Item #5

Traffic assignment convergence testing

Presentation to the TPB Travel Forecasting Subcommittee

May 18, 2012

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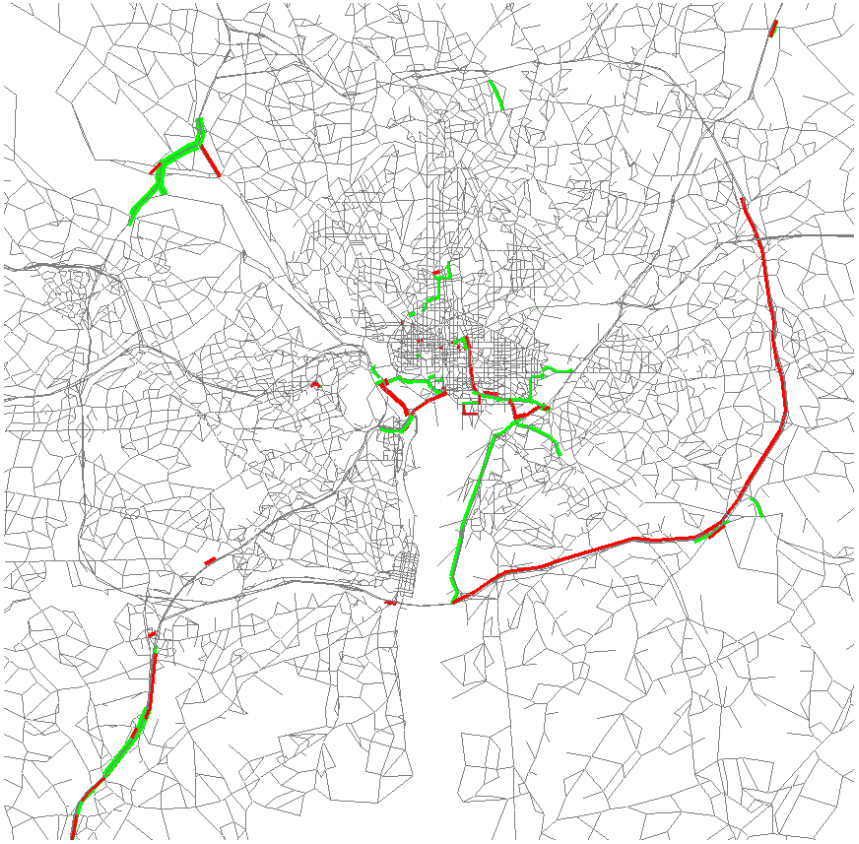
Background

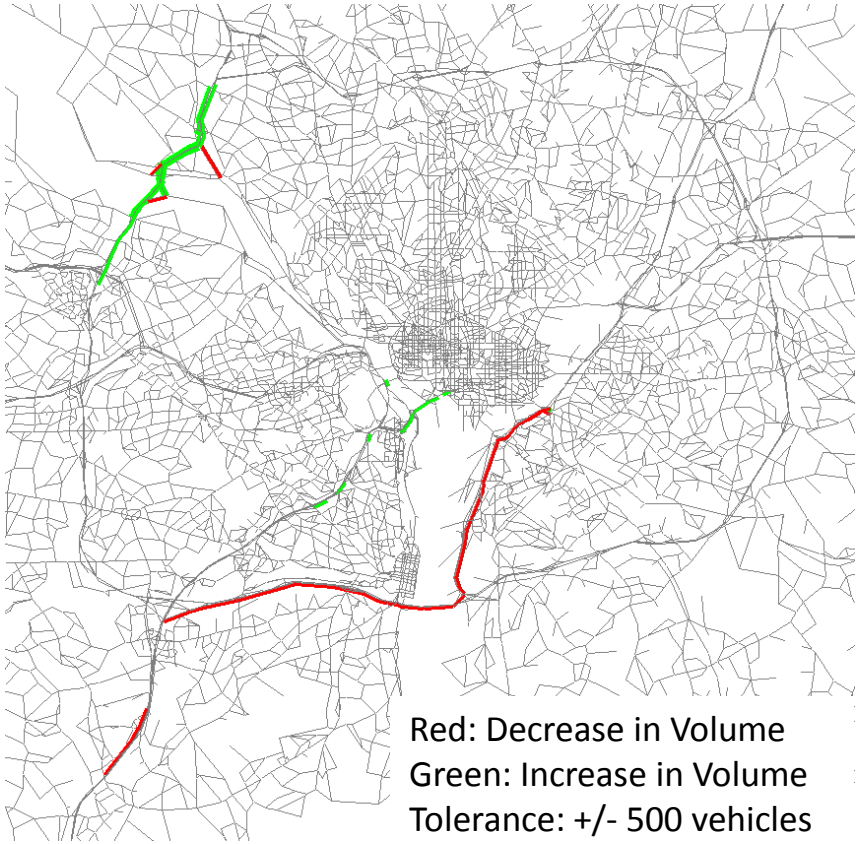
- The existing V2.3 traffic assignment convergence criterion for regional analysis is:
  - 10^{-3} relative gap OR 300 user equilibrium iters.
- TPB staff has found that a higher level of convergence will improve the ability to study corridor and project planning alternatives
- Previous testing has indicated that a relative gap value of 10^{-4} would substantially improve the analysis of alternatives at the project planning level
- Convergence levels must be set with practical computation times in mind

