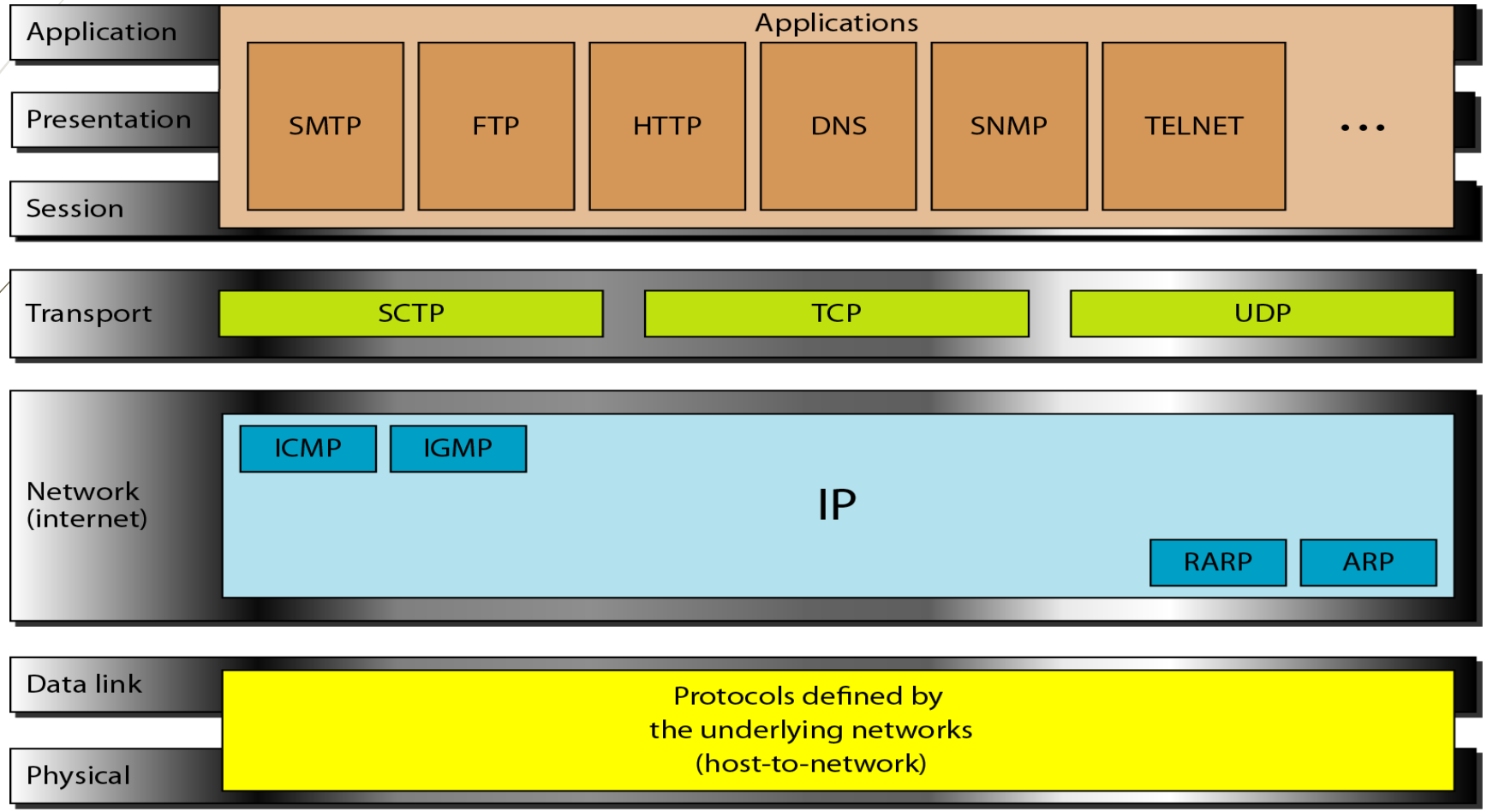
CN121: Introduction to Networking

Lecture 05: Addressing in Networking(Part I)

