Development and Application Assistance for TPB Travel Model

Mr. David B. Roden, Senior Consulting Manager

AECOM

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2012 Task Orders

- T.O. 1 – meetings and general support
- T.O. 2 – potential transit model improvements
- T.O. 3 – transit summaries and access coding
- T.O. 4 – parallel processing
- T.O. 5 – begin converting TRNBUILD to PT
- T.O. 6 – special transit trips – Phase 1
  - Subcontracted to Stump Hausman/Bill Allen
- Draft Final Report
  - The results of each task order plus recommendations

Draft Final Report

- Chapter 1 – introduction
- Chapter 2 – general support tasks
- Chapter 3 – potential transit model improvements
- Chapter 4 – transit summaries and access coding
- Chapter 5 – parallel processing
- Chapter 6 – begin converting TRNBUILD to PT
- Chapter 7 – non-resident Metrorail trips
- Chapter 8 – airport-related Metrorail trips
- Chapter 9 – recommendations
- Appendix – special transit trip scripts

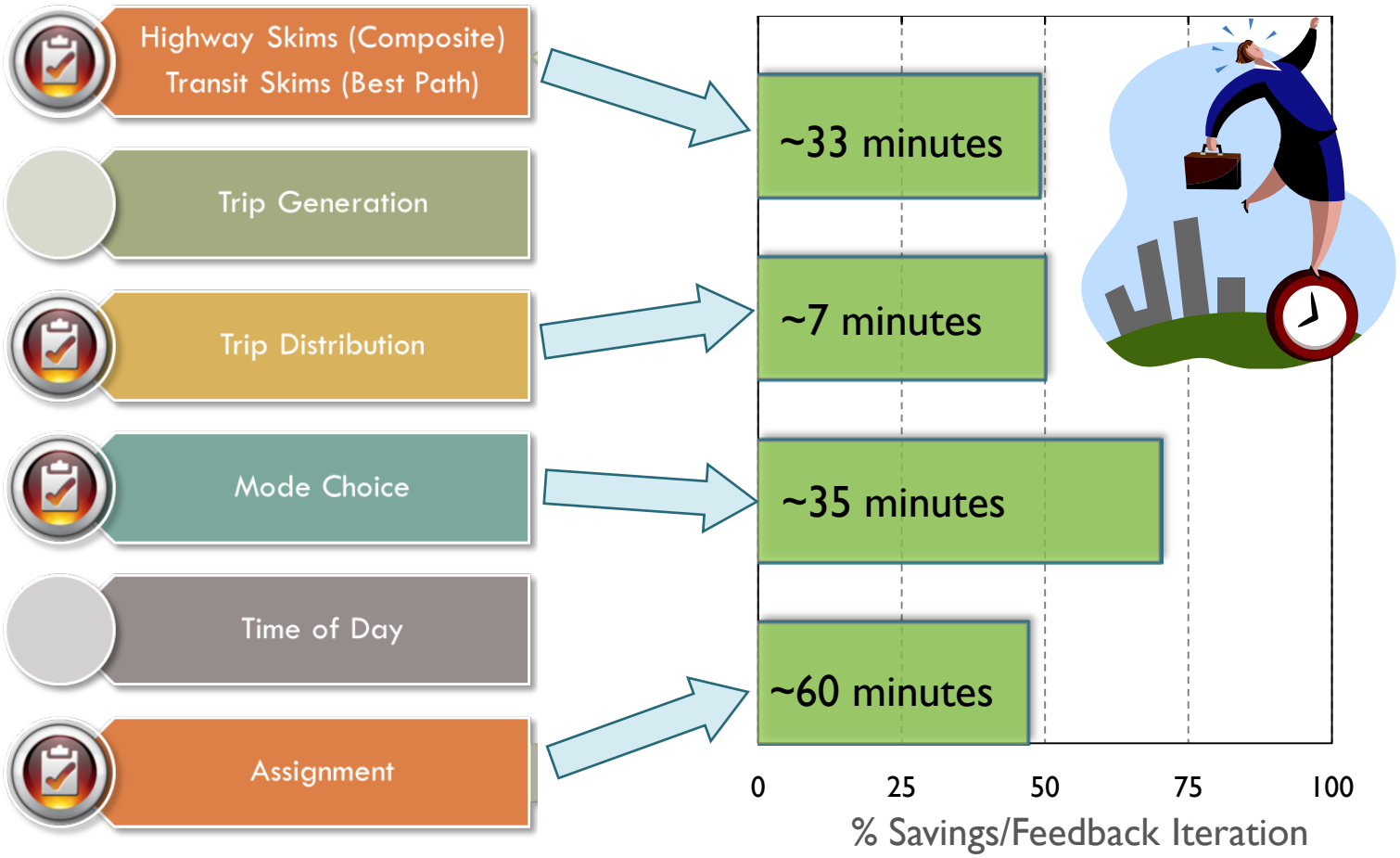
Chronological Order

- Chapter 5 – parallel processing
- Chapter 3 – potential transit improvements
- Chapter 4 – transit summaries and access coding
- Chapter 7 – non-resident Metrorail trips
- ------- Presented at previous TFS meetings -------
- Chapter 2 – general support tasks
- Chapter 6 – begin converting TRNBUILD to PT
- Chapter 8 – airport-related Metrorail trips
- Chapter 9 – recommendations

Chapter 5 – Parallel Processing

- Model performance enhancements
  - Initial concepts developed and tested in Fall 2011
  - Presented to TFS on November 18, 2011
  - Memo submitted in February
  - Comments addressed in June
- MWCOG has tested all the proposed changes, but has not decided which changes to implement
- MWCOG reservations:
  - HOV3+ assignment volumes a major concern
  - Script complexity and maintenance concerns

Potential Improvements



Chapter 3 – Transit Improvements

- Identify potential mode choice and transit model improvements – initial assessment of PT
  - Draft memo in November
  - MWCOG comments incorporated in December
- PT conversion looked like a significant effort
  - Non-transit coding is very different
  - Resulted in a scope change for Task Order 3 and a new task (Task Order 5) to study the PT conversion impacts in more detail

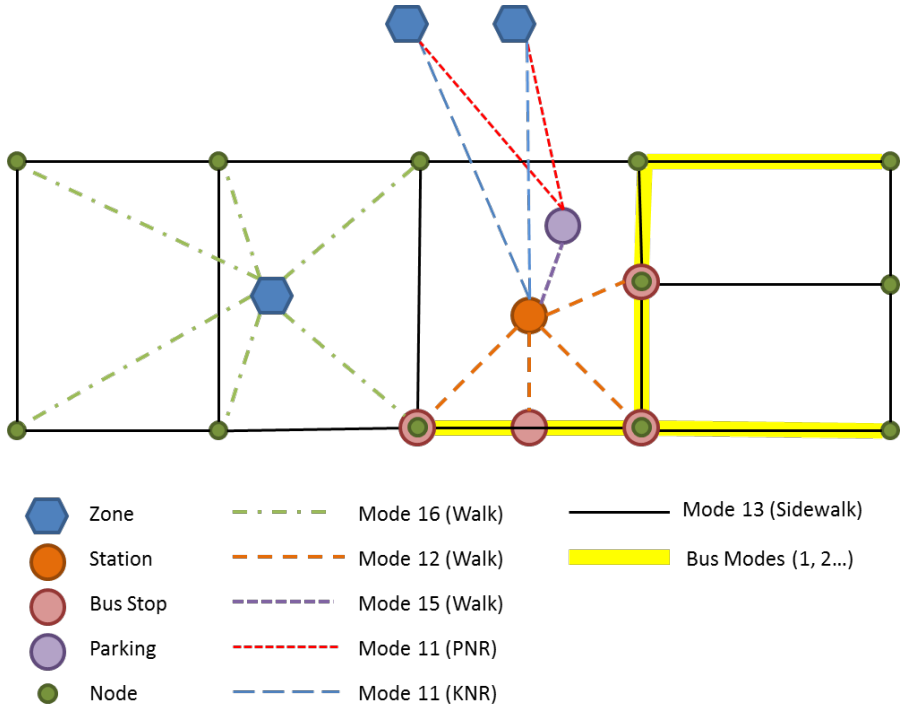
Chapter 4 – Transit Summaries

- Support and upgrades to the LineSum program
  - LineSum software issues and functionality improvements were addressed in April
  - Presented to the TFS on May 18, 2012
  - Additional improvements implemented for WMATA
    - Service levels by route, link shape files, transfer estimates
- Transit access coding changes to enable mode of access summaries at Metrorail stations
  - Separate walk access from bus transfers
  - Current coding uses the same access link for both

