Computer Network(CSC 503)

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Lecture 21 and 22

IP(Internet Protocol) ADDRESSES

Two Versions

- IPv4 ADDRESSES
- IPv6 ADDRESSES

Note: The **IP address** space is managed globally by the Internet **Assigned** Numbers Authority (IANA)

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 IP addresses are unique.

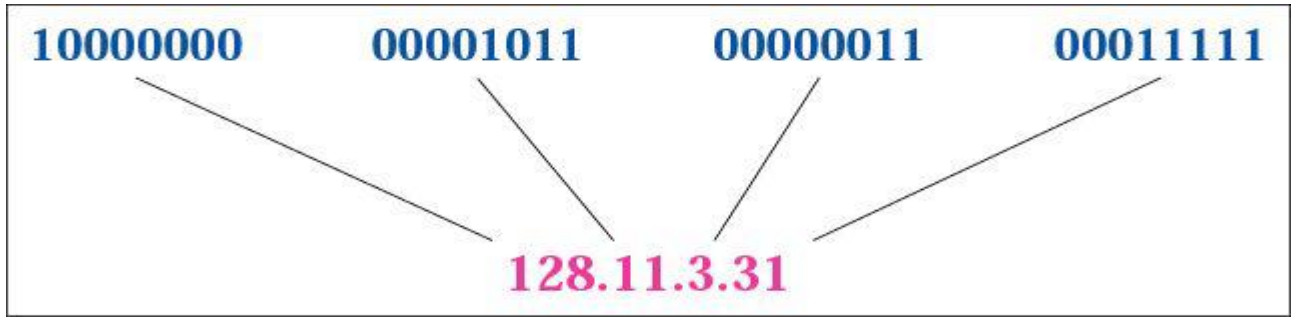
The address space of IPv4 is 2^{32} or 4,294,967,296.

Notation :

- 1. Binary Notation

  01110101 10010101 00011101 11101010

- **2. Dotted-decimal notation**



- ***3. Hexadecimal Notation***
- **0111 0101 1001 0101 0001 1101 1110 1010**

  75 95 1D EA

- **0x75951DEA**

Examples:

Example 1: Change the following IPv4 addresses from binary notation to dotted-decimal notation.

11000011 10000011 00011010 11111111

193.131.26.255

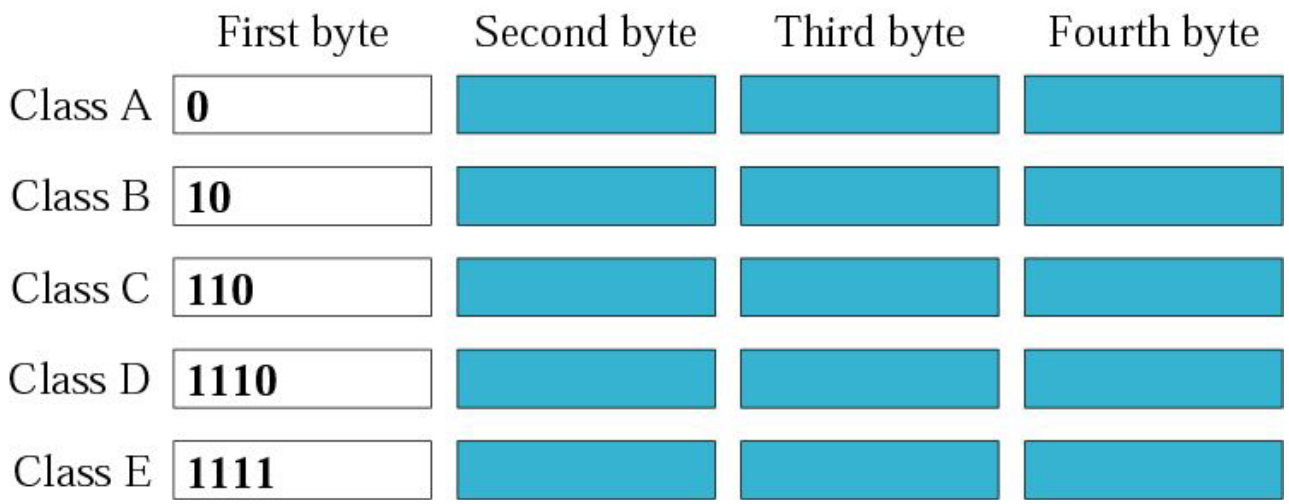
Example 2 : Find the valid - IPv4 addresses.

