HOV / HOT Lane Modeling and Public Transport Research

Mr. David B. Roden, Senior Consulting Manager

AECOM

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2013 Task Orders (** today's topics)

- T.O. 7 – Meetings and General Support
- T.O. 8 – Traffic Assignment
  - 8.1 – HOT-lane Modeling **
  - 8.2 – HOV Modeling **
  - 8.3 – Speed Validation (submitted draft research memo)
  - Added – tech memo, meetings, and simple HOV model
- T.O. 9 – Mode Choice and Transit Modeling
  - 9.1 – Network Preparation **
  - 9.2 – Path Building
  - Added – AEMS→ModeChoice example/documentation

HOV Modeling

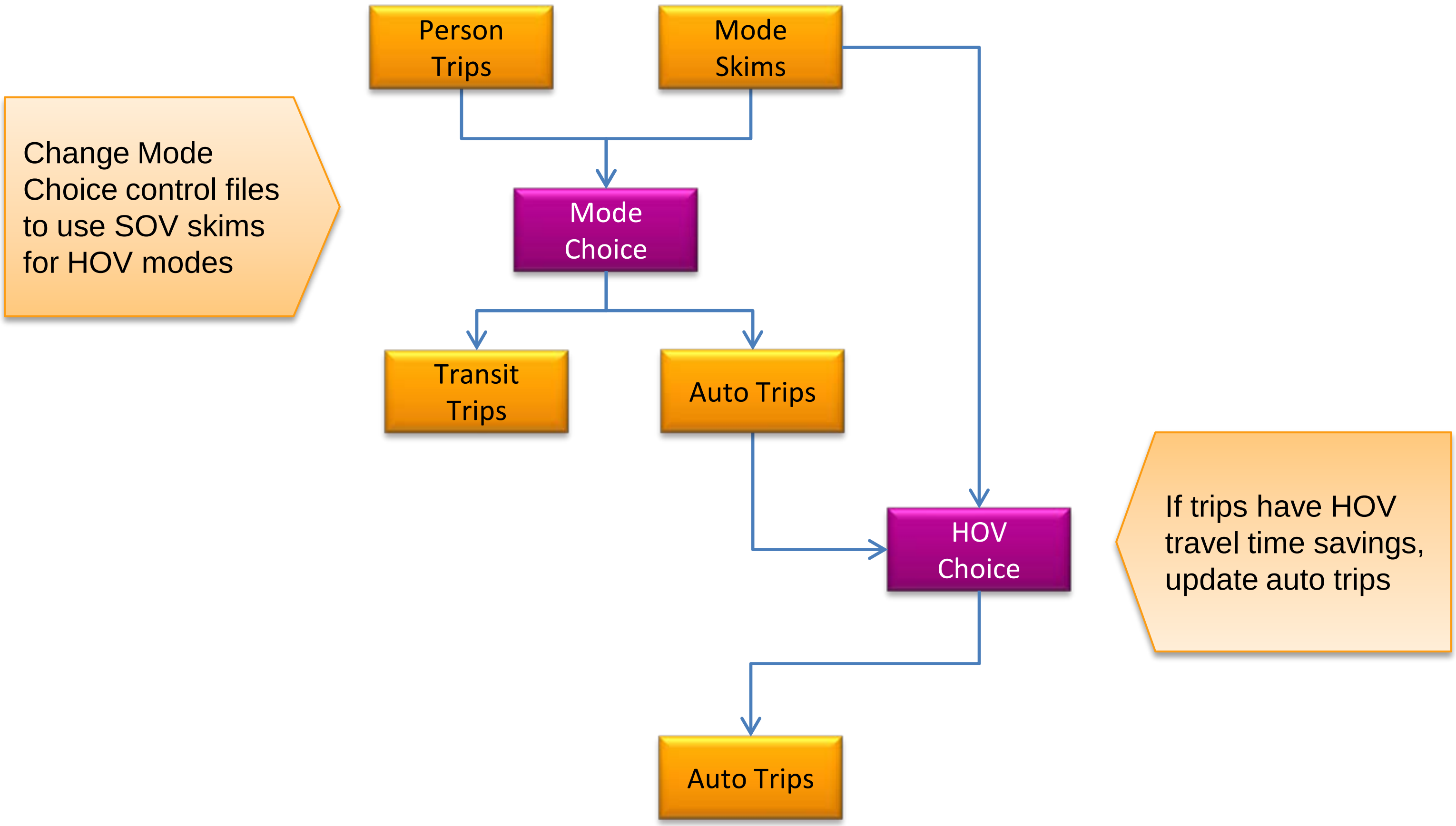
- Motivation and Objective
  - Distinguish natural carpool travelers (joint travel) from those seeking travel time or cost saving (HOV choice)
  - HOV choice should be modeled in Mode Choice
    - Identify independent person and joint trips
    - For individual person trips, limit HOV option to interchanges with travel time or cost advantage
  - A simple HOV choice model was developed as in interim test for evaluation purposes
    - Calibrated to daily and peak period counts on I-95/I-395
    - Only AM peak HBW trips

