Seamless Multicast Handover in a Hierarchical Mobile IPv6 Environment (M-HMIPv6)

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Outline

⏰ Problem Statement

⏰ Why start from HMIPv6?

⏰ M-HMIPv6

⏰ Conclusions & Outlook

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The Problem: Mobile Multicast

! Mcast in low bandwidth mobile environments

! Seamless data service for multimedia streams

o Mcast applications source address aware (HoA)

o Routing: asymmetric, slow convergence

- up to $\approx$ 30 s at listener

- up to $\approx$ 3 min at sender

- Routing source address dependent (CoA)

o Comply with common mobility/
multicast infrastructure

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M-HMIPv6 Approach

draft-schmidt-waehlisch-mhmipv6-03

o Agent based: MAP as Multicast agent

o Mobile multicast reception and source

o Built on Hierarchical MIPv6 (HMIPv6)

- Micro mobile handovers hidden by MAP

- Reactive handovers between MAPs

- Unicast (tunnel) forwarding MN : MAP

- Extends signalling of HMIPv6 by multicast advertisement flag

o Independent of Mcast Routing Protocol

Why Based on HMIPv6?

o HA tunnelling (BT): topological triangle

o Find local agents to shield mobility

o Use unicast infrastructure with minor extensions

o Reduce handover frequencies

o Reactive handover pleasant for multicast routing

o Low signalling overhead

o Robustness easy to achieve

Analysing Handover Performance

Questions:

- How many Processed HOs?

- Packet loss on HO?

- Correctness of Predictions?

Relevant quantities:

- Cell residence time

- Call holding time

- AR-to-MAP ratio

Modelling assumptions:

- Cell residence & call holding time exp. distributed
  (homogeneous distribution)
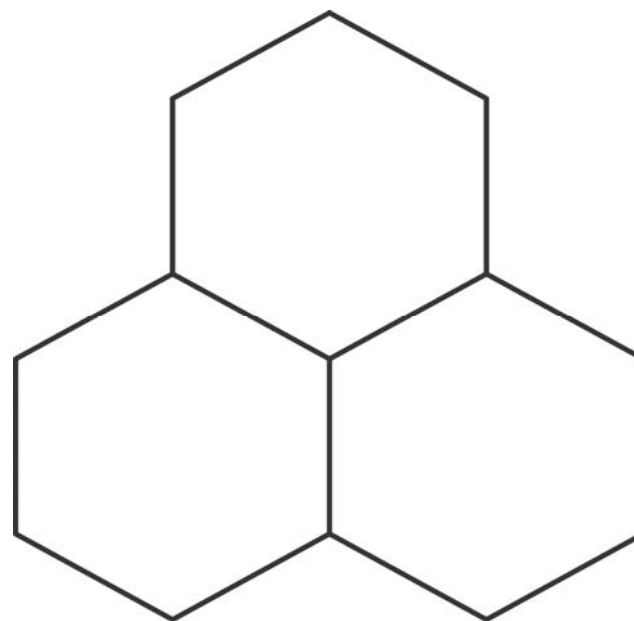
Handover Frequencies

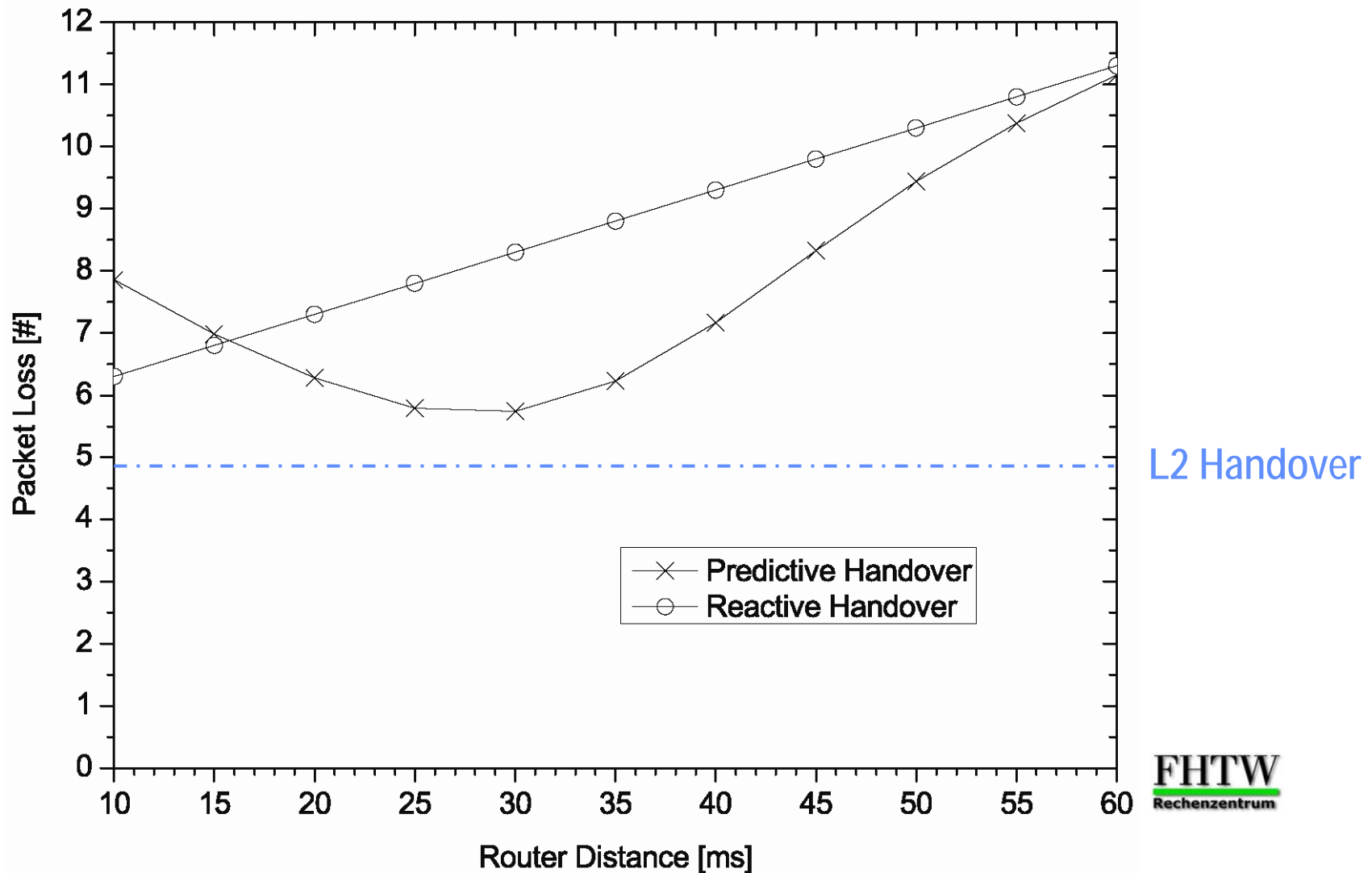Analytical result:

ρ = Call-to-mobility factor

k = AR-to-MAP ratio
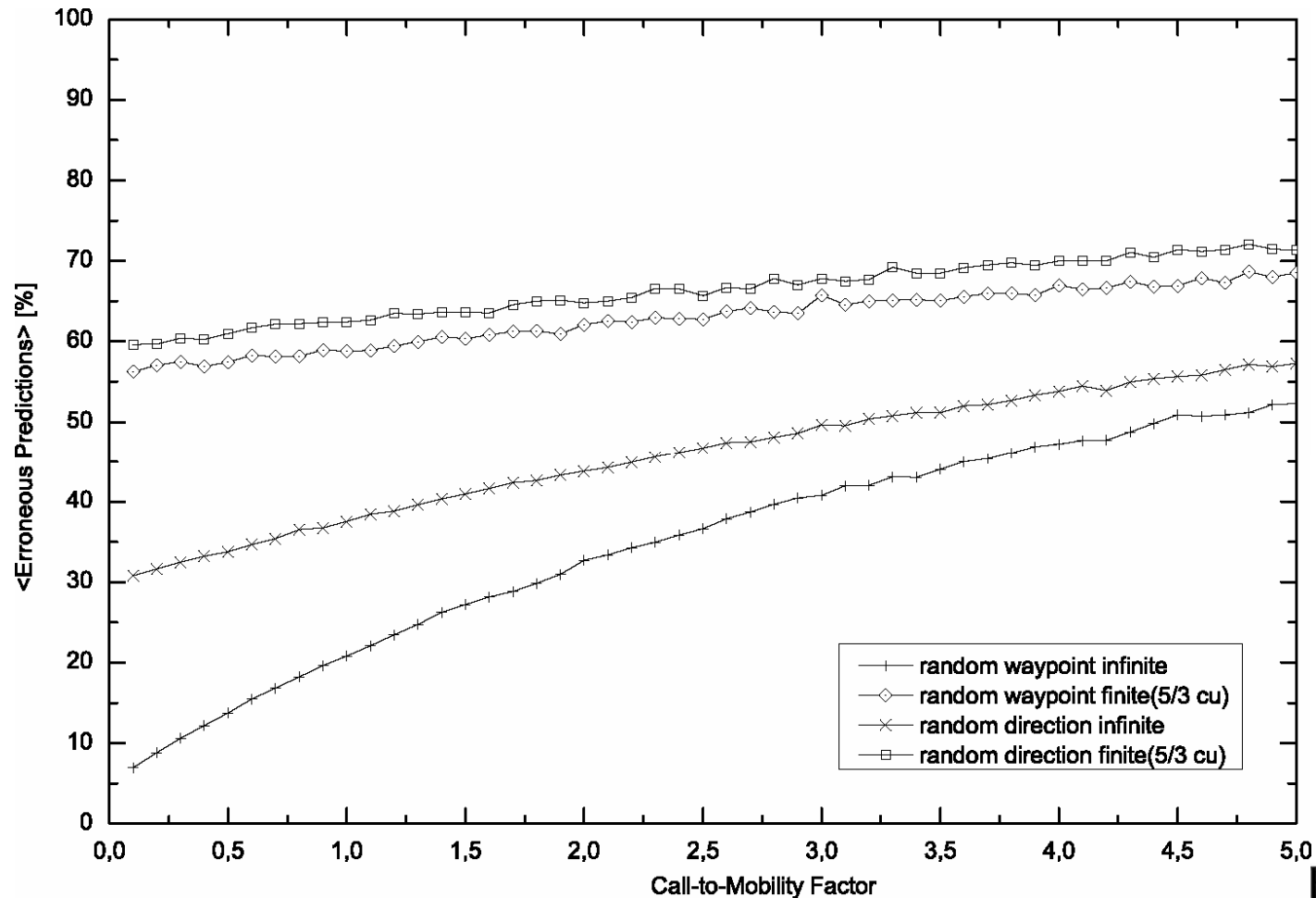
Expected # of HOs:

$$\mathrm{E}[HO] = \frac{1}{k\rho^2} + \frac{1}{\sqrt{k}\,\rho}$$
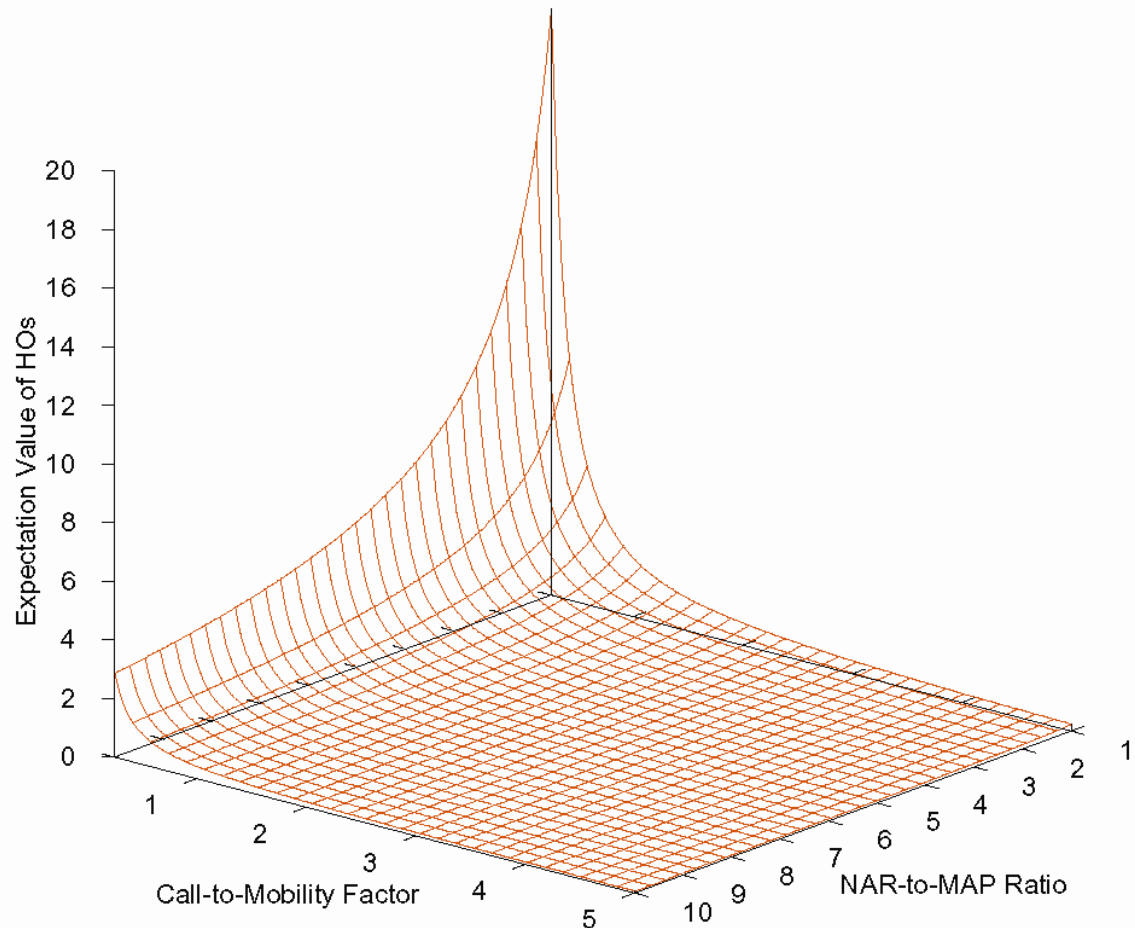
Results for high mobility: Ratio approaches 1 : 10

