Chapter 6B: IPv4 Addressing (II)

More IPv4 Addresses

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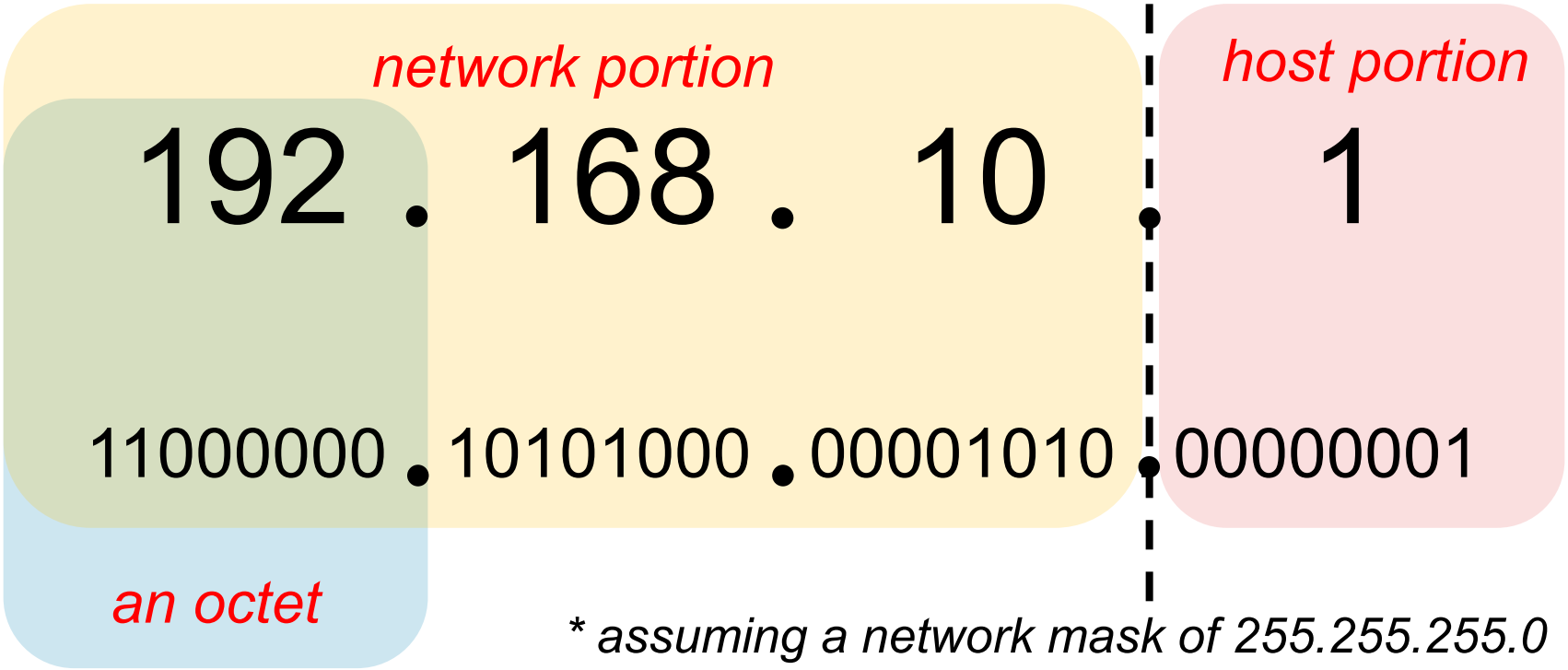
Represented in Dotted Decimal Format



