Introduction to Addressing in Computer Networks

In a computer network, many devices (computers, laptops, mobiles, routers) are connected. To communicate correctly, each device must have a **unique address**.

Just like a home address identifies your house, a **network address** identifies a device in a network.

There are **two main types of addresses** in networking:

1. **Physical Address (MAC Address)**
2. **Logical Address (IP Address)**

These two addresses work together to deliver data correctly.

Physical Address (MAC Address)

A **Physical Address** is a hardware address assigned to a device's **Network Interface Card (NIC)**.
This address is written permanently by the manufacturer.

Key Points:

- Works at **Data Link Layer (Layer 2)**
- **48-bit** address
- Written in **Hexadecimal**
- Example: `A4-B3-21-6F-8C-90`

Features:

- Unique worldwide
- Never changes (unless manually modified)
- Used for communication inside the **Local Area Network (LAN)**
- Helps in device identification at hardware level

Logical Address (IP Address)

A **Logical Address** is a software-assigned address used to identify a device on a global network like the **Internet**.

Key Points:

- Works at **Network Layer (Layer 3)**
- Provided by **Administrator / Router / DHCP**
- Can change (dynamic)
- Used for device identification across **multiple networks**

Example:

```
192.168.1.5
```

Why Do We Need Physical & Logical Addresses Both?

Because:

- **MAC Address** helps devices communicate **within the same network (LAN)**.
- **IP Address** helps devices communicate **across different networks or the internet**.

Both are used together in communication.

IP Address (Internet Protocol Address)

Definition:

An **IP Address** is a unique identifier assigned to devices so they can communicate on a network.

There are **two versions of IP**:

1. **IPv4 (older)**
2. **IPv6 (newer)**

IPv4 (Internet Protocol Version 4)

Introduction:

IPv4 is the most commonly used type of IP address in networks. It was introduced in 1980s.

Characteristics:

- **32-bit** address
- Supports around **4.3 billion devices**
- Written in **decimal format**
- Divided into **4 parts (octets)**

Example:

```
192.168.0.1
```

Format:

```
A.B.C.D
```
Each part contains **0–255** values.

IPv4 Address Classes (Beginner Friendly)

IPv4 addresses are divided into five classes based on size:

Class	Range	Used For
A	0–127	Very large networks
B	128–191	Medium networks
C	192–223	Small networks
D	224–239	Multicast
E	240–255	Experimental

Private IPv4 Address Ranges:

- **Class A:** 10.0.0.0 – 10.255.255.255
- **Class B:** 172.16.0.0 – 172.31.255.255
- **Class C:** 192.168.0.0 – 192.168.255.255

IPv6 (Internet Protocol Version 6)

Introduction:

IPv6 was introduced because IPv4 addresses were getting over (shortage issue).

Characteristics:

- **128-bit** address
- Supports **unlimited devices**
- Written in **hexadecimal**
- Divided into **8 blocks**, each separated by :

Example:

```
2001:0db8:85a3:0000:0000:8a2e:0370:7334
```

Why IPv6 is Better:

- Huge address space
- Faster routing
- More secure (built-in IPSec)
- Auto-configuration supported
- No need for NAT

Short Form:

- Remove leading zeros
- Use :: for continuous zeros
  Example short address:
  ```
  2001:db8:85a3::8a2e:370:7334
  ```

Difference Between IPv4 and IPv6 (Beginner Table)

Feature	IPv4	IPv6
Address Size	32-bit	128-bit
Format	Decimal	Hexadecimal
Example	192.168.1.1	2001:db8::1
Count	4.3 billion	Unlimited
Security	Less secure	More secure
Speed	Slower	Faster
Header	Complex	Simple

Summary

- **MAC Address = Physical Address = Hardware Address (Layer 2)**
- **IP Address = Logical Address = Internet Layer Address (Layer 3)**
- **IPv4 = 32-bit, limited**
- **IPv6 = 128-bit, unlimited**

Network ID and Host ID

An IP Address has two parts:

1. **Network ID (Network Portion)**
2. **Host ID (Host Portion)**

Example:
```
192.168.10.25
```

- Network ID → tells **which network** the device belongs to
- Host ID → tells **which device** in that network

The **subnet mask** decides how many bits are for Network ID and how many for Host ID.

What is Network ID?

Network ID is the part of the IP address that identifies the **network** to which the device belongs.

It is **same for all devices** inside the same subnet.

Example:

IP: `192.168.1.10`
Mask: `/24` → (255.255.255.0)

Network ID = **192.168.1.0**

Key Points:

- First address of subnet
- Cannot be assigned to any device
- Used by routers to forward packets
- Also called **Network Address**

What is Host ID?

Host ID is the part of the IP address that identifies the **specific device** inside the network.

Example:

IP: `192.168.1.10`
Mask: `/24`

Host ID = **0.0.0.10**

Key Points:

- Unique inside a network
- Used to identify individual computers
- Range always lies between **Network Address** and **Broadcast Address**

How to Find Network ID and Host ID?