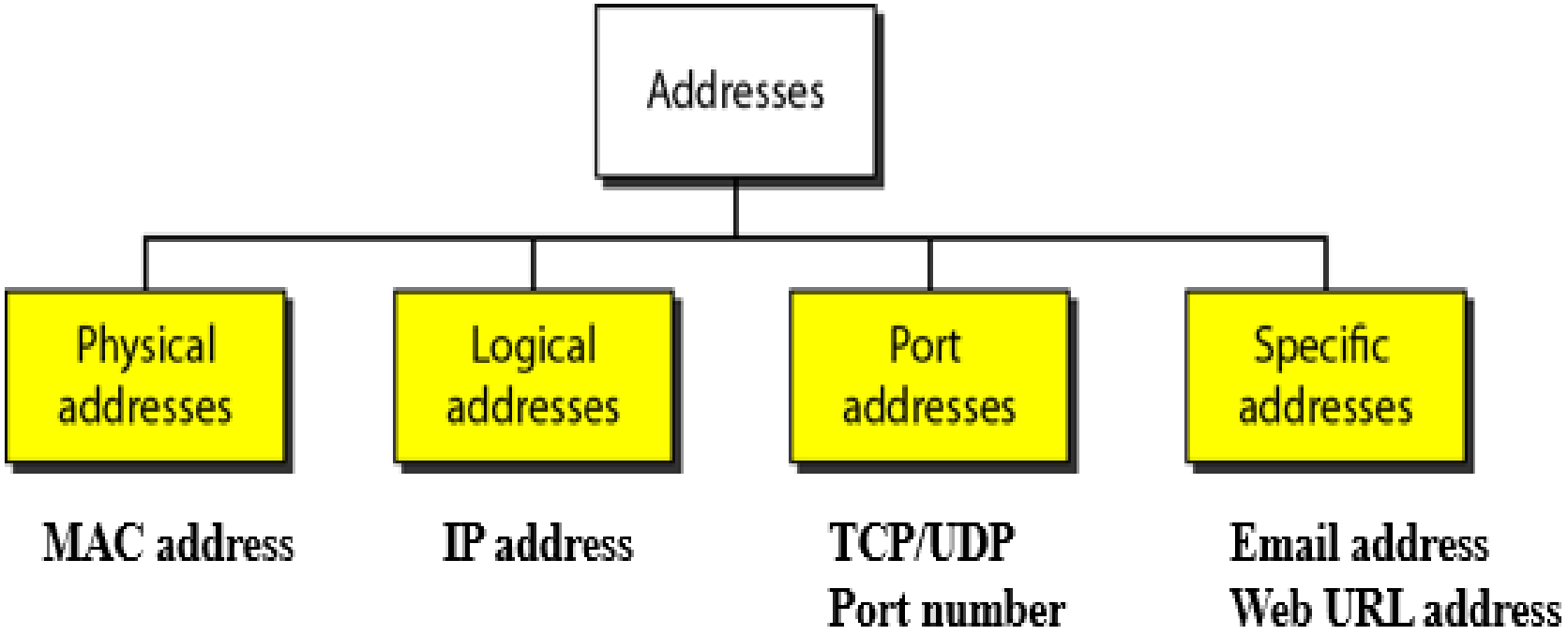
A quick Recap on TCP/IP and OSI model



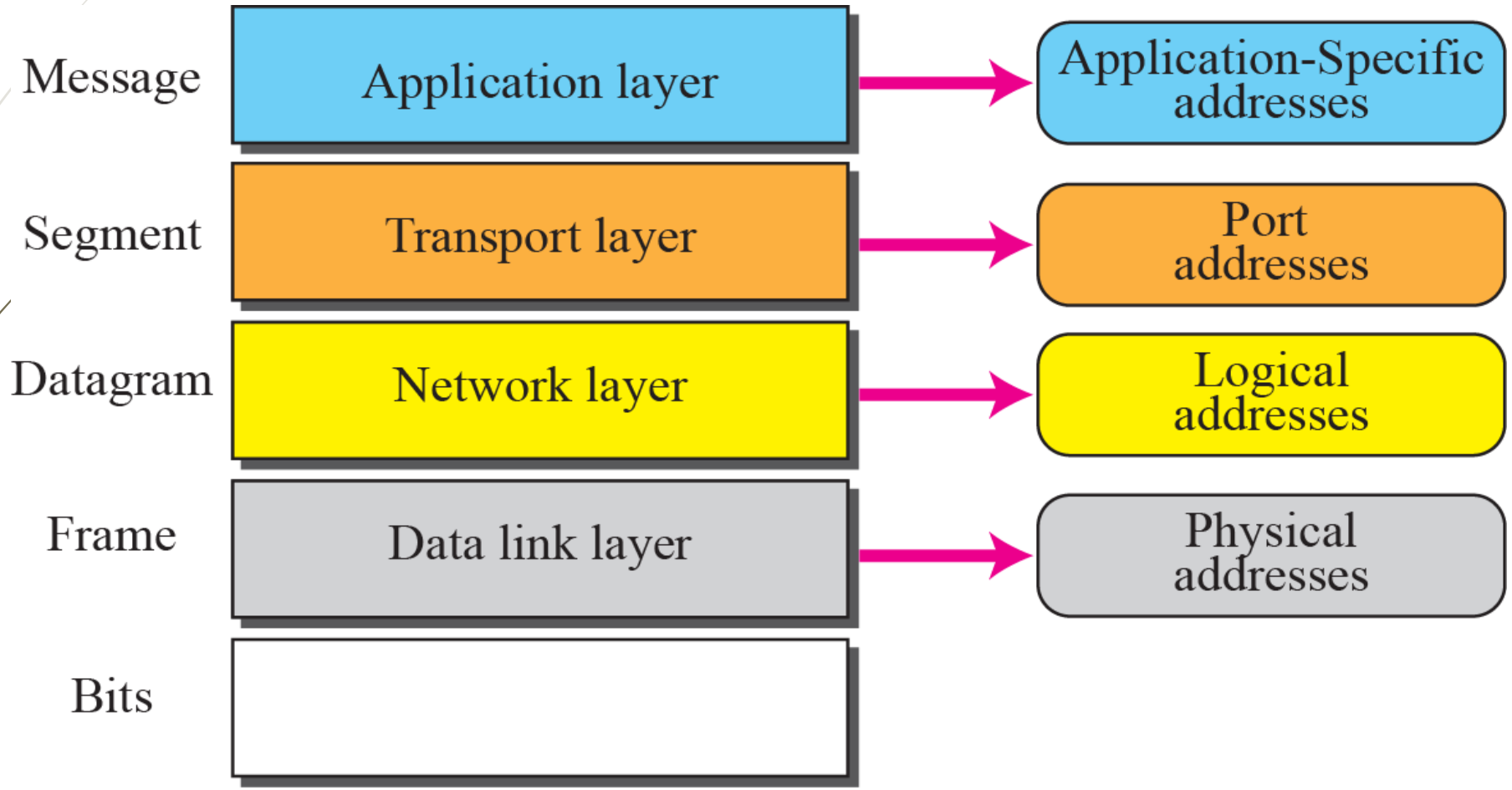
Addressing

- Four levels of addresses are used in an internet employing the TCP/IP protocols:
  - physical address
  - logical address
  - port address
  - application-specific address.
- Each address is related to a one layer in the TCP/IP architecture

Addresses in TCP/IP



Addresses in the TCP/IP Protocol Suite



Physical Addresses

- Physical address is also known as link address or MAC address.
  - The address of a node as defined by its LAN or WAN.
  - Being included in the frame used by data link layer.
  - Lowest level address.
- Size and format of these addresses vary depending on the network.
  - Ethernet uses a 6-byte physical address that is imprinted on the Network Interface Card (NIC).

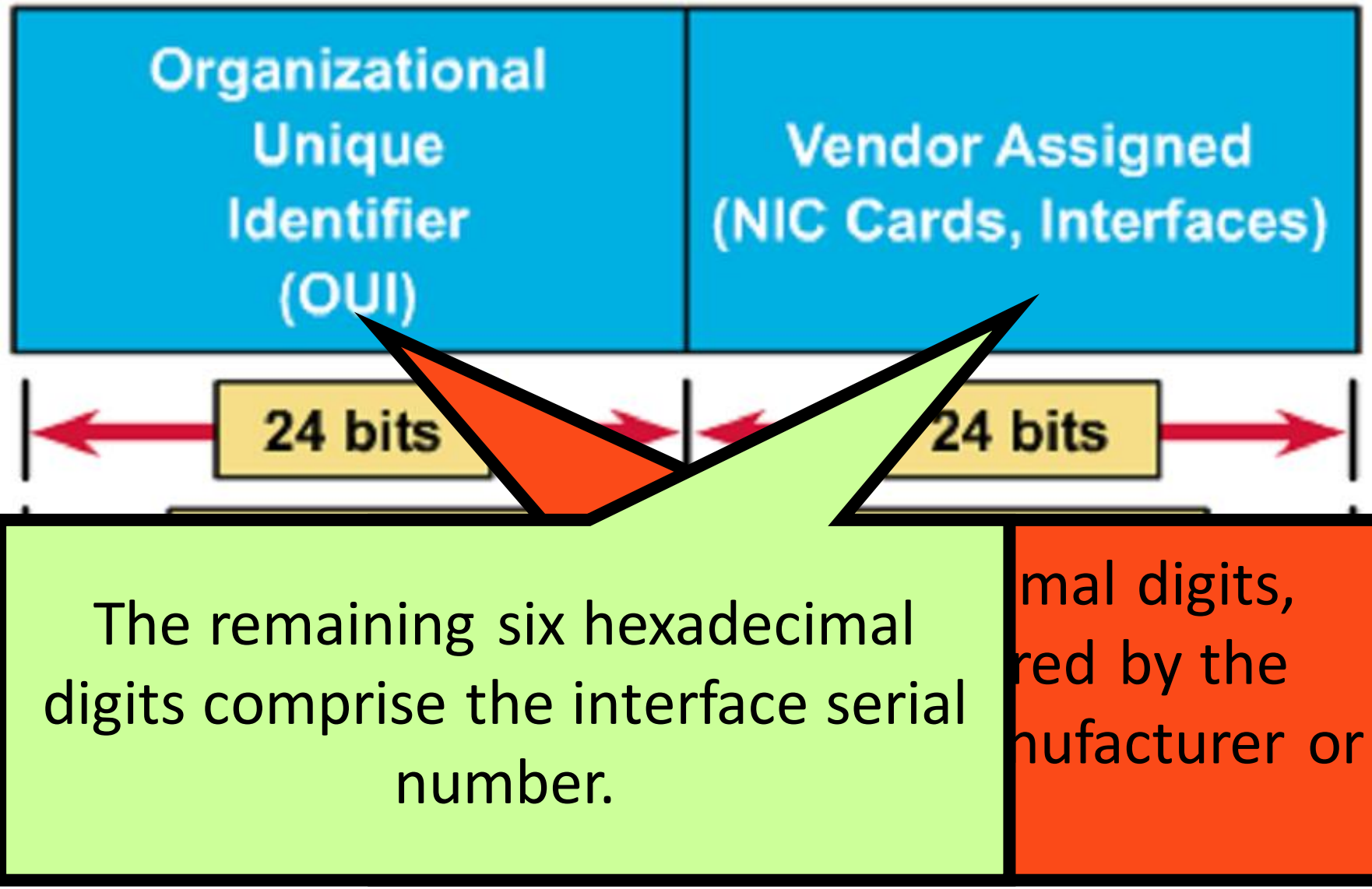
07:01:02:01:2C:4B

A 6-byte (12 hexadecimal digits) physical address

Physical Addresses…

- The physical address is located on the Network Interface Card (NIC).
- MAC addresses have no structure, and are considered flat address spaces.

