IPv6

Kameswari Chebrolu

IPv4 - 1981

Background

- Early 1990's CIDR, NAT proposed
  - Temporary fixes; Not possible to achieve 100% efficiency
- Mid 1990's: Next Generation IP (IPng) – IPv6
  - Apart from addressing, fix other aspects of the protocol based on experience

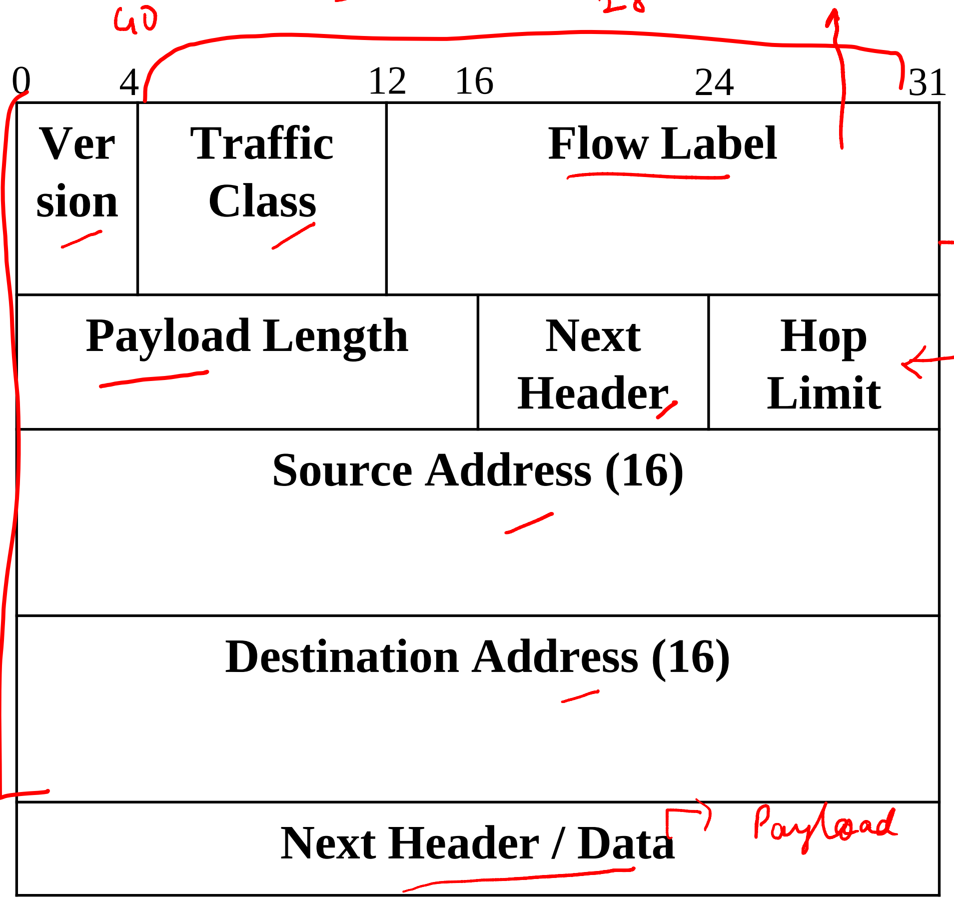
IPv5

Desirable Features

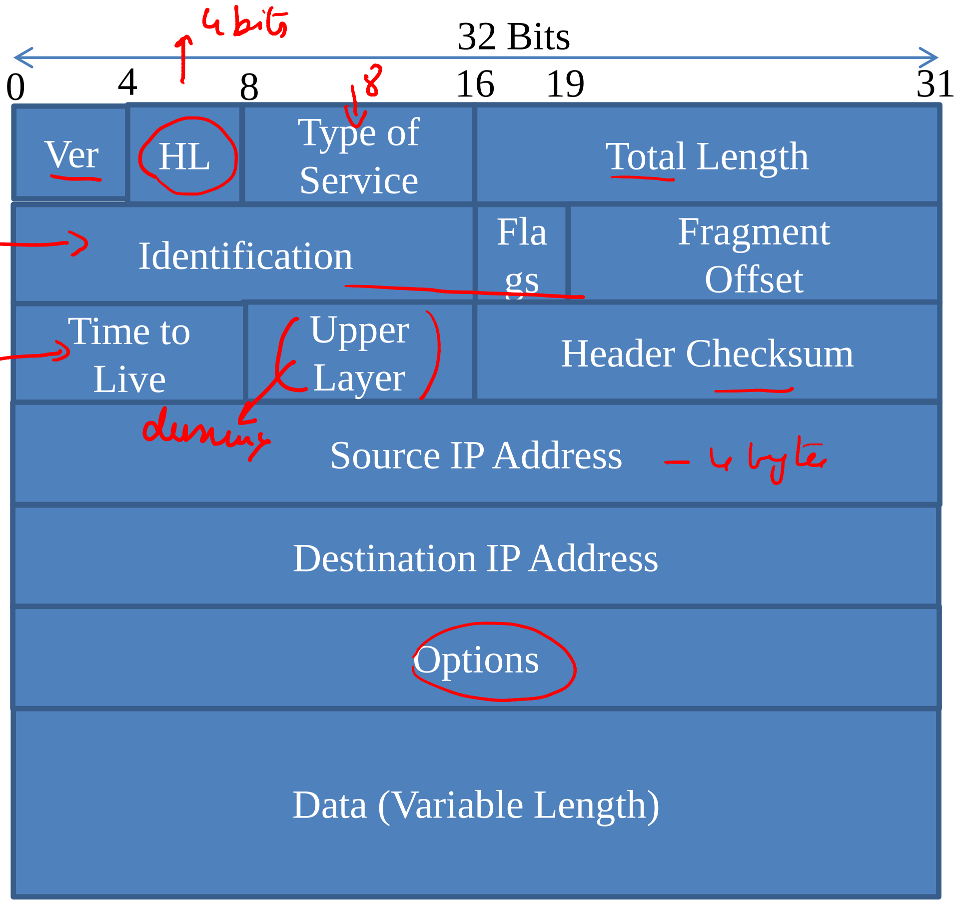
- Support billions of hosts in a scalable fashion
- Allow fast processing at routers
- Support real-time applications
- Provide security
- Multicast support
- Mobility support
- Need to be backward compatible

IPv6 Header

VC



IPv4 Header



Extension Headers

HL $2^4 \times 4$
$= 64$ bytes
20
$= 44$

- Next Header field replaces both options and ‘upper-layer protocol field’ of IPv4
  - Structure improves router performance
  - Can support arbitrary length options (IPv4 restricted to be under 44 bytes)
- Each option has an ‘extension header’
  - Next Header field within indentifies the header following it

IPv6 Fragmentation Extension Header

demux 6

0	8	16		31
Next Header	Reserved	Offset	RES	M
Ident				

40 Bytes | next header = 44

→ Next header/data

- Assume only one option that of fragmentation
- Next header field in Ipv6 header will take value 44 to indicate fragmentation header
- Next header in fragmentation header will take the value 6 to indicate pass to TCP

* Only source host does fragmentation, not routers

Points to Note

- 128 bit addresses can support $3 * 10^{38}$ hosts
- Fast router processing
  - Streamlined header of 40 bytes
  - No checksum, no fragmentation
- Support for real-time applications via traffic class and flow label

Points to Note

- Other features handled via options field
