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NEW COMPUTATIONAL RESULTS ON SOLVING THE SEQUENTIAL PROCEDURE WITH FEEDBACK

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Overview

- Objectives of the Study
- Travel Forecasting Model of the Capital District Transportation Committee, Albany, NY
- Principles of Feedback and Measures of Convergence
- Findings of the Tests
- Convergence of the Route-based Assignment Method
- Conclusions, Recommendations and Future Studies

Objectives of the Study

- Evaluate the performance of the proposed method for solving the Sequential Procedure with Feedback for a practitioner model.
- Compare the effectiveness of different averaging methods.
- Improve CDTC's travel forecasting model.
- Test the impact of improved assignment routines.
- Draw general conclusions for practitioners.

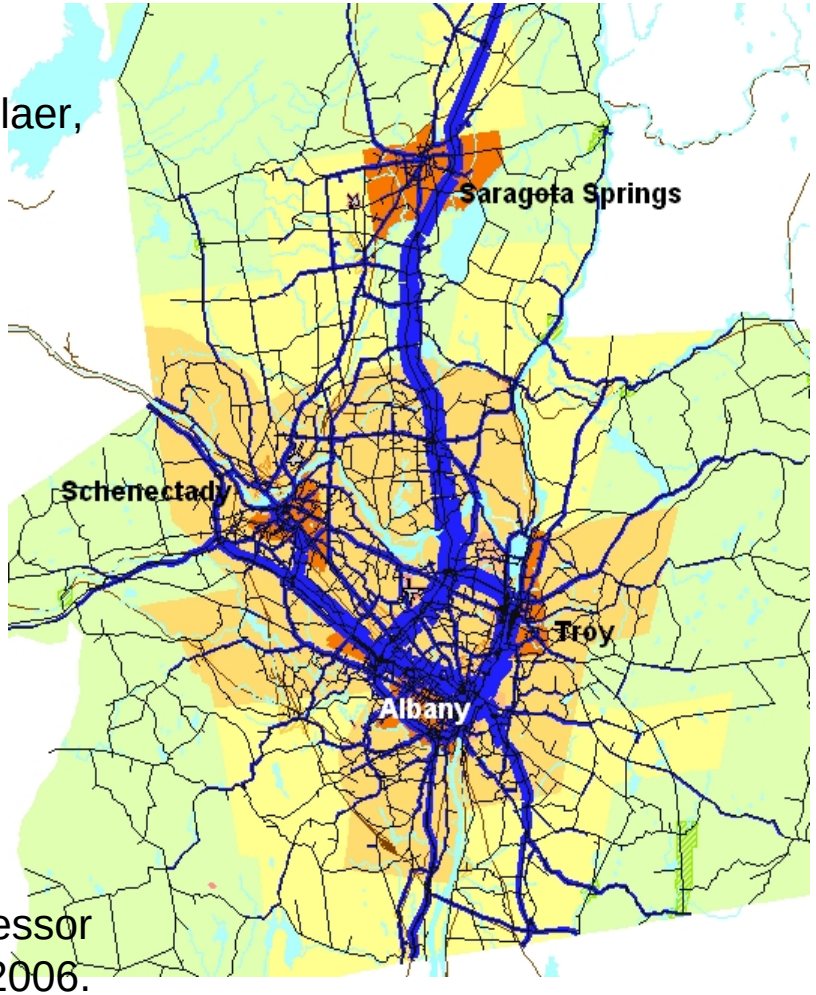
CDTC's Travel Forecasting Model

CTDC, Albany, NY

- MPO for four counties: Albany, Rensselaer, Saratoga and Schenectady
- Population 800,000

Travel forecasting model

- Generation, distribution of vehicle trips with 5 purposes
- Peak-hour equilibrium assignment
- MSA feedback with VISUM 9.5
- Model dimensions: 1,000 zones, 4,000 nodes, 10,000 links, 21,000 capacity-constraint turns
- Tests performed with VISUM 10.0 beta on a Windows PC with a 2.0 GHz processor and 2.0 GB RAM memory acquired in 2006.



Test Cases

Three cases from CDTC practice:

- **Base2000**
  - Current model calibration for 2000 census
- **Plan2030**
  - Current 2030 forecast for the RTP baseline
- **Base2000x1.5**
  - Base2000 with productions and attractions factored by 1.5
  - Created to obtain a more congested case

Review of Previous Studies

1957

> The question of how to solve the Sequential Procedure with feedback arose in its first description (Carroll and Bevis, 1957);

1993 (TRB Transportation Planning Applications Conference)

> Lawton, Florian and Boyce considered alternative approaches,

> no consensus reached (experiments reported in Boyce et al., 1994);

1996

> Comsis Corporation reported on experiments,

> did not achieve a definite recommendation for practice;

2003, 2006

> Bar-Gera and Boyce described experimental results;

Subsequently

> software developers have offered their approaches,

> none has been widely accepted so far.

