Transit Modeling Update

presented to
MTF Transit & Rail Committee

presented by
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March 5, 2012
Objectives

- Improve the preparation of transit demand forecasts in Florida to a point consistent with federal expectations

- Incorporate state of the practice techniques and tools in FSUTMS through a prototype model application
Transit Working Group

Vidya Mysore, FDOT Systems Planning
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Larry Foutz, Miami-Dade MPO
Dan Macmurphy, Traf-O-Data
Jeannette Berk, Advanced Planning, Inc.
Myung-Hak Sung, Gannett Fleming
Presentation Overview

- Project Overview
- PT Improvements
- Model Design and Development Guidelines
  - Auto Ownership and Trip Generation Model
  - Time of Day Segmentation
  - Trip Distribution Model
  - Transit Network Coding & Path Building
  - Mode Choice Model
- Prototype Application
- Concluding Remarks & Discussion
Project Overview

- On-Board Rider Survey – Synthesis of Practice
- Model Design & Development Guidelines
- Principles of Model Calibration and Validation
- Use of User Benefits Analysis Tools
- New Starts: Building a Case for the Project
On-Board Rider Survey Synthesis of Practice

- Understanding Markets
- Build on FTA Guidelines

Topics
- Fielding Surveys
  - Self Administered
- Selected Data Items – Lessons Learned
- Expansion Methodologies
- Emerging Use of APC Data
- File Manipulation & Preparation
- Survey Assignment
Principles of Model Calibration and Validation

- Transit Travel Time Functions
- Upper Level Model Influences
- Model Assessment
- Model Calibration
- Forecasting Testing
- Documentation Recommendations
User Benefit Analysis Tools

- User Benefit Analysis Guidelines
  - Builds upon SUMMIT Program User’s Guide

- UserbenC Program

- Quality Control Guidelines & Procedures
  - Basic Quality Control Comparisons
  - Standard SUMMIT Outputs
  - Understanding Service Level Changes
  - Capped Benefits
  - Understanding the Source of User Benefits
  - User Benefits per Project Trip
Case for the Project Workshop

- Pilot held in Miami – November 15th and 16th
- 12 Sessions
  - Including 3 Mini-Workshops for Participants
- Framing the Benefits of the Project
  - Important Principles
  - Example Test Cases
  - Uncertainty Analysis
  - Defining the Problem
  - Implications for Practice
- Next Offering – May 2012 in Orlando
Transit Modeling Update

NEW PT FEATURES IN CUBE VOYAGER 6.0
New PT Features in Cube Voyager 6.0

- Enhanced Drive-Access Generation
- Enhanced Fares along with BestPathOnly
- Enhanced Transit Line Keywords
Enhanced Drive-Access Generation

- Enhanced Drive-Access Generation
- Drive-Access Generation in 5.x
- Drive-Access Generation Examples in 5.x
- Drive-Access Generation in 6.x
- Enhanced Drive-Access Generation Example
Examples of Drive-Access Coding

- Aerial photograph for parking lot & transit stops
Examples of Drive-Access Coding

- Schematic diagram
Examples of Drive-Access Coding

- Network with transit lines and non-transit access links
Examples of Drive-Access Coding

- Example for kiss-ride facility with bus stop
Drive-Access Generation in 5.x

- Historically Cube Voyager has been very strong in allowing users to automatically generate PT access connectors.

- The user was able to consider many factors including:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROMNODE / TONODE</td>
<td>Defines nodes that will be considered as “beginning” and “ending” nodes</td>
</tr>
<tr>
<td>COST</td>
<td>Variable/equation that determines the minimum path</td>
</tr>
<tr>
<td>DIRECTION</td>
<td>Direction of the generated non-transit legs</td>
</tr>
<tr>
<td></td>
<td>1 - from -&gt; to node</td>
</tr>
<tr>
<td></td>
<td>2 - to -&gt; from node</td>
</tr>
<tr>
<td></td>
<td>3 - both directions</td>
</tr>
<tr>
<td>EXTRACTCOST</td>
<td>Skimmed variable/equation</td>
</tr>
<tr>
<td>INCLUDELINK / EXCLUDELINK</td>
<td>INCLUDE - Defines links that should only be used in generating non-transit legs; all links not listed are excluded</td>
</tr>
<tr>
<td></td>
<td>EXCLUDE - Defines links that should not be used in generating non-transit legs; all links not listed are included</td>
</tr>
<tr>
<td>ACCESSLINK</td>
<td>One or more access links from park-and-ride facilities to stop nodes. If the link does not exist in the network, the program generates the link</td>
</tr>
</tbody>
</table>
## Drive-Access Generation in 5.x

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXCOST</td>
<td>Maximum value of COST (vector by mode)</td>
</tr>
<tr>
<td>MAXNTLEGES</td>
<td>Maximum number of non-transit legs per mode (vector by mode)</td>
</tr>
<tr>
<td>MINCOST</td>
<td>Minimum value of COST</td>
</tr>
<tr>
<td>NTLEGMODE</td>
<td>Mode for the non-transit leg</td>
</tr>
<tr>
<td>ONEWAY</td>
<td>Determines whether to use one-way links in the network in one direction or in both If true, use only A→B direction If false, use both directions</td>
</tr>
<tr>
<td>READNTLEGI</td>
<td>Index number of the input non-transit leg file</td>
</tr>
<tr>
<td>DIRECTLINK</td>
<td>Maximum number of network links a non-transit leg can traverse</td>
</tr>
<tr>
<td>SLACK</td>
<td>Amount added to the best cost non-transit leg to determine the maximum cost of legs saved. Specified for each mode</td>
</tr>
</tbody>
</table>
## Drive-Access Generation Examples in 5.x

- Potential GENERATE keyword values

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Values (Example)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROMNODE</td>
<td>Zones</td>
</tr>
<tr>
<td>TONODE</td>
<td>All station nodes with park-ride facility</td>
</tr>
<tr>
<td>COST</td>
<td>LI.DISTANCE</td>
</tr>
<tr>
<td>MAXCOST</td>
<td>10 miles</td>
</tr>
<tr>
<td>EXTRACTCOST</td>
<td>Time + time equivalent of toll</td>
</tr>
<tr>
<td>EXCLUDELINK</td>
<td>Transit guideways</td>
</tr>
<tr>
<td>NTLEGMODE</td>
<td>2</td>
</tr>
<tr>
<td>MAXNTLEG</td>
<td>2</td>
</tr>
<tr>
<td>DIRECTION</td>
<td>1</td>
</tr>
<tr>
<td>ONEWAY</td>
<td>T</td>
</tr>
</tbody>
</table>
Drive-Access Generation Examples in 5.x

- Direct drive-access connection without parking nodes

```
PROCESS PHASE = LINKREAD
  LW.WALKSPEED = 2.5
  LW.TRANTIME = 0.80*(li.DISTANCE*60/li.SPEED)
  LW.AUTOTIME = 1.00*(li.DISTANCE*60/li.SPEED)
  LW.WALKTIME = 1.00*(li.DISTANCE*60/LW.WALKSPEED)
ENDPROCESS

PROCESS PHASE = DATAPREP
  GENERATE,
  COST=LI.DISTANCE,
  EXTRACTCOST=LW.AUTOTIME,
  MAXNTLEG=1,
  MAXCOST=9993.0,
  LIST=T,
  NTLEGMODE=201,
  DIRECTION=1,
  FROMNODE=1-25, TONODE=1342-1343, 1347-1349 ; RAIL SYSTEM ONLY
ENDPROCESS
```
Drive-Access Generation Examples in 5.x

Using ACCESSLINK with GENERATE

- Optional keyword that provides a link connection from the park-ride facilities to stop nodes
- An access link is specified as ACCESSLINK = A-S, cost, distance where:
  - A—Surrogate access point
  - S—Stop node
  - Cost—cost of using the access link
  - Distance—distance traveled on the access link
- TONODE is ignored and the connectors are generated to the stop node S
- If the accesslink does not exist in the network, PT generates it
Drive-Access Generation Examples in 5.x

Drive-access connection with parking nodes

PROCESS PHASE = DATAPREP
GENERATE,
   COST=L1.DISTANCE,
   EXTRACTCOST=LW.AUTOTIME,
   MAXNTLEGS=1,
   MAXCOST=999*3.0,
   LIST=T,
   NTLEGMODE=201,
   DIRECTION=1,
   ONEWAY=T,
   FROMNODE=1-25,
   ACCESSLINK= 31342-1342, 0.20, 0.01,
              31343-1343, 0.20, 0.01,
              31347-1347, 0.20, 0.01,
              31348-1348, 0.20, 0.01,
              31349-1349, 0.20, 0.01;
   ; RAIL SYSTEM ONLY
ENDPROCESS

NT LEG=1-1342 MODE=201 COST=1.75 DIST=0.63 ONEWAY=T XN=1153 1069 1175 1152 804 31342
NT LEG=2-1342 MODE=201 COST=1.24 DIST=0.42 ONEWAY=T XN=954 804 31342
NT LEG=3-1343 MODE=201 COST=0.53 DIST=0.13 ONEWAY=T XN=1266 31343
NT LEG=4-1347 MODE=201 COST=1.52 DIST=0.54 ONEWAY=T XN=962 766 966 974 975 758 759 750 751 31347
NT LEG=5-1347 MODE=201 COST=2.89 DIST=1.22 ONEWAY=T XN=1012 770 735 738 1238 739 740 1239 752 1010 751 31347
NT LEG=6-1347 MODE=201 COST=0.72 DIST=0.22 ONEWAY=T XN=976 758 759 750 751 31347
NT LEG=7-1348 MODE=201 COST=0.58 DIST=0.14 ONEWAY=T XN=1015 31348
NT LEG=8-1348 MODE=201 COST=1.52 DIST=0.54 ONEWAY=T XN=1014 741 744 1015 31348
NT LEG=9-1349 MODE=201 COST=0.81 DIST=0.24 ONEWAY=T XN=1021 31349
NT LEG=10-1349 MODE=201 COST=2.68 DIST=1.02 ONEWAY=T XN=1276 725 1145 723 1020 721 720 1021 31349
Drive-Access Generation in 6.x

