UNIT-III (Contd.)

IP ADDRESSING

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IP Address

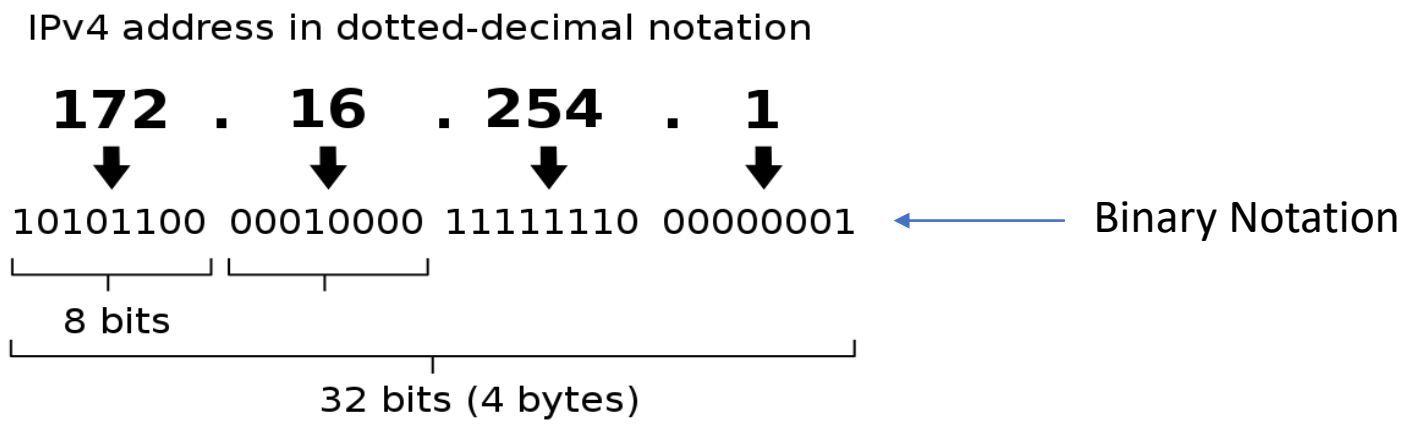
- An IP address is a unique global address for a network interface.

- IP address can be categorized as:
  - **Special Addresses:** these are assigned to specific host/network like:
    - Network Address: address assigned to some network
    - Broadcast Address: used to send information to all other computers within the network
  - **Normal Addresses:** these are assigned to any host/computer in the network.

