

*IP Addresses:  
Classful Addressing*

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*4.1*

# **INTRODUCTION**

Note

*An IP address is a  
32-bit  
address.*

Note

*The IP addresses  
are  
unique.*

## ***RULE:***

**If a protocol uses  $N$  bits to define an address, the address space is  $2^N$  because each bit can have two different values (0 and 1) and  $N$  bits can have  $2^N$  values.**

## Note

*The address space of IPv4 is*

*$2^{32}$*

*or*

*4,294,967,296.*

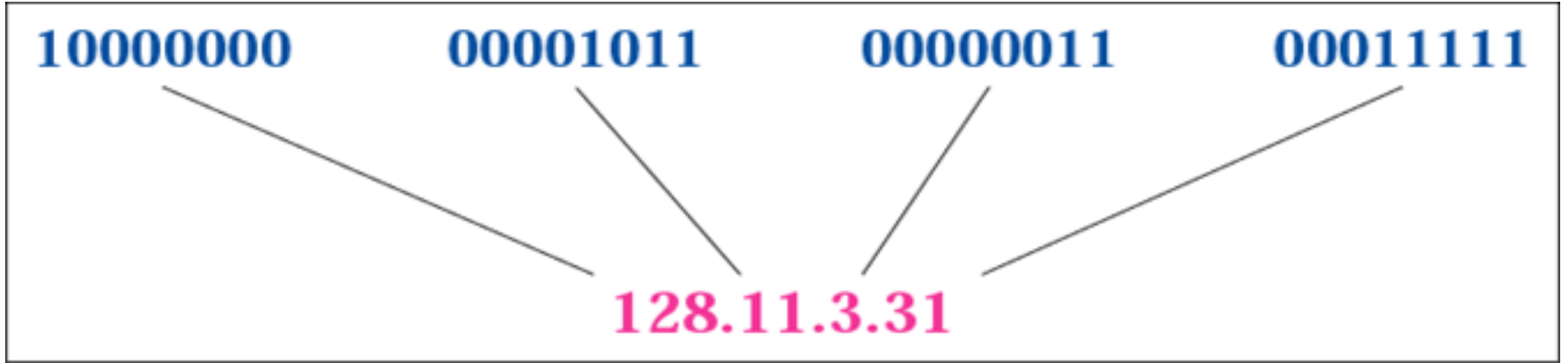
# *Binary Notation*

**01110101 10010101 00011101 11101010**



Figure 4-1

# Dotted-decimal notation



# *Hexadecimal Notation*

**0111 0101   1001 0101   0001 1101   1110 1010**

**75**

**95**

**1D**

**EA**

**0x75951DEA**

## Note

*The binary, decimal, and hexadecimal number systems are reviewed in Appendix B.*

## *Example 1*

Change the following IP address from binary notation to dotted-decimal notation.

10000001 00001011 00001011 11101111

## *Solution*

*129.11.11.239*

## *Example 2*

Change the following IP address from dotted-decimal notation to binary notation.

111.56.45.78

## *Solution*

*01101111 00111000 00101101 01001110*

### *Example 3*

Find the error, if any, in the following IP address:

111.56.045.78

### *Solution*

There are no leading zeroes in dotted-decimal notation (045).

### *Example 3 (continued)*

Find the error, if any, in the following IP address:

75.45.301.14

### ***Solution***

In dotted-decimal notation, each number is less than or equal to 255; 301 is outside this range.

## *Example 4*

Change the following IP addresses from binary notation to hexadecimal notation.