Cube Voyager 6.0 has built upon the features of the existing Generate command to now consider:

<table>
<thead>
<tr>
<th>Name</th>
<th>Abbreviation</th>
<th>Description</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>AATRATIO</td>
<td>AATRATIO</td>
<td>to specify the ratio of drive-access time to IVT mode choice coefficients</td>
<td></td>
</tr>
<tr>
<td>AOC</td>
<td>AOC</td>
<td>to specify the auto operating cost</td>
<td></td>
</tr>
<tr>
<td>AUTOCCPNR</td>
<td>AUTOCCPNR</td>
<td>to specify the auto occupancy for PNR</td>
<td></td>
</tr>
<tr>
<td>AUTOCKKNR</td>
<td>AUTOCKKNR</td>
<td>to specify the auto occupancy for KNR</td>
<td></td>
</tr>
<tr>
<td>AUTOMATCH</td>
<td></td>
<td>to indicate if using original AUTOCON logic or enhanced AUTOCON logic</td>
<td>True (=original)</td>
</tr>
<tr>
<td>AUTOMODE</td>
<td></td>
<td>to allow user specify the mode for auto access connectors (for AUTODAT file)</td>
<td></td>
</tr>
<tr>
<td>CBDZONE</td>
<td>CBDZONE</td>
<td>to specify the CBD area</td>
<td></td>
</tr>
<tr>
<td>CHECKRELEVANCE</td>
<td>NOPT</td>
<td>flag to indicate whether to check relevance of the connectors</td>
<td></td>
</tr>
<tr>
<td>CHECKBACKTRACT</td>
<td>BACK</td>
<td>flag to indicate whether to check backtracking of the connectors</td>
<td></td>
</tr>
<tr>
<td>CONNREPORT</td>
<td>ACONLIST</td>
<td>to specify the PRINTO number for connector list</td>
<td></td>
</tr>
<tr>
<td>DEFDRIVETIME</td>
<td>DEF</td>
<td>to specify default drive-access time used if time from matrix is zero</td>
<td></td>
</tr>
<tr>
<td>DISTANCEFACTOR</td>
<td>UNITS</td>
<td>to specify the factor to convert distance to coordinate</td>
<td></td>
</tr>
<tr>
<td>DISTMAT</td>
<td></td>
<td>numerical expression used to get the distance skim matrix</td>
<td></td>
</tr>
<tr>
<td>GENREPORT</td>
<td>AUTOCONRPT</td>
<td>to specify the PRINTO number for AUTOCON report</td>
<td></td>
</tr>
<tr>
<td>INFLTRANSITFARE</td>
<td>INFLTRANSITFARE</td>
<td>to specify inflation factor for transit fare</td>
<td></td>
</tr>
<tr>
<td>INFLAOC</td>
<td>INFLAOC</td>
<td>to specify inflation factor for auto operating cost</td>
<td></td>
</tr>
</tbody>
</table>
# Drive-Access Generation in 6.x

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT</td>
<td>AUTOCON</td>
<td></td>
</tr>
<tr>
<td>INFLPARKINGCOST</td>
<td>INFLPARKINGCOST</td>
<td></td>
</tr>
<tr>
<td>INTERNALZONES</td>
<td>ZONESI</td>
<td></td>
</tr>
<tr>
<td>KNR</td>
<td>flag indicating whether to turn on the additional Kiss and Ride generation</td>
<td>False</td>
</tr>
<tr>
<td>KNRMODE</td>
<td>to allow user specify the mode for KNR connectors</td>
<td></td>
</tr>
<tr>
<td>MAXBACKDIST</td>
<td>BACKD</td>
<td></td>
</tr>
<tr>
<td>MAXBACKFACTOR</td>
<td>BACKPC</td>
<td></td>
</tr>
<tr>
<td>MAXCHECK</td>
<td>to specify the maximum connectors to consider</td>
<td></td>
</tr>
<tr>
<td>MAXCONN</td>
<td>to specify the maximum connectors to use</td>
<td></td>
</tr>
<tr>
<td>MODEPRIORITY</td>
<td>PRIORITY[M]</td>
<td>999</td>
</tr>
<tr>
<td>ORIGININTERMTIME</td>
<td>TERM</td>
<td></td>
</tr>
<tr>
<td>OVTRATIO</td>
<td>OVTRATIOAM, OVTRATIOPM</td>
<td></td>
</tr>
<tr>
<td>PERIOD</td>
<td>to indicate the AUTOCON process period (0 - Off-peak, 1 - peak)</td>
<td></td>
</tr>
<tr>
<td>PNR</td>
<td>flag indicating whether to turn on the enhanced AUTOCON process</td>
<td>False</td>
</tr>
<tr>
<td>PNRMODE</td>
<td>to allow user specify the mode for PNR connectors</td>
<td></td>
</tr>
<tr>
<td>PREMIUMMODE</td>
<td>PRFLAG[M]</td>
<td></td>
</tr>
<tr>
<td>SKIPZONES</td>
<td>to specify the zones should not be considered in the AUTOCON process</td>
<td>no skip zones</td>
</tr>
<tr>
<td>TIMEMAT</td>
<td>TIMEMAT</td>
<td></td>
</tr>
<tr>
<td>VOT</td>
<td>VOT</td>
<td></td>
</tr>
<tr>
<td>XTRAAUTONTLEGI</td>
<td>to specify the NTLEGI file number to use</td>
<td>no override</td>
</tr>
</tbody>
</table>
Enhanced Drive-Access Generation Example

**AUTOCON process in NERPM**

```
; Output
AUTOCONRPT  C:\Cube_PT_Updates_NERPM
PNSAUTOAM  C:\Cube_PT_Updates_NERPM
PNSAUTOMD  C:\Cube_PT_Updates_NERPM
KNRAUTOAM  C:\Cube_PT_Updates_NERPM
KNRAUTOMD  C:\Cube_PT_Updates_NERPM

; AutoCon Parameters
AUTOCONVERSION 2
ZONESI  2494
CBDZONE  730
TERM  2.00
DEF  2.00
NOPT  1
BACK  1
BACKD  4.0
BACKPC  0.30
UNITS  5280
MAXMODE  27
MODENUM (not used)  21 22 23 24 25 26 27
PREMIUMFLAG  0 1 0 1 1 1 1
MODEPRIORITY  7 5 7 2 1 4 3
VOTAN  6.00
VOTMD  3.00
OVTRATIOAM  2.00
OVTRATIOMD  2.00
ÀATRATIOAM  1.50
ÀATRATIOMD  1.50
AUTOCCPNR  1.2
AUTOCCNKR  1.2
AOC  9.5
InfilTransitFare  0.9487
InflAOOC  1
InflParkingCost  1.1976
AUTODATAM  C:\Cube_PT_Updates_NERPM
AUTODATMD  C:\Cube_PT_Updates_NERPM
ACONLISTAM  C:\Cube_PT_Updates_NERPM
ACONLISTMD  C:\Cube_PT_Updates_NERPM

PROCESS PHASE=DATAFREQ
; GENERATE AUTO CONNECTORS FOR PNR AND KNR
list='\nGenerate Zone Access/Egress Legs'
GENERATE,
PNR=T,
KRN=T,
PERIOD=1,
PNNMODE=2,
KNNMODE=3,
INTERNALZONES=1-2494,
CBDZONE=730,
ORIGININTERTIME=2.0,
DEDFRIVETIME=2.0,
CHECKRELEVANCE=1,
CHECKBACKTRACK=1,
MAXBACKDIST=4.0,
MAXBACKFACTOR=0.30,
DISTANCEFACTOR=5280,
PREMIUMMODE=0,1,0,1,1,1,1,
MODEPRIORITY=7,5,7,2,1,4,3,
VOI=6.3,
OVTARIO=2,2,
ATRATIO=1.5,1.5,
AUTOCCPNR=1.2,
AUTOCCNKR=1.2,
AOC=9.5,
INFLTRANSITFARE=0.9487,
INFLAOOC=1,
INFLPARKINGCOST=1.1976,
MAXCHECK = 2,
MAXCONN = 2,
CONNREPORT=1,
GENREPORT=2,
TMEMAT=MI.1.4,
DISTMAT=MI.1.2,
AUTOMATCH=T ; T-original logic, F-Enhanced logic
ENDPROCESS
```
Output Files by PT AUTOCON Process

- Network with transit & non-transit links
Output Files by PT AUTOCON Process

- Non-transit links (e.g. ‘PNRAUTOAM’ & ‘KNRAUTOAM’ in original AUTOCON)

```plaintext
;;;<<PT>>;;;
NT LEG=188-28469 MODE=2 COST=69.18 DIST=4.38 ONEWAY=T
NT LEG=188-28469 MODE=3 COST=66.18 DIST=4.38 ONEWAY=T
NT LEG=191-37148 MODE=2 COST=96.05 DIST=4.44 ONEWAY=T
NT LEG=191-37148 MODE=3 COST=93.05 DIST=4.44 ONEWAY=T
NT LEG=197-37148 MODE=2 COST=84.59 DIST=4.38 ONEWAY=T
NT LEG=197-37148 MODE=3 COST=81.59 DIST=4.38 ONEWAY=T
NT LEG=198-37148 MODE=2 COST=46.54 DIST=3.82 ONEWAY=T
NT LEG=198-37148 MODE=3 COST=43.54 DIST=3.82 ONEWAY=T
NT LEG=200-28469 MODE=2 COST=59.66 DIST=4.26 ONEWAY=T
NT LEG=200-28469 MODE=3 COST=56.66 DIST=4.26 ONEWAY=T
```