Sample Load Factor Map

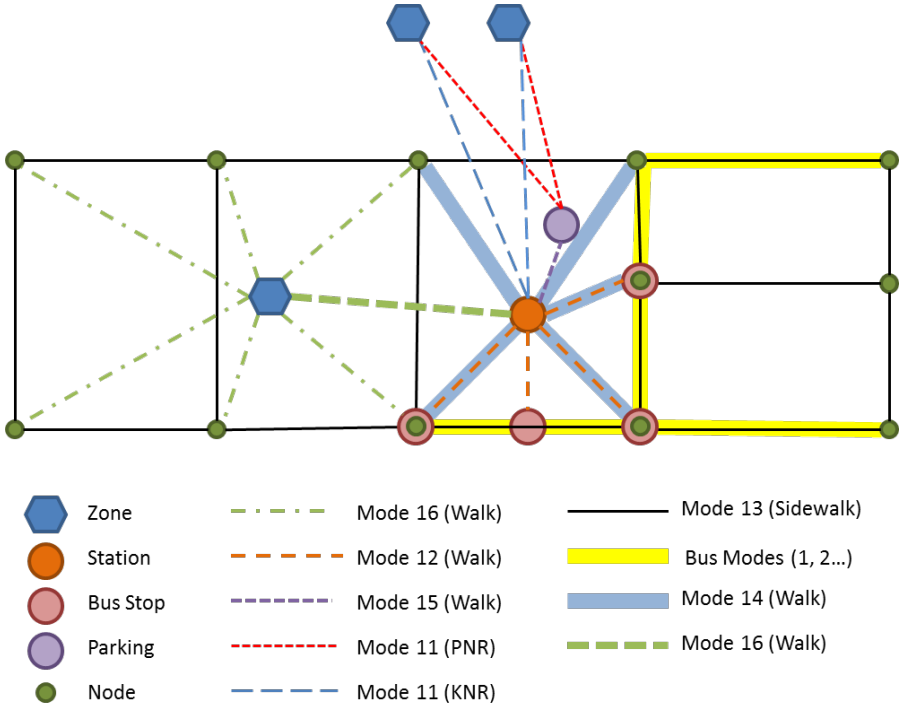
Current Access Coding

- Station access modes = 11, 12, 15
  - 11 → KNR, 15 → PNR, 12 → walk (zone/transfer)



Proposed Access Coding

- Add modes 14 and 16 for station access
  - 11 → KNR, 15 → PNR, 12 → Bus access
  - 14 → sidewalk access, 16 → near zone access



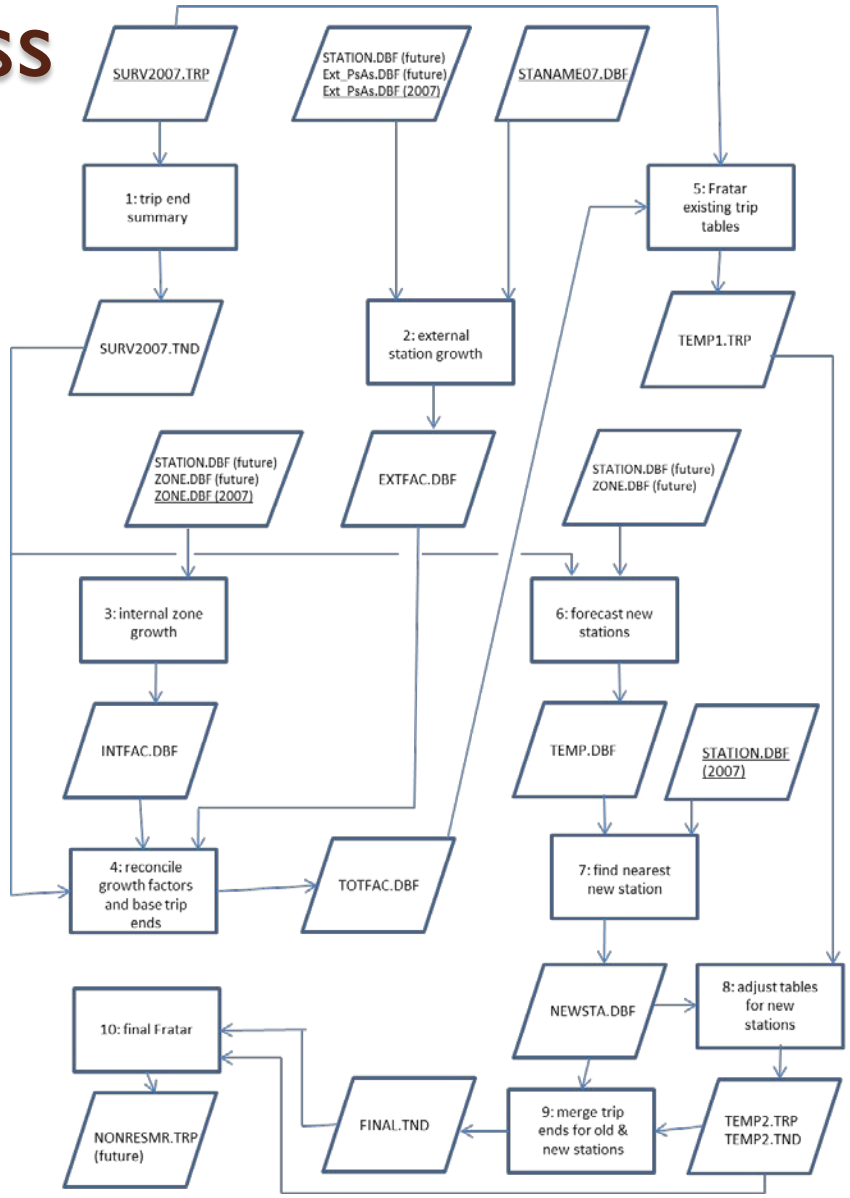
NOX:
11-16 → 12
14 → 1-10

Chapter 7 – Non-Resident Transit

- Estimate transit trips for visitors and external trips → non-residents
  - Phase 1 focused on Metrorail trips using 2007 Metrorail survey
  - Initial model relationships and Cube scripts were developed in April
- Findings presented to the TFS on May 18, 2012
  - MWCOG comments were addressed in Chapter 7

Forecasting Process

- Cube script in the Appendix



Forecasting Steps

- Process for forecasting non-resident Metrorail trips
  1. 2007 trip end summary
  2. External growth factor
  3. Internal growth factor
  4. Reconcile growth factors and trip ends
  5. Initial Fratar
  6. Estimate B+A and boarding split for new stations
  7. Find nearest existing station to each new Metrorail station
  8. Adjust interim tables for new Metrorail stations
  9. Merge trip ends for existing and new Metrorail stations
  10. Final Fratar

Resulting Trip Tables

Table	Definition	Period	Access Mode
1	E/I Commuters, auto access	AM	PnR
2	E/I Non-Work, auto access	OP	PnR
3	E/I Commuters, walk access/train transfer	AM	PnR
4	E/I Non-Work, walk access/train transfer	OP	PnR
5	NHB Visitors (walk access)	OP	Walk
6	NHB Business (walk access)	OP	Walk
7	Air Passengers (walk access)*	OP	Walk

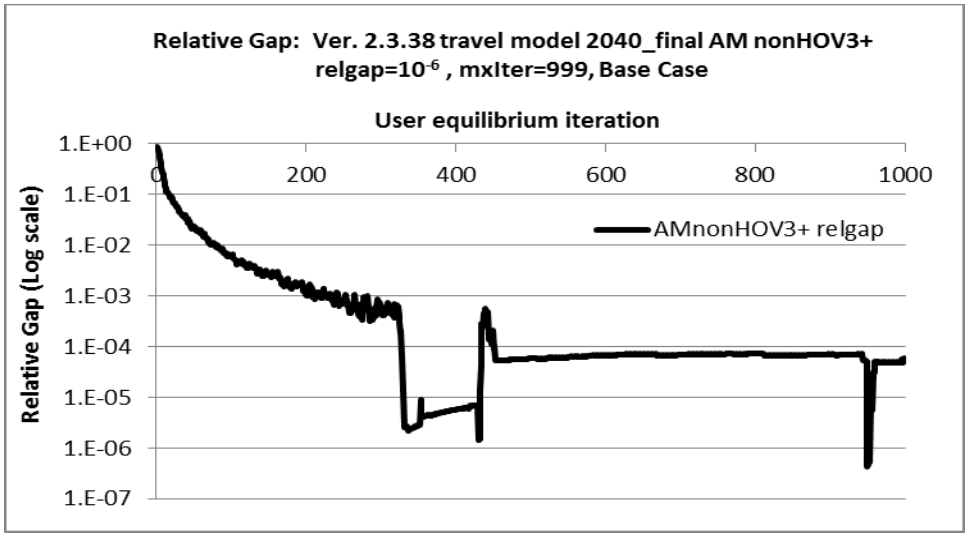
*Air passengers are a temporary substitute for the more rigorous model

Chapter 2 – General Support

- Assistance with Cube highway assignment convergence issues
- Briefed MWCOG staff about the WMATA model upgrade to Version 2.3

