A Methodology for **A**chieving **I**nternal **C**onsistency in the **D**allas-**F**ort **W**orth **T**ravel **D**emand **M**odel through **I**mprovements in **T**raffic **A**ssignment

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North Central Texas Council
of Governments (NCTCOG)

Background

1. Earlier tasks investigated the effects of the following elements:
   - Number of feedbacks in the traffic assignment step
   - Magnitude of the relative gap
   - Method of Successive Averages (MSA) vs. constant weights
   - Exponential vs conical VDFs

2. Later focus has been on defining an integrated and more robust assignment convergence criteria.

Assignment Improvements

1. Introduction of a conical VDF with integrated traffic control delay;
2. Integration of a robust traffic assignment convergence criteria; and
3. Introduction of accuracy statements in the forecasted volumes.

Model Setup

- Roadway and Transit models in TransCAD 5.0 R2
- Multi-modal generalized-cost user equilibrium traffic assignment
- Microsoft® Windows® XP operating system
- Intel Xeon, dual quad cores, 3.2 GHz, 3 GB RAM

Model Attributes

Number of links : ~**31,300**

Number of nodes : ~**20,400**

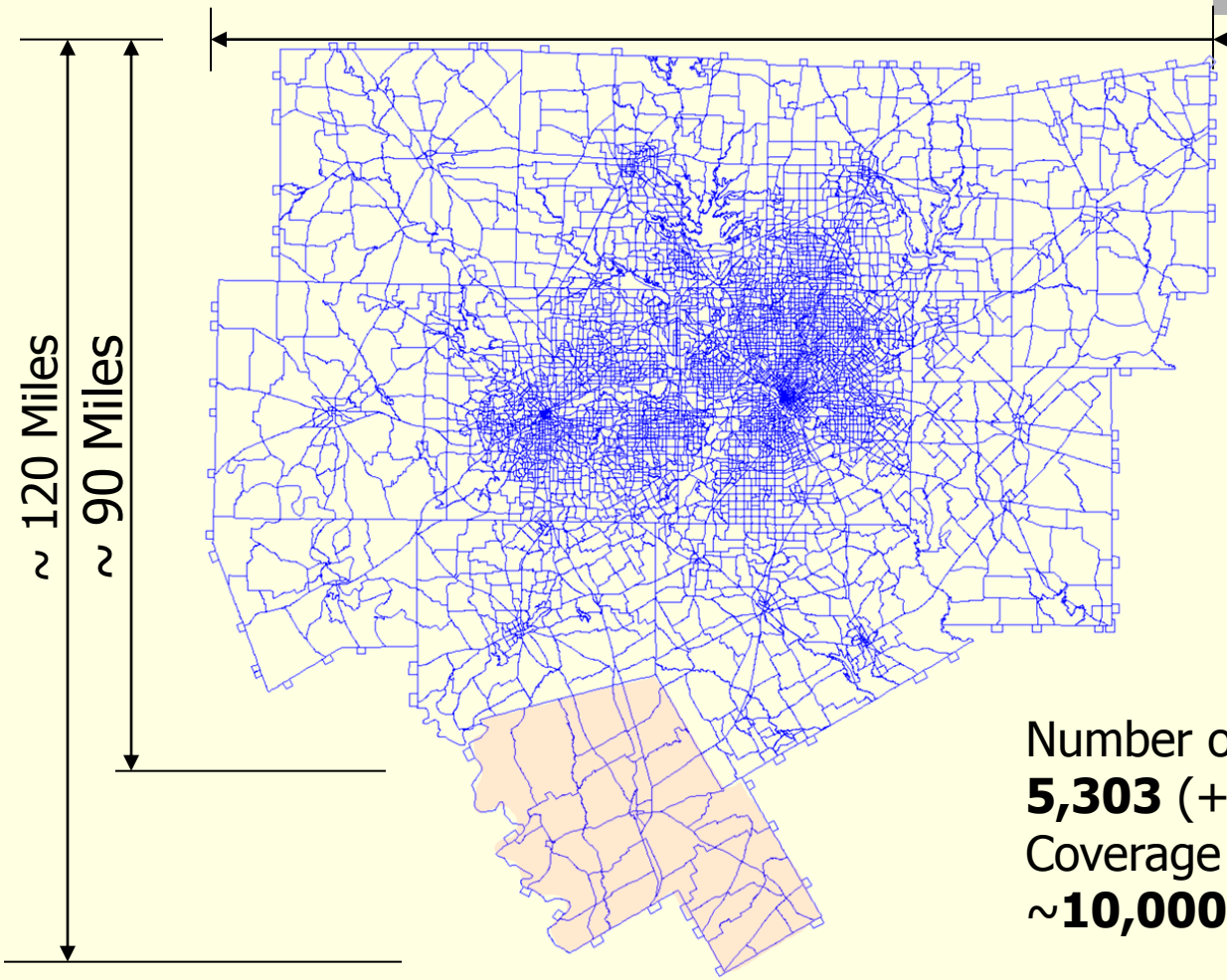
Number of zones : **5,386** (83 Externals)

Coverage area : ~**10,000** sq. miles

Counties completely covered : **12+1**

Total daily trips : ~**17.0×10^6** (in 2004)

