

Appendix G: SRM12 Model Description

- This appendix contains a description of the SRM12 Demand Model and illustrates the functioning of the demand model and its components. The Appendix contains a flow diagram for each of the main stages in the process which is supported by explanatory text.

Figure 1: Model Structure

This figure shows the overall model structure.

- The figure shows the enhanced four stage structure of the model. It has the traditional Trip Generation, Mode Choice, Destination Choice and Assignment, enhanced by Park and Ride site choice.
- The capability for High Occupancy Vehicle Modelling is also contained within the underlying SRM12 structure, although this element would need to be updated to be utilised.
- The required data inputs to the model in forecasting mode are a set of trip ends as produced by the trip end model, and highway and public transport networks along with any model parameters which change through time (eg values of time, vehicle operating costs).
- The model is segmented by the following person household types:
 - No Car Households;
 - 1 Car 1 Adult Households;
 - 1 Car 2 Adult Households; and
 - 2+ Car Households.
- It is also segmented by the following six journey purposes:
 - home-based work;
 - home-based employer's business;
 - home-based other;
 - home-based education;
 - non-home-based employer's business; and
 - non-home-based other.
- The model is applied in an incremental manner. The absolute forecasts produced by the demand model are an intermediate step in applying the model incrementally. The incremental approach is implemented in practice by calculating absolute forecasts (based on trip ends, travel costs and parameters) for road and public transport movements. During forecasting, an incremental adjustment is made to incorporate the difference between the base year assignment matrices (generated by the demand model) and the calibrated road and PT assignment matrices (at the zone-to-zone level).

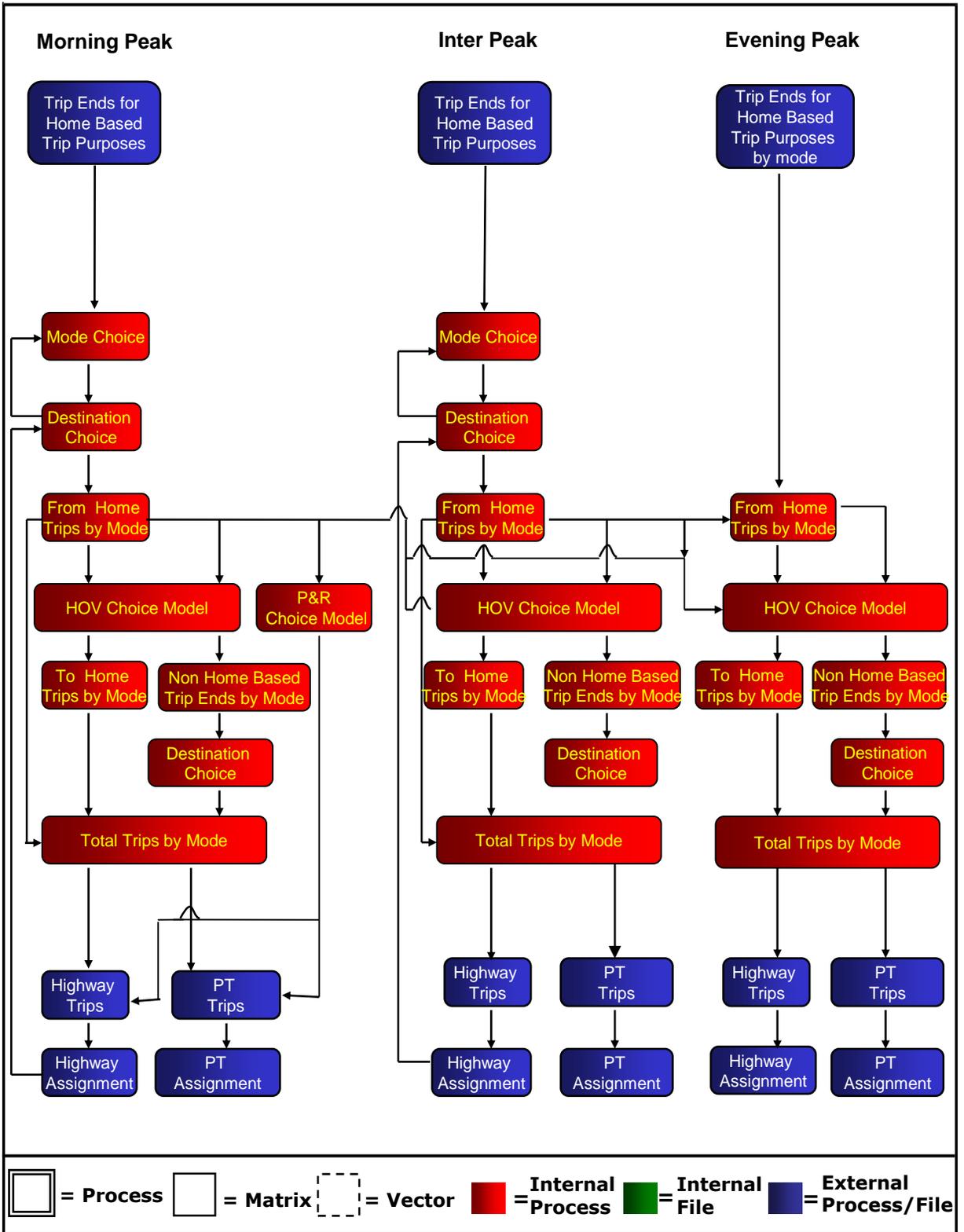
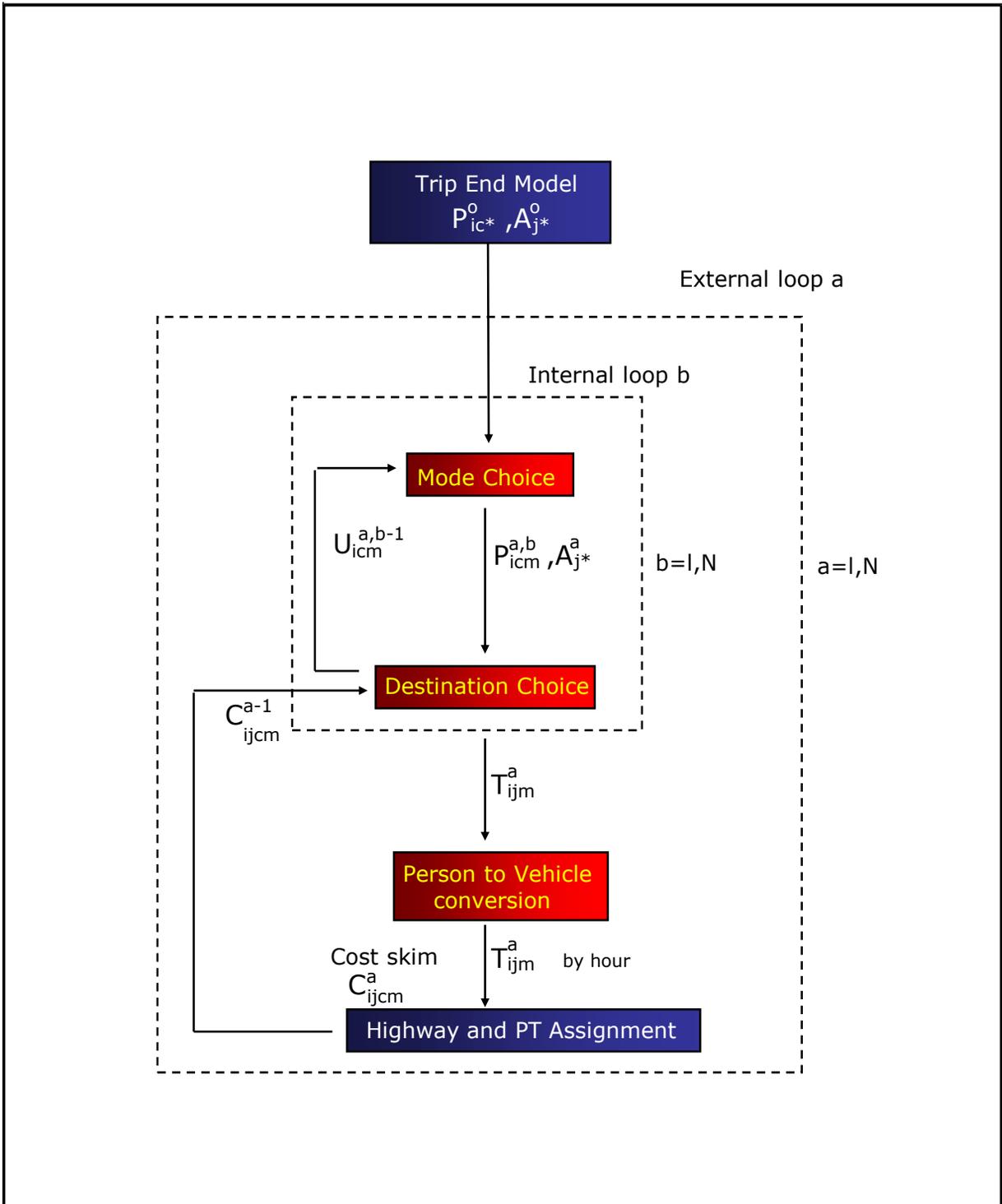


