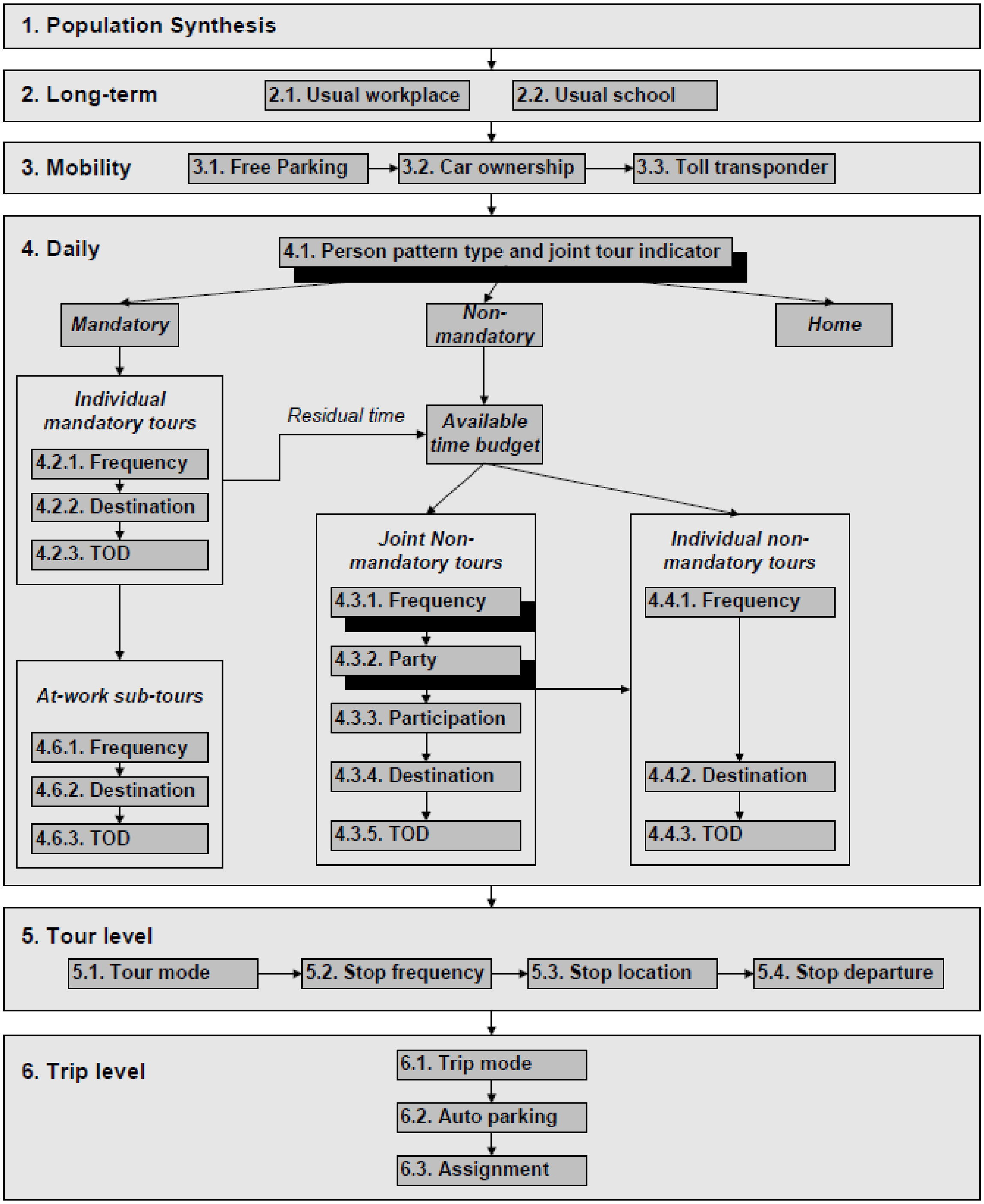
Source: SERPM 7 Model Development Report – DRAFT February 2015

The disaggregate demand component structure, shown in Figure 1-2, will also remain largely unchanged from the SERPM 7 design.

The choice sequence begins with long-term choices of school and work location for students and workers, followed by household-level choices on car ownership and transponder ownership. Next, for each person in the synthetic population, the level, location and timing of mandatory and non-mandatory travel are simulated. Coordinated travel within a household, fully-joint travel, is also simulated.

Once the number, location and timing of tours is simulated, the tour-level choices are made around mode and, if there are intermediate stops, the stop location and timing. Finally, the trip mode and parking location are simulated.

Figure 1-2: SERPM 7 Disaggregate Demand Model Flow Diagram



Source: SERPM 7 Model Development Report – DRAFT February 2015

As part of this model update, the primary software will remain as Citilabs' Cube and the Coordinated Travel Regional Activity-Based Modeling Platform (CT-RAMP) activity-based modeling program.

1.2 Model Update Purpose

The primary motivation for the SERPM 8.0 model update is to support the 2045 LRTP. In addition to supporting the new LRTP, the model update will serve a variety of county and regional transportation plans, project development and environmental (PD&E) planning, multimodal corridors studies, freight studies, and toll studies among others.

In preparation for this document, the CS team conducted a series of interviews with the RTTAC-MS members. The team also prepared a short survey and contacted users in the modeling community through the November FSUTMS Southeastern Florida Users Group meeting and email lists. The model users were invited to submit their feedback on their experiences running the SERPM 7 model and to identify areas where they would like to see improvement for SERPM 8.0.

This section first summarizes the key stakeholder interview responses and then the model users.

1.2.1 Summary of responses from RTTAC-MS interviews

The interviews were structured to identify the primary needs for the model update, a detailed description of the SERPM 8.0 model, desired results, and acceptance criteria from the perspective of the key stakeholders.

The overwhelming response from the RTTAC-MS is that the model update needs to improve the accuracy and reliability of the forecasts. Moreover, the members specially emphasized the need to improve the transit forecasts.

A close second in project priority is to improve the accessibility and usability of the model. Many users had challenges installing and running the model and have not been able to make use of the plethora of data generated by the ABM system. RTTAC-MS users want to see better reporting in the SERPM 8 platform, specifically reports that draw upon the disaggregate demand data. In response to this priority, the CS team has decided to address model usability in a dedicated Model Usability Plan document.

The RTTAC-MS would also like to see more capability in the model to represent emerging technology and travel behavior. Emerging technologies, changing demographics, and shifting attitudes and preferences are positioned to disrupt travel patterns as we currently know them. Millennials are comfortable with using a wider array of options to address their activities and are eschewing or delaying automobile ownership at a time when an aging Baby Boomer population is also looking for transportation alternatives. Ubiquitous Internet expands the ability to accomplish the same tasks that used to require trip making (e.g., teleworking; telecommuting; online schooling, shopping, banking, and entertainment). At the same time, ridesourcing modes facilitated by smartphones increase the mobility options, particularly for those who do not own a vehicle.

Of major interest, connected vehicles and various types of automated and autonomous vehicles (C/AV) represent a breakthrough in surface transportation, with potentially profound implications for land use, travel behavior, transportation investments, safety, and economic productivity. While there is not likely to be a full consensus on how C/AV will benefit and/or impact transportation networks until we actually see them on the roadways, there is general agreement that the potential for change is high. On top of the uncertainty in timing, there is a range of possible scenarios under which these technologies will develop and be able to operate on public roadways. Beyond improvements to safety, operating costs, reliability, and throughput, effects on travel behavior are not very well understood. Many indicators point to C/AV becoming a reality, at least to some degree, within the timeframe of current long range planning horizons.

That said, to date, only a few state or regional long range planning processes have considered the implications of these emerging travel trends on transportation needs of the future. The Florida Department of Transportation District Four Planning and Environmental Management Office recently sponsored an exploration of using innovative techniques, tools, and data to consider travel behavior changes due to emerging technology and demographic changes. The lessons learned from this project will be incorporated into the model design to add the capabilities in this model to represent the changing behaviors.

1.2.2 Summary of responses from SERPM 7 model users survey

The CS team invited input from the model user community through the FSUTMS Southeastern Florida Users Group meeting and email lists. There were eight responses representing seven different consulting firms that had worked with the SERPM 7 model.

Similar to the RTTAC-MS feedback, the model users also cited the transit validation as a key aspect to improve in the model. The model users are also concerned about the model usability, specifically: model portability, i.e. ability to load and run the model on various systems; reporting and visualization; installation support; and guidance for typical applications.

Other aspects to improve that were identified by model users are the following:

- Reporting and data visualization
- Validation by time of day (highway)
- Subarea analysis

Key areas where better model documentation is needed are the following:

- Installation
- Guidance for typical applications with information on model assumptions and limitations
- Model performance
- Performance measures

The CS team will address the documentation and training needs in a dedicated Model Documentation and Training document.

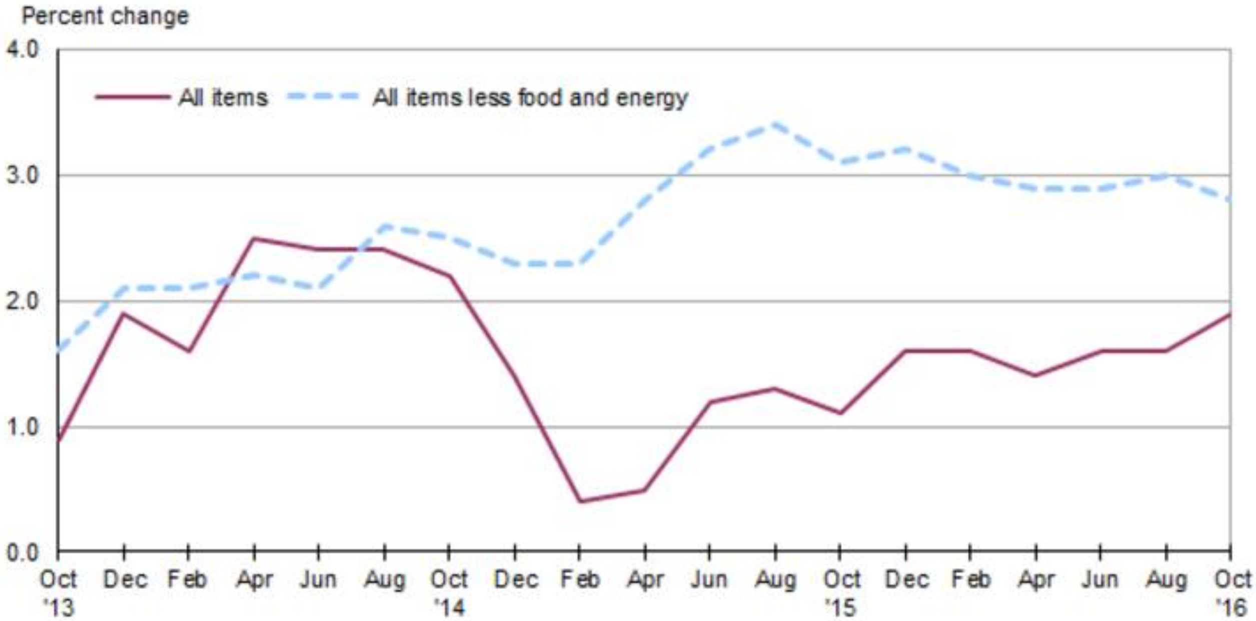
2.0 Model Input Data Requirements

This section describes the data currently used by the SERPM 7 model and the data items that will be needed for re-estimation of the components for the SERPM 8 model.

2.1 Model Year Dollars

It is important that the costs, prices, and incomes all use a consistent year dollar value. SERPM 7 utilizes 2009 dollars. The SERPM 8.0 model base year will be 2015, although the household survey was collected in late 2016 and early 2017. The household survey categorizes income into bins, so a direct adjustment cannot be made, but the consumer price index (CPI) shows a small over-the-year percent change (see Figure 2-1). Therefore the SERPM 8.0 model will use a 2015 dollar value.

Figure 2-1: Over-the-year percent change in CPI-U, Miami



Source: U.S. Bureau of Labor Statistics.

2.2 Zonal / Land Use Data

The updated base year zonal data required for inputs to the population synthesizer and the model follow that of the current model. Aside from small changes being considered, the structure will remain the same.

2.2.1 Spatial Resolution

SERPM 7 has three levels of spatial resolution:

- Traffic Analysis Districts (TADs), which are made up of
- Traffic Analysis Zones (TAZs), which are made up of
- Micro-Analysis Zones (MAZs);

The number, size, shape of TAZs and MAZs will be unchanged in the SERPM 8 model update. SERPM 8 will use the 2010 TAZs, MAZs, and TADs.

