



Assistance with Development and Application of the TPB Travel Demand Model

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AECOM

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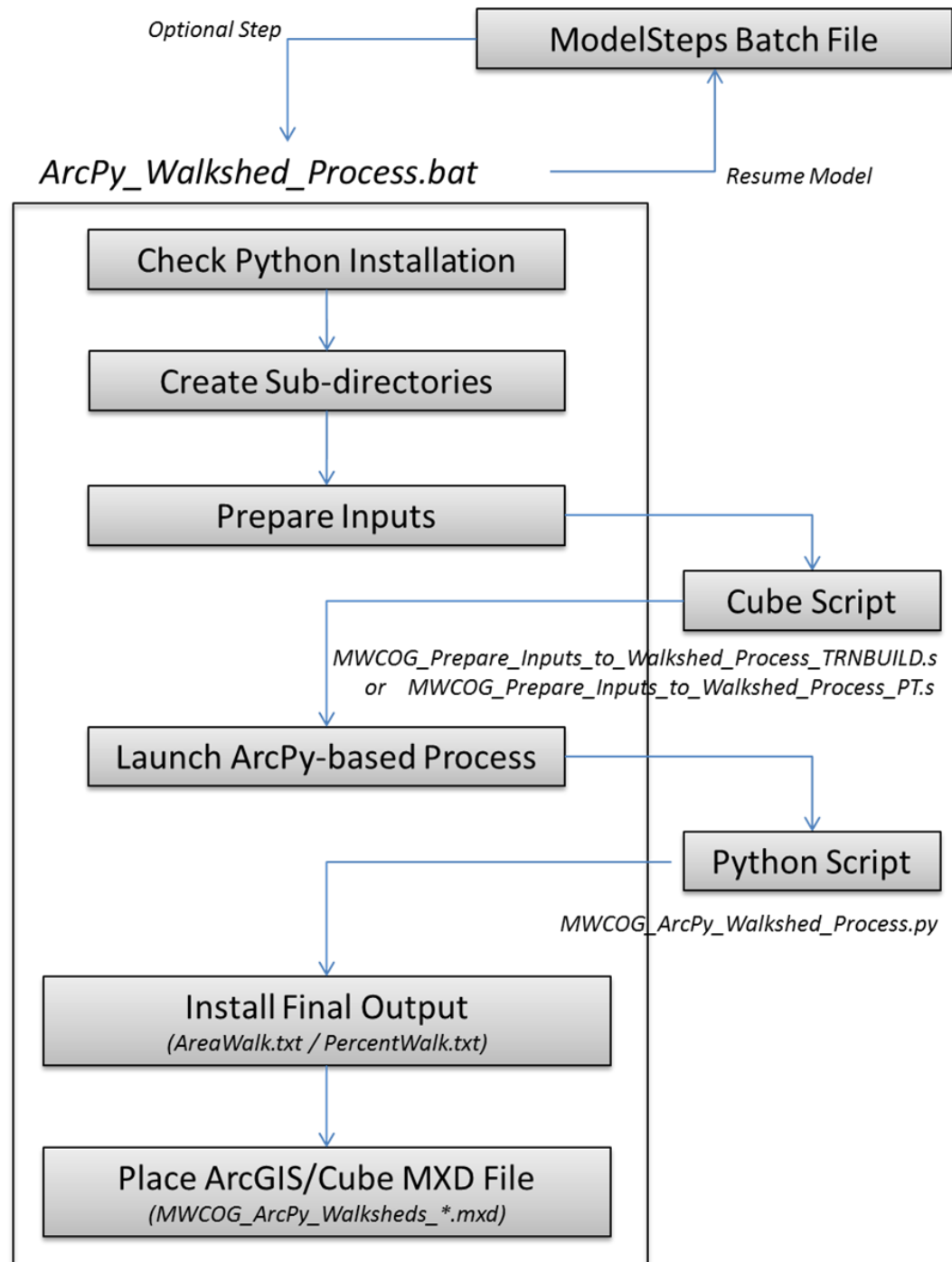
FY 2014 Task Orders

- T.O. 10 – Meetings and General Support
- T.O. 11 – Cube-Based Walkshed Process
- T.O. 12 – HOT/HOV Highway Assignment
- T.O. 13 – Mode Choice and Transit Modeling
 - 13.1 – Network Preparation and Path Building
 - 13.2 – Mode Choice Calibration

T.O. 11 – Cube-Based Walkshed Process

- **ArcPy-Cube based process**
 - Software & documentation delivered March 17th
 - Currently being tested at MWCOG
 - Integrated with TPB model v.2.3.52 procedures
 - Relies on ArcGIS runtime version 10.1 or above
 - Automated data preparation (Cube script)
 - Works with both PT and TRNBUILD line files
 - Automated walkshed process (Python script)
 - AreaWalk or PercentWalk
 - Specify TAZ area or calculate from TAZ shapefile
 - All buffers saved in geo-database for display
 - ArcGIS '.mxd' file for visualization in Cube or ArcGIS

Overview

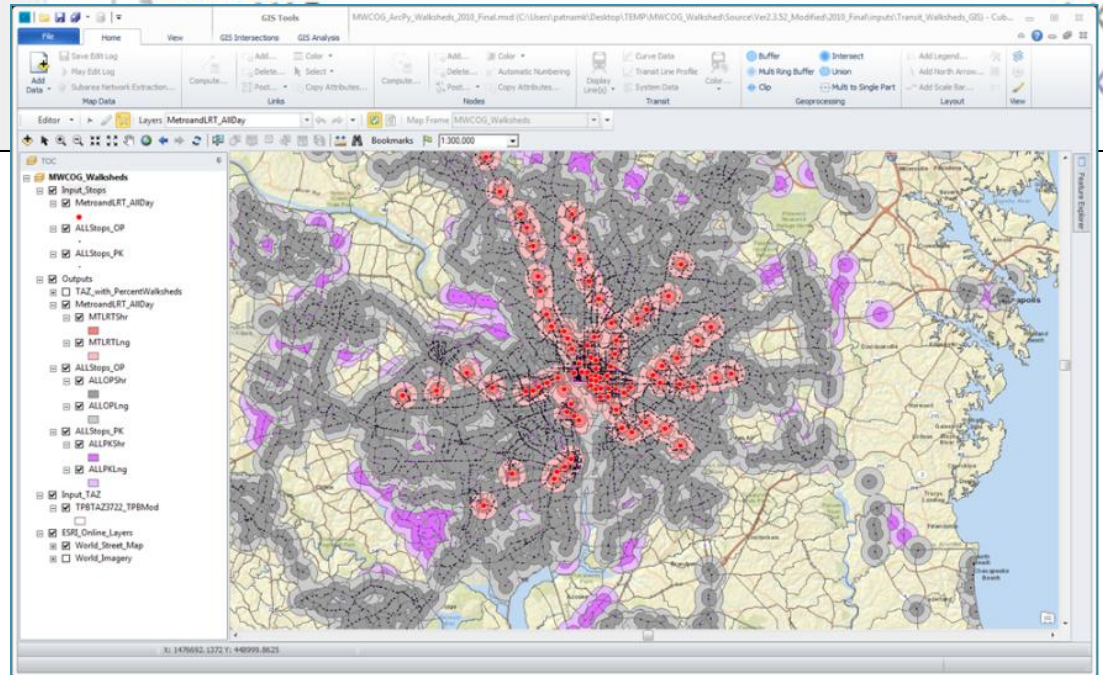
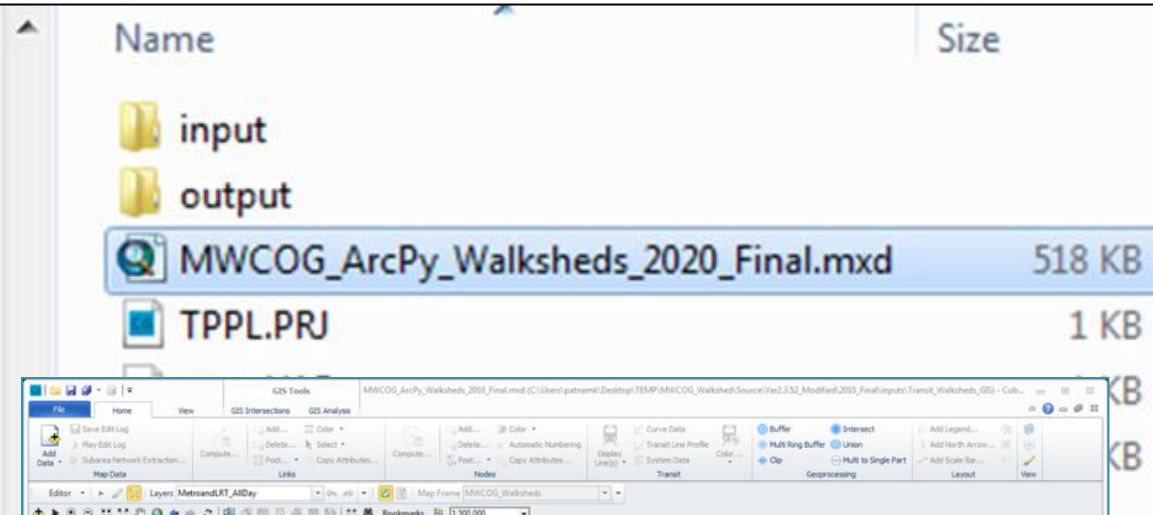
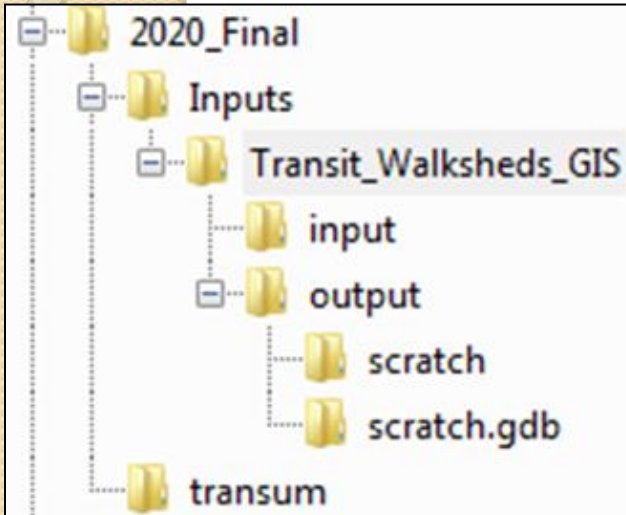


