Performance Analysis of Multicast Mobility in a H-MIP Proxy Environment

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MIPv6 Ready for Release – and Now?

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What may we expect?

- o Devices using Home Address while away
- o ‘Workspaces’ roaming between local subnets
  - + Improvements on handover performance
  - + 3G Mobiles operating IP
  - + ...
- o VoIP/VCoIP conferencing: real-time mobility
- o Group communication by Mobile Multicast

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Agenda

- Multicast Mobility
- Current Proposals
- Performance Analysis
- Conclusions & Outlook

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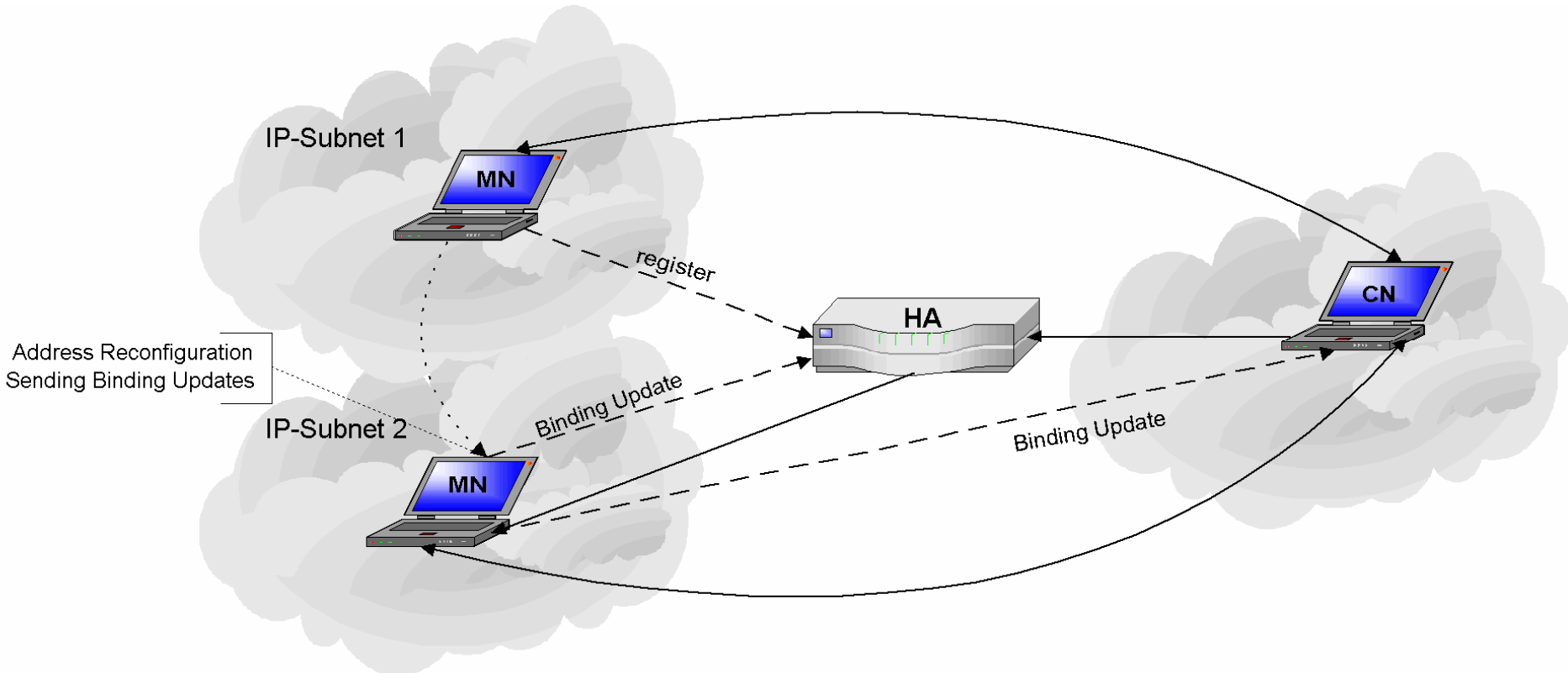
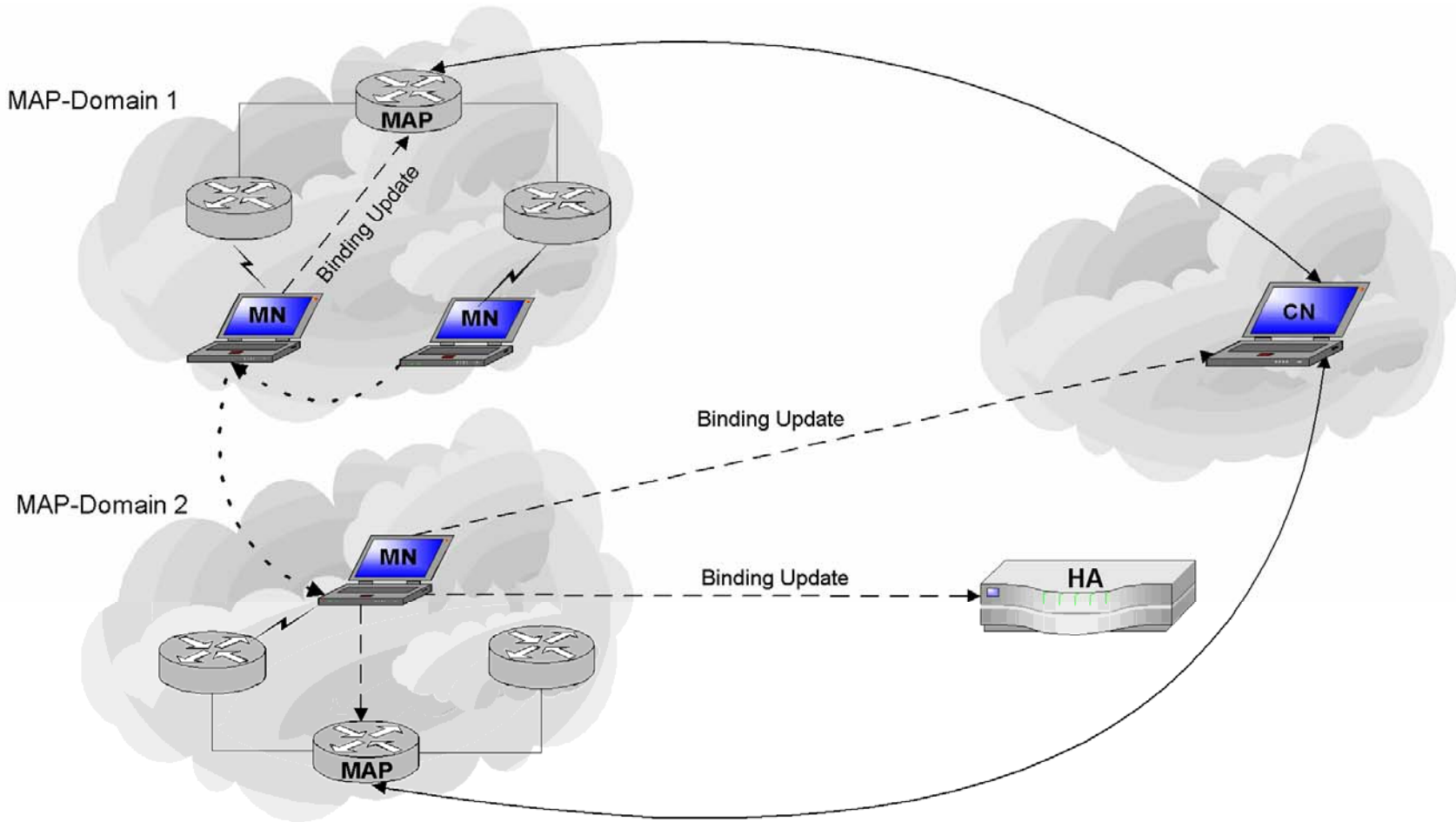
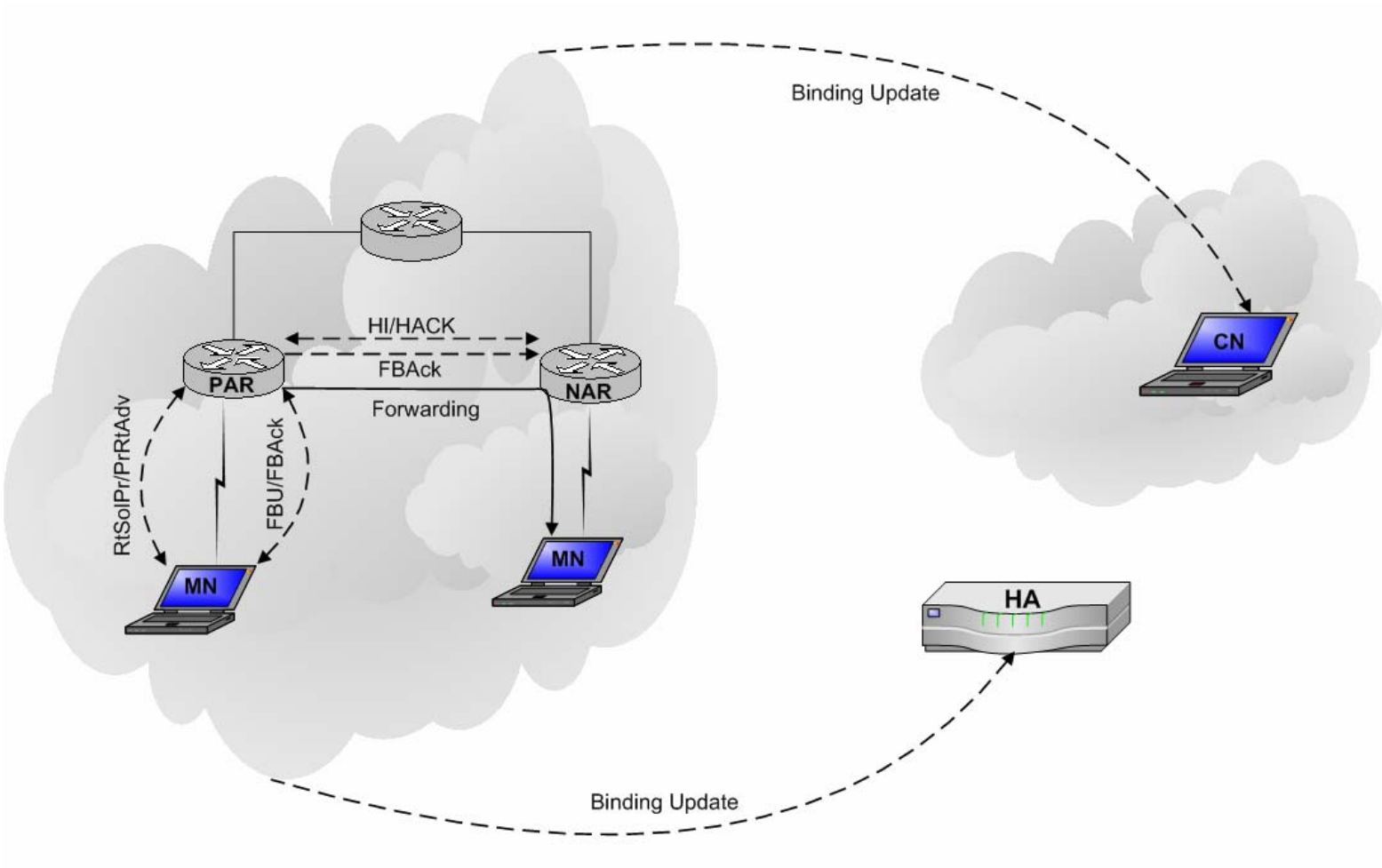
Mobile IPv6


