Data Communication Network
DAY – 2

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Network Physical Structure

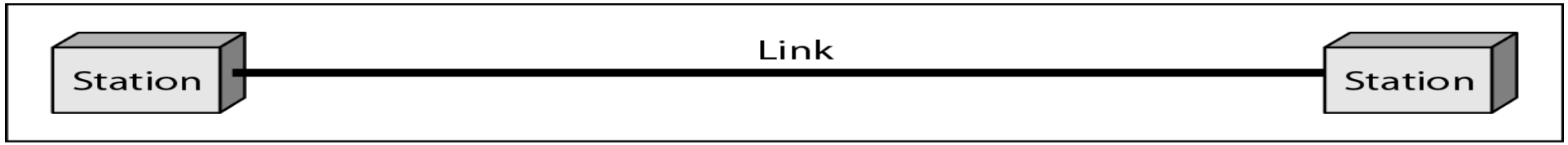
Type of Connection

- Point to Point - single transmitter and receiver
- Multipoint - multiple recipients of single transmission

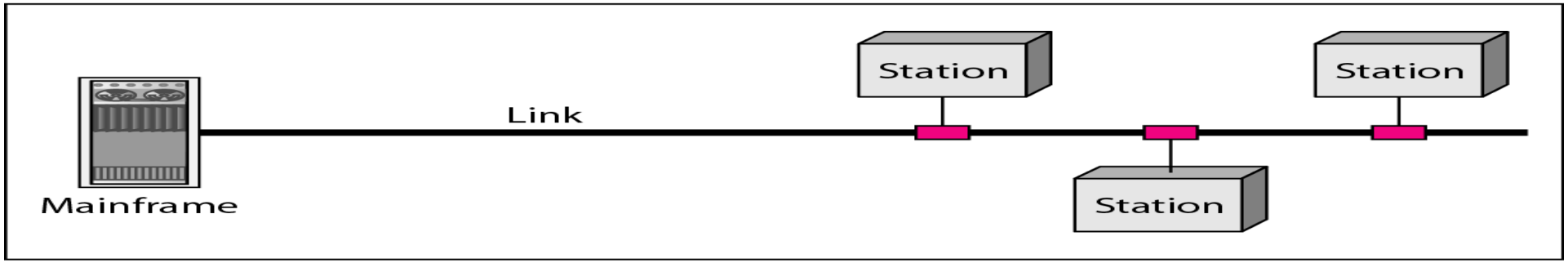
Physical Topology

- Connection of devices
- Refers to the way in which a network is laid out physically
- The geometric representation of the relationship of all the links and linking devices (usually called nodes) to one another.
- **Type of transmission** - unicast, mulitcast, broadcast

