IP Addressing

TCP/IP（Transmission Control Protocol/Internet Protocol

IP Addresses

The IP addresses used to identify systems on a TCP/IP network. The IP address is an absolute identifier of both the individual machine and the network on which it resides.

Every IP datagram packet transmitted over a TCP/IP network contains the IP addresses of the source system that generated it and the destination system for which it’s intended in its IP header.

IP Addresses

To send a packet across an internet, the sender places the destination's protocol address in the packet and passes the packet to protocol software for delivery.

To provide uniform addressing in an internet, protocol software defines an abstract **addressing scheme** that assigns **each host a unique protocol address**. Users, application programs, and higher layers of protocol software use the abstract protocol addresses to communicate.

IP Addresses

In the TCP/IP protocol stack, addressing is specified by the Internet Protocol (IP).

The IP standard specifies that each host is assigned a unique **32-bit number** known as the host's **Internet Protocol address**, which is often abbreviated **IP address**, or **Internet address**.

Each packet sent across an internet contains the 32-bit IP address of the sender (source) as well as the intended recipient (destination). Thus, to transmit information across a TCP/IP internet, a computer must know the IP address of the remote computer to which the information is being sent.

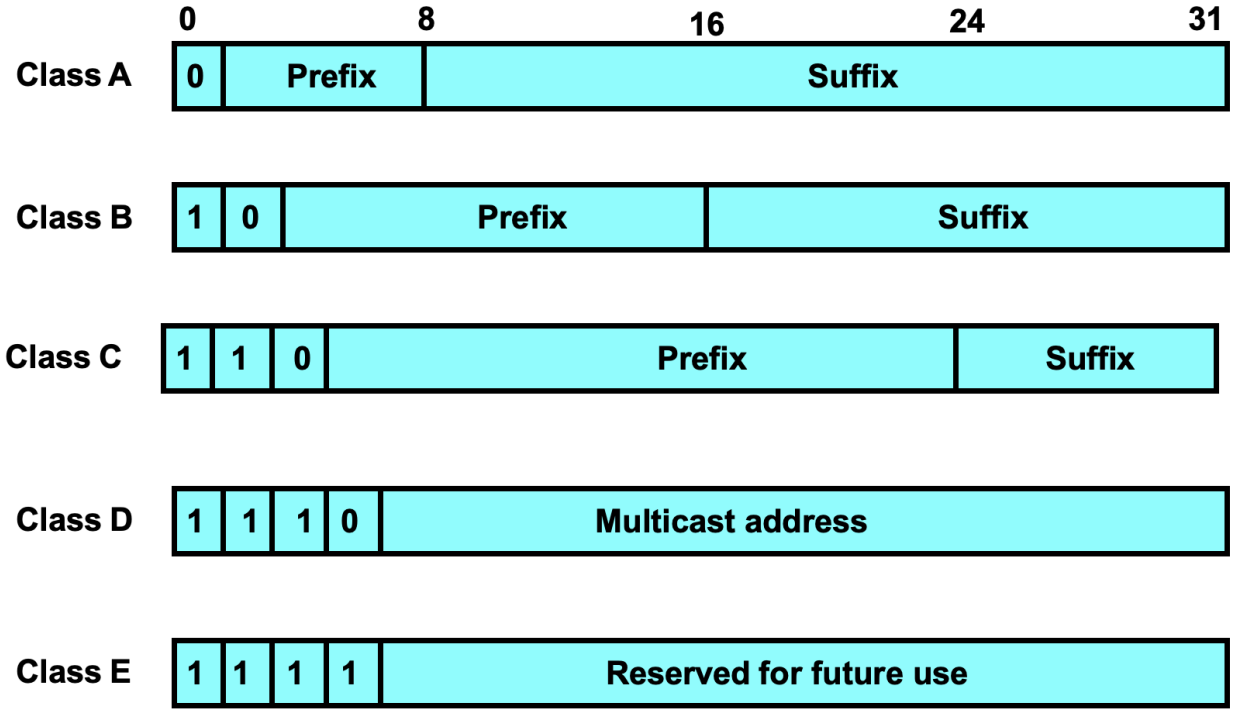
IP Addresses

Every 32-bit address is divided into to two parts**:**
a prefix and suffix.