Run Times

2010: ~30-35 min

2040: ~40-45 min

Intermediate Folders



Changes (1/2)

- In the root folder:
 - ArcPy_Walkshed_Process.bat
 - New Windows Batch File
 - run_ModelSteps_Ver2.3.52_2010_Final.bat
 - Calls ArcPy batch file
 - ... (13 model steps files in total)
 - run_ModelSteps_Ver2.3.52_2040_Final.bat
 - Calls ArcPy batch file

Changes (2/2)

- In the 'Scripts' sub-folder:
 - MWCOCG_ArcPy_Walkshed_Process.py
 - New Python Script
 - MWCOCG_Prepare_Inputs_to_Walkshed_Process_TRNBUILD.s
 - New Cube Script
 - MWCOCG_Prepare_Inputs_to_Walkshed_Process_PT.s
 - New Cube Script
 - MWCOCG_ArcPy_Walkshed_Process_TEMPLATE.mxd
 - New ArcGIS/Cube MXD
 - MarylandI900Ft_ShapefileProjection_TEMPLATE.prj
 - New Text File
- In the 'TPBTAX3722_TPBMod' sub-folder (optional):
 - TPBTAZ3722_TPBMod_SortedbyTAZ.shp
 - TAZ sorted Shapefile

File Structure

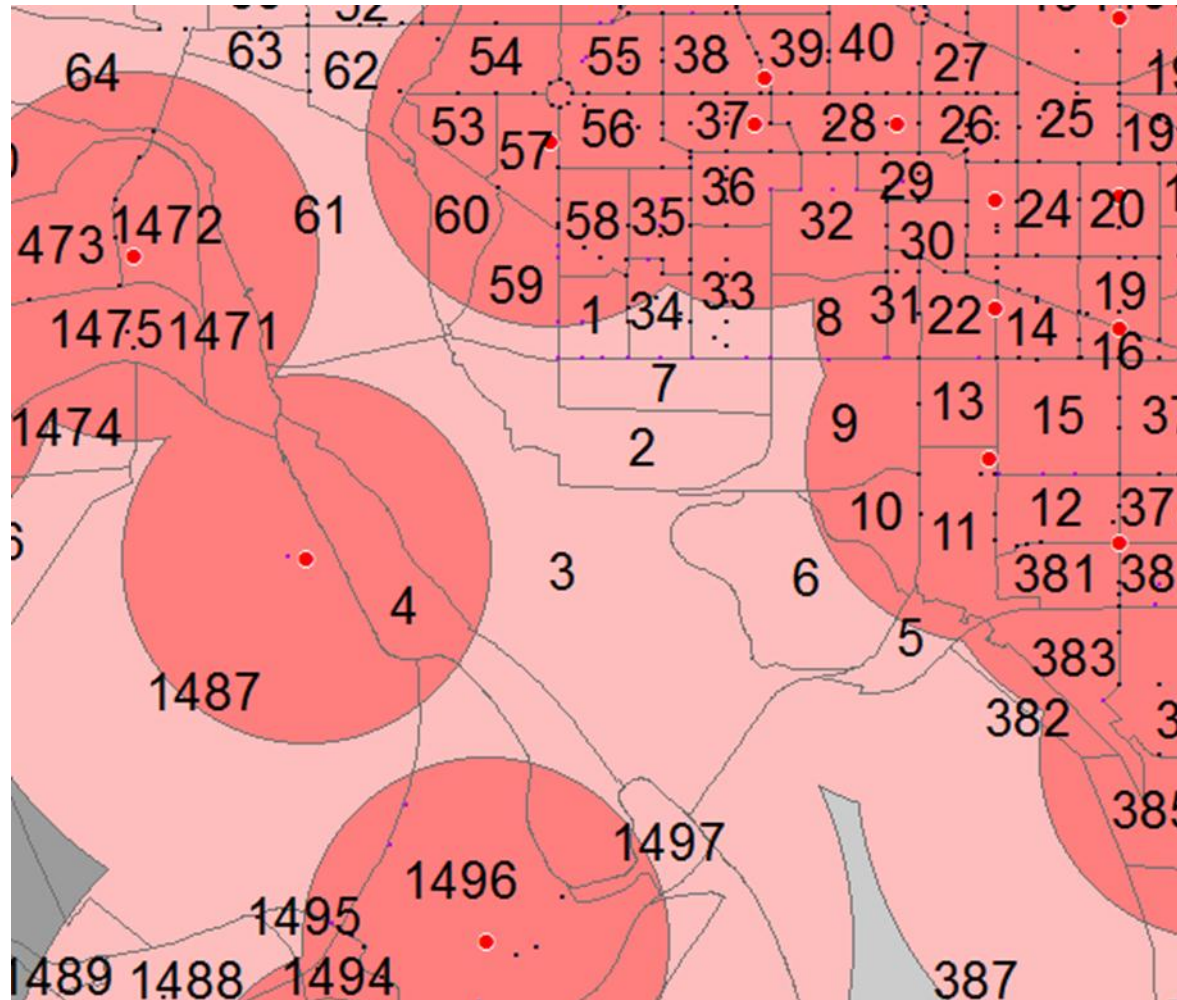
Current COG AreaWalk.txt

TAZID	TAZAREA	MtrShort	MtrLong	AmShort	AmLong	PmShort	PmLong
998	0.1963	0.0000	0.0173	0.1963	0.1963	0.1963	0.1963
993	0.4766	0.0000	0.0450	0.4766	0.4766	0.4766	0.4766
941	0.1731	0.0000	0.0000	0.1731	0.1731	0.1731	0.1731
946	0.1711	0.0000	0.0000	0.1711	0.1711	0.1711	0.1711
952	0.1218	0.0000	0.1218	0.1218	0.1218	0.1218	0.1218

New AreaWalk.txt

TAZ	TAZ_AREA	MTLRTSHR	MTLRTLNG	ALLPKSHR	ALLPKLNG	ALLOPSHR	ALLOPLNG
998	0.1963	0.0000	0.0173	0.1963	0.1963	0.1963	0.1963
993	0.4766	0.0000	0.0450	0.4766	0.4766	0.4766	0.4766
941	0.1731	0.0000	0.0000	0.1731	0.1731	0.1731	0.1731
946	0.1711	0.0000	0.0000	0.1711	0.1711	0.1711	0.1711
952	0.1218	0.0000	0.1218	0.1218	0.1218	0.1218	0.1218