IP-Subnet 1
MN
register
HA
CN
Address Reconfiguration
Sending Binding Updates
IP-Subnet 2
Binding Update
Binding Update
MN

Proxy: Hierarchical MIPv6



Delay Hiding: Fast MIPv6



Mobile Group Conferencing

- o Bi-directional multicast capabilities needed
- o Mcast applications source address aware
- o Problem: asymmetric, slow convergence
  - up to ≈ 30 s at listener
  - up to ≈ 3 min at sender
  - Routing source address dependent through source or shared trees
- o Comply with unicast mobility infrastructure

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Multicast Mobility Approaches

- Bi-directional Tunneling
  - Hide all movement by tunneling via Home Agent
- Remote Subscription
  - Show all movement by local multicast subscription
- Agent Based
  - Compromise: Intermediate agents shield Mobile

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Fast Multicast Protocol for MIPv6

draft-suh-mipshop-fmcast-mip6-00

- Remote subscription with agent support
- Mobile multicast reception only
- Built on Fast Handovers for MIPv6 (FMIPv6)
  - Predictive handovers based on L2 : L3 map
  - Handled at access routers
- Extends signalling of FMIPv6 by multicast address option

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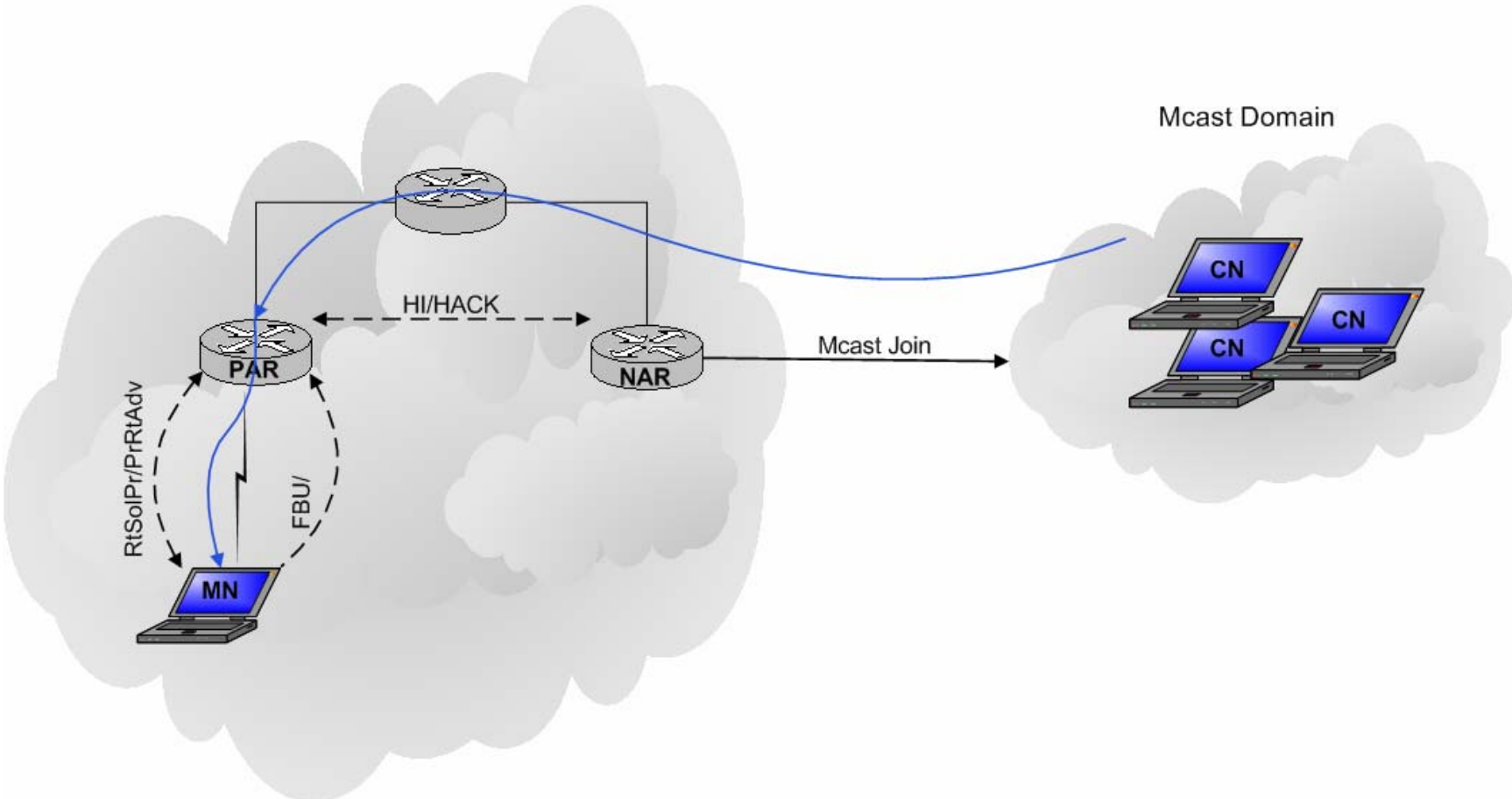
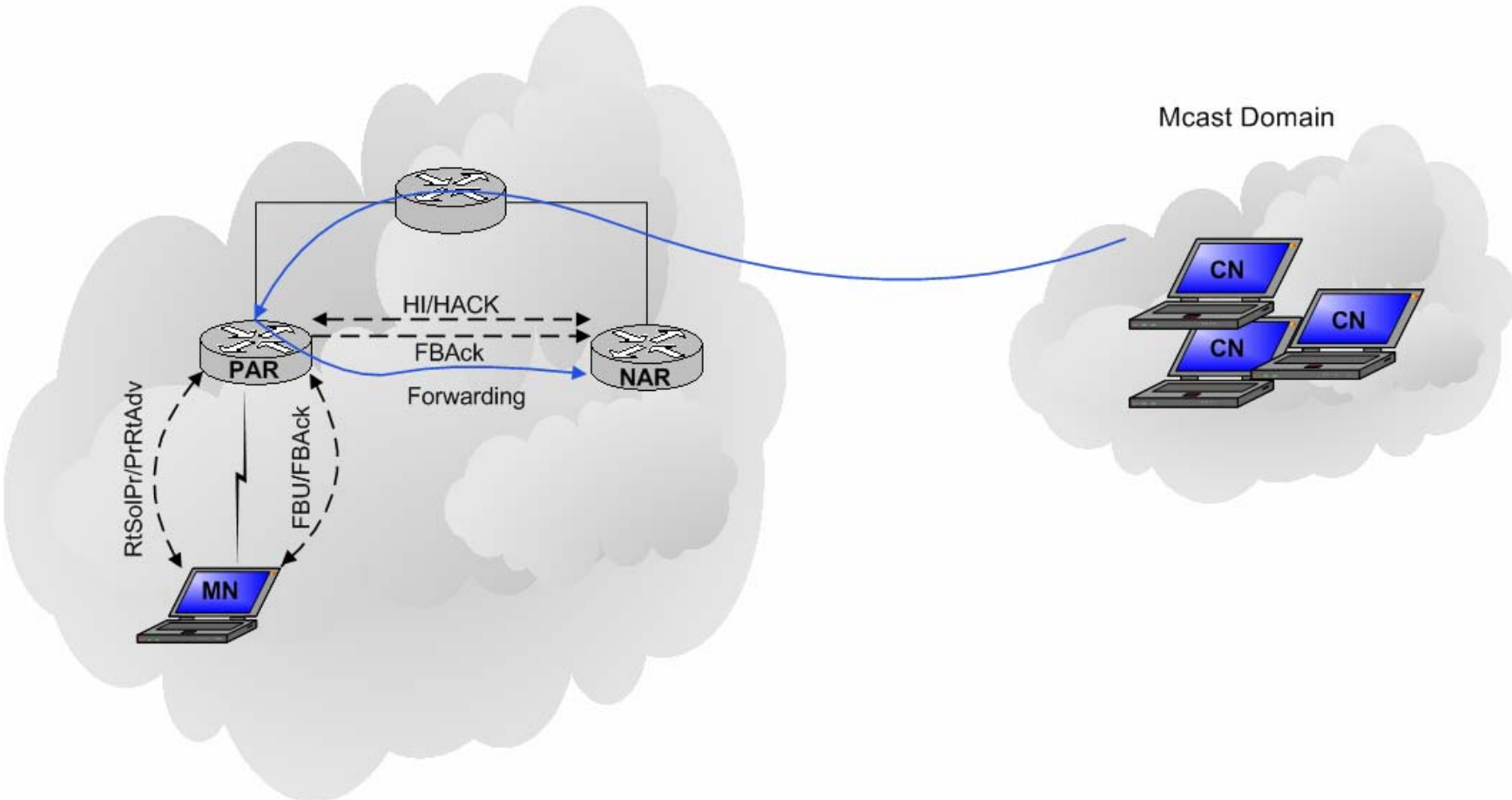
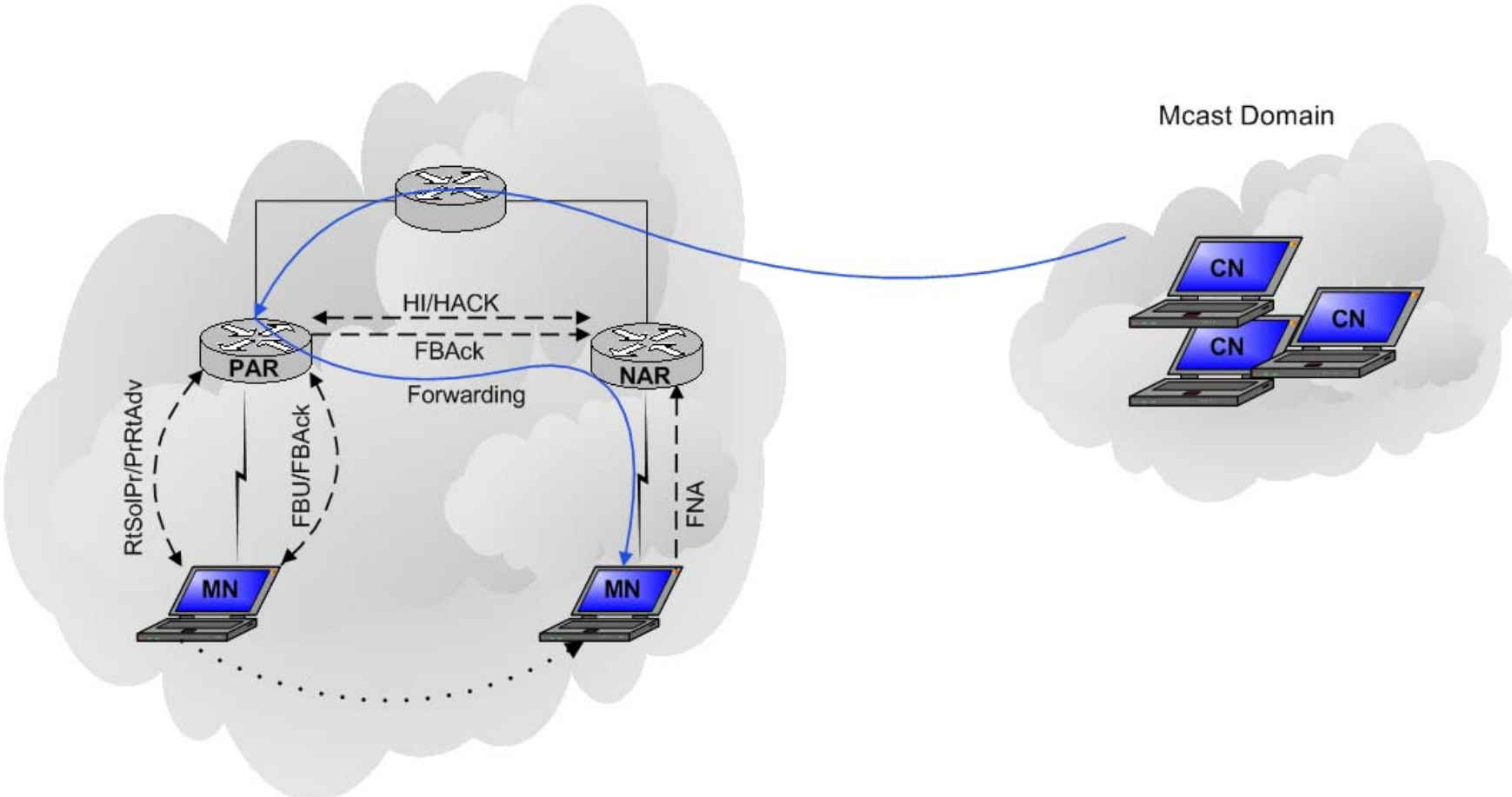
M-FMIPv6: Prediction



