Multicast Mobility in MIPv6: Problem Statement Update

- draft-schmidt-mobopts-mmcastv6-ps-01.txt -

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Scope

- Status of the Draft
- Recall: Mobile Multicast Key Issues
- Mobile Source Problem
- Characteristics of Multicast Routing Trees under Mobility
- Solution Space
- Deployment Issues

Status of the Draft

- Several reviews on version 00
- New version 01 in Oct. 06:
  - Incorporates all reviews
  - New sections on deployment & routing tree characteristics
  - Largely extended section on solutions & bibliography
- First reviews on version 01:
  - Request to address initial CoA distribution for SSM sources
  - Request for application specific aspects (adaptations, …)
  - Request to address nemo
  - Request to include further solutions
  - Editorial issues

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Mobile Multicast: What is the Problem?

- ! Enable seamless session continuity
- ! Preserve multicast nature of packet distribution
- ! Approximate optimal routing (in concordance with mcast routing protocol)
- ! Unreliable, but avoid extra packet loss – bicasting o.k.

→ Address duality – logical (HoA) & topological ID (CoA), mcast apps. & SSM routers source address aware!

→ Decoupling of sources & receivers

→ Rapid movement vers. protocol convergence

Multicast Receiver Mobility

- Multicast Routing is 'Mobile' :
  - On handover listeners may re-subscribe to multicast group (ASM & SSM)
- Problem: Multicast routing not seamless, but slow
  - Branch construction up to seconds
- Problem: Ensure multicast reception in visited networks without multicast support
- Problem: Realize native forwarding, whenever possible
- Routing: Experience 'leave' on detachment

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Multicast Mobility Approaches

- Remote Subscription
  - Show all movement by local multicast subscription
- Bi-directional Tunneling
  - Hide all movement by tunneling via Home Agent
- Agent Based
  - Compromise: Intermediate agents shield Mobile
  - Approaches: Extend unicast expediting schemes M-FMIPv6, M-HMIPv6, context transfer, dynamic agents …

Multicast Source Mobility

- Distribution Tree (somehow) rooted at source:
  - Collapses after movement
  - Reconstruction slow (protocol dependent)
  - RPs may facilitate mobility (as they are static)
    but: triangular routing (like BT) or active source discovery problem
- Address Duality Problem:
  - Logical ID: HoA at socket layer
  - Topological ID: CoA at routing layer (RPF checks!)
- Decoupling Problem on Handover:
  - Source has no feedback from receivers

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Multicast Source Mobility: SSM ++Problems

SSM requires Source Filters:

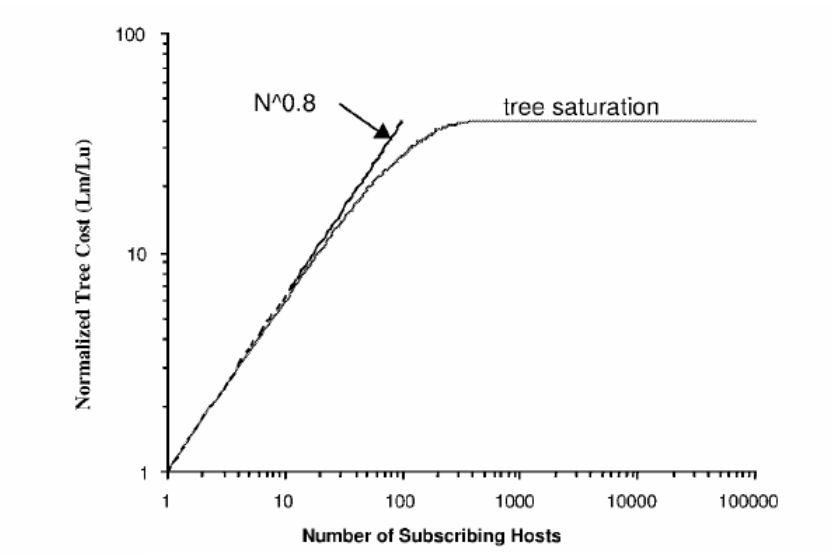
- Receivers need to Subscribe to Source Addresses:
  - HoA & current CoA needed at Receiver
  - Receivers need to re-subscribe to nCoA
- Routers Maintain Source Specific States:
  - HoA & current CoA semantics at Routers
- Decoupling - Source cannot Control Receiver Initiated Updates:
  - May loose receivers on handover
- SSM should remain a 'lightweight' solution

