1. Understanding How an IP Address is Structured

An **IP Address** (IPv4) is a **32-bit number**, usually written in **four octets** (e.g., `192.168.1.10`).

🔹 The **IP Address** has **two parts**:

- **Network ID** → Identifies the network
- **Host ID** → Identifies a specific device in the network

📌 The **Subnet Mask** decides how many bits are for the **Network ID** and how many are for the **Host ID**.

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2. How the Subnet Mask Works

A **Subnet Mask** is also a **32-bit number**, and it uses:

- **1s (ones)** to represent the **Network ID**
- **0s (zeros)** to represent the **Host ID**

For example:

- **Subnet Mask:** `255.255.255.0`
  → **Binary:** `11111111.11111111.11111111.00000000`
  → **Means:** The first 24 bits are for the **Network ID**, and the last 8 bits are for the **Host ID**.

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3. Example: Extracting the Subnet ID

Let's use this example:

📌 **IP Address:** `9.100.100.100`
📌 **Subnet Mask:** `255.255.255.0`

Step 1: Convert Both to Binary

IP Address (9.100.100.100)

```
CopyEdit
9       → 00001001
100     → 01100100
100     → 01100100
100     → 01100100
```

Subnet Mask (255.255.255.0)

```
CopyEdit
255     → 11111111
255     → 11111111
255     → 11111111
0       → 00000000
```

Step 2: Perform a Binary AND Operation

We now **AND** the IP Address with the Subnet Mask. The rule for AND:

- `1 AND 1 = 1`
- `1 AND 0 = 0`
- `0 AND 0 = 0`

Apply AND operation bit by bit

```
yaml
CopyEdit
IP Address:  00001001 01100100 01100100 01100100
Subnet Mask: 11111111 11111111 11111111 00000000
-----------------------------------------------
Subnet ID:   00001001 01100100 01100100 00000000
```

Step 3: Convert the Subnet ID Back to Decimal

```
CopyEdit
00001001 → 9
01100100 → 100
01100100 → 100
00000000 → 0
```

📌 **Subnet ID =** `9.100.100.0`

☑ **Subnet ID = Network ID + Subnet Bits**
☑ **Host ID = The remaining bits (last octet,** `100`**)**

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4. How to Tell the Host ID

Since the **last octet** is for hosts (`00000000` to `11111111`), the **Host ID** is the part that was **ANDed to 0s**:

```
sql
CopyEdit
Original last octet:   01100100  (100 in decimal)
Masked last octet:     00000000  (0 in decimal)
```

📌 **Host ID =** `100` **(which is device 100 in this subnet)**

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5. Another Example With a Different Subnet Mask

Now, let's try **255.255.255.224** instead of `255.255.255.0`.

New Subnet Mask: `255.255.255.224`

```
CopyEdit
255     → 11111111
255     → 11111111
255     → 11111111
224     → 11100000
```

Now, applying AND:

```
yaml
CopyEdit
IP Address:  00001001 01100100 01100100 01100100
Subnet Mask: 11111111 11111111 11111111 11100000
-----------------------------------------------
Subnet ID:   00001001 01100100 01100100 01100000
```

🔹 **Converted Back to Decimal:** `9.100.100.96`
📌 **Subnet ID =** `9.100.100.96`
📌 **Host ID =** `4` **(last 5 bits of the last octet,** `00100`**)**

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6. Key Takeaways

☑ **Subnet ID = The portion of the IP Address that is ANDed with 1s in the Subnet Mask**
☑ **Host ID = The portion that is ANDed with 0s in the Subnet Mask**
☑ **Subnetting helps divide a network into smaller networks, making routing more efficient.**