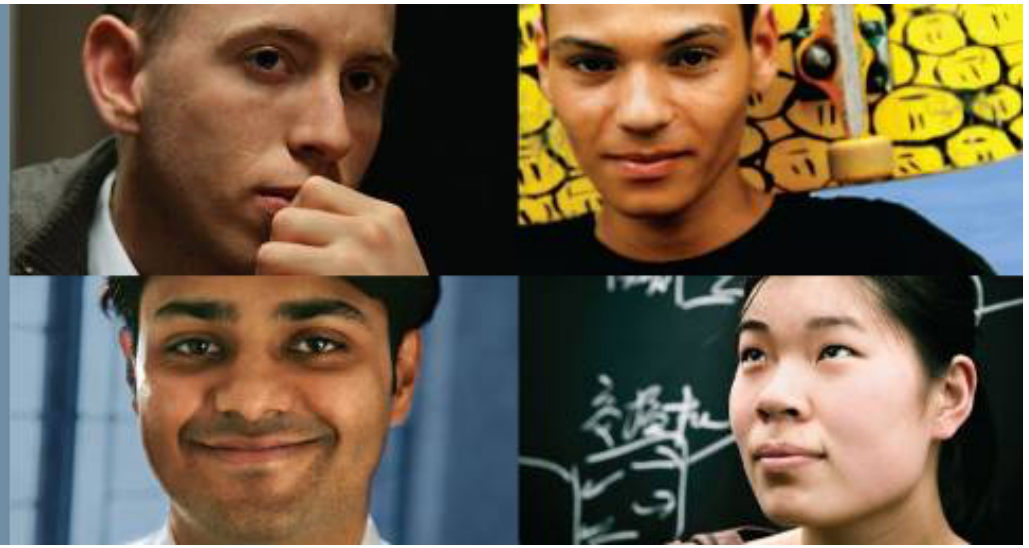
TNE10006/TNE60006: Networks and Switching



IP (Internet Protocol) v4

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Outline

- Characteristics of the IP Protocol
- IPv4 Packet Format
- IPv4 Addressing
- IPv4 Modes of Communication
- Address Types and Assignment
- IPv4 Limitations

