Network Layer/Internet Layer Protocols and Addressing

By,

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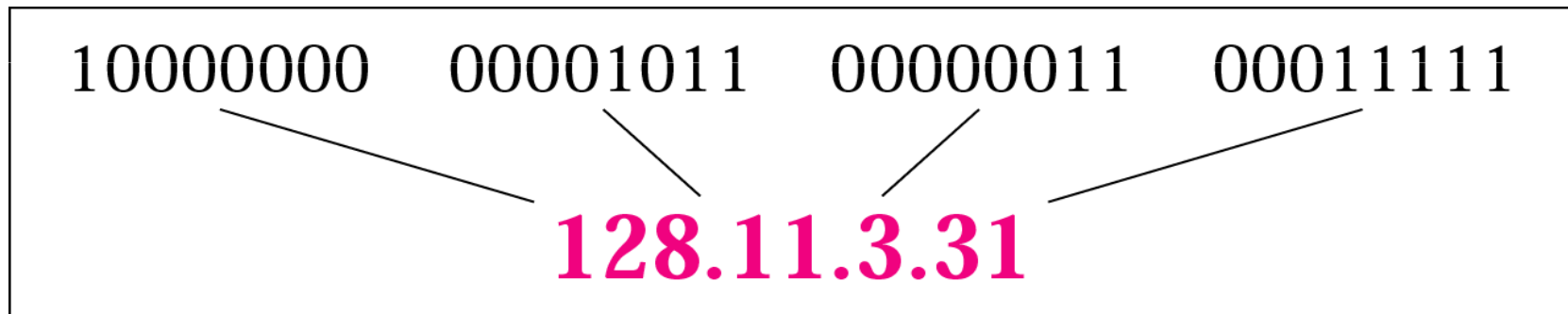Ramshahpath, Kathmandu
Nepal

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OSI Model Compared to TCP/IP

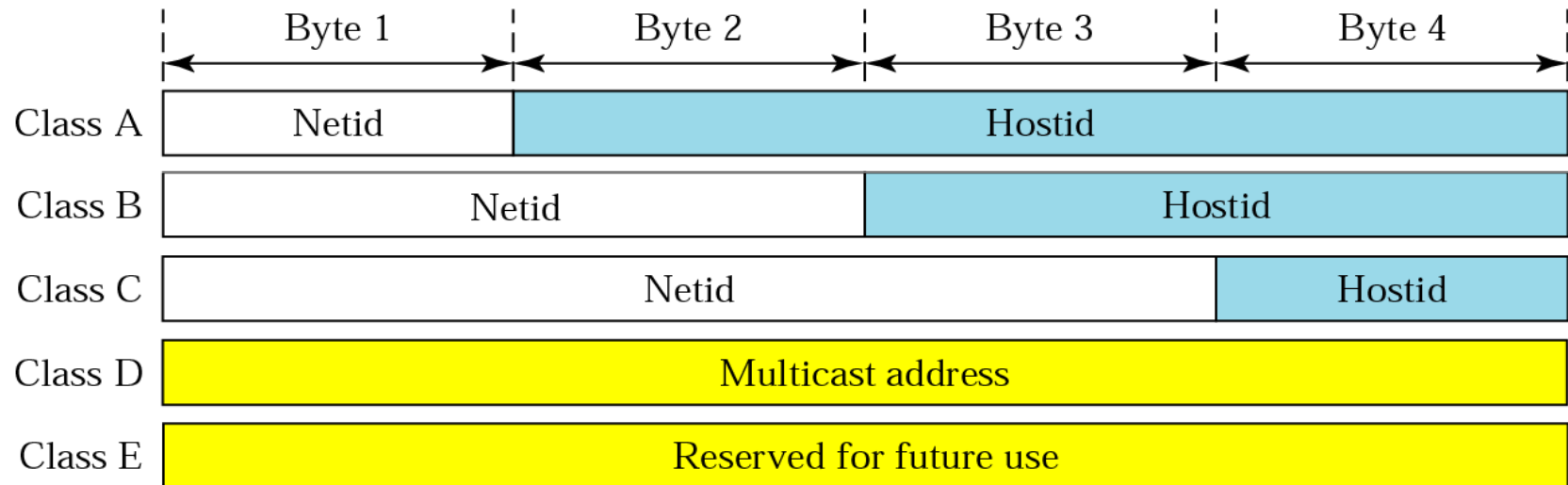| OSI model	TCP/IP
Application	Telnet FTP DHCP TFTP
Presentation	HTTP SMTP DNS SNMP
Session	Application layer
Transport	TCP UDP Transport layer
Network	ICMP ARP IP Internet layer
Data Link	Network interface layer
Physical	

IP Address : Representation in Dotted Decimal Notation

10000000   00001011   00000011   00011111

128.11.3.31

IP Address : Two Levels of Hierarchy

	Byte 1	Byte 2	Byte 3	Byte 4
Class A	Netid	Hostid		
Class B	Netid		Hostid	
Class C	Netid			Hostid
Class D	Multicast address			
Class E	Reserved for future use			

IP Address : Classes ??