10000001 00001011 00001011 11101111

## *Solution*

0X810B0BEF or 810B0BEF<sub>16</sub>



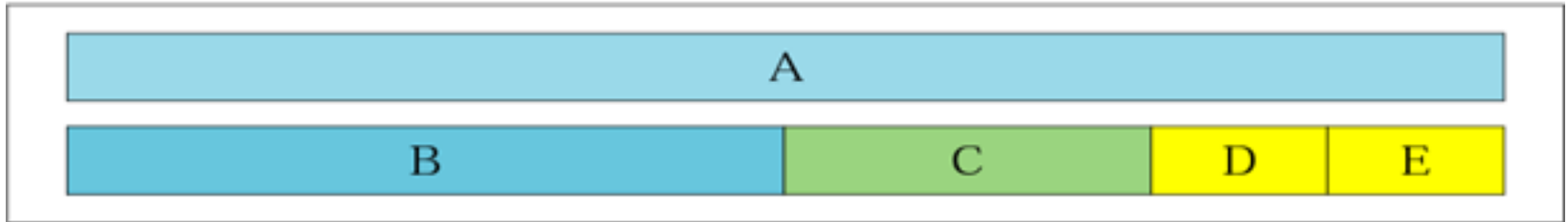
**4.2**

# **CLASSFUL ADDRESSING**

Figure 4-2

# Occupation of the address space

Address space



## Note

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

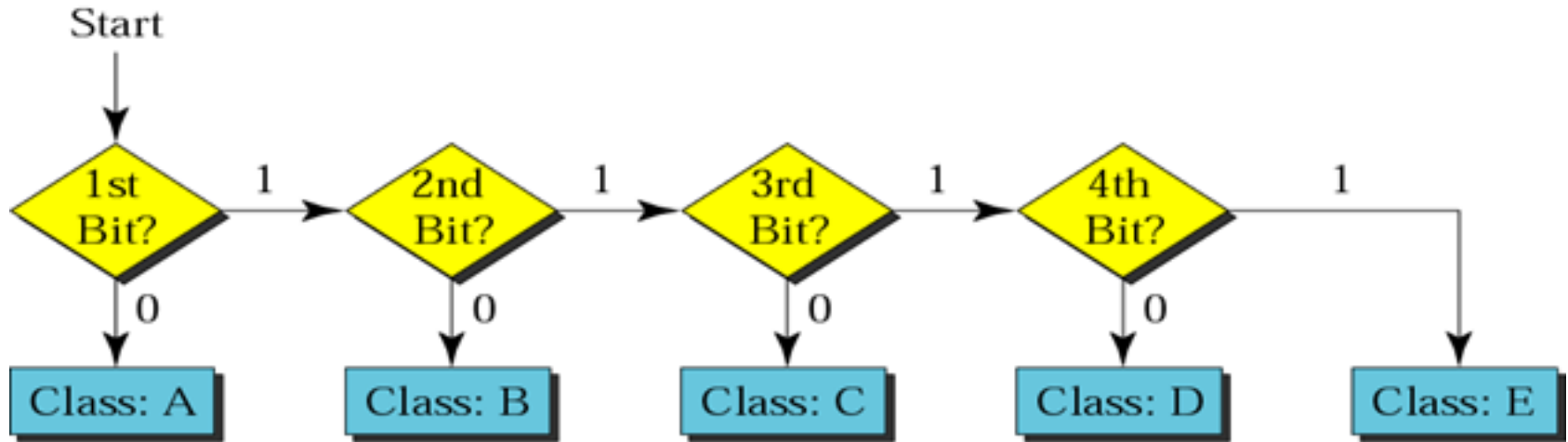
Figure 4-3

## Finding the class in binary notation

	First byte	Second byte	Third byte	Fourth byte
Class A	<b>0</b>			
Class B	<b>10</b>			
Class C	<b>110</b>			
Class D	<b>1110</b>			
Class E	<b>1111</b>			

Figure 4-4

# Finding the address class



## *Example 5*

How can we prove that we have 2,147,483,648 addresses in class A?

## *Solution*

In class A, only 1 bit defines the class. The remaining 31 bits are available for the address. With 31 bits, we can have  $2^{31}$  or 2,147,483,648 addresses.

