IP Address

IP addresses are unique numerical identifiers assigned to devices connecting to the internet, facilitating communication between them. This 32-bit binary number is represented in decimal format for human readability.

An IP address is divided into four octets (e.g., 192.168.0.1), each representing a binary number ranging from 0 to 255. These octets compose two parts: the network portion and the host portion, determined by the subnet mask.

Difference between IPv4 and IPv6

IPv6 was invented primarily to address the limitations of IPv4 and to accommodate the growing number of devices connecting to the internet.

IPv4 offering about 4.3 billion unique addresses, shown in decimal format as four groups of numbers. IPv6 addresses utilize 128 bits, providing 340 undecillion unique addresses, presented in hexadecimal format as eight groups of four digits.

Classes of IP addresses:

Class	IP Range
A	0.0.0.0 – 127.255.255.255
B	128.0.0.0 – 191.255.255.255
C	192.0.0.0 – 223.255.255.255
D	224.0.0.0 – 239.255.255.255
E	240.0.0.0 – 255.255.255.255

The five classes of IP addresses, Class A through E, are categorized based on the range of addresses and their intended purposes. The first octet of an IP address determines its class:

- **Class A:**
  - Range: 0--- (0.0.0.0 to 127.255.255.255).
  - The first bit is "0".
  - Supports up to 126 networks, each with up to 16,777,214 hosts.
- **Class B:**
  - Range: 10-- (128.0.0.0 to 191.255.255.255).
  - The first bit is "1" and the second bit is "0".
  - Allows for up to 16,384 networks, each with up to 65,534 hosts.

- **Class C:**
  - Range: 110- (192.0.0.0 to 223.255.255.255).
  - The first two bits are "1" and the third bit is "0".
  - Supports up to 2,097,152 networks, each with up to 254 hosts.
- **Class D:**
  - Range: 1110 (224.0.0.0 to 239.255.255.255).
  - The first three bits are "1" and the fourth bit is "0".
  - Used for multicasting, not for network addressing.
- **Class E:**
  - Range: 1111 (240.0.0.0 to 255.255.255.255).
  - The first four bits are "1".
  - Reserved for experimental purposes, not for general networking.

Each class has a specific range of addresses and serves different purposes, from addressing individual hosts to multicast groups and experimental use.

The traditional division of IPv4 address space into classes (A, B, and C) was initially designed to accommodate networks of varying sizes. However, this class-based approach has become outdated, primarily due to the rapid depletion of IPv4 addresses. As a result, more flexible allocation methods like CIDR have been adopted, rendering classful addressing a legacy concept.

Public IP address - assigned by IANA and allocated to ISPs and organizations, are globally unique and routable on the internet.

The public IP address range - five classes:

- **Class A:**
  - 1.0.0.0 to 9.255.255.255
  - 11.0.0.0 to 126.255.255.255
- **Class B:**
  - 128.0.0.0 to 172.15.255.255
  - 172.32.0.0 to 191.255.255.255
- **Class C:**
  - 192.0.0.0 to 192.167.255.255
  - 192.169.0.0 to 223.255.255.255

Private IP address - designated for internal networks and non-routable on the internet, are assigned by network administrators.

The private IP address range - three classes:

- **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

Netmasks and Subnets

- **Subnetting:** Dividing a network into smaller sections to enhance efficiency and management.
- **Netmask**: Specifies the number of bits used for the network portion of an IP address.
- **Subnet mask**: Another netmask used to further divide a network into smaller subsections, allowing for finer segmentation and resource management.

CIDR Notation

CIDR (Classless Inter-Domain Routing) notation expresses the division between network and host portions of an IP address. It uses a forward slash followed by a number to denote the number of network bits. A higher number indicates fewer available host addresses.

Loopback Address

The class A network 127.0.0.0 (CIDR notation 127.0.0.0/8) is reserved for loopback. IP packets with source addresses in this network should never leave a host. Any packets received on a non-loopback interface with a loopback source or destination address should be discarded.

Gateway IP

A gateway IP is the address of the router connecting a local network to external networks like the internet, acting as the entry and exit point for network traffic. Typically, it's the first usable address in a subnet, obtained by setting the host portion to zeros in the network address.