(a) 123.35.56.78.90
(b) 111.49.096.66
(c) 11100101.45.67.34
(d) 67.56.345.17

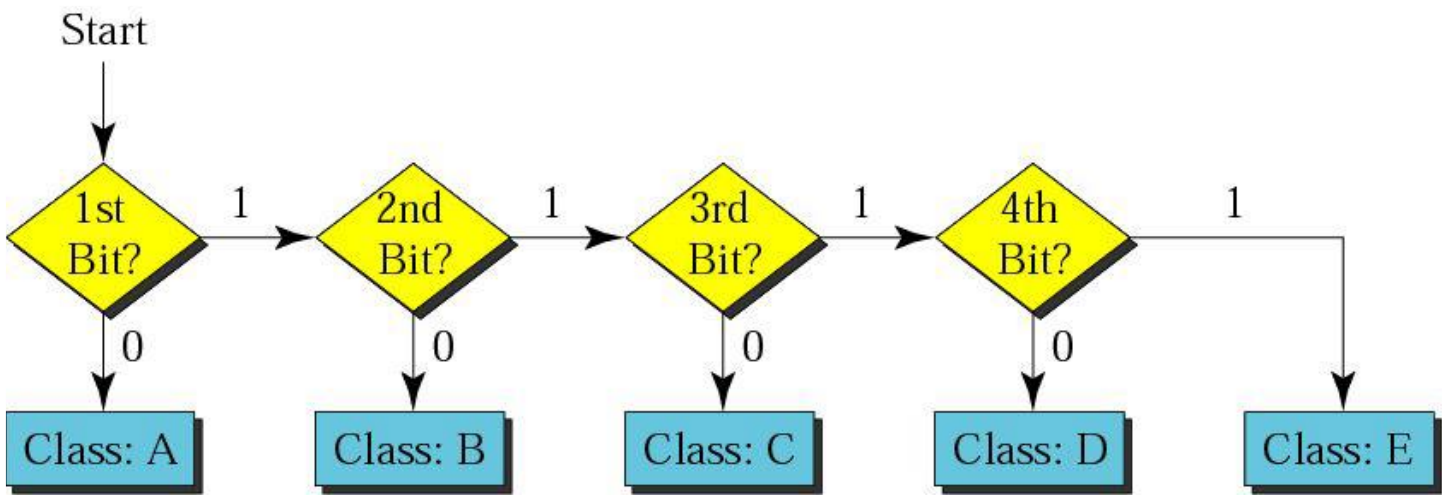
CLASSFUL ADDRESSING

- ***In classful addressing, the address space is divided into five classes:***
- ***A, B, C, D, and E.***

Finding the class in binary notation



- **Finding the address class**



Memorize 1st Octet Values

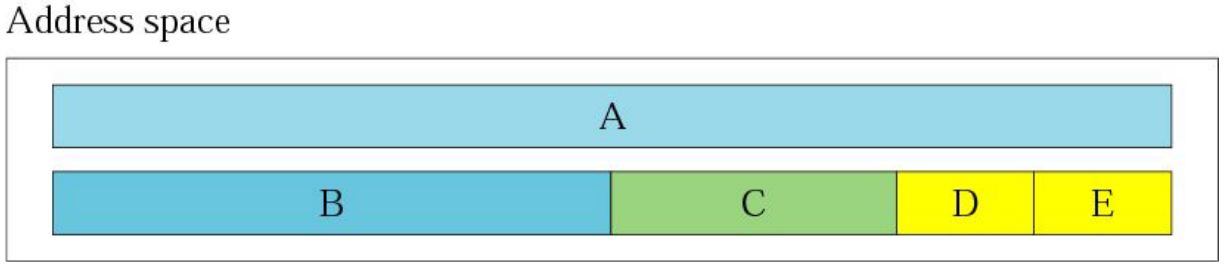
- Class A 1—126*
- Class B 128—191
- Class C 192—223
- Class D 224—239
- Class E 240—255

