Networking

- IP Address is a unique number assigned to device for communication.
- We have two types of IP
    - Public IP:
        - This is unique number across internet.
        - Generally depending on internet connection type (Static ip & Dynamic Ip)
        - Multiple devices sharing a network might share some public ip
    - Private IP:
        - This is a unique number for a network
        - Each device gets a unique ip
- Priniciples
    - Two devices in a network can communicate only when they belong to same network, to communicate with other networks they need extra configurations/devices
    - IP Address is combination of
        - Network id
        - Host id

Private IP Address

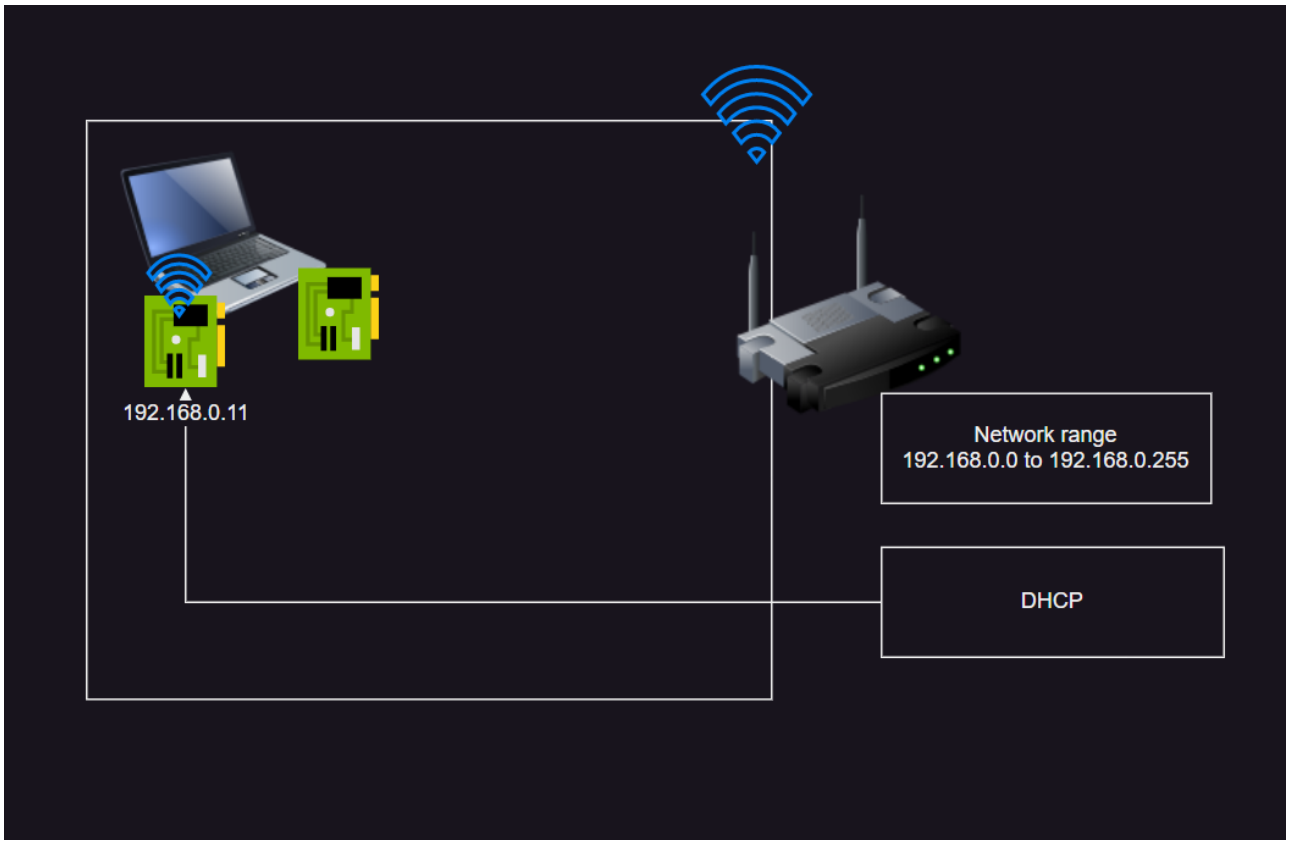
- Private IP adresses have a reserved ip range

```
192.168.0.0 to 192.168.255.255
172.16.0.0 to 172.31.255.255
10.0.0.0 to 10.255.255.255
```

How does a system get an Ip Address in Private Network

Home network

- Typically we would have a wifi router ina home where a network range is predefined
- When a device is connected to a wifi via a network interface, DHCP program running in wifi router will assign an ip address to the network interface



- This ip can be used to communicate with the device.

