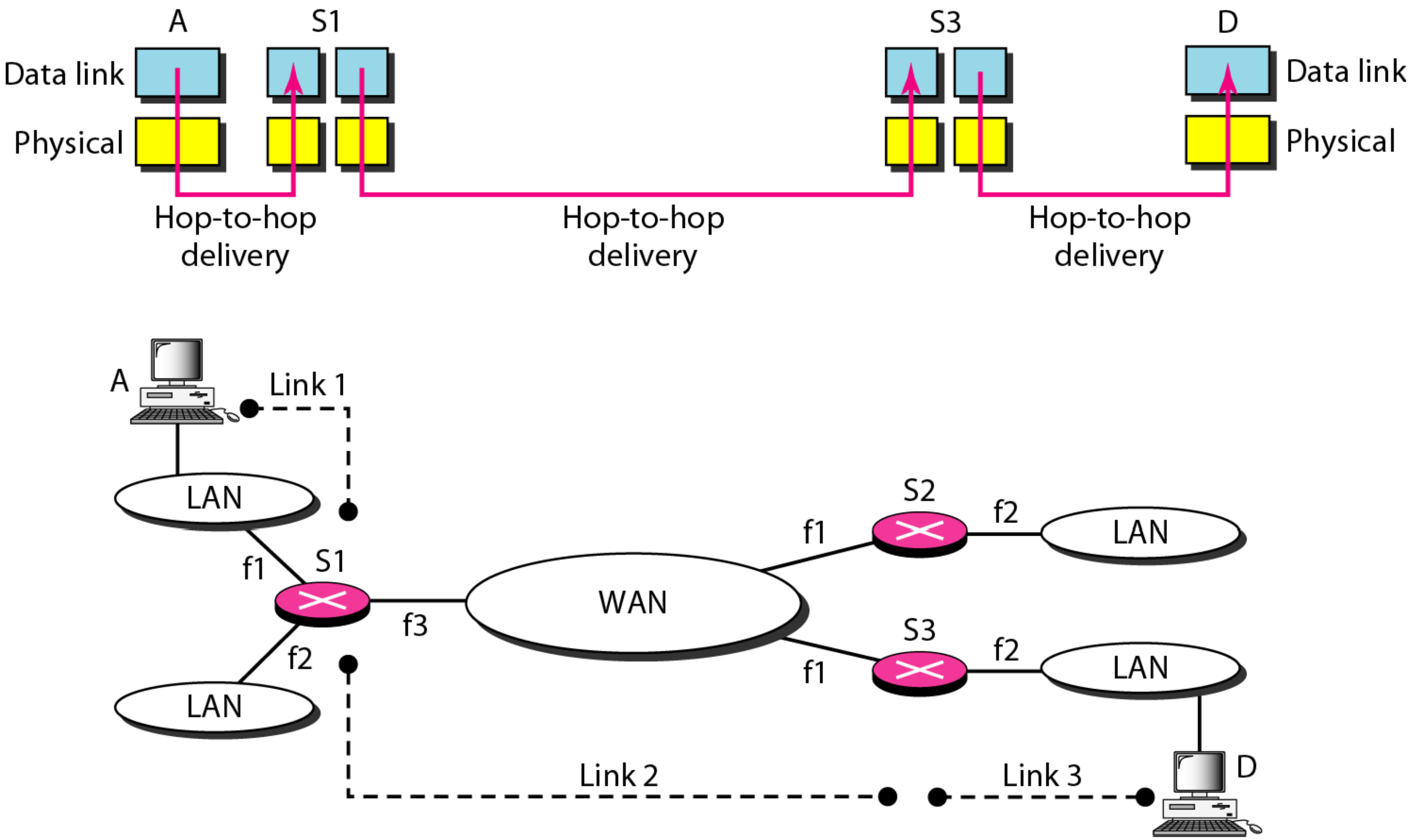
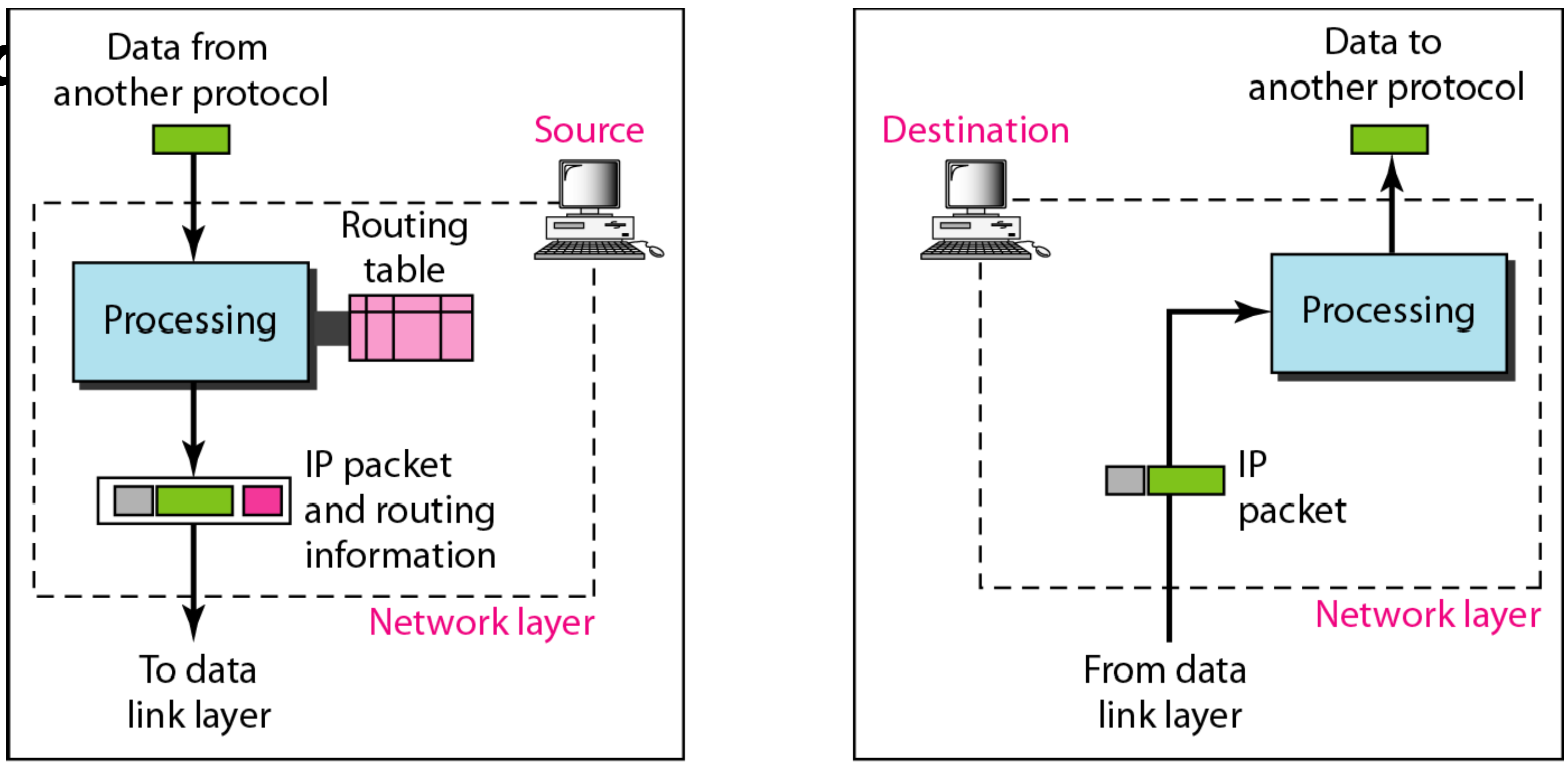
INTERNETWORKING

