PSIT
Kanpur

COMPUTER NETWORKS (RCS – 601)

IP & SUBNET MASKING (PART 2)

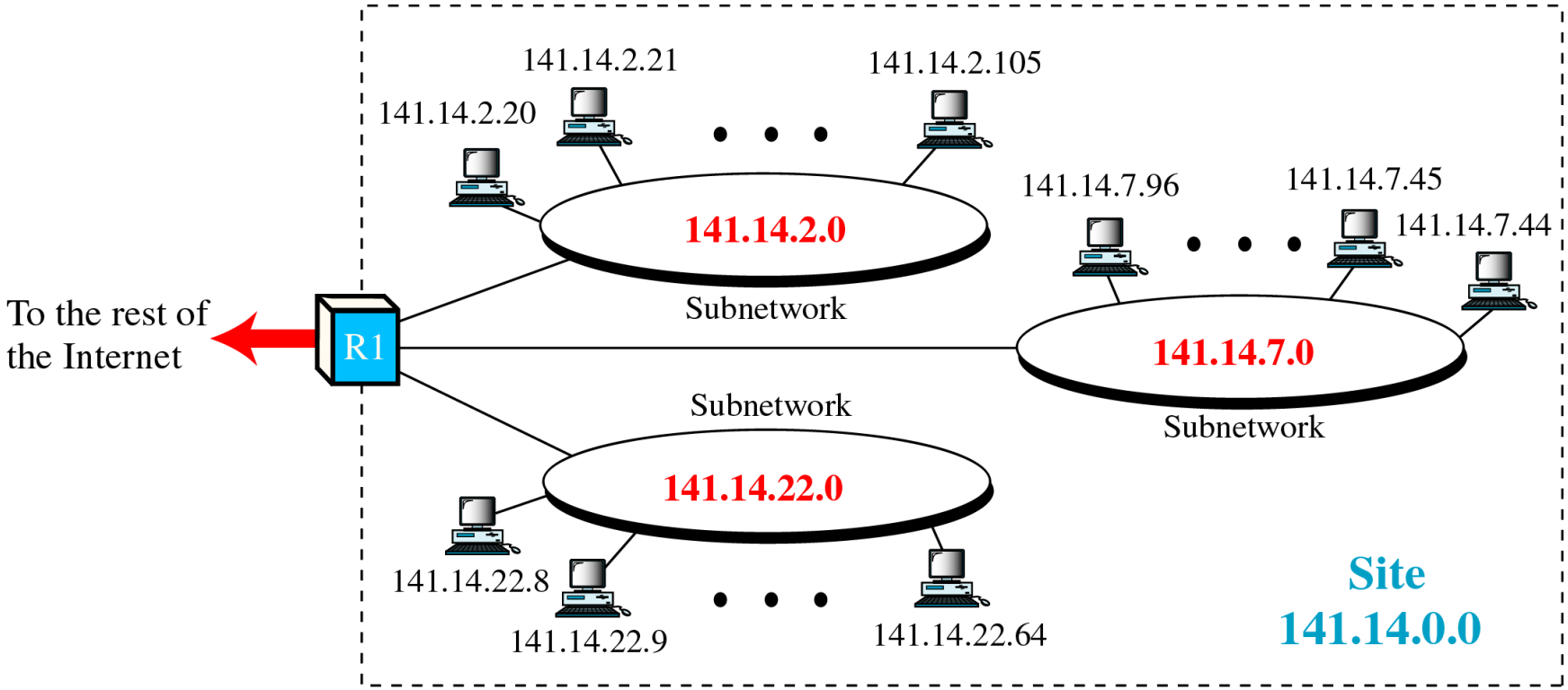
PSIT
Kanpur

Subnetting

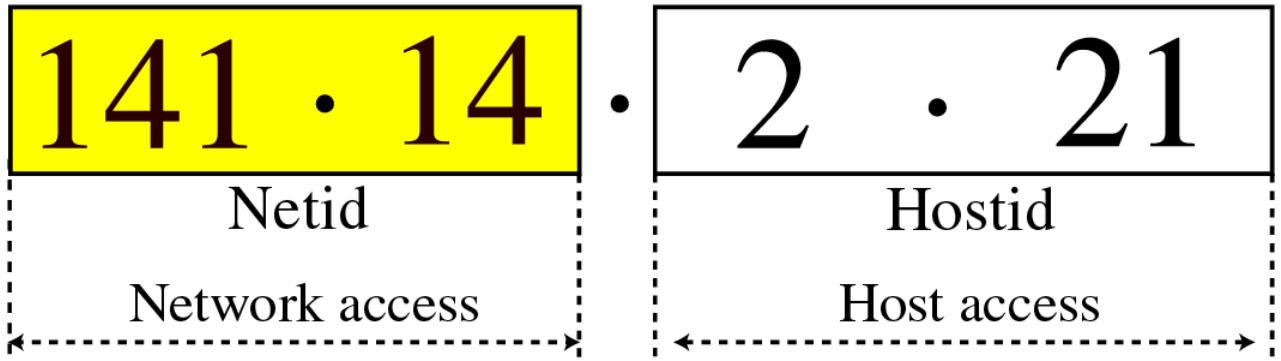
Subnetting is a process of dividing large network into the smaller networks based on layer 3 IP address. Every computer in network has an IP address which represents its location in network.

