TASK 4: MODEL PERFORMANCE ENHANCEMENTS

MWCOG TPB Version 2.3.28 Travel Model

November 17, 2011

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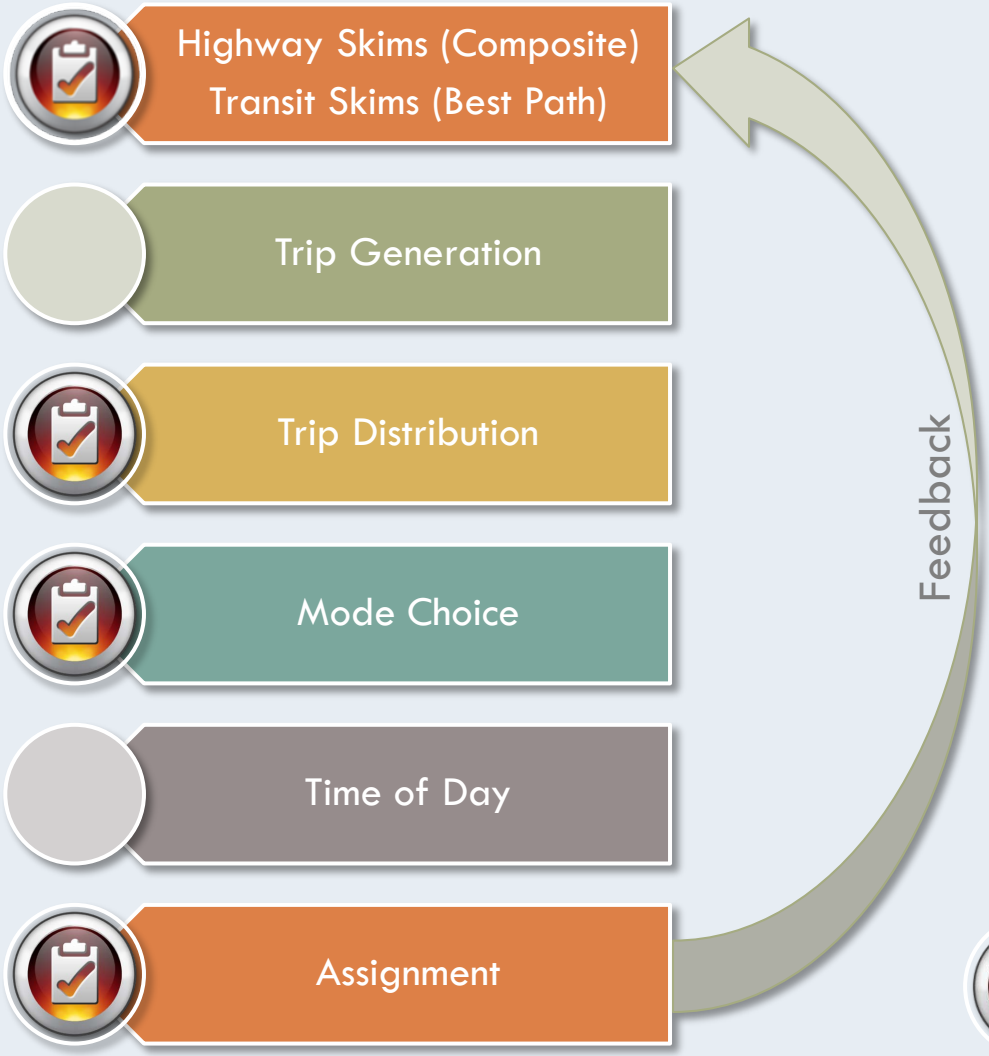
Objective / Status

- Objective: evaluate strategies designed to reduce the clock time for the TPB Version 2.3 Travel Model
  - Take full advantage of multi-core computing and the Cube Cluster software
  - Consider changes to the modeling methods that generate the required outcome with fewer processing steps
- Status: these are preliminary findings that have not been fully tested or evaluated by MWCOG
  - Additional strategies have been suggested, but not as yet implemented

