



Inspiring Excellence

# Network Layer: IPv4 Addressing

Lecture 9 | CSE421 – Computer Networks

Department of Computer Science and Engineering  
School of Data & Science

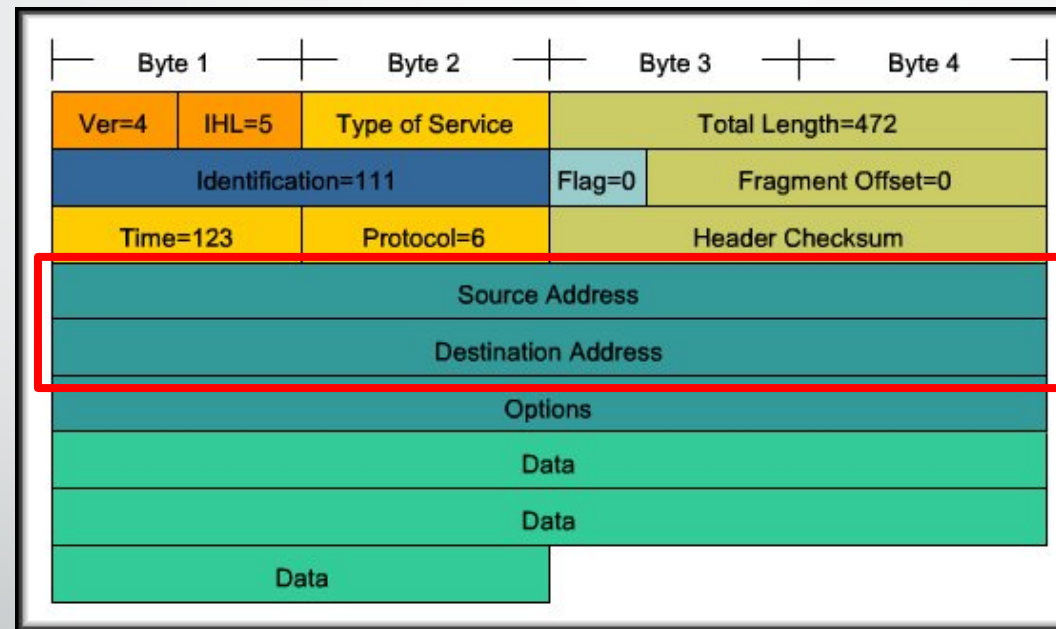
# Objectives

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

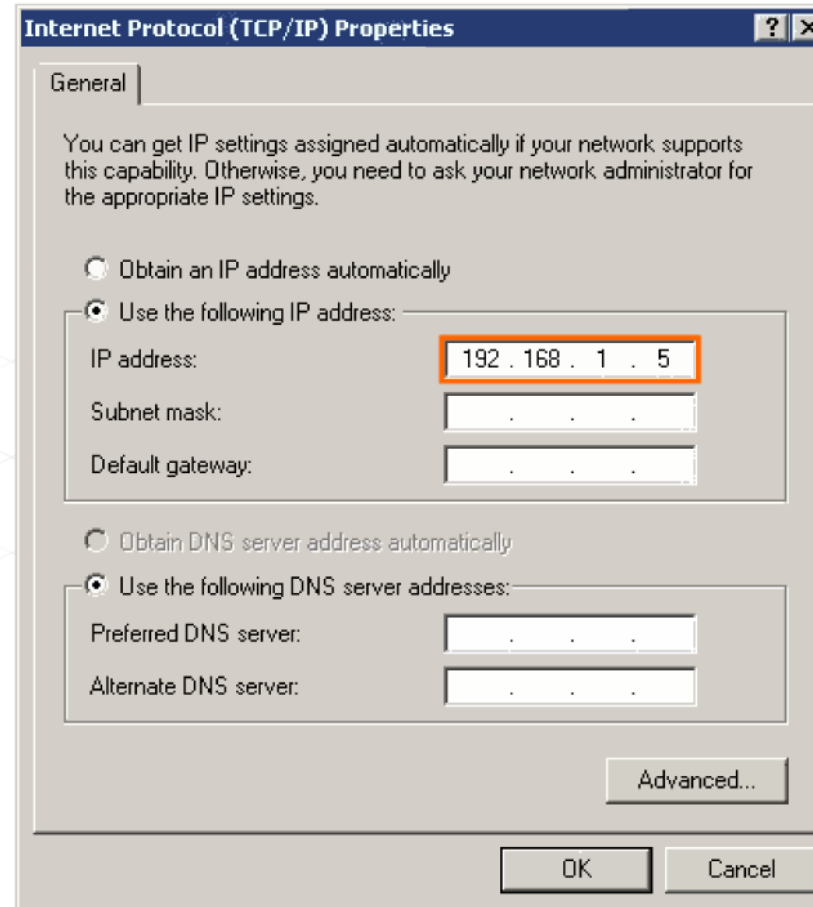
# Anatomy of IPv4

# 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



**Internet Protocol (TCP/IP) Properties**

General

You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

☐ Obtain an IP address automatically

☒ Use the following IP address:

IP address: **192.168.1.5**

Subnet mask: . . .

Default gateway: . . .

☐ Obtain DNS server address automatically

☒ Use the following DNS server addresses:

Preferred DNS server: . . .

Alternate DNS server: . . .

Advanced...

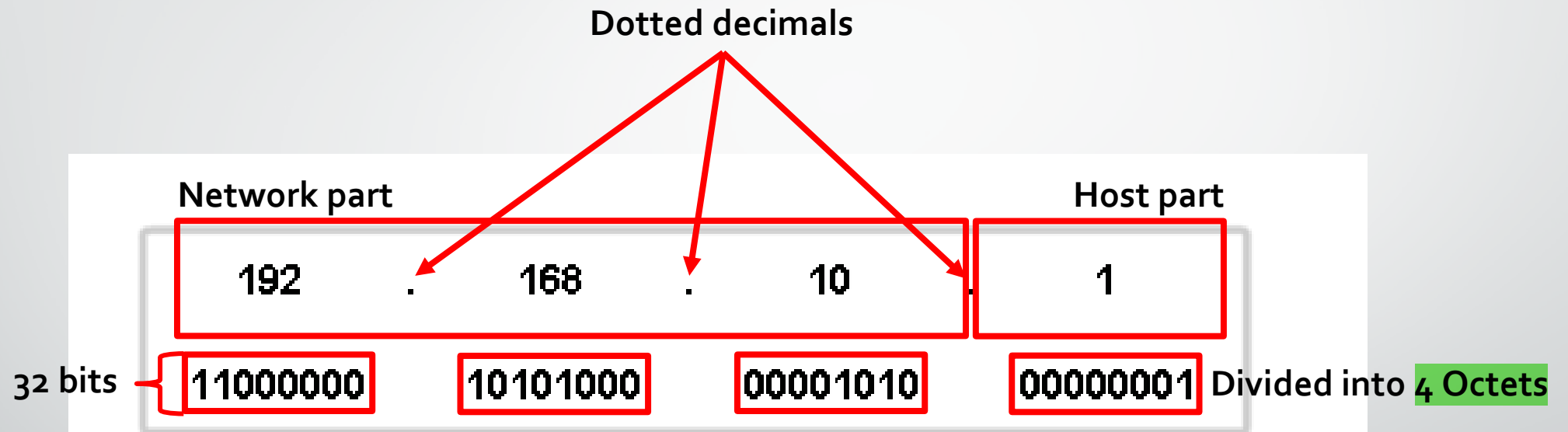
OK Cancel

I see you have  
assigned me  
an IP address  
**11000000.1010  
1000.00000001.  
00000101**  
Now other  
hosts can find  
me!



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

# Anatomy of an IPv4 Address



The computer using this IP address is on network 192.168.10.0.