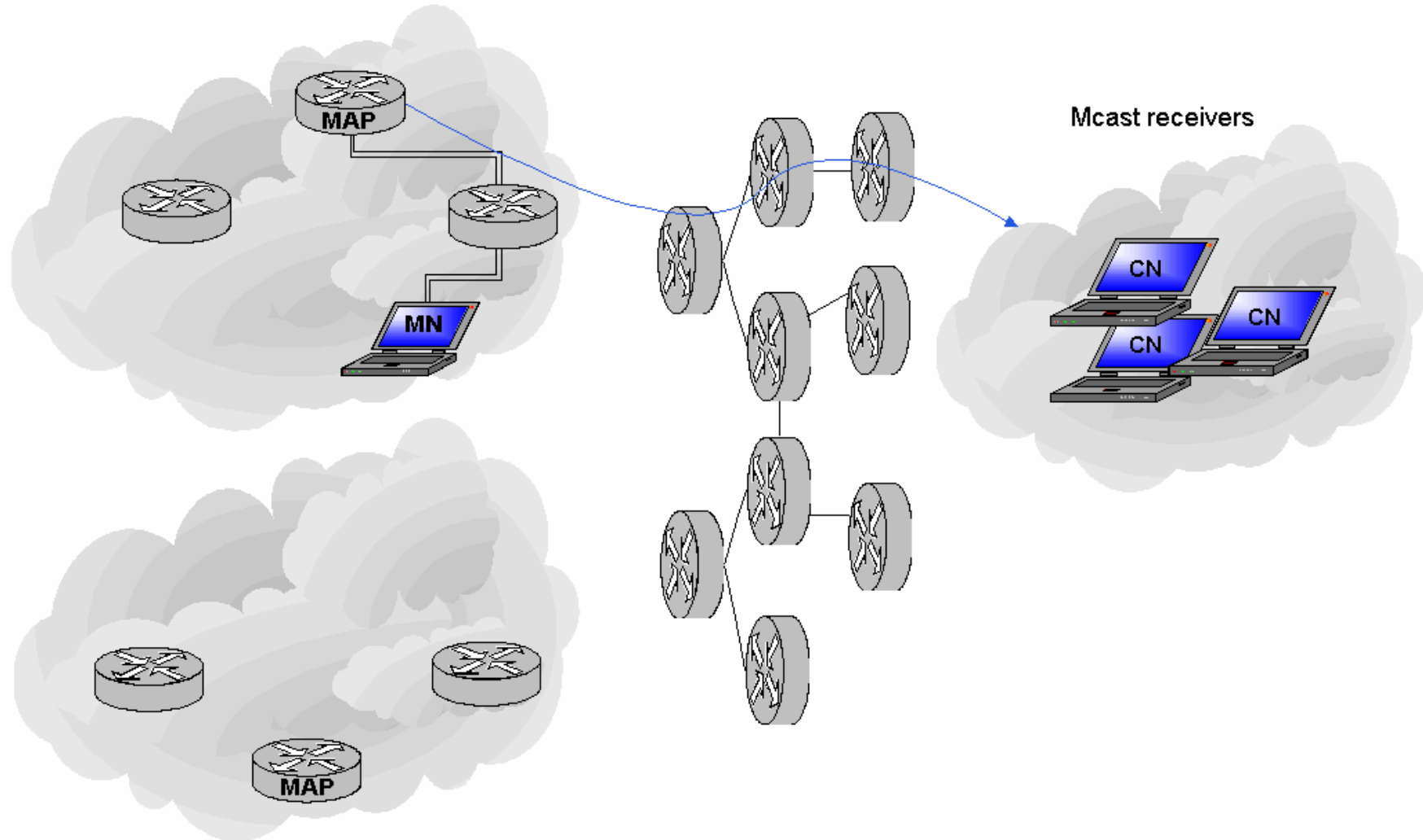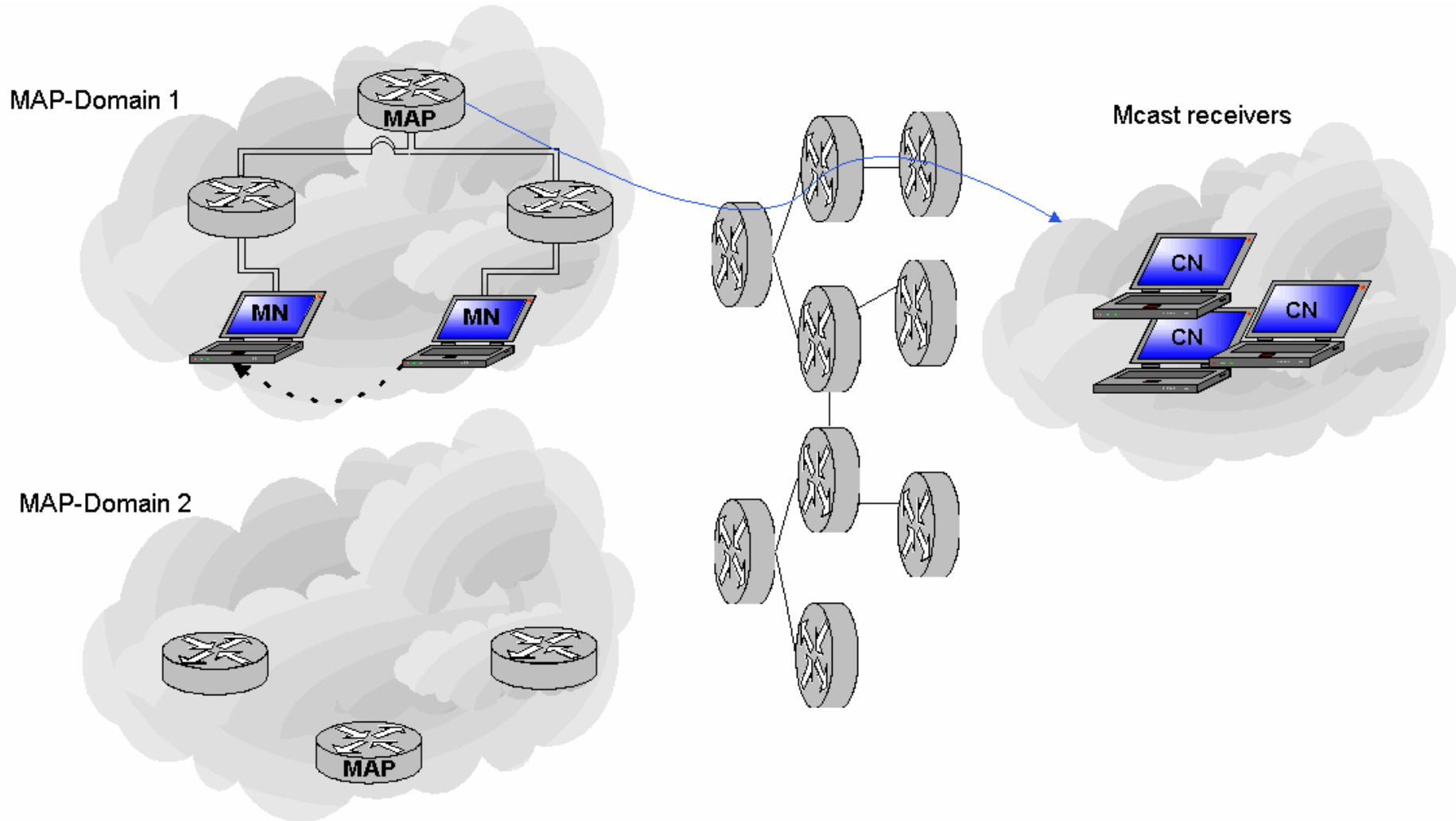# Predictive versus Reactive HO?