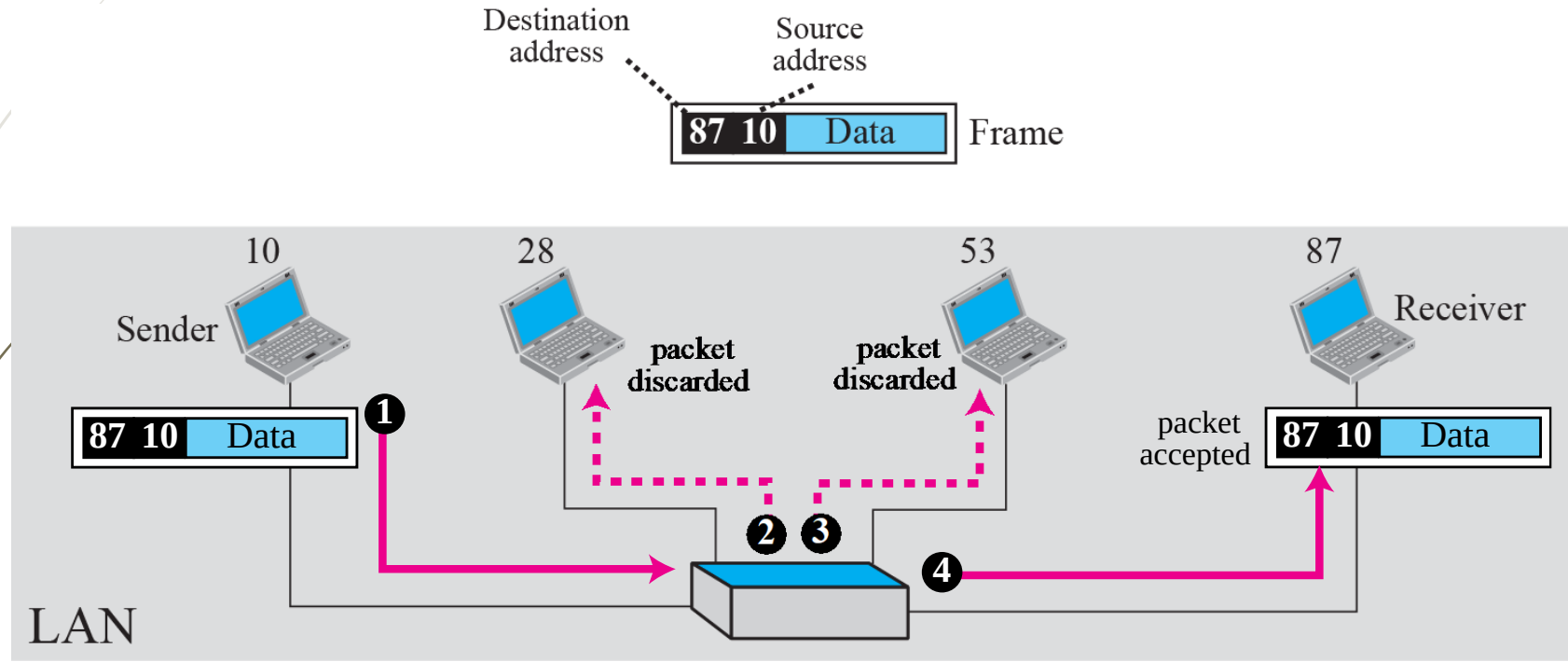
MAC address format



Example : Physical Addresses

- A node with physical address 10 sends a frame to a node with physical address 87. The two nodes are connected by a link (a LAN).
- At the data link layer, this frame contains physical (link) addresses in the header. These are the only addresses needed. The rest of the header contains other information needed at this level.
- The data link layer at the sender receives data from an upper layer. It encapsulates the data in a frame. The frame is propagated through the LAN.
- Each station with a physical address other than 87 drops the frame because the destination address in the frame does not match its own physical address. The intended destination computer, however, finds a match between the destination address in the frame and its own physical address.

Example : Physical Addresses...



Logical Address

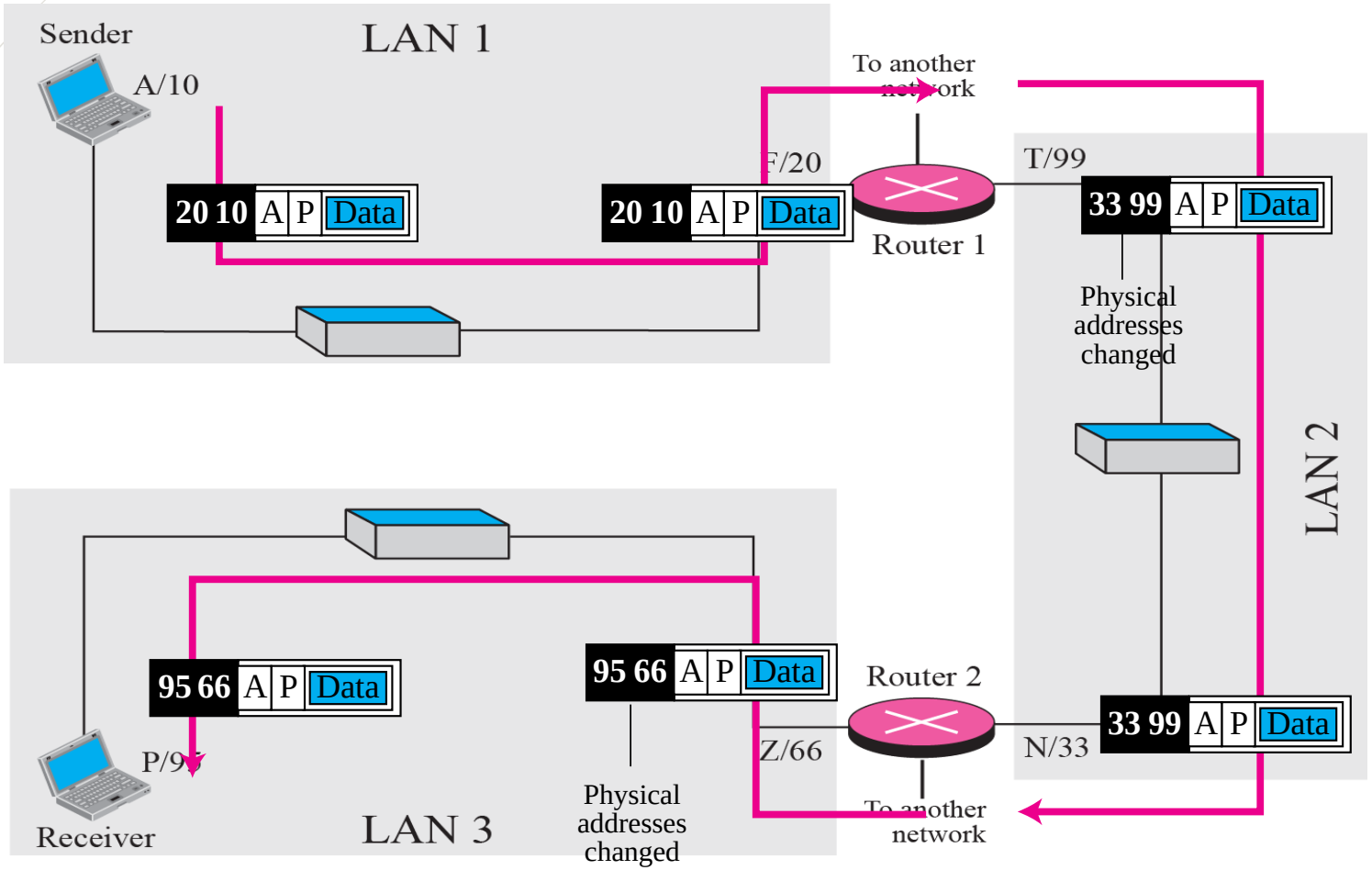
- A universal addressing system is needed in which each host can be identified uniquely, regardless of the underlying physical network.
  - Logic addresses are designed for this purpose.

