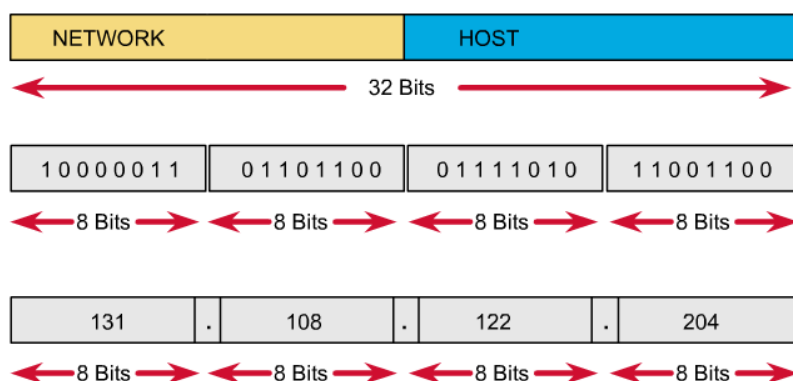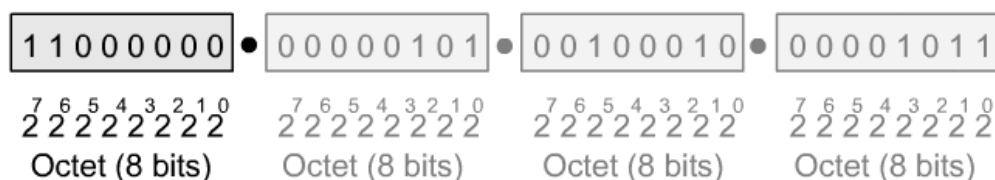# What is IP Address?

- **I**nternet **P**rotocol Address (or IP Address) is a unique address that computing devices used to identify itself and communicate with other devices in the Internet Protocol network.

- Any device connected to the IP network must have a unique IP address within its network.

- Most networks today, including all computers on the Internet, use the TCP/IP protocol as the standard for how to communicate on the network.

- In the TCP/IP protocol, the unique identifier for a computer is called its IP address.

- There are two standards for IP addresses: IP Version 4 (IPv4) and IP Version 6 (IPv6). All computers with IP addresses have an IPv4 address, and many are starting to use the new IPv6 address system as well.

- IPv4 uses 32 binary bits to create a single unique address on the network. An IPv4 address is expressed by four numbers separated by dots. Each number is the decimal (base-10) representation for an eight-digit binary (base-2) number, also called an octet. For example: 216.27.61.137

- IPv6 uses 128 binary bits to create a single unique address on the network. An IPv6 address is expressed by eight groups of hexadecimal (base-16) numbers separated by colons, as in 2001:cdba:0000:0000:0000:0000:3257:9652.

- IP addresses are not random. They are mathematically produced and allocated by the Internet Assigned Numbers Authority (IANA), a division of the Internet Corporation for Assigned Names and Numbers (ICANN). ICANN is a non-profit organization that was established in the United States in 1998 to help maintain the security of the internet and allow it to be usable by all. Each time anyone registers a domain on the internet, they go through a domain name registrar, who pays a small fee to ICANN to register the domain.
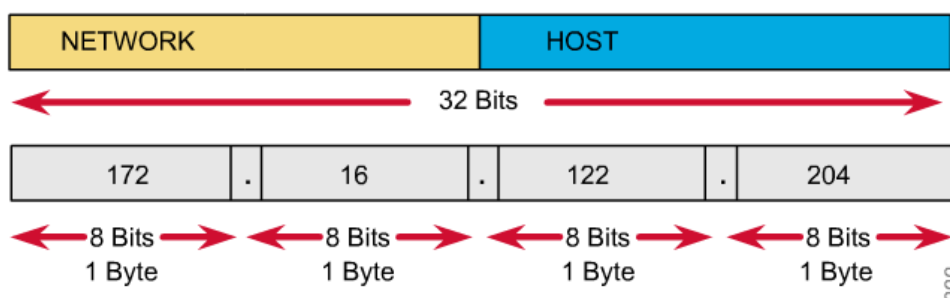
IP Addressing Format