Results Identical Except for some TAZs*

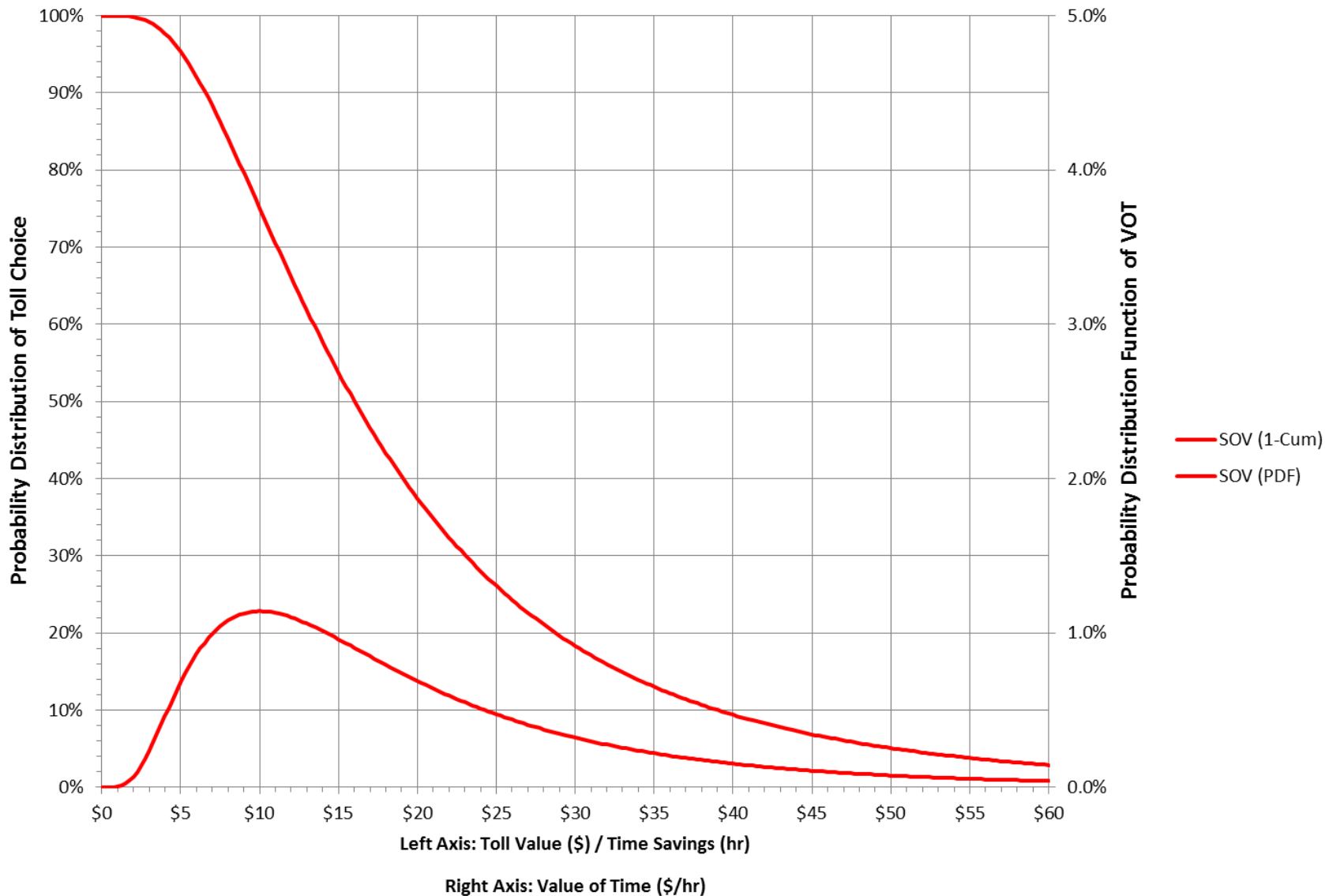


*TAZs that contain water-bodies

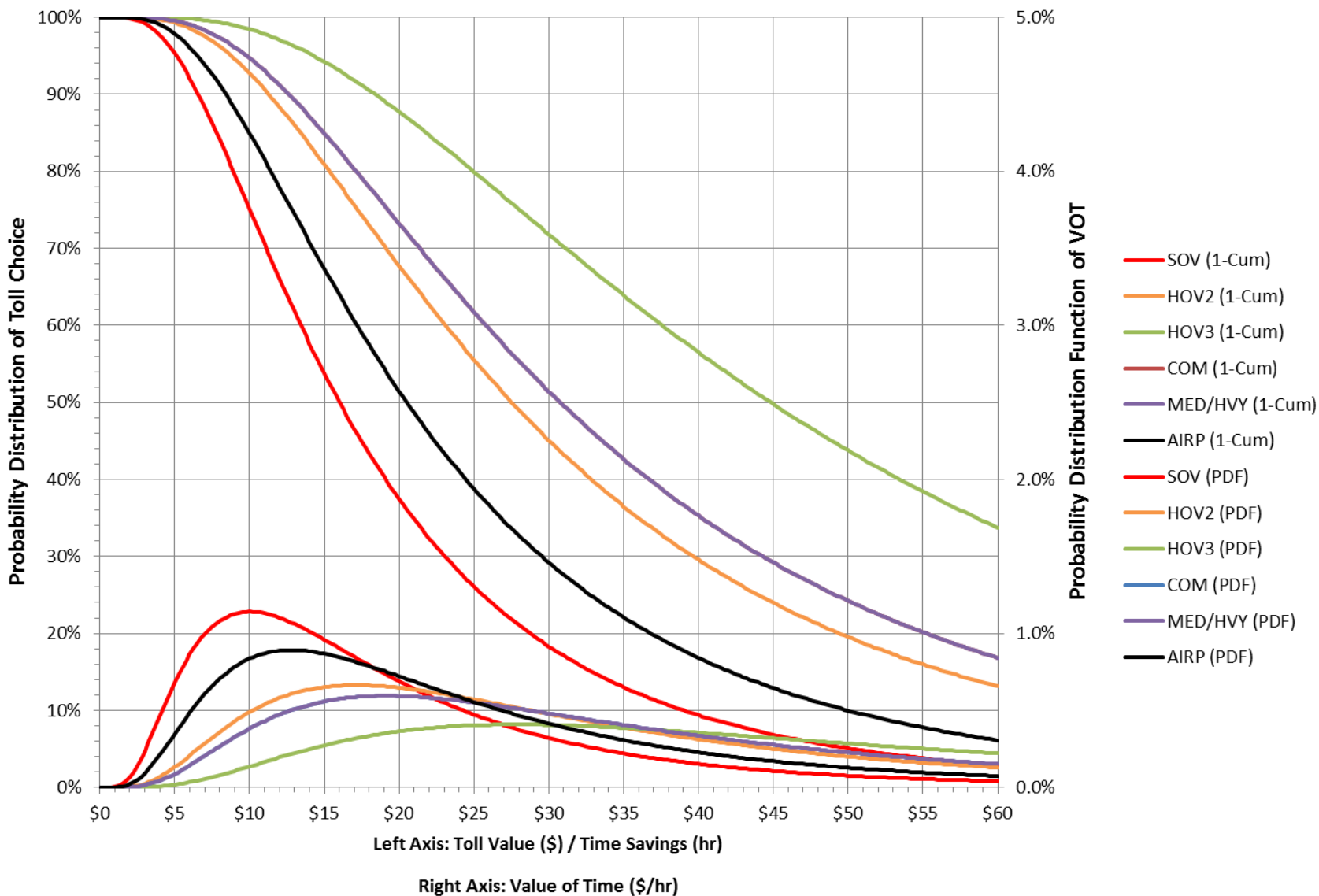
T.O. 12 – HOT/HOV Assignments

- **Implement the recommendations from T.O. 8**
 - Additional HOV count data and calibration before integrating an HOV choice model into mode choice and highway assignment
 - Incorporate toll-setting and toll-choice into the standard highway assignment process
- **Update HOV choice model**
 - Use HOV counts provided by TPB
 - SOV <> HOV2 <> HOV3
- **Update and test HOT lane model**
 - Integrate toll choice into standard modeling process
 - Use Value of Time by six vehicle classes provided by TPB