Zone Structure



Number of zones :
5,303 (+83 Externals)
Coverage area :
~**10,000** sq. miles

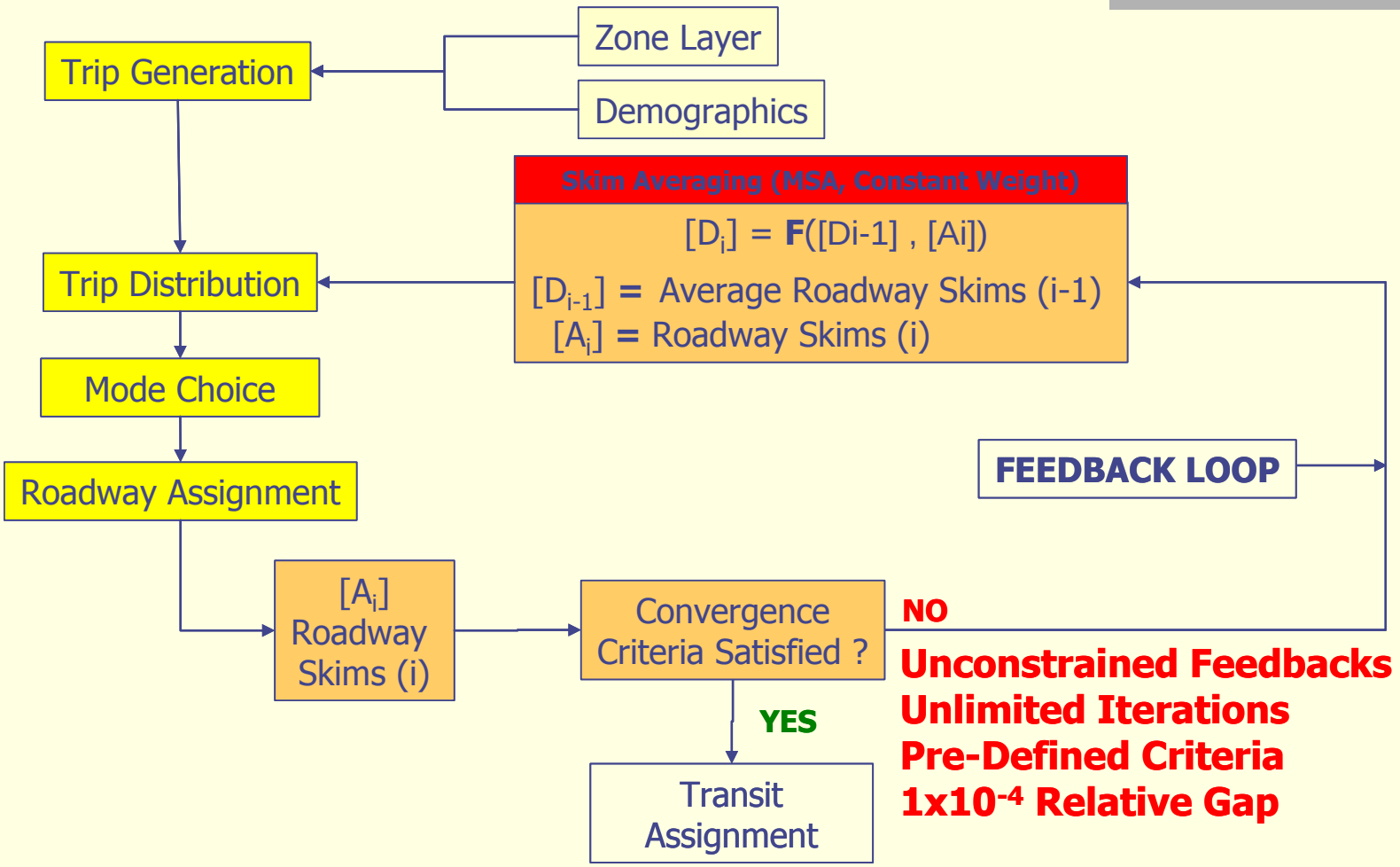
Link Network

Link Functional Classification

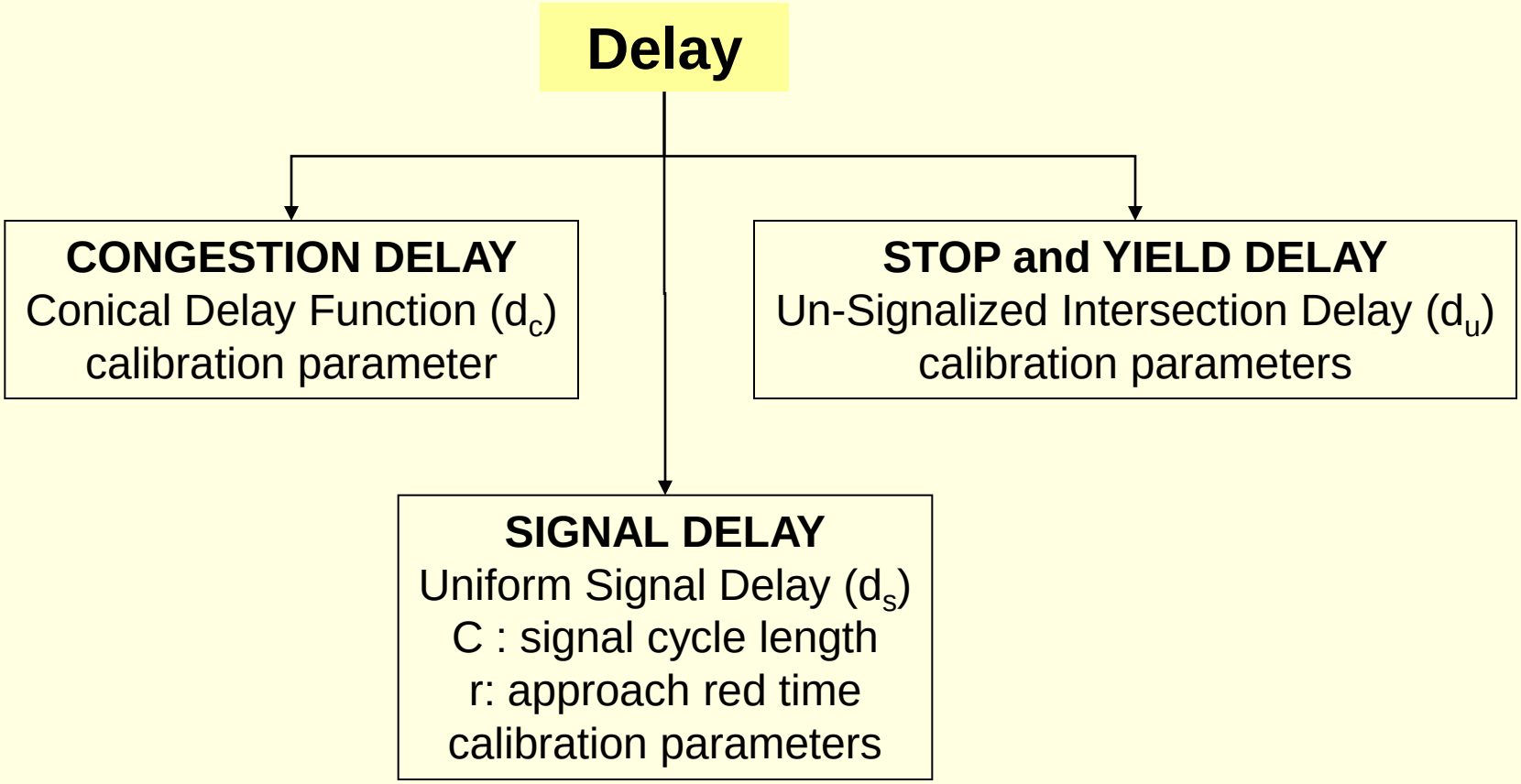
F0 → Centroid Connector
F1 → Freeway
F2 → Major Arterial
F3 → Minor Arterial
F4 → Collector
F6 → Ramp
F7 → Frontage Road
F8 → HOV Lane
F9 → Transit Line