Types of Connection



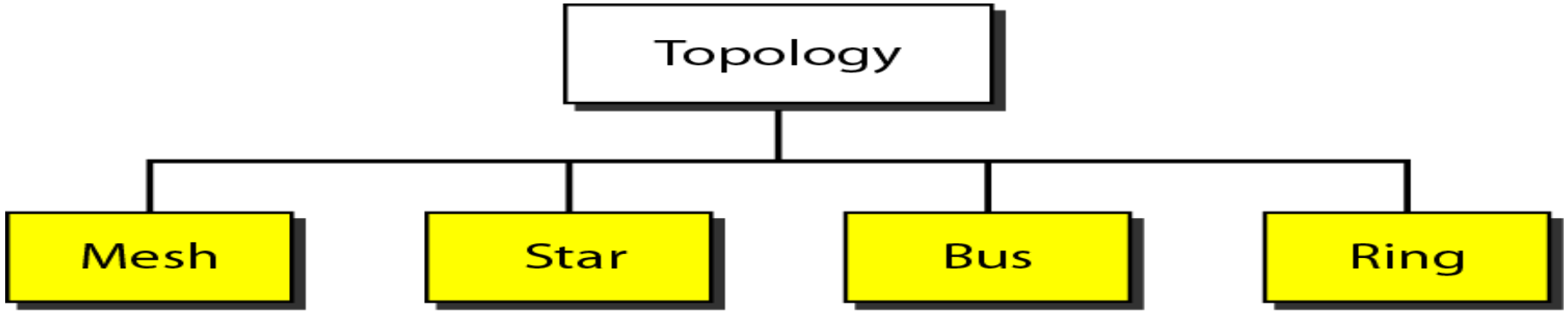
a. Point-to-point



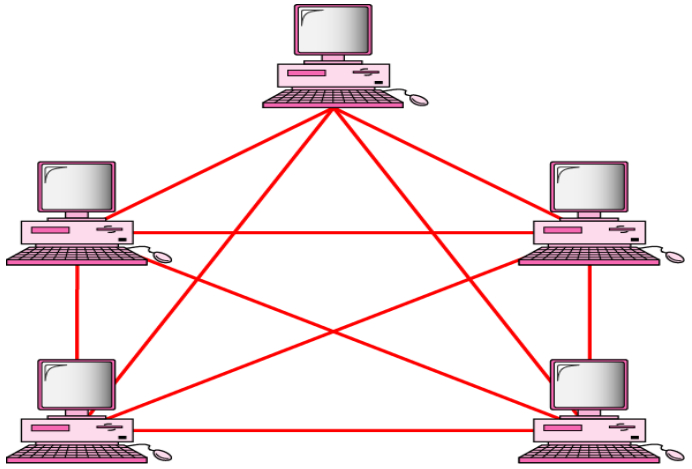
b. Multipoint

Physical Topology

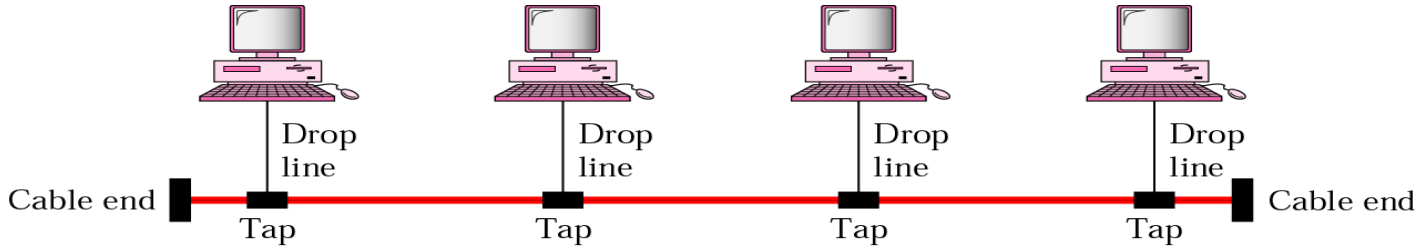
- Topology defines the way hosts are connected to the network
- The network topology defines the way in which computers, printers, and other devices are connected.
- A network topology describes the layout of the wire and devices as well as the paths used by data transmissions.



