Extending SSM to MIPv6 —
Problems, Solutions and Improvements

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Agenda

Review of Any Source and Source Specific Multicast

Problems of Mobile SSM

Approaches to Mobile SSM

Improvements

Conclusions & Outlook
ASM – Any Source Multicast

Join (∗, G)

- Receivers harvest traffic from any source in group
- Two types of routing protocols are around:

  - Dense
    - Router announces source by flooding
  - Sparse
    - Uses Rendezvous Points to establish new sources
    - RP forwards packets along *shared tree* to receiver
    - Short cut switches to *source based forwarding trees*
    - Inter-domain routing via Multicast Source Discovery Protocol or embedded RP in IPv6
    - Complex deployment and heavy load on infrastructure

- Currently mainly used within manageable domains
SSM – Source Specific Multicast

Figure: ASM

Figure: SSM

- Receive traffic from source known via SDR, web sites, etc.
- Source based distribution tree constructed directly from RPF
- No shared trees or RPs required
- Immediately optimized tree and traffic flow resp.
- Well suited for interdomain applications
- Applications: streaming (radio, virtual lectures, ... )
Applications – Mobile?!
Mobile IPv6 (RFC 3775)
Problems of Mobile Multicast Sources

General:
- Delivery tree is rooted at the sender
- Tree collapses after movement
- Slow tree reconstruction
- Applications identify streams by unicast source address
- Source does not know single receivers

SSM specific:
- Dynamic source address
  - Source has to inform the receivers about any new Care of Address
  - Receivers have to use the current source IP address to join source based forwarding tree
- Note: Source cannot control updates at receivers
Address Duality Problem

Addresses carry dual meaning of logical and topological identifiers

- Logical address is Home Address (HoA)
- Topological address is Care of Address (CoA)
- Mcast states at receivers & routers are \((S, G)\)
- What is \(S\) ?

Multicast members (receivers & routers) need to account for this address duality!
Solutions in MIPv6 for ASM

- **Bi-directional tunneling**
  - Multicast streams are tunneled via Home Agent to receivers
  - At any time correct information about (static) source address
    - Inefficient triangular routing

- **Remote subscription**
  - On handover mobile source changes to nCoA
    - Reconstruction of delivery tree
    - Change of address not application transparent

- **Improvements: Agent based approaches**
  - Fixed agents anchor distribution trees
  - On handover new tree constructed in parallel
  - Old tree used for data delivery until source initiated switchover
SSM Differs

- Only Bi-directional tunneling extends to SSM
- SSM requires an ‘active’ subscription by receivers to the new source address of the sender because old router states invalidate
  - Remote subscription: traffic will not reach receivers
  - Agent based approaches: SSM cannot be solely initiated by source
Approaches to Mobile SSM (1) – Thaler, Dec. 2001

Idea

1. Mobile source announces current CoA via \((\text{HomeAddress}, G)\)-tree
2. Receivers join \((\text{CoA}, G)\) after \((\text{HomeAddress}, G)\)
3. On source movement \text{CoA} update announcement via \((\text{HomeAddress}, G)\)-tree
4. Application transparency analogous to MIPv6

Problems

- New receivers have to wait for the update cycle
- Resubscription on handover is not smooth
- Overhead: 1 administration tree + 1 delivery tree
Approaches for Mobile SSM (2) – Jelger & Noel, 2002

Idea

- Construct new triple (HoA, cCoA, G) for session announcement, e.g. via SDR
- Introduce new Binding Update sub-option “SSM-Source Handover Notification”
- Source setup tunnel to previous AR and send BU via (cCoA, G)-tree
- BU includes the new Care of Address (nCoA) of the source
- Continuous data reception by employing anchor points
  - New distribution tree is constructed in parallel to (cCoA, G)-tree

Problems

- Every movement results in an update of the session announcement for new receivers
- Unlimited number of ‘historic’ delivery trees!
Improvements (1) – Initial discovery of current Care of Address

- We need a mechanism transparent to applications
- Borrow Care of Address discovery from unicast
- MIPv6 provides *Binding Refresh Request Message*:
  - “always sent to the home address of the mobile node”
  - “the mobile node should to be careful to not respond to Binding Refresh Requests for addresses not in the Binding Update List”

**Advantage**

Independent of additional mcast trees or updated session information.
Improvements (1) – Initial discovery of current CoA

Algorithm

Start with tupel \((S = \text{HomeAddress}, G)\) as in regular SSM, then:

1. Application joins \((S, G)\)
2. Lookup Binding Cache for \(S\)
3. No Entry
   - 3.1 Send Binding Refresh Request
4. Entry found
   - 4.1 Initiate join \((CoA, G)\)

How can we update the receivers and the router states after a handoff?
Improvements (2) – New Routing Protocol: Tree Morphing

- Account for address duality: use \((HoA, CoA, G)\)-states
- Submit multicast data from nDR through pDR using source routing
- Send state update message in Hop-by-Hop option message – piggybacked by first data packet(s)
- Discover potential shortcuts by RPF-checks
- Optimise distribution tree incrementally

Advantages

- No data encapsulation at any stage!
- All routers and receivers along the path will learn new CoA
- Self reconstructing delivery trees
Improvements (2) – Tree Morphing

Examples

Figure: Tree Elongation
Improvements (2) – Tree Morphing

Examples

Figure: Tree Optimisation
Conclusions & Outlook

- SSM paves the way for wide multicast deployment
- An Overview of possible approaches to deal with mobility in SSM was presented
- There is an easy and robust mechanism to get the current source IP address
- Introduction of an efficient routing protocol for Mobile SSM

Outlook:

- Simulation and formal analysis of the tree morphing routing protocol