



Traffic Assignment – Toll Modeling

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2013 Task Orders (** today's topic)

- 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

Presentation Outline

1. HOT Lane Modeling Goals
2. Proposed Toll Modeling Design
 - a) Design Considerations
 - b) Details
 - c) Observations
3. Next Steps

HOT Lane Modeling Goals

- Enhance current highway assignment
 - Replace “two-step” with a single, multiclass 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

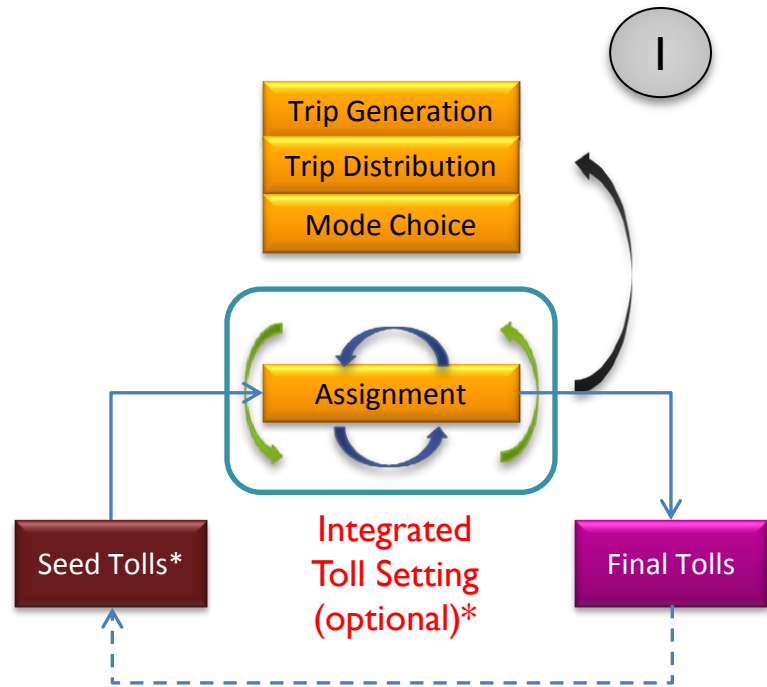
Development Platform

- Version 2.3.48
- 2020
- 8-core CPU (quad core with hyper threading)
- Cube Voyager 6.0.2
 - Latest release - Cube Voyager 6.1.0 SPI, has changes to Bi-Conjugate Franke Wolfe assignment process

Acknowledgement

- Current toll-setting procedures developed by TPB staff by JC Park were modified and adapted.

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

Design Considerations

- **User controlled options**
 - Disable toll-setting
 - Disable MDP/IDP
 - Specify precision in toll-search
- **Computational efficiency**
 - Minimize runtime with toll-setting
- **Streamline script**
- **Follow “best practices”**
 - Slave/master node format
 - Move FUNCTIONS & LW variables to ADJUST phase

Highway Assignment Script Overview

- **Cube Cluster (MDP) (optional)**
 - AM & NT
 - PM & MD
- **Cube Cluster (IDP) (optional)**
 - Toll / Non-Toll skims
 - Assignments
- **Bi-Conjugate Franke Wolfe assignment process**
 - Relative Gap = 0.001 or 300 Iterations
 - AM ≈ 195+ iterations, PM ≈ 150+, MD ≈ 45+, NT ≈ 15

Highway Assignment Script Steps

- Step 1: Read (seed/revised) toll file
- Step 2: Update tolls on all links
- Step 3: Split trips into Toll and Non-Toll
 - Only done once
 - Write out toll / non-toll skims (distance, toll, time)
- Step 4: Full multiclass assignment
- Step 5: Compute restrained speeds
- Step 6: Copy network
- Step 7: Summarize and adjust tolls
 - Create revised toll file
- Step 8: Toll setting termination check
 - Go to step 1 if criteria not met