Number of links : **~31,300**
Number of nodes : **~20,400**

NCTCOG 4-Step Modeling



VDF Components



Congestion Delay

$$d_c = T_0 * (K_d - \{K_d \mid \frac{v}{c} = 0\})$$

$$K_d = \left(1 + \sqrt{A\_CONICAL^2 * (1 - \frac{v}{c} + dx)^2 + B\_CONICAL^2} - A\_CONICAL * (1 - \frac{v}{c} + dx) - B\_CONICAL\right)$$

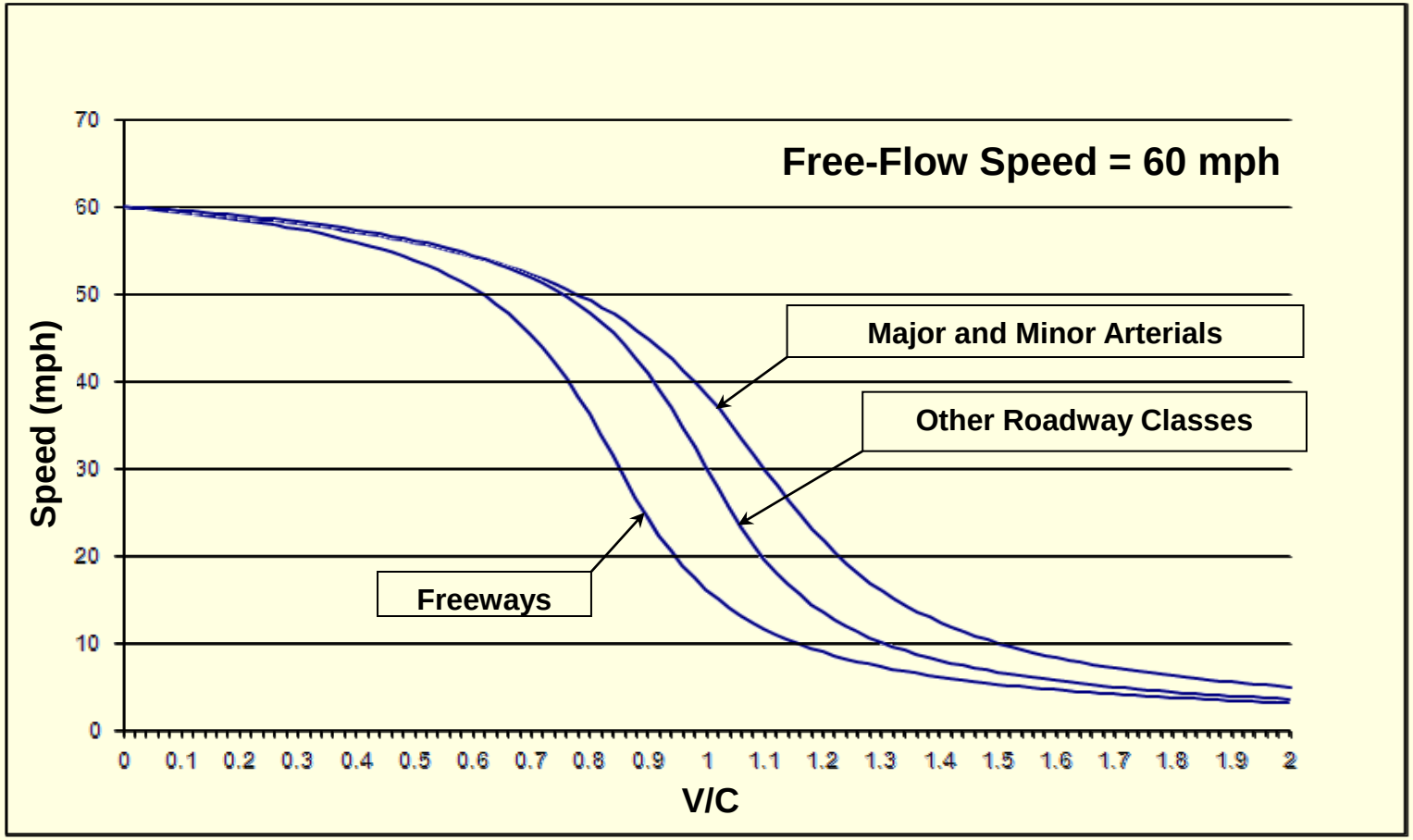
$$B\_CONICAL = \left(\left[\frac{(2 * A\_CONICAL - 1)}{(2 * A\_CONICAL - 2)}\right]\right)$$

dx = horizontal shift in the VDF

d_c = congestion delay

T_0 = free-flow travel time

Link Speed by Class



Signalized Intersection Delay

$$d_{su} = \frac{C(1-\frac{g}{C})^2}{2(1-\frac{q}{s})} = \frac{C(1-\frac{(C-r)}{C})^2}{2(1-\frac{q}{s})} = \frac{(C-g)^2}{2C(1-\frac{q}{s})} = \frac{r^2}{2C(1-\frac{q}{s})}$$

$$d_{su} = \left(\frac{r^2}{2C[\max(1-\frac{q}{s}, L)]}\right)$$

r = approach red time (seconds)

s = approach saturation flow rate

$$r_{ij} = C_r^k C_j \left(1 - \frac{n_j w_{ij}}{2\sum w_{ij}}\right) \qquad C_j = C_s + K_s\, n_j \sum w_{ij}$$