a. How many bits in an IPv4 address? _____

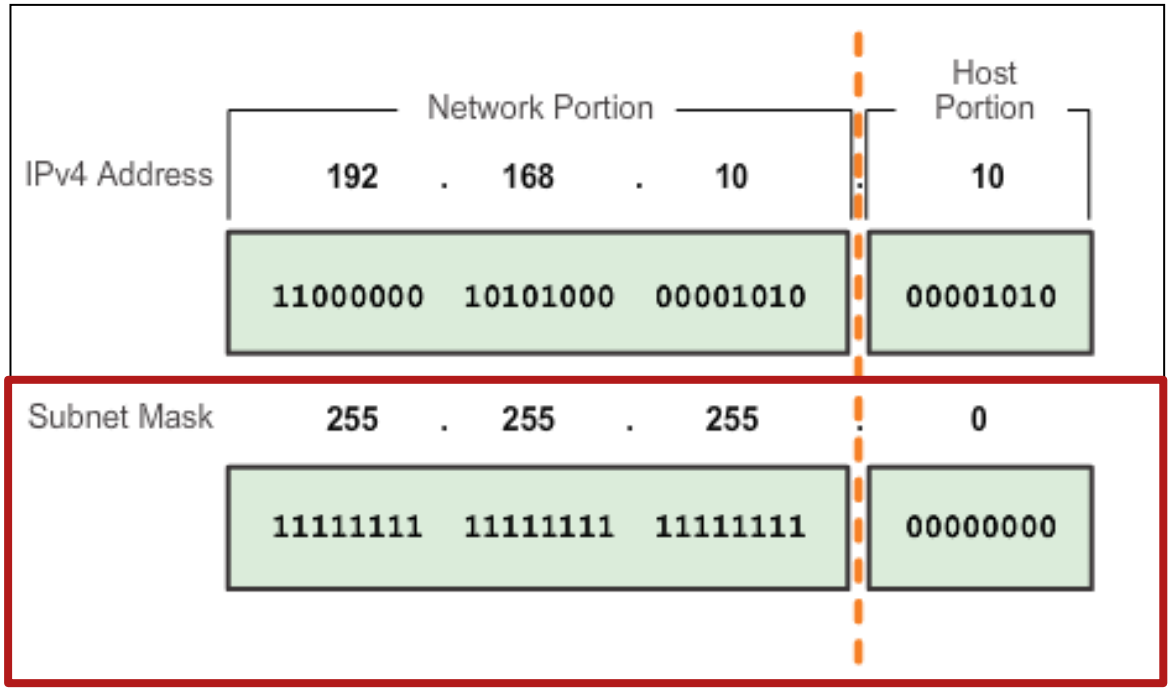
b. How many octets are there? _____

c. How many bits are there in an octet? _____

d. What is the decimal range of each octet? _____

Network Portion and Host Portion of an IPv4 Address

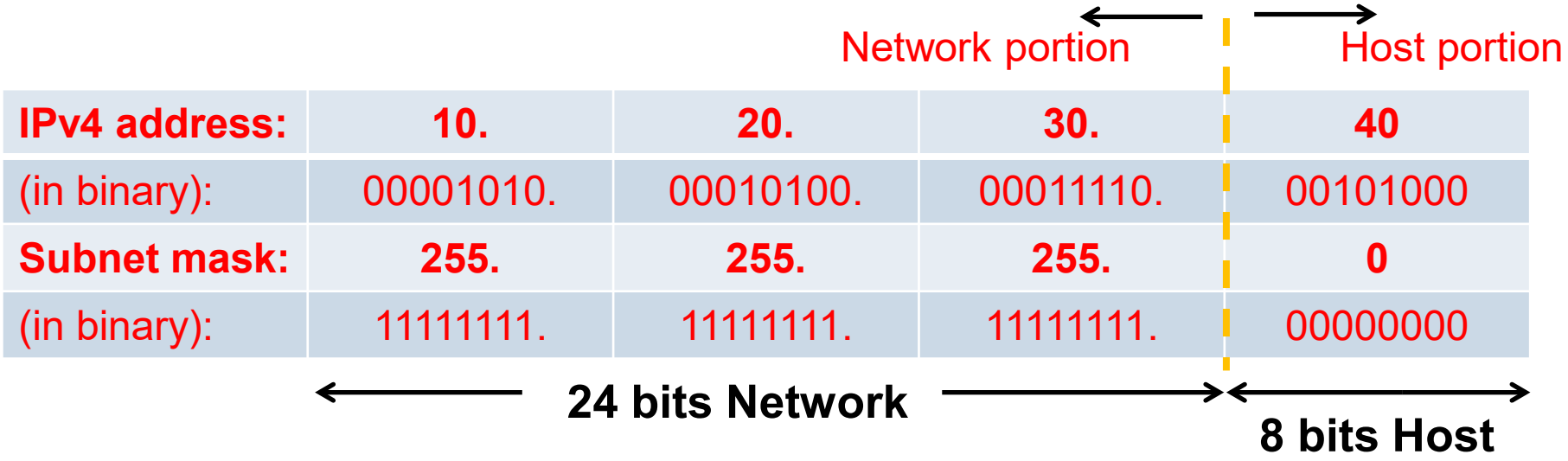
- To define the network and host portion of an address, a separate 32-bit pattern called a subnet mask is used.
- The subnet mask does not actually contain the network or host portion of an IPv4 address, it just tells you where to look for these portions in a given IPv4 address



- Subnet mask appears in binary as a series of 1s followed by a series of 0s.
- The network divide (dash line) for the IP address is where the series of 1s meet the 0s in the subnet mask.

