

*Subnetting/Supernetting
and
Classless Addressing*

CONTENTS

- **SUBNETTING**
- **SUPERNETTING**
- **CLASSLESS ADDRESSING**

A decorative border resembling a scroll, with a horizontal line at the top that curves down at the right end, and a vertical line on the left that curves up at the bottom. The word "SUBNETTING" is centered within this frame.

SUBNETTING

Note

IP addresses are designed with two levels of hierarchy.

Figure 5-1

A network with two levels of hierarchy (not subnetted)

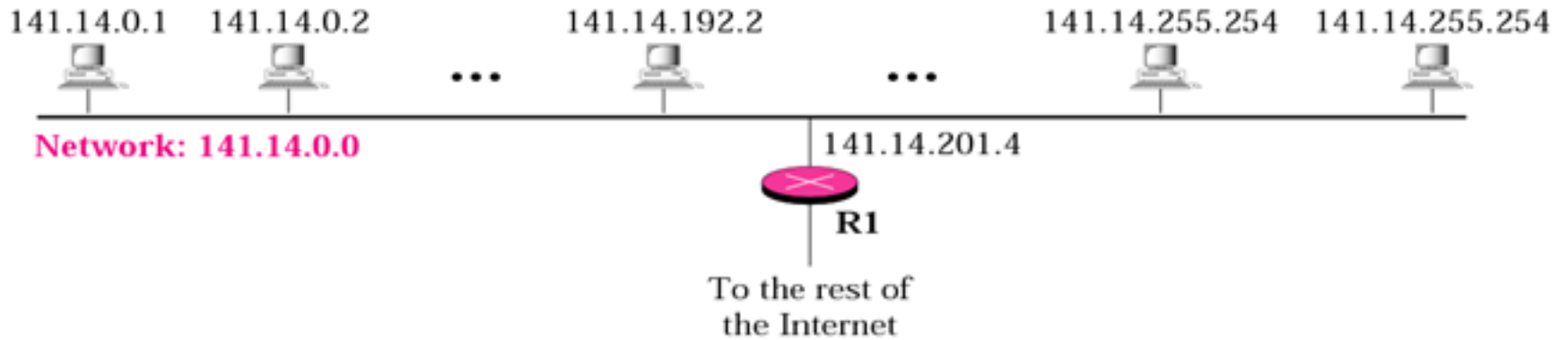


Figure 5-2

A network with three levels of hierarchy (subnetted)

