CS 302 Data Communication and Networks

Lecture 32: Internet Protocol Version 6 (IPv6)

Why Do We Need a New IP Structure?

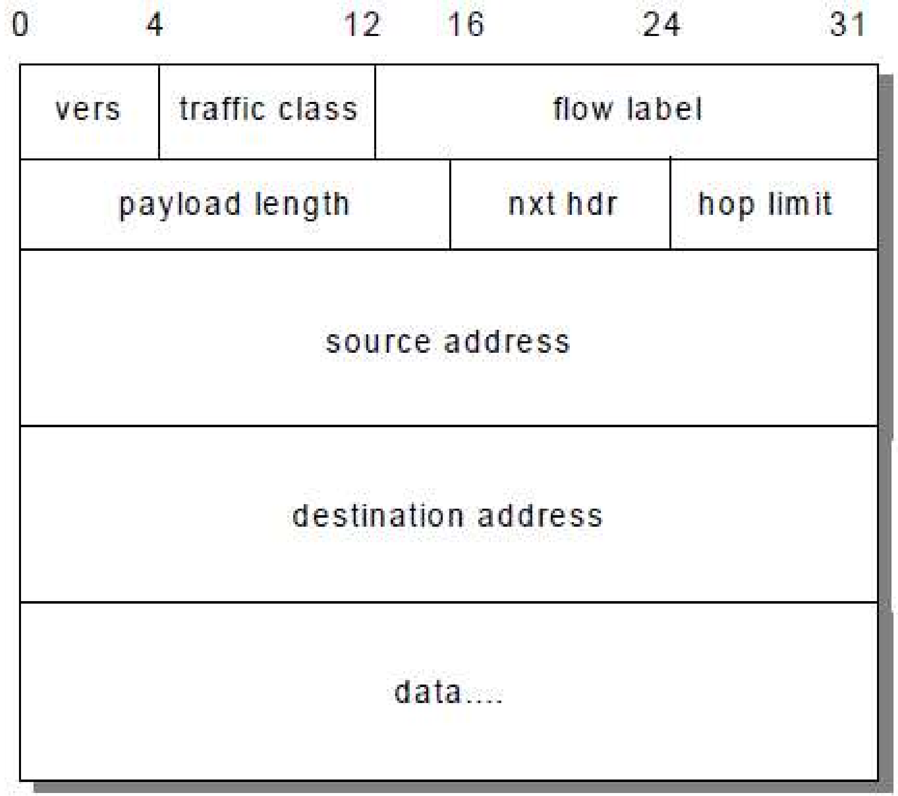
- Address space in IPv4 is not sufficient even with CIDR
- QoS is not clearly defined
  - We need real time service support for modern day applications (Skype, VoIP etc.)
- Mobile applications are unmanageable
- There is no direct security support in IPv4

IPv6 Features

- Larger address space
- Globally unique and hierarchical addressing
- Optimized routing table using prefixes rather than address classes
- A mechanism for the auto-configuration of network interfaces
- Service class support to manage QoS classes
- Built-in authentication and encryption
- Transition methods to migrate from IPv4
- Compatibility methods to coexist and communicate with IPv4
- It has base header of 40 bytes (fixed)