Figure 1: Time Period Demand Model

Figure 2: Iterative Demand/Supply Balancing

- This figure shows the balancing of the supply and demand parts of the model. The process consists of a feedback of Generalised Costs from the assignment models to the distribution, mode split components of the demand model.
- Two loops are shown in this figure, the inner loop 'b', which is the loop between the mode and destination choice elements of the model and the outer loop 'a', which is the loop between the demand model and the assignment models.
- The Public Transport costs are set after one external loop of the demand model. However, if crowding effects are considered sufficient to cause large changes in costs, it can be run on every external loop. The Highway Assignment is carried out for each outer loop.



Key: C_{ijcm}^a - generalised cost skim for cell ij, car availability c, mode m, external loop a
 $U_{icm}^{a,b}$ - logsum composite utility for zone i, car availability c, external loop a, internal loop b

■ = Internal Process ■ = Internal File ■ = External Process/File

Figure 2: Iterative Demand/Supply Balancing

Figure 3: Destination Choice

- This is the destination choice model for from-home purposes, which takes as inputs:
 - trip productions for car and public transport by each car availability segment;
 - trip attractions/attraction factors for all modes and car availability types combined; and
 - generalised costs of travel by car and by public transport.
- These inputs are used to create matrices of person trips, separately by time period and trip purpose, for from-home trips and non-home-based trips. The process is carried out at a zonal level.
- The process is a traditional gravity model process applied in a doubly constrained manner for from-home commute trips and non-home-based trips, and singly constrained for other from-home purposes. There are separate sensitivity parameters for each trip purpose/mode/car availability combination.
- The spread parameters are α_1 and α_2 . There are also Intra-Zonal factors α_0 , which produce intra-zonal trips in the matrix
- The outputs of this process are person trip matrices by time period, trip purpose/mode/car availability at zonal level, which are the inputs to the person to vehicle conversion process.

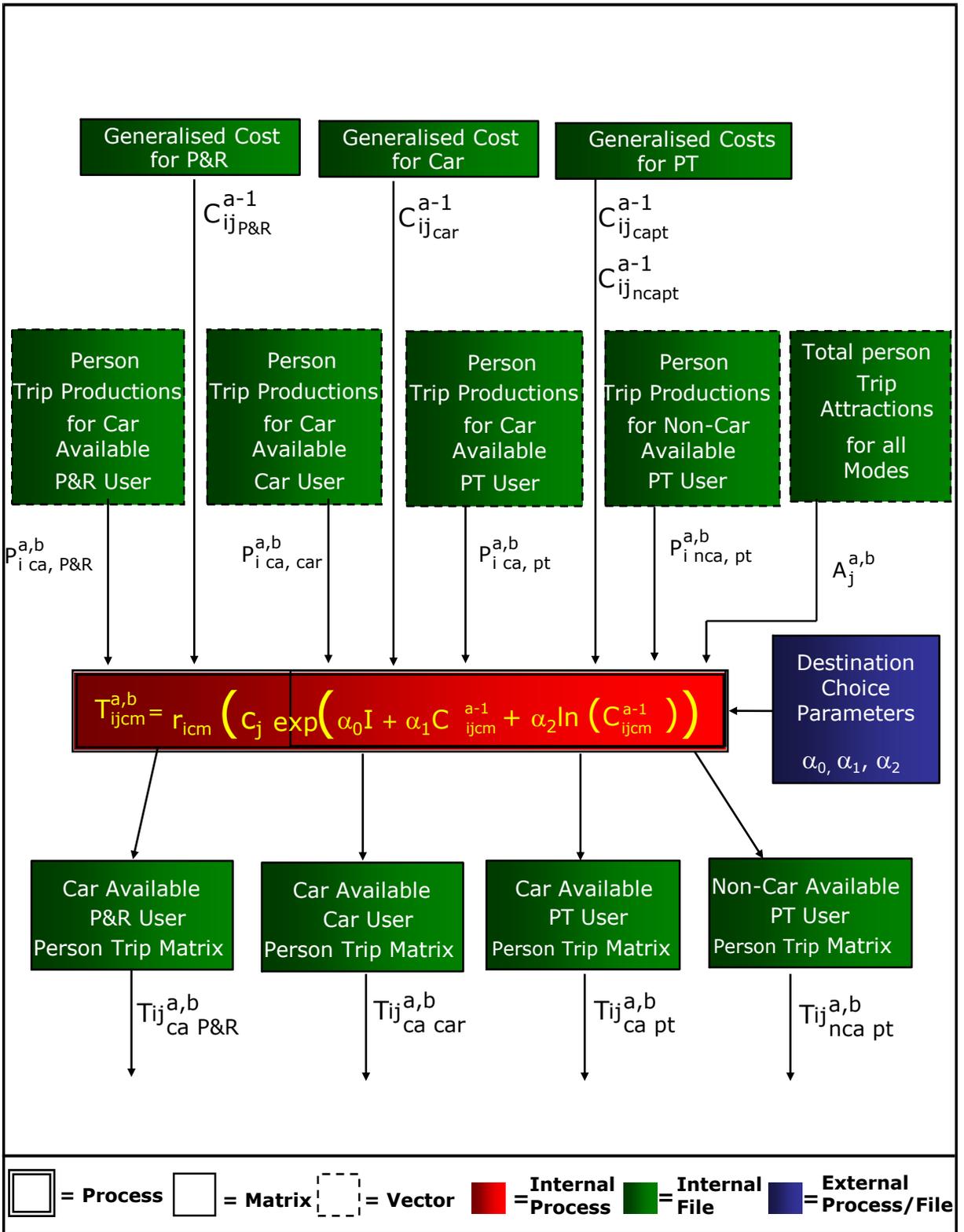


Figure 3: Destination Choice

Figure 4: Calculation of Logsum Composite Utility for Input to Mode Choice

- This process follows the destination choice process and calculates logsum composite utilities at a zonal level for input to the mode choice model.
- The process takes the matrices generated by the destination choice model along with the generalised costs by mode used in the destination choice model, and calculates a logsum composite utility for each zone.
- The process is conducted separately for each from-home trip purpose and car available segment. In the case of car available persons the output utilities are used as input to both the mode choice, time of day choice and trip frequency choice processes. For non-car available there is no mode choice but the utilities are input to the time of day choice and trip frequency choice processes.
- The sensitivity parameters ($\alpha_0, \alpha_1, \alpha_2$) shown in this figure are the same sensitivity parameters used in the destination choice process.