Agenda

- Model processes identified for parallelization
- How to parallelize?
- Implementation
  - Are the results different?
  - Is the model (UE) convergence different?
  - Can we capture on-screen output?
- Quantification of time savings
- Further enhancements

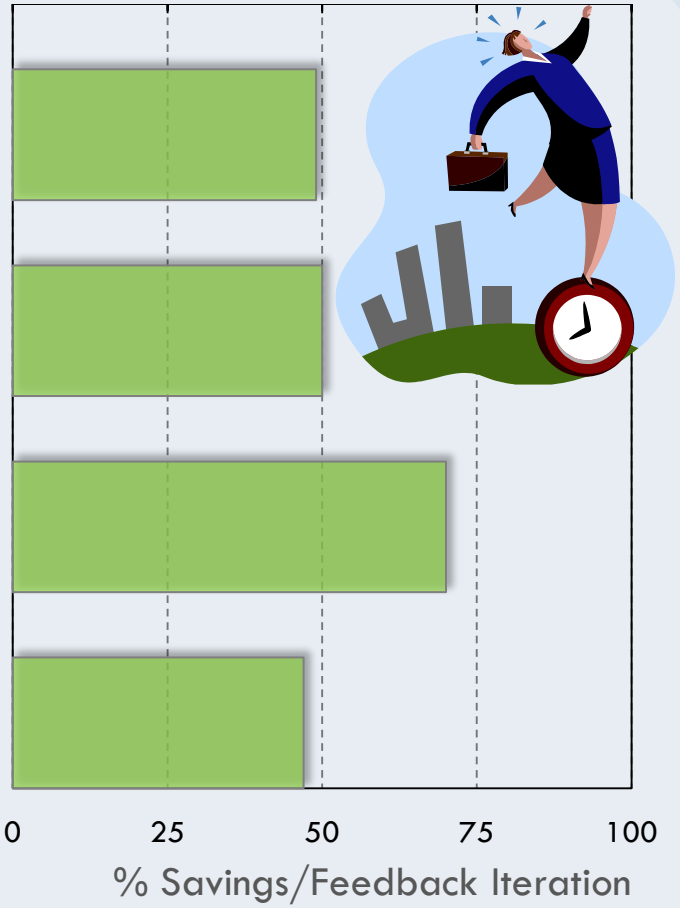
Model Processes



Identified for parallelization

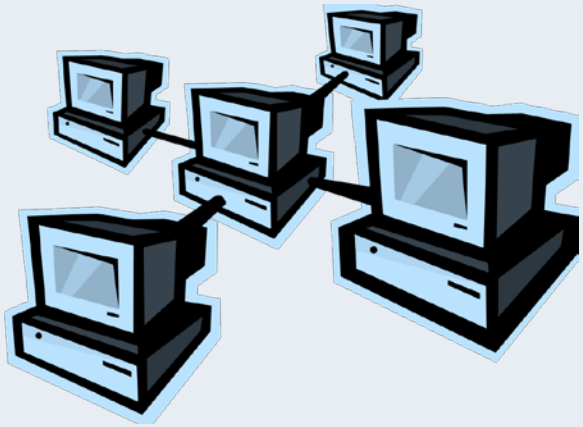
Steps Identified for Parallelization

- Highway and Transit Skims
  - Process time periods together
- Trip Distribution
  - Process trip purposes together
- Mode Choice
  - Process trip purposes together
- Highway and Transit Assignment
  - Process time periods together
  - Combine non-HOV and HOV



~40% Savings for all steps

Highway Skims



- Periods (2)
  - AM, MD
- Steps
  - Highway Skim, Matrix manipulation
- Performance enhancements
  - Multi-step (2) distributed processing for time periods
  - Intra-step (4) distributed processing within time periods
- Time savings
  - About 40% = 3 minutes/feedback iteration