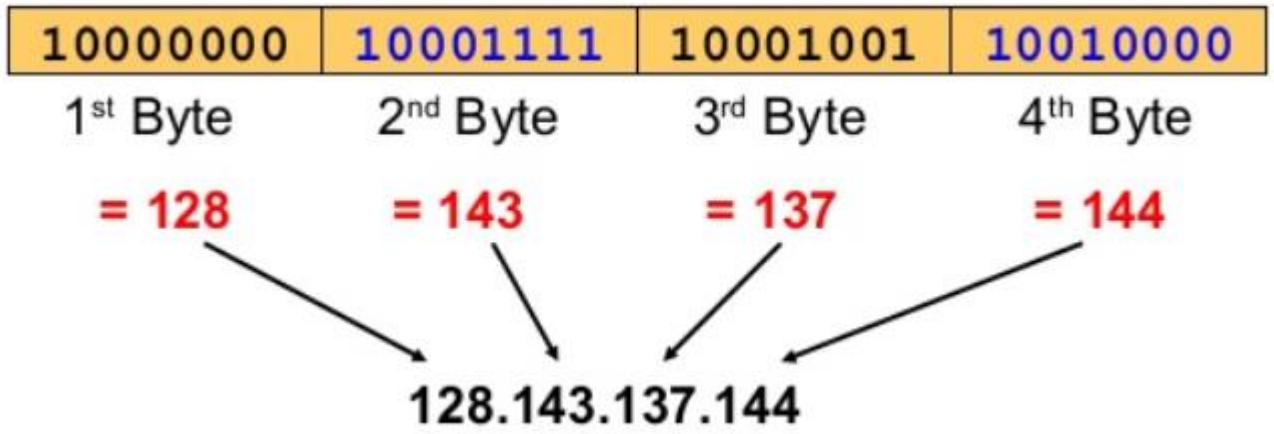
IP Address Representation

- Binary Notation
- Dotted Decimal Notation

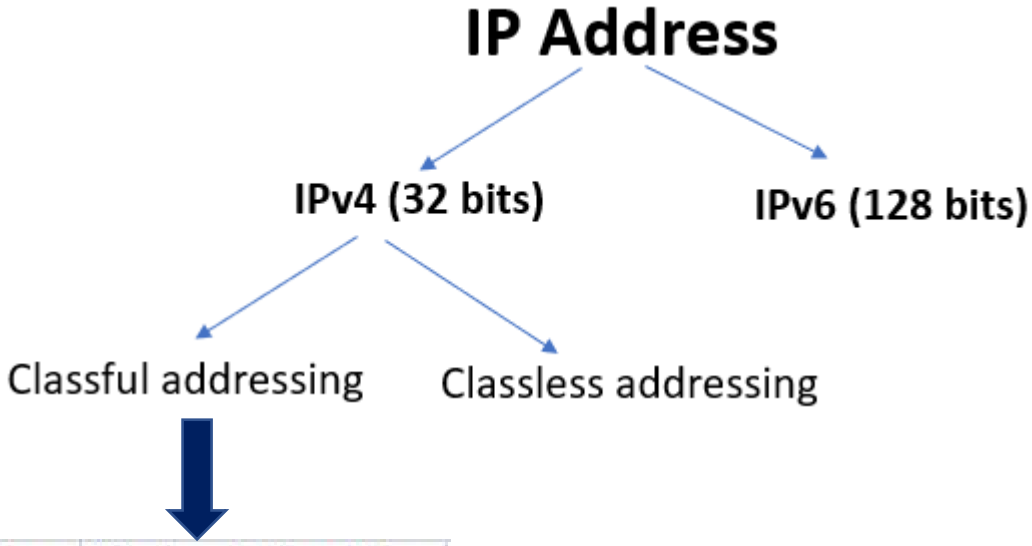
E.g.



E.g.



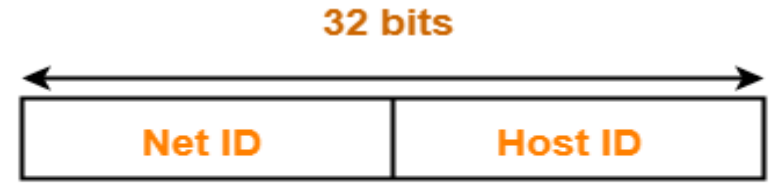
IP ADDRESSING



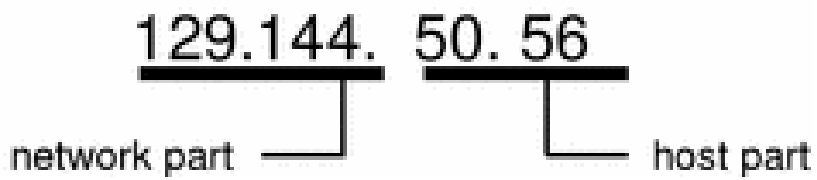
Class	First octet value
A	0-127
B	128-191
C	192-223
D	224-239
E	240-255

E.g. IP address **172.16.254.1** belongs to **Class B** as the 1st byte or the 1st octet i.e. 172 lies in Class B range i.e. 128-191.

- IP address is divided into **two parts:**
  - Network part i.e. **net id** (identifies a network in the internet)
  - Host part i.e. **host id** (identifies a host in that network)