# Binary to decimal and Vice Versa

## Binary To Decimal Conversion

Exponent	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
Position	128	64	32	16	8	4	2	1
Bits	1	1	1	1	0	1	0	1
1 BYTE / 1 Octet								
Add these numbers together	128 + 64 + 32 + 16 + 0 + 4 + 0 + 1							
Decimal	245							

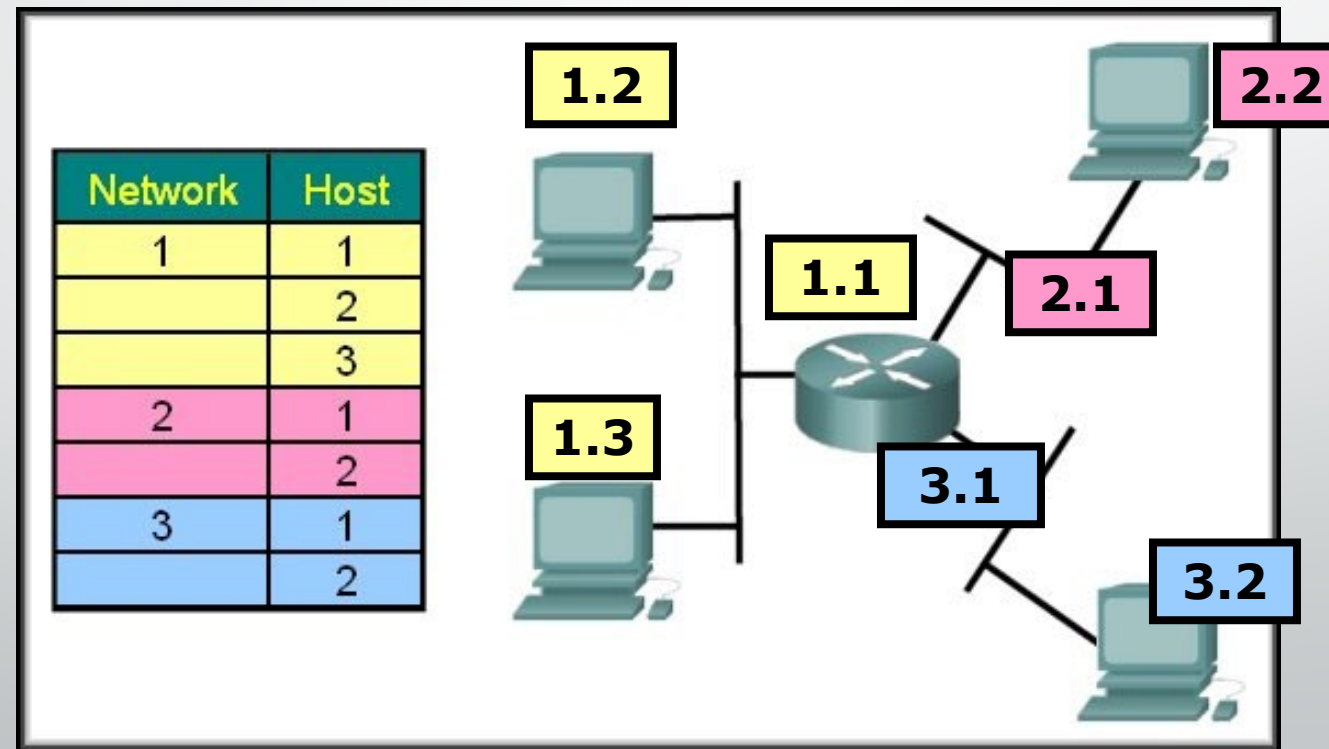
A 1 in this position means 64 is added to the total.

A 0 in any position means that 0 is added to the total.