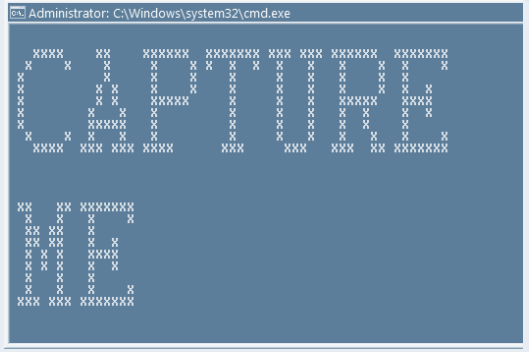
Transit Skims

- Periods (2)
  - AM, MD
- Line-haul paths (4)
  - Metrorail, commuter rail, all bus, bus & Metrorail
- Transit access modes (3)
  - Walk, park-&-ride, kiss-&-ride
- Performance enhancements
  - Parallelize processing for each line-haul path
- Time Savings
  - About 50% = 30 minutes / feedback iteration

Trip Distribution

- Trip purpose groups (5)
  - HBW, HBO, HBS, NHW/NHO, COM/TRK
- Steps
  - Trip Distribution, matrix manipulation
- Performance enhancements
  - Multi-step (4) distributed processing for purposes
    - COM/TRK distribution not parallelized
  - Intra-step (4) distributed processing within purpose
    - Only the matrix steps can use intra-step processing
- Time savings
  - About 50% = 7 minutes / feedback iteration

Mode Choice



- Trip purposes (5)
  - HBW, HBO, HBS, NHO, NHW
- Performance enhancements
  - Parallel processing (5) for trip purposes
- Issues / solutions
  - Capturing on screen output
  - Output to intermediate file, append to master log file
  - Error trapping through batch file scripting
- Time savings
  - About 70% = 35 minutes / feedback iteration

Highway Assignment

- Periods (4)
  - AM, MD, PM, NT
- Steps
  - Highway assignment, convergence checking
- Performance enhancements
  - Combine non-HOV and HOV
  - Run AM, PM together using multi-step (2) distributed proc.
  - Run MD, NT together using multi-step (2) distributed proc.
  - Intra-step (4) distributed processing already implemented
- Time savings
  - About 40% = 45 minutes / feedback iteration

Transit Assignment

- Periods (2)
  - AM, Off-peak
- Line-haul modes (4)
  - Metrorail, commuter rail, all bus, bus & Metrorail
- Transit access (3)
  - Walk, park-&-ride, kiss-&-ride
- Performance enhancement
  - Parallelize processing for each line haul path (4)
- Time savings
  - About 50% = 15 minutes (run only once)

Results

- Model result checks
  - With and without parallelization
    - Highway and Transit Skim matrices identical
    - Trip Distribution matrices identical
    - Mode Choice matrices identical
    - Highway Assignment produces the same VMT
- Reports and screen logs
  - Screen logs captured for all the processes
  - Reports replicated
- Total time savings
  - About 40% = 10½ hours (four feedback iterations)