Erroneous Prediction Yields

Schmidt, Wählisch: "Predictive versus Reactive – Analysis of Handover Performance and its Implications on IPv6 and Multicast Mobility." In: *Telecommunication Systems*, to appear 2005.
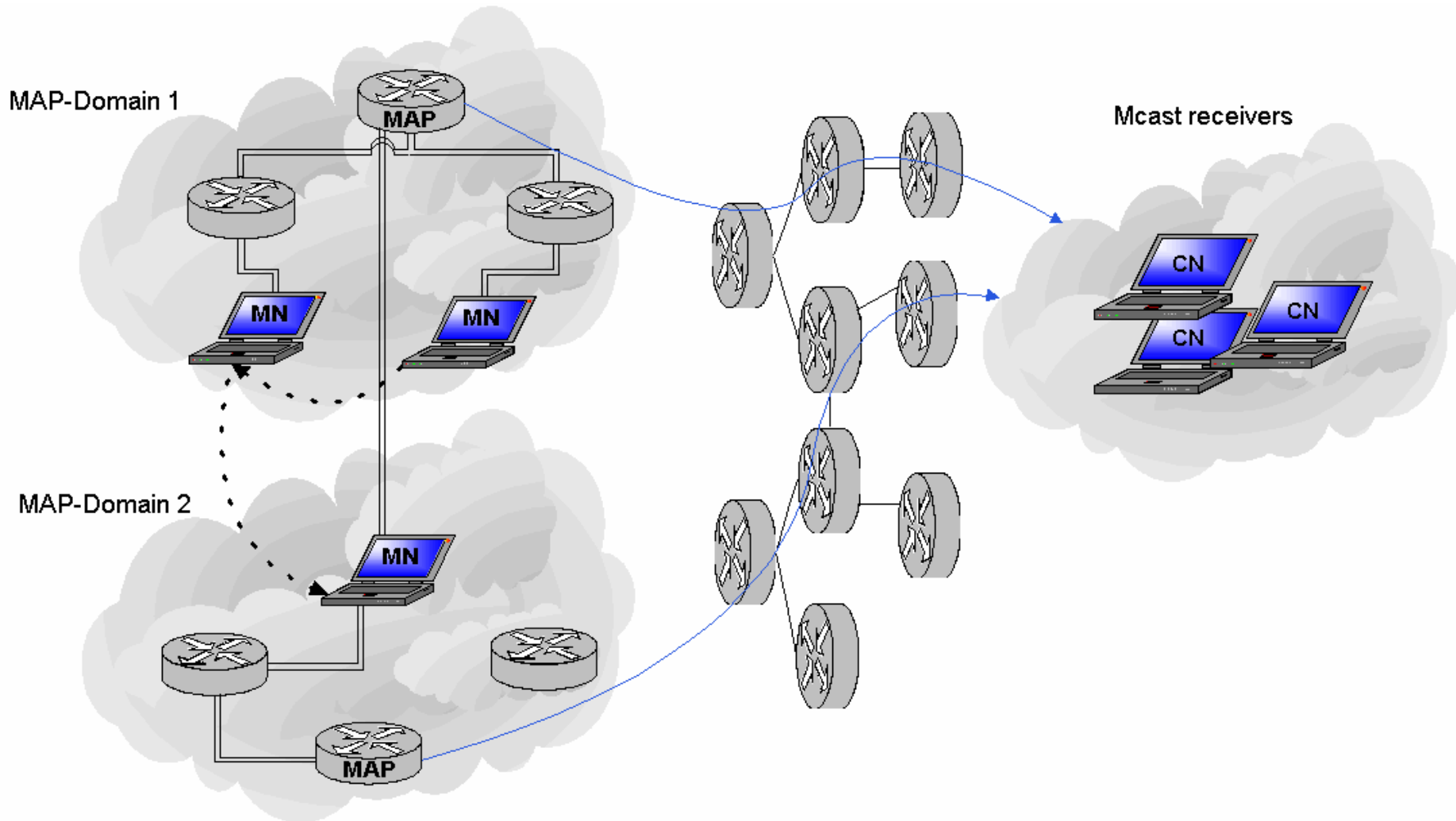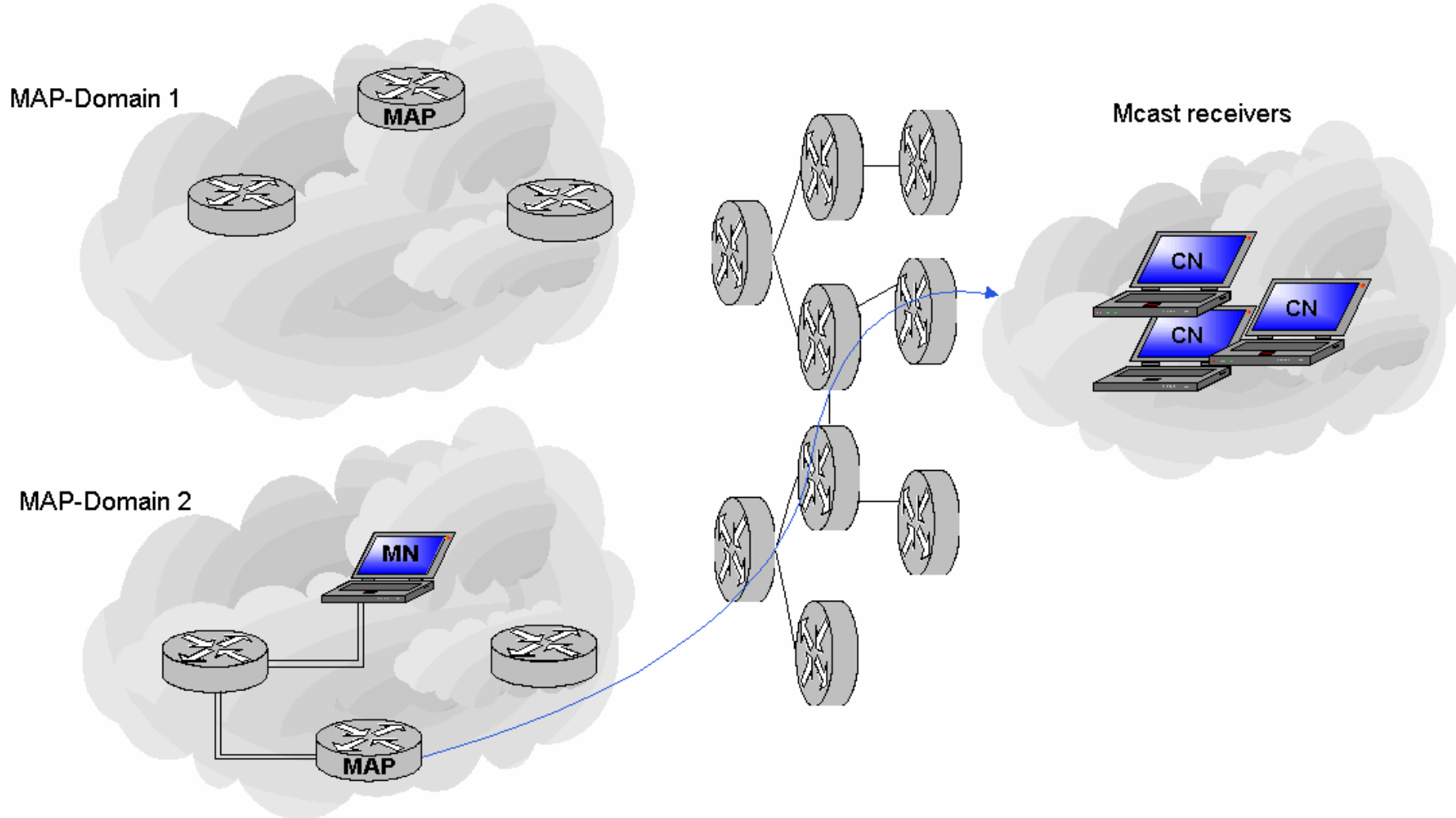
M-HMIPv6: Multicast Source

M-HMIPv6: MAP-Local Handover

M-HMIPv6: Inter-MAP Handover (1)

M-HMIPv6: Inter-MAP Handover (2)

M-HMIPv6: Mobile Multicast Listener

Anchored at MAP:

o MN : MAP – tunnel using RCoA

o Group membership management through MAP

o On Intra-MAP handover: unicast BU (HMIPv6)

o On Inter-MAP handover:

- BU with previous MAP (packet forwarding)

- Subscribe through new MAP

- On traffic reception: BU with 0 lifetime (stop forwarding)

o Optimisation: Remote subscription with MAP attendance

M-HMIPv6: Mobile Multicast Sender

Anchored at MAP:

o MN : MAP – tunnel using RCoA + HoA option

o Use separate/no binding cache (unicast hijacking)

o On Intra-MAP handover: unicast BU (HMIPv6)

o On Inter-MAP handover:

- BU with previous MAP (continue packet submission)

- Tree initialisation through new MAP:
  Send empty probes (IPv6-NoNxt value)

- HO on (protocol dependent) timeout

o No bi-casting needed

Robustness

o Topology

  M-HMIPv6 is unaffected by long distance topology
  (local 'step size' only)

o Rapid Movement

  M-HMIPv6: Remain with previously
  established MAP (or HA)

  $\rightarrow$ Forwarding will function for large scale of
  handover frequency, but delays may increase

o M-HMIPv6 smoothly extends BT

Conclusions & Outlook

M-HMIPv6:

- Smooth handover within unicast infrastructure

- Reduced # of handovers

- 'Smoothed' mcast routing, robust in rapid mobility
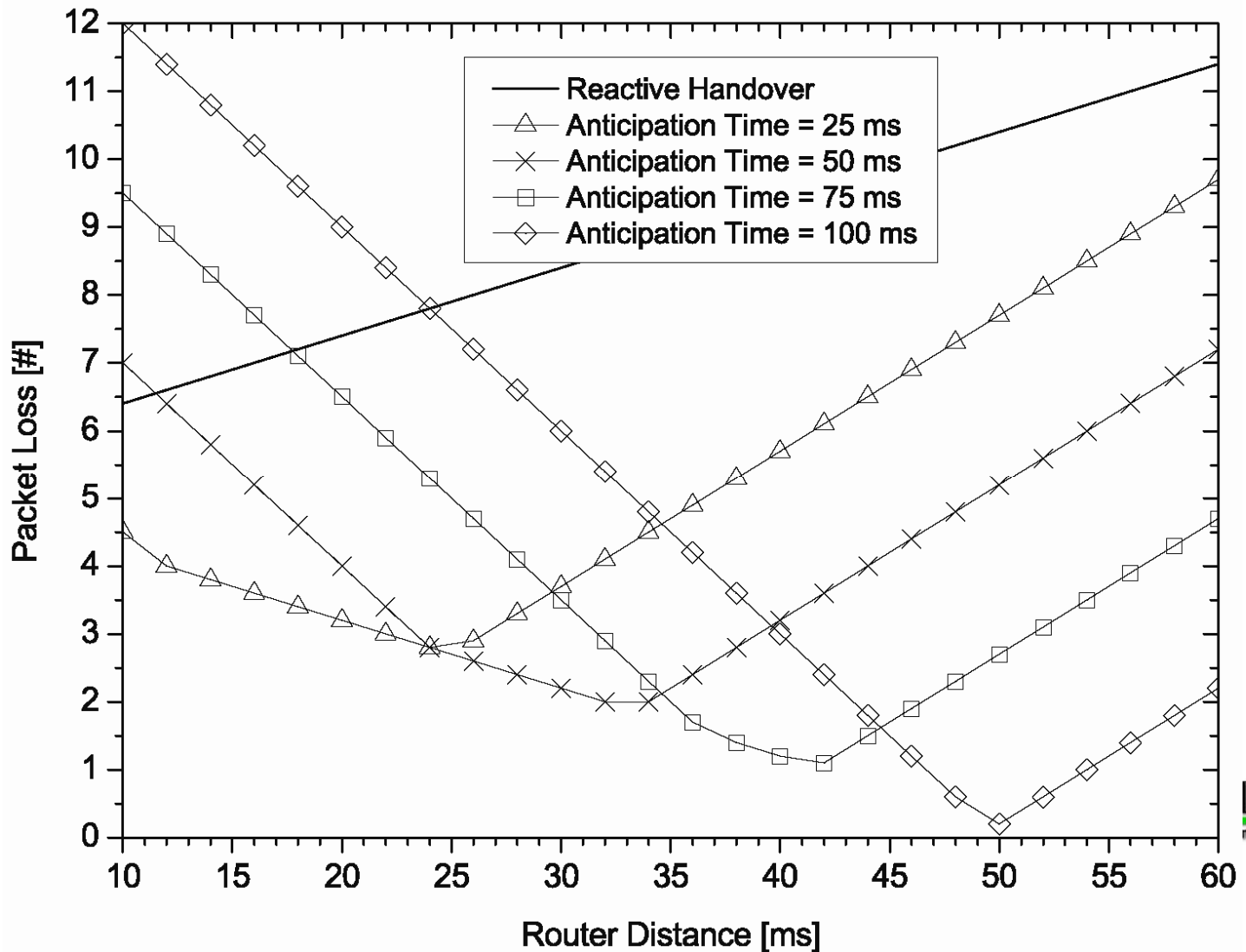
Future Work:

- Follow HMIPv6 development

- Look at Multicast Source Mobility for SSM

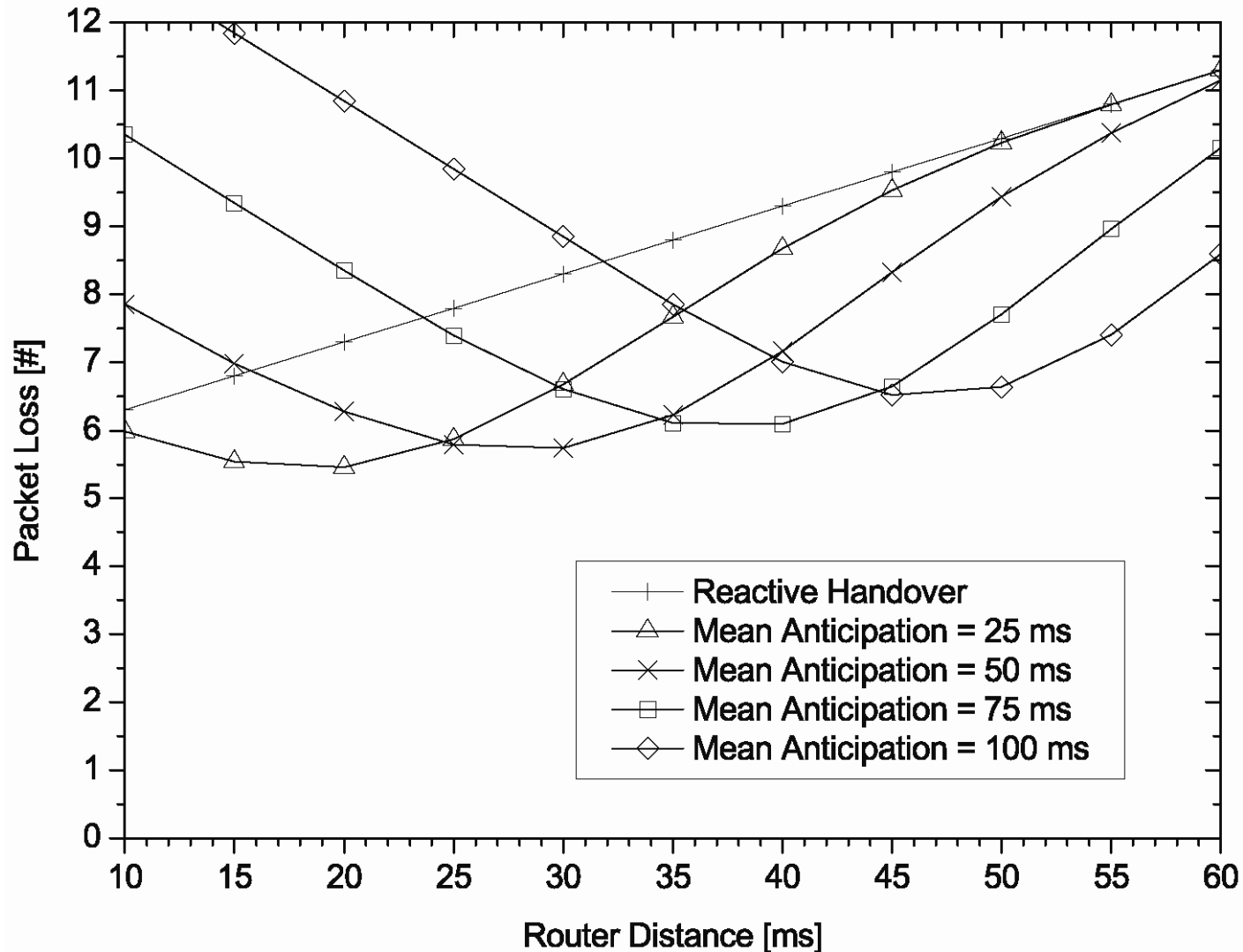- ?? Your comments/ideas for improvement ??
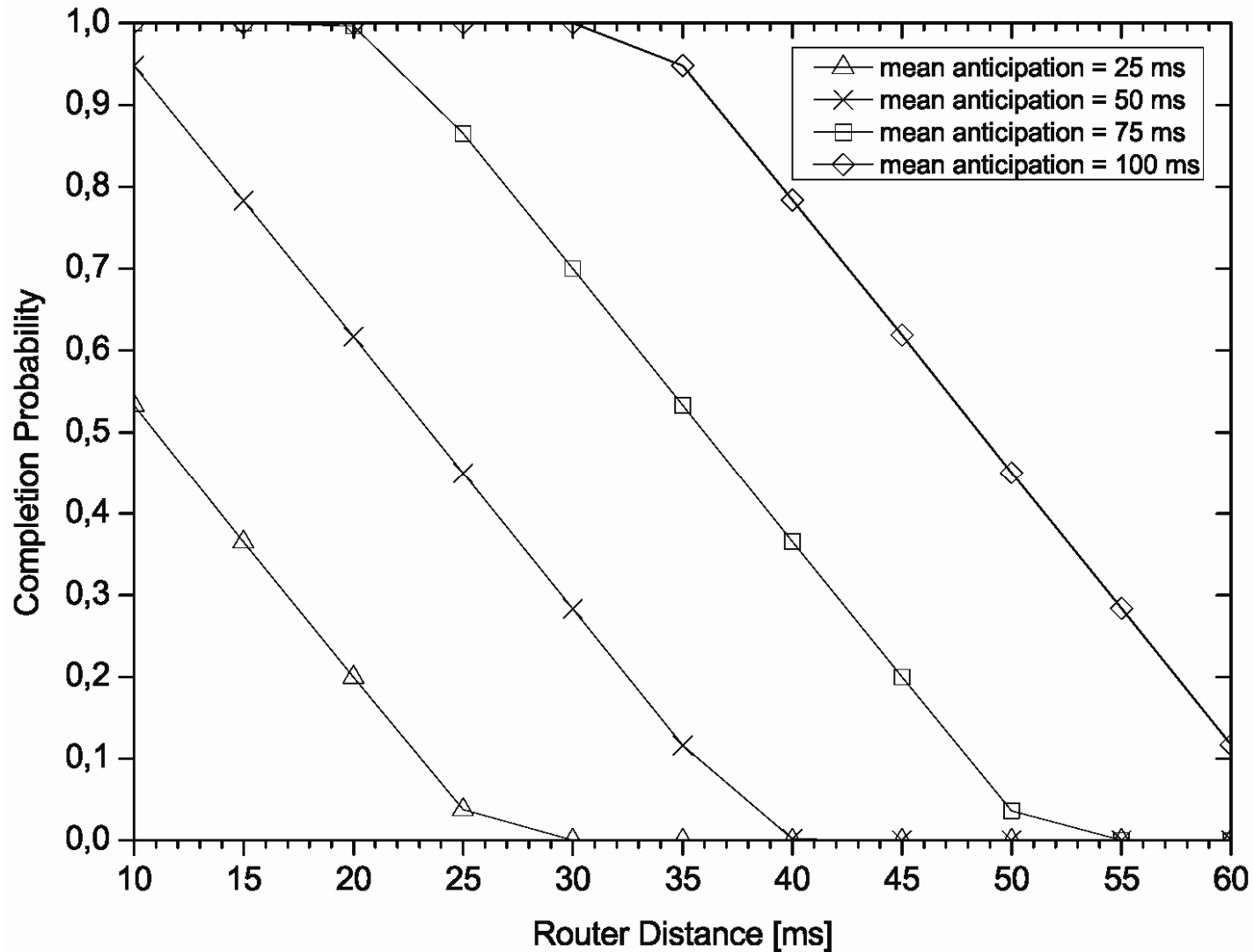
Backup Slides

