IPV4/IPV6 - IP Adressing Schemes

IPV4 addressing formats

IPv4 addresses can be written in the following formats:

- **Dotted Decimal Notation:** The most common representation of IPv4 addresses is in dotted decimal notation, where each octet is represented as a decimal number ranging from 0 to 255.

  For example: 192.168.0.1

- **Binary Notation**: In binary notation, each octet is represented by an 8-digit binary number.

  For example: 11000000.10101000.00000000.00000001

- **Hexadecimal Notation:** In hexadecimal notation, each octet is represented by a 2-digit hexadecimal number.

  For example: C0.A8.00.01

Subnet masks are also represented using the same dotted decimal notation, indicating which bits in the IPv4 address represent the network and host portions.

For example, a subnet mask of 255.255.255.0 means that the first three octets represent the network, and the last octet is used for host addresses within that network.

IPV6 addressing formats

IPv6 addresses can be written in the following formats:

- **Colon-Hexadecimal Notation:** This is the standard and most common representation of IPv6 addresses. Each set of four hexadecimal digits is separated by colons.

  For example: 2001:0db8:85a3:0000:0000:8a2e:0370:7334

- **Zero Compression:** When there are consecutive sets of zeroes, they can be compressed to ::. However, this can only be done once in an IPv6 address to avoid ambiguity.

  For example, 2001:0db8::8a2e:0370:7334

- **IPv4-Compatible IPv6 Address:** For backward compatibility, an IPv6 address can include an embedded IPv4 address. This is represented by appending the IPv4 address at the end, preceded by ::ffff:.

  For example: ::ffff:192.0.2.1 (represents IPv4 address 192.0.2.1)

- **IPv4-Mapped IPv6 Address:** Similar to the IPv4-compatible address, this notation is used to represent IPv4 addresses in the IPv6 format. It is represented by appending the IPv4 address at the end, preceded by ::ffff:, but with the last two sets of digits represented in decimal format.

  For example: ::ffff:192.0.2.1 (also represents IPv4 address 192.0.2.1)

IPV4 addressing schemes

IPv4 addressing schemes fall into three main categories:

1. **Public IP Addresses**: These are globally unique IP addresses assigned by the Internet Assigned Numbers Authority (IANA) to organizations, ISPs, and network operators. Public IP addresses are routable over the internet and are used to identify devices on public networks. Examples of public IP address ranges are:

   - Class A: 1.0.0.0 to 126.255.255.255
   - Class B: 128.0.0.0 to 191.255.255.255
   - Class C: 192.0.0.0 to 223.255.255.255

2. **Private IP Addresses:** These IP addresses are used within private networks, such as home networks, office intranets, or local area networks (LANs). Private IP addresses are not routable over the internet and are intended for internal use only. Devices with private IP addresses can access the internet through a router using NAT, which translates private IP addresses to a single public IP address. Examples of private IP address ranges are:

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

3. **Special Use IP Addresses:** These addresses are reserved for special purposes and should not be assigned to devices on a network. Examples include:

   - 127.0.0.1: Loopback address, used to test the network interface on the local device (localhost).
   - 0.0.0.0: Default route or "unspecified" address, used when a device doesn't know its IP address.

- 169.254.0.0 to 169.254.255.255: APIPA (Automatic Private IP Addressing) range, used when a device cannot obtain an IP address from a DHCP server.

IPV6 addressing schemes

- IPv6 uses 128-bit addresses, providing a vast number of unique addresses.
- **Global Unicast Addresses:** Equivalent to public IPv4 addresses, used for internet communication (2000::/3).
- **Link-Local Addresses:** Used for local network communication (fe80::/10).
- **Unique Local Addresses (ULA):** Equivalent to private IPv4 addresses, used for private networks (fc00::/7).
- **Multicast Addresses:** Used for sending packets to multiple devices simultaneously (ff00::/8).
- **Anycast Addresses:** Allow multiple devices to share the same address, routing packets to the nearest one.
- **Special Addresses**: Include loopback address (::1) and others with specific purposes.

RESERVED PORTS

- In networking, reserved ports, also known **as well-known ports**, are a range of port numbers that are typically assigned to specific services and protocols by the Internet Assigned Numbers Authority (IANA).
- These ports are commonly used by well-known and widely-used network applications to ensure consistency and **ease of communication** across different systems.
- The port numbers are **16-bit unsigned integers**, ranging from 0 to 65535. The reserved port range is generally from 0 to 1023, totalling 1024 ports**.**

APPLICATIONS THAT USE RESERVED PORTS

There are many applications that use reserved ports for their standard communication. Here are some examples of popular applications and the reserved ports they commonly use:

- **HTTP Server** (e.g., Apache, Nginx): Uses port 80 for regular HTTP communication and port 443 for encrypted HTTPS communication.
- **SSH** (Secure Shell): Uses port 22 for secure remote login and command execution.
- **FTP** (File Transfer Protocol): Uses ports 20 and 21 for data transfer and control respectively.
- **SMTP** (Simple Mail Transfer Protocol): Uses port 25 for email sending and routing.

- **DNS** (Domain Name System): Uses port 53 for domain name resolution.
- **POP3** (Post Office Protocol version 3): Uses port 110 for email retrieval.
- IMAP (Internet Message Access Protocol): Uses port 143 for email access and management.
- **HTTPS** (Hypertext Transfer Protocol Secure): Uses port 443 for encrypted HTTP communication.
- **RDP** (Remote Desktop Protocol): Uses port 3389 for remote desktop connections.
- **Telnet:** Uses port 23 for unencrypted remote terminal access.

THE FUTURE OF IP ADDRESSING

- **Vast Address Space:** IPv6 provides a 128-bit address space, allowing for an astronomically large number of unique IP addresses.

- **Address Allocation Efficiency:** With IPv6, address allocation is designed to be more efficient, reducing the need for techniques like Network Address Translation (NAT) used extensively in IPv4.

- **Internet of Things (IoT) Support:** The vast address space of IPv6 is particularly crucial for the Internet of Things, as it allows for virtually every connected device to have a unique IP address, enabling seamless communication and management of IoT devices.

- **Transition Mechanisms:** The transition from IPv4 to IPv6 is an ongoing process, as many legacy systems and networks still primarily use IPv4.

- **IPv4 Deprecation:** As IPv6 adoption continues to grow, there may be a gradual deprecation of IPv4. However, IPv4 will likely coexist with IPv6 for a considerable period due to its legacy infrastructure and extensive use.