*127 is reserved for loopback

Finding the class in decimal notation

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

Occupation of the address space

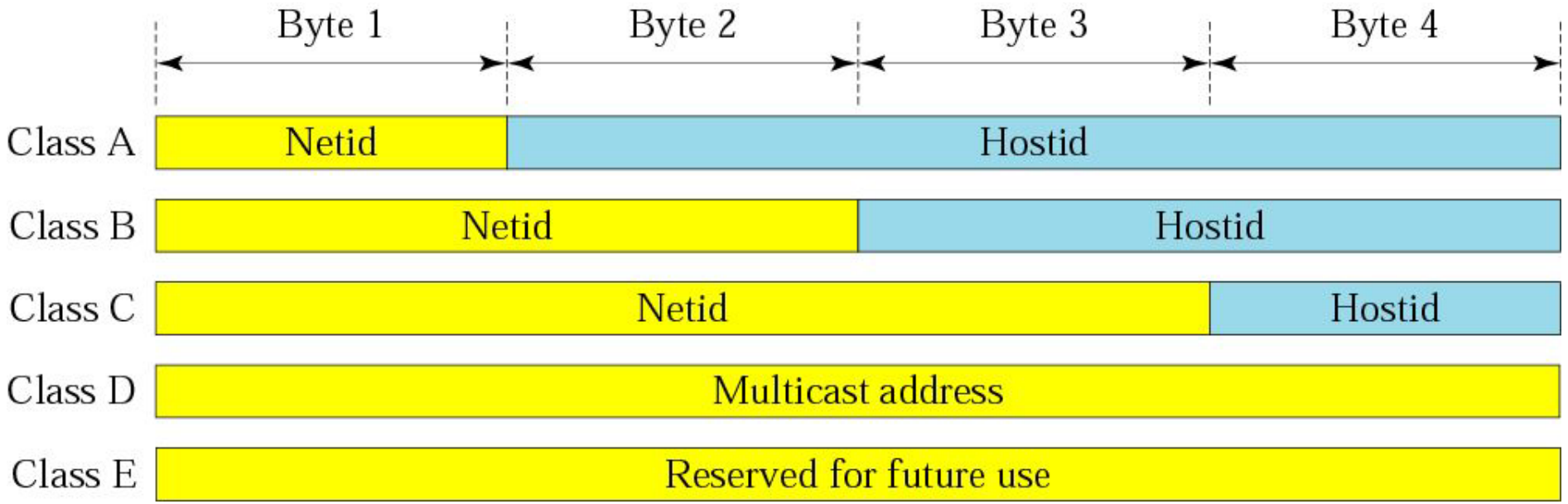


CLASSFUL ADDRESSING

- **IP addresses are hierarchical. It is mainly divided into two parts :**

  (i)Network identification((Netid)

  (ii)Host identification (Hostid)



HOB Values (High Order Bit Values)

	1st Octet Range	1st Octet HOB
Class A	1—126*	0
Class B	128—191	10
Class C	192—223	110
Class D	224—239	1110
Class E	240—255	1111

- *127 is reserved for loopback

Why is the leading HOB a '0' in the 1st octet of a Class A IP address?

Class A IP addresses have a value of 1—126 in the 1st octet.

Let's examine several values in that range:

- 1 in binary is 0 0 0 0 0 0 0 1
- 50 in binary is 0 0 1 1 0 0 1 0
- 88 in binary is 0 1 0 1 1 0 0 0
- 125 in binary is 0 1 1 1 1 1 0 1
- 126 in binary is 0 1 1 1 1 1 1 0

Notice the first bit in each number listed is 0.

All of the numbers 1—126 will have a leading 0.

Why are the 2 leading HOBs '1 0' in the 1st octet of a class B IP address?

- Class B IP addresses have a value of 128—191 in the first octet.
- Let's examine several values in that range:

  - 128 in binary is **1 0** 0 0 0 0 0 0
  - 151 in binary is **1 0** 0 1 0 1 1 1
  - 174 in binary is **1 0** 1 0 1 1 1 0
  - 183 in binary is **1 0** 1 1 0 1 1 1
  - 191 in binary is **1 0** 1 1 1 1 1 1

- Notice the first 2 bits in each number listed are **1 0**.
- The first 2 bits of all of the numbers 128—191 will lead with bits 1 0.

Why are the 3 leading HOBs '1 1 0' in the 1st octet of a class C IP address?

- Class C IP addresses have a value of 192—223 in the first octet.
- Let's examine several values in that range:

  - 192 in binary is **1 1 0** 0 0 0 0 0
  - 201 in binary is **1 1 0** 0 1 0 0 1
  - 213 in binary is **1 1 0** 1 0 1 0 1
  - 220 in binary is **1 1 0** 1 1 1 0 0
  - 223 in binary is **1 1 0** 1 1 1 1 1

- Notice the first 3 bits in each number listed are **1 1 0**.
- The first 3 bits for all the numbers 192—223 will lead with bits 1 1 0.

