Network Layer

Module 3

Introduction

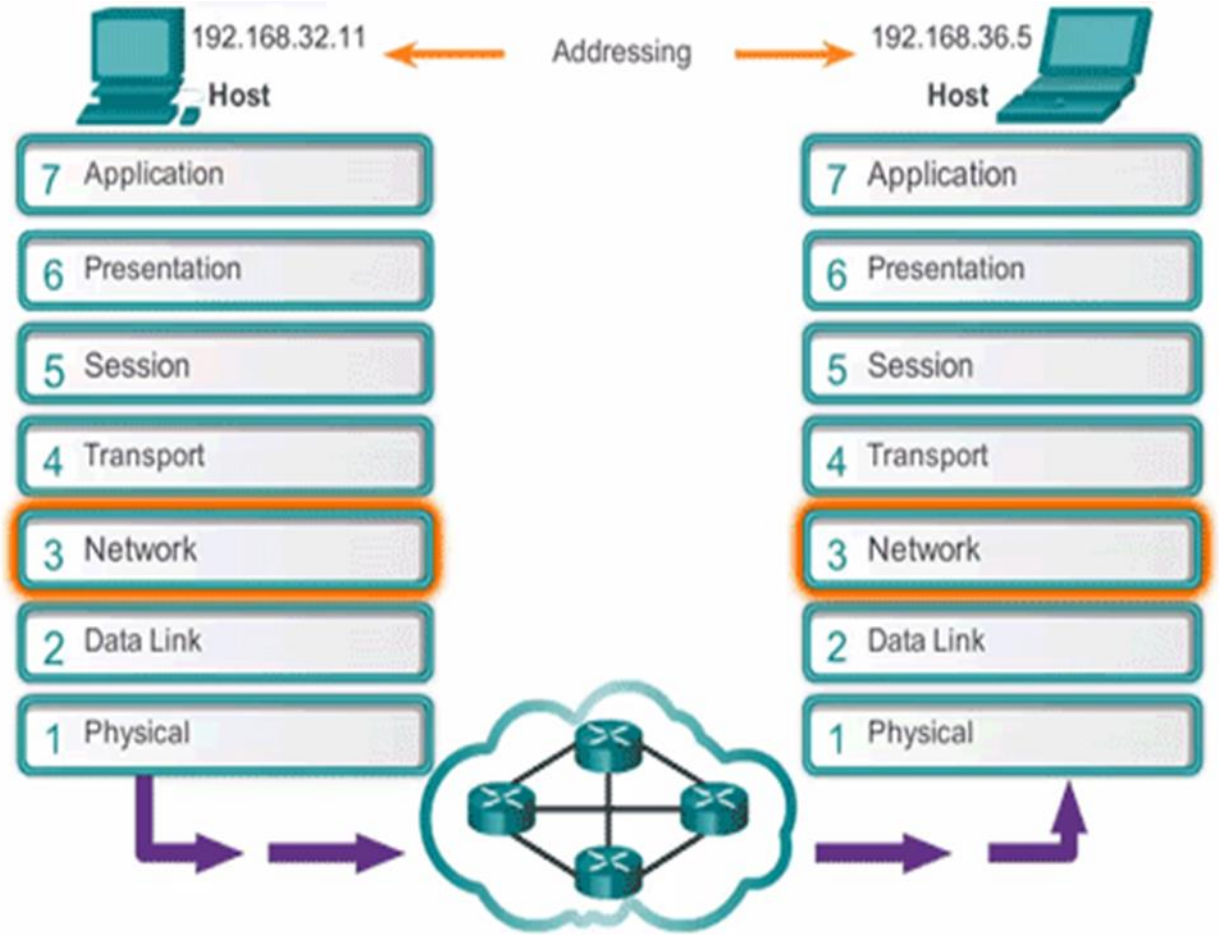
Network layer Services:

- Packetizing
- Routing and Forwarding
- Provide Services to upper layers.
- Other Features:
  - Error Control, Flow Control, Congestion Control, QoS and Security

Characteristics of IP:

- Connectionless
- Best Effort

Communication at Network Layer



IPv4 Address

- IPv4 is 32 bit long

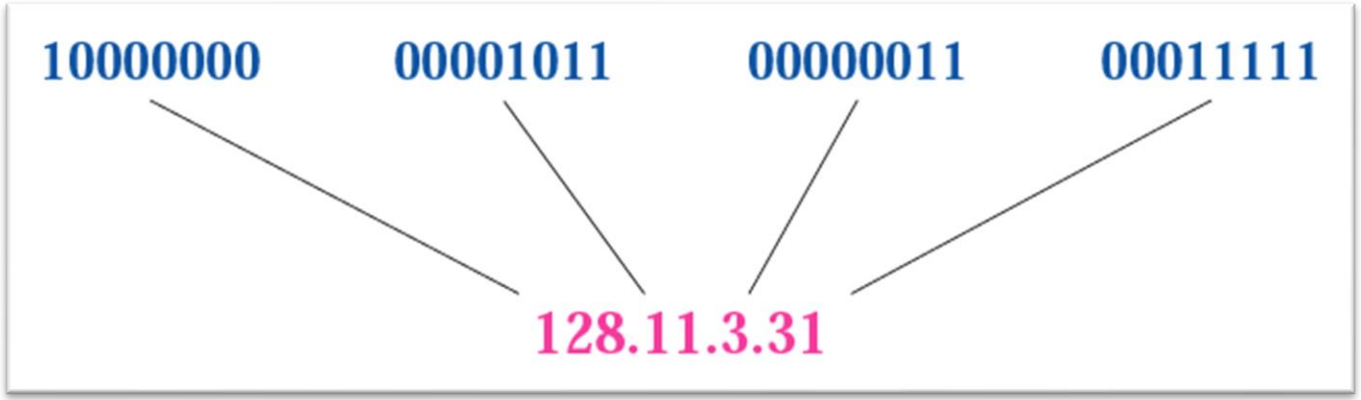
Address Space

- IPv4 is 32 bit long
- Total Addresses available are

  2^{32} i.e. 42,94,96,296

Note: 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.

Dotted-Decimal Notation



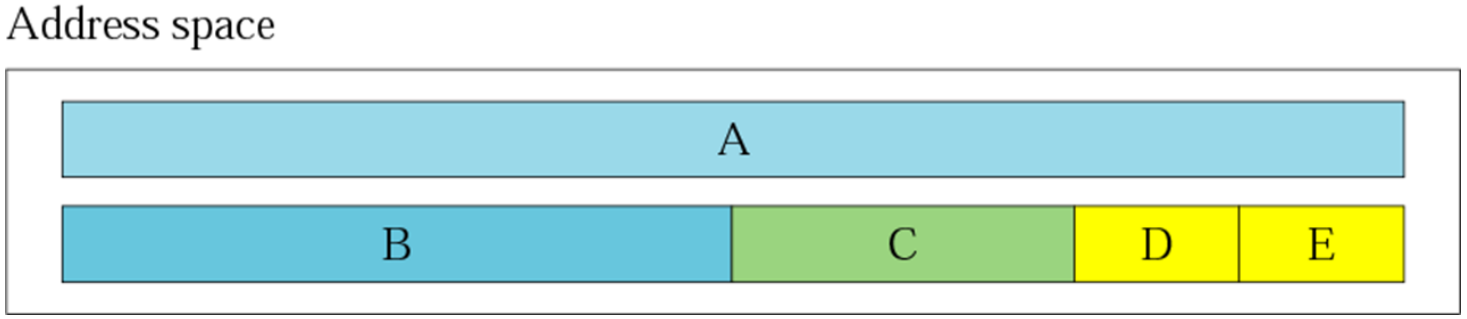
Hexadecimal Notation

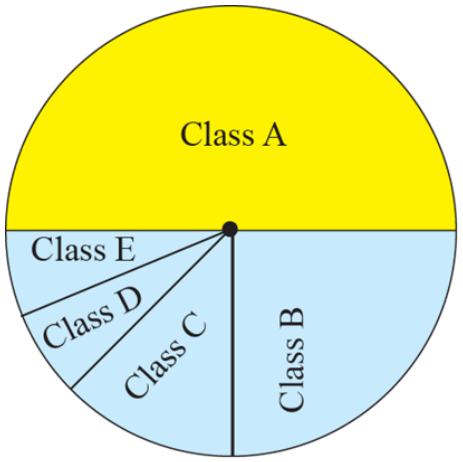
0111 0101	1001 0101	0001 1101	1110 1010
75	95	1D	EA