- Additional information for drive-access links (e.g. ‘ACONLISTAM’ in original AUTOCON)

```plaintext
188, 28469, 3.00, 4.38, 4.85, 2.22, 33.63, 39.47, 1.50, 57.70, 9.50, 41.62,
191, 37148, 3.00, 4.44, 5.63, 2.70, 50.72, 56.35, 1.50, 81.83, 9.50, 42.19,
197, 37148, 3.00, 4.38, 5.46, 2.81, 43.29, 48.75, 1.50, 73.12, 9.50, 41.62,
198, 37148, 3.00, 3.82, 5.90, 1.60, 17.78, 23.67, 1.50, 35.51, 9.50, 36.50,
200, 28469, 3.00, 4.26, 4.80, 2.01, 27.39, 32.19, 1.50, 48.28, 9.50, 40.48,
202, 37148, 3.00, 3.45, 5.10, 0.76, 5.69, 10.39, 1.50, 15.89, 9.50, 32.75,
227, 69831, 3.00, 3.35, 6.46, 0.81, 5.29, 12.42, 1.50, 18.43, 9.50, 32.12,
228, 64593, 3.00, 2.61, 3.93, 0.00, 0.00, 3.93, 1.50, 5.90, 9.50, 24.80,
229, 50551, 3.00, 3.40, 7.00, 0.83, 7.23, 14.22, 1.50, 21.04, 9.50, 32.31,
230, 58551, 3.00, 3.91, 6.92, 2.09, 29.71, 36.62, 1.50, 54.93, 9.50, 37.15,
231, 61893, 3.00, 1.59, 3.36, 0.00, 0.00, 3.36, 1.50, 5.04, 9.50, 15.11,
233, 65945, 3.00, 3.98, 5.31, 1.73, 20.43, 25.74, 1.50, 38.60, 9.50, 37.81,
234, 56551, 3.00, 2.50, 6.61, 0.00, 0.00, 6.61, 1.50, 9.92, 9.50, 23.75,
```
Output Files by PT AUTOCON Process

- Report (e.g. ‘AUTOCONRPT’ in original AUTOCON

<table>
<thead>
<tr>
<th>NUMBER OF STATIONS:</th>
<th>32</th>
</tr>
</thead>
<tbody>
<tr>
<td>STA</td>
<td>NODE</td>
</tr>
<tr>
<td>1,</td>
<td>19503</td>
</tr>
<tr>
<td>2,</td>
<td>20242</td>
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<td>23981</td>
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<td>21,</td>
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<td>80001</td>
</tr>
<tr>
<td>23,</td>
<td>80005</td>
</tr>
<tr>
<td>27,</td>
<td>80006</td>
</tr>
<tr>
<td>25,</td>
<td>80008</td>
</tr>
<tr>
<td>32,</td>
<td>80025</td>
</tr>
</tbody>
</table>

1, 4867.00000, 3.00000000000, 6570.00000, 4.0497226217
19503, 24030, 9755098377
1, 4528.00000, 3.00000000000, 6161.00000, 4.0846908840
Enhanced Fares along with BestPathOnly

- Fare Process in 5.x
- Enhanced Fare Process in 6.x
Fare Process in 5.x

- Fares for PT modeling are generally evaluated after the routes have been built. This is because for many fare systems, the cost is not known until the complete route is known.

- Especially, the fares are not included into the generalized cost during enumerating/evaluating the routes with BestPathPath=T.
Fare Process in 5.x

Output example of route-evaluation process with BestPathOnly=T. Note that the route doesn’t include the fare in cost.

```
REval Route(s) from Origin 194 to Destination 2204
194 -> 32376
32376 -> 22080 -> 2204 lines L8 WB
Cost= 107.703 Probability=1.0000

REval Route(s) from Origin 194 to Destination 2204
N: 194 Mode WaitA TimeA Actual B/XPen Percvd Dist Total Lines(weight)
   -> 32376 1 - 5.59 5.59 - 11.18 0.23 0.23
   -> 22080 21 15.00 55.34 75.93 2.00 98.52 17.06 17.29 L8 WB(1.000)
   -> 2204 1 - 4.59 80.52 - 107.70 0.19 17.48
Mode TimeA Dist IWaitA XWaitA
   21 55.34 17.06 15.00 0.00
   1 10.18 0.42
Fare= 0.90
```
Enhanced Fare Process in 6.x

The user may specify a simple fare structure during while enumerating the routes to enhance the path building process.

Cube Voyager 6.0 includes additional fare keywords along with BestPathOnly:

- **ENUMFARE**: if set to True, we allow a subset of fare systems to be considered in the best path enumeration process.
- **EVALFARE**: if set to True, we allow fare to be calculated in the best path evaluation and skimming process.
- **EFARE**: flag indicating whether to input descriptions of fare systems. If ENUMFARE=T and no fare skimming and route evaluation required, EFARE must be set to True to allow fares to be considered during the BESTPATHONLY route enumeration process.
Enhanced Fare Process in 6.x

Example 1: Input fare settings for EVALFARE=T

```plaintext
*** INPUT FACTOR FILE ***
;Global Settings ; fare to be calculated in the best
BESTPATHONLY=T, EVALFARE=T ; path evaluation process

*** SCRIPT PROGRAM ***
PARAMETERS FARE=T

*** ORIGINAL FARE FILE ***
FARESYSTEM NUMBER=1 LONGNAME="Local Buses" NAME="LB" STRUCTURE=FLAT
SAME=CUMULATIVE,
IBOARDFARE=0.90, FAREFROMFS=0.00,0.00,0.00,0.00,0.00,0.00,0.90,0.00
```

Example 1: Output report for EVALFARE=T

```
R Eval Route(s) from Origin 194 to Destination 2204

194 -> 32376
32376 -> 22080 -> 2204 lines L8 WB
Cost= 117.521 Probability=1.0000

R Eval Route(s) from Origin 194 to Destination 2204

N: 194 Mode WaitA TimeA Actual B/XPen Percvd Dist Total Lines(weight)
-> 32376 1 - 5.59 5.59 - 11.18 0.23 0.23
-> 22080 21 15.00 55.34 75.93 2.00 98.52 17.06 17.29 L8 WB(1.000)
-> 2204 1 - 4.59 80.52 - 107.70 0.19 17.48
Mode TimeA Dist IWaitA XWaitA
21 55.34 17.06 15.00 0.00
1 10.18 0.42
Fare= 0.90
```
Example 2: Input fare settings for **EVALFARE=T & ENUMFARE=T**

```plaintext
*** INPUT FACTOR FILE ***
;Global Settings ; to be calculated in the best
BESTPATHONLY=T, EVALFARE=T, ENUMFARE=T ; path enumeration & evaluation

*** SCRIPT PROGRAM ***
PARAMETERS FARE=T

*** REVISED FARE FILE ***
FARESYSTEM NUMBER=1 LONGNAME="Local Buses" NAME="LB" STRUCTURE=FLAT
SAME=CUMULATIVE,
IBOARDFARE=5.00,FAREFROMFS=0.00,0.00,0.00,0.00,0.00,0.90,0.00
```

Example 2: Output report for **EVALFARE=T & ENUMFARE=T**

```
REval Route(s) from Origin 194 to Destination 2204

194 --> 32376
32376 --> 22080 --> 2204 lines L8 WB
Cost= 162.248 Probability=1.0000

REval Route(s) from Origin 194 to Destination 2204

N: 194 Mode WaitA TimeA Actual B/XPen Percvd Dist Total Lines(weight)
   --> 32376 1  5.59  5.59  11.18 0.23 0.23
   --> 22080 21 15.00 55.34 75.93 2.00 98.52 17.06 17.29 L8 WB(1.000)
   --> 2204 1  4.59 80.52 107.70 0.19 17.48
Mode TimeA Dist IWaitA XWaitA
  21 55.34 17.06 15.00 0.00
  1 10.18 0.42
Fare= 5.00
```
Enhanced Fare Process in 6.x

Example 3: Input fare settings for **ENUMFARE=T & EFARE=T**

```plaintext
*** INPUT FACTOR FILE ***
;Global Settings ; fare to be calculated in the best
BESTPATHONLY=T, ENUMFARE=T ; path evaluation process

*** SCRIPT PROGRAM ***
PARAMETERS EFARE=T

*** ORIGINAL FARE FILE ***
FARESYSTEM NUMBER=1 LONGNAME="Local Buses" NAME="LB" STRUCTURE=FLAT
SAME=CUMULATIVE,
IBOARDFARE=0.90,FAREFROMFS=0.00,0.00,0.00,0.00,0.00,0.90,0.00
```

Example 3: Output report for **ENUMFARE=T & EFARE=T**

```
REnum Route(s) from Origin 194 to Destination 2204
194 -> 32376
32376 -> 22080 -> 2204 lines L8 WB
```
Cube Voyager’s PT program uses a series of keywords embedded in the description of the public transport line data to save information.

In order to provide better ways to calibrate and adjust transit travel times, some of the node specific keywords (specifically DWELL and DELAY) have also been made available as a line level keyword:

- **DWELL_DEFAULT**: dwell time, in minutes, the line spends at all stop nodes for the line until one specifies a DWELL_C or DWELL sub-keyword.
- **DELAY_DEFAULT**: additional time delay added to all link times for the line until one specifies a DELAY_C or DELAY sub-keyword.
- **TIMEFAC**: time factor applied to the travel time of all links the line traverses.
Enhanced Transit Line Keywords in 6.x

- Example 1: Transit line setting using **DWELL_DEFAULT**

```plaintext
LINE NAME="B6 EB", LONGNAME="Stockton-Wilson EB", HEADWAY[1]=60,
HEADWAY[2]=60, MODE=21, ONEWAY=T, OPERATOR=1, CIRCULAR=F,
DWELL_DEFAULT[1]=2, DWELL_DEFAULT[2]=1,
USERA3="Line 026", USERA2="B6", USERA1="LOCAL", N=11964,
-11967, -11960, -11965, -11962, -11966, -11963, -11969,
DELAY=5, N=11961, -11968, -11972, -11959, -11958, -11956,
```