Subnetting reduces the size of the routing tables stored in routers. Subnetting extends the existing IP address base & restructures the IP address. As a result, routers must have a way to extract from a IP address both the Network address & the Host address.

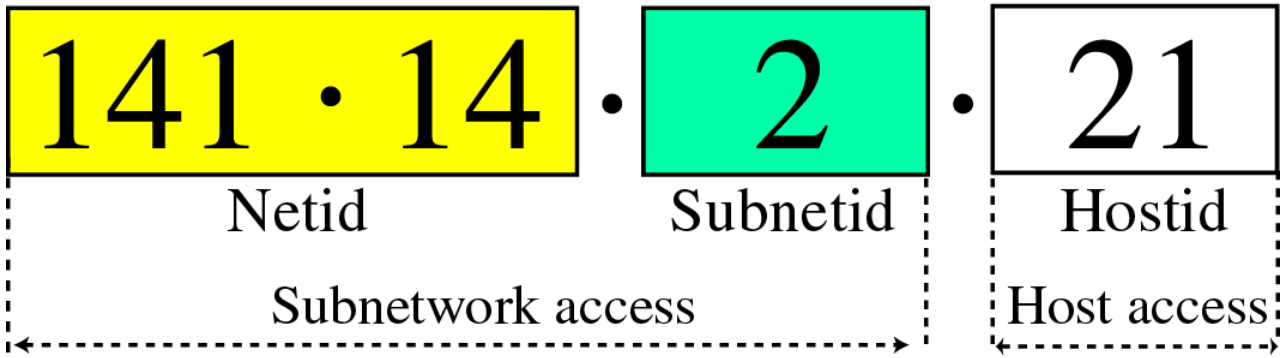
A Network with Three Levels of Hierarchy



