Stateless Dual Stack Lite*

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Dual Stack Lite (DS-Lite)
IPv6 Residual Deployment (4rd)
Protocol Details:
Three essential parts of 4rd:

① Global IPv4 Address and Port Set derived from IPv6 configuration
   ➢ 4rd programs an IPv4 NAPT that stays at the Edge of the network

② Algorithmic mapping and encap of IPv4 over IPv6
   ➢ IPv6 destination determined from each packet’s IPv4 destination address and port via a stateless algorithm
   ➢ No per-subscriber tunnel state or provisioning

③ Stateless Border Relays
   ➢ No new centralized NAT State
   ➢ Border Relays reachable via anycast
IPv6 → IPv4 + Port Mapping

IPv6 Delegated Prefix (e.g., /X)

Size = X bits (provisioned)

2001:0DB8:00 /X

Y - Z = a

01010101 111000

Subnet-ID

64 (fixed)

Interface ID

“EA Bits”

Z bits (provisioned)

32 - Z = b

130.67.1 /Z

IPv4 Prefix

IPv4 Suffix

IPv4 Address

6 (fixed)

a - b = c

10-c

Port Set ID

Port

IPv4 Prefix

IPv4 Suffix

IPv4 Address

Port
IPv6 → IPv4 + Port Mapping

IPv6 Delegated Prefix (e.g., /56)

Size = 42 bits (provisioned)

IPv4 Address

For this Example...

Ports 0-1023 skipped, each CPE gets $2^6 / 2^6 - 2^1 = 1008$ ports

One IPv4 /24 serves $2^{(6+8)} = 16,384$ (vs. $256$) subscribers
② Packet Flow and Encapsulation

IPv4 Dest = Inside 4rd Domain

IPv4 + IPv6
IPv4 + IPv6
IPv4 + IPv6

IPv4 Dest = Outside 6rd Domain

IPv4 + IPv6
IPv4 + IPv6
IPv4 + IPv6

If within 4rd Mapping Domain

THEN encap with IPv6 source and destination built from IPv4 address and port

ELSE (prefix does not match)

Forward to Border Relays (via IPv6 anycast)

Mapping Domain IPv4 Prefix + IPv4 Suffix + > 0 Port Set ID user ports

NOT Mapping Domain IPv4 Prefix + > 0 Port Set ID user ports
Stateless Border Relays

- Handle traffic to/from the 4rd domain
- Simple algorithmic mapping and encap/decap function
- No per-packet state, so may be reached via anycast
- BR placement is solely a function of IPv4 traffic, not the number of subscribers
Residential Gateway (4rd CE) Implementation

Stateful NAPT Stays here!

IPv6-Only! No DHCPv4, IPCP, etc.

IPv6 + IPv4 Dual Stack Service

Native IPv6 SP Network
Residential Gateway Configuration

- Home is configured for dual-stack, 4rd config elements identical for all CEs in a Domain
  1) ISP IPv6 Mapping Domain Prefix and Length
  2) Global IPv4 Prefix and Length
  3) 4rd Border Relay IPv6 address or prefix (anycast)
Border Relay Implementation

- Single multipoint tunnel interface in Border Relay
- No per-user state or CGN, serves all users in 4rd Domain
Stateless DS-Lite Forwarding Architecture

- **Private IPv4**
- **IPv4 Internet**
- **NAPT 44 (w/ALGs)**
- **Forward IPv4**
- **MAP (algorithmic)**
- **MAP (algorithmic)**
- **Forward (via IPv6)**
- **Receive (via IPv6)**
Encapsulation Forwarding Architecture
Translation Forwarding Architecture

1. **Private IPv4**
2. **NAPT 44 (w/ALGs)**
3. **MAP IPv4 Address and Port to IPv6**
4. **Replace IPv4 Header with IPv6 Header**
5. **IPv4 Internet**
6. **Forward IPv4**
7. **MAP and recreate IPv4 Header**
8. **Decap IPv6**
Encapsulation or Translation – Boils down to 20 bytes
Encapsulation or Translation – Boils down to 20 bytes

- Parties are entrenched on both sides of E vs T (vs U!) debate
- Encapsulation:
  - Well-understood, simple, transparent, same as stateful dual-stack lite
  - Translation:
    - Native IPv6 ACLs and DPI functionality not masked by IPv4 header. NAT64 code reuse. Looks like “Real IPv6.”
- Arguments gravitate towards speculation about what future IPv6 deployments will require and what feature availability will be
So Where Are We Headed With All This?
IPv4 over IPv6 mechanisms date as far back as DSTM, proposed in 2000
- Softwires created in 2006
- 6rd and DS-Lite emerge in ~2008 (RFC5969 & RFC 6333)
- IETF Shara BOF focusing on “A+P” in 2009
  - Resulted in RFC6269 on Shared IP address issues (applies to CGN, DS-lite, any A+P solution)
  - No consensus on the need for A+P based solutions
  - Experimental RFC 6346 published in 2011
- A myriad of solutions appear with reckless abandon, searching for a home in the IETF
  - 4rd, 4over6, dIVI, ...
- “Solution Motivation” document published in 2011
  - Authors include France Telecom, Softbank, Comcast, DT, Portugal Telecom, China Mobile…
More Recently…

• Consensus to agree upon a single mapping algorithm, coupled with an encapsulation and translation option
  Softwires Interim Meeting in China (Sept 2011)

• Mapping Design Team formed
  Latest result (Oct 31): draft-mdt-softwire-mapping-address-and-port-01

• Since China, Remi Despres has brought forth a compromise between Encapsulation and Translation “4rd-U” in hopes of merging the two. No consensus yet.

• A great deal of activity around this topic, demanding strong leadership in the IETF
Stateless A+P Technology – Bottom Line

• Seems to work, and comes with very compelling scalability properties

• Could become a very strong alternative to stateful DS-Lite

• Standardization effort has been troublesome until recent months

• Cautiously optimistic the IETF will produce a standard (or two) in 1H2012, and choices among interoperable products across the industry thereafter.
Thank you.