IP Address in Networking

## Classes of IP Address

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November 5, 2020

IP Address in Networking

- In networking,
  - IP Address is short for Internet Protocol Address.
  - It is a unique address assigned to each computing device in an IP network.
  - ISP assigns IP Address to all the devices present on its network.
  - Computing devices use IP Address to identify and communicate with other devices in the IP network.
- Types Of IP Address
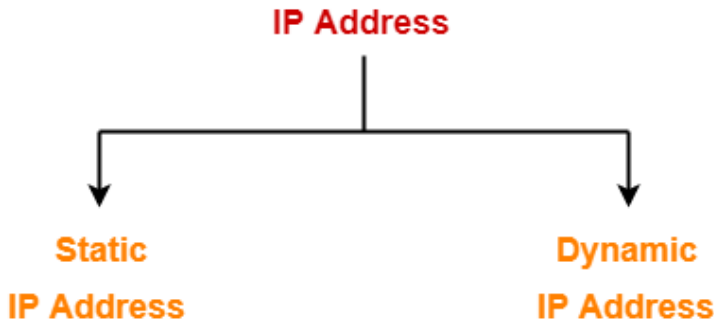
Static IP Address & Dynamic IP Address

- **Static IP address**
  - Static IP Address is an IP Address that once assigned to a network element always remains the same.
  - They are configured manually.
    - Some ISPs do not provide static IP addresses.
    - Static IP Addresses are more costly than dynamic IP Addresses.
- **Dynamic IP Address**
  - Dynamic IP Address is a temporarily assigned IP Address to a network element.
  - It can be assigned to a different device if it is not in use.
  - DHCP or PPPoE assigns dynamic IP addresses.

IP Address Format

- IP Address is a 32 bit binary address written as 4 numbers separated by dots.
- The 4 numbers are called as octets where each octet has 8 bits.
- The octets are divided into 2 components- Net ID and Host ID.
- **Network ID** represents the IP Address of the network and is used to identify the network.
- **Host ID** represents the IP Address of the host and is used to identify the host within the network.
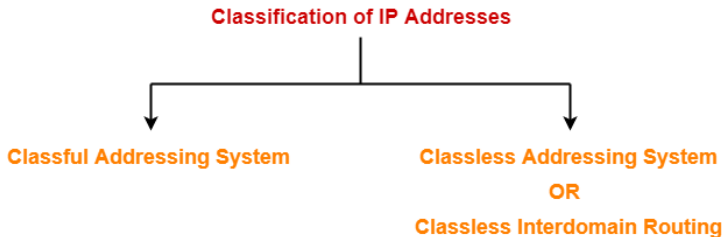
32 bits

| Net ID	Host ID
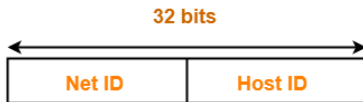
Format of an IP Address

IP Address Example

- Example of an IP Address is-
  - 00000001.10100000.00001010.11110000
    (Binary Representation)
    OR
   1.160.10.240 (Decimal Representation)
  - **IP Addressing**

Classification of IP Addresses

Classful Addressing System

Classless Addressing System

OR

Classless Interdomain Routing

Classful Addressing

- In Classful Addressing System, IP Addresses are organized into following 5 classes-

Classes of an IP Address

Class A	Class B	Class C	Class D	Class E
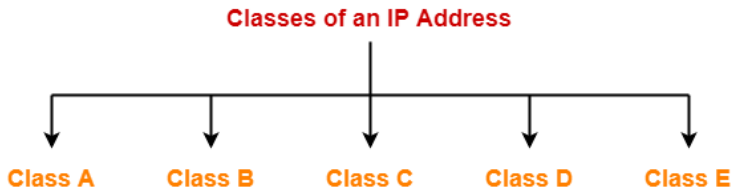
- **Class A:** If the 32 bit binary address starts with a bit 0, then IP Address belongs to class A.
  - In class A IP Address,
    - The first 8 bits are used for the Network ID.
    - The remaining 24 bits are used for the Host ID.