	First byte	Second byte	Third byte	Fourth byte
Class A	0			
Class B	10			
Class C	110			
Class D	1110			
Class E	1111			

IP Address : Subnet and Subnet Mask

Class	Default Subnet	Subnet Mask
Class A	/8	255.0.0.0
Class B	/16	255.255.0.0
Class C	/24	255.255.255.0

IP Address : Private IP Address Space

Range	Total Hosts
10.0.0.0 - 10.255.255.255	2^{24}
172.16.0.0 - 172.31.255.255	2^{20}
192.168.0.0 - 192.168.255.255	2^{16}

NAT : Network Address Translation

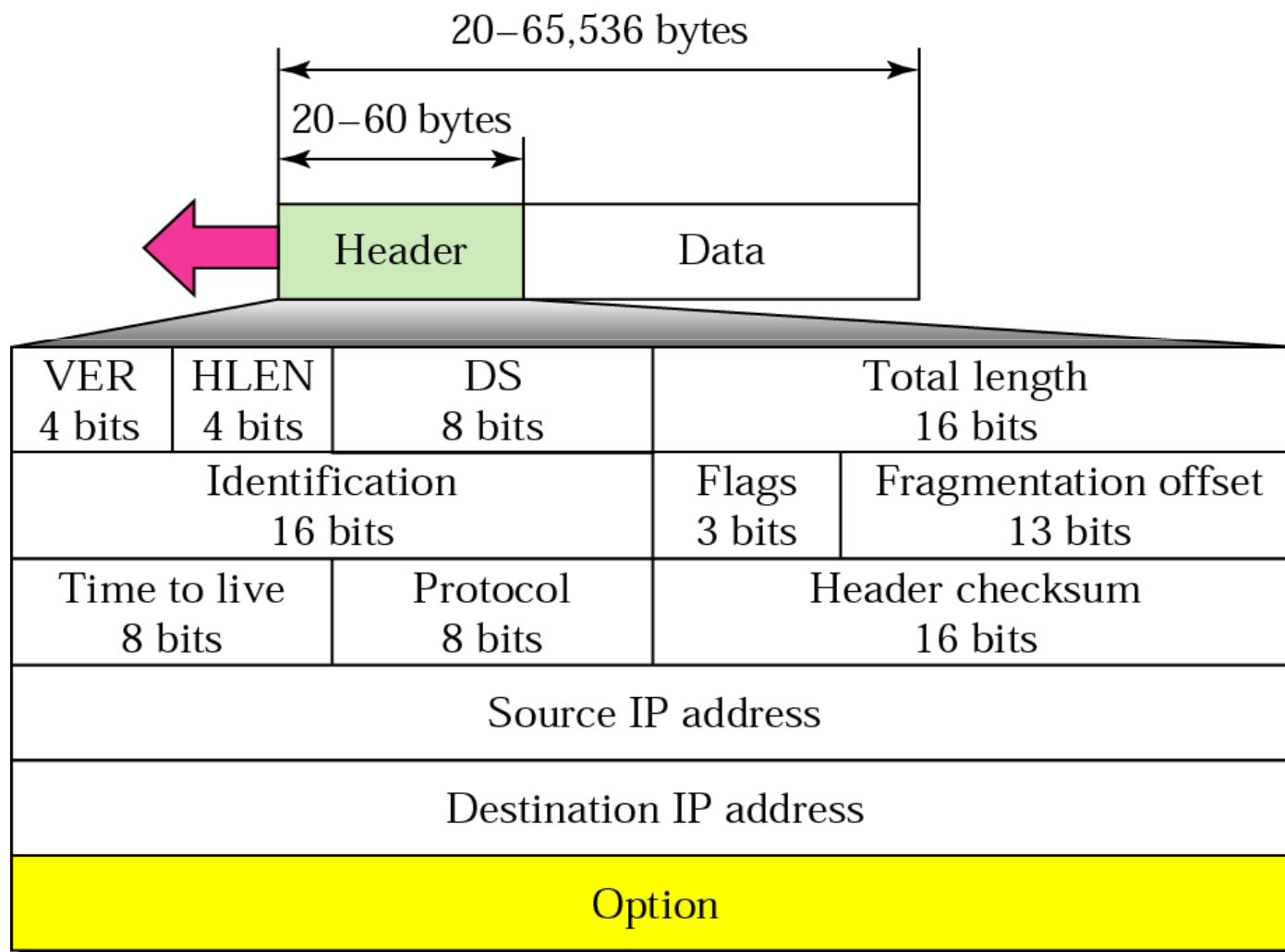Site using private addresses

172.18.3.1   172.18.3.2   172.18.3.20

NAT router

Internet

172.18.3.30   200.24.5.8
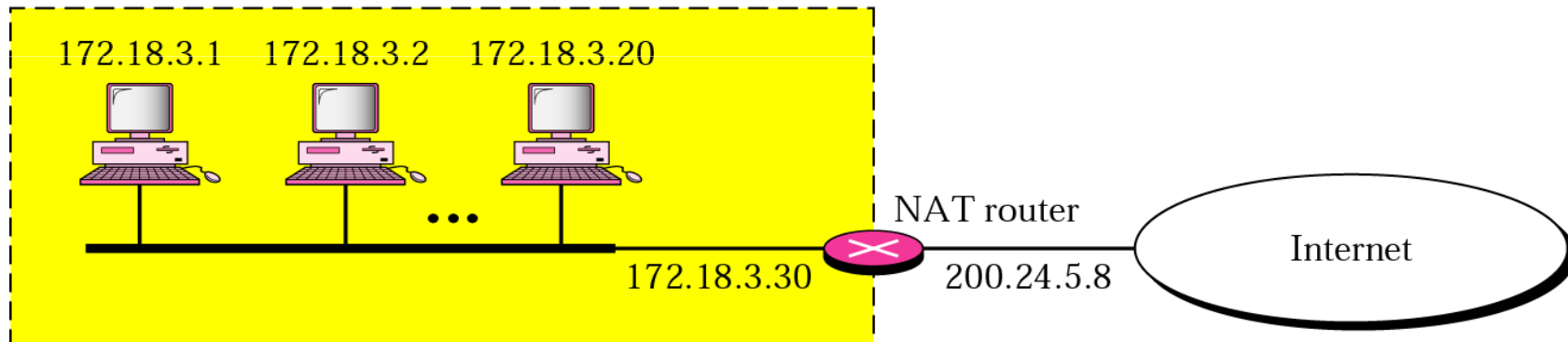
MTU : Maximum Transmission Unit

