Computer Networks

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INTERNET PROTOCOL (IP) OVERVIEW

- Primary network-layer protocol
- Unreliable, connectionless delivery mechanism
- Packet routing
- Packet Fragmentation

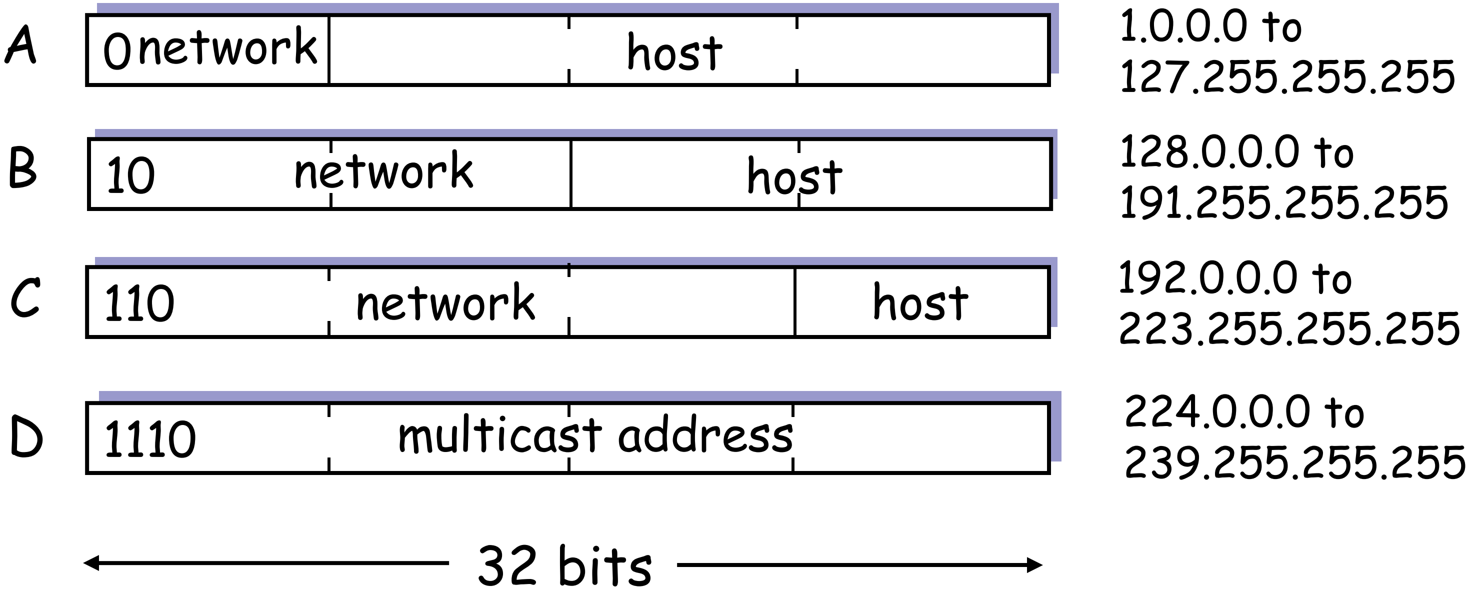
INTERNET PROTOCOL (IP) ADDRESSES

- Interface
- 32-bits separated into four fields of 1 byte each
- Represented in decimal dotted notation
- Identifies a network id and a host id

IP Addresses

- Special network numbers
  - 0 – this network
  - 255 – broadcast
  - 127 - loopback
- Special host numbers
  - 0 – this host
  - 255 - broadcast

IP Addresses



IP Addresses

- Classes (Available Networks/Available Hosts)

Class	Available Networks	Available Hosts
A	126	16,777,214
B	16,384	65,534
C	2,097,151	254

Class	Class ID	IP range	Default mask
A	0	1-126	255.0.0.0
B	10	128-191	255.255.0.0
C	110	192-223	255.255.255.0
D	111	224-247	Used for multicast
E	11111	248-254	Reserved for future use

IP Addresses

- Loopback testing
- Subnets
  - Subnet Masks

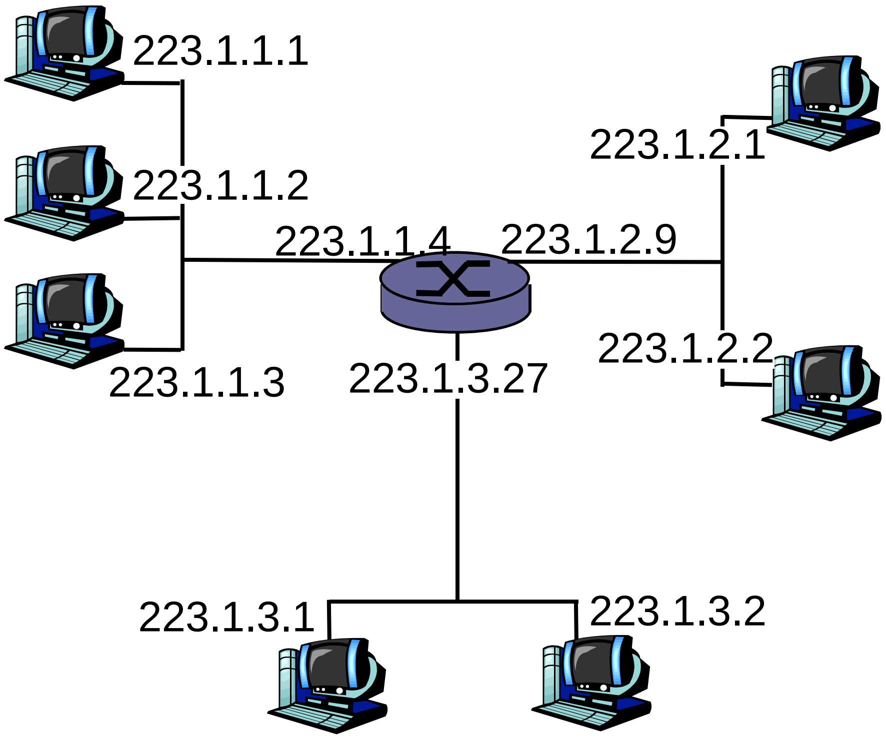
Number of Mask Bits	Subnet Mask	Available SubNets	Available Hosts
2	255.255.255.192	2	62
3	255.255.255.224	6	30
4	255.255.255.240	14	14
5	255.255.255.248	30	6
6	255.255.255.252	62	2