Example: For the IP address 10.0.0.0/24, the network portion is "10.0.0," and the host portion is "0." Therefore, the gateway IP for this subnet is 10.0.0.1.

Broadcast IP

A broadcast IP address sends data to all devices in a subnet and is the highest address in that subnet. To find it, set all bits in the host portion to ones while keeping the network portion unchanged.

Example: In subnet 10.0.0.0/24, with network portion "10.0.0.," the broadcast IP is 10.0.0.255.

Host Calculation

To calculate the number of hosts that can be assigned to a network, use the following formula:

Number of Hosts=2^(Number of Host Bits)−2

Where:

- Number of Host Bits = Total bits in the host portion of the IP address.

Remember to subtract 2 from the result to account for the network address (all zeros) and the broadcast address (all ones), which cannot be assigned to hosts.

For example, in a network with a subnet mask of /24 or 255.255.255.0 (which means there are 24 bits allocated for the network portion), leaving 8 bits for the host portion:

Number of Hosts=2^8−2=256−2=254

So, 254 hosts can be assigned to this network.

Calculate Network Address and Broadcast Address

To calculate the network address:

1. Write the given IP address and subnet mask in binary format.
2. Perform a logical AND operation between corresponding octets of the IP address and subnet mask.
3. Convert the result back to decimal format; this is the network address.

To calculate the broadcast address:

1. Write the given IP address in binary format.
2. Write the inverse of the subnet mask in binary form.
3. Perform a logical OR operation between corresponding octets of the IP address and the inverse of the subnet mask.

Example - IP address 192.168.5.50 with a subnet mask of /28(255.255.255.240)

Network Address

IP Address in Decimal notation	192	168	5	50
Binary equivalent IP address(A)	11000000	10101000	00000101	00110010
Binary equivalent Subnet mask(B)	11111111	11111111	11111111	11110000
A AND B	11000000	10101000	00000101	00110000
Network Address	192	168	5	48

Broadcast Address

IP Address in Decimal notation	192	168	5	50
Binary equivalent IP address(A)	11000000	10101000	00000101	00110010
Inverse of Subnet mask(B)	00000000	00000000	00000000	00001111
A OR B	11000000	10101000	00000101	00111111
Broadcast Address	192	168	5	63

Subnet Mask Values

CIDR	SUBNET MASK	Number of IP ADDRESSES	Number of USABLE IP ADDRESSES
/32	255.255.255.255	1	1
/31	255.255.255.254	2	2*
/30	255.255.255.252	4	2
/29	255.255.255.248	8	6
/28	255.255.255.240	16	14
/27	255.255.255.224	32	30
/26	255.255.255.192	64	62
/25	255.255.255.128	128	126
/24	255.255.255.0	256	254
/23	255.255.254.0	512	510
/22	255.255.252.0	1,024	1,022
/21	255.255.248.0	2,048	2,046
/20	255.255.240.0	4,096	4,094
/19	255.255.224.0	8,192	8,190
/18	255.255.192.0	16,384	16,382
/17	255.255.128.0	32,768	32,766
/16	255.255.0.0	65,536	65,534

Subnet Mask Values

CIDR	SUBNET MASK	Number of IP ADDRESSES	Number of USABLE IP ADDRESSES
/15	255.254.0.0	131,072	131,070
/14	255.252.0.0	262,144	262,142
/13	255.248.0.0	524,288	524,286
/12	255.240.0.0	1,048,576	1,048,574
/11	255.224.0.0	2,097,152	2,097,150
/10	255.192.0.0	4,194,304	4,194,302
/9	255.128.0.0	8,388,608	8,388,606
/8	255.0.0.0	16,777,216	16,777,214
/7	254.0.0.0	33,554,432	33,554,430
/6	252.0.0.0	67,108,864	67,108,862
/5	248.0.0.0	134,217,728	134,217,726
/4	240.0.0.0	268,435,456	268,435,454
/3	224.0.0.0	536,870,912	536,870,910
/2	192.0.0.0	1,073,741,824	1,073,741,822
/1	128.0.0.0	2,147,483,648	2,147,483,646
/0	0.0.0.0	4,294,967,296	4,294,967,294