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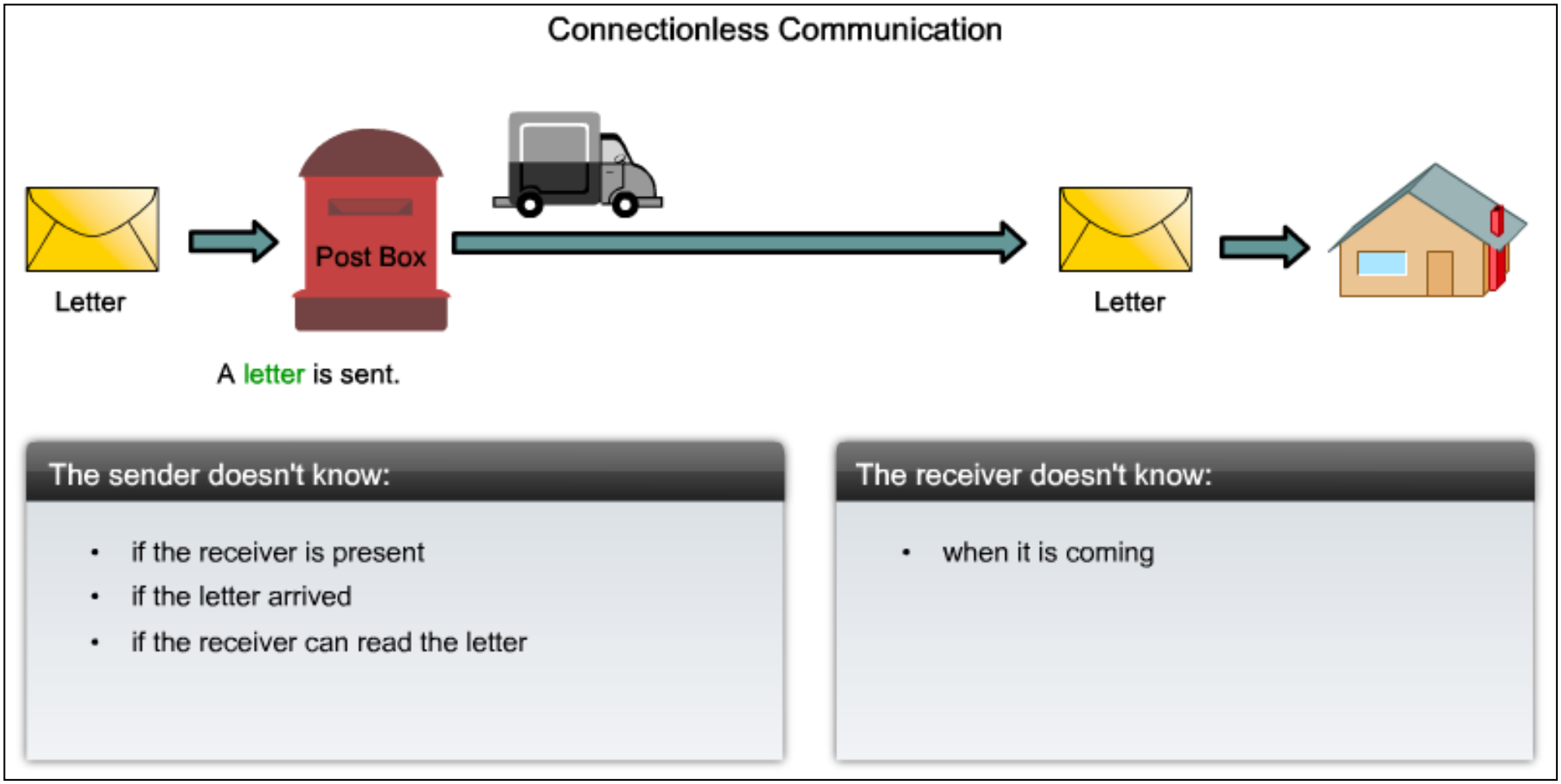
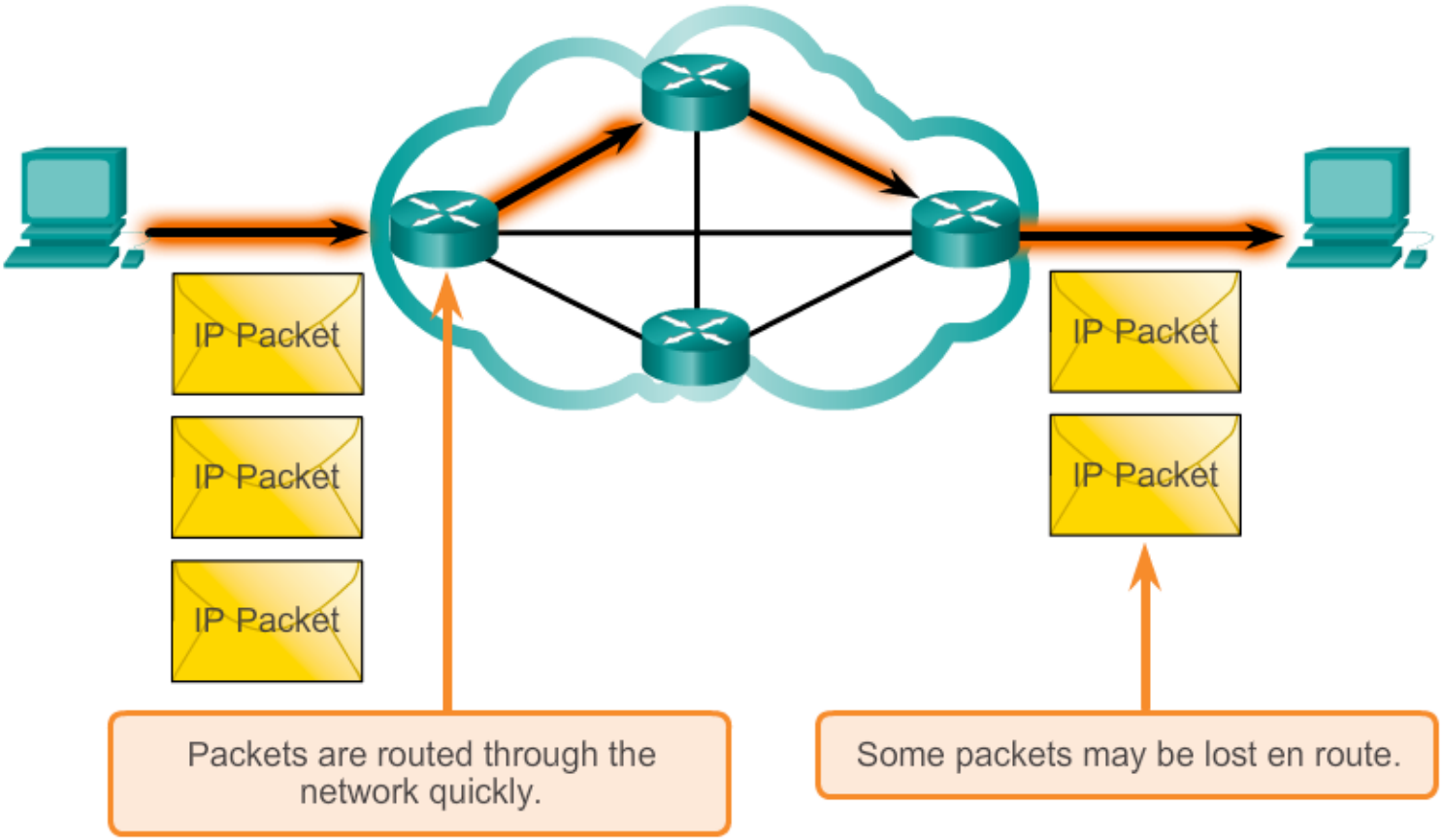
Characteristics of the IP protocol