Signalized Intersection Delay

$$r_{ij} = C_r^k C_j \left(1 - \frac{n_j w_{ij}}{2 \sum w_{ij}}\right) \qquad C_j = C_s + K_s \, n_j \sum w_{ij}$$

r_{ij} = approach red time (seconds)

C_j = cycle length at intersection j (seconds)

C_s = signal cycle constant (seconds)

K_s = cycle-length multiplier

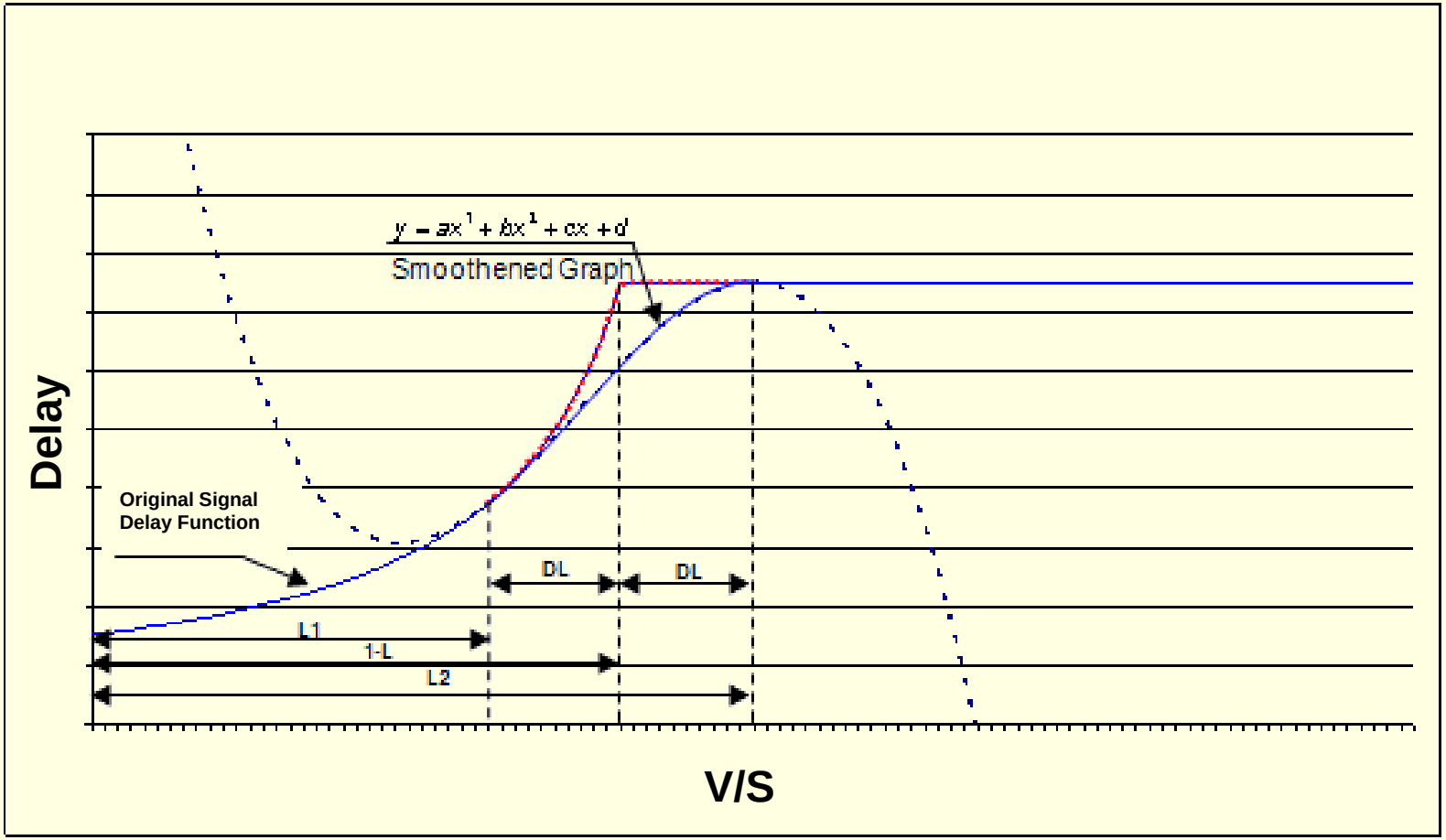
C_r^k = red time constant for functional classification k, k = 1, 2, 3, 4, 6, 7