IP datagram

| Header | MTU
Maximum length of data to be encapsulated in a frame | Trailer |

Frame

IPV4 Frame Format

20–65,536 bytes

20–60 bytes

Header	Data

VER 4 bits	HLEN 4 bits	DS 8 bits	Total length 16 bits	
Identification 16 bits			Flags 3 bits	Fragmentation offset 13 bits
Time to live 8 bits		Protocol 8 bits	Header checksum 16 bits	
Source IP address				
Destination IP address				
Option				
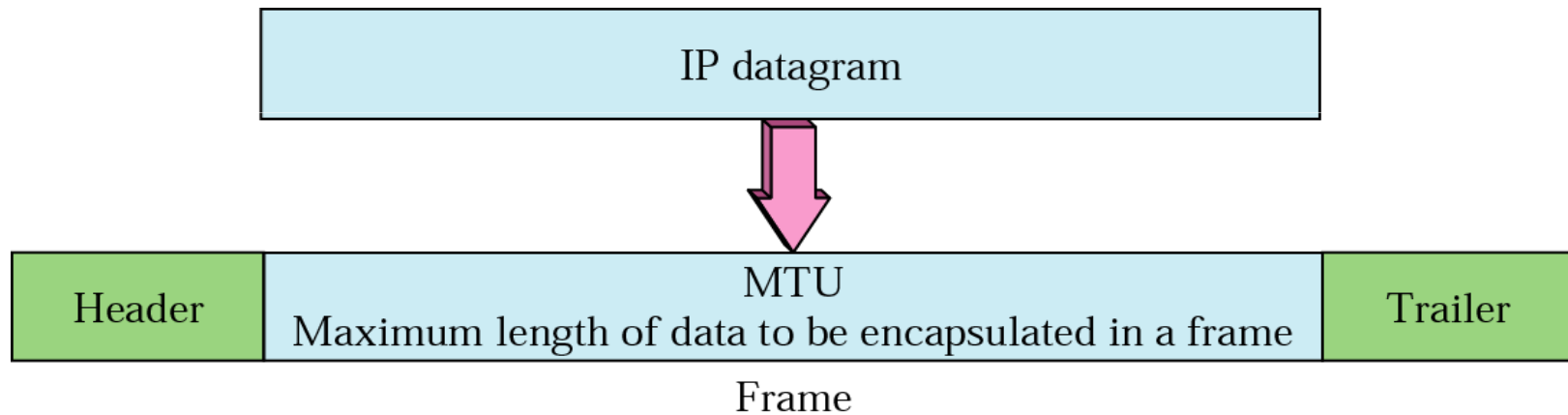
IPV4 Frame Format: Description

- VER => Defines the Version of IP.
- HLEN => Header Length
- DS => Differentiated Service. Defines the Class of Packet for QoS.
- Total Length => Length of Data = Total Length-Header Length.

- Identification
  - When datagram is Fragmented => Identification copied to all.
  - All Fragments have the same Identification.
  - Helps in Reassembling the datagram.

- Flags
  - 3 Bits => Reserved, MF and DF
  - DF => Don't Fragment.
  - MF => More Fragment.

IPV4 Frame Format: Description

- Fragmentation Offset => Offset value of Fragment.
- TTL => Time To Live. If TTL =0 Then Packet is discarded.
- Protocol
    - Defines Higher Layer Protocols.
    - Higher Layer Protocols => TCP, UDP.

- Checksum => Computes Checksum

- Source IP Address => IP Address of Source Machine.

- Destination IP Address => IP Address of Destination Machine.

- Option => Optional Field Used for Network Testing and debugging.

Header Checksum Calculation

4	5	0	28	
1			0	0
4		17	0	
10.12.14.5				
12.6.7.9				

4, 5, and 0 ⟶ 0100010100000000
28 ⟶ 0000000000011100
1 ⟶ 0000000000000001
0 and 0 ⟶ 0000000000000000
4 and 17 ⟶ 0000010000010001
0 ⟶ 0000000000000000
10.12 ⟶ 0000101000001100
14.5 ⟶ 0000111000000101
12.6 ⟶ 0000110000000110
7.9 ⟶ 0000011100001001

Sum ⟶ 0111010001001110
Checksum ⟶ 1000101110110001

Question ??

- The Asia Pacific Network Information Center (APNIC) has to provide service to 8 Local ISPs from the network pool of 17.10.0.0/20. From the available pool each Local ISP has to provide service to their Six (6) dedicated clients.

- Design the complete IP Address Plan which includes IP Pool, Usable IP Pool and Subnet Mask for each network.

???

IPV6 : Internet Protocol Version 6

- ❑ It is Known as Internetworking Protocol Next Generation (IPng).

- ❑ It is suitable for Fast growing Internet.