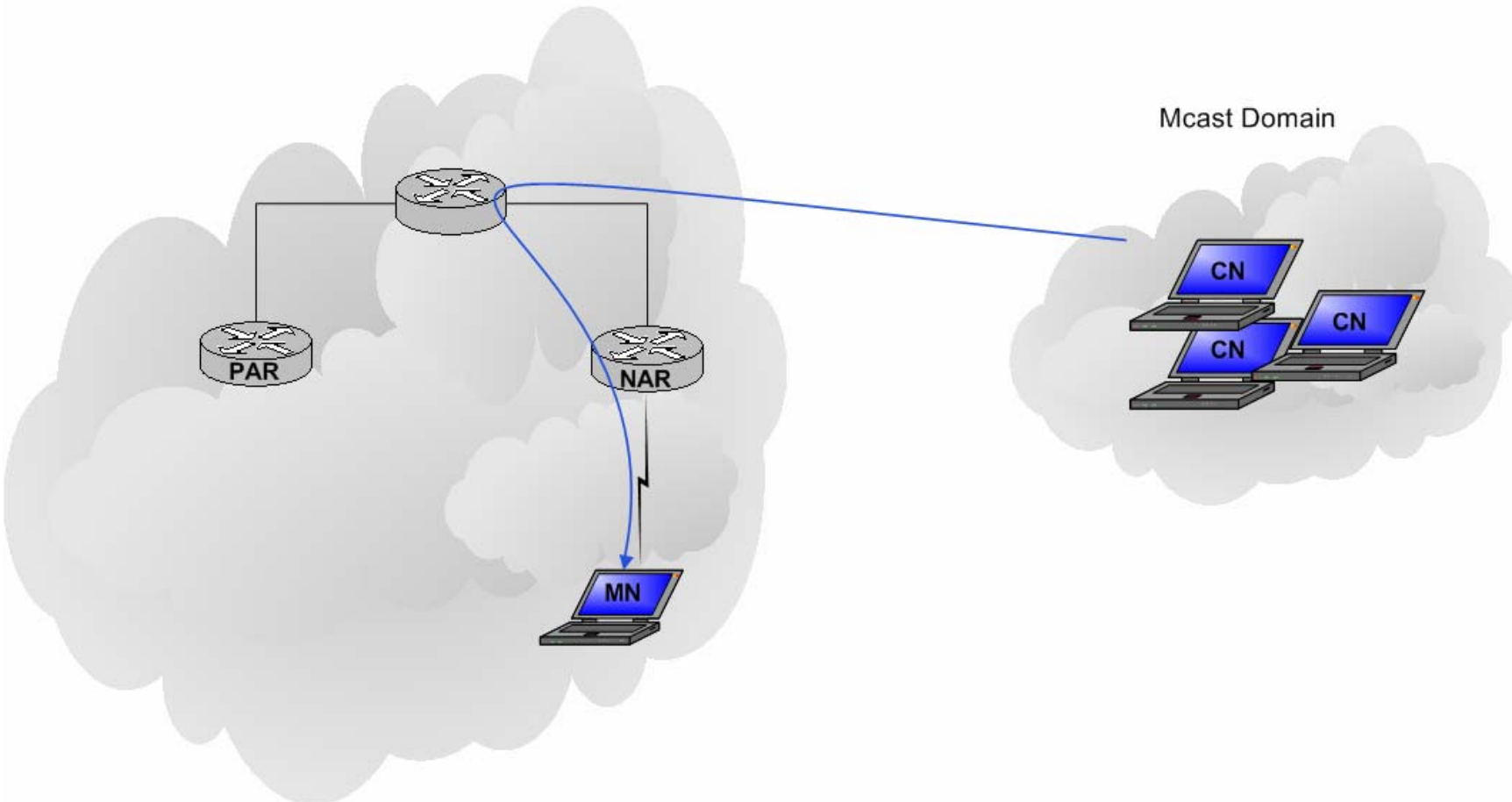
M-FMIPv6: Forwarding



M-FMIPv6: Handover



M-FMIPv6: Completion



Seamless Multicast Handover in a HMIPv6 Environment

draft-schmidt-waehlisch-mhmipv6-01

- 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
- o Extends signalling of HMIPv6 by multicast advertisement flag

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M-HMIP: Mobile Multicast

Mobile multicast listener anchored at MAP:

o Group membership management through MAP

o On handover: packet forwarding to MN through previous MAP

Mobile multicast sender anchored at MAP:

o Use Home Address Destination Option (CN must not verify BC on mcast)