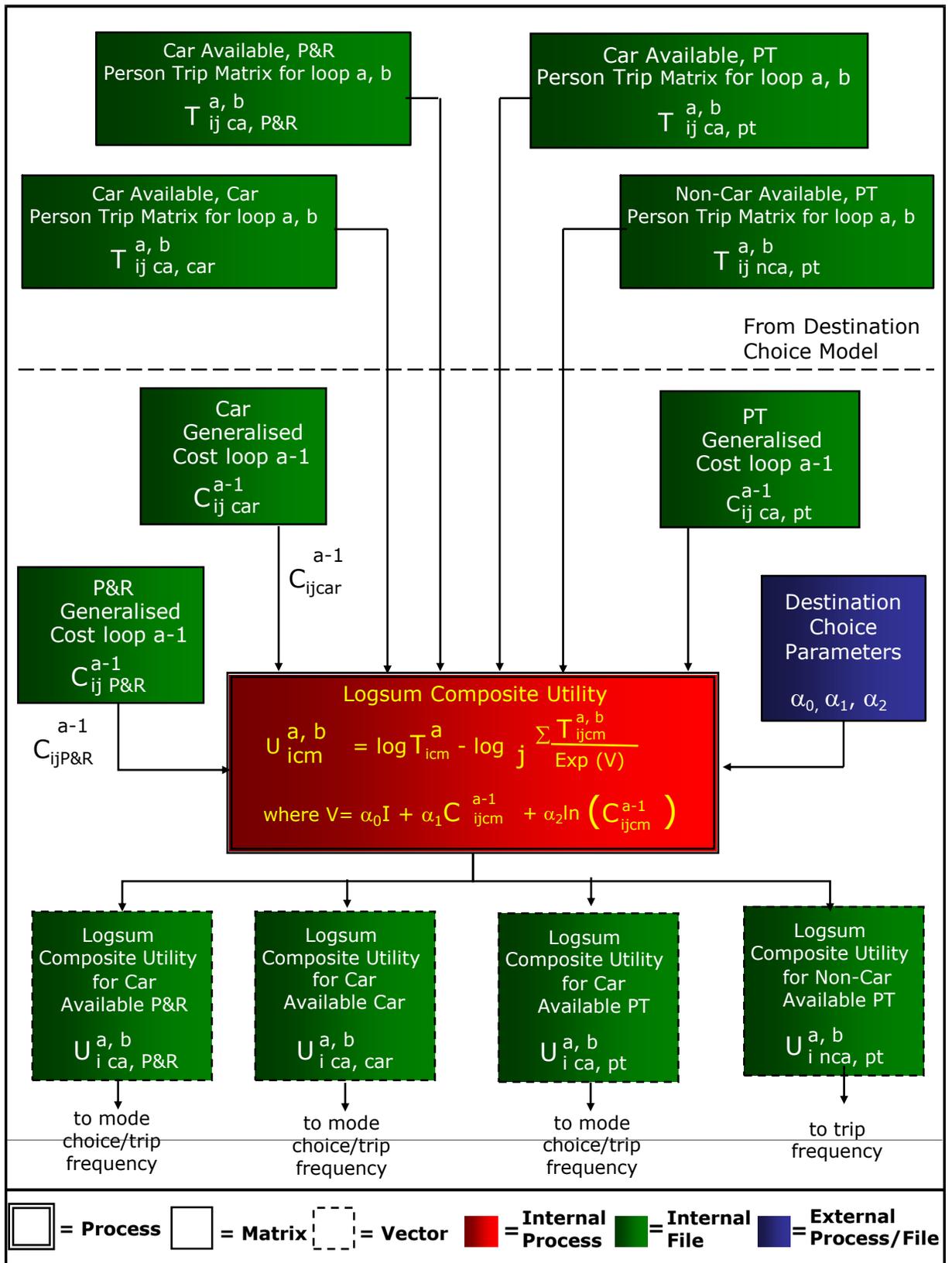


Figure 4: Calculation of Logsum Composite Utility for input to Mode Choice

Figure 5: Mode Choice

- This figure shows the mode choice process. It is undertaken at the trip end level because of the position of mode choice in the model hierarchy. It takes as inputs:
 - person trip productions by time period for from-home purposes; and
 - logsum composite utilities calculated using the destination choice model.
- The process is carried out for car available persons only; persons from non-car available households are assumed to be captive to public transport..
- The calculation of the logsum composite utilities is undertaken using the process described in Figure 4.
- There are two types of parameter input:
 - The scaling factors (β) which control the sensitivity of the mode choice process.
 - The mode specific constants (for car mode only) which ensure that the base mode choice proportions in the model match the base data at a zonal level.
- There are separate scaling parameters for each trip purpose.
- The outputs of the process are vectors of trip productions which are then input to the destination choice process which is shown in Figure 3.