connecting networks together to make an internetwork or an internet..

Links between two hosts



Network layer at the source, router, and

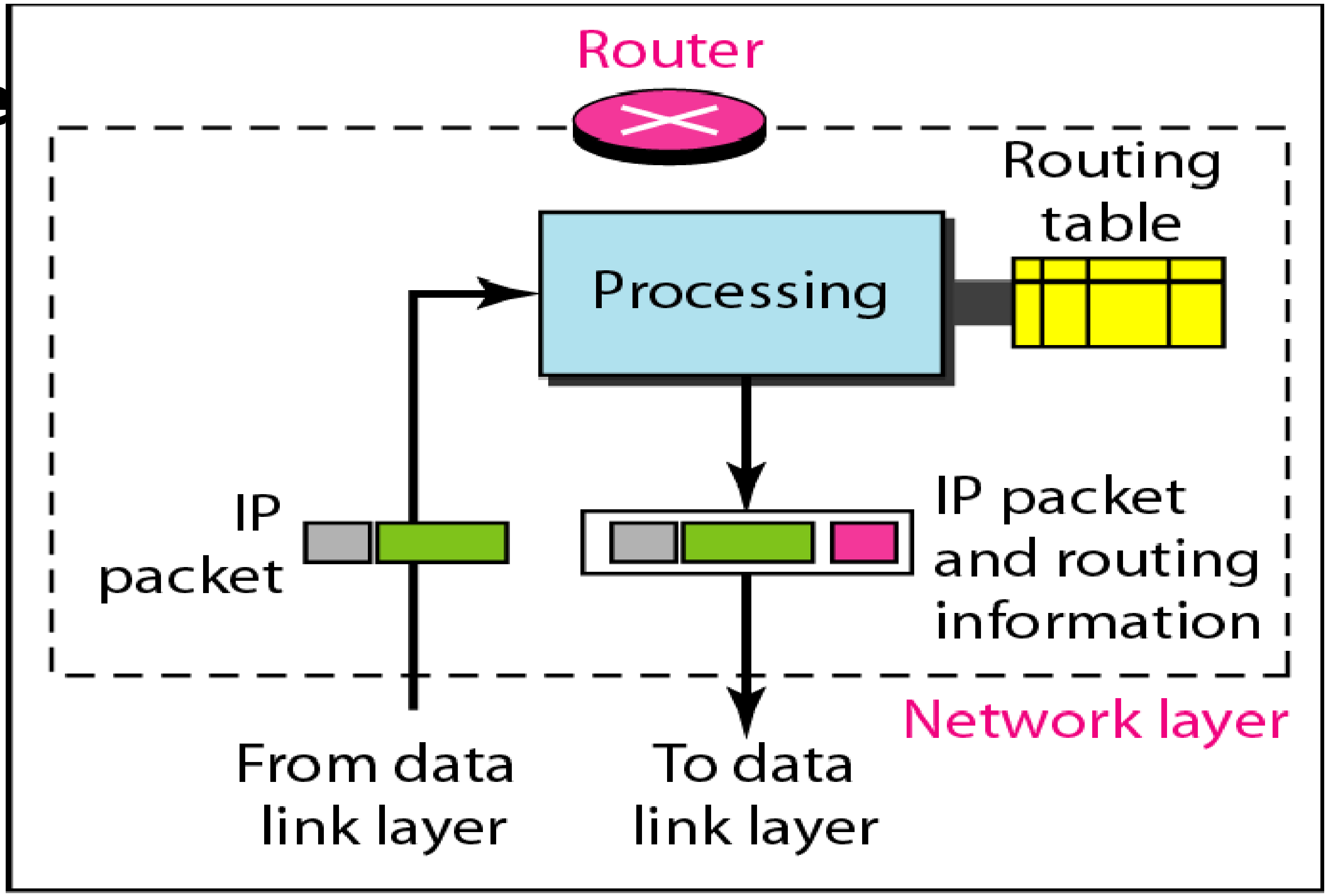