The address prefix identifies the physical network to which the computer is attached, while the suffix identifies an individual computer on that network. That is, each physical network in an internet is assigned a unique value known as a **network number.** The network number appears as a **prefix** in the address of each computer attached to the network

No two networks can be assigned the same network number and no two computers on the same network can be assigned the same suffix.

Classes of IP Addresses



Classes of IP Addresses

The prefix needs sufficient bits to allow a unique network number to be assigned to each physical network in an internet. The suffix needs sufficient bits to permit each computer attached to a network to be assigned a unique suffix.

Classful IP addressing divides the IP address space into three primary classes, where each class has a different size of prefix and suffix.

The first four bits of an address determine the class to which the address belongs, and specify how the remainder of the address is divided into prefix and suffix.

Above Fig. illustrates the five address classes, the leading bits used to identify each class and the division into prefix & suffix.

Classes of IP Addresses

First Four Bits of Address	Table Index	Classes of Address
0000		A
0001	1	A
0010	2	A
0011	3	A
0100	4	A
0101	5	A
0110	6	A
0111	7	A
1000	8	B
1001	9	B
1010	10	B
1011	11	B
1100	12	C
1101	13	C
1110	14	D
1111	15	E

Classes of IP Addresses

Above fig. shows the eight combinations that begin with a 0 bit correspond to class A. The four combinations that begins with 10 corresponds to class B, and the two combinations that begins with 110 corresponds to class C. An address that begins with 111 belongs to class D. Finally an address that begins with 1111 belongs to a reserved class that is not currently used.

Dotted Decimal Notation

Software uses a notation that is more convenient for humans to understand called Dotted Decimal Notation, the form expresses each 8-bit section of a 32-bit number as a decimal value and uses periods to separate the sections.

32-bit Binary Number				Equivalent Dotted Decimal
10000001	00110100	00000110	00000000	129.52.6.0
11000000	00000101	00110000	00000011	192.5.48.3
00001010	00000010	00000000	00100101	10.2.0.370
10000000	00001010	00000010	00000011	128.10.2.3

Dotted Decimal Notation

Dotted Decimal treats each other as an unsigned binary integer. As the final example in the fig. shows the smallest possible value 0, occurs when all bits of an octet are zero, and the largest possible value,255, occurs when all bits of an octet are one.

Thus dotted decimal addresses range from 0.0.0.0 through 255.255.255.255

Dotted Decimal worked well with classful IP addresses because IP uses octet boundaries to separate an address into a prefix and suffix.

In a class A address, the last three octets corresponds to host suffix. Similarly, class B addresses have two octets of host suffix, and class C address have one octet.

Dotted Decimal Notation

Following fig shows decimal range of values for each class

Class	Range of Values
A	O through 127
B	128 through 191
C	192 through 223
D	224 through 239
E	240 through 255

Division of the Address Space

Following fig shows the maximum number of networks available in each class and the maximum number of hosts per network.

Address Class	Max. no of network	Max. no of hosts per network
A	**128**	**16777216**
B	**16384**	**65536**
C	**2097152**	**256**

Authority for Address

Throughout an internet, each network prefix must be unique. For networks connected to the global Internet, an organization obtains network numbers from the communication company that supplies Internet connections. Such companies are called **Internet Service Providers (ISPs).**

ISPs coordinate with a central organization, **the Internet Assigned Number Authority,** to ensure that each network prefix is unique throughout the entire Internet.

For a private network, the choice of network prefix can be made by the organization. To ensure that each prefix is unique, a group that builds a private internet must decide how to coordinate network number assignments.

