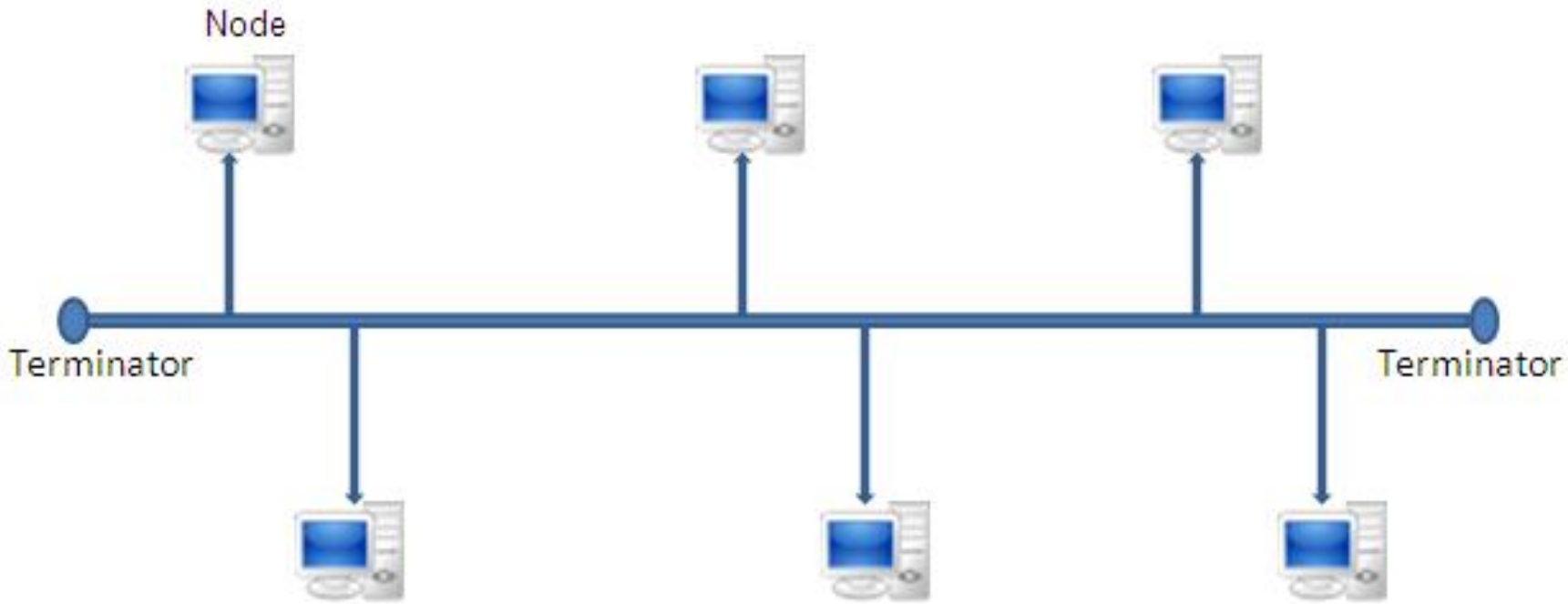
Course Title: Computer Networks

IP ADDRESSING :PART-1

LECTURE OUTLINE

- Classful IP Address
- Network and Host Address
- Broadcast

HOW TO IDENTIFY THE RECIPIENT?



IP ADDRESS LENGTH

An IPv4 address is 32 bits long.