Connectionless

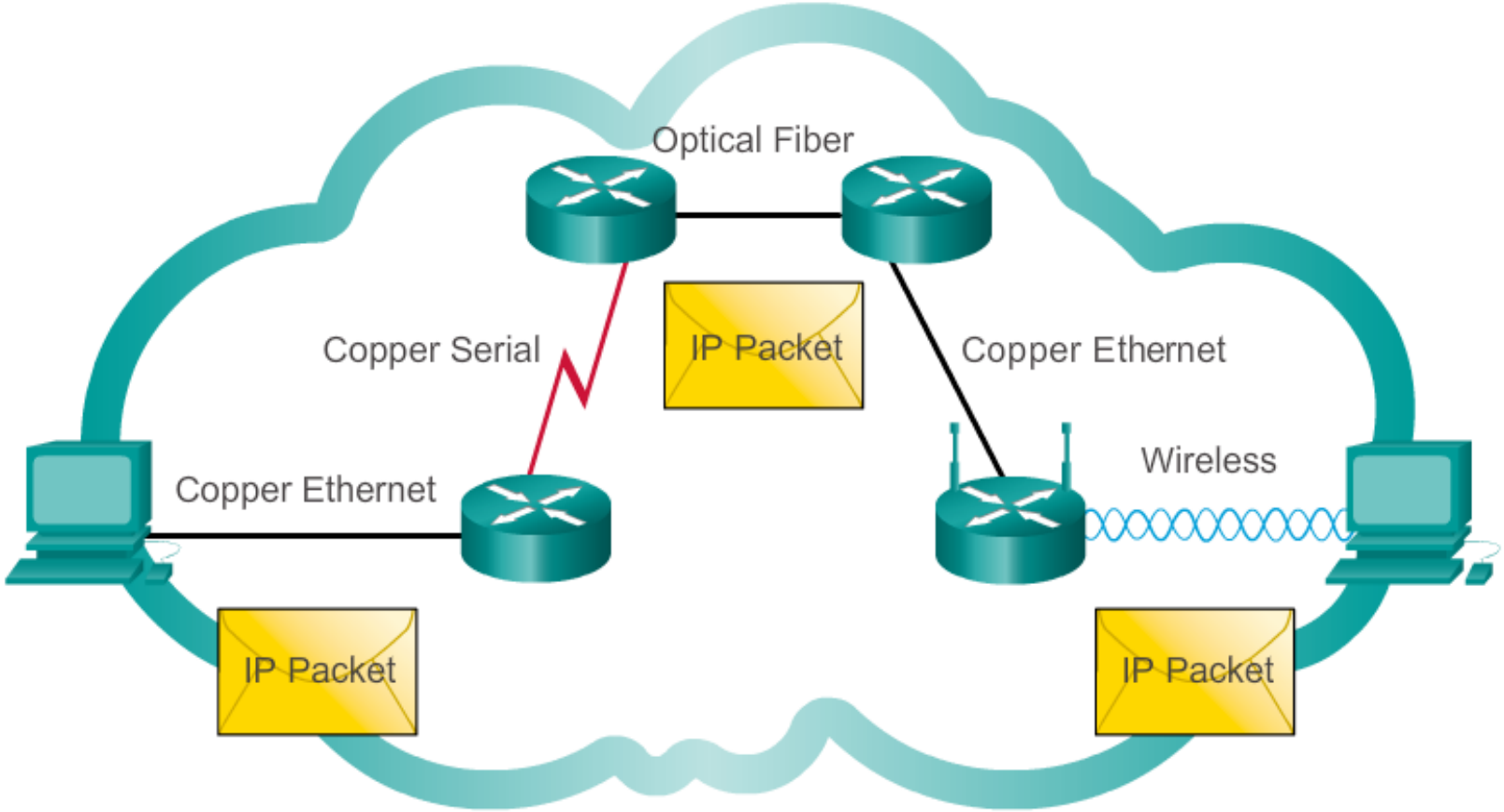


Best Effort Delivery



As an unreliable network layer protocol, IP does not guarantee that all sent packets will be received. Other protocols manage the process of tracking packets and ensuring their delivery.

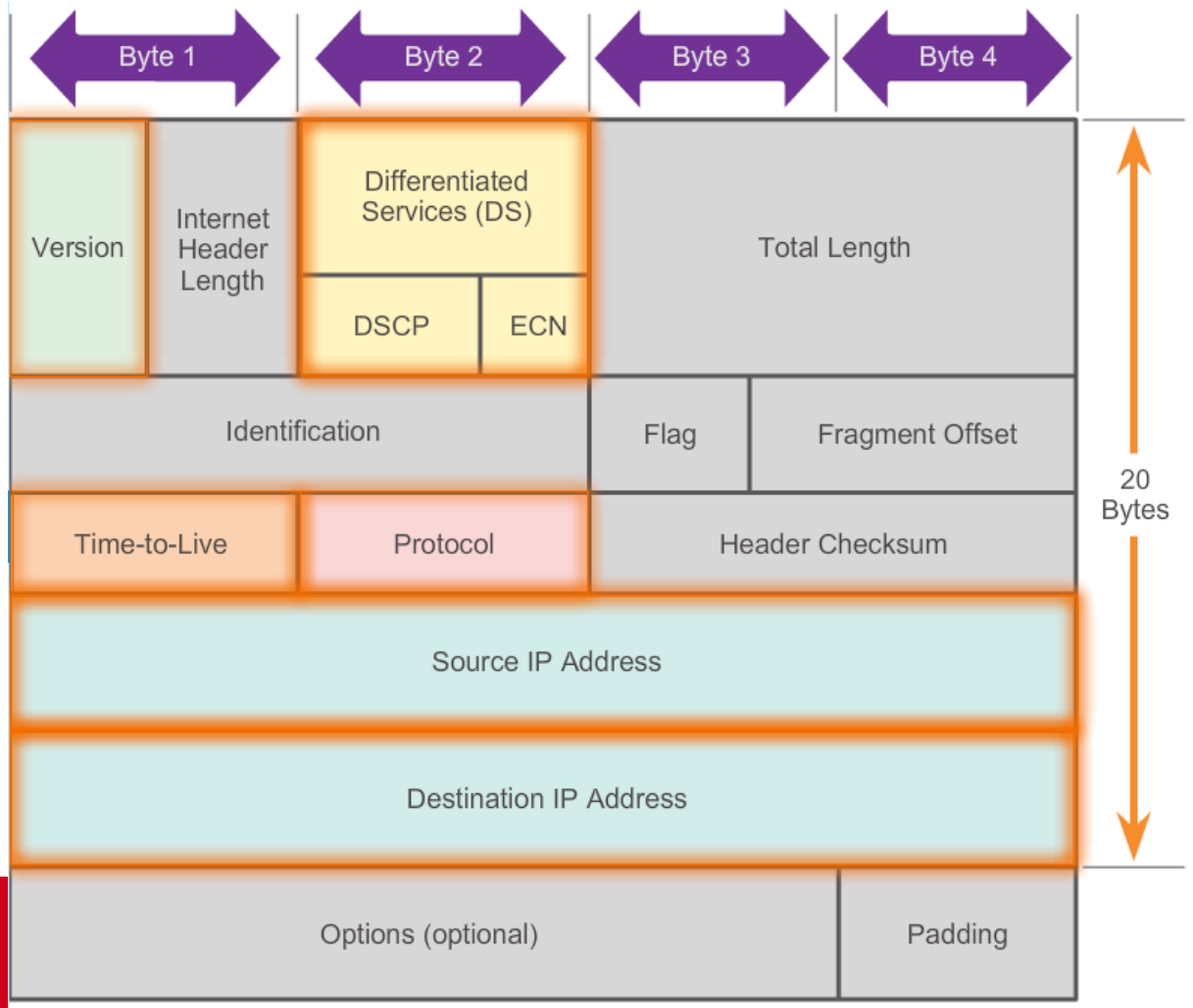
Media Independence



IP packets can travel over different media.