0x75951DEA

Classful Addressing

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





Class A: 2^{31} = 2,147,483,648 addresses, 50%

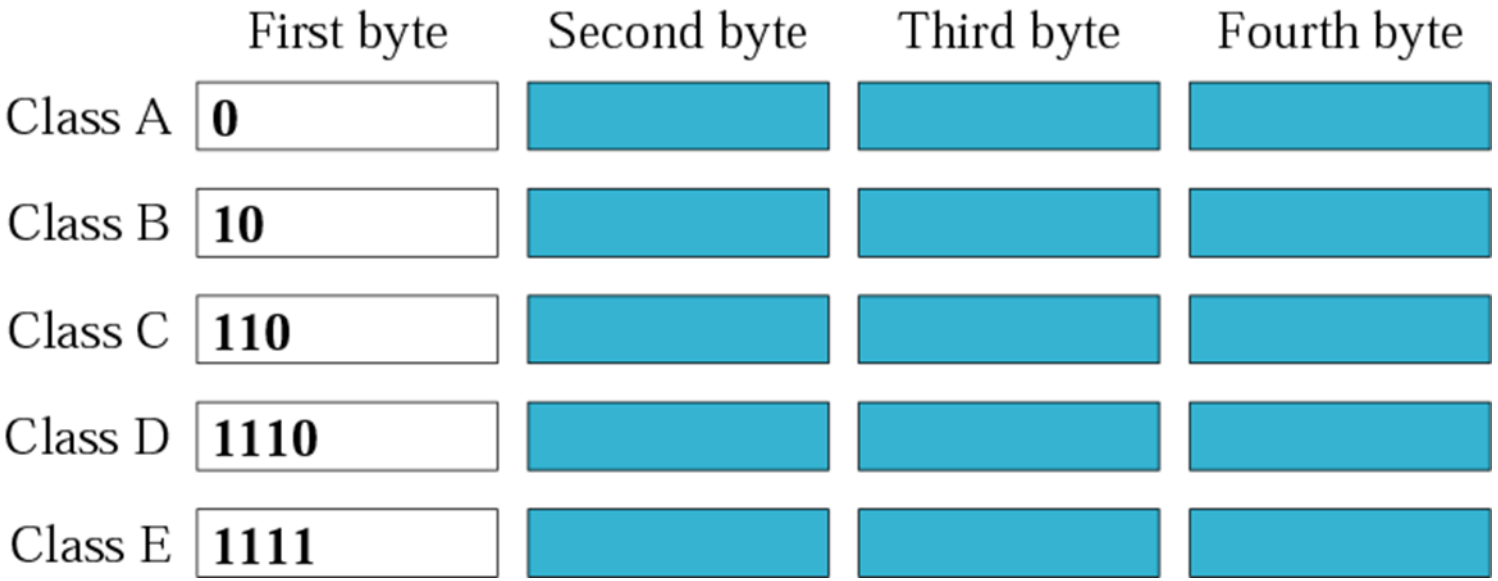
Class B: 2^{30} = 1,073,741,824 addresses, 25%

Class C: 2^{29} = 536,870,912 addresses, 12.5%

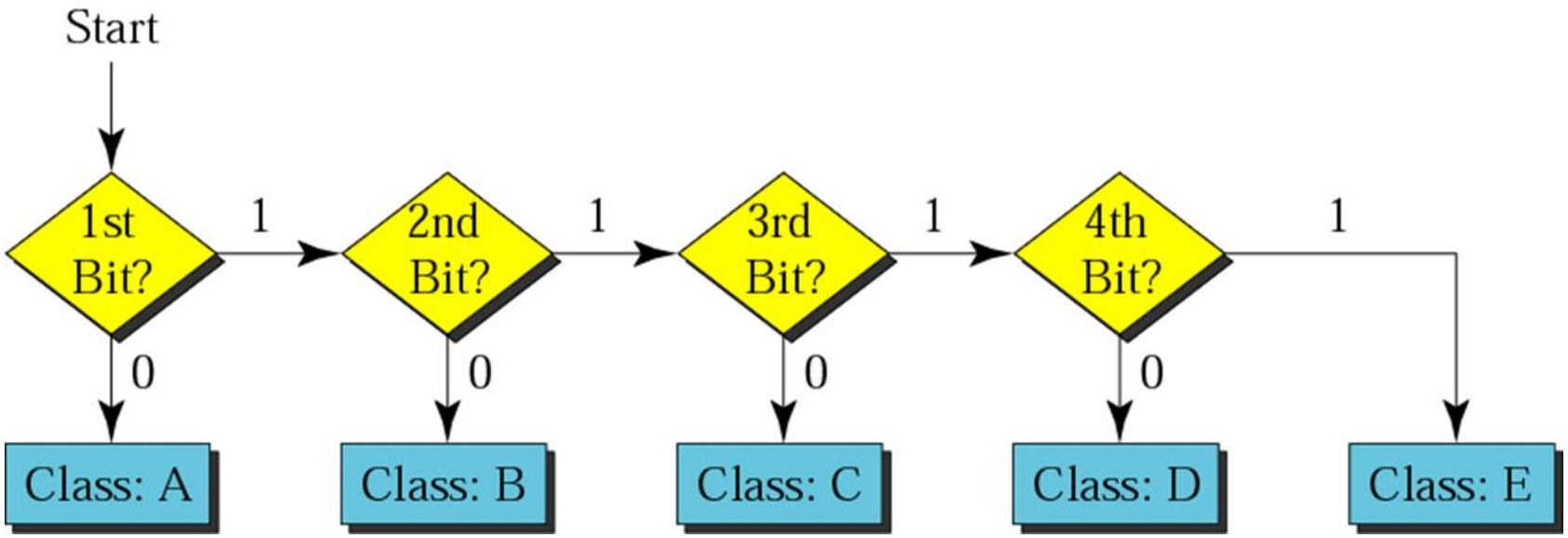
Class D: 2^{28} = 268,435,456 addresses, 6.25%