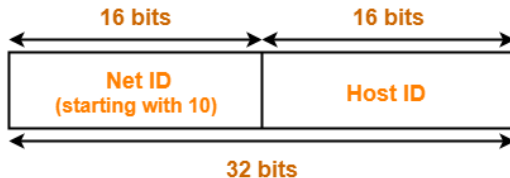| 8 bits	24 bits
Net ID (starting with 0)	Host ID

32 bits
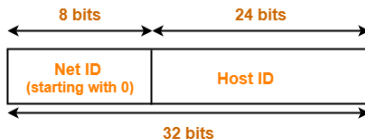
Class A IP Address

Total Number Of IP Addresses

- Total number of IP Addresses available in class A
  - = Numbers possible due to remaining available 31 bits
  - = 2^{31}
  - **Total Number Of Networks**-
    - Total number of networks available in class A
    - = Numbers possible due to remaining available 7 bits in the Net ID 2
    - = 2^7- 2 = 126
  - **Total Number Of Hosts**-
    - Total number of hosts that can be configured in class A
    - = Numbers possible due to available 24 bits in the Host ID 2
    - = 2^{24}-2
- **Range Of 1st Octet**-
  - Minimum value of 1st octet = 00000000 = 0
  - Maximum value of 1st octet = 01111111 = 127
  - we have
    - Range of 1st octet = [0, 127]
    - But 2 networks are reserved and unused.
    - So, Range of 1st octet = [1, 126]

Class B

- If the 32 bit binary address starts with bits 10, then IP Address belongs to class B.
  - The first 16 bits are used for the Network ID.
  - The remaining 16 bits are used for the Host ID.

Class B IP Address

- **Total Number Of IP Addresses-**
  - Total number of IP Addresses available in class B
  - = Numbers possible due to remaining available 30 bits
  - = 2^{30}

Class B Cont...

- **Total Number Of Networks**
  - Total number of networks available in class B
  - = Numbers possible due to remaining available 14 bits in the Net ID
  - $= 2^{14}$
- **Total Number Of Hosts**-
  - Total number of hosts that can be configured in class B
  - = Numbers possible due to available 16 bits in the Host ID-2
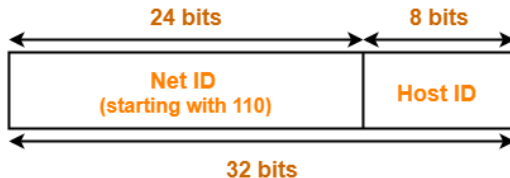 - $= 2^{16}$-2
- **Range Of 1st Octet**-
  - We have-
    - Minimum value of 1st octet = 10000000 = 128
    - Maximum value of 1st octet = 10111111 = 191
    - **Range of 1st octet = [128, 191]**

Class C-

- If the 32 bit binary address starts with bits 110, then IP Address belongs to class C.
  - In class C IP Address
    - The first 24 bits are used for the Network ID.
    - The remaining 8 bits are used for the Host ID.

Class C IP Address

- **Total Number Of IP Addresses**
  - Total number of IP Addresses available in class C
  - = Numbers possible due to remaining available 29 bits
  - $= 2^{29}$

Class C Cont...

- **Total Number Of Networks**-
  - Total number of networks available in class C
  - = Numbers possible due to remaining available 21 bits in the Net ID
  - = 2^{21}
- **Total Number Of Hosts**-
  - Total number of hosts that can be configured in class C
  - = Numbers possible due to available 8 bits in the Host ID 2
  - = 2^8 - 2
- **Range Of 1st Octet**-
  - We have-
    - Minimum value of 1st octet = 11000000 = 192
    - Maximum value of 1st octet = 110111111 = 223
    - **Range of 1st octet = [192, 223]**

Class D

- If the 32 bit binary address starts with bits 1110, then IP Address belongs to class D.
- Class D is not divided into Network ID and Host ID

IP Address
(starting with 1110)

32 bits

Class D IP Address

- **Total Number Of IP Addresses**
  - Total number of IP Addresses available in class D
  - $=$ Numbers possible due to remaining available 28 bits
  - $= 2^{28}$
- **Range Of 1st Octet-**
  - Minimum value of 1st octet $= 11100000 = 224$
  - Maximum value of 1st octet $= 11101111 = 239$
  - Range of 1st octet $= [224, 239]$

Class D Cont...