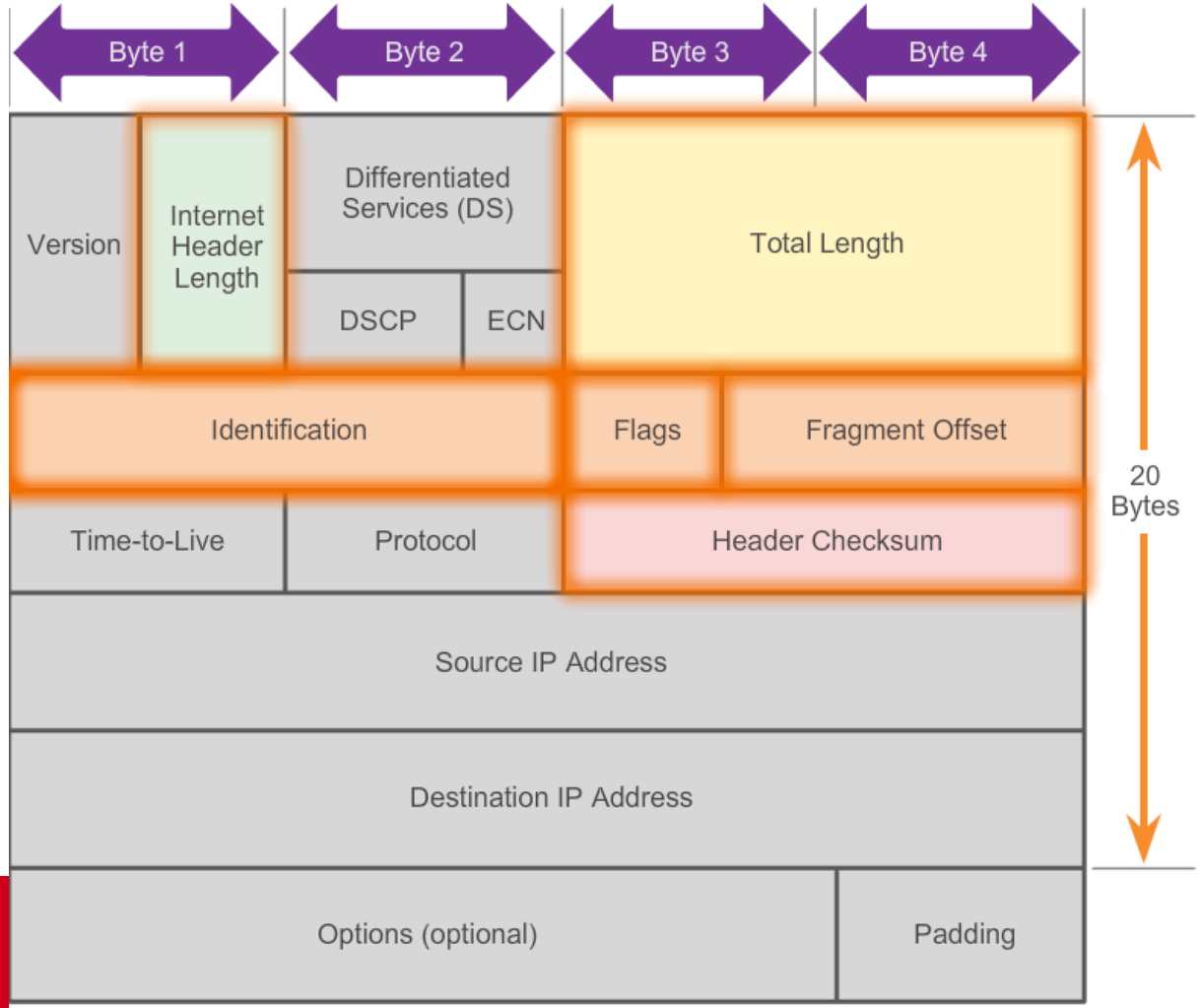
IPv4 Packet Header

Contents of the IPv4 packet header



IPv4 Packet Header

Contents of the IPv4 packet header



Header Fields

- Ver (4bits) – protocol version eg IPv4, IPv6
- IHL(4bits) – Internet Header Length in 32 bit words
- Service Type (8bits) – QoS, the field describes a level of throughput priority a router should use in processing a packet eg a packet containing IP voice data gets precedence over a packet containing a HTTP request
- Packet length – total length of packet, including header
- Identification – a sequence number used on reassembling fragments into packets
- Flags – More Flag is used in fragmentation and reassembly

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Header Fields

- Fragment Offset – a router may have to fragment a packet when forwarding it from one medium to another medium that has a smaller MTU. Offset and More Flag used in reassembling packet from fragments at the destination
- Time to Live (TTL) – maximum hops a packet can take before it is considered undeliverable. Each router decrements 1, when TTL = 0 packet dropped
- Protocol – upper level protocol segment encapsulated eg TCP, UDP
- Options – special routing services, rarely used
- Padding – used to ensure header ends on a 32 bit boundary

IP Addressing – IP is not names

- Addresses like:

  www.swin.edu.au

  mail.swin.edu.au

- Are not IP addresses
- The Internet uses a naming system (DNS – Domain Name System) to translate names to addresses

