Hands-On With IPv6

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Topics

- Overview of IPv6
  - Intro only – focus is on high level, introduce concepts, whet your appetite
  - Keep going on your own
- Motivation – why IPv6
- Basic Concepts
- Demo of concepts and operations
  - Create your own IPv6 lab

What is IPv6

- IPv4 has been around since late 70's/early 80's (RFC 791, 1981)
  - Almost 40 years – starting to show age
  - Lots of band-aids and workarounds
- IPv6 RFC 2460 published in 1998
  - Address limitations
  - Provide for growth
  - Allow evolution from IPv4

Why IPv6?

- IPv4 address exhaustion
  - 4.3 billion theoretically available – not all available for use
  - Regional internet registries cannot grant new blocks
  - Mitigation by things like NAT, renumbering subnets, secondary markets for IP address,etc. but only delaying inevitable

Why IPv6? (Cont)

- Simplified packet processing
  - Fixed length, simpler header
  - Simplified Hierarchical Routing
- Security - Standard implementation required
- QOS - Traffic classes, Flow labels
- Auto-configuration (stateless and stateful) simplifies adding (large numbers of) new devices

IPv6 Addresses

- Addresses are 128 bits (4x IPv4 addresses)
- Usually 48 bits for network, 16 bits for subnet, 64 bits for host
- Represented as 8 groups of 16 bits:
  `FE80:0032:0000:0CDE:1257:0000:211E:729C`
- Skip leading zeroes in group:
  `FE80:32:0:CDE:1257:0:211E:729C`
- Skip repeated strings of zeroes (once):
  `FE80:32::CDE:1257:0:211E:729C`