a. Network layer at source

b. Network layer at destination

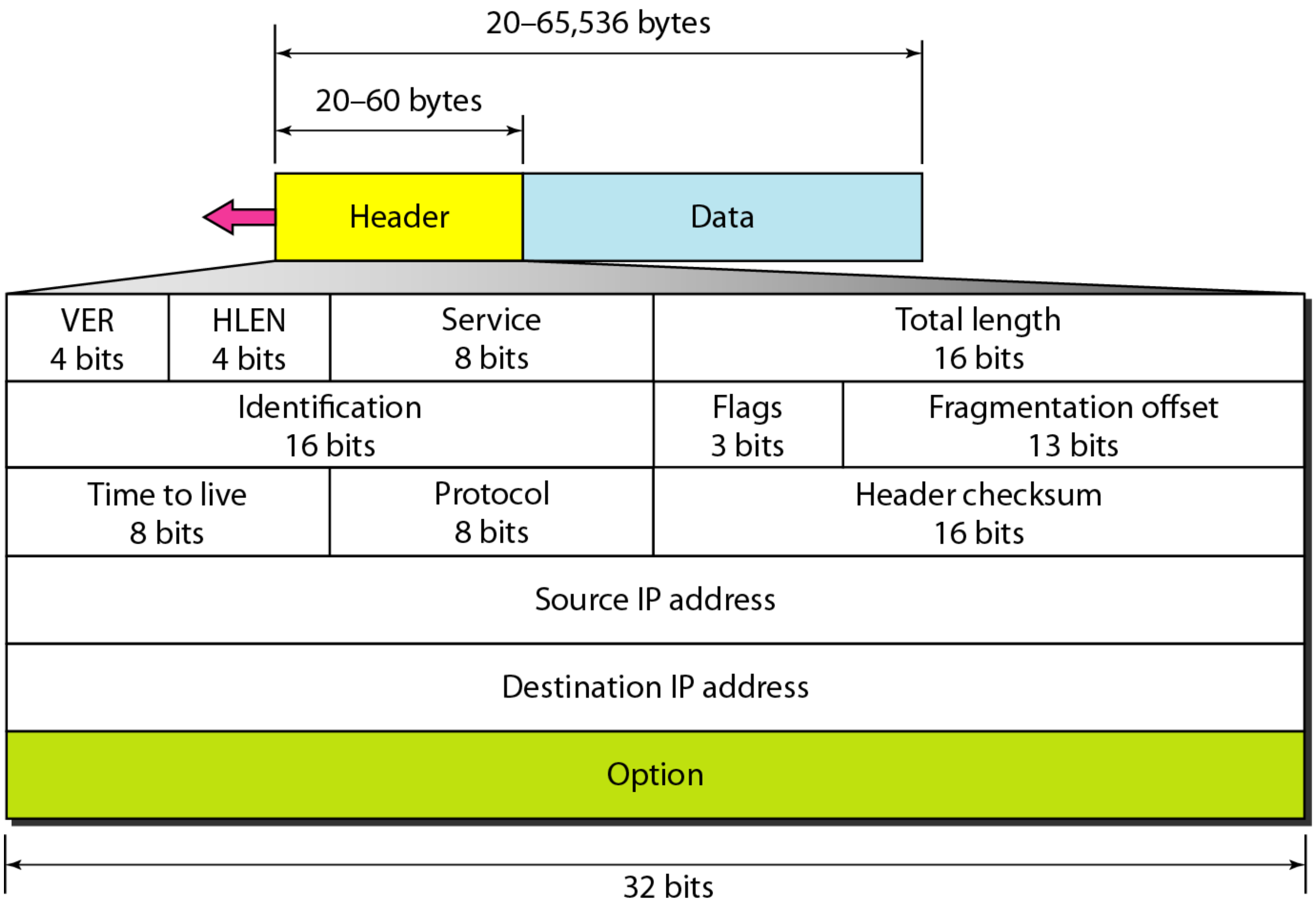
Network layer at the source, router, and