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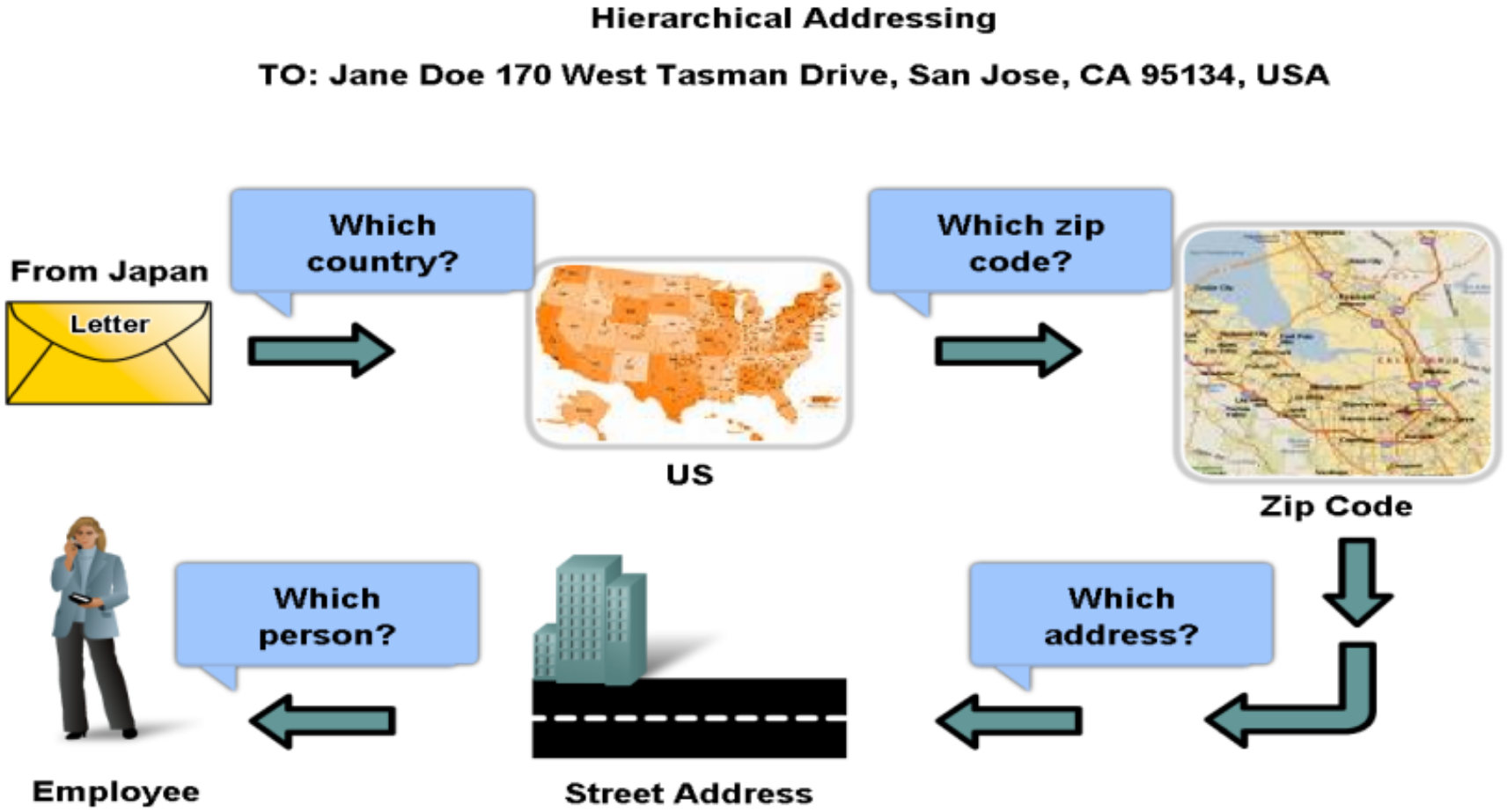
Hierarchical Addressing – Postal Service



At each step of delivery, the post office need only examine the next hierarchical level.

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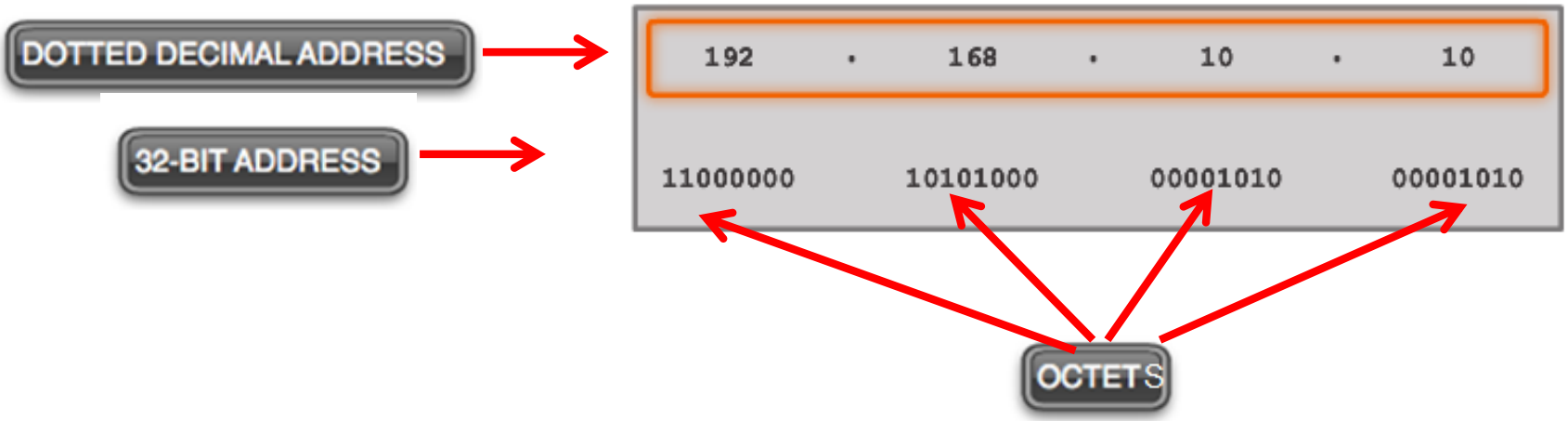
Binary Number System



192.168.10.10 is an IP address that is assigned to a computer.