o On handover:
bicast through old and new MAP

o On rapid Movement:
stay with established MAP

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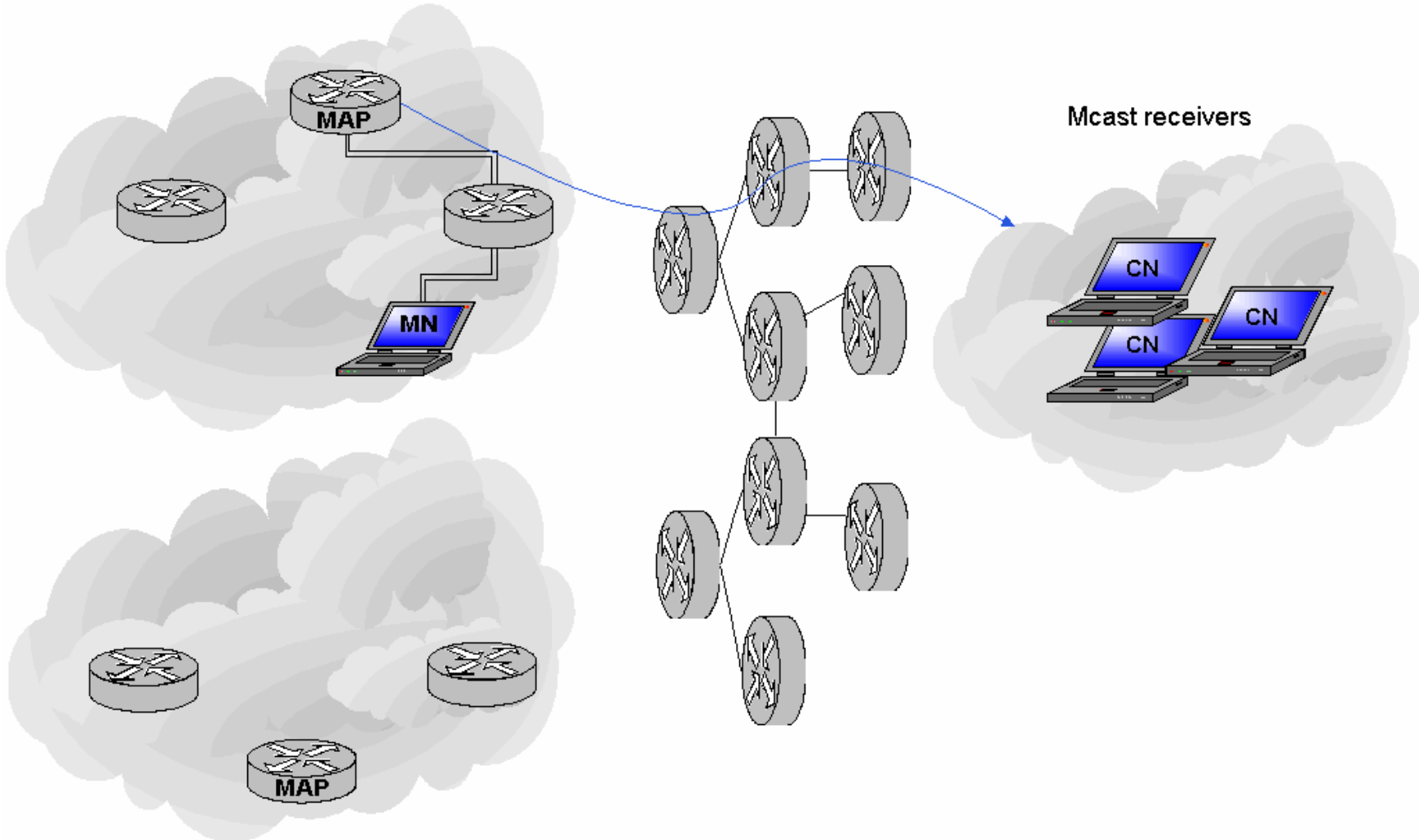
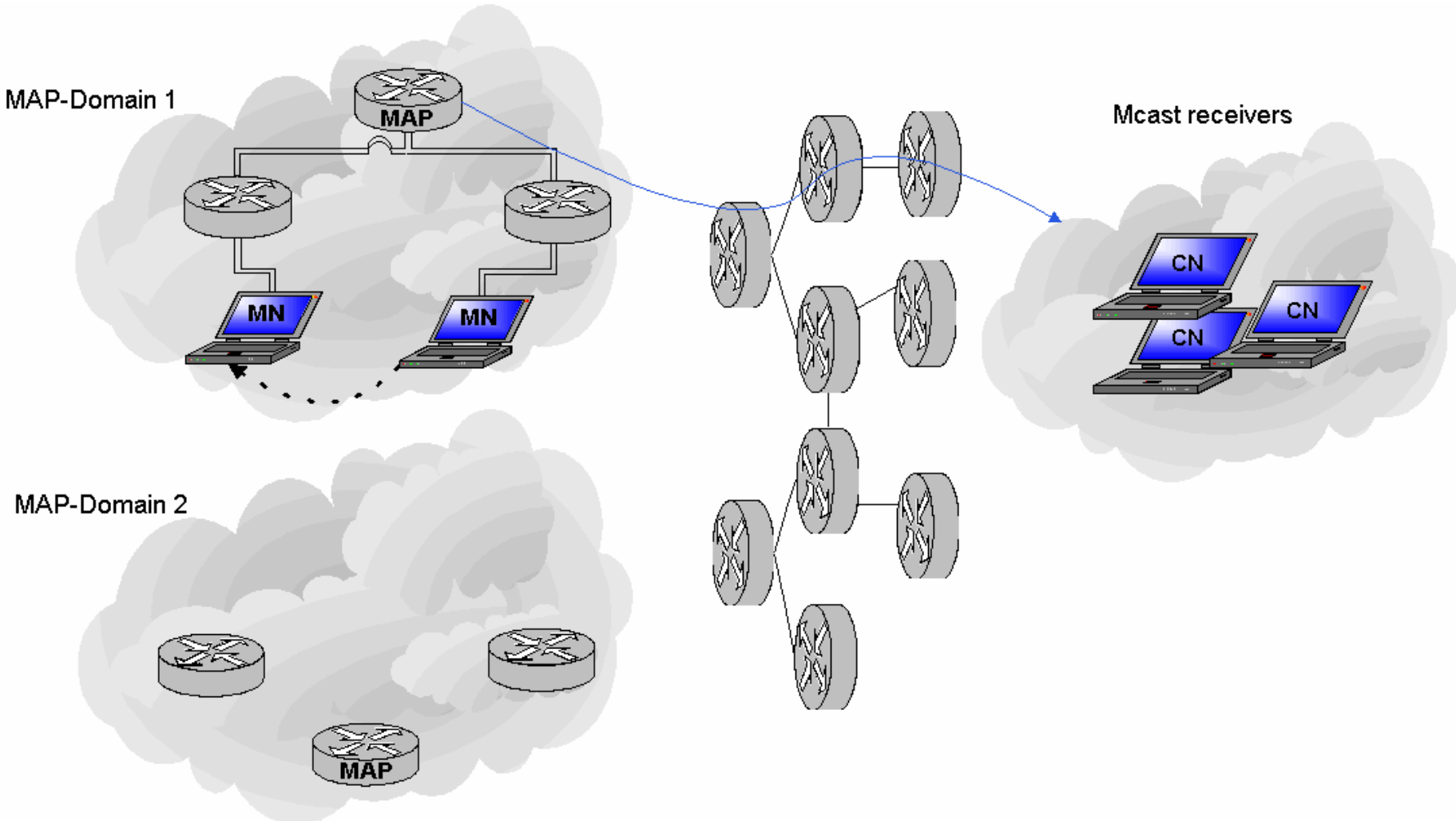
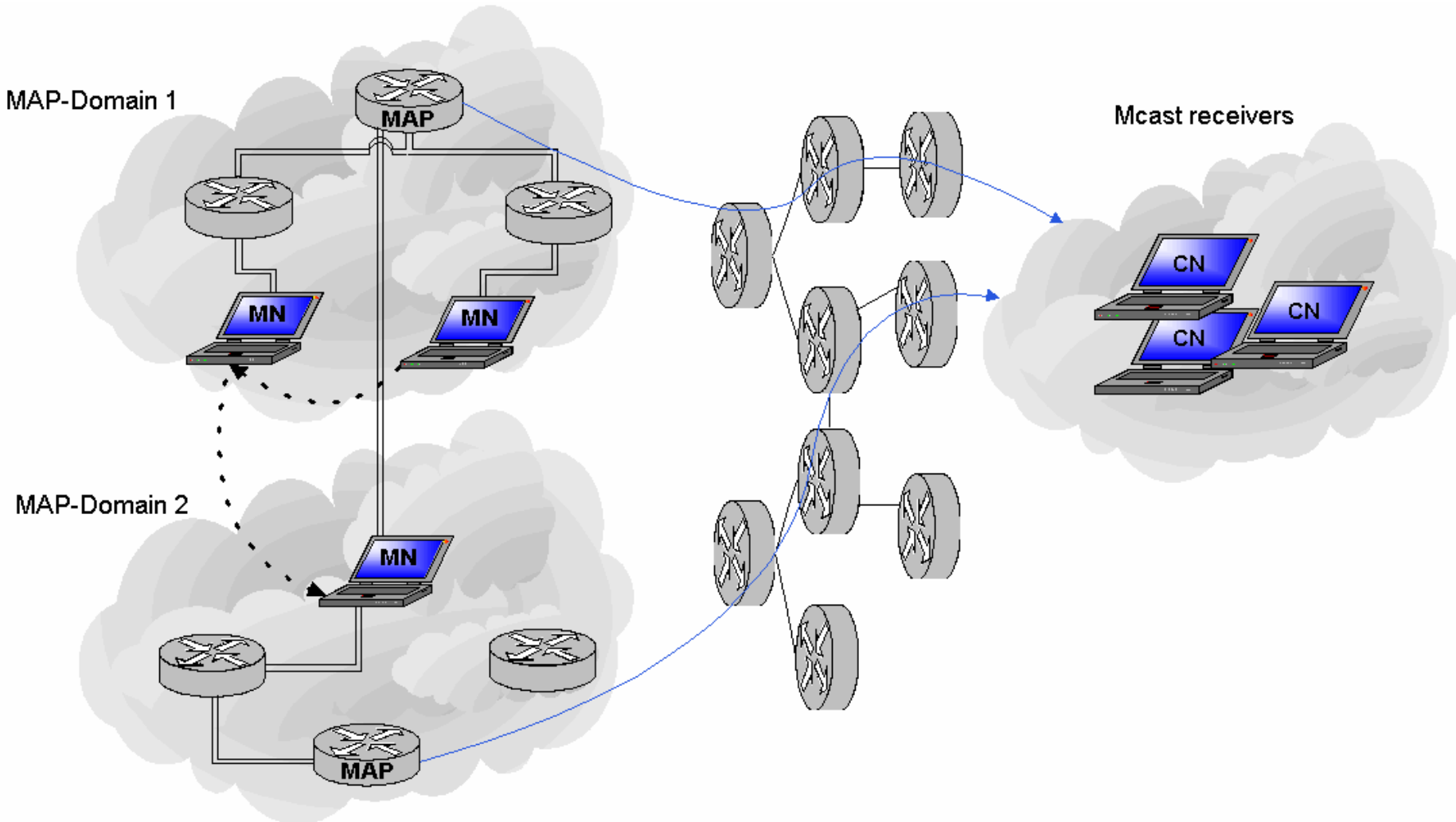
M-HMIP: Multicast Source



