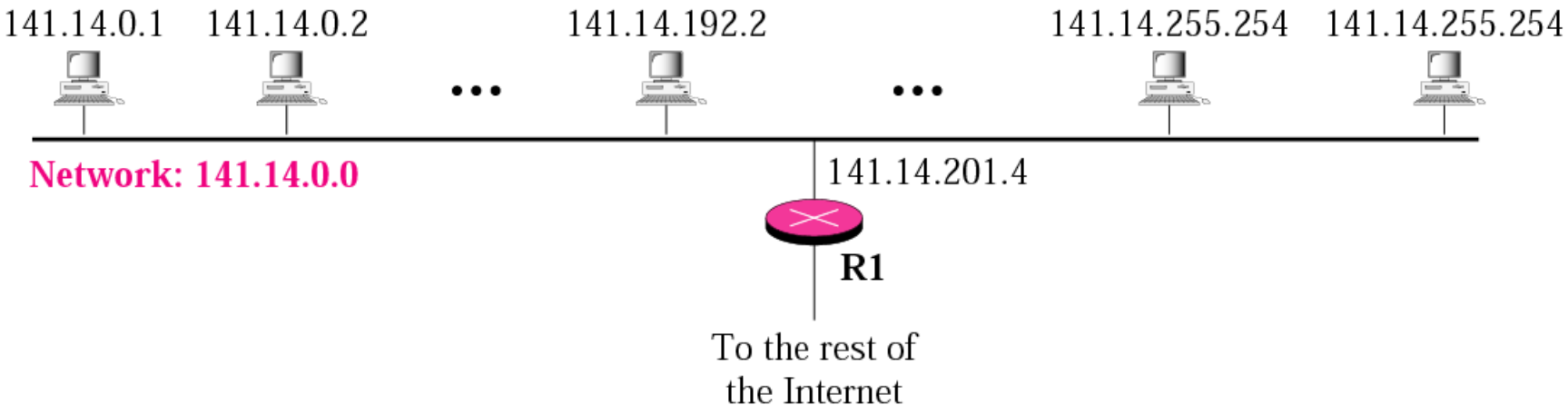
SUBNETTING

Note

IP addresses are designed with two levels of hierarchy.

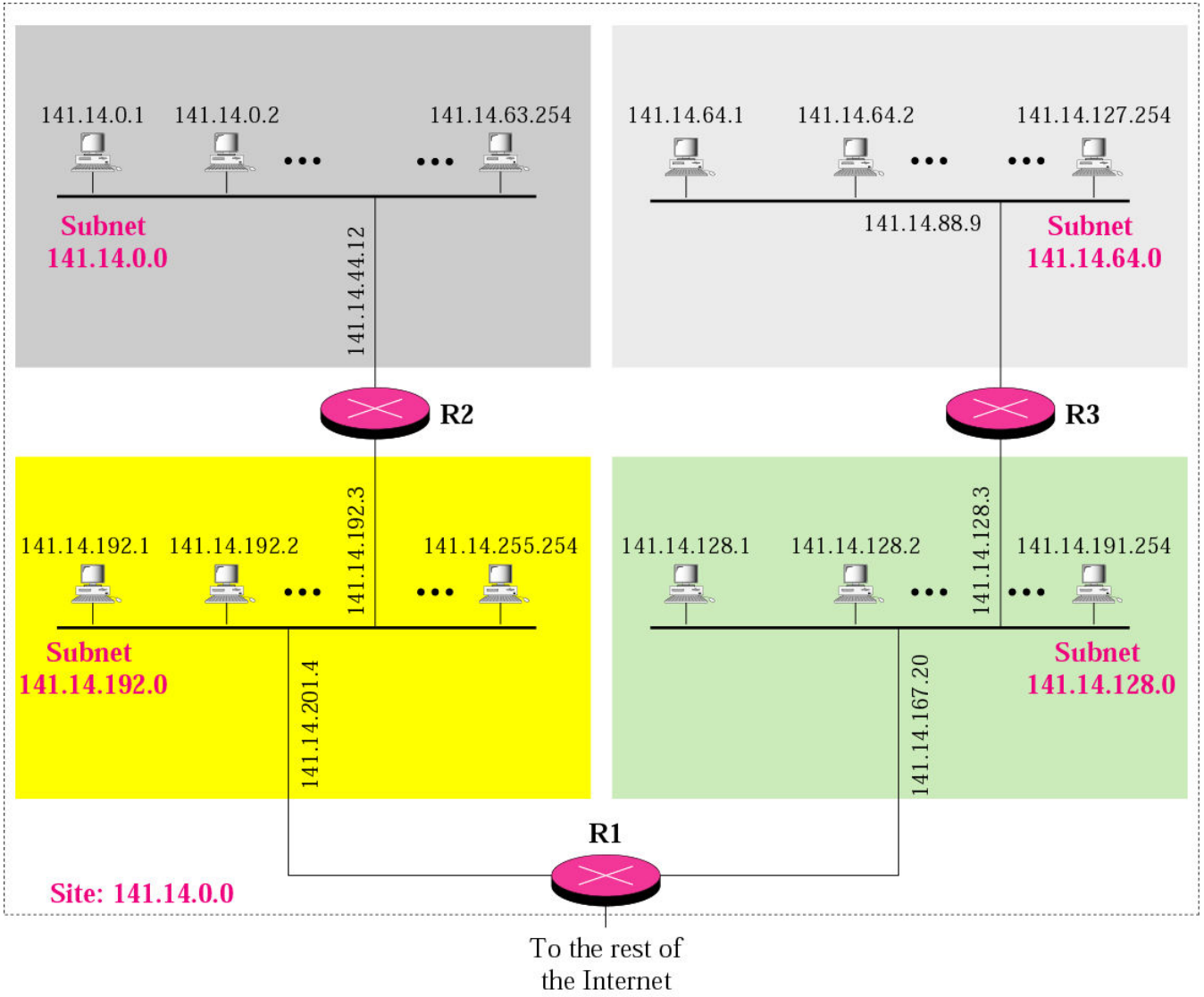
A network with two levels of hierarchy (not sub netted)



