Explain CIDR .
CIDR stands for Classless Inter-Domain Routing.

You are given a VPC with a CIDR block of 192.168.0.0/24.
You need to create both public and private subnets within this VPC.
How would you divide the IP range to create public and private subnets?

✅ **What is CIDR?**
CIDR is a method used to allocate IP addresses and route IP packets more efficiently.
It replaces the old **Class A, B, C** system.

- **CIDR Notation:** IP address/prefix length
  Example: 192.168.1.0/24

192.168.1.0 in binary =
11000000.10101000.00000001.00000000

2. The Rope Analogy

- Imagine a rope representing **all 4.2 billion IPv4 addresses** (the entire IPv4 space).
  - /1 = Half the rope = ~2.1 billion addresses.
  - /2 = Half of /1 = ~1.05 billion addresses.

CIDR Concepts

Term	Meaning
IP Address	A unique address like 192.168.1.2
Prefix (/24)	Number of bits used for network part (like a mask)

Term	Meaning
Host bits	Remaining bits used for host devices (e.g., computers, routers)
CIDR Block	A range of IP addresses, e.g., /24 has 256 addresses

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Decimal vs Binary View
CIDR Notation: 192.168.1.0/24

Part	Decimal	Binary
IP Address	192.168.1.0	11000000.10101000.00000001.00000000
Subnet Mask	255.255.255.0	11111111.11111111.11111111.00000000

- /24 means **first 24 bits** for network, last 8 bits for hosts
- So, host range = 192.168.1.1 to 192.168.1.254

✅ **What is a Subnet Mask?**
A **Subnet Mask** is used in networking to **divide an IP address** into:

- **Network portion** (which identifies the network)
- **Host portion** (which identifies individual devices on that network)

📘 **Simple Explanation:**
Imagine a street address:

- **Network** = the neighborhood
- **Host** = the specific house

A **subnet mask** tells the router how many bits belong to the neighborhood and how many belong to individual houses.

🧠 **Example:**
IP Address: 192.168.1.10
Subnet Mask: 255.255.255.0

- The first **24 bits** (255.255.255) = network
- The last **8 bits** (0) = host

So, all devices in 192.168.1.0 – 192.168.1.255 are in the same network.

CIDR Block: /24

- A /24 network means **24 bits** are used for the **network** part.

- IPv4 address has **32 bits total**, so **32 - 24 = 8 bits** are left for **hosts**.

✅ **How many /24 networks can exist in IPv4?**
IPv4 has **2^{32} = 4,294,967,296** addresses.
A /24 network has **256 IPs** (2^8), so:

- **Total /24 networks = 2^{32} / 2^8 = 2^{24} = 16,777,216 networks**

✅ **How many usable hosts per /24 network?**

- Total IPs in /24 = **2^8 = 256**
- But **2 are reserved**:
  - Network address (e.g., 192.168.1.0)
  - Broadcast address (e.g., 192.168.1.255)

➡️ **Usable hosts = 256 - 2 = 254**

- **Network Address:** The first address in a subnet that identifies the network itself (e.g., 192.168.1.0).
- **Broadcast Address:** The last address in a subnet used to send data to all hosts in that network (e.g., 192.168.1.255).

When a device needs to communicate with **every other device** on the network **at once**—like:

🔎 **Summary Table:**

Item	Value
Total /24 networks	16,777,216
IPs per /24 network	256
Usable hosts per /24	254

🎯 **Advantages of CIDR**

Advantage	Why it Matters
Efficient IP Allocation	Prevents wastage, no need to use fixed class sizes
Flexible Subnetting	You can create subnets like /28, /30 depending on need

Advantage	Why it Matters
Reduces Routing Table Size	Helps ISPs combine multiple IPs (route summarization)
Slowed IPv4 Exhaustion	Conserves available addresses by fine-grained allocation

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🧪 **Example: Compare**

CIDR	Total IPs	Usable Hosts	Subnet Mask
/24	256	254	255.255.255.0
/30	4	2	255.255.255.252

- /30 is often used in **point-to-point** links (only 2 devices)
- /24 is common in **small networks**

CIDR Notation Analysis

/30 means 30 bits for network, 2 bits for hosts

- IPv4 has 32 bits total
- /30 reserves 30 bits for the network portion
- Leaves 2 bits for host addressing (32 - 30 = 2)