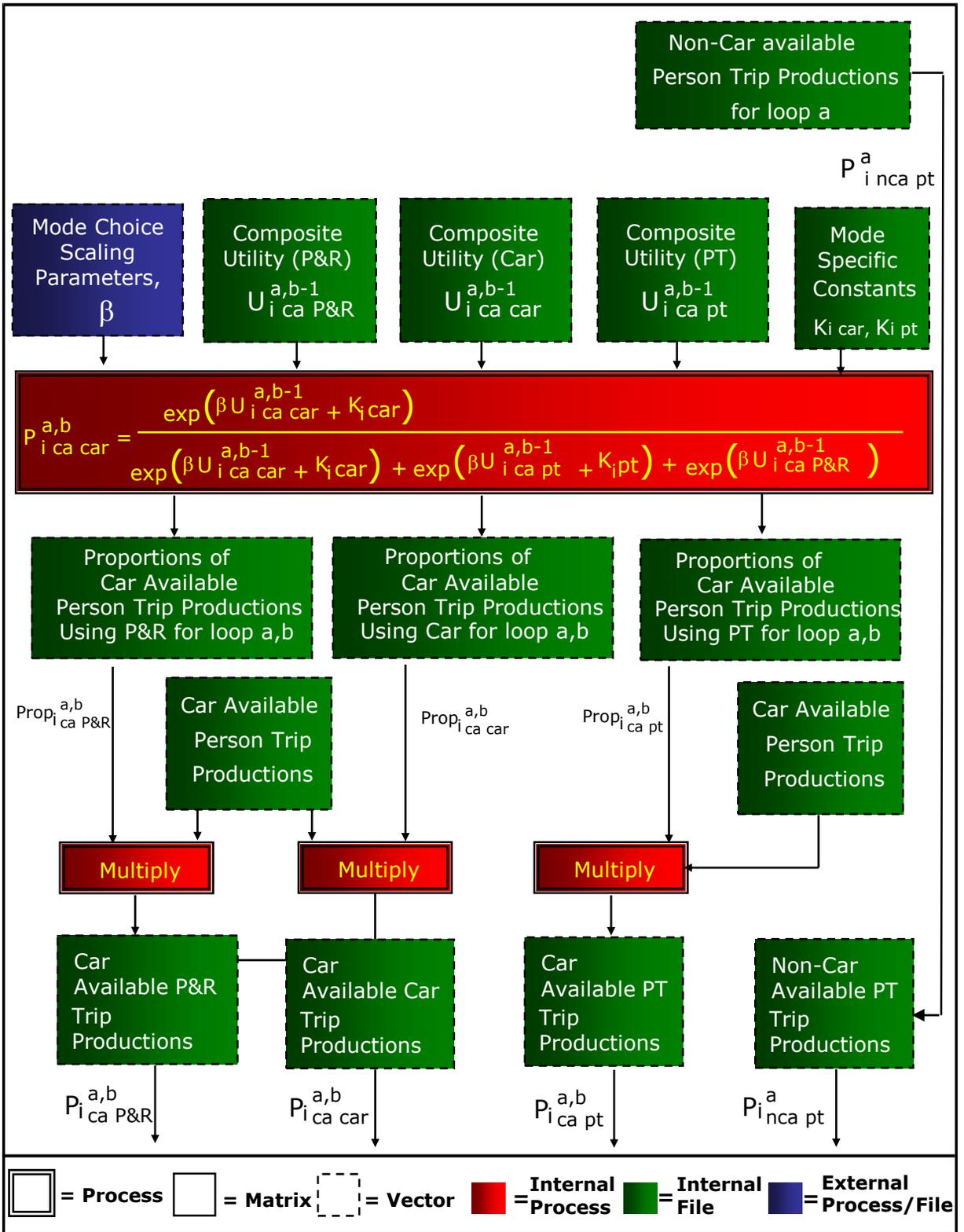


Figure 5: Mode Choice

Figure 6: Creation of To-Home Trips

- This model produces the matrices of to-home trips by mode, car availability, time period and purpose. It takes as input:
 - matrices of from-home trips, by mode, car availability, journey purpose and time period, as produced by the destination choice models; and
 - to-home factors derived from analysis of the Scottish Household Survey.
- The to-home factors are multiplied by the transposed from-home matrices at a cellular level to give to-home matrices by mode, car availability, journey purpose and time period.

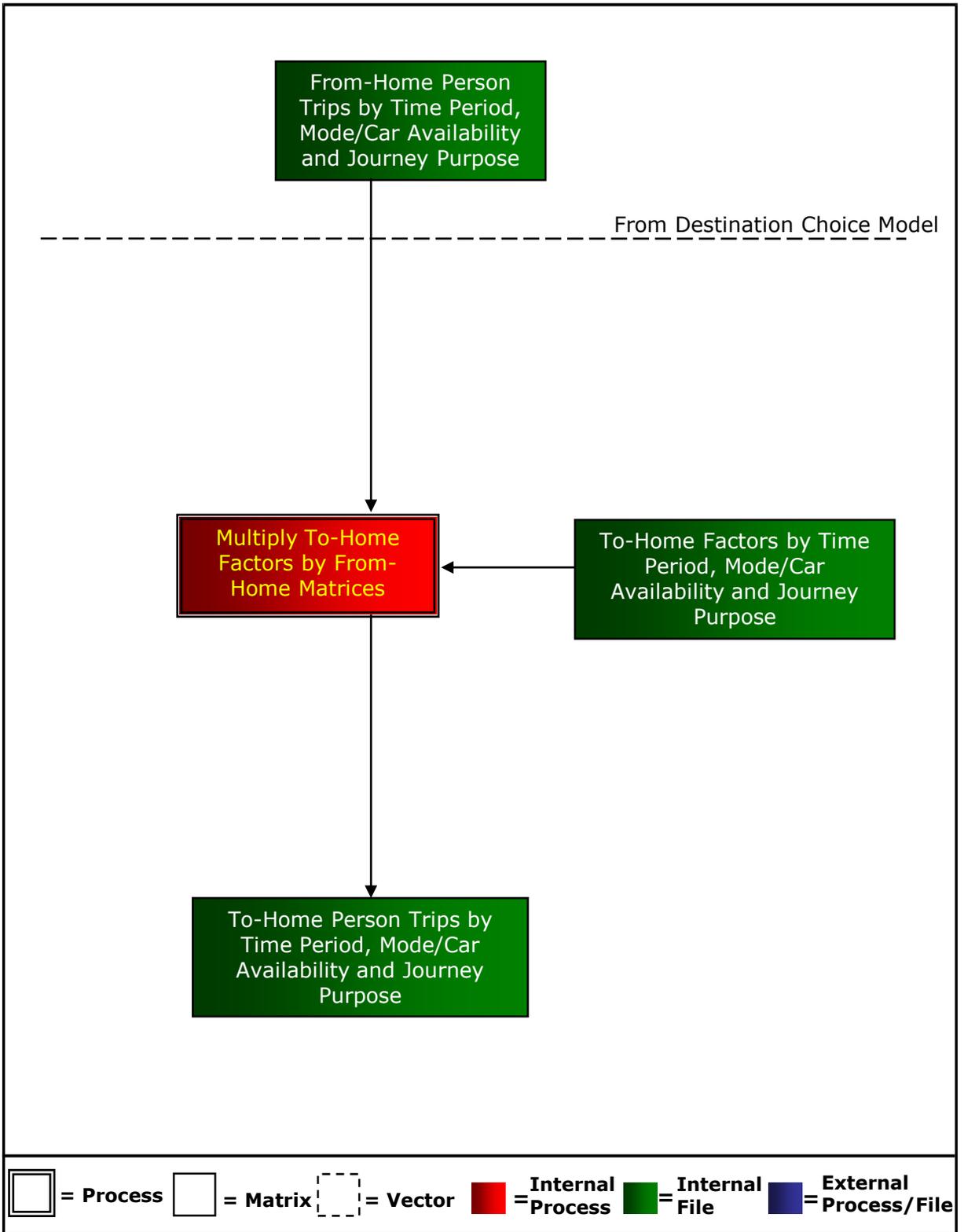


Figure 6: Creation of To-Home Matrices

Figure 7: Park and Ride Station Choice

- Park and Ride station choice is applied to the AM From-Home Park and ride trips, which are output for each purpose by the mode/destination choice model.
- The choice model takes as input:
 - The generalised cost of P&R;
 - Park and Ride Site Files; and
 - Park and Ride Trip Matrices.
- The station choice model then attributes all the Park and Ride trips amongst all the sites available, based on the attributes of the sites.