The transit network also implements Transit Access Points (TAPs), which are described in Section 2.2.

2.2.2 Synthetic Population

The population synthesizer produces a set of households and persons whose activities are simulated by the model. To mirror the people in the observed population or projected population, households are drawn from a sample set subject to control totals. Each TAZ has control totals for key demographics as shown in Table 2-1. On the left are person-level variables and on the right household-level. The input dataset will have an entry for each TAZ and counts of people or household for each category in each zone. The resultant household and person datasets will have an entry for each person and household, respectively, with their TAZ and characteristics. SERPM includes a residential location choice model that allocates these households to MAZs.

Table 2-1: PopSynII Control Totals

Persons:			**Households:**		
Age			Income in 2009 dollars		
	1	0-4		1	<$25,000
	2	4-14		2	$25,000-$50,000
	3	15-17		3	$50,000-$75,000
	4	18-24		4	$75,000-$100,000
	5	25-34		5	$100,000 or more
	6	35-54	Household size		
	7	55-64		1	1
	8	65-79		2	2
	9	80+		3	3
Occupation				4	4+
	1	Unemployed	Number of Workers		
	2	White collar labor		1	0
	3	Service labor		2	1
	4	Retail labor		3	2
	5	Blue collar labor		4	3+
Gender			Type of Housing Unit		
	1	Male		1	Single-Family
	2	Female		2	Multi-Family
Race/Ethnicity				3	Mobile Home
	1	Hispanic	Presence of Children in Household		
	2	White Non-Hispanic		1	No children present
	3	Other Non-Hispanic		2	One or more children
			Group quarters*		
				1	Institutionalized
				2	College
				3	Other

*Group quarters are not counted in the household segments.

PopSynII minimizes the difference between the synthetic and observed populations in the totals in each category simultaneously. This ensures, for example, that the number of two worker households is close to the zonal target as well as the number of white collar workers. Counts for all of these variables will be necessary for each zone, and the totals must match – i.e. the total households in size categories must match the total in types of housing units and the household size values must be consistent with the number of persons in the person categories. These are all univariate distributions.

The control totals for the 2015 base year will use 2015 dollars, but with the same income breakpoints. The produced population has a continuous income value, although maintaining a consistency between the PopSyn control totals and the model income segments will assure that the simulated market segments are appropriately sampled. The specific income segments will be determined following a review of the household survey data and analysis of travel behavior by income segment.

2.2.3 Model Input Data

The model takes the synthetic population as well as demographic summaries as input. The summary variables relate to zonal characteristics outside the home, such as employment, enrollment, and parking. Instead of the TAZs used as input to PopSynII, these are needed at the more disaggregate MAZ level. They should be consistent with each other as well as with the PopSynII control totals. Table 2-2 shows this input data.

Table 2-2: Input Data for SERPM by MAZ

Total number of households	Employment
Total population	(See categories below)
School Enrollment	School District
Grade School (K-8)	Elementary
High School (9-12)	High School
Major College	Parking
Other College	(See variables below)
Adult School	Total hotel rooms
Private K-8	Shopping mall flag
Private 9-12*	Beach acres
	Daily Enplanements

*Private high schools (9-12) are in the SERPM 7 data plan but not in its input data files

School enrollment is broken down into 5 education levels or types. These categories reflect differences in travel behavior, particularly mode, person type, and time of day. School districts can be used to influence the destination choice for children's school trips. Special areas – beaches, airports, and malls – are included as explanatory variables for conditions not captured completely in the employment numbers. The shopping mall flag is a binary variable, while the beach acres and daily enplanements are integer values. Parking variables describing cost and availability are shown in Table 2-3.

Table 2-3: Parking Input Data

MAZ Space Availability On/Off Street	Cost, in 2010 dollars
Hourly	Hourly cost of hourly parking

Daily	Daily cost of daily parking
Monthly	Daily cost of monthly parking

Calculations within the model run produce additional variables such as densities and accessibility indices. The accessibilities are computed using logsums from destination and mode choice models. The “floating” densities are calculated for intersection by taking a sum of the intersections within a circle of a ½ mile radius centered on the MAZ. The population, households, and employment densities are calculated as the total values and acres of all MAZs with a centroid within ½ mile. Mixed residential-employment density is calculated by the product of the household and employment densities divided by their sum.

The 16 employment categories are shown in Table 2-4 below. The values will be sourced from FDOT InfoGroup and ES-202 file from Florida Department of Economic Opportunity’s Quarterly Census of Employment Wages (QCEW). Accurate distribution of employment geographically and by industry is essential for allocating work and other types of activities, as well as associating behavioral characteristics associated with those activities.

Table 2-4: Employment Categories

1.	Agriculture, Mining, Forestry, Fishing	9.	Post-Secondary Education
2.	Construction	10.	Health Services
3.	Utilities	11.	Personal Services
4.	Manufacturing	12.	Amusement Services
5.	Wholesale Trade, Warehousing	13.	Hotel and Motel Services
6.	Transportation	14.	Restaurant and Bar Services
7.	Retail Trade	15.	Government
8.	Professional, Business Services	16.	Elementary and Secondary Education

The zonal data provided by the MPOs and partner agencies will be compiled and reviewed to assure that the values and format are correct.

2.2.4 Area Type and Terminal Times

SERPM 7 does not utilize terminal times or pre-designated area types although the functionality is there to input terminal times through the MAZ data file. Some localized characteristics can be measured using the accessibility and density. The model calculates a “dynamic area type” based on population and employment densities for each TAZ including TAZs within ½ mile. CBD TAZs are defined exogenously, and the threshold density values are used to define the other 4 area types: fringe, OBD (other business district), generally residential, and rural. SERPM 7 2040 area types are shown in Figure 2-2 and Figure 2-3. The area types are fairly contiguous, without many pockets of different area types or large steps between area types.

Figure 2-2: SERPM 7 2040 Area Types

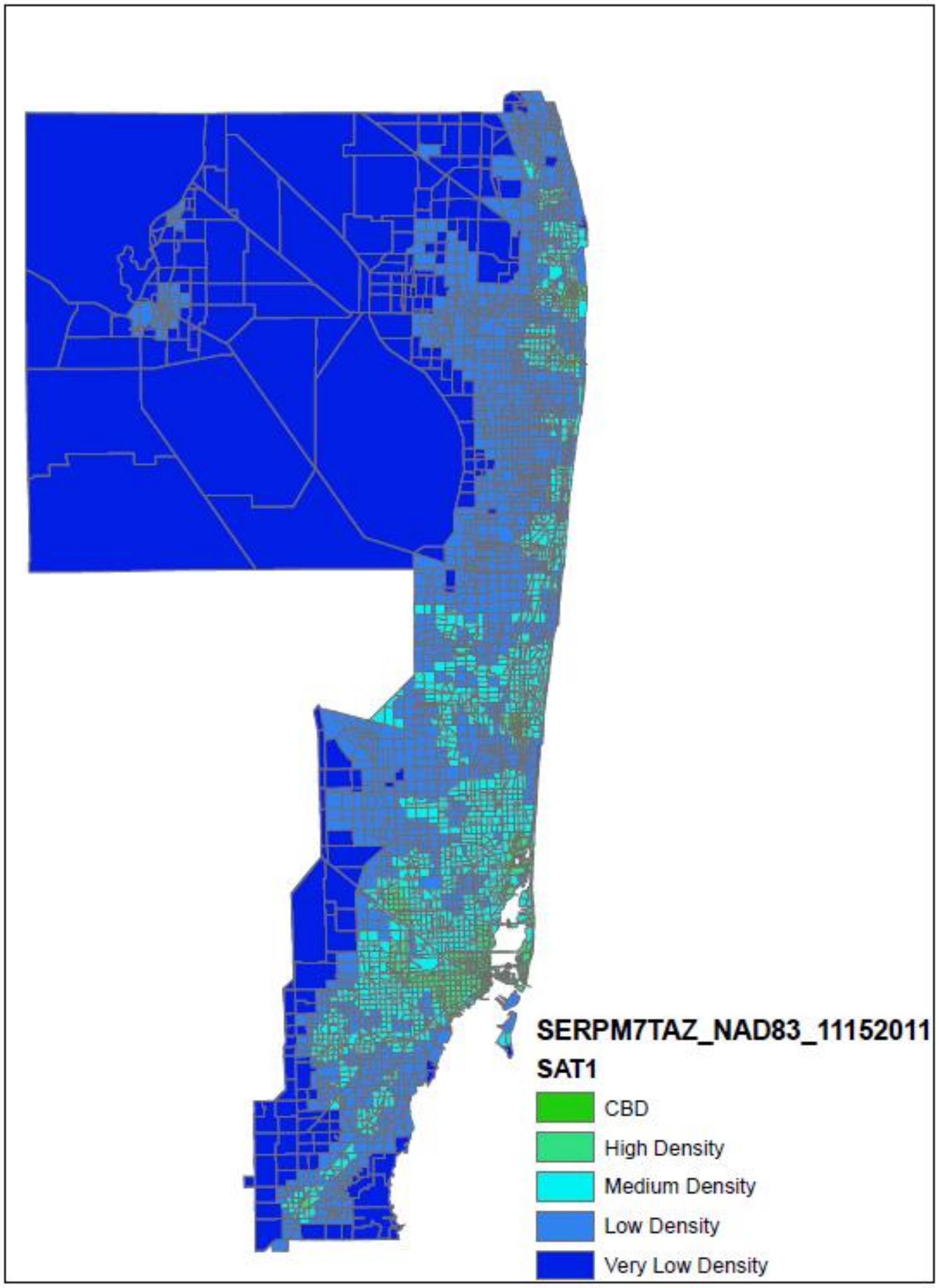
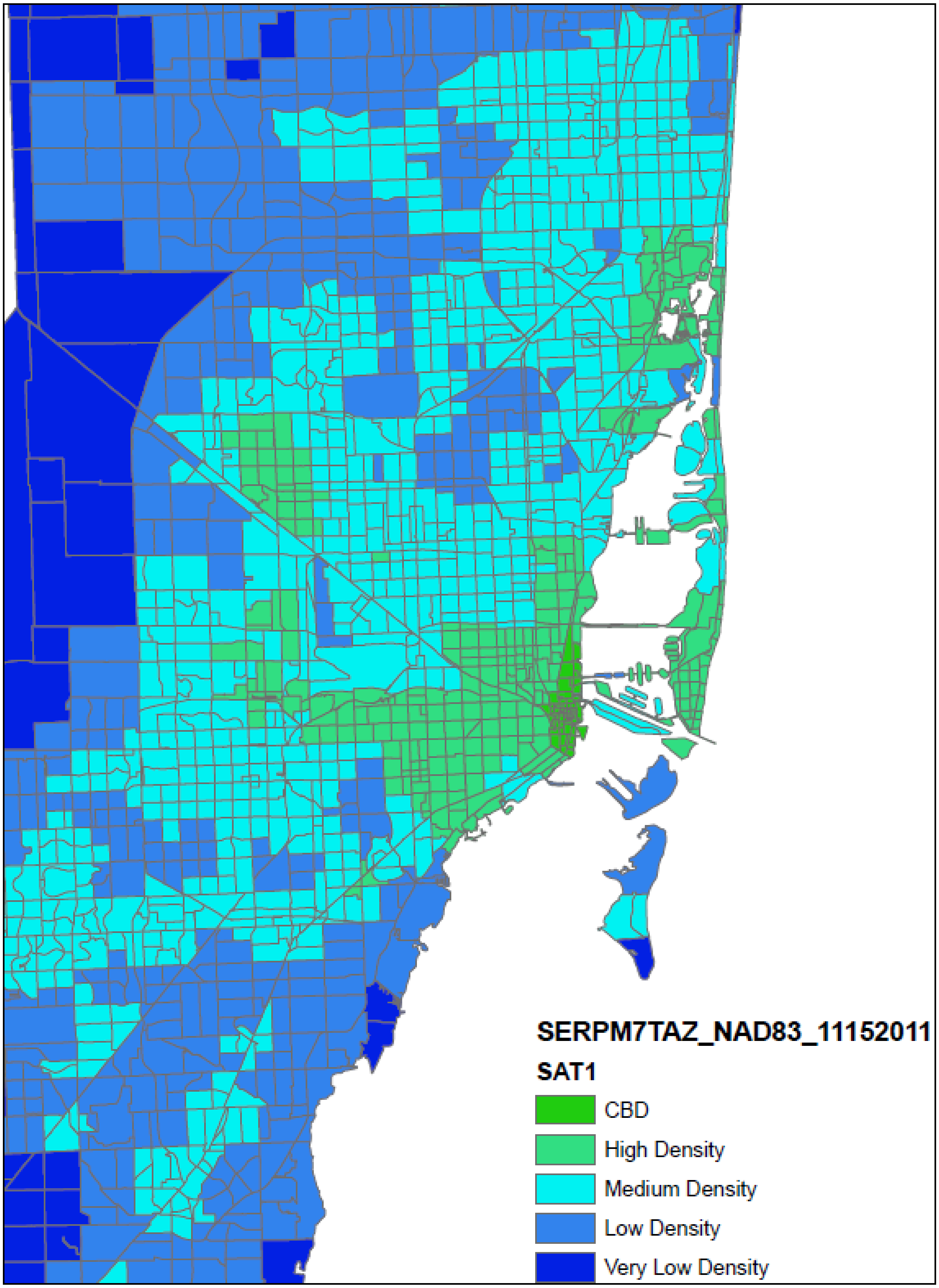


Figure 2-3: SERPM 7 2040 Area Types – Miami



2.3 Networks / Level of Service Variables

2.3.1 Time Periods

The SERPM 7 model has five time periods defined for assignment, as defined in Table 2-5. The disaggregate demand components take as input three time periods: AM peak, PM peak, and off-peak. The off-peak period represents the Midday and Evening periods. The three time periods are input for both Highway and Transit. Transit is assumed to be unavailable between 10PM and 6AM.