- Write the IP address 129.17.129.97 in its binary form.
  1. 10000001 00100001 10000001 01100001
  2. 10000001 00010001 10000001 01000111
  3. 11111111 00010001 11111111 01100001
  4. 10000001 00010001 10000001 01100001
  5. 11111111 00100001 11111111 01000111

- Consider an Internet address of the form 129.19.40.0/23. What does the /23 signify?
    1. IP address of specific host
    2. Number of bits in network portion
    3. Number of bits in subnet portion
    4. Number of bits in host portion

- Consider an IP subnet with prefix 129.17.129.97/27. What is the range of IP addresses that can be assigned to this subnet?
    1. 129.17.129.96 – 129.17.129.127
    2. 129.17.129.97 – 129.17.129.128
    3. 129.17.129.64 – 129.17.129.95
    4. 129.17.129.65 – 129.17.129.96

Network Layer - Source to Destination



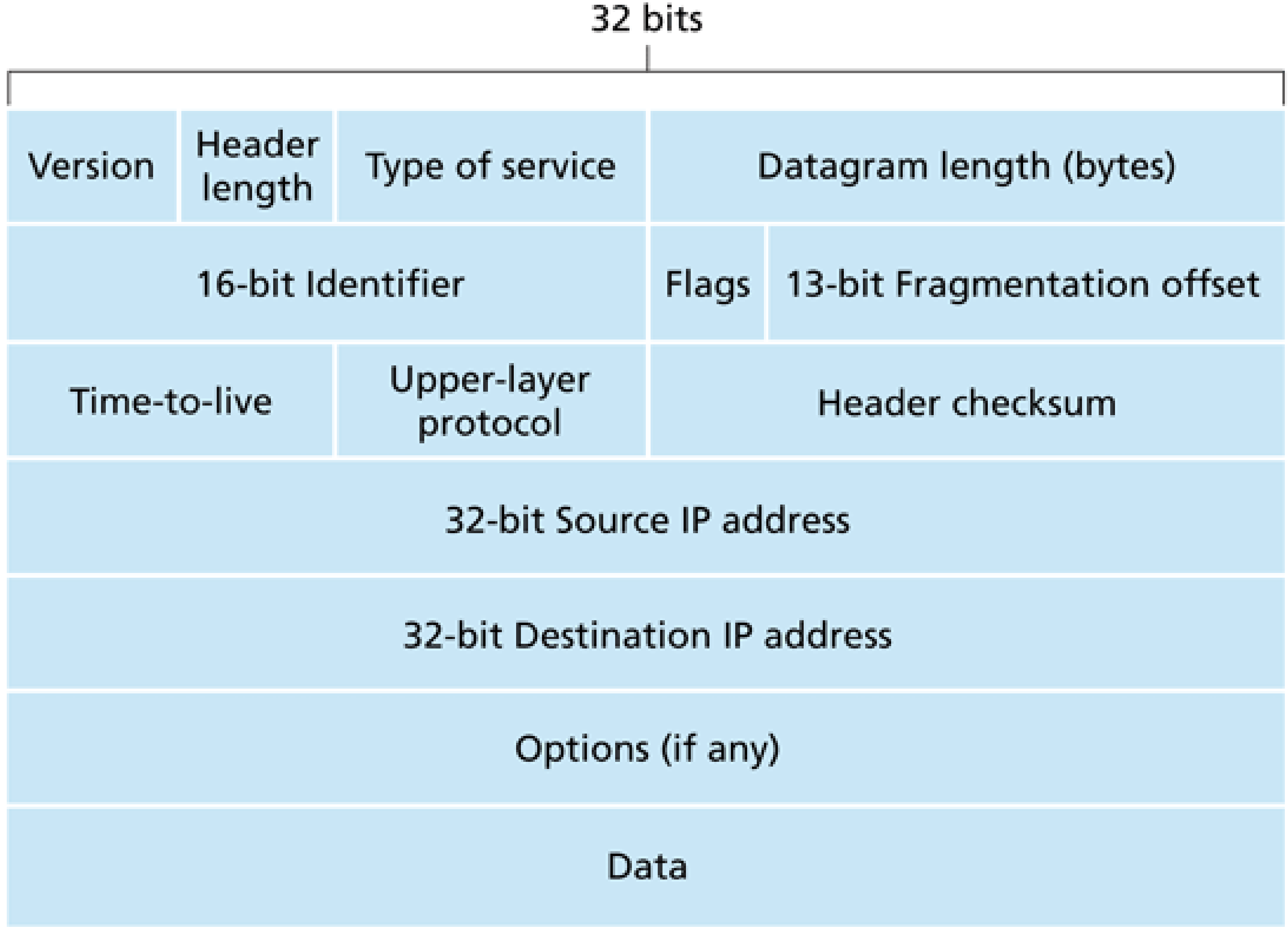
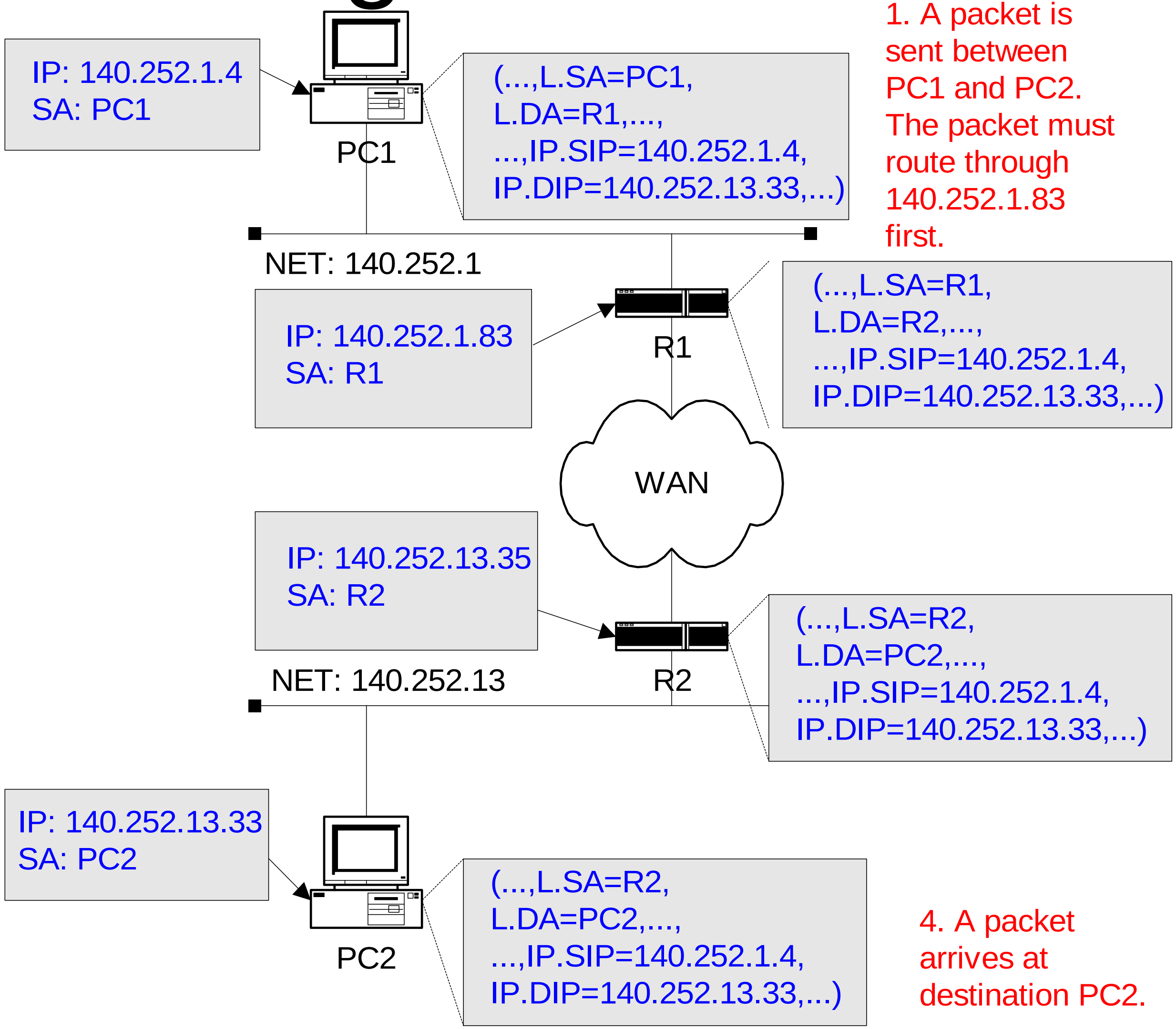


