Using ALM to enable 6over4 IPv6 transition

Motivation, Overview, Directions ...

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Transition to IPv6 for legacy ISP

- Limited significant commercial IPv6 deployment
- Emerging niche IPv6 markets:
  - IPv6 support in MS-Windows /Office XP
  - Mobile & Ubiquitous Computing (UMT 3G)
  - Multimedia Distribution (better support for multicast and QoS mechanisms)
- Challenge for legacy ISP is to enable IPv6 connectivity without incurring high CAPEX
IPv6 transition mechanisms

- 6 main approaches to transition:
  - Dual IPv6 and IPv4 stacks
  - Static tunnels overlay
  - Tunnel brokers, dynamically establish (static) tunnels (possibly through web interface)
  - 6to4, embed IPv4 address into IPv6 address
  - 6over4, use multicast IPv4 network to emulate virtual ethernet
  - ISATAP,
6over4 transition mechanism

- RFC 2529 “Transmission of IPv6 over IPv4 Domains without Explicit Tunnels”
- Mandated that IPv6 multicast is provided over first hop
- Used for Router/Neighbour Solicitation and Advertisement

- IPv6 predefined multicast address:
  - FF02::1 address of all nodes on local link
  - FF02::2 address of all routers on local link

- Use IPv4 multicast to emulate broadcast property of IEEE 802.x networks and create “virtual Ethernet”
- Establish tunnels directly between peers or IPv6 POPs
Application Layer Multicast

- Where native IP multicast unavailable build multicast overlay on unicast infrastructure
- Or to provide further multicast distribution models, e.g. where PIM-SSM (1..N) is deployed can provide additional backchannel (M..N)
- Use programmable network infrastructure to enable dynamic building of multicast overlay
- Yallcast, ALMI and others etc.
- Various tree building algorithms under investigation at Lancaster University:
  - Tree Building Control Protocol (TBCP) developed in conjunction with GCAP project
Tree Building Control Protocol

Score function

HELLO

HELLO_ACK(a,b,c)

R

a

b

c

d

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Application Layer Neighbour Discovery

- No widescale 6over4 due to lack of IPv4 multicast
- Use ALM technology to provide IPv6 multicast over legacy IPv4 infrastructure and emulate “virtual Ethernet”
- No impact on legacy network engineering & operations
- No need for IPv4 compatible IPv6 addresses

Multicast model:
- ALM is ideally suited to low bandwidth M..N signalling
- For multicast multimedia distribution (1..N) other approaches e.g. PIM-SSM more suitable

Active Network technology offers low cost mechanism for introducing multicast overlay
Application Layer Neighbour Discovery

IPv6 Network

IPv4/v6 Router

IPv6 Network

IPv4/v6 PC

RAS

HELLO

JOIN

ARP

ALAN running ALM proxylet

ALAN running ALM proxylet

ALAN running ALM proxylet

ALAN running ALM proxylet

IPv4/v6 PC

RAS
Test Infrastructure

- Telekom Austria and Lancaster University are building test infrastructure for ALND based on FunnelWeb node architecture.
- Application Layer Active Network approach (e.g. FunnelWeb from UTS) is ideal platform for deploying ALM for ALND.
- Port ALM code to Java proxylet.
- Enable code to be uploaded over HTTP to international overlay network of FunnelWeb nodes.
- Adapt IPv6 clients to run ALND software.
- IPv6 clients in Lancaster and Vienna use FunnelWeb ALM multicast tree to distributed 6over4 ND requests.
Neighbour Solicitation Multicast strategies

- Efficiency of ALND is dependant on efficiency of the multicast overlay tree
- Question of scalability of tree join procedure, but should be adequate for small/medium size IPv6 groups
- Various algorithms for evaluation by “score function”
  - round trip time
  - number of hops
  - packet loss
- Simple strategy to multicast ND to whole group (all nodes in ALM tree)
- Use recursive search increasing ALM hop count to find nearest node able to service ND request
Neighbour Solicitation Multicast strategies

- However, many IPv6 networks (e.g. 6Bone) are partial overlays of IPv4 Internet
  - Hence IPv6 network is a subset of IPv4 connectivity mesh
  - And IPv6 routing may be suboptimal to IPv4 routes
  - Therefore contrary to common strategy, IPv6 traffic should be tunnelled to POP nearest to sink and not the source
- Build ALM tree based on IPv6 hierarchical address structure rather than IPv4 topological consideration
- ND requests are Application Layer Routed over ALM tree to best match domain, and from there expanding search conducted.
- More efficient use of tree, since ND requests are not flooded through-out whole ALM tree
Application Layer Routing over ALM tree

Node D wants to establish tunnel with Node G

TLA=Top Level Aggregator
NLA=Next Level Aggregator
SLA=Site Level Aggregator

TD IPv6 Network

3FEE::/16
3FEE:2100::/24
3FEE:2100::/48
3FEE::/16
3FEE:8060::/28

ND response
V6v4 tunnel
Conclusion & Future Work

- Legacy ISPs require IPv6 low cost transition strategy without impact current IPv4 infrastructure
- 6over4 suffers from lack of native IPv4 multicast support but ALM and programmable network technology can solve this
- Need to evaluate suitability of 6over4 against competing strategies
- So far only considered the TBCP algorithm for ALM tree construction but “tree clustering” work at Lancaster University promises better scalability