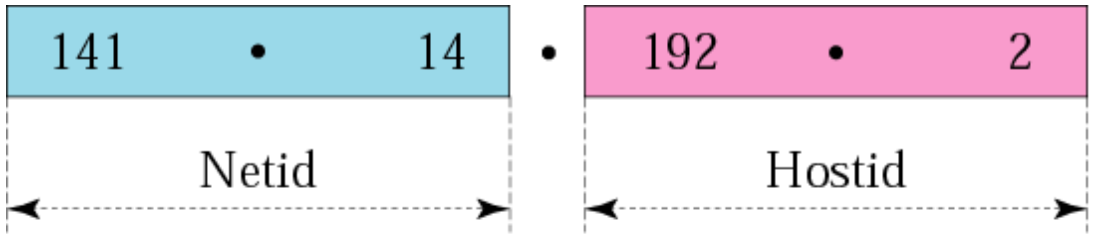
Subnetting

- Subnetting is a process of dividing a single large network in multiple smaller networks.
- A single large network is just like a town without any sector and street address
- Subnetting is done by borrowing bits from the host part and add them the network part

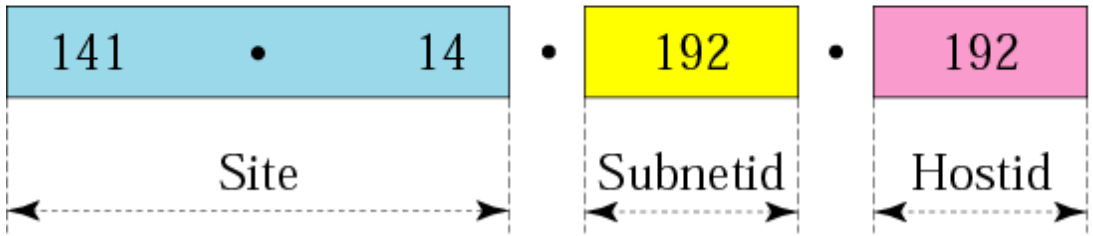
A network with three levels of hierarchy (subnetted)