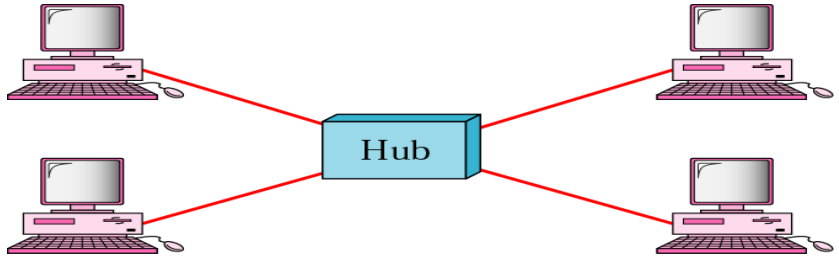
Network Topology



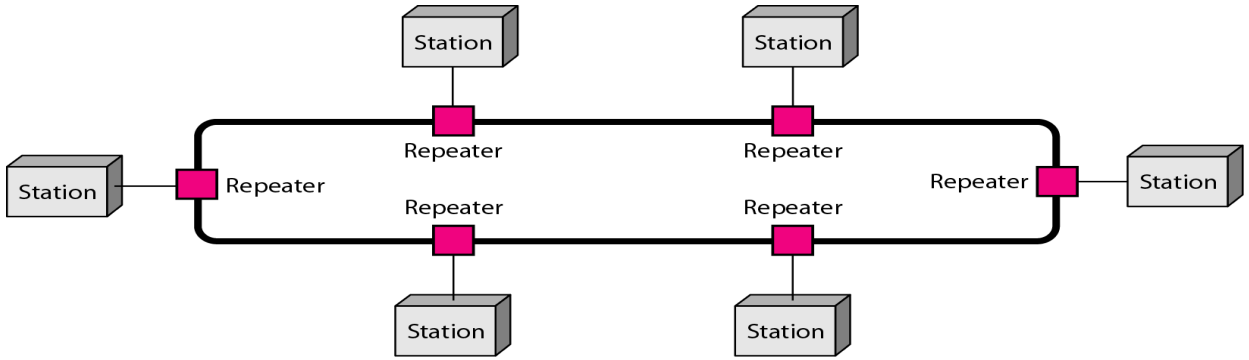
mesh



bus



star



ring

Network Devices / Internetworking Devices

Internetworking Devices

- Internetworking devices are products used to connect networks.
- As computer networks grow in size and complexity, so the internetworking devices used to connect them.
  - Hubs
  - Repeaters
  - Bridges
  - Switches
  - Routers
  - Gateways

Hubs

- Hub is used to build a LAN.
- Common connection point for devices in a network.
- It is non intelligent device.
- It does not understand the addressing.
- Hub is Multiport repeater containing multiple ports to interconnect multiple devices
- Hubs regenerate and retime network signals (increases traffic and collision)
- They cannot filter network traffic and they cannot determine best path
- The hub contains multiple ports.
- When a packet arrives at one port, it is copied to the other ports so that all segments of the LAN can see all packets.
  - does not concern about the address
  - concerns with only electrical signals
  - increases the traffic, as they broadcast data to all
  - increases the collision

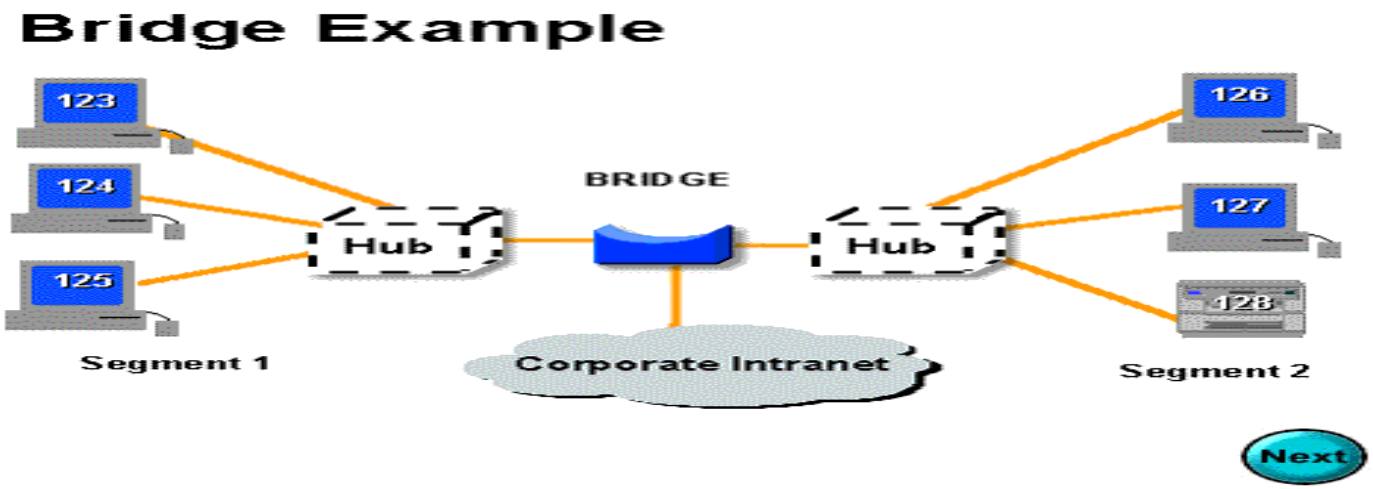
Repeaters

- **Repeaters or hubs work at the OSI physical layer to regenerate the network's signal and resend them to other segments.**
- Its job is to regenerate the signal over the same network before the signal becomes too weak or corrupted so as to extend the length to which the signal can be transmitted over the same network.
- The longer the cable length, the weaker and more deteriorated the signals become as they pass along the networking media.
- Repeaters can be installed along the way to ensure that data packets reach destination.

One way to solve the problems of too much traffic on a network and too many collisions is to use an internetworking device **called a bridge.**

Bridges : Operates at Data Link Layer

- A bridge eliminates unnecessary traffic and minimizes the chances of collisions occurring on a network by dividing it into segments .
- Device that connects and passes packets between two network segments.
- More intelligent than hub- As they analyze incoming packets and forwards (or drops) based on addressing information.(Routing Table is Build to record segment number of address)
- Bridges work best where traffic from one segment of a network to other segments is not too great.