- Example 1: Comparison of run times in link level

```
<table>
<thead>
<tr>
<th>NAME</th>
<th>A</th>
<th>B</th>
<th>MODE</th>
<th>LINKSEQ</th>
<th>STOPA</th>
<th>DIST</th>
<th>TIME_ORG</th>
<th>TIME_TEST1</th>
<th>TIME_DIFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>B6 EB</td>
<td>11964</td>
<td>11967</td>
<td>21</td>
<td>1</td>
<td>1</td>
<td>0.08</td>
<td>0.21</td>
<td>0.21</td>
<td>0</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11967</td>
<td>11960</td>
<td>21</td>
<td>2</td>
<td>0</td>
<td>0.07</td>
<td>0.2</td>
<td>0.2</td>
<td>0</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11960</td>
<td>11965</td>
<td>21</td>
<td>3</td>
<td>0</td>
<td>0.04</td>
<td>0.11</td>
<td>0.11</td>
<td>0</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11965</td>
<td>11962</td>
<td>21</td>
<td>4</td>
<td>0</td>
<td>0.09</td>
<td>0.23</td>
<td>0.23</td>
<td>0</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11962</td>
<td>11966</td>
<td>21</td>
<td>5</td>
<td>0</td>
<td>0.09</td>
<td>0.24</td>
<td>0.24</td>
<td>0</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11966</td>
<td>11963</td>
<td>21</td>
<td>6</td>
<td>0</td>
<td>0.03</td>
<td>0.08</td>
<td>0.08</td>
<td>0</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11963</td>
<td>11969</td>
<td>21</td>
<td>7</td>
<td>0</td>
<td>0.06</td>
<td>0.16</td>
<td>0.16</td>
<td>0</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11969</td>
<td>11961</td>
<td>21</td>
<td>8</td>
<td>0</td>
<td>0.1</td>
<td>5.27</td>
<td>5.27</td>
<td>0</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11961</td>
<td>11968</td>
<td>21</td>
<td>9</td>
<td>1</td>
<td>0.07</td>
<td>0.18</td>
<td>2.18</td>
<td>2</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11968</td>
<td>11972</td>
<td>21</td>
<td>10</td>
<td>0</td>
<td>0.14</td>
<td>0.37</td>
<td>0.37</td>
<td>0</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11972</td>
<td>11959</td>
<td>21</td>
<td>11</td>
<td>0</td>
<td>0.08</td>
<td>0.21</td>
<td>0.21</td>
<td>0</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11959</td>
<td>11958</td>
<td>21</td>
<td>12</td>
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<td>0.17</td>
<td>0.47</td>
<td>0.47</td>
<td>0</td>
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<td>B6 EB</td>
<td>11958</td>
<td>11956</td>
<td>21</td>
<td>13</td>
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<td>0.33</td>
<td>0.9</td>
<td>0.9</td>
<td>0</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11956</td>
<td>11952</td>
<td>21</td>
<td>14</td>
<td>0</td>
<td>0.07</td>
<td>0.19</td>
<td>0.19</td>
<td>0</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11952</td>
<td>12111</td>
<td>21</td>
<td>15</td>
<td>1</td>
<td>0.19</td>
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<td>2.44</td>
<td>2</td>
</tr>
<tr>
<td>B6 EB</td>
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<td>12135</td>
<td>21</td>
<td>16</td>
<td>0</td>
<td>0.02</td>
<td>0.05</td>
<td>0.05</td>
<td>0</td>
</tr>
</tbody>
</table>
Enhanced Transit Line Keywords in 6.x

Example 1: Comparison of run times in transit line (‘B6 EB’)

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>DISTANCE (mile)</th>
<th>ORIGINAL (min)</th>
<th>TEST 1 (min)</th>
<th>DIFF (min)</th>
<th>DIFF (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEAK</td>
<td>22.1</td>
<td>77.9</td>
<td>269.9</td>
<td>192.0</td>
<td>246.5</td>
</tr>
<tr>
<td>OFF-PEAK</td>
<td>22.1</td>
<td>72.7</td>
<td>168.7</td>
<td>96.0</td>
<td>132.1</td>
</tr>
</tbody>
</table>
Enhanced Transit Line Keywords in 6.x

Example 2: Transit line setting using `DELAY_DEFAULT`

```plaintext
```

Example 2: Comparison of run times in link level

<table>
<thead>
<tr>
<th>NAME</th>
<th>A</th>
<th>B</th>
<th>MODE</th>
<th>LINKSEQ</th>
<th>STOPA</th>
<th>DIST</th>
<th>TIME_ORG</th>
<th>TIME_TEST1</th>
<th>TIME_DIFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>B6 EB</td>
<td>11964</td>
<td>11967</td>
<td>21</td>
<td>1</td>
<td>1</td>
<td>0.08</td>
<td>0.21</td>
<td>1.21</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11967</td>
<td>11960</td>
<td>21</td>
<td>2</td>
<td>0</td>
<td>0.07</td>
<td>0.2</td>
<td>1.2</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11960</td>
<td>11965</td>
<td>21</td>
<td>3</td>
<td>0</td>
<td>0.04</td>
<td>0.11</td>
<td>1.11</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11965</td>
<td>11962</td>
<td>21</td>
<td>4</td>
<td>0</td>
<td>0.09</td>
<td>0.23</td>
<td>1.23</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11962</td>
<td>11966</td>
<td>21</td>
<td>5</td>
<td>0</td>
<td>0.09</td>
<td>0.24</td>
<td>1.24</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11966</td>
<td>11963</td>
<td>21</td>
<td>6</td>
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<td>0.03</td>
<td>0.08</td>
<td>1.08</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11963</td>
<td>11969</td>
<td>21</td>
<td>7</td>
<td>0</td>
<td>0.06</td>
<td>0.16</td>
<td>1.16</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11969</td>
<td>11961</td>
<td>21</td>
<td>8</td>
<td>0</td>
<td>0.1</td>
<td>5.27</td>
<td>5.27</td>
<td>0</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11961</td>
<td>11968</td>
<td>21</td>
<td>9</td>
<td>1</td>
<td>0.07</td>
<td>0.18</td>
<td>1.18</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11968</td>
<td>11972</td>
<td>21</td>
<td>10</td>
<td>0</td>
<td>0.14</td>
<td>0.37</td>
<td>1.37</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11972</td>
<td>11959</td>
<td>21</td>
<td>11</td>
<td>0</td>
<td>0.08</td>
<td>0.21</td>
<td>1.21</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11959</td>
<td>11958</td>
<td>21</td>
<td>12</td>
<td>0</td>
<td>0.17</td>
<td>0.47</td>
<td>1.47</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11958</td>
<td>11956</td>
<td>21</td>
<td>13</td>
<td>0</td>
<td>0.33</td>
<td>0.9</td>
<td>1.9</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11956</td>
<td>11952</td>
<td>21</td>
<td>14</td>
<td>0</td>
<td>0.07</td>
<td>0.19</td>
<td>1.19</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11952</td>
<td>12111</td>
<td>21</td>
<td>15</td>
<td>1</td>
<td>0.19</td>
<td>0.44</td>
<td>1.44</td>
<td>1</td>
</tr>
<tr>
<td>B6 EB</td>
<td>12111</td>
<td>12135</td>
<td>21</td>
<td>16</td>
<td>0</td>
<td>0.02</td>
<td>0.05</td>
<td>1.05</td>
<td>1</td>
</tr>
</tbody>
</table>
Example 2: Comparison of run times in transit line (‘B6 EB’)

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>DISTANCE (mile)</th>
<th>ORIGINAL (min)</th>
<th>TEST 3 (min)</th>
<th>DIFF (min)</th>
<th>DIFF (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEAK</td>
<td>22.1</td>
<td>77.9</td>
<td>187.2</td>
<td>109.3</td>
<td>140.4</td>
</tr>
<tr>
<td>OFF-PEAK</td>
<td>22.1</td>
<td>72.7</td>
<td>106.5</td>
<td>33.8</td>
<td>46.5</td>
</tr>
</tbody>
</table>

Enhanced Transit Line Keywords in 6.x
Enhanced Transit Line Keywords in 6.x

Example 3: Transit line setting using **TIMEFAC**