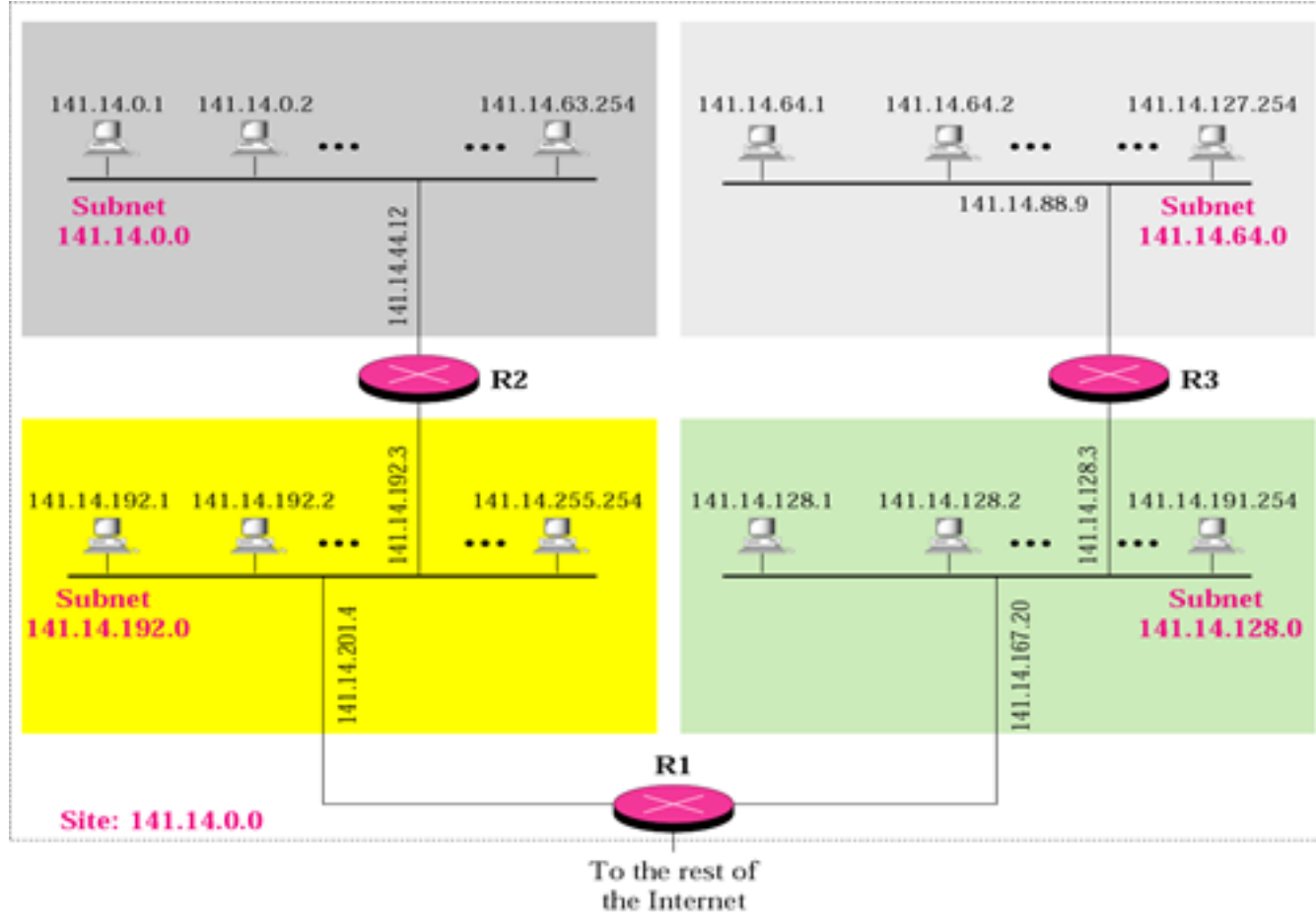
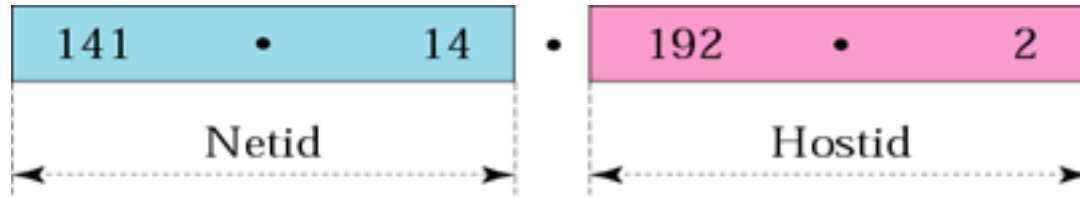
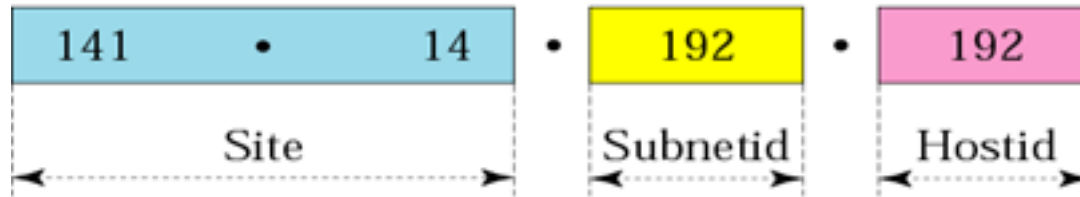