Subnet Mask Calculation

255.255.255.252 is correct

- 30 network bits = 11111111.11111111.11111111.11111100
- In decimal: 255.255.255.252

Total IP Addresses

2^2 = 4 total IPs is accurate

- With 2 host bits, you get 2^2 = 4 possible combinations
- 00, 01, 10, 11 in binary

IP Address Allocation

Using your example 192.168.1.0/30:

Address	Binary (last octet)	Purpose
192.168.1.0	00000000	Network Address
192.168.1.1	00000001	Usable Host
192.168.1.2	00000010	Usable Host
192.168.1.3	00000011	Broadcast Address

If you're assigning a **/24 CIDR block to a VPC** (i.e., 256 IPs), and want to split it into **public and private subnets**, here's how you can do it.

Step-by-Step: Splitting /24 into Public & Private Subnets

✅ **Total IPs in /24:**

- **256 IPs** (192.168.0.0 to 192.168.0.255)
- **Usable per subnet = 256 - 2 = 254**

✂️ **Option 1: 2 Equal Subnets (/25)**

A /25 subnet means **128 IPs** (2^7) → usable: **126**

🔷 **Subnet Split:**

- **Public subnet (/25):** 192.168.0.0/25 → IPs from 192.168.0.0 to 192.168.0.127
- **Private subnet (/25):** 192.168.0.128/25 → IPs from 192.168.0.128 to 192.168.0.255

Each subnet has **126 usable IPs**.

✂️ **Option 2: Unequal Subnets (e.g., /26 + /26 + /26 + /26)**

If you want more granular subnets:

- You can divide /24 into **4 subnets of /26**, each with:
  - **64 IPs total**
  - **62 usable**

Then choose:

- **Public subnet:** e.g., 192.168.0.0/26
- **Private subnet(s):** 192.168.0.64/26, 192.168.0.128/26, etc.

🔄 **How to Decide Which Subnet is Public or Private?**

- **Public Subnet:**
  - Has a **route to Internet Gateway**
  - Instances get **public IPs**
- **Private Subnet:**
  - No direct route to Internet Gateway
  - Uses **NAT Gateway** or **no internet access**

✅ **Recommendation:**

Network	CIDR	Purpose	Usable IPs
Public	192.168.0.0/25	Public access	126
Private	192.168.0.128/25	Internal-only	126

This setup gives you a clean, balanced split with room for NAT Gateway, bastion host, and application instances.

🔥 **Example of Conflict:**
Let's say you assign:

- **Network A: 192.168.0.0/24**
- **Network B: 192.168.0.0/16**

These overlap! Because:

- /24 covers: 192.168.0.0 – 192.168.0.255
- /16 covers: 192.168.0.0 – 192.168.255.255

❌ **Conflict: Both claim 192.168.0.0 – 192.168.0.255**

What You *Can* Do:
You can:

- Assign **non-overlapping** CIDR blocks:
  - e.g., /24 → 10.0.1.0/24, 10.0.2.0/24, ..., up to 10.255.255.0/24
  - Then, if you want a **/16**, pick a block that **doesn't intersect** existing /24s.

✅ Example of no conflict:

- /24: 10.0.1.0/24
- /16: 10.1.0.0/16 (no overlap)

Use Case	CIDR Block Type	IP Type	Example
VPC in AWS	/16 or /24	Private IP	10.0.0.0/16
Hosting a website	/32 or /24	Public IP	3.21.45.67
Office LAN	/24	Private IP	192.168.1.0/24
NAT Gateway in AWS	-	Public IP	Assigned by AWS
Subnetting in a VPC	/24 or /26	Private IP	10.0.1.0/24, 10.0.2.0/24
Mobile internet user	/32	Public IP	Dynamic from ISP

- **CIDR blocks** define IP ranges — you choose them when creating networks.
- **Private IPs** are for internal use (LAN, VPC) — you assign them.
- **Public IPs** are for internet use — given by AWS, ISPs, or RIRs.
- No overlapping between CIDR blocks — plan carefully.

What does the "/24" in the CIDR block "192.168.0.0/24" represent?

A. 24 hosts
B. 24 subnets
C. 24 bits in the host portion
D. 24 bits in the network portion

Answer: ✅ D. 24 bits in the network portion

Which CIDR block provides exactly 8 IP addresses?

A. /29
B. /28
C. /30
D. /27

Answer: ✅ A. /29
(Formula: 2^(32 - subnet bits), so /29 → 2^3 = 8 IPs)