Class E: 2^{28} = 268,435,456 addresses, 6.25%

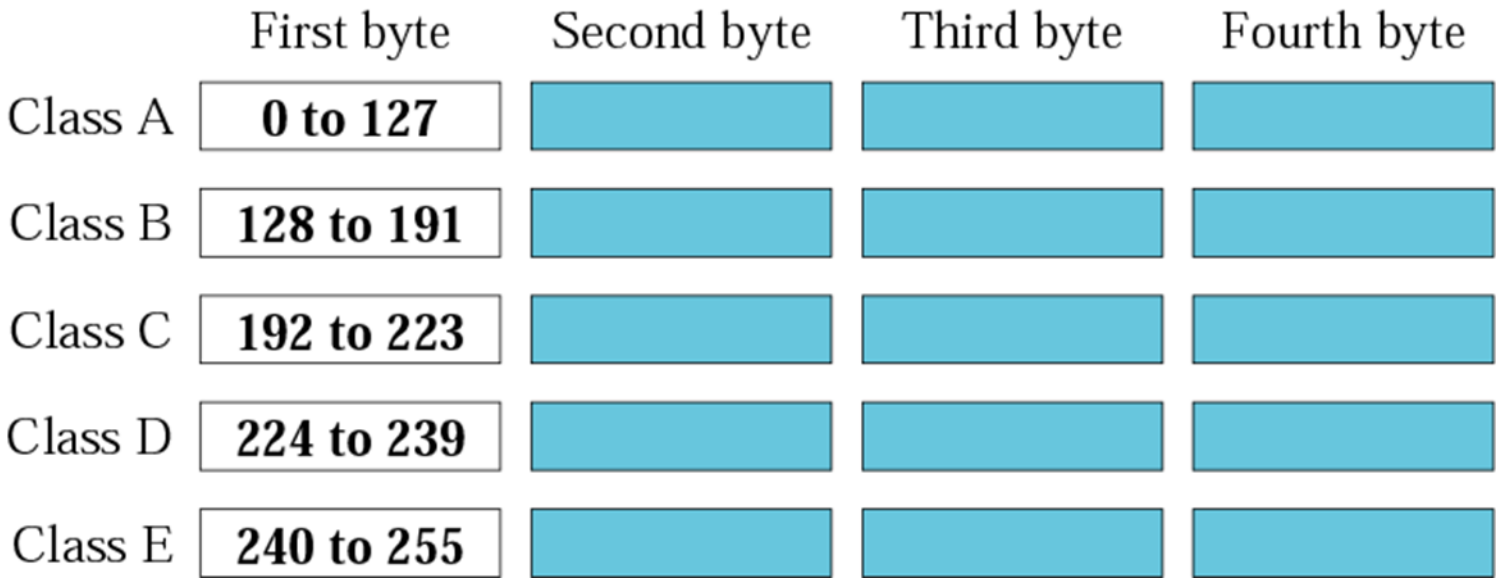
Finding the class in binary notation



Finding the address class

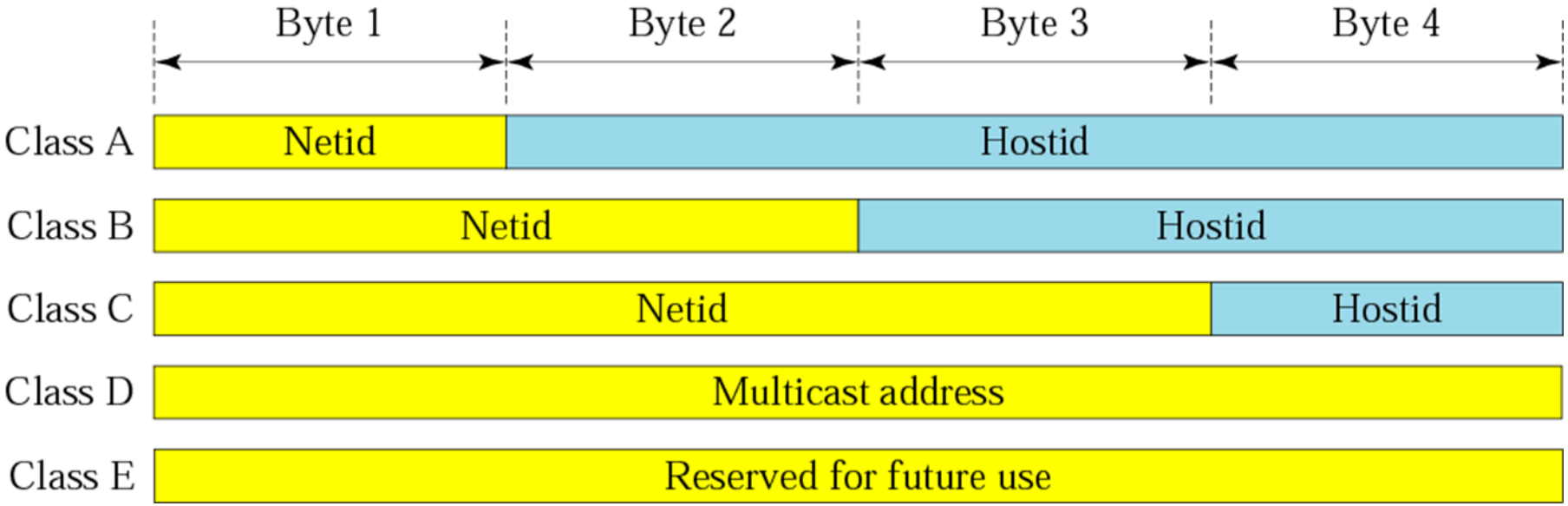


Finding the class in decimal notation

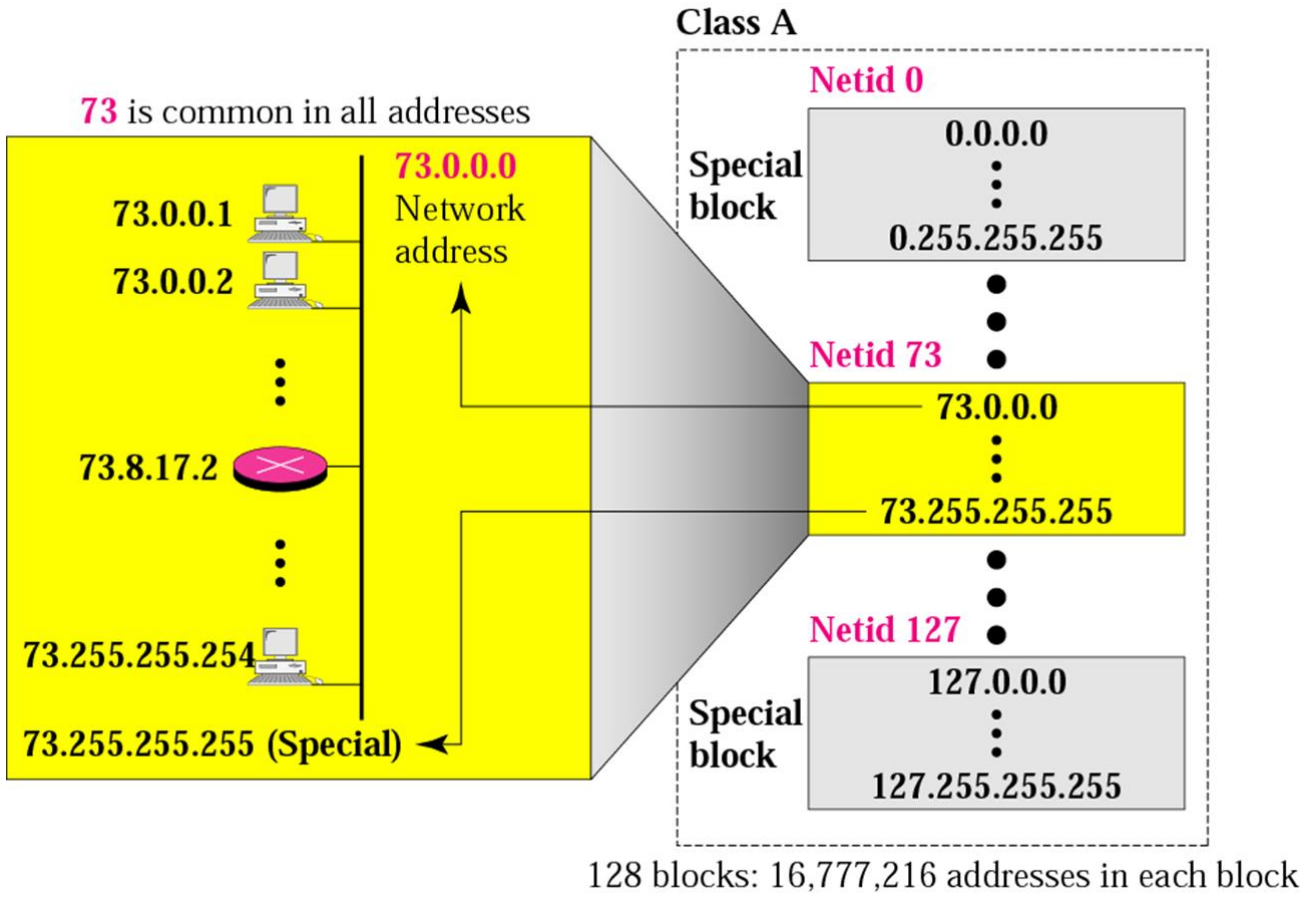


Note:
The range of addresses allocated to an organization in classful addressing was a block of addresses in Class A, B, or C.