Characteristics of Multicast Routing Trees: Chuang and Sirbu Scaling Law

- Empirical Scaling Law (Chuang and Sirbu 1998/2001):

$$L_M(m) \approx \langle L_U \rangle * m^{0.8}$$

  - This means: multicast shortest path trees are of self-similar nature with many nodes of small, but few of higher degrees
  - Trees are shaped rather tall than wide
- Exponent found to be topol.-independent
- Saturation due to full network exploration
- Van Mieghem et al. (2001):
  - Cannot hold in general
  - Reasonable approximation for current Internet size



Graphic from Chuang Sirbu (2001)

Properties of Shortest Path Trees

- Assume: *m* multicast receivers are uniformly chosen out of *N* network nodes*, then

  If the link weights are iid., exponential with mean 1, the Shortest Path Tree is a Uniform Recursive Tree

  - URTs are well studied self-similar trees
  - Relevant quantities can be derived analytically: Average hopcount, path weights, stability …
  - Allows to answer á priori deployment questions, e.g. cost efficiency of multicast …

* This assumption has been theoretically and empirically justified, cf. P. Van Mieghem, *Performance Analysis of Communication Networks and Systems*, Cambridge University Press, 2006

Analysis of ‘Moving’ Distribution Trees

- Multicast Distribution Trees subsequent under Mobility are highly correlated
- Previous and Next Tree overlap from receivers downward
- Coinciding subtrees: self-similar URT
- Results in frequent re-use of Mcast Router States
- Two characteristic measures
  - ‘Step-Size’: pDR-to-nDR Distance
  - Tree evolvement: Number of Receivers

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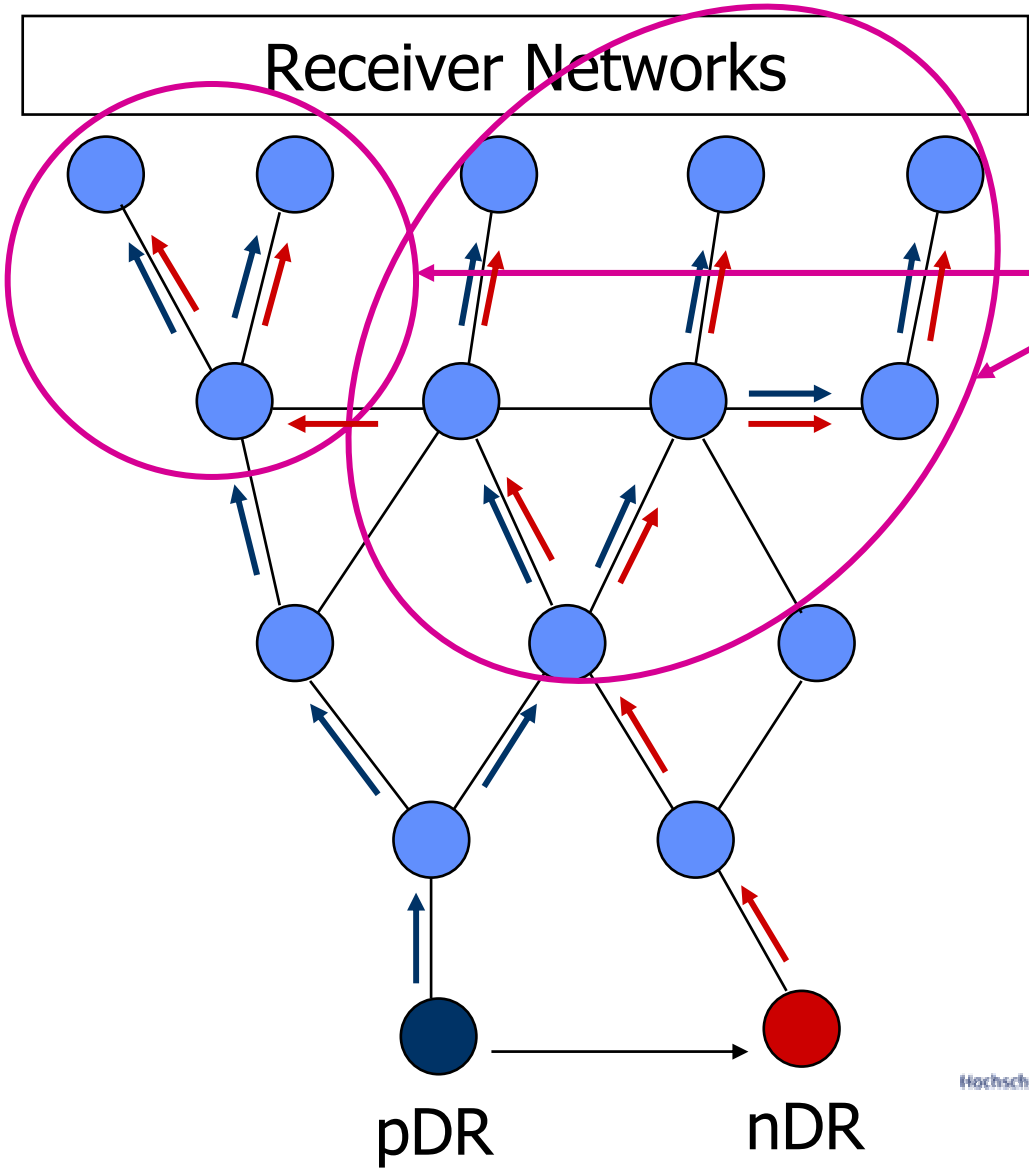
Evolution of Distribution Trees



