Network Layer: IPv4 Addressing

Lecture 9 | CSE421 – Computer Networks

Department of Computer Science and Engineering
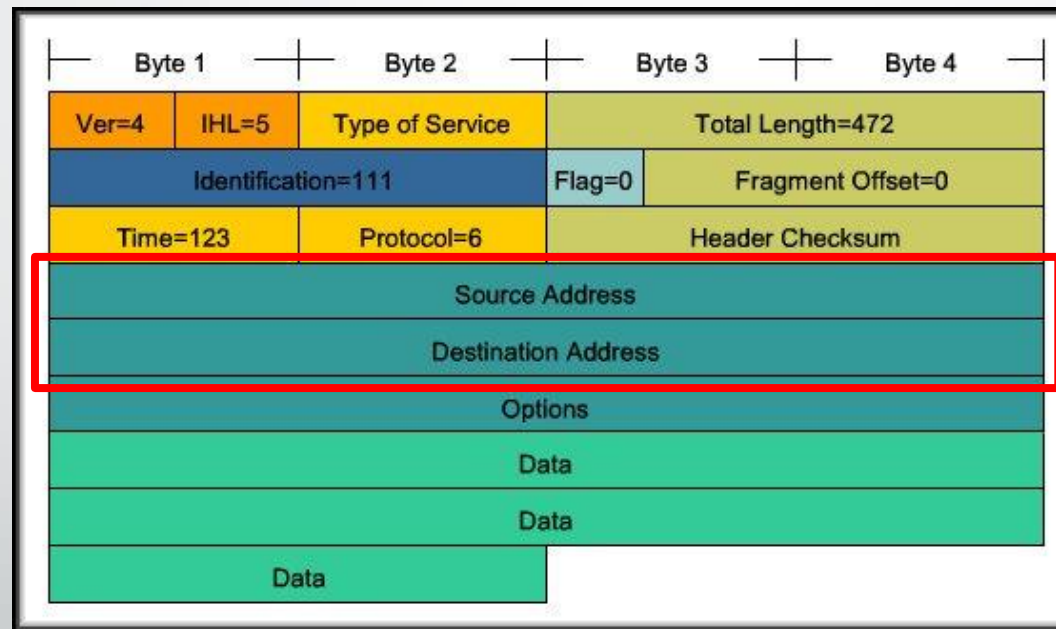School of Data & Science

Objectives

- Anatomy of IPv4 Address
  - Subnet/Prefix Mask
- Types of Address
  - Network
  - Host
  - Broadcast
- Specific Address
  - Unicast
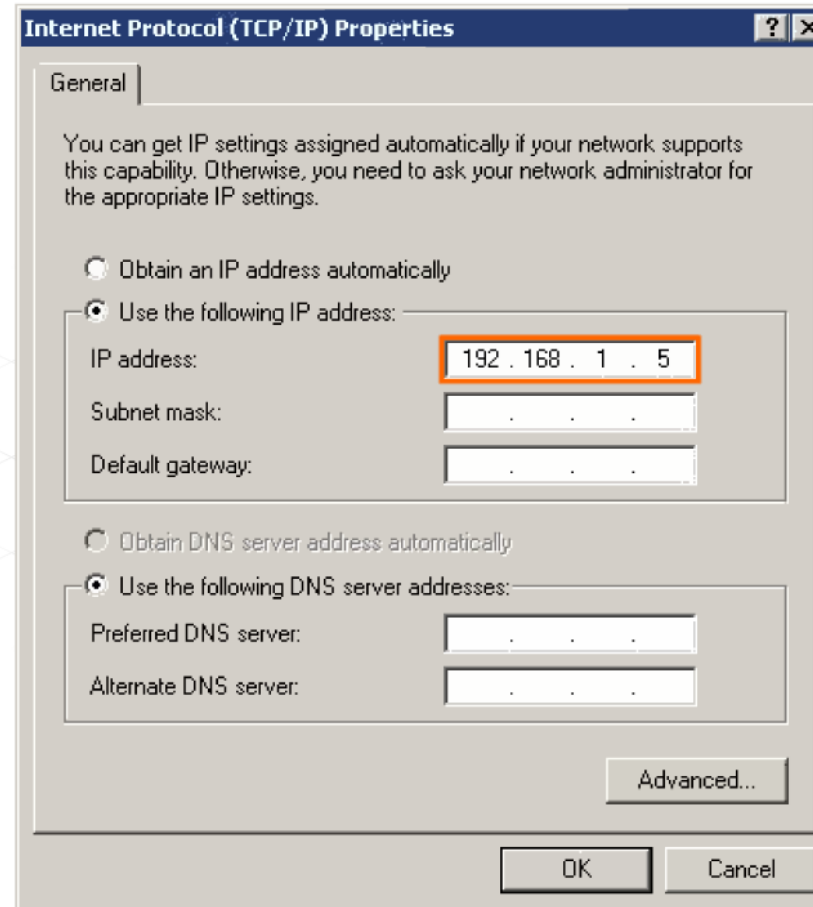 - Multicast
  - Broadcast
- Classful IP Addressing