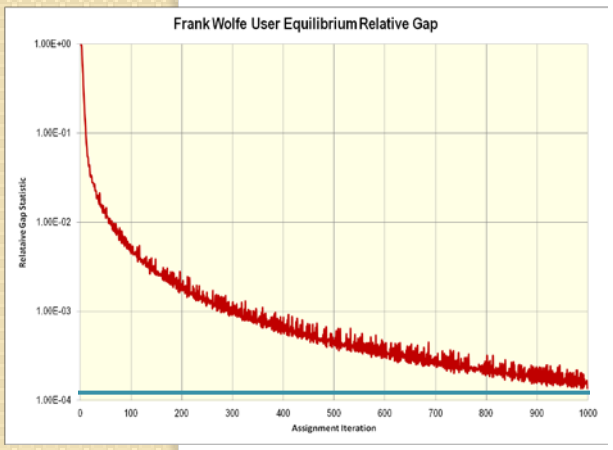
Assignment Convergence

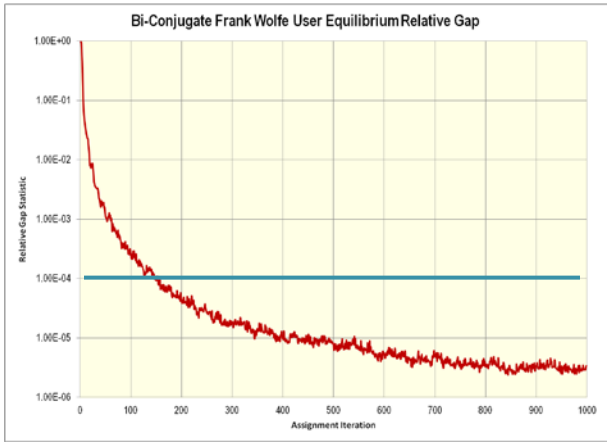
- MWCOG has been testing Cube assignments with relative gaps less than 10^{-4}
  - Reduce volume differences from small changes
  - Odd behavior has been discussed with Citilabs
    - They told MWCOG the algorithm could not do better

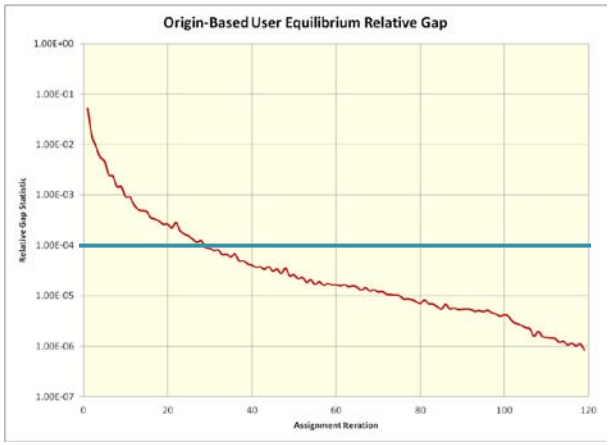


Software Tests

- AECOM agreed to run a quick test using TransCAD and the M-NCPPC (PG Co.) model
  - The M-NCPPC model is significantly different, but several algorithms generated relative gaps < 10^{-4}







WMATA Modeling Process

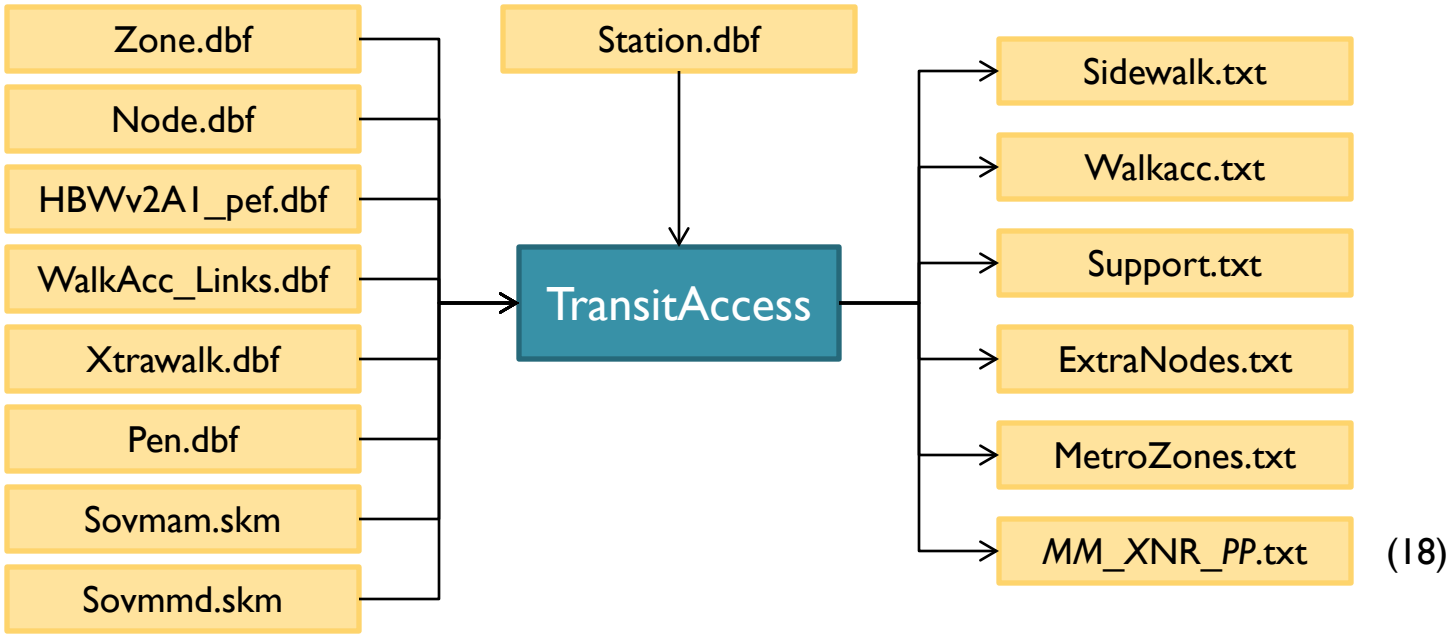
- Post-processor to the MWCOG v2.3 Model
  - Uses person trip tables, highway skims, and "inputs" directory from a Version 2.3 run
  - Evaluates multiple transit alternatives given fixed person trip tables and highway travel times
  - Replicates the MWCOG v2.3 transit network and access processing, and fare, skim, and assignment methods in less computer processing time
  - Replaces AEMS software with recalibrated models for three trip purposes in peak and offpeak periods

Parallel Processing

- Skims – 22 modes executed simultaneously
- Fares – 22 fare calculations simultaneously
- Mode Choice – 6 purpose/periods
- Assignment – 22 modes loaded simultaneously
- Issues running simultaneous alternatives
  - Environment variables
  - Cube Cluster ID conflicts
  - Writes to the Support directory
    - HBWK.DAT, HBOK.DAT, HBSK.DAT, NHWK.DAT, NHOK.DAT

Network Preparation

- TransitAccess program
  - STAPROTP_V23.exe, parker.s, walkacc.s, autoacc4.s
    - ~45 minutes → 8 seconds