Network Portion and Host Portion of an IPv4 Address

Example 3: IPv4 address: 10.20.30.40 **/24**
Subnet mask: 255.255.255.0



IPv4 address:	**10.**	**20.**	**30.**	**40**
(in binary):	00001010.	00010100.	00011110.	00101000
Subnet mask:	**255.**	**255.**	**255.**	**0**
(in binary):	11111111.	11111111.	11111111.	00000000

The Subnet Mask – Network and Host Portions

	1st octet	2nd octet	3rd octet	4th octet
172.0.0.0	Network	Host	Host	Host
Subnet Mask	11111111	00000000	00000000	00000000
192.4.0.0	Network	Network	Host	Host
Subnet Mask	11111111	11111111	00000000	00000000
192.168.1.0	Network	Network	Network	Host
Subnet Mask	11111111	11111111	11111111	00000000

- A “1” bit in the subnet mask means that the corresponding bit in the IP address should be read as a network number
- A “0” bit in the subnet mask means that the corresponding bit in the IP address should be read as a host bit.

The Subnet Mask – Network and Host Portions

	1st octet	2nd octet	3rd octet	4th octet
172.0.0.0	Network	Host	Host	Host
Subnet Mask: 255.0.0.0 or /8	255	0	0	0
192.4.0.0	Network	Network	Host	Host
Subnet Mask: 255.255.0.0 or /16	255	255	0	0
192.168.1.0	Network	Network	Network	Host
Subnet Mask: 255.255.255.0 or /24	255	255	255	0

- /n "slash" tells us how many "1" bits are in the subnet mask.
- Subnet masks do not have to end on "natural octet boundaries"
- **Network Addresses have all zeros in the host portion of the address.**

Why the mask matters: Number of hosts!

Subnet Mask:	1st octet	2nd octet	3rd octet	4th octet
255.0.0.0 or /8	Network	Host	Host	Host
255.255.0.0 or /16	Network	Network	Host	Host
255.255.255.0 or /24	Network	Network	Network	Host

- Subnet masks do not have to end on “natural octet boundaries”

Examining the Prefix Length

	Dotted Decimal	Significant bits shown in binary
Network Address	**10.1.1.0/24**	**10.1.1.00000000**
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.254	10.1.1.11111110
Broadcast Address	10.1.1.255	10.1.1.11111111
Number of hosts: 2^8 – 2 = 254 hosts		

24 bits Network

Network Address	**10.1.1.0/25**	**10.1.1.00000000**
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.126	10.1.1.01111110
Broadcast Address	10.1.1.127	10.1.1.01111111
Number of hosts: 2^7 – 2 = 126 hosts		

25 bits Network

Network Address	**10.1.1.0/26**	**10.1.1.00000000**
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.62	10.1.1.00111110
Broadcast Address	10.1.1.63	10.1.1.00111111
Number of hosts: 2^6 – 2 = 62 hosts		

26 bits Network

Examining the Prefix Length (contd)

	Dotted Decimal	Significant bits shown in binary
Network Address	**10.1.1.0/27**	**10.1.1.00000000**
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.30	10.1.1.00011110
Broadcast Address	10.1.1.31	10.1.1.00011111
Number of hosts: 2^5 – 2 = 30 hosts		

Network Address	**10.1.1.0/28**	**10.1.1.00000000**
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.14	10.1.1.00001110
Broadcast Address	10.1.1.15	10.1.1.00001111
Number of hosts: 2^4 – 2 = 14 hosts		

No. of Hosts = $2^H - 2$

Where H = no. of host bits

Examining the Prefix Length (cont.)