Enterprise Network

- Typically every enterprise network has two servers
  - DHCP (Dynamic Host Configuration Protocol) Server:
    - Assign available ipaddress to the servers or devices
  - DNS (Domain Name System) Server
    - Maintain name to ip address mapping

Finding Network id and Host Id from Ipaddress

- On your laptop, execute the command ipconfig

```
PS C:\Users\Dell> ipconfig

Windows IP Configuration


Ethernet adapter vEthernet (New Virtual Switch):

   Connection-specific DNS Suffix  . :
   Link-local IPv6 Address . . . . . : fe80::fea0:7291:544:8d0d%2
   IPv4 Address. . . . . . . . . . . : 192.168.0.134
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 192.168.0.1
```

- We have the following information
  - ip address
  - Subnet mask

    - Default Gateway
- Generally Default Gateway is ipaddress of your router
- Lets find network id and host id

```
ip: 192.168.0.134
sm: 255.255.255.0
```

- Find out The octets where subnet mask has 255's and write ip value and whatever is left is host id

```
network id:  192.168.0
host id: 134
```

- Example 2

```
ip: 192.168.0.133
sm: 255.255.255.0
nid : 192.168.0  (Fixed )
hid : 133        (Variable  = 8 bits)
```

- Example 3

```
ip: 192.168.0.17
sm: 255.255.0.0

nid: 192.168
hid: 0.17      (Variable  = 16 bits)
```

- Example 4

```
ip: 10.0.0.16
sm: 255.0.0.0
nid: 10
hid: 0.0.16   (Variable  = 24 bits )
```

- IP Address are of two sizes
    - ip v4
    - ip v6
- IP v4: Is a 32 bit number divided into 4 octets

```
X.X.X.X
range:
```

```
0.0.0.0 to 255.255.255.255
```

Reference ipv4 vs ipv6

The differences between IPv4 and IPv6 are significant, reflecting the evolution of internet protocols to accommodate the growing number of devices and enhance security and efficiency. Here are the key distinctions:

Feature	IPv4 (Internet Protocol Version 4)	IPv6 (Internet Protocol Version 6)
Address Length	32 bits (approximately 4.3 billion addresses)	128 bits (approximately 340 undecillion addresses)
Address Format	Decimal notation (e.g., 192.168.1.1)	Hexadecimal notation (e.g., 2001:0db8:85a3:0000:0000:8a2e:0370:7334)
Header Size	Variable (20 to 60 bytes)	Fixed (40 bytes)
Checksum	Yes, includes a checksum field	No, does not include a checksum field
Fragmentation	Handled by both sender and routers	Handled only by the sender
Security	Security features are optional and rely on applications	Built-in security features (IPsec)
Address Configuration	Manual or DHCP	Stateless Address Autoconfiguration (SLAAC) and DHCPv6
Broadcast Support	Supports broadcast communication	Does not support broadcast; uses multicast and anycast
Routing Efficiency	Less efficient due to larger headers and routing tables	More efficient with simplified header structure
Mobile Device Support	Requires Mobile IP	Built-in support for mobile devices

Summary of Key Differences

1. **Address Space**: IPv4 has a limited address space, which has been exhausted due to the rapid growth of internet-connected devices. IPv6, with its vast address space, is designed to accommodate the future growth of the internet.
2. **Address Representation**: IPv4 addresses are represented in a dot-decimal format, while IPv6 addresses use hexadecimal notation separated by colons, allowing for a more compact representation.
3. **Header Complexity**: IPv4 headers can vary in size and include a checksum, making them more complex. In contrast, IPv6 has a fixed header size, simplifying processing and improving routing efficiency.

4. **Security Features**: IPv6 includes mandatory security features, whereas IPv4 relies on optional security measures that must be implemented at the application level.

5. **Fragmentation Handling**: In IPv4, both the sender and routers can fragment packets, while in IPv6, only the sender is responsible for fragmentation, which can lead to more efficient routing.

These differences highlight the advancements in IPv6 over IPv4, particularly in addressing, security, and efficiency, making IPv6 essential for the modern internet landscape[1][2][3][4].

Citations: [1] https://byjus.com/free-ias-prep/difference-between-ipv4-and-ipv6/ [2] https://aws.amazon.com/compare/the-difference-between-ipv4-and-ipv6/ [3] https://www.geeksforgeeks.org/differences-between-ipv4-and-ipv6/ [4] https://www.javatpoint.com/ipv4-vs-ipv6 [5] https://www.geeksforgeeks.org/software-engineering-integration-testing/ [6] https://www.youtube.com/watch?v=Ieib1_yRHxc