Addition of Lanes to American Legion Bridge

Relative gap: 10^{-3}



Relative gap: 10^{-4}

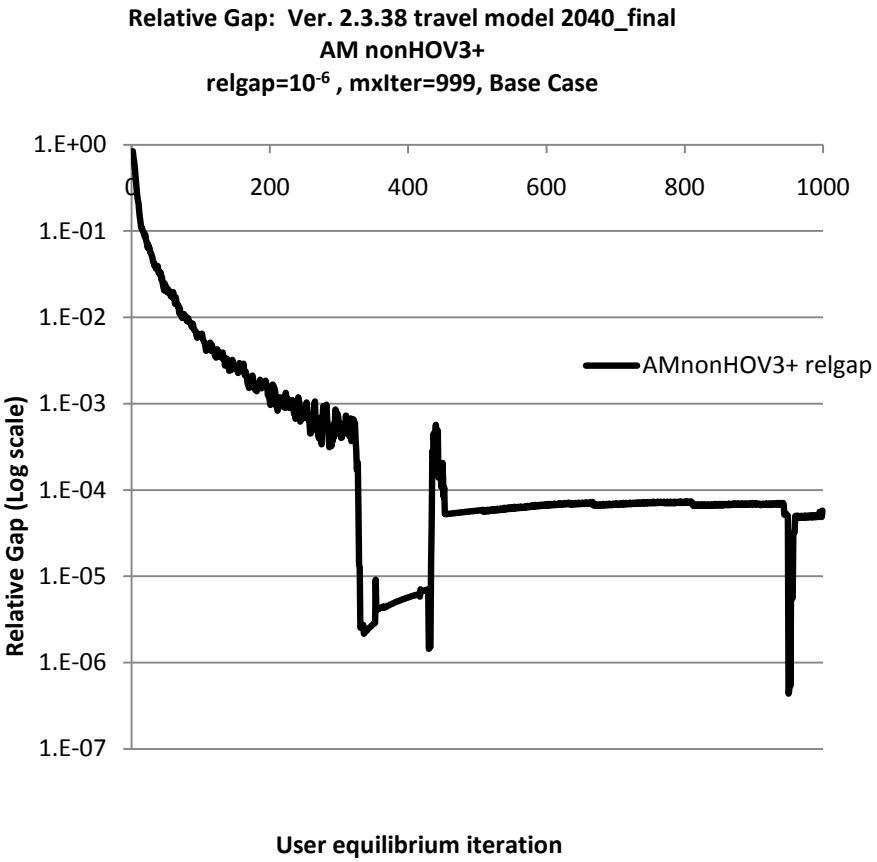


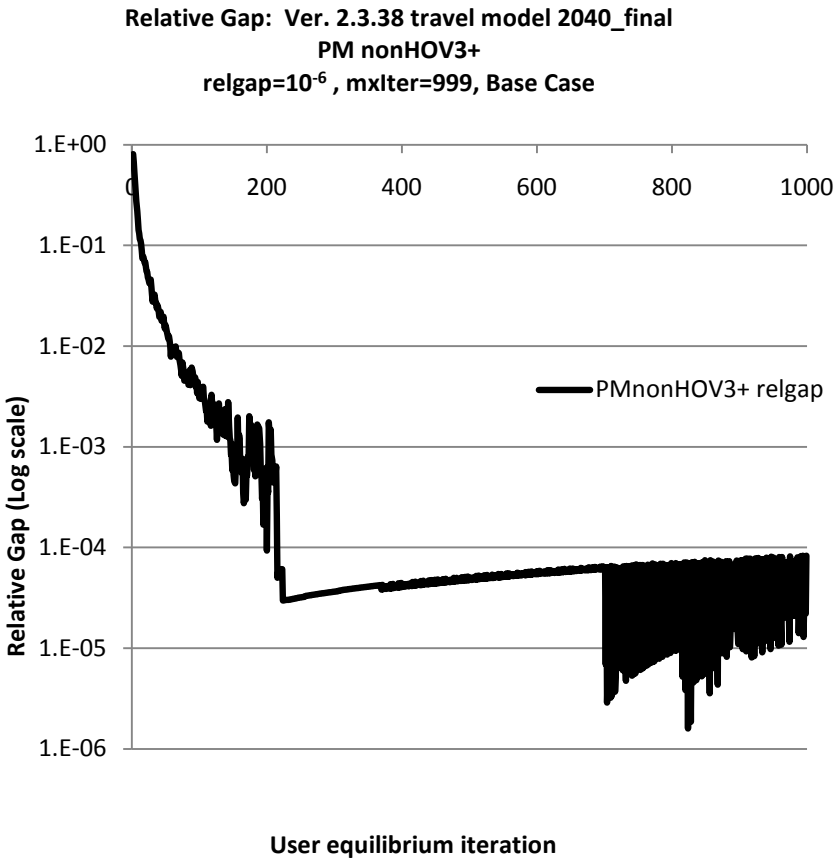
Red: Decrease in Volume
Green: Increase in Volume
Tolerance: +/- 500 vehicles

Background

- While calibrating Version 2.3 Travel Model, staff noted odd behavior in the relative gap plots for cases where relative gap was set lower than 10^{-3}
- The relative gap function was observed to:
  - Flatline
  - Increase
  - Exhibit large fluctuations
- Gap parameter would sometimes drop to zero

Examples of Odd Relative Gap





October 2011

- TPB staff first initiated communication with Citilabs regarding convergence issues in October 2011
- In December, TPB staff transmitted a stand-alone highway assignment process from the Version 2.3.34 model and asked Citilabs to investigate the issues of
  - Gap values of zero
  - Fluctuations on the relative gap values

December 2011

- Citilabs responded that:
  - The observed zero values of the gap parameter occur due to limitations in software precision
  - The plateau observed in the relative gap graph corresponds to a solution that is very close to equilibrium, which cannot be improved
  - They did not see the relative gap parameter increase during their tests
  - It may be helpful to explicitly define the COST function in the highway assignment and to replace the VDF lookup table with a functional form
- In addition, they provided relative gap plots from their runs

