IPv10.0: A Strawman Design
Beyond IPv6

ReArch 2009
Rome, Italy
1 December, 2009

Ken Carlberg  Saleem Bhatti  Jon Crowcroft
Once upon a time…

- The Internet was unknown by the general public
- Best Effort was the only game in town
- People used Telnet

And then THEY came...

- And brought the need for
  - Security, more services models, and…

Next Generation IP
Problems with IPv4

• Running out of address space
  – A/B/C class hierarchy was too inefficient
  – '92-'93 estimates of Class-B depletion by 2000
  – Near-term solutions:
    • Class-less Inter-Domain Routing (CIDR)
    • Network Address Translators (NAT)
      » Has become the continuing solution

• Associated routing table size explosion
  – Solutions:
    • New lookup algorithms reduced impact
    • Faster hardware
  – Multi-homing has renewed the problem
Next Generation IP: Background

- **Simple IP (or Steve’s IP)**
  - Theme: Minimize header
  - Add more extensibility (e.g., one or more Next Header)
  - Flow Identifier (reflected current state-of-the-art work)
  - Larger flat address structure

- **The P Internet Protocol (or Paul’s IP)**
  - Change addressing to Locator & Identifier split
  - Hierarchical and variable length Locator
    - Implied source routing

- **The Grand Compromise of ‘94: Simple IP-Plus**
  - Simple IP with hierarchical addresses of Paul’s IP
    - Becomes IPv6 (RFC-1883)
  - HOWEVER, in ’98, RFC-2460 removes hierarchical addresses
Critique

Not much of an architectural change…

• Large 128 bit addresses
  – Retains Locator & Identifier
  – Providers still cling to NATs
    • No economic incentives to migrate
• Same size diff-serv field
• Multiple Next Headers
  – Only inserted by source
    • Encapsulation or Multi-Protocol Label Switching (MPLS) is the work-around
• End-to-End Flow Labels
  – “Market” uses island(s) of cut-through routing (e.g., MPLS)

• Note: ‘08 report shows IPv6 traffic is 1/100 of 1% of all IP traffic

….Does “more” qualify as an architectural change?
….Where are the “must have” features?
Locator / Identifier Split

• Four significant discussions in ARPAnet/Internet history
  – ’77 (TCP and mobility)
  – ‘92-93 (Paul’s Internet Protocol work),
  – ‘96 (O’Dell 8+8 proposal),
  – ’07 (Internet Architecture Board report)

• Three Current efforts
  – Host Identity Protocol (HIP)
  – Locator/Identifier Separation Protocol (LISP)
  – Identifier Locator Network Protocol (ILNP)
Locator / Identifier Split (cont.)

- **Multi-Homing problem**
  - Provider Independent prefixes tend to be popular, but are non-aggregable

- **ILNP Example**
  - Locators are from Internet Service Provider and are always Provider Aggregable

Traditional address approach

```
SBR 1 (P.1.1) → ISP 1 (P.3) → ISP 2 (P.4) → SBR 2 (P.2.1)
```

**P.x = location + identity**

Locator-only approach

```
SBR 1 (L.3.1) → ISP 1 (L.3) → ISP 2 (L.4) → SBR 2 (L.4.1)
```

**L.x = location**

**Legend**
- SBR - Site Border Router
- ISP - Internet Service Provider

SBR - Site Border Router
ISP - Internet Service Provider
IPv10.0 Design

• Retain minimalism and extensibility of IPv6
• Incorporate Identifier / Locator Split
• Introduce Tails
  – Change state-insertion model: temporary Headers and Tails

...a starting point for future discussions
IPv10.0 Design (cont.)

- **Header**
  - Header navigation
  - Forwarding information

- **Trailer**
  - Trailer navigation
  - End-to-end information
  - Diff-serv

  ....Non-forwarding information
Final Thoughts

• Impact of Tails
  – Change the end-to-end model of constructing headers
    • Facilitate temporary insertion of overhead information
  – Avoid inefficient encapsulation
  – Foster need to go beyond current ASIC header lookup limitation

• Should we be more radical in our design?
  – Are there “must have” features in IPv10.0?