Table 2-5: SERPM 7 Assignment Time Periods

Number	Description	Begin Time	End Time
1	Early	10:00 P.M.	5:59 A.M.
2	A.M. Peak	6:00 A.M.	8:59 A.M.
3	Midday	9:00 A.M.	2:59 P.M.
4	P.M. Peak	3:00 P.M.	6:59 P.M.
5	Evening	7:00 P.M.	9:59 P.M.

2.3.2 Highway Network and Skims

This section first describes the SERPM 7 transit network and skimming procedures and describes potential improvements to the transit network and skimming that will be done as part of the SERPM 8.0 update.

Network attributes

The SERPM 7 highway network is maintained in Cube Voyager format. This network includes all streets of facility type collector or above. The cost of using the toll facilities is coded on the network links at the point where the cost is incurred (i.e., location of toll plazas and collection points). The cost of using the managed lanes is computed as a function of the volume-to-capacity ratio on the managed lane facility, based on a function developed by Florida Turnpike Enterprises. The input network includes an attribute to account for reversible lanes. The efficacy and usefulness of the dynamic toll function is under review by FDOT. Currently, the total facility volume is fed into a post-processor with a dynamic toll calculation for revenue estimations and the direct output of the dynamic toll process in SERPM 7 is not utilized.

Highway skims

The highway network is used to produce the following skim data for each of the three time periods:

- Drive alone – general purpose lanes only:
  - time, free-flow time, and distance
- Drive alone – general purpose and toll facilities:
  - time, free-flow time, distance, toll, distance on toll facilities
- HOV – general purpose lanes only:

  - time, free-flow time, distance, distance on HOV facilities

- HOV – general purpose and toll facilities:

  - time, free-flow time, distance, toll, distance on toll facilities, distance on HOV facilities

The in-vehicle travel times are measured in minutes and estimated as a function of free-flow travel time and volume delay curves. Volume delay is determined as a function of the volume to capacity ratio for the time period being estimated. The current volume-delay functions will be used and adjusted if necessary during the assignment validation process.

Network-based models generally calculate the travel time between zones (interzonal time) as a function of the travel time required to traverse from one zone to another. Intrazonal travel times cannot be calculated in this manner, because the modeled trips do not use the roadway network and the time within a zone would be calculated as zero. Intrazonal time in the SERPM 7 model is computed as 25% of the average time to the nearest two zones.

The highway assignment model uses travel time and toll with a value-of-time (VOT) in the calculation of generalized costs, which serve as the basis of the skimming and path-building. Since the model system uses generalized costs as inputs to various ABM components (such as destination choice, mode choice, and time-of-day choice), the assumed value-of-time in the highway assignment is related to the rest of the model system in many ways. The SERPM 7 model uses a $15 / hour peak VOT and 12$ / hour off-peak VOT.

Distance between an origin and a destination is calculated total of the link lengths used in the shortest path. If there are multiple paths used, an average for all paths used in the highway network will be used. This can vary by time period since the path from an origin to destination can be affected by congestion in the system. Distance is estimated in miles.

Potential Improvements to the Highway Network and Skims

The highway network will be updated with the latest capacity improvements. Non-motorized network data features will be added into the SERPM highway network as well as the intersection and roadway median attributes to later support meso/microscopic highway simulations.

The 2010 highway network will be updated to include all capacity improvements that were built since 2010 through 2015. The 2015 forecast networks that have been developed for project work will be made available to us. The provided forecast networks will be verified and checked against completed projects. Noted inaccuracies in the network alignment and other coded features of highway facilities will also be corrected.

The network data task will also assemble all available GIS-based pedestrian and bicycle network attributes, roadway median identifications, and intersection attributes. We will review the available data and propose field and value typology to identify these attributes in the highway network. A 2015 highway baseline network with the updated data will be produced.

The relevant operational data will be accessed in coordination with FDOT from project stakeholders and update the highway network. Where the network fields are insufficient to identify relevant data, we will propose a field and value typology to identify these attributes.

The distinction between general purpose and HOV facilities in the HOV skims will be assessed and removed if it is not contributing to the models explanatory power. It is not clear what basis this distinction has in traveler behavior and may be an artifact of the SANDAG model that can be removed.

2.3.3 Transit Network and Skims

This section first describes the SERPM 7 transit network and skimming procedures and describes potential improvements to the transit network and skimming that will be done as part of the SERPM 8.0 update.

Network attributes

The current model maintains the routing, mode and fare information for each transit line and each transit provider in the region:

- Miami-Dade Transit (MDT),
- Broward Transit (BCT),
- Palm Tran, and
- South Florida Regional Transportation Authority (SFRTA), which operates Tri-Rail.

For each fixed route bus operator (MDT, BCT and Palm Tran), one or more transit mode codes are defined that segment the transit service into six major mode groups:

- Local bus;
- Express bus;
- Bus rapid transit (BRT);
- Light rail transit (LRT);
- Heavy rail (subway); and
- Commuter rail.

The operator / mode code structure gives full flexibility to represent specific fare structures and operating characteristics, such as dwell time differences. This structure can accommodate anticipated future transit projects. However, SERPM 7 implements 33 different mode codes, potentially far more than the actual difference in transit modes perceived by the riders. In addition, it complicates network coding process for model appliers.

The transit networks include other information that is not currently used by the model, such as the number of spaces at park and ride nodes and sub-mode codes that distinguish local and limited-stop buses.

Transit frequency and availability by time of day are specified in the transit network files. Transit stops are not used directly, instead a set of transit access points are identified, as described in the following section.

2.3.4 Transit Time Functions

Transit time functions are used to account for the fact that transit vehicles have to stop and pick up passengers along the route, and typically travel at slightly slower speeds than passenger cars due to their size and weight. The transit time functions are used to estimate transit travel time as a function of highway travel time. In-vehicle time for the rail modes is coded directly on the rail segments while in-vehicle time for the routes operating in mixed traffic is computed as highway time plus a dwell time per stop.

Transit Access Points

The SERPM 7 transit network end nodes are identified transit access points (TAPs), which are a subset of transit stops coded into the network. TAPs are identified as:

- All stops coded on Commuter Rail routes are identified as TAPs;
- All stops coded on Urban Rail and Light rail routes are identified as TAPs;
- All stops coded on People Movers and Circulators are identified as TAPs;
- All stops coded on Express Bus and BRT routes are identified as TAPs; and
- First and last stop on Local Bus routes are identified as TAPs. Additional stops located at approximately 0.5 mile intervals are identified as TAPs. Stops that are used by multiple routes are also identified as TAPs.

Transit Skims

The SERPM 7 model generates transit skims between transit access points. The skims are segmented into paths that only involve local-bus service and paths where premium (non-local-bus) transit is also available. The TAP to TAP premium mode skims may not include any premium transit modes, it is only that the premium modes are available to use.

The local-bus only TAP-level transit skims contain the following matrix cores:

- Number of Transfers
- In-Vehicle travel time
- Transit Fare
- Initial wait time
- Transfer wait time
- Transfer time

The local and premium mode skims contain the following matrix cores:

- Number of Transfers

- In-Vehicle travel time – one matrix core per mode: Commuter Rail, HRT, LRT, BRT, Express Bus, Local Bus
- Primary mode identifier for the path, i.e. the highest level transit mode in use;
- Transit Fare
- Initial wait time
- Transfer wait time
- Transfer time
- Total travel time
- Path mode: indicates the transit sub-mode that is used for the longest distance on the transit path.

The TAP-TAP skims are then combined with access/egress links to build MAZ to MAZ paths by walk and drive access modes. The effective skimming approach in the model is implemented in three parts.

1. TAP to TAP paths:
    - Segmented by time of day and whether premium transit modes are used
    - Paths are discovered according to the total travel time, which includes in-vehicle time, weighted initial wait and transfer time, weighted transfer walk time, and boarding and transfer fares represented as boarding/transfer time penalties.
    - Initial and transfer wait times are calculated as half of the combined headway, which implies random arrivals at transit stops, but is not necessarily appropriate for transit service with long (>20 minute) headways where travelers would time their travel to arrive close to the scheduled departure time.
2. Access and egress generation:
    - Walk access and egress links are generated using a complete street network to find all the TAPs that are within walking distance of a MAZ. Limited access roadways such as freeways and interstate highways are excluded from the walk paths. The complete street network may not include all walking facilities, but does ensure that natural barriers, such as waterways that are ubiquitous in the SERPM region, are represented.
    - Drive access links are generated using the model highway network to find the two TAPs closest to each MAZ for each transit sub-mode, within maximum distance thresholds specified by mode and type of park-and-ride (PnR) facility (formal and informal).
3. Combine and find shortest path: Find a single shortest path between each MAZ pair by transit sub-mode and access mode by combining the access and egress mode paths with the TAP to TAP path.

Potential Improvements to the Transit Network and Skims

It is important that estimates of transit impedance be as accurate as possible from the very beginning of the model development process. The effort involved with preparing a model estimation dataset is significant, so all aspects of the transit impedance matrices should be carefully reviewed prior to their use. This review is typically done by developing a transit person trip table from a large scale transit onboard survey, assigning these trips to the transit network, and revising assignment parameters until assigned ridership corresponds to counts to an acceptable degree of accuracy. Key questions to be answered during this process include:

1. **What are the appropriate access and egress choices?** The current choice model allows walk access and two types of drive access (Park-and-Ride and Kiss-and-Ride) but constrains all egress modes to be walk. Drive egress, particularly from the premium transit mode stations, is observed at a substantial level on Tri-Rail. Additionally, ridesourcing is becoming more prevalent in the Southeast Florida region and there is increased interest in testing the complementary and competitive impact of ridesourcing on transit.

2. **What are the appropriate transit line-haul choices?** SERPM 7 is set up to separately model local bus, express bus, BRT, LRT, HRT, and commuter rail. Recent research[1] indicates there may be alternate ways of identifying transit sub-modes that may be helpful in reducing the values of alternative specific constants in mode choice models.

3. **What are the appropriate path parameters?** Test assignments will be used to determine the relative importance of in-vehicle time, waiting time, walking time, transfers and fare. Assignment results will be compared to observed ridership patterns and adjusted as necessary. During this phase of the analysis, it may be determined that a simple assessment of the minimum generalized cost of transit is insufficient to generate appropriate paths, in which case strategies for favoring some types of transit paths over others will be explored. Options include:

    - Testing the desirability of using different weights for walk time to reflect the fact that walking in some areas (downtown or transit-oriented development locations) is more pleasant than walking in areas involving large blocks, fast moving arterials, or the absence/limited availability of sidewalks.

    - Implementing sub-mode preferences for individual links on a path by discounting the perceived travel time, transfer time, or boarding time for selected “premium transit” modes. (e.g., light rail or subway).