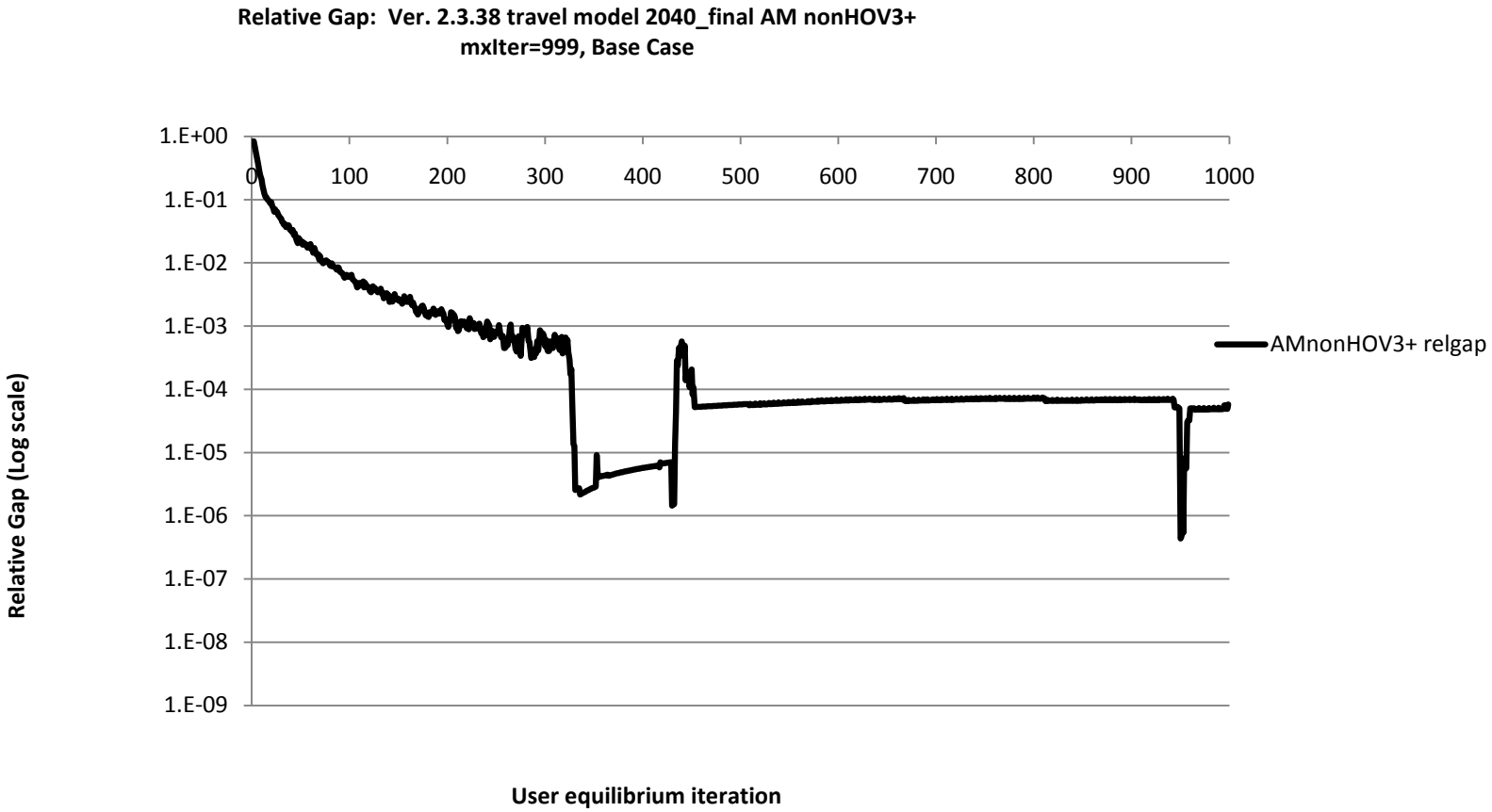
March 2012

- TPB staff noted that the relative gap plots in the Citilabs' response did not match those obtained by running the transmitted Version 2.3.24 and conveyed their concerns to Citilabs via an e-mail on March 14, 2012
- TPB staff transmitted
  - Traffic assignment process extracted from the Version 2.3.38 model
  - Plots showing the relative gap
  - Instructions on how to replicate the relative gap plots
- TPB staff requested that Citilabs replicate the results and transmit the scripts implementing any suggestions that Citilabs staff make