Time Savings

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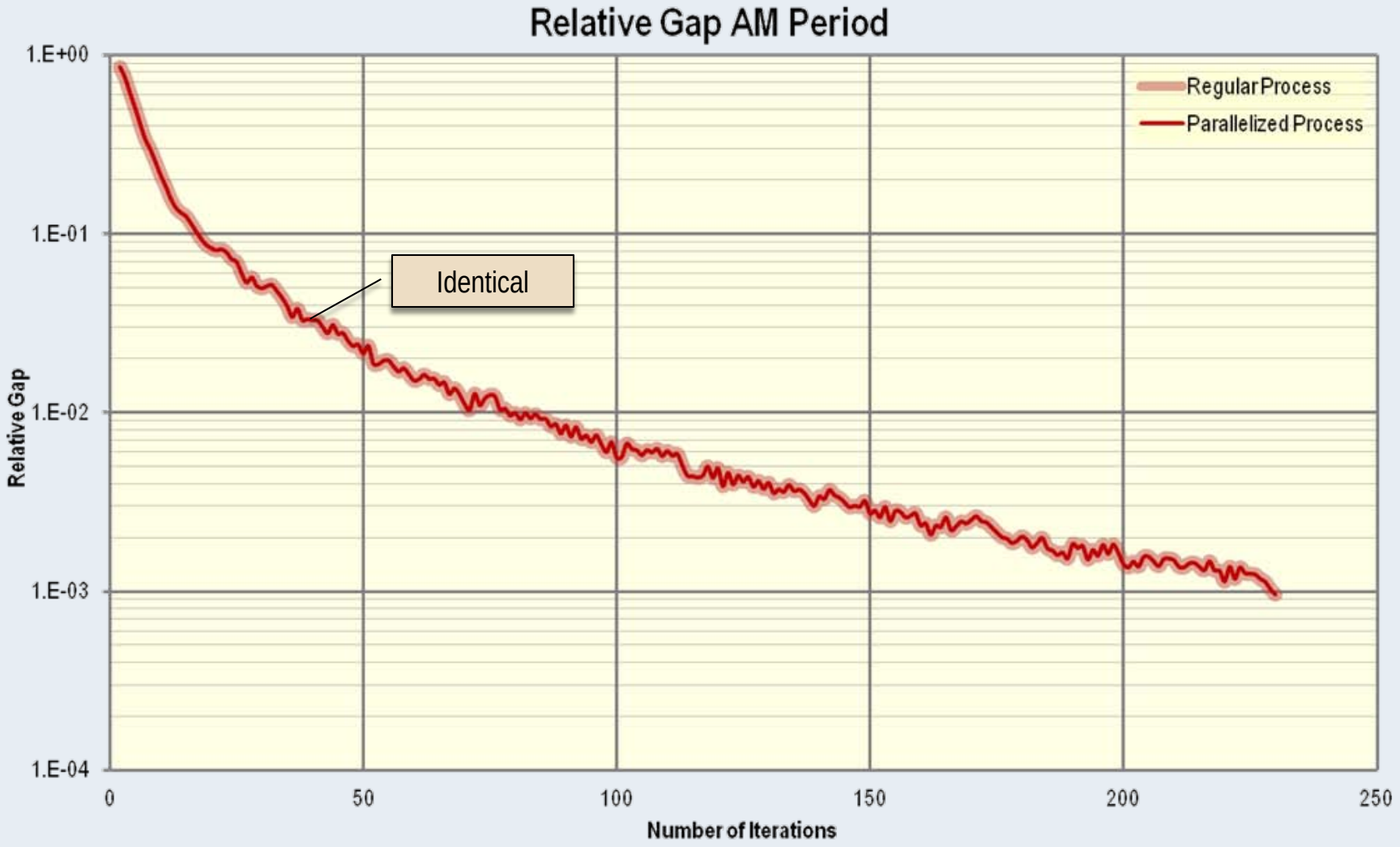
- Base Year (2007) full model application
  - Two (2) hours of savings / iteration
  - Total savings = 10½ hours
  - Full run in 17½ hours → results overnight