Addresses in a network with and without subnetting

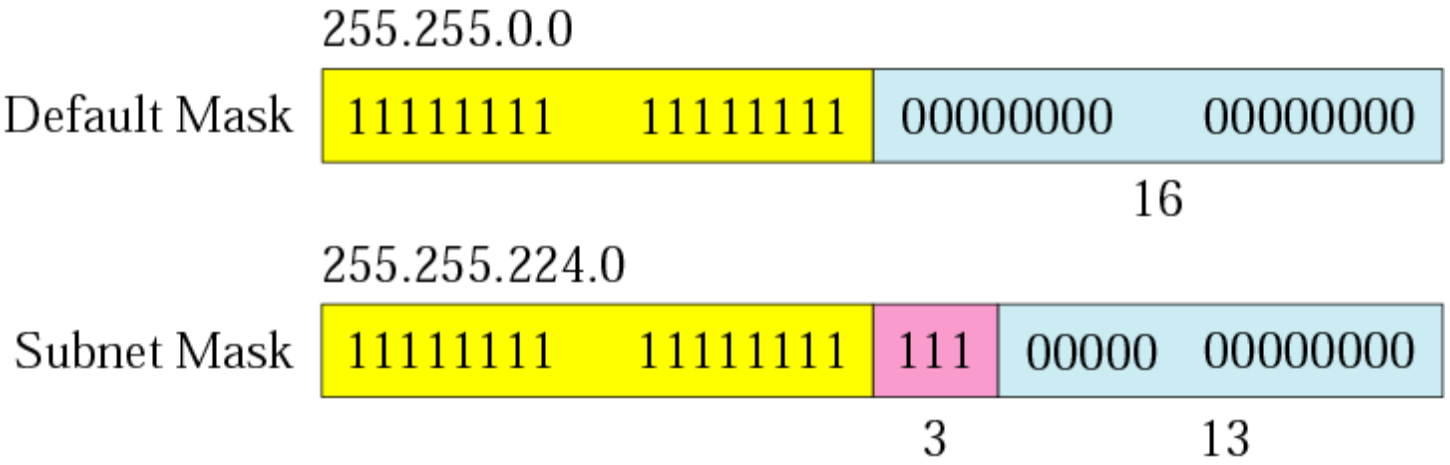


a. Without subnetting

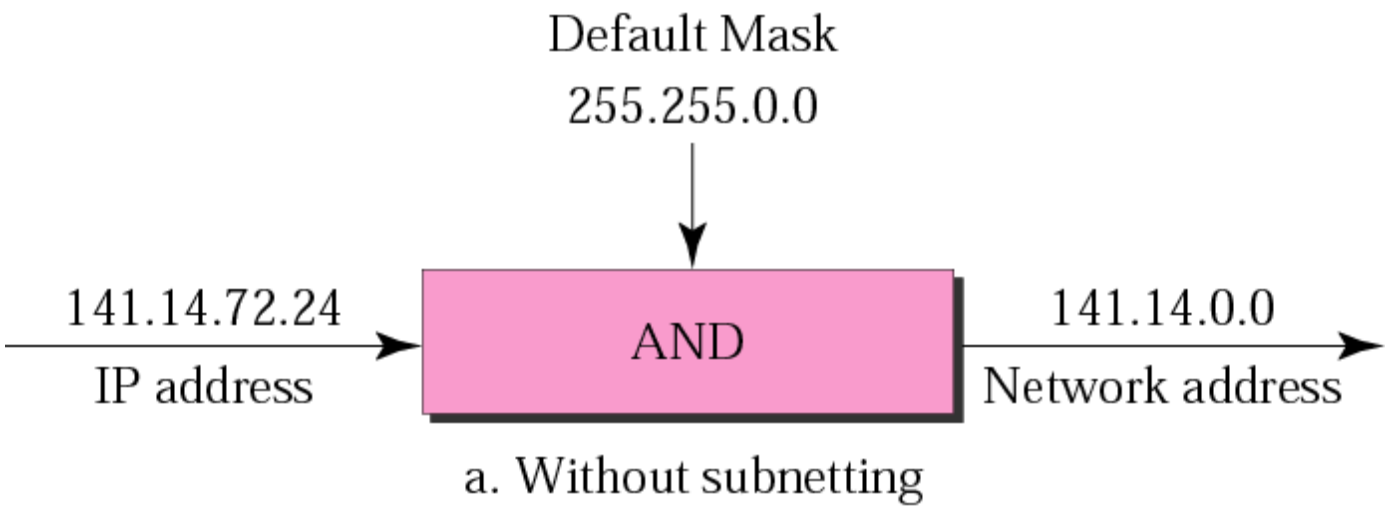


b. With subnetting

Comparison of a default mask and a subnet mask



Default mask and subnet mask



Finding the Subnet Address

Given an IP address, we can find the subnet address the same way we found the network address. We apply the mask to the address.