Proposed Changes

- Current Process
  - 5 Mode Choice models
    - SOV, HOV2, HOV3+, etc.
  - "Two-step"; 6 assignments
    - AM Non-HOV3+
    - AM HOV3+ Only
    - PM Non-HOV3+
    - PM HOV3+ Only
    - MD ALL
    - NT ALL

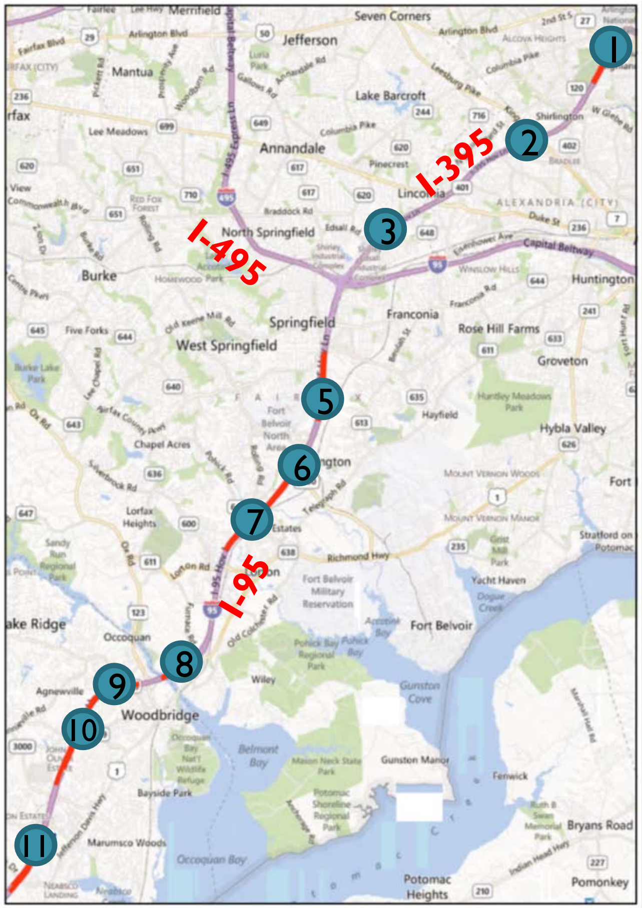
- Proposed Process
  - 5 Mode Choice* models
    - SOV, HOV2, HOV3+, etc.
  - HOV choice model
    - SOV*, HOV2*, HOV3+*
  - 4 assignments
    - AM ALL
    - PM ALL
    - MD ALL
    - NT ALL

Interim HOV Choice Process



HOV Model Calibration

Compare estimated HOV traffic to counts



- Daily traffic counts from VDOT on the general purpose (GP) lanes and HOV lanes.
- The GP and HOV lane counts include SOV, HOV2 and HOV3+ vehicles since the HOV lanes are available to all travelers at some times of day.
- Source: Kile, M., Documentation for HOV_LOV_Volumes.xlsx, 2/28/13.

Background HOV Traffic

2010 daily background LOV and HOV3+ assigned volumes on I-95/I-395 general purpose lanes and HOV lanes compared to daily counts (AAWDT)

Loc	GPL OBS	GPL EST	EST/ OBS	HOVL OBS	HOVL EST	EST/ OBS	OBS	EST	EST/ OBS
1	87,000	80,210	92%	21,500	21,490	100%	108,500	101,700	94%
2	82,000	83,060	101%	19,500	19,710	101%	101,500	102,770	101%
3	76,500	72,800	95%	19,000	18,870	99%	95,500	91,670	96%
5	89,500	102,030	114%	16,000	17,190	107%	105,500	119,220	113%
6	82,000	81,850	100%	25,000	19,130	77%	107,000	100,980	94%
7	80,000	83,480	104%	22,000	17,500	80%	102,000	100,980	99%
8	83,000	82,800	100%	21,000	16,620	79%	104,000	99,420	96%
9	82,000	81,980	100%	14,500	15,120	104%	96,500	97,100	101%
10	77,000	69,380	90%	12,000	13,720	114%	89,000	83,100	93%
11	68,500	75,900	111%	12,000	12,420	104%	80,500	88,320	110%
All	80,750	81,350	101%	18,250	17,180	94%	99,000	98,530	100%