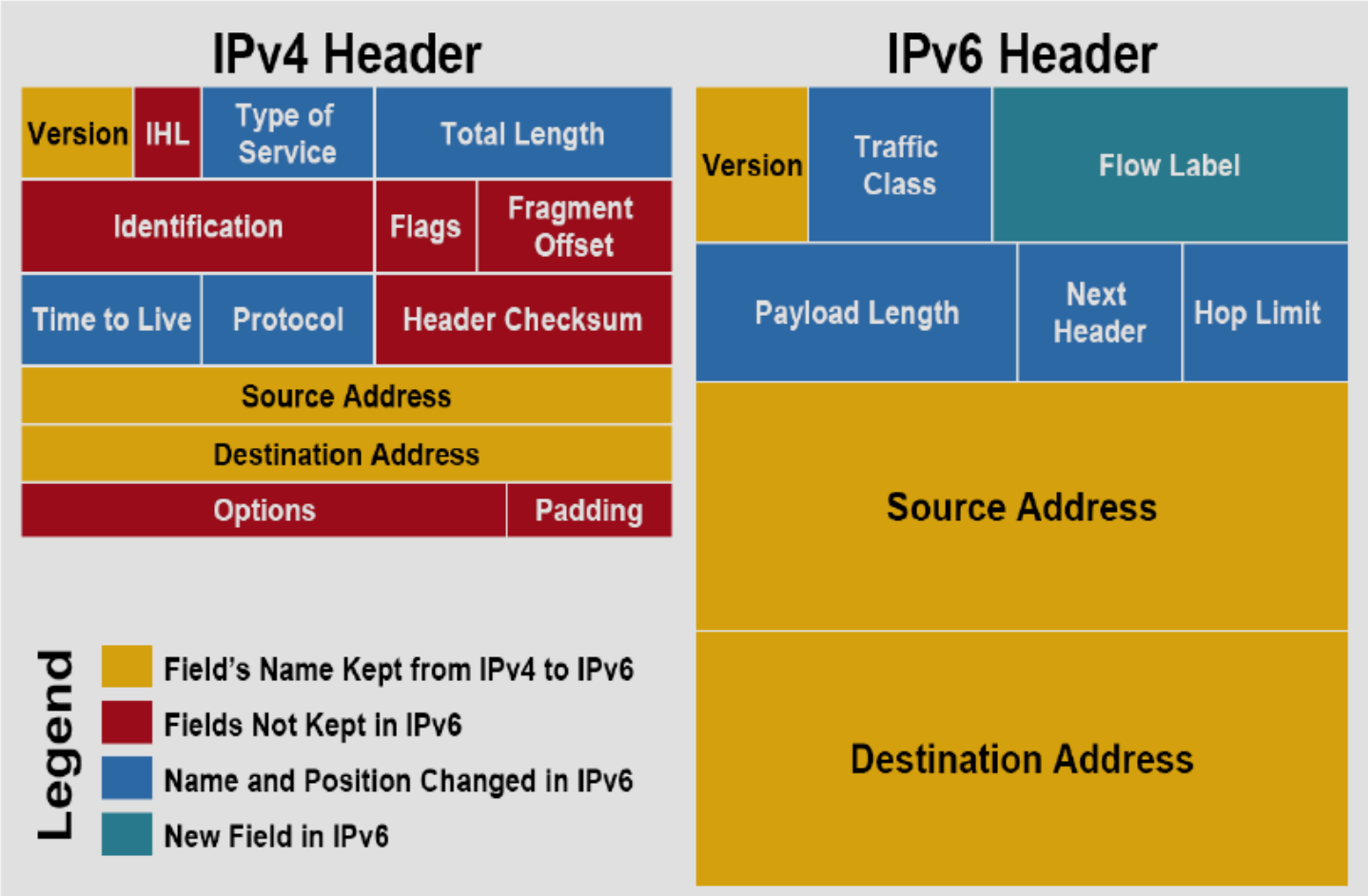
IPv6 Addresses

- Use brackets where needed for disambiguation:
  `[FE80:32::CDE:1257:0000:211E:729C]:8080`
- Partial list of reserved address ranges:
  - Link local FE80:--------
  - Unique local FDxx:---------
  - Multicast FF0x:-------
  - Loopback ::1
  - Unassigned ::

IPv6 Header

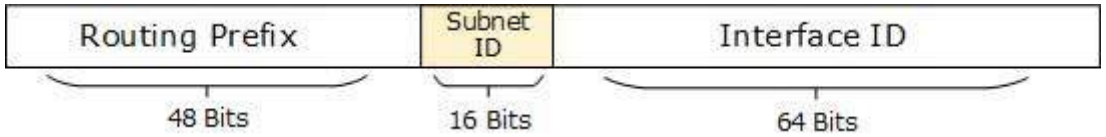
- Similar in spirit to IPv4 header
- Some rarely used fields removed
- Other fields moved to optional extension headers. (Fixed order for extensions simplifies processing)
- Less than twice as long as IPv4 header even though source and destination addresses are both 4 times as long

IPv6 Header



https://www.researchgate.net/publication/269810379_IPv4IPv6_Transition

Subnets



https://www.tutorialspoint.com/ipv6/ipv6_subnetting.htm

- Subnet similar to CIDR or variable length subnet masking in IPv4
- Most commonly split as above with 64 bits used for host IDs, though other combinations are possible
- Examples:
  - Routed /64 - 2001:460:7c:3a6::/64
  - Routed /48 - 2001:460:3927::/48
  - Unique Local – fd00::/8 (plus 40 more bits)

Getting Connected with IPv6

- Several options may be available to you (some are preferable to others)...
  - Your ISP
  - 6in4
  - 6to4
  - Teredo
  - ISATAP
  - Virtual IPv6 “Lab”

Getting Connected – Your ISP

- Best: fast, supported, managed
- You may already be using it
  - Comcast cable modem
  - Sprint Hotspot
  - Verizon Hotspot
  - ~~WideOpenWest cable modem~~
  - ~~AT&T Hotspot~~

Getting Connected - 6in4

- Not ideal – managed, free, but routes traffic through third-party gateway
- Must have public-facing (nearly) stable IP address
- All IPv6 traffic tunneled through IPv4 traffic to gateway
- Also needs support in router/Gateway – might just need to be enabled. (Linux: forward protocol 41)
- Free addresses from Hurricane Electric

  https://tunnelbroker.net/

  https://fedoraproject.org/wiki/IPv6_tunnel_via_Hurricane_Electric

Getting Connected - 6to4

- Not good – unsupported, unmanaged
- Transition mechanism. Deprecated, but still available.
- Conceptually similar to 6in4, but you don't know where your gateway is. Could be your ISP, but could be a random "good Samaritan" a long way away. (6rd is similar supported alternative, using ISP's address space)
- Also needs support in router/Gateway – might just need to be enabled. (Linux: forward protocol 41)
- https://test-ipv6.com/faq_6to4.html

Getting Connected - Teredo

- Deprecated choice – but if behind NAT/firewall there are few others
  - SixXS has shut down: https://www.sixxs.net/home/
  - Freenet6 (Gogonet) has shut down
- Deprecated, but still works:
  - Few servers (Germany, Japan, Microsoft)
  - Not subnettable
  - Slow
  - Built-in with Windows, “Miredo” on Linux

Getting Connected - ISATAP

- “Intra-Site Tunnel Addressing Protocol”
- IPv6 using IPv4 as “physical layer”
- Requires a machine with both IPv6 and IPv4 connectivity as router.
- Machines must be reachable via IPv4 address
- No multicast, so normal Neighbor Discovery does not work – clients find router using DNS or (static configuration)
- http://www.litech.org/isatap/

Getting Connected – Virtual Lab

- Provides a way to experiment, learn concepts
- Virtual Box with Host only network
  - Need a randomly generated Unique Local address (RFC 4193):

https://www.ultratools.com/tools/rangeGeneratorResult?globalId=&subnetId=

Transition

- “Dual Stack”
- Hosts
  - Can be IPv4, IPv6, or both
- Clients
  - Both IPv4 and IPv6 address
  - Connect to IPv4 only hosts (DNS)
  - Connect to IPv6 only hosts (DNS)
  - If both are available, client choice – modern browsers typically prefer IPv6

Live Demo

Q & A