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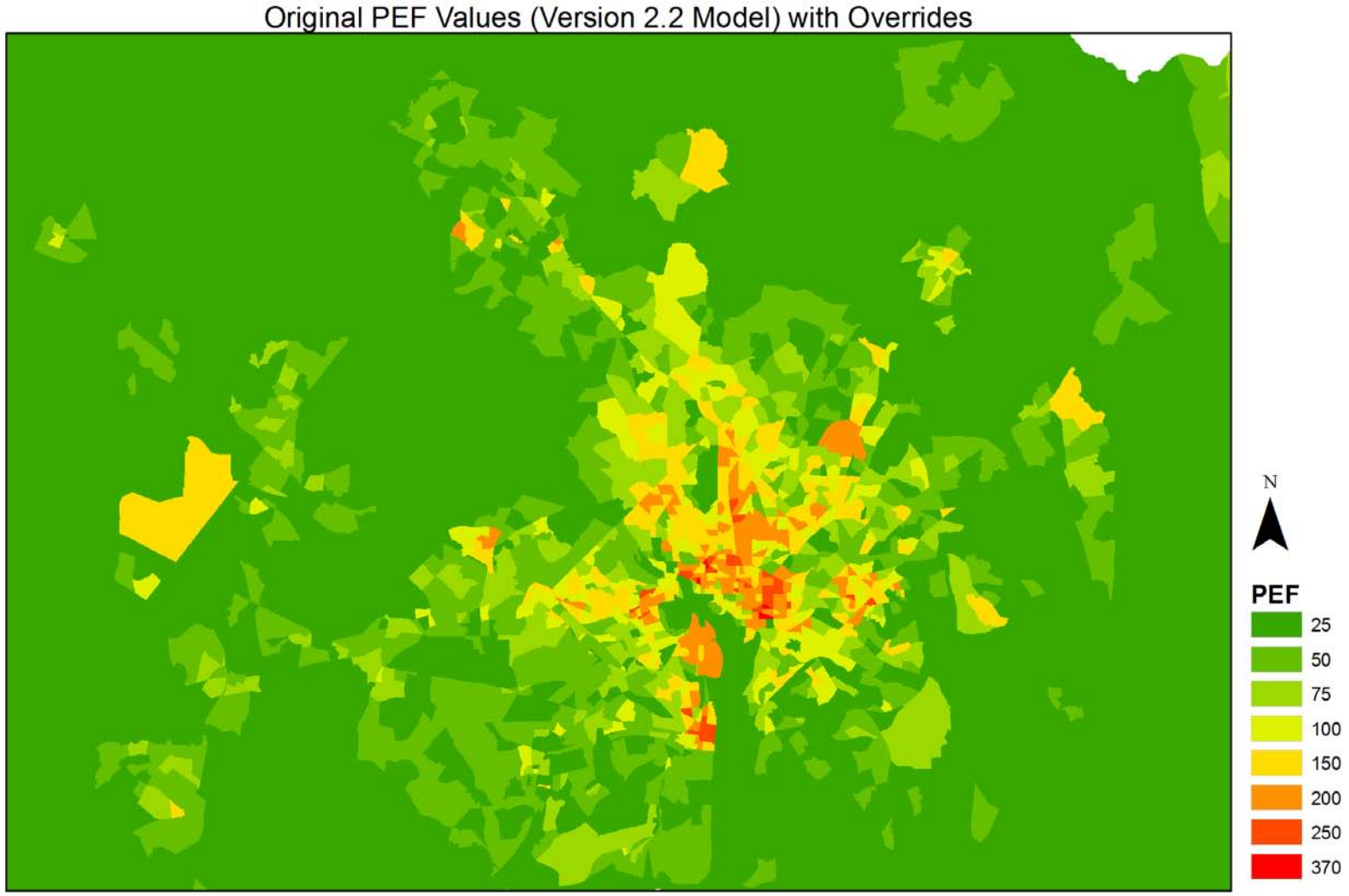
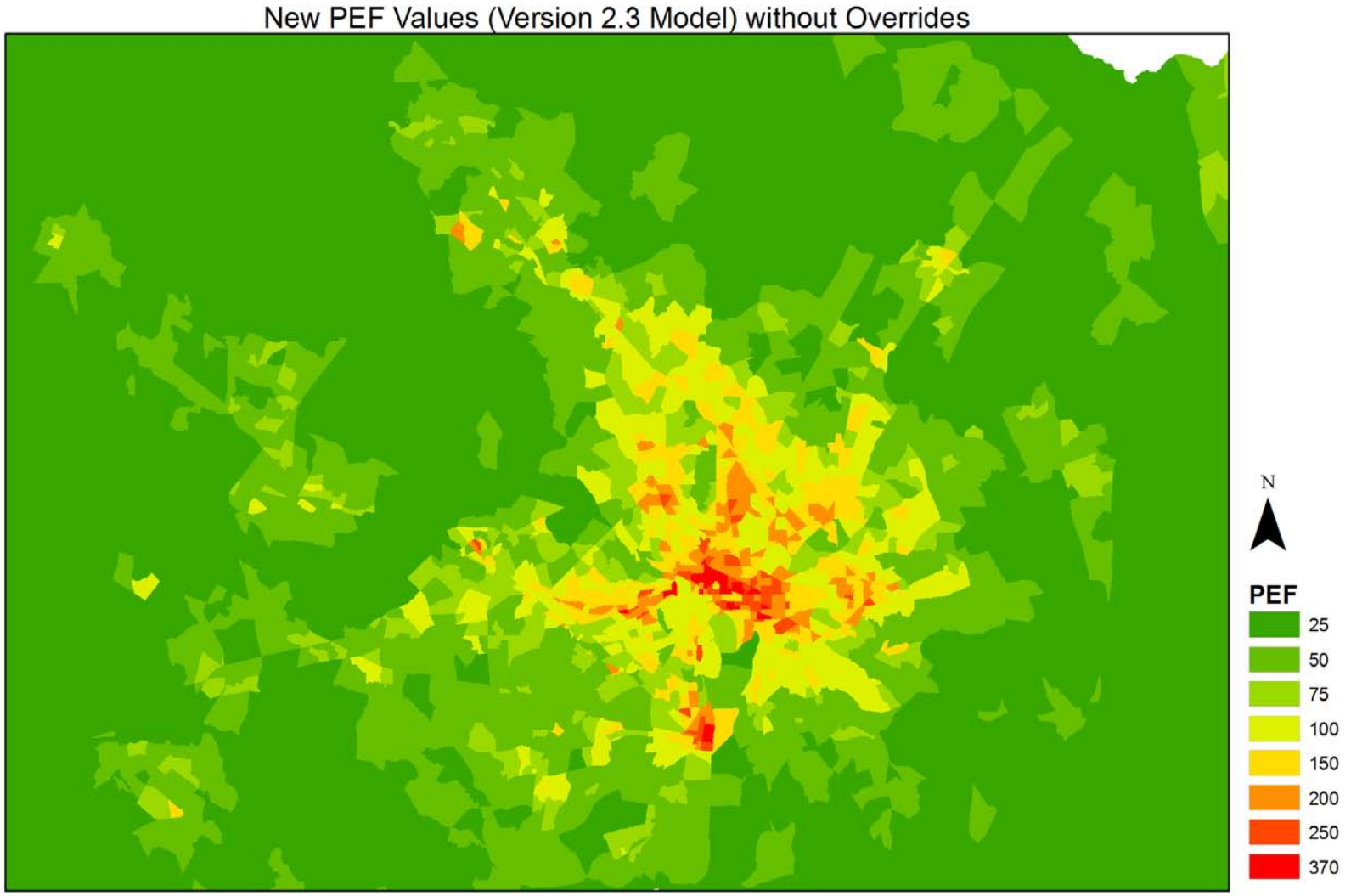
Mode Choice Process

- AEMS → ModeChoice software
  - 3 purposes – HBW, HBO, NHB
  - 2 time periods – peak, offpeak
- New PEF concept
  - Future development density and transit accessibility
  - Proximity smoothing
- Recalibrated without market segments
  - 21 mode / nesting constants
  - 15 modes * 4 income constants → 60 constants
- Metrorail parking constraints – shadow price

