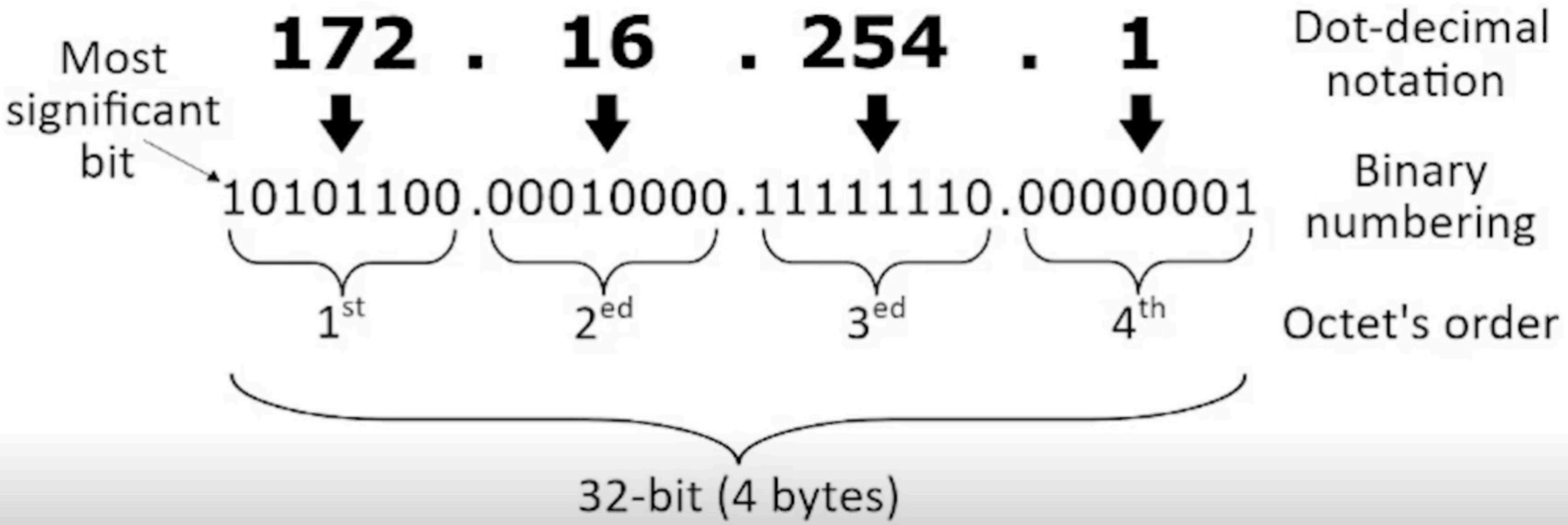
What is an IP Address?

- A unique numerical identifier assigned to each device connected to a network
- Facilitates communication between devices by providing identification and location information
- IPv4 and IPv6 are the two most common versions of IP addresses
- IPv4 addresses are 32-bit numbers, represented in dotted-decimal notation (e.g., 192.168.1.1)
- IPv6 addresses are 128-bit numbers, represented in colon-hexadecimal notation (e.g., 2001:0db8:85a3:0000:0000:8a2e:0370:7334)

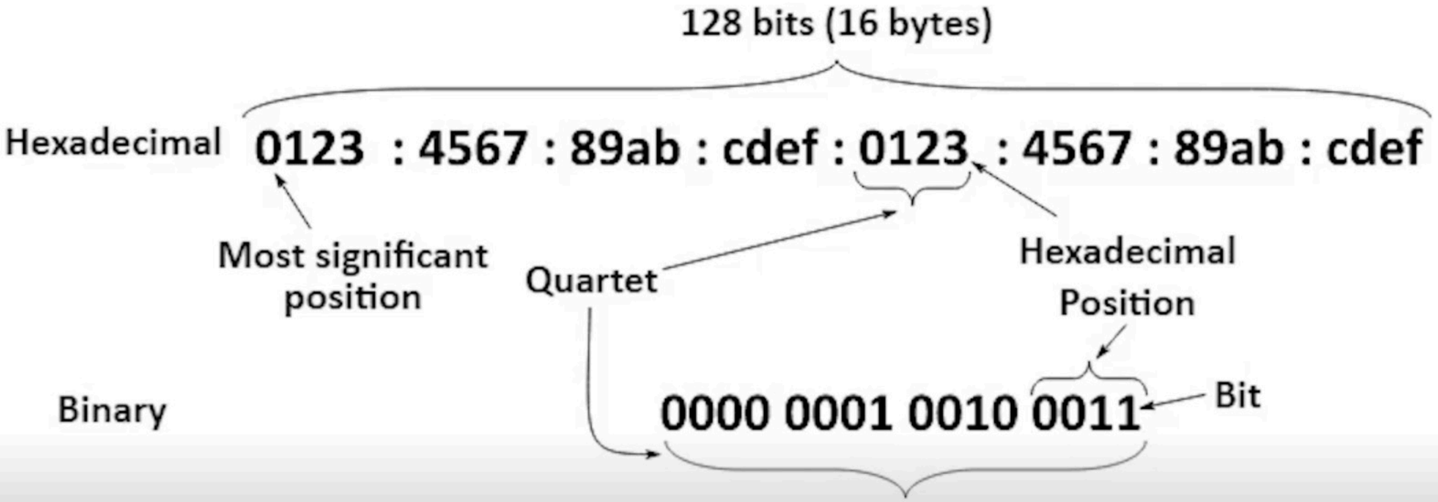
IPv4 Addressing

- Developed in the 1980s, IPv4 is a 32-bit address space
- Provides approximately 4.3 billion unique IP addresses
- IPv4 addresses consist of four sets of decimal numbers separated by periods (e.g., 192.168.1.1)
- IPv4 addresses are assigned using Dynamic Host Configuration Protocol (DHCP) or manually by a network administrator
- IPv4 address exhaustion is a significant concern due to the limited number of available addresses