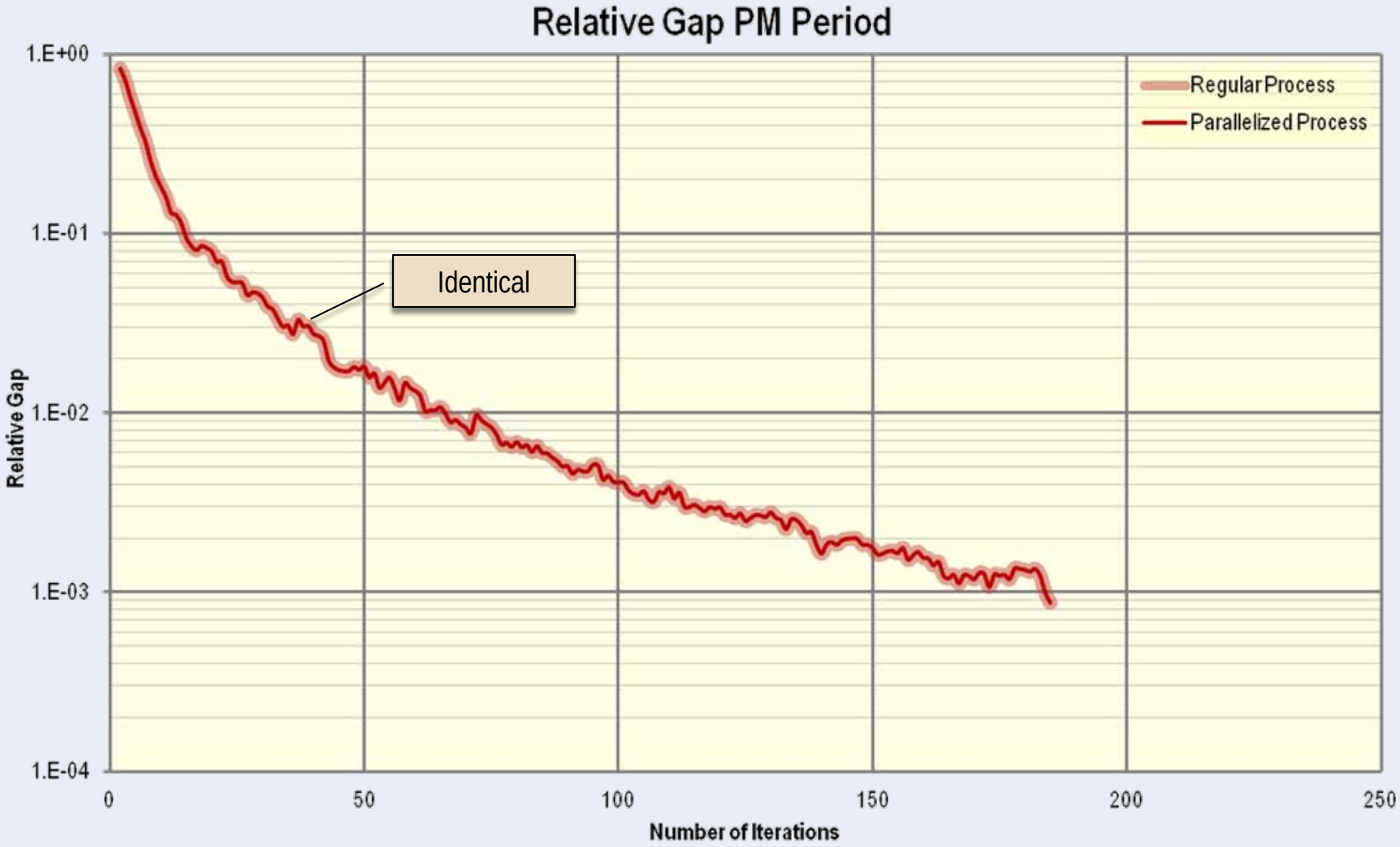
Iteration	Regular Process	Parallelized Process	Savings	Percent Savings
Pump Prime	5:41	3:48	1:53	33%
Iteration 1	5:06	3:06	2:00	39%
Iteration 2	5:57	3:39	2:18	39%
Iteration 3	5:31	3:27	2:04	37%
Iteration 4	5:35	3:24	2:11	39%
Transit Assignment	0:30	0:15	0:15	50%
Full Run	28:20	17:39	10:41	38%

Iteration 1 Step	Regular Process	Parallelized Process	Savings	Percent Savings
Transit Skims	0:59	0:29	0:30	51%
Transit Fare	0:19	0:19	0:00	0%
Trip Generation	0:01	0:01	0:00	0%
Trip Distribution	0:14	0:07	0:07	50%
Mode Choice	0:51	0:16	0:35	69%
Auto Driver	0:08	0:08	0:00	0%
Time of day	0:26	0:26	0:00	0%
Hwy Assignment	2:00	1:15	0:45	38%
Hwy Skims	0:08	0:05	0:03	38%
Total	5:06	3:06	2:00	39%