- Network address is the first address of a network/subnet:-
  - Host bits are all 0
  - This address is an identity address for the subnet
  - CANNOT be assigned to network interfaces

- Broadcast address is the last address of a network/subnet:-
  - Host bits are all 1
  - This address is used to send data to all hosts
  - CANNOT be assigned to network interfaces

- First to Last host address:-
  - The usable range which can be assigned to network interfaces

Observation:-

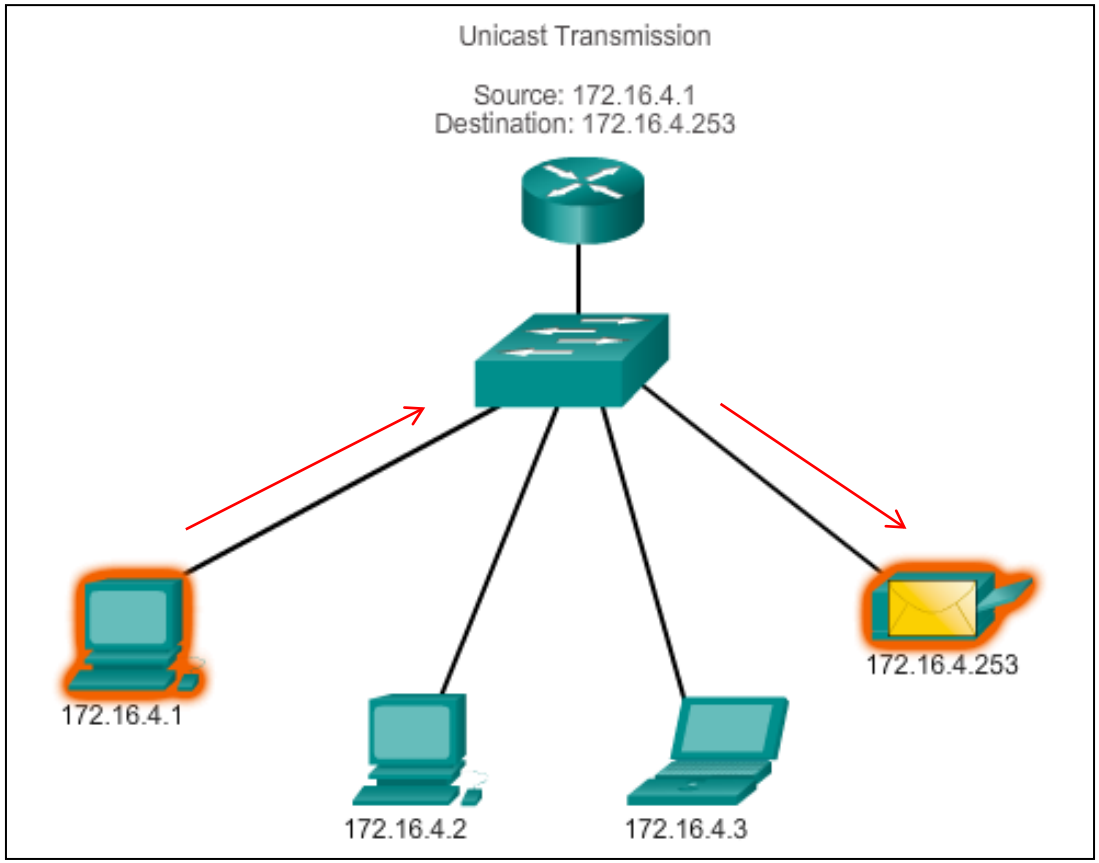
- Subnet mask / prefix determines the size of the subnet:
  - the bigger the prefix number, the small the subnet

- To find the size of the subnet:-
  - Number of usable hosts = 2^(number of host bits) - 2

