NETWORK LAYER

By

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Logical Addressing

- Communication at the network layer is host-to-host (computer-to-computer); a computer somewhere in the world needs to communicate with another computer somewhere else in the world.
- For this level of communication, we need a global addressing scheme; we called this logical addressing.
- The Internet addresses are 32 bits in length; this gives us a maximum of 2^{32} addresses.
- These addresses are referred to as IPv4 (IP version 4) addresses or simply IP addresses.

IP Addresses

- Assigned by the Internet Assigned Numbers Authority (IANA)
- Addressing system is divided into IPv4 and IPv6
- It consists of 32 bits for IPv4 and 128 bits for IPv6
- Using the binary and decimal number systems

International Institution for IP Management

- America :America Registry for Internet Number (ARIN)
- Europe : Reseaux IP Europeens (RIPE)
- Africa :African Regional Internet Registry Network Information Center (AFRINIC)
- Asia Pacific :Asia Pacific Network Information Center (APNIC)

IP Version 4 Classes (IPv 4)

	Range for first byte
Class A	0 - 127
Class B	128 - 191
Class C	192 - 223
Class D	224 - 239
Class E	240 - 255

- Class A,B,C – LAN/WAN
- Class D – Multicasting
- Class E- Reserved for future research and development.

IP Address Category

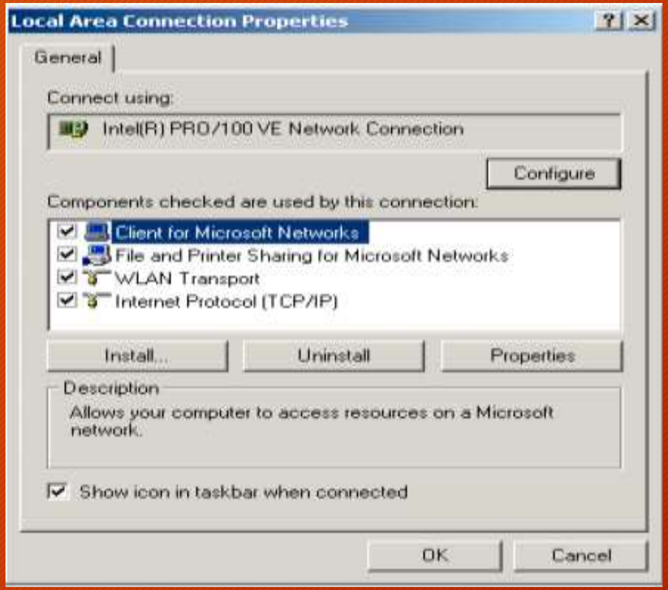
1. Private IP
   - IP Address with a special network address that is used for addressing in the local network.
   - To find out the Private IP is by typing “IPCONFIG” at the Command prompt
     - Class A : 10.0.0.0 – 10.255.255.255
     - Class B :172.16.0.0 – 172.31.255.255
     - Class C : 192.168.0.0 – 192.168.255.255
2. Public IP
   - It’s an IP Address used on the internet, provided by the ISP
   - The way to find out a public IP is by using a particular website.