- Class D is reserved for multicasting.
- In multicasting, there is no need to extract host address from the IP Address.
- This is because data is not destined for a particular host.
- **Class E**
  - If the 32 bit binary address starts with bits 1111, then IP Address belongs to class E.
  - Class E is not divided into Network ID and Host ID.

IP Address
(starting with 1111)

32 bits

Class E IP Address

Class E Cont...

- **Total Number Of IP Addresses-**
  - Total number of IP Addresses available in class E
  - $=$ Numbers possible due to remaining available 28 bits
  - $= 2^{28}$
- **Range Of 1st Octet-**
  - Minimum value of 1st octet $= 11110000 = 240$
  - Maximum value of 1st octet $= 11111111 = 255$
  - Range of 1st octet $= [240, 255]$
- **Class E is reserved for future or experimental purposes.**

Classes of IP Address-

- All the classes of IP Address are summarized in the following table-

Class of IP Address	Total Number of IP Addresses	1st Octet Decimal Range	Number of Networks available	Hosts per network	Default Subnet Mask
Class A	2^{31}	1 – 126	$2^7 - 2$	$2^{24} - 2$	255.0.0.0
Class B	2^{30}	128 – 191	2^{14}	$2^{16} - 2$	255.255.0.0
Class C	2^{29}	192 – 223	2^{21}	$2^8 - 2$	255.255.255.0
Class D	2^{28}	224 – 239	Not defined	Not defined	Not defined
Class E	2^{28}	240 – 254	Not defined	Not defined	Not defined

Important Notes

- Notes:
  - All the hosts in a single network always have the same network ID but different Host ID.
  - However, two hosts in two different networks can have the same host ID.
  - A single network interface can be associated with more than one IP Address.
  - There is no relation between MAC Address and IP Address of a host.
  - IP Address of the network called Net ID is obtained by setting all the bits for Host ID to zero.
  - Class A Networks accounts for half of the total available IP Addresses.
  - In class A, total number of IP Addresses available for networks are 2 less.
    - This is to account for the two reserved network IP Addresses 0.xxx.xxx.xxx and 127.xxx.xxx.xxx.
    - IP Address 0.0.0.0 is reserved for broadcasting requirements.
    - IP Address 127.0.0.1 is reserved for loopback address used for software testing.

Important Notes

- In all the classes, total number of hosts that can be configured are 2 less.
    - This is to account for the two reserved IP addresses in which all the bits for host ID are either zero or one.
    - When all Host ID bits are 0, it represents the Network ID for the network.
    - When all Host ID bits are 1, it represents the Broadcast Address.
- Only those devices which have the network layer will have IP Address.
- So, switches, hubs and repeaters does not have any IP Address.

Casting in Networking

- Transmitting data (stream of packets) over the network is termed as casting.

Types of casting

Unicast   Broadcast   Multicast

Limited Broadcast   Direct Broadcast
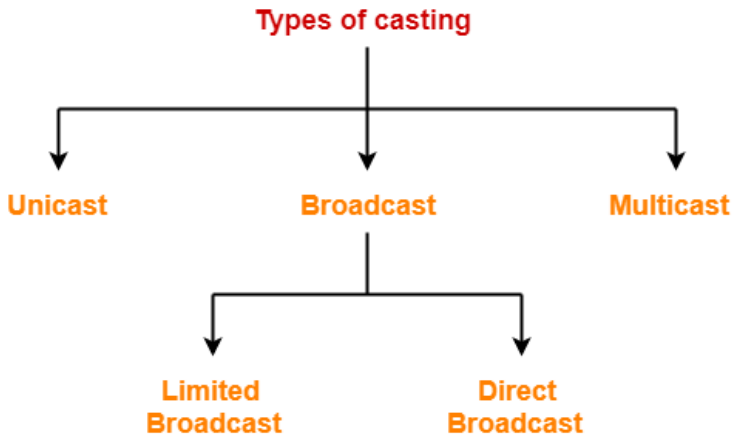
Casting in Networking Cont...