Persistent Subtrees
- Self-similar subsets
- Identical stochastic properties

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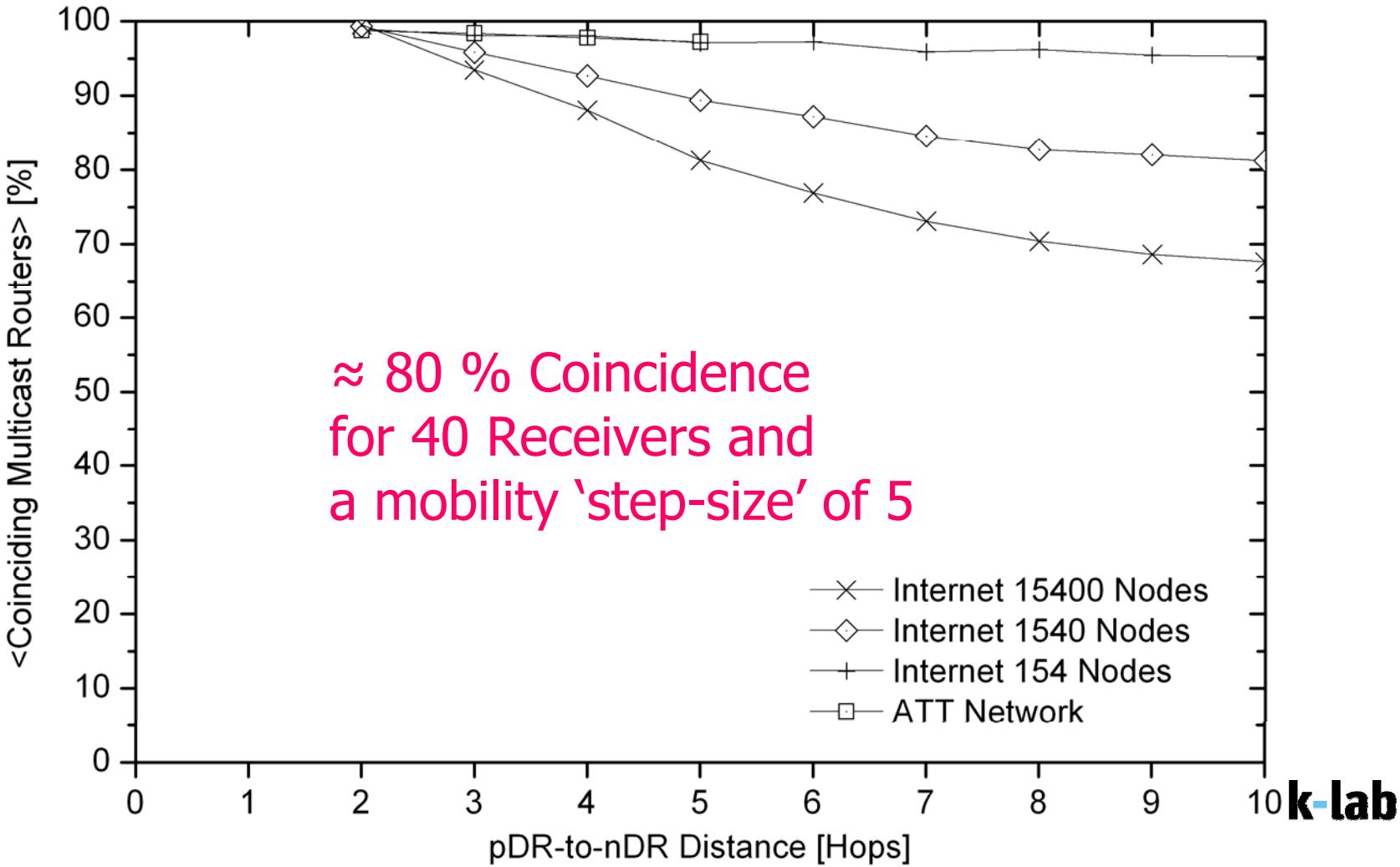
Simulation Study: Tree Coincidence wrt. pDR-nDR Distance