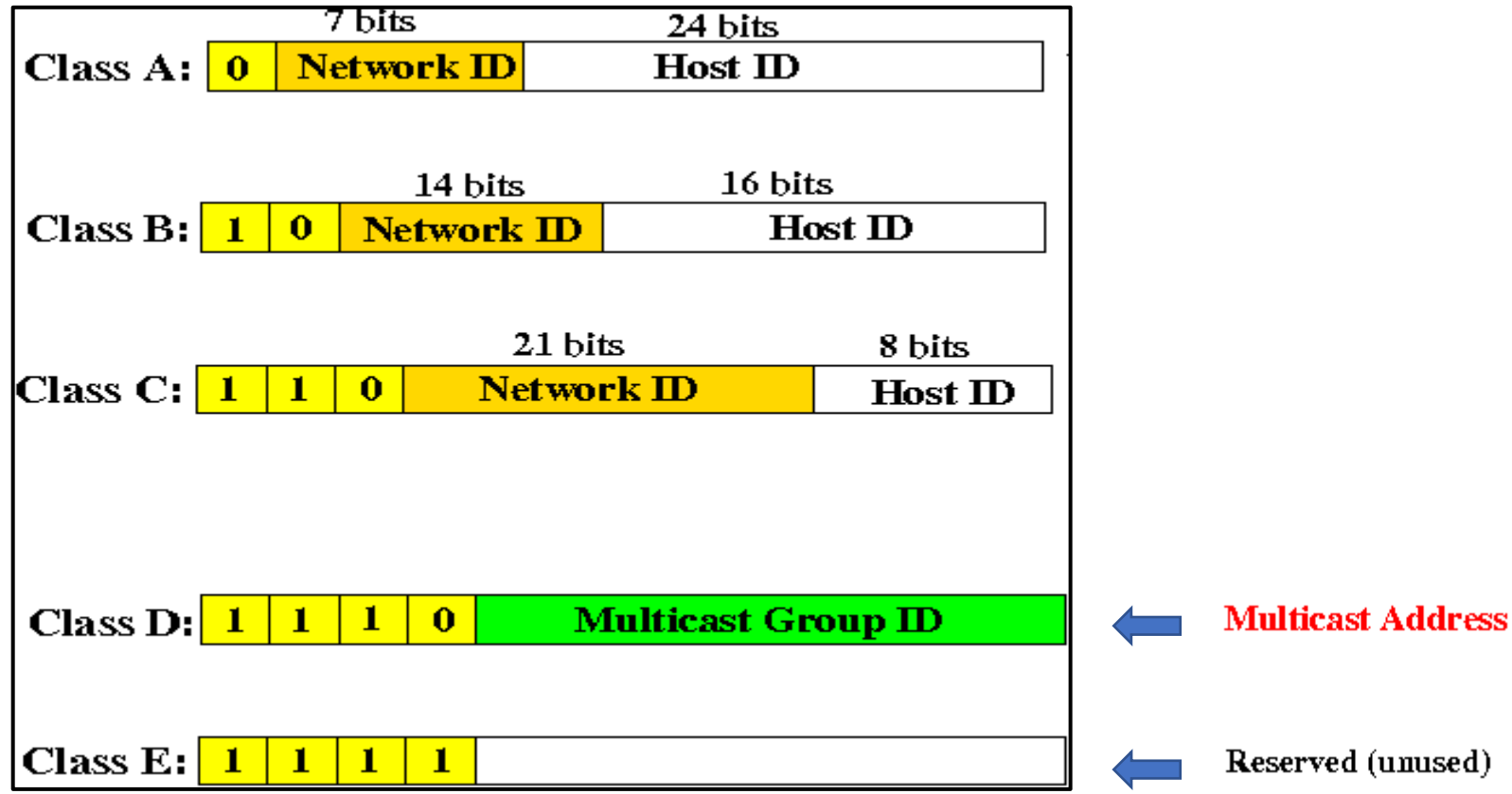
Format of an IP Address



Depending on the class to which this IP Address belongs

Classes of IP Address

Class	Range
A	**0**.0.0.0 to **127**.255.255.255
B	**128**.0.0.0 to **191**.255.255.255
C	**192**.0.0.0 to **223**.255.255.255
D	**224**.0.0.0 to **239**.255.255.255
E	**240**.0.0.0 to **255**.255.255.255

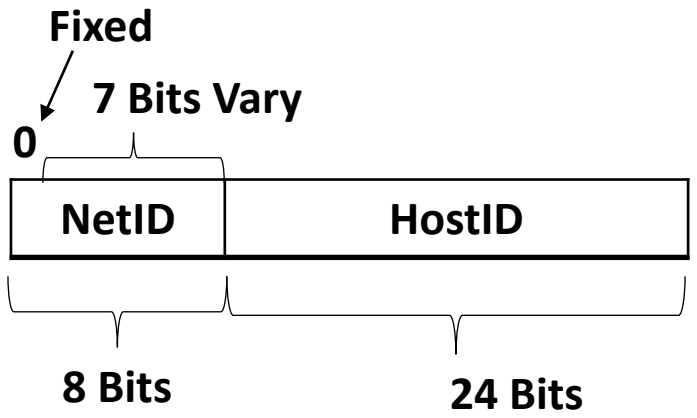


Multicast Address

Reserved (unused)

Class A:

- In a Class A Network binary address start with 0 and rest of the 7 bits may vary, therefore the decimal number in the first byte can be anywhere from 0 to 127.
- Class A IP address range: **[0.0.0.0] to [127.255.255.255]**
- The first 8 bits (the first octet) identify the network and the remaining 24 bits indicate the host within the network.
- An example of a Class A IP address is 102.168.212.226, where "102" identifies the network and "168.212.226" identifies the host on that network.
- **No. of Class A networks possible = 2^7**
- **No. of Class A hosts possible within any Class A network = $2^{24} - 2$** → (Except Network address and Broadcast address)



NetID varies from **0** 0000000 → 0
0 1111111 → 127 } (0-127)

- **NOTE:**
  - To identify the **network address,** all host bits must be 0
  - To identify the **broadcast address,** all host bits are set to 1

E.g. 7.20.180.5 is a class A IP address

To find the network address of this IP address, 1st identify the netID and the hostID.

Here, the netID is “7” and the hostID is “20.180.5”

Therefore, to find its **network address,** set all the host bits to 0, that is,

00000111 00000000 00000000 00000000

i.e. 7.0.0.0 is the network address of the given IP address.

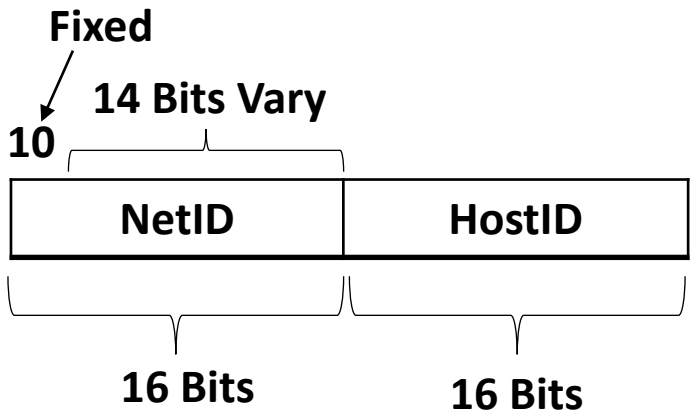
To find its **broadcast address**, set all host bits to 1, that is,

00000111 11111111 11111111 11111111 i.e. 7. 255.255.255 is the broadcast address.