Background AM Peak HOV Demand

2010 AM peak period background LOV and HOV3+ assigned volumes on I-395 at Glebe Road compared with AM peak period vehicle classification counts

	OBS	EST	EST/ OBS
SOV	20,275	17,643	87%
HOV2	1,464	544	37%
HOV3+	6,266	3,167	51%
Total	28,005	21,354	76%

- Source: 2010 Performance of High-Occupancy Vehicle Facilities on Freeways in the Washington Region. Washington, D.C.: National Capital Region Transportation Planning Board, 2011.
- AM Peak Period from 6 to 9 AM.

HOV3 Binary Choice Model

- $$HOV3p' = (SOV + HOV2 + HOV3p) * \frac{HOV3p * \exp(-\lambda * (\Delta TT))}{(SOV + HOV2) + (HOV3p * \exp(-\lambda * (\Delta TT)))}$$

$$SOV' = (SOV + HOV2 + HOV3p - HOV3p') * \frac{SOV}{(SOV + HOV2)}$$

$$HOV2' = (SOV + HOV2 + HOV3p - HOV3p') * \frac{HOV2}{(SOV + HOV2)}$$

where:

- SOV, HOV2 and HOV3p are the background trips
- HOV3p' is the adjusted HOV3+ demand based in travel time benefit
- ΔTT is the travel time benefit to using HOV lanes
- λ is the calibration parameter to shift LOV to HOV3+
  - Two sets of λ are calibrated – one $\lambda 1$ for significant travel time benefits, and another $\lambda 2$ for moderate travel time benefits

HOV Model Impacts

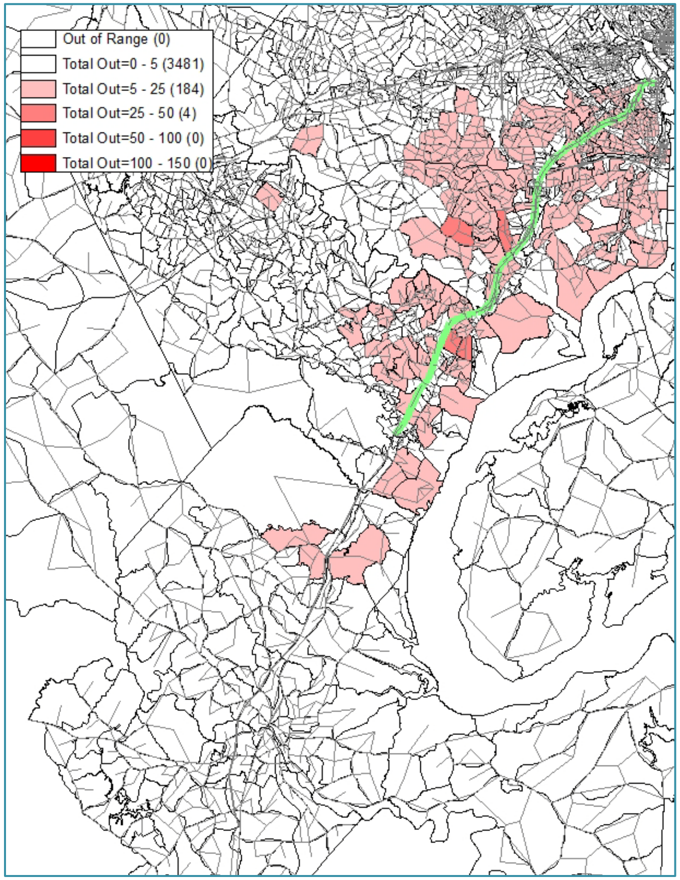
2010 AM peak period volumes on I-395 at Glebe Road based on the HOV model

		Background HOV		Adjusted HOV		Adjusted HOV	
				λ1=0.15 λ2=0.10		λ1=0.20 λ2=0.10	
	OBS	EST	EST/ OBS	EST	EST/ OBS	EST	EST/ OBS
SOV	20,275	17,643	87%	15,152	75%	14,493	71%
HOV2	1,464	544	37%	986	67%	1,128	77%
HOV3+	6,266	3,167	51%	6,541	104%	7,193	115%
Total	28,005	21,354	76%	22,679	81%	22,814	81%