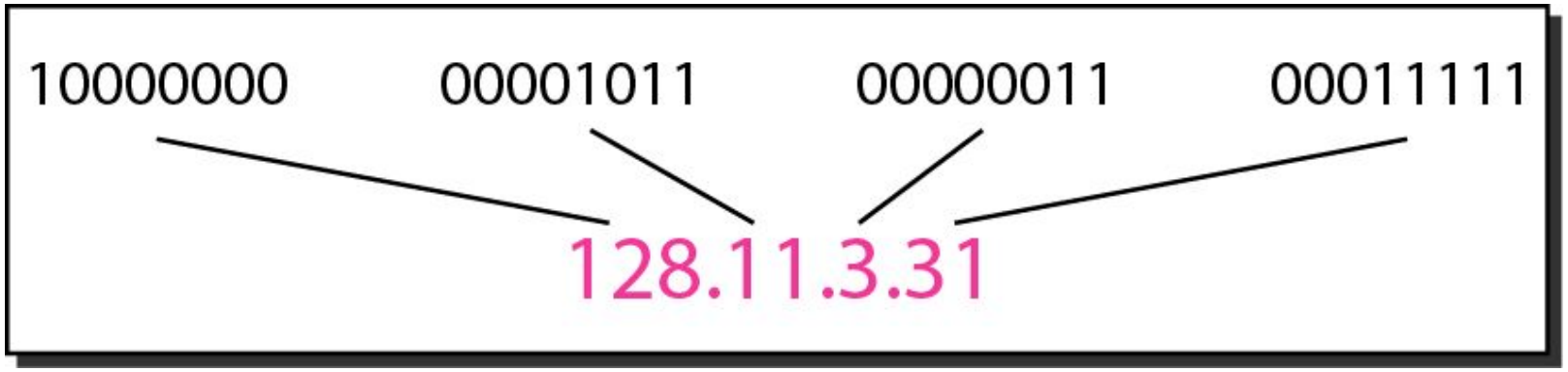
IP ADDRESSES ARE UNIQUE

The IPv4 addresses are unique and universal.

IP ADDRESS SPACE

The address space of IPv4 is 2^{32} or 4,294,967,296.