Figure 5-3

Addresses in a network with and without subnetting



a. Without subnetting



b. With subnetting

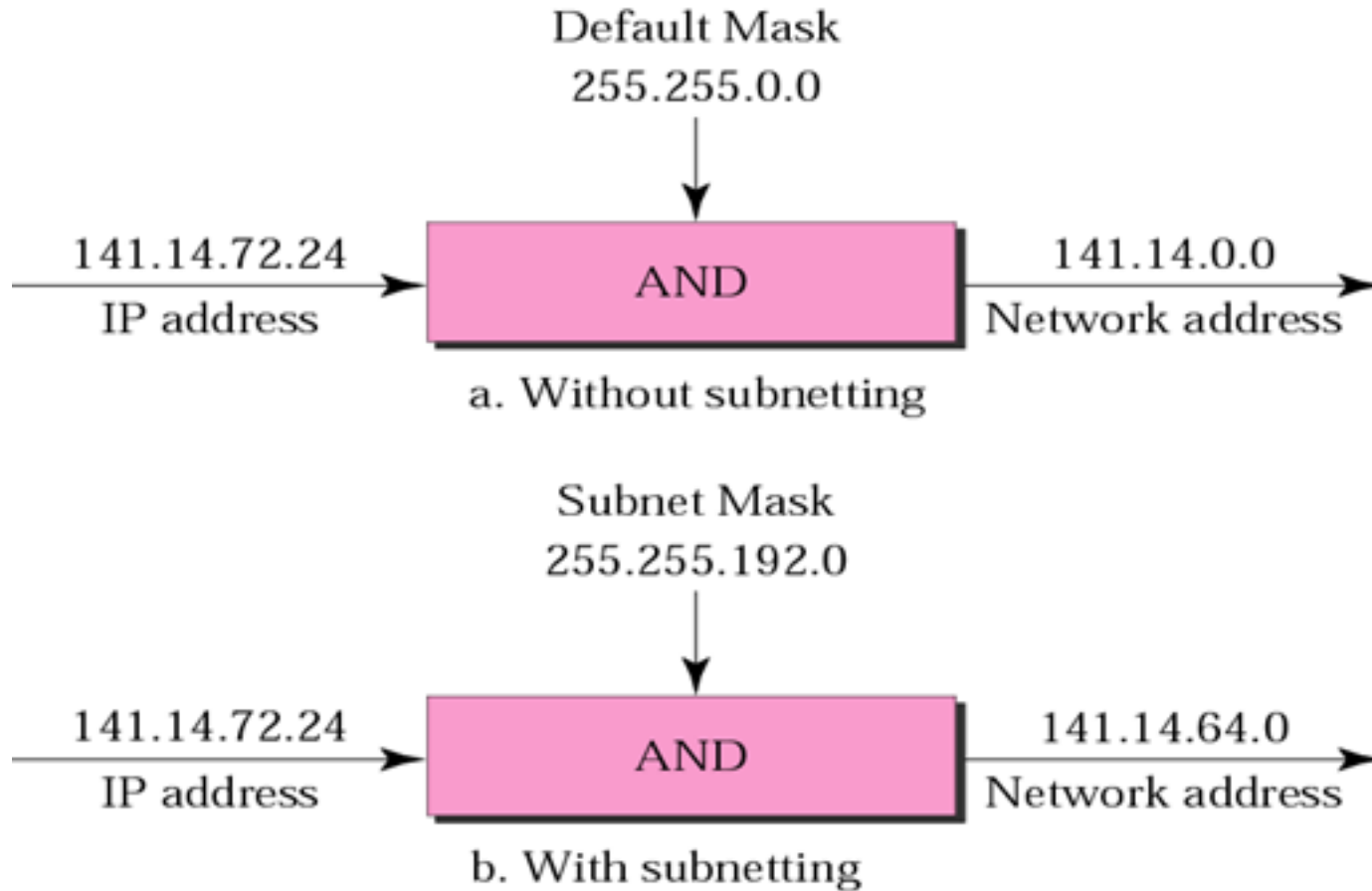
Figure 5-4

Hierarchy concept in a telephone number



Figure 5-5

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 in the previous chapter.

We apply the mask to the address. We can do this in two ways: straight or short-cut.

Straight Method

In the straight method, we use binary notation for both the address and the mask and then apply the AND operation to find the subnet address.

Example 1

What is the subnetwork 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 11110000 00000000

11001000 00101101 00100000 00000000

The subnetwork address is **200.45.32.0**.

Short-Cut Method

****** If the byte in the mask is 255, copy the byte in the address.

****** If the byte in the mask is 0, replace the byte in the address with 0.

****** If the byte in the mask is neither 255 nor 0, we write the mask and the address in binary and apply the AND operation.

Example 2

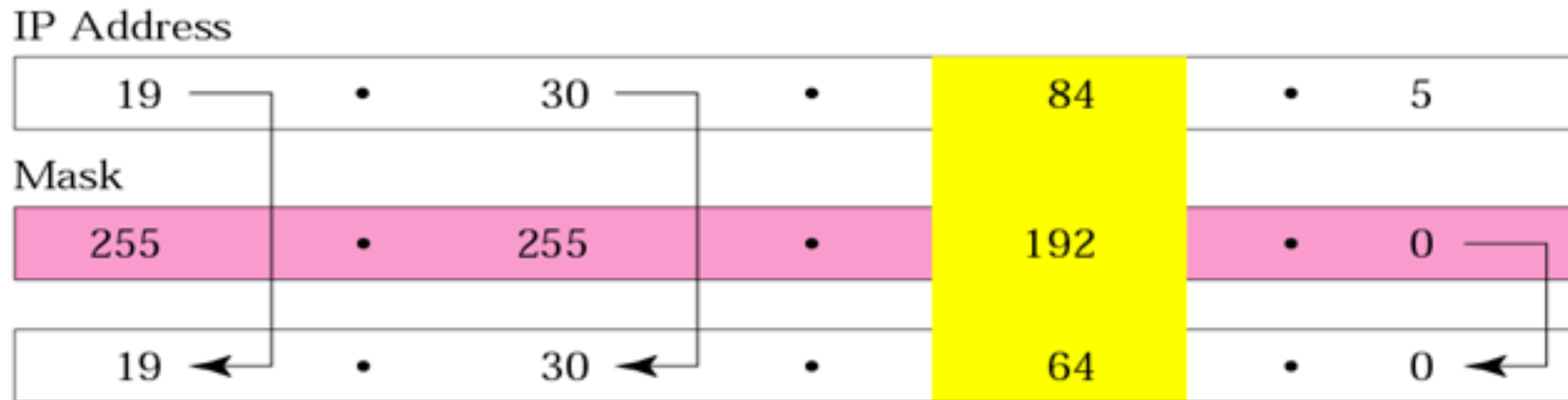
What is the subnetwork address if the destination address is 19.30.80.5 and the mask is 255.255.192.0?