Anatomy of IPv4

Anatomy of an IPv4 Address

- Each device on a network must be uniquely identified at the Network layer.
- For IPv4, a 32 bit source and destination address is contained in each packet.

IPv4 Addressing Structure

IP version 4 (IPv4) is the current form of addressing used on the Internet.

Anatomy of an IPv4 Address

Dotted decimals

Network part   Host part

| 192 | . | 168 | . | 10 | . | 1 |

32 bits — 11000000   10101000   00001010   00000001   Divided into 4 Octets
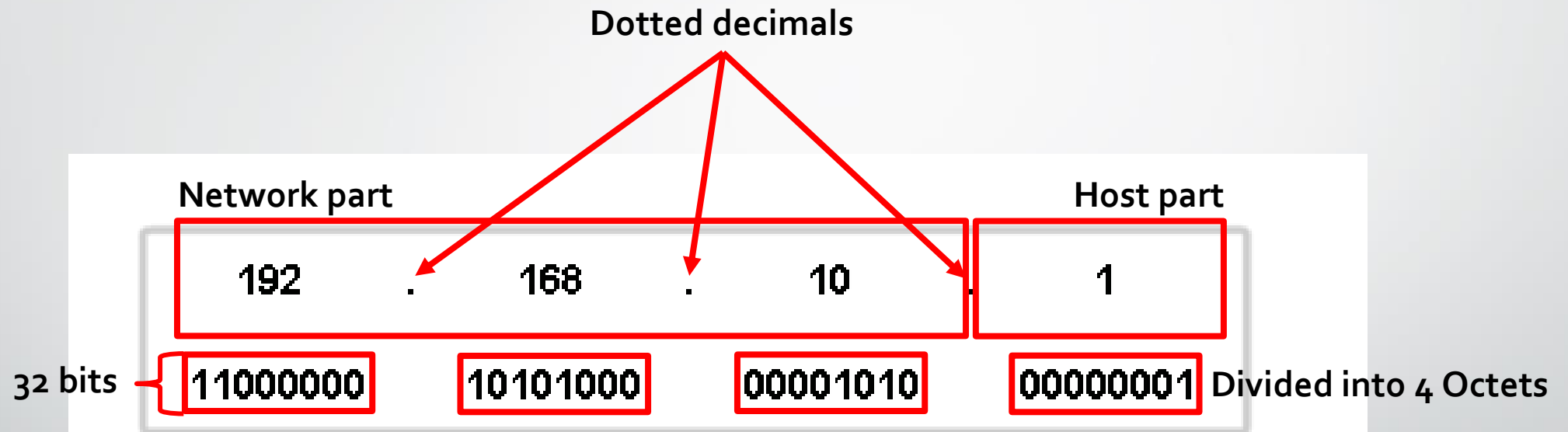
The computer using this IP address is on network 192.168.10.0.