The HOBs in the 1st octet of Class D IP addresses & Class E IP addresses

- Class D IP addresses have a value of 224—239 in the first octet.
- If we examine the lowest and highest values:
  - 224 in binary is **1 1 1 0** 0 0 0 0
  - 239 in binary is **1 1 1 0** 1 1 1 1
- Notice the first 4 bits in both numbers are 1 1 1 0.
- The first 4 bits for all the numbers 224—239 will lead with the bits 1 1 1 0.

- Class E IP addresses have a value of 240—255 in the first octet.
- If we examine the lowest and highest values:
  - 240 in binary is **1 1 1 1** 0 0 0 0
  - 255 in binary is **1 1 1 1** 1 1 1 1
- Notice the first 4 bits in both numbers are 1 1 1 1.
- The first 4 bits for all the numbers 240—255 will lead with the bits 1 1 1 1.

Example

Find the class of each address.

(a) 00000001 00011011 00001011 11101111

(b) 11000001 10000011 00011011 11111111

(c) 16.23.120.8

(d) 252.5.15.111

Ans :

a. **The first bit is 0 → class A address.**

b. The first 3bits are 110 → so class C address.

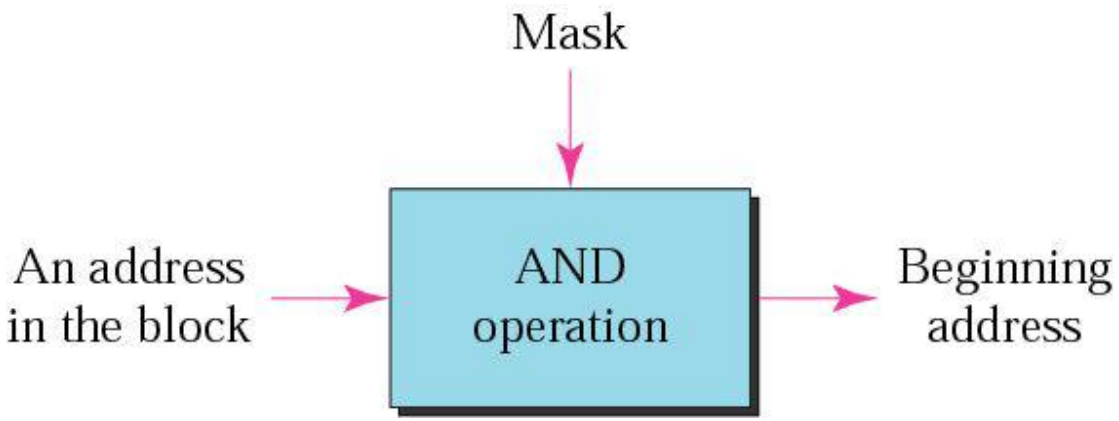
c. The first byte is 16 → class is A.

d. The first byte is 252→ class is E.

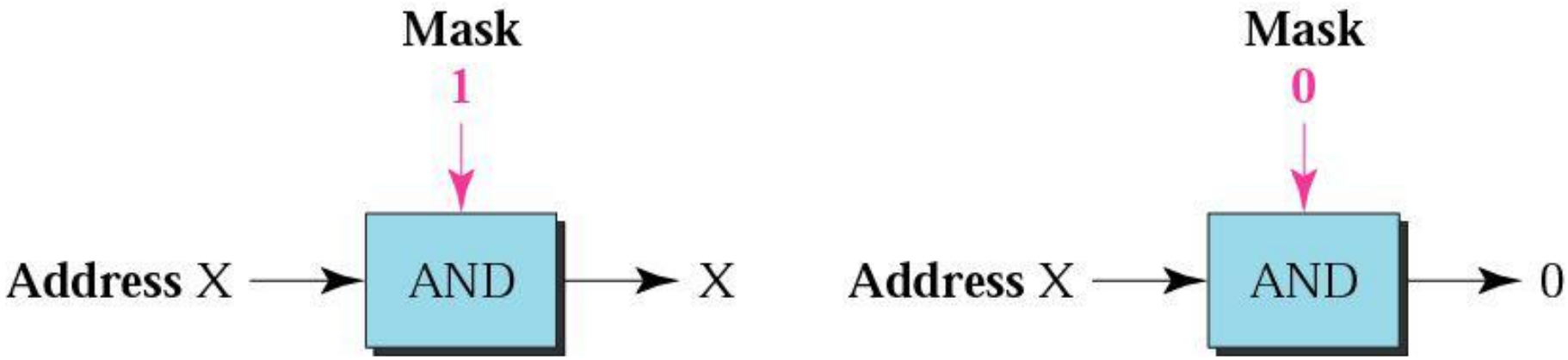
Mask

- A mask is a 32-bit binary number that gives the first address in the block (the network address) when bitwise ANDed with an address in the block.