Toll Setting Overview

- Step 1: Compute toll-group ($id > 2$) average v/c (no rounding)
- Step 2: For each toll-group, set new tolls (lower or higher)
 - Default flags
 - Helps avoid infinite loops
 - Non-linear function to raise tolls if $rounded\ V/C < threshold$
 - $New\ Toll = Old\ Toll + \{constant * LN((abs(V/C\ difference)) + constant2)\}$
 - Helps reduce number of toll loops
 - Linear function to lower tolls if $rounded\ V/C > threshold$
 - Dampens any potential oscillations
 - Round tolls
 - Helps reduce number of toll loops
 - Check if new tolls are different
 - Check against toll cap/floor
- Step 3: Save toll file
 - Flag = '1' if no-more trials required; Flag = '0' if more loops required

Toll Setting Termination Criteria

- Stop if all toll-groups have flags = '1'
 - Tolls are not effectively changing
- Maximum number of tries (default = 100)

Changes from a User's Perspective

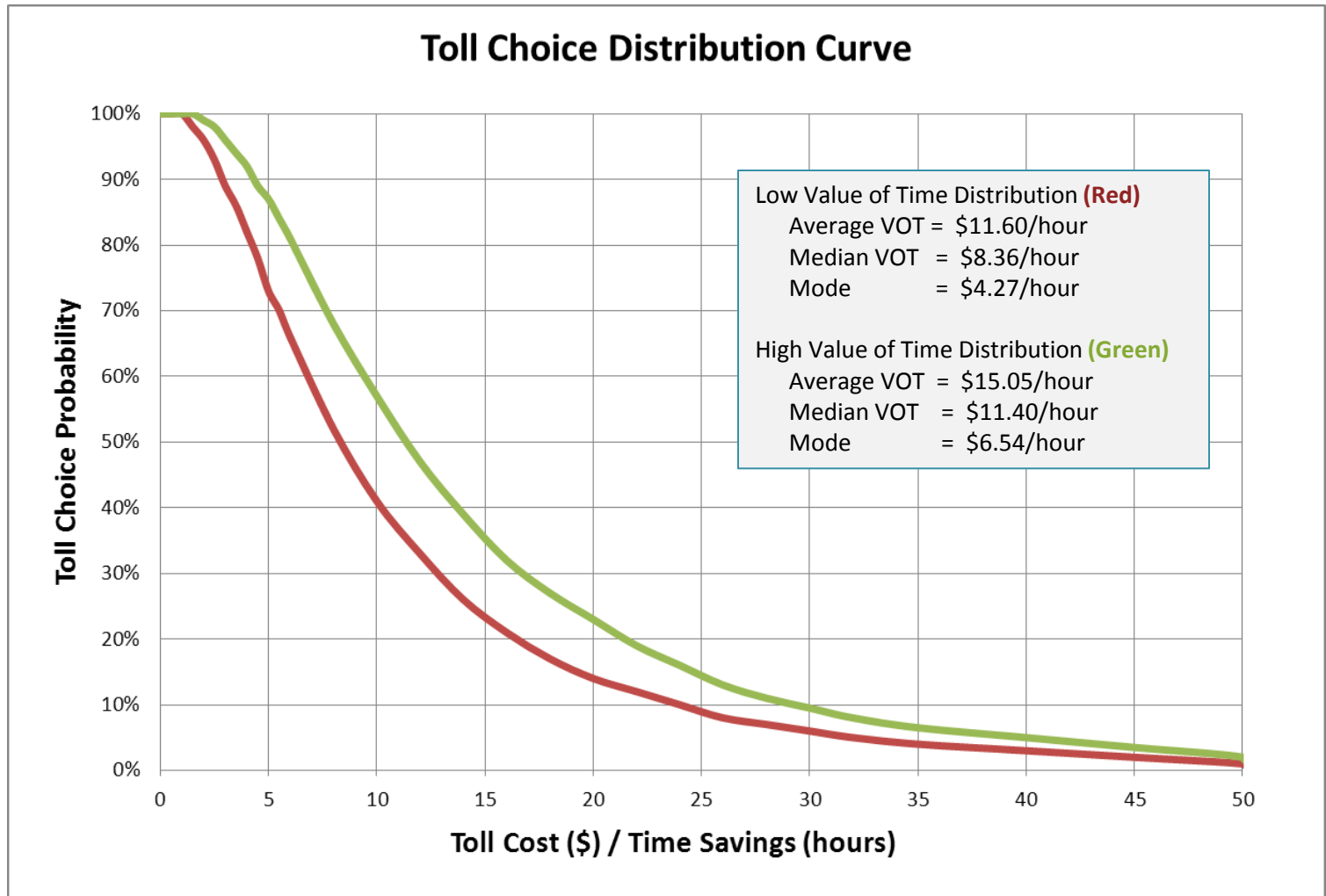
- **Batch files**
 - **Wrapper batch file**
 - Both 'AMsubnode' and 'MDsubnode' start from 1
 - **Model steps batch file**
 - Enable/Disable Toll Setting
 - Enable/Disable VOT Distribution
- **Highway_Assignment_Parallel.s - partitioned**
 - **Broken into six files to avoid code repetition**
 - Common code is loaded with 'READ FILE' statements
- **Seed tolls**
 - **Seed tolls are read from inputs**
- **Value of Time distributions (Toll Choice Probability)**
 - **Are coded in the highway assignment script as lookups**