Binary to decimal and Vice Versa

Networks and Hosts

- To identify a path or "route" through a network, the address must be composed of two parts:

  - **Network** portion

  - **Host** portion
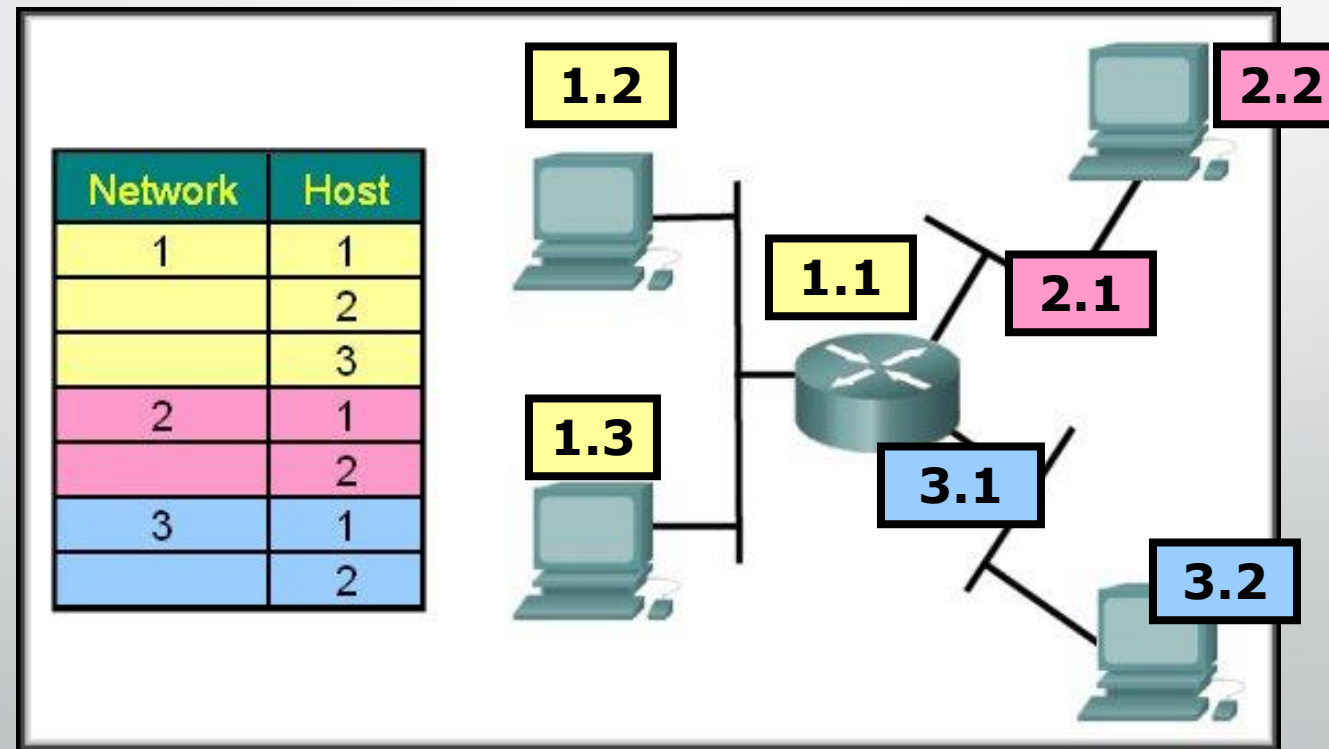
Network Portion

- Network Portion:
  - Some portion of the high-order bits
  - A network can be defined as a group of hosts that have identical bit patterns in the network address portion of their addresses.

IP Address	192.	168.	1.	2
Binary IP Address	11000000	10101000	00000001	00000010

192.168.1.2	11000000	10101000	00000001	00000010
192.168.1.67	11000000	10101000	00000001	01000011
192.168.1.204	11000000	10101000	00000001	11001100

Network Portion

- Host Portion:
  - A variable number of least significant bits that are called the **host portion** of the address.
  - The **number of bits** used in this **host portion** determines the **number of hosts** that we can have within the network.

IP Address	192.	168.	1.	2
Binary IP Address	11000000	10101000	00000001	00000010

192.168.1.2	11000000	10101000	00000001	00000010
192.168.1.67	11000000	10101000	00000001	01000011
192.168.1.204	11000000	10101000	00000001	11001100

Prefix Mask

- How do we or devices identify the network part or the host part?

- **Answer:** Using the **"Prefix Mask".**

- **192.168.10.2**/24
  - Means that the **first 24 bits** are the network portion.
  - The **last 8 bits** are the host portion.