Class B:

- In a Class B Network binary address start with 10 and rest of the 14 bits may vary, therefore the decimal number in the first byte can be anywhere from 128 to 191.
- Class B IP address range: **[128.0.0.0] to [191.255.255.255]**
- The first 16 bits (two bytes) identify the network and the remaining 16 bits indicate the host within the network.
- An example of a Class B IP address is 182.18.255.20, where "182.18" identifies the network and "255.20" identifies the host on that network.
- **No. of Class B networks possible = 2^{14}**
- **No. of Class B hosts possible within any Class B network = $2^{16} - 2$**

NetID varies from **10** 000000 → 128
10 111111 → 191
} (128-191)



E.g. 128.227.0.50 is a class B IP address

Here, the netID is “128.227” and the hostID is “0.50”

Therefore, it’s **network address,** is 10000000 11100011 00000000 00000000

i.e. 128.227.0.0 is the network address of the given IP address.

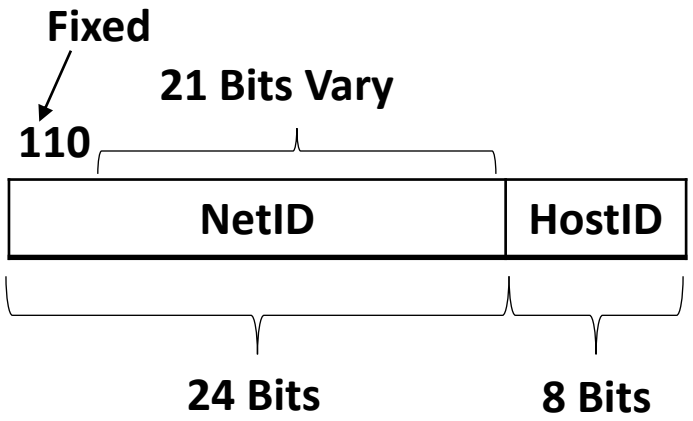
To find its **broadcast address**, set all host bits to 1, that is,

10000000 11100011 11111111 11111111 i.e. 128. 227.255.255 is the broadcast address.

Class C:

- In a Class C Network binary address start with 110 and rest of the 21 bits may vary, therefore the decimal number in the first byte can be anywhere from 192 to 223.
- Class C IP address range: **[192.0.0.0] to [223.255.255.255]**
- The first 24 bits (three bytes) identify the network and the remaining 8 bits indicate the host within the network.
- An example of a Class C IP address is 211.64.15.1, where "211.64.15" identifies the network and “1" identifies the host on that network.
- **No. of Class C networks possible = 2^{21}**
- **No. of Class C hosts possible within any Class C network = $2^8 – 2$**

NetID varies from **110** 00000 → 192
110 11111 → 223
} (192-223)



E.g. 211.64.15.1 is a class C IP address

Here, the netID is “211.64.15” and the hostID is “1”

Therefore, it’s **network address,** is 11010011 01000000 00001111 00000000

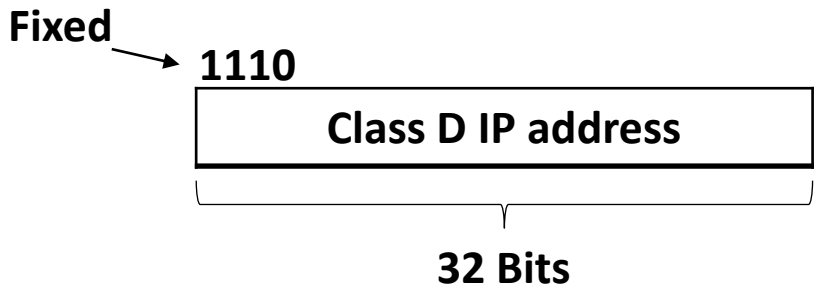
i.e. 211.64.15.0 is the network address of the given IP address.

To find its **broadcast address**, set all host bits to 1, that is,

11010011 01000000 00001111 11111111 i.e. 211.64.15.255 is the broadcast address.

Class D:

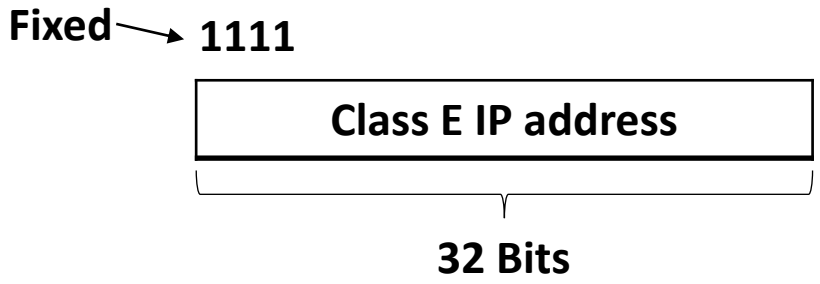
- Class D IP addresses are reserved for **Multicasting.**
- There is no netID and hostID in a Class D IP address but it's first four bits are fixed starting from 1110 and rest of the 28 bits may vary, therefore the decimal number in the first byte can be anywhere from 224 to 239.
- Class D IP address range: **[224.0.0.0] to [239.255.255.255]**