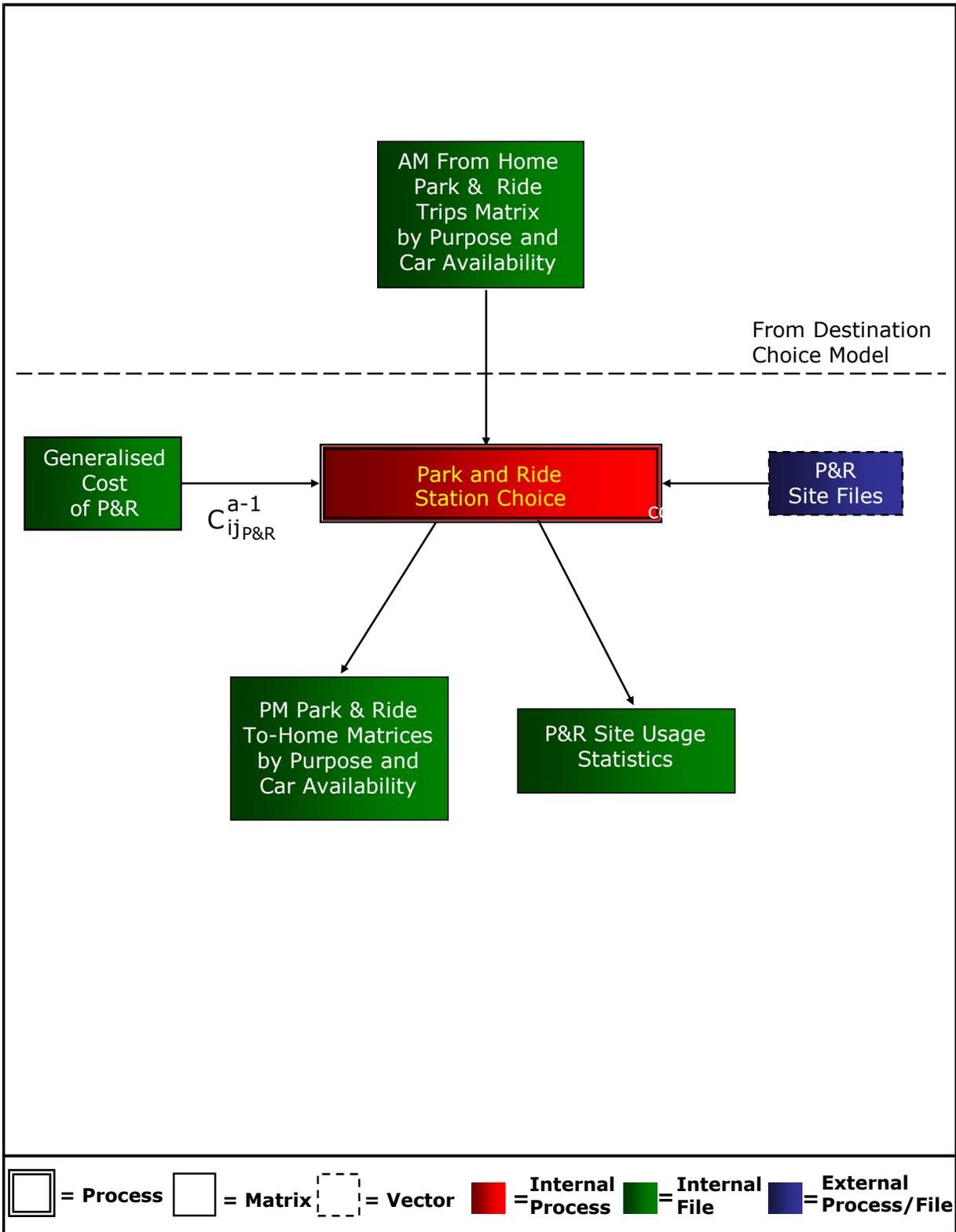


Figure 7: Park and Ride Station Choice

Figure 8: Trip End Model for Non-Home-Based Purposes

- This model produces the trip productions and attractions by mode, time period and purpose for non-home-based trips. It takes as input:
 - trip attractions for From-Home trips, by mode, car availability, journey purpose and time period, as produced by the destination choice models;
 - trip productions for To-Home trips, by mode, car availability, journey purpose and time period;
 - non-home-based production trip rate factors derived from analysis of the Scottish Household Survey; and
 - non-home-based attraction trip rate factors derived from analysis of the Scottish Household Survey.
- The production trip rate factors are multiplied by the From-Home trip attractions to give the Non Home Based trip productions by mode, car availability, journey purpose and time period.
- The attraction trip rate factors are multiplied by the To-Home trip productions to give the Non Home Based trip attractions by mode, car availability, journey purpose and time period.

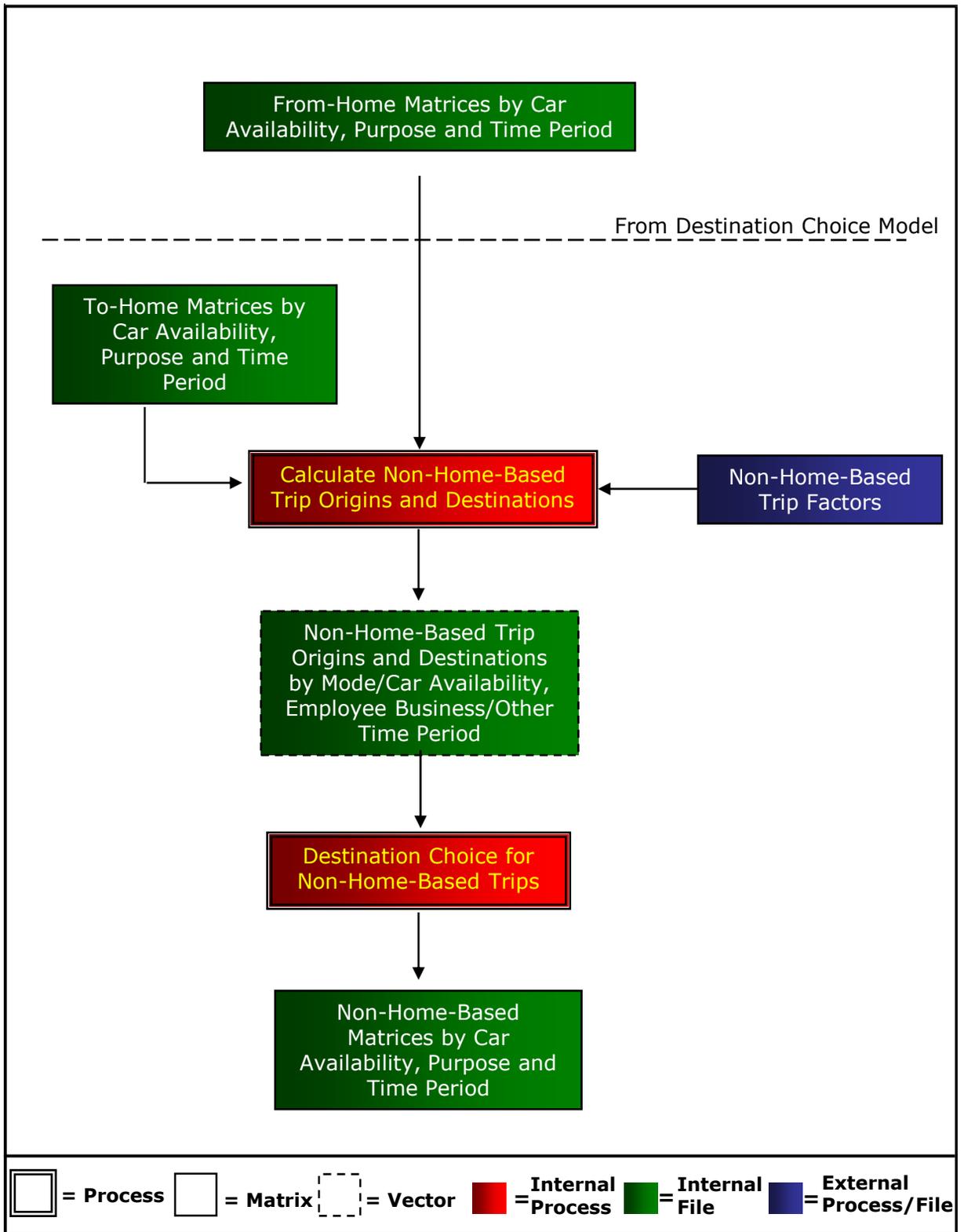


Figure 8: Trip End Model for Non-Home-Based Purposes

Figure 9: Person to Vehicle Conversion for Car Trips

- This process takes as input the time period matrices which are output by the processes shown in Figures 3, 6, 7 and 8 as well as Education add-in's, and applies vehicle occupancy factors to convert from person trips to vehicle trips.
- The process is carried out separately for each trip purpose and there are separate vehicle occupancy factors for each time period/trip purpose combination.