Figure 4.13 ♦ IPv4 datagram format

- Suppose Host A sends Host B a TCP segment encapsulated in an IP datagram. When Host B receives the datagram, how does the network layer in Host B know it should pass the segment to TCP rather than to UDP or something else?
  1. Destination port number
  2. Destination address
  3. TOS field
  4. Protocol field

IP Routing



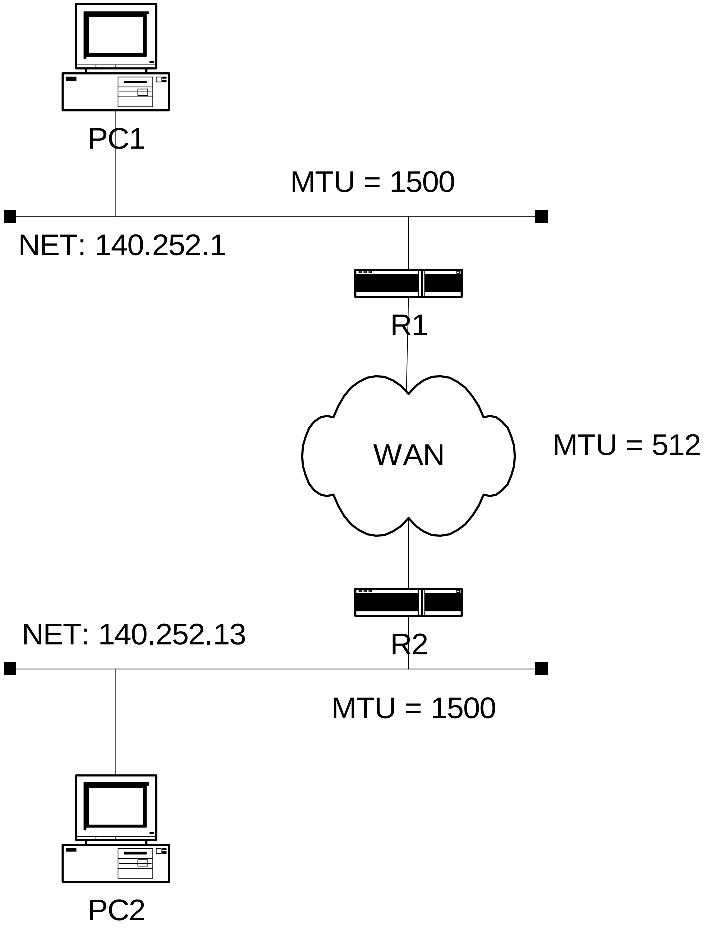
1. A packet is sent between PC1 and PC2. The packet must route through 140.252.1.83 first.

2. A packet arrives at router R1. IP decides to route it to 140.252.13.35.

3. A packet arrives at router R2. IP decides to route it to 140.252.13.33.

4. A packet arrives at destination PC2.

IP Fragmentation



- MTU - Maximum Transfer Unit
- Examples
  - Token Ring (16 Mb/s) MTU is 17914 bytes
  - Ethernet MTU is 1500 bytes
  - FDDI MTU is 4352 bytes