n_j = number of links ending at node j

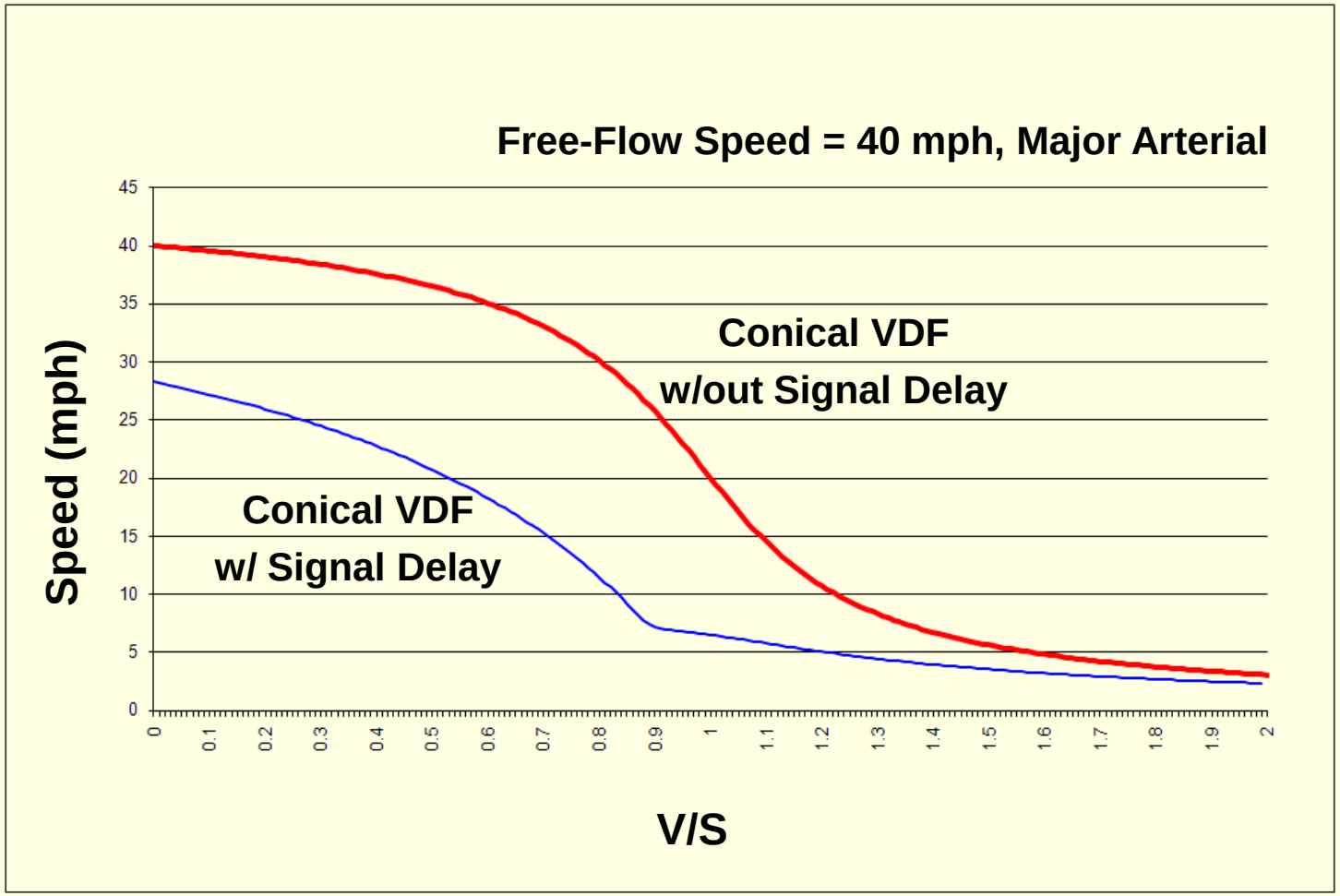
w_{ij} = weight assigned to the approach link ij, as follows:

- 0, centroid connectors
- 2, collectors
- 3, minor arterials
- 4, major arterials
- 5, freeway and expressways

Signalized Intersection Delay



Congestion + Signal Delay



Un-Signalized Intersection Delay

$$d_u = d_{min} + d \cdot \left(\frac{v}{c}\right)$$