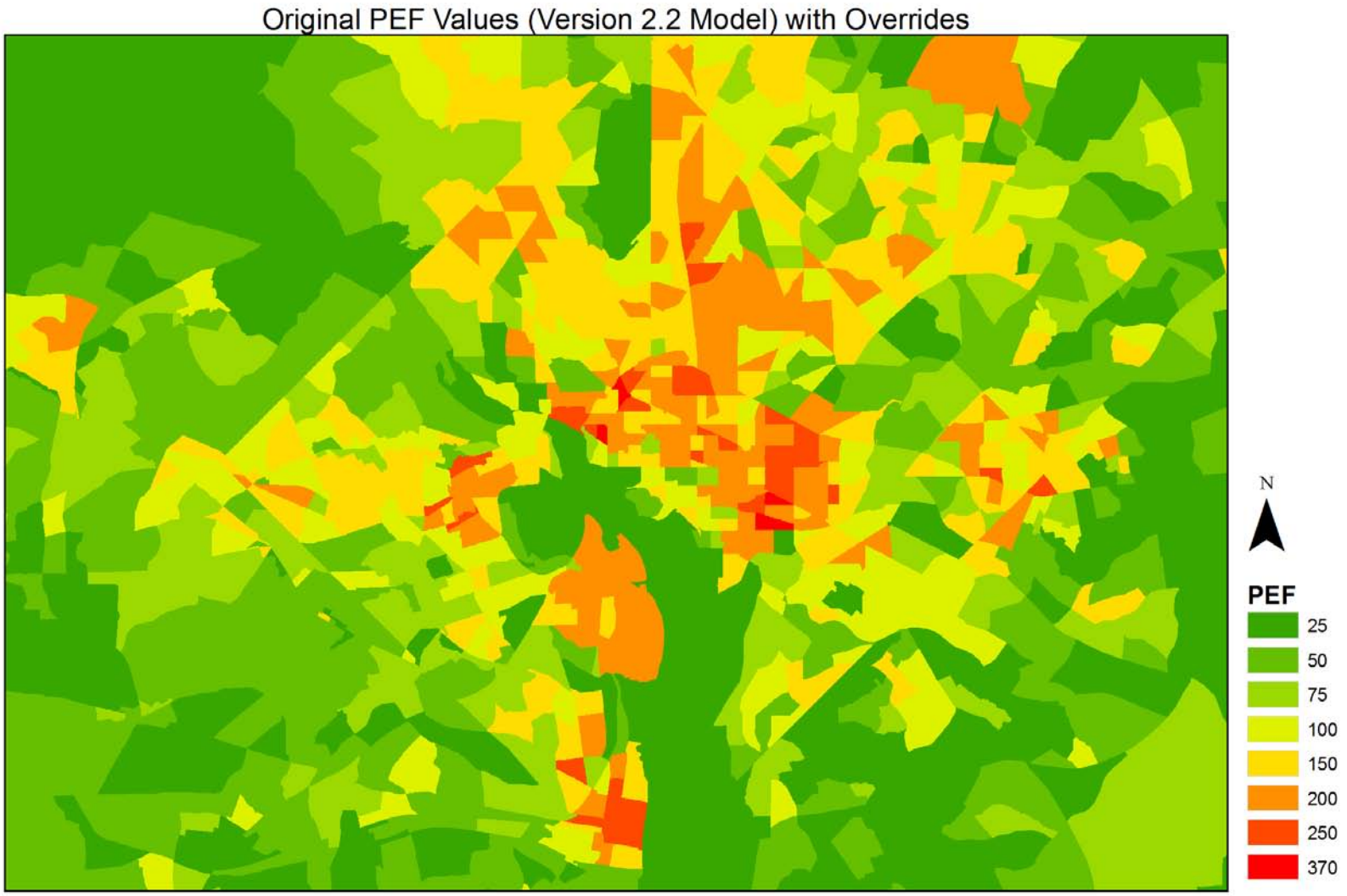
Original WMATA PEFs



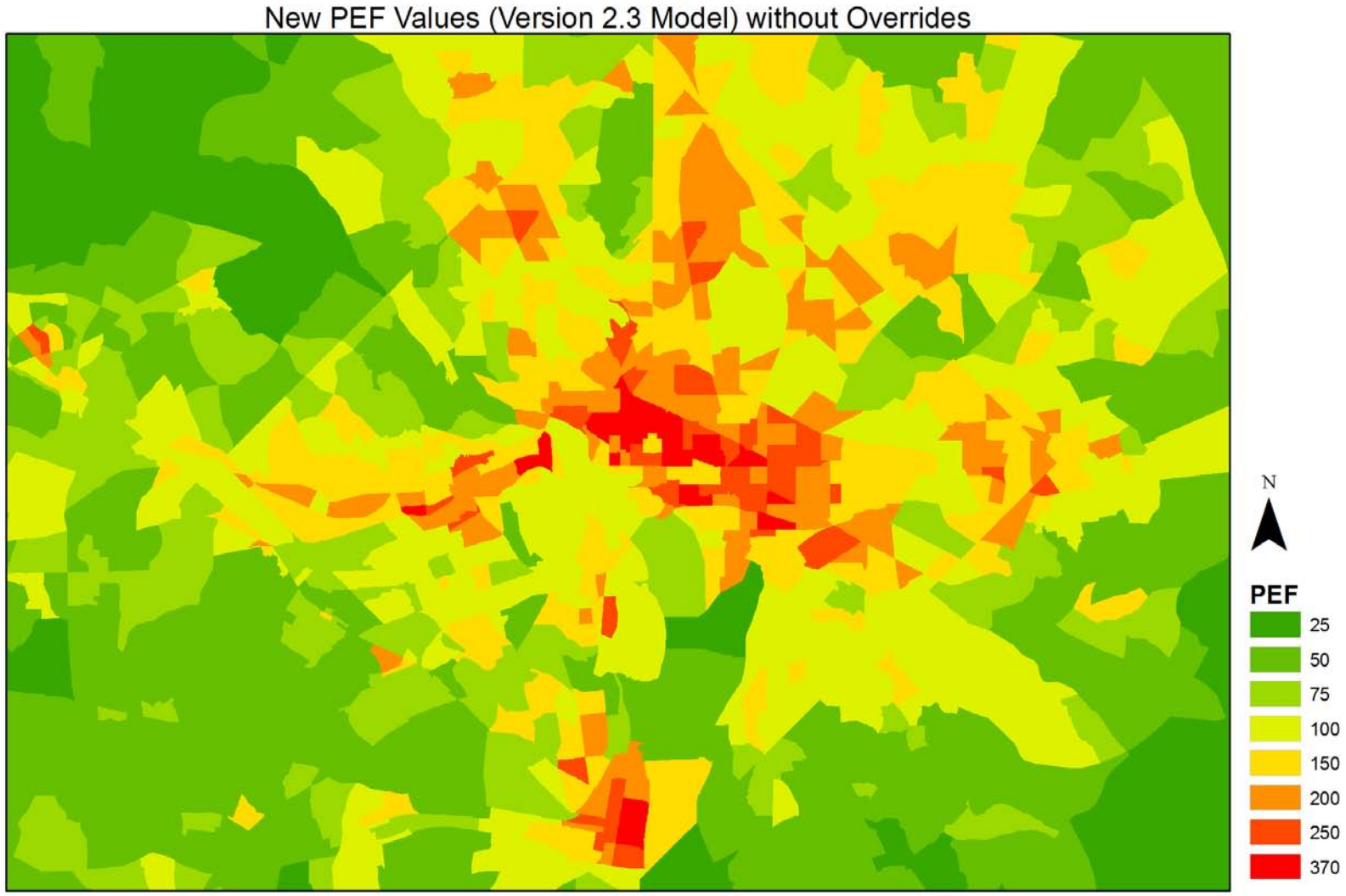
New PEFs


New PEF Values (Version 2.3 Model) without Overrides
N
PEF
25
50
75
100
150
200
250
370

Original PEFs Inside the Beltway

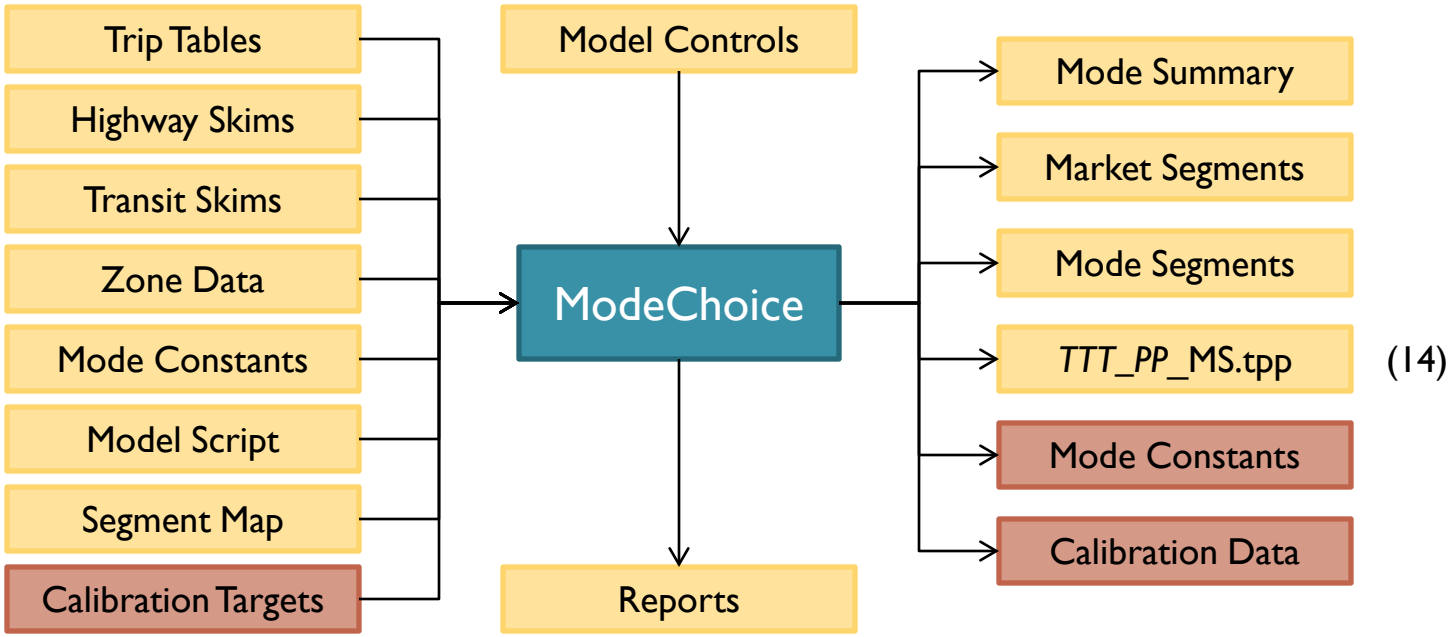


New PEFs Inside the Beltway



ModeChoice Software

- Mimics AEMS functionality
  - New control structure and script
  - Includes automatic calibration option



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ModeChoice Functionality

- Apply a nested-logit or multinomial mode choice model
  - Read trip tables and skim files in TPPlus or TransCAD format
    - Trip tables can be subdivided by income or other attribute
  - Constants by market segments and traveler attribute
  - Short and long walk access for sub-market shares
  - User scripts for manipulating the skim and zonal attributes
- Iterative model calibration process to match targets
  - Targets by mode, market segment, and traveler attribute
    - Constants have min/max constraints and seed values
  - Exit criteria by maximum iterations and RMSE convergence
  - Output files for model application or additional calibration
- Generate reports and files summarizing mode shares, market segments, user benefits, and calibration results

Chapter 6 – PT Conversions

- The full conversion from TRNBUILD to PT is planned for fiscal year 2013
  - The purpose of this task was to gain a clearer understanding of the level of effort and the impact on transit path building and mode choice
- Two primary approaches
  - Convert existing TRNBUILD data to PT format and apply the PT path builder to compare results
  - Use the PT GENERATE process to build non-transit links and build paths

Converting TRNBUILD

- Must add all transit-only links and station nodes to the highway network
  - Metrorail, commuter rail, light rail, BRT, streetcar, and bus links, nodes, and park-n-ride lots
  - Simple Cube script → A, B, mode, distance, speed
- TRNBUILD line files to PT line files
  - Simple search and replace MATRIX script
- Convert 24 transit access files
  - Cube script to read fixed column files and recalculate distance/speed and cost

