The Hybrid Shared Tree Architecture

Matthias Wählisch[1,2] Thomas C. Schmidt[1]
{t.schmidt, waehlisch}@ieee.org

[1]HAW Hamburg & [2]link-lab

69th IETF Metting, 2007

Hochschule für Angewandte Wissenschaften Hamburg
Hamburg University of Applied Sciences

Agenda

Motivation

Overview of the Hybrid Shared Tree Architecture

Construction of the Distribution Tree

Routing within the Distribution Tree

Discussion

Outlook

Motivation

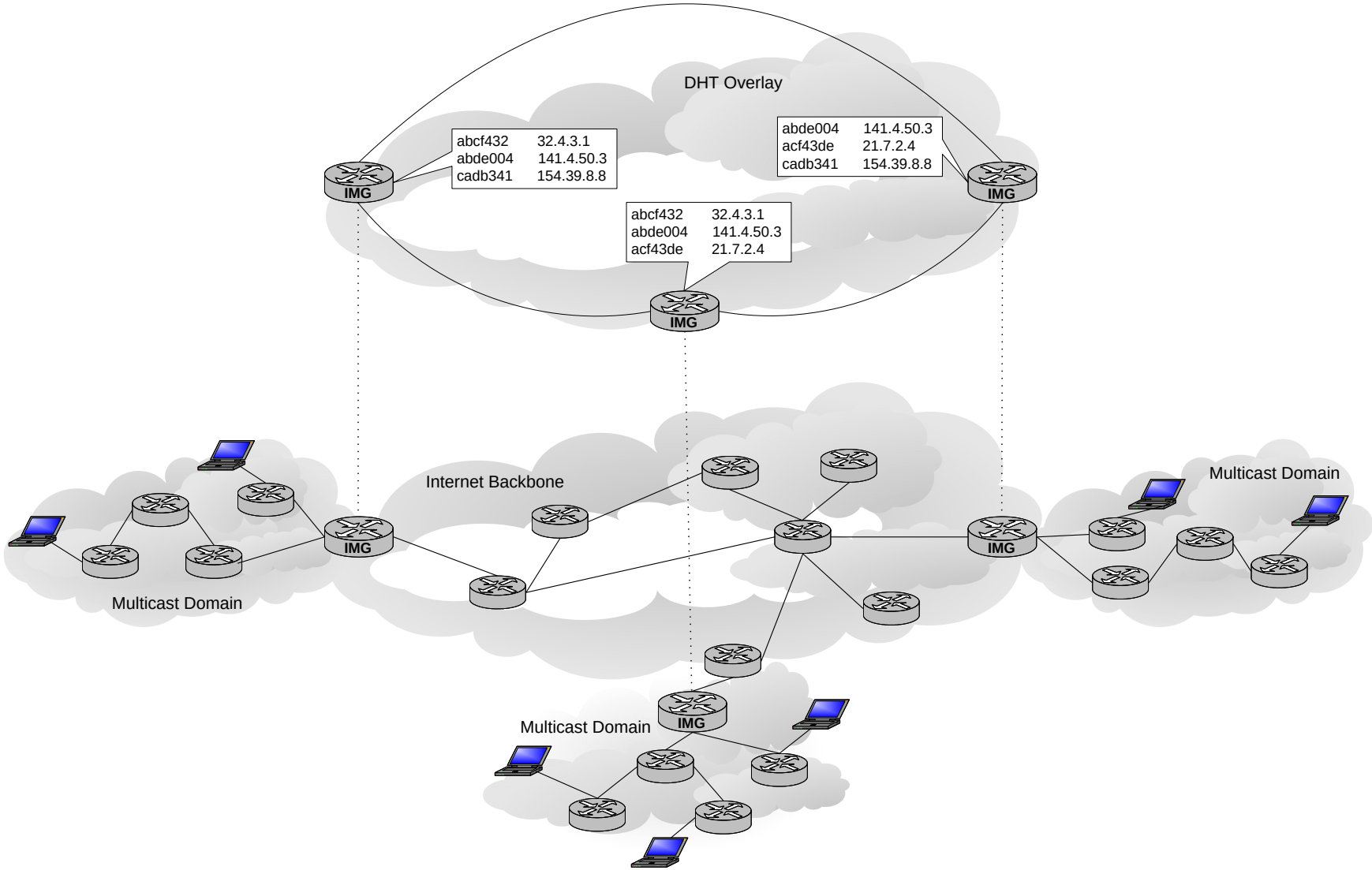
There are . . .