d_u = un-signalized approach delay (seconds)

d_{min} = minimum delay at un-signalized intersections (seconds)

v = approach volume

c = approach capacity

$$d = m.\left[\frac{nk - w - p}{2}\right]$$

Un-Signalized Intersection Delay

$$d = m.\left[\frac{nk - w - p}{2}\right]$$

n = number of inbound links

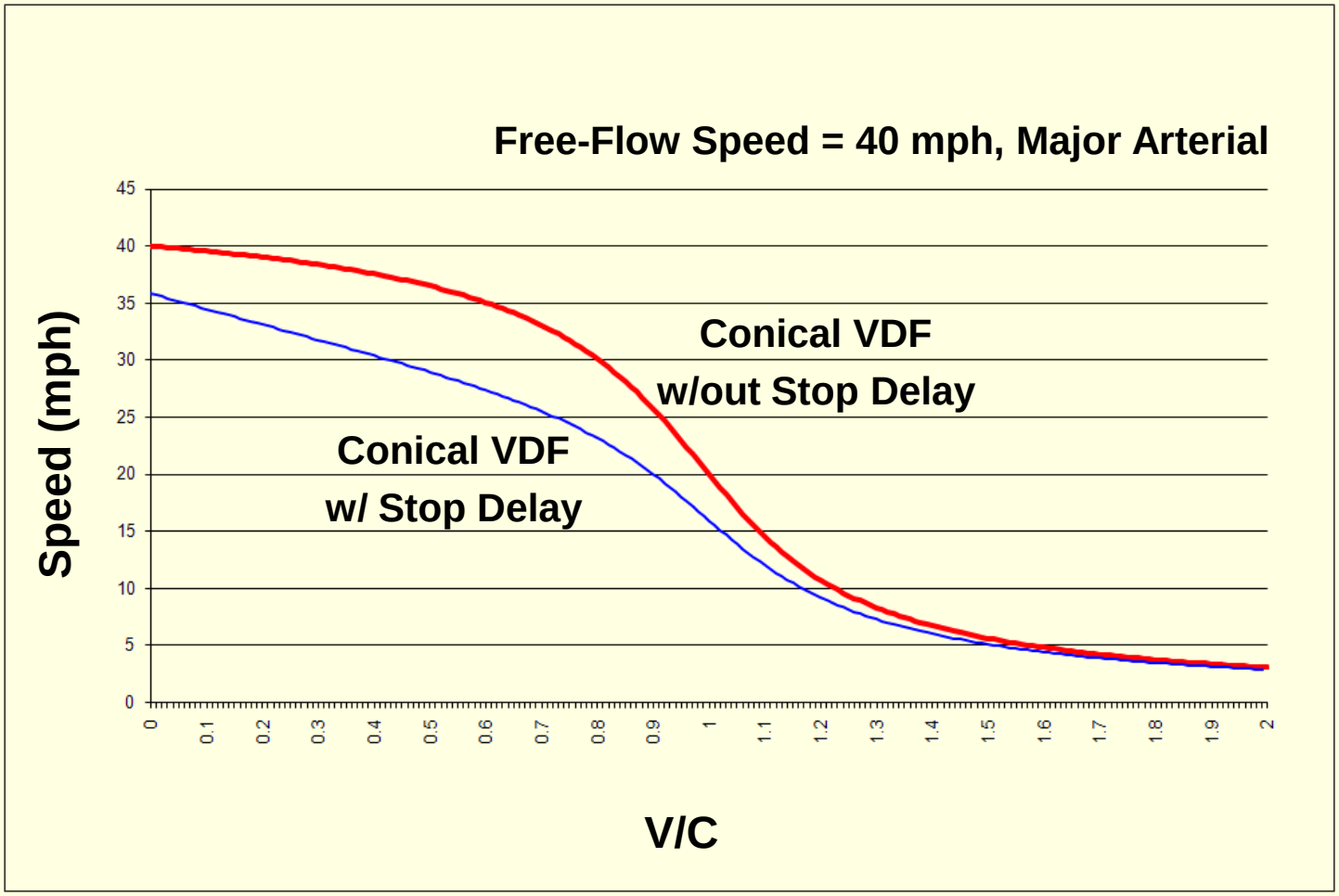
m = 3 seconds for yield and four-way stops
6 seconds for two-way stops