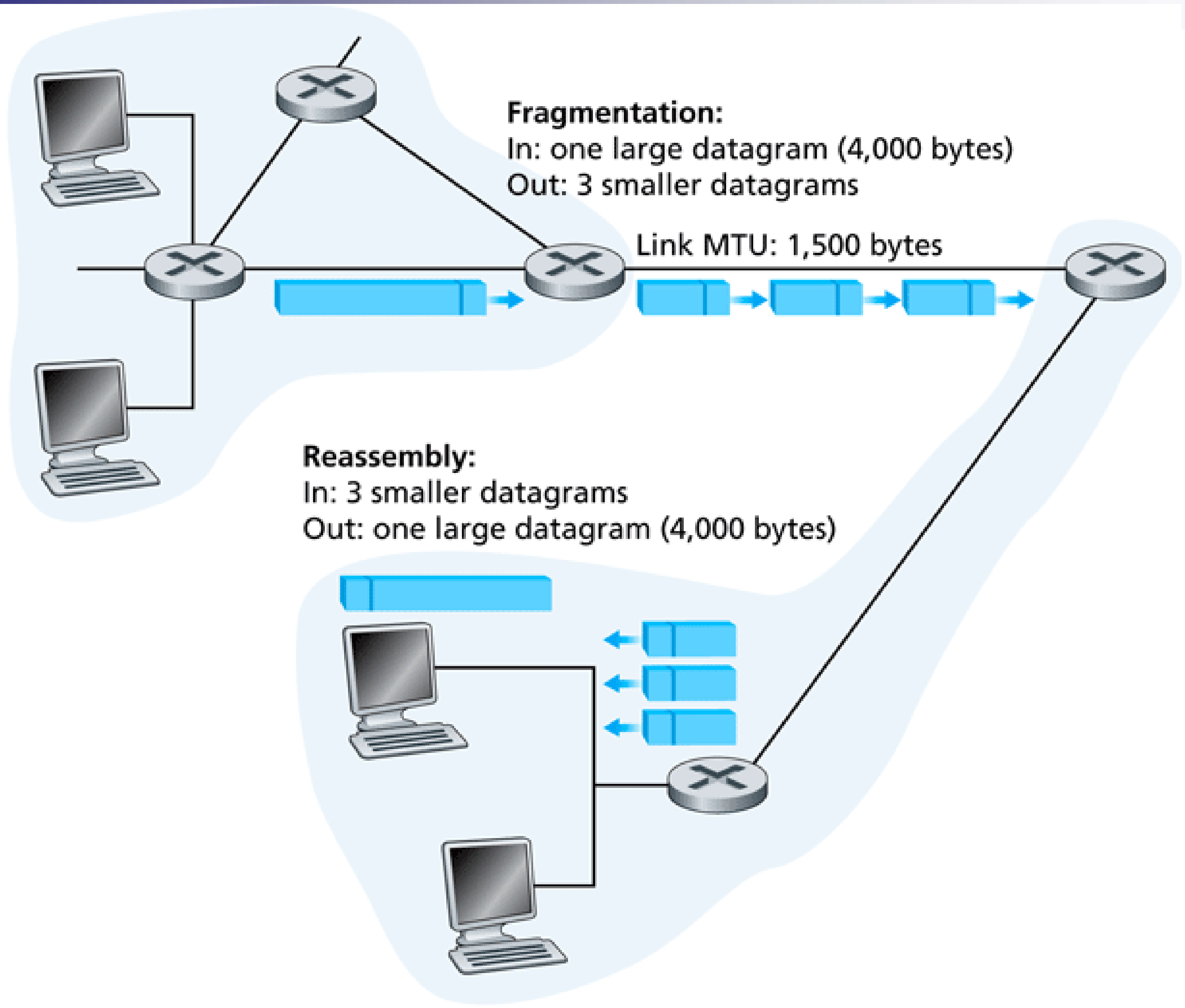
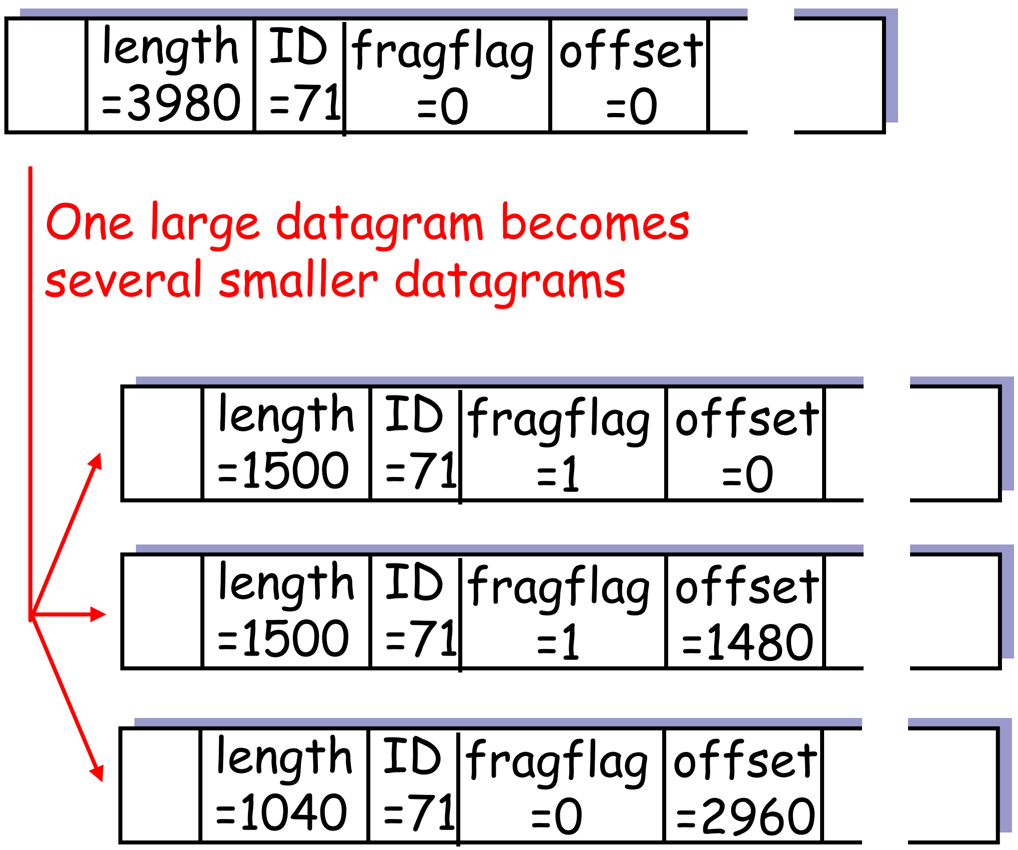


Figure 4.14 ♦ IP fragmentation and reassembly

IP Fragmentation and Reassembly



- Consider sending a 2,000-byte datagram into a link with a MTU of 980 bytes. Suppose the original datagram has the identification number 227. How many fragments are generated?
  1. 2
  2. 3
  3. 4
  4. 5

- For each fragment, what is its size, what is the value of its identification, fragment offset, and fragment flag?

- Consider sending a 2,500-byte datagram into a link that has an MTU of 600 bytes. Suppose the original datagram is stamped with the identification number 41. How many fragments are generated?

- For each fragment, what is its size, what is the value of its identification, fragment offset, and fragment flag?