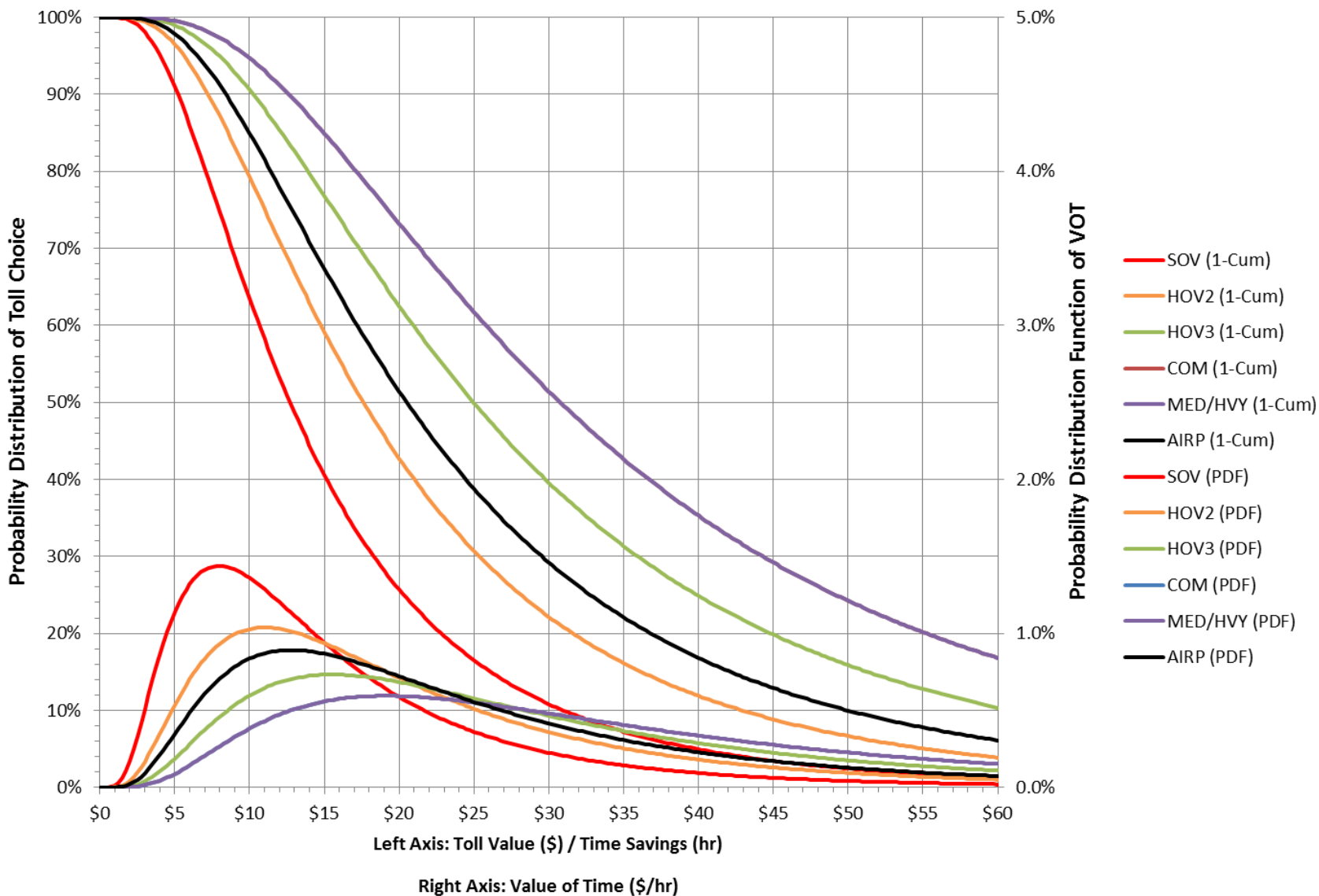
AM Value of Time Distributions



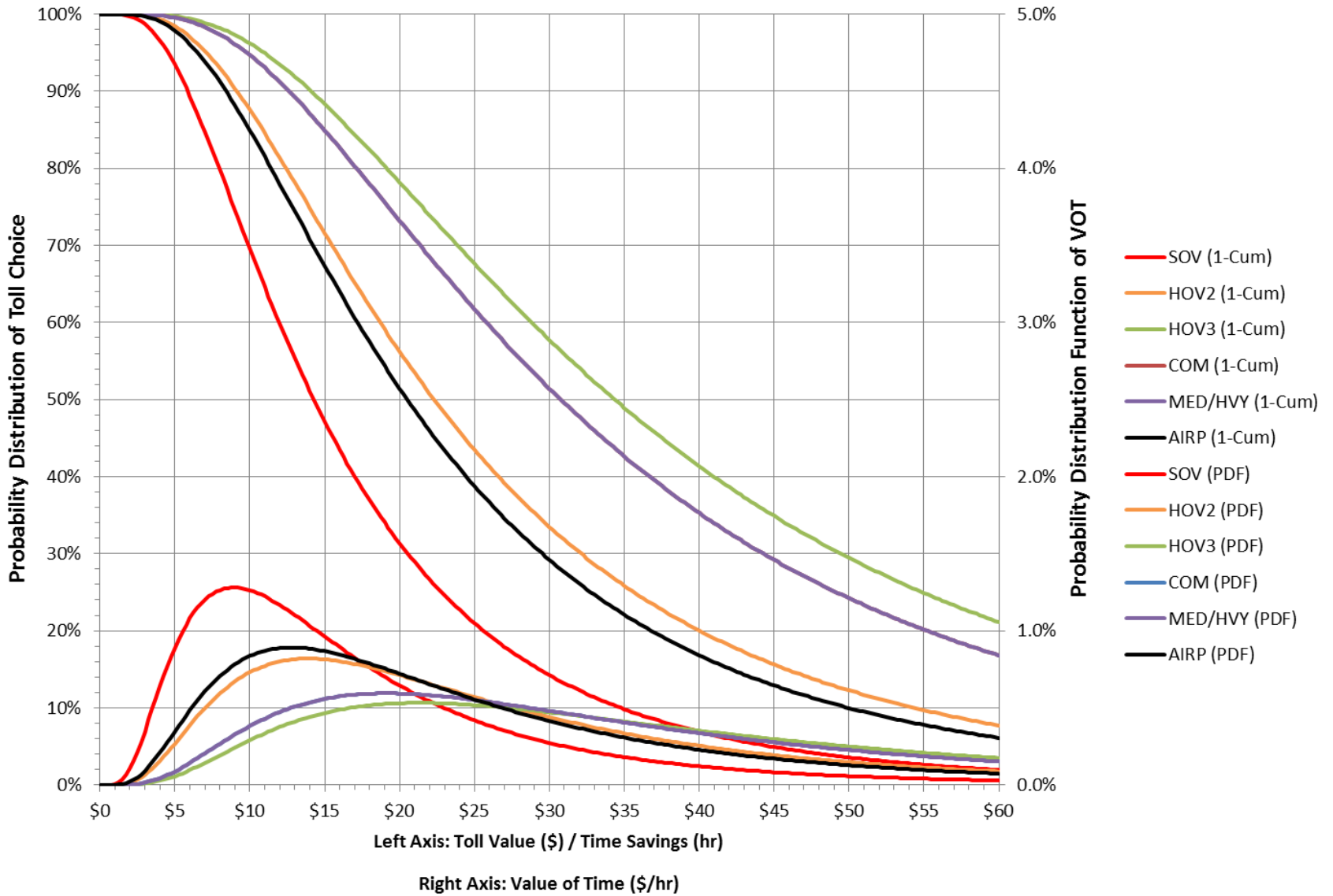
AM Value of Time Distributions by Vehicle Class



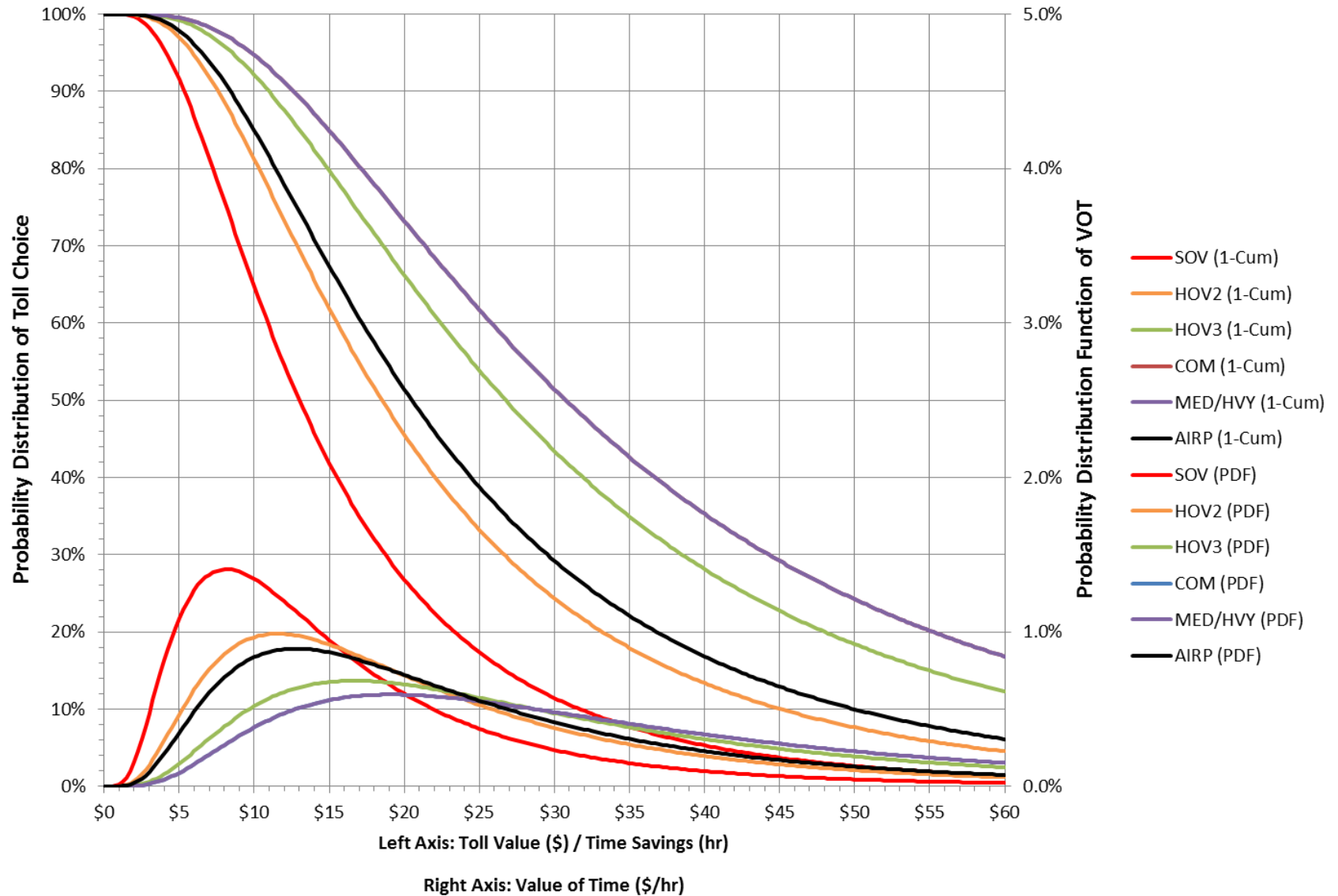
MD Value of Time Distributions by Vehicle Class