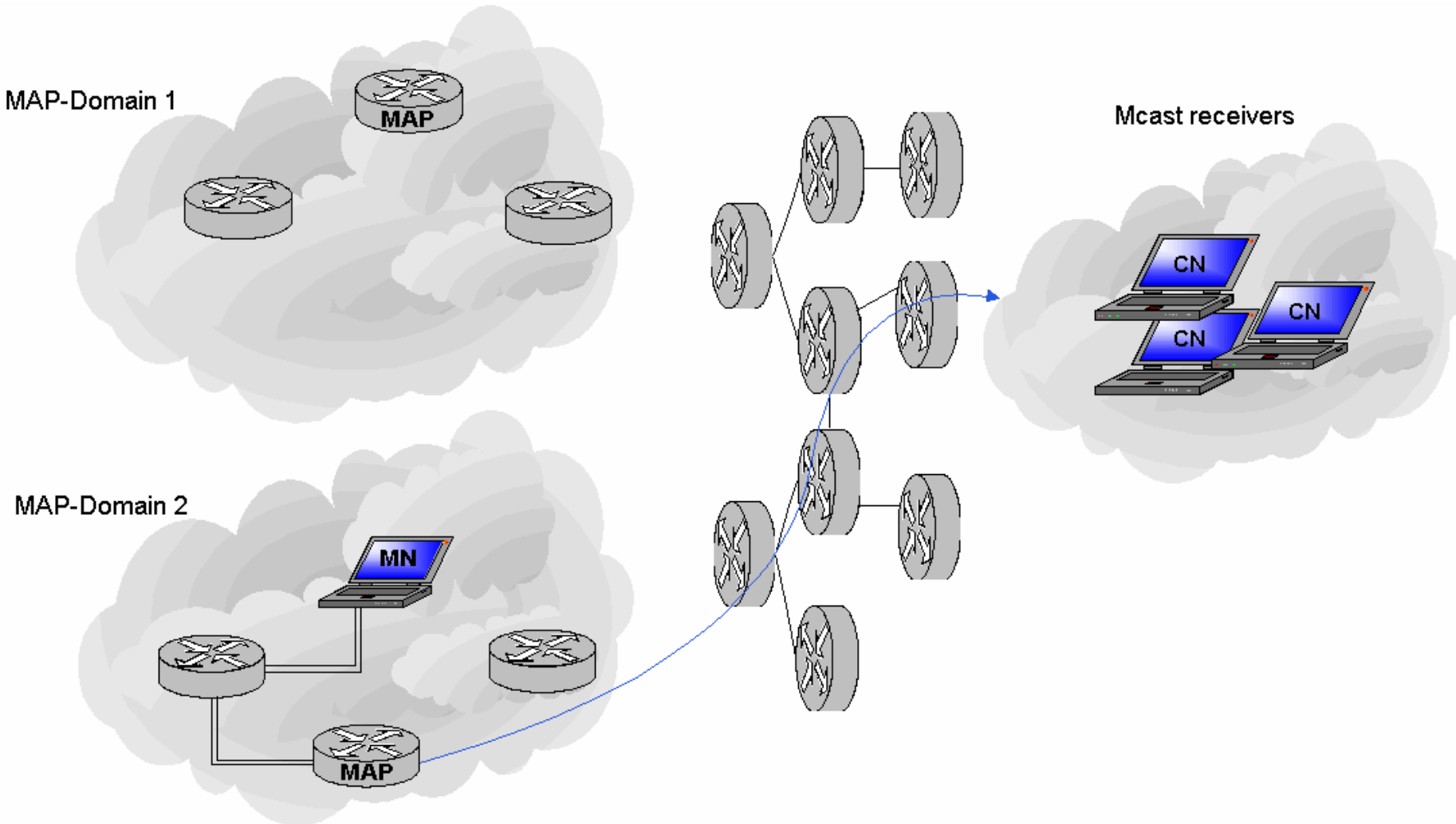
M-HMIP: MAP-Local Handover



M-HMIP: Inter-MAP Handover (1)



M-HMIP: Inter-MAP Handover (2)



Handover Analysis (listener)

Relevant criteria

- Handover performance: packet loss, delay + jitter
- Number of performed handovers
- Number of processed handovers
- Robustness (topological, rapid movement)
- Signalling overhead

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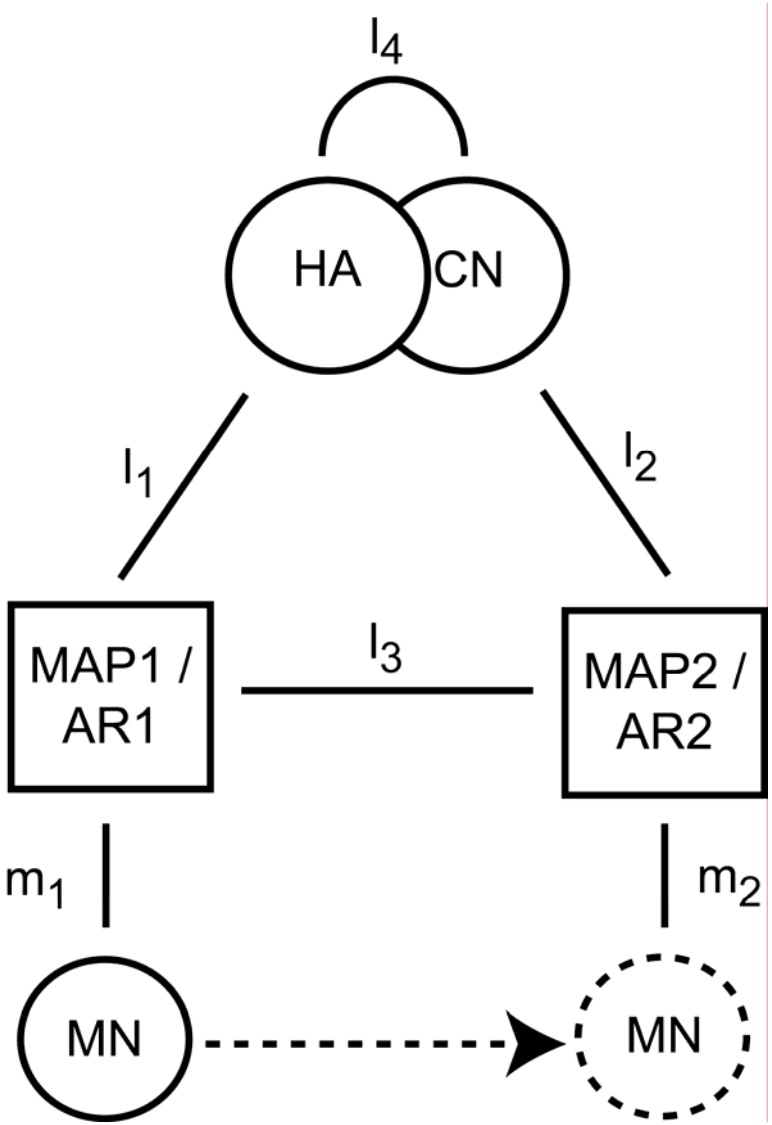
Handover Performance



Simple analytical model:

- Compare reactive vers. predictive handover
- Characteristic to problem: Router distance t_{l3}
- Charac. to predictive HO:

$$2t_{l3} - t_{L2}$$

- Charac. to reactive HO:

$$t_{l3} + t_{L2}$$

Stochastic Simulation

- o Constant bit rate traffic from CN/HA (at 10 ms)
- o Random perturbations (ξ) at each link
- o Parameters:
  - Anticipation Time: **<x> = 50 ms, ξ = 30 ms**
  - L2 Handoff: **<x> = 50 ms, ξ = 10 ms**
  - Local Links: **<x> = 2 ms, ξ = 1 ms**