```plaintext
LINE NAME="B6 EB", LONGNAME="Stockton-Wilson EB", HEADWAY[1]=60,
  HEADWAY[2]=60, MODE=21, ONEWAY=T, OPERATOR=1, CIRCULAR=F,
  TIMEFAC[1]=2.0, TIMEFAC[2]=1.5,
  USERA3="Line 026", USERA2="B6", USERA1="LOCAL", N=11964,
  -11967, -11960, -11965, -11962, -11966, -11963, -11969,
  DELAY=5, N=11961, -11968, -11972, -11959, -11958, -11956,
```

Example 3: Comparison of run times in link level

<table>
<thead>
<tr>
<th>NAME</th>
<th>A</th>
<th>B</th>
<th>MODE</th>
<th>LINKSEQ</th>
<th>STOPA</th>
<th>DIST</th>
<th>TIME_ORG</th>
<th>TIME_TEST</th>
<th>TIME_DIFF</th>
<th>TIME_PROP</th>
</tr>
</thead>
<tbody>
<tr>
<td>B6 EB</td>
<td>11964</td>
<td>11967</td>
<td>21</td>
<td>1</td>
<td>1</td>
<td>0.08</td>
<td>0.21</td>
<td>0.42</td>
<td>0.21</td>
<td>2</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11967</td>
<td>11960</td>
<td>21</td>
<td>2</td>
<td>0</td>
<td>0.07</td>
<td>0.2</td>
<td>0.39</td>
<td>0.19</td>
<td>1.95</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11960</td>
<td>11965</td>
<td>21</td>
<td>3</td>
<td>0</td>
<td>0.04</td>
<td>0.11</td>
<td>0.23</td>
<td>0.12</td>
<td>2.09</td>
</tr>
<tr>
<td>B6 EB</td>
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<td>11962</td>
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<td>0.09</td>
<td>0.23</td>
<td>0.47</td>
<td>0.24</td>
<td>2.04</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11962</td>
<td>11966</td>
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<td>5</td>
<td>0</td>
<td>0.09</td>
<td>0.24</td>
<td>0.49</td>
<td>0.25</td>
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</tr>
<tr>
<td>B6 EB</td>
<td>11966</td>
<td>11963</td>
<td>21</td>
<td>6</td>
<td>0</td>
<td>0.03</td>
<td>0.08</td>
<td>0.16</td>
<td>0.08</td>
<td>2</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11963</td>
<td>11969</td>
<td>21</td>
<td>7</td>
<td>0</td>
<td>0.06</td>
<td>0.16</td>
<td>0.33</td>
<td>0.17</td>
<td>2.06</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11969</td>
<td>11961</td>
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<td>8</td>
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<td>0.27</td>
<td>0.53</td>
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<td>1.05</td>
</tr>
<tr>
<td>B6 EB</td>
<td>11961</td>
<td>11968</td>
<td>21</td>
<td>9</td>
<td>1</td>
<td>0.07</td>
<td>0.18</td>
<td>0.37</td>
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<td>0.09</td>
<td>0.04</td>
<td>1.8</td>
</tr>
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</table>
Enhanced Transit Line Keywords in 6.x

Example 3: Comparison of run times in transit line (‘B6 EB’)

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>DISTANCE (mile)</th>
<th>ORIGINAL (min)</th>
<th>TEST 3 (min)</th>
<th>DIFF (min)</th>
<th>PROPORTION</th>
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<td>PEAK</td>
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Transit Modeling Update

TRIP MARKET SEGMENTATION
## Key Travel Market Attributes

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>Current</th>
<th>Proposed</th>
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</thead>
<tbody>
<tr>
<td>Home-Based Work</td>
<td>Home-Based Work</td>
<td>Home-Based Work</td>
</tr>
<tr>
<td>Home-Based Shop</td>
<td>Home-Based Shop</td>
<td>Home-Based Shop</td>
</tr>
<tr>
<td>Home-Based Social/Recreation</td>
<td>Home-Based Social/Recreation</td>
<td>Home-Based Social/Recreation</td>
</tr>
<tr>
<td>Home-Based Other</td>
<td>Home-Based Other</td>
<td>Home-Based Other</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Home-Based College/University</td>
</tr>
<tr>
<td>Non-Home-Based</td>
<td>Non-Home-Based Work</td>
<td>Non-Home Based Other</td>
</tr>
</tbody>
</table>
Proposed New Trip Purposes

- HB College/University
  - An important transit market in some regions
  - Comprised of several different subpopulations, each with distinct travel behavior characteristics
  - Well-identified destinations, less information available about place of residence
  - Mode split related to residence type, proximity to campus, transportation options
Proposed New Trip Purposes

• HB School
  • May comprise a large fraction of the transit riders in some cities
  • Possibly transit-dependent population
  • Often entitled to discounted fares
  • More likely observed on local buses
  • Short trips with distinct time-of-day patterns
Proposed New Trip Purposes

- **NHB Work**
  - Different diurnal patterns and transit mode shares than NHB Other
  - May comprise a large share of midday, downtown transit trips
  - May be forecasted with direct demand models
### Key Travel Market Attributes

#### FSUTMS Household Markets

<table>
<thead>
<tr>
<th>Current</th>
<th>Proposed</th>
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</thead>
<tbody>
<tr>
<td>Type of Dwelling Unit</td>
<td>Type of Dwelling Unit</td>
</tr>
<tr>
<td>Household Size</td>
<td>Household Size</td>
</tr>
<tr>
<td>Auto Ownership</td>
<td>Auto Ownership</td>
</tr>
<tr>
<td>Workers in Household</td>
<td></td>
</tr>
<tr>
<td>Household Income</td>
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</table>
### Key Travel Market Attributes

<table>
<thead>
<tr>
<th>Household Attribute</th>
<th>Trip Generation</th>
<th>Trip Distribution</th>
<th>Mode Choice</th>
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</tr>
<tr>
<td>Income</td>
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<tr>
<td>Workers</td>
<td>✓</td>
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<td></td>
</tr>
<tr>
<td>Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto ownership</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car Sufficiency</td>
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<td></td>
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## Key Travel Market Attributes

### Home-Based Work Car Competition

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>Zero car households</td>
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<tr>
<td>Car insufficient households:</td>
<td>fewer workers than autos</td>
</tr>
<tr>
<td>Car sufficient households:</td>
<td>equal or more workers than autos</td>
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</tbody>
</table>

### Home-Based Non-Work Car Competition

<table>
<thead>
<tr>
<th>Type</th>
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<tbody>
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<td></td>
</tr>
<tr>
<td>Car insufficient households:</td>
<td>1 auto, 2+ persons</td>
</tr>
<tr>
<td>Car sufficient households:</td>
<td>1 auto, 1 person</td>
</tr>
<tr>
<td></td>
<td>1+ autos, 2+ persons</td>
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</table>
### Key Travel Market Attributes

#### FTA Recommended Mode Choice Stratification

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<th></th>
<th>Zero Cars</th>
<th>Car Insufficient</th>
<th>Car Sufficient</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>Medium Income</td>
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</tr>
<tr>
<td>High Income</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Building the Household Classification

- Number of proposed household strata is too large to obtain directly from observed data for each TAZ
  - Housing unit type (2)
  - Income (3)
  - Workers (4)
  - Size (4)
  - Autos (4)

\[2 \times 3 \times 4 \times 4 \times 4 = 384 \text{ Strata!}\]

- Proposed method is to apply household classification models combined with an auto ownership model
Building the Household Classification

**Desired outcome:**
number of households in each feasible combination, for each TAZ

<table>
<thead>
<tr>
<th>Income 1</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4+</th>
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</tr>
<tr>
<td>W2</td>
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</tr>
<tr>
<td>W3+</td>
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</table>

<table>
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<td>W1</td>
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</tr>
<tr>
<td>W2</td>
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</tr>
<tr>
<td>W3+</td>
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<table>
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<tr>
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</tr>
<tr>
<td>W2</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>W3+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Desired outcome网吧：
number of households in each feasible combination, for each TAZ
Building the Household Classification

- Start with a *regional* distribution of households (seed)

- Find, for each TAZ, the *marginal* distributions:
  - Number of 1p, 2p, 3p, 4p+ households
  - Number of 0w, 1w, 2w, 3+w households
  - Number of low inc, med inc, high inc households

- Apply Iterative Proportional Fitting (IPF) to fit the seed distributions to the marginal distributions
Building the Household Classification

- Marginal distributions may be developed with a classification model,
- Or they can be prepared as a model input
- User-specified option
Household size classification model

Source data: Florida 2008 NHTS Add-On Sample
Household Workers Classification Model

Source data: Florida 2008 NHTS Add-On Sample
Household Income Classification Model

Source Data: Florida 2008 NHTS Add-On Sample
Transit Modeling Update

AUTO OWNERSHIP MODEL
Why an Auto Ownership Model?

- Transit and non-motorized accessibility matters. An auto ownership model can be sensitive to accessibility, while a classification model is not.

- Can be estimated and validated from readily available data.

- Several effects are measurable: household size, workers, income and type of housing unit are good predictors of auto ownership.

- Reduces the number of IPF dimensions, which helps the household classification model to converge more quickly.
Proposed Auto Ownership Model

- Multinomial logit

- Choice set: 0, 1, 2, 3, 4+ autos per household

- Explanatory variables:
  - Household size, income, workers
  - Type of housing unit
  - Household and employment density
  - Transit and non-motorized accessibility
Mixed Household / Employment Density

Mixed Density = \ln \left[ \frac{\text{Intersections} \times (a \times \text{Households}) \times (b \times \text{Employment})}{\text{Intersections} + (a \times \text{Households}) + (b \times \text{Employment})} \right]

Calculated as floating densities!!
Mixed Household / Employment Density

Traditional zonal-based densities do not capture neighborhood effects as well as floating densities.
Transit Accessibility to Employment

Transit logsum = \ln \sum (-0.025 \times travel\ time + \ln(employment))
### Sample Auto Ownership Coefficients

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<thead>
<tr>
<th></th>
<th>1 Car</th>
<th>2 Cars</th>
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<th>4+ Cars</th>
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<td>Coeff.</td>
<td>t-stat</td>