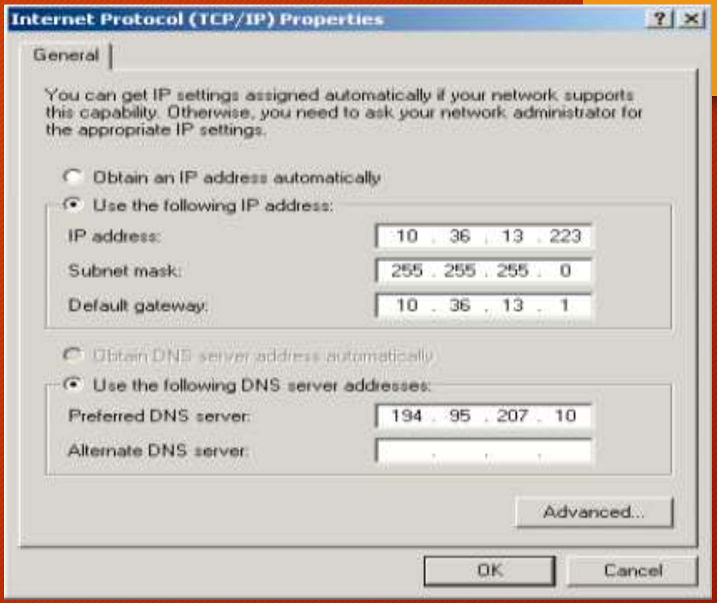
     For example: www.ipsaya.com

IP Address Implementation

1. Static IP
   - It’s an IP address that is permanently owned by a computer system.
   - It sets manually by Network Admin.
2. Dynamic IP
   - An IP Address on a computer system that always changes according to the use of the IP Address in the network at that time, which is set by the DHCP (Dynamic Host Configuration Protocol) Server.

IP Address Implementation on Windows





IPv4 Addresses

- 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.
- The address space of IPv4 is:

2^{32} or 4,294,967,296.

IPv4 Addresses

There are two prevalent notations to show an IPv4 address: ***binary notation*** and ***dotted decimal notation***.

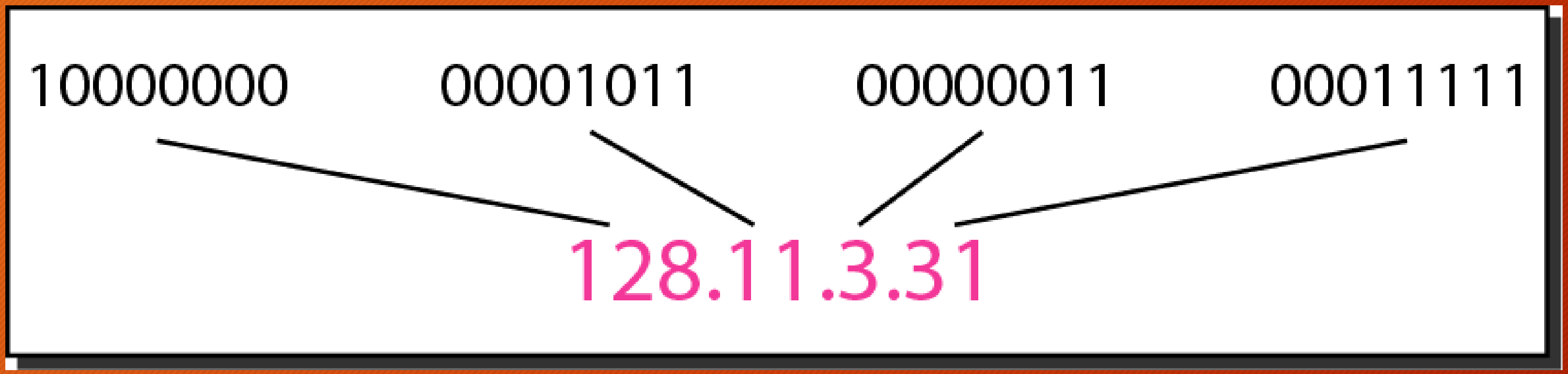
- Binary notation:

  01110101 10010101 00011101 00000010

- Dotted decimal notation

  117.149.29.2

IPv4 Addresses



Example 1:

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. X . Y . Z .T

b. X . Y . Z . T

Example 2:

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

Example 3:

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

SUBNETTING

Subnet Mask

- Subnet mask is a special technique to divide a computer network become subnetworks with smaller sizes.
- This activity is called subnetting and it can only be done on IP addresses consisting of classes A, B and C only.

Binary Conversion to Decimal

11000000 . 10101000 . 00001010 . 00000001

N = 0 – 7 (8 Bit)	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Result	128	64	32	16	8	4	2	1
Sum								

Conversion for Decimal to Binary

192 / 2 = 96 sisa 0
96 / 2 = 48 sisa 0
48 / 2 = 24 sisa 0
24 / 2 = 12 sisa 0
12 / 2 = 6 sisa 0
6 / 2 = 3 sisa 0
3 / 2 = 1 sisa 1

8 digit

168 / 2 = 84 sisa 0
84 / 2 = 42 sisa 0
42 / 2 = 21 sisa 0
21 / 2 = 10 sisa 1
10 / 2 = 5 sisa 0
5 / 2 = 2 sisa 1
2 / 2 = 1 sisa 0