Toll File Format

- Contains cents-per-mile toll *rates*
- Posted on links as per-link toll in cents

TOLLGROUP	TOLLGROUP	TYPE	OLD TOLL	NEW TOLL	SPEED	V/C	VMT	DIFF	FLAG
3	3	0	0	0	0	0	0	-1.01	1
4	4	0	0	0	0	0	0	-1.01	1
5	5	0	0	0	0	0	0	-1.01	1
6	6	1	35.916	35.916	28.3924	1.0127	1942.74	0.0027	1
7	7	1	20	20	51.3802	0.8853	1443.63	-0.1247	1
8	8	1	35.916	35.916	28.3924	1.0127	5002.55	0.0027	1
9	9	1	20	20	60.2045	0.6919	5575.11	-0.3181	1
10	10	1	20	20	62.7329	0.5063	3399.79	-0.5037	1
11	11	1	20	20	53.907	0.8455	24087.33	-0.1645	1
12	12	1	20	20	62.7329	0.5063	874.23	-0.5037	1
13	13	1	23.1327	23.1327	29.5429	1.0088	11224.5	-0.0012	1
14	14	1	20	20	63.6907	0.3618	1977.94	-0.6482	1

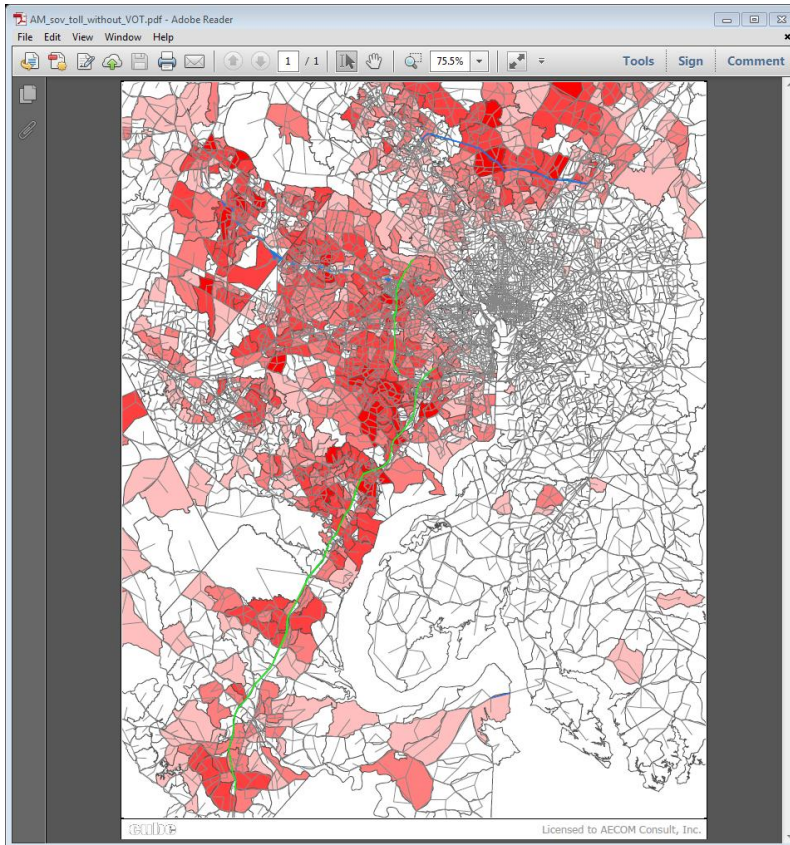
Toll Choice Probability (=VOT)