- ICMP extended for IPv6
  - Packet too big
  - Multicast, mobility support

Intermission

Addressing

- 128 bits → $3 * 10^{38}$ nodes ← 2^{128}
  - Consider entire surface of earth; $7 * 10^{23}$ IP addresses per square foot
  - $4.354 \pm 0.012 \times 10^{23}$ micro seconds since Big Bang

202.13.5.6

- Notation: x:x:x:x:x:x:x:x
  - X is hexadecimal representation of 16 bit piece of address
  - E.g: 2001:0DB8:0000:0000:95CD:BBE0:000B:0001
  - Short form: 2001:DB8::95CD:BBE0:B:1

- Classless addressing   /41   /32 . . .
- Number of addresses with special meaning

Prefix	Usage
00…0 (128 bits)	Unspecified
00…1 (128 bits)	loopback
1111 1111	Multicast
1111 1110 10	Link local unicast
::ffff:0:0/96	IPv4 mapped IPv6 addresses

→ IPv6

0's ← 16 1's

Sample Set

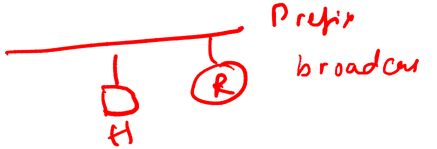
- Routing very similar to IPv4 except for some new extension routing header

flow → PN1   cheap

flow → PN2 ←

  - Can specify which provider network to use for which packets

Autoconfiguration



- In IPv4 done via DHCP servers
- IPv6: Stateless auto configuration without servers
  - Need unique IP address, need correct address prefix

netmask

- Solution: Routers announce prefix; Host autoconfigures address as: prefix 00..00 Ethernet-MAC-addr

few bytes 6 bytes

128 bits

- Globally not routable: 1111 1110 10 0….0 Ethernet-MAC-Addr

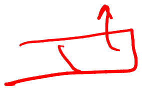
128 bits

Transition from IPv4 to IPv6

- Impossible for a flag-day
- Incremental deployment of IPv6
  - IPv4 nodes should be able to talk with other IPv4 nodes and IPv6 nodes IPv4
  - IPv6 nodes should be able to talk with other IPv6 nodes over intermediate IPv4 nodes
- Solution: Dual stack operation and Tunneling