DHCP

- Dynamic Host Configuration Protocol

- DHCP Discovery Message
- DHCP Offer Message
- Client responds back
- DHCP ACK

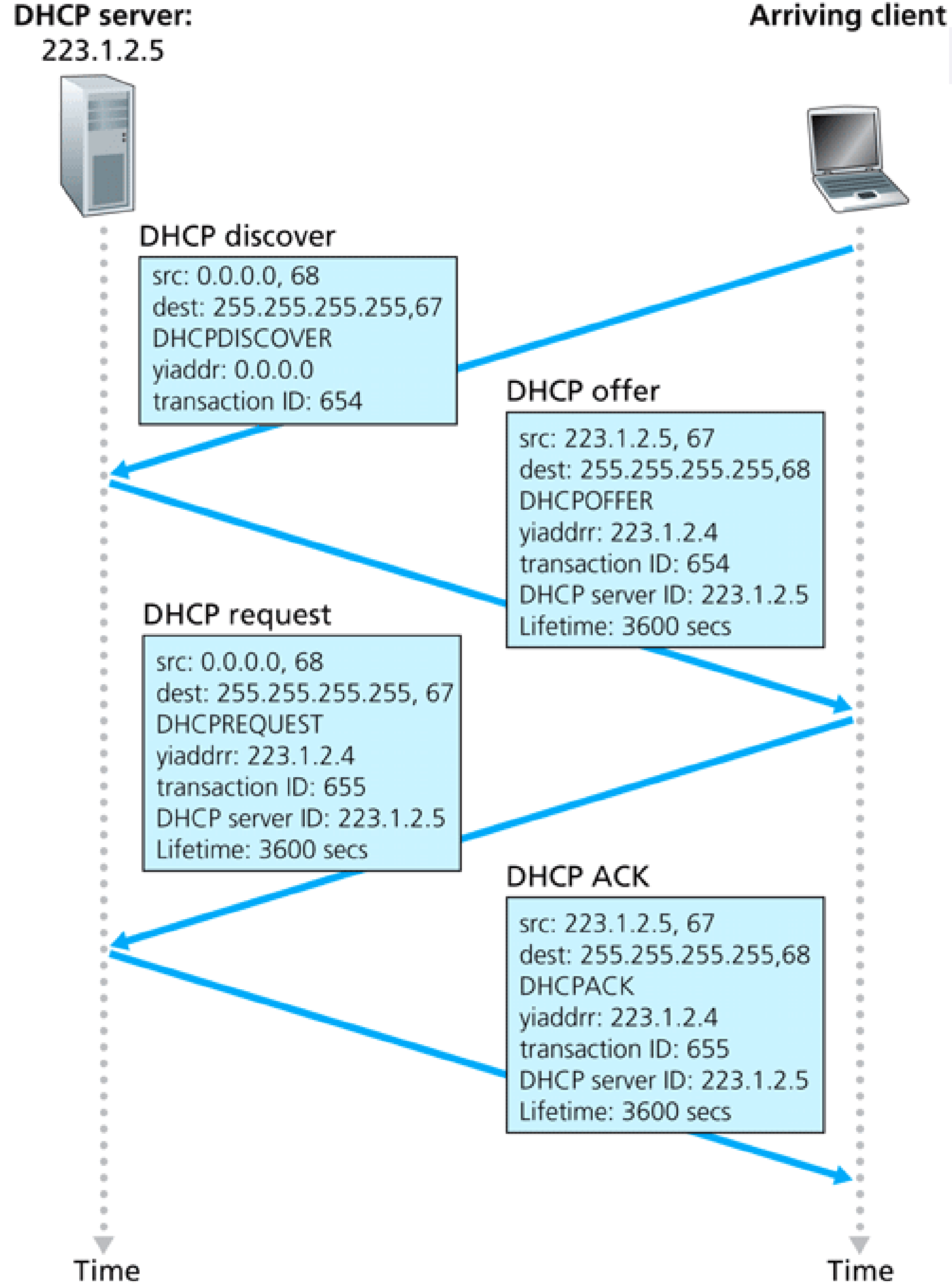


Figure 4.21 ♦ DHCP client-server interaction

CIDR

- Wasted IP addresses
  - Classful IP Addresses
- Classless Interdomain Routing
  - Classles IP Addresses
- a.b.c.d/x