Addresses with and without Subnetting

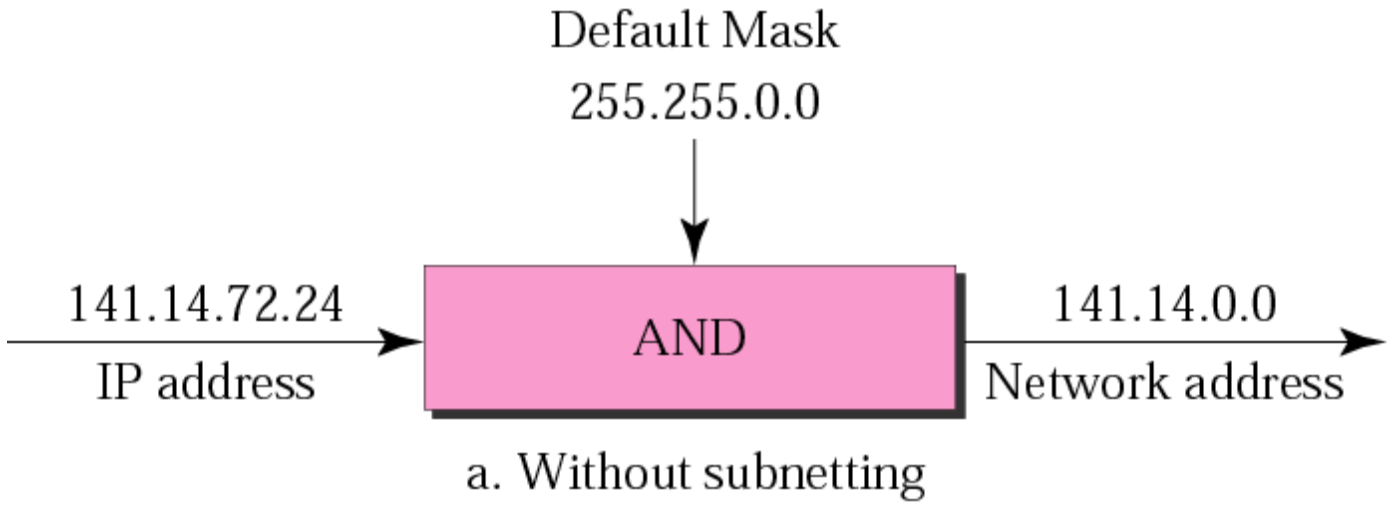


a. Without subnetting

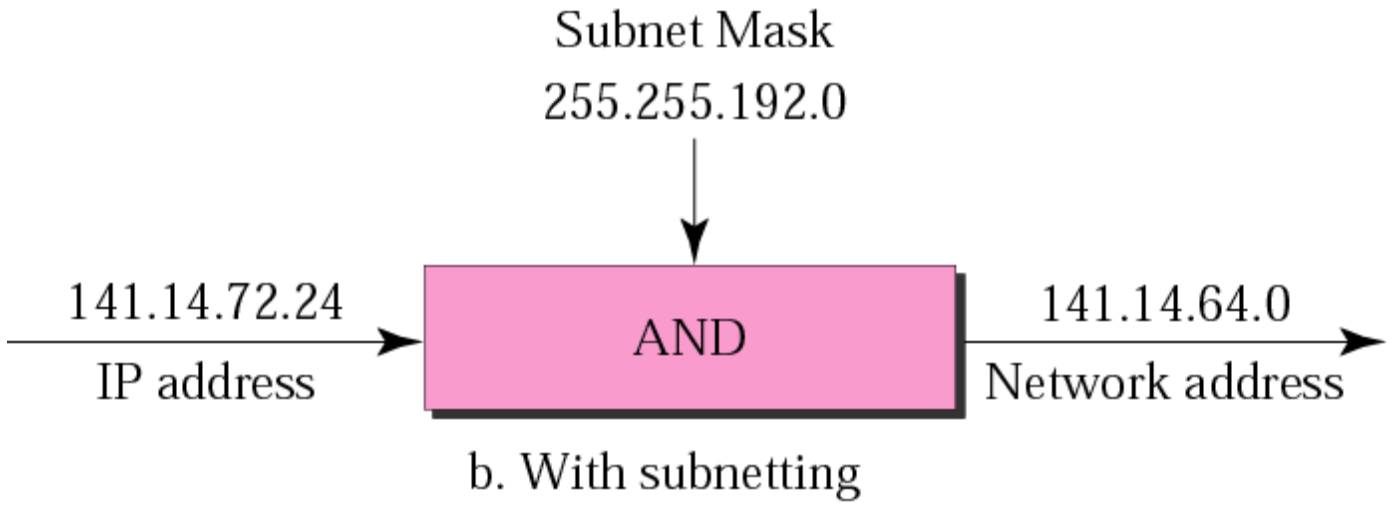


b. With subnetting

Default mask and subnet mask

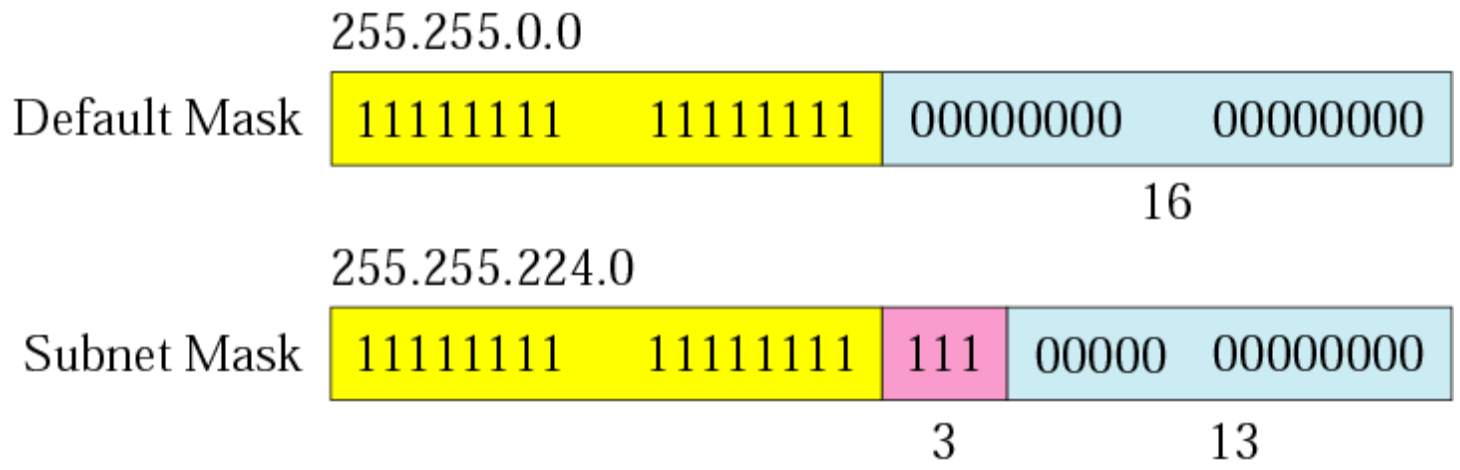


a. Without subnetting



b. With subnetting

Comparison of a default mask and a subnet mask



Key terms to remember

- A subnet is a smaller portion of large network treated as its own separate network. To create subnet we borrow bits from host portion and assign them as network bits. This mean more networks, fewer hosts.
- If the network bits on two addresses do not match, then the two packets are intended for two separate networks.
- On a 32 bits IP address at least eight bits must belong to the network portion and at least 2 bits must belong to the host portion.
- Each IP address has a predefined IP class and that cannot be changed.
- Each class has a predefined default subnet mask that tell us the octets, which are already part of the network portion, as well as how many bits we have available to work with.
- Whatever network class is it, we cannot change those bits that are already assigned.
- We cannot assign the network ID and the broadcast address to a host.
- Regardless how many bits are left in the host field, network ID and the broadcast address must be reserved.
- Subnet bits start at the left and go to the right, without skipping bits.

PSIT
Kanpur

Method of subnetting

In subnetting we find the answer of following questions-

- What is subnet mask for given address?
- How many subnets does given subnet mask provide ?
- What is block size for given subnet mask?
- What are the valid subnets?
- What are the total hosts?
- How many valid hosts are available per subnet?
- What is broadcast address of each subnet?