Net-ID and Host-ID

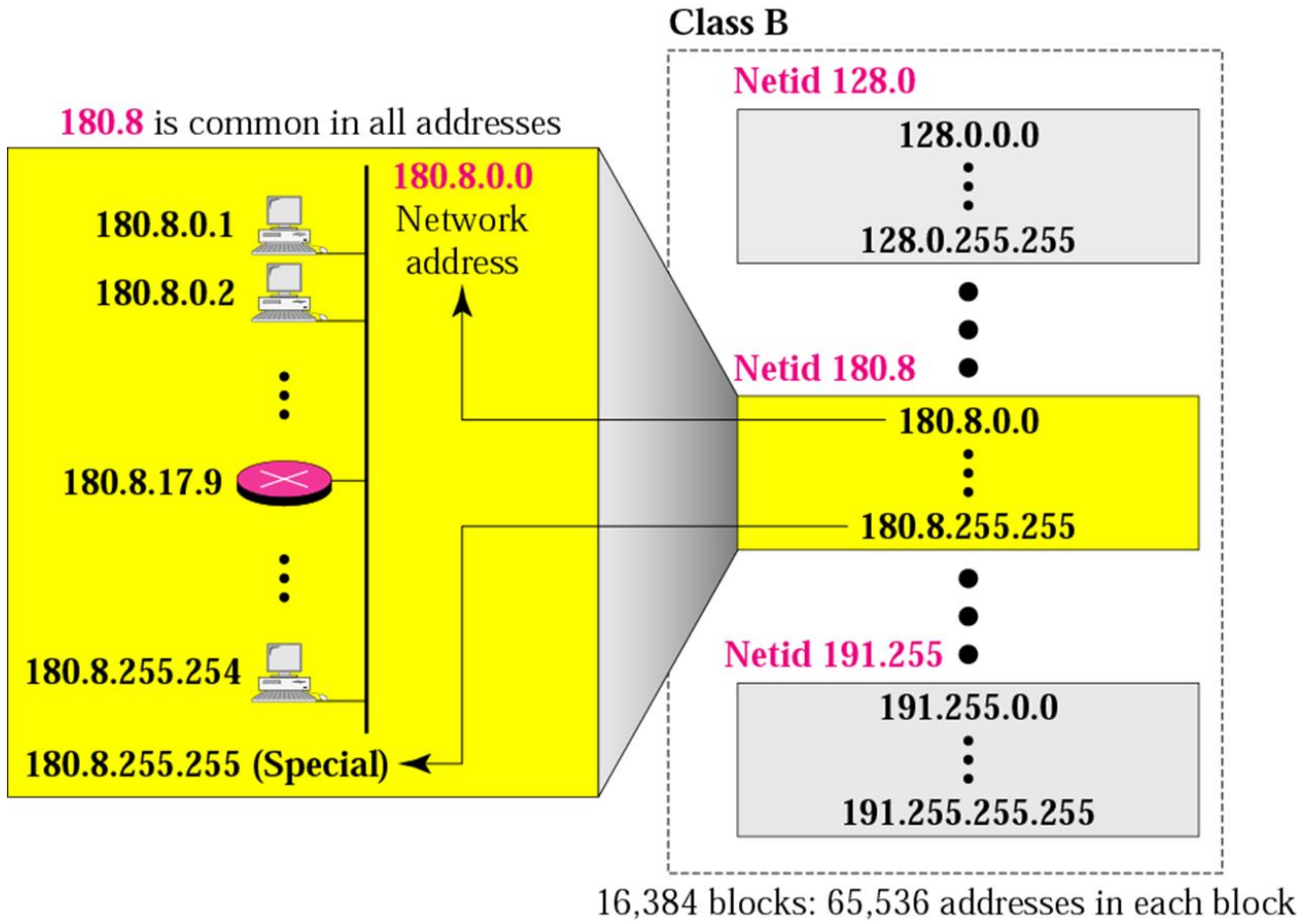


Blocks in class A



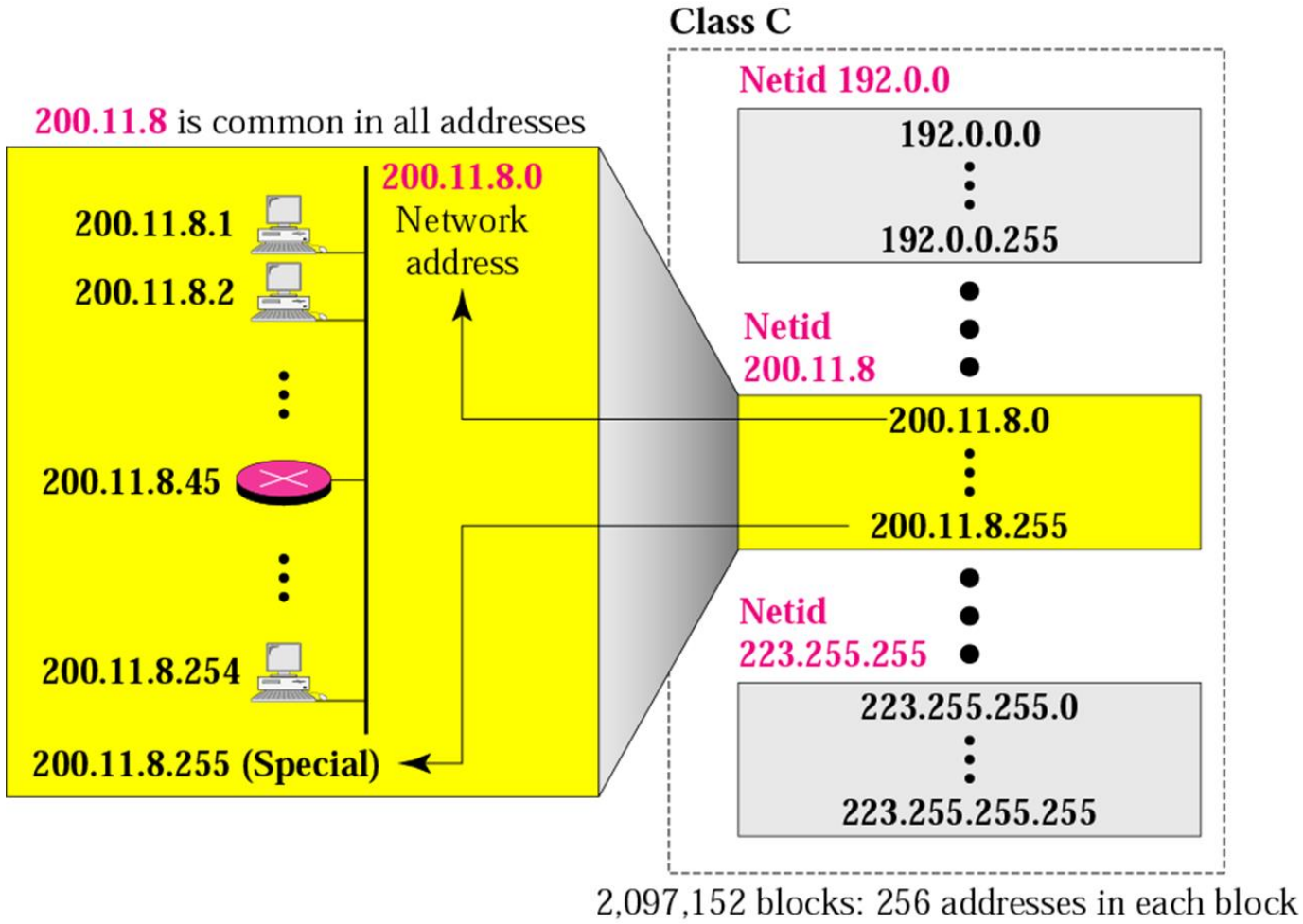
Note: Millions of class A addresses are wasted

Blocks in class B



Note: Many class B addresses are wasted.