NAT

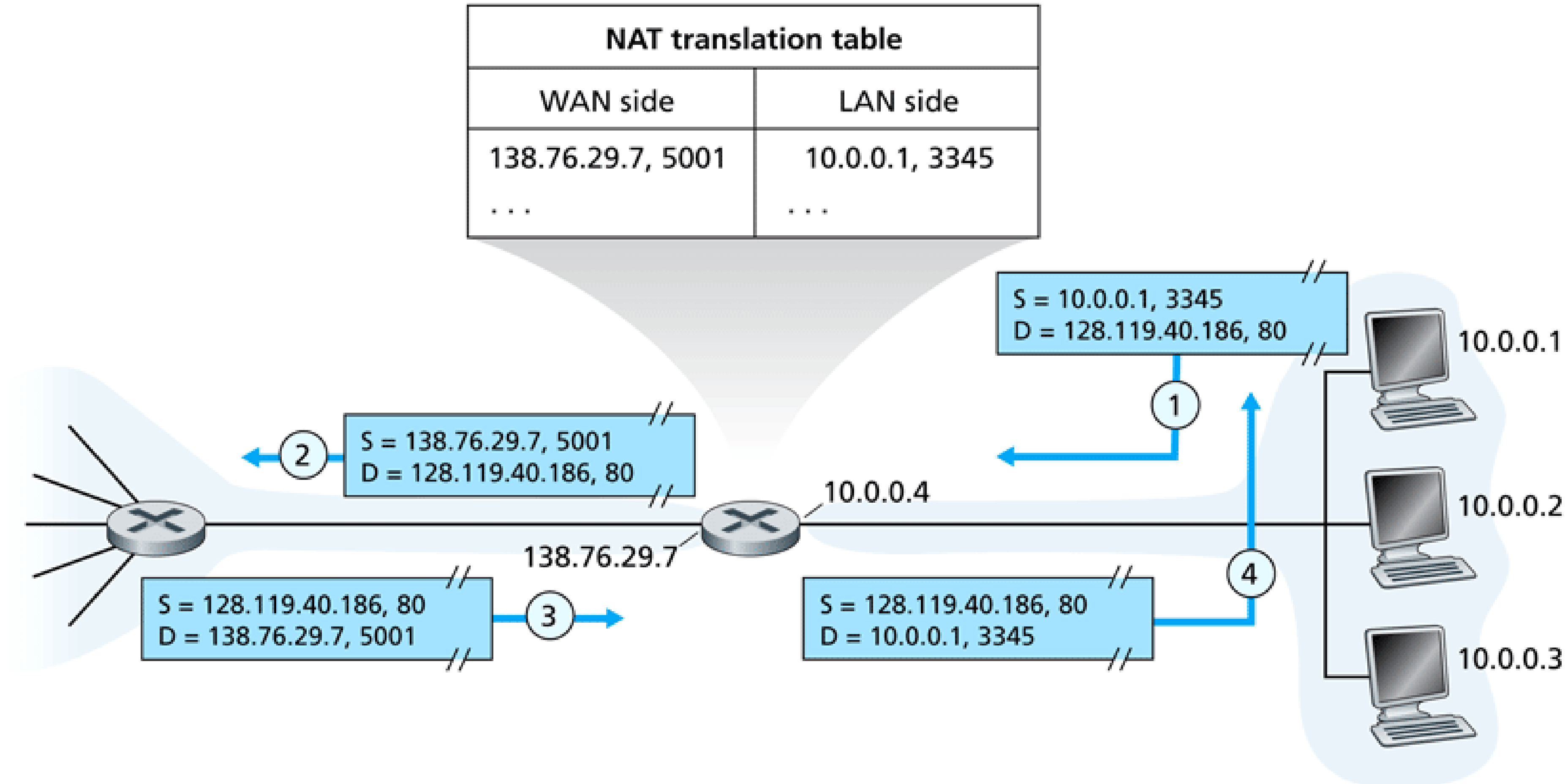


Figure 4.22 ♦ Network address translation

ICMP

- Internet Control Message Protocol
- Considered part of IP
- Really lies just above IP

- Ping
- Traceroute

ICMP Type	Code	Description
0	0	echo reply (to ping)
3	0	destination network unreachable
3	1	destination host unreachable
3	2	destination protocol unreachable
3	3	destination port unreachable
3	6	destination network unknown
3	7	destination host unknown
4	0	source quench (congestion control)
8	0	echo request
9	0	router advertisement
10	0	router discovery
11	0	TTL expired
12	0	IP header bad

Figure 4.23 ♦ ICMP message types

IPv6

- 32-bit address space of IPv4 was being used up
- Uses 128-bit addresses

IPv6 Datagram Format

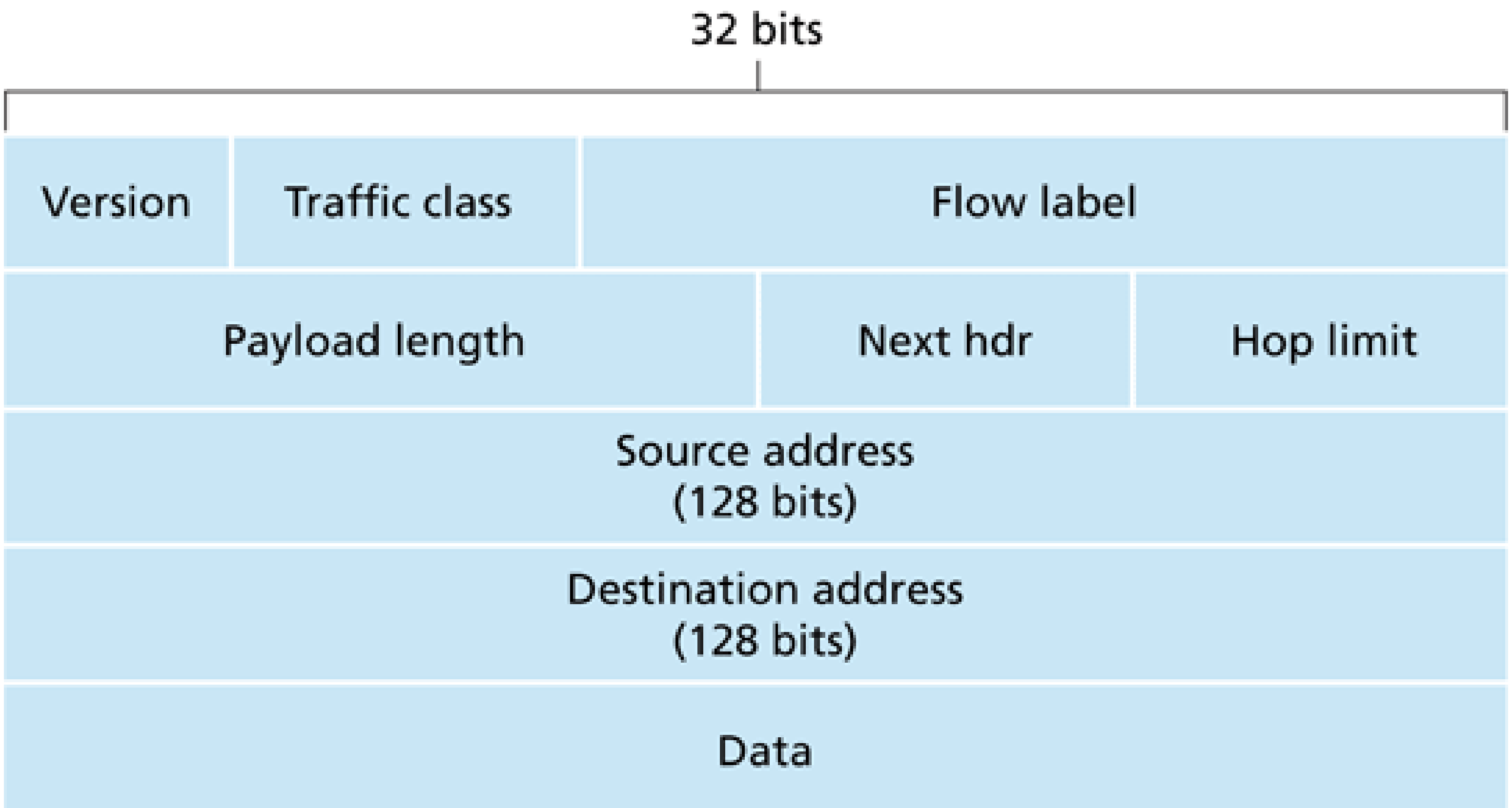


Figure 4.24 ♦ IPv6 datagram format

New Features

- Expanded IP address size
- Streamlined 40-byte header
- New type of address – anycast address
- Dropped some IPv4 header fields
  - Fragmentation / Reassembly
  - Header checksum
  - Options
- Flow labeling and priority
- New version of ICMP