    The calibrated time weights and sub-mode preferences will be implemented in a consistent manner in tour and trip mode choice.

4. **How accurate are the estimates of transit running times?** In-vehicle time for the rail modes is coded directly on the rail segments while in-vehicle time for the bus modes is computed as highway time plus a dwell time per stop. As part of the model update, the highway travel time and dwell times will be updated through a transit speed calibration procedure. This may involve network updates, dwell time adjustments and modal definition changes. The modeled speeds will be made consistent

[1] Outwater, M., J. Lobb, B. Sana, N. Ferdous, B. Woodford, D. Schmitt, J. Roux, C. Bhat, R. Sidharthan, R. Pendyala, and S. Hess. *Characteristics of Premium Transit Services that Affect Choice of Mode*. TCRP H-37 Final Report, Transit Cooperative Research Program, Transportation Research Board, 2014.

with the observed speeds through the development of 2015 transit speeds by line and by time period.

5. **What is the impact of transfers, beyond the additional waiting time?** Errors in the boarding and transfer penalties will be corrected. The survey data will be used to obtain a reasonable estimate of preliminary transfer penalties. Several coefficients which are not consistently applied in the path building and mode choice steps will be updated.

6. **Is half the headway a reasonable assumption for commuter rail service and other low-frequency transit lines?** Using half the headway implies that passengers arrive at the initial stop in a random fashion, which is not necessarily true of services with long headways where passengers can time their arrival to minimize waiting time at the stop and there are real-time arrival predictions available.

7. **Are Park and Ride (PnR) lots over-assigned in the model?** A non-capacity constrained transit assignment process may simulate more PnR trips through a given parking lot than there is parking capacity. If this is the case, shadow-pricing may be applied to the over-assigned lot to shift demand to paths using other PnR lots.

8. **Which modes should be identified separately in the network?** There are many distinct transit modes defined in the network. SERPM 7 currently has 33 mode and 19 operator identifying codes. The mode numbers may be simplified to facilitate reporting and new scenario definitions, see Table 2-6. Even with the simplified mode code definition structure, the model will be adjusted to give full flexibility to represent specific fare structures and service operating characteristics, such as travel time, dwell time and modal characteristics differences. This structure will be able to accommodate anticipated future transit projects as well.

Table 2-6: Current and Proposed Transit Mode Codes

Route Type	SERPM 7 Operator and Mode Codes: Operator / Fares System Code – Code	Operator / Fares System Code – Name	Mode – Code	Mode – Name	SERPM 8 Proposed Mode Code
Tri-Rail	11	Tri-Rail	111	Commuter	111
Trolleys/Shuttles-Reg	12	Tri-Rail Shuttles	191	Local	191
Trolleys/Shuttles-Reg	*12*	*Tri-Rail Shuttles*	*192*	*Local*	Remove
Metrorail	25	Metrorail	121	Urban Rail	221
Regional LRT		*Regional LRT*	*131*	*Urban Rail*	131
Inter-County Express Bus	33	I-95 Inter-County Express (MDT or BCT)	151	Express	151
Exclusive ROW Cir-Reg	*13*	*Exclusive ROW Circulator*	*181*	*Local*	Remove
LRT	*25*	*MDT LRT*	*231*	*Urban Rail*	231
Busway Flyers	27	MDT Busway Flyers	241	BRT	291
MAX/KAT Buses	27	MDT MAX/KAT	242	Local	291
BRT	*28*	*MDT BRT*	*243*	*BRT*	241
Express	22	MDT Express	251	Express	251
I-95 Express	24	MDT I-95 Express	252	Express	151
Inter-County Express	24	I-95 Inter-County Express	253	Express	Remove (Coded as 151)
Metromover	26	Metromover	281	Local	281
Trolleys/Shuttles	*21*	*MDT Trolleys/Shuttles*	*291*	*Local*	291
Local Bus	21	MDT Local	292	Local	291
Shuttle	*23*	*MDT Shuttle*	*293*	*Local*	291
LRT	*35*	*BCT LRT*	*331*	*Urban Rail*	231
Rapid Bus	*34*	*BCT Rapid Bus*	*341*	*Local*	241
BRT	*35*	*BCT BRT*	*342*	*BRT*	241
Breeze	32	BCT Breeze	351	Local	291
Express	*33*	*BCT Express*	*352*	*Express*	151
Exclusive ROW Circulator	*31*	*BCT Exclusive ROW Circ.*	*381*	*Local*	281
Trolleys/Shuttles	*31*	*BCT Trolleys/Shuttles*	*393*	*Local*	291
Local Bus	*31*	*BCT Local*	*391*	*Local*	291
Local Bus	31	BCT Local	392	Local	291
LRT	*43*	*Palm Tran LRT*	*431*	*Urban Rail*	231
BRT	*43*	*Palm Tran BRT*	*441*	*BRT*	241
Express	*42*	*Palm Tran Express*	*451*	*Express*	251
Exclusive ROW Circulator	*41*	*Palm Tran Exclusive ROW Cir.*	*481*	*Local*	281
Trolleys/Shuttles	*41*	*Palm Tran Trolleys/Shuttles*	*491*	*Local*	291
Local Bus	41	Palm Tran Local	492	Local	291

2.3.5 Non-Motorized Network and Skims

SERPM 7 calculates walk travel distances from MAZ to MAZ by building shortest distance paths on an all-streets network, excluding freeways. The travel time is derived from the distance assuming 3 mph walk speed. The bike travel distance is measured from TAZ to TAZ using the model highway network, and travel time is derived assuming a constant 12 mph bike speed.

In this model update, we will explore representing bike distances at the MAZ to MAZ level as well.

2.4 Survey Data for Estimation and Validation

The household survey data are the first data items required for the model estimation. The survey is currently being conducted in the SERPM region. Once processed, the survey data will be organized in three relational databases described as the household file, person file and trip file. The trip file will be reprocessed using several criteria related to activity types, joint travel and intermediate stop-making to develop tour profiles for survey respondents. Each of these files provides key variables necessary to develop tour, trip, and long-term decision-making models. Table 2-7 shows the variables that are expected to be available or will be derived from the data and used in model estimation. Other variables may be derived from those listed in the table, but the basic information is fully contained in this table.

Table 2-7: Expected Data Items from Survey Dataset

Description	Details
BASIC PERSON & HH VARIABLES	
Household ID number	Survey ID field
Person ID number	Survey ID field
# people in household	
# vehicles in household	(Dependent variable for auto ownership model)
Total household income level	Categorical household income
Gender	1=male, 2=female
Age	Years
Employment status	1=employed full-time, 2=employed part-time, 0=not employed
Student status	1=enrolled full-time, 2=enrolled part-time, 0=not enrolled
Type of school enrolled in	1=preschool, 2=K-12, 3=post-HS, 0=not enrolled
Relationship to respondent	1=Head, spouse, partner, 2=other HH member, 3=visitor
DERIVED PERSON & HH VARIABLES	**DERIVED FROM BASIC PERSON & HH VARIABLES**
Person type	Derived (e.g., 1=full-time worker, 2=part-time worker, 3=retired 4=other adult, 5=university student, 6=driving age high school student, 7=child age 5-15, 8=child age 0-4)
# employed HH members	Derived by adding across HH members
# student HH members	Derived by adding across HH members
# HH members by person type	Derived by adding across HH members
PERSON/HH LOCATION VARIABLES	
Household residence ID number	Survey ID field
Household residence X coordinate	Geocode
Household residence Y coordinate	Geocode
Household zone	Geocode (Dependent variable for population synthesizer)
Regular work location id	Survey ID field
Regular work X coordinate	Geocode
Regular work Y coordinate	Geocode
Regular work zone	Geocode (Dependent variable for regular work location model)
DAY PATTERN-LEVEL VARIABLES	**CREATED BY TOUR & PATTERN FORMATION CODE**
# home-based tour records	
# home-based tours by tour type	Dependent variables for day activity pattern models
# work-based subtour records	
# intermediate stops by stop purpose	Dependent variable for day activity pattern models

Expected Data Items from Survey Dataset (continued)

Description	Details
TOUR-LEVEL VARIABLES	**CREATED BY TOUR & PATTERN FORMATION CODE**
Tour ID number (in priority order)	Created ID field
Subtour parent tour ID (work based subtour only)	Created ID field
Subtour ID within parent tour (work based subtour only)	Created ID field
# of subtours within tour	Dependent variable for subtour frequency/purpose model
Primary destination activity purpose	(1=work, 2=school, 3=serve passenger, 4=personal bus., 5=shopping, 6=meal, 7=social/recreation)
Tour origin outbound departure time	
Primary destination arrival time	Dependent variable for tour times of day model
Primary destination departure time	Dependent variable for tour times of day model
Tour origin return arrival time	
Primary destination location id	Survey ID field
Primary destination X coordinate	Geocode
Primary destination Y coordinate	Geocode
Primary destination zone	Geocode (Dependent variable for tour destination model)
Tour primary mode	Codes to be decided (Dependent variable for tour mode model)
# trips in outbound tour half	Dependent variable for tour stop frequency/purpose model
# trips in return tour half	Dependent variable for tour stop frequency/purpose model
TRIP-LEVEL VARIABLES	**CREATED BY TOUR AND PATTERN FORMATION CODE**
Trip tour half	1 or 2, Created ID field
Trip ID within tour half	Created ID field
Trip origin activity purpose	Same codes as primary destination activity purpose
Trip destination activity purpose	Same codes as primary destination activity purpose
Trip origin location ID	Survey ID field
Trip origin X coordinate	Geocode
Trip origin Y coordinate	Geocode
Trip origin zone	Geocode (Tour destination, or destination of previous trip)
Trip destination location ID	Survey ID field
Trip destination X coordinate	Geocode
Trip destination Y coordinate	Geocode
Trip destination zone	Geocode (Tour origin, or dependent variable for stop location)
Trip mode	Same codes as tours (Dependent variable for trip mode model)
Trip origin departure time	Dependent variable for trip departure time model
Trip destination arrival time	

The data in Table 2-7 are split into six main categories:

1. **Basic person and household variables**. These are the truly exogenous variables. In application, these will be taken from the U.S. Census Public Use Microdata Sample (PUMS) records in the synthetic sample, and so certain variables from the household survey may need to be recoded in a way that is consistent with PUMS coding.

2. **Key-derived person and household variables**. These variables are developed using the definitions of the basic variables. One such important variable is person type, which has been found to be very useful in other activity-based models and is in use in the SERPM 7 model. While the specific person type categories for this model will emerge from an analysis of the household survey data, typical classifications include full-time worker, part-time worker, driving-age child, child below driving age (and occasionally infant as a separate category), nonworking adult, and senior. Note that additional variables can be derived from these and used in specific models – e.g., a dummy variable for female adults with one or more children aged 0-4.

3. **Person and household location variables**. This is the start of the endogenous variables in the model system. In application, the household location (at the zone level) will be predicted by the population synthesizer, and the regular work zone will be predicted by the choice models.

4. **Day pattern-level variables**. These are created by the code that processes trips into tours. They are person-day counts of the numbers of home-based tours and intermediate stops for each of the seven proposed activity purpose types, plus the count of the number of work-based subtours made. In application, these will be predicted by the day activity pattern model(s).

5. **Tour-level variables**. These are also generated by the tour formation code and contain all the variables needed to model a tour: purpose, timing, destination, mode, the number of intermediate stops on each half-tour, and the correspondence between work tours and subtours. In application, these will all be predicted by the various tour-level models.

6. **Trip-level variables**. Some of these variables are also created by the tour formation code. The variables include trip origin and destination location and purpose, trip departure and arrival time, and trip mode. In application, these will either already be known from the tour-level predictions (e.g., the locations for half-tours with no intermediate stops), or will be predicted by the trip-level models.

To prepare these data items, tour formation code will be used, which sets up the data in these structures. Also note that there are other variables in the survey that might be interesting from a behavioral sense, but there is no means of easily forecasting them, and so it is not proposed to include them in the estimation data or models. These include:

- Residence building type;
- Tenure at residence;
- Auto make and model;
- Auto fuel type;
- Auto own/lease type;
- Bicycle ownership;
- Driving license status;

- Job occupation and industry;
- Job workplace type;
- Job flextime status;
- Travel disability;
- More detailed activity purpose coding than used in models;
- More detailed mode coding/combinations than used in models;
- Activity place type;
- Which vehicle each trip was made in; and
- Self-reported parking cost paid and payment method.