Blocks in class C



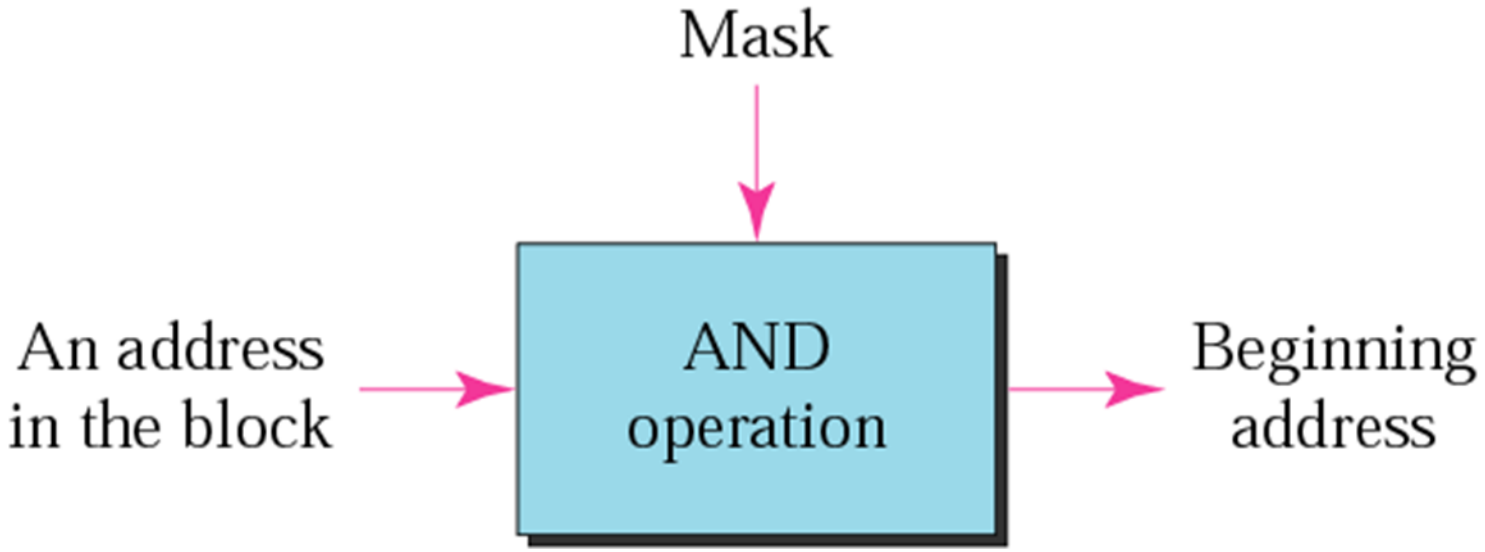
Note: The number of addresses in a class C block is smaller than the needs of most organizations.

Blocks in class D and E

- Class D addresses are used for multicasting; there is only one block in this class.
- In classful addressing, the network address (the first address in the block) is the one that is assigned to the organization.

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.



Mask

- 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 net-id of the block and sets the hos-tid to zero.

Example

An address in a block is given as 73.22.17.25. Find the number of addresses in the block, the first address, and the last address.

Solution:

- Figure shows a possible configuration of the network that uses this block.
- The number of addresses in this block is N = 232−n =16,777,216.
- To find the first address, we keep the leftmost 8 bits and set the rightmost 24 bits all to 0s. The first address is 73.0.0.0/8, in which 8 is the value of n.
- To find the last address, we keep the leftmost 8 bits and set the rightmost 24 bits all to 1s. The last address is 73.255.255.255.

Example

Solution:

- The number of addresses in this block is N = 232−n = 16,777,216.
- To find the first address, we keep the leftmost 8 bits and set the rightmost 24 bits all to 0s. The first address is 73.0.0.0/8, in which 8 is the value of n.
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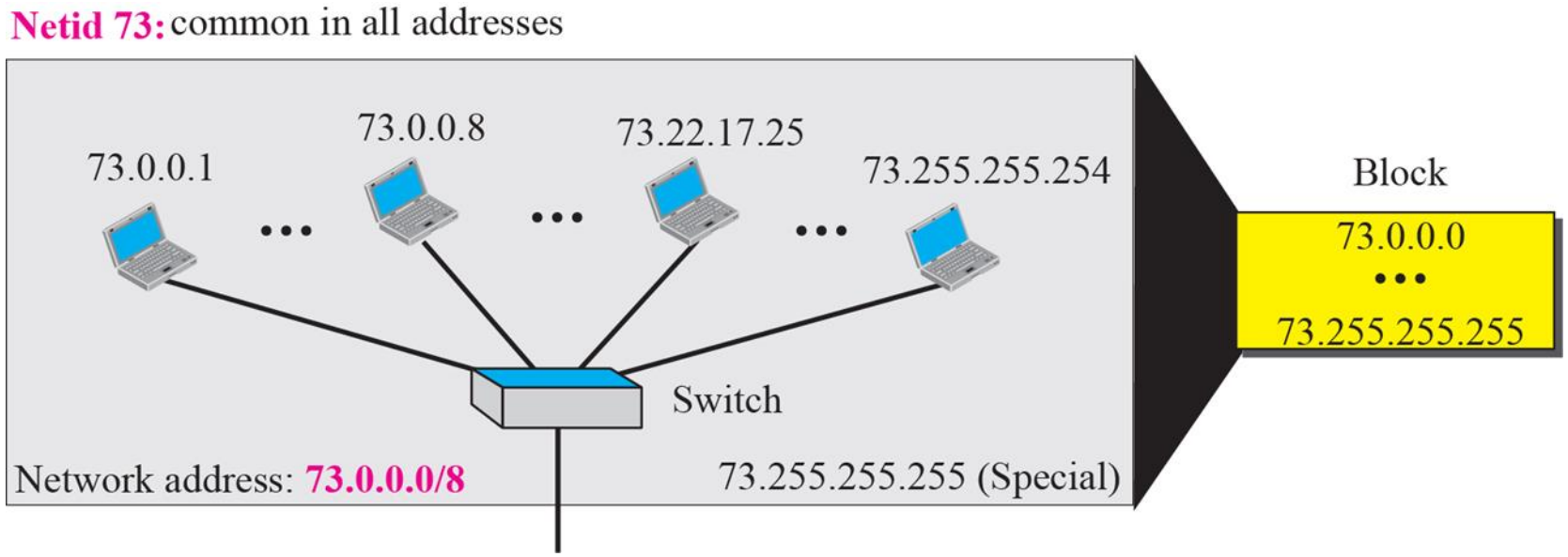
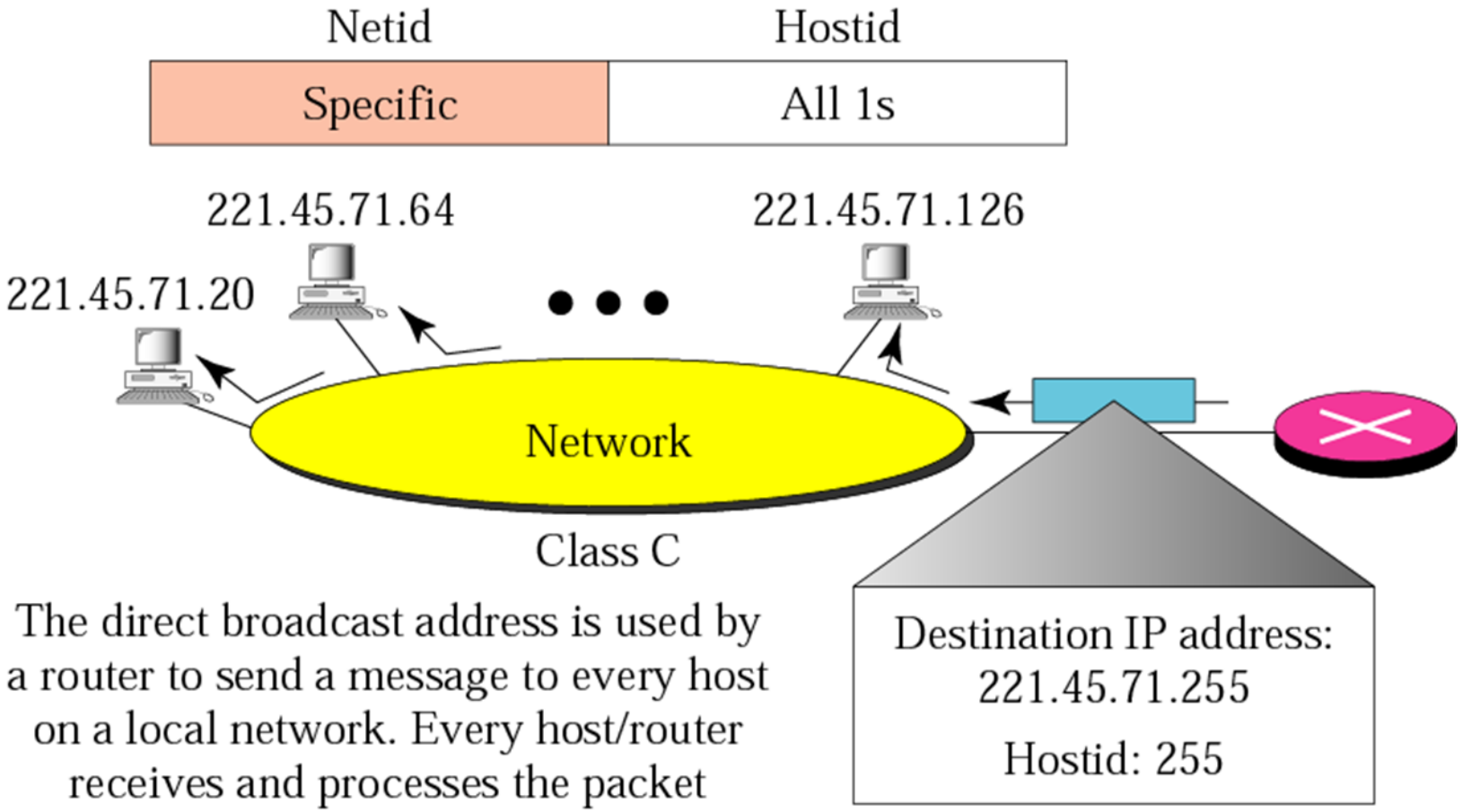