Basic Principles of Feedback

The basic problem

> Achieve consistent travel costs among inputs and outputs

Averaging

> Necessary to converge to a consistent solution

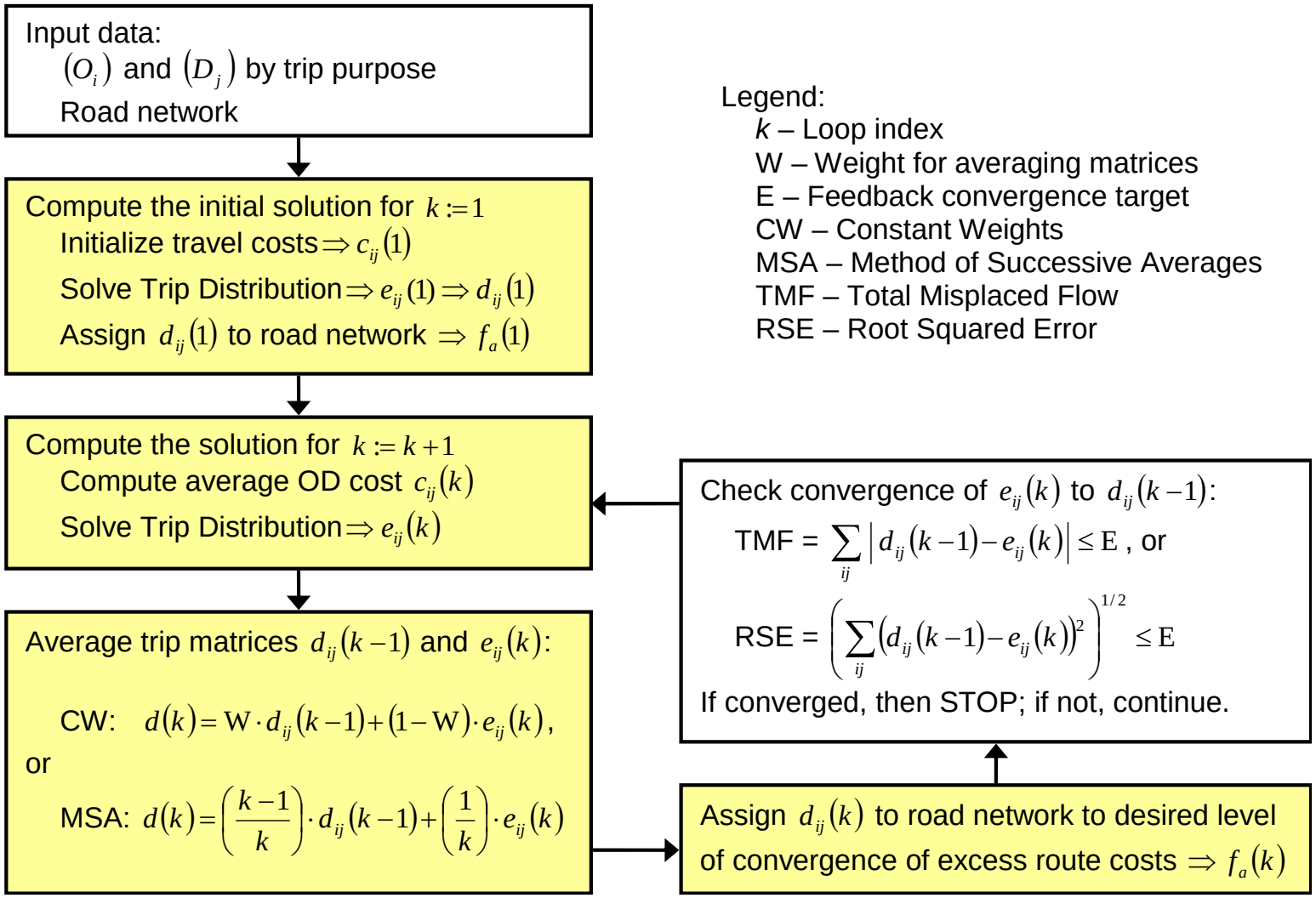
> What should be averaged?
link flows, link costs, link speeds or trip matrices?

Our method

> Seek a trip matrix, dependent on travel costs, which when assigned to the network, yields those same costs.

> Compute a sequence of trip matrices, averaging each new matrix into the solution matrix until a stable solution is found.