To find Network ID:

```
IP Address AND Subnet Mask
```

To find Host ID:

```
IP Address MINUS Network ID
```

Example:
IP: `192.168.1.130`
Mask: `255.255.255.0` (/24)

- Network ID = 192.168.1.0
- Host ID = 0.0.0.130

Network ID and Host ID in Different Subnets

Example: /26 Subnet

Subnet Mask: 255.255.255.192
Block Size: 64
Subnets:

- 0–63
- 64–127

- 128–191
- 192–255

Take IP = **192.168.1.70**

Step 1 → Find its subnet:
70 belongs to 64–127 range

Step 2 → Network ID:
192.168.1.64

Step 3 → Broadcast Address:
192.168.1.127

Step 4 → Host ID:
70 – 64 = **6**

So Host ID = **0.0.0.6**

Special Addresses in a Subnet

Type	Meaning
Network ID	First IP of subnet, identifies network
Broadcast ID	Last IP of subnet, used to communicate with all hosts
Host Range	All usable IPs in between

Example (Subnet: 192.168.1.64/26):

- Network ID → **192.168.1.64**
- First Host → **192.168.1.65**
- Last Host → **192.168.1.126**
- Broadcast ID → **192.168.1.127**

Difference Between Network ID and Host ID

Network ID	Host ID
Identifies the network	Identifies a device within the network
Same for all devices in subnet	Different for each device
Cannot be assigned to a host	Assigned to devices (PC, laptop, router)
Starts the subnet	Part of usable host space
Used by routers	Used by end devices

Why Network ID & Host ID Are Important?

- Without Network ID → routers cannot forward packets
- Without Host ID → device cannot be uniquely identified

- Essential for **subnetting**
- Important for secure network design
- Helps reduce broadcast and improve performance

Super Easy Memory Trick

- **Network ID** = "Area name" (like a colony)
- **Host ID** = "House number" inside that colony

Example:
Colony: *192.168.1.*
House number: *10*

So 192.168.1.10 = House No. 10 in that colony.

Summary

- IP address = Network ID + Host ID
- Network ID = Identifies the network
- Host ID = Identifies the device
- Subnet mask decides how network and host bits are split
- Network ID is always the **first address**
- Broadcast ID is always the **last address**
- Hosts lie in between them

What is Subnetting?

Subnetting means **dividing one large network into smaller networks**.

Example:
If you have a big network **192.168.1.0**, you can divide it into small groups like:

- 192.168.1.0
- 192.168.1.64
- 192.168.1.128
- 192.168.1.192

This helps in:

- ➢ Better security
- ➢ Better management
- ➢ Less broadcast traffic
- ➢ Faster network

Why Subnetting is Needed?

Subnetting is used when:

- You want to **separate departments** (like Accounts, HR, IT).

- You want **security**, so each department has its own network.
- You want to **reduce broadcast** traffic.
- You want to **efficiently use IP addresses**.

Without subnetting = One big crowd
With subnetting = Divided into smaller, manageable groups

Important Terms in Subnetting

1. Network Address

The starting address of a network.
Example: 192.168.1.0

2. Broadcast Address

The last address of a network.
Used to send data to **all devices** in the subnet.
Example: 192.168.1.63

3. Host Address

Addresses used by devices (computers, mobiles).
Example: 192.168.1.1 – 192.168.1.62

4. Subnet Mask

A number that tells how many bits are used for the network.

Example:
255.255.255.0 → 24 bits for network → **/24**
255.255.255.128 → 25 bits for network → **/25**

Subnet Mask Basics

Subnet mask divides the IP address into:

- **Network part**
- **Host part**

Example:
255.255.255.0 → /24

Binary:
11111111.11111111.11111111.00000000
(24 ones → network bits)

How Subnetting Works (Very Simple Explanation)

Original network: **192.168.1.0/24**

If you divide it into **2 subnets**:

- New mask becomes /25
- Each network gets 128 addresses
- Subnets formed:

Subnet 1:

Network: 192.168.1.0
Broadcast: 192.168.1.127
Hosts: 1–126

Subnet 2:

Network: 192.168.1.128
Broadcast: 192.168.1.255
Hosts: 129–254

Number of Hosts Formula

Formula:

Hosts = (2^remaining bits) – 2

We subtract 2 because:

- 1 network address
- 1 broadcast address

Example for /26:
/26 means 32 - 26 = 6 host bits
Hosts = 2^6 – 2 = 64 – 2 = **62 hosts**

Finding Subnet Size (Block Size)

Easy method:
256 – last subnet mask value

Example:
Subnet mask: **255.255.255.192**
Last part: 192
Block size = 256 – 192 = **64**

So networks will be:
0, 64, 128, 192

Example 1: Subnet 192.168.10.0/26

Step 1: /26 → mask 255.255.255.192
Step 2: Block size = 256 – 192 = 64
Step 3: Subnets:

1. 192.168.10.0
   Broadcast: 63
   Hosts: 1–62
2. 192.168.10.64
   Broadcast: 127
   Hosts: 65–126
3. 192.168.10.128
   Broadcast: 191
   Hosts: 129–190
4. 192.168.10.192
   Broadcast: 255
   Hosts: 193–254

Example 2: How many hosts in /27?