1st octet of Class D varies from
1110 0000 → 224
1110 1111 → 239

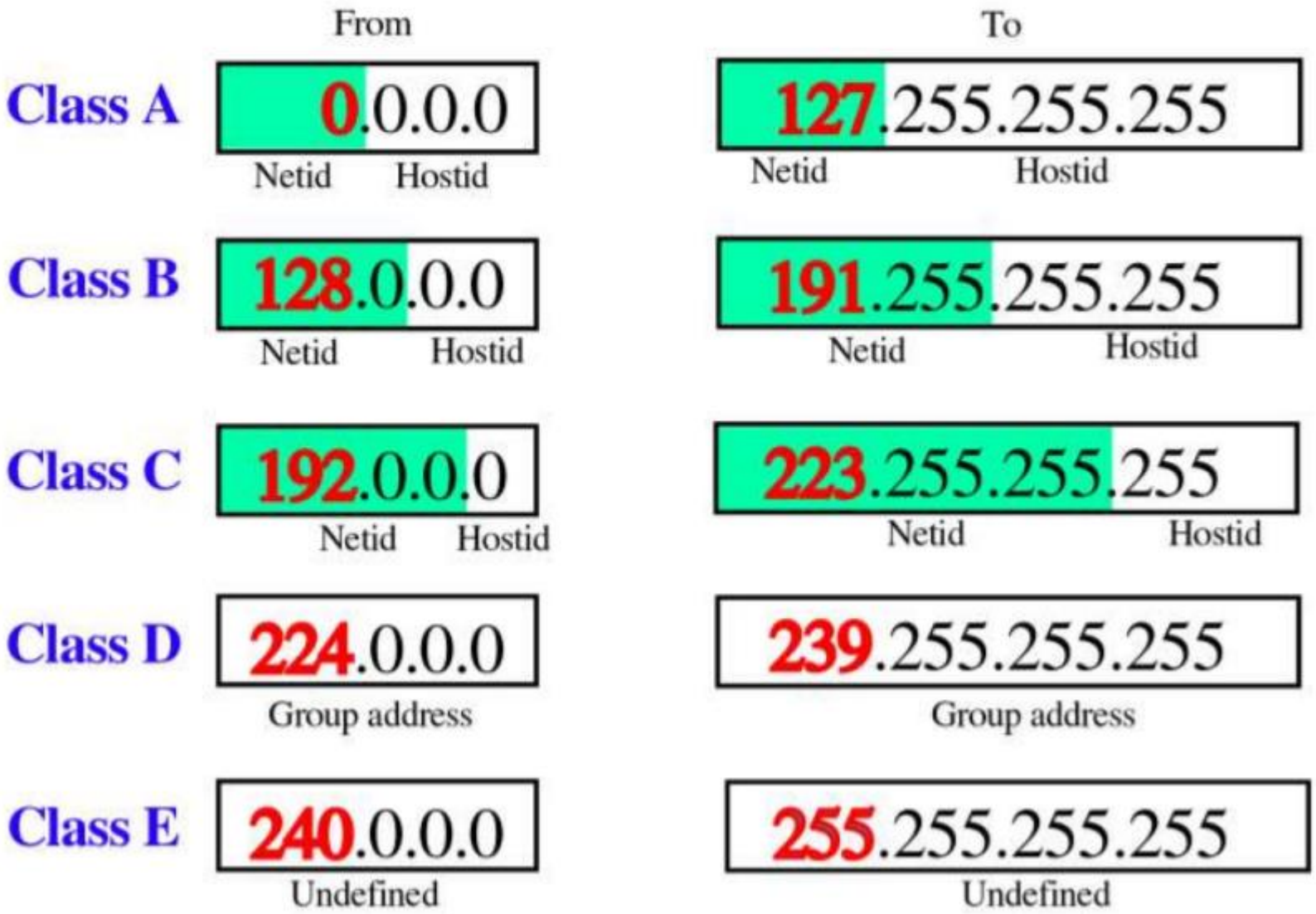
Class E:

- Class E IP addresses are reserved for future purposes such as research, testing and experimentation. They have never been documented or utilized in a standard way.
- In a Class E Network, binary IP addresses start with 1111, therefore the decimal number can range from 240 to 255.
- Class E IP address range: **[240.0.0.0] to [255.255.255.255]**