PM Value of Time Distributions by Vehicle Class



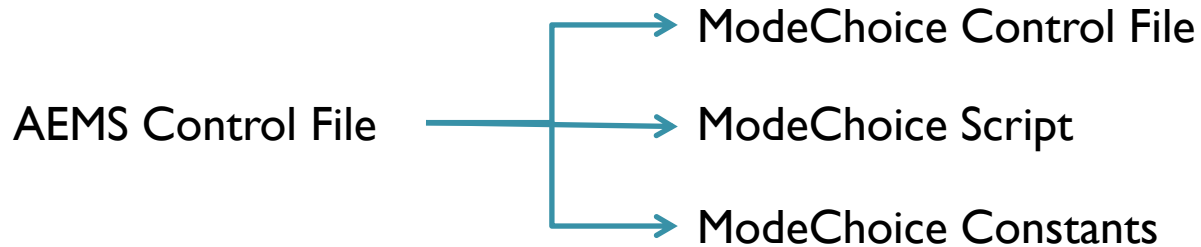
NT Value of Time Distributions by Vehicle Class



T.O. 13 – Mode Choice and PT Paths

- AEMS → ModeChoice conversion
- ModeChoice calibration
- Compare PT transit paths to TRNBUILD paths

AEMS to ModeChoice Conversion



AEMS Control File

```
* WALK COMMUTER RAIL
COMPUTE >IF(m305>0)
COMPUTE WCIV >m305/100.
COMPUTE WCOV >(m303+m304)/100.
COMPUTE WCXF >m312
COMPUTE WCCS >m313
COMPUTE WCXP >m314/100.
COMPUTE WCWK >(m301+m302)/100.
COMPUTE >ENDIF

* WALK BUS
COMPUTE >IF(m405>0)
COMPUTE WBIV >m405/100.
COMPUTE WBOV >(m403+m404)/100.
COMPUTE WBXF >m412
COMPUTE WBCS >m413
COMPUTE WBXP >m414/100.
COMPUTE WBWK >(m401+m402)/100.
COMPUTE >ENDIF
```

ModeChoice Script File

```
//---- walk to commuter rail ----
IF (SKIM3.5 > 0) THEN
  WK_CR.TIME = SKIM3.5 / 100.0
  WK_CR.WALK = (SKIM3.1 + SKIM3.2) / 100.0
  WK_CR.WAIT = (SKIM3.3 + SKIM3.4) / 100.0
  WK_CR.COST = SKIM3.13
  WK_CR.XFER = SKIM3.12
  WK_CR.TPEN = SKIM3.14 / 100.0
ENDIF

//---- walk to bus ----
IF (SKIM4.5 > 0) THEN
  WK_BUS.TIME = SKIM4.5 / 100.0
  WK_BUS.WALK = (SKIM4.1 + SKIM4.2) / 100.0
  WK_BUS.WAIT = (SKIM4.3 + SKIM4.4) / 100.0
  WK_BUS.COST = SKIM4.13
  WK_BUS.XFER = SKIM4.12
  WK_BUS.TPEN = SKIM4.14 / 100.0
ENDIF
```

AEMS to ModeChoice - Coefficients

AEMS Coefficients

*LOGIT COEFFICIENTS BY CHOICE FOR EACH SKIM (NO INPUT SKIM IS EQUIVALENT TO A CONSTANT)															
*CHOICE	1>DR ALONE	SR2	SR3+	WK-CR	WK-BUS	WK-BU/MR	WK-MR	PNR-CR	KNR-CR	PNR-BUS	KNR-BUS	PNR-BU/MR	KNR-BU/MR	PNR-MR	KNR-MR
COEF01:IVTT	1>-0.02128	-0.02128	-0.02128	-0.02128	-0.02128	-0.02128	-0.02128	-0.02128	-0.02128	-0.02128	-0.02128	-0.02128	-0.02128	-0.02128	-0.02128
SKIM01:IVTT	1>DAIV	S2IV	S3IV	WCIV	WBIV	WTIV	WMIV	PCIV	KCIV	PBIV	KBIV	PTIV	KTIV	PMIV	KMIV
COEF02:AUTO ACC	1>							-0.03192	-0.03192	-0.03192	-0.03192	-0.03192	-0.03192	-0.03192	-0.03192
SKIM02:AUTO ACC	1>							PCAA	KCAA	PBAA	KBAA	PTAA	KTAA	PMAA	KMAA
COEF03:TERM/OVTT	1>-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320
SKIM03:TERM/OVTT	1>DATE	S2TE	S3TE	WCOV	WBOV	WTOV	WMOV	PCOV	KCOV	PBOV	KBOV	PTOV	KTOV	PMOV	KMOV
* LIMIT COEF 04 TO PURPOSE 1	>1														
COEF04:COST INCL	1>-0.00185	-0.00185	-0.00185	-0.00185	-0.00185	-0.00185	-0.00185	-0.00185	-0.00185	-0.00185	-0.00185	-0.00185	-0.00185	-0.00185	-0.00185
SKIM04:COST INCL	1>DACS	S2CS	S3CS	WCCS	WBCS	WTCS	WMCs	PCCS	KCCS	PBCS	KBCS	PTCS	KTCS	PMCS	KMCS
* LIMIT COEF 05 TO PURPOSE 2	>2														
COEF05:COST INCL	1>-0.00093	-0.00093	-0.00093	-0.00093	-0.00093	-0.00093	-0.00093	-0.00093	-0.00093	-0.00093	-0.00093	-0.00093	-0.00093	-0.00093	-0.00093
SKIM05:COST INCL	1>DACS	S2CS	S3CS	WCCS	WBCS	WTCS	WMCs	PCCS	KCCS	PBCS	KBCS	PTCS	KTCS	PMCS	KMCS
* LIMIT COEF 06 TO PURPOSE 3	>3														
COEF06:COST INCL	1>-0.00062	-0.00062	-0.00062	-0.00062	-0.00062	-0.00062	-0.00062	-0.00062	-0.00062	-0.00062	-0.00062	-0.00062	-0.00062	-0.00062	-0.00062
SKIM06:COST INCL	1>DACS	S2CS	S3CS	WCCS	WBCS	WTCS	WMCs	PCCS	KCCS	PBCS	KBCS	PTCS	KTCS	PMCS	KMCS
* LIMIT COEF 07 TO PURPOSE 4	>4														
COEF07:COST INCL	1>-0.00046	-0.00046	-0.00046	-0.00046	-0.00046	-0.00046	-0.00046	-0.00046	-0.00046	-0.00046	-0.00046	-0.00046	-0.00046	-0.00046	-0.00046
SKIM07:COST INCL	1>DACS	S2CS	S3CS	WCCS	WBCS	WTCS	WMCs	PCCS	KCCS	PBCS	KBCS	PTCS	KTCS	PMCS	KMCS
COEF08:TRN XFERS	1>			-0.00000	-0.00000	-0.00000	-0.00000	-0.00000	-0.00000	-0.00000	-0.00000	-0.00000	-0.00000	-0.00000	-0.00000
SKIM08:TRN XFERS	1>			WCXF	WBXF	WTXF	WMXF	PCXF	KCXF	PBXF	KBXF	PTXF	KTXF	PMXF	KMXF
COEF09:TRN BRDPEN	1>			-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320	-0.05320
SKIM09:TRN BRDPEN	1>			WCXP	WBXP	WTXP	WMXP	PCXP	KCXP	PBXP	KBXP	PTXP	KTXP	PMXP	KMXP
*WALK WEIGHT															
COEF10:TRN WLKWT	1>			-0.04256	-0.04256	-0.04256	-0.04256	-0.04256	-0.04256	-0.04256	-0.04256	-0.04256	-0.04256	-0.04256	-0.04256
SKIM10:TRN WLKWT	1>			WCWK	WBWK	WTWK	WMWK	PCWK	KCWK	PBWK	KBWK	PTWK	KTWK	PMWK	KMWK

