Multicast Mobility in MI Pv6: Problem Statement Update

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

Thomas C. Schmidt, Matthias Wählisch

{schmidt, mw}@fhtw-berlin.de

HAW Hamburg & link-lab
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
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
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
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

  \[ L_M(m) \approx \langle L_U \rangle \times m^{0.8} \]
  - 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 ...

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Analysis of ‘Moving’ Distribution Trees

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

Hochschule für Angewandte Wissenschaften Hamburg
Hamburg University of Applied Sciences
Evolution of Distribution Trees

Receiver Networks

Persistent Subtrees
- Self-similar subsets
- Identical stochastic properties
Simulation Study: Tree Coincidence wrt. pDR-nDR Distance

≈ 80 % Coincidence for 40 Receivers and a mobility ‘step-size’ of 5

Simulation Study: Tree Coincidence wrt. Tree Evolvement

> 80 % Coincidence for a mobility 'step-size' of 5 and 100 Receivers

![Graph showing coincidence percentage over number of receivers for different network scenarios.](image-url)
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 & Währisch) +++
  - 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

- Complexity versus Performance Efficiency
  - IP Layer : Application Layer : Hybrids

- Keep Infrastructure in Mobility Agnostic State
  - Restrict mobility management to end nodes (?)

- Security
  - Preserve trust equivalent to unicast routes
  - Prevent interference with unicast Binding Caches
  - Care for SSM source admission control
Multicast Mobility at IETF

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