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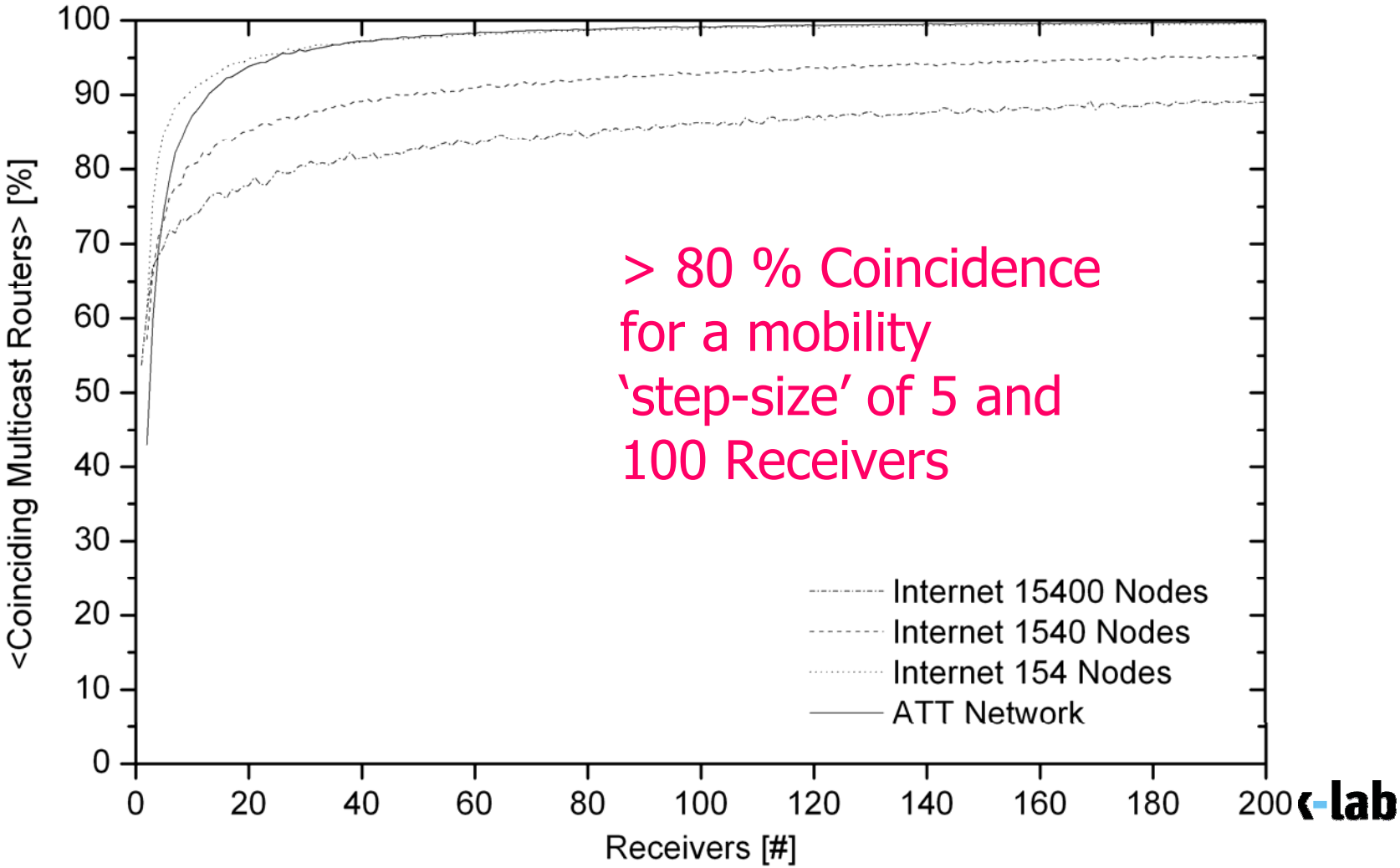
Source - Schmidt & Wählisch: *Morphing Distribution Trees – On the Evolution of Multicast States under Mobility and an Adaptive Routing Scheme for Mobile SSM Sources*, In: Telecommunication Systems, Oct. 2006