Feedback by Averaging of OD Matrices



Legend:
- *k* – Loop index
- W – Weight for averaging matrices
- E – Feedback convergence target
- CW – Constant Weights
- MSA – Method of Successive Averages
- TMF – Total Misplaced Flow
- RSE – Root Squared Error

Measuring Convergence

Two convergence measures were used to monitor the convergence of the trip matrices:

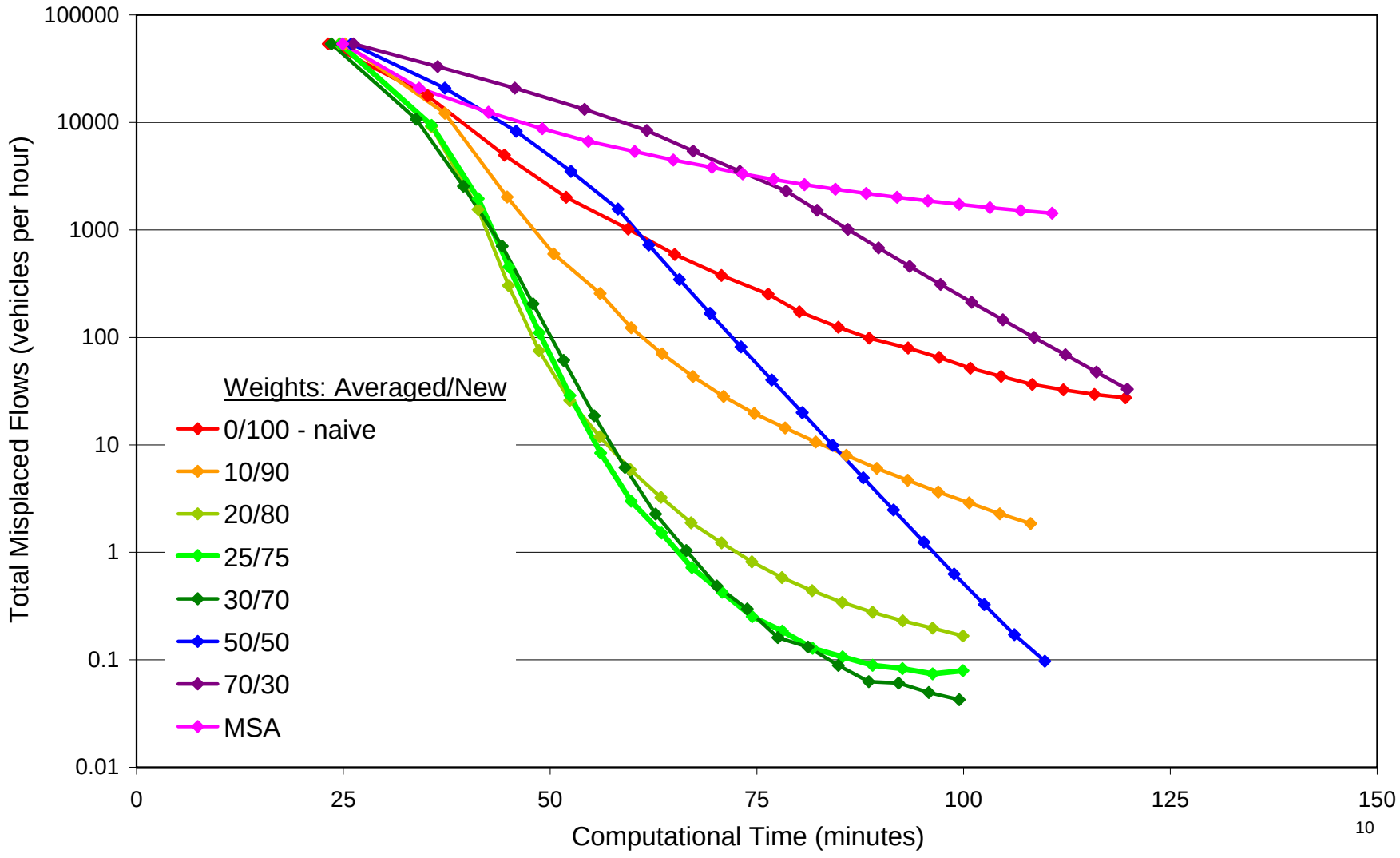
- Total Misplaced Flows (TMF) – sum of absolute values of cell differences
- Root Square Error (RSE) – square root of squared cell differences