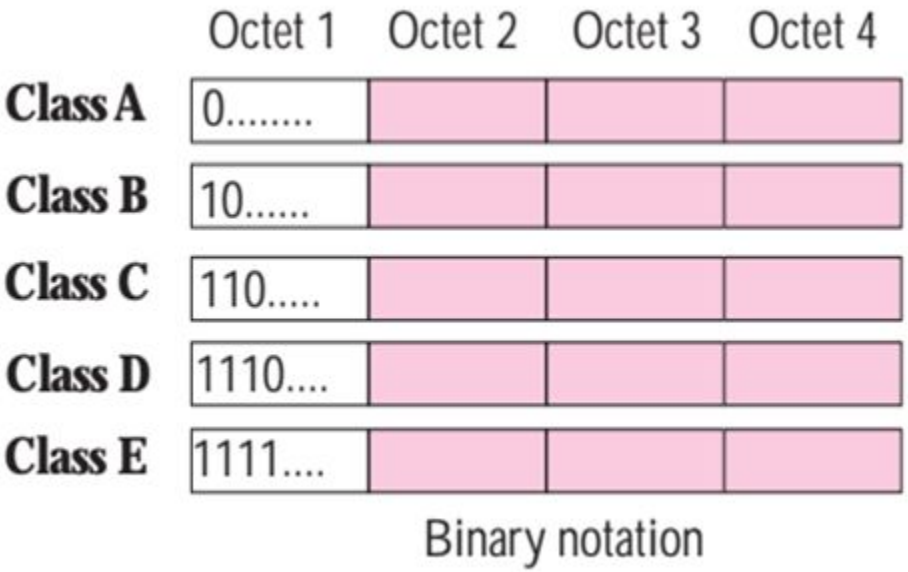
IP ADDRESS REPRESENTATION

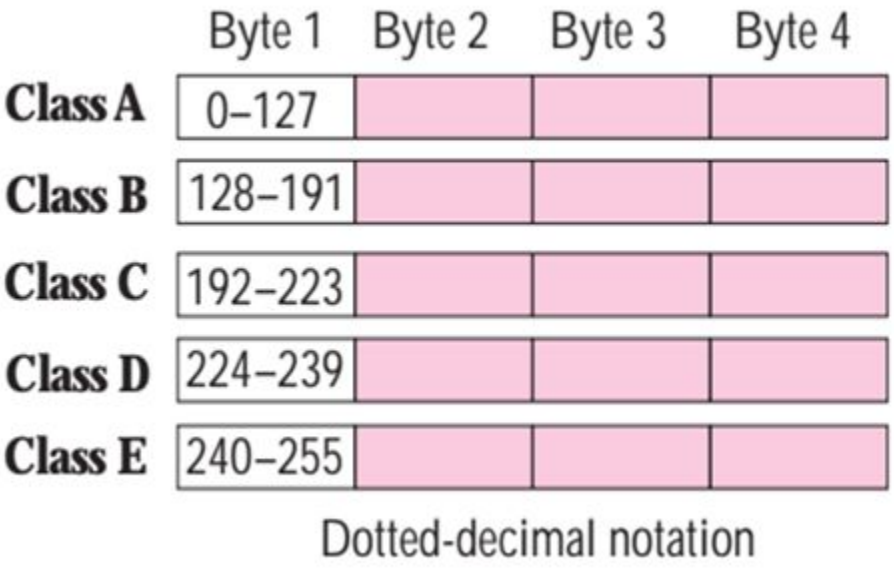


CLASSFUL ADDRESSING

- Address
  1. Class A
  2. Class B
  3. Class C
  4. Class D
  5. Class E

RECOGNIZING CLASS

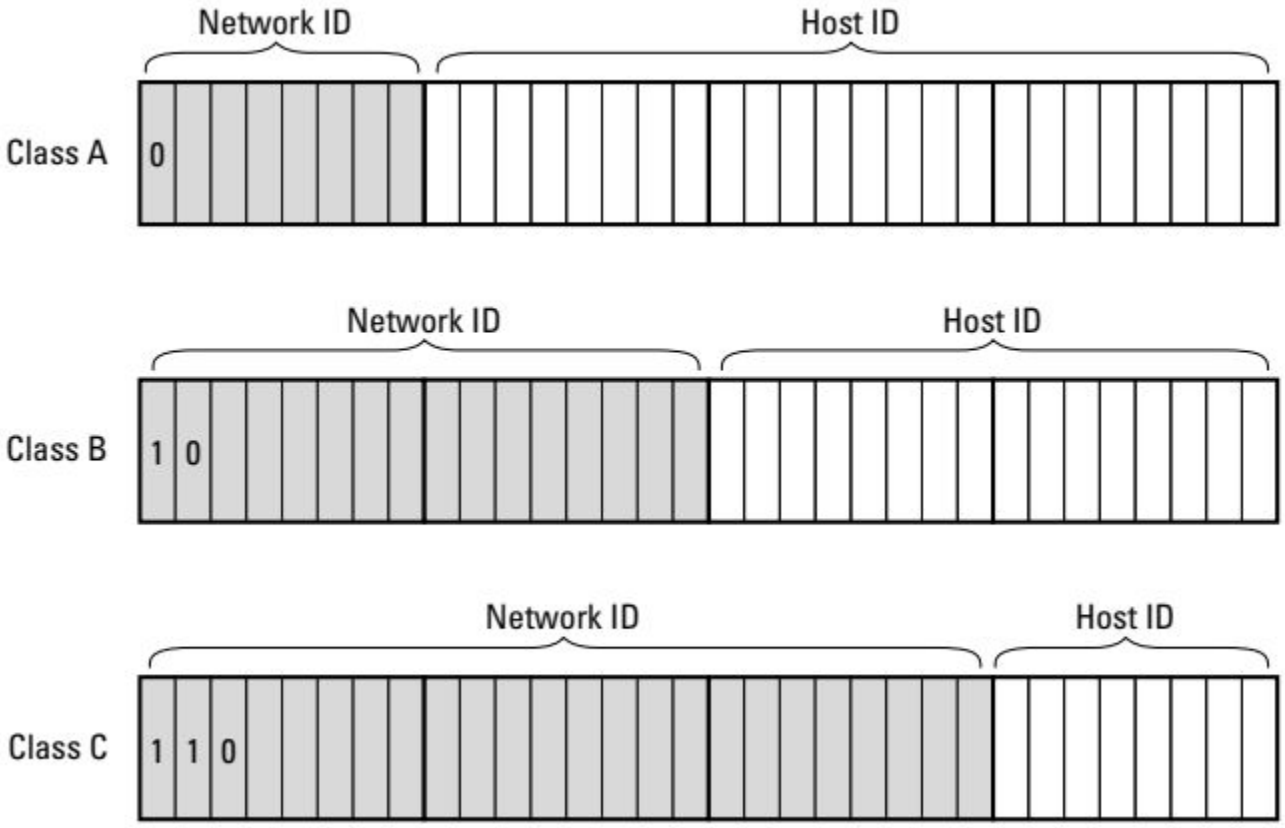




RECOGNIZING CLASS (CONT.….)