The IPv6 Header Format

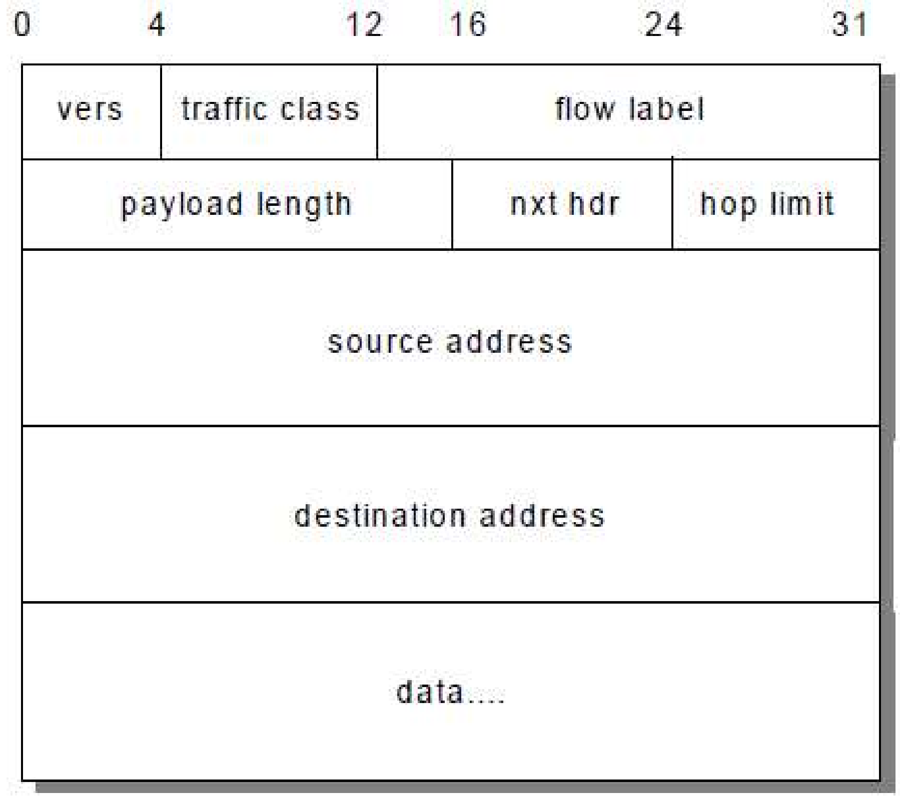
- **Vers:** 4-bit IP version number, here 6
- **Traffic class or priority:** The 8-bit traffic class field allows applications to specify a certain priority for the traffic they generate
- **Flow label:** 20-bit field. A series of related packets that requires a particular type of handling (for example, real-time service) have the same source address, destination address and flow label
- **Payload length:** The length of the packet in bytes (excluding header)