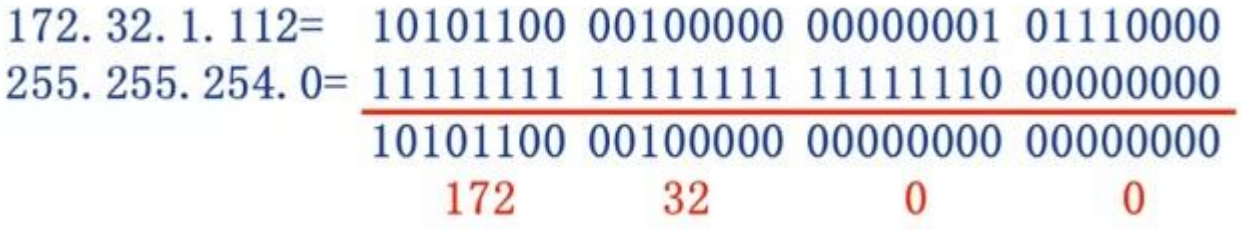
Subnet Masking

IP addresses always dedicate some of their bits to the network identifier and some to the host identifier, but the number of bits used for each purpose is not always the same. Many common addresses use 24-bits for the network and eight for the host, but the split between the network and host bits can be anywhere in the address.

To identify which bits are used for each purpose, every TCP/IP system has a subnet mask along with its IP address.

A **subnet mask** is 32-bit binary number in which the bits corresponds to those of the IP address.

Subnet Masking



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IP address : **192.168.2.45**

Subnet mask : **255.255.255.0**

Its binary equivalent is –

IP address : **11000000 10101000 00000010 00101101**

Subnet mask : **11111111 11111111 11111111 00000000**

Subnet Masking

	Class A	Class B	Class C	Class D	Class E
Network address bits	8	16	24	N/A	N/A
Host address bits	24	16	8	N/A	N/A
Subnet Mask	255.0.0.0	255.255.0.0	255.255.255.0	N/A	N/A
Address Begin with: (Binary)	0	10	110	1110	1111
First Byte Values (Decimal)	0-127	128-191	192-223	224-239	240-255
Number of Networks	127	16,384	2,097,151	N/A	N/A
Number of hosts	16,777214	65,534	254	N/A	N/A

Subnet Masking

A company building a relatively small network can register a class C address which , because the addresses have only eight host bits, supports up to 254 systems, while large organizations can use class B or A address with 16 or 24 host bits and create subnets out of them.

Class D addresses are not intended for allocation in blocks like the other classes. This part of the address space is allocated for multicast address. Multicast addresses represent groups of systems that have a common attribute, but that are not necessarily located in the same place or even administered by the same organization.

For example packets sent to the multicast address 224.0.0.1 are processed by all of the routers on the local subnet.

Class E is reserved for future use.

Special IP Address

Network Address:

IP reserves host address zero and uses it to denote a network. Thus, the address 128.211.0.0 denotes a network that has been assigned the prefix 128.211.

The network address refers to the network itself and not to the host computers attached to the network. Thus, the network address should never appear as the destination address in a packet.

IP address with **host id portion equal to zero** is used to refer to the network itself.

Special IP Address

Directed Broadcast Address:

According to the standard, any address with the **host id consisting of all 1s** is reserved for directed broadcast.

Sometimes, it is convenient to send a copy of a packet to all hosts on a physical network. To make broadcasting easy, IP defines a directed broadcast address for each physical network.

When a packet is sent to network's directed broadcast address, a single copy of the packet travels across the internet until it reaches the specified network. The packet is delivered to all hosts on the network.

Special IP Address

Limited Broadcast Address:

The term Limited Broadcast address refers to a broadcast on a local physical network.

Limited broadcast is used during system startup by a computer that does not yet know the network number.

IP reserves the address consisting of **all 1 bits** to refer to limited broadcast. Thus IP will broadcast any packet sent to the all-ones address across the local network.

Special IP Address

Loopback Address:

The network **prefix 127.0.0.0 a value** from the class A range is reserved for loopback, and is intended for use in testing TCP/IP and for inter-process communication on the local computer.

When any program uses the loopback address as a destination, the protocol software in the computer processes the data without sending traffic across any network.

The packet sent to a network 127 address should never appear on any network.

IP defines a loopback address used to test network applications. Programmers often used loopback for preliminary debugging after a network application has been created.

Summary of Special IP addresses

Prefix	Suffix	Type of Address	Purpose
All – 0s	All - 0s	This computer	Used during bootstrap
Network	All- 0s	Network	Identifies a network
Network	All – 1s	Directed broadcast	Broadcast on specified net
all – 1s	All – 1s	Limited broadcast	Broadcast
127	Any	Loopback	testing