- **Unicast**
  - Transmitting data from one source host to one destination host is called as unicast.
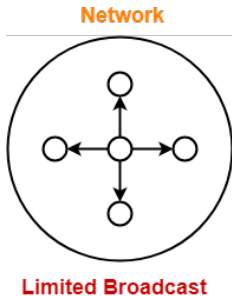 - It is a one to one transmission.

Unicast
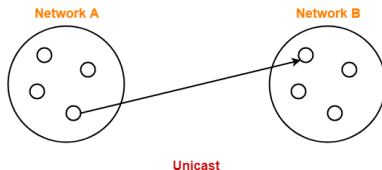
- Host A having IP Address 11.1.2.3 sending data to host B having IP Address 20.12.4.2.
    - Source Address = IP Address of host A = 11.1.2.3
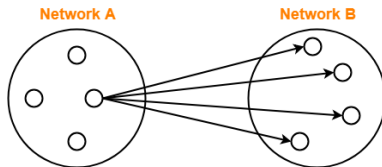   - Destination Address = IP Address of host B = 20.12.4.2

Broadcast

- Transmitting data from one source host to all other hosts residing in the same or other network is called as broadcast.
- It is a one to all transmission.
- Based on recipients network, it is classified as-
    1. Limited Broadcast
    2. Direct Broadcast
- **Limited Broadcast**
    - Transmitting data from one source host to all other hosts residing in the same network is called as limited broadcast.

Network

Limited Broadcast

Broadcast Cont...

- Limited Broadcast Address for any network
  1. = All 32 bits set to 1
  2. = 11111111.11111111.11111111.11111111
  3. = 255.255.255.255
- Host A having IP Address 11.1.2.3 sending data to all other hosts residing in the same network.
  - Source Address = IP Address of host A = 11.1.2.3
  - Destination Address = 255.255.255.255
- **Direct Broadcast-**
  - Transmitting data from one source host to all other hosts residing in some other network is called as direct broadcast.

Direct Broadcast

Broadcast cont...

- Direct Broadcast Address for any network is the IP Address where-
  - Network ID is the IP Address of the network where all the destination hosts are present.
  - Host ID bits are all set to 1.
- Host A having IP Address 11.1.2.3 sending data to all other hosts residing in the network having IP Address 20.0.0.0
  - Source Address = IP Address of host A = 11.1.2.3
  - Destination Address = 20.255.255.255
- **Multicast**
  - Transmitting data from one source host to a particular group of hosts having interest in receiving the data is called as multicast.
  - It is a one to many transmission.

Network A   Network B
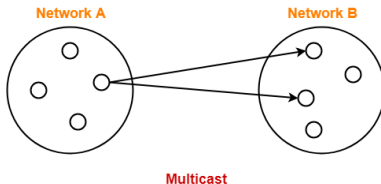
Multicast

Multicast cont...

- **Example**
  - Sending a message to a particular group of people on whatsapp
  - Sending an email to a particular group of people
  - Video conference or teleconference
- **MAC Address Vs IP Address**-

MAC Address	IP Address
It stands for Media Access Control Address.	It stands for Internet Protocol Address.
MAC Address identifies the physical address of a computer on the internet.	IP Address identifies the connection of a computer on the internet.
Manufacturer of NIC card assigns the MAC Address.	Network Administrator or ISP assigns the IP Address.
Reverse Address Resolution Protocol (RARP) is used for resolving physical (MAC) Address into IP address.	Address Resolution Protocol (ARP) is used for resolving IP Address into physical (MAC) address.

- Multicast makes use of IGMP (Internet Group Management Protocol) to identify its group.
- Each group is assigned with an IP Address from class D of IPv4.

Thank You