- Logical address is necessary for universal communications that are independent of underlying physical networks.
  - **Physical addresses** are not adequate in an internetwork environment where different networks can have different address formats.

Example : Logical Addresses

- It shows a part of an internet with two routers connecting three LANs.
- Each device (computer or router) has a pair of addresses (logical and physical) for each connection.
  - Each computer is connected to only one link and so has only one pair of addresses.
  - Each router is connected to three networks. So each router has three pairs of addresses, one for each connection.
- The computer with logical address A and physical address 10 needs to send a packet to the computer with logical address P and physical address 95. We use letters to show logical addresses and numbers for physical addresses, but note that both are actually numbers.

Example : Logical Addresses...



Note

The physical addresses will change from hop to hop, but the logical addresses remain the same.

Logical Address…

- The identifier used in the IP layer of the TCP/IP protocol suite to identify each device connected to the Internet is called the Internet address or IP address.

- An IP address **(IPv4):** is a 32-bit address that uniquely and universally defines the connection of a host or a router to the Internet.

- IP addresses are unique. They are unique in the sense that each address defines one, and only one, connection to the Internet. Two devices on the Internet can never have the same address.

Logical Address-The Internet Protocol (IP)

- The Internet Protocol is the corner-stone of the TCP/IP architecture. All computers in the Internet understand IP.
- The main tasks of IP are:
  - The **addressing** of the computers, and the **fragmentation** of packets.

There are two types of Internet Protocol:

- **Internet Protocol version 4 (IPv4):** currently used version of Internet Protocol.
- **Internet Protocol version 6 (IPv6):** the upcoming replacement for IPv4. It contains some major improvements and new features.

IPv4 Address

- An IPv4 address is a 32-bit address that uniquely and universally defines the connection of a device (for example, a computer or a router) to the Internet.
  - Connectionless protocol
  - Fragments (divides) packets where necessary
  - Addressing via 32 bit Internet addresses

- However, it contains no functions for end-to-end message reliability or flow control. IP makes the ‘best effort’ to forward packets to the next destination, but **does not guarantee delivery because it is connectionless.**

IPv4 Address…

- The IP (IPv4) address can be classified into two classes:
  - **Private Address:**
    - Any number or address assigned to a device on a private TCP/IP Local Area Network that is accessible only within the Local Area Network.
  - **Public address:**
    - This address considered as any valid address assigned to any user, and the organization who is responsible for registering IP ranges called Internet Service Providers (ISPs), and this address will be unique.

IPv4 Address…

The address space of IPv4 is 2^{32} or 4,294,967,296.

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IPv4 Address…

- IPv4 Address can be represented in either three (3) ways
  - Dotted Binary notation
  - Dotted Decimal notation
  - Hexadecimal notation

Examples-01

*Change the following IP(*IPv4*) addresses from binary notation to dotted-decimal notation.*

a. 10000001 00001011 00001011 11101111
b. 11000001 10000011 00011011 11111111
c. 11100111 11011011 10001011 01101111
d. 11111001 10011011 11111011 00001111

Solution

We replace each group of 8 bits with its equivalent decimal number and add dots for separation:

a. 129.11.11.239 *b. 193.131.27.255*

Examples-02

*Change the following IP (*IPv4*) addresses from dotted-decimal notation to binary notation.*

a. 111.56.45.78
b. 221.34.7.82
c. 241.8.56.12
d. 75.45.34.78

Solution

We replace each decimal number with its binary equivalent:

a. 01101111 00111000 00101101 01001110
b. 11011101 00100010 00000111 01010010

Examples-03

*Find the error, if any, in the following IP (*IPv4*) addresses:*

a. 111.56.045.78

b. 221.34.7.8.20

c. 75.45.301.14

d. 11100010.23.14.67

Solution

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

b. *We may not have more than four numbers in an IP (*IPv4*) address.*

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

d. *A mixture of binary notation and dotted-decimal notation is not allowed.*

Examples-04

*Change the following IP (*IPv4*) addresses from binary notation to hexadecimal notation.*

a. 10000001 00001011 00001011 11101111

b. 11000001 10000011 00011011 11111111

Solution

We replace each group of 4 bits with its hexadecimal equivalent. Note that hexadecimal notation normally has no added spaces or dots; however, 0X (or 0x) is added at the beginning or the subscript 16 at the end to show that the number is in hexadecimal.

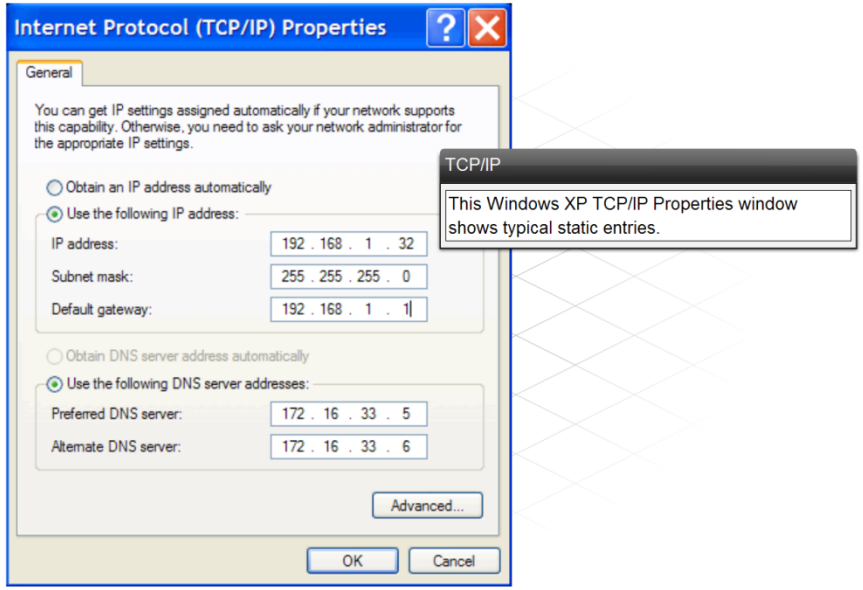
a. 0X810B0BEF or $810B0BEF_{16}$

Two Method for IP (IPv4) Addressing

- Dynamic addressing
  - IP address is obtained automatically by DHCP (Dynamic Host Configuration Protocol)
- Static Addressing
  - IP address is manually configured by a network administrator