Migrating to IPv6

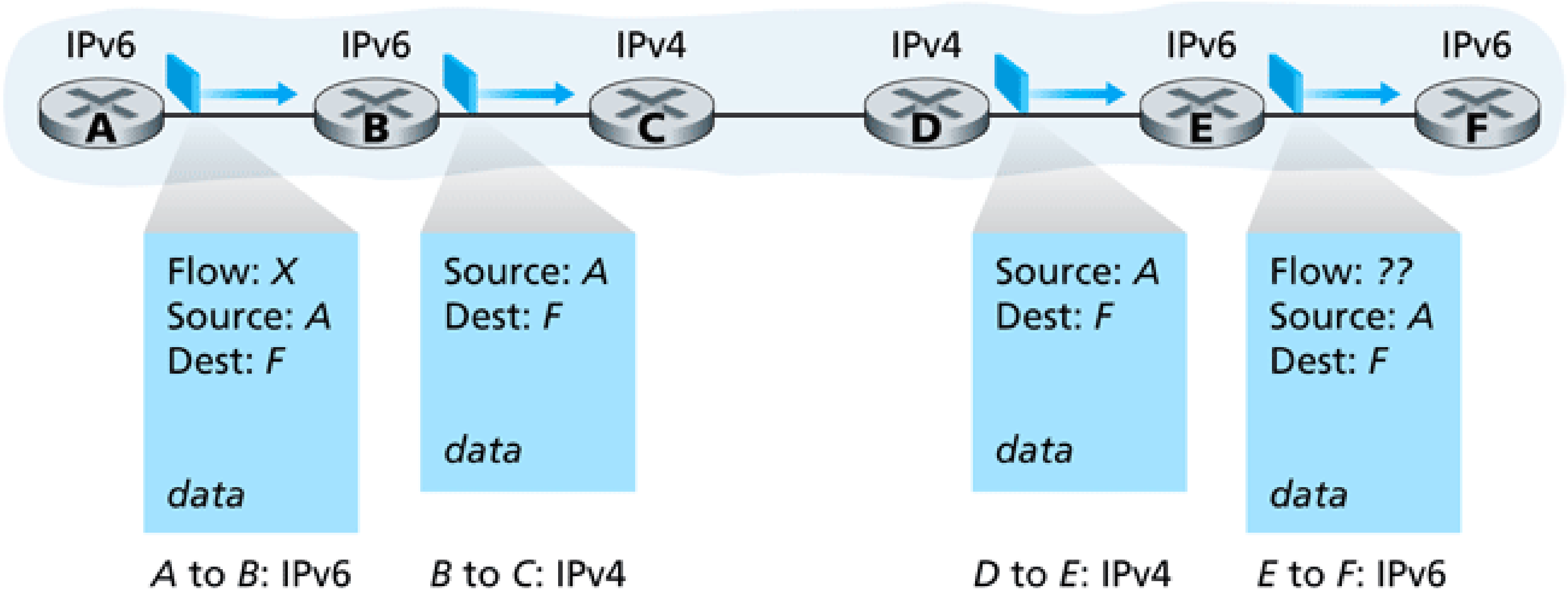


Figure 4.25 ♦ A dual-stack approach

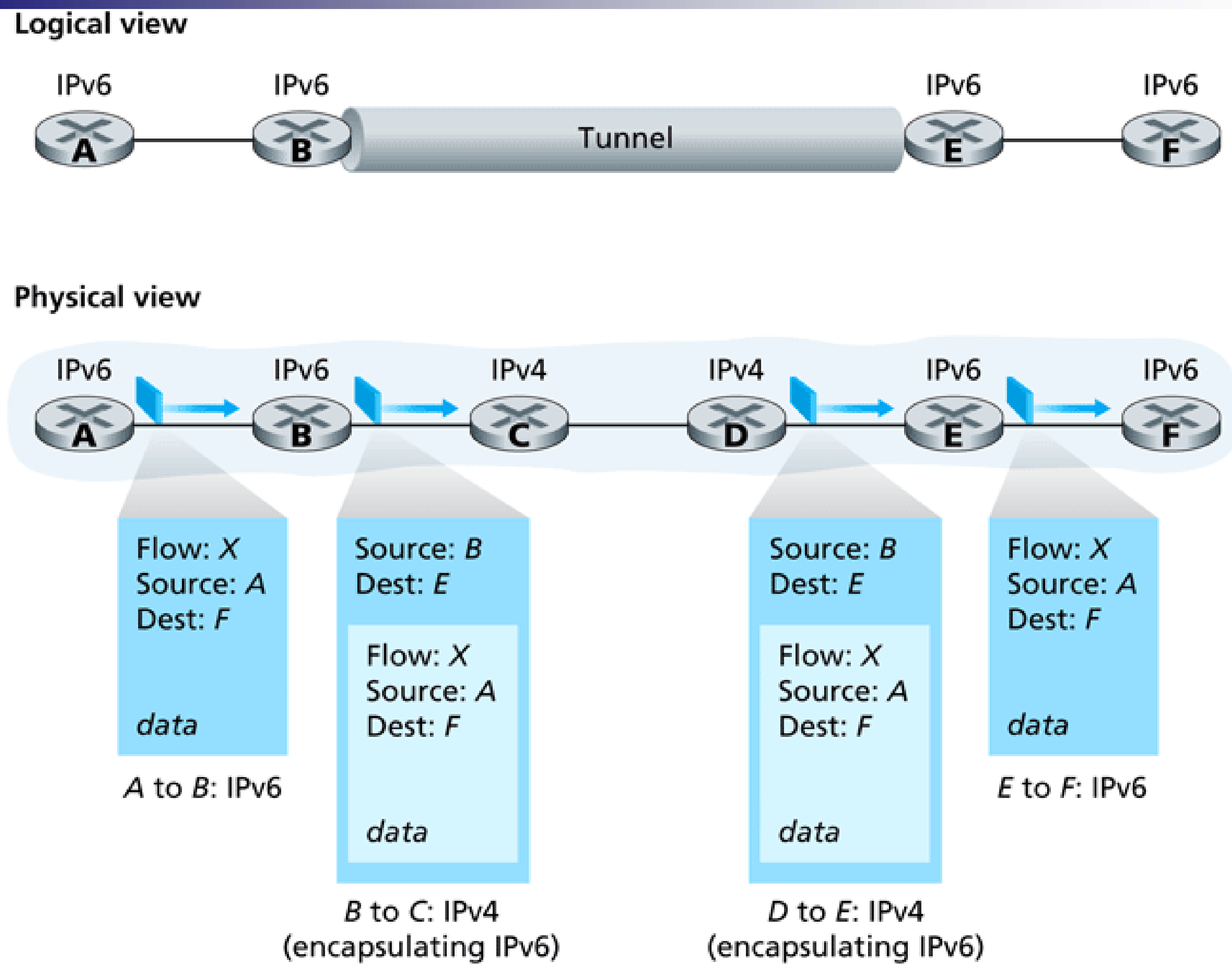


Figure 4.26 ♦ Tunneling

- It has been said that when IPv6 tunnels through IPv4 routers, IPv6 treats the IPv4 tunnels as link-layer protocols. Do you agree with this statement?
  - Yes – true
  - No - false