- ❑ It is also suitable for Next Generation Networks (NGN).

- ❑ Features
    - ✓ Larger Address Space (128 Bit Address Space).
    - ✓ Supports Resource Allocation via Flow Control Field.
    - ✓ Supports More Security.
    - ✓ Better Header Format (Base Header and Extension Header)

IPV6 : 128 Bit Addressing Scheme

Unabbreviated
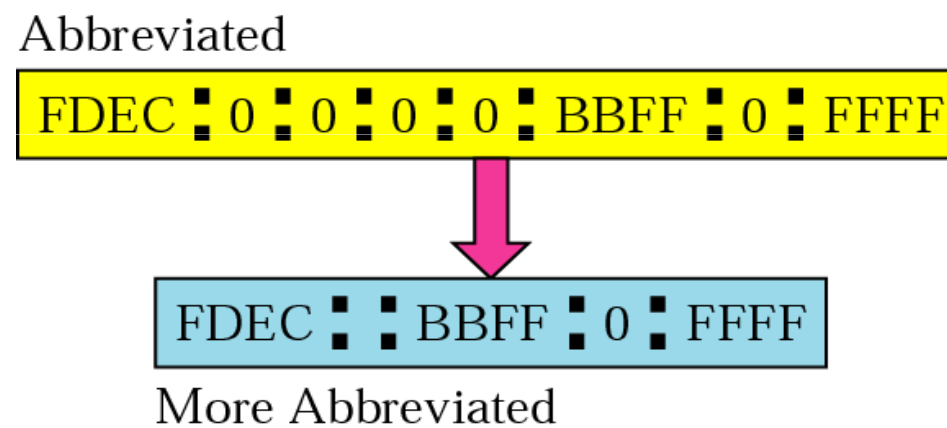
FDEC : BA98 : 0074 : 3210 : 000F : BBFF : 0000 : FFFF
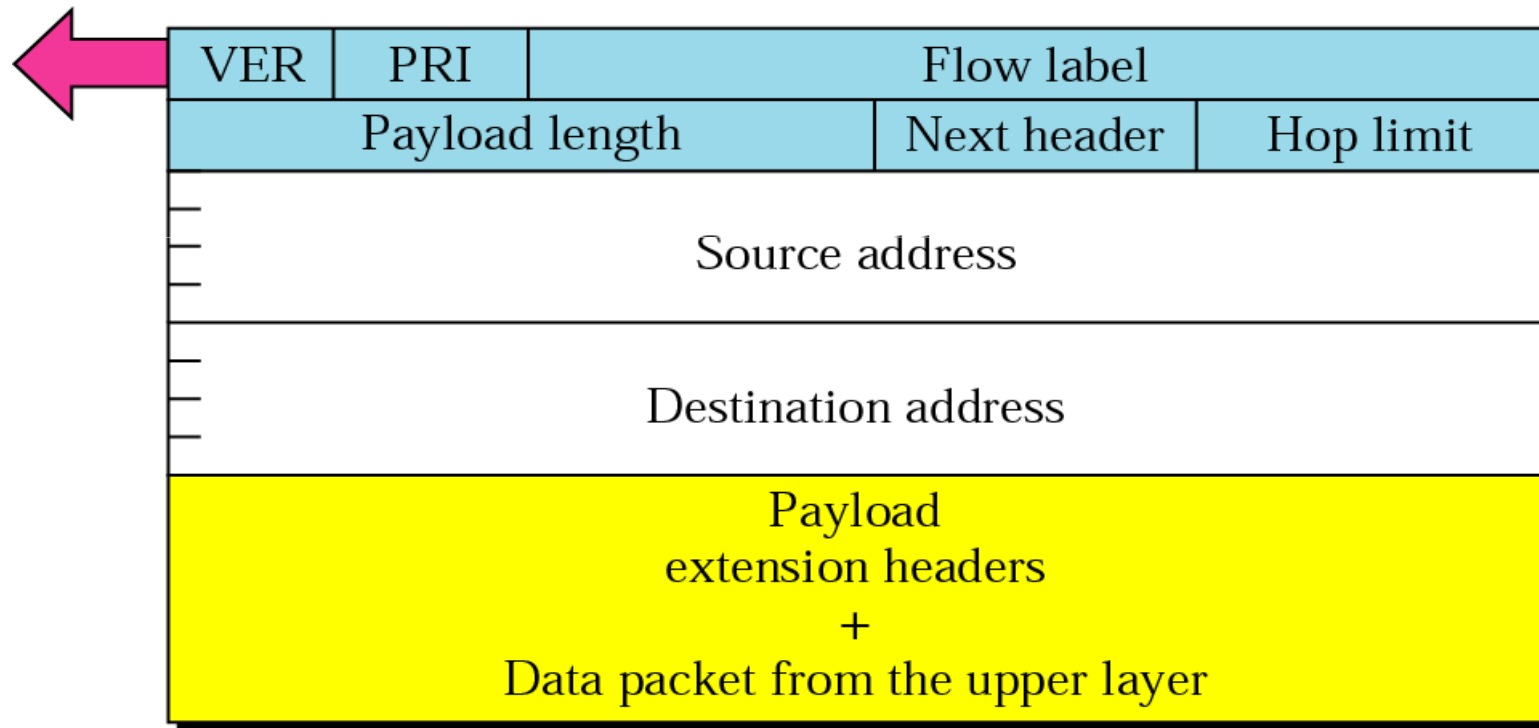
FDEC : BA98 : 74 : 3210 : F : BBFF : 0 : FFFF