- **Subnet Mask**; the other form of **"Prefix Mask"**.
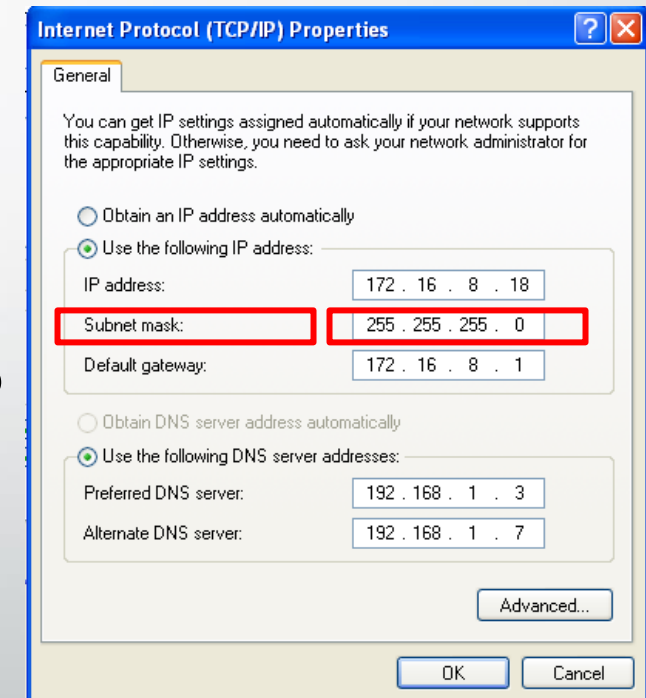 - Prefix length of **/24** means a subnet mask of **255.255.255.0**

Subnet Mask

- The Prefix Mask and the Subnet Mask are different ways of representing the same information.

- Examples:

  - Prefix Mask of **/24** or a subnet mask of **255.255.255.0**

  - Prefix Mask of **/16** or a subnet mask of **255.255.0.0**

  - Prefix Mask of **/8** or a subnet mask of **255.0.0.0**

- Conversion:

  - Subnet mask has the **same format** as an IP address. Hence, it has **32 bits divided into 8 bits (octets)**

  - Prefix mask of **/24** means, the **first (MSB) 24 bits** of subnet mask would be 1

  - Binary: 11111111.11111111.11111111.00000000

  Decimal: **255   .   255   .   255   .   0**

Exercise

- What's the **subnet mask** of the following?
  - **IP Address:** 10.24.36.2 / 4
  - **IP Address:** 10.24.36.2 / 12
  - **IP Address:** 10.24.36.2 / 16
  - **IP Address:** 10.24.36.2 / 23
- What's the **prefix mask** of the following?
  - **IP Address:** 10.24.36.2; **Subnet Mask:** 255.255.224.0
  - **IP Address:** 10.24.36.2; **Subnet Mask:** 255.255.255.192
  - **IP Address:** 10.24.36.2; **Subnet Mask:** 255.255.255.252
  - **IP Address:** 10.24.36.2; **Subnet Mask:** 255.254.0.0
  - **IP Address:** 10.24.36.2; **Subnet Mask:** 255.255.240.0

ANDing the Binaries

- Inside data network devices, digital logic is applied for their interpretation of the addresses.

- AND is used in determining the network address.

  - 0 AND 0 = 0

  - 1 AND 0 = 0

  - 1 AND 1 = 1

  - 0 AND 1 = 0

	Decimal	Binary
IP Address	135.15.2.1	10000111 00001111 00000010 00000001
Subnet Mask	255.255.0.0	11111111 11111111 00000000 00000000
Network Address	135.15.0.0	

But Why AND?

- **Routers** use the **ANDing** process to determine the route a packet will take.

- The network number of the destination address is used to find the network in the routing table.

- The router then determines the best path for the frame.