## *Example 6*

Find the class of the address:

00000001 00001011 00001011 11101111

## *Solution*

The first bit is 0. This is a class A address.

## *Example 6 (Continued)*

Find the class of the address:

11000001 10000011 00011011 11111111

## *Solution*

The first 2 bits are 1; the third bit is 0.  
This is a class C address.



Figure 4-5

# Finding the class in decimal notation

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

## *Example 7*

Find the class of the address:

*227.12.14.87*

## *Solution*

The first byte is 227 (between 224 and 239);  
the class is D.

## *Example 7 (Continued)*

Find the class of the address:

**193.14.56.22**

### *Solution*

The first byte is 193 (between 192 and 223);  
the class is C.

Figure 4-6

# Netid and hostid

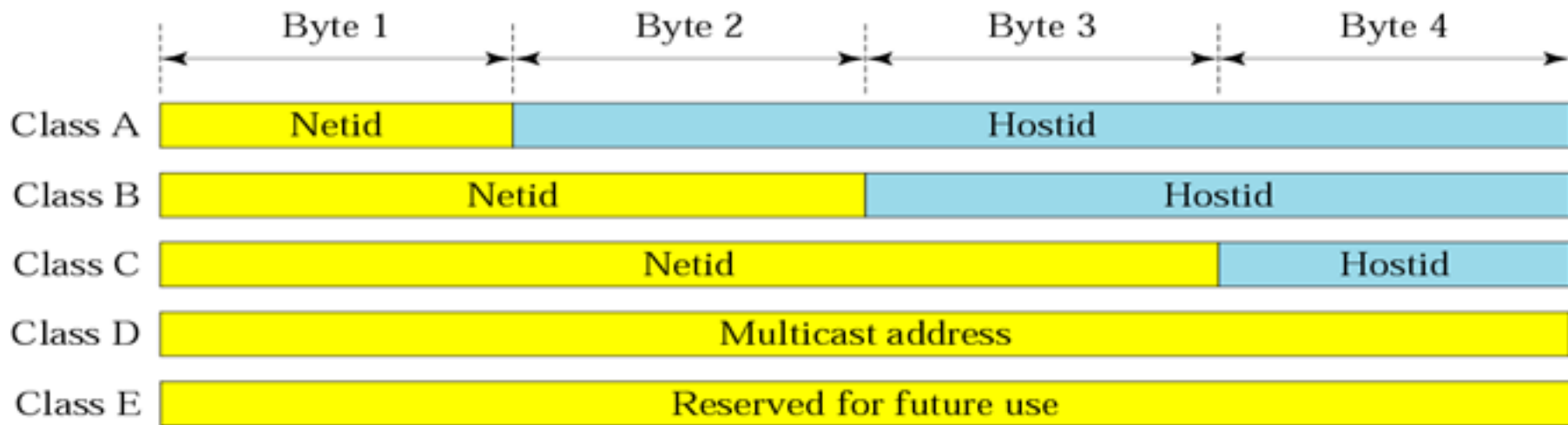
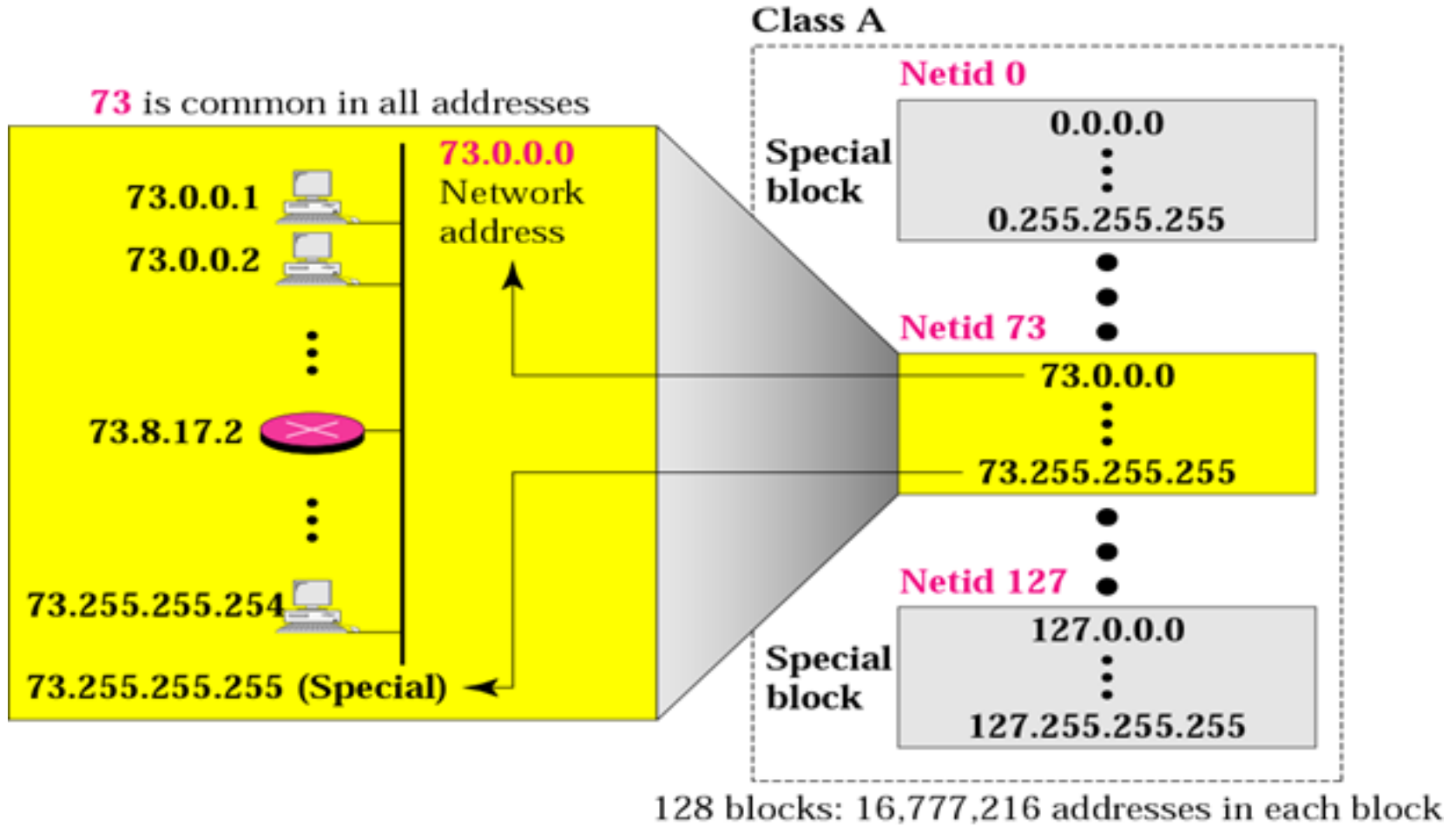