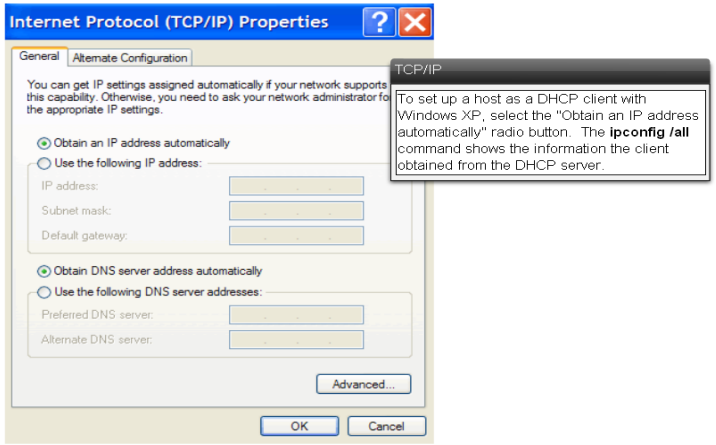
Using Static IP (IPv4) Addressing

- Manually configured by the network administrator
- Advantages
  - useful for printers, servers, etc
  - increased control of resources (security)
- Disadvantages
  - time consuming



Using Dynamic IP (IPv4) Addressing

- Automatic assignment of IP addresses
- Useful if frequent change in users (wireless hotspot)
- Uses DHCP (Dynamic Host Configuration Protocol) server
- IP addresses leased for a period of time
  - if host is removed from the network (turned off), the IP address goes back into the pool of IP address
- Preferred method for large networks
  - reduces the burden of network support

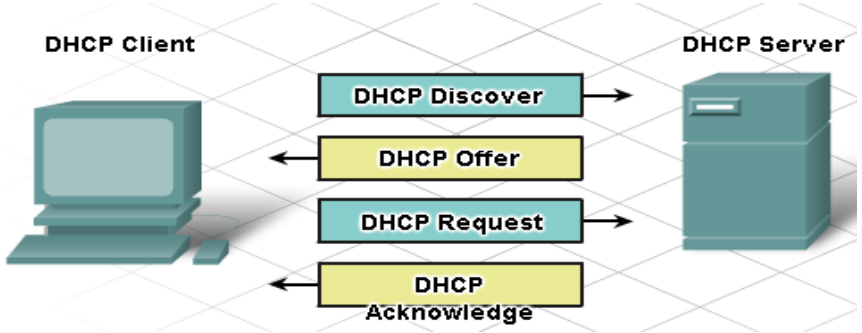


DHCP

- DHCP dynamically assigns an IP address to a host
- A PC obtains its IP address from a DHCP server. If the PC is taken off the network for repair, what happens to the IP address configuration?
  - The addresses is returned to the pool for reuse when the lease expires.

Configuring DHCP

- If host is configured as DHCP client, it will not have a
  - IP address
  - Subnet Mask
  - Default Gateway
- **Clients send a DHCP Discover Message**
  - The message comes from a client seeking an IP address
  - The destination IP address of the message is 255.255.255.255.
  - All hosts receive the message, but only a DHCP server replies



Obtaining An IP Address From DHCP Server

- Multifunction device (Linksys Router) provides services to clients (SOHO network)

- If a host connects to a Linksys integrated router that is also a DHCP server and receives an IP address from it. Which address does the host need to access the ISP and the Internet?
  - Internal IP address of the integrated router that connects to the local network

Classful Addressing

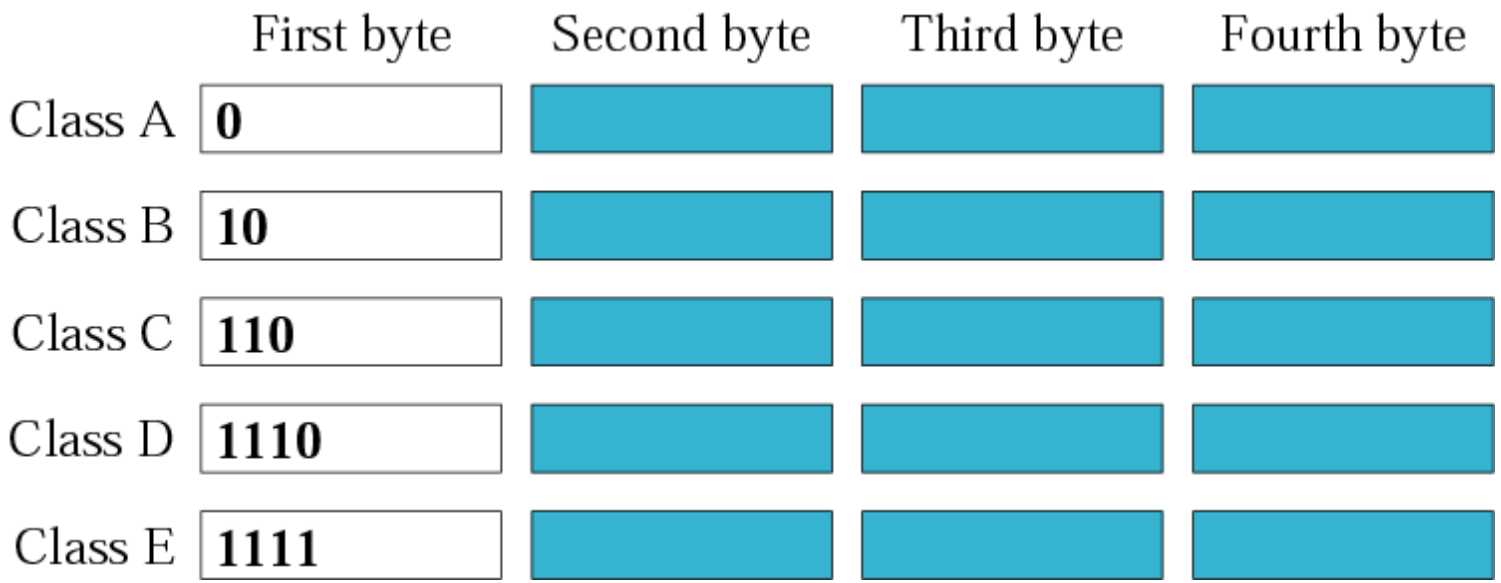
- IP addresses, when started a few decades ago, used the concept of classes.
- This architecture is called classful addressing.
- In the mid-1990s, a new architecture, called classless addressing, was introduced and will eventually supersede the original architecture.
- However, part of the Internet is still using classful addressing, but the migration is very fast.