Types of Addresses

Types of address

- Every network has
  - **Network Address** – The first IP in the range
  - **Broadcast Address** – The second IP in the range
  - **Host Addresses** – Everything in between
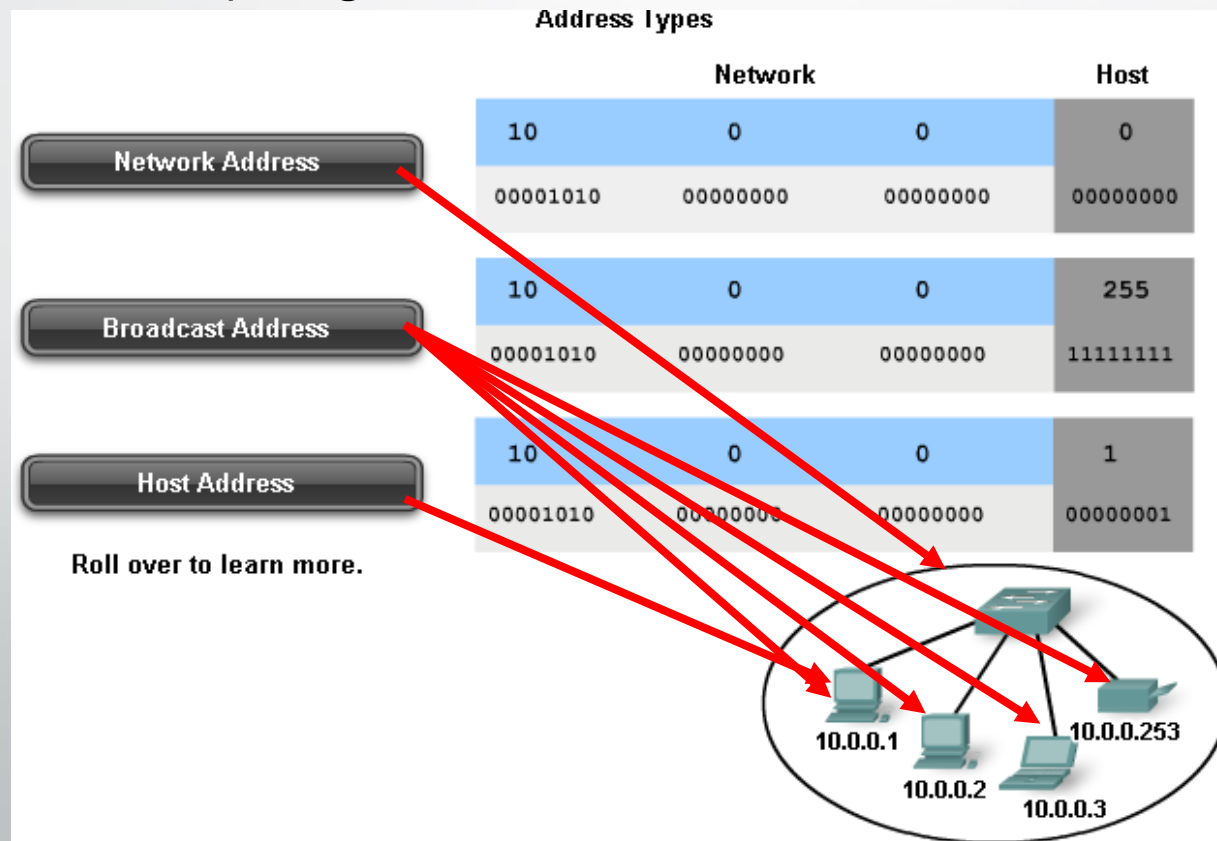
The Addresses

- Network Address
  - All hosts in the network will have the same network bits.
  - Cannot be assigned to a device.
  - Each host bit in this address will be 0.
- Broadcast Address
  - Cannot be assigned to a device.
  - Each host bit in this address will be 1.
- Host Address
  - The unique address assigned to each device on the network.
  - For a network of 192.168.10.0/24
    - Addresses **192.168.10.1** through **192.168.10.254** are all host addresses

The Addresses at a Glance

- Say, you have a random IP address 192.168.10.193/24

Network Prefix

- The network prefix is not always /24.