Figure 4-7

# Blocks in class A

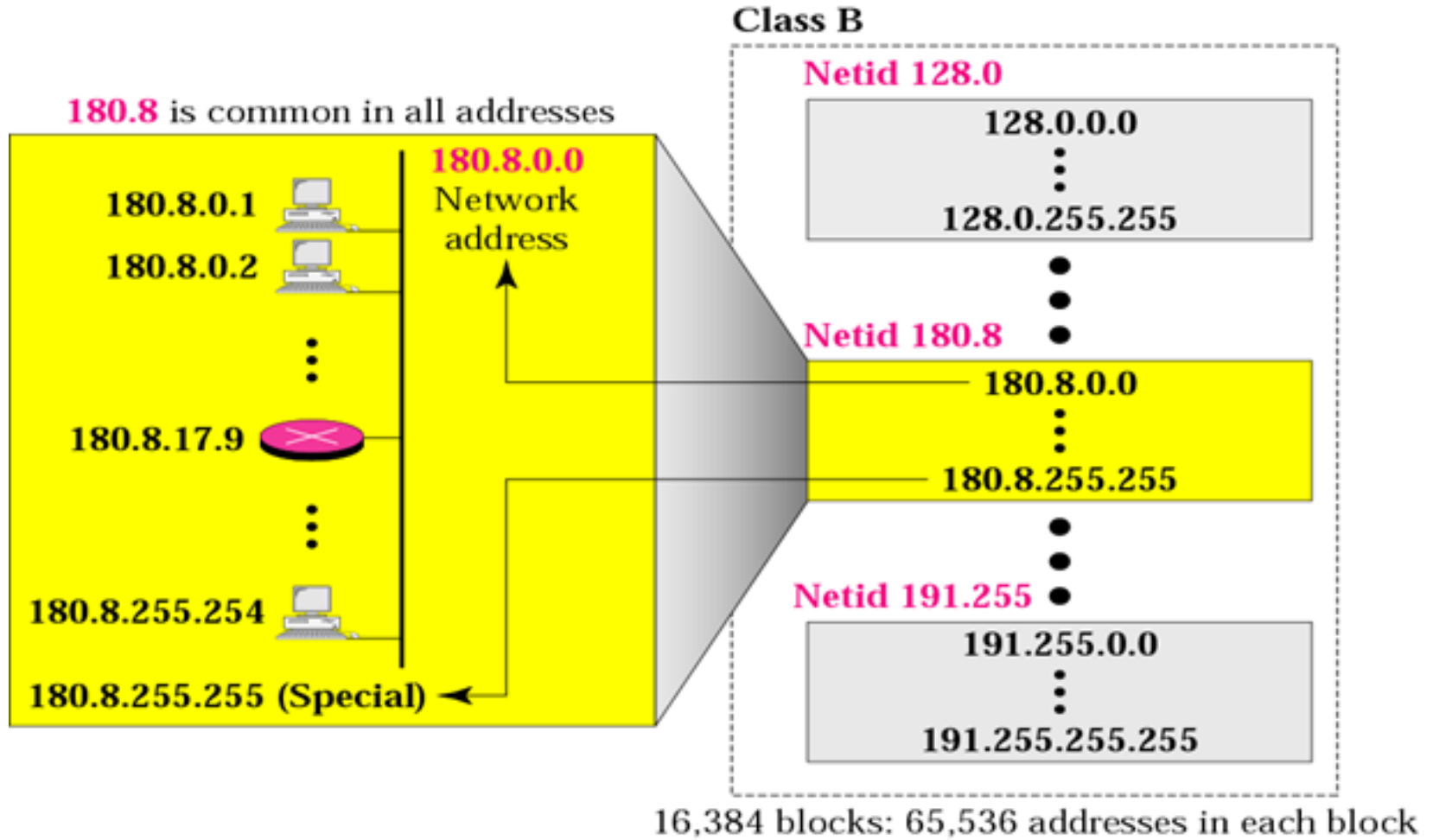


Note

*Millions of class A addresses  
are wasted.*

Figure 4-8

# Blocks in class B



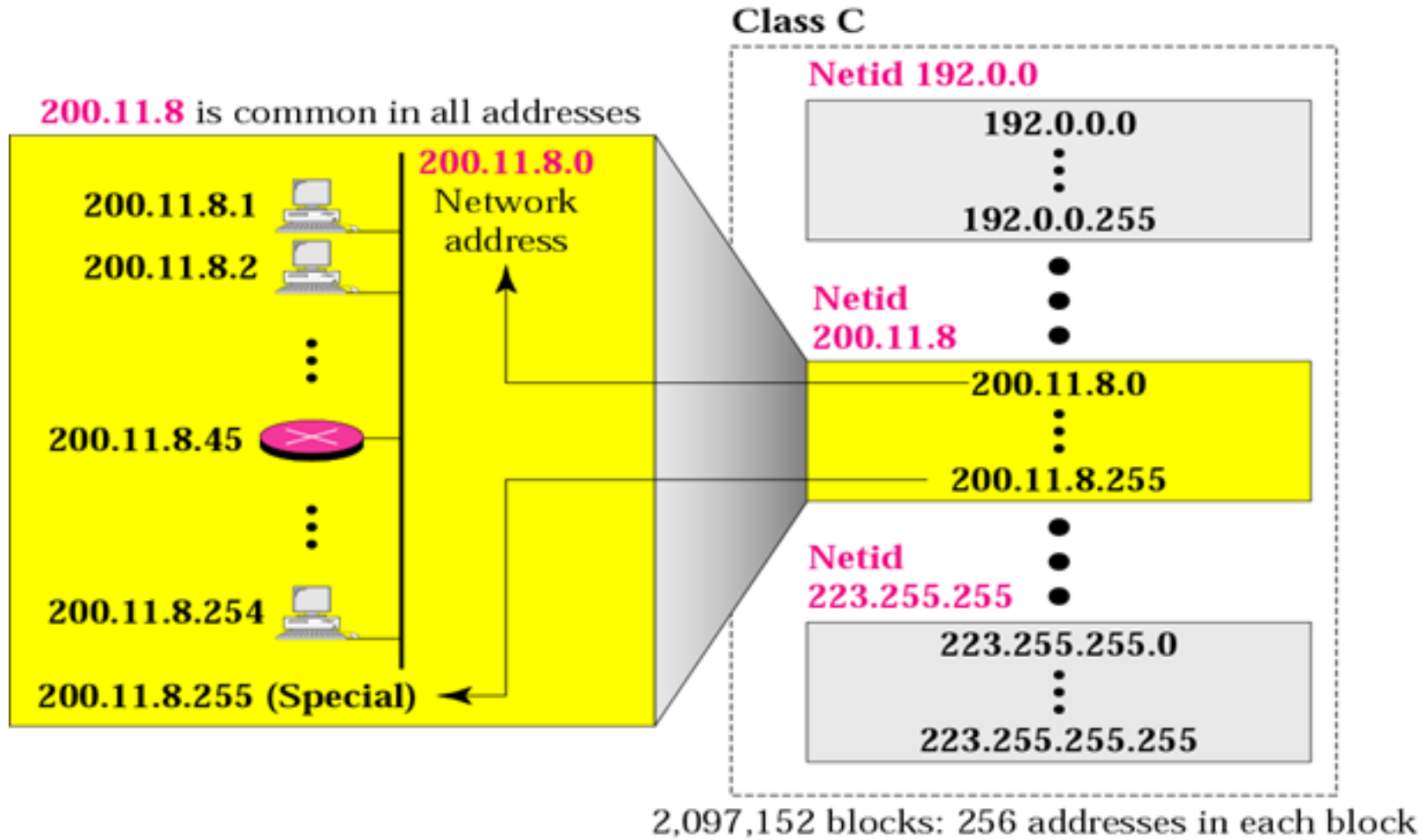
Note

*Many class B addresses  
are wasted.*



Figure 4-9

# Blocks in class C



## Note

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

## Note

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

## Note

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

# Network Addresses

The network address is the first address.

The network address defines the network to the rest of the Internet.

Given the network address, we can find the class of the address, the block, and the range of the addresses in the block

## Note

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

## *Example 10*

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

## *Solution*

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

## *Example 9*

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

## *Solution*

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.



## *Example 11*

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

## *Solution*

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.