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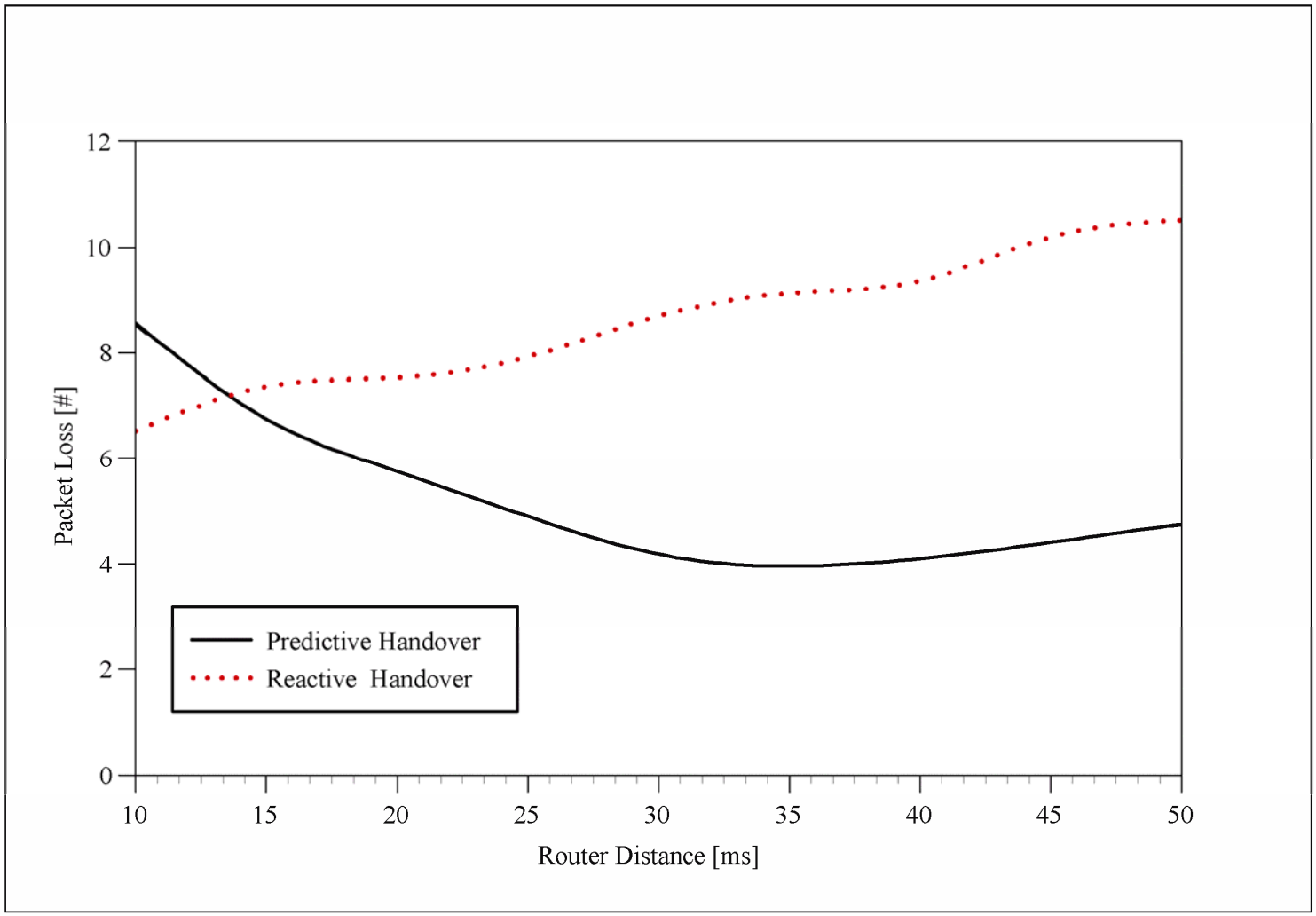
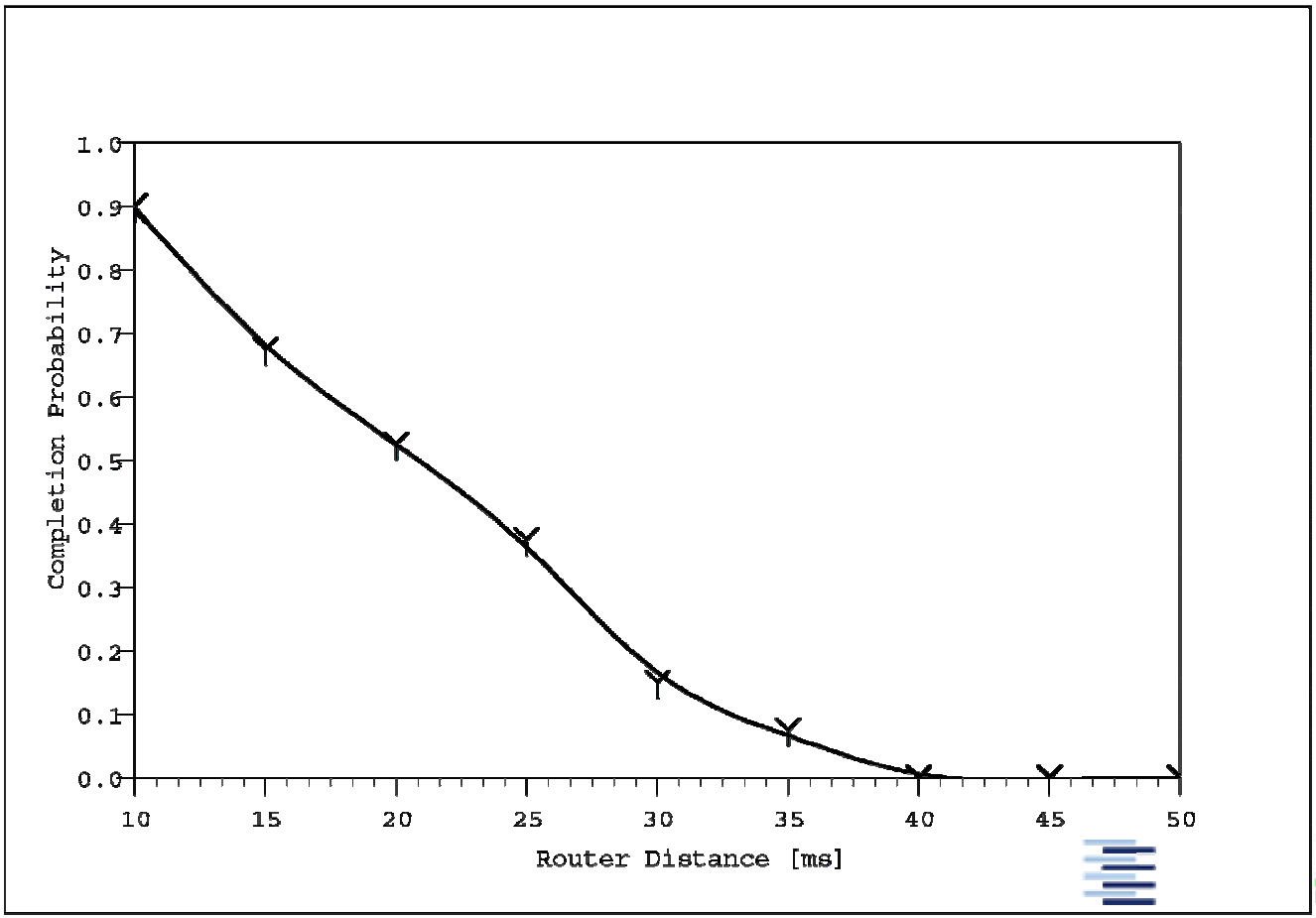
Simulation: Packet Loss



Simulation: Probability of Successfully Completing Prediction



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Number of Handovers

Relevant quantities:

- Cell residence time
- Call holding time
- AR-to-MAP ratio

Modelling assumptions:

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

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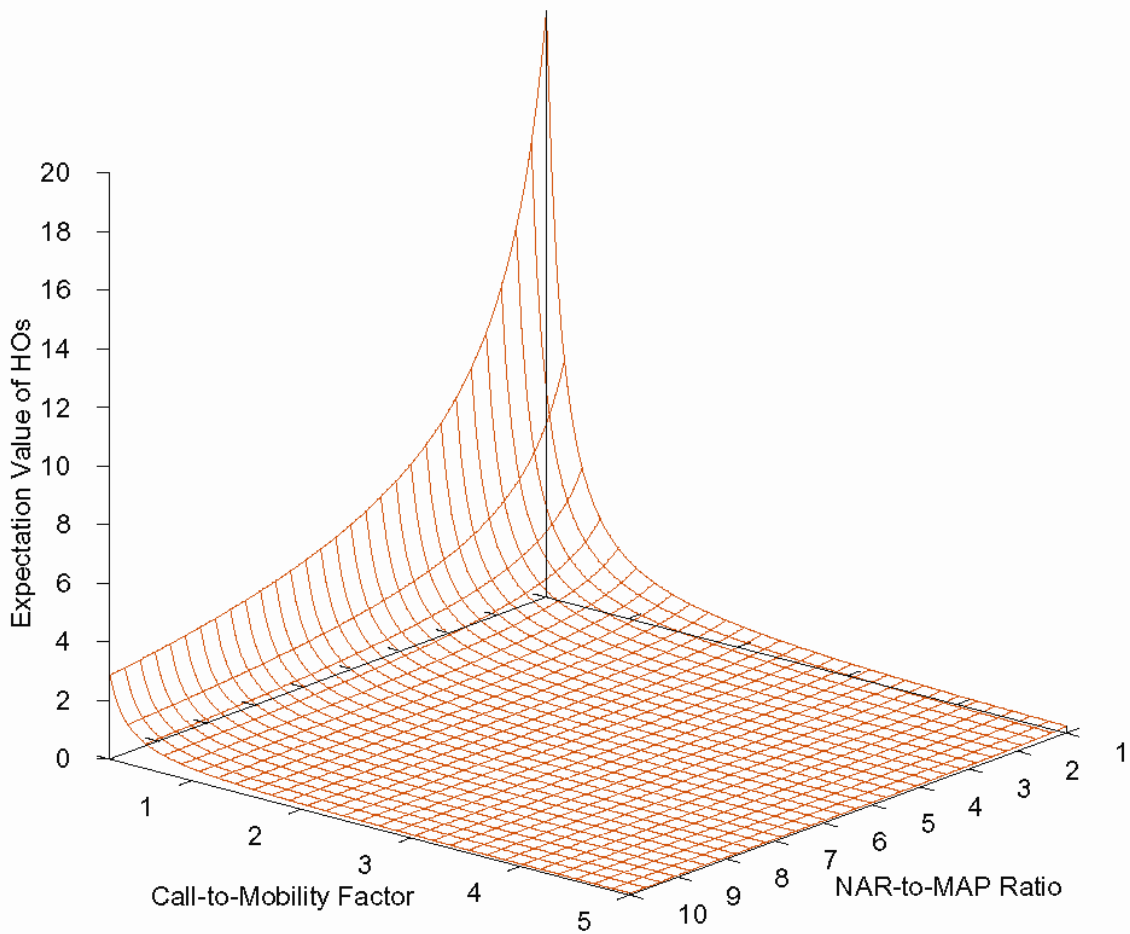
Expected # of (proc.) Handovers

Analytical result:

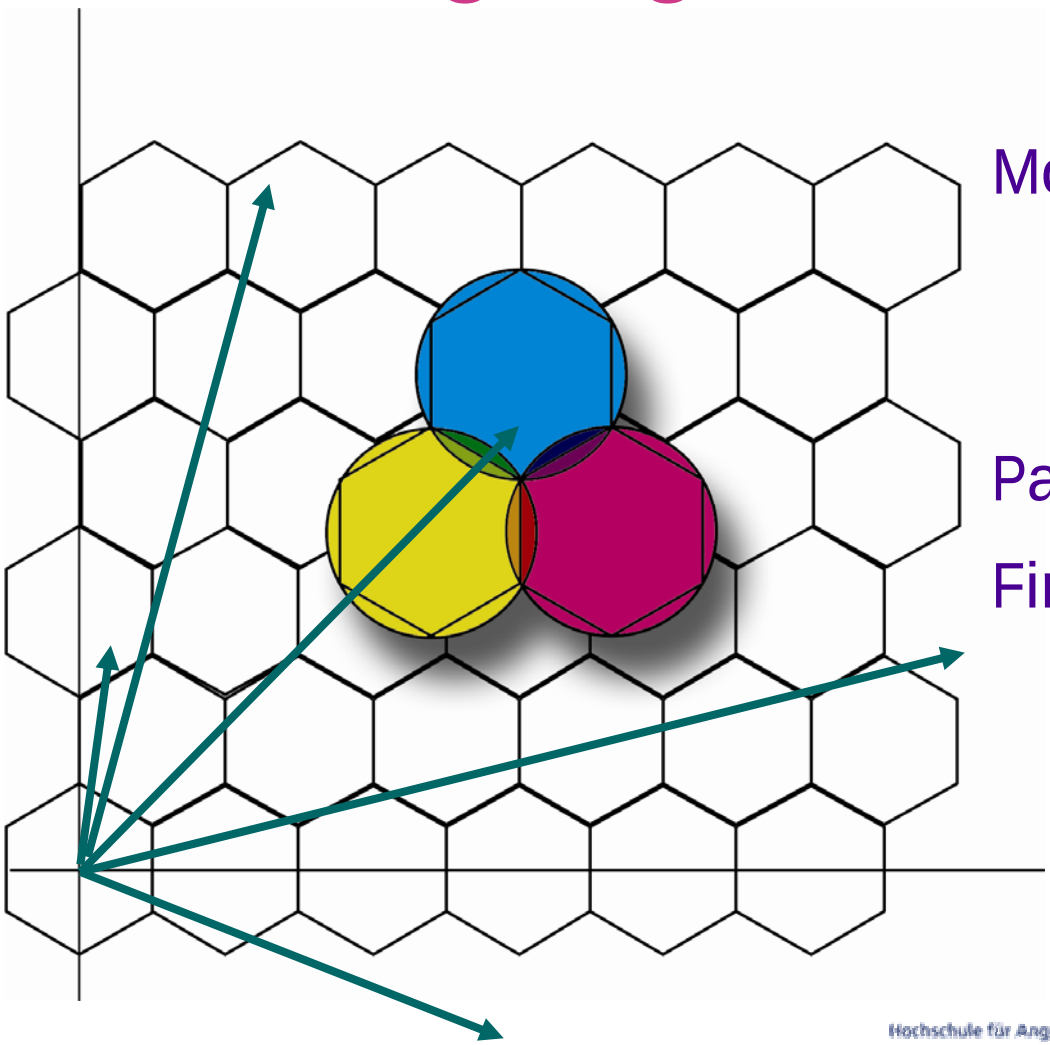
ρ = Call-to-mobility factor

k = AR-to-MAP ratio

$$\mathrm{E}[HO] = \frac{1}{k\rho^2} + \frac{1}{\sqrt{k}\,\rho}$$



Overpredicted Handovers: Ongoing Simulation



Model:

- Boundary-free Random Waypoint

Parameters: Pedestrian

First results:

- 20 % obsolete predictions

Robustness

- Topology
  - M-FMIPv6 and M-HMIPv6 both are unaffected by long distance topology (local ‘step size’ only)
- Rapid Movement
  - M-FMIPv6: Forwarding will fail for handover intervals below signalling period
  - M-HMIPv6: Forwarding will function for any handover frequency, but delays may increase

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Signalling Overhead

M-FMIPv6:

- Advertisement
- 7 messages per handover (+MIPv6 +mcast)

M-HMIPv6:

- Advertisement
- 1 message per micromobile handover
- 2 messages per MAP handover (+MIPv6 +mcast)

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Conclusions & Outlook

√ Two mobile multicast approaches: M-FMIPv6 (mcast listeners) & M-HMIPv6 (mcast listeners & senders)

√ M-FMIPv6:

- Faster handovers at intermediate router distance (≈ 20 ms).
- ‘Nervous’ Routing demands, will fail at rapid mobility

√ M-HMIPv6:

- Reduced # of Handovers at compatible timing
- ‘Smoothing’ mcast Routing, robust in rapid mobility

Future Development:

- Further analysis & simulations of motion sceneries, Optimisation