Example 1

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

Solution

11001000 00101101 00100010 00111000

11111111 11111111 1111**0000** **00000000**

11001000 00101101 0010**0000** **00000000**

The subnetwork address is **200.45.32.0**.

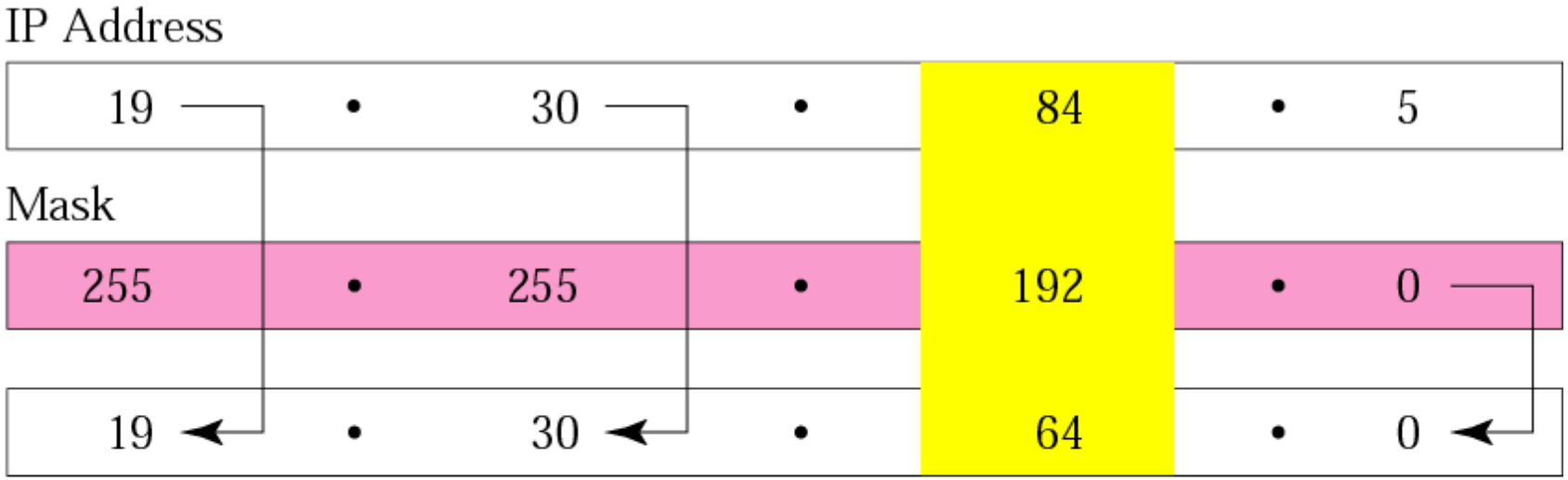
Example 2

What is the subnetwork address if the destination address is 19.30.80.5 and the mask is 255.255.192.0?

Solution

See next slide

Solution



84	0	1	0	1	0	1	0	0
192	1	1	0	0	0	0	0	0
64	0	1	0	0	0	0	0	0

Note

The number of subnets must be a power of 2.

Example 3

A company is granted the site address 201.70.64.0 (class C). The company needs six subnets. Design the subnets.

Solution

The number of 1s in the default mask is 24 (class C).

Solution (Continued)

The company needs six subnets. This number 6 is not a power of 2. The next number that is a power of 2 is 8 (2^3). We need 3 more 1s in the subnet mask. The total number of 1s in the subnet mask is 27 (24 + 3).

The total number of 0s is 5 (32 – 27). The mask is

Solution (Continued)