# 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.

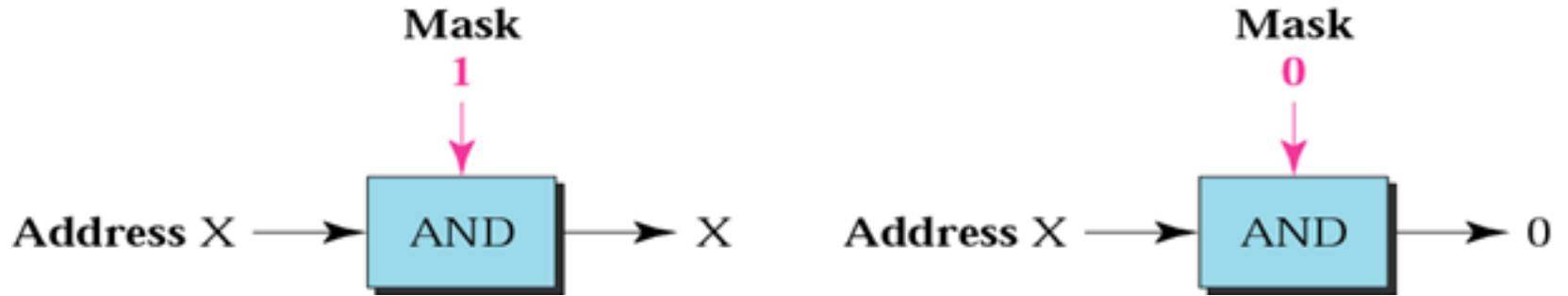
Figure 4-10

# Masking concept



Figure 4-11

# AND operation



## Note

*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.*

## ***Example 12***

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

## ***Solution***

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.

### ***Example 13***

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

### ***Solution***

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.

### ***Example 14***

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

### ***Solution***

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.