Masking concept



AND operation



Default Subnetmasks

Class	1st Octet	2nd Octet	3rd Octet	4th Octet
A	N 255	H 0	H 0	H 0
B	N 255	N 255	H 0	H 0
C	N 255	N 255	N 255	H 0
The default subnetmask has all ones for each network octet. (255 = 11111111)				

Default Subnetmask Patterns

Network and Host bits

Default Subnetmask in dotted decimal

Default Subnetmask in binary

Class	Format	Dotted Decimal	Binary
A	NHHH	255.0.0.0	11111111 00000000 00000000 00000000
B	NNHH	255.255.0.0	11111111 11111111 00000000 00000000
C	NNNH	255.255.255.0	11111111 11111111 11111111 00000000

OBSERVE! In binary, there are all ones for the network bits!

In binary, there are all zeros for the host bits!

IMPORTANT IP FACTS

CLASS	1ST OCTET RANGE	HOB	Format	Default Subnetmask		
A	1-126	0-------	N.H.H.H	255.0.0.0		
B	128-191	10------	N.N.H.H	255.255.0.0		
C	192-223	110-----	N.N.N.H	255.255.255.0		
D	**224-239**	**1110----**	**-------**	**-------**		
E	**240-255**	**1111----**	**-------**	**-------**		

‘ANDing’ with a Class A Default Subnetmask

- Every IP address has a subnetmask (SM).
- The subnetmask is used by the internetworking devices to determine the network bits and the host bits.
- ‘ANDing’ the IP address and subnetmask identifies the network ID or subnet ID.

To ‘AND’ the IP and the SM, multiply each bit:

	Dotted Decimal	**Binary**
IP:	93.12. 5. 3	01011101 00001100 00000101 00000011
SM:	255. 0. 0. 0	11111111 00000000 00000000 00000000
Network ID after ANDing		01011101 00000000 00000000 00000000

For the IP Address 93.12.5.3, the network ID IS 93.0.0.0

‘ANDing’ the ones returns the same value for the 1st octet: 01011101 or 93.

‘ANDing’ the zeros in octets 2, 3, and 4, returns 0 for each octet.

‘ANDing’ with a Class B Default Subnetmask

- Every IP address has a subnetmask (SM).
- The subnetmask is used by the internetworking devices to determine the network bits and the host bits.
- ‘ANDing’ the IP address and subnetmask identifies the network/subnet ID.

To ‘AND’ the IP and the SM, multiply each bit:

	Dotted Decimal	**Binary**
IP:	155. 144.17. 15	10011011 10010000 00010001 00001111
SM:	255. 255. 0 .0	11111111 11111111 00000000 00000000
Network ID after ANDing		10011011 10010000 00000000 00000000

For the IP Address 155.144.17.15, the network ID IS 155.144.0.0

‘ANDing’ the ones returns the same value for 1st & 2nd octets: 10011011 10010000 00010001 or 155.144.
‘ANDing’ the zeros in octets 3 and 4, returns 0 for those octets .0.0.

‘ANDing’ with a Class C Default Subnetmask

- Every IP address has a subnetmask (SM).
- The subnetmask is used by the internetworking devices to determine the network bits and the host bits.
- ‘ANDing’ the IP address and subnetmask identifies the network/subnet ID.

To ‘AND’ the IP and the SM, multiply each bit:

	Dotted Decimal	**Binary**
IP:	211. 44. 7. 5	11010011 00101100 00000111 00000101
SM:	255.255. 255. 0	11111111 11111111 11111111 00000000
Network ID after ANDing		11010011 00101100 00000111 00000000

For the IP Address 211.44.7.5, the network ID IS 211.44.7.0

‘ANDing’ the ones returns the same value for 1st, 2nd, & 3rd octets: 11010011 00101100 00000111or 211.44.7.
‘ANDing’ the zeros in octet 4, returns 0 for that octet.