Both measures gave similar results, only TMF is reported here

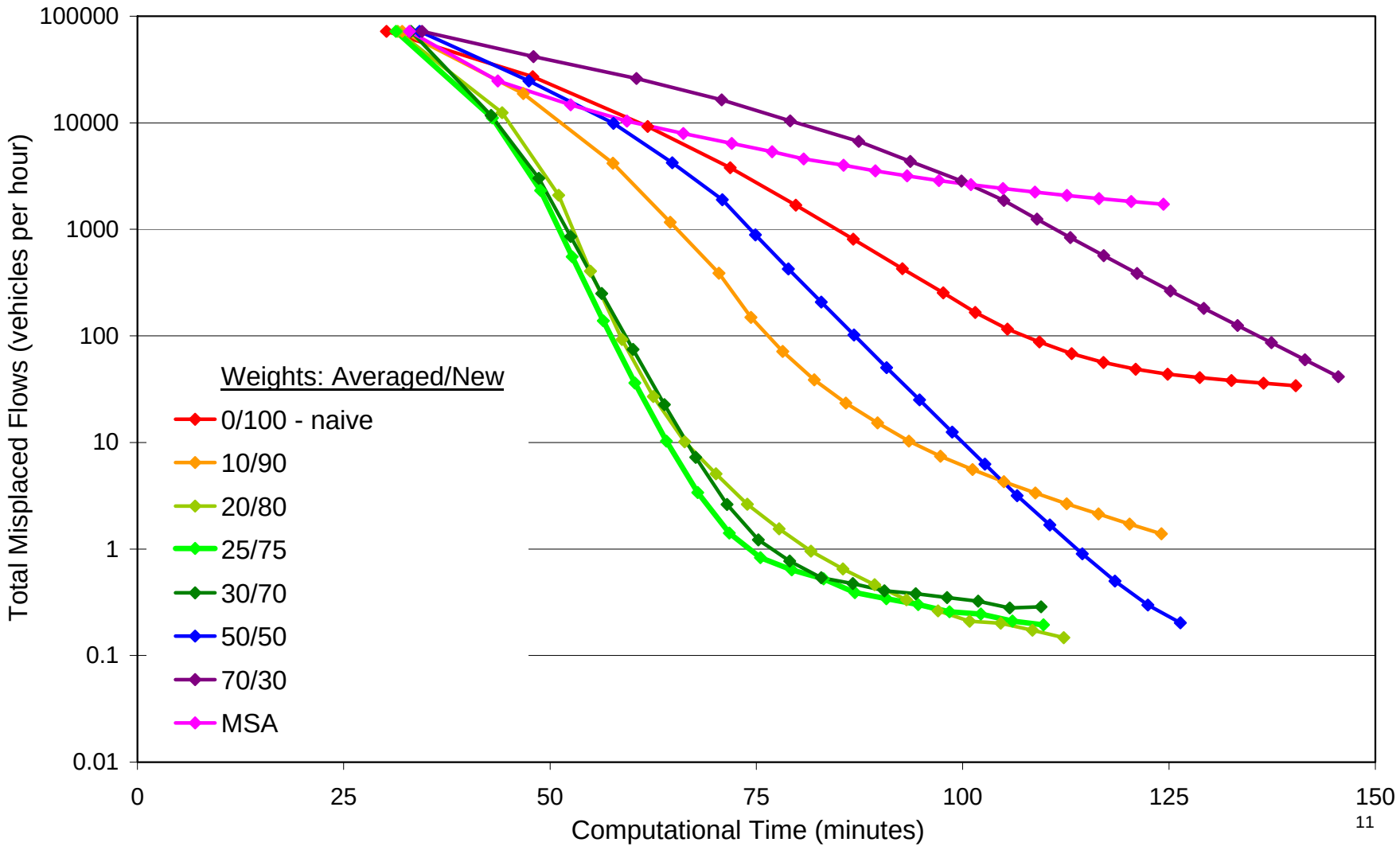
In addition we monitored the behavior of sub-problems:

- Convergence of the traffic assignment: Relative Gap
- Convergence of the cost matrix ("skim"): RSE