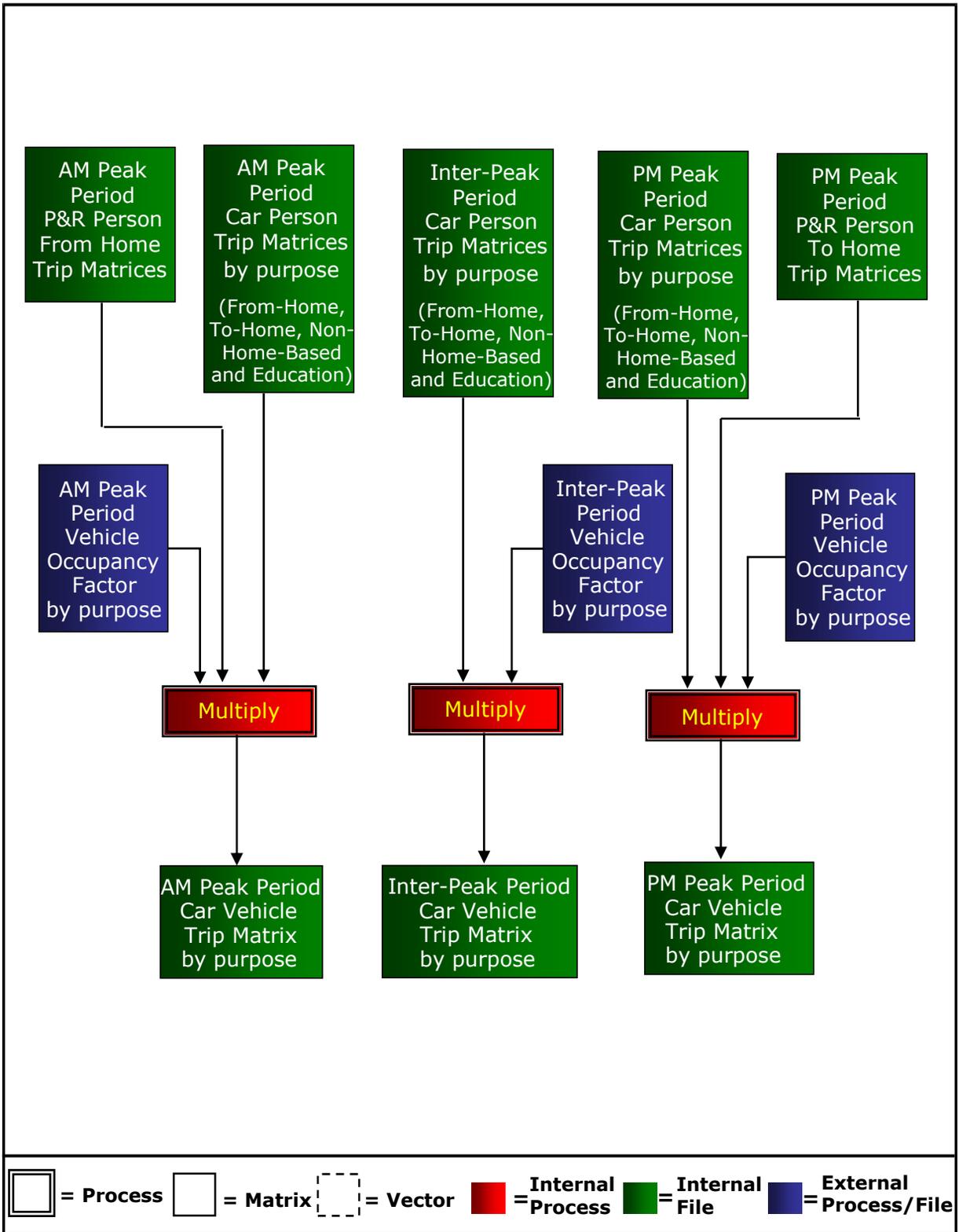


Figure 9: Person to Vehicle Conversion for Car Trips

Figure 10: Hourly Matrix Creation for Car and Public Transport

- This process converts the time period matrices by vehicle or person, as appropriate, into hourly matrices.
- The process is carried out for all trip purposes. The Inter-Peak and PM Peak factors will generally remain the same in all forecasting situations.