k = number of outbound links

w = number of two-way links

p = number of turn prohibitions

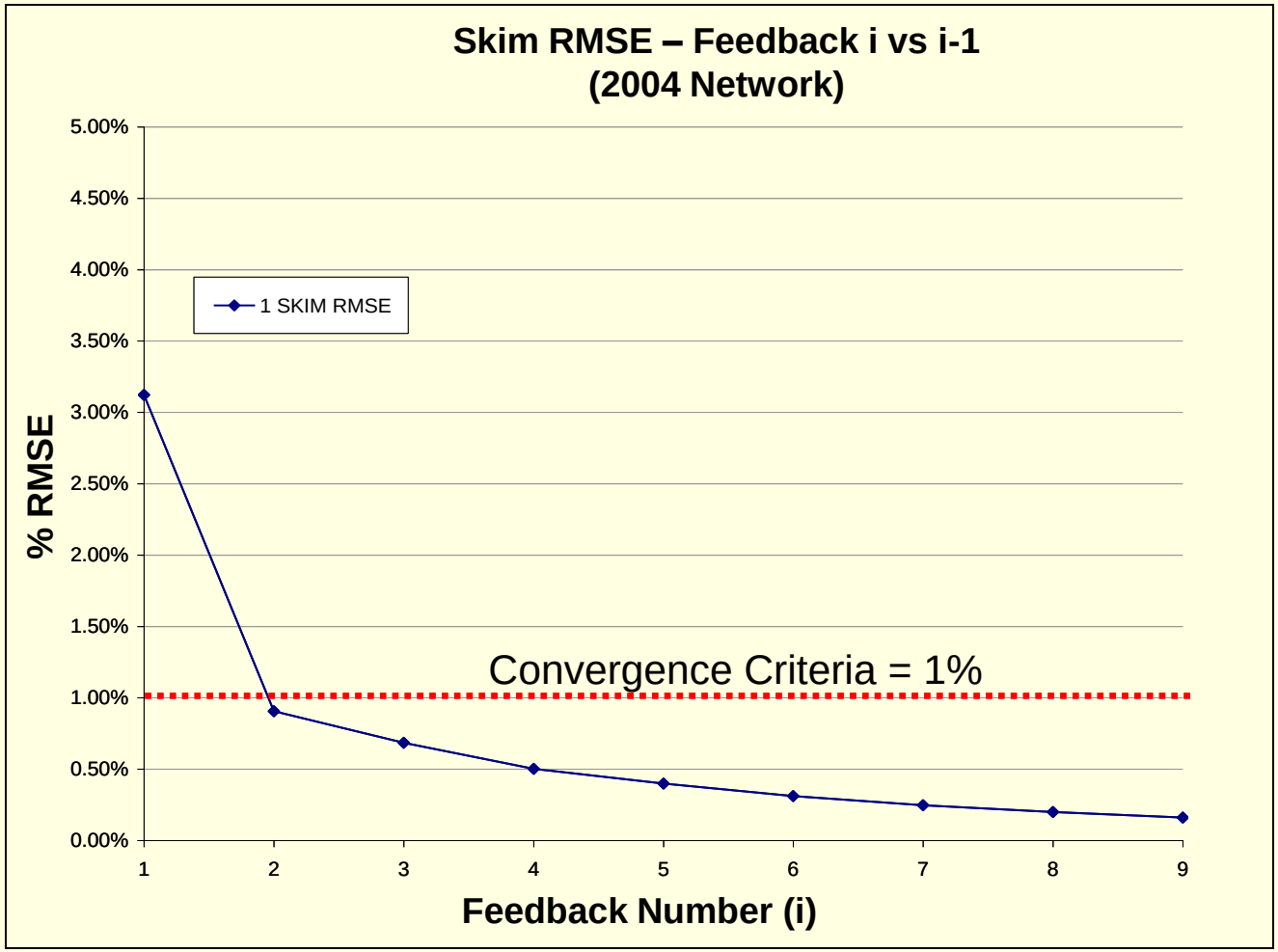
Congestion + Stop Delay



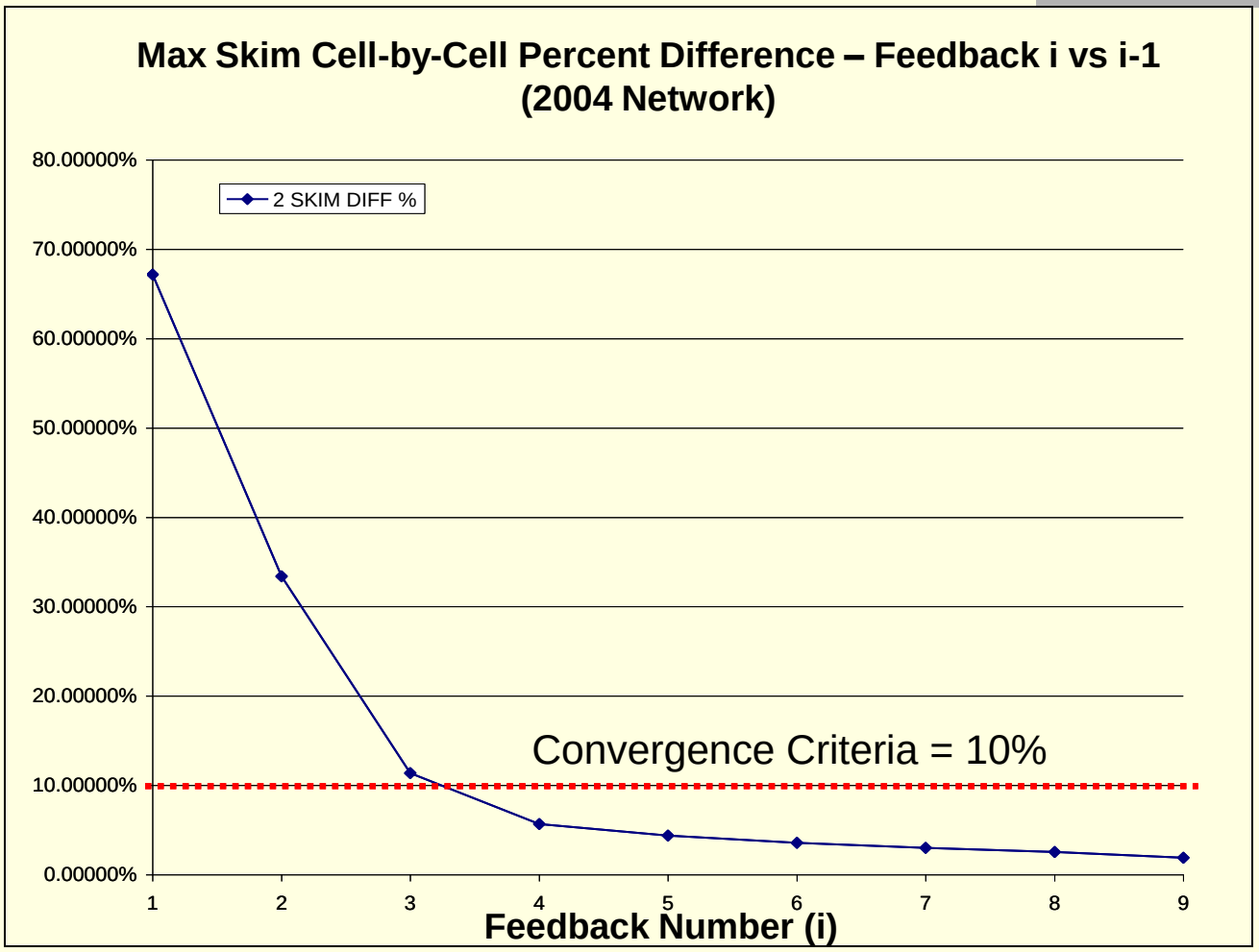
Assignment Convergence Criteria

- 3 to 12 feedbacks (18-45 hours)
- Unlimited iterations
- 0.0001 relative gap
- Skim Matrices RMSE ≤ 1%
- Maximum change in Skim Matrix cells ≤ 10%
- Link Volume RMSE ≤ 2%
- Maximum Link Volume Change over One-Lane Capacity ratio :
  - ≤ 15% F1 – Freeways
  - ≤ 20% F2 – Major Arterials
  - ≤ 25% F3 – Minor Arterials
  - ≤ 25% F4 – Collectors
  - ≤ 25% F6 – Ramps
  - ≤ 50% F7 – Frontage Roads