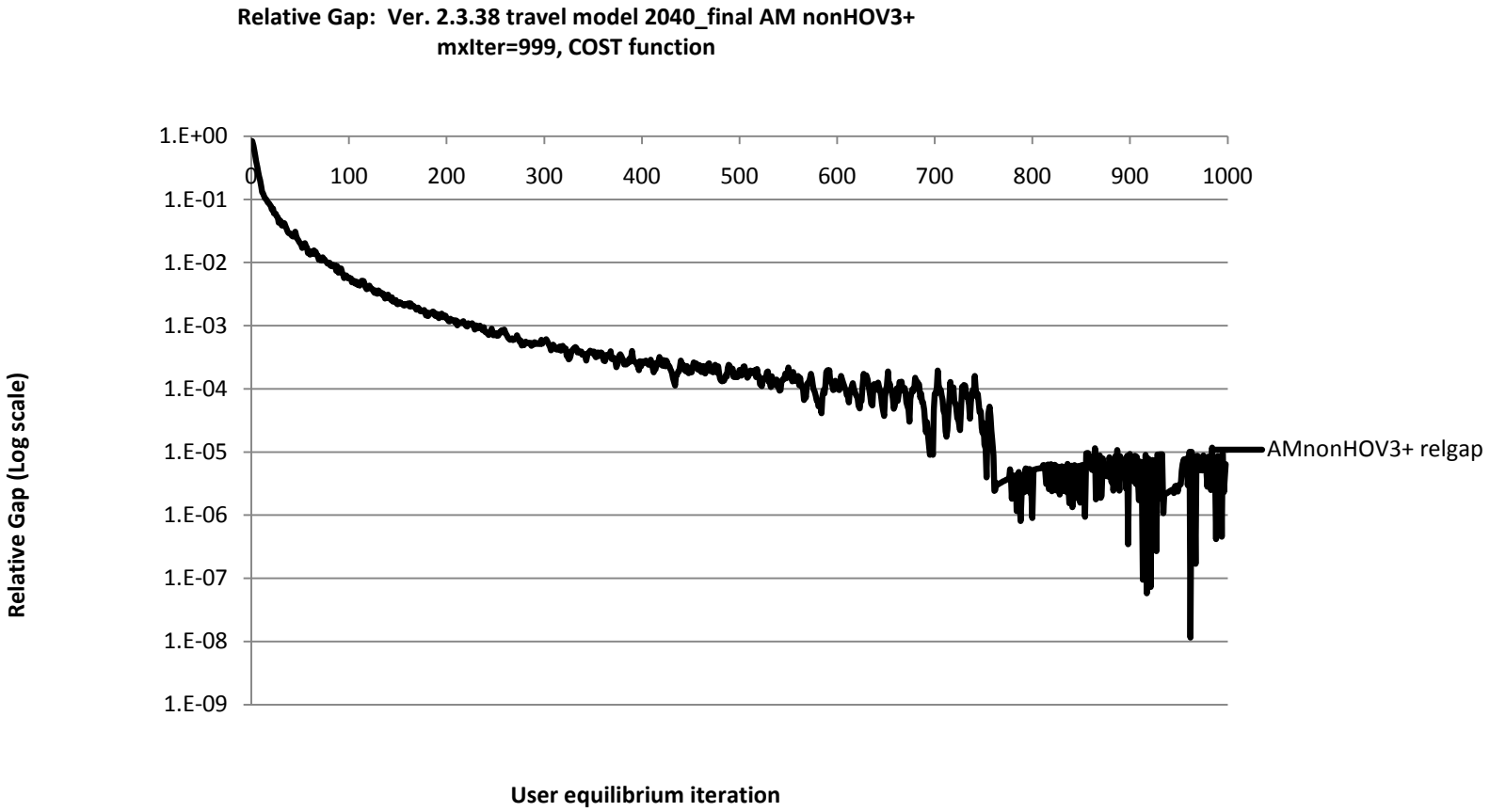
March 2012

- Citilabs replicated the results and made the following suggestions:
  - Explicitly define COST function in the highway assignment
  - Calculate tolls before the assignment process instead of in the LINKREAD phase of each assignment
  - Change the VDF from a lookup table to a functional form
- TPB staff tested all the aforementioned suggestions by executing the Version 2.3.38 model with a maximum number of user equilibrium iterations set to 999