- An IP address is 32 bits in length
- It is broken into 4 octets (or bytes)
- Each byte is represented as a decimal number (0-255) and separated by a period (.)

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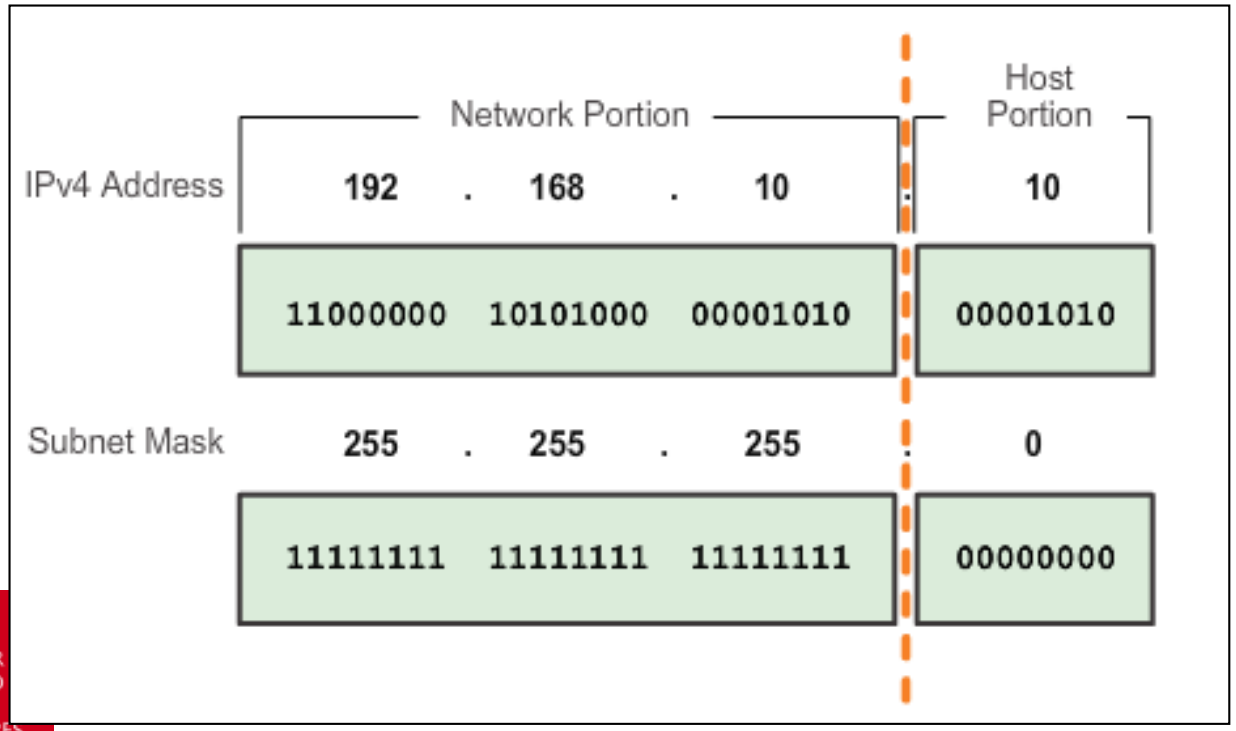
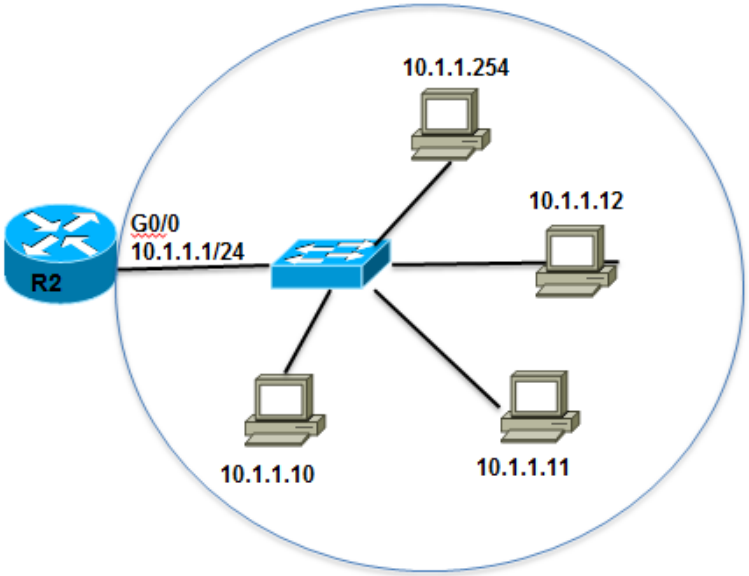
Network Portion and Host Portion of an IPv4 Address

- To define the network and host portions of an address, a devices use a separate 32-bit pattern called a subnet mask
- The subnet mask does not actually contain the network or host portion of an IPv4 address, it just says where to look for these portions in a given IPv4 address