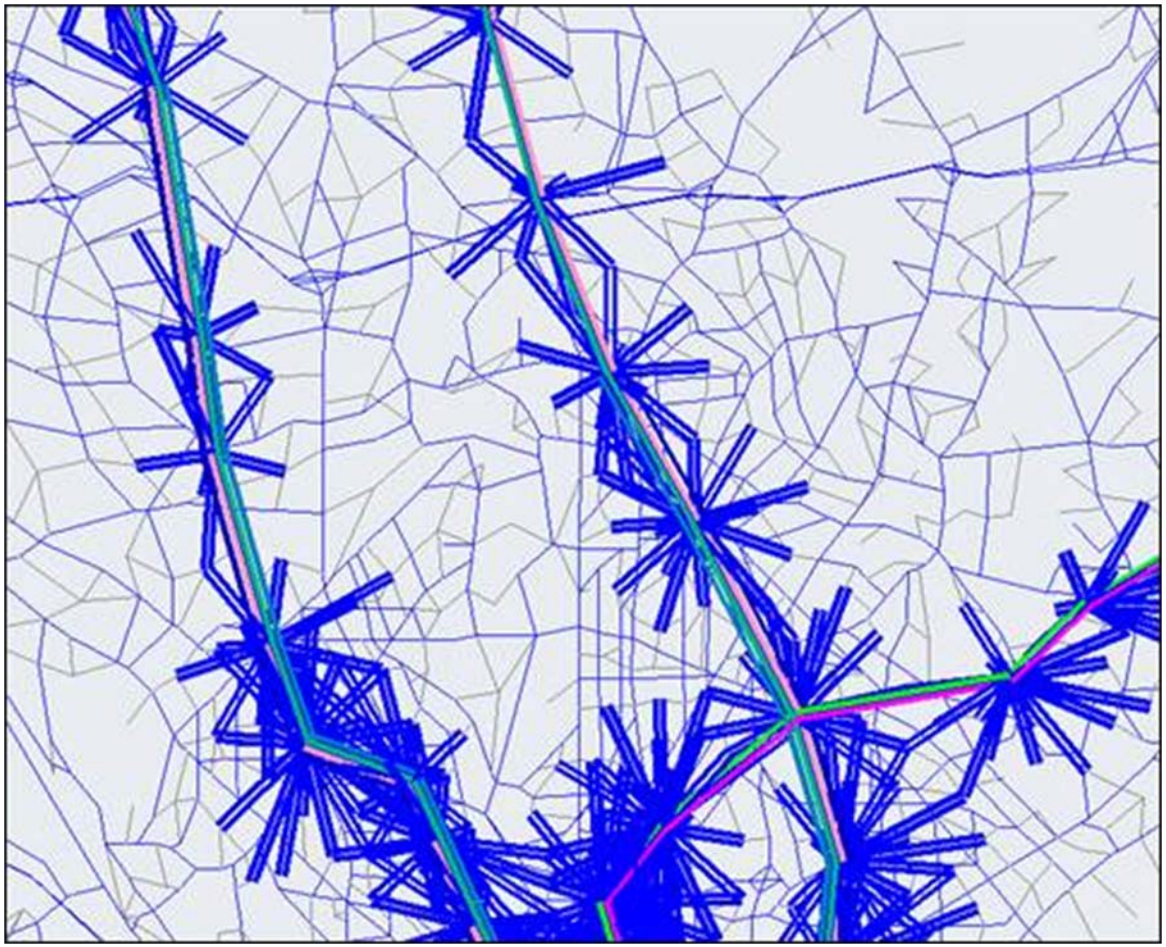
Path Building Issues

- Public Transport does not work with blank files
  - LRT and mode 10 (BRT/streetcar) data is not included in some model years
    - These data needed to be combined with a non-blank mode file to avoid processing errors
- Skim items needed to be reconfigured
  - Actual and perceived times (TIMEA vs. TIMEP)
  - Add a route-set code: TIMEA(0, 3) = Metrorail time
    - The software currently doesn't support multiple route-sets
  - NODE0 and NODEL options are no longer supported
    - Needed for Metrorail fare calculations

PT Non-Transit Links

- PT does not permit multiple non-transit legs between transit legs
  - The MWCOG TRNBUILD access structure often requires at least two modes and links to access transit
    - Drive → park → walk → transit
    - Zone walk → sidewalk → sidewalk → station walk → transit
- The MWCOG access software will need to be rewritten or converted to PT GENERATE
  - PT GENERATE includes may attractive features
  - PEF weighting factors may be difficult to implement

PT GENERATE Results



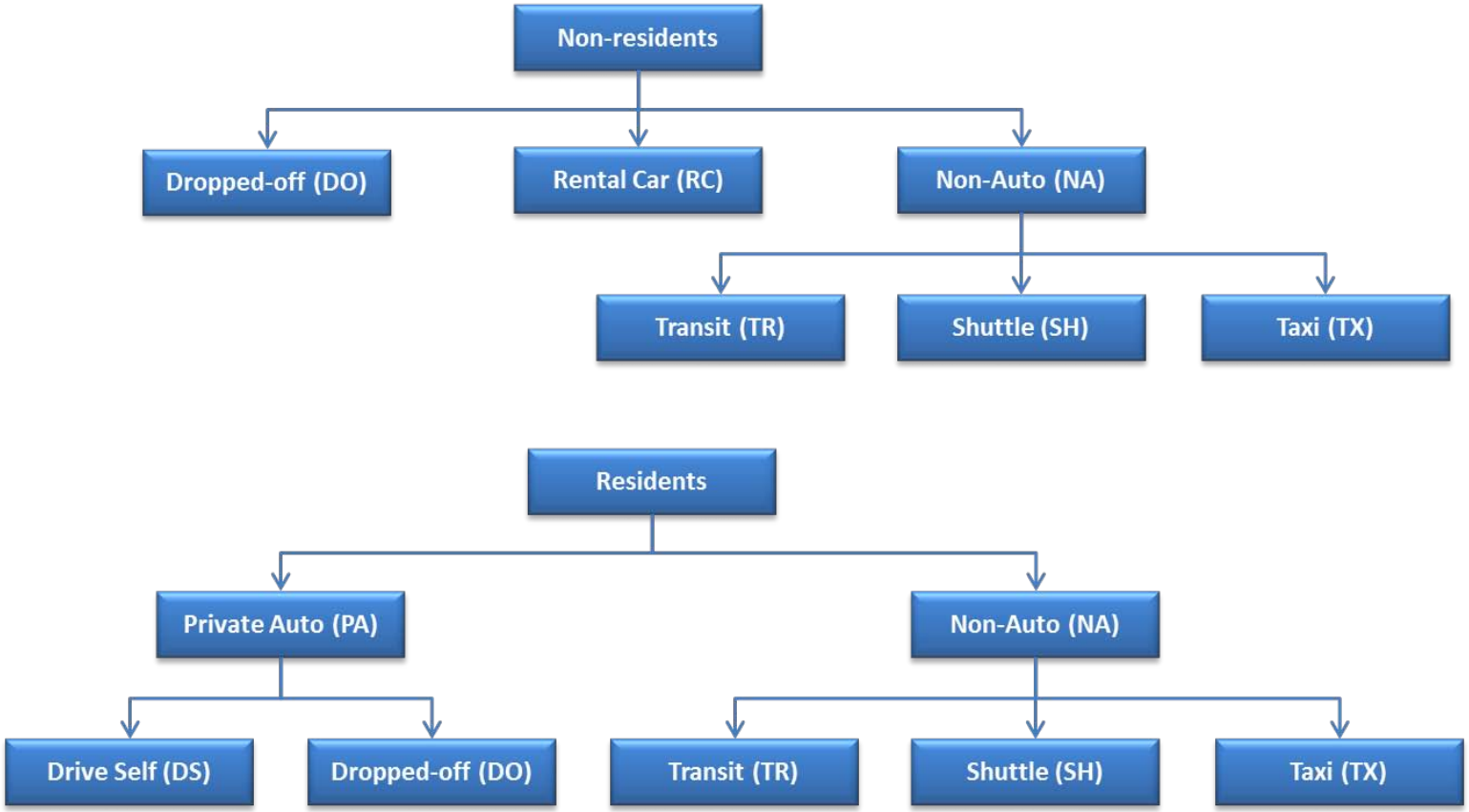
Proposed Work Program

- Phase 1: Network Preparation
  - Develop the PT network, routes, and non-transit legs
- Phase 2: Path Building and Loading
  - Generate a set of reasonable paths under a variety of conditions
- Phase 3: Transit Fares
  - Use PT to calculate fares including station-to-station Metrorail fares
- Phase 4: Mode Choice Calibration
  - Reduce market segments, constrain constants, and include a pedestrian environment factor
- Phase 5: Advanced Applications
  - Public Transport offers a number of opportunities to perform sophisticated analysis of the transit system

Chapter 8 – Airport Transit Trips

- The air passenger model
  - Originally developed by the Regional Planning Commission in New Orleans and converted to Cube by the Baltimore Metropolitan Council
- Three step modeling process
  1. Estimate total air passengers by obtaining the total average daily enplanements – external data sources
  2. Allocate the daily originating passengers to their "ground side" trip ends using household and employment stratified by the four income groups
  3. Estimate the mode used to travel between the airport and the "ground side" trip end using a nested logit choice model