Note:

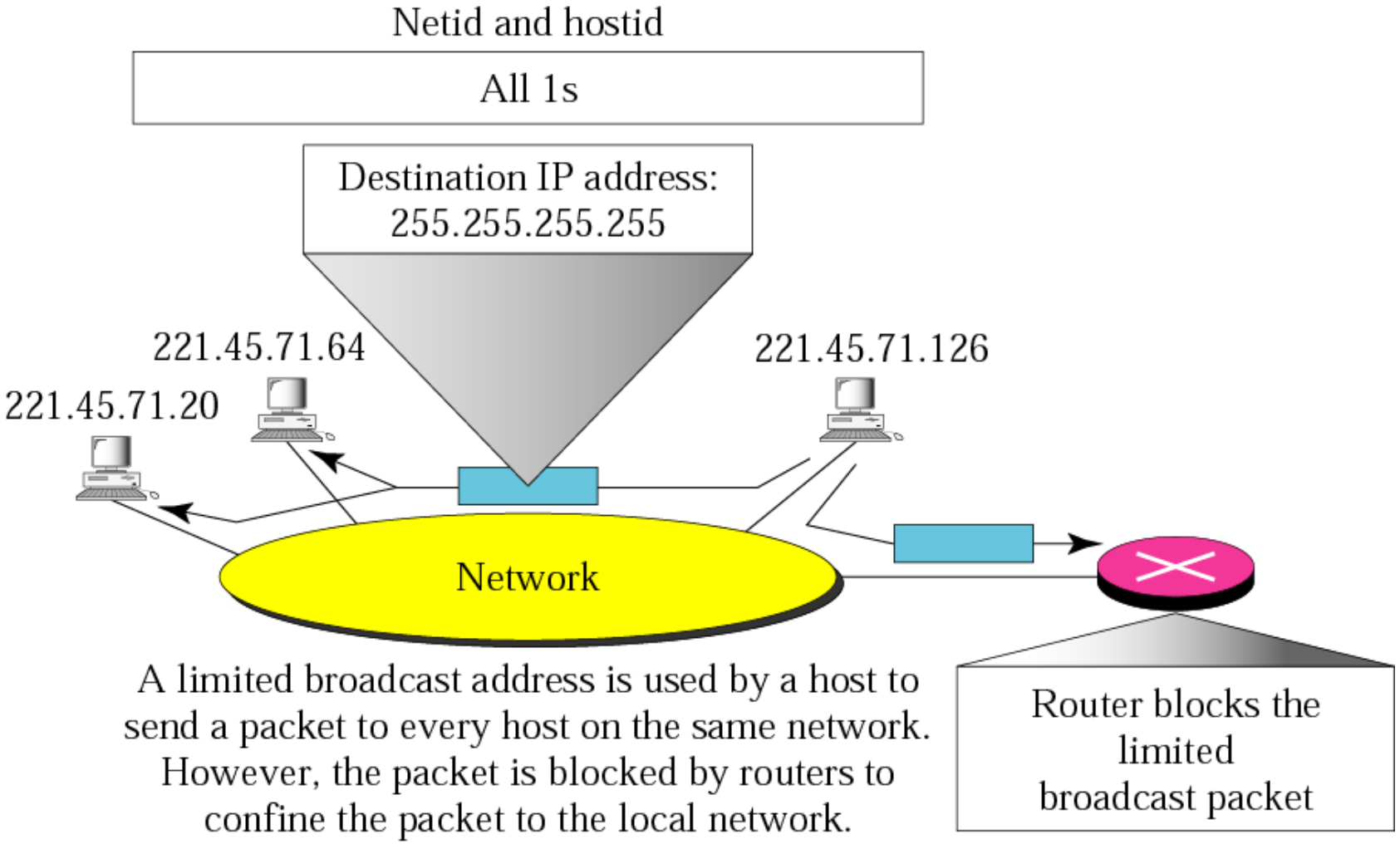
We must not apply the default mask of one class to an address belonging to another class.

Example of direct broadcast address

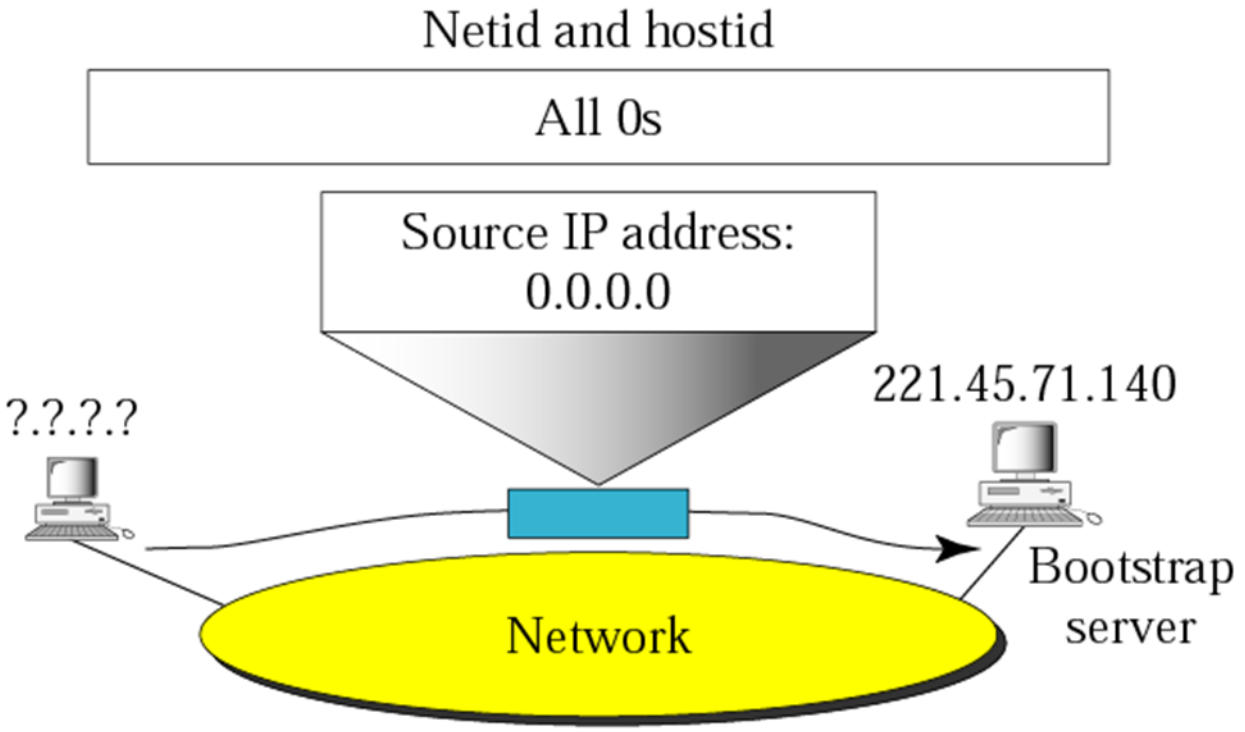


The direct broadcast address is used by a router to send a message to every host on a local network. Every host/router receives and processes the packet with a direct broadcast address.