2.4.1 Onboard Transit Survey Data

Onboard transit survey data contain information on the respondent's current transit trip. This includes trip starting and ending location, trip start time, time spent waiting for the transit vehicle, access and egress modes, as well as several socioeconomic characteristics of the respondent like gender, age, and vehicle availability. There are several sources of transit data from the four transit operators in the SERPM region. Table 2-8 shows the recent transit surveys and highlights any issues that may limit their usefulness for SERPM 8.0.

Table 2-8: Transit Surveys

Agency/System	On-Board Survey Year	Notes on 2015 Expansion
Tri-Rail	2013	O/D information not sufficient; MIA station closed when the survey was conducted. Supplement data using the 2008 survey.
Palm Tran	2015	System-wide (or district-level) information should be generated only; may need to supplement information with the 2009 on-board survey
BCT	2010	2015 expanded data available through previous studies
MDT Metrobus	2012-2015	Low sample rate; does not cover all routes in the system; only system-wide targets likely
MDT Metromover	2015	Only high-level targets by purpose and access modes
Metrorail	2009	No survey available for modeling purposes after the new line serving MIA station became operational
I-95/I-595 Express	2012	Major service re-organization on routes operated by BCT

Transit person trip table(s) will be developed from the on-board survey and assigned to the model's transit network to evaluate the modeled path-building procedures and parameters, to evaluate access and egress coding for walk, park-and-ride and kiss-and-ride, and compare prediction-success tables between modeled and observed travel patterns for choosing the appropriate mode choice structure for SERPM 8 (discussed in the next section).

3.0 Demand Model Components

This section summarizes the current operation of and potential changes to the demand components, including the accessibility measures that are calculated each iteration; synthetic population generator, residential internal travel demand components, visitor components, and the aggregate demand models (truck, special generators, externals).

The SERPM 8 model update will utilize the same microsimulation software, CT-RAMP, as is used for SERPM 7. As such, changes to the model structures may be constrained by the capabilities of the software and will be implemented only when well justified.

3.1 Accessibility Measures

In SERPM 7, accessibility measures are utilized by the long term and mobility models. These measures include auto, transit, and non-motorized accessibilities to both mandatory and non-mandatory activities.

The accessibility measures will retain the same segmentation and structure, but will be updated using the new household survey data.

3.2 Population Synthesis

The population synthesis process will be unchanged as part of the SERPM 8.0 model update. However, the implementation of the population synthesizer may be ported from SQL Server to a more available platform, such as the R statistical software, as part of a separate project.

3.3 Resident Internal Travel Demand Models

This section reviews the overall structure and sequence of the SERPM 7 resident internal demand models and identifies model structure and specification changes and a new components. Unless otherwise noted, each component will be re-estimated using data from the new household travel survey.

A major risk of this model update is the availability of a usable household travel survey data set by May 2017. Updating the resident internal travel demand models primarily relies on this survey data set and samples of particular market segments, depending on the model specification. The tables in each model section identify areas of the model that are anticipated to be updated, either because there was insufficient data in the SERPM 7 model to calibrate it well or because of an issue in model calibration. The tables also identify the SERPM 7 calibration that was implemented, which used the NHTS dataset. In several places, the models were not able to be calibrated at the market segment level. These market segments will need to be well represented in the household survey data for it to be useable in estimation.

3.3.1 Long Term Models

The long term model components, listed in Table 3-1, are the residence, usual work, and school locations. The usual work location model has two parts. First a binary model is simulated to determine whether the workplace is located at home. Second the work location is simulated, if work not at home was simulated in the first step. School location models are segmented into four child types: preschool, grade-school, high-school, and college. The workplace and school location choice models use a shadow-pricing routine where the size functions are modified to match the number of workers by type with the distribution of employment types in each MAZ.

Table 3-1: Long Term Models

Model Name	Decision-Making Unit	What is Predicted	Specification / Structure Changes	SERPM 7 Calibration
Residential Location Choice	Household	Residence location zone (MAZ)	Segment by income type and household size	No
Work from home	Worker	Workplace location within or outside of the home	None	No
Out of home workplace location choice	Worker	Workplace location zone (MAZ)	Piecewise linear distance; area type controls	Distance and county flows only - shadow pricing used to adjust size terms segmented by worker
Preschool location choice	Persons age 0-4	Preschool location zone (MAZ)	Piecewise linear distance	No
Grade school location choice	Persons age 5-13	School location zone (MAZ)	Piecewise linear distance District boundaries Private school locations	Distance terms
High school location choice	Persons age 14-17	School location zone (MAZ)	Piecewise linear distance District boundaries Private school locations	Distance terms
University location choice	College Student	School location zone (MAZ)	Piecewise linear distance	Distance terms

Of these models, the residential location, work from home, and preschool location models were not calibrated based on data from the SERPM region.

The **residential location** model is simply an allocation model based on the distribution of households by type within each MAZ of the TAZ. The model uses the housing type from the synthetic population sampled data to determine which household type distribution to use as MAZ weights. It may be better to simulate the choice of housing type based on income or family size. We will determine if the survey data supports segmenting the distribution by income and will update the model accordingly.

The **work from home** model is a binary choice and is sensitive to worker type, gender, income, age and the presence of children in the household.

For the **usual workplace location** choice model, area type as a categorical or continuous density variable will be considered since it can influence workplace location choice as it takes agglomeration affects into account, along with inclusion of retail accessibility at the workplace location as it can influence the workplace sub-tour models. The retail accessibility at the workplace location can be obtained from retail employment at the MAZ level.

The SERPM 7 **school location choice** models do not consider district boundaries. These can be useful to represent the constraints for public students to attend a school within their district. By interacting this term with income, the correlation with higher income students attending private schools outside of their district can also be represented. Private schools are not currently available in the zonal data. If this data is available and can be forecasted, it may be included in the model inputs.

Distance Formulations

For both the usual workplace and school location models, as well as the other destination choice models, we will explore using a different distance formulation.

Non-linear distance formulations are common to capture the different sensitivity to a single unit (mile) change in distance between destinations that are close to the origin zone and those that are far away. For example, the utilities of two zones with the same attractions but a 1 mile different distance should be more similar if they are far away (say 99 and 100 miles) than if they are close (say 4 and 5 miles). A non-linear distance formulation is also convenient in calibration if the modeled trip length distribution does not reproduce the observed distribution. To represent this complex response, models have implemented distance with polynomial, natural log, and piecewise linear formulations. The destination choice models estimated for the SANDAG region and calibrated for SERPM 7 are formulated with a polynomial distance representation. However, it is difficult to recognize where a polynomial formulation generates a positive slope without calculating the distance term for a range of inputs and this can cause problems during calibration.

A piecewise linear formulation estimates several linear terms with different starting offsets. For example, if the trip length distribution has the most variation in distances less than 20 miles the models would be estimated with 5 mile distance increments under 20 miles and 10 mile increments over 20. In this case, the model formulation would be:

- Distance in miles
- Max(Distance in miles – 5, 0)
- Max(Distance in miles – 10, 0)
- Max(Distance in miles – 15, 0)
- Max(Distance in miles – 20, 0)
- Max(Distance in miles – 30, 0)
- Max(Distance in miles – 40, 0)

In application, the sum across the terms is applied to the distance variable by the distance range. The effective distance ranges from the model formulations are shown in Table 3-2.

Table 3-2: Effective Piecewise Linear Distance Ranges

Begin mile	End mile
0 miles	4.99 miles
5 miles	9.99 miles
10 miles	14.99 miles
15 miles	19.99 miles
20 miles	29.99 miles
30 miles	39.99 miles
40 miles	maximum

The resulting piecewise linear term must be monotonically decreasing. Furthermore, coefficients with a large magnitude and alternating sign indicate over-fitting of the model. We will examine the trip length frequencies from the household survey data and select breakpoints accordingly.

Shadow Pricing

Current Shadow Pricing Implementation and Issues. The shadow pricing process in SERPM7 applies to the usual workplace and usual school location long-term choice models. The purpose of this process is to balance the simulated demand for conducting activities in a zone with the employment and enrollment levels present in the zone. The shadow price calibration is an iterative process whereby the size term in the destination choice model is adjusted to effectively making a zone more or less attractive based on the simulated demand from the previous iteration. In application, the shadow price essentially acts as a K-Factor in the way that it influences the modeled trip distribution.

During the SERPM7 model calibration, a single set of work and school shadow prices were developed with the intention that these would be applied across all forecast years. Later, in model application, slightly modified shadow prices were developed for the 2040 forecast year. Recently, model application projects have been delayed by further recalibration of the shadow prices, which can have a substantial impact on the model results.

Proposed Approach to Utilize Shadow Pricing in SERPM8. The use of shadow prices to balance the distribution of usual workplaces and schools is common model practice and it is desirable to have a reasonably good balance between the work and school activities and the levels of employment and enrollment within each zone. The SERPM8 model will continue the use of shadow prices for these two components, but will incorporate some key enhancements to address the issues seen in the SERPM7 application.

The primary enhancement will be to replace the current procedure's convergence application. The current application gives the user control over the number of shadow pricing iterations, but not much insight into what is happening during each iteration or when the prices are sufficiently calibrated. In SERPM8, the sufficiency of the shadow prices will be defined by thresholds on the percentage differences for each zone.

The number of zones outside of the threshold by employment and school type will be reported after each run of the usual workplace and school location models. The thresholds will be developed based on observed model sensitivities.

Another key enhancement will be that the application of the shadow prices will be well documented and described through case study examples. The shadow prices should not necessarily be changed with each model scenario. For example, a change in the network accessibilities will lead to a change in activity distributions, but does not warrant a recalculation of the shadow prices. Recalibrating the shadow prices for each scenario reduces the sensitivity, and forecasting power, of the model. However, changes in employment levels may require a recalibration of the shadow prices, especially if there is a large change in concentrated areas. The threshold reports will help guide the modeler to know if a recalibration is advisable.

3.3.2 Mobility Models

The mobility models, listed in Table 3-3, include the subsidized parking availability, auto availability, ridesourcing propensity, and toll transponder ownership.

The **Employer Parking Provision and Reimbursement** model will be updated to 2015 using the same model structure. An additional enhancement can be to consider the percent of government employment as an additional explanatory variable because of the way parking is reimbursed for government employees in South Florida. These would be applicable to white collar employees only.

Auto Availability will replace the SERPM 7 "**Car Ownership"** model to allow for car-sharing programs. The SERPM 8 model will test the impact of transit availability to usual workplace locations in addition to the accessibility measures implemented in SERPM 7. We will also explore implementing an **Auto Technology** component to simulate the level of connected / automated vehicle technology for the household vehicles. This component would be used in future mobility scenario analysis.

We will explore developing a **Willingness to Ridesource** model to simulate whether household members would use ridesourcing modes. This component will be useful to support future mobility scenarios and may include household factors such as income, age range, auto availability, and household/workplace area types. The reason for including it as a new model rather than as an enhancement to the Car Ownership model is keep the model structure consistent and not disrupt the car sufficiency variables in the daily pattern models. A household that is "willing to ridesource" would have the ridesourcing alternative available in tour mode choice, see Section 3.3.4.

The efficacy of the SERPM 7 **Toll Transponder Ownership** model will be assessed, and this model may be removed from the model stream because it does not necessarily contribute to the forecasting power of the model. The toll for SUNPASS is about $0.25 less than toll-by-plate.

Table 3-3: Mobility Models

Model Name	Decision-Making Unit	What is Predicted	Specification / Structure Changes	SERPM 7 Calibration
Employer Parking Provision and Reimbursement Model	Workers whose workplace is in parking-priced areas	Whether worker has free on-site parking, parking reimbursement, no free/subsidized parking	Include government Employment	None
Auto Availability (Car Ownership)	Household	Number of vehicles available	Availability of transit to workplace	Added zero-car term for multi-worker non-family hhs
Auto technology	Household	Connected / Automated technology level	New Model	N/A
Willingness to Ridesource	Household	Whether household members will use ridesourcing	New Model	N/A
Toll Transponder Ownership	Household	Whether a household owns a toll transponder (SUNPASS) unit	Efficacy will be assessed and this model may be removed.	Developed from SUNPASS user data

3.3.3 Daily Choice Models

The daily choice models simulate the daily activity pattern for each member of the household and the tour frequency, purpose, destination, and timing. The components are listed in Table 3-4.