IP BASICS Information

128 192 224 240 248 252 254 255 Accumulated High Order Bit Values*

___ ___ ___ ___ ___ ___ ___ ___

128 64 32 16 8 4 2 1 Values of Each Bit in an Octet

*Accumulated High Order Bits Values match subnetmask values

PRIVATE IP ADDRESS RANGES

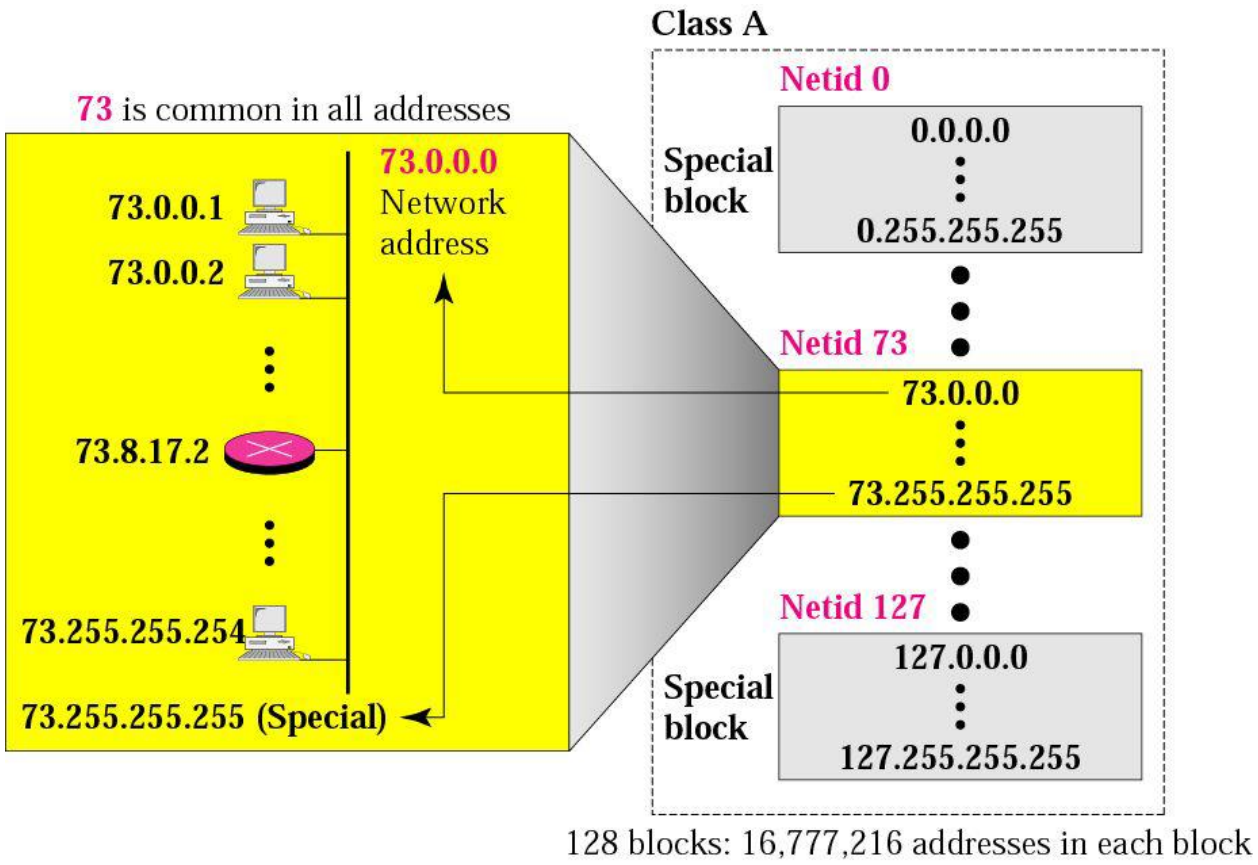
KNOW THESE **PRIVATE ADDRESS** RANGES

- 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

- Private addresses created by RFC 1918 are to be used for addressing internal networks.

The network address is the beginning address of each block. It can be found by applying the default mask to any of the addresses in the block (including itself). It retains the netid of the block and sets the hostid to zero.