However, when traffic between network segments becomes too heavy, the bridge can become a bottleneck and actually slow down communication.

Switches (Multiport Bridges)

- **Switches operate at the Data Link layer (layer 2) of the OSI model**
- A switch is a device that is used to segment networks into sub networks called subnets. (Used to build LAN)
- **Can interpret address information**
- Uses Addressing Scheme knows as MAC Addressing.
- Switches are capable of inspecting data packets as they are received, determining the source and destination device of that packet, and forwarding it appropriately
- Switch conserves network bandwidth and offers generally better performance than a hub.
- **Switch may Broadcase , unicast or Multicast .**

Learning the MAC Addresses and forwarding to the respective machine is switching.

- Switches have
  - ASIC (Application Specific IC)
  - OS is hardcoded in microprocessor
  - So switches are hardware based.
  - Ports are unlimited

- Bridges have
  - OS is separated
  - So bridges are not used
  - Bridges are software based.
  - Limited Ports (16)

Routers

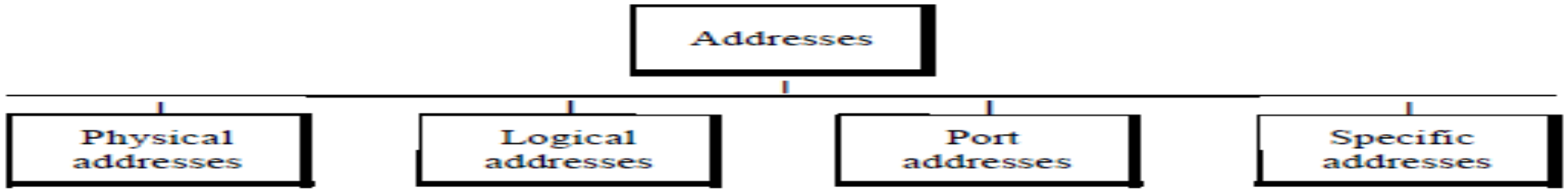
- Used to build WAN
- Router connect multiple networks and route the packets.
- Uses IP Address to identify every machine uniquely.
- Routers are used to connect two or more networks. For routing to be successful, each network must have a unique network number
- Routers have the ability to make intelligent decisions as to the best path for delivery of data on the network.
- **They use the "logical address" of packets and routing tables to determine the best path for data delivery.**
- To determine the **best path**, routers communicate with each other through **routing protocols**
- The four most common routing protocols:
  - RIP (Routing Information Protocol) for IP
  - OSPF (Open Shortest Path First) for IP
  - EIGRP (Enhanced Interior Gateway Routing Protocol) for IP, IPX, and AppleTalk
  - BGP (Border Gateway Protocol) for IP

Gateways

- Device that connects dissimilar networks.
- Operates at the highest level of abstraction.
- Expands the functionality of routers by performing data translation and protocol conversion.
- Establishes an intelligent connection between a local network and external networks with completely different structures.
- Gateways serve as an entry and exit point for a network as all data must pass through or communicate with the gateway prior to being routed.
- If a network wants to communicate with devices, nodes or networks outside of that boundary, they require the functionality of a gateway.
- A gateway is often characterized as being the combination of a router and a modem.

Addressing

Addressing



Physical Address/ Link Address

- For example, Ethernet uses a 6-byte (48-bit) physical address that is imprinted on the network interface card (NIC).

Logical Address

- logical address in the Internet is currently a 32-bit address that can uniquely define a host connected to the Internet.

Port Address

- computer A can communicate with computer C by using TELNET. At the same time, computer A communicates with computer B by using the File Transfer Protocol (FTP).

Specific Addresses

- Examples include the e-mail address and any Universal Resource Locator (URL)

MAC Address / Physical Address/ Ethernet Address

- used on data link layer
- used to identify every NIC uniquely
- is burnt into the ROM part of NIC once written the MAC address can not be changed
- also known as read only address
- to find the MAC address of NIC
  - windows: ipconfig /all
  - linux/macOS: ifconfig
- e.g. 78 : 4f : 43 : 90 : 13 : d0
- size: 6 bytes = 8 x 6 = 48 bits
- Group of first three bytes(78 : 4f : 43) represent's manufacturer ID and last 3 bytes (90 : 13 : d0) represents NIC's unique address.
- to find the manufacturer, please visit https://hwaddress.com/