The potential simplification of the **Coordinated Daily Activity Pattern (CDAP)** would be to reduce the household choices 1 to 5+ to 1 to 4+ because the 2015 5-year ACS data shows that less than five percent of households have 5+ members in the household. This will reduce the number of alternatives from 691 to 216, simplifying estimation and reducing model run time. The survey data will dictate the final number of alternatives.

In the CDAP model, retired persons (defined as non-working over 65) and non-workers are prohibited from making mandatory tours. We will assess the survey data to determine if this assumption holds. For example, some volunteering activities may be considered mandatory.

The **Individual Mandatory Tour Frequency** model simulates the number of work tours (1 or 2) for workers, number of school/university tours for students (1 or 2), and a combined 1 work and 1 school tour for persons who are identified as both students and workers. We will review the survey data to confirm that these alternatives are sufficient. We will also re-assess the SERPM 7 approach to simulate work-from-home persons as not having work tours. Work-from-home timing will not be explicitly available in the household survey, but the non-mandatory travel of a work-from-home person would be different from somebody who is not working at all.

The **Individual Non-Mandatory Tour Frequency** model simulates the number and purpose of non-mandatory tours. The simulated non-mandatory tour types are the following:

- Escort
- Shopping
- Other / Maintenance / Personal Business
- Meal
- Visit / Social Recreation
- Other / Discretionary

Various combinations of 0, 1, and 2 tours of each of these purposes are simulated. We will review the combinations present in the survey and revise the simulated combinations accordingly, with an eye toward by reducing the number of alternatives, if the data support such a simplification.

A similar approach will be taken with the **Joint Tour Frequency and Composition** models whereby we will review the number, and types of tours supported by the model.

The **Time of Day** models simulate the half hour arrivals between 5:00 AM and 1:00 AM. Times prior to 5:00 AM are simulated as a single period as are times after 1:00 AM. This is a reasonable aggregation of the periods and will be maintained in the SERPM 8.0 implementation. The SERPM 7 model overestimates morning peak travel and under-estimates midday travel. During re-estimation of the time of day models, special consideration will be given to terms that shift travel from the peak to off-peak periods.

The **Destination Choice** models will be handled in a similar manner as described in Section 3.3.1. Note that the 'usual' workplace and school locations are actually applied for ALL work, school and university tours, i.e. there is no destination choice at the tour level. This is reasonable for school and university tours, but may not be for work travel, where workers may perform work activities at locations that are not their regular workplaces. The household survey data includes the primary workplace location and the location of each work tour. We will review the survey data and explore incorporating a work tour destination choice model if there are substantial work tours to non-usual workplace locations. This would also allow non-workers to make work tours.

At Work Subtour frequency models have a restricted set of 9 alternatives with work and meal explicitly defined along with an 'other' category and up to 2 total work subtours per person. The work subtour destination and time of day choice models are generic across all tour purposes. We will test purpose specific variables in redeveloping these models to represent the preference for meal tours to go to zones with Restaurant and Bar Services employment and to travel during meal times, for example.

Table 3-4: Daily Choice Models

Model Name	Decision-Making Unit	What is Predicted	Specification / Structure Changes	SERPM 7 Calibration
Coordinated Daily Activity Pattern (DAP)	Household	Personal DAPs (Mandatory, Non-Mandatory, Stay and Home)	Reduce from 1 to 5+ to 1 to 4+. Alternatives reduced from 691 to 216	Adjusted ASCs to fit NHTS distributions
Individual Mandatory Tour Frequency	Person	Number and purpose of mandatory tours for each person.	None	ASCs by person type
Individual Mandatory Tour Time of Day Choice	Tour	Tour departure and arrival half-hour periods	None	ASCs by arrival, departure and duration
Joint Tour Frequency	Household	Joint tour frequency (0,1,2) by purpose of the joint tours	None	Number of tours by HH and tours by purpose
Joint Tour Composition	Joint Tour	Person type (adults only, children only, adults & children) in the tour	None	Party composition and tour purpose
Joint Tour Participation	Persons	Whether each person corresponds to each joint tour.	None	Number of participants
Joint Tour Primary Destination Choice	Joint Tour	Tour primary destination zone (MAZ)	Piecewise linear distance	Distance terms Maximum distance threshold
Joint Tour Time of Day Choice	Joint Tour	Tour departure and arrival half-hour periods	None	ASCs by arrival, departure and duration
Individual Non-Mandatory Tour Frequency	Person	0-3 tours of each type of Non-mandatory activity	Update combinations	ASCs by person type
Individual Non-Mandatory Tour Primary Destination Choice	Tour	Tour primary destination zone (MAZ)	Piecewise linear distance	Distance terms Maximum distance threshold
Individual Non-Mandatory Tour Time of Day Choice	Tour	Tour departure and arrival half-hour periods	None	ASCs by arrival, departure and duration
At-Work Sub-Tour Frequency	Person	Number and purpose of tours by 9 alternatives of work-based sub-tours	None	Number of at-work tours by person type
At-Work Sub-Tour Primary Destination Choice	Tour	Tour primary destination zone (MAZ)	Piecewise linear distance Purpose-specific terms	Distance terms Maximum distance threshold

At-Work Sub-Tour Time of Day Choice	Tour	Tour departure and arrival half-hour periods	Purpose-specific terms	ASCs by arrival, departure and duration

The willingness to ridesource will be built in across all of the daily models to mitigate the impacts of vehicle sufficiency on mobility, i.e. with ridesourcing, mobility will not be as dependent on vehicles available to the household.

3.3.4 Tour Level Models

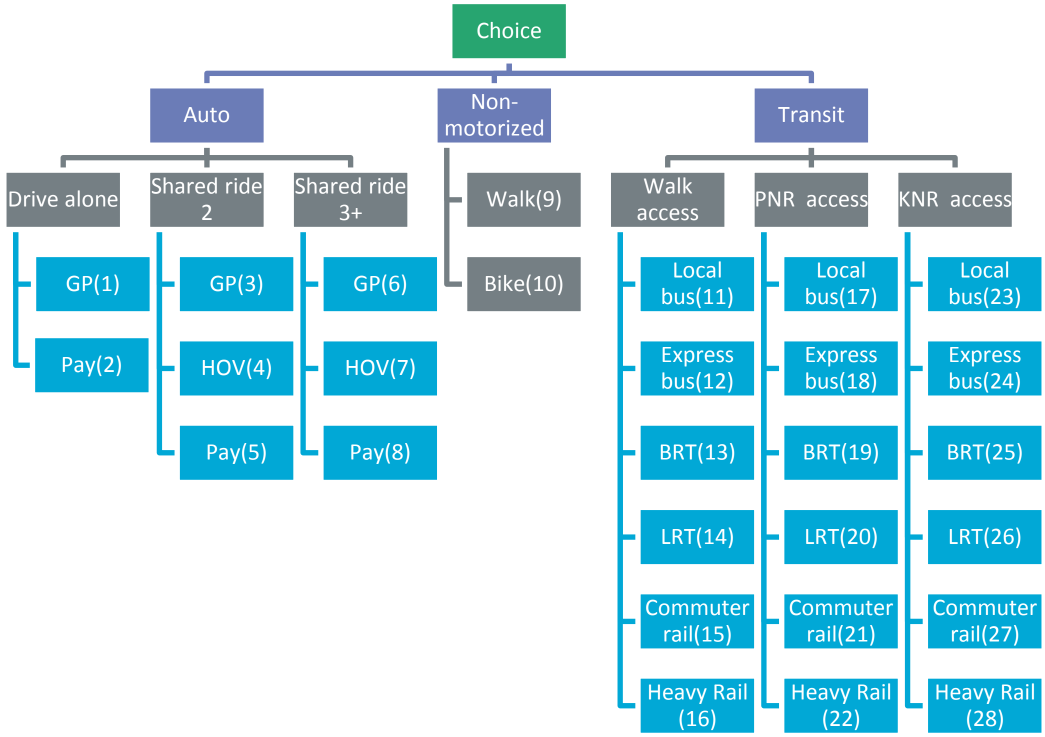
The tour level models, shown in Table 3-5, include the tour mode choice and intermediate stop models.

Table 3-5: Tour Level Models

Model Name	Decision-Making Unit	What is Predicted	Specification / Structure Changes	SERPM 7 Calibration
Tour Mode Choice Model	Tour	Main tour mode	Change to SERPM 6.7 or STOPS or STOPS-Like structure. Include ridesourcing as a mode	Tour purpose, auto sufficiency, time period
Intermediate Stop Frequency Model	Person	Number of intermediate stops (0-3) on the way to/from the primary destination	None	None
Intermediate Stop Purpose	Stop	Stop purpose	Maintain Monte Carlo choice or replace with generic label.	Proportions estimated from NHTS
Intermediate Stop Location Choice Model	Tour	Intermediate stop location (MAZ)	Maintain segmentation between Mandatory and Non-Mandatory tours	Distance
Intermediate Stop Departure Time Model	Tour	Intermediate stop departure time period	Maintain Monte Carlo choice	Proportions estimated from NHTS

The current **tour level mode choice** model, shown in Figure 3-1, has 28 alternatives, of which 26 have a time of day specific path, implying that there are 26 X 3 + 2 = 80 total paths. As discussed in Sections 2.3.2 and 2.3.3, the highway and transit alternatives will be re-evaluated based on their contribution to model accuracy, usability, and forecasting power. The need to evaluate ridesourcing as a separate tour mode further increases the need to evaluate simpler mode choice structures.

Figure 3-1: SERPM 7 Mode Choice Structure



Transit Nest

Several transit nest alternatives will be evaluated using the available on-board survey data, starting with the SERPM 6.7 structure, shown in Figure 3-2, as well as structures that are similar to the FTA STOPS model, shown in Figure 3-3. A potential "STOPS-Like" combination of these approaches is shown in Figure 3-4. In these structures, ridesourcing is available through a drive-egress alternative, which is available to each access mode. Drive-egress observations in the transit on-board surveys are primarily through private shuttle pick-ups or a private auto parked at the transit station. However, incorporating drive egress in the transit paths will support testing with scenarios with increased ridesourcing availability.