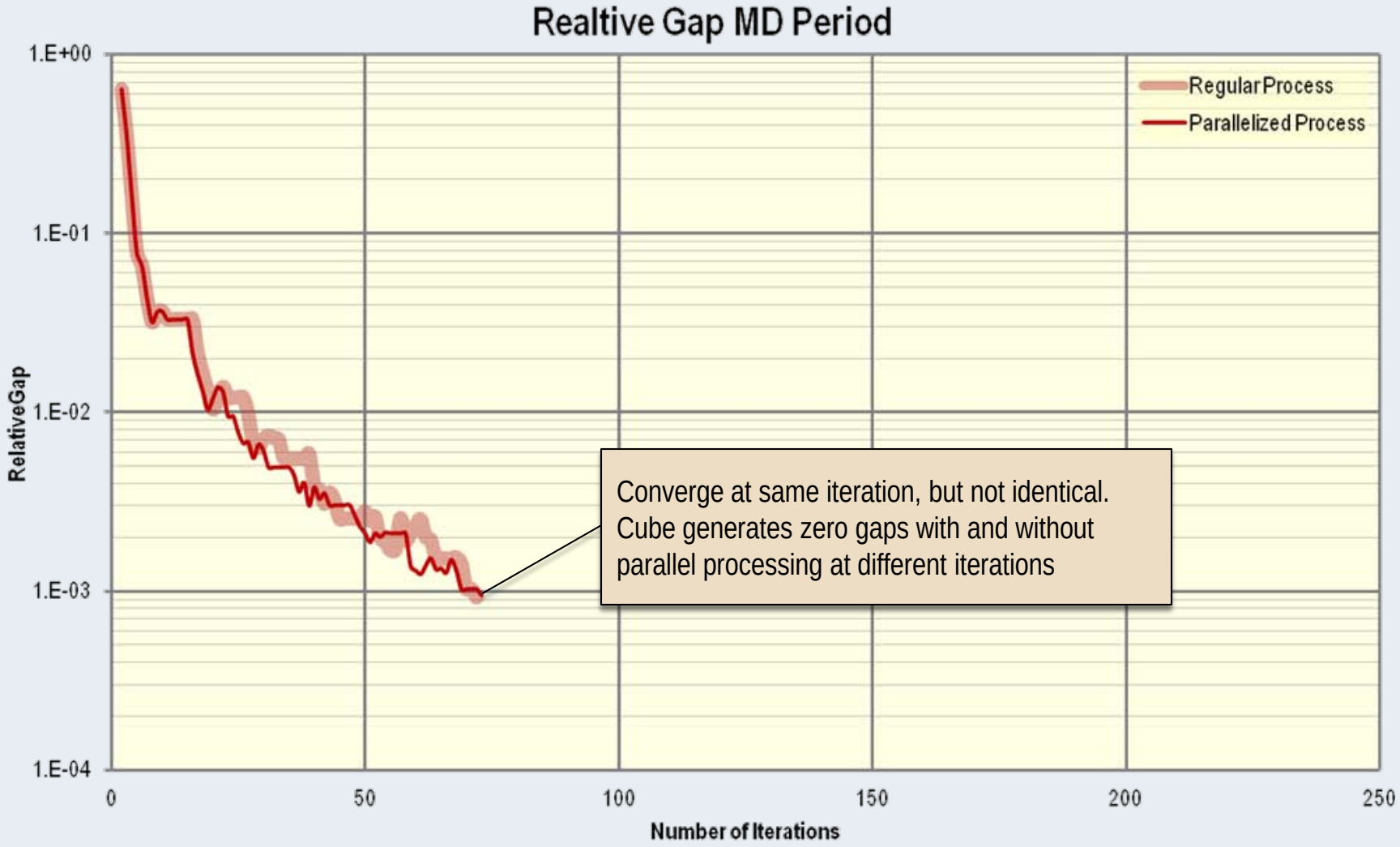
UE Convergence Comparison (AM)



