R&D Document

IP Addressing and Subnetting IPv4 & IPv6

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IP Address

The Internet Protocol addresses are 32 bits in length; this gives us a maximum of 232 addresses. These addresses are referred to as IPv4 (IP version 4) addresses or simply IP addresses if there is no confusion.

This means that, theoretically, if there were no restrictions, more than 4 billion (4,29,49,67,296) dr could be connected to the Internet. The actual number is much less because of the restrictions in on the addresses.

World population is often used to refer to the total number of humans currently living, and was estimated to have exceeded 7.9 billion as of November 2021.

The need for more addresses, in addition to other concerns about the IP layer, motivated a new design of the IP layer called the new generation of IP or IPv6 (IP version 6). In this version, the Internet uses 128-bit addresses that give much greater flexibility in address allocation (3.4*1038). These addresses are referred to as IPv6 (IP version 6) addresses.

Unique and Universal

An IP address is uniquely and universally defining the connection of a host or a router to the Internet.

They are unique in the sense that each address defines one, and only one, connection to the Internet.

Two devices on the Internet can never have the same address at the same time.

• The IPv4 addresses are universal in the sense that the addressing system must be accepted by any host that wants to be connected to the Internet.

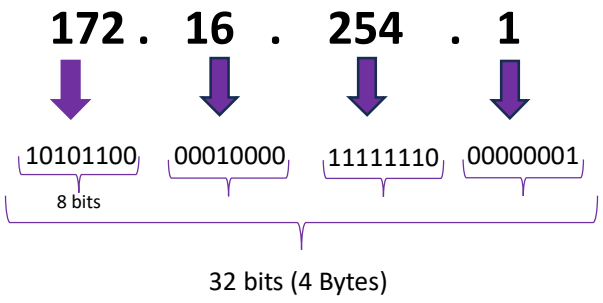
• The IP address is the address of the connection, not the host or the router, because if the device is moved to another network, the IP address may be changed.

Binary Notation Vs Dotted Decimal Notation

There are two prevalent notations to show an IPv4 address: Binary notation and Dotted decimal notation.

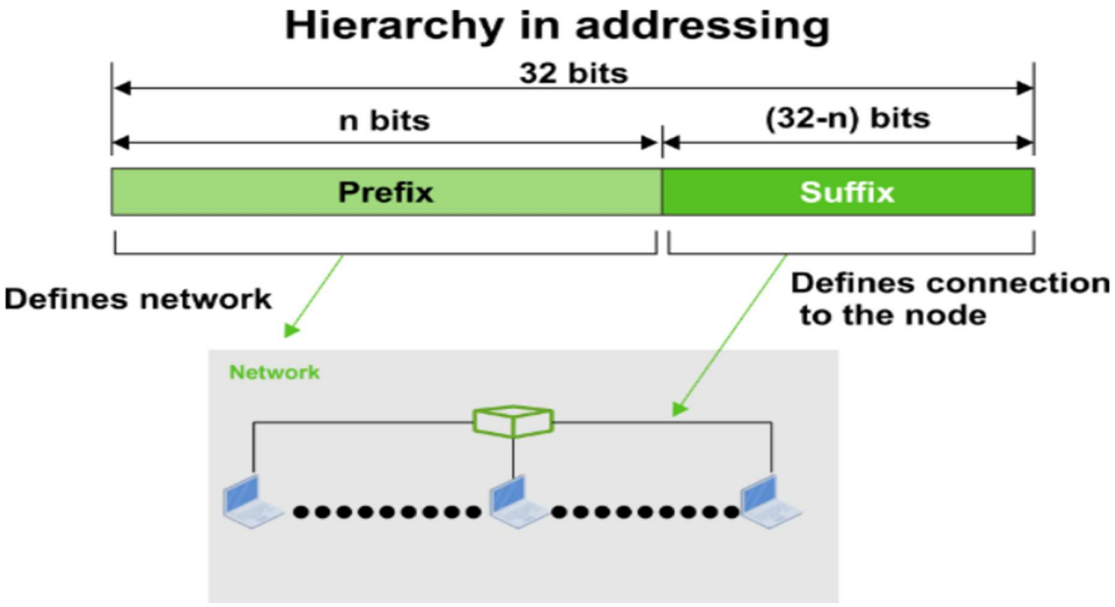
- **Binary Notation** - In binary notation, the IPv4 address is displayed as 32 bits. Each octet is often referred to as a byte. So, it is common to hear an IPv4 address referred to as a 32-bit address or a 4-byte address. An example of an IPv4 address in binary notation: 01110101 10010101 00011101 00000010
- **Dotted-Decimal Notation** - To make the IPv4 address more-compact and easier to read, Internet addresses are usually written in decimal form with a decimal point (dot) separating the bytes. The following is the dotted decimal notation of the above address:117.149.29.2

IPv4 address in dotted-decimal notation.