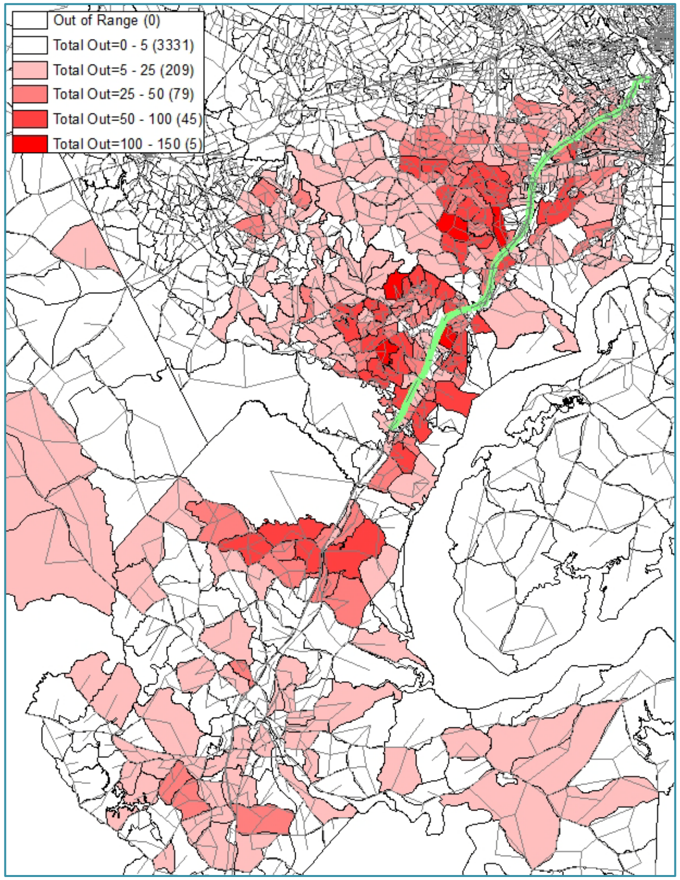
Distribution of HOV Demand

2010 AM peak period Shirley Highway HOV3+ trip origins

Background HOV



Background + HOV Choice



AM Peak Shirley Highway Assignment

2010 AM peak adjusted LOV and HOV3+ assigned volumes on I-95/I-395 general purpose and HOV lanes compared to current MWCOG volumes

Loc	GPL COG	GPL EST	EST/ COG	HOVL COG	HOVL EST	EST/ COG	COG	EST	EST/ COG
1	17,300	17,310	100%	5,690	5,380	95%	22,990	22,690	99%
2	17,910	17,930	100%	5,250	4,910	94%	23,160	22,840	99%
3	16,500	16,430	100%	4,350	4,140	95%	20,850	20,570	99%
5	19,270	18,950	98%	4,060	3,890	96%	23,330	22,840	98%
6	17,260	17,110	99%	3,840	3,760	98%	21,100	20,870	99%
7	17,260	17,110	99%	3,840	3,760	98%	21,100	20,870	99%
8	18,900	18,480	98%	3,650	3,570	98%	22,550	22,050	98%
9	15,930	15,750	99%	3,260	3,220	99%	19,190	18,970	99%
10	14,980	14,650	98%	3,260	3,220	99%	18,240	17,870	98%
11	14,810	14,560	98%	1,760	1,810	103%	16,570	16,370	99%
All	**17,010**	**16,830**	**99%**	**3,900**	**3,770**	**97%**	**20,910**	**20,590**	**98%**