Mode Choice Coefficients

VEHICLE_TIME_VALUE	-0.02128
WALK_TIME_VALUE	-0.04256
DRIVE_ACCESS_VALUE	-0.03192
WAIT_TIME_VALUE	-0.05320
TRANSFER_COUNT_VALUE	-0.00000
PENALTY_TIME_VALUE	-0.05320
TERMINAL_TIME_VALUE	-0.05320
COST_VALUE_TABLE_1	-0.00185
COST_VALUE_TABLE_2	-0.00093
COST_VALUE_TABLE_3	-0.00062
COST_VALUE_TABLE_4	-0.00046

AEMS to ModeChoice - Constants

AEMS Constants

```

*CONSTANTS BY CHOICE FOR EACH PURPOSE
*CHOICE      1>DR ALONE  SR2      SR3+      WK-CR      WK-BUS      WK-BU/MR      WK-MR
PURP01 1INC 1      1>      2.000000      2.000000      2.000000      2.000000
PURP02 1INC 2      1>
PURP03 1INC 3      1>
PURP04 1INC 4      1>
PURP01 2INC 1      1>      -2.000000      -2.000000      -2.000000      -2.000000
PURP02 2INC 2      1>      2.000000      2.000000      2.000000      2.000000
PURP03 2INC 3      1>
PURP04 2INC 4      1>
PURP01 3INC 1      1>      -2.000000      -2.000000      -2.000000      -2.000000
PURP02 3INC 2      1>      2.000000      2.000000      2.000000      2.000000
PURP03 3INC 3      1>
PURP04 3INC 4      1>
PURP01 4INC 1      1>      -2.000000      -2.000000      -2.000000      -2.000000
PURP02 4INC 2      1>      2.000000      2.000000      2.000000      2.000000
PURP03 4INC 3      1>
PURP04 4INC 4      1>      -2.000000      -2.000000      -2.000000      -2.000000
    
```

```

* SEGMENT 1
NSTC 10 1GRND TOTAL>
NSTC 11 1AUTO > 0.5 0.00000
NSTC 12 1TRANSIT > 0.5 3.72445
NSTC 20 1TOTAL TRN >
NSTC 21 1WALK ACC > 0.5 0.00000
NSTC 22 1PNR ACC > 0.5 -3.76433
NSTC 23 1KNR ACC > 0.5 -7.33524
NSTC 30 1WLK TRN
NSTC 31 1WLK CR > 1.0 -0.80725
NSTC 32 1WLK BUS > 1.0 -1.44958
NSTC 33 1WLK BU/MR > 1.0 -1.46039
NSTC 34 1WLK METRO > 1.0 0.00000
NSTC 40 1PNR TRN
NSTC 41 1PNR CR > 1.0 -0.39351
NSTC 42 1PNR BUS > 1.0 -2.45057
NSTC 43 1PNR BU/MR > 1.0 0.85057
NSTC 44 1PNR METRO > 1.0 0.00000
NSTC 50 1KNR TRN
NSTC 51 1KNR CR > 1.0 3.57299
NSTC 52 1KNR BUS > 1.0 1.26089
NSTC 53 1KNR BU/MR > 1.0 5.74345
NSTC 54 1KNR METRO > 1.0 0.00000
NSTC 60 1AUTO
NSTC 61 1LOV > 1.0 0.00000
NSTC 62 1HOV > 0.5 -1.29504
NSTC 70 1HOV
NSTC 71 1HOV2 > 1.0 0.00000
NSTC 72 1HOV3+ > 1.0 -1.55713
    
```

Mode Choice Constants File

SEGMENT	MODE	CONSTANT	Inc_Grp1	Inc_Grp2	Inc_Grp3	Inc_Grp4
1	AUTO	0	0	0	0	0
1	TRANSIT	3.72445	0	0	0	0
1	SOV	0	0	0	0	0
1	HOV	-1.29504	0	0	0	0
1	SR2	0	0	0	0	0
1	SR3	-1.55713	0	0	0	0
1	WALK	0	0	0	0	0
1	PNR	-3.76433	0	0	0	0
1	KNR	-7.33524	0	0	0	0
1	WK_CR	-0.80725	2	0	0	-2
1	WK_BUS	-1.44958	2	0	0	-2
1	WK_BUS_	-1.46039	2	0	0	-2
1	WK_MR	0	2	0	0	-2
1	PNR_CR	-0.39351	0	0	0	0
1	PNR_BUS	-2.45057	0	0	0	0
1	PNR_BUS_	0.85057	0	0	0	0
1	PNR_MR	0	0	0	0	0
1	KNR_CR	3.57299	0	0	0	0
1	KNR_BUS	1.26089	0	0	0	0
1	KNR_BUS_	5.74345	0	0	0	0
1	KNR_MR	0	0	0	0	0
2	AUTO	0	0	0	0	0
2	TRANSIT	4.41614	0	0	0	0
2	SOV	0	0	0	0	0
2	HOV	-1.77697	0	0	0	0

AEMS to ModeChoice - Results

Purpose	AEMS		ModeChoice		Difference	
	Auto	Transit	Auto	Transit	Auto	Transit
HBW	2,974,260	788,720	2,974,260	788,719	0	0
HBO	6,658,699	199,628	6,658,699	199,628	0	0
HBS	2,929,669	20,075	2,929,669	20,075	0	0
NHW	1,480,717	75,107	1,480,717	75,107	0	0
NHO	3,129,409	31,418	3,129,409	31,418	0	0

HBW Calibration Targets

HBW_Target1.txt

Segment	Mode	Inc_Grp1	Inc_Grp2	Inc_Grp3	Inc_Grp4	Target	Min_Const	Max_Const
1	AUTO	766	3338	2679	4248	11031	-8	8
1	TRANSIT	23030	42413	31015	16633	113090	-8	8
1	SOV	603	2755	2296	3670	9324	-8	8
1	HOV	163	583	383	578	1707	-8	8
1	SR2	116	448	309	479	1352	-8	8
1	SR3	47	136	74	99	355	-8	8
1	WALK	22634	40482	29496	13384	105996	-8	8
1	PNR	186	1643	1313	2566	5708	-8	8
1	KNR	209	287	206	683	1386	-8	8
1	WK_CR	0	0	0	0	0	-8	8
1	WK_BUS	5684	8105	4994	2292	21076	-8	8
1	WK_BUS_MR	325	265	192	49	830	-8	8
1	WK_MR	16626	32113	24310	11042	84091	-8	8
1	PNR_CR	0	1	2	10	12	-8	8
1	PNR_BUS	21	213	221	1074	1530	-8	8
1	PNR_BUS_MF	1	8	5	28	41	-8	8
1	PNR_MR	164	1422	1085	1455	4125	-8	8
1	KNR_CR	0	1	1	9	11	-8	8
1	KNR_BUS	9	38	15	130	193	-8	8
1	KNR_BUS_MF	0	2	1	10	13	-8	8
1	KNR_MR	200	247	188	534	1168	-8	8
2	AUTO	153	419	307	297	1177	-8	8
2	TRANSIT	2267	2881	1956	900	8003	-8	8
2	SOV	133	372	279	271	1055	-8	8

Mode Choice Script

```

CALIBRATION_TARGET_FILE      ..\Targets\HBW_Target1.txt
CALIBRATION_SCALING_FACTOR   1.0
MAX_CALIBRATION_ITERATIONS   5
CALIBRATION_EXIT_RMSE        1.0
NEW_MODE_CONSTANT_FILE        Results\HBW_AM_Constant01.txt
NEW_CALIBRATION_DATA_FILE     Results\HBW_AM_Data01.txt
    
```

PT Path Building Task

- **Purpose/Objective**
 - Develop PT scripts to skim/load 22 transit path options
 - Two time periods (peak and off-peak), three access modes (walk, kiss-n-ride and park-n-ride), and four line-haul modes (bus-only, Metrorail-only, bus and Metrorail, and commuter rail)
- **Task Activities**
 - Validate integrated PT network prepared by MWCOCG
 - Highway links, transit-only links, and special access links
 - Create transit paths using PT
 - Prepare required inputs for MWCOCG fare calculation using PT