de



c. Network layer at a router

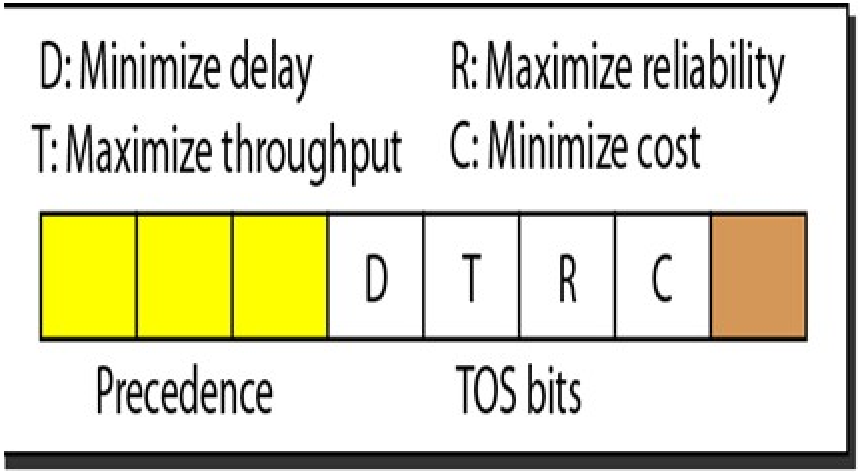
Pv4 datagram format (IPV4 Header)



IPv4 datagram format (IPV4 Header)

- **Version: IP Version**
  - 4 for IPv4
  - 6 for IPv6
- **HLen: Header Length**
  - 32-bit words (typically 5)
- **TOS: Type of Service**
  - Priority information
- **Identifier, flags, fragment offset** used primarily for fragmentation
- **Time to live**
  - Must be decremented at each router
  - Packets with TTL=0 are thrown away
  - Ensure packets exit the network
- **Protocol**
  - Demultiplexing to higher layer protocols
  - TCP = 6, ICMP = 1, UDP = 17…
- **Header checksum**
  - Ensures some degree of header integrity
  - Relatively weak – only 16 bits
- **Options**
  - E.g. Source routing, record route, etc.
  - Performance issues at routers
    - Poorly supported or not at all
- **Source Address**
  - 32-bit IP address of sender
- **Destination Address**
  - 32-bit IP address of destination