Abbreviated

IPV6 : Abbreviated Address

Abbreviated

FDEC : 0 : 0 : 0 : 0 : BBFF : 0 : FFFF

FDEC : : BBFF : 0 : FFFF

More Abbreviated

IPV6 : Header Format (Base Header + Extension Header)

VER	PRI	Flow label		
Payload length			Next header	Hop limit

Source address

Destination address

Payload
extension headers
+
Data packet from the upper layer

IPV6 : Header Format Description

- VER (4 Bits) => Specifies the Version of IPV6.
- Priority (4 Bits) => Defines the Priority of Packet.
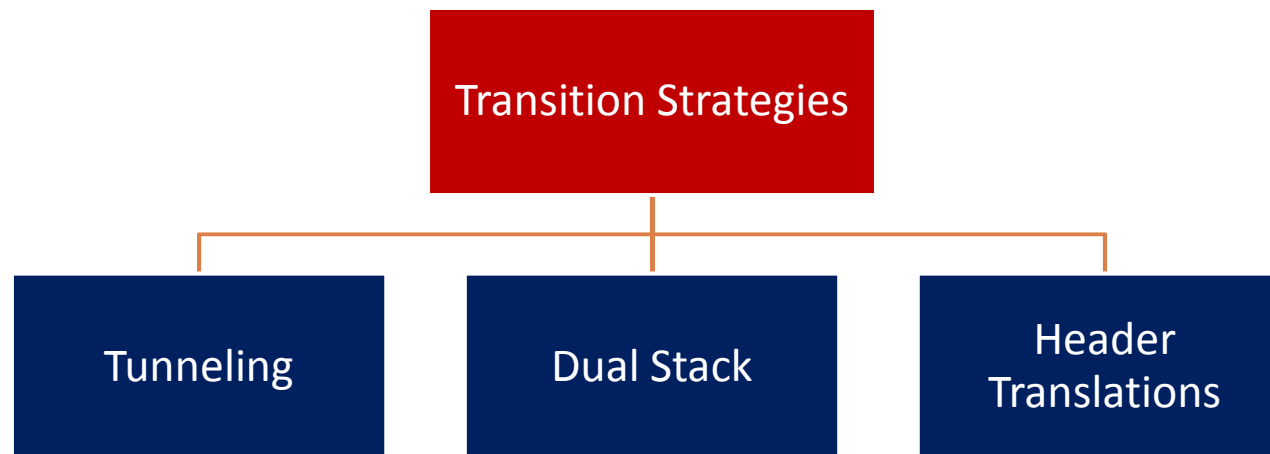- Flow Label (24 Bits) => Used for Resource Reservation.

- Payload Length (16 Bits)
  Total Length of IP Datagram Excluding Base Header.

- Next Header (8 Bits)
  Provides Information about Extension Header.

- Hop Limit (8 Bits) => Same as TTL in IPV4.
- Source Address => 128 Bit Source IPV6 Address
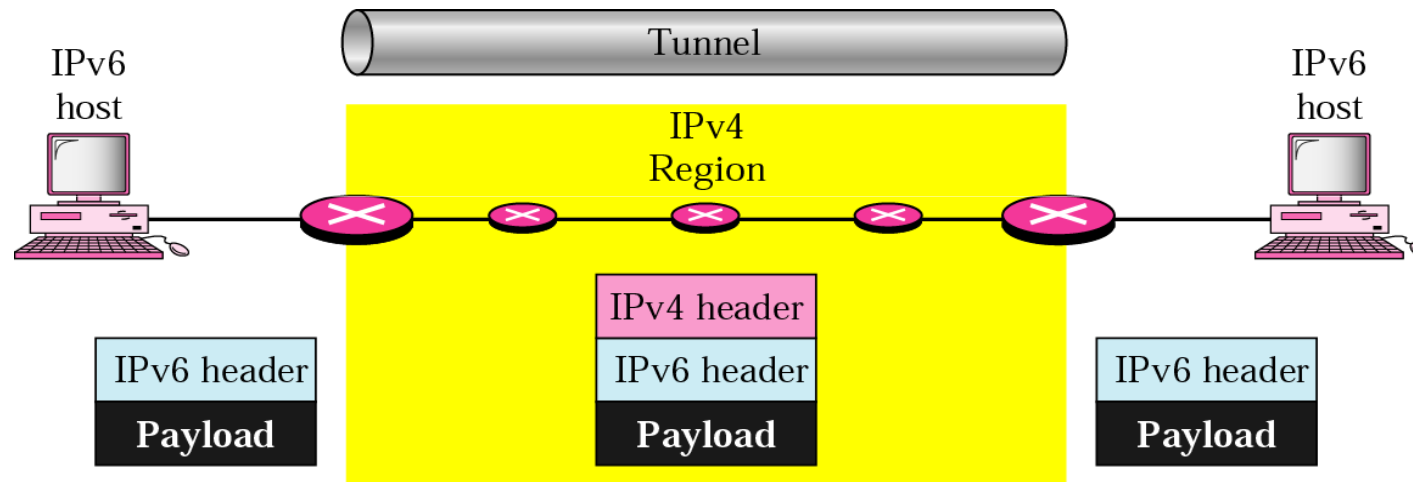- Destination Address => 128 Bit Destination IPV6 Address