Occupation of the Address Space

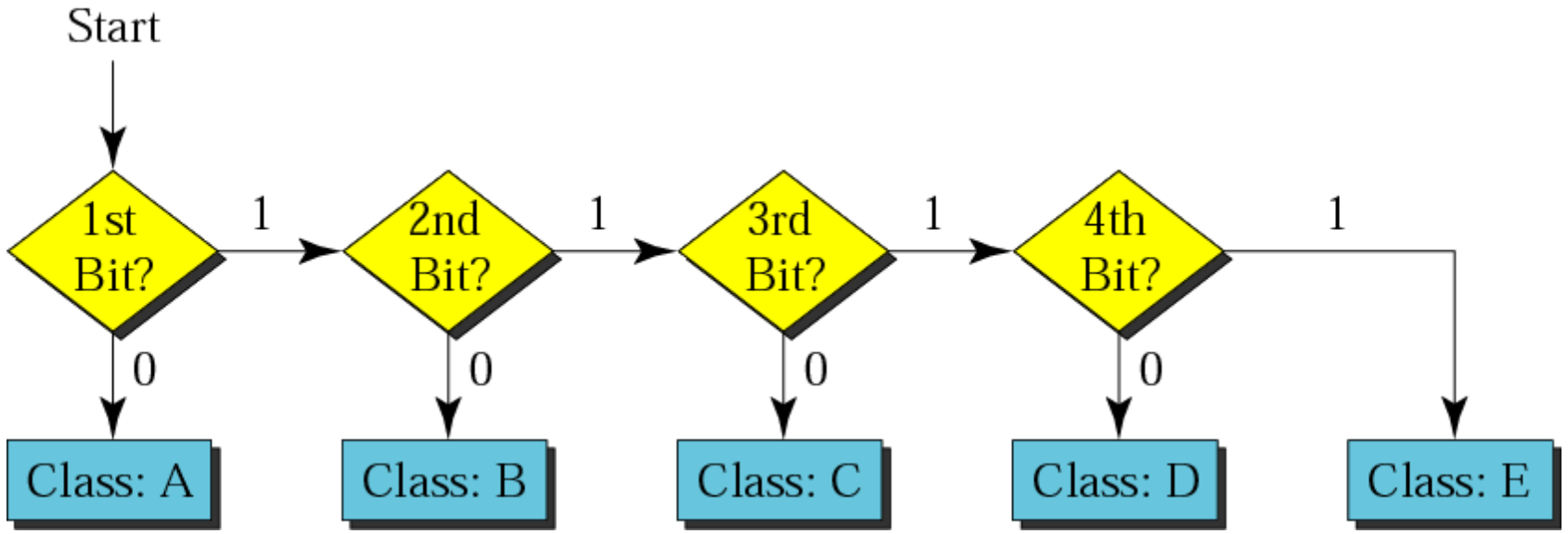
In classful addressing the address space is divided into 5 classes:

A, B, C, D, and E.

Finding the Class in Binary Notation



Finding the Address Class



Example 5

Show that Class A has
$2^{31} = 2{,}147{,}483{,}648$ *addresses*

Example 6

Find the class of the following IP addresses

***0**00000001 00001011 00001011 11101111*

11000001 00001011 00001011 11101111

Solution

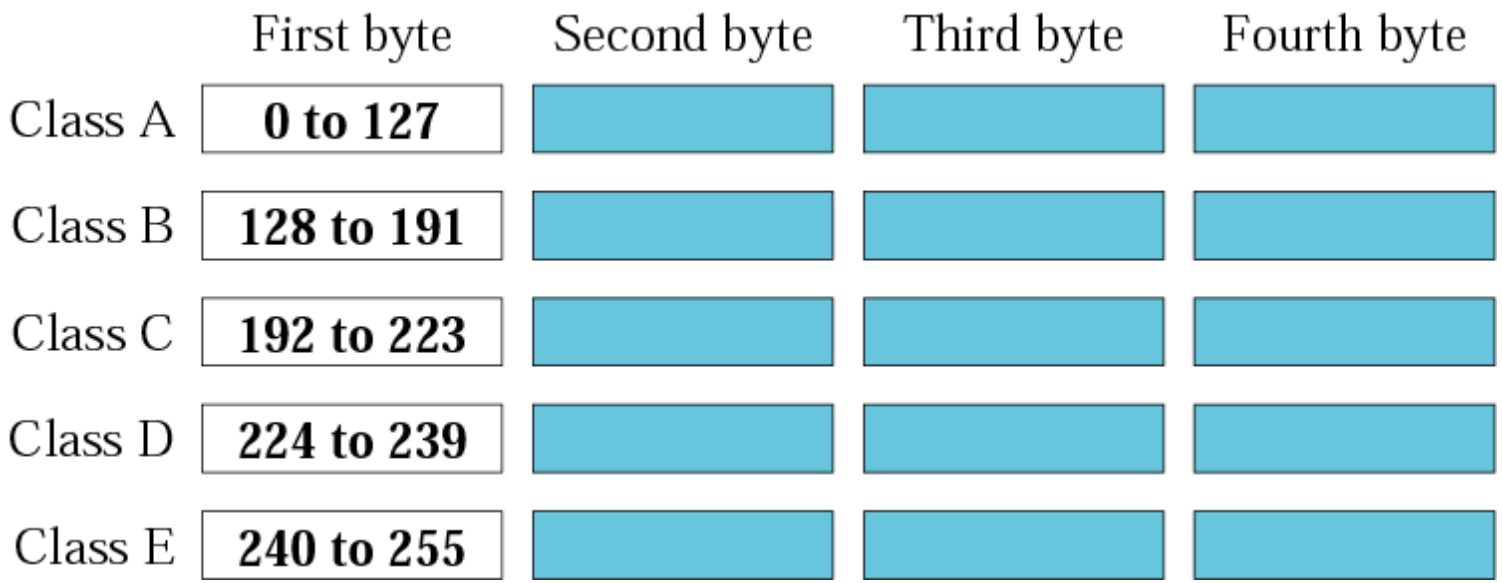
- **0**0000001 00001011 00001011 11101111