11110101 in Binary = Decimal Number 245

# 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**

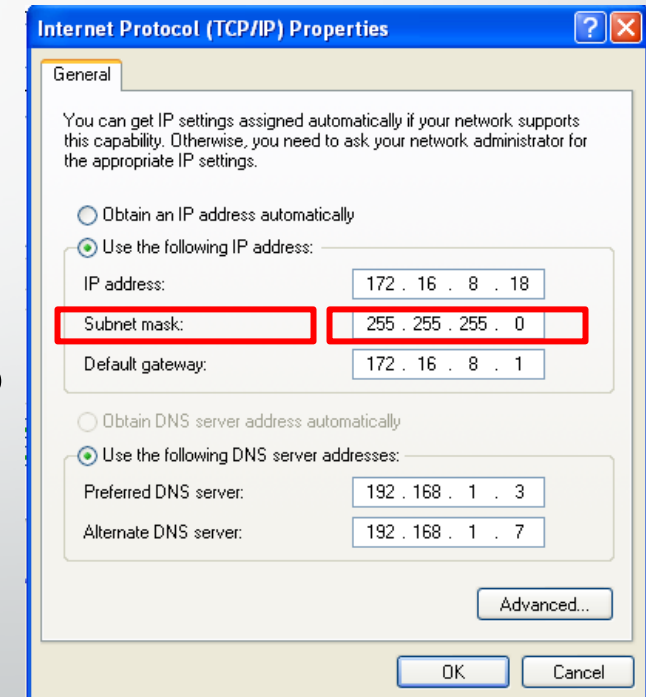
```
Z:\>ipconfig

Windows IP Configuration

Ethernet adapter Local Area Connection:

    Connection-specific DNS Suffix  . : 
    IP Address . . . . . : 172.16.8.18
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 172.16.8.1

Z:\>
```



# 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      240.0.0.0
  - IP Address: 10.24.36.2 / 12      255.240.0.0
  - IP Address: 10.24.36.2 / 16      255.255.0.0
  - IP Address: 10.24.36.2 / 23      255.255.248
- What's the **prefix mask** of the following?
  - IP Address: 10.24.36.2; Subnet Mask: 255.255.224.0      /19
  - IP Address: 10.24.36.2; Subnet Mask: 255.255.255.192      /26
  - IP Address: 10.24.36.2; Subnet Mask: 255.255.255.252      /30
  - IP Address: 10.24.36.2; Subnet Mask: 255.254.0.0      /15
  - IP Address: 10.24.36.2; Subnet Mask: 255.255.240.0      /20

# 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.
  - $0 \text{ AND } 0 = 0$
  - $1 \text{ AND } 0 = 0$
  - $1 \text{ AND } 1 = 1$
  - $0 \text{ AND } 1 = 0$

	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?

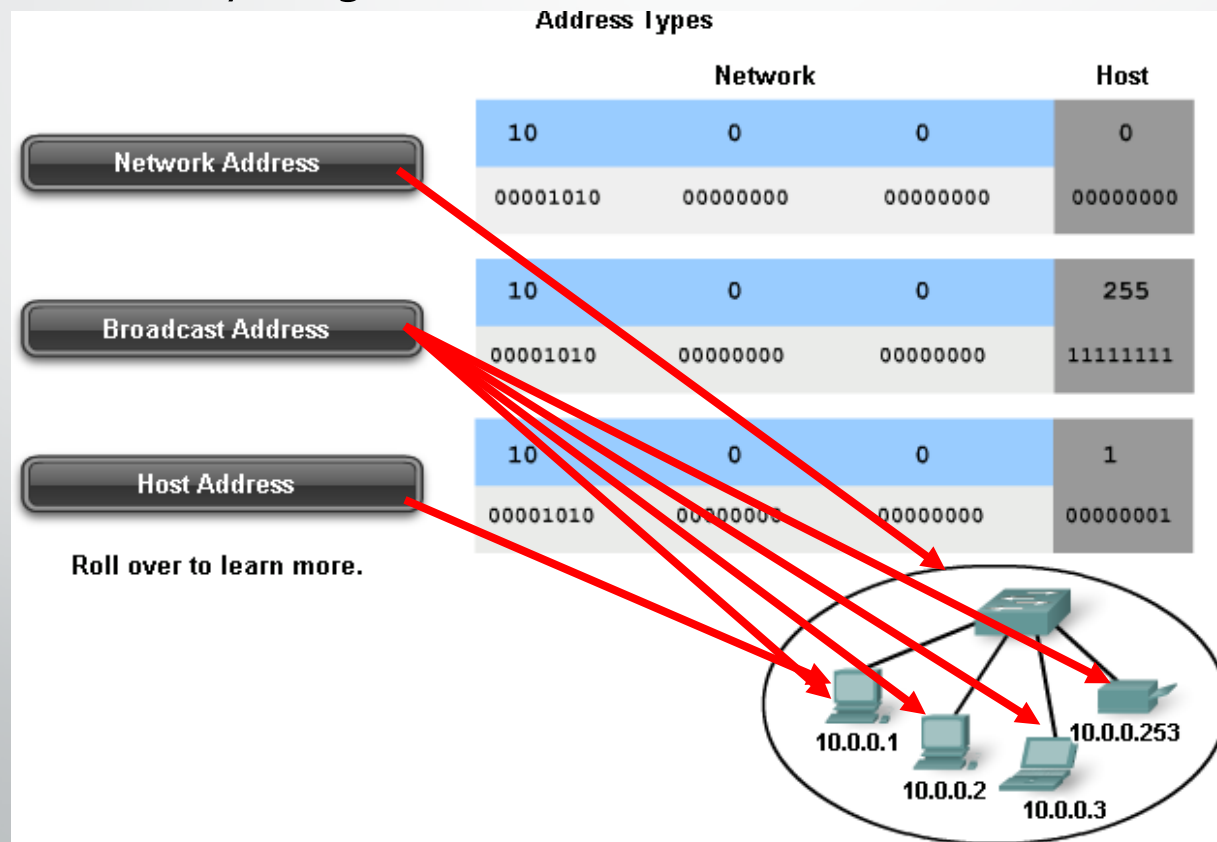
- **Routers** use the **ANDing** process to **determine the route** a packet will take.
- The network number of the **destination address** is used to find the network in the **routing table**.
- The router then determines the **best path** for the frame.