o HO Performance

o HO Frequencies

Predictive versus Reactive: Analytical Comparison
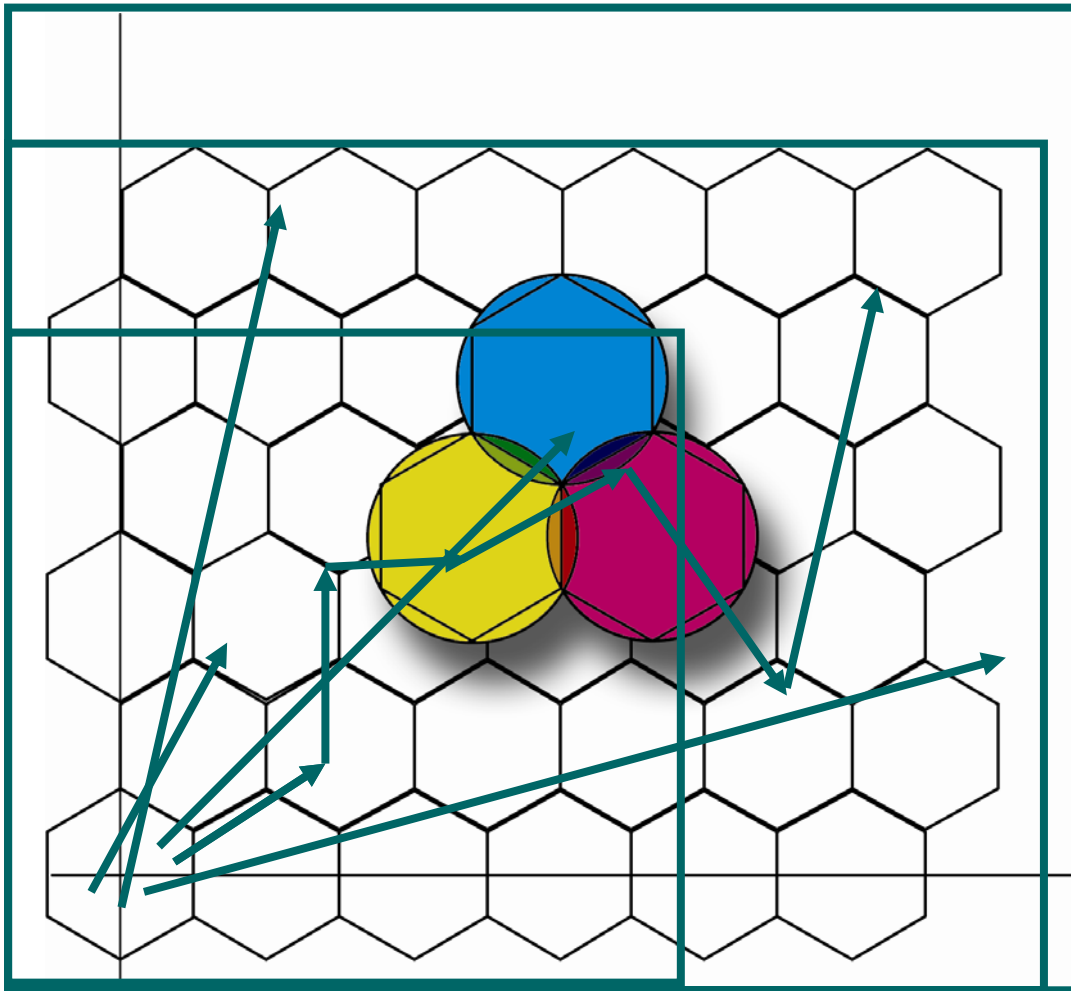
Predictive versus Reactive: Simulations

Problem: Completing the Prediction

Handover Predictions: Stochastic Simulation

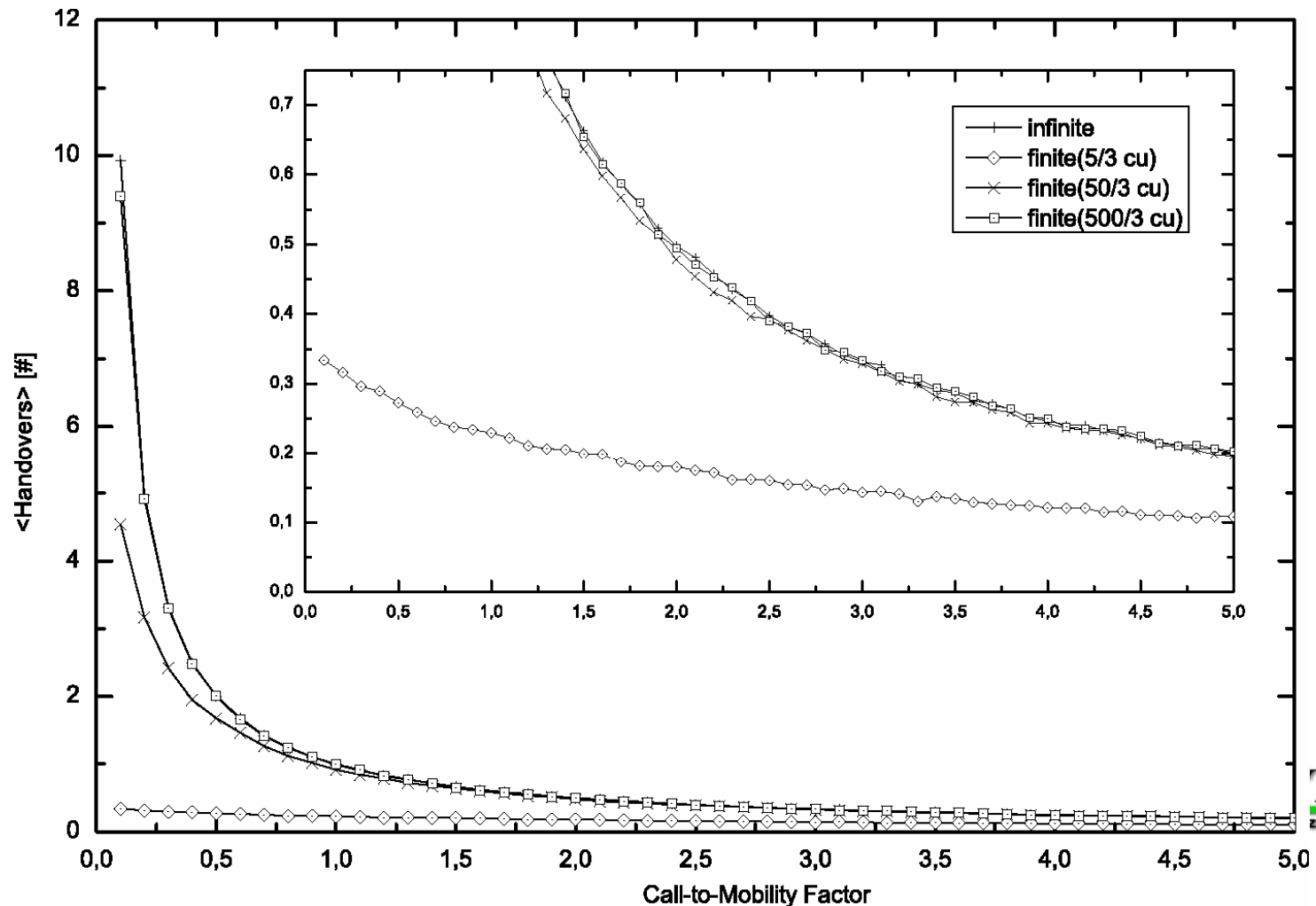Models:

Random Waypoint

Varying Geometry

Random Direction

Varying Geometry

Varying Speeds

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Mean Handover Frequencies: Random Direction Model

Sources of Erroneous Prediction