Example of limited broadcast address

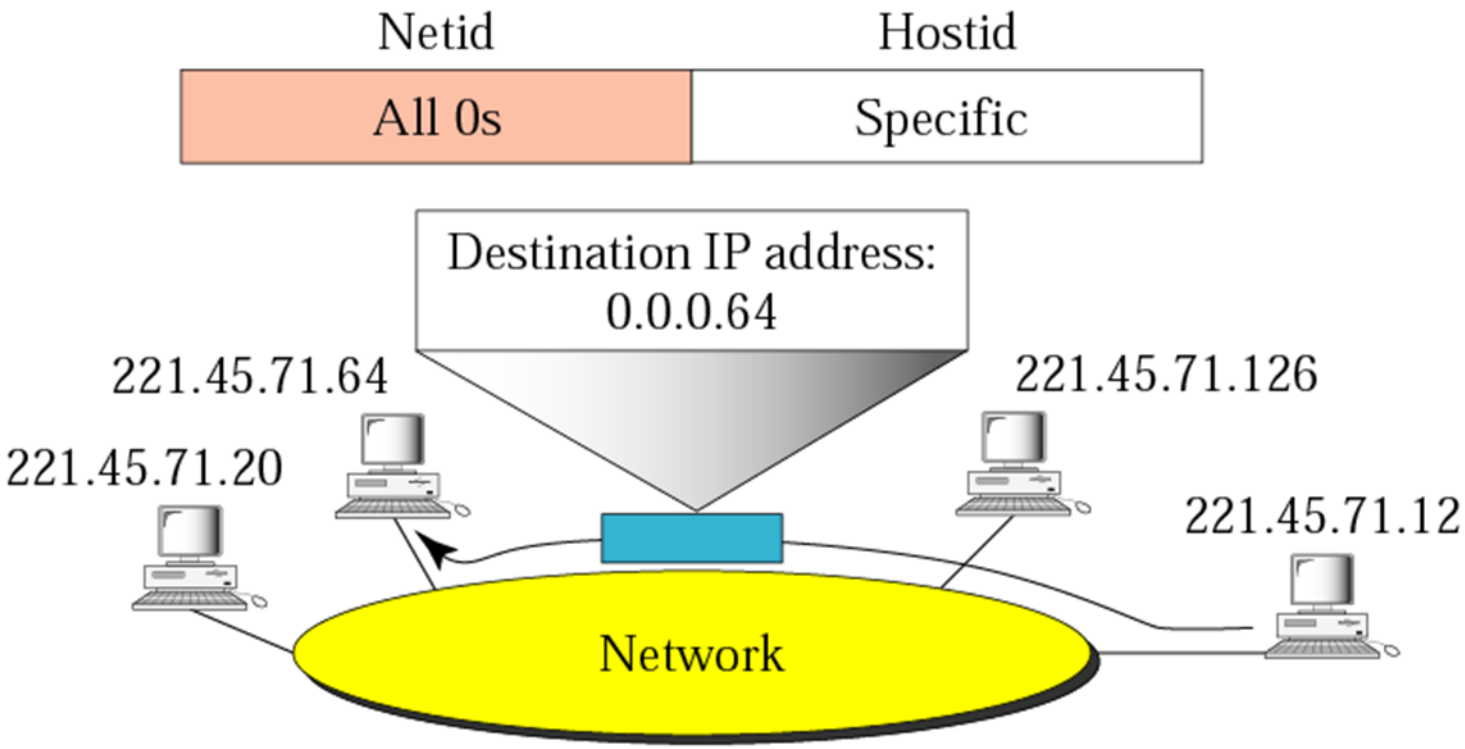


Example of **“this”** host on **“this”** address



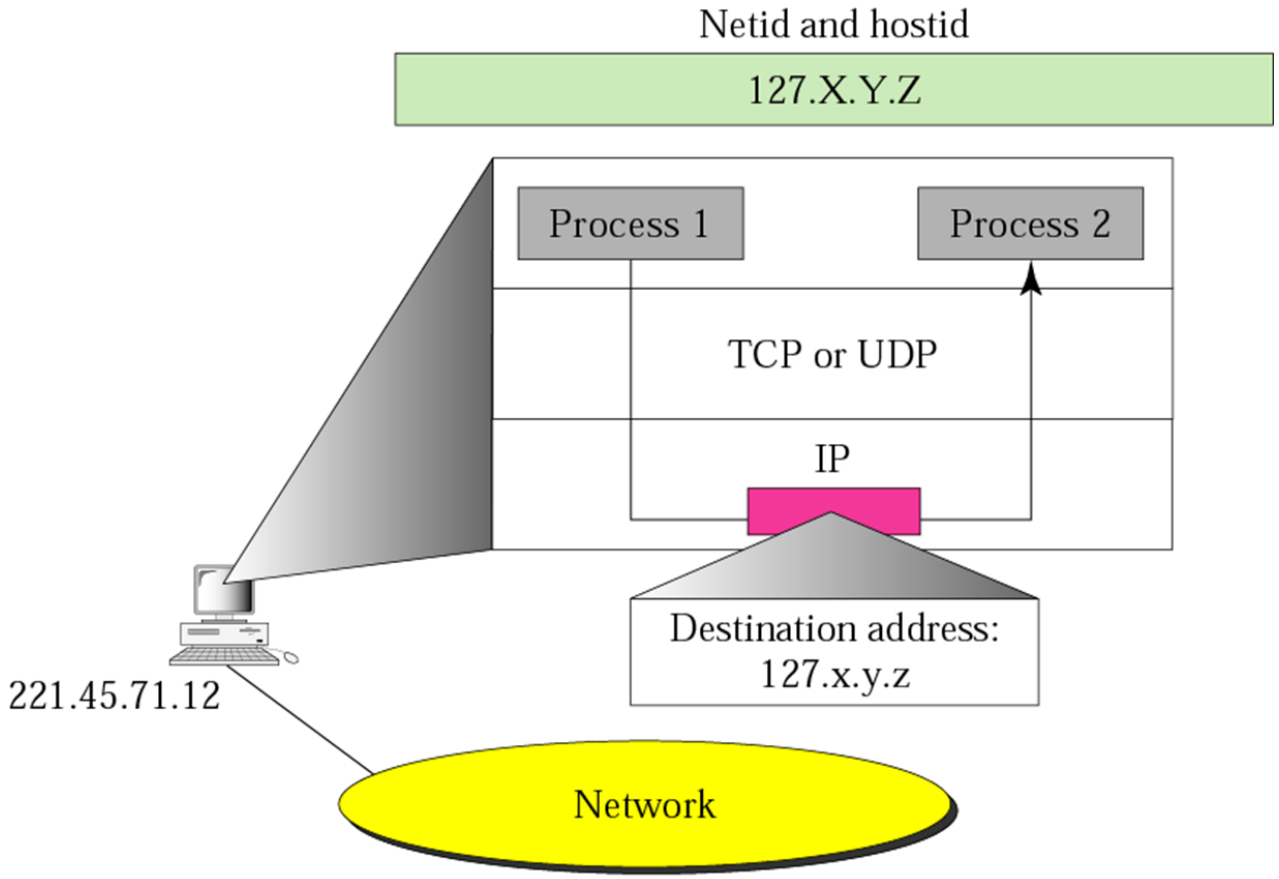
A host that does not know its IP address uses the IP address 0.0.0.0 as the source address and 255.255.255.255 as the destination address to send a message to a bootstrap server.