IPV6 Transition Strategies

```
                    ┌──────────────────────┐
                    │ Transition Strategies │
                    └──────────────────────┘
        ┌──────────────┬──────────┴──────────┬──────────────┐
┌────────────┐    ┌────────────┐    ┌──────────────┐
│  Tunneling │    │ Dual Stack │    │    Header    │
│            │    │            │    │ Translations │
└────────────┘    └────────────┘    └──────────────┘
```
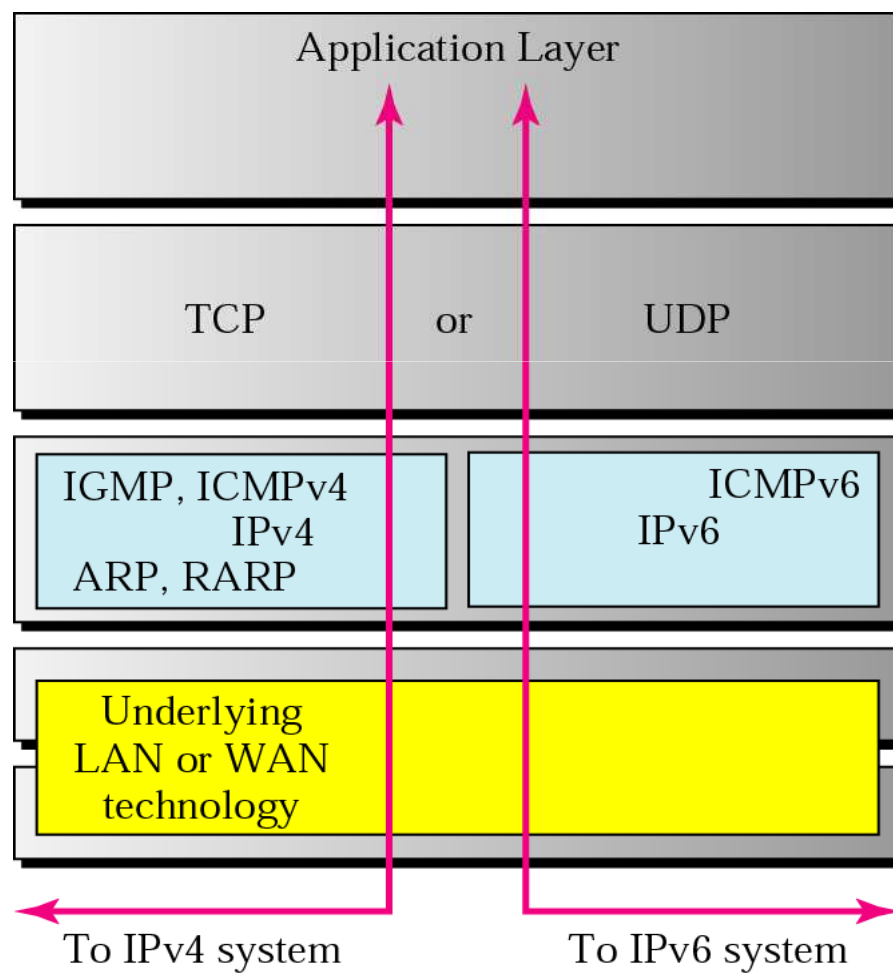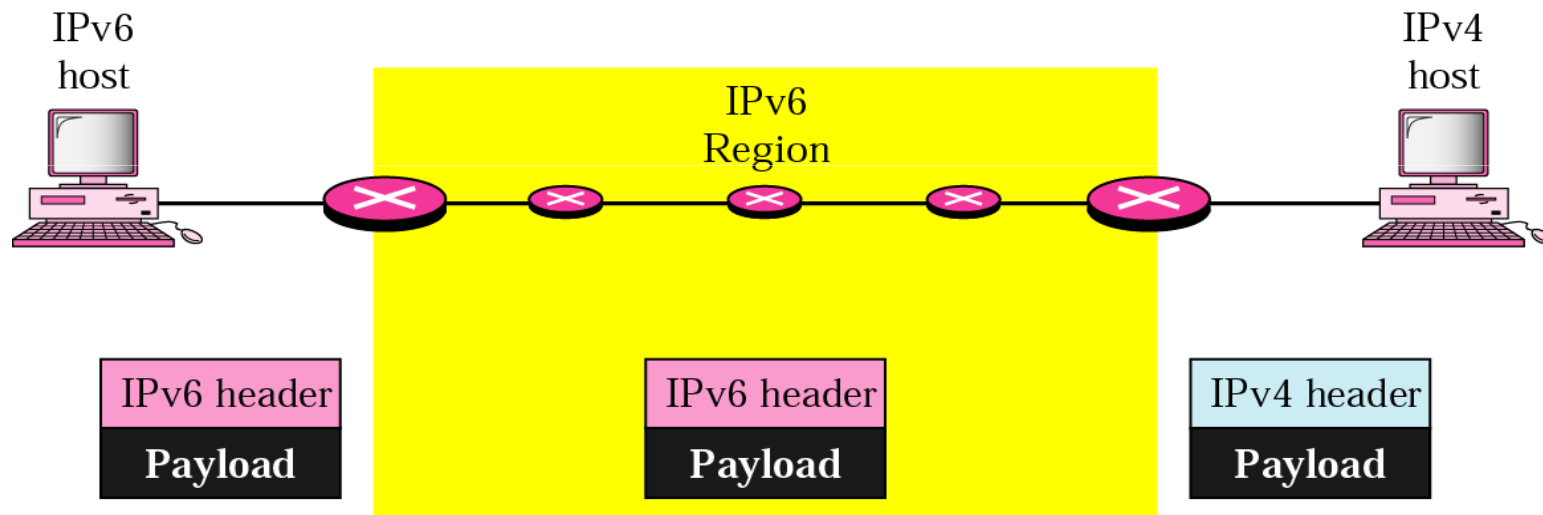
IPV6 Transition : Tunneling