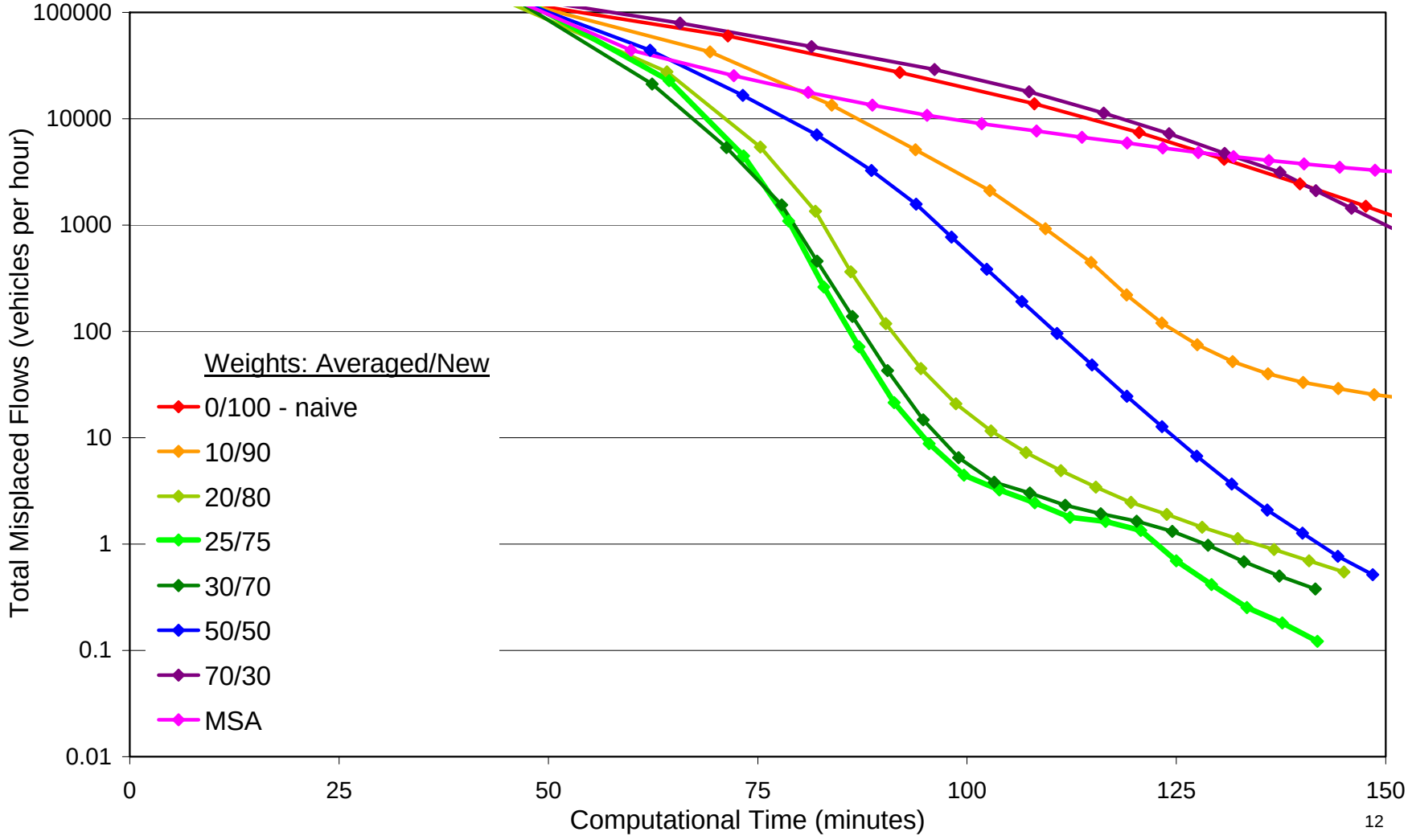
Convergence of Trip Matrices for Base2000



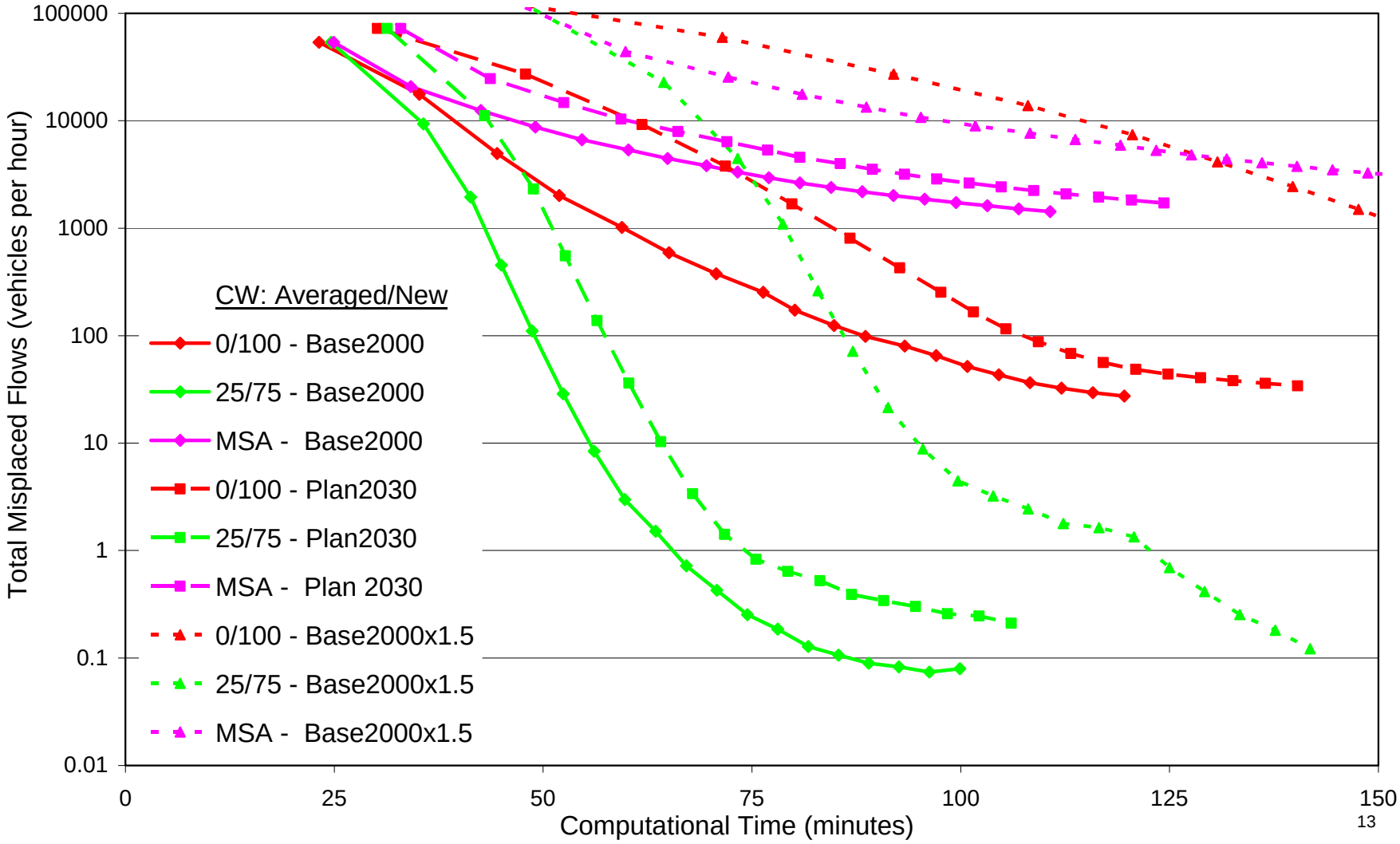
Convergence of Trip Matrices for Plan2030