IPv6 Addressing

- IPv6 is the most recent version of the Internet Protocol
- Utilizes a 128-bit address space, providing approximately 3.4 x 10^38 unique addresses
- IPv6 addresses consist of eight groups of four hexadecimal digits separated by colons (e.g., 2001:0db8:85a3:0000:0000:8a2e:0370:7334)
- Simplified address assignment and improved routing efficiency
- Enhanced security features, such as built-in support for Internet Protocol Security (IPsec)



Public IP Addresses

- Globally unique IP addresses assigned by an Internet Service Provider (ISP)
- Required for devices that need to be directly accessible from the Internet, such as web servers and email servers
- Typically dynamic, which can change periodically as ISPs may rotate IP addresses
- Some organizations may require static public IP addresses, which remain constant and are necessary for services that depend on a fixed IP address, such as remote access and certain online gaming applications

Private IP Addresses

- Reserved for use within private networks and are not routable over the Internet
- Used to facilitate communication between devices on a local network, such as a home or office network
- Assigned from specifically reserved IP address ranges, as defined by the Internet Assigned Numbers Authority (IANA)
- Three private IP address ranges:
  - Range 1: 10.0.0.0 - 10.255.255.255 (10.0.0.0/8)
  - Range 2: 172.16.0.0 - 172.31.255.255 (172.16.0.0/12)
  - Range 3: 192.168.0.0 - 192.168.255.255 (192.168.0.0/16)

Subnet Masks

- IP addresses contain two components: the network address and the host address
- Subnet masks separate the network and host portions of an IP address
- A subnet mask is a 32-bit number that uses binary 1s followed by binary 0s to separate the network and host portions

- **Examples:**
  - IP Address: 192.168.1.10
  - Subnet Mask: 255.255.255.0

- Performing a bitwise AND operation between the IP address and subnet mask results in the network address: 192.168.1.0

Network Classes

- In the past, IP addresses were divided into classes based on network size and number of hosts:
  - **Class A:** large networks with a subnet mask of 255.0.0.0
  - **Class B:** medium-sized networks with a subnet mask of 255.255.0.0
  - **Class C:** small networks with a subnet mask of 255.255.255.0

Problems With Network Classes

- Classful addressing led to inefficient use of IP address space

- It could only allocate fixed-sized network blocks, leading to waste of available addresses

Classless Inter-Domain Routing (CIDR)

- CIDR was developed to improve IP address allocation efficiency
- It allows for flexible allocation of addresses using variable-length subnet masks (VLSM)
- It matches network requirements better, avoids wastage of address space, and simplifies routing

Introduction to IP Address Configuration

- Configuring IP addresses on devices is an essential step in setting up a functional network

- There are two primary methods for IP address assignment:
  - Static IP Address
  - Dynamic IP Address

Static IP Address Assignment

- Manually configuring an IP address, subnet mask, and default gateway on a network device
- Typically used for devices that require a fixed IP address, such as servers or network infrastructure devices
- Access network settings and enter the necessary information, including IP address, subnet mask, default gateway, and DNS servers
- Chosen IP address must be within the same network range as other devices and should not conflict with any other assigned IP addresses

Dynamic IP Address Assignment

- Automatically assigns IP addresses to devices on a network using a DHCP server
- DHCP server manages a pool of available IP addresses and leases them to devices as they connect to the network
- Simplifies IP address management and reduces the risk of IP address conflicts

Dynamic IP Address Assignment (Cont.)

- Configured device sends a DHCP discover message to the network upon connecting
- DHCP server responds with a DHCP offer message containing an available IP address, subnet mask, default gateway, and other network configuration information
- Device sends a DHCP request message to the server indicating acceptance of the offered IP address
- Server sends a DHCP acknowledgment message to confirm the lease

Dynamic IP Address Assignment (Cont.)

- DHCP leases have a specified duration, called the lease time
- Devices attempt to renew their lease before it expires to maintain the same IP address
- If the lease expires or the device is disconnected from the network, the IP address returns to the available pool and can be reassigned to another device

TCP/IP Addressing Techniques

IPv4 — 4 bytes

class	leading bit	netid bytes	hostid bytes	no. of n/ws	range
A	0	1 — 8	3	$2^7 - 2$	0.0.0.0 – 127.255.255.255
B	10	2	2	2^{14}	128.0.0.0 – 191.255.255.255
C	110	3 — 3×8=24	1	2^{21}	192.0.0.0 – 223.255.255.255
D	1110	Multicasting		—	224.0.0.0 – 239.255.255.255
E	1111	Reserved for future		—	240.0.0.0 – 255.255.255.255

TCP/IP Addressing Techniques

IPv6 — 128 bits in contrast to 32 bits of IP v4.

→ Hexadecimal nos.

4 bits → 32 Hex nos.

_ 8 groups.

_ colon

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

→ 128 bits.

or 32 Hex

Unicasting — one to one

Anycasting — (S) → { } group

Multicasting →