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COMPUTER NETWORKS (RCS – 601)

IP & SUBNET MASKING (PART 1)

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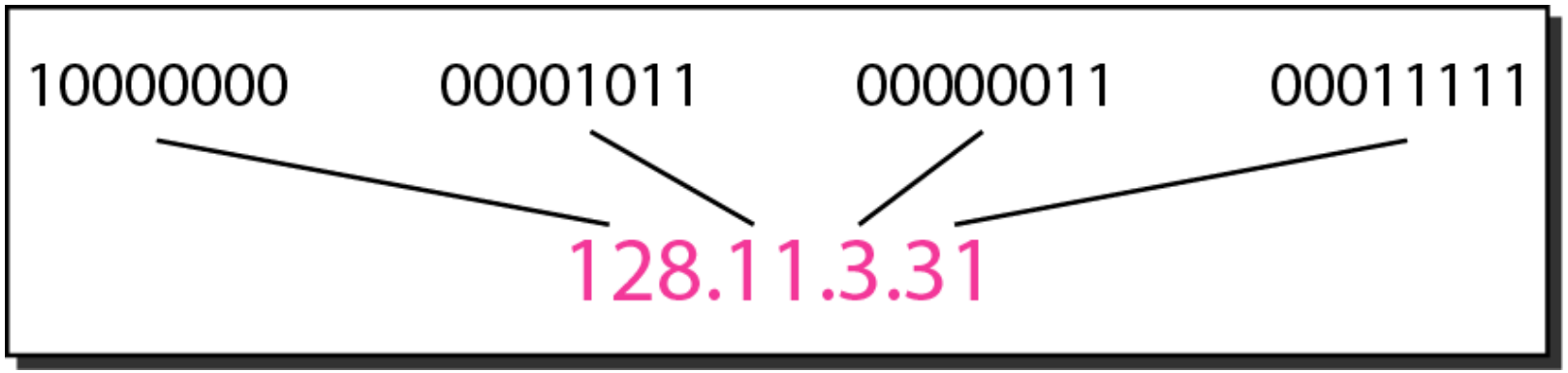
IP ADDRESS

An IPv4 address is a 32-bit address that uniquely and universally defines the connection of a device (for example, a computer or a router) to the Internet.

Dotted-decimal notation and binary notation for an IPv4 address



Change the following IPv4 addresses from binary notation to dotted-decimal notation.

a. 10000001 00001011 00001011 11101111

b. 11000001 10000011 00011011 11111111

Solution

We replace each group of 8 bits with its equivalent decimal number and add dots for separation.

a. 129.11.11.239

b. 193.131.27.255

Change the following IPv4 addresses from dotted-decimal notation to binary notation.

a. 111.56.45.78

b. 221.34.7.82

Solution

We replace each decimal number with its binary equivalent.

a. 01101111 00111000 00101101 01001110

b. 11011101 00100010 00000111 01010010

- ***Find the error, if any, in the following IPv4 addresses.***

a. 111.56.045.78
b. 221.34.7.8.20
c. 75.45.301.14
d. 11100010.23.14.67

Solution

a. There must be no leading zero (045).
b. There can be no more than four numbers.
c. Each number needs to be less than or equal to 255.
d. A mixture of binary notation and dotted-decimal notation is not allowed.

In classful addressing, the address space is divided into five classes:

A, B, C, D, and E.

Finding the classes in binary and dotted-decimal notation

	First byte	Second byte	Third byte	Fourth byte
Class A	0			
Class B	10			
Class C	110			
Class D	1110			
Class E	1111			

a. Binary notation

	First byte	Second byte	Third byte	Fourth byte
Class A	0–127			
Class B	128–191			
Class C	192–223			
Class D	224–239			
Class E	240–255			

b. Dotted-decimal notation

Find the class of each address.

a. 00000001 00001011 00001011 11101111

b. 11000001 10000011 00011011 11111111

c. 14.23.120.8

d. 252.5.15.111

Solution

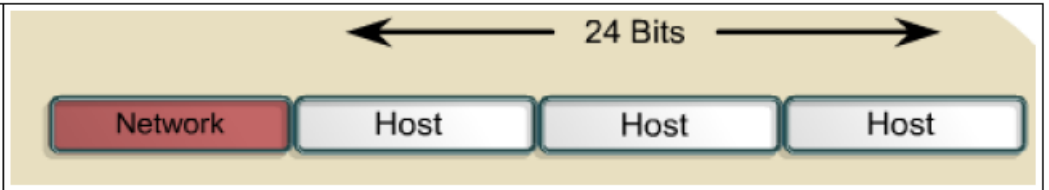
a. The first bit is 0. This is a class A address.

b. The first 2 bits are 1; the third bit is 0. This is a class C address.

c. The first byte is 14; the class is A.

d. The first byte is 252; the class is E.

- **Every IP address also has two parts-**
- The first part identifies the network (Network ID) where the system is connected
- the second part identifies the system (Host ID)

Class A	
Class B	
Class C	

Within the address range of each IPv4 network, we have three types of addresses:

- Network address - The address by which we refer to the network
- Broadcast address - A special address used to send data to all hosts in the network
- Host addresses - The addresses assigned to the end devices in the network

Class A :

No of Network: 2^7 (The first bit of a Class A address is always 0.)