Base Case

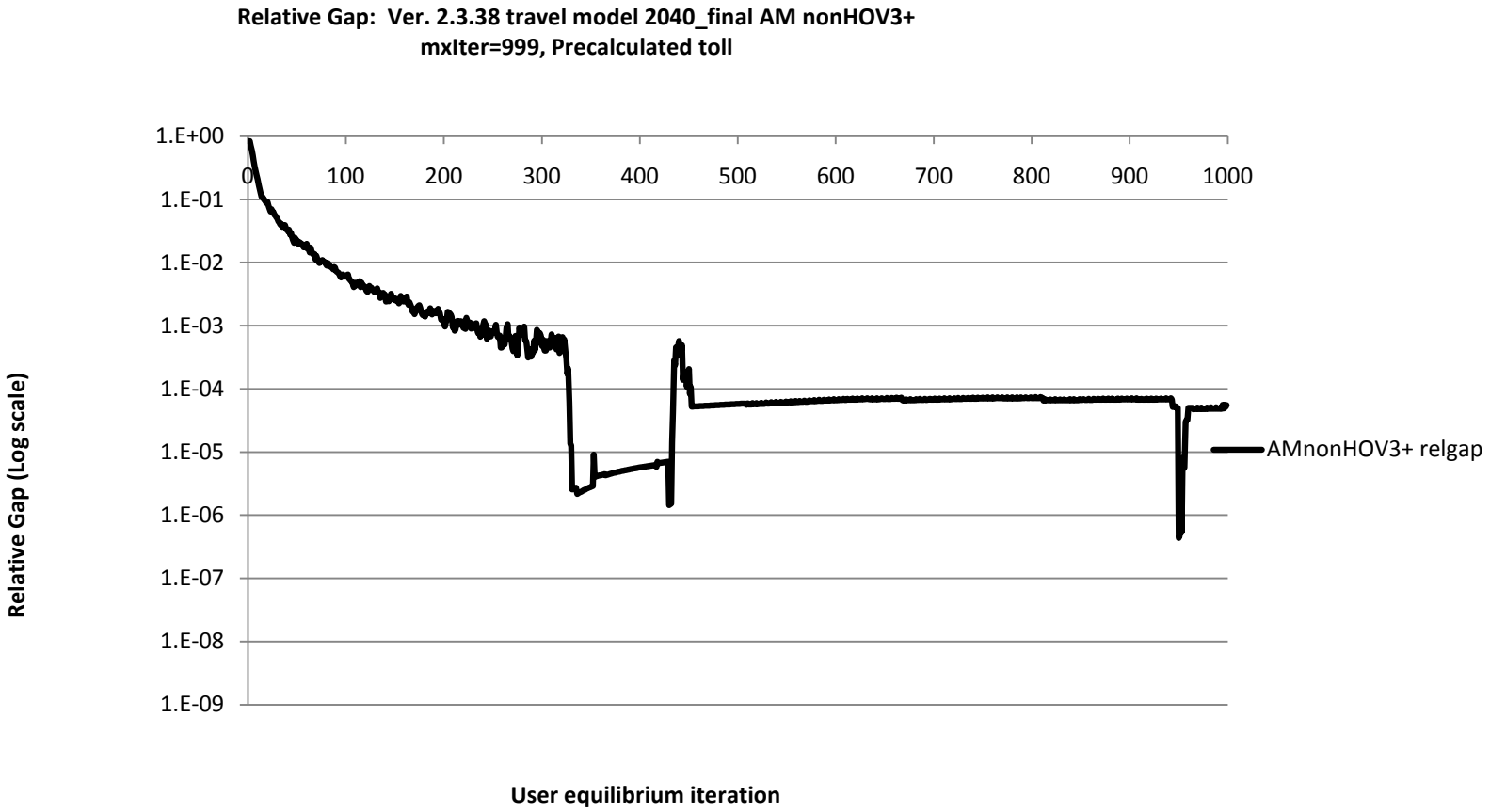

Relative Gap: Ver. 2.3.38 travel model 2040_final AM nonHOV3+ mxIter=999, Base Case
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
0
100
200
300
400
500
600
700
800
900
1000
AMnonHOV3+ relgap
Relative Gap (Log scale)
User equilibrium iteration