Blocks in class A



128 blocks: 16,777,216 addresses in each block

- Total netid blocks possible are 2 ^ 7 = 128
- The first and last block in this class reserved for special purpose:

a) This network : netid= all 0's

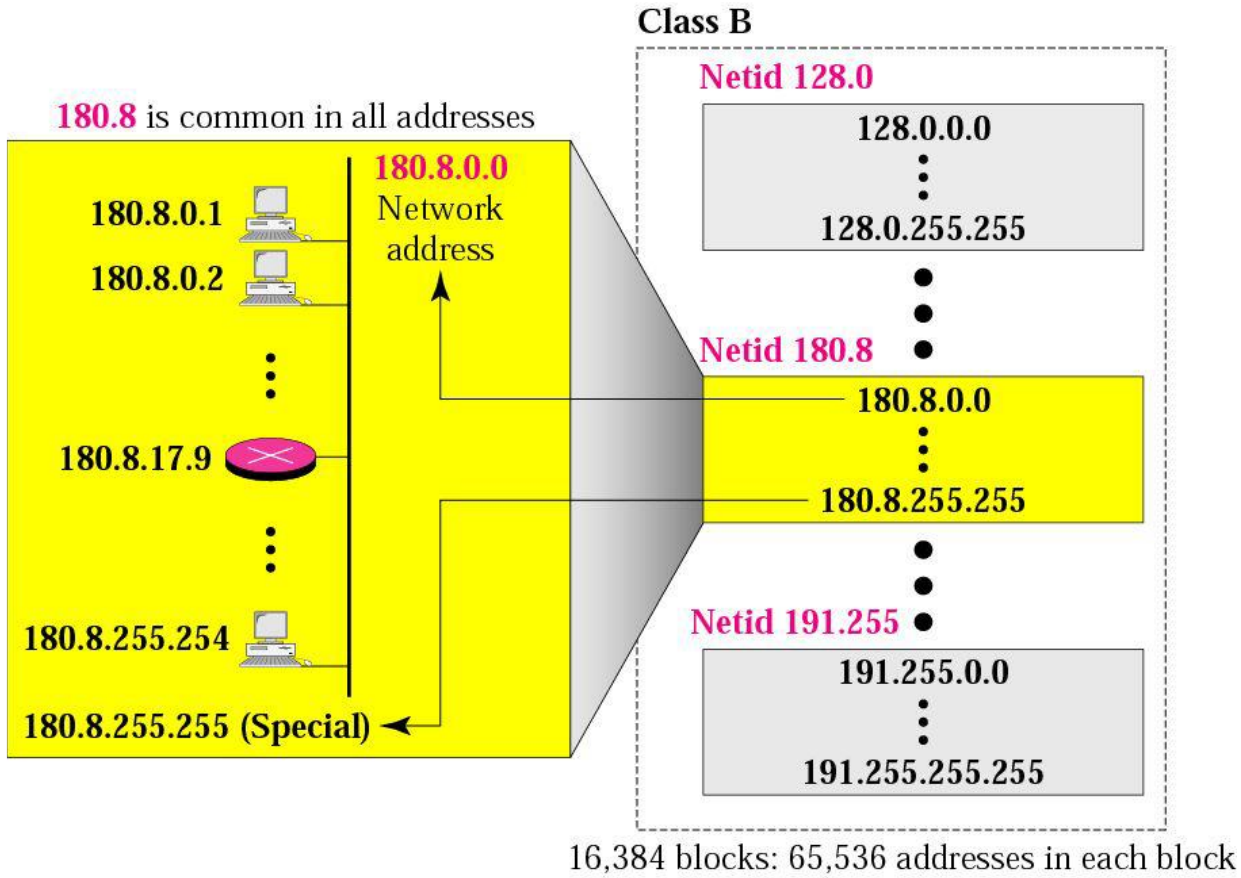
b) Loopback address: netid = 127

- Also one block (netid 10) used for private address.
- Therefore,

total no. of organizations that can have class A addresses is only **125**

Millions of class A addresses are wasted.