- What is network address of each subnet?

PSIT
Kanpur

Method of subnetting

What is subnet mask for given address?

- Subnetting take places when we extend the default subnet mask. We cannot perform subnetting with default subnet mask and every classes have default subnet mask.
- To figure out subnetted subnet mask ,we first need to write down the default subnet mask. Now find the host bits borrowed to create subnets and convert them in decimal.
- For example **find the subnet mask of address 188.25.45.48/20 ?**
- This address belong to class B and class B has default subnet mask 255.255.0.0[/16 in CIDR]. We borrowed 4 bits from hosts portion. As you know subnetting move from left to right and it cannot skip any network bit. So this subnet mask in binary would be 11111111. 11111111.11110000.00000000.
- First two octet have default value so its decimal value would be 255.255. We will convert third octet in decimal value.
- To convert a binary number in decimal we add its decimal equivalent value. In our example it would be 128+64+32+16+0+0+0+0 = 240.
- Our fourth octet has all bits off so its decimal value would be 0+0+0+0+0+0+0+0 =0. Our answer subnet mask would be **255.255.240.0**

Method of subnetting

❑ How many subnets does given subnet mask provide ?

To calculate the number of subnets provided by given subnet mask we use 2^N , where N = number of bits borrowed from host bits to create subnets.

For example in 192.168.1.0/27, N is 3. By looking at address we can determined that this address is belong to class C and class C has default subnet mask 255.255.255.0 [/24 in CIDR].

In given address we borrowed 27 - 24 = 3 host bits to create subnets. Now $2^3 = 8$, so our **answer is 8.**

❑ What is block size for subnet mask?