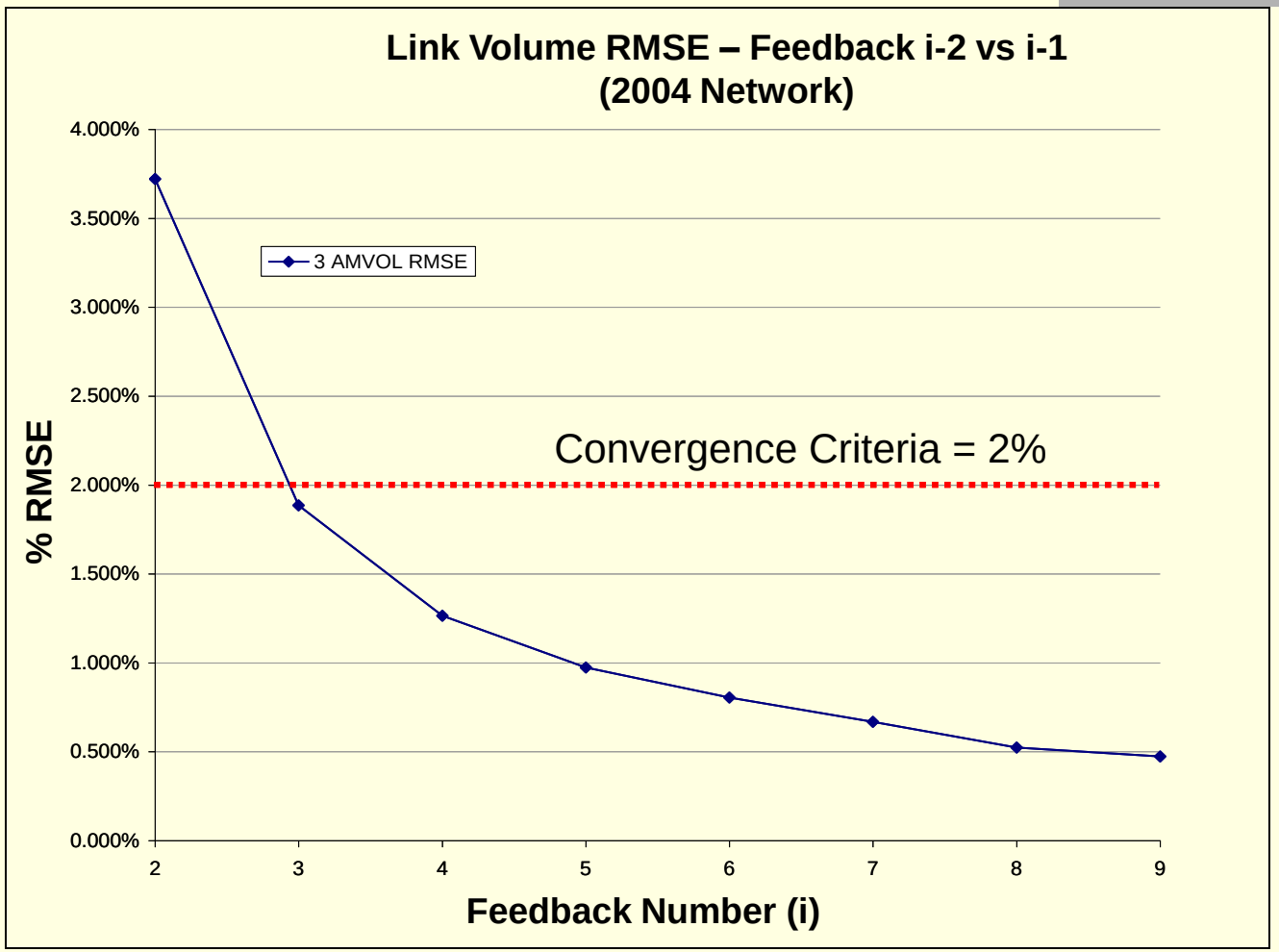
Skim Matrix RMSE



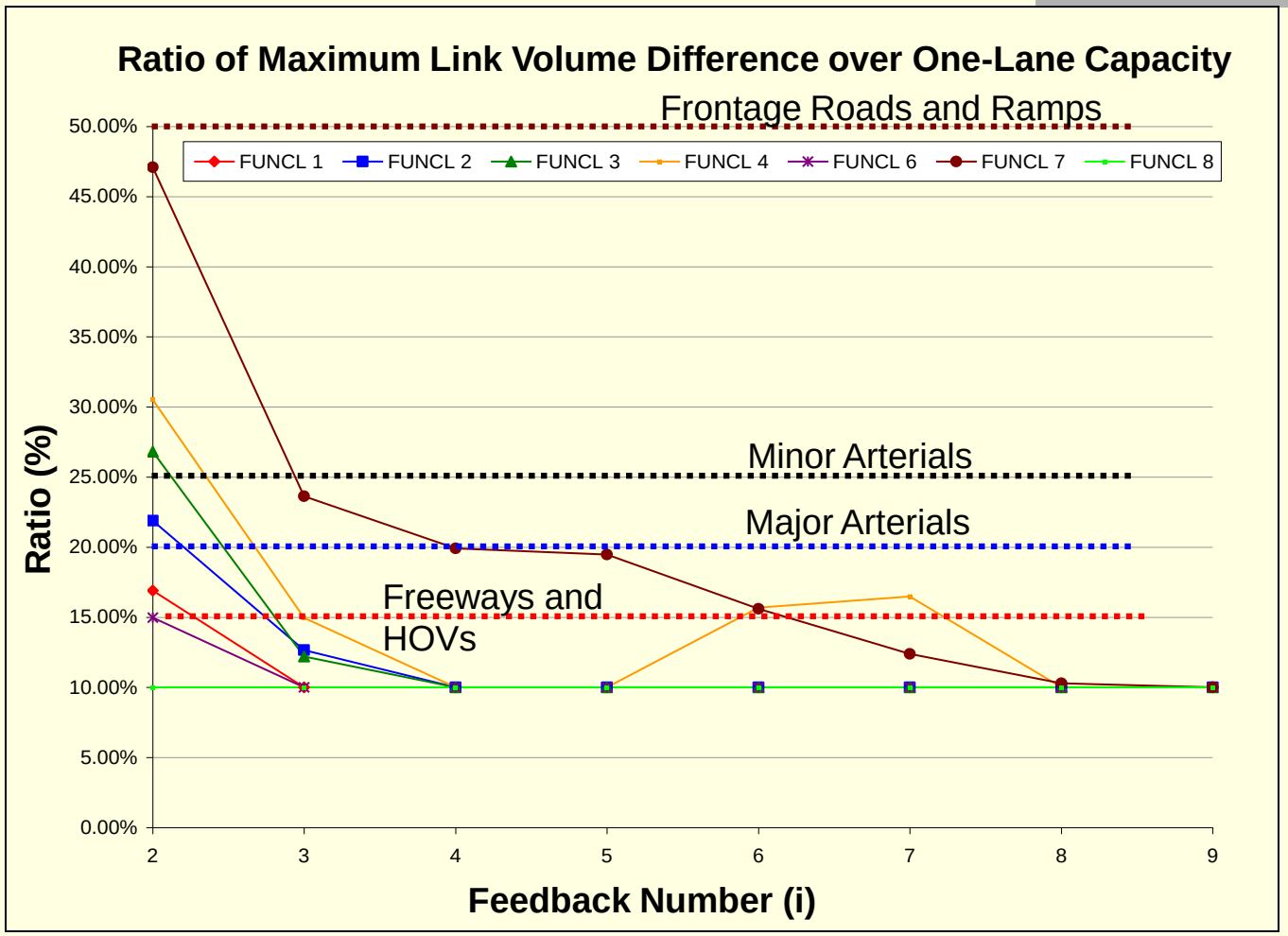
Max Skim Cell-by-Cell % Difference



Link Volume RMSE



Maximum Link Volume Difference



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