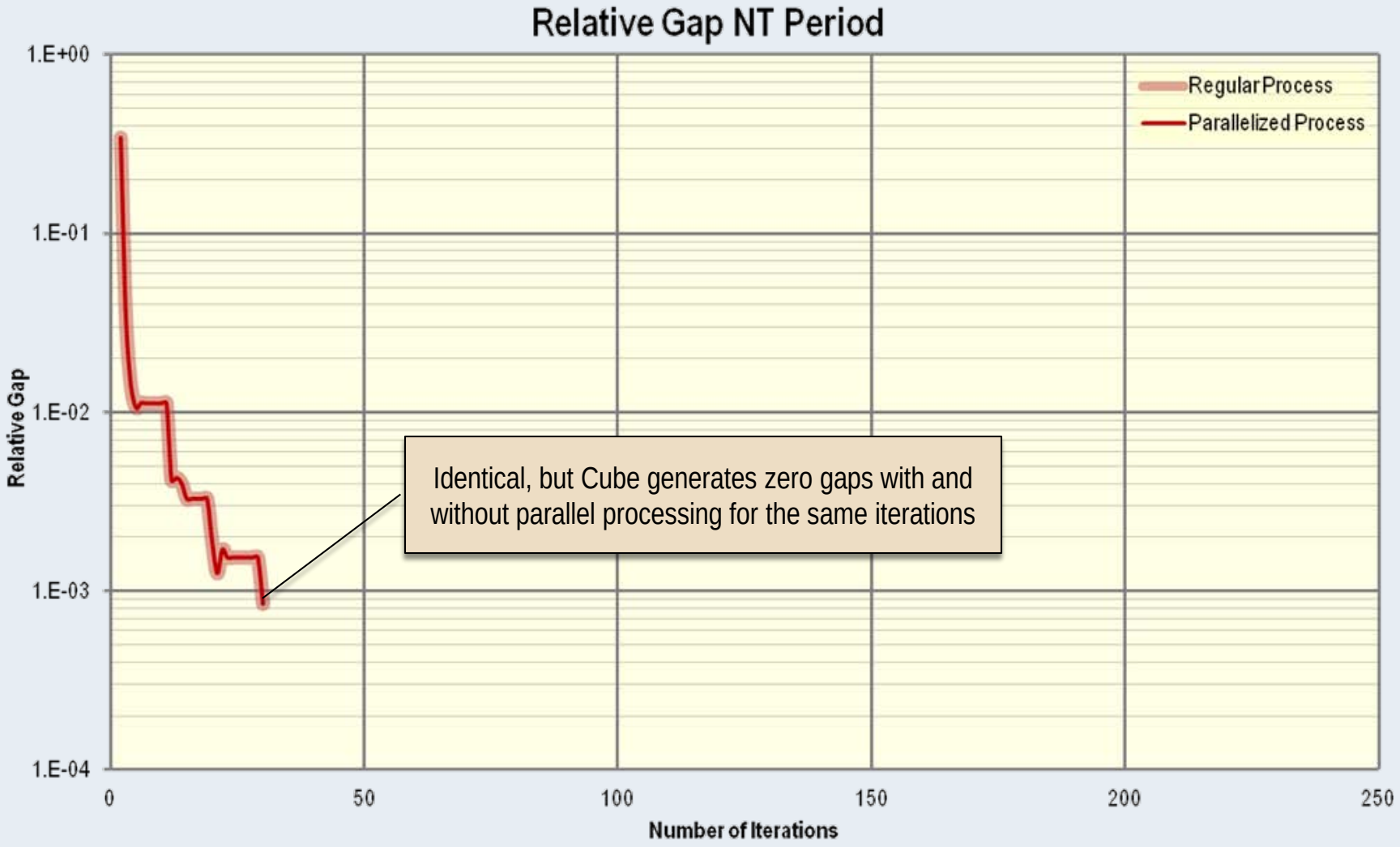
UE Convergence Comparison (PM)



UE Convergence Comparison (MD)



UE Convergence Comparison (NT)



Conclusions

- Parallel processing reduces processing time by about 40 percent
- Implementation required some changes to scripts
  - Loops typically were replaced by replicated code
    - Increased level of complexity for code management
  - Capturing log files and errors is more involved
  - Additional debugging of scripts is required
- Cube Cluster assignments using multiple threads have software problems that Citilabs needs to fix

Further Enhancements

- Use more processors?
  - Results are not identical
    - Test on CUBE 6
- Forecast Year runs with HOT lanes
  - Single run with HOT lanes
    - Combine BASE and CONF runs
    - Yet to be implemented and tested