Solution

See Figure 5.6

Figure 5-6

Example 2

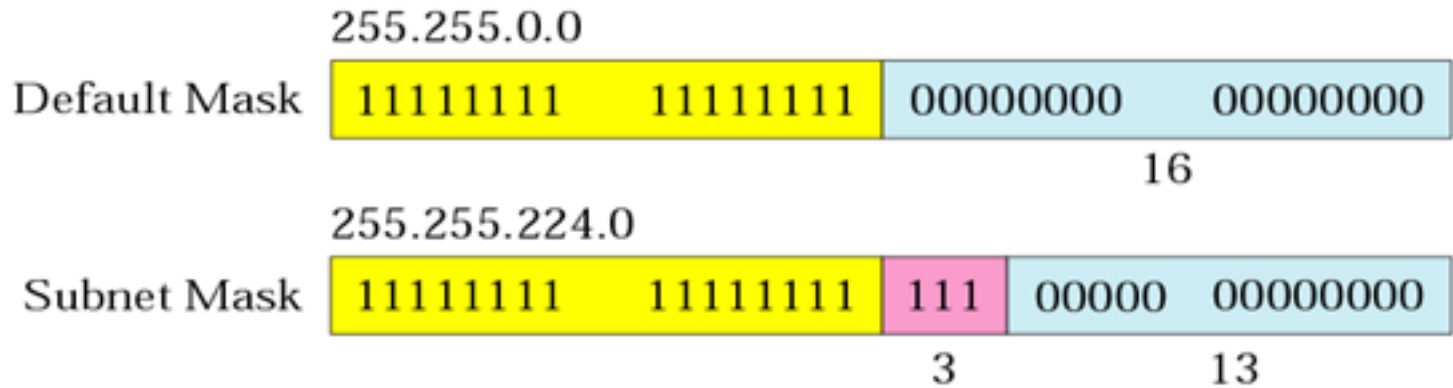


↓

84	0	1	0	1	0	1	0	0
192	1	1	0	0	0	0	0	0
<hr/>								
64	0	1	0	0	0	0	0	0

Figure 5-7

Comparison of a default mask and a subnet mask



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

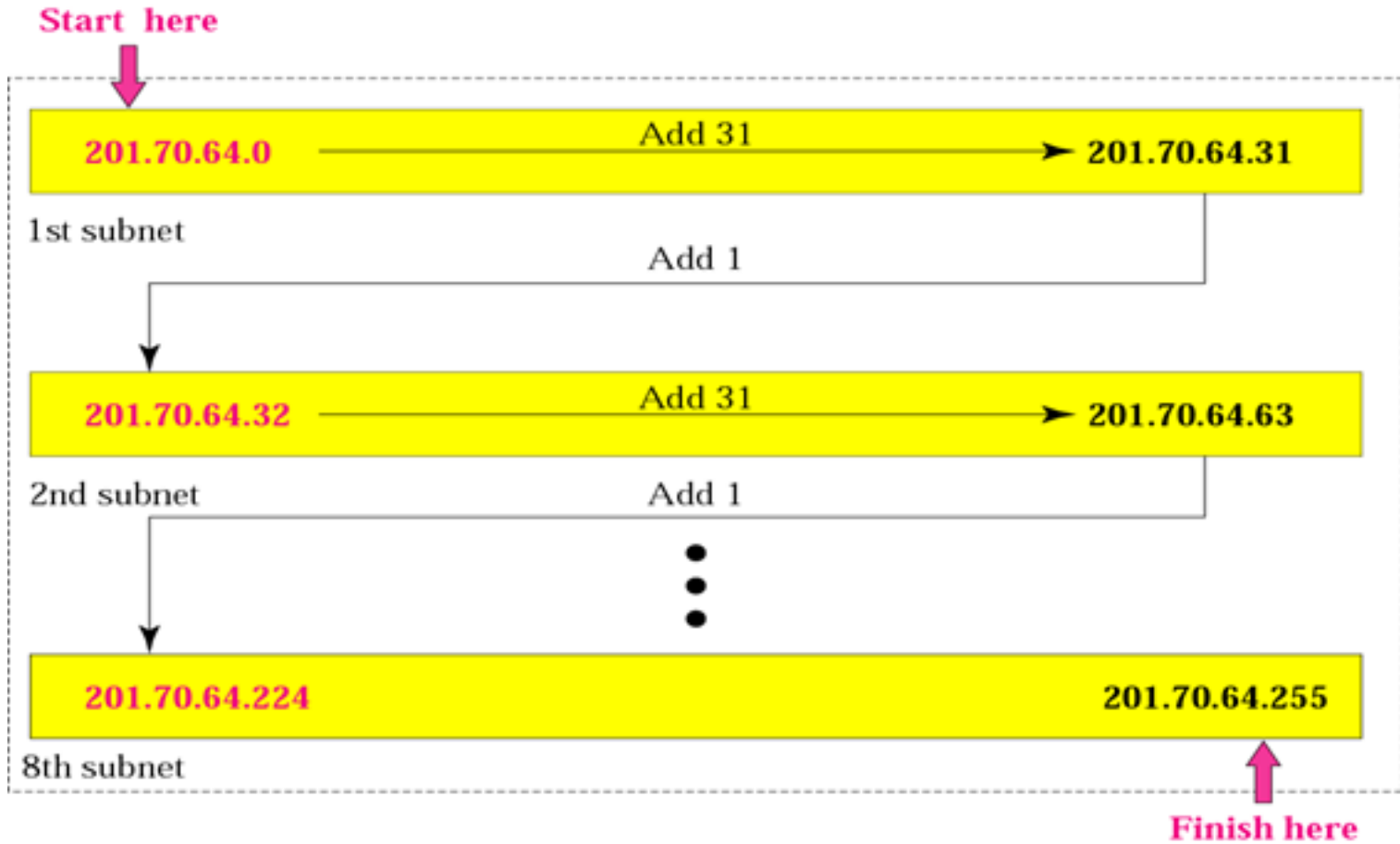
The number of subnets is 8.