## Note

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

***4.13***

**OTHER  
ISSUES**

Figure 4-12

# Multihomed devices

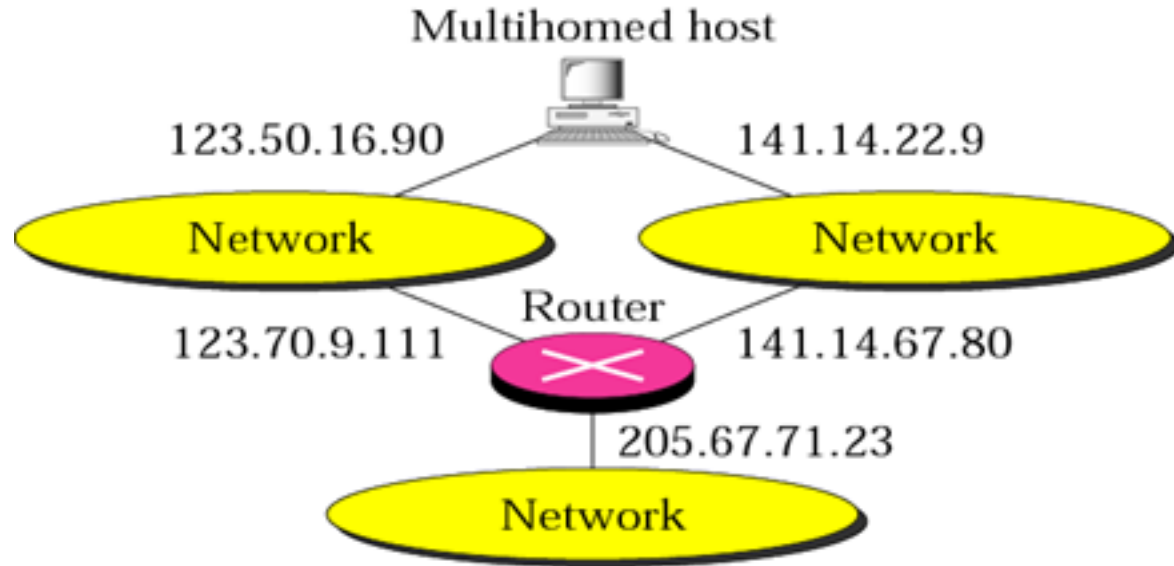


Figure 4-13

# Network addresses

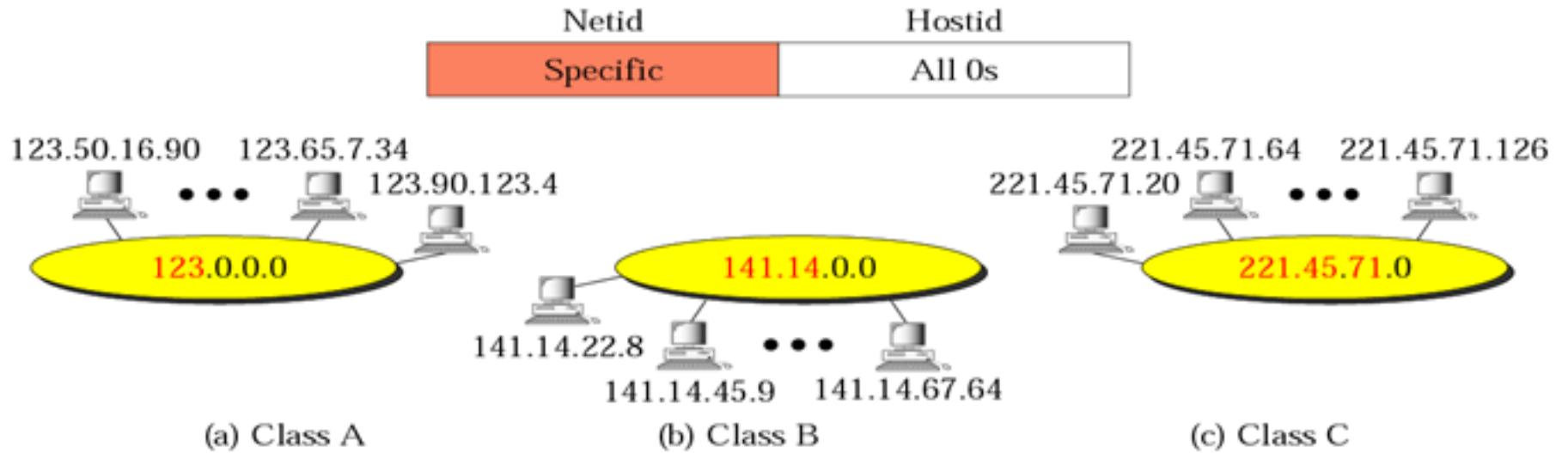
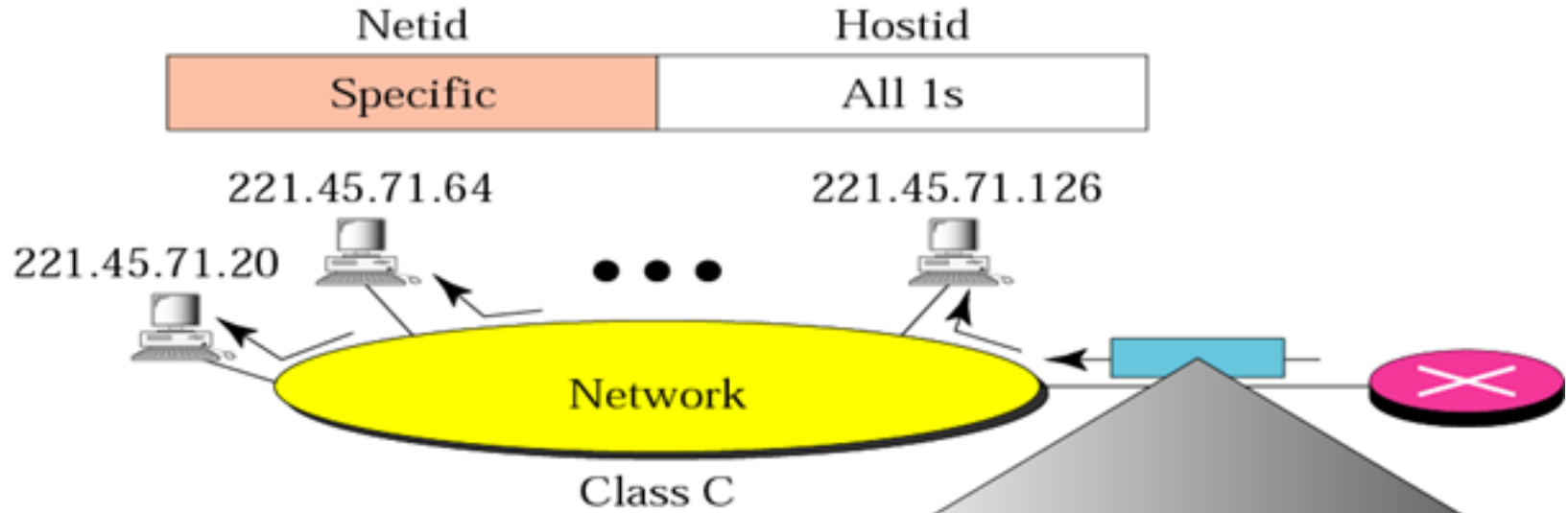


Figure 4-14

# Example of direct broadcast address



The direct broadcast address is used by a router to send a message to every host on a local network. Every host/router receives and processes the packet with a direct broadcast address.