Blocks in class B



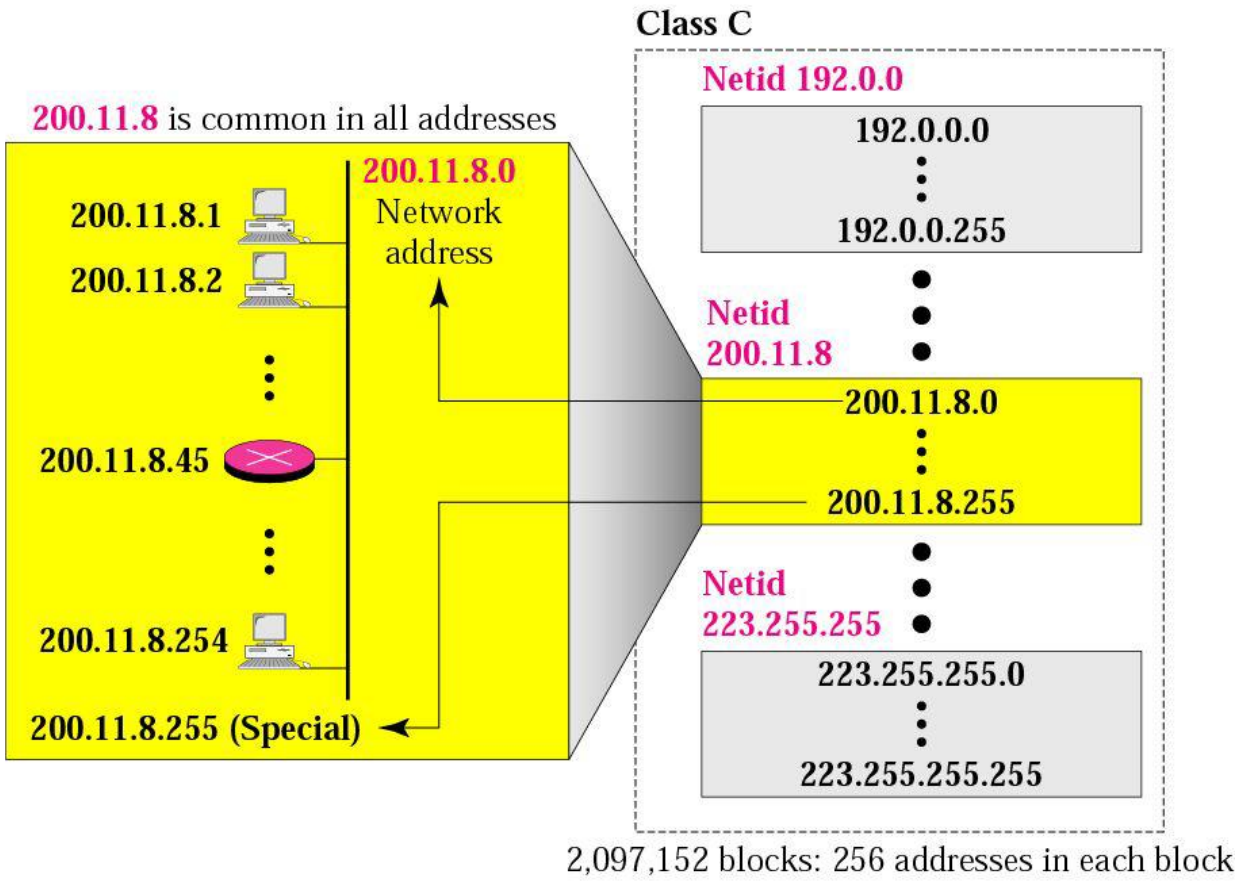
Total netid blocks possible are 2^14 = 16384

•Sixteen blocks are reserved for private addresses:
netids 172.16 to 172.31

• Therefore, total no. of organizations that can have class A addresses is only **16384 – 16 = 16368**

Many class B addresses are wasted.

Blocks in class C



•Total netid blocks possible are 2^21 = 2097152

•256 blocks are reserved for private addresses:
netids 192.168.0 to 192.168.255

• Therefore,
total no. of organizations that can have class A addresses is only
2097152 – 256 = 2096896

The number of addresses in a class C block is smaller than the needs of most organizations.

Class D addresses are used for multicasting; there is only one block in this class.

Class E addresses are reserved for special purposes; most of the block is wasted.

In classful addressing,
the network address
(the first address in the block)
is the one that is assigned
to the organization.

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

- 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.

Given the network address 132.21.0.0, find the class, the block, and the range of the addresses.

- The class is B because the first byte is between 128 and 191. The block has a netid of 132.21.
- The addresses range from 132.21.0.0 to 132.21.255.255.

Given the network address 220.34.76.0, find the class, the block, and the range of the addresses.

- The class is C because the first byte is between 192 and 223. The block has a netid of 220.34.76.
- The addresses range from 220.34.76.0 to 220.34.76.255.

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

- 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.

Given the address 132.6.17.85 and the default class B mask, find the beginning address (network address).

- The default mask is 255.255.0.0, which means that the first 2 bytes are preserved and the other 2 bytes are set to 0s.
- The network address is 132.6.0.0.

Given the address 201.180.56.5 and the class C default mask, find the beginning address (network address).

- The default mask is 255.255.255.0, which means that the first 3 bytes are preserved and the last byte is set to 0.
- The network address is 201.180.56.0.

We must not apply the default mask of one class to an address belonging to another class.