Service type field in IPV4

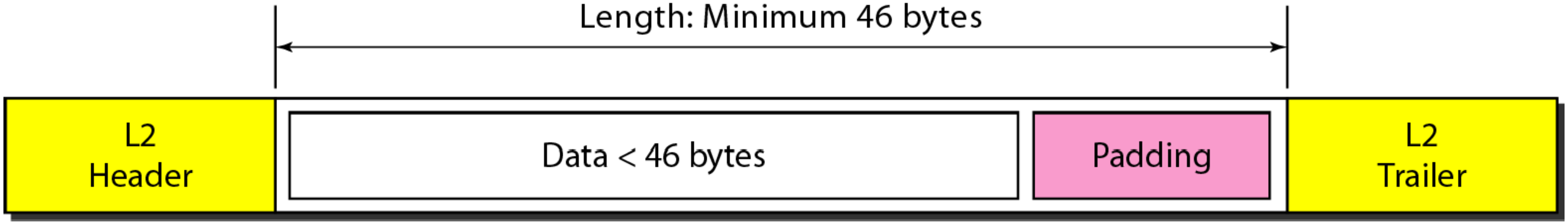


Service type

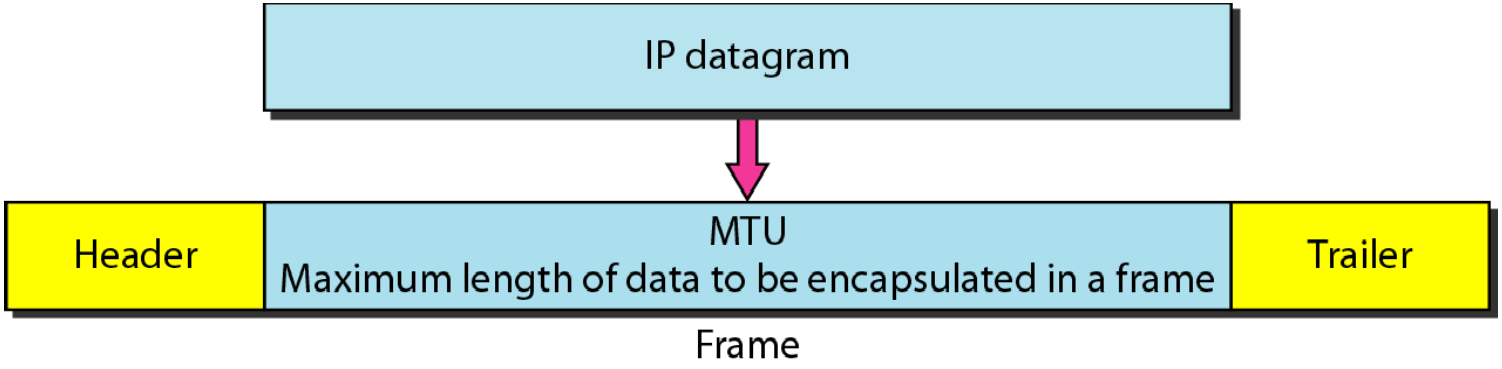
Protocol values

Value	*Protocol*
1	ICMP
2	IGMP
6	TCP
17	UDP
89	OSPF

Encapsulation of a small datagram in an Ethernet frame



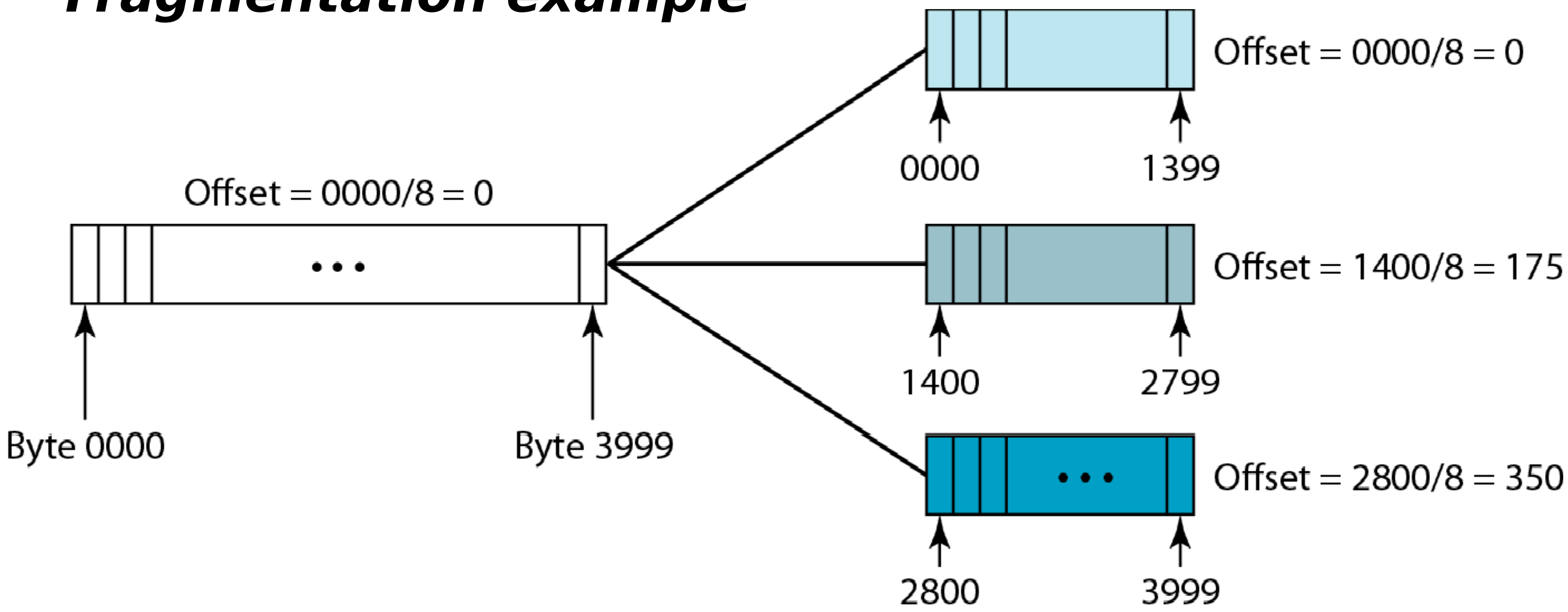
aximum transfer unit (MTU)



Protocol	*MTU*
Hyperchannel	65,535
Token Ring (16 Mbps)	17,914
Token Ring (4 Mbps)	4,464
FDDI	4,352
Ethernet	1,500
X.25	576
PPP	296

Flags used in fragmentation

Fragmentation example



EXAMPLE: ***A packet has arrived with an M bit value of 1 and a fragmentation offset value of 0. Is this the first fragment, the last fragment, or a middle fragment?***

Solution

Because the M bit is 1, it is either the first fragment or a middle one Because the offset value is 0, fragment.