Destination IP address:  
221.45.71.255  
Hostid: 255

Figure 4-15

# Example of limited broadcast address

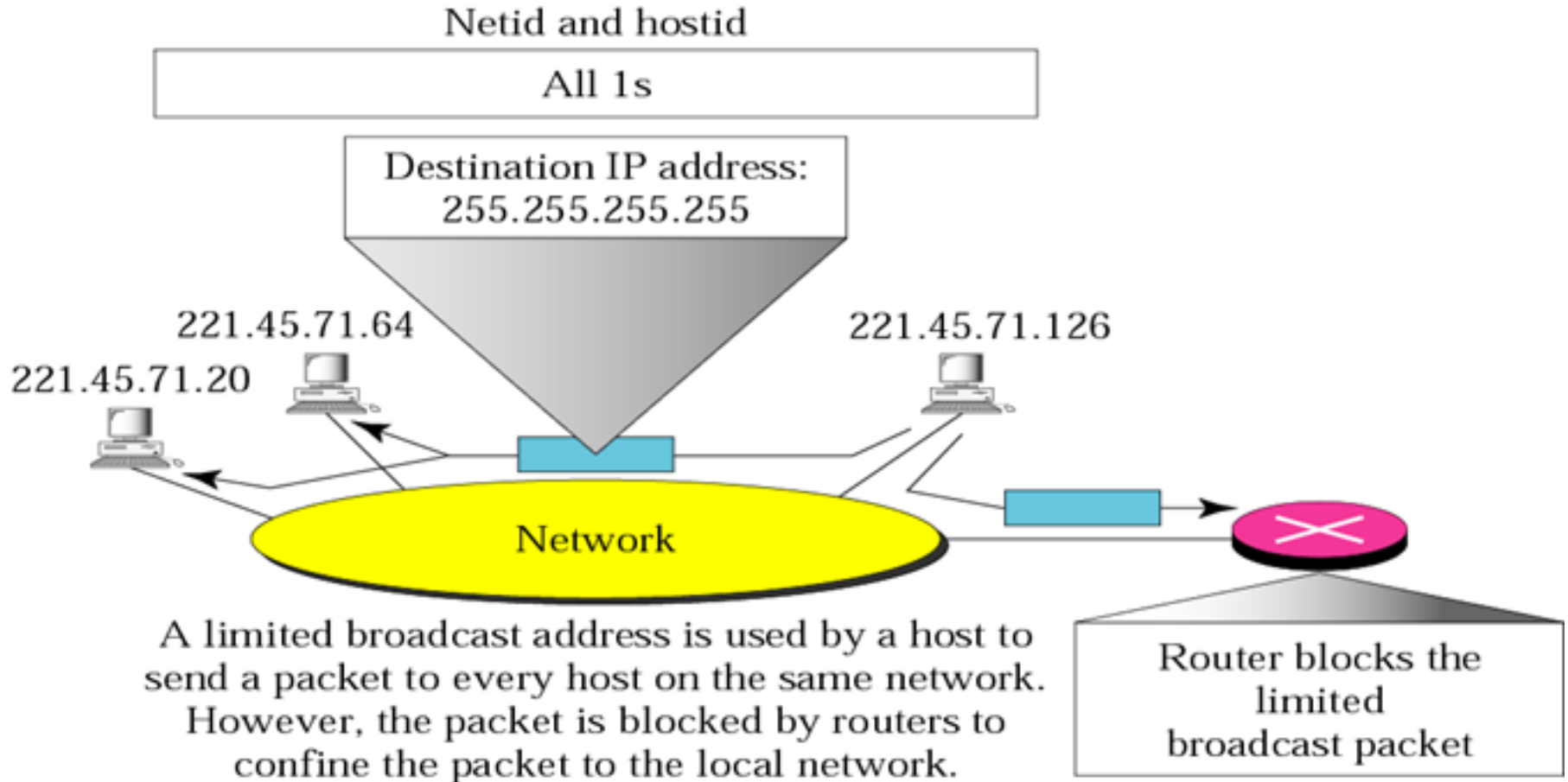
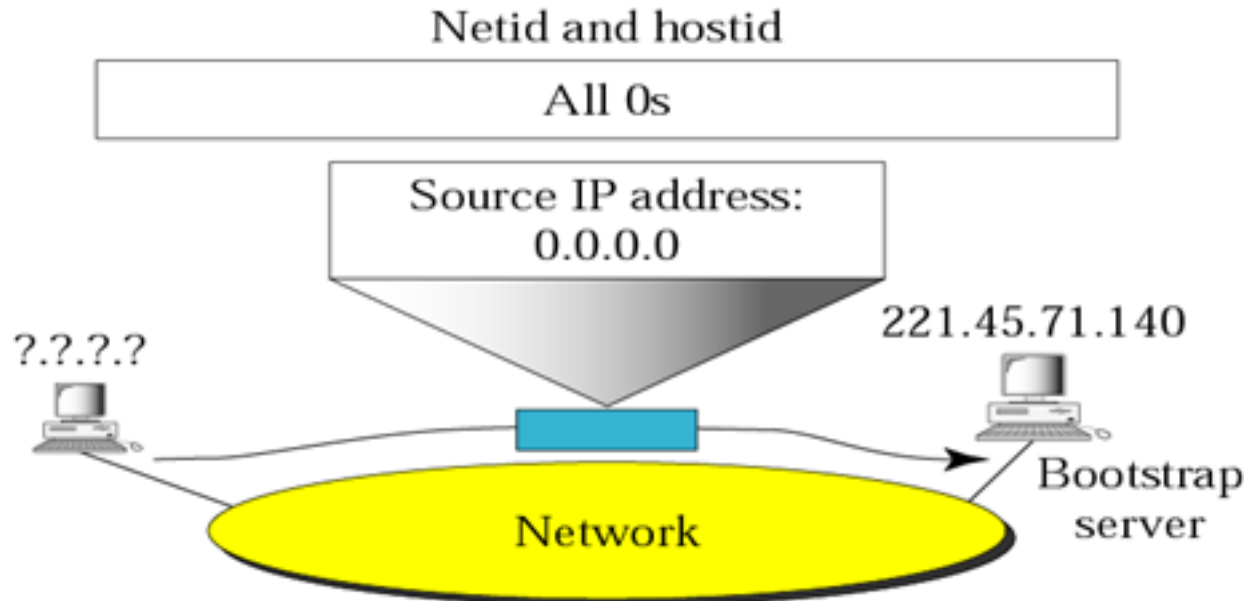


Figure 4-16

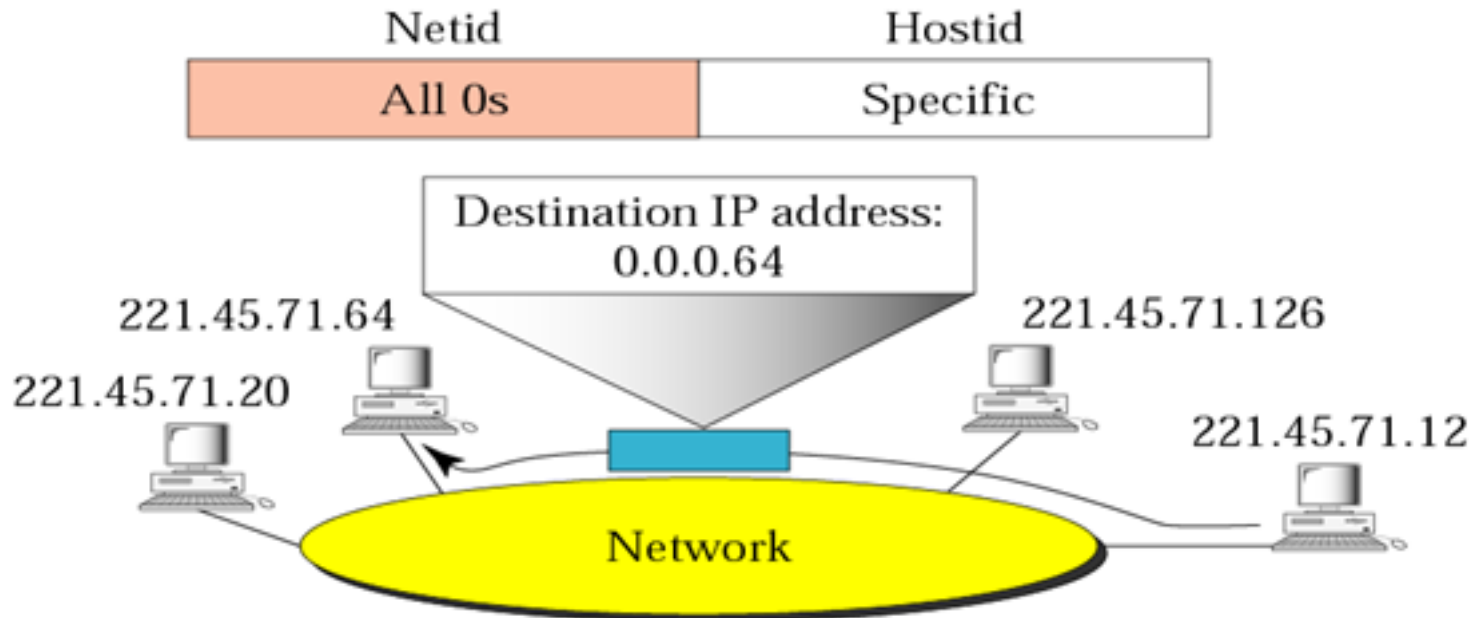
# Example of *this* host on *this* address