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

See Figure 5.8

Figure 5-8

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.

Figure 5-9

Example 4

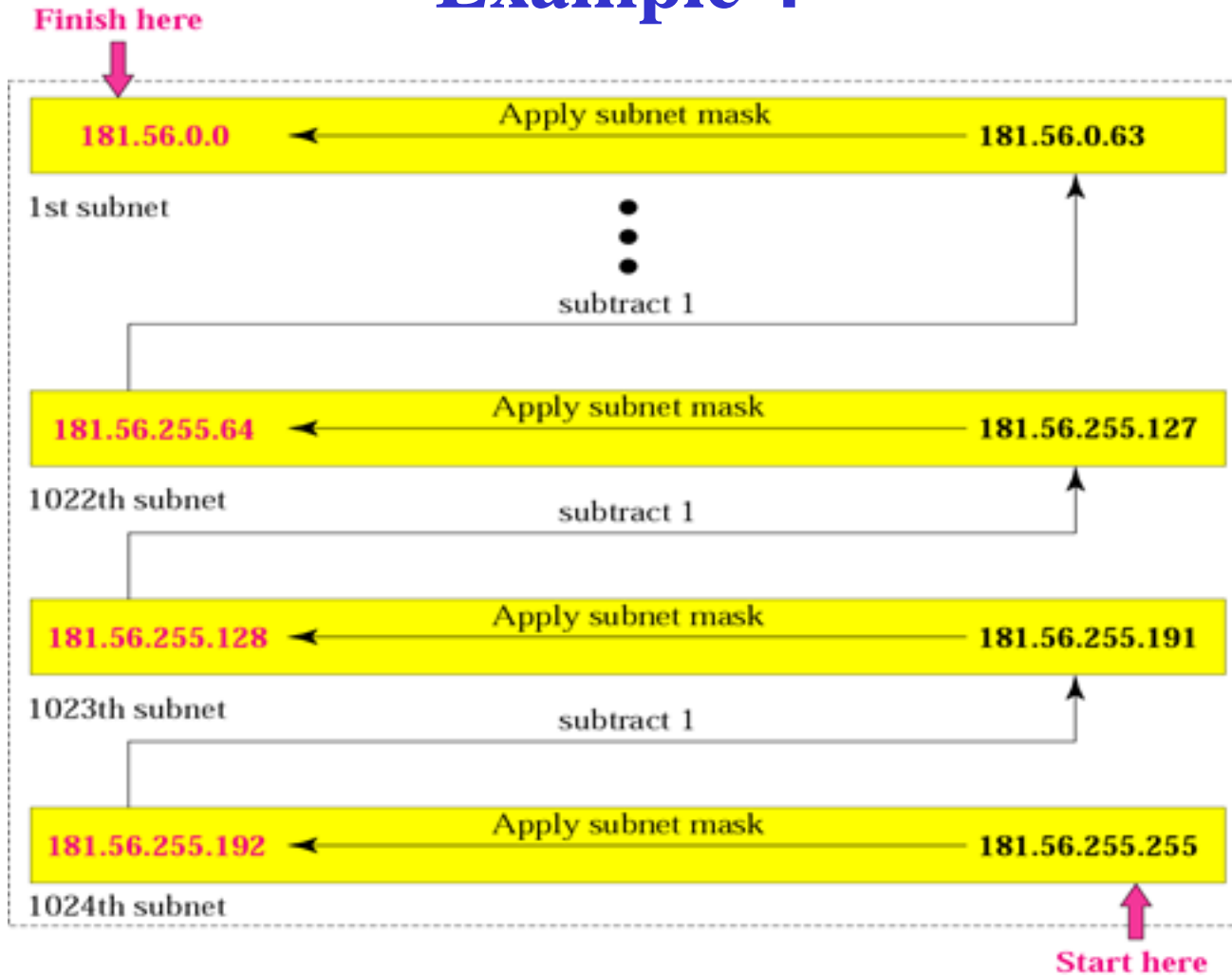
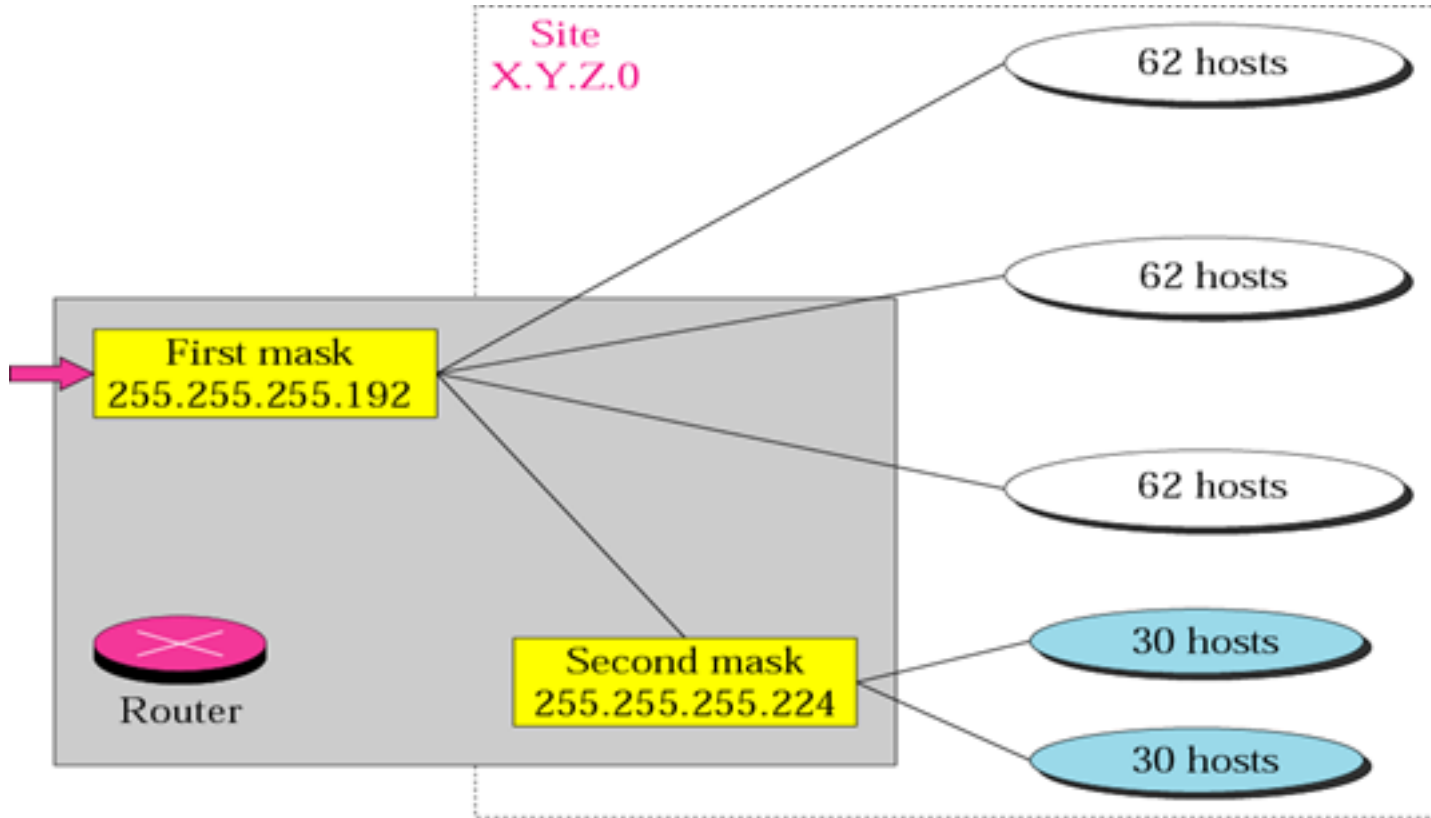