Class	Address Number Range	Starting Bits	Length of Network ID	Number of Networks	Hosts
A	1–126.*x.y.z*	0	8	126	16,777,214
B	128–191.*x.y.z*	10	16	16,384	65,534
C	192–223.*x.y.z*	110	24	2,097,152	254

NETWORK ADDRESS AND HOST ADDRESS (CONT….)

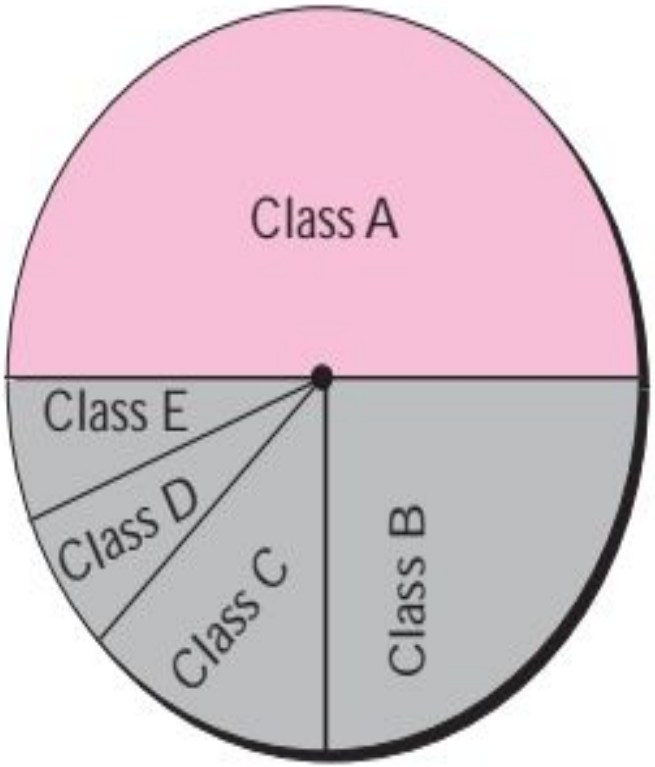


Network ID length: 8 bits
Host ID length: 24 bits

Network ID length: 16 bits
Host ID length: 16 bits

Network ID length: 24 bits
Host ID length: 8 bits

ADDRESS SPACE



Class A: 2^{31} = 2,147,483,648 addresses, 50%

Class B: 2^{30} = 1,073,741,824 addresses, 25%

Class C: 2^{29} = 536,870,912 addresses, 12.5%

Class D: 2^{28} = 268,435,456 addresses, 6.25%

Class E: 2^{28} = 268,435,456 addresses, 6.25%

ADDRESS SPACE (CONT.…)

Proble

Find the class of each address:

a. 00000001 00001011 00001011 11101111

b. 11000001 10000011 00011011 11111111

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.

ADDRESS SPACE (CONT.…)

Find the class of each address:

a. 227.12.14.87

b. 193.14.56.22

c. 14.23.120.8

d. 252.5.15.111

Solution

a. The first byte is 227 (between 224 and 239); the class is D.

b. The first byte is 193 (between 192 and 223); the class is C.

c. The first byte is 14 (between 0 and 127); the class is A.