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.

Example of loopback address



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

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Private Addresses

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

Table 5.2 *Addresses for private networks*

Block	*Number of addresses*	*Block*	*Number of addresses*
10.0.0.0/8	16,777,216	192.168.0.0/16	65,536
172.16.0.0/12	1,047,584	169.254.0.0/16	65,536

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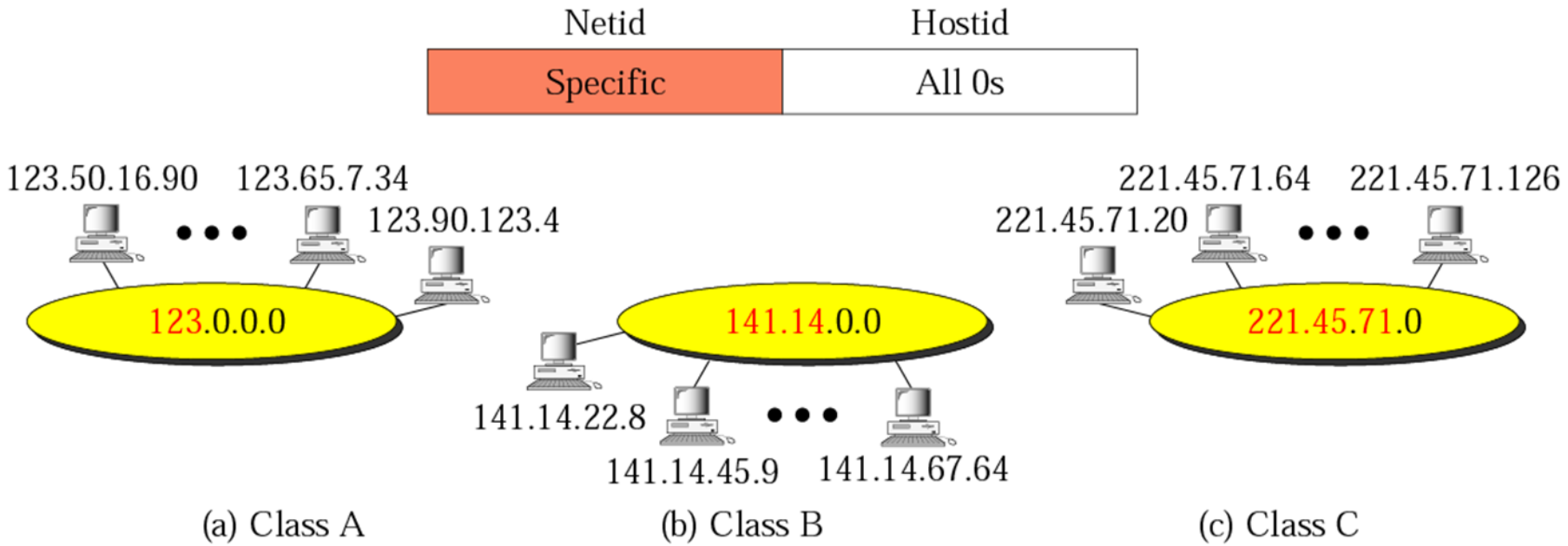
Network addresses



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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

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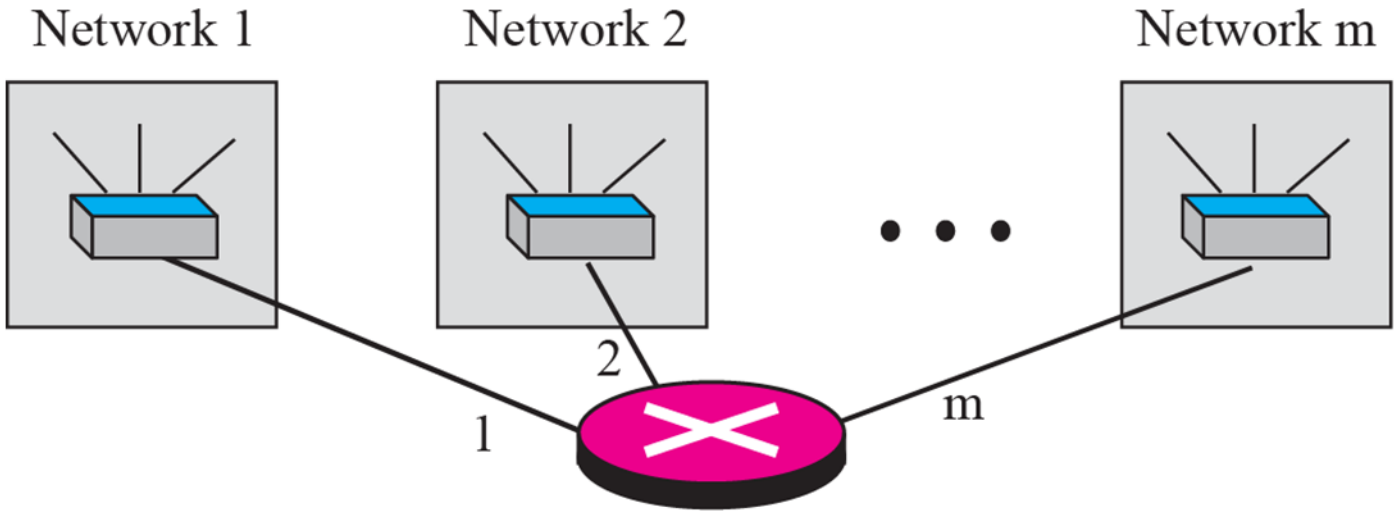
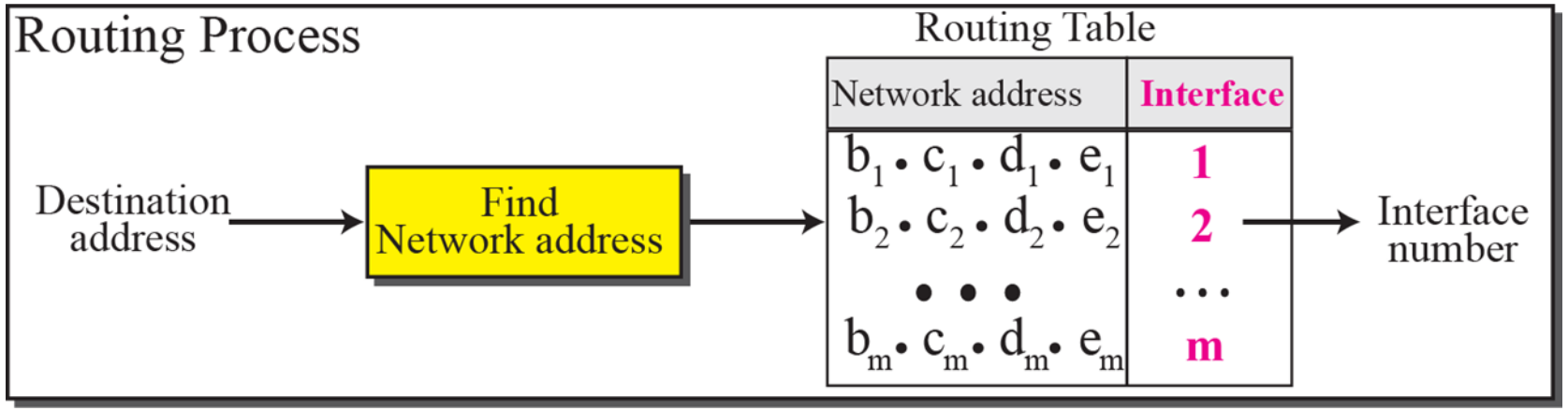
Network addresses





Sample internet