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<tr>
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<td>-11.2</td>
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<tr>
<td>Medium</td>
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<td>+2.02</td>
<td>+33.1</td>
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<tr>
<td>3 Person HH</td>
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<td>--</td>
<td>+1.80</td>
<td>+22.5</td>
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<tr>
<td>4+ Person HH</td>
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<td>--</td>
<td>+2.09</td>
<td>+27.7</td>
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<td>3+ Workers HH</td>
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<td>+0.76</td>
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<td><strong>Walk Accessibility</strong></td>
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Transit Modeling Update

TRIP PRODUCTION MODEL
## Trip Production Model

### Home-Based Work Trip Rates

<table>
<thead>
<tr>
<th>Household Income</th>
<th>Household Autos</th>
<th>Number of Workers in Household</th>
<th>Wrks0</th>
<th>Wrks1</th>
<th>Wrks2</th>
<th>Wrks3+</th>
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<tbody>
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<td>$0-$24999</td>
<td>Veh0</td>
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<td>1.783</td>
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<td>1.000</td>
<td>1.783</td>
<td>3.500</td>
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<td>0.000</td>
<td>1.000</td>
<td>1.783</td>
<td>3.500</td>
</tr>
<tr>
<td>$75000+</td>
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<td></td>
<td>0.000</td>
<td>1.000</td>
<td>1.783</td>
<td>3.500</td>
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<tr>
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<td>1.604</td>
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<td>0.000</td>
<td>1.330</td>
<td>3.111</td>
<td>4.102</td>
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<td>3.119</td>
<td>5.799</td>
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</table>

Data Source: Florida 2008 NHTS Add-On Sample
### Trip Productions Model

#### Home-Based Other Trip Rates

<table>
<thead>
<tr>
<th>Household Income</th>
<th>Household Autos</th>
<th>Household Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Size1</td>
<td>Size2</td>
</tr>
<tr>
<td>$0-$24999</td>
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</tr>
<tr>
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<td>0.535</td>
<td>1.057</td>
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<tr>
<td>$50000-$74999</td>
<td>0.535</td>
<td>1.057</td>
</tr>
<tr>
<td>$75000+</td>
<td>0.535</td>
<td>1.057</td>
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<td>$0-$24999</td>
<td>0.611</td>
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<td>1.443</td>
</tr>
<tr>
<td>$75000+</td>
<td>1.175</td>
<td>1.319</td>
</tr>
</tbody>
</table>

Data Source: Florida 2008 NHTS Add-On Sample
Transit Modeling Update

TRIP ATTRACTION MODEL
Trip Attraction Model Alternatives

- Logit share model
  - Estimates the share of workers in each income group, at place of work, as a function of type of employment
  - Requires CTPP place of work data - 2012

- Cross-classification model
  - Similar to a trip production model
  - Requires establishment survey
## Trip Attraction Model

- **Linear regression model**
  - Attractions stratified by income

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>Common Trip Rate</th>
<th>Industrial Employment</th>
<th>Service Employment</th>
<th>Commercial Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>HBW Inc1</td>
<td>0.0910</td>
<td>0.728</td>
<td>1.000</td>
<td>2.437</td>
</tr>
<tr>
<td>HBW Inc2</td>
<td>0.1943</td>
<td>2.452</td>
<td>1.000</td>
<td>1.874</td>
</tr>
<tr>
<td>HBW Inc3</td>
<td>0.1932</td>
<td>0.754</td>
<td>1.000</td>
<td>1.325</td>
</tr>
<tr>
<td>HBW Inc4</td>
<td>0.4225</td>
<td>1.231</td>
<td>1.000</td>
<td>0.741</td>
</tr>
</tbody>
</table>
Trip Attraction Model

- Trip attraction models are optional when the distribution model is a destination choice model.
- The destination choice “size term” replaces the attraction model.
Transit Modeling Update

SPECIAL TRIP MARKETS
Special Trip Markets

- Seasonal Residents
- Visitors
- External Workers
- Air Passengers
- Other Special Generators
- Special Events
Example 1: Portland Air Passenger Trip Model

Portland Ground Access Air Trip Generation

Portland Ground Access Mode Choice

Residents Only

Private Vehicle
Taxi/Limo
Hotel Shuttle
Rental Car
LRT

Choice

Drive and Park
Pick-up/Drop-Off
Drive
Walk

Garage
Long-Term
Economy
Off-Site
Garage/Escort
Curb

Visitors Only
Example 2: Phoenix Event Model

Trip Origin Choice Set

| TAZ 1 | TAZ 2 | TAZ 3 | TAZ n |

Event Location

Event "Reverse" Destination Choice Model

Choice Set for each Event

- Auto
- Walk
- Walk to Transit
- Drive to Transit
  - Bus
  - Bus & LRT
  - LRT
Transit Modeling Update

TIME OF DAY STRATIFICATION
Why Time of Day Stratification?

- Account for and represent time-of-day differences in transit levels of service:
  - frequency of service
  - fare
  - speed
  - routing

- Account for differences in travel markets:
  - peak period commute market
  - midday circulation market
  - off-peak period market(s)
FSUTMS Approach to Time of Day Effects

- **Trip Generation** (Daily)
- **Trip Distribution** (Daily)
- **Highway Pre-Assignment** (Daily)
- **Mode Choice** (PK/OP)
- **Highway Assignment** (Daily)
- **Transit Assignment** (PK/OP)

Based on free-flow travel times

Peak travel times based on average daily conditions (HBW)
Off-Peak travel times based on free-flow conditions

No travel time feedback
Recommended Approach

Initial speeds → Trip Generation (Daily)

Peaking Factors → Trip Distribution (PK/OP)

Mode Choice (PK/OP) → Diurnal & PA/OD Factors

Transit Assignment (PK/OP) → Highway Assignment (AM/PM/MD/NT)

AM and MD travel time feedback
Implications for other model components

- Modifies the definition of peak and off-peak times
  - Peak conditions – AM peak, PM peak, mixed?
  - Off-peak conditions – assume midday (not free-flow)

- Requires period-specific networks:
  - Transit – peak & midday service levels
  - Highway -- AM / MD / PM / NT capacity factors

- True diurnal stratification of trip distribution and mode choice models

- Requires performing more highway assignments
  - More time periods
  - More feedback loops
Time of Day Periods

- Allow for region-specific definitions of the peak period
  - Longer peak periods observed in urban areas

- Define periods on the basis of:
  - Observed diurnal patterns (surveys, traffic counts)
  - Transit levels of service
  - Levels of congestion (today)
  - Levels of congestion (future) – leave room for peak spreading
FSUTMS Diurnal Factors

Developed from 2008 NHTS Add-On data, for these periods:

- AM Peak: 7:00 AM to 8:59 AM
- Midday: 9:00 AM to 2:59 PM
- PM Peak: 3:00 PM to 5:59 PM
- Night: 6:00 PM to 6:59 AM

Stratified by trip purpose (standard practice)

Also stratified by household income and region
HBW Peaking & Diurnal Factors

### HBW Peak Factors

<table>
<thead>
<tr>
<th>Period</th>
<th>CRTPA</th>
<th>Region</th>
<th>Florida</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak</td>
<td>0.773</td>
<td>0.420</td>
<td></td>
</tr>
<tr>
<td>Off-Peak</td>
<td>0.227</td>
<td>0.580</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.000</td>
<td>1.000</td>
<td></td>
</tr>
</tbody>
</table>

### HBW Diurnal Factors

<table>
<thead>
<tr>
<th>Period</th>
<th>CRTPA</th>
<th>Florida</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P/A</td>
<td>A/P</td>
</tr>
<tr>
<td>AM</td>
<td>0.418</td>
<td>0.000</td>
</tr>
<tr>
<td>MD</td>
<td>0.108</td>
<td>0.039</td>
</tr>
<tr>
<td>PM</td>
<td>0.031</td>
<td>0.325</td>
</tr>
<tr>
<td>NT</td>
<td>0.046</td>
<td>0.033</td>
</tr>
<tr>
<td></td>
<td>1.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>
Travel Time Feedback: Why?

- Ensure consistency of supply and demand assumptions and outcomes in the forecast

Travel Times derived from Link Flows
Output from highway assignment

= Travel Times that yield the assigned Trips
Input to distribution & mode choice
Travel Time Feedback: How?

- Combine link volumes of previous feedback loops with a decreasing weight (to ensure convergence)

\[ \text{Link Flow}^{n+1} = \text{Link Flow}^n \times (1 - 1/n) + \text{Link Flow}^{n-1} \times (1/n) \]

- Compute new travel time by applying the speed-delay functions to the “averaged” volume

- Exit feedback loop when the relative change in link volumes and/or travel times is small
Transit Modeling Update

TRIP DISTRIBUTION MODEL
Proposed changes to FSUTMS discussed so far affect the specification and calibration of the distribution model:

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Levels of Service</strong></td>
<td>Free-flow</td>
<td>Peak Off-Peak</td>
</tr>
<tr>
<td><strong>Household markets</strong></td>
<td>None</td>
<td>Income &amp; Car Sufficiency</td>
</tr>
<tr>
<td><strong>Input/output travel time consistency</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Model Structure</strong></td>
<td>Gravity</td>
<td>Destination Choice</td>
</tr>
</tbody>
</table>
Destination Choice Advantages

- Sensitive to changes in highway and transit levels of service *commensurate* with their share of the travel market.
  - No more illogical changes to transit or auto trips!
  - e.g., when total person trips between two zones increase because of better travel times, the additional demand is allocated to the improved modes.
  - Total person trips respond to changes in transit or non-motorized accessibilities
Destination Choice Advantages

- Very flexible model form
  - Can accommodate multi-modal impedances and many other variables
  - Allows generic and market-specific variables, which result in parsimonious specifications that capture key market differences
  - Can be calibrated to match observed trip length frequencies and other calibration measures
  - Could even be used to apply the current gravity models!
Destination Choice Model

- Multinomial logit formulation

Utility:

\[ U_{ijm} = \sum_k \beta^k \times X^k_{ij} + \ln \sum_m \gamma^n \times S^m_j \]

choice set contains all TAZs in the region

"quality" variables: travel time, travel distance, etc.

"quantity" variables employment, households
### Utility Function Variables

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
</table>
| **Mode choice**           | - Impedance measure  
  - Considers travel times, costs and preferences for all modes                                                                               |
| **Distance**              | - Used to reproduce observed trip length frequencies                                                                                         |
| **Trip market attributes**| - Provide additional sensitivity to attributes such as urban form or household income  