No. of Usable Host address per Network: 2^{24}-2

(Minus 2 because 2 addresses are reserved for network and broadcast address)

Class B :

No of Network: 2^{14} (The first two bits of the first octet of a Class B address are always 10.)

No. of Usable Host address per Network: 2^{16}-2

Class C :

No of Network: 2^{21} (A Class C address begins with binary 110.)

No. of Usable Host address per Network: 2^8-2

- **Class D:** The Class D address class was created to enable multicasting in an IP address. A multicast address is a unique network address that directs packets with that destination address to predefined groups of IP addresses. Therefore, a single station can simultaneously transmit a single stream of data to multiple recipients. The Class D address space, much like the other address spaces, is mathematically constrained. The first four bits of a Class D address must be 1110.

- **Class E:** A Class E address has been defined. However, the Internet Engineering Task Force (IETF) reserves these addresses for its own research. Therefore, no Class E addresses have been released for use in the Internet. The first four bits of a Class E address are always set to 1s. Therefore, the first octet range for Class E addresses is 11110000 to 11111111, or 240 to 255.

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Number of blocks (Networks) and block (Hosts) size in classful IPv4 addressing

Class	*Number of Blocks*	*Block Size*	*Application*
A	128	16,777,216	Unicast
B	16,384	65,536	Unicast
C	2,097,152	256	Unicast
D	1	268,435,456	Multicast
E	1	268,435,456	Reserved

In classful addressing, a large part of the available addresses were wasted.

Classful vs. Classless Addressing

- **Classful addressing, as we have seen, has too many problems**
- **Classless addressing, announced in 1996, allows an ISP to assign as few or as many IP addresses as requested**
- **The entire 2^32 address space is divided into variable-sized blocks, which are multiples of powers of 2**

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- **Masking-**
- ***Masking is finding the network address from an IP address.***

Table *Default masks for* ***classful addressing***

Class	*Binary*	*Dotted-Decimal*	*CIDR*
A	11111111 00000000 00000000 00000000	255.0.0.0	/8
B	11111111 11111111 00000000 00000000	255.255.0.0	/16
C	11111111 11111111 11111111 00000000	255.255.255.0	/24

Classful addressing, which is almost obsolete, is replaced with classless addressing.

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Table- Prefix lengths

/n	Mask	/n	Mask	/n	Mask	/n	Mask
/1	128.0.0.0	/9	255.128.0.0	/17	255.255.128.0	/25	255.255.255.128
/2	192.0.0.0	/10	255.192.0.0	/18	255.255.192.0	/26	255.255.255.192
/3	224.0.0.0	/11	255.224.0.0	/19	255.255.224.0	/27	255.255.255.224
/4	240.0.0.0	/12	255.240.0.0	/20	255.255.240.0	/28	255.255.255.240
/5	248.0.0.0	/13	255.248.0.0	/21	255.255.248.0	/29	255.255.255.248
/6	252.0.0.0	/14	255.252.0.0	/22	255.255.252.0	/30	255.255.255.252
/7	254.0.0.0	/15	255.254.0.0	/23	255.255.254.0	/31	255.255.255.254
/8	255.0.0.0	/16	255.255.0.0	/24	255.255.255.0	/32	255.255.255.255

The addresses in color are the default masks for classes A, B, and C.

Thus, classful addressing is a special case of classless addressing

The last address in the block can be found by setting the rightmost $32 - n$ bits to 1s.

The number of addresses in the block can be found by using the formula 2^{32-n}.

Find the number of host addresses in 205.16.37.39/28.

Solution

The value of n is 28, which means that number of addresses is 2^{32-28} *or 16.*

The first address in a block is normally not assigned to any device; it is used as the network address that represents the organization to the rest of the world.

How can we prove that we have 2,147,483,648 addresses in class A?

Solution

In class A, only 1 bit defines the class. The remaining 31 bits are available for the address. With 31 bits, we can have 2^31 or 2,147,483,648 addresses.

Example Given the network address 17.0.0.0, find the class, the block, and the range of the addresses.

Solution

The class is A because the first byte is between 0 and 127. The block has a netid of 17. The addresses range from 17.0.0.0 to 17.255.255.255.

Example

Given the address 23.56.7.91 and the default class A mask, find the beginning address (network address).

Solution

The default mask is 255.0.0.0, which means that only the first byte is preserved and the other 3 bytes are set to 0s. The network address is 23.0.0.0.

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CIDR [Classless Inter Domain Routing]

- CIDR is a slash notation of subnet mask. CIDR tells us number of on bits in a network address.
- Class A has default subnet mask 255.0.0.0. that means first octet of the subnet mask has all on bits. In slash notation it would be written as /8, means address has 8 bits on.
- Class B has default subnet mask 255.255.0.0. that means first two octets of the subnet mask have all on bits. In slash notation it would be written as /16, means address has 16 bits on.
- Class C has default subnet mask 255.255.255.0. that means first three octets of the subnet mask have all on bits. In slash notation it would be written as /24, means address has 24 bits on.

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THANK YOU