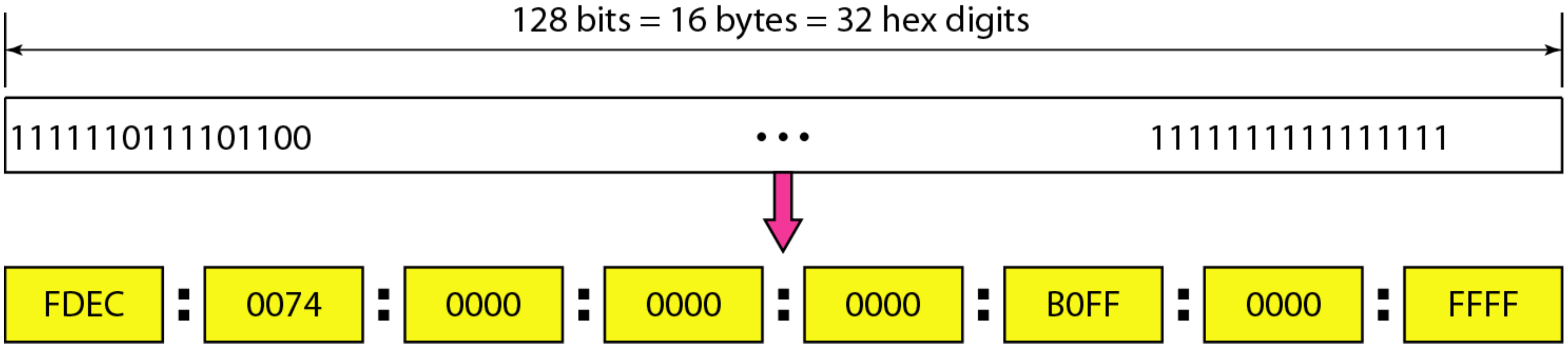
IPv6 ADDRESSES

Despite all short-term solutions, address depletion is still a long-term problem for the Internet. This and other problems in the IP protocol itself have been the motivation for IPv6.

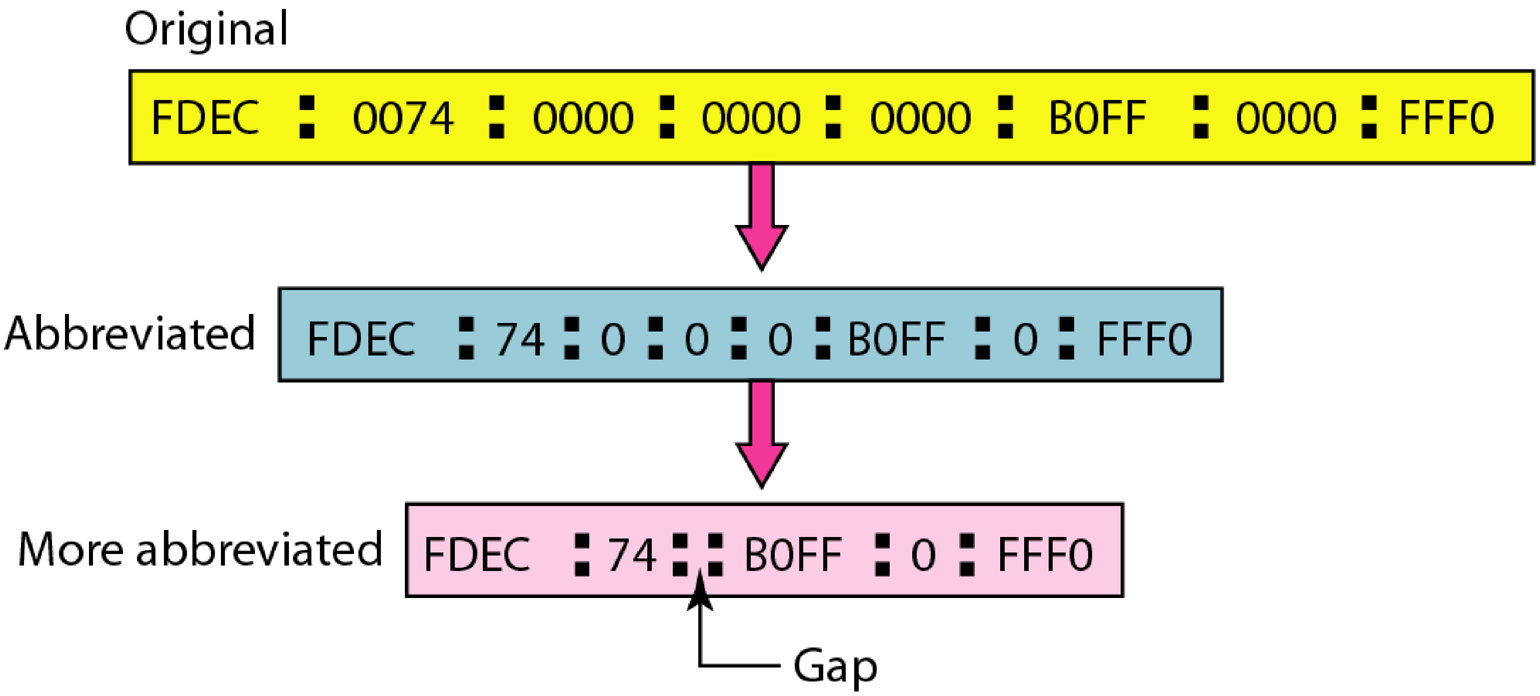
Note

An IPv6 address is 128 bits long.