# 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 **Last IP**
  - **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

[illegible]

# 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

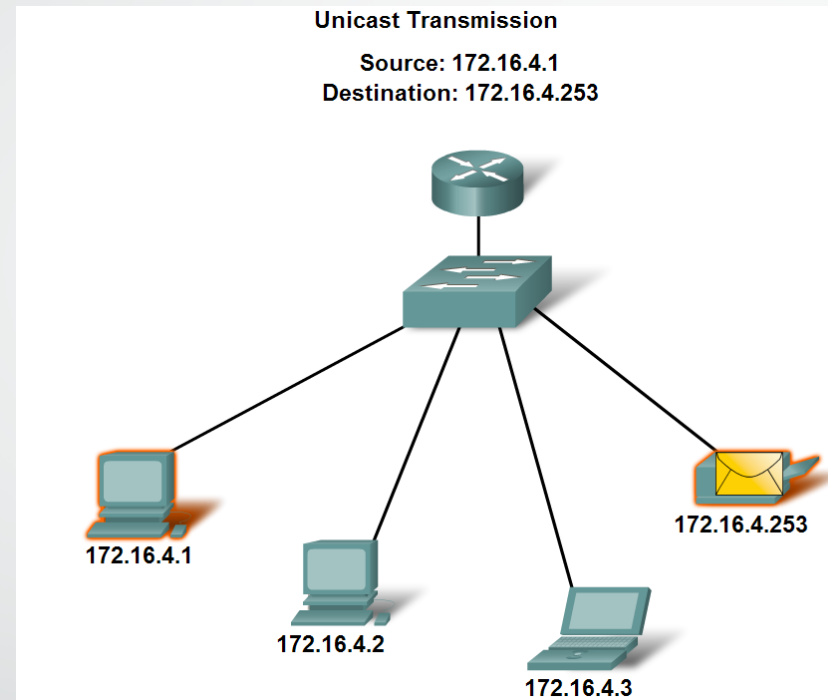
- **Broadcast**

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

- **Multicast**

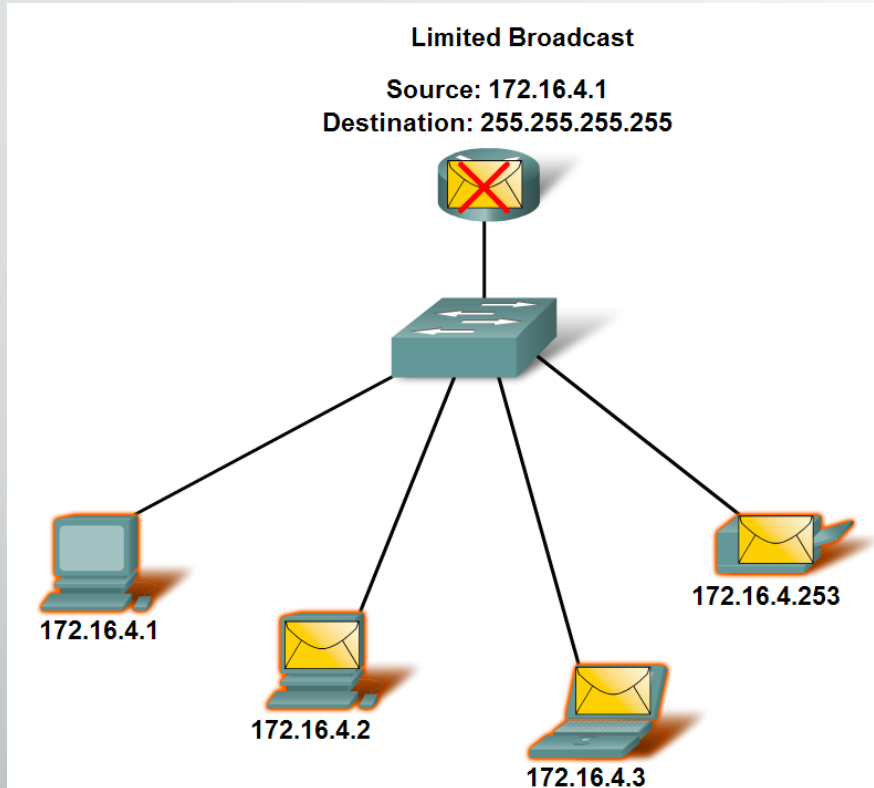
- A message addressed to a group of hosts.
- Uses an IP address starting with 224 - 239

# Unicast



# Broadcast Address

- Limited Broadcast