11111111 11111111 11111111 11100000

or

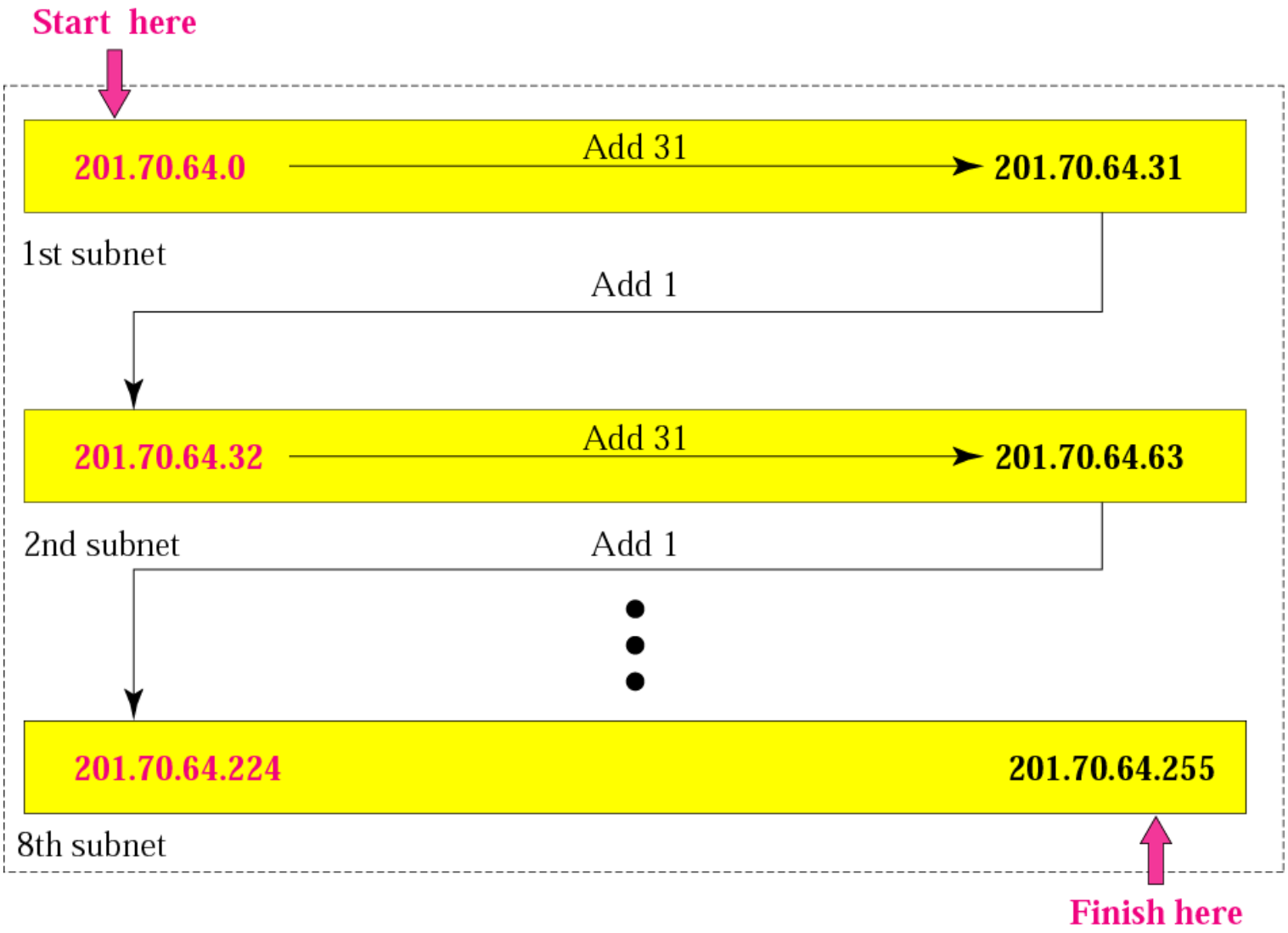
255.255.255.224

The number of subnets is 8.

The number of addresses in each subnet is 2^5 (5 is the number of 0s) or 32.

See Next slide

Example 3



Example 4

A company is granted the site address 181.56.0.0 (class B). The company needs 1000 subnets. Design the subnets.

Solution

The number of 1s in the default mask is 16 (class B).

Solution (Continued)

The company needs 1000 subnets. This number is not a power of 2. The next number that is a power of 2 is 1024 (2^{10}). We need 10 more 1s in the subnet mask.

The total number of 1s in the subnet mask is 26 (16 + 10).

The total number of 0s is 6 (32 – 26).