Figure 5-10

Variable-length subnetting

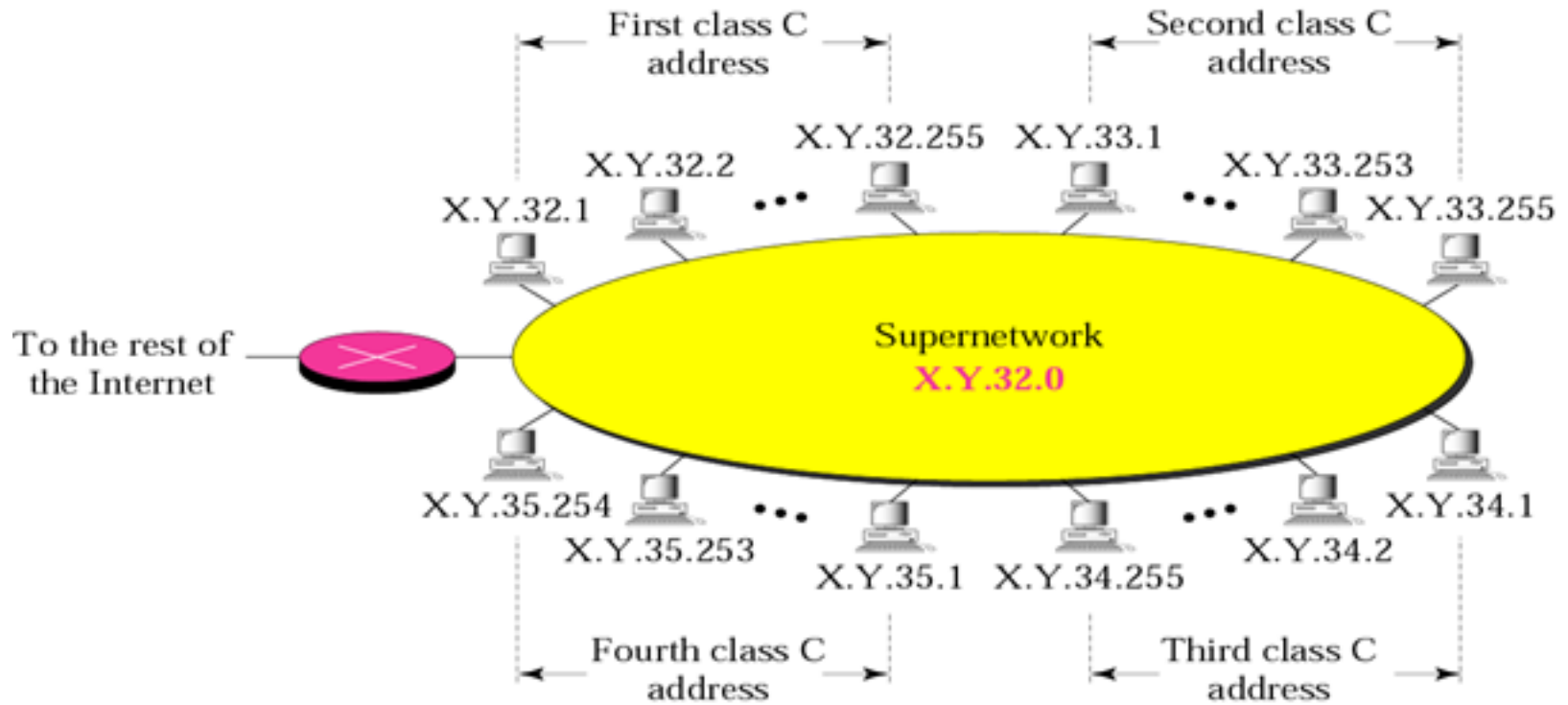


5.2

SUPERNETTING

Figure 5-11

A supernet



Rules:

- ** The number of blocks must be a power of 2 (1, 2, 4, 8, 16, ...).
- ** The blocks must be contiguous in the address space (no gaps between the blocks).
- ** The third byte of the first address in the superblock must be evenly divisible by the number of blocks. In other words, if the number of blocks is N , the third byte must be divisible by N .

Example 5

A company needs 600 addresses. Which of the following set of class C blocks can be used to form a supernet for this company?

198.47.32.0 198.47.33.0 198.47.34.0

198.47.32.0 198.47.42.0 198.47.52.0 198.47.62.0

198.47.31.0 198.47.32.0 198.47.33.0 198.47.52.0

198.47.32.0 198.47.33.0 198.47.34.0 198.47.35.0

Solution

- 1: No, there are only three blocks.**
- 2: No, the blocks are not contiguous.**
- 3: No, 31 in the first block is not divisible by 4.**
- 4: Yes, all three requirements are fulfilled.**