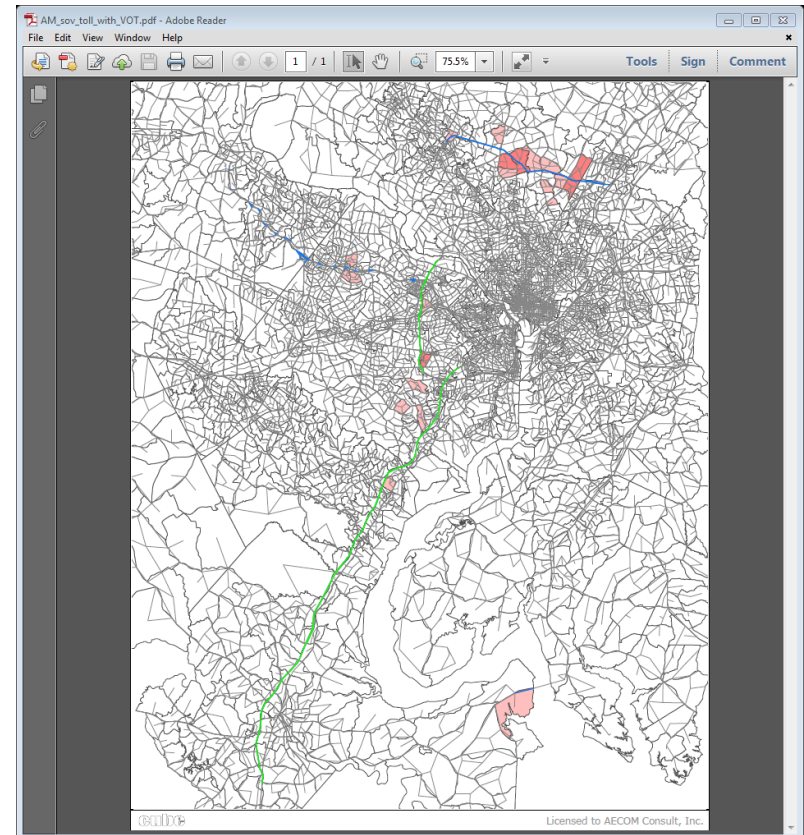
Observations

- Toll-setting is most efficient when provided with good seed tolls
- Assignments are very sensitive to input value of time distributions as seen in following images