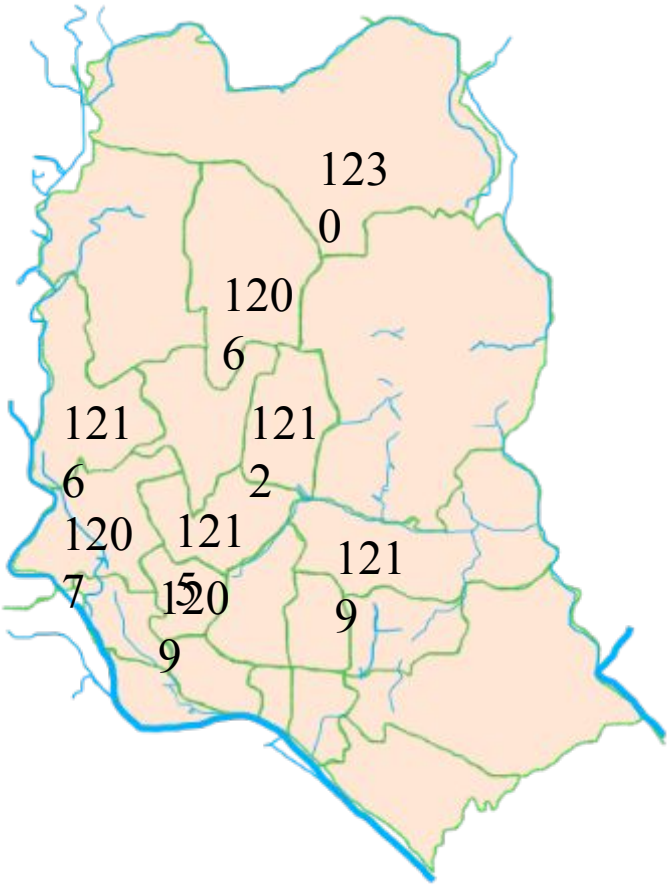
d. The first byte is 252 (between 240 and 255); the class is E.

FEW OF THE SPECIAL PURPOSE IP ADDRESSES

IP address	Purpose
0.0.0.0	For several reasons*
10.0.0.0 to 10.255.255.255, 8-bits mask	Private IP address
172.16.0.0 to 172.31.255.255, 12-bits mask	Private IP address
192.168.0.0 to 192.168.255.255, 16-bits mask	Private IP address
255.255.255.255	Limited Broadcast IP address
127.0.0.1	Loopback address

- Automatically temporarily assigned to host for DHCP discovery
- If a host has two IP addresses, 192.168.1.1 and 10.1.2.1, and a server running on the host is configured to listen on 0.0.0.0, it will be reachable at both of those IP addresses.

NETWORK ADDRESS AND HOST ADDRESS



NETWORK ADDRESS AND HOST ADDRESS (CONT….)

- **The network ID (or network address:** Identifies the network on which a host computer can be found
- **The host ID (or host address):** Identifies a specific device on the network indicated by the network ID

Analogy:

- **Network address------>Postcode of an area**
- **Host address---------> House number of a person in that area**

NETWORK ADDRESS AND HOST ADDRESS (CONT….)

- No. of Networks= $2^{No.of\ bits\ in\ the\ network\ ID}$
- No. of hosts= $2^{No.of\ bits\ in\ the\ host\ ID}$ -2

EXTRACTING INFORMATION IN A BLOCK

How many addresses are there in a block?
What is the first address?
What is the last address?

1. The number of addresses in the block, N, can be found using $N = 2^{32-n}$.
2. To find the first address, we keep the n leftmost bits and set the $(32 - n)$ rightmost bits all to 0s.
3. To find the last address, we keep the n leftmost bits and set the $(32 - n)$ rightmost bits all to 1s.

Note

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.

Note

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

Example 19.6

A block of addresses is granted to a small organization. We know that one of the addresses is 205.16.37.39/28. What is the first address in the block?

Solution

The binary representation of the given address is

11001101 00010000 00100101 00100111

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

11001101 00010000 00100101 0010000

or

205.16.37.32.

This is actually the block shown in Figure 19.3.

Note

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

Example 19.7

Find the last address for the block in Example 19.6.

Solution

The binary representation of the given address is

11001101 00010000 00100101 00100111

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

11001101 00010000 00100101 00101111

or

205.16.37.47

This is actually the block shown in Figure 19.3.

Note

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

Example 19.9

Another way to find the first address, the last address, and the number of addresses is to represent the mask as a 32-bit binary (or 8-digit hexadecimal) number. This is particularly useful when we are writing a program to find these pieces of information. In Example 19.5 the /28 can be represented as

11111111 11111111 11111111 11110000

(twenty-eight 1s and four 0s).