Note

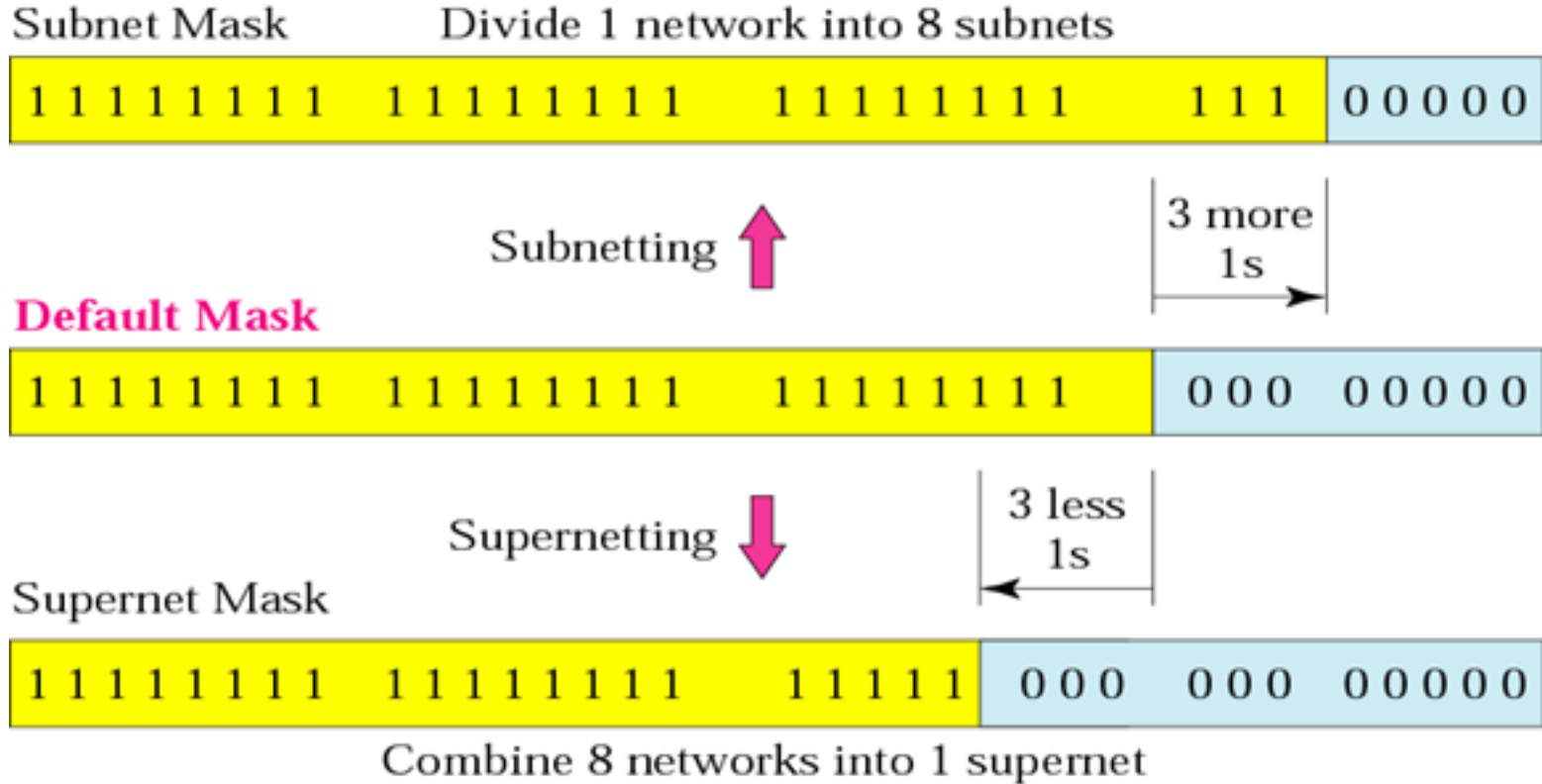
*In subnetting,
we need the first address of the
subnet and the subnet mask to
define the range of addresses.*

Note

**In supernetting,
we need the first address of
the supernet
and the supernet mask to
define the range of addresses.**

Figure 5-12

Comparison of subnet, default, and supernet masks



Example 6

We need to make a supernet out of 16 class C blocks. What is the supernet mask?

Solution

We need 16 blocks. For 16 blocks we need to change four 1s to 0s in the default mask. So the mask is

11111111 11111111 1111**0000** 00000000

or

255.255.240.0

Example 7

A supernet has a first address of 205.16.32.0 and a supernet mask of 255.255.248.0. A router receives three packets with the following destination addresses:

205.16.37.44

205.16.42.56

205.17.33.76

Which packet belongs to the supernet?

Solution

We apply the supernet mask to see if we can find the beginning address.

205.16.37.44 AND 255.255.248.0 → 205.16.32.0

205.16.42.56 AND 255.255.248.0 → 205.16.40.0

205.17.33.76 AND 255.255.248.0 → 205.17.32.0

Only the first address belongs to this supernet.

Example 8

A supernet has a first address of 205.16.32.0 and a supernet mask of 255.255.248.0. How many blocks are in this supernet and what is the range of addresses?

Solution

The supernet has 21 1s. The default mask has 24 1s. Since the difference is 3, there are 2^3 or 8 blocks in this supernet. The blocks are 205.16.32.0 to 205.16.39.0. The first address is 205.16.32.0. The last address is 205.16.39.255.