IPV6 Transition : Dual Stack

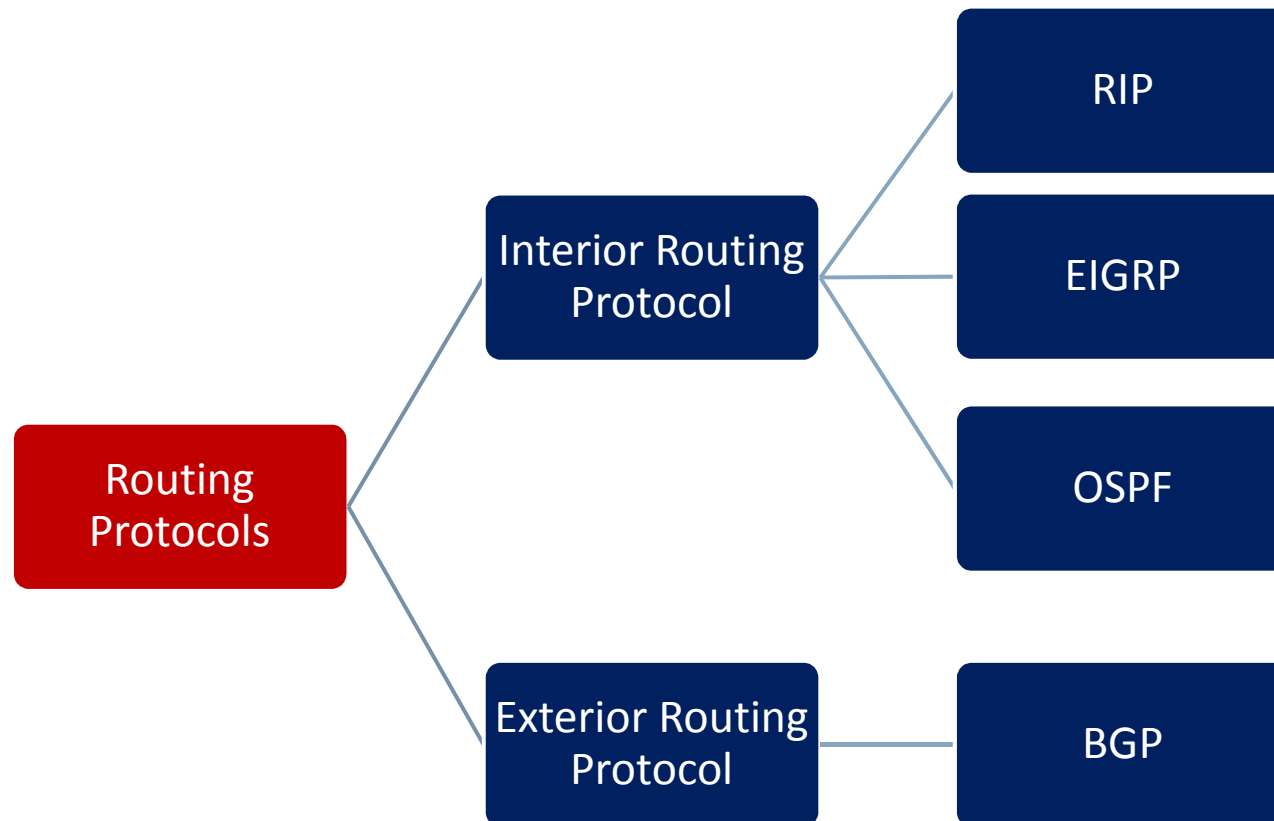# IPV6 Transition : Header Translation

Routing Protocols: Approaches ??

Routing Protocols

- Interior Gateway Routing Protocols

  - ✓ Used for Routing Inside an Autonomous System (AS).

  - ✓ AS => Network under Common Administration.