Find

a. The first address

b. The last address

c. The number of addresses.

Example 19.9 (continued)

Solution

a. The first address can be found by ANDing the given addresses with the mask. ANDing here is done bit by bit. The result of ANDing 2 bits is 1 if both bits are 1s; the result is 0 otherwise.

Address:	11001101	00010000	00100101	00100111
Mask:	**11111111**	**11111111**	**11111111**	**11110000**
First address:	11001101	00010000	00100101	00100000

Example 19.9 (continued)

b. The last address can be found by ORing the given addresses with the complement of the mask. ORing here is done bit by bit. The result of ORing 2 bits is 0 if both bits are 0s; the result is 1 otherwise. The complement of a number is found by changing each 1 to 0 and each 0 to 1.

Address:	11001101	00010000	00100101	00100111
Mask complement:	**00000000**	**00000000**	**00000000**	**00001111**
Last address:	11001101	00010000	00100101	00101111

Example 19.9 (continued)

c. The number of addresses can be found by complementing the mask, interpreting it as a decimal number, and adding 1 to it.

Mask complement:	00000000 00000000 00000000 00001111
Number of addresses:	15 + 1 = 16

BROADCAST

- A network has three kinds of IP addresses
  - Network IP address
    - Lowest IP address of the network
  - Broadcast IP address
    - Highest IP address of the network
  - Host IP addresses
    - All IP addresses of the network except the lowest and highest IP address

BROADCAST

- How to get network IP address and broadcast IP address?
  - Network IP address: Replace all host bits by zeroes (0) of any IP address of the network
  - Broadcast IP address: Replace all host bits by ones of any IP address of the network

BROADCAST

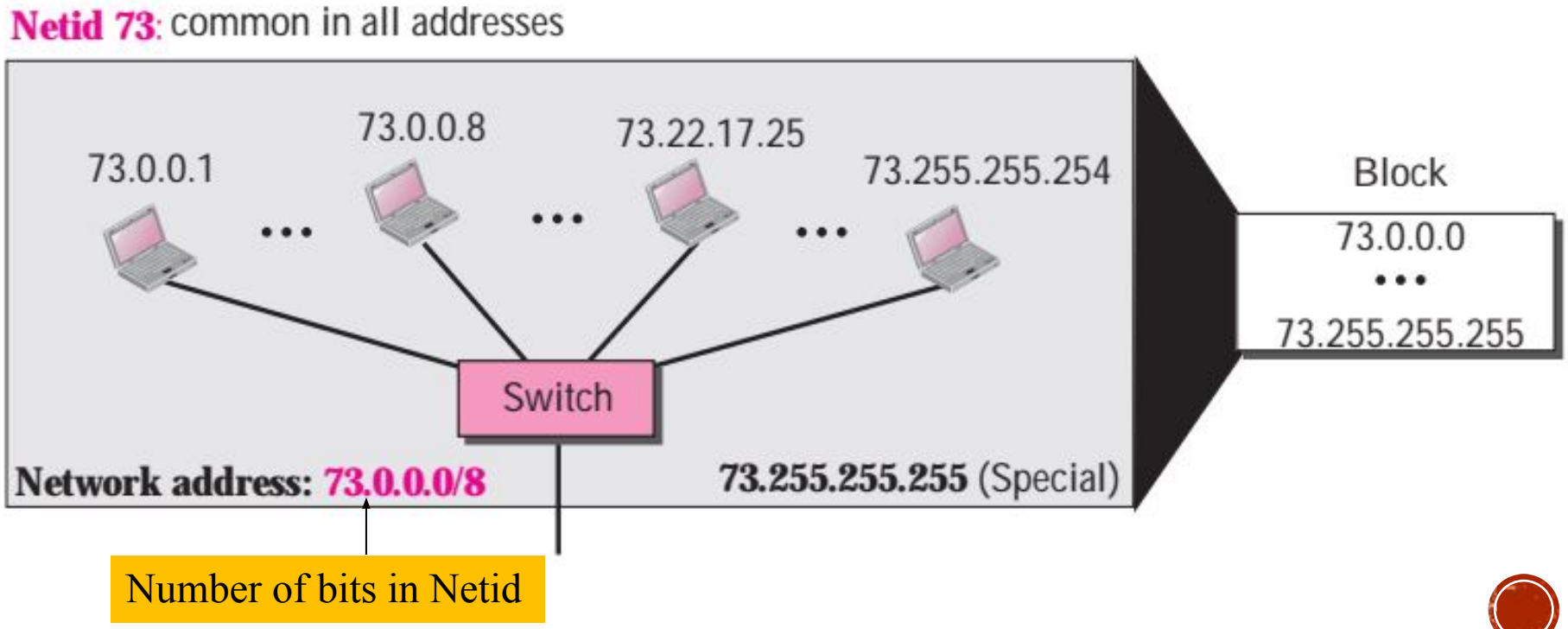
What is the network and broadcast IP addresses of the network which uses 192.100.12.110 as a host address?