IPv6 address in binary and hexadecimal colon notation



Abbreviated IPv6 addresses



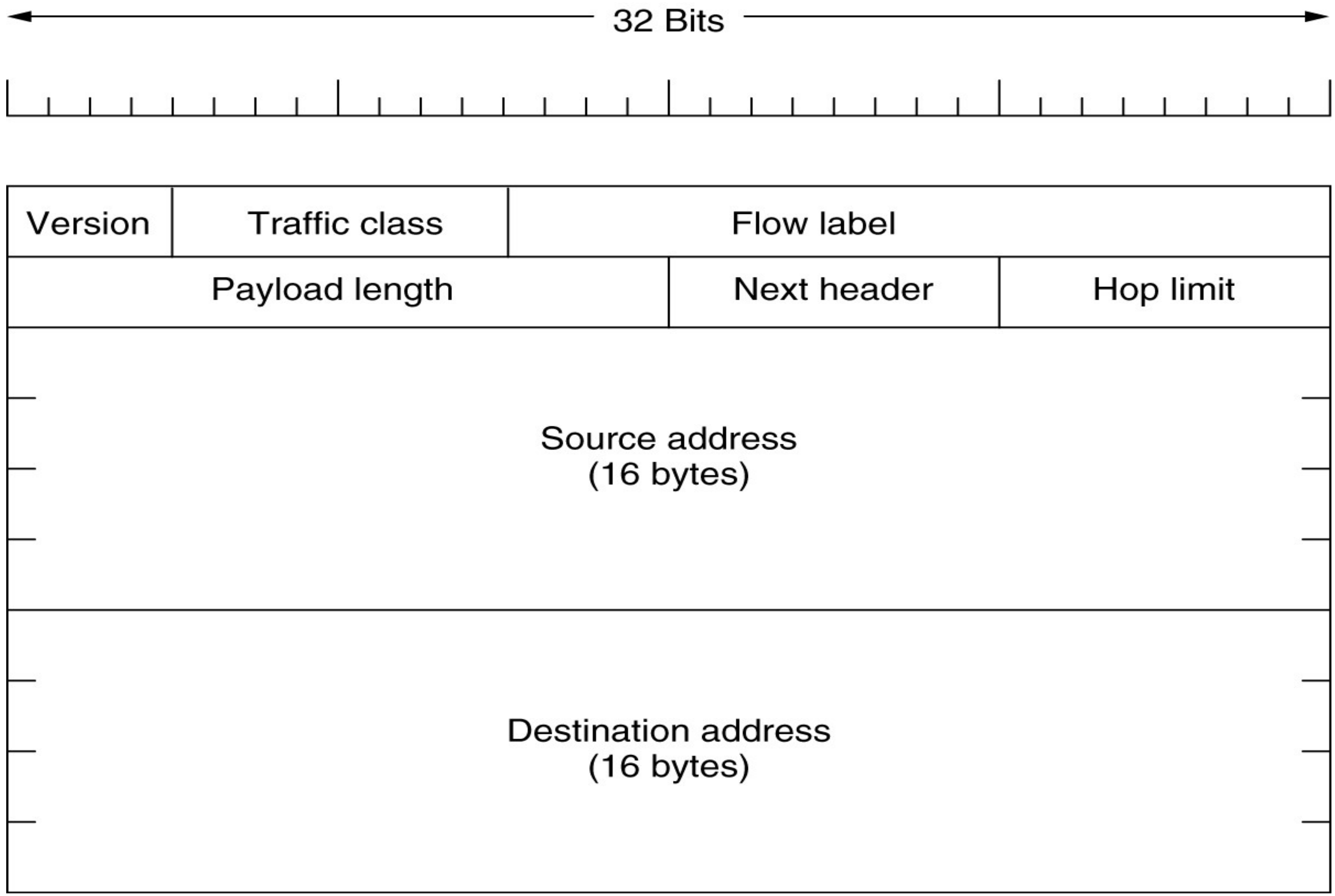
IPv6 Colon Hexadecimal Notation

- 128 bit number expressed as dotted decimal

104.230.140.100.255.255.255.255.0.0.17.128.150.10.255.255
becomes
68E6:8C64:FFFF:FFFF:0:1180:96A:FFFF

- **Hex notation allows <u>zero compression</u>**
  - A string of repeated zeros is replaced with a pair of colons
  - FF05:0:0:0:0:0:0:B3 becomes FF05::B3
  - **Can be applied only once in any address**

The Main IPv6 Header



The IPv6 fixed header (required)

IPV6 Header Description

- **Version** (4-bits): It represents the version of Internet Protocol
- **Traffic Class** (8-bits): These 8 bits are divided into two parts. The most significant 6 bits are used for Type of Service & The least significant 2 bits are used for Explicit Congestion Notification (ECN).
- **Flow Label** (20-bits): This label is used to maintain the sequential flow of the packets belonging to a communication. **Payload Length** (16-bits): This field is used to tell the routers how much information a particular packet contains in its payload.

IPV6 Header Description

- **Next Header** (8-bits): This field is used to indicate either the type of Extension Header.
- **Hop Limit** (8-bits): This field is used to stop packet to loop in the network infinitely. The value of Hop Limit field is decremented by 1 as it passes a link (router/hop). When the field reaches 0 the packet is discarded.
- **Source Address** (128-bits): This field indicates the address of originator of the packet.
- **Destination Address** (128-bits): This field provides the address of intended recipient of the packet.