Simulation Study:
Tree Coincidence wrt. Tree Evolvement



Source Mobility – Solution Space

- Statically Routed Trees:
  - Bidirectional Tunnelling (Xylomenos & Plyzos)
  - Rendezvous Points (mobility aware):
    Interdomain Backbone (Romdhani et al.)
    For *SSM*: Add HoA-record to MRPs to account for RPF check
- Reconstruction of Distribution Trees:
  - Agent-assisted Handovers: RBMOM (Lin et al.),
    M-HMIPv6 (Schmidt & Wählisch) +++
  - For *SSM*: Listener-Initiated Tree reconstruction – based on
    HA-centred Control Tree (Thaler)
    Agent-assisted Tree Anchors + SDR announcements
    (Jelger & Noel)

Source Mobility – Solution Space (2)

- Tree Modification Schemes:
  - Tree Extension for new source locations in DVMRP SPTs (Chang & Yen)
- SSM Tree Modification Schemes:
  - Add RPF-redirect Hop-by-Hop Header to Mcast data in RP-based routing (O'Neill)
  - Extend previous tree by source routing, inject State-Updates through Hop-by-Hop signalling + initiate shortcuts (Schmidt & Wählisch)
  - Signal new CoA state along HA-based Tree in State-Update messages (Lee et al.)

Deployment Issues

- o Complexity versus Performance Efficiency
  - IP Layer : Application Layer : Hybrids
- o Keep Infrastructure in Mobility Agnostic State
  - Restrict mobility management to end nodes (?)
- o Security
  - Preserve trust equivalent to unicast routes
  - Prevent interference with unicast Binding Caches
  - Care for SSM source admission control

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Multicast Mobility at IETF

Thaler: www3.ietf.org/proceedings/01dec/slides/magma-2.pdf - 2001

draft-jelger-mssmv6-00.txt - 2002

draft-oneill-mip-multicast-01.txt – 2003

draft-suh-mipshop-fmcast-mip6-00 - 2004

draft-schmidt-waehlisch-mhmipv6-04.txt – 2005

draft-miloucheva-mldv2-mipv6-00.txt – 2005

draft-zhang-mipshop-multicast-dma-02.txt – 2006

draft-xia-mipshop-fmip-multicast-00.txt – 2006