Solution (Continued)

The mask is

11111111 11111111 11111111 11000000

or

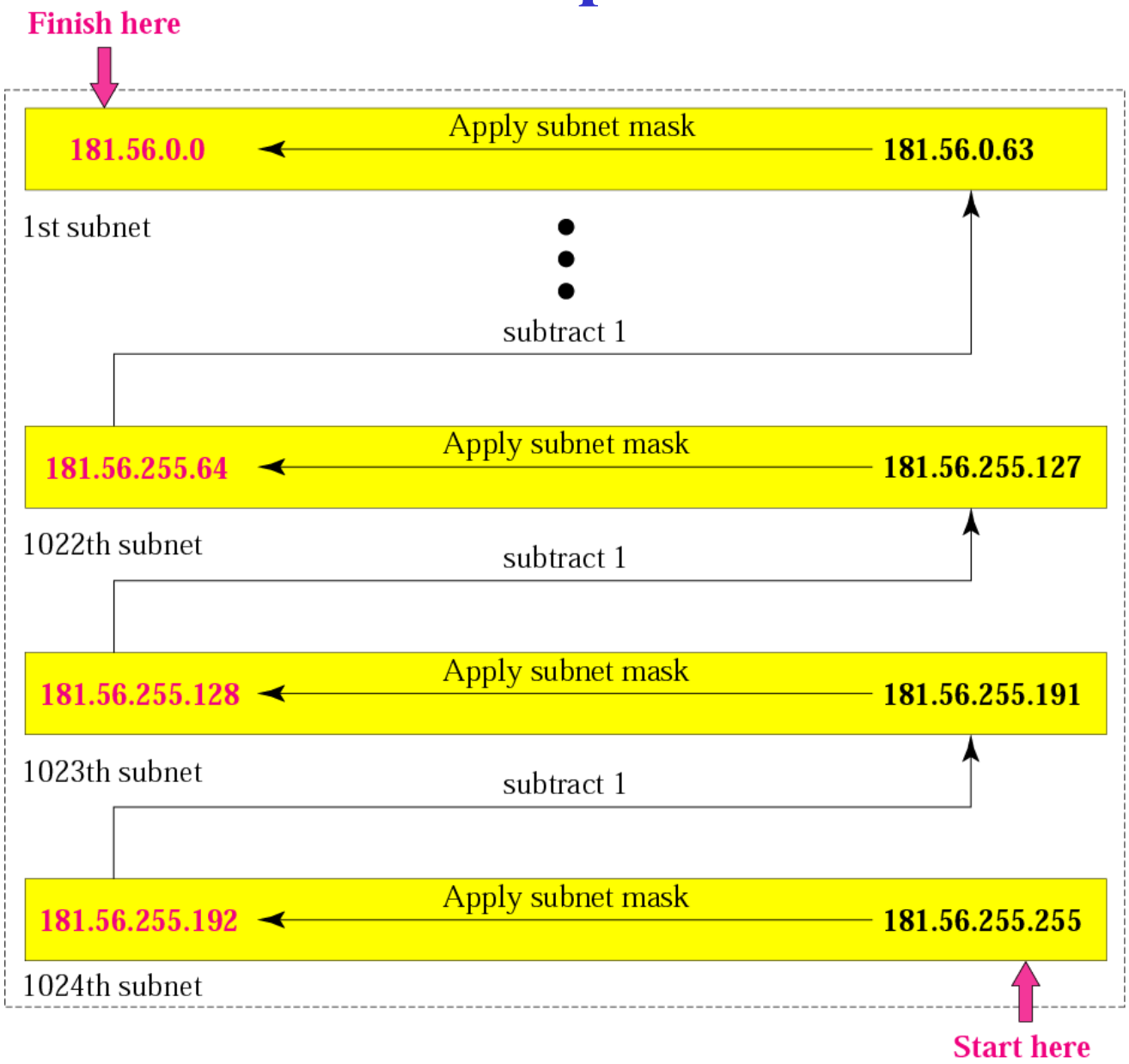
255.255.255.192.

The number of subnets is 1024.

The number of addresses in each subnet is 2^6 (6 is the number of 0s) or 64.

See next slide

Example 12



Example 5

Imagine, you are a network administrator, and your network address is 170.170.0.0. Your authority asks to make subnets where each subnet will contain 1024 usable hosts.

i. How many subnet can be achieved?
ii. What is the subnet mask?
iii. What is the IP address of the 1st subnet?
iv. What is the IP address of the last subnet?
v. What is the broadcast address if the second subnet?

Example 5

- 170.170.0.0.

Solution

i. Host bit needed=11,No of subnet=32
ii. 11111111.11111111.11111000.00000000
iii. 170.170.0.0
iv. 170.170.248.0
v. 170.170.15.255

Example 6

Let you are a network administrator and your network address is 180.180.0.0. Your authority asks to make subnets where each subnet will contain 512 usable hosts.

i. How many subnet can be achieved?
ii. What is the subnet mask?
iii. What is the IP address of the last subnet?
iv. What is the broadcast address if the second subnet?