Classful Addressing

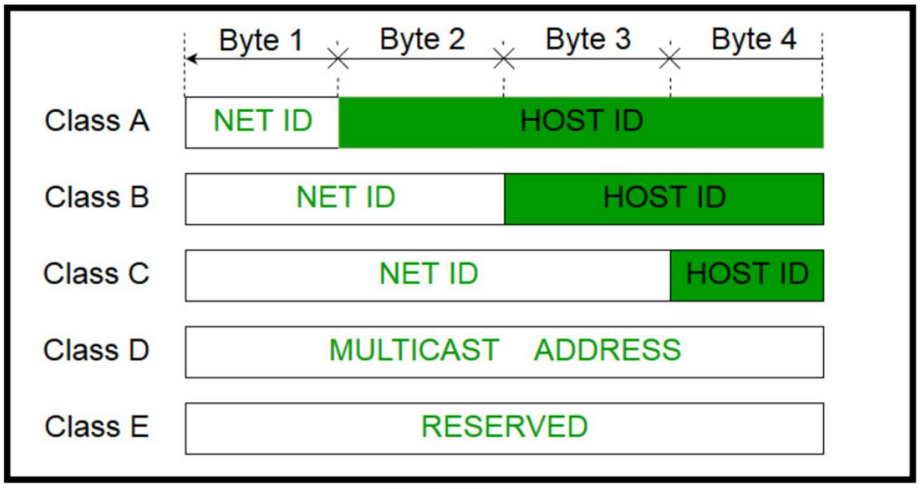
- IPv4 addressing, at its inception, used the concept of classes. This architecture is called classful addressing.
- A 32-bit IPv4 address is hierarchical and divided only into two parts:
- The first part of the address, called the prefix, defines the network (NetworkID).
- The second part of the address, called the suffix, defines the node (connection of a device to the Internet (HostID)).



IPv4 was first designed as a fixed-length prefix and is referred to as classful addressing

In classful addressing, the address space is divided into five classes: A, B, C, D, and E. Each class occupies some part of the address space.

To accommodate both small and large networks, three fixed-length prefixes were designed (n = 8, n = 16, and n = 24).



Classful Addressing

Class A

- In Class A NetID = 8 bits and HostID = 24.
- How to identify class A address
    - First bit is reversed to 0 in binary notation.
    - Range of 1st octet is [0,127] in dotted decimal notation.
- Total number of connections in class A is 2^31 (2,14,74,83,648) There are 27 -2 = 126 networks in Class A network.
- In Class A, total network available are 2 less, because:
    - 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.
    - The range of 1st octet is [0, 127] but since two addresses are reserved it is: [1, 126].
    - There are 2242 (1,67,77,214) HostID in Class A.
- In all the classes, total number of hosts that can be configured are 2 less because:
- 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 D bits are 0, it represents the Network ID for the network.
- When all Host ID bits are 1, it represents the Broadcast Address.
- Class A is used by organizations requiring very large size networks like Indian Railways.

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Class A Networks

Bits Count	8 Bits	8 Bits	8 Bits	8 Bits
Network Part / Host Part	Network	Host	Host	Host
Subnet Mask in Decimals	255	0	0	0
Subnet Mask in Binaries	11111111	00000000	00000000	00000000

Class B

- In Class B NetID = 16 bits and Hs 16.
- How to identify class B address
    - First two bits are reserved to 10 in binary notation
    - Range of 1st octet is [128, 191] in dotted decimal notation
- Total number of connections in class B is 2^30 (1,07,37,41,824).
- Total number of networks available in class B is 2^14 (16,384).
- Total number of hosts that can be configured in every network in class B is 2^16 - 2(65,534).
- Class B is used by organizations requiring medium size networks.

Bits Count	8 Bits	8 Bits	8 Bits	8 Bits
Network Part / Host Part	Network	Network	Host	Host
Subnet Mask in Decimals	255	255	0	0
Subnet Mask in Binaries	11111111	11111111	00000000	00000000

Class C

- In Class C NetID = 24 bits and HS 8.
- How to identify class C address
    - First three bits are reserved to 110 in binary notation
    - Range of 1st octet is [192, 223] in dotted decimal notation
- Total number of connections in class C is 229 (53,68,70,912)
- Total number of networks available in class C is 221 (20,97,152)
- Total number of hosts that can be configured in every network in class C is 28
- (254)
- Class C is used by organizations requiring small to medium size networks.

Class C Networks

Bits Count	8 Bits	8 Bits	8 Bits	8 Bits
Network Part / Host Part	Network	Network	Network	Host
Subnet Mask in Decimals	255	255	255	0
Subnet Mask in Binaries	11111111	11111111	11111111	00000000

Class D

- Class D is not divided into Network ID and Host ID.
- How to identify class D address
    - First four bits are reserved to 1110 in binary notation
    - Range of 1st octet is [224, 239] in dotted decimal notation
- Total number of IP Addresses available in class D = 2^28 (26,84,35,456)
- 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