MWCOG Non-Transit Legs in PT

- Walk access/egress and transfer legs

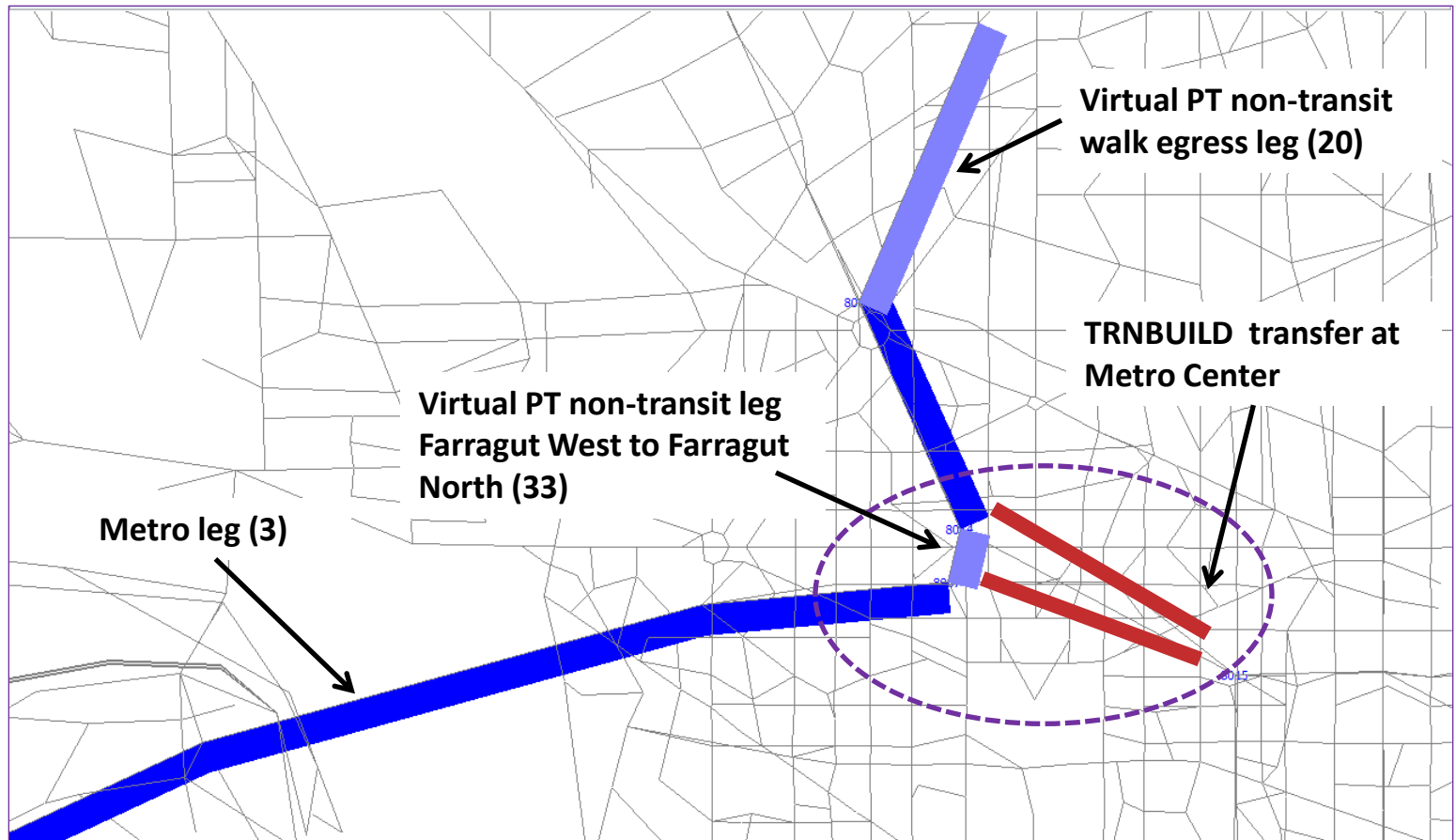
From	To				
	Zone Centroid	Bus	Metro	Commuter Rail	LRT
Zone Centroid	-	20	20	20	20
Bus	20	22	23	24	25
Metro	20	32	33	34	35
Commuter Rail	20	42	43	44	45
LRT	20	52	53	54	55

- Drive access legs

From	Mode	To			
		Bus	Metro	Commuter Rail	LRT
Zone Centroid	Drive (Kiss-and-Ride)	18	18	18	18
Zone Centroid	Drive (Park-and-Ride)	19	19	19	19

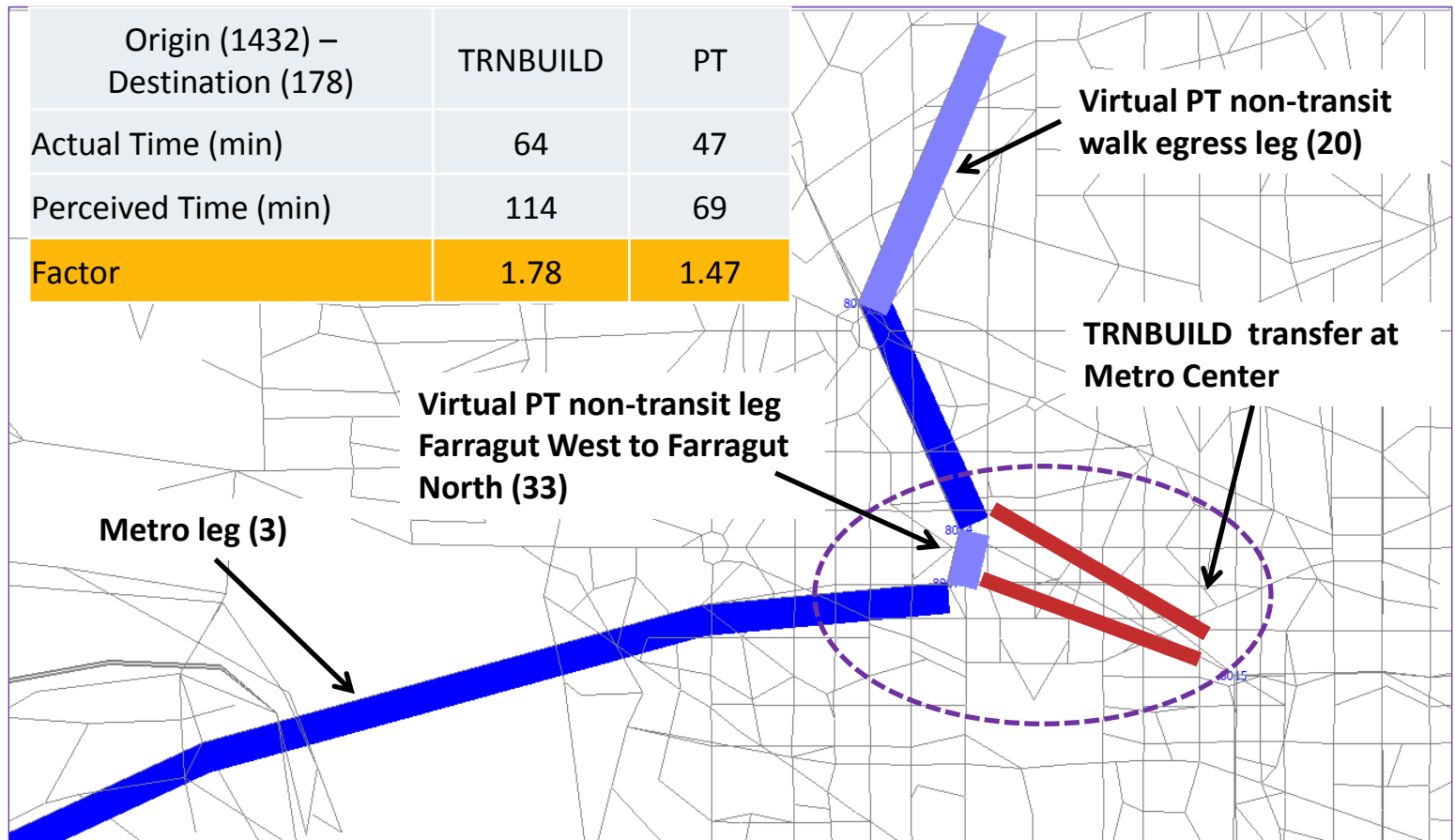
PT vs. TRNBUILD – Path Structure

- East Falls Church Metro to Adams Morgan (Auto-Access)