Block size or increment number is used to calculate the valid subnets. Once you figure out the block size, calculation of valid subnets become piece of cake. To figure out the block size, use this formula 256 - Subnet mask = block size.

For example block size for subnet mask 255.255.255.240 is 256 - 240 = **16**.

Method of subnetting

❑ What are the valid subnets?

Calculating valid subnet is two steps process. First calculate total subnet by using formula 2^N. In second step find the block size and count from zero in block until you reach the subnet mask value.

For example calculate the valid subnets for 192.168.1.0/26.

Borrowed host bits are 2 [26-24].

Total subnets are $2^2 = 4$.

Subnet mask would be 255.255.255.192.

Block size would be 256-192 = 64.

Start counting from zero at blocks of 64,

so our **valid subnets would be 0,64,128,192.**

❑ What are the total hosts?

Total hosts are the hosts available per subnet. To calculate total hosts use formula 2^H = Total hosts.

H is the number of host bits. For example in address 192.168.1.0/26 we have 32 - 26 [Total bits in IP address - Bits consumed by network address] = 6.

Total hosts per subnet would be $2^6 = 64$.

Method of subnetting

- **How many valid hosts are available per subnet?**

Valid hosts are the number of hosts those can be assigned to devices. As we know, we need to reduce two address per subnet, one for network ID and another for broadcast ID. So our formula, to calculate valid hosts would be Total hosts - 2 = Valid hosts.

In above example we have 64 hosts per subnet, so valid hosts in each subnet would be 64 - 2 = 62.

- **What is the network address of each subnet?**

Network address is the first address of subnet. This address is used to locate the network, and cannot be assigned to any host. In above example address 0,64,128,192 are the network address.

Network address is always the first IP address of subnet.

Broadcast address is always the last IP address of subnet (IP address before the next subnet).

Valid hosts are the IP addresses between network address and broadcast address.

Method of subnetting

❑ What is broadcast address of each subnet?

Broadcast address is the last address of subnet. This address is reserve for network broadcast, and cannot be assigned to any host.

In the previous example-
0 Subnet has broadcast address 63
64 Subnet has broadcast address 127
128 Subnet has broadcast address 191
192 Subnet has broadcast address 255

Method of subnetting

/26

CIDR /26 has subnet mask 255.255.255.192 and 192 is 11000000 in binary. We used two host bits in network address.

N = 2
H = 6
Total subnets (2^N) :- $2^2 = 4$
Block size (256 - subnet mask) :- 256 - 192 = 64
Valid subnets (Count blocks from 0) :- 0,64,128,192
Total hosts (2^H) :- $2^6 = 64$
Valid hosts per subnet (Total host - 2) :- 64 - 2 = 62

Subnets	Subnet 1	Subnet 2	Subnet 3	Subnet 4
Network ID	0	64	128	192
First host	1	65	129	193
Last host	62	126	190	254
Broadcast ID	63	127	191	255

What is the maximum number of hosts which a network on internet having a subnet mask of 255.255.240.0 can handle?

Answer:

Convert the subnet mask to binary:
11111111.11111111.11110000.00000000

The zeroes tell you which bytes indicate the host;

in this case, 12 zeroes allow for 2^12 = 4096 different IP addresses within the subnet.

Of these, two (the first and the last) are unusable for a host, so you have a maximum of 4094 hosts.

You work for a large communications corporation which has been assigned a Class A network address.

Currently, the company has 1,000 subnets in offices around the world. You want to add 100 new subnets over the next three years, and you want to allow for the largest possible number of host addresses per subnet.

Which subnet mask would you choose?

Answer: **255.255.224.0**

Requirements: 1,000 subnets + 100 subnets = 1,100 subnets, and as many host addresses as possible

2^10-2 = 1022 we Know from memory that 2^10= 1024, and will yield ONLY 1022 usable subnets with 10 bits of subnetting

Because our requirements ask for over 1024 subnets, we must borrow one more host bit for our subnetting:

2^11-2 = (1024 * 2) - 2 = 2046 unique usable subnets

Default class A subnet mask 11111111 00000000 00000000 00000000 = 255.0.0.0

SUBNET MASK REQUIRED 11111111 **11111111 111**00000 00000000 = **255.255.224.0**

i.e. Default Class A subnet mask **with ANOTHER 11 bits of subnetting**

What is the subnetwork address if the destination address is 200.45.34.56 and the subnet mask is 255.255.240.0?