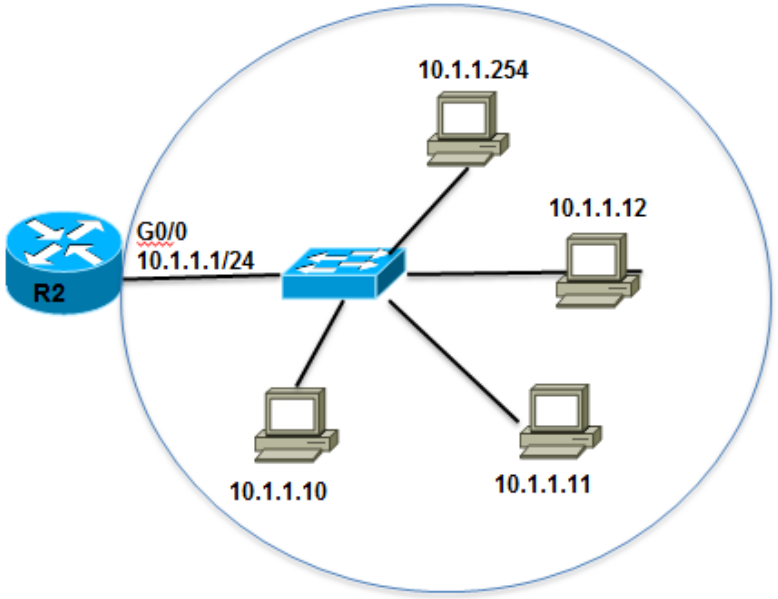
Network, Host, and Broadcast Address



10.1.1.0/24

Network Portion			Host Portion	
10	1	1	0	
00001010	00000001	00000001	00000000	All 0s – NETWORK ADDRESS
10	1	1	10	
00001010	00000001	00000001	00001010	0s and 1s in host portion
10	1	1	255	
00001010	00000001	00000001	11111111	All 1s – BROADCAST ADDRESS

First and Last Host Addresses



10.1.1.0/24

Network Portion			Host Portion	
10	1	1	1	FIRST HOST
00001010	00000001	00000001	00000001	All 0s and a 1 in the host portion
10	1	1	254	LAST HOST
00001010	00000001	00000001	11111110	All 1s and a 0 in the host portion

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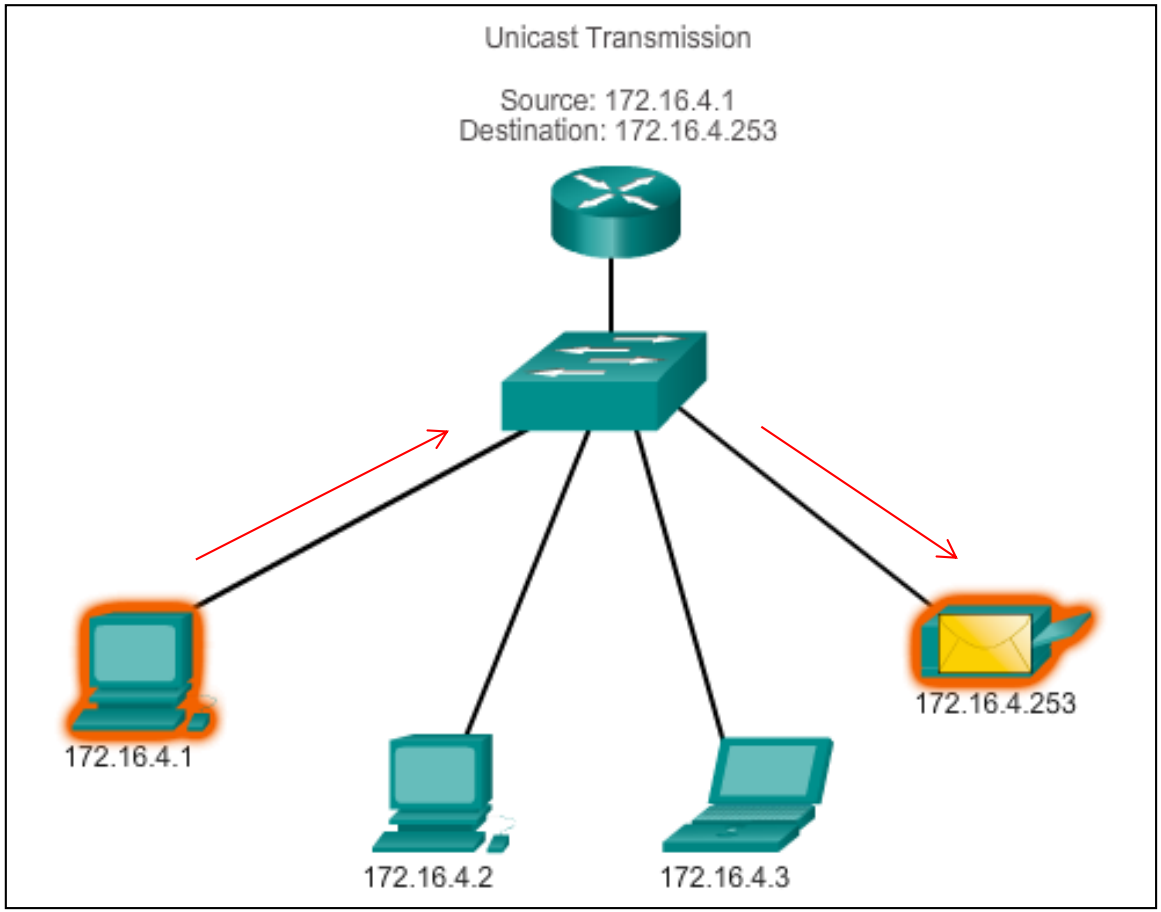
Unicast Transmission

In an IPv4 network, the hosts can communicate one of three different ways: **Unicast**, Broadcast, and Multicast

#1 Unicast – the process of sending a packet from one host to an individual host.