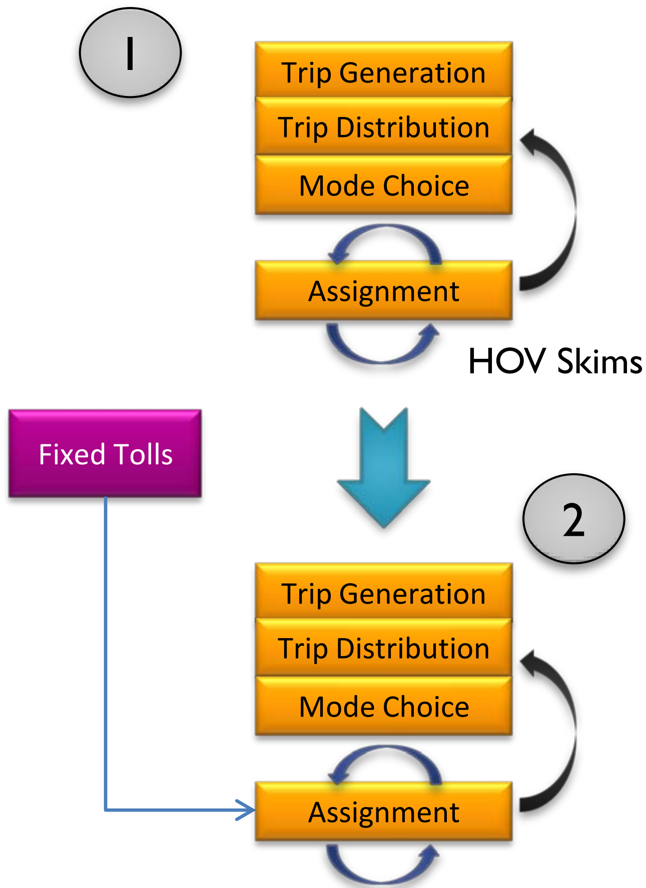
HOV Summary

- A simple HOV choice model was calibrated to achieve desired HOV volumes on HOV facilities
  - Low overall assignment for Shirley Highway prevents estimated HOV volumes from matching counts without estimated LOV volumes being off-target from counts
- Additional count detail required to better calibrate HOV choice model parameters
  - Difference between validation of peak period and daily HOV volumes to be considered in calibration
- HOV choice model is integrated into the overall model stream and with HOT lane modeling