Distribution of SOV Toll-based Time Savings:AM

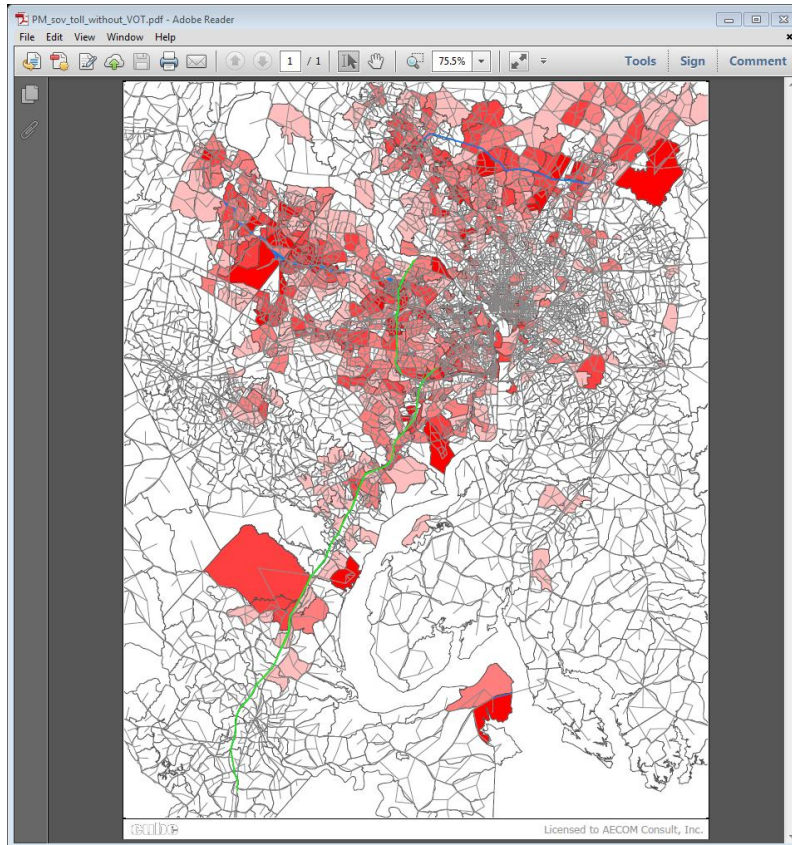


All SOV trips with time-savings

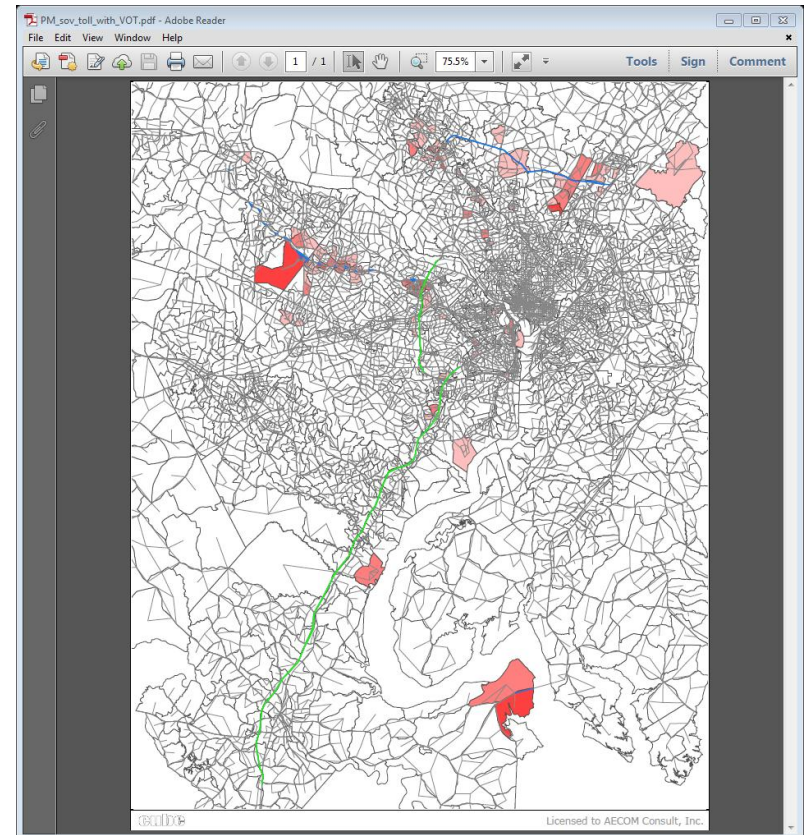


After Toll Choice Probability

Distribution of SOV Toll-based Time Savings: PM

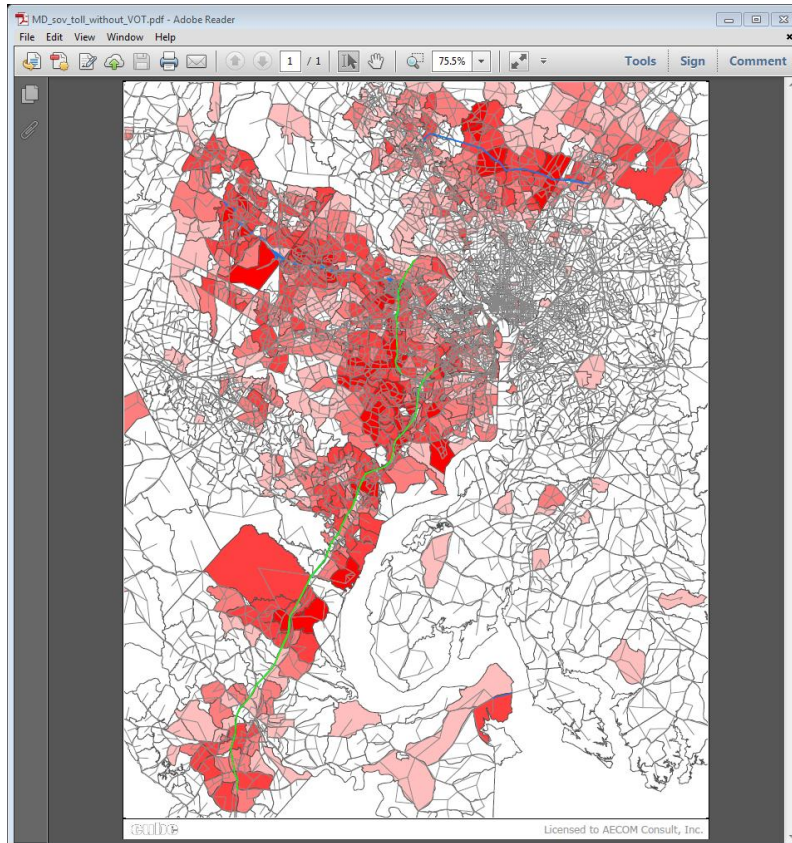