Using Different Prefixes for the 172.16.4.0 Network

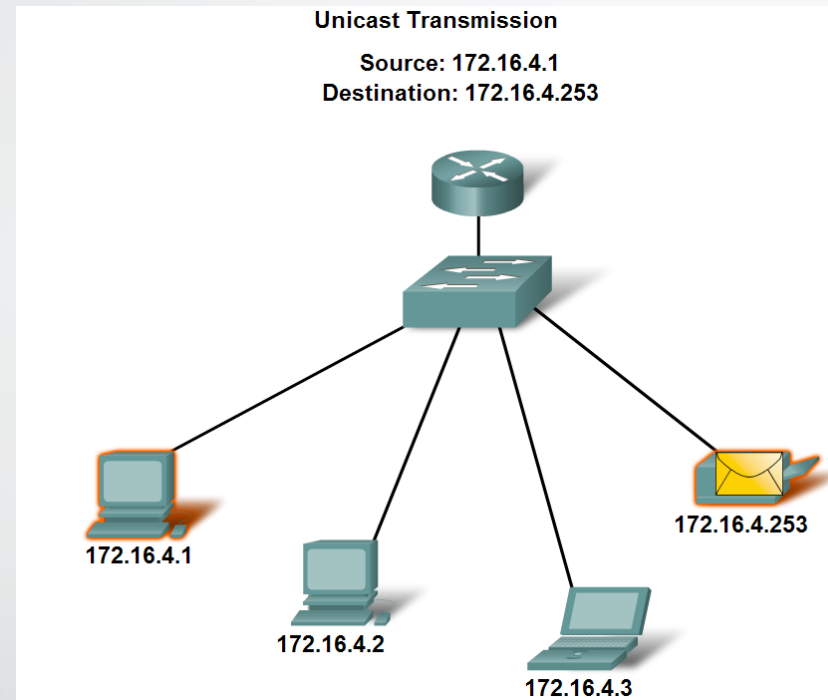| Network	Network address	Host range	Broadcast address
172.16.4.0 /24	172.16.4.0	172.16.4.1 - 172.16.4.254	172.16.4.255
172.16.4.0 /25	172.16.4.0	172.16.4.1 - 172.16.4.126	172.16.4.127
172.16.4.0 /26	172.16.4.0	172.16.4.1 - 172.16.4.62	172.16.4.63
172.16.4.0 /27	172.16.4.0	172.16.4.1 - 172.16.4.30	172.16.4.31

SAME NETWORK ADDRESS ALL PREFIXES

DIFFERENT BROADCAST ADDRESS EACH PREFIX

Special Addresses

Special Addresses

- **Unicast**
  - A message addressed to one host

- **Broadcast**
  - A message addressed to all hosts on a network.
  - Uses network's broadcast address or **255.255.255.255** locally

- **Multicast**
  - A message addressed to a group of hosts.
  - Uses an IP address starting with **224 - 239**