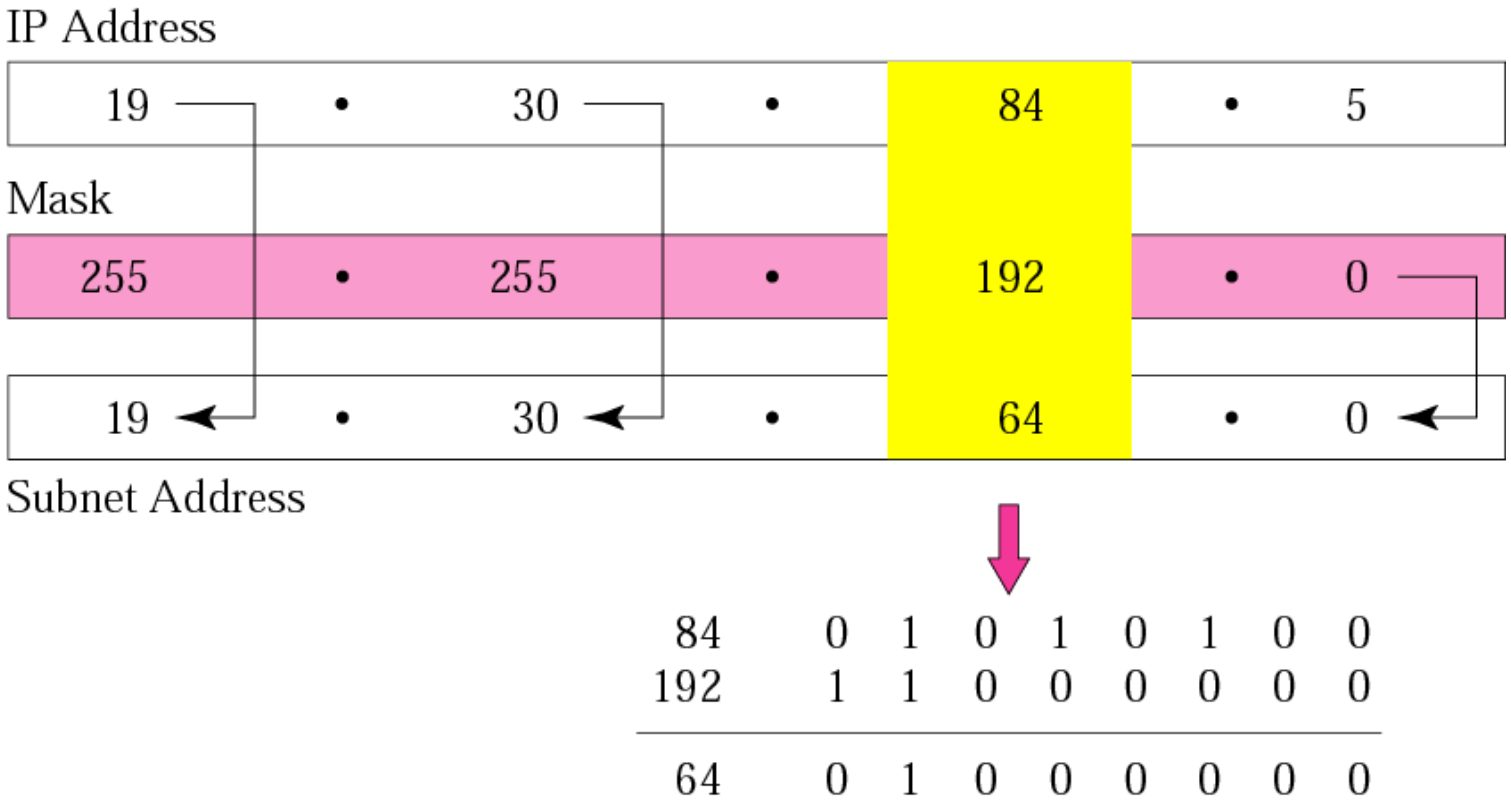
11001000 00101101 00100010 00111000

11111111 11111111 11110000 00000000

11001000 00101101 00100000 00000000

The subnetwork address is 200.45.32.0.

What is the subnetwork address if the destination address is 19.30.84.5 and the mask is 255.255.192.0?



PSIT
Kanpur

THANK YOU