Solution

i. Host bit needed=10,No of subnet=64
ii. 11111111.11111111.11111100.00000000
iii. 180.180.252.0
iv. 180.180.7.255

Example 6

- What is the maximum number of subnet in class c using the following mask?

i. 255.255.255.192

ii. 255.255.255.240

Solutuins

- i. 4
- ii. 16

Example 19.10

An ISP is granted a block of addresses starting with 190.100.0.0/16 (65,536 addresses). The ISP needs to distribute these addresses to three groups of customers as follows:

a. *The first group has 64 customers; each needs 256 addresses.*
b. *The second group has 128 customers; each needs 128 addresses.*
c. *The third group has 128 customers; each needs 64 addresses.*

Design the subblocks and find out how many addresses are still available after these allocations.

Example 19.10 (continued)

Solution

Figure 19.9 shows the situation.

Group 1

For this group, each customer needs 256 addresses. This means that 8 (log2 256) bits are needed to define each host. The prefix length is then 32 − 8 = 24. The addresses are

1st Customer:	190.100.0.0/24	190.100.0.255/24
2nd Customer:	190.100.1.0/24	190.100.1.255/24
. . .		
64th Customer:	190.100.63.0/24	190.100.63.255/24

Total = 64 × 256 = 16,384

Example 19.10 (continued)

Group 2

For this group, each customer needs 128 addresses. This means that 7 (log2 128) bits are needed to define each host. The prefix length is then 32 − 7 = 25. The addresses are

1st Customer:	*190.100.64.0/25*	*190.100.64.127/25*
2nd Customer:	*190.100.64.128/25*	*190.100.64.255/25*
. . .		
128th Customer:	*190.100.127.128/25*	*190.100.127.255/25*

Total = 128 × 128 = 16,384

Example 19.10 (continued)

Group 3

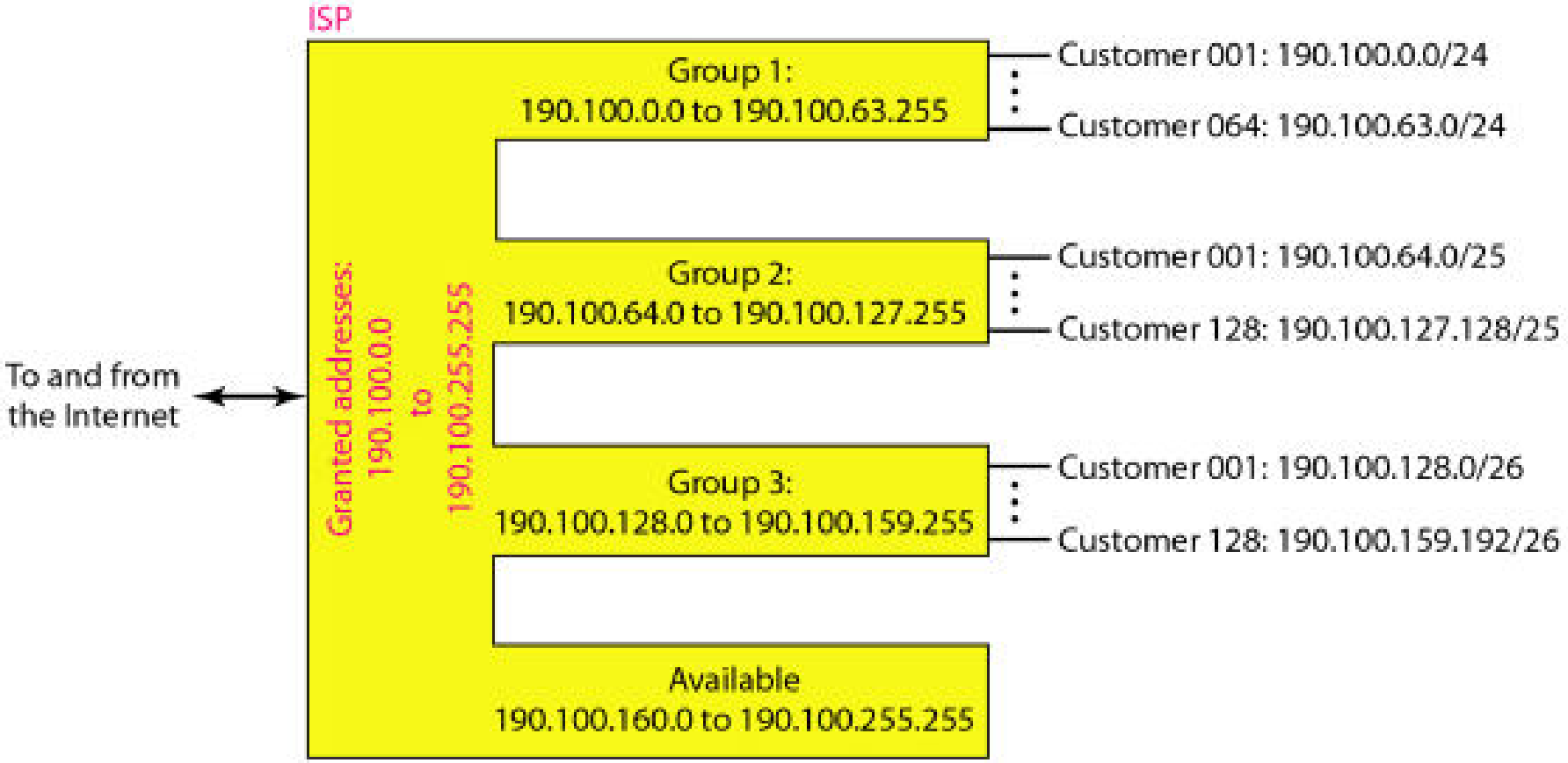
For this group, each customer needs 64 addresses. This means that 6 ($log_2 64$) bits are needed to each host. The prefix length is then 32 − 6 = 26. The addresses are