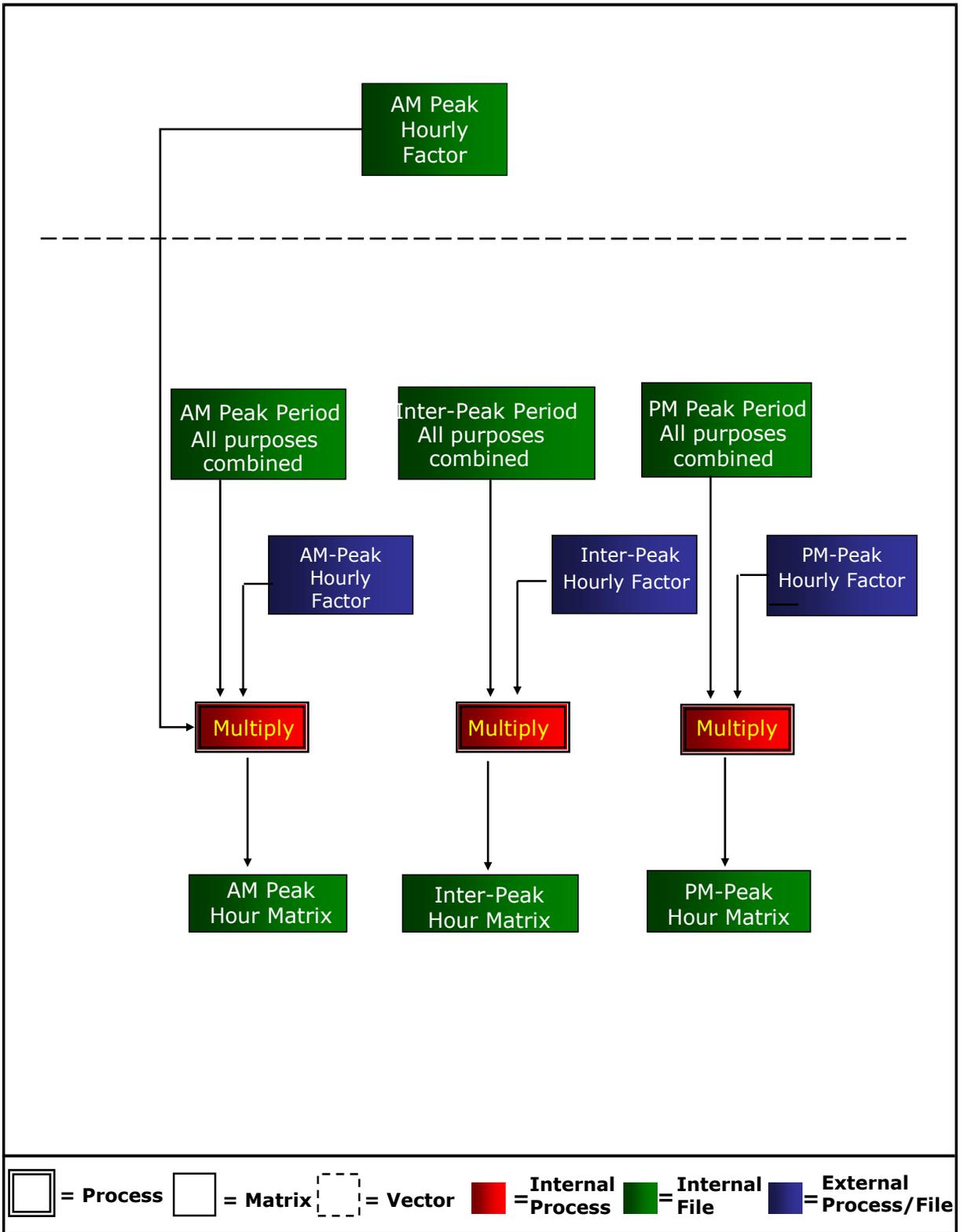
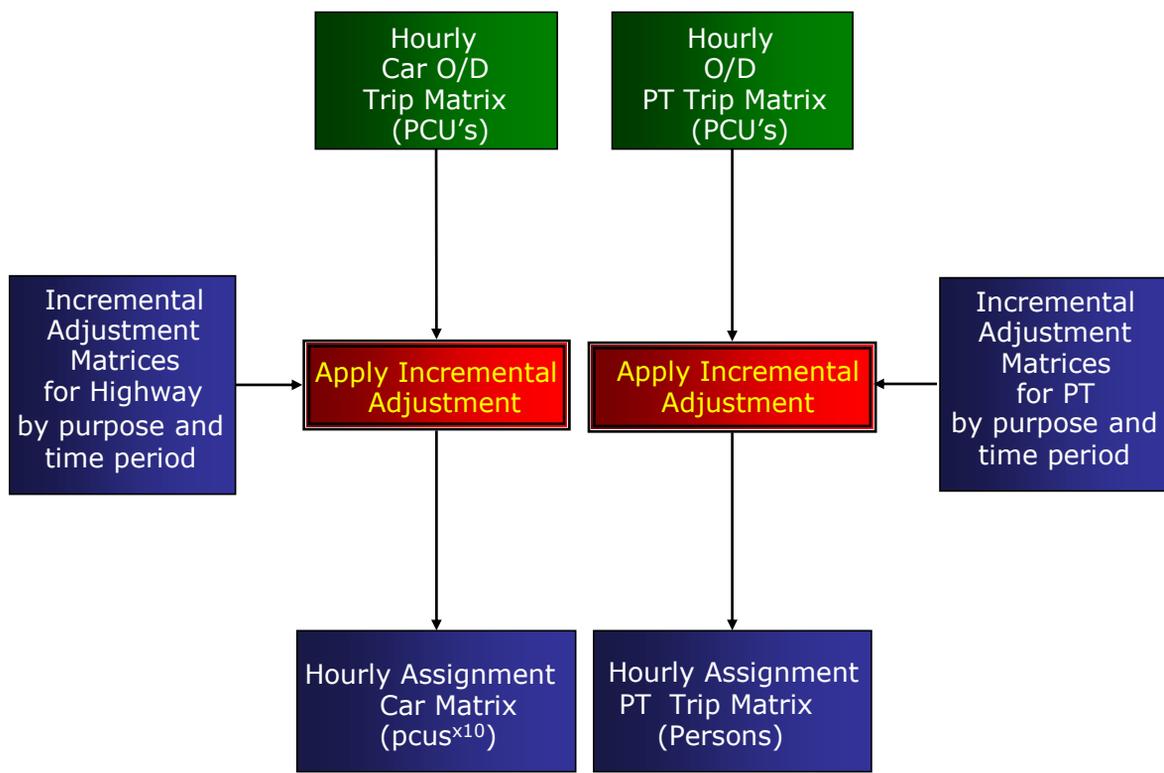


Figure 10: Hourly Matrix Creation for car and pt

Figure 11: Incremental Adjustments

- The incremental adjustment process ensures that the model functions in an incremental manner. The incremental adjustment factors are applied to Origin-Destination matrices (separately by hour and mode), to generate the final hourly assignment matrices at zonal level.

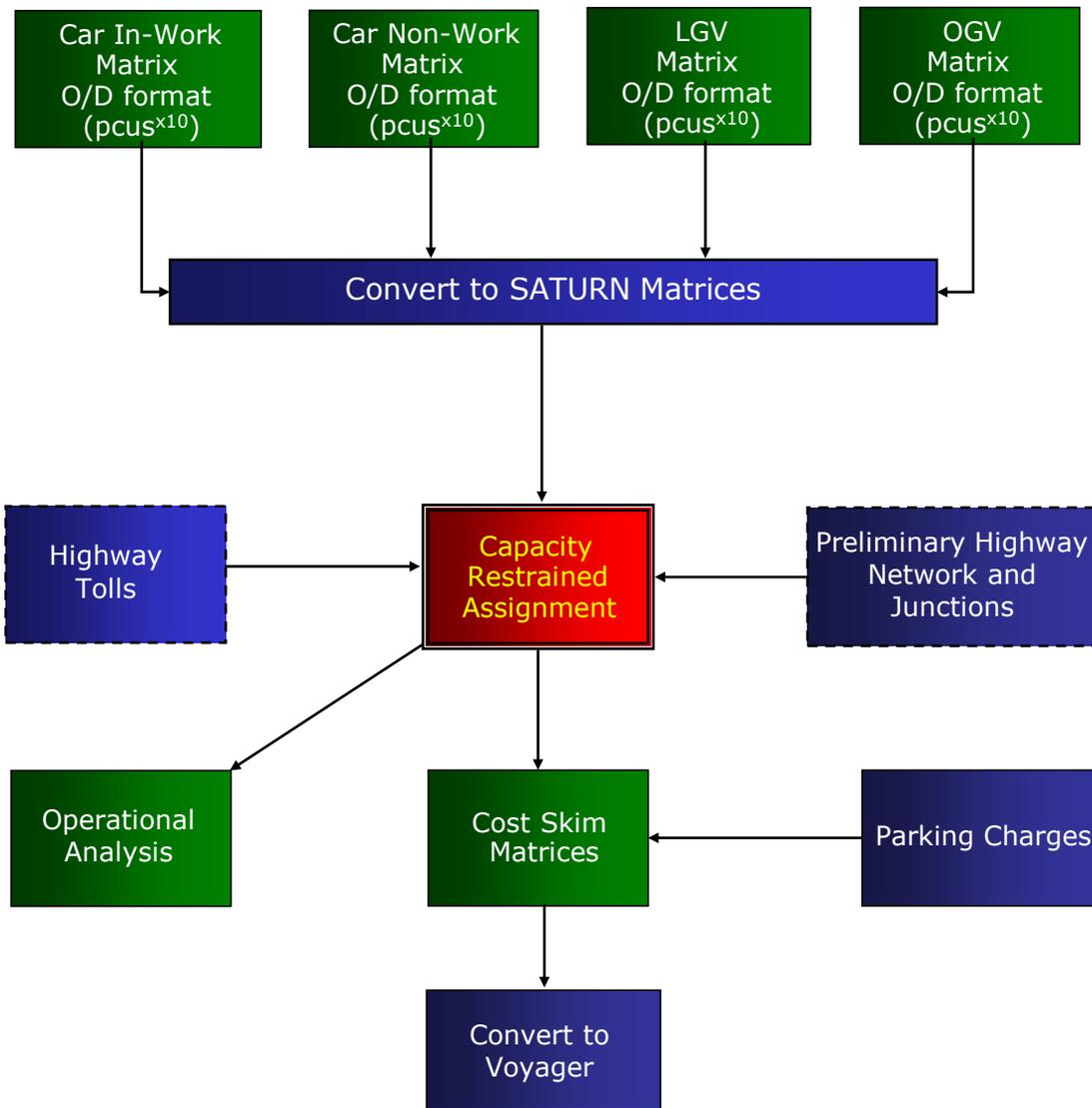


= Process
 = Matrix
 = Vector
 = Internal Process
 = Internal File
 = External Process/File

Figure 11: Incremental Adjustment

Figure 12: Highway Assignment

- This is a conventional capacity restrained equilibrium multi-class assignment procedure. It is run using the SATURN program. There are five user classes:
 1. Car In-Work;
 2. Car Commute;
 3. Car Other;
 4. Light goods vehicles; and
 5. Heavy goods vehicles.
- The cost skims are created at a zonal level from the assignment model. Parking charges are added into the cost skims where appropriate.