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

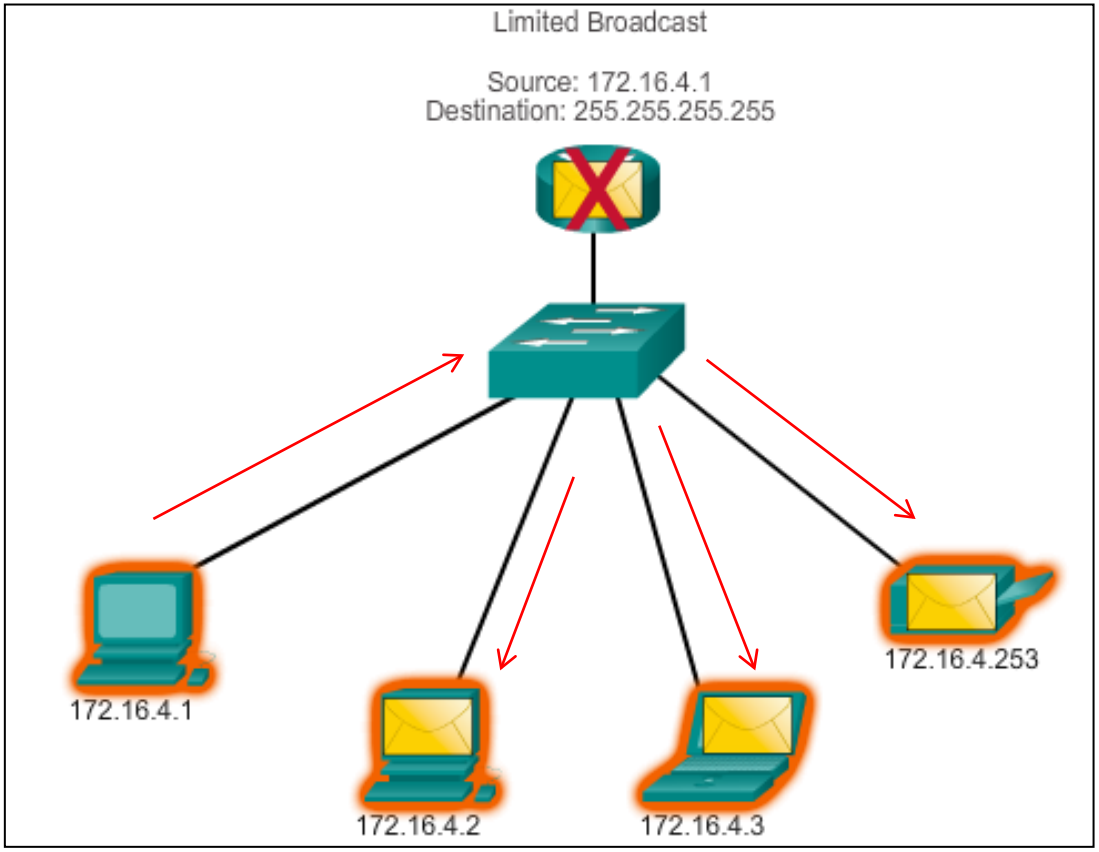
In an IPv4 network, the hosts can communicate one of three different ways: Unicast, **Broadcast**, and Multicast.

#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!