  - May be interacted with one or more distance terms                                                                                       |
| **Location attributes**   | - Represent barriers to travel, natural or perceived  
  - Conceptually equivalent to a bridge time penalty                                                                                           |
| **Size terms**            | - Represent activity opportunities at the destination  
  - Often times consists of a weighted sum of employment by industry                                                                          |
Trip Market Stratification

- At least as many market segments as required by the mode choice model:
  - Trip purpose
  - Time period (peak & off-peak)
  - Household income & Car sufficiency

- Full segmentation is not required - some parameters are common across market segments

- Market segmentation helps to get the right workers to the right jobs, and exposes trips to accessibilities consistent with mode choice
Attraction Balancing

- The home-based work model is constrained so that attractions are proportional to employment at the destination zone.

- A shadow price is added to each destination zone to increase or decrease its attractiveness.

\[
U'_{ijm} = U_{ijm} + sp_j
\]

- The HBW destination choice model is applied iteratively until the shadow price, \( sp_j \), converges.

\[
sp_{j}^{n+1} = sp_{j}^{n} + \ln\left(\frac{\alpha Emp_j}{\sum_i T_{ij}^n}\right)
\]
Attraction Balancing

Whether to shadow price hinges on the level of confidence in the attractions forecast
- Usually not very high confidence, except for HBW

Recommended approach is to only constrain the HBW trips
- Zonal employment is known
- Compute shadow price for all household & car sufficiency segments combined.
Specifying a Destination Choice Model

- Unlike a gravity model, that only requires calibration, a destination choice model has parameters that need to be specified.

- Model parameters are specified via model estimation and model calibration.

- Some parameters may be transferred, but others must at least be calibrated.
Destination Choice Estimation

- Requires commercially-available econometric software (Alogit, Biogene, Stata, etc.),

- ... a sample of trip records from NHTS or local household travel survey:
  - Trip Id
  - Trip purpose
  - Production zone
  - Attraction zone (choice)
  - Household income (& other trip or hh. variables)

- ... employment data, skims, and mode choice logsums
Destination Choice Estimation

- Sample the region’s zones to construct the destination choice set for each trip record
- Attach logsum, distance and employment information to each zone in the destination choice set
Destination Choice Estimation

• Sampling-by-importance:
  • Define an ‘importance’ function:
    \[ W_{ij} = \exp(D_{ij}^{-\alpha}) \times S_j \]
    \[ P_{ij} = \frac{W_{ij}}{\sum_j W_{ij}} \]
  • Importance function gives the probability of being selected as the destination zone
  • Sample from this probability distribution to select the destination choice set (20 – 40 draws) for each observed trip record
Destination Choice Estimation

- Optionally, explode the sample
  - Reproduce each trip record $k$ times, and choose a different destination set for each ‘exploded’ record

- Approximately statistically equivalent to choosing a destination set of $10 \times k$ for each original trip record

- Apply weights $(1/k)$ and sampling correction factor during estimation

$$U''_{ijm} = U_{ijm} + C_{jm}$$
Destination Choice Estimation

- Size variable coefficients may be estimated simultaneously, or pre-calculated

- Size variable pre-calculation options:
  - Use representative employment
    - HBW - total employment
    - HBSH - retail employment
    - HBU – college enrollment
  - Estimate coefficients using linear regression, similar to attraction model estimation
  - Tabulate workers by household income and industry (provides HBW income stratification)
Linking Destination & Mode Choice

\[ U_{ij} = \lambda \times L_{ij} + \sum_k \beta^k \times X^k_{ij} + \ln \sum_m \gamma^m S^m_j \]

mode choice logsum

nesting coefficient
Destination Choice

The mode choice logsum coefficient ($\lambda$) affects the sensitivity of the distribution model to level-of-service attributes (time, cost, etc.)

- When $\lambda \ll 1$, the destination choice model is relatively insensitive to changes in travel time or cost
  - HBW models: $0.5 \leq \lambda \leq 0.8$
  - HBO & NHB models: $0.7 \leq \lambda \leq 1.0$

What happens when $\lambda > 1$?
Destination Choice Calibration

- Calibration consists of adjusting the distance term(s) coefficients
- Similar calibration measures as a gravity model

| Estimated/Observed Work Trip Flows by Origin and Destination District |
|-------------------------------------------------------------|-----------------|
|                  | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | Row Totals |
| Origin          |     |     |     |     |     |     |     |     |            |
| 1               | 1.1 | 0.5 | 1.0 | 0.6 | 0.2 | 0.0 | 0.0 | 0.0 | 1.0        |
| 2               | 0.1 | 1.3 | 0.1 | 0.7 | 0.0 | 0.1 | 0.0 | 0.0 | 1.0        |
| 3               | 1.3 | 1.4 | 1.0 | 0.4 | 0.3 | 0.2 | 0.0 | 0.0 | 1.0        |
| 4               | 0.9 | 1.4 | 0.8 | 1.4 | 0.6 | 0.3 | 0.2 | 0.0 | 1.0        |
| 5               | 1.3 | 1.0 | 1.4 | 1.1 | 0.9 | 0.2 | 0.0 | 0.0 | 1.0        |
| 6               | 0.0 | 1.2 | 0.6 | 1.1 | 2.6 | 1.0 | 0.4 | 0.4 | 1.0        |
| 7               | 0.4 | 0.7 | 2.1 | 0.0 | 1.0 | 0.8 | 1.0 | 0.8 | 1.0        |
| 8               | 0.0 | 0.4 | 0.0 | 0.8 | 0.7 | 0.8 | 0.7 | 1.1 | 1.0        |

| Source District|     |     |     |     |     |     |     |     |     |
|---------------|-----------------|
| 1             | 0.0             |
| 2             | 1.0             |
| 3             | 0.0             |
| 4             | 0.0             |
| 5             | 0.0             |
| 6             | 0.0             |
| 7             | 0.0             |
| 8             | 0.0             |

- Normalized Trip Frequency
- Trip Distance (mi)
- Observed Avg = 12.6 mi
- Model Avg = 12.8 mi
Transit Modeling Update

TRANSIT NETWORK CODING AND PATH BUILDING
Many good practices already applied …

Route and Stop/Station Location

Follows actual routing and exact stop location as accurately as allowed by the model’s representation of the highway system. Recommend using transit agencies electronic records to obtain stop (lat, long) coordinates.

- Improves estimation of in-vehicle travel times, walk distances and transfer opportunities

Applies faithful station coding (station micro-coding)

- Faithfully represents street-to-station, PNR-to-station, platform-to-platform separation (horizontal & vertical).
Good transit coding practices …

Route attributes:  Mode

Defined on the basis of differences in operating characteristics and attributes not included in the model (reliability, comfort, etc.).

- Can be more detailed than required by the mode choice model
- Used to create in-vehicle time skims

### FSUTMS Transit Modes

<table>
<thead>
<tr>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Bus</td>
</tr>
<tr>
<td>Premium Bus</td>
</tr>
<tr>
<td>Circulators (Skyway and Trolley)</td>
</tr>
<tr>
<td>Urban Rail</td>
</tr>
<tr>
<td>Commuter Rail</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Project</td>
</tr>
</tbody>
</table>

### Additional Transit Mode

- Bus Rapid Transit
Good transit coding practices …

Route attributes: Fare & Operator

Applies the prevalent fare system(s) as faithfully as possible.

⇒ Each fare system is assigned a unique operator code
⇒ A given transit agency may be given more than one operator code, and conversely multiple transit agencies may share the operator code
⇒ Coded fare represents average fare cost per boarding or transfer

<table>
<thead>
<tr>
<th>FSUTMS Operators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Service</td>
</tr>
<tr>
<td>Circulator</td>
</tr>
<tr>
<td>Commuter Rail</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Revised Operators?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Service</td>
</tr>
<tr>
<td>Premium Service</td>
</tr>
<tr>
<td>Circulator</td>
</tr>
<tr>
<td>BRT</td>
</tr>
<tr>
<td>Urban Rail</td>
</tr>
<tr>
<td>Commuter Rail</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Project</td>
</tr>
</tbody>
</table>
Good transit coding practices …

Route attributes: Headway and Wait Time

Compute time-period representative headways

⇒ May require coding ‘short routes’ separately from regular runs

Compute wait time as ½ of the headway

⇒ Remove current 30 minute cap
⇒ Cap makes the model insensitive to some headway improvements
⇒ In mode choice model, apply lower weight to first wait times higher than 5 minutes, in recognition that arrivals are not random
## Transit network coding

### Transit speed

<table>
<thead>
<tr>
<th>Mode</th>
<th>Current Method</th>
<th>Proposed Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed-guideway</td>
<td>Coded station-to-station travel time</td>
<td>(same)</td>
</tr>
<tr>
<td>Buses</td>
<td>Proportional to auto travel time</td>
<td>Auto travel time + delay per stop</td>
</tr>
</tbody>
</table>
## Transit network coding

### Access Connectors

<table>
<thead>
<tr>
<th></th>
<th><strong>Walk Access</strong></th>
<th><strong>Drive Access</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector generation</td>
<td>Shortest distance from TAZ to stop</td>
<td>Generalized cost from TAZ to PNR/KNR node</td>
</tr>
<tr>
<td>Generalized cost components</td>
<td></td>
<td>Drive time, terminal time operating cost, parking cost</td>
</tr>
<tr>
<td>Access time</td>
<td>Based on highway distance and assumed walk speed</td>
<td>Based on volume-dependent travel times</td>
</tr>
<tr>
<td>Maximum length</td>
<td>0.6 miles</td>
<td>3.0 miles, lot specific</td>
</tr>
<tr>
<td>Maximum connections</td>
<td>99 per TAZ</td>
<td>3 per TAZ</td>
</tr>
</tbody>
</table>

May not be long enough, depending on average TAZ size and local behavior.
Transit network coding

Access Connectors: REWALK program

Proceed with caution; unclear whether REWALK may have un-intended consequences (gains/loses in coverage unrelated to the project)

Useful network coding diagnostic tool

<table>
<thead>
<tr>
<th>If the following condition exists,</th>
<th>Then:</th>
</tr>
</thead>
<tbody>
<tr>
<td>No connectors were generated</td>
<td>Reset % walk to zero</td>
</tr>
<tr>
<td>No transit stop at centroid connectors, % walk &lt; 95%</td>
<td>Reset all % walks to zero and delete all connectors</td>
</tr>
<tr>
<td>No transit stop at centroid connector, % walk greater than or equal to 95% and shortest connector is less than ½ mi.</td>
<td>None (CBD exception)</td>
</tr>
<tr>
<td>No transit stop at centroid connector, % walk greater than or equal to 95% and shortest connector greater than ½ mi.</td>
<td>Reset all % walks to zero and delete all connectors</td>