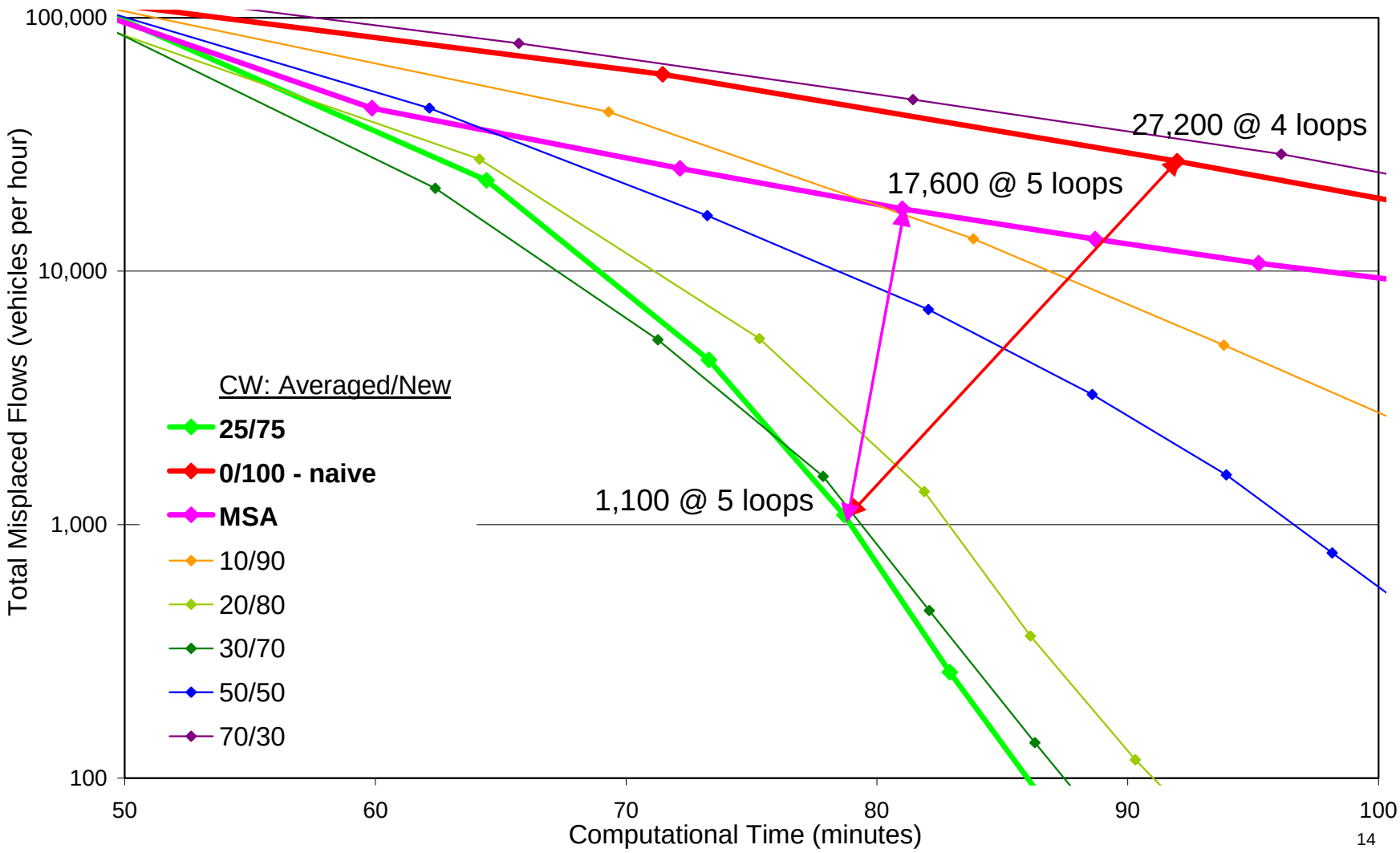
Convergence of Trip Matrices for Base2000x1.5



Convergence of Matrices for All Three Cases



Recommendation on Number of Feedback Loops



Convergence of the Travel Cost Matrix

Regarded by some as another important measure of convergence of the feedback procedure.