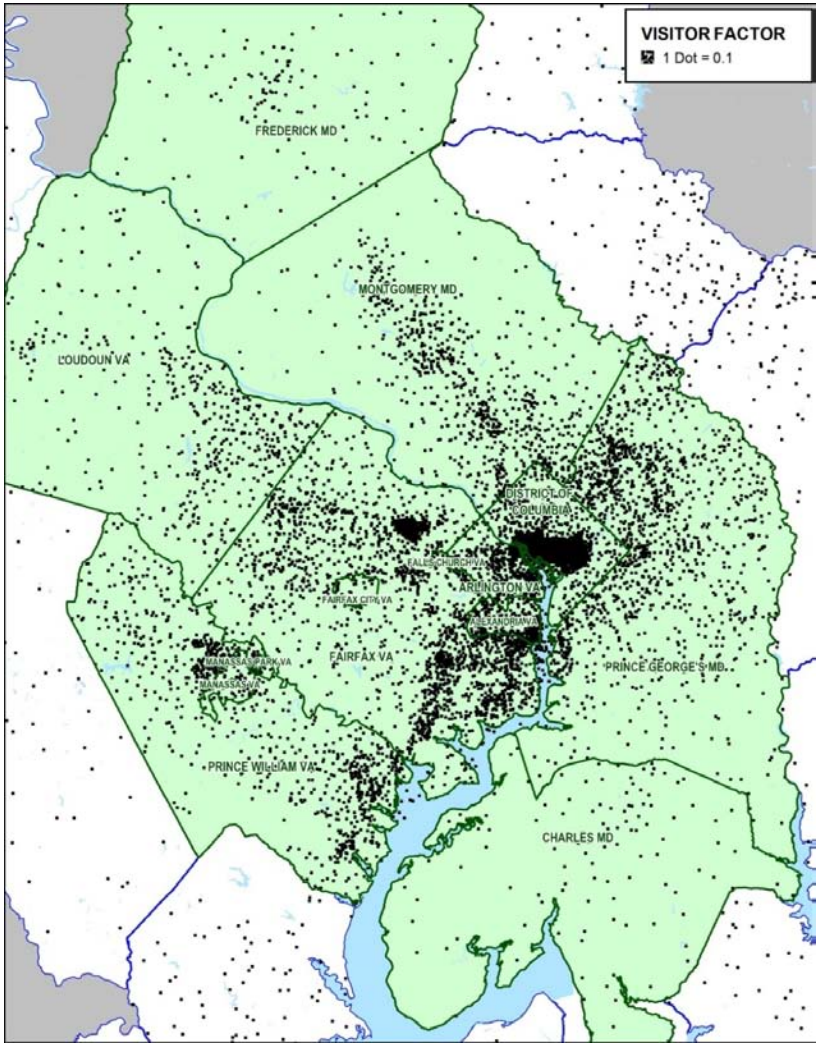
Model Structure



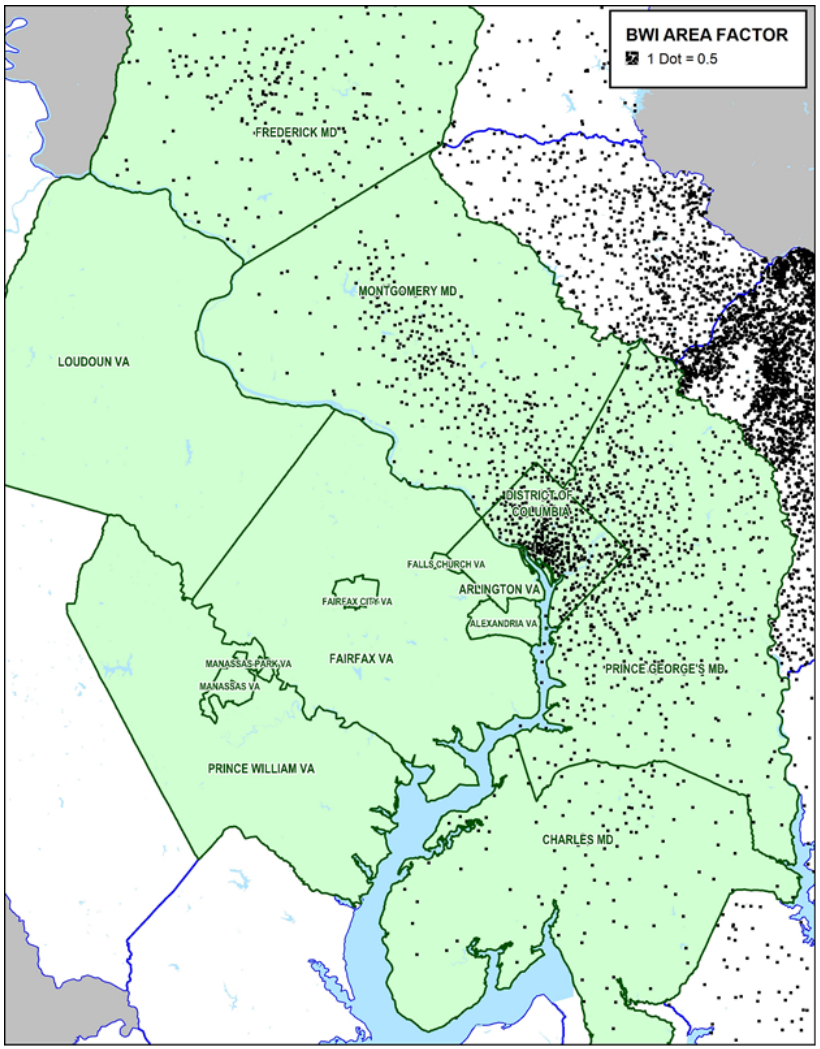
Primary Reasons for Selecting Airport

Reason	BWI Marshall (BWI)	Washington Dulles (IAD)	Reagan National (DCA)	All Airports
Closest airport	56%	53%	72%	61%
Better public transportation	1%	1%	6%	3%
Better access roads and parking	3%	3%	1%	2%
Subtotal - Accessibility	**60%**	**57%**	**79%**	**66%**
More convenient flight times	5%	8%	8%	7%
Direct / Non-Stop Service	4%	11%	2%	5%
Less expensive airfare	27%	16%	7%	17%
Frequent flyer	1%	4%	2%	2%
Only airport serving market	1%	3%	1%	2%
Subtotal – Quality of Service	**39%**	**42%**	**20%**	**33%**
Other	1%	1%	1%	1%
Total	100%	100%	100%	100%