8 digit

100 / 2 = 50 sisa 0
50 / 2 = 25 sisa 0
25 / 2 = 12 sisa 1
12 / 2 = 6 sisa 0
6 / 2 = 3 sisa 0
3 / 2 = 1 sisa 1

7 digit

20 / 2 = 10 sisa 0
10 / 2 = 5 sisa 0
5 / 2 = 2 sisa 1
2 / 2 = 1 sisa 0

5 digit

	128	64	32	16	8	4	2	1
192	1	1	0	0	0	0	0	0
168	1	0	1	0	1	0	0	0
100	0	1	1	0	0	1	0	0
20	0	0	0	1	0	1	0	0

Classful Addressing
and
Classless Addressing

Classful Addressing

- IPv4 addressing, at its inception, used the concept of classes.
- 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.

	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

Finding the classes in binary and dotted-decimal notation

Example 4:

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

Classful Addressing
Classes and Blocks

- One problem with classful addressing is that each class is divided into a fixed number of blocks with each block having a fixed size as shown in Table:

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

Classful Addressing

Classes and Blocks

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

Classful Addressing

Netid and Hostid

- In classful addressing, an IP address in class A, B, or C is divided into netid and hostid.
- In class A, one byte defines the netid and three bytes define the hostid.
- In class B, two bytes define the netid and two bytes define the hostid.
- class C, three bytes define the netid and one byte defines the hostid.

Classful Addressing

Mask

- Although the length of the netid and hostid (in bits) is predetermined in classful addressing, we can also use a mask (also called the default mask), a 32-bit number made of contiguous 1s followed by contiguous as.

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

Default masks for classful addressing

Classful Addressing

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

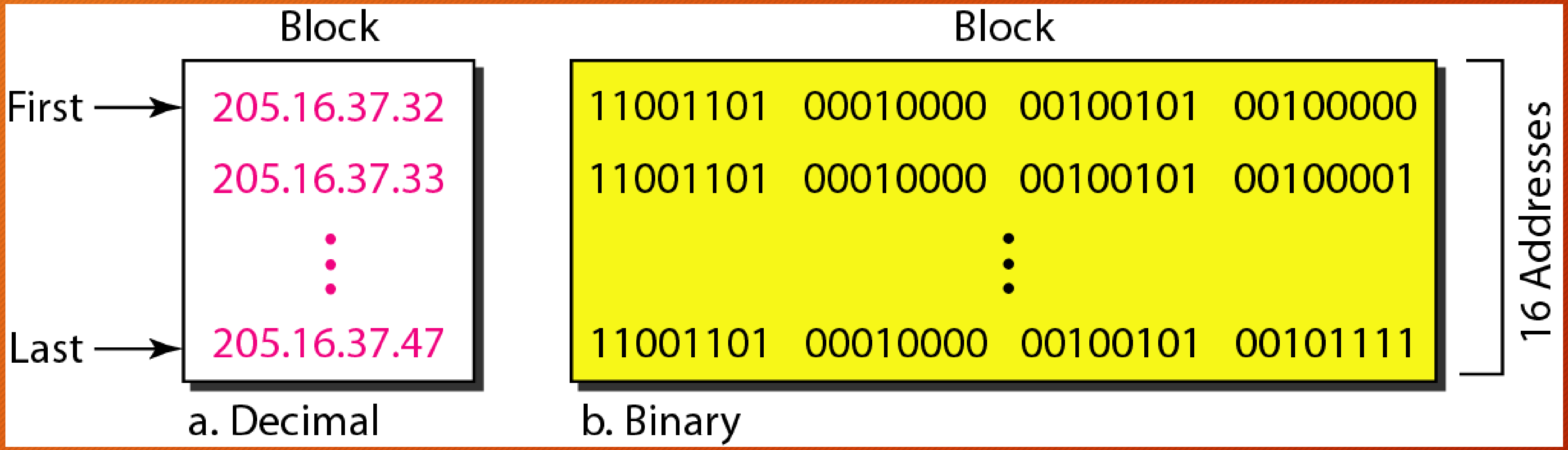
Classless Addressing

- To overcome address depletion and give more organizations access to the Internet, classless addressing was designed and implemented.
- In this scheme, there are no classes, but the addresses are still granted in blocks.