A host that does not know its IP address uses the IP address 0.0.0.0 as the source address and 255.255.255.255 as the destination address to send a message to a bootstrap server.

Figure 4-17

# Example of specific host on *this* network

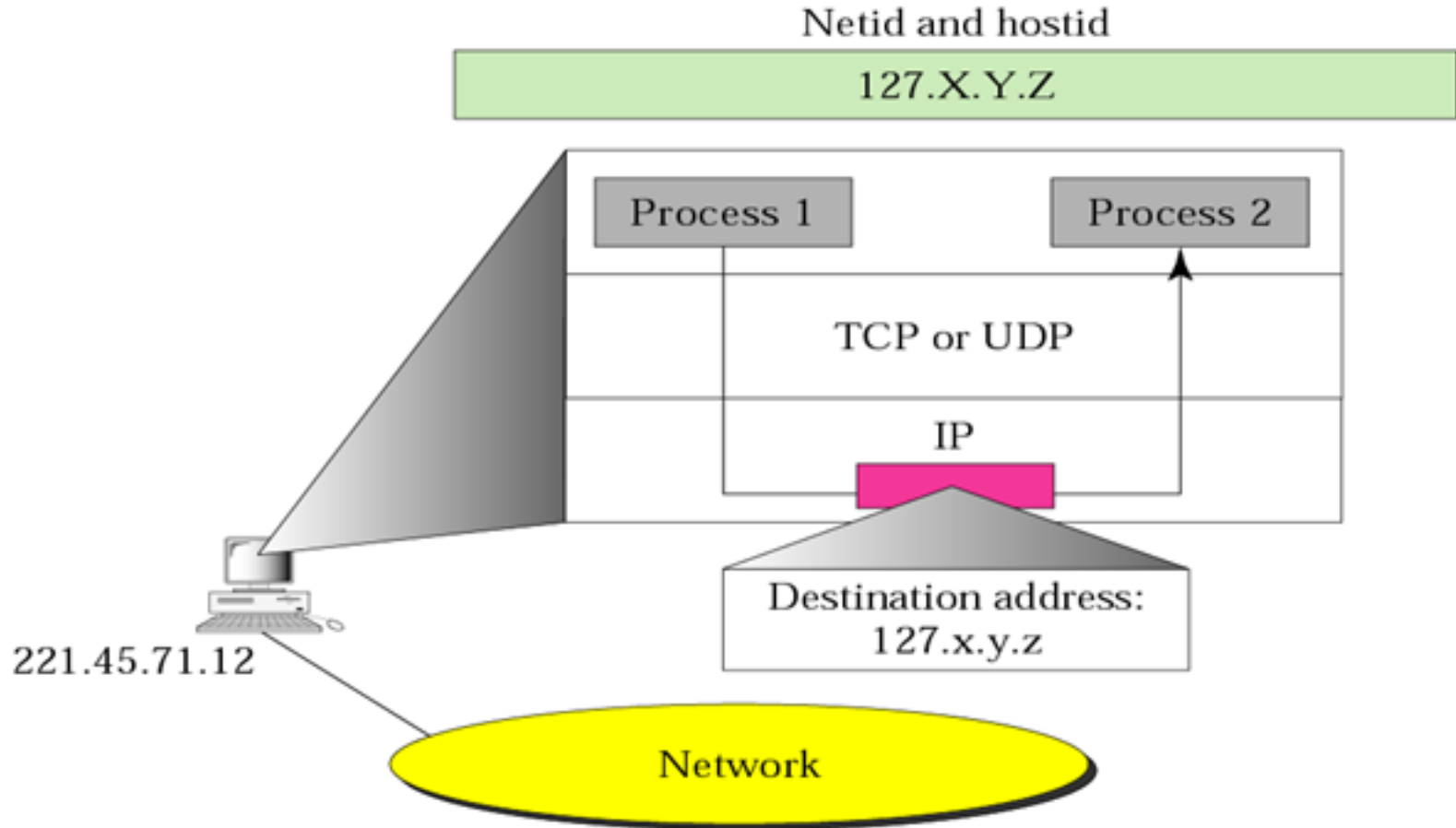


This address is used by a router or host to send a message to a specific host on the same network.



Figure 4-18

# Example of loopback address



A packet with a loopback address will not reach the network.

# Private Addresses

A number of blocks in each class are assigned for private use. They are not recognized globally.

# Unicast, Multicast, and Broadcast Addresses

Unicast communication is *one-to-one*.

Multicast communication is *one-to-many*.

Broadcast communication is *one-to-all*.

## **4.4**

# **A SAMPLE INTERNET WITH CLASSFUL ADDRESSES**

Figure 4-19

# Sample internet