Figure 3-2: SERPM 6.7 Transit Mode Choice Structure

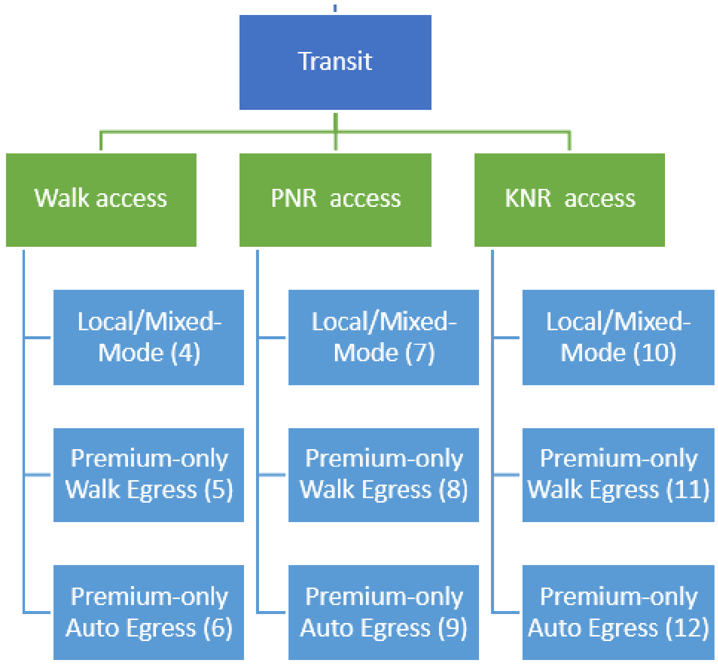


Figure 3-3: STOPS Model Transit Mode Choice Structure

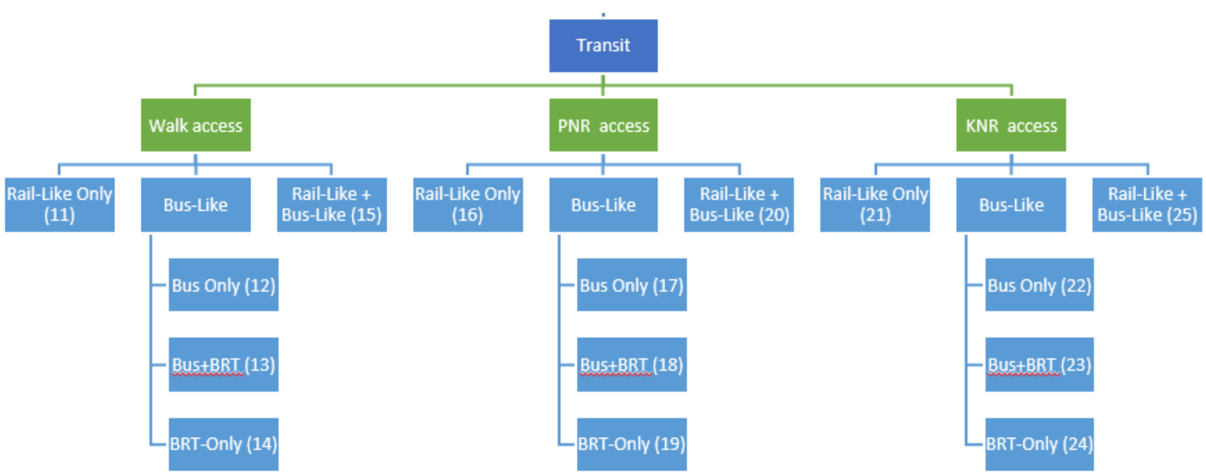
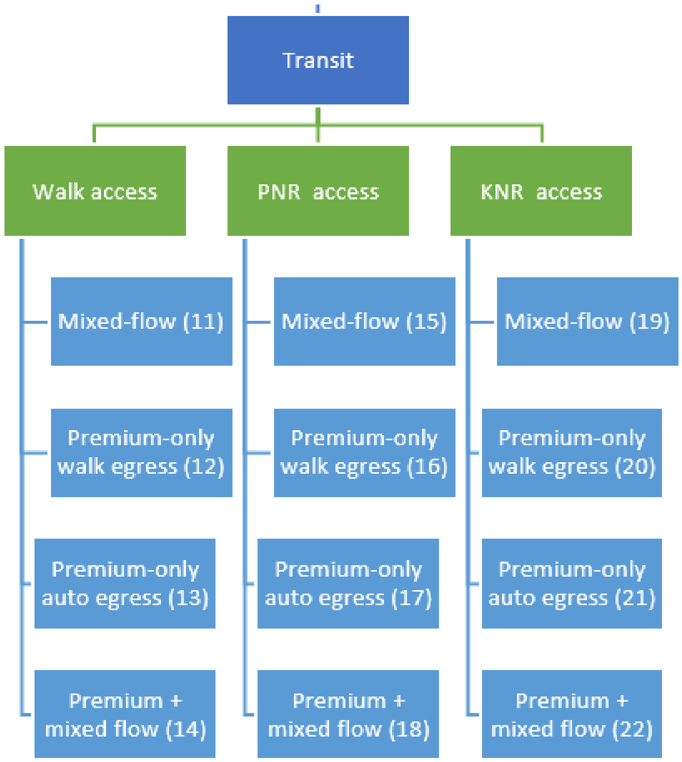


Figure 3-4: "STOPS-Like" Transit Mode Choice Structure

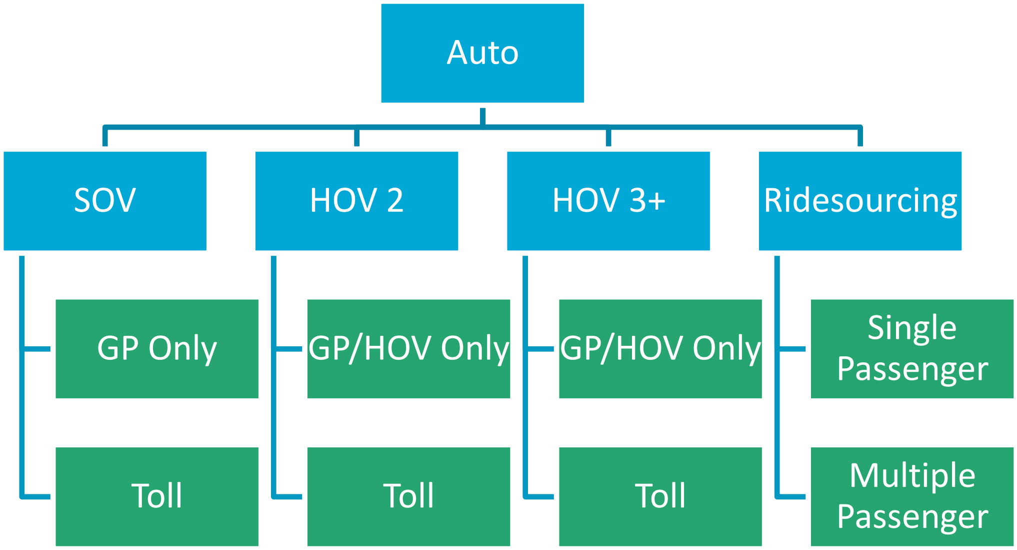


Auto Nest

The major changes under consideration for the auto modes will be to remove the general-purpose-lane-only HOV alternatives and to add a ridesourcing alternative. It is likely that there will be insufficient data to estimate terms for the ridesourcing alternative, in which case they will be constrained to be equal to the auto modes (see Figure 3-5). We will evaluate developing the Ridesourcing alternative with two sub-modes segmented by occupancy (single passenger or multiple passenger). The multiple passenger mode could be used to evaluate micro-transit type services although, again, there is not likely to be data available to estimate parameters on these alternatives so their usefulness will be limited to exploratory analysis.

Note that the HOV and Pay alternatives do not restrict the trip to using these facilities, only that the facility is available for use. The actual use is determined in assignment. This inconsistency is part of the reason why regions are replacing the Pay / GP alternatives with value of time segments. However, given the limited schedule for SERPM 8, the Pay / GP segmentation will be maintained.

Figure 3-5: Proposed Auto Nest Structure



The **Intermediate Stop Frequency** model first simulates the presence and number of stops on each half-tour. A distribution of stop purposes is then used to simulate the stop purpose by tour type, half-tour, time period, and person type. This approach does not consider inter-dependencies between the stop purposes (e.g. all stops may have the same purpose). However, the stop purpose is not used by the **Intermediate Stop Location** model or the subsequent determination of the stop arrival and departure times or trip mode choice. Constructing a purpose-sensitive model would require substantial enhancements and would be difficult within the development time frame.

We will consider replacing the stop purposes with a generic term to represent "intermediate stop", i.e. remove the intermediate stop purpose Monte Carlo simulation entirely. This will avoid confusion around the data that the model is actually producing.

3.3.5 Trip Level Models

The trip level models are listed in Table 3-6.

Table 3-6: Trip Level Models

Model Name	Decision-Making Unit	What is Predicted	Specification / Structure Changes	SERPM 7 Calibration
Trip Mode Choice Model	Trip	Mode for each trip along the tour	Follow structure of tour mode choice	Tour purpose, auto sufficiency, time period
Parking Location Choice	Tour	Parking-priced zone (MAZ) of the terminal end of tour	None	None

The **Trip Mode Choice** model will follow the structure of the tour mode choice model, with the exception that only those modes that have a logical chance of being considered as a mode will enter the choice set. For example, a tour whose chosen mode is transit with walk egress will not have a drive alone as the trip mode.

Unlike a trip-based model that conducts mode choice in a production-attraction format, there is no constraint in an activity-based model that the return trip occurs by the same mode. This is by design because actual travel tours are not necessarily symmetrical. However, it can be problematic with certain trip modes that imply a level of symmetry. For example, park-and-ride transit trips often involve the traveler returning to the original PnR lot on the way home to retrieve their car. There are potential exceptions to this behavior, such as: carpooling to the PnR lot and the auto passengers traveling home by other means; a 'car-swap' amongst family members coordinated through a PnR lot; or a user electing to leave their car overnight at the lot and retrieve it at another time. The SERPM 7 model does not have any explicit constraints to ensure that PnR travelers return to the original lot on the return half-tour. The level of symmetry at PnR lots in SERPM 7 will be reviewed and, if an unreasonable level of asymmetry is detected, we will investigate constraints that can be included in the model to mitigate it.

The **Parking Location Choice** model is segmented by work and non-work tours and applies only to the primary destination (tour destination). This model was transferred 'as is' from SANDAG for SERPM 7 and will be assessed and re-estimated for SERPM 8.0.

3.4 Visitor Model

SERPM 7 includes a disaggregate visitor model that was transferred 'as is' from SANDAG because no visitor travel data was available for the SERPM region. Many of the visitor models are simple applications of rates and exogenous shares. The mode choice (tour and trip), tour primary destination choice, and intermediate stop destination choice are implemented as discrete choice models. The set of visitor model components is listed in Table 3-7. As this table shows, only a few minor changes to some components are proposed.

Table 3-7: Visitor Model Components

Model Name	Decision-Making Unit	What is Predicted	Specification / Structure Changes
Generate business and personal visitor tours	N/A – fixed rate applied to hotel rooms and households	Number of tours (work, recreation, other)	
Tour party size	Tour – by purpose	Number of persons on the tour	
Auto availability	Tour – by purpose	Binary if an auto is available on this tour	
Income	Tour – segmented by business and personal	Income quintile	Updated to match income segments of SERPM 8 resident models
Tour Primary Destination Choice	Tour	Primary tour destination (MAZ)	

Tour TOD Choice	Tour	Arrival / Departure time period	
Tour Mode Choice	Tour	Tour Mode	Update structure to match resident model
Intermediate Stop Frequency	Tour	Number of stops by half-tour and purpose	None – stop purposes are generic
Intermediate Stop TOD	Half-Tour	Arrival/Departure period for all stops by half-tour	
Intermediate Stop Location	Stop	Stop location (MAZ)	
Trip Mode Choice	Trip	Trip Mode	Update structure to match resident model

3.5 Zero-Occupancy Vehicles

A major consideration for evaluating the impact of future technology, specifically automated vehicles, is the potential for zero-occupancy vehicles (ZOVs) traveling on the roadways. Simulating ZOVs is an area of active research, and we will conduct a careful review of the latest methods from researchers and practitioners. We will explore simulating ZOV trips in three cases: self-parking vehicles, vehicles shared amongst household members, and vehicles repositioning as part of a ridesourcing service.

Each of these cases are described in more detail in the following sections. The ZOV trip generation will likely be implemented as a post processor to the disaggregate demand modeling process. Potential changes to the demand models are also discussed in the sections below.

3.5.1 Self-parking

A self-parking autonomous vehicle would be attractive for trips to MAZs with parking costs because the autonomous vehicle may move itself to a nearby location with free parking. In this case, the vehicle would first drop off the traveler at their destination and then drive itself to the free or cheaper parking. On the return trip, the vehicle would drive from the parking lot to pick up the traveler and continue to the next destination. In simulation, this implies that an additional parking tour should be generated when an autonomous vehicle is used to travel to an area with paid parking. Simulation of this behavior requires:

- The location or locations of free or reduced rate parking for each MAZ with paid parking;
- Removing or reducing parking costs in mode choice when an AV is available; and
- Generation of a tour for assignment between the original destination and the free parking MAZ.

3.5.2 Relocation to share amongst household members

It is common for a vehicle to be shared across household members. A fully autonomous vehicle could be shared more effectively because the vehicle can serve other passengers while activities are underway. For example, a vehicle could take a household member to work, return home and take another household member to school, return home and be available for a third household member to run errands during the day and, finally, pick up the first two household members at the end of the day.

Accurately simulating this behavior within the demand models would require complex scheduling procedures and direct tracking of vehicle use through the day. The SERPM 8.0 development schedule does not allow for that level of complexity and, in any case, the process would be highly constrained and assumption driven because of the lack of data. Instead, we are proposing a post-processor that would generate return trips with controls around the sharing propensity based on:

- Household size and travel by other household members;
- Activity duration;
- Tour purpose; and
- Distance to home.

3.5.3 Public Shared Services

Overhead vehicle travel from ridesourcing services are unique in these cases in that they exist today, albeit with a driver.

Recent research[2] has been conducted to explore the optimal fleet size and dispatching algorithms for ridesourcing vehicles. We will leverage this research where applicable but propose to implement a simpler heuristic method to generate the overhead on a ridesourcing trip. The length and distribution of the ridesourcing overhead trip will be sensitive to:

- Land use density and/or area type;
- Time of day; and
- Trip distance.