</tr>
<tr>
<td>Transit stop(s) at centroid connector and zone is 100% walk</td>
<td>None</td>
</tr>
<tr>
<td>Transit stop(s) at centroid connector and % walk is between minimum threshold and 100%</td>
<td>Adjust all connector times to ½ mile walk</td>
</tr>
<tr>
<td>Transit stop(s) at centroid connector and % walk is less than minimum threshold</td>
<td>Reset all % walks to zero and delete all connectors</td>
</tr>
</tbody>
</table>
# Path building and skimming

## Path Building Weights – Tier B Cities

<table>
<thead>
<tr>
<th>Path Attribute</th>
<th>FSUTMS</th>
<th>Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Local Bus</td>
<td>Project</td>
</tr>
<tr>
<td>Walk access time</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Drive access time</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>All walk time</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Transfer walk time</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Initial and transfer wait</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Transfers</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Local Bus IVTT</td>
<td>1.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Premium Bus IVTT</td>
<td>10</td>
<td>1.0</td>
</tr>
<tr>
<td>Circulator IVTT</td>
<td>1.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Urban Rail IVTT</td>
<td>10</td>
<td>1.0</td>
</tr>
<tr>
<td>Commuter Rail IVTT</td>
<td>10</td>
<td>1.0</td>
</tr>
<tr>
<td>Project IVTT</td>
<td>10</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Path building and skimming

Path Conditioning

Removes irrelevant paths from the skim matrices:
- all walk paths
- paths that do not use relevant line-haul mode

Recommendation:
Implement logic directly in mode choice program
Transit Modeling Update

MODE CHOICE MODEL
Trip market segmentation

Walk Market Segmentation

Recommendation: Implement short & long walk market segmentation

Short walk: ¼ mile buffer around stops & stations
Long walk: ½ mile buffer around stops and stations

… or as established by analysis of on-board survey data

<table>
<thead>
<tr>
<th>Access</th>
<th>Egress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short Walk</td>
</tr>
<tr>
<td>Short Walk</td>
<td>1</td>
</tr>
<tr>
<td>Long Walk</td>
<td>3</td>
</tr>
<tr>
<td>Drive</td>
<td>5</td>
</tr>
<tr>
<td>No Transit</td>
<td></td>
</tr>
</tbody>
</table>
# Trip market segmentation

## Household Market Segmentation

<table>
<thead>
<tr>
<th>FTA Recommended Mode Choice Stratification</th>
<th>Zero Cars</th>
<th>Car Insufficient</th>
<th>Car Sufficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Income</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Time Period Segmentation

Stratify all purposes by peak and off-peak periods
Tier A Mode Choice Nesting Structure

Person Trips

Auto
- Drive Alone
- Shared Ride
  - SR2
  - SR3+

Transit
- Walk
- PnR
- KnR
Tier B/C Cities Mode Choice Nesting Structure

Person Trips

Auto
  Drive Alone
    SR2
  Shared Ride
    SR3+

Transit
  Walk
    Bus
    Project
  PnR
    Bus
    Project
  KnR
    Bus
    Project
Proposed Choice Set and Nesting Structure

Person Trips

Auto
- Drive Alone
  - SR2
- Shared Ride
  - SR3+

Transit
- Walk
- PnR
  - LB
  - EB
  - UR
  - CR

Non Mot
- KnR
- Walk
- Bike
FSUTMS Nesting Coefficients

Unequal scaling factors applied to auto and transit coefficients
Nesting coefficient: what is it?

A measure of the correlation between alternatives

\[ 0 < \mu < 1 \]

\[ 1 - \mu \sim \text{correlation} \]

The diagram illustrates the choice structure with different modes of transportation:

- **Choice**
  - **Auto**
    - Drive-Alone
    - Shared-Ride
  - **Transit**
    - Bus
    - Light-Rail Transit

The relationships between the choices are indicated as:

- More elastic
- Less elastic

The diagram visually represents the nesting coefficient and the correlation between the alternatives.
Nested Logit Model: How?

- Nesting coefficients scale the utilities: \( U^N_{\text{bus}} = U_{\text{bus}} / \mu \)
- Nesting coefficients take values between 0 and 1
  - Steeper diversion curve between nested alternatives
  - Smaller the nesting coefficient, the more similar the nested alternatives
  - When \( \mu = 1 \), the model becomes multinomial logit (MNL)
  - When \( \mu << 1 \), the choice is practically all-or-nothing

Nest coefficient \( \mu = 0.3 \)
Logit Model Curve

Auto Probability

Transit Utility - Auto Utility

No Parking Cost

Less correlated $\mu = 0.9$

More correlated $\mu = 0.3$

Paid Parking Cost
Proposed Nesting Coefficients

- Person Trips
  - Auto
    - Drive Alone
    - Shared Ride
      - SR2
      - SR3+
  - Transit
    - Walk
      - LB
      - EB
      - UR
      - CR
    - PnR
      - LB
      - EB
      - UR
      - CR
  - Non Mot
    - KnR
      - LB
      - EB
      - UR
      - CR
    - Walk
    - Bike
Coordinating DC and MC Calibration

If confident of soundness of mode choice model, use logsums ‘as is’ for destination choice estimation.

If confident of soundness of person trip tables, start by calibrating mode choice.
Transit Modeling Update

PROTOTYPE APPLICATION
Current CRTPA Program Flow

Trip Generation
- EE Trips
- Visitor & Seasonal Resident Trips
- Permanent Resident Trips

Build Highway Network & Free-Flow Skims

Trip Distribution
- Gravity Model
- Pre-Assignment
- Congested Skims

Mode Choice

Transit Model: Build Transit Network & Skims

Trip Assignment

Reporting
Demo CRTPA Transit Update Program Flow

- **Build Hwy Networks & Skims**
- **Build Peak Trn Network & Skims**
- **Trip Generation**
  - EE Trips
  - HH Classification
  - Auto Ownership
  - Visitor & Seasonal Resident Trips
  - Permanent Resident Trips
- **Peak Factoring**
- **Transit Model: Build Transit Network & Skims**
- **Mode Choice Logsums**
- **Trip Distribution**
  - Peak & Off-Peak Destination Choice
- **Mode Choice (apply probabilities)**
- **Time of Day Factoring**
- **Highway Assignment**
- **Converged?**
  - **NO**
    - Peak & Off-Peak Highway Skims
  - **YES**
    - Transit Assignment
    - Reporting
Develop initial highway skims

Build Hwy Networks & Skims
Build Peak Trn Network & Skims
Develop initial transit skims

Build Hwy Networks & Skims
Build Peak Trn Network & Skims
Household Classification Model
Auto Ownership Model
Updated Trip Generation Model

Trip Generation
- EE Trips
- Visitor & Seasonal Resident Trips
- HH Classification
- Permanent Resident Trips

Household Joint Classification Model (PF)
- Script File
- HHInc_Dist
- HHSize_Dist
- HHWk_Dist
- Dutype_Dist
- ZONEDATA
- HHSeed

Auto Availability Model
- Script File
- Zonal Data 1
- Zonal Data 2
- Zonal Data 3
- Zonal Data 4
- Zonal Data 5
- Zonal Data 6

HH Share by: HHMHW & HHMHWP
- Print File

Floating Zone
- Network
- ZONEDATA

Put Total Emplan into trip matrix
- Script File
- Floating Zn 1

Transit and Walk Accessibility
- Script File
- D2T Skm - P
- W2T Skm - P
- Matrix File 3
- AM Cong Skm
- Zonal Data 1

New TMLI Trip Generation
- Script File
- Zone Data
- PANDA_pre
- Work PRate
- Non Work PRate
- HHShare WP
- HHShare NM

Print File
P&A Daily
**Trip Generation**
- EE Trips
- HH Classification
- Auto Ownership

**Trip Distribution**
- Visitor & Seasonal Resident Trips
- Permanent Resident Trips

**Time of Day**
- AM | MD | PM | NT

**Highway Assignment**

**Peak Factoring**

**Transit Model:**
- Build Transit Network & Skims

**Mode Choice**
- Logsums

**Trip Distribution**
- Peak & Off-Peak Destination Choice

**Mode Choice**
- (apply probabilities)

**Converged?**
- NO:
  - Peak & Off-Peak Highway Skims
  - NO:
  - Converged?
  - YES:
  - Build Hwy Networks & Skims
  - Build Peak Trn Network & Skims

**Peak | Off-Peak**
Travel time feedback
Feedback loop control

- Model exits the travel time feedback loop when it reaches convergence or performs the maximum number of loops
  - Convergence is measured by travel time and link volume average percent change
  - Convergence threshold is a user-input
  - Maximum number of loops is a user input

- Successive averages are used to compute the feedback volumes
Trip Distribution

- Destination choice models replace the current gravity models
- Stratified by trip purpose, household market and time period
- Completely scripted in Cube/Voyager
- Parameter file includes “place-holders” to allow for more detailed specifications
## Model Inputs: What’s New?

### Zonal Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACRES</td>
<td>Area of the TAZ (in acres).</td>
</tr>
<tr>
<td>ST_CNTY</td>
<td>State/County code.</td>
</tr>
<tr>
<td>RESDHHLD</td>
<td>Permanent resident households.</td>
</tr>
<tr>
<td>RESDPOP</td>
<td>Permanent resident population.</td>
</tr>
<tr>
<td>HHINCIINDEX</td>
<td>Median household income index: ratio of the median household income of the TAZ to the median household income of the region.</td>
</tr>
<tr>
<td>WRKRPHHLD</td>
<td>Average number of workers per household.</td>
</tr>
<tr>
<td>UNV_ENROL</td>
<td>Number of student enrolled at university and college institutions</td>
</tr>
</tbody>
</table>
Model Inputs: What’s New?

- Initial AM and MD person trip tables
  - For generating first loop peak and off-peak travel times
  - Derived from an existing model run

- Seed household classification table
  - Obtained from 2010 PUMS

- Percent walk file
  - Percent of a TAZ that has short and long walk access to transit (new to Tier A model)
Model Parameters: What’s New?

- Peaking factors & diurnal factors
- Household classification curves
- Updated trip production rates
- Destination choice parameters
- Updated mode choice nesting coefficients
Model Outputs: What’s New?

- Trip productions by trip purpose, revised household markets, and time of day split
- Person trips by trip purpose, revised household markets, and time of day split
- Auto trips by four time periods
- Loaded highway networks for four time periods
Catalog Keys: What’s New?

- Auto occupancy factors by trip purpose
- Highway capacity factors
- IPF control parameters (convergence & iterations)
- Travel time feedback control parameters
- Select zone – for debugging purposes
Transit Modeling Updates

PROJECT DELIVERABLES
Deliverables

- Technical Memoranda
  - Trip Generation Review and Recommendations
  - Time of Day Stratification
  - Trip Distribution Review and Recommendations
  - Mode Choice Review and Recommendations
  - AUTOCON Development
  - Additional PT Functionality
  - On-Board Rider Survey Synthesis of Practice
  - Principles of Model Calibration and Validation
  - User Benefit Analysis Guidelines
  - Quality Control Guidelines
Deliverables

- Powerpoint Presentations
  - Trip Generation Review and Recommendations
  - Time of Day Stratification
  - Trip Distribution Review and Recommendations
  - Mode Choice Review and Recommendations
  - Logit Model Primer
  - User Benefits
Deliverables

- Workshops
  - Case for the Project – Miami Pilot

- Software & Applications
  - UserBenC
  - Transit Update Prototype Model
  - Additional PT functionality (Cube 6.0)