/27 → 32 - 27 = 5 host bits
$2^5 - 2 = 32 - 2 = $ **30 hosts**

CIDR Notation (Super Simple)

CIDR means writing subnet mask in **slash format**.

Examples:

- /24 = 255.255.255.0
- /25 = 255.255.255.128
- /26 = 255.255.255.192
- /27 = 255.255.255.224
- /28 = 255.255.255.240

Think: **bigger number = smaller subnet = fewer hosts**

Summary (Beginner Level)

- **Subnetting = dividing one network into smaller networks.**
- Helps security, speed, and organization.
- **Subnet mask** decides network size.
- **Block size = 256 – subnet mask last value.**
- **Hosts = (2^host bits) – 2.**
- Smaller subnets = fewer host devices.

Subnetting Practice Questions (with Answers)

Q1. Find the Network ID of IP: 192.168.10.25/24

Solution:
/24 → 255.255.255.0
Network ID = **192.168.10.0**

Q2. Find Broadcast Address of 192.168.5.90/26

/26 → Mask 255.255.255.192
Block Size = 256 − 192 = 64
Subnet ranges: 0–63, 64–127, 128–191, 192–255

90 lies in **64–127**
Network ID = **192.168.5.64**
Broadcast = **192.168.5.127**

Q3. How many hosts in a /27 network?

Host bits = 32 − 27 = 5
Hosts = $2^5 − 2$ = **30 hosts**

Q4. Find first host of 10.0.8.0/22

/22 = Mask → 255.255.252.0
Block size = 256 − 252 = 4
Subnets: 0, 4, 8, 12...

Given network: 10.0.8.0
First host = **10.0.8.1**

Q5. Find last host of 10.0.12.0/22

Same block 4
Subnet ranges: 8.0–11.255, **12.0–15.255**

Last host = **10.0.15.254**

Q6. IP 172.16.50.100/20 → Find Network ID

/20 mask = 255.255.240.0
Block = 256 − 240 = 16
50 lies in 48–63

Network = **172.16.48.0**

Q7. How many subnets in /26 if original is /24?

Borrowed bits = 26 − 24 = 2
Subnets = 2^2 = **4 subnets**

Q8. IP 192.168.1.200/25 → Find Broadcast

/25 mask = 255.255.255.128
Block = 256 − 128 = 128
Subnet ranges: 0–127, **128–255**

Broadcast = **192.168.1.255**

Q9. Find host range of 172.16.0.0/23

/23 → Mask 255.255.254.0
Block = 256 − 254 = 2
Subnets: 0–1, 2–3, etc.

Network = 172.16.0.0
Broadcast: 172.16.1.255

Hosts: **172.16.0.1 → 172.16.1.254**

Q10. IP 192.168.100.77/28 → Find Network ID & Broadcast

/28 → Mask 255.255.255.240
Block = 256 − 240 = 16
Subnets: 0,16,32,48,64,80...

77 lies in **64–79**

Network ID = **192.168.100.64**
Broadcast = **192.168.100.79**

2. Subnet Mask Table for Exam (Easy Memory Table)

CIDR	Subnet Mask	Block Size	Usable Hosts
/24	255.255.255.0	256	254
/25	255.255.255.128	128	126
/26	255.255.255.192	64	62
/27	255.255.255.224	32	30
/28	255.255.255.240	16	14
/29	255.255.255.248	8	6
/30	255.255.255.252	4	2
/31	255.255.255.254	2	0 (Used for P2P Links)
/32	255.255.255.255	1	0 (Single host label)

Tip:
Bigger CIDR number → smaller network → fewer hosts.

3. Network ID & Host ID Exercises

Try these yourself (answers also included below).

Exercise 1

IP: **192.168.20.55/26**
Find:

1. Network ID
2. Broadcast
3. Host Range
4. Host ID

Solution:

Block = 64
Subnets: 0–63, **64–127**, 128–191, 192–255
55 → 0–63 subnet

1. Network: **192.168.20.0**
2. Broadcast: **192.168.20.63**
3. Hosts: **1–62**
4. Host ID = 55 − 0 = **55**

Exercise 2

IP: **10.10.17.200/20**
Find Network ID.

Solution:

/20 → 255.255.240.0
Block = 16
17 is in **16–31**
Network = **10.10.16.0**

Exercise 3

IP: **172.31.46.8/23**
Find Host Range.

Solution:

/23 → 255.255.254.0
Block = 2
46 is in **46–47**

Network = 172.31.46.0
Broadcast = 172.31.47.255
Hosts = **172.31.46.1 → 172.31.47.254**

Exercise 4

IP: **192.168.1.150/25**
Find Host ID.

Solution:

/25 → 128 block
150 lies in **128–255**
Network = 128
Host ID = 150 − 128 = **22**

Exercise 5

How many hosts in **/21**?

Solution:

Host bits = 32 − 21 = 11
Hosts = $2^{11} - 2$ = **2046 hosts**