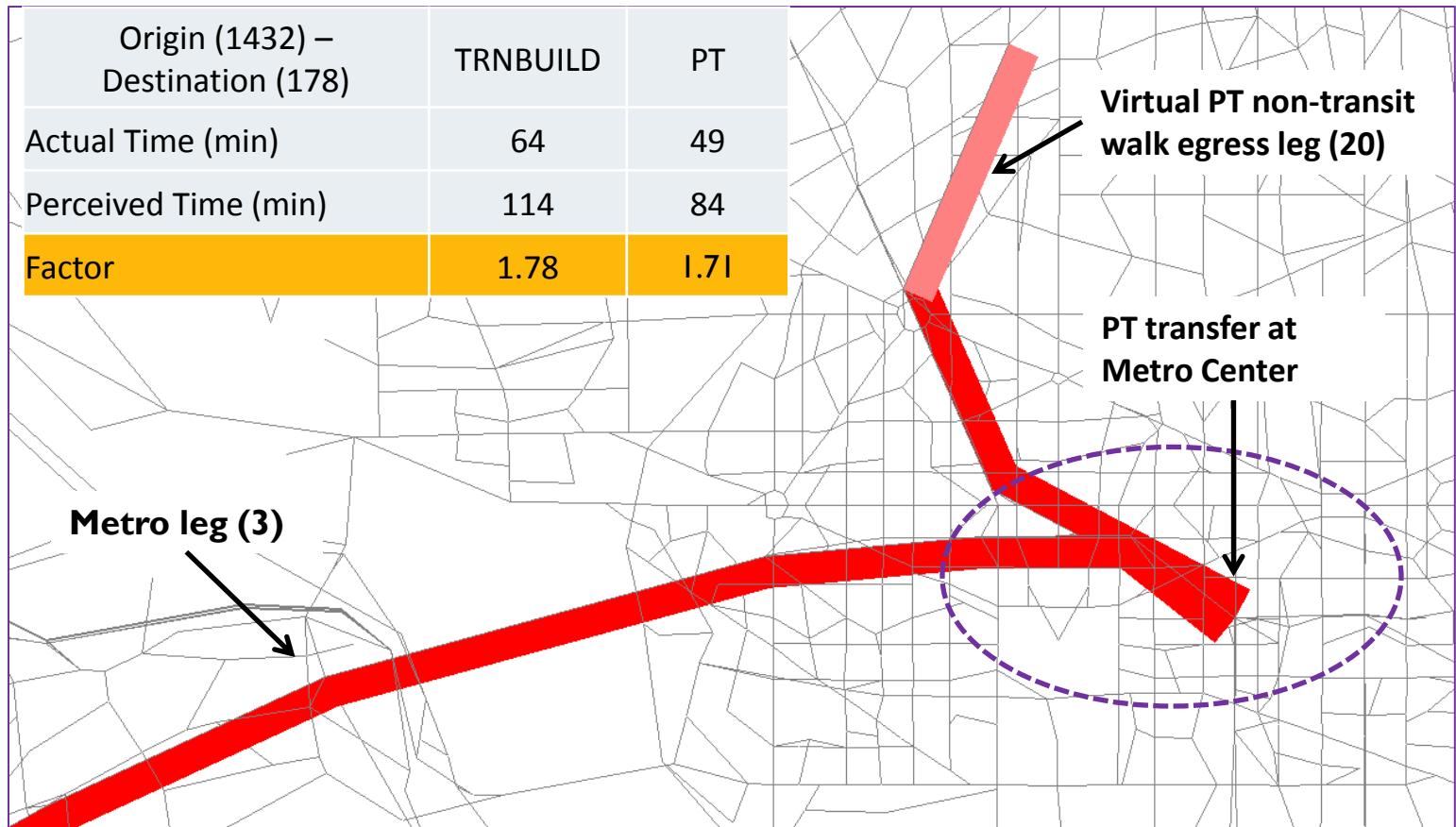
Actual and Perceived Time

- East Falls Church Metro to Adams Morgan (Auto-Access)



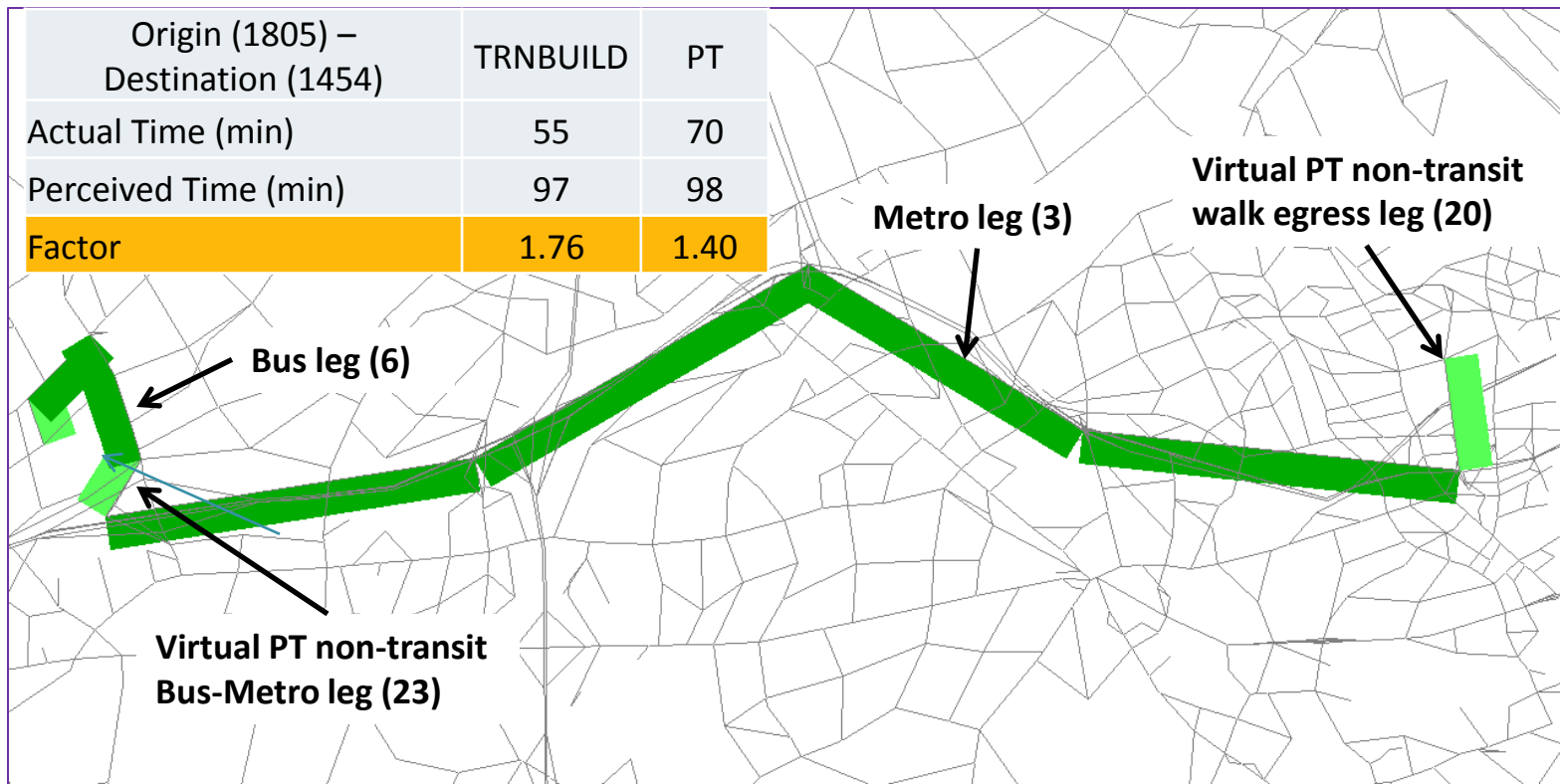
Adjusted Path Building Parameters

- East Falls Church Metro to Adams Morgan (Auto-Access)



PT vs. TRNBUILD – Calibration

- North of Vienna to North of Ballston (Walk-Access)
- TRNBUILD path walks directly to Metro – no bus leg



PT vs TRNBUILD Transit Skim

- Average AM Peak Bus-Metro skim values by mode of access

		TRNBUILD			PT		
		PNR	KNR	WK	PNR	KNR	WK
In-Vehicle Time (minutes)	Local Bus	24	24	27	37	40	38
	Express Bus	45	46	43	50	50	43
	Metro Rail	32	32	32	27	27	28

Next Steps

- **T.O. 11 – Cube-Based Walkshed Process**
 - Respond to MWCOCG comments
- **T.O. 12 – HOT/HOV Highway Assignment**
 - Revise HOV choice model, incorporate VOT curves
 - Incorporate Task 8 & other procedures → do testing
- **T.O. 13 – Mode-Choice and Transit Modeling**
 - Compare PT and TRNBUILD transit paths
 - Adjust parameters and calibrate PT-based paths
 - Finalize ModeChoice calibration targets
 - Calibrate ModeChoice with PT or TRNBUILD skims