WEEK 1 – NETWORKING FOUNDATIONS

DAY 3 – IP ADDRESSING (IPv4) — FULL EXPLANATION

1. Why IP Addressing Exists (Foundation First)

In networking:

- MAC address → identifies a device **inside a local network**

- IP address → identifies a device **across networks (globally)**

Without IP addresses:

- Internet cannot work

- Routers cannot forward packets

- Servers cannot be reached

Think of it like:

- **MAC address = House number**

- **IP address = City + Area + House number**

2. What Is an IPv4 Address?

IPv4 address is:

- A **32-bit logical address**

- Written in **decimal dotted format**

- Divided into **4 octets (bytes)**

Example:

192.168.1.10

Each octet:

- Ranges from **0 to 255**

- Because 1 byte = 8 bits → 2^8 = 256 values

Binary Representation (Very Important for Subnetting)

Example:

192 = 11000000

168 = 10101000

1 = 00000001

10 = 00001010

Interview sentence:

"IPv4 is a 32-bit logical addressing system written as four decimal octets."

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3. Classful IP Addressing (Old System)

Originally, IPv4 addresses were divided into **classes**.

Why Classes Were Created?

- To simplify allocation

- To group networks by size

But this created **huge wastage** (you will see why).

IPv4 Classes Explained

Class	Range	Network / Host Split	Use
A	1.0.0.0 – 126.0.0.0	8 / 24	Very large networks
B	128.0.0.0 – 191.255.0.0	16 / 16	Medium networks
C	192.0.0.0 – 223.255.255.0	24 / 8	Small networks
D	224.0.0.0 – 239.255.255.255	Multicast	Streaming
E	240.0.0.0 – 255.255.255.255	Experimental	Reserved

Example: Class C

192.168.1.10

- Network part → first 3 octets

- Host part → last octet

- Total hosts = $2^8 - 2 = $ **254**

(−2 for network & broadcast)

Problem with Classful Addressing

Suppose a company needs:

- **50 IP addresses**

Class C gives:

- **254 addresses**

- **204 wasted**

This is why classful addressing **failed**.

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4. CIDR (Classless Inter-Domain Routing)

CIDR was introduced to:

- Remove fixed classes

- Reduce IP wastage

- Improve routing efficiency

CIDR uses:

IP address + /prefix

Example:

192.168.1.0/26

What Does /26 Mean?

- First **26 bits = network**

- Remaining **6 bits = hosts**

Total bits = 32
32 − 26 = 6 host bits

Hosts = $2^6 − 2$ = **62**

Interview sentence:

"CIDR allows flexible allocation of IP addresses by using variable-length subnet masks."

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5. CIDR vs Classful (Clear Comparison)

Feature	Classful	CIDR
Fixed classes	Yes	No
IP wastage	High	Low
Flexible subnetting	No	Yes
Modern Internet	No	Yes

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6. Public vs Private IP Addresses

Public IP

- Globally unique
- Assigned by ISP
- Used on the Internet

Example:

8.8.8.8

Private IP (Defined by RFC 1918)

Used inside **local networks**.

Class Range

A   10.0.0.0 – 10.255.255.255

B   172.16.0.0 – 172.31.255.255

C   192.168.0.0 – 192.168.255.255

Private IPs:

- Cannot be routed on the Internet
- Must use NAT

Interview sentence:

"Private IP addresses are used internally and are not routable on the public Internet."

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7. NAT (Network Address Translation) – Basics

Why NAT Exists?

Because:

- IPv4 addresses are limited
- Private IPs are not Internet-routable

NAT allows:

- Many private devices
- To share **one public IP**

How NAT Works (Simple Flow)

1. Device sends packet with private IP

2. Router replaces source IP with public IP

3. Router maintains translation table

4. Response mapped back to private device

Types of NAT (Basic Awareness)

- Static NAT → one-to-one

- Dynamic NAT → many-to-many

- PAT (NAT Overload) → many-to-one (most common)

Interview sentence:

"NAT maps private IP addresses to public IPs to conserve IPv4 address space."

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8. Hands-On: Manual Subnet Calculation (Step-by-Step)

Example 1:

192.168.1.0/26

Step 1: Identify Host Bits

32 − 26 = 6

Hosts = 2^6 − 2 = **62**

Step 2: Find Block Size

Look at subnet mask:

/26 → 255.255.255.192

Block size:

256 − 192 = 64

Step 3: Subnet Ranges

Subnet	Network	Broadcast	Hosts
1	192.168.1.0	192.168.1.63	.1 – .62
2	192.168.1.64	192.168.1.127	.65 – .126

Subnet	Network	Broadcast	Hosts
3	192.168.1.128	192.168.1.191	.129 – .190
4	192.168.1.192	192.168.1.255	.193 – .254

Interview Tip

Always mention:

- Network address

- Broadcast address

- Usable host range

9. Common Subnet Sizes to Remember (Interview Gold)

CIDR	Hosts
/24	254
/25	126
/26	62
/27	30
/28	14
/29	6
/30	2

10. Interview Question (High Probability)

❓ Why Did CIDR Replace Classful IP Addressing?

Strong Interview Answer:

"Classful IP addressing wasted a large number of IP addresses because of fixed network sizes. CIDR replaced it by allowing variable-length subnet masks, which improved address utilization and reduced routing table size."

11. Security Relevance of IP Addressing

- IP spoofing attacks

- Network segmentation using CIDR

- Firewall rule design
- NAT hiding internal IP structure