Directed broadcast

- Destination 172.16.4.255
- Hosts within the 172.16.4.0/24 network

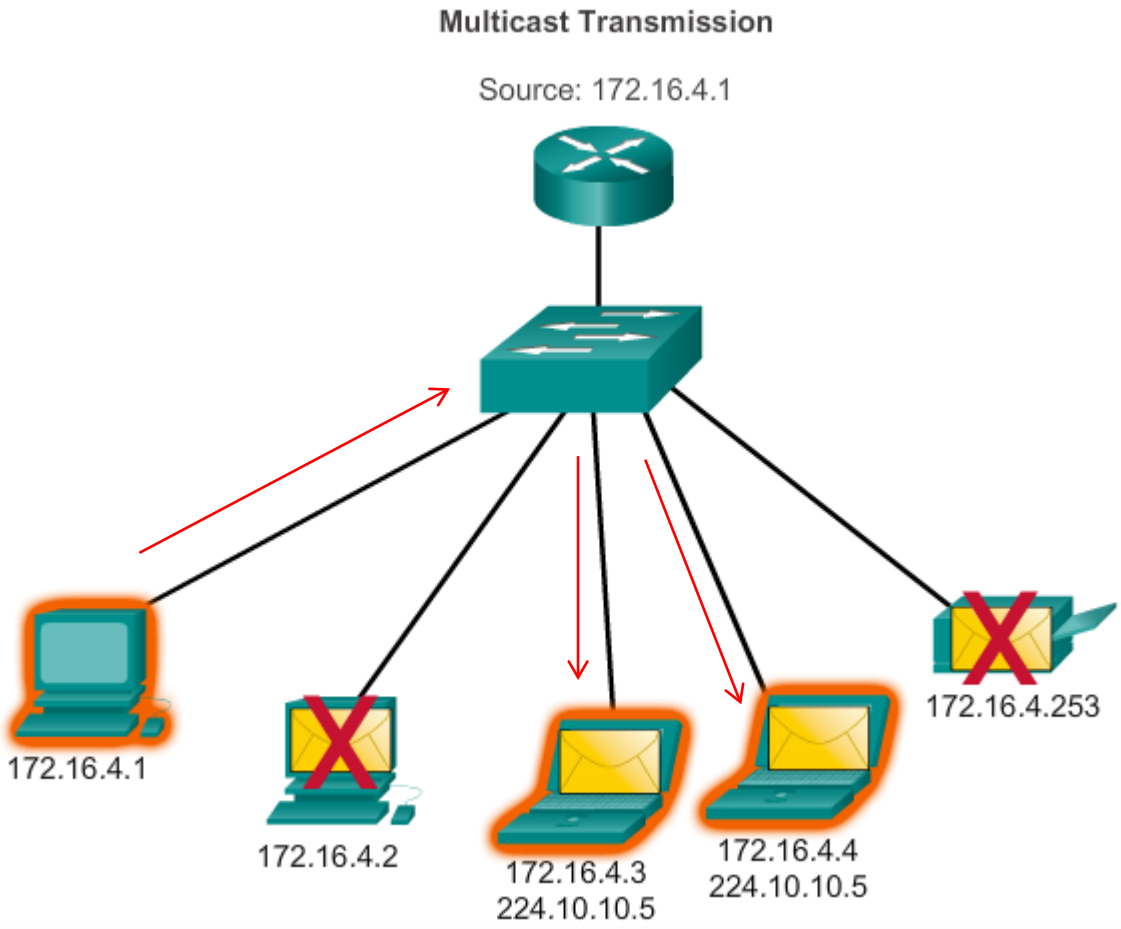


Multicast Transmission

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 group of hosts in the network which subscribes to a special range of addresses know as multicast addresses.

In this example, the multicast address is 224.10.10.5



Public and Private IPv4 Addresses

Private address blocks:

- Hosts that do not require direct 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)

Public address blocks:

- Most of the other addresses are publicly accessible from the Internet
- Some address blocks are set aside for special purpose (see next slide)

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

Legacy Classful Addressing (cont.)

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)		

Legacy Classful Addressing (cont.)

Class A Addresses

- Use a fixed **/8** prefix → 8 bits network & 24 bits for hosts.
- The most significant bit of the high-order octet is a zero (**00000000 to 01111111 → 0 to 127**).
- This meant that there were only 128 possible class A networks, **0.0.0.0 /8 to 127.0.0.0 /8**.

Class B Addresses

- Use a fixed **/16** prefix → 16 bits network & 16 bits for hosts.
- The most significant 2 bits of the high-order octet is 10. (**10000000 to 10111111 → 128 to 191**)
- The address block for class B is **128.0.0.0 /16 to 191.255.0.0 /16**.

Legacy Classful Addressing (cont.)

Class C Addresses

- Use a **/24** prefix → 24 bits network & 8 bits for hosts.
- It uses only the last octet as host addresses with the three high-order octets used for the network address.
- The most significant 3 bits of the high-order octet is 110 **(11000000 to 11011111)**.
- The address block for class C to **192.0.0.0 /24 to 223.255.255.0 /24**.

Legacy Classful Addressing (cont.)

Problems of legacy classful addressing:-

- There are not more than 128 Class A blocks, 16,384 Class B blocks and 2,097,150 Class C blocks
- Insufficient for modern world
- A company that needs 260 addresses will be assigned a Class B block which leads to wastage of many addresses

Classless Addressing

- Formal name is Classless Inter-Domain Routing (CIDR, pronounced “cider”)
- Created a new set of standards that allowed service providers to allocate IPv4 addresses on any address bit boundary (prefix length) instead of class A, B, or C address

Classless IPv4 Addressing

Newer technology - **Classless IP Addressing**

- The **subnet mask** determines the network portion and the host portion.
- Value of first octet does NOT matter (unlike the legacy Classful IP addressing).
- Classless IP Addressing is currently used within the Internet and in most internal networks.

Summary

- An IP address can represent a complete network, a host, or the broadcast address of the network.
- The subnet mask or prefix is used to determine the network portion of an IP address.
- IPv4 hosts can communicate one of three different ways: unicast, broadcast, and multicast.
- The private IPv4 address blocks are: 10.0.0.0/8, 172.16.0.0/12, and 192.168.0.0/16.