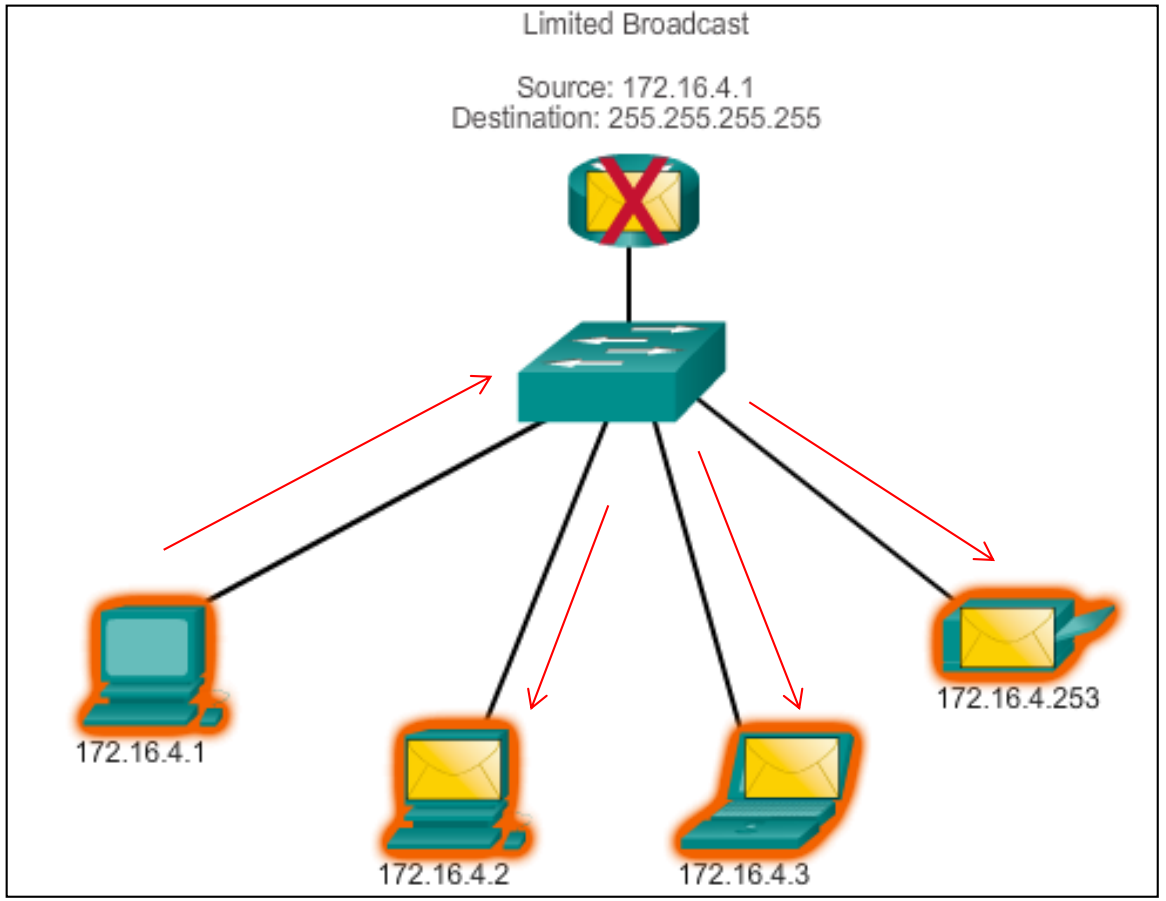


Broadcast Transmission

In an IPv4 network, the hosts can communicate one of three different ways: Unicast, **Broadcast**, and Multicast.

#2 Broadcast – the process of sending a packet from one host to all hosts in the network.

NOTE: Routers do not forward a limited broadcast!



Multicast Transmission

In an IPv4 network, the hosts can communicate one of three different ways: Unicast, Broadcast, and **Multicast.**

#3 Multicast – The process of sending a packet from one host to a selected group of hosts, possibly in different networks.

- Reduces traffic
- Reserved for addressing multicast groups – 224.0.0.0 to 239.255.255.255.
- Link local – 224.0.0.0 to 224.0.0.255 (Example: routing information exchanged by routing protocols)
- Globally scoped addresses – 224.0.1.0 to 238.255.255.255 (Example: 224.0.1.1 has been reserved for Network Time Protocol)

Public and Private IPv4 Addresses

Private address blocks are:

- Hosts that do not require access to the Internet can use private addresses
  - 10.0.0.0 to 10.255.255.255 (10.0.0.0/8)
  - 172.16.0.0 to 172.31.255.255 (172.16.0.0/12)
  - 192.168.0.0 to 192.168.255.255 (192.168.0.0/16)

Shared address space addresses:

- Not globally routable
- Intended only for use in service provider networks
- Address block is 100.64.0.0/10

Special Use IPv4 Addresses

- **Network and Broadcast addresses** – within each network the first and last addresses cannot be assigned to hosts
- **Loopback address** – 127.0.0.1 a special address that hosts use to direct traffic to themselves (addresses 127.0.0.0 to 127.255.255.255 are reserved)
- **Link-Local address** – 169.254.0.0 to 169.254.255.255 (169.254.0.0/16) addresses can be automatically assigned to the local host
- **TEST-NET addresses** – 192.0.2.0 to 192.0.2.255 (192.0.2.0/24) set aside for teaching and learning purposes, used in documentation and network examples
- **Experimental addresses** – 240.0.0.0 to 255.255.255.254 are listed as reserved

Types of IPv4 Address

Legacy Classful Addressing

IP Address Classes

Address Class	1st octet range (decimal)	1st octet bits (green bits do not change)	Network(N) and Host(H) parts of address	Default subnet mask (decimal and binary)	Number of possible networks and hosts per network
A	1-127**	00000000-01111111	N.H.H.H	255.0.0.0	128 nets (2^7) 16,777,214 hosts per net (2^24-2)
B	128-191	10000000-10111111	N.N.H.H	255.255.0.0	16,384 nets (2^14) 65,534 hosts per net (2^16-2)
C	192-223	11000000-11011111	N.N.N.H	255.255.255.0	2,097,150 nets (2^21) 254 hosts per net (2^8-2)
D	224-239	11100000-11101111	NA (multicast)		
E	240-255	11110000-11111111	NA (experimental)		

Assignment of IP Addresses

Regional Internet Registries (RIRs)

Limitations of IPv4

- 4 thousand million is a lot of addresses
- Consider:
  - Each router on the Internet often has many IP addresses
  - Each network connected device (printers, servers, PC's) needs an address
  - All the people in India and China
- 4 thousand million is not enough
- NAT
  - Lack of end-to-end connectivity

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Summary

In this lecture, we covered:

- Characteristics of the IP Protocol
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- IPv4 Addressing
- IPv4 Modes of Communication
- Address Types and Assignment
- IPv4 Limitations

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