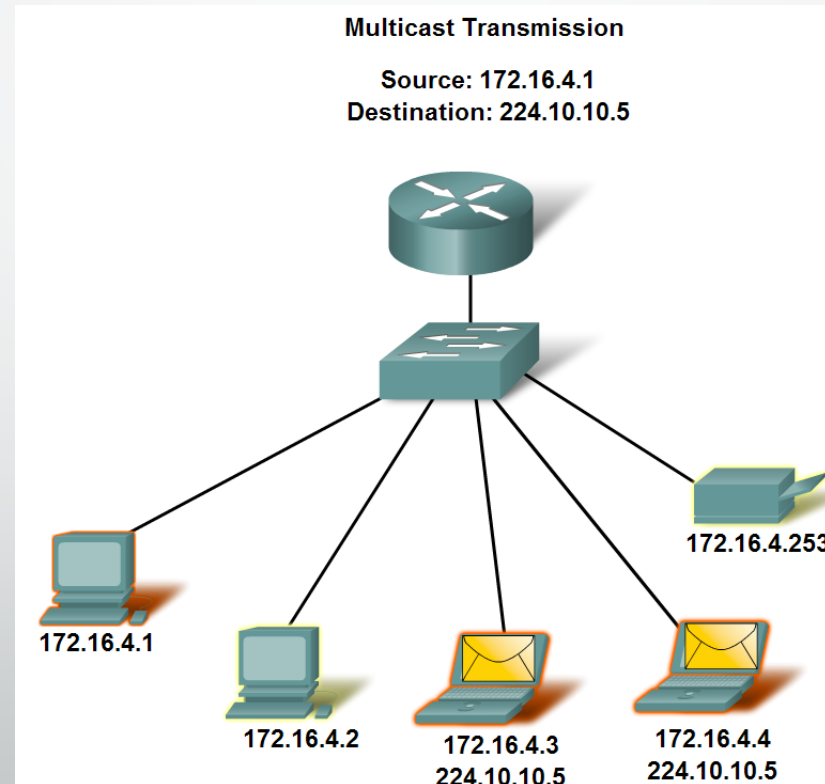
- Directed Broadcast

- 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



# Classful Addressing

# Classful Addressing

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

## Class and Subnet Mask

	Octet 1	Octet 2	Octet 3	Octet 4	Subnet mask
<b>Class A</b>	Network	Host	Host	Host	255.0.0.0 or /8
<b>Class B</b>	Network	Network	Host	Host	255.255.0.0 or /16
<b>Class C</b>	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

# The End