1st octet of Class E varies from
1111 0000 → 240
1111 1111 → 255

Class Ranges of IPv4 Address



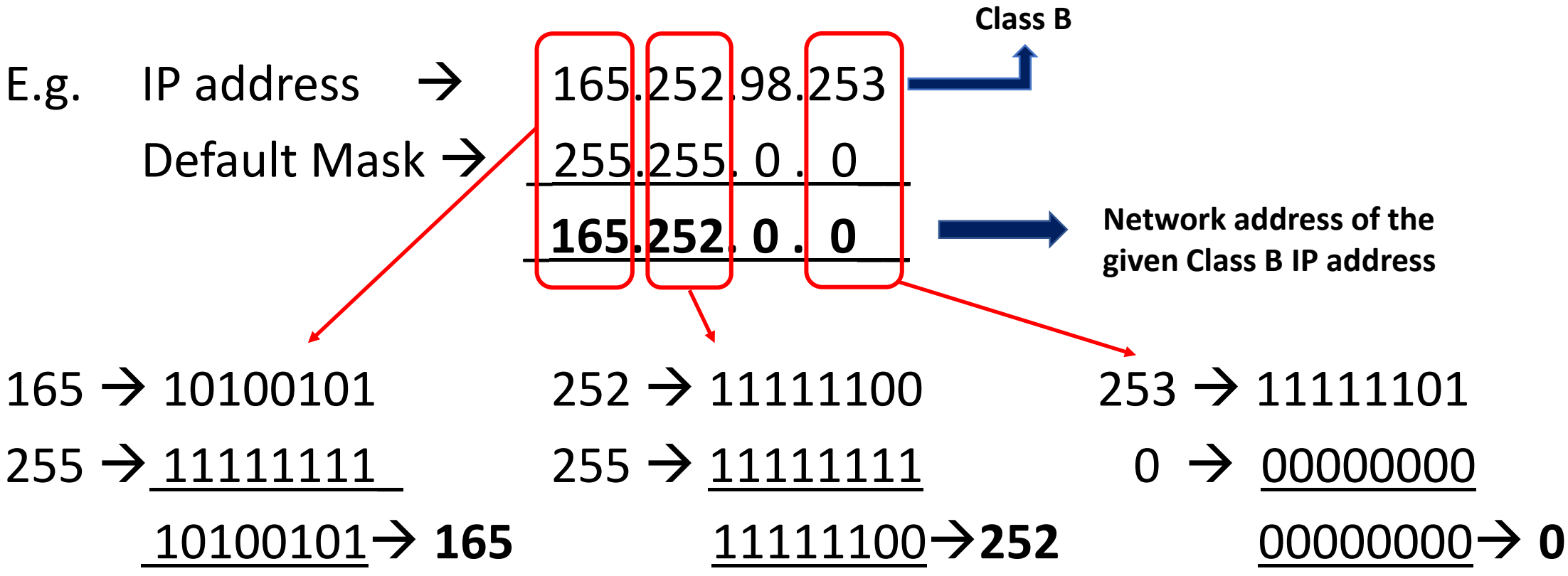
Default Mask:

- Although the length of the netid and hostid (in bits) is predetermined in classful addressing, we can also use a default mask
- **Default Mask** is used to determine the network address of a given IP address.
- Default mask can be created by setting all NetID bits to 1 and HostID bits to 0.

The masks for classes A, B, and C are shown below:

Class	*Binary*	*Dotted-Decimal*
A	11111111 00000000 00000000 00000000	255.0.0.0
B	11111111 11111111 00000000 00000000	255.255.0.0
C	11111111 11111111 11111111 00000000	255.255.255.0

- Default mask is masked (AND operation) with the given IP address to produce it's **Network address**.



- **IP Addresses can also be categorized as:**
  - Private IP address
  - Public IP address

PRIVATE IP	PUBLIC IP
• Used within LAN or within the organization	• Used on public networks (INTERNET)
• Not recognized on internet	• Recognized on internet
• Provided by Administrator	• Provided by Service Provider
• Unique within network or organization	• Globally unique
• Free of cost	• Fee paid to service provider (or IANA)
• Scope is Local	• Scope is Global
• Unregistered IP address	• Registered IP address

Private IP Addresses:

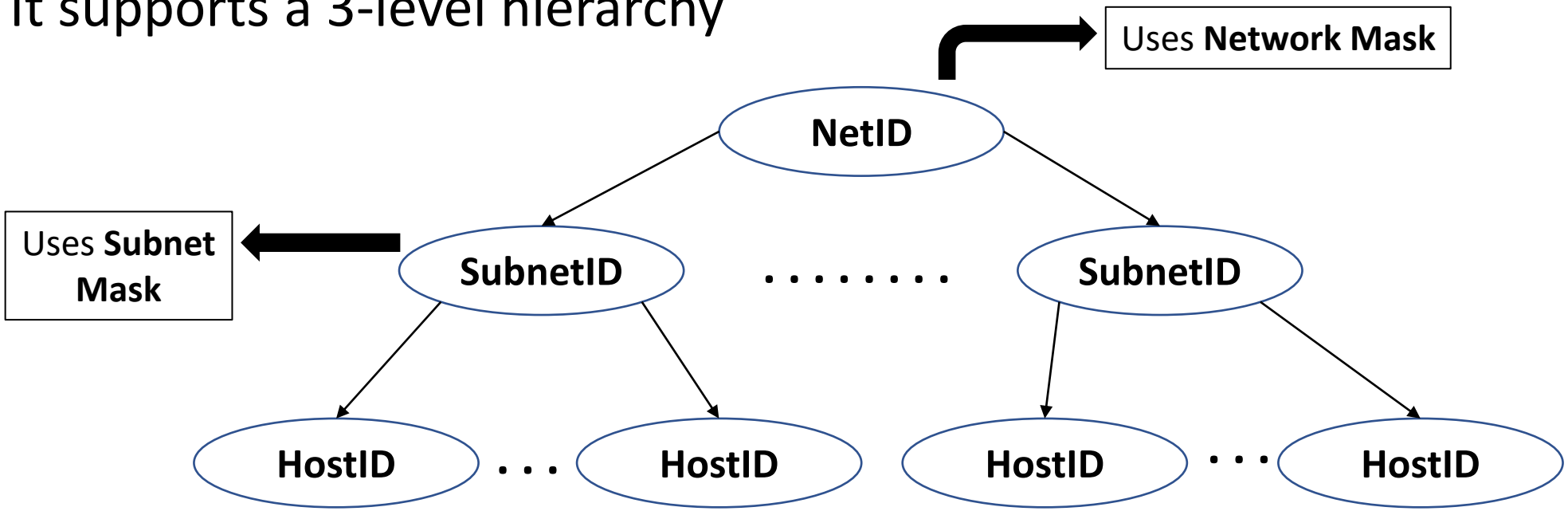
Private IP address space	
From	**To**
10.0.0.0	10.255.255.255
172.16.0.0	172.31.255.255
192.168.0.0	192.168.255.255

All other IP addresses are <u>Public addresses</u>

Eg. 11.1.5.60

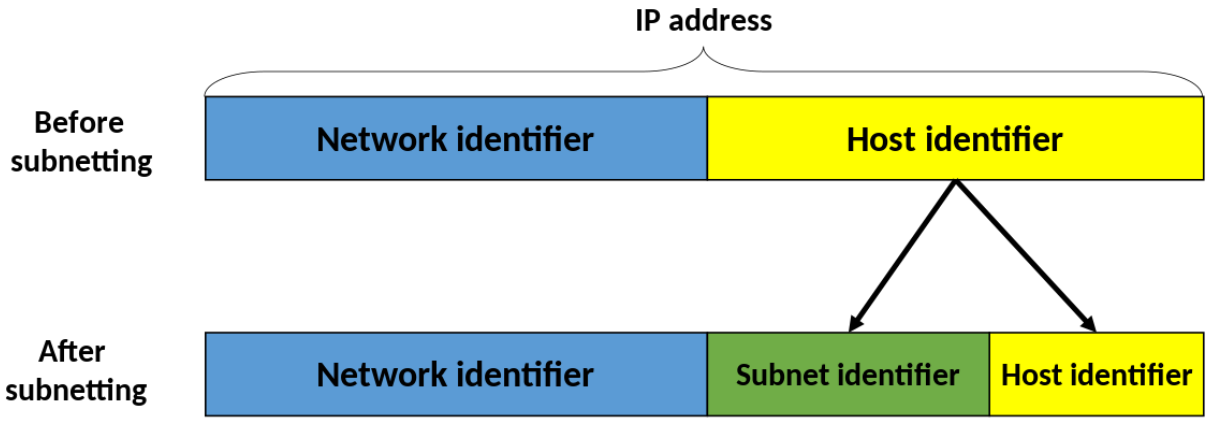
Subnetting

- Dividing a network into smaller networks for efficient utilization of IP addresses is known as **Subnetting.**
- It supports a 3-level hierarchy



- Subnetwork→ always in power of 2 i.e. no. of subnetworks possible will always be power of 2

- To create a subnetwork, we borrow some of the HostID bits as SubnetID



Total no. of subnets created = 2^n

Total no. of subnets utilized = $2^n - 2$

Eg. Create 8 subnetworks for a network 165.170.0.0 and list them.

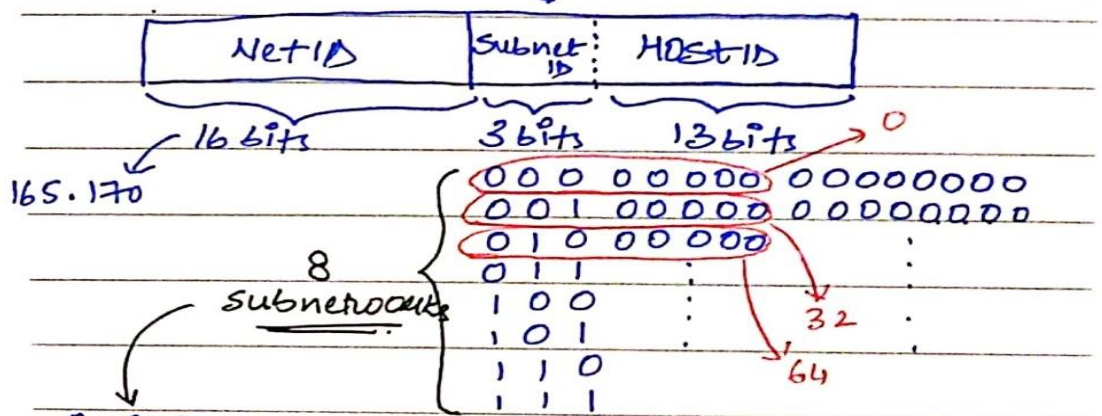
Soln:

165.170.0.0 ⇒ Class B

∴ NetID ⇒ 165.170

Subnetwork ⇒ $8 = 2^3$

∴ subnetwork can be represented using 3 bits



∴ Subnetworks:

165.170.0.0 → cannot be assigned anywhere ∴ it is equal (due to conflict) to network address.
165.170.32.0
165.170.64.0
165.170.96.0
165.170.128.0
165.170.160.0
165.170.192.0
165.170.224.0

⇒ To find broadcast address for a given subnetwork IP address :

eg 165.170.96.0

165.170 . 011 00000 00000000

Net ID | Subnet ID bits | Host ID

To find its broadcast address, set all HOST bits to 1.

i.e.

165.170 . 011 11111 11111111

165.170.127.255 ⇒ Broadcast address.

SUBNET MASK:

- The Subnet mask is used to get the **Subnetwork address** for the given IP address.
- Subnet mask can be generated by setting the NetID and SubnetID bits to 1 and remaining HostID bits are set to 0.

For the previous example, when we have 8 subnets.

The given IP address 165.170.0.0 ⇒ Class B IP add.

where NetID bits → 16 bits

HostID bits → 13 bits

Subnet ID bits → 3 bits.

Set NetID bits & SubnetID bits to 1 & HostID bits to 0.

∴ Class B subnet mask for this subnetwork ⇒ 11111111 11111111 11100000 00000000

NetID SubnetID HostID

255.255.244.0

- Subnet Mask can be used to identify the **Subnetwork Address** of the given IP address by masking the subnet mask with the IP address.

IP Address
Subnet Mask
Subnet Address

Eg. **Identify the Subnet address for the given IP address 165.170.198.200 when there are 8 subnets for a given network.**

165.170.198.200
255.225.224. 0
165.170.**192**. 0 → **Subnet Address**

Address Depletion

- The imperfection in classful addressing scheme combined with the fast growth of the Internet led to the near depletion of the available addresses.

- Yet the number of devices on the Internet is much less than the 2^{32} address space. We have run out of class A and B addresses, and class C address space is too small for most midsize organizations.

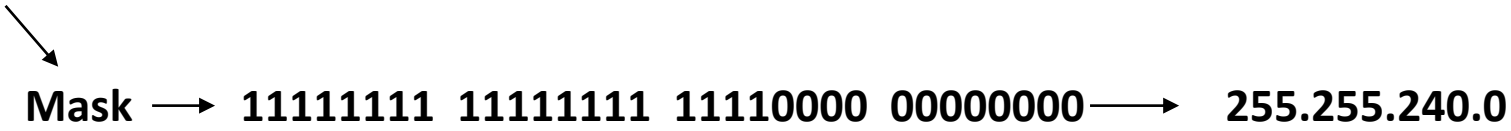
- One solution that has alleviated the problem is the idea of **Classless Addressing**.

Classless Addressing

- Classless addressing is used to overcome address depletion and give organizations more access to the Internet.
- In this addressing scheme, there **no classes**, but the addresses are represented as **Blocks** (group of IP addresses).
- 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 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.

- Classless address is represented using **CIDR notation (Classless Inter Domain Routing notation).** Also known as **Slash notation**.
- **Format of CIDR notation:** x. y. z. w/ n

e.g. 190.36.73.119/20



n helps find the default mask for the given IP address, where n denotes that 1st n bits of the mask IP address is set to 1 and rest of the bits are set to 0.

No. of addresses in a Block = $2^{32 - n}$

eg. Q) If one of the addresses of Block is 201.15.89.99/26 the no. of addresses in a Block = ?

Soln:

No. of addresses in a Block = 2^{32-n} n → mask

$= 2^{32-26}$

$= 2^6$ → (should be available in the last octet)

$= 64$ IP addresses.

99 ⇒ 01100011

01 000000 = 64 → 1st address of the Block

01 111111 = 127 → Last address of the Block.

∴ Range of Block = 201.15.89.64/26 to 201.15.89.127/26

(continuous addresses)

1st add. → 64

add. = 64

$64 \overline{)64}\ 1$

$\frac{64}{0}$ → ∴ exactly divisible.

eg. If 1 of the add. of the Block is 136.196.130.143/27.

Soln: # addresses in a Block = $2^{32-27} = 2^5$ (last octet)

$= 32$ IP addresses.

143 ⇒ 10001111

100 00000 = 128

100 11111 = 159

Range of the Block = 136.196.130.128/27 to 136.196.130.159/27