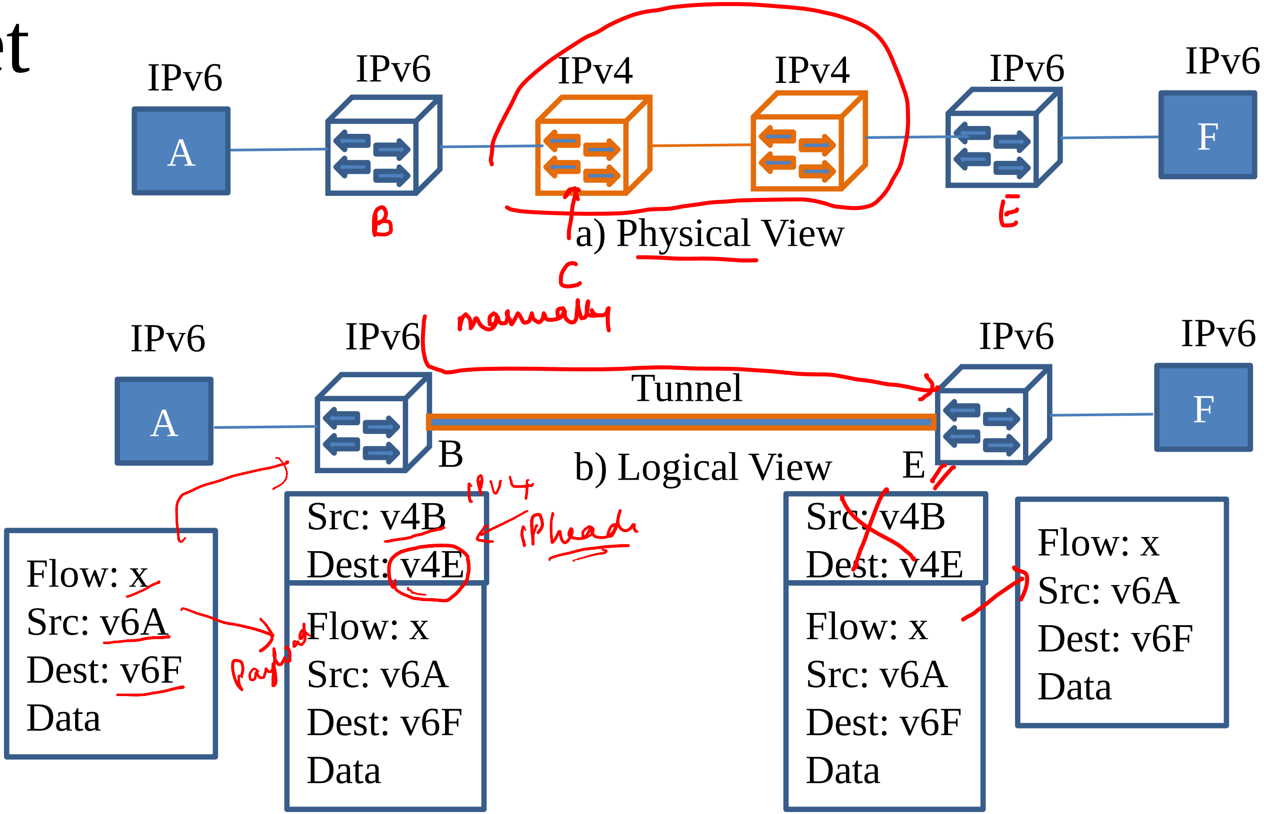
Dual Stack Operation

- IPv6 nodes run both IPv4 and IPv6 and use version field to call the right process



Tunneling

- Send IP packet as a payload of another IP packet



Summary

- IPv6 long term solution to IPv4 address exhaustion
- Addresses other shortcomings of IPv4
- Many interesting features
- Migration via Dual-stack operation/Tunneling
- As of 2011, few RIRs have exhausted their IPv4 address space
- As of Nov 2012, IPv6 share of Internet traffic is 1%