Next header codes for IPv6

Code	*Next Header*
0	Hop-by-hop option
2	ICMP
6	TCP
17	UDP
43	Source routing
44	Fragmentation
50	Encrypted security payload
51	Authentication
59	Null (no next header)
60	Destination option

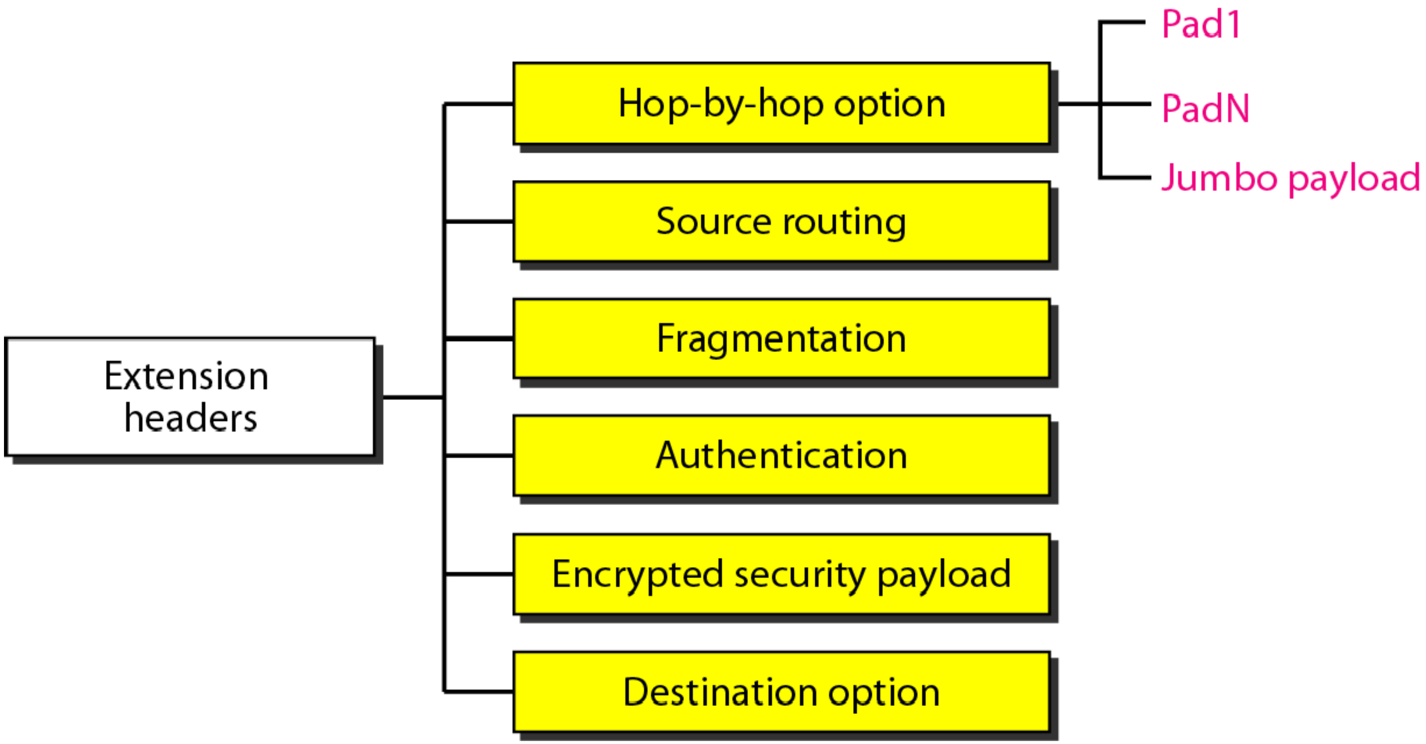
Priorities for congestion-

Priority	*Meaning*
0	No specific traffic
1	Background data
2	Unattended data traffic
3	Reserved
4	Attended bulk data traffic
5	Reserved
6	Interactive traffic
7	Control traffic

Priorities for noncongestion-controlled traffic

Priority	*Meaning*
8	Data with greatest redundancy
. . .	. . .
15	Data with least redundancy

Extension header types



Advantages of IPv6 over IPv4(Ipv4 v/s Ipv6)

Feature	IPv4	IPv6
Source and destination address	32 bits	128 bits
Address Format	Dotted Decimal	Hexadecimal Notation
No of Address	2^32	2^128
IPSec	Optional	required
Payload ID for QoS in the header	No identification	Using Flow label field
Fragmentation	Both router and the sending hosts	Only supported at the sending hosts
Header checksum	included	Not included
Resolve IP address to a link layer address	broadcast ARP request	Multicast Neighbor Solicitation message

Advantages of IPv6 over IPv4 (Ipv4 v/s Ipv6) (2)

Feature	IPv4	IPv6
Determine the address of the best default gateway	ICMP Router Discovery(optional)	ICMPv6 Router Solicitation and Router Advertisement (required)
Send traffic to all nodes on a subnet	Broadcast	Link-local scope all-nodes multicast address
Configure address	Manually or DHCP	Autoconfiguration
Manage local subnet group membership	(IGMP)	Multicast Listener Discovery (MLD)