In the context of route-based assignment

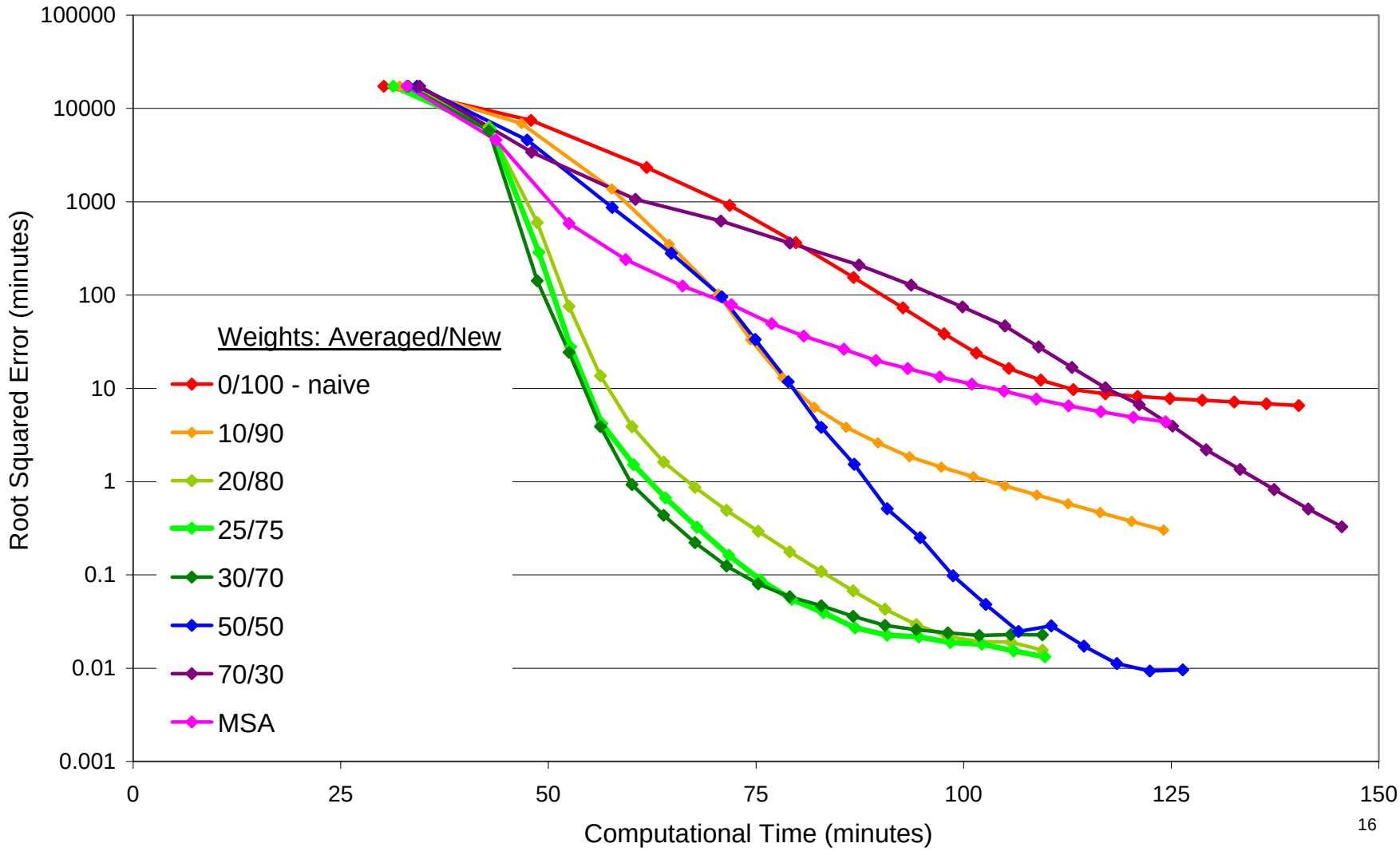
> knowledge of used routes permits computation of cost matrices as the average cost over all used routes for each zone pair.

Convergence measure:

> Root Squared Error (RSE) of successive travel cost matrices ("skims");

> Confirms that Constant Weight of 0.25 is the most effective way of averaging for this model.