Basic IP header format

The IPv6 Header Format

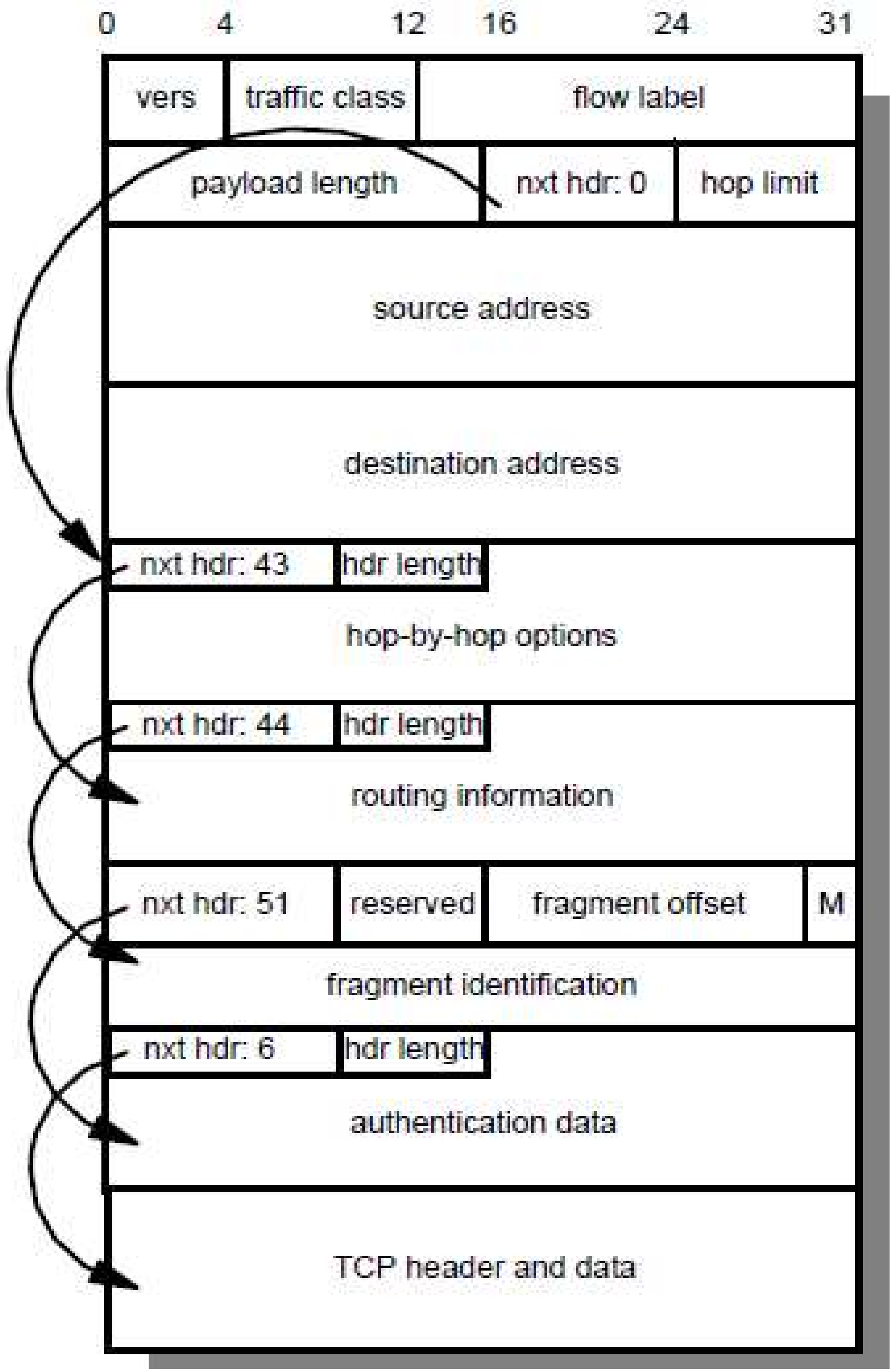
- **Next header (nxt hdr):** Indicates the type of header immediately following the basic IP header
- **Hop limit:** It is measured in hops. The packet is discarded after the hop limit is decremented to zero
- **Source address:** A 128-bit address
- **Destination address:** A 128-bit address



Basic IP header format

IPv6 Extension Headers

- Additional information are transmitted through the extension headers
- The base header points to the extension headers



IPv6 Addressing

- 128 bit addresses - represented in the form of eight hexadecimal numbers separated by colons, for example:

  FE80:0000:0000:0000:0001:0800:23E7:F5DB

- Leading zeroes can be omitted - FE80:0:0:0:1:800:23E7:F5DB

- A group of zeroes can be replaced by a double colon -

  FE80::1:800:23E7:F5DB (The double colon can be used only once)

Address Space Allocation based on Prefix

Allocation	Prefix (bin)	Start of address range (hex)	Mask length (bits)	Fraction of address space
Reserved	0000 0000	0:: /8	8	1/256
Reserved for NSAP	0000 001	200:: /7	7	1/128
Reserved for IPX	0000 010	400:: /7	7	1/128
Aggregatable global unicast addresses	001	2000:: /3	3	1/8