1st Customer:	*190.100.128.0/26*	*190.100.128.63/26*
2nd Customer:	*190.100.128.64/26*	*190.100.128.127/26*
. . .		
128th Customer:	*190.100.159.192/26*	*190.100.159.255/26*

Total = 128 × 64 = 8192

Number of granted addresses to the ISP: 65,536
Number of allocated addresses by the ISP: 40,960
Number of available addresses: 24,576

Figure 19.9 *An example of address allocation and distribution by an ISP*



Suppose, one day your supervisor saying here is the network id **192.168.4.0** please create **three** subnets for our company. One subnet is the officers, one for front desk and storage room and one the public use.

Now you task is to list each **network ID, subnet mask, Host ID range of usable host and broadcast id**

CLASSLESS ADDRESSING

Disadvantage of Classful Addressing

- Class A with a mask of 255.0.0.0 can support 16, 777, 214 addresses
- Class B with a mask of 255.255.0.0 can support 65, 534 addresses
- Class C with a mask of 255.255.255.0 can support 254 addresses

Slash notation

$$A.B.C.D/n$$

Note

Slash notation is also called CIDR notation.

Example 17

A small organization is given a block with the beginning address and the prefix length **205.16.37.24/29** (in slash notation). What is the range of the block?

Solution

- The beginning address is 205.16.37.24. To find the last address we keep the first 29 bits and change the last 3 bits to 1s.
- Beginning: **11001111 00010000 00100101 00011**000
- Ending : 11001111 00010000 00100101 00011111
- There are only 8 addresses in this block.

Example 17 cont'd

We can find the range of addresses in Example 17 by another method. We can argue that the length of the suffix is 32 – 29 or 3. So there are $2^3 = 8$ addresses in this block. If the first address is 205.16.37.24, the last address is 205.16.37.31 (24 + 7 = 31).

Question 1

Subnet the address 200.200.200.0/24 in such a way that you can make 4 usable subnets and maximum number of addresses can be used. Hence answer the following-

(i) Define subnet mask for the first usable subnet.

(ii) Find out the first usable host address of first subnet.

(iii)Find out the last usable host of last subnet.

(iv)Find out how many IPs are being lost in this subnetting.

Question 2

➔ Suppose Varendra University has a range of IP address 200.200.0.0/16.You have to create at least 15 usable subnets so that each subnet contains as many host as possible. Answer the following

1. What is the class of the given IP block ?
2. How many usable Ip address there in each subnet ?
3. What will be the subnet mask of the fourth subnet ?
4. What will be the second usable IP address of the third subnet ?

Question 3

For example, assume that you are a network administrator and buy 192.168.1.0/24 for Laxmisoftwares. Company has three departments connected with wan links.

- Development department has 74 computers.
- Production department has 52 computers.
- Administrative department has 28 computers.