3.6 Sampling

All of the destination choice models, including the intermediate stop destination and visitor destination choice models, utilize sampling to reduce the number of logsum calculations. These models operate at the MAZ level, but first calculate a probability at the TAZ level based on distance and the size function. 40 MAZ alternatives are sampled based on the TAZ probability and the full mode choice logsums are calculated for these alternatives. A full destination choice implementation would require logsum calculations to each of the ~12,000 MAZs.

The calibrated SERPM 7 model runs a 25% sample.

The development schedule restricts fundamental changes to the sampling process. We will assess changing the number of alternatives sampled.

[2] Behavioral Choice Model of Use of Carsharing and Ride-Sourcing Services. Bhat et al, TRB Annual Meeting 2017.

3.7 Aggregate Models

This section describes the model components in SERPM 7 that follow a trip-based modeling framework and will continue to do so in SERPM 8.0.

3.7.1 External-External Model

The external-external (EE) model is currently driven by external station origin and destination targets, or marginal, and a seed trip table with flows between all external stations. A Fratar process is used to adjust the seed trip table such that it matches the origin and destination targets. The daily trip table is then segmented into auto and truck (four-tire, single unit, combination) tables and times of day using factors defined exogenously to the model.

As part of the model update, we will generate new base year 2015 targets using the traffic count information at the external stations. The newly collected Streetlight survey dataset will be leveraged to update the seed trip table and shares of external to external trips.

3.7.2 Internal-External Model

A new internal-external (IE) model was developed to represent internal-external and external-internal (EI) trips for SERPM 7. This model takes as input the number of EI and IE trips at each external station. The model simulates the distribution of EI and IE trips to internal TAZs using network drive-alone time as the impedance and the size term is internal attractions. The daily P-A auto vehicle trip table is then split into time periods and converted to O-D format using fixed factors.

Recently, FDOT supported a study[3] that estimated IE trip generation rates and distribution factors based on a license plate survey at 9 of the 13 SERPM 7 external stations. The model produced by this study was a singly-constrained destination choice model that used EI+IE volumes at external stations as origins, the sum of ABM trip ends at each internal zone as the size term, and developed destination choice parameters for each external station that reasonably replicated the average trip length (distance), and trip length frequency distribution found in the survey.

The station-specific distribution model did improve the model fit, but could be overfitting the dataset. The study also produced a station-generic distribution model, which, while it did not perform as well as the station-specific because it had fewer degrees of freedom, may be more reasonable. We will explore implementing a facility-type specific IE distribution model. This will capture the unique travel patterns by facility type, without overfitting to a particular sample dataset. The newly collected Streetlight data will also be used to assess and update the external-internal model.

[3] Technical Memorandum SERPM 7 External Model Improvements, The Corradino Group, March 2016

3.7.3 Truck Model

The current truck model produces heavy truck trips using a matrix-estimated truck trip table based on the existing heavy truck counts and combines that with the estimated change in truck trips as derived through an approach similar to that defined by the Quick Response Freight Manual (QRFM[4]). Four-tire truck trips are produced through a direct process, no matrix estimation, because they are not separated in the roadway count classifications.

Truck trip ends are generated at each TAZ based on zonal attributes (households, industrial employment, commercial employment, and service employment). Trip rates are segmented by truck class: four-tire, single units with more than four tires, and combinations. Trips are distributed by a destination choice model using the drive-alone travel time as the model impedance. The change in heavy truck trips is then applied to the matrix-estimated heavy truck trip table. Finally, the trips are segmented by time period using exogenously defined factors.

The Florida Statewide model has recently developed a new tour-based truck model process: FreightSIM. A complementary project will compare the FreightSIM forecast with the SERPM count data and SERPM 7 model results. Depending on the robustness of the FreightSIM forecast, portability of the module, and schedule availability, we will assess incorporating that model structure into the SERPM 8.0 model.

If the FreightSIM model is not incorporated into the SERPM 8.0 model release, we will update incorporate the new truck count data into the model and update the time of day factors according to the classified count data.

3.7.4 Airport Model

The current model produces airport trips at the three international airports in the SERPM area:

- Miami International Airport (MIA);
- Hollywood-Ft. Lauderdale International Airport (FLL), and
- Palm Beach International Airport (PBI).

The trip production equations apply a simple vehicle trip rate to the number of daily enplanements expected for each alternative at each of the airports. We will incorporate the latest enplanements forecasted by the Federal Aviation Agency (FAA) and incorporate them into the SERPM 8.0 model.

The airport trip attraction rates are sensitive to total employment, households, and hotel/motels at the TAZ level and vary by county and area type. Airport attraction rates vary by county and area type. Attraction rates were estimated for each of these TAZ attributes from a survey analyzed in SERPM 6. Time-of-day and directional factors were developed from hourly passenger counts at MIA and FLL, provided by the airport authorities. These rates were developed during the SERPM 6 model update and will be maintained for this model update.

[4] https://ops.fhwa.dot.gov/Freight/publications/qrfm2/index.htm

4.0 Assignment

The trip assignment model is the last step of the modeling process. Trip assignment estimates the volume on each link in the transportation system for both highway and transit modes. In addition, the trip assignment model generates specific performance measures, such as the congested speed or travel time on a highway link and the boardings and alightings on a transit route. Trip assignment is performed separately for each mode (auto and transit) and time period (auto – early a.m., a.m. peak, mid-day off-peak, p.m. peak, and evening; transit – a.m. peak, midday and evening off-peak, p.m. peak).

There are two primary objectives for the trip assignment model. The first objective is to assign trip tables and produce measures of impedance for most of the ABM components. The second objective is to assign the trip tables and produce volumes for auto and transit networks. These are described separately in the following sections.

4.1 Time Periods

As discussed in Section 2.3.1, the SERPM 7 five highway assignment time periods and three transit assignment time periods will be maintained in the SERPM 8.0 model update.

4.2 Highway Assignment

The SERPM 7 highway assignment is a multi-class static user equilibrium assignment with the following user classes:

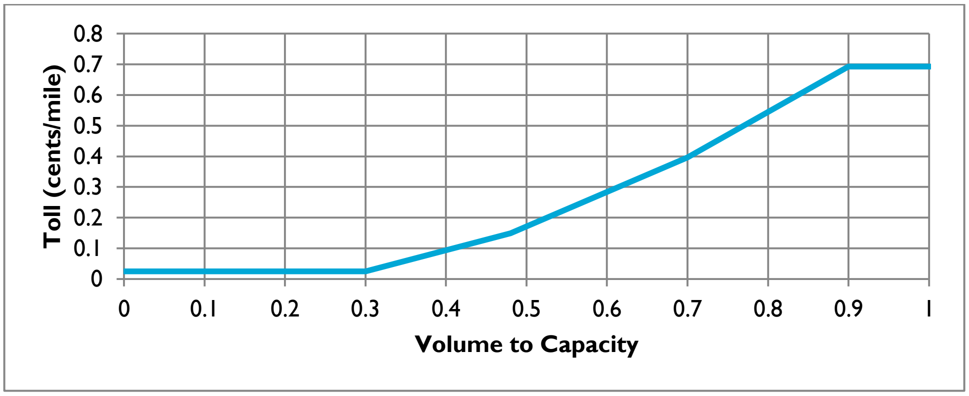
- Drive Alone (free),
- Drive Alone (pay),
- Shared Ride 2 (free non-HOV),
- Shared Ride 2 (free HOV),
- Shared Ride 2 (pay),
- Shared Ride 3+ (free non-HOV),
- Shared Ride 3+ (free HOV),
- Shared Ride 3+ (pay),
- Small Trucks, and
- Large Trucks.

The solution to the traffic assignment problem is found using the Frank-Wolfe algorithm. The convergence criterion is a relative gap of 0.0001 achieved on three consecutive equilibrium iterations. A generalized cost function that includes travel time and toll cost is used to find the least cost paths at each user equilibrium iteration. The generalized cost is based on a $15 / hour peak VOT and 12$ / hour off-peak VOT. Distance /

operating costs are not considered in the assignment procedure and the VOT is consistent across occupancy rates, i.e. the toll cost is not assumed to be shared amongst all passengers.

The cost of using the managed lane facilities is calculated during highway assignment based on a unit toll (expressed in cents per mile) that is a function of the volume-to-capacity (VC) ratio. The unit toll function was adapted from data provided by Florida Turnpike Enterprise (see Figure 4-1). The VC ratio and corresponding segment toll are recalculated at each user equilibrium iteration.

Figure 4-1: SERPM 7 Managed Lane Toll Cost



Source: SERPM 7 Model Development Report, February 2015

As part of the model update, the managed lane toll cost will be reviewed and updated to reflect the current dynamic toll setting.

A consideration for classes of trips to be assigned is how the data will be used as a measure of impedance or as a planning tool. The SERPM 7 model assigns SOV2 and SOV3+ separately, yet the SOV2 impedance is used for both SOV2 and SOV3+ mode alternatives. If there is no planning need, the model could be run faster by combining these two trip classes. Similarly the toll vs. HOV vs. general purpose lane only segments may be collapsed into a simple toll and non-toll distinction as discussed in Section 2.2.2.

Another consideration would be to segment the trips by value of time. One approach would be to segment the value of time based on the tour purpose, with mandatory tour purposes having a higher value of time than non-mandatory tour purposes. However, changing the value of time segmentation has far-reaching impacts on the model implementation and may not be possible within the model development timeframe.

Currently, trips are associated with assignment time periods according to the trip departure time. This can cause a bias for trips in the last 30 minutes of an assignment period. We will assess determining the time period that each trip is associated using the mid-point of the trip, but this will require additional modeling steps. The ABM simulates the arrival and departure time at the activity locations within half-hour periods. To find the mid-point, the specific minute of travel is needed within the half-hour period. A uniform distribution can be assumed to simulate the specific minute of travel. Once the minute of travel is determined, the trip mid-point can be derived using the travel time. We will assess the complexity and impact on model results of this method in application and determine if it is warranted.

A DTA application may be configured to input a roster of trips, which would require the minute-level departure time. Alternatively, a DTA application may also input an aggregate trip table and will simulate the distribution within the time period as part of the assignment process. The required trip input structure for the recommended DTA application will inform the need to simulate minute-level departure times.

As discussed in the section on Long Term Models, SERPM 8 will include the functionality to simulation vehicle technology to test future mobility scenarios. By default, the model will simulate one type of vehicle technology. In a future scenario test, the model would simulate multiple types of vehicle technologies and would load trips by vehicle technology separately in assignment. This will be more computationally demanding and thus would be implemented as a special run mode.

4.2.1 Volume-Delay Functions

The highway assignment procedure is applied in an iterative fashion, where travel times are updated after each iteration to reflect congestion occurring on the network. These updates to travel time are based on a volume-delay function for each link. The existing volume-delay functions are the modified versions of the standard BPR functions with parameters varying by facility types, which will be reviewed and modified if necessary during validation. The free-flow time is based initially on the network data provided for each link and then updated in each iteration to represent the travel time resulting from the assigned traffic volumes from the last iteration.

4.2.2 Turn Penalties

Turn penalties are included in the trip assignment model to either prohibit certain turn movements or to penalize certain turn movements. These are included in the model by identifying specific turn movements by their node numbers, and then coding the penalty function that will apply to these turn movements. It is assumed that the current model turn penalties will be retained.

4.2.3 Speed Feedback Averaging

Link volumes from the current speed feedback iteration are averaged with the averaged results of previous iterations. Volumes are averaged by applying 1/iteration of the difference between the last MSA volumes with the current volumes. This means of successive averaging (MSA) process ensures that the speed feedback iterations will converge by dampening the iteration to iteration changes.

4.3 Transit Assignment

Transit trips are assigned between transit access points. Transit assignment in SERPM 7 aggregates the local bus-only transit trips across all access modes (PnR, KnR, and Walk) but maintains a separate assignment for premium transit trips by access mode. In total, there are twelve transit segments assigned to the network, see Table 4-1.

Table 4-1: SERPM 7 Transit Assignment Segments

Transit Path	Time of Day	Access Mode
Local-Bus Only	Off-peak AM peak PM peak	All (PnR + KnR + Walk)

Premium Transit and Local-Bus (mixed mode paths)	Off-peak AM peak PM peak	PnR KnR Walk

Note that, because transit trips are assigned between TAPs, the access mode distinction is not necessary. However, the auto component of the transit trip is not assigned to the highway network.

As part of the model update, the transit assignment segments will be made consistent with the mode choice alternatives, as described in section 2.3.3. The auto component trips for PnR, KnR, and auto egress will also be identified and added to the highway assignment.