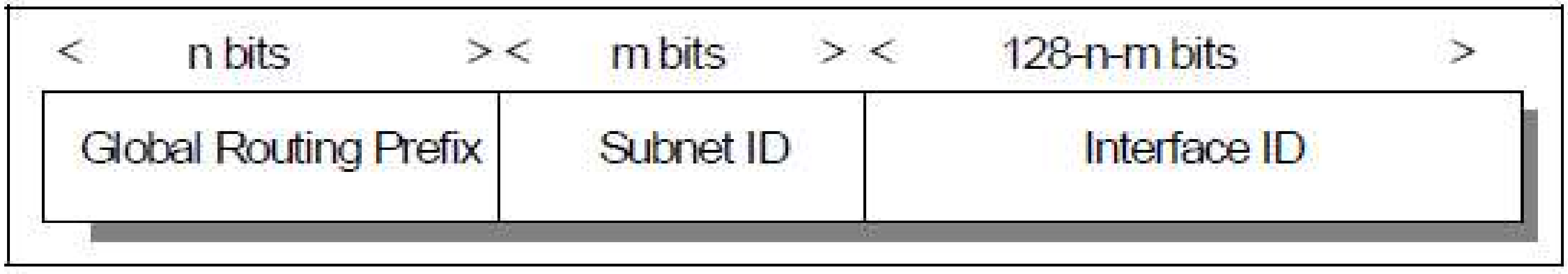
NSAP : Network Service Access Point

IPX : Internetwork Packet Exchange (Protocol)

Address Space Allocation based on Prefix

Allocation	Prefix (bin)	Start of address range (hex)	Mask length (bits)	Fraction of address space
Link-local unicast	1111 1110 10	FE80:: /10	10	1/1024
Site-local unicast	1111 1110 11	FEC0:: /10	10	1/1024
Multicast	1111 1111	FF00:: /8	8	1/256
Total allocation				15%

Global Unicast Address Format

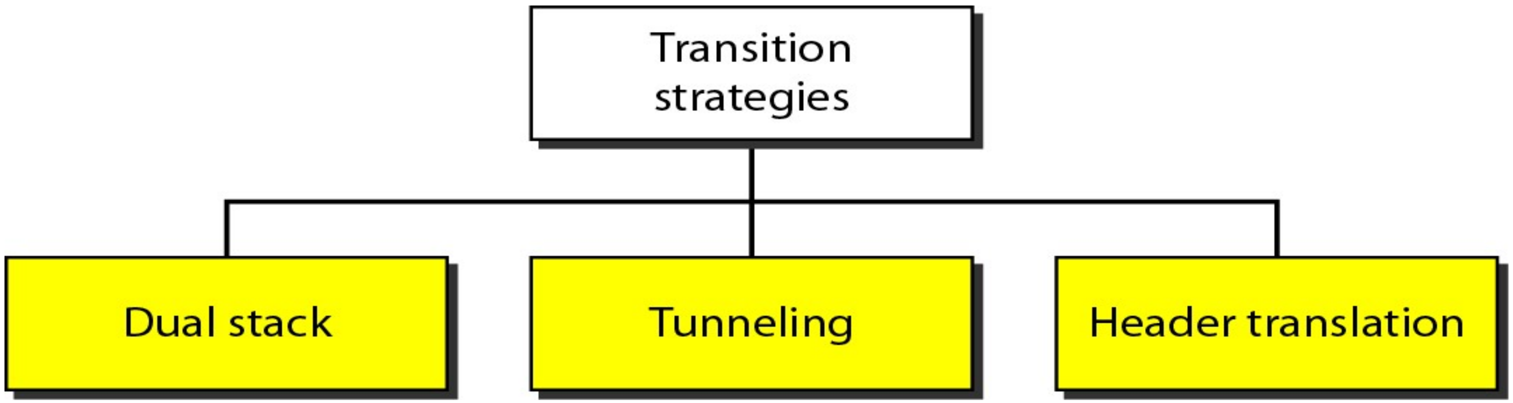


- **Global Routing Prefix:** A value assigned to a site for a cluster of subnets/links. The global routing prefix is designed to be structured hierarchically
- **Subnet ID:** An identifier of a subnet within the site
- **Interface ID:** Interface identifiers in IPv6 unicast addresses are used to identify interfaces on a link

Transition from IPv4 to IPv6

- Because of the huge number of systems on the Internet, the transition from IPv4 to IPv6 cannot happen suddenly
- It takes a considerable amount of time before every system in the Internet can move from IPv4 to IPv6
- The transition must be smooth to prevent any problems between IPv4 and IPv6 systems