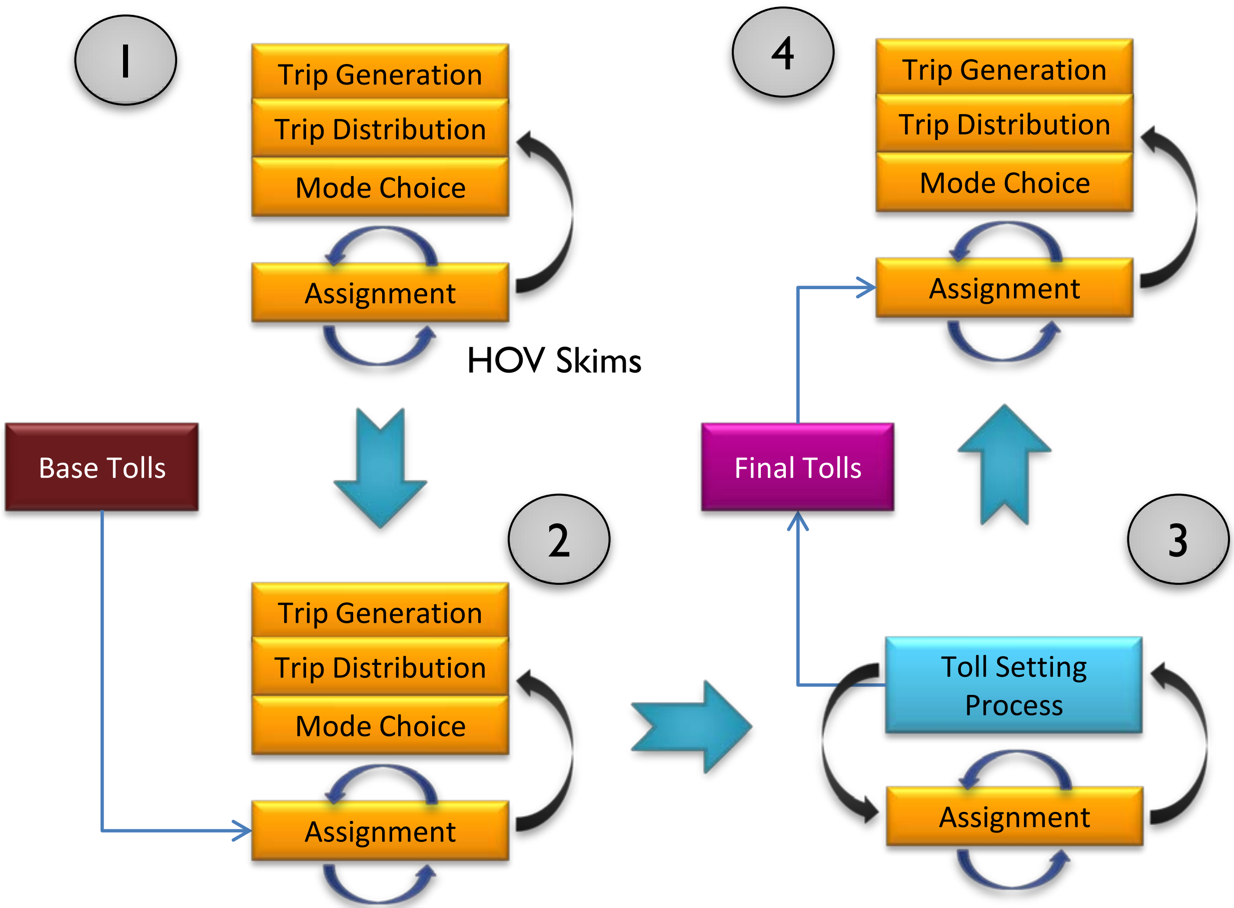
HOT Lane Modeling Goals

- Enhance current highway assignment
  - Replace "two-step" with a full multi-class assignment
    - Utilize proposed HOV modeling
  - Include dynamic toll setting in the standard model
    - Determine HOT lane tolls as part of highway assignment
  - Streamline highway assignment
    - Utilize CUBE cluster efficiently (MDP & IDP)
    - Minimizing repetition of common code
- Improve overall highway assignment runtime

Current HOT Lane Model

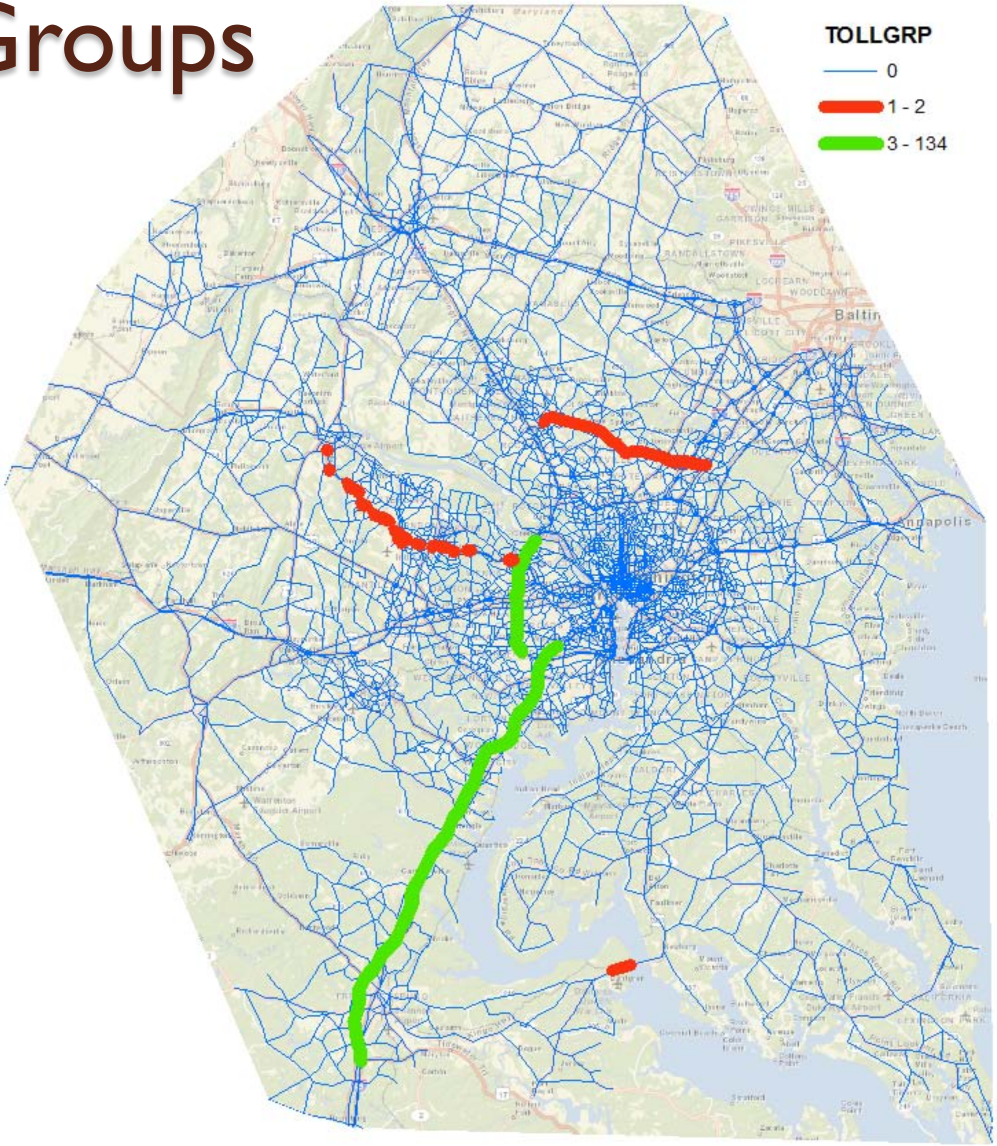


Current HOT Lane Toll Setting



Current Toll Groups

- 134 toll groups
- Two types:
  - Static (red)
  - Dynamic (green)
- Groups formed with contiguous links
- Each is adjusted independently