Classless Addressing

Address block

- In classless addressing, when an entity, small or large, needs to be connected to the Internet, it is granted a block (range) of addresses.
- The size of the block (the number of addresses) varies based on the nature and size of the entity.
- For example, a household may be given only two addresses; a large organization may be given thousands of addresses.
- An ISP, as the Internet service provider, may be given thousands or hundreds of thousands based on the number of customers it may serve.



A block of 16 addresses granted to a small organization

Classless Addressing

In IPv4 addressing, a block of addresses can be defined as
x.y.z.t */n*
in which x.y.z.t defines one of the addresses and the */n* defines the mask.

Classless Addressing

The first address in the block can be found by setting the rightmost $32 - n$ bits to 0s.

Example 1

A block of addresses is granted to a small organization. We know that one of the addresses is 205.16.37.39/28.

a. What is the first address in the block?
b. What is the last address in the block?
c. Find the number of addresses in the block!

Solution

The binary representation of the given address is:

11001101 00010000 00100101 00100111

a. If we set 32−28 rightmost bits to 0, we get:

11001101 00010000 00100101 00100000

or

205.16.37.32

Classless Addressing

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

Solution

b. If we set 32 − 28 rightmost bits to 1, we get:

11001101 00010000 00100101 00101111

or

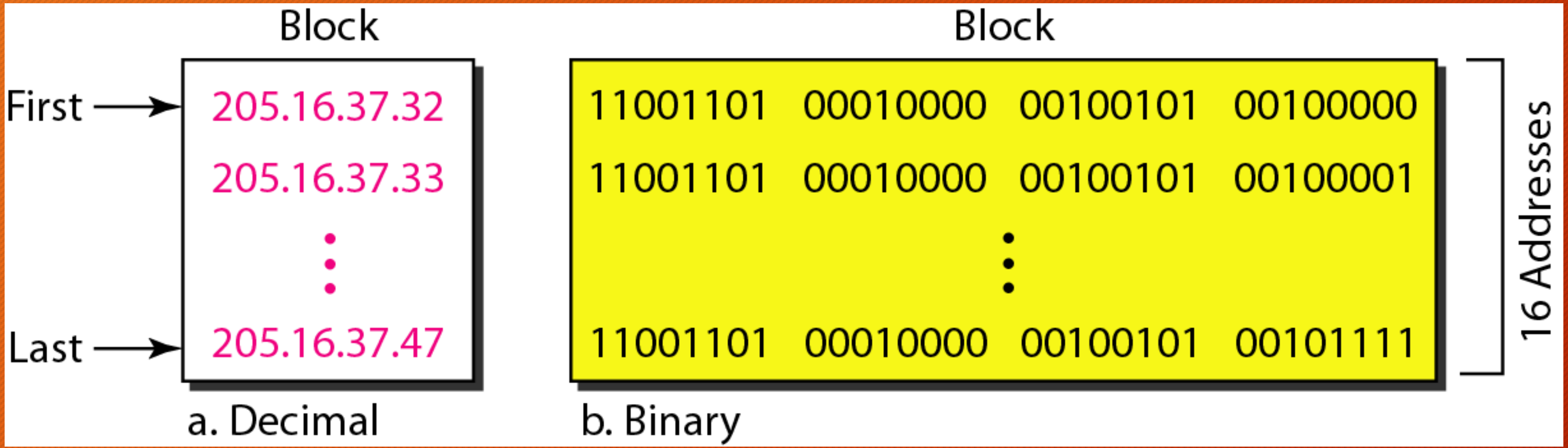
205.16.37.47

Classless Addressing

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

Solution

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



A network configuration for the block 205.16.37.32/28

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.

Task 3

1. In a block of addresses, we know the IP address of one host is 25.34.12.56/16. What are:
    a. The first address (network address)
    b. The last address (limited broadcast address) in this block?
    c. The number of address above!

Task 3

2. In a block of addresses, we know the IP address of one host is 182.44.82.16/26. What are:
   a. The first address (network address)
   b. The last address in this block?
   c. The number of address!