Convergence of Travel Cost Matrix (Plan2030)



Convergence of Traffic Assignment

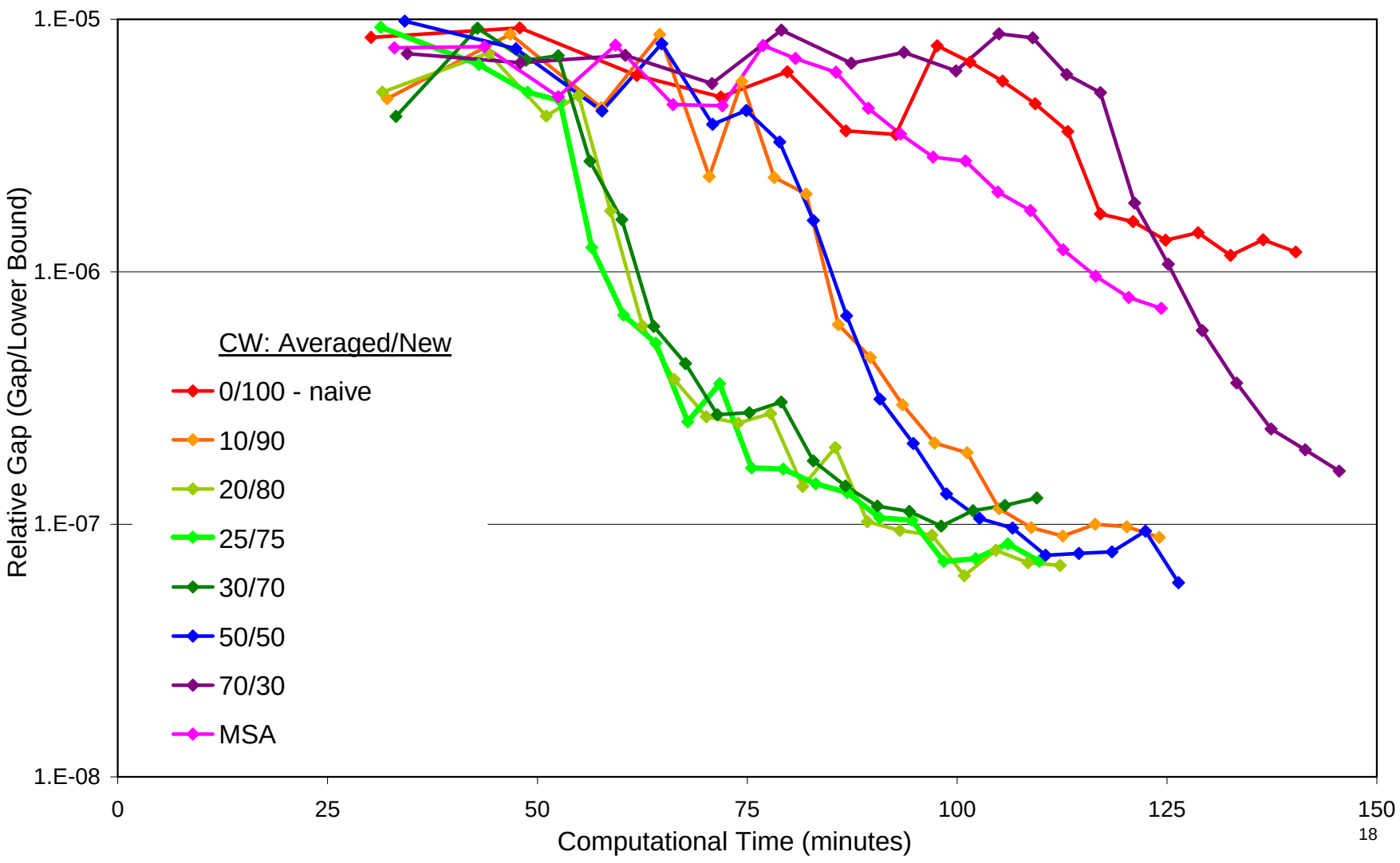
VISUM's route-based, user-equilibrium method

- Stores all shortest routes for all zone pairs identified during the assignment process
- Outer iterations perform shortest route searches and convergence checks defined on the Relative Gap
- Inner iterations balance route flows among competing routes identified, so as to find equal and minimal costs, while updating

Convergence monitored with Relative Gap

- Confirms that Constant Weights of 0.25/0.75 are the most effective way of averaging
- Relative Gap < 1.0E-7 obtained for all three cases
- Exceeds common practice for link-based methods

Convergence of the Assignment (Plan2030)



Conclusions and Recommendations

- Averaging the trip matrix using Constant Weights yields a stable, converged solution to the Sequential Procedure with Feedback.
- The same weights were best for three cases with quite different congestion levels.
- Performing feedback without averaging (Naïve Feedback) is ineffective and should not be used. MSA is much less effective than using Constant Weights in these tests.
- Performing five feedback loops was generally effective in reaching convergence for this model and cases.
- As a recommendation, TMF should be less than 1% of the total number of trips.

Future Studies

- The experience accumulated to date using the VISUM software system pertains to three cases solved with the CDTC model.
- Additional tests with more complex models and other software systems are needed to generalize and validate these findings.
- Practitioners are urged to perform their own tests and report them in a manner that findings across models, networks and software systems can be compared.