Base Case with COST Function



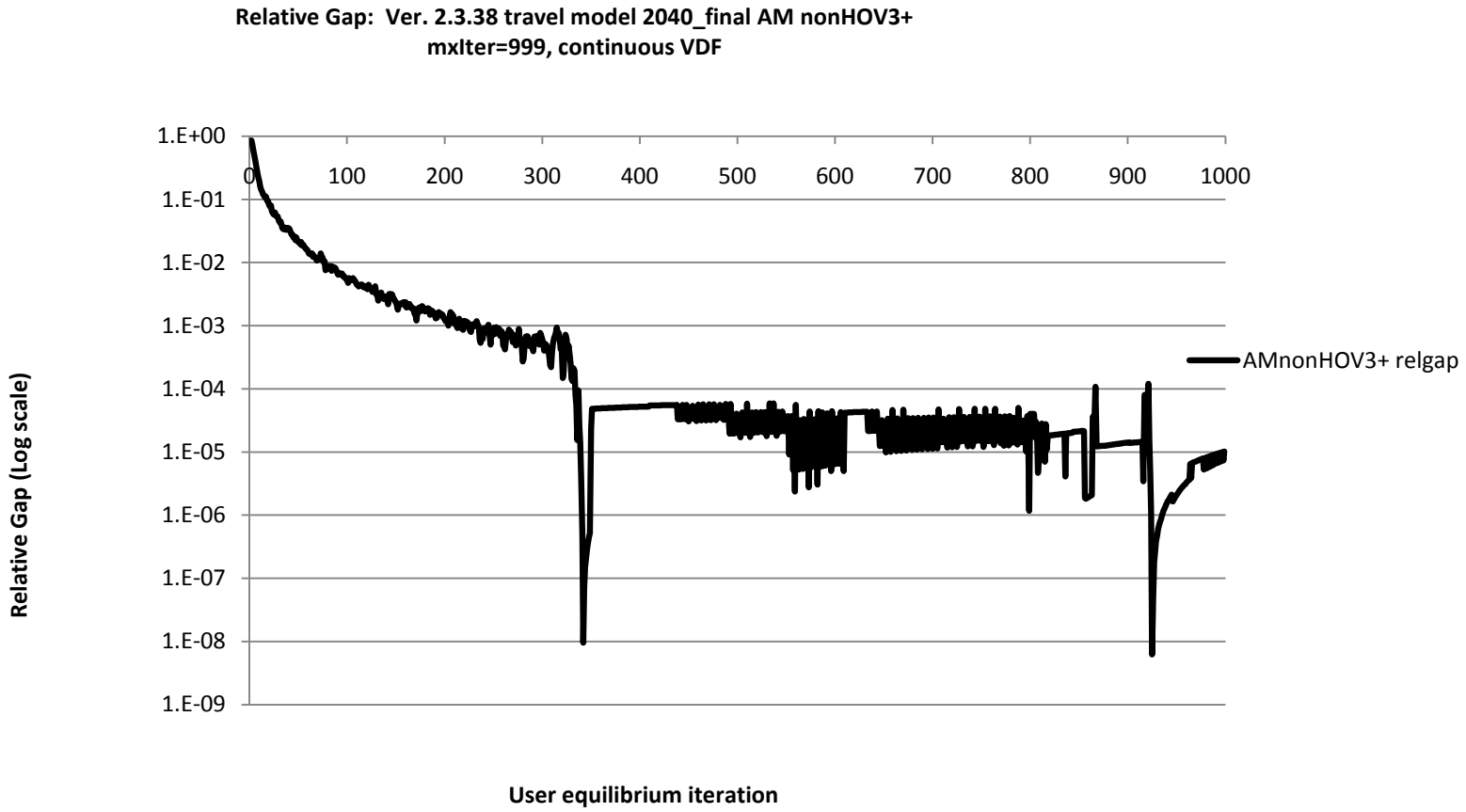
The assignment appears better converged than in the Base Case

Base Case with Pre-calculated Tolls



Relative gap profile identical to the Base Case

Base Case with Continuous VDF



Convergence is not better than in the Base Case

Testing Results- COST Function

- Adding the COST function improves convergence pattern
- However, it also increases run times

#	Run	Run time (4 cores)
1	Base case (existing Ver. 2.3.38 process)	30:55:43
2	Base Case + COST	48:49:06
3	Base Case + Pre-calculated toll	29:57:28
4	Base Case + Continuous VDF	35:20:45

Testing Results- Pre-calculated Tolls

- Pre-calculating tolls does not reduce run times significantly
- Pre-calculating tolls changed the relative gap profile for two of the six assignments including AM HOV3+ and PM HOV3+, which is unexpected

Testing Results- Continuous VDF

- Moving from a VDF lookup table to a continuous form of the VDF did not dramatically change traffic assignment convergence
- Implementation of a continuous VDF increased run times by 15%

Conclusions

- TPB will continue to use a relative gap of 10^{-3} for regional analyses and will consider a relative gap of 10^{-4} for project planning
- TPB plans to implement the COST function in order to achieve better convergence for project planning studies
- Suggestions regarding pre-calculating tolls and moving to a continuous VDF will not be acted upon
- TPB is still using Cube 5.1.3. It's possible that once Citilabs changes the software to a 64-bit platform, precision will improve and the convergence profile will improve