All SOV trips with time-savings

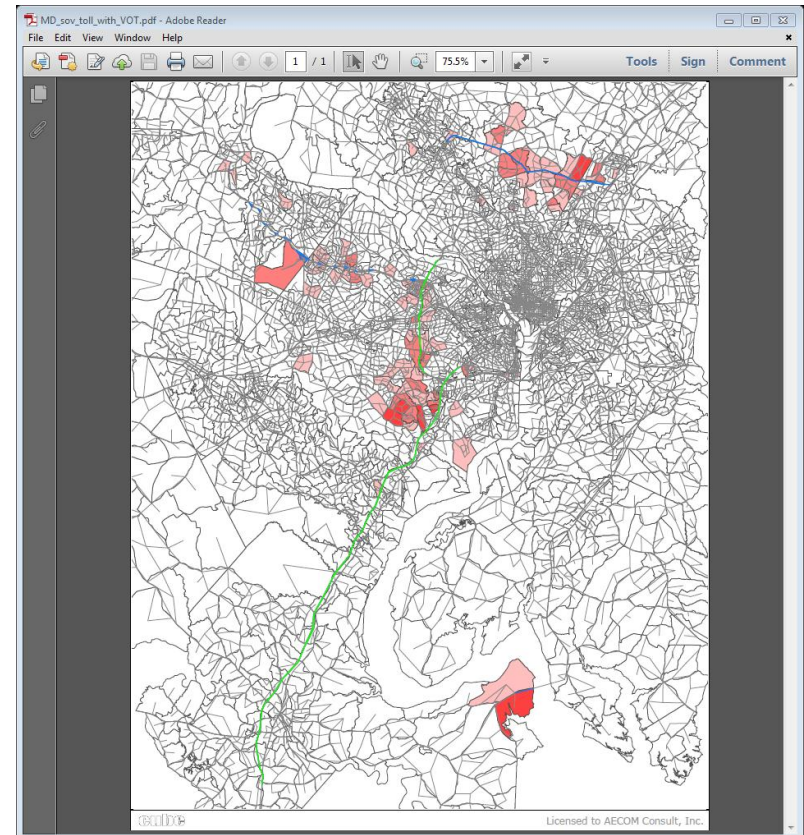


After Toll Choice Probability

Distribution of SOV Toll-based Time Savings: MD

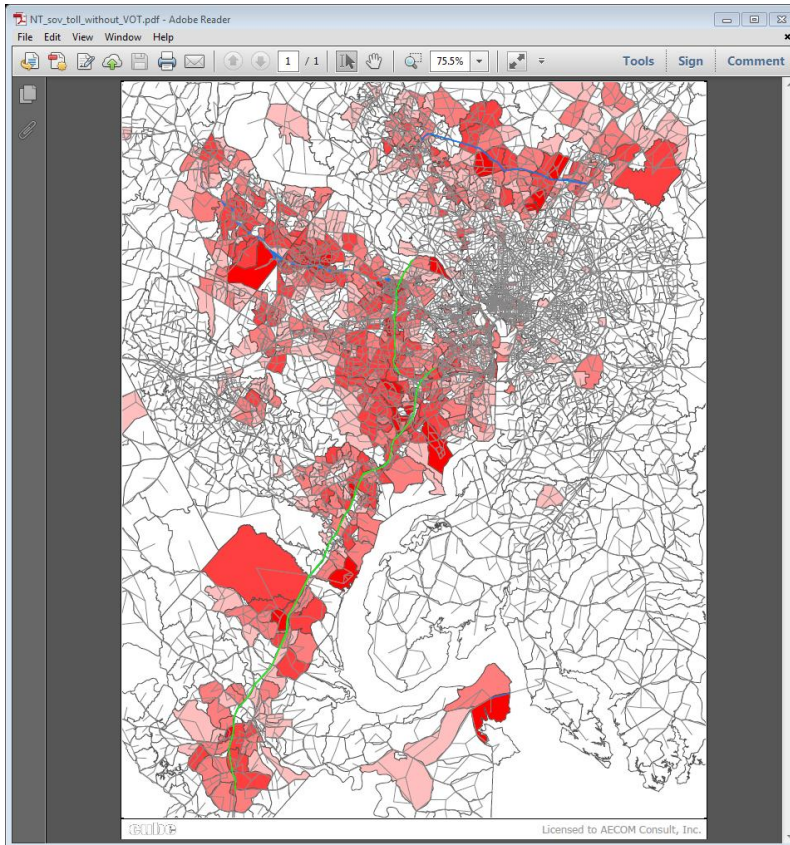


All SOV trips with time-savings

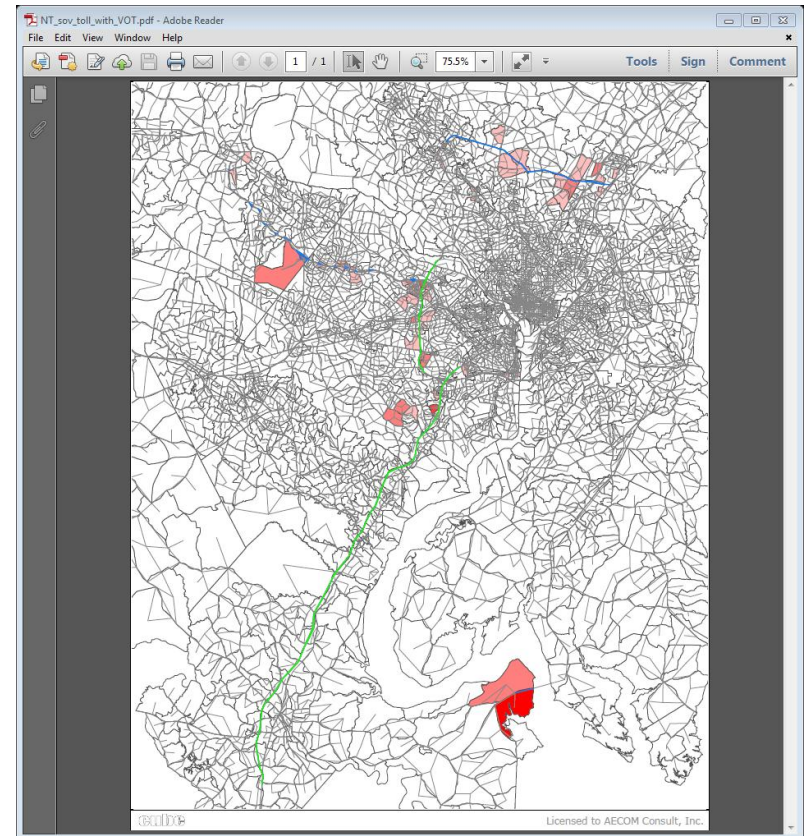


After Toll Choice Probability

Distribution of SOV Toll-based Time Savings: NT



All SOV trips with time-savings



After Toll Choice Probability

Next Steps

- **HOT lanes model**
 - Complete full performance tests with
 - Latest release: Cube Voyager 6.1.0 SPI
 - Reduced Toll Groups
 - “Progressive” Convergence