- discrepancies between intra- and inter-domain deployment
  - Use of hybrid overlay multicast approaches (draft-irtf-sam-hybrid-overlay-framework-01.txt)
- DHT-based routing schemes
  - Typical: *hash*(*groupaddress*) defines rendezvous point + routing like PIM-SM
  - SCRIBE distribution tree build on RP: triangular routing
- problems with efficient multicast mobility
  - Multicast mobility PS: draft-irtf-mobopts-mmcastv6-ps-01.txt
  - Mobility agnostic routing with Bi-directional PIM

The Hybrid Shared Tree Architecture

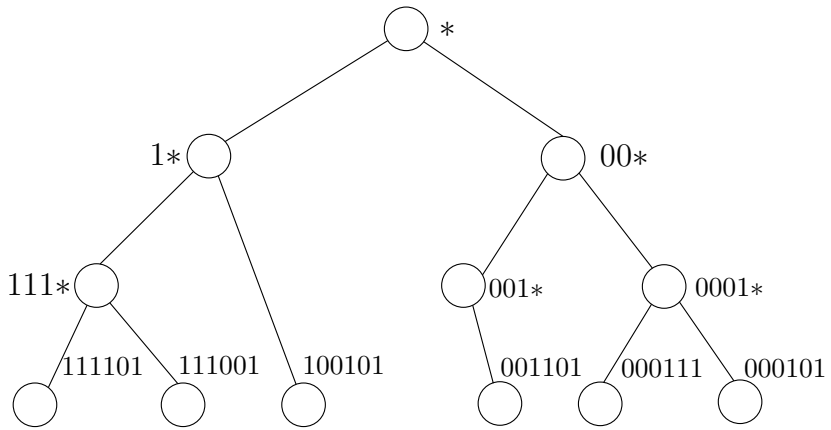
- Complement to draft-irtf-sam-hybrid-overlay-framework
- Introduce Inter–domain Multicast Gateways (IMGs)
  - Similar to Peers
  - Provide gateway functions
  - Reside between overlay and intra–domain underlay
  - Interconnect local multicast with distributed overlay peering
- Network layer multicast unchanged in end system domains
- Overlay network based on well established DHT, equipped with a new overlay routing scheme
  - Distribution tree independent of source location
  - Homogenously efficient forwarding, no RPs
- Use Pastry due to its proximity-awareness and prefix table

Architectural Overview



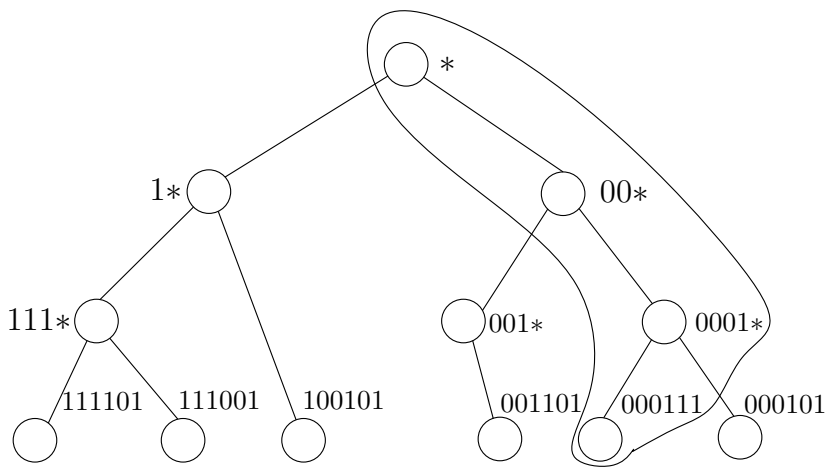
Constructing the Distribution Tree

- Every IMG has an overlay address: *hash*(*IMG ID*)
- IMGs learn about all group memberships
  - Membership updates are communicated incrementally
- Each IMG constructs a groupwise common prefix tree
  - IMGs of multicast receiver domains represent the leaves
  - Inner vertices correspond to longest common prefixes
  - Vertices on path to root share prefix with node
  - Tree will be used as bi-directional shared tree