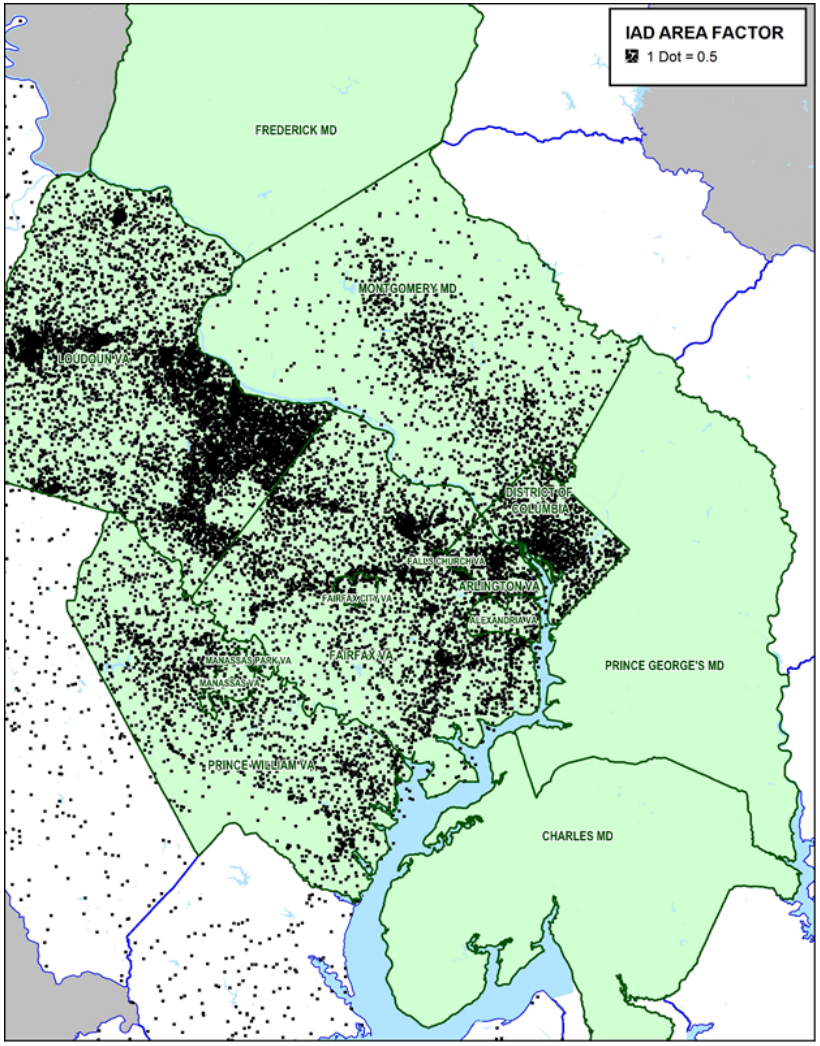
Visitor Factor by TAZ



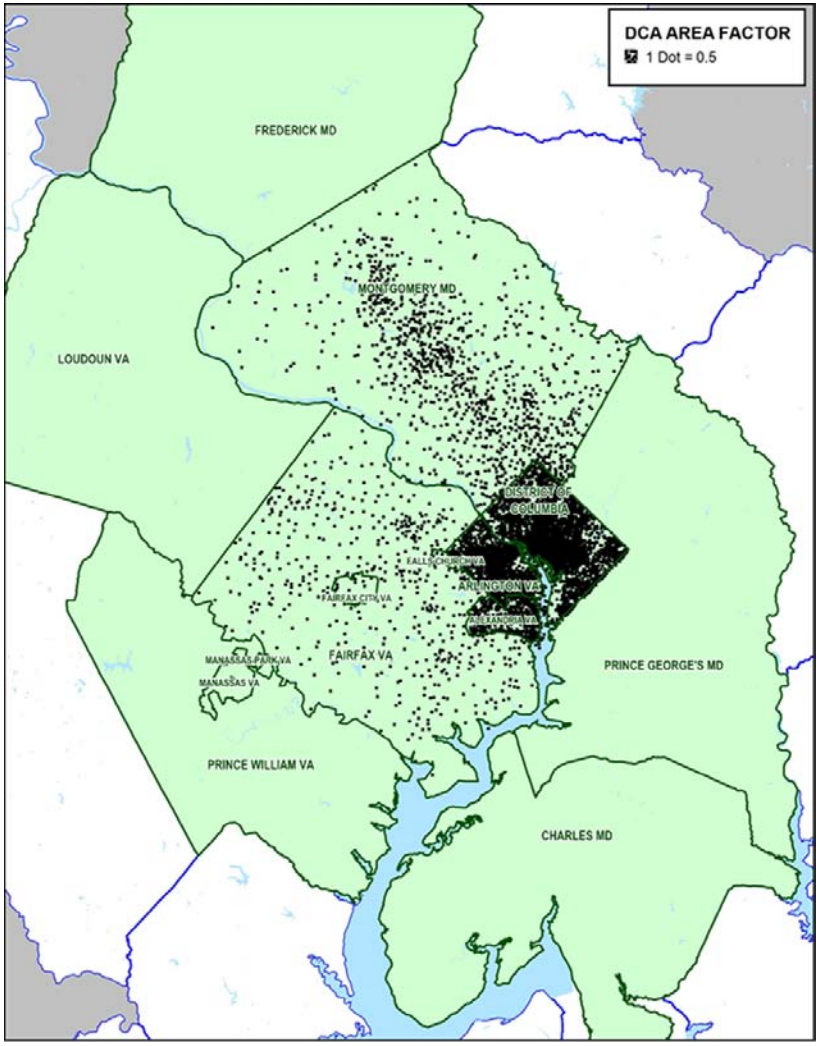
BWI Market Factor



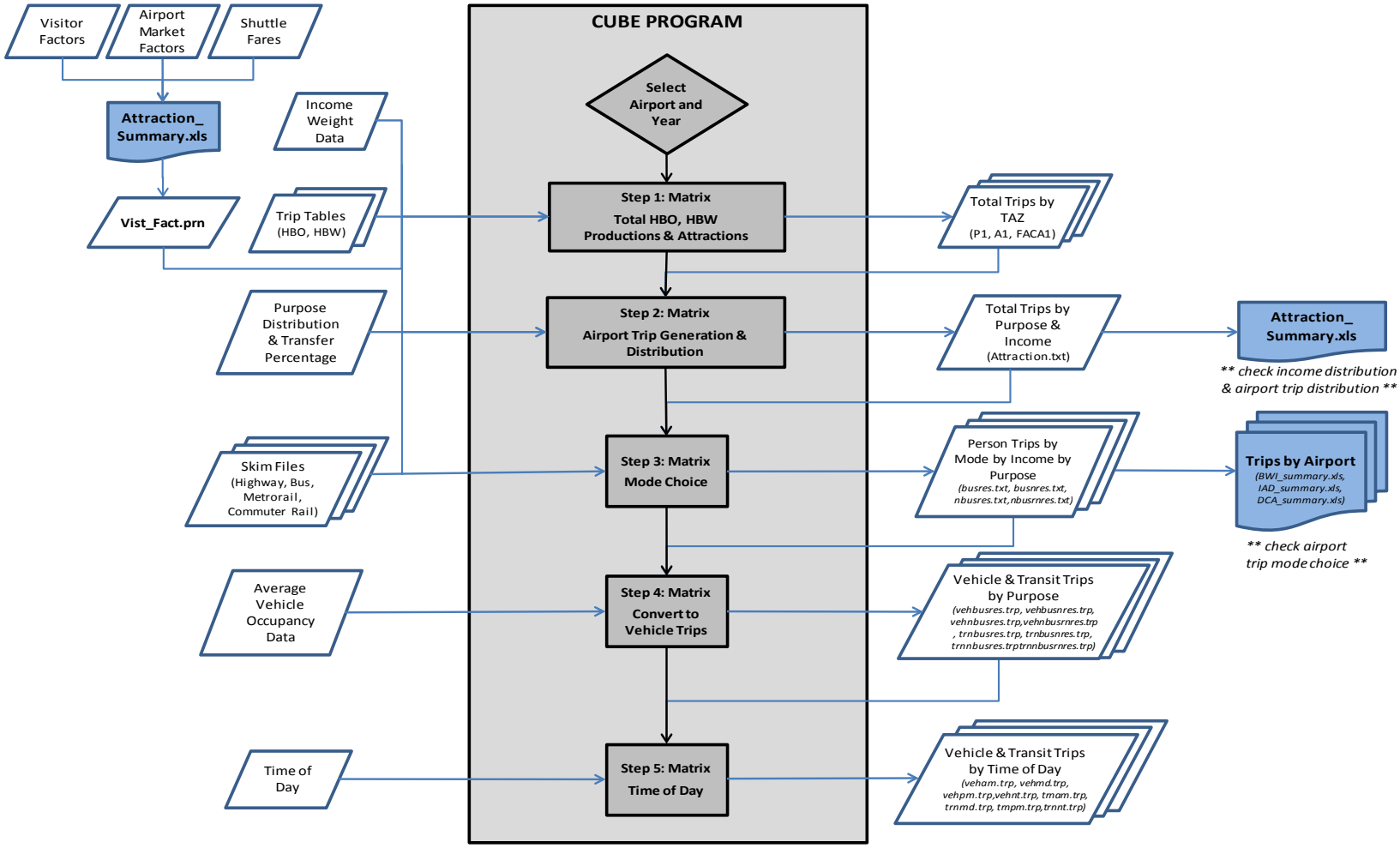
Dulles Market Factor



Reagan National Market Factor



Cube Script in Appendix



Chapter 9 – Recommendations

- Perform a TransCAD assignment using inputs from a congested Version 2.3 run to share with Citilabs
  - Attempt to resolve the assignment convergence issue
- General improvements to the Version 2.3 model
  - Consolidate input/output files to serve the needs of multiple programs or scripts
  - Include additional checks to minimize application errors
  - Add logic to minimize conflicts between multiple applications running at the same time
  - Implement additional IDP and MDP processing
    - Use more than four CPUs when the computer resources are available and the results are not affected by the change

Additional Recommendations

- Consider adjusting the trip distribution and path-building parameters to improve the HOV volumes generated by a multi-class traffic assignment
  - It "should" be possible to assign non-HOV and HOV3+ trip tables in the same multi-class assignment step
- Consider some of the processing changes and software tools developed for WMATA
  - Modeling work and non-work trip purposes by time of day is helpful for mode choice and transit capacity analysis
  - Add Pedestrian Environment Factors to mode choice
  - Recalibrate with fewer geographic market segments and constrained constants

Convert to Public Transport (PT)

- In the near-term
  - Upgrade transit summaries to LineSum 5.0.x
  - Add logic to the TRNBUILD walk access process to connect stations to nearby zones and sidewalk nodes
  - Add transfer prohibitions in the path-builder in order to quantify bus transfers at Metrorail stations
- Start a five phase work program to convert the modeling process to PT
  - Transit networks, transit path building/loading, transit fares, mode choice calibration, and advanced applications
    - Pursue at least the first two phases during fiscal year 2013
    - Phases 3 and 4 can be implemented if funds and time permit
    - Phase 5 may be more appropriate for fiscal year 2014
  - Coordinate the effort with WMATA

Stump/Hausman Recommendations

- Non-resident transit trips
  - Revise the external trip model to estimate person trips instead of vehicle trips and include external stations in the transit network coding and the mode choice models
  - Develop a separate four-step model for Visitor travel
- Airport transit trips
  - Recalibrate the air passenger model using the latest air passenger survey
  - Develop a partial airport choice model to address the portion of travelers that choose an airport based on distance and/or travel time