Unicast

Broadcast Address

- Limited Broadcast

Limited Broadcast

Source: 172.16.4.1
Destination: 255.255.255.255
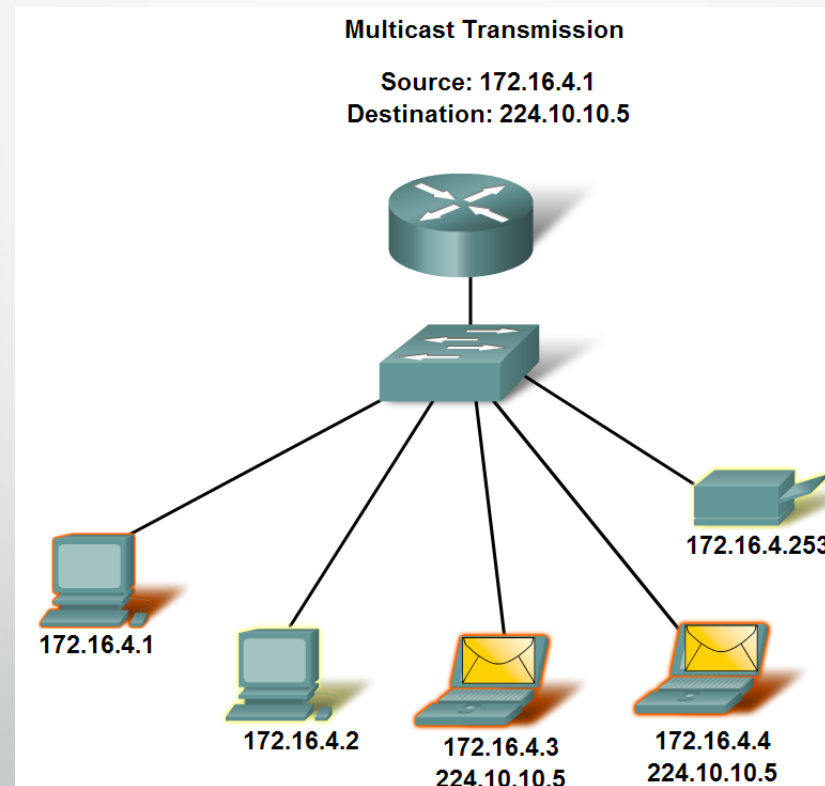
172.16.4.1
172.16.4.2
172.16.4.3
172.16.4.253
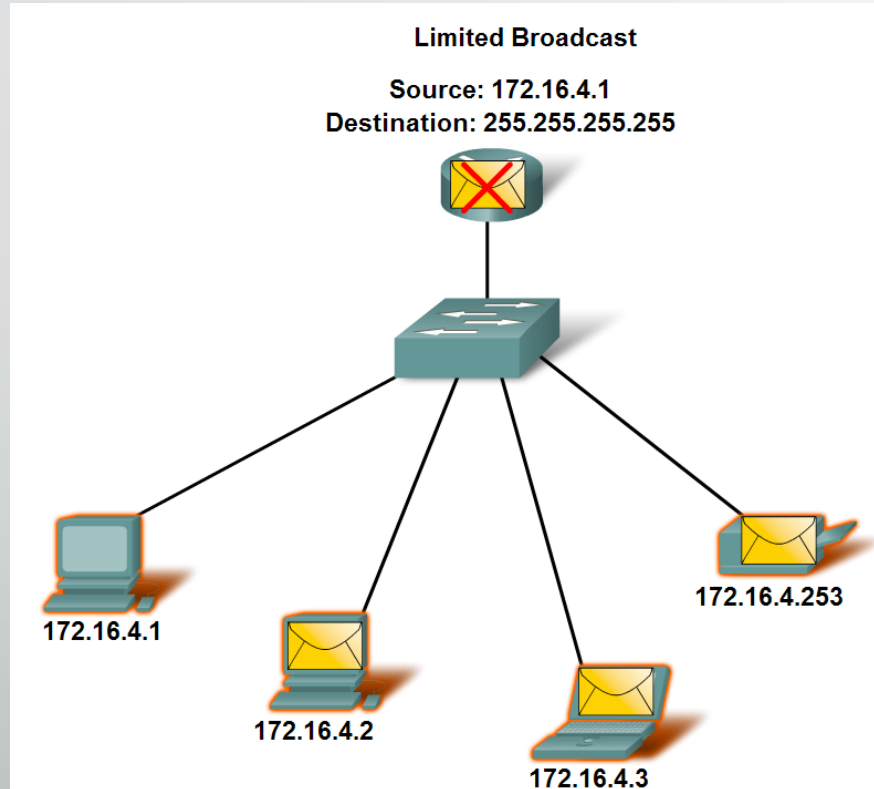
- Directed Broadcast
  - For a host outside of the network to communicate with the hosts within the **172.16.4.0 /24** network, the destination address of the packet would be **172.16.4.255**.

Multicast

- Examples of Multicast Application
  - Video and audio broadcasts
  - Routing information exchange by routing protocols
  - Distribution of software
  - News feeds

Multicast Transmission

Source: 172.16.4.1
Destination: 224.10.10.5

172.16.4.253

172.16.4.1

172.16.4.2

172.16.4.3
224.10.10.5

172.16.4.4
224.10.10.5

Classful Addressing

Classful Addressing

Class	High Order Bits	Start	End
Class A	0	0.0.0.0	127.255.255.255
Class B	10	128.0.0.0	191.255.255.255
Class C	110	192.0.0.0	223.255.255.255
Multicast	1110	224.0.0.0	239.255.255.255
Experimental	1111	240.0.0.0	255.255.255.255

Class and Subnet Mask

	Octet 1	Octet 2	Octet 3	Octet 4	Subnet mask
Class A	Network	Host	Host	Host	255.0.0.0 or /8
Class B	Network	Network	Host	Host	255.255.0.0 or /16
Class C	Network	Network	Network	Host	255.255.255.0 or /24

Classful Networks : Range

Address class	First octet range	Number of networks	Hosts per network
Class A	0 to 127	128 (less 0 and 127)	16,777,214
Class B	128 to 191	16,384	65,534
Class C	192 to 224	2,097,152	254