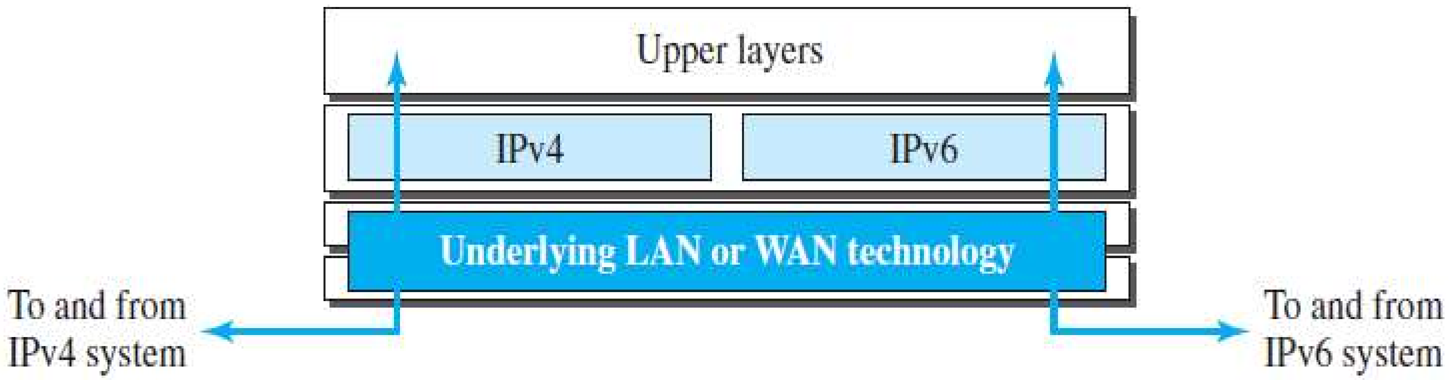
Three transition strategies



Internet Transition: Migrating from IPv4 to IPv6

- **Dual Stack:**
- It is recommended that all hosts, before migrating completely to version 6, have a **dual stack** of protocols during the transition
- A station must run IPv4 and IPv6 simultaneously until all the Internet uses IPv6
- To determine which version to use when sending a packet to a destination, the source host queries the DNS
  - If the DNS returns an IPv4 address, the source host sends an IPv4 packet
  - If the DNS returns an IPv6 address, the source host sends an IPv6 packet