HOT Lane Modeling Changes

- Current Process
  - Fixed Toll Model
    - Two full model runs

    Total = ~40 hours
  - Toll Setting Model
    - Two full model runs (~40 hours)
    - Toll setting process (~30 hours+)
    - Final full model run (~20 hours)

    Total = 90 hours (~4 days)

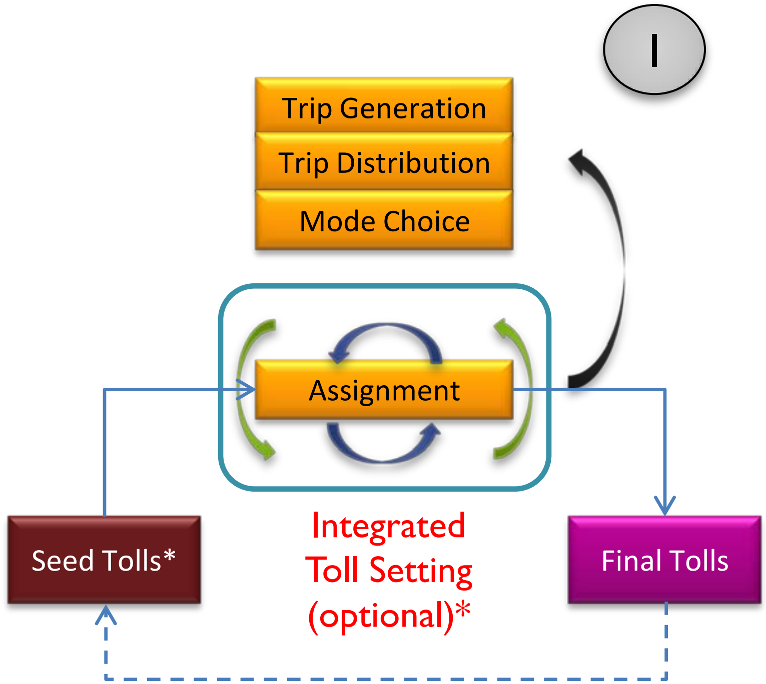
- Proposed Process
  - Fixed Toll Model
    - Single full model run

    Estimated ~1 day
  - Dynamic Toll Model
    - Single full model run
      - "Progressive" gap

    Estimated ~1+ days
  - Full Toll Setting Model
    - Single full model run with enhanced toll-search