NETWORK		HOST	
← 32 Bits →			

10000011	01101100	01111010	11001100
←8 Bits→	←8 Bits→	←8 Bits→	←8 Bits→

131	.	108	.	122	.	204
←8 Bits→		←8 Bits→		←8 Bits→		←8 Bits→

The 32bit binary address

11000000	•	00000101	•	00100010	•	00001011

$2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0$ $2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0$ $2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0$ $2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0$

Octet (8 bits)   Octet (8 bits)   Octet (8 bits)   Octet (8 bits)

IP address component fields

NETWORK		HOST	
← 32 Bits →			

172	.	16	.	122	.	204
←8 Bits→		←8 Bits→		←8 Bits→		←8 Bits→
1 Byte		1 Byte		1 Byte		1 Byte

The network number of an IP address identifies the network to which a device is attached. The host portion of an IP address identifies the specific device on that network. Because IP addresses consist of four octets

separated by dots, one, two, or three of these octets may be used to identify the network number.

IP Address classes

	1 Byte	1 Byte	1 Byte	1 Byte
	←8 Bits→	←8 Bits→	←8 Bits→	←8 Bits→
Class A:	N	H	H	H
Class B:	N	N	H	H
Class C:	N	N	N	H

Decimal to Binary conversion

192.57.30.224

11000000.00111001.00011110.11100000

Example:
Convert the first octet of 192.57.30.224 to a binary format.

$$128 \quad +64 \; +0 \; +0 \; +0 \; +0 \; +0 \; +0 = 192$$
$$2^7 \quad 2^6 \; 2^5 \; 2^4 \; 2^3 \; 2^2 \; 2^1 \; 2^0$$
$$1 \quad 1 \; 0 \; 0 \; 0 \; 0 \; 0 \; 0 = 11000000$$

Example:
Convert the first octet of the binary IP address 10101010.11111111.00000000.11001101 to a dotted decimal number.

$$1 \; 0 \; 1 \; 0 \; 1 \; 0 \; 1 \; 0$$
$$2^7 \; 2^6 \; 2^5 \; 2^4 \; 2^3 \; 2^2 \; 2^1 \; 2^0$$
$$128 \; 0 \; 32 \; 0 \; 8 \; 0 \; 2 \; 0 \; = 128 + 32 + 8 + 2 = 170$$

Classes of IP Addresses

Class A Blocks (1 to 127 range)

A class address block was designed to support extremely large networks with more than 16 million host addresses. Class A IPv4 addresses used a fixed /8 prefix with the first octet to indicate the network address. The remaining three octets were used for host addresses.

Class B Blocks (128 to 191 range)

Class B address space was designed to support the needs of moderate to large size networks with more than 65,000 hosts. A class B IP address used the two high-order octets to indicate the network address. The other two octets specified host addresses.

Class C Blocks (192 to 223 range)

The class C address space was the most commonly available of the historic address classes. This address space was intended to provide addresses for small networks with a maximum of 254 hosts.

Class D Address

Class D has IP address range from 224.0.0.0 to 239.255.255.255. Class D is reserved for Multicasting. In multicasting data is not destined for a particular host, that is why there is no need to extract host address from the IP address, and Class D does not have any subnet mask.

Class E Address

This IP Class is reserved for experimental purposes only for R&D or Study. IP addresses in this class ranges from 240.0.0.0 to 255.255.255.254. Like Class D, this class too is not equipped with any subnet mask.