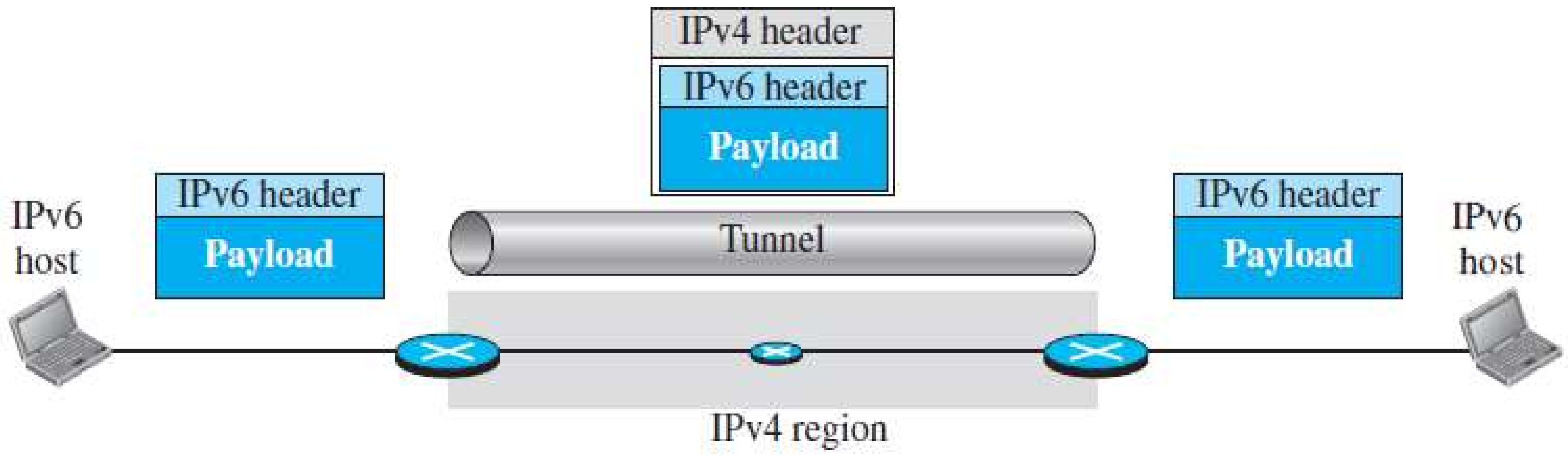
Dual stack



Internet Transition: Migrating from IPv4 to IPv6

- **Tunneling:** It is a strategy used when two computers using IPv6 want to communicate with each other and the packet must pass through a region that uses IPv4
  - To pass through this region, the packet must have an IPv4 address
- So the IPv6 packet is encapsulated in an IPv4 packet when it enters the region, and decapsulated when it exits the region

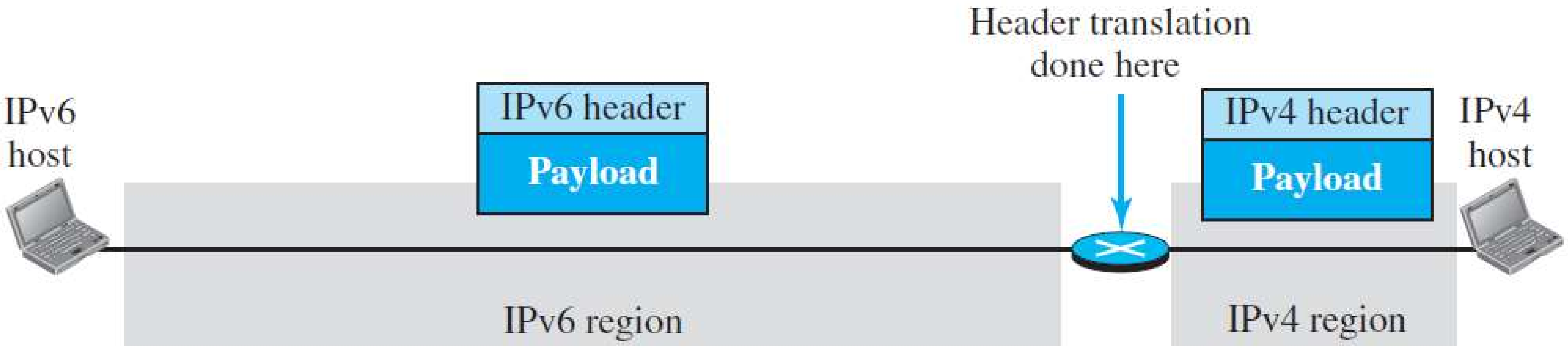
Tunneling strategy



Internet Transition: Migrating from IPv4 to IPv6

- **Header translation:** Header translation is necessary when the majority of the Internet has moved to IPv6 but some systems still use IPv4
- Suppose, the sender wants to use IPv6, but the receiver does not understand IPv6. In this case, the header format must be totally changed through header translation
  - Address must be translated as well during translation
  - Take low order 32 bits (i.e. rightmost 32 bits) for IPv6 to IPv4
  - Append :: FFFF/96 prefix for IPv4 to IPv6

Header translation strategy



Difference Between IPv4 and IPv6

IPv4	IPv6
IPv4 has 32-bit address length	IPv6 has 128-bit address length
Address representation of IPv4 is in decimal	Address representation of IPv6 is in hexadecimal
Fragmentation performed by sender and forwarding routers	In IPv6 fragmentation performed only by sender
IPv4 does not provide encryption and authentication	IPv6 provides encryption and authentication
Security feature is dependent on application	IP security (IPSec) is inbuilt security feature in the IPv6 protocol
IPv4 has header of 20-60 bytes	IPv6 has base header of 40 bytes (fixed)
It supports manual and DHCP address configuration	It supports autoconfiguration of hosts

End