- 192.100.12.110 is a class C address
- 192.100.12 is the network part and 110 is the host part
- Network IP address: 192.100.12.0
- Broadcast IP address: 192.100.12.255

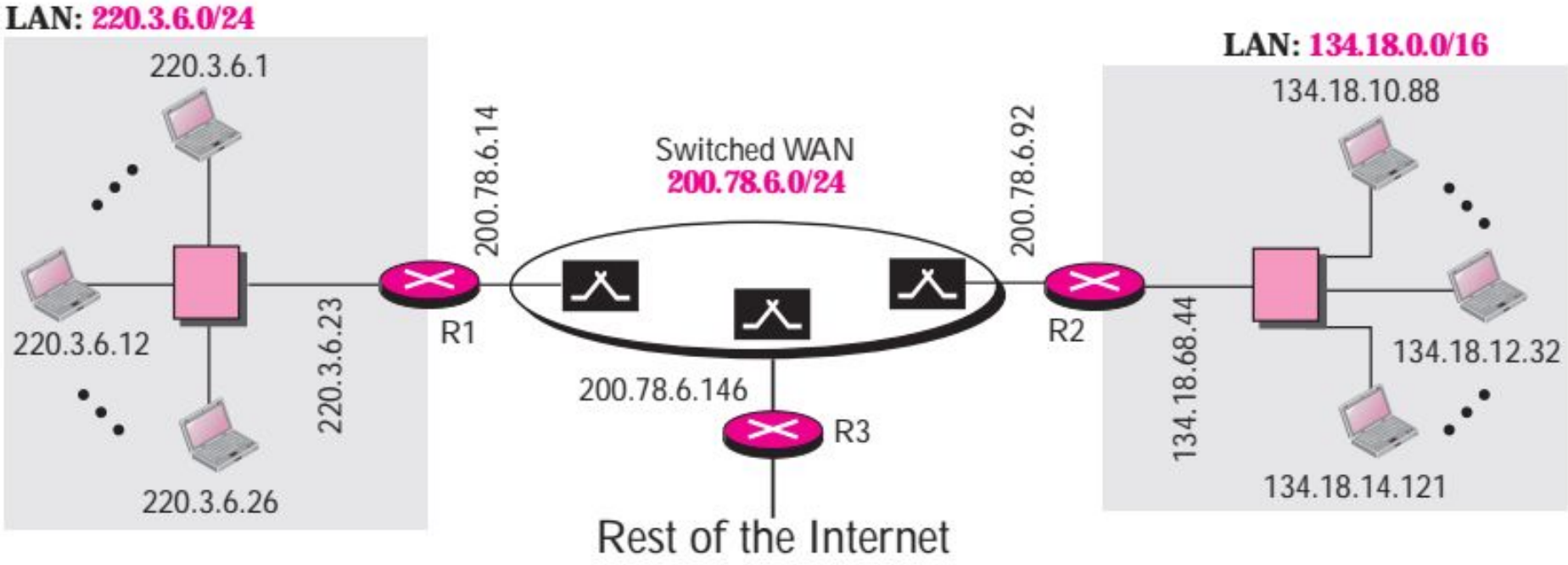
No. of usable host IP address: No. of addresses-2