  - ✓ Examples => RIP, EIGRP and OSPF

- Exterior Gateway Routing Protocols

  - ✓ Used for Routing between Autonomous System (AS)
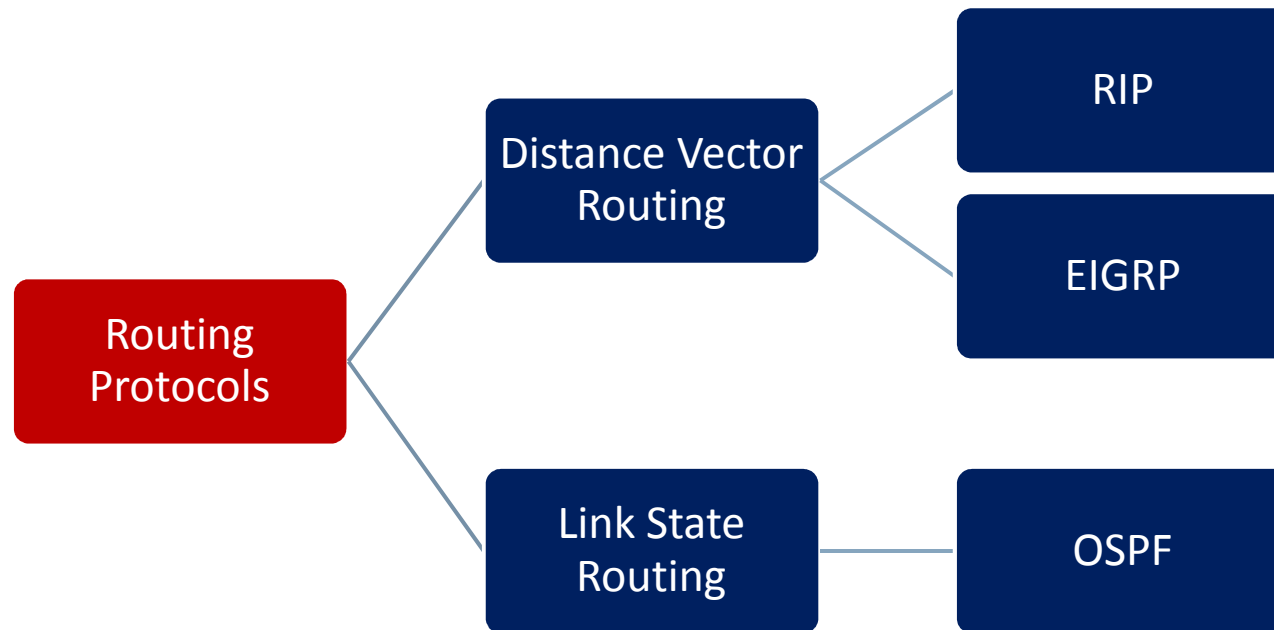
Routing Protocols: Example

IGP vs. EGP Routing Protocols

Exterior Gateway Protocol:
- BGP

Autonomous System 100

Interior Gateway Protocols:
- RIP
- IGRP
- EIGRP
- OSPF
- IS-IS

Autonomous System 200
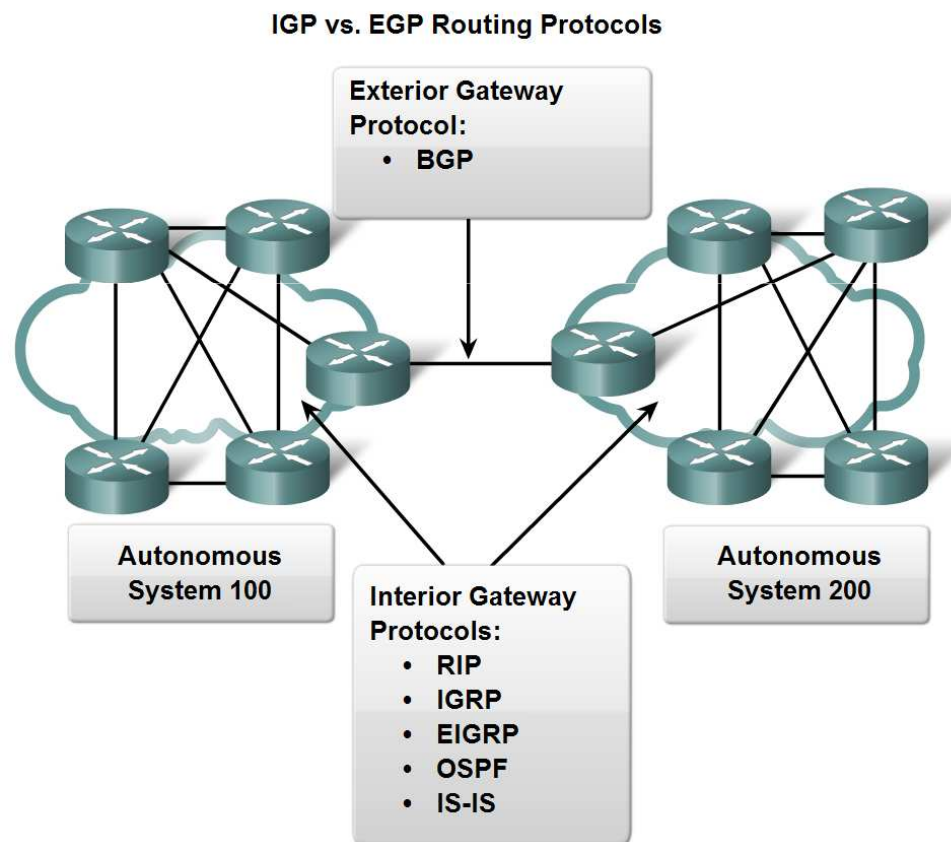
Routing Protocols: Classification

```
                                        ┌──────────────┐
                                        │     RIP      │
                        ┌──────────────┐└──────────────┘
                        │   Distance   │
                        │    Vector    │
                        │   Routing    │┌──────────────┐
                        └──────────────┘│    EIGRP     │
         ┌──────────────┐               └──────────────┘
         │   Routing    │
         │  Protocols   │
         └──────────────┘┌──────────────┐┌──────────────┐
                         │  Link State  ││     OSPF     │
                         │   Routing    │└──────────────┘
                         └──────────────┘
```

Routing Protocols
Distance Vector Routing — RIP, EIGRP
Link State Routing — OSPF

Routing Protocols

- Distance Vector Routing Protocols

  - ✓ Incomplete View of Topology.

  - ✓ Routes are advertised as Vectors of Distance and Direction.

  - ✓ Generally Periodic Updates.

- Link State Routing Protocols

  - ✓ Complete View of Network Topology.

  - ✓ Updates are Not Periodic. (Bounded and Triggered Updates).

Thank You