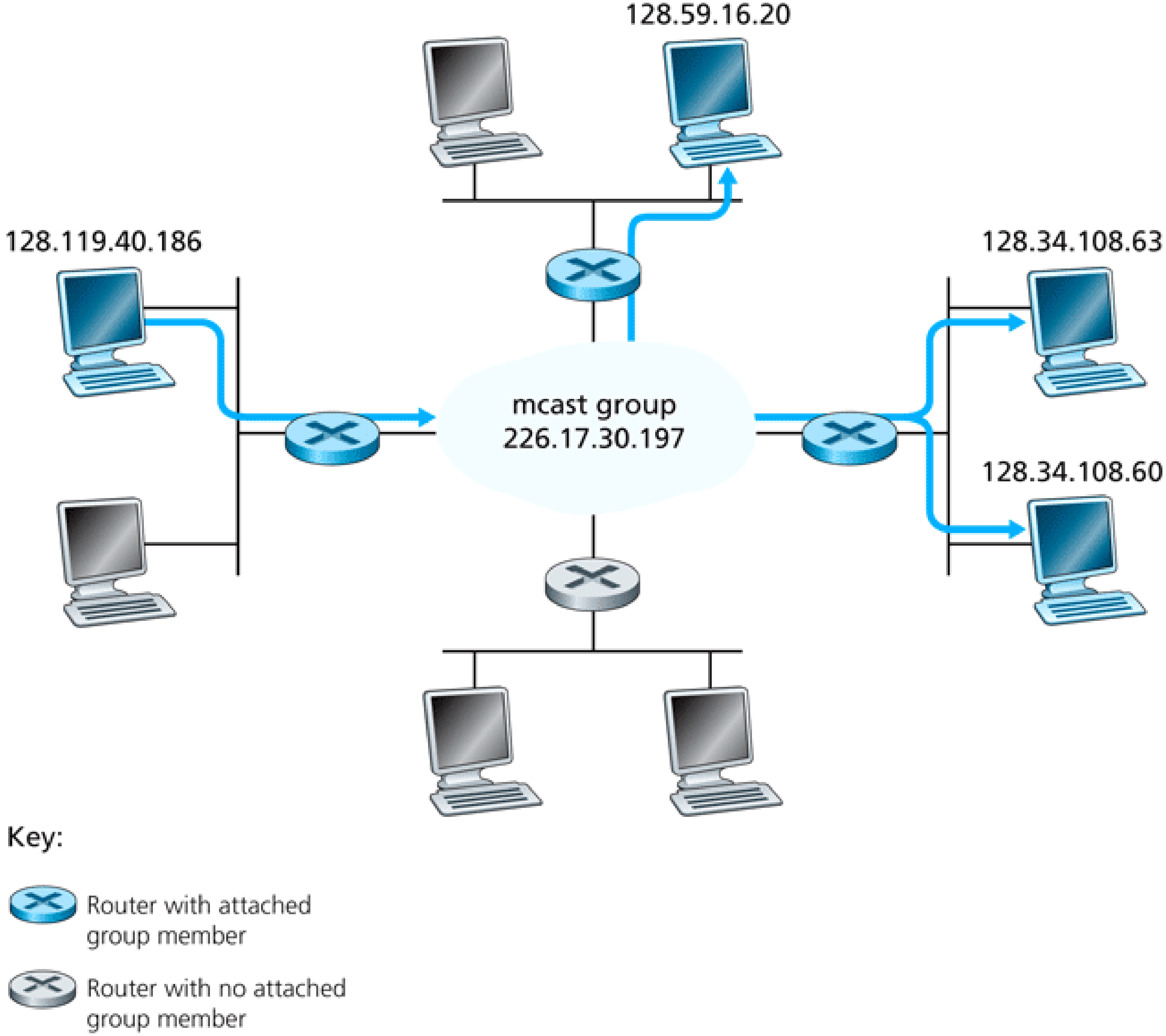
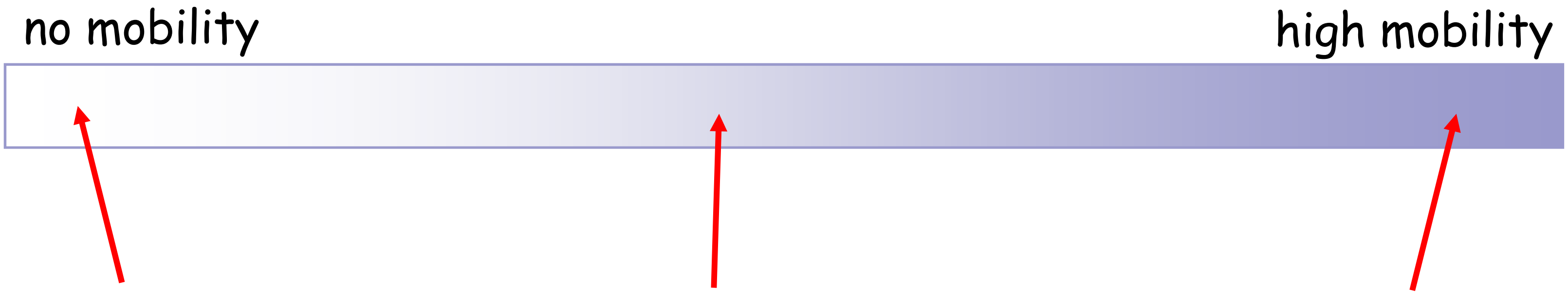


Figure 4.48 ♦ The multicast group: A datagram addressed to the group is delivered to all members of the multicast group.

Mobility and the Network Layer



mobile user, using same access point

mobile user, connecting/ disconnecting from network using DHCP.

mobile user, passing through multiple access point while maintaining ongoing connections (like cell phone)

Mobile IP

- Ad hoc networking

- Mobile IP
  - RFC 3220