1st is 0, hence it is Class A

- 11000001 00001011 00001011 11101111

1st and 2nd bits are 1, and 3rd bit is 0 hence, Class C

Finding the Class in Decimal Notation



Example 7

Find the class of the following addresses
158.223.1.108
227.13.14.88

Solution

- *158.223.1.108*

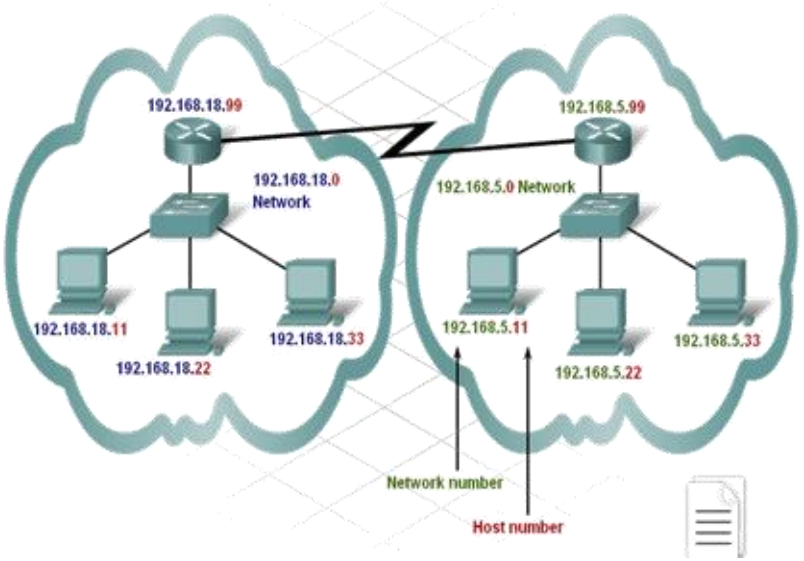
1st byte = 158 (128<158<191) class B

- *227.13.14.88*

1st byte = 227 (224<227<239) class D

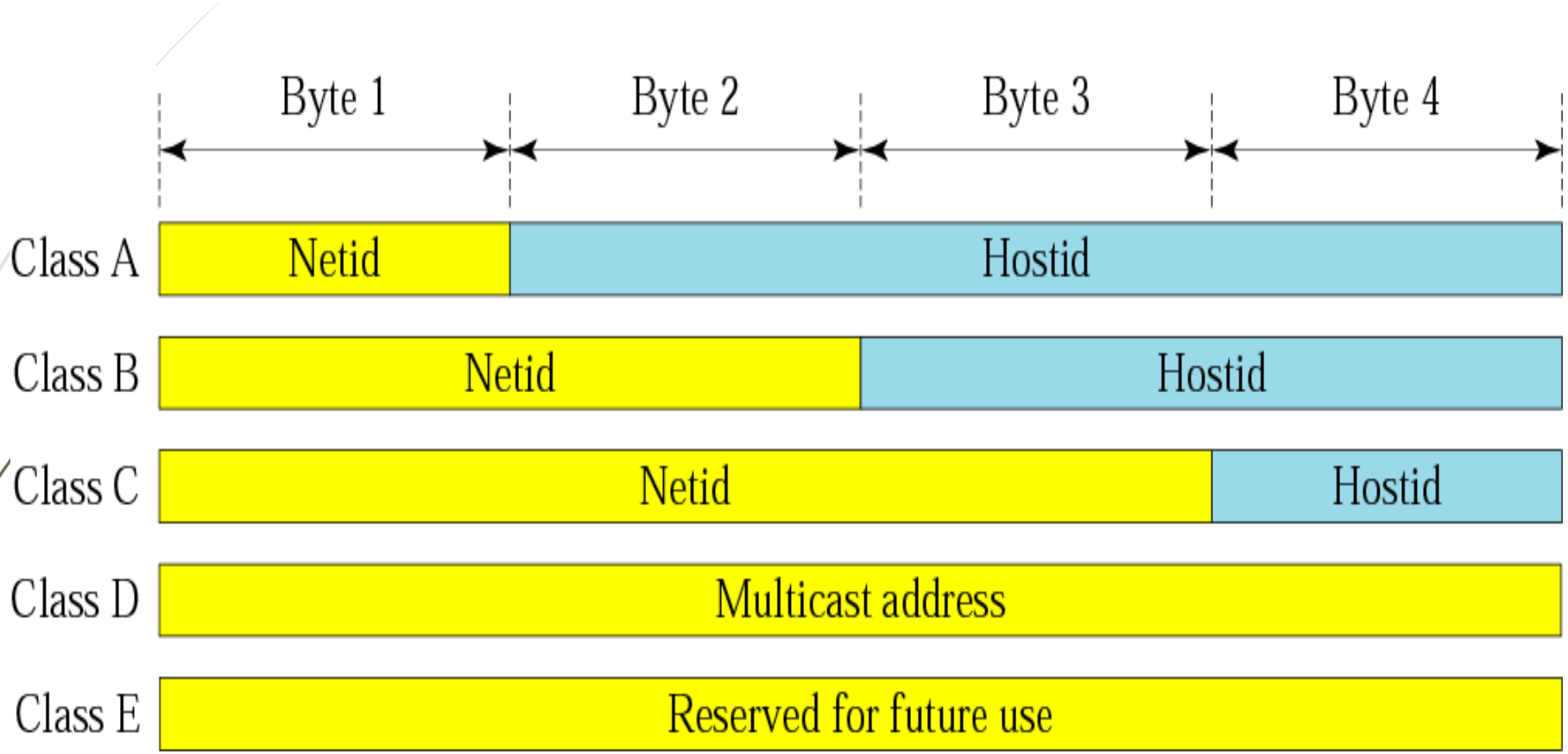
Parts of an IP Address

- Hierarchical
  - made up of 2 parts
    - network
    - host(Id's of the specific device)
  - determined by IP class

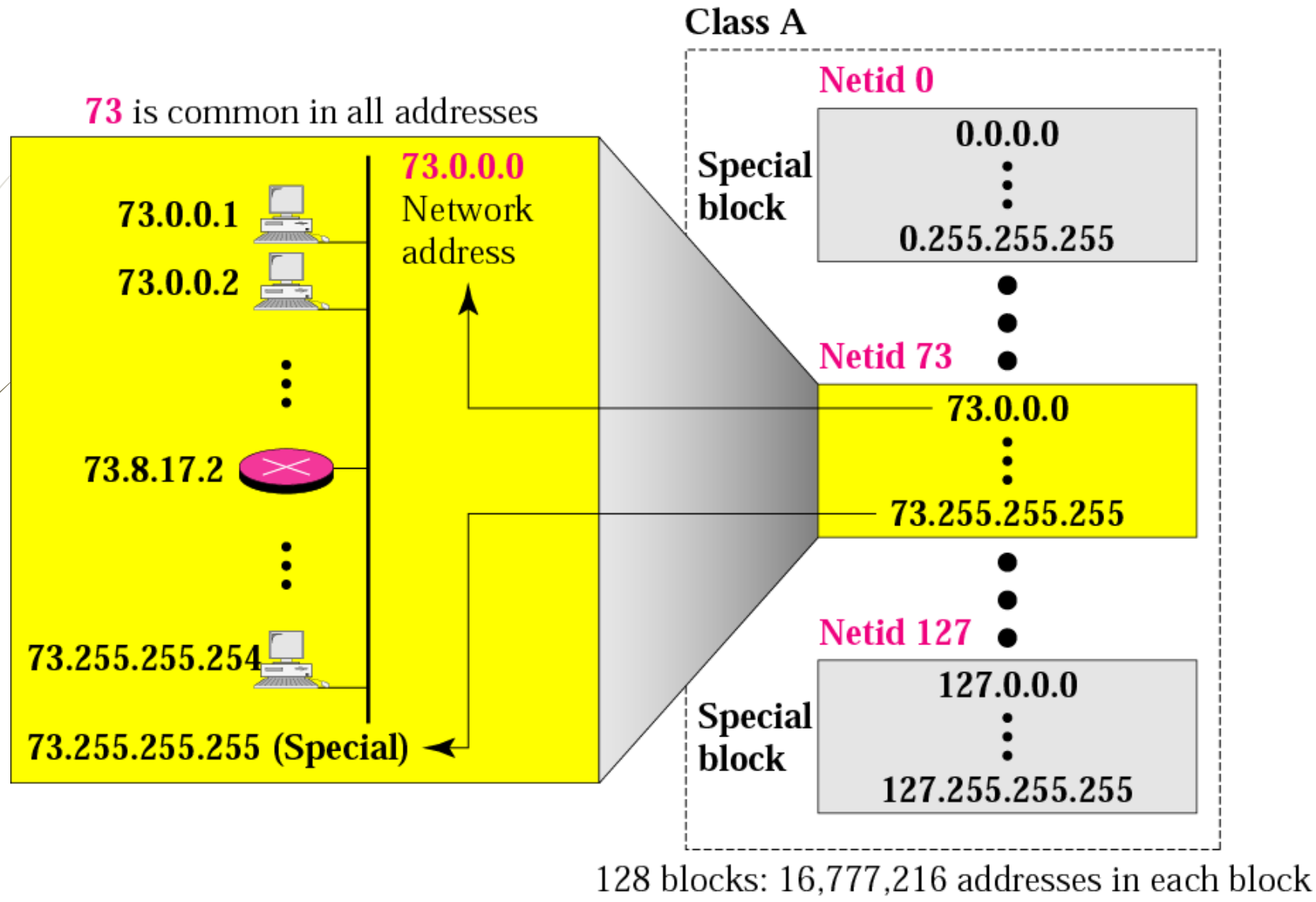


- Similar to your phone number
  - Area code = network
  - phone number = host(specific location)