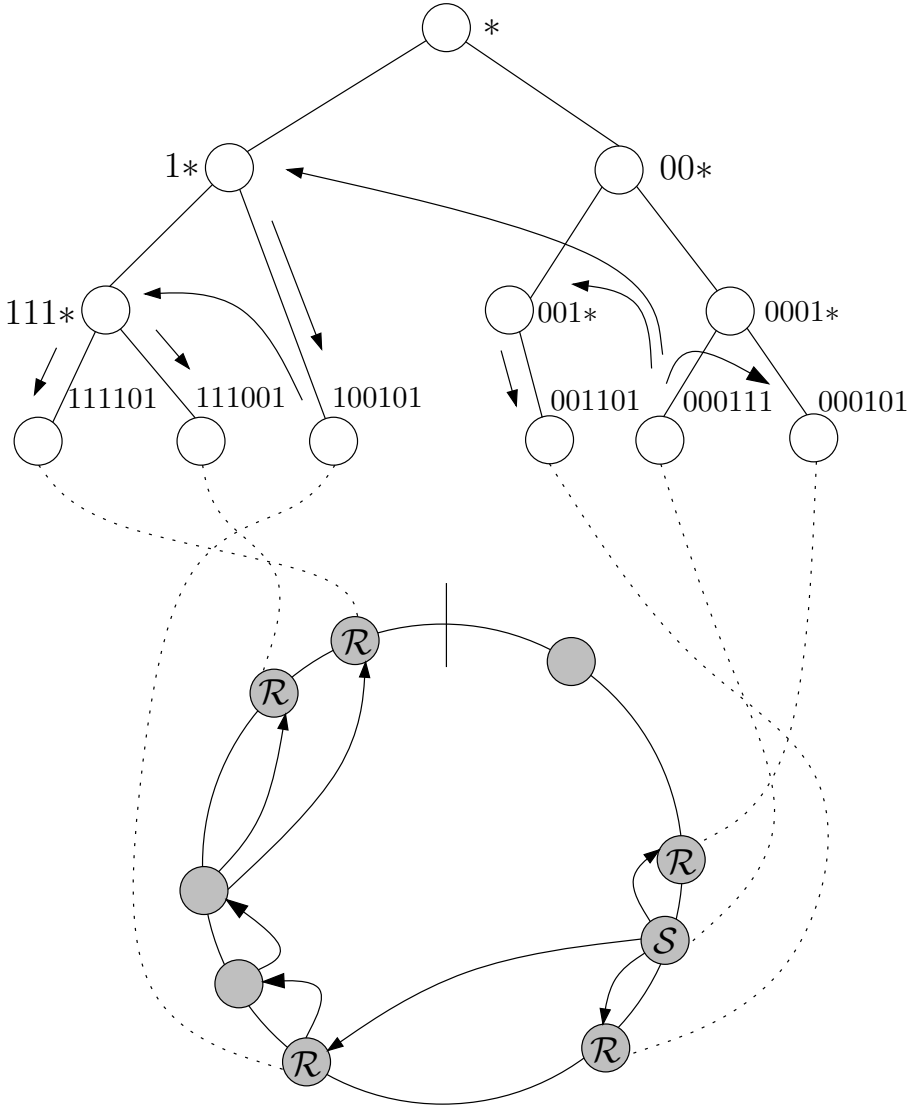
Constructing the Distribution Tree

- Every IMG has an overlay address: *hash*(*IMG ID*)
- IMGs learn about all group memberships
  - Membership updates are communicated incrementally
- Each IMG constructs a groupwise common prefix tree
  - IMGs of multicast receiver domains represent the leaves
  - Inner vertices correspond to longest common prefixes
  - Vertices on path to root share prefix with node
  - Tree will be used as bi-directional shared tree



Routing within the Distribution Tree

- Prefix tree is a routing overlay to the DHT
- Source node determines its position on the tree
  - Longest common prefix
- Multicast traffic distributed to prefix neighbors
  - Only downward flow
- Underlay routing correspondence extracted from Pastry routing table



Discussion

- Unmodified layer2/3 multicast in end system domains
- HST inherits from Pastry
  - Proximity selection benefits
  - Number of overlay routing hops: $\leq \log_{2^b}(b)$
- Replication load on forwarders limited by size of prefix alphabet 2^b
  - Strictly predictable per packet processing costs
  - With g number of receiver domains: $\leq \log_2(g)(2^b - 1)$

  $\Rightarrow$ Number of neighbor states: $\leq \log_2(g)(2^b - 1)$
- No dedicated overlay nodes
  - Advoids bottlenecks and single points of failure
- In combination with Bidir-PIM: mobility-agnostic routing
  - Prefix tree will be built only receiver-based
  - HST decouples group and state management from forwarding plane

Outlook

M. Wählisch, T. C. Schmidt:
Between Underlay and Overlay: On Deployable, Efficient, Mobility-agnostic Group Communication Services.
In: Internet Research, 2007, to appear.

- Protocol optimization of prefix-controlled forwarding
- Further analysis of the Hybrid Shared Tree approach
  - Large scale experiments based on PlanetLab platform
- Work of interest for SAM RG?

Appendix

The Hybrid Shared Tree Architecture

Routing within the Distribution Tree (2)

- Intermediate vertices need to know tree position
  - Overlay packets carry destination prefix
- Check if associated with destination prefix
  - Yes? Forward to next prefix neighbour(s) (routing in prefix tree + DHT)
  - No? Just forward to destination prefix (routing in DHT)