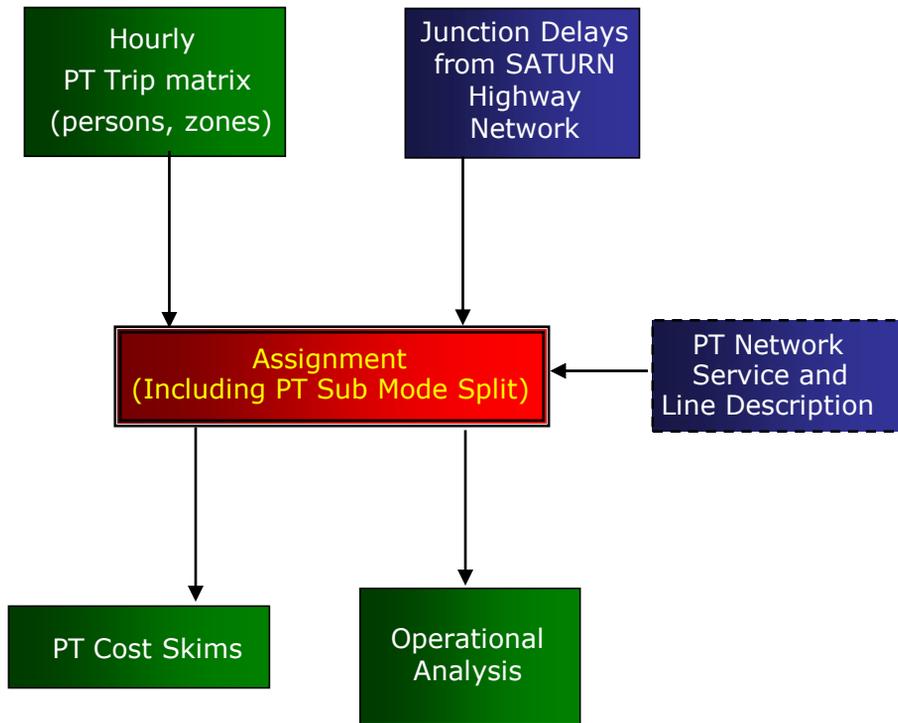


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Figure 12: Highway Assignment

Figure 13: Public Transport Passenger Assignment

- This is a standard PT assignment procedure, with sub-mode choice, undertaken in VOYAGER. This includes the effects of crowding within the AM and PM Peaks. It is standard to skim the PT costs only on the first loop of the demand model. However, if crowding is considered to have a large impact on a particular test, it can be skimmed on every loop of the model.



= Process
 = Matrix
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Figure 13: Public Transport Passenger Assignment

Figure 14: High Occupancy Vehicle Modelling

- The High Occupancy vehicle module takes in the From-Home matrices from the Destination Choice module.
- It also takes in High Occupancy and Single Occupancy generalised costs from an assignment.
- It uses these costs along with a sensitivity parameter to split the From-Home trips between High Occupant and Single Occupant Matrices.
- *Note: The implementation of HOV Modelling has impacts in a number of places in the model structure. This diagram shows the main choice model element of the HOV model. The HOV modelling processes would require updating to be implemented within SRM12.*

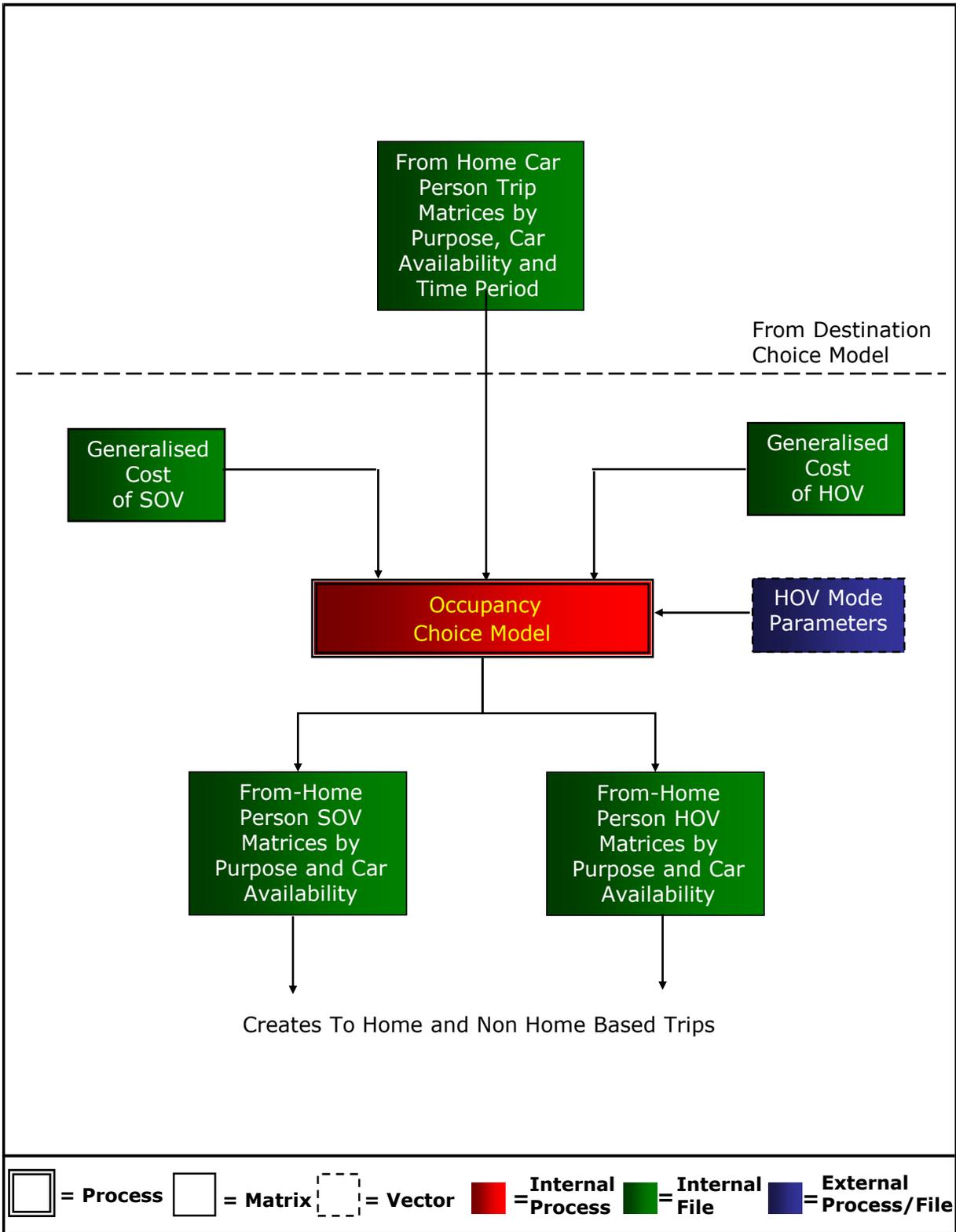


Figure 14: High Occupancy Vehicle Modeling