    Estimated 2-5 days

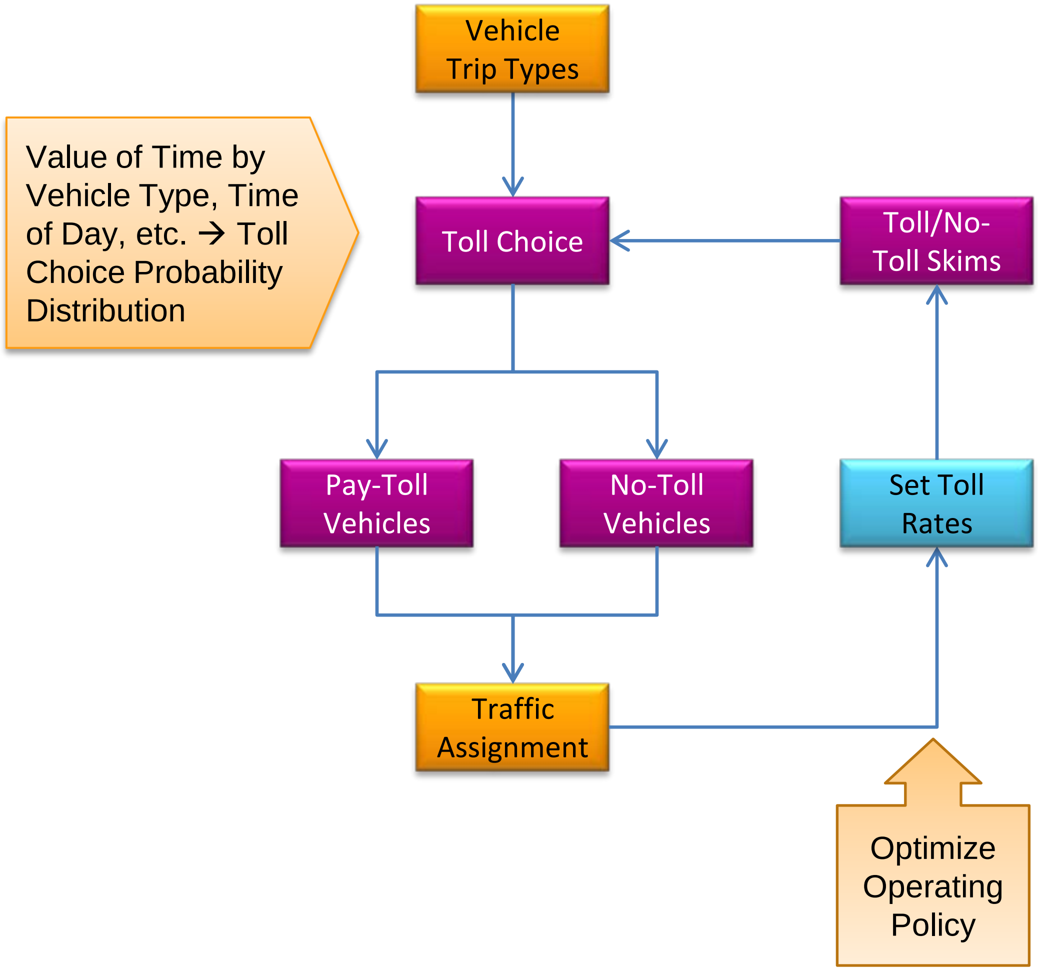
Proposed HOT Lane Model



* Fixed tolls or outputs from the toll setting process of the previous global iteration

* Two levels of toll setting convergence criteria and search methods

Toll Choice in Assignment



Model Runtime Considerations

- Compute-intensive due to iterative toll-setting
  - Each highway assignment takes ~2 hours @ 0.001 gap
    - "Progressive" gap criteria can reduce runtime
- The key factor in toll-setting efficiency:
  - Minimize optimal-toll search loops
    - Limit number of loops
    - Use good starting "seed" tolls
    - Smart logic
    - Protect against infinite loops
    - Aggregate toll groups
      - Reduce combinations to evaluate

TRNBUILD to PT Conversion

- Background
  - Evaluated issues in converting from TRNBUILD to PT
  - Developed scripts to convert TRNBUILD routes to PT
  - Tested PT procedures for generating access links
- Recent Progress
  - MWCOG converted the TRNBUILD routes to PT
    - Added transit-only links to the highway network
  - Implemented PT Generate processes to develop walk access, P&R access and K&R access links
  - Compared PT generated paths with TRNBUILD paths

Key Differences

TRNBUILD	PT
Station nodes and links are part of a transit-only network	Station nodes and links are part of a single multi-modal network
Transit-only nodes and links (LINK, SUPPLINK, XY data) added during path-building	Transit-only nodes and links are part of the master network
Transit paths are a series of links between origin and destination zones	Transit paths are a set of legs between transit stops or between a transit stop and a zone centroid
Paths may include multiple non-transit links	No consecutive non-transit legs in a path

Path Differences

- TRNBUILD
  - Zone X to Node Y using Mode 16 link
  - Node Y to Node Z using Mode 13 link
  - Node Z to Station A using Mode 12 link
  - Station A to Station B using Route X
  - Station B to Station C using Mode 12 link…
- PT
  - Zone X to Station A using Non-Transit Leg E
    - walk path from X to A using "E" constraints
  - Station A to Station B using Route X
  - Station B to Station C using Non-Transit Leg F
    - Walk path from B to C using "F" constraints

Generating Non-Transit Legs

- PT Generate statement builds non-transit legs between zones and stops using "permitted" links
  - Walk access legs
    - Zone centroids to bus stops using links that permit walking
    - Zone centroids to stations…
    - Bus stops to stations…
    - Bus stops to bus stops…
  - Kiss-n-Ride access legs
    - Zone centroids to stations using auto links and travel times
  - Park-n-Ride access legs
    - Zone centroids to stations passing through a park-n-ride lot

Station Connection Options

- Need to connect Metrorail and commuter rail stations to the highway/transit network
  - Manual Coding
    - One-time task, ensure feasibility of connector links
  - Connect each station to the station centroid
    - Only one connection, may not be appropriate for walk access
  - Connect stations to nearest "N" nodes
    - Spatial analysis does not consider physical barriers
  - Recode existing access generation programs to output data in PT network format
    - Contrary to the "spirit" of PT

Next Steps

- HOV model
  - Document the results and propose additional data collections for calibration purposes
- HOT lanes model
  - Implement additional process performance tests
  - Propose a reduced number of toll groups
- PT conversion
  - Connect stations to the highway network
  - Develop scripts to generate "useful" non-transit leg modes (e.g., walk, PNR, KNR, bus-rail transfer, etc.)