NETWORK DESIGN

Example
An address in a block is given as 73.22.17.25. Find the number of addresses in the block, the first address, and the last address. Number of bits in the netid is 8

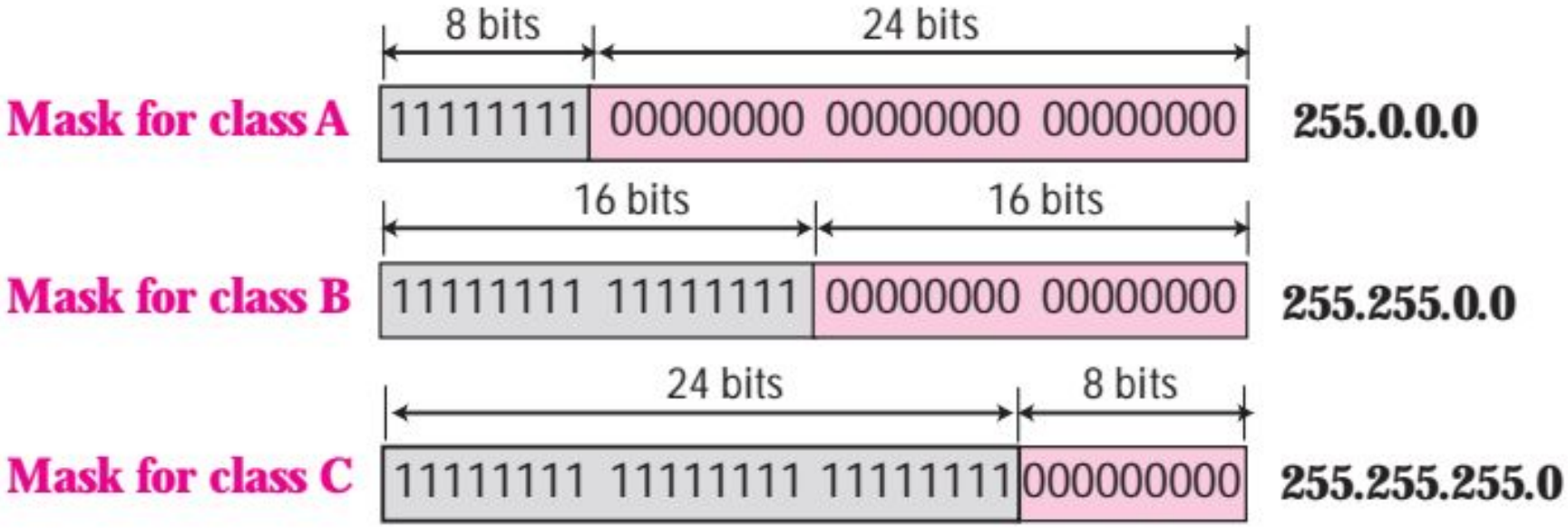


INTERCONNECTIONS OF MULTIPLE NETWORKS



NETWORK MASK/SUBNET MASK

A **network mask** or a **default mask** in classful addressing is a 32-bit number with *n* leftmost bits all set to 1s and (32 - *n*) rightmost bits all set to 0s



NETWORK MASK/SUBNET MASK

Class	*n*	*k*		
Class A	8	1	128	16,777,216
Class B	16	2	16,384	65,536
Class C	24	3	2,097,152	256

Huge wastage of IP addresses

Wastage of IP addresses

No enough for all organizations

References

1. Official Cert Guide CCNA 200-301 , vol. 1, *W. Odom*, Cisco Press, First Edition, 2019, USA.

2. CCNA Routing and Switching, *T. Lammle*, John Wily & Sons, Second Edition, 2016, USA.

3. Cisco IOS Configuration Fundamentals Command Reference. http://www.cisco.com

Books

1. Official Cert Guide CCNA 200-301 , vol. 1, *W. Odom*, Cisco Press, First Edition, 2019, USA.

2. CCNA Routing and Switching, *T. Lammle*, John Wily & Sons, Second Edition, 2016, USA.

3. **Data communications and networking by Forouzen**