Class	IP address range (1st Octet)	Network Mask	Prefix	Number of Networks	Number of Hosts
A	1. - 127.	255.0.0.0	/8	125	16,777,214
B	128. - 191.	255.255.0.0	/16	16,382	65,534
C	192. - 223.	255.255.255.0	/24	2,097,150	254
D	224. - 239.	Multicast addresses			
E	240. - 254.	Restricted/Experimental			
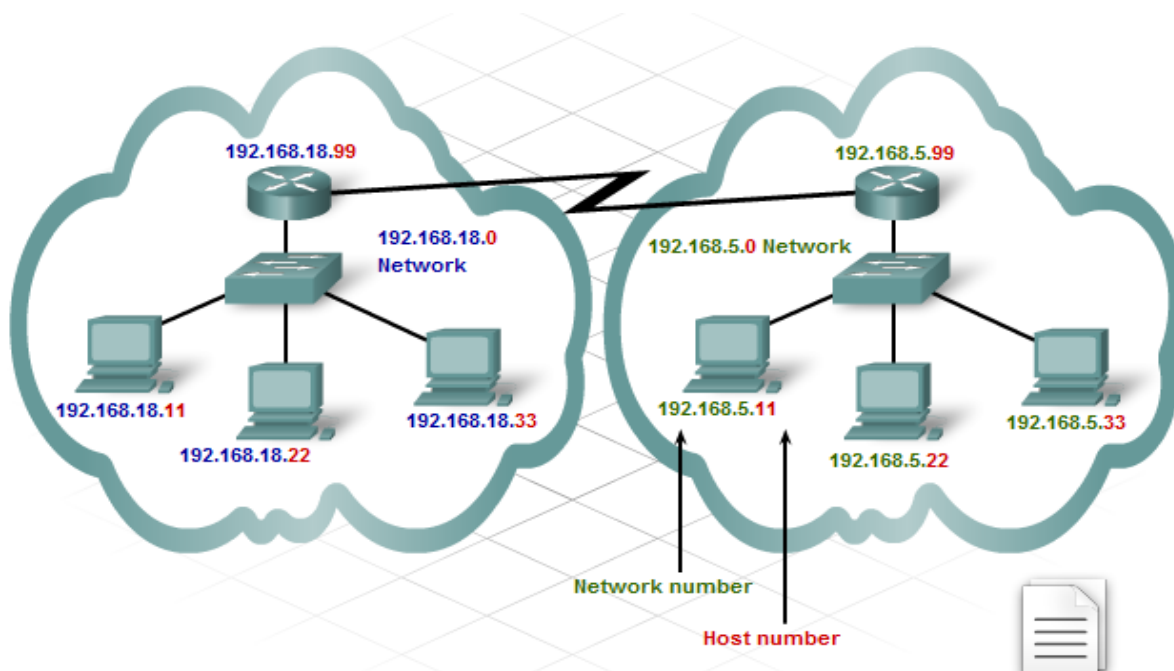
Types of IP addresses

Private IP Address

A private IP address is the address of your device connected on the home or business network. If you have a few different devices connected to one ISP (Internet Service Provider), then all your devices will have a unique private IP address. This IP address cannot be accessed from devices outside your home or business network.

For example: 192.168.1.1

Public IP Address

Your public IP address is the main IP address to which your home or business network is connected. This IP address connects you to the world, and it's unique for all users.

Static and Dynamic IP Addresses

All private and public IP addresses can be either static or dynamic. IP addresses that you configure manually and fix them to the network of your device are called static IP addresses. Static IP addresses cannot change automatically.

The dynamic IP addresses configure automatically and assign an IP to your network when you set up the router with internet. This distribution of IP addresses is managed by Dynamic Host Configuration Protocol (DHCP).

DHCP can be your internet router that assigns an IP address to your network in your home or business environment.

Dynamic IP addresses are issued using a leasing system, meaning that the IP address is only active for a limited time. If the lease expires, the computer will automatically request a new lease.

Subnet Mask

A subnet mask or masks the network part of a system's IP address and leaves only the host part as the machine identifier. It uses the same format as an IPv4 address — four sections of one to three numbers, separated by dots. Each section of the subnet mask can contain a number from 0 to 255, just like an IP address. For example, a typical subnet mask for a Class C IP address is:

255.255.255.0

MAC Addressing

Every computer has a unique way of identifying itself. Each computer, whether it is attached to a network or not, has a physical address.

No two physical addresses are ever alike. Referred to as the Media Access Control address (or MAC address), the physical address is located on the Network Interface Card (NIC).

Before it leaves the factory, the hardware manufacturer assigns a physical address to each NIC. This address is programmed into a chip on the NIC.

MAC addresses are written using hexadecimal (Base 16) numbers. There are two formats for MAC addresses:

0000.0c12.3456 or 00-00-0c-12-34-56