Netid and Hostid



Blocks in class A

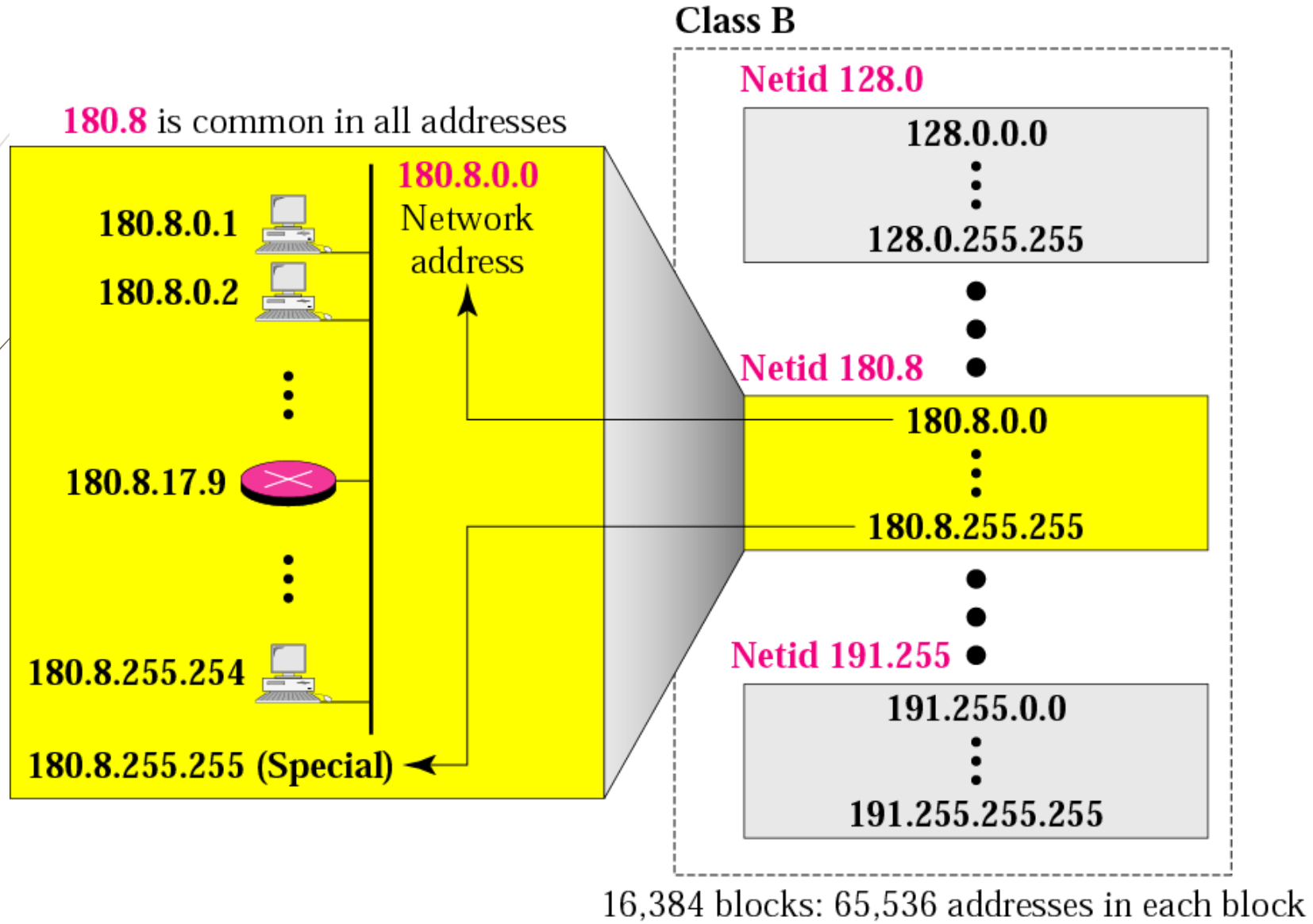


128 blocks: 16,777,216 addresses in each block

Note

Millions of class A addresses are wasted.

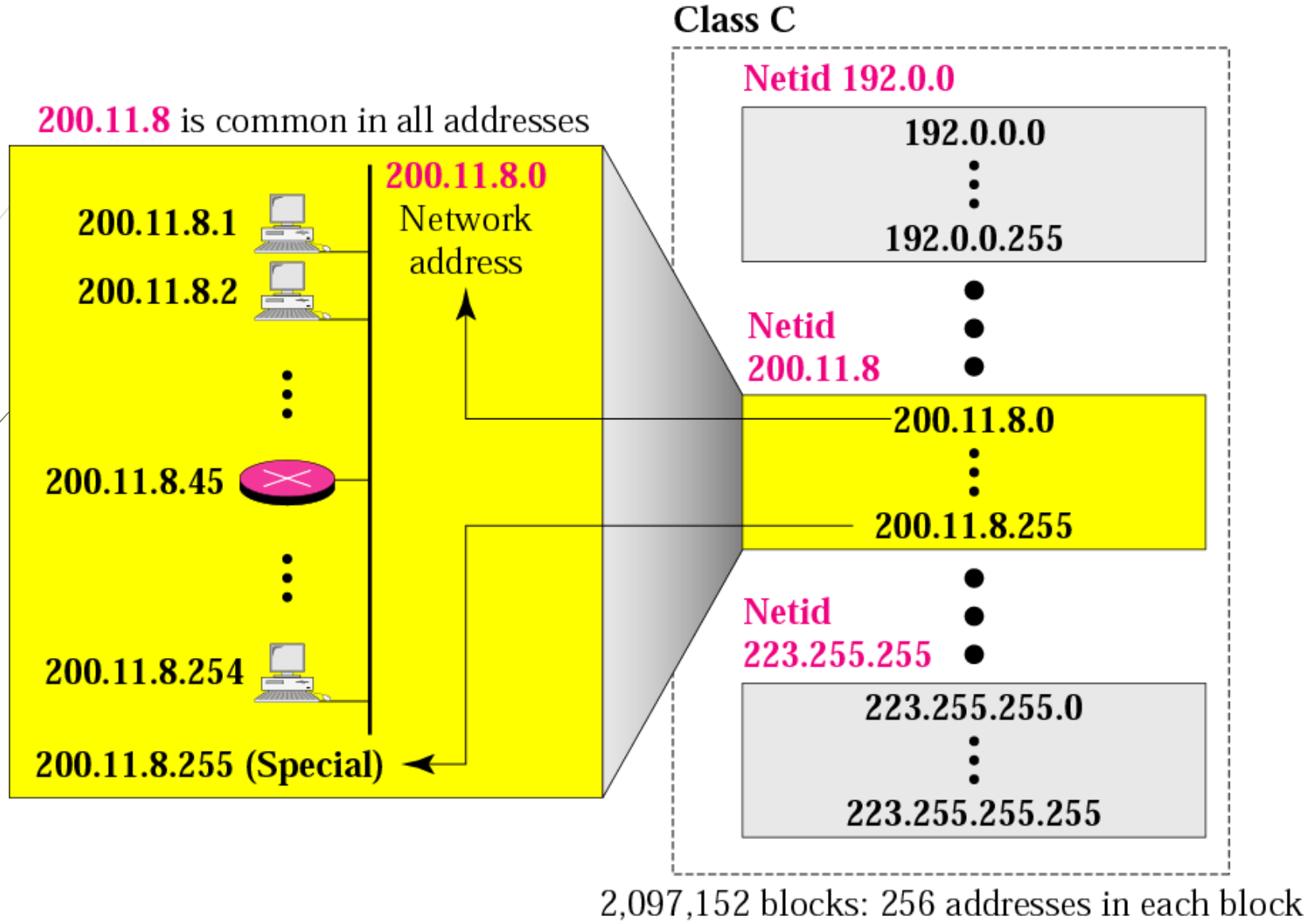
Blocks in class B



Note

Many class B addresses are wasted.

Blocks in class C



2,097,152 blocks: 256 addresses in each block

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 8

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

Solution

The 1st byte is between 128 and 191.
Hence, Class B
The block has a netid of 132.21.
The addresses range from
132.21.0.0 to 132.21.255.255.

THANK YOU FOR LISTENING