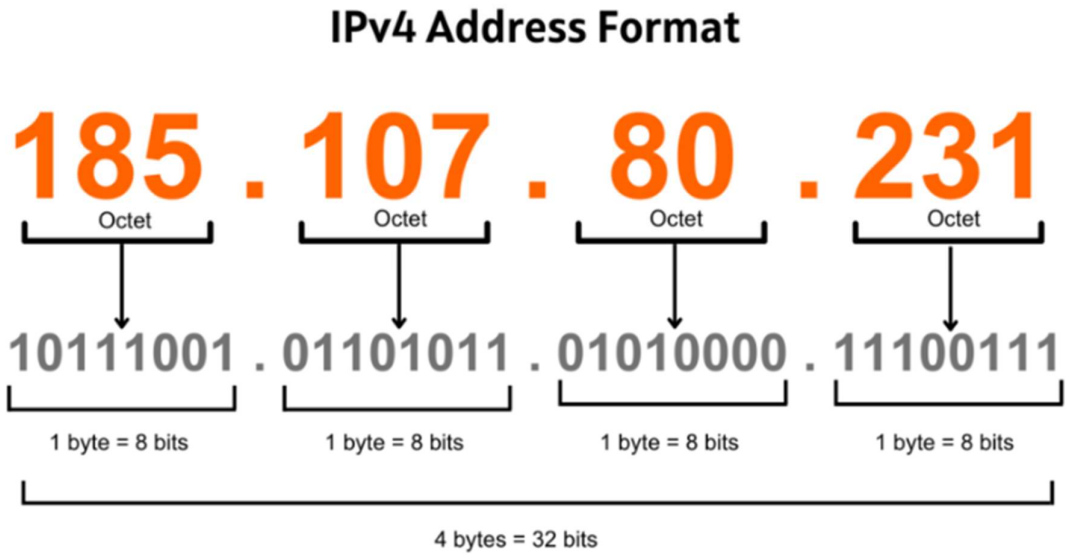
- Class E is not divided into Network ID and Host ID.
- How to identify class E address
    - First four bits are reserved to 1111 in binary notation
    - Range of 1st octet is [240, 255] in dotted decimal notation
- Total number of IP Addresses available in class E = 2^28 (26,84,35,456)
- Class D is reserved for future or experimental purposes.

Types of IP Addresses

- IPv4 (Internet Protocol Version 4)
- IPv4 (Internet Protocol Version 6)

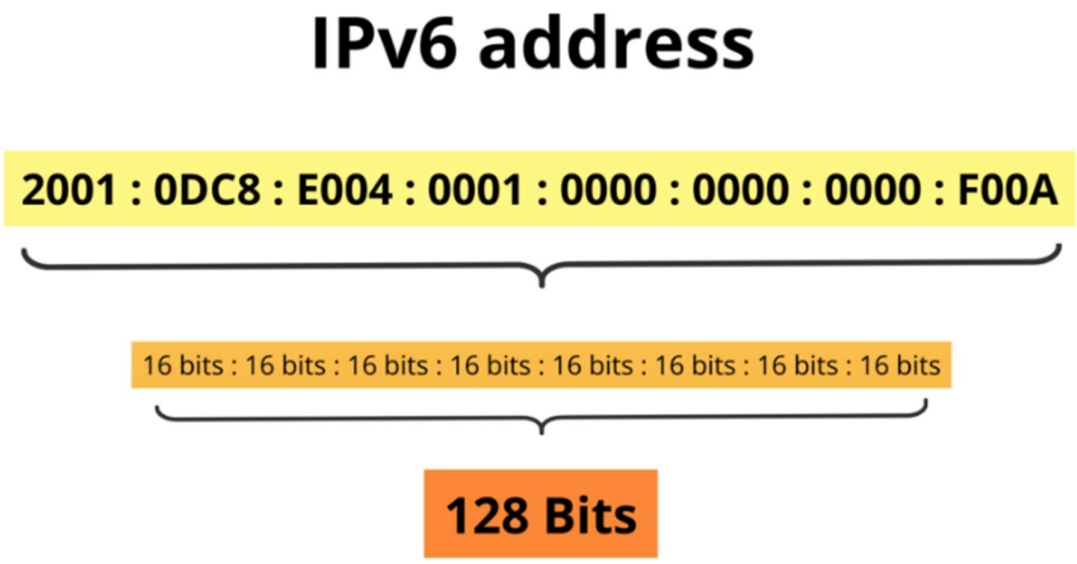
IPv4

- IPv4 address consists of two things that are the network address and the host address.
- It stands for Internet Protocol version four. It was introduced in 1981 by DARPA and was the first deployed version in 1982 for production on SATNET and on the ARPANET in January 1983.
- IPv4 addresses are 32-bit integers that have to be expressed in Decimal Notation.
- It is represented by 4 numbers separated by dots in the range of 0-255, which have to be converted to 0 and 1, to be understood by Computers.
- For Example, An IPv4 Address can be written as 189.123.123.90.



IPv6

- IPv6 is based on IPv4 and stands for Internet Protocol version 6.
- It was first introduced in December 1995 by Internet Engineering Task Force.
- IP version 6 is the new version of Internet Protocol, which is way better than IP version 4 in terms of complexity and efficiency.
- IPv6 is written as a group of 8 hexadecimal numbers separated by colon (:). It can be written as 128 bits of 0s and 1s.



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