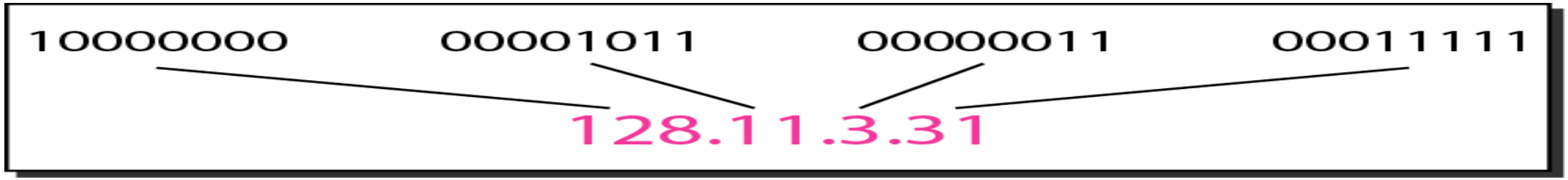
IP Address / Logical Address

- IP address to mean a logical address in the network layer of the TCP/IP protocol suite.
- Identify a machine / device uniquely.
- Size = 4 bytes = 32 bits
- to find the IP address of Machine
  - windows: ipconfig
  - linux/macOS: ifconfig
- IP Versions:
  - IPV4 (32 bits address length)
  - IPV6 (128 bits address length)
- IP addresses are made up of four sets of numbers called **“Octets”.**
- Types
  - Private : used to identify a machine on the LAN and can not be used to connect to internet
  - Public : used to connect to the internet
- e.g.
  - decimal: 192.168.1.6
  - binary : 11000000.10101000.00000001.00000110

IP Addressing Types

- Classful : IP Address is split into 5 classes
- Classless

  - IPv4 uses 32-bit addresses, which means that the address space is 2^{32} or4,294,967,296 (more than 4 billion)
  - **There are two prevalent notations to show an IPv4 address:**
    - binary notation
    - dotted decimal notation



Example

- *Find the error, if any, in the following IPv4 addresses.*

a. 111.56.045.78
b. 221.34.7.8.20
c. 75.45.301.14
d. 11100010.23.14.67

Example

- *Find the error, if any, in the following IPv4 addresses.*

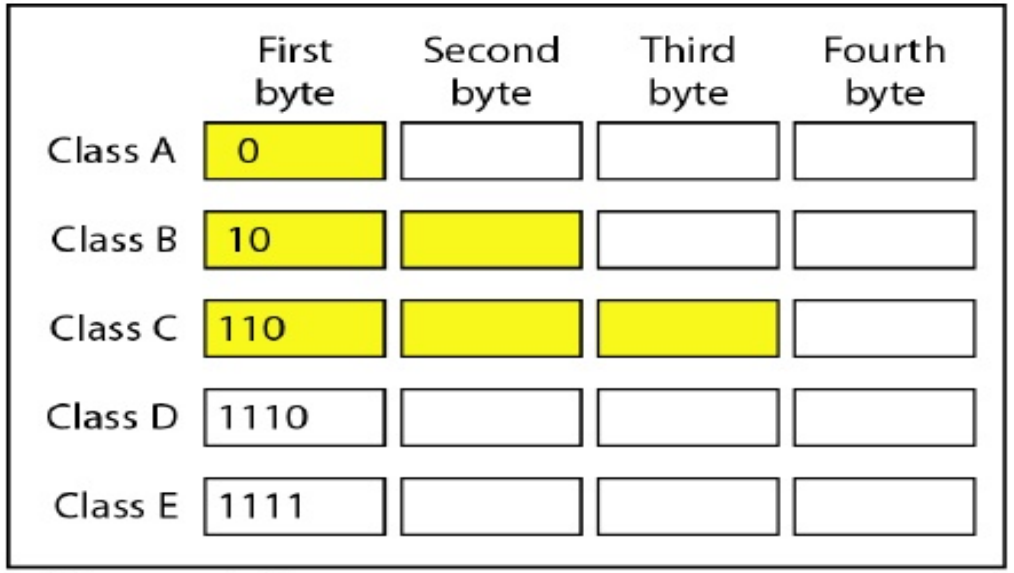
a. 111.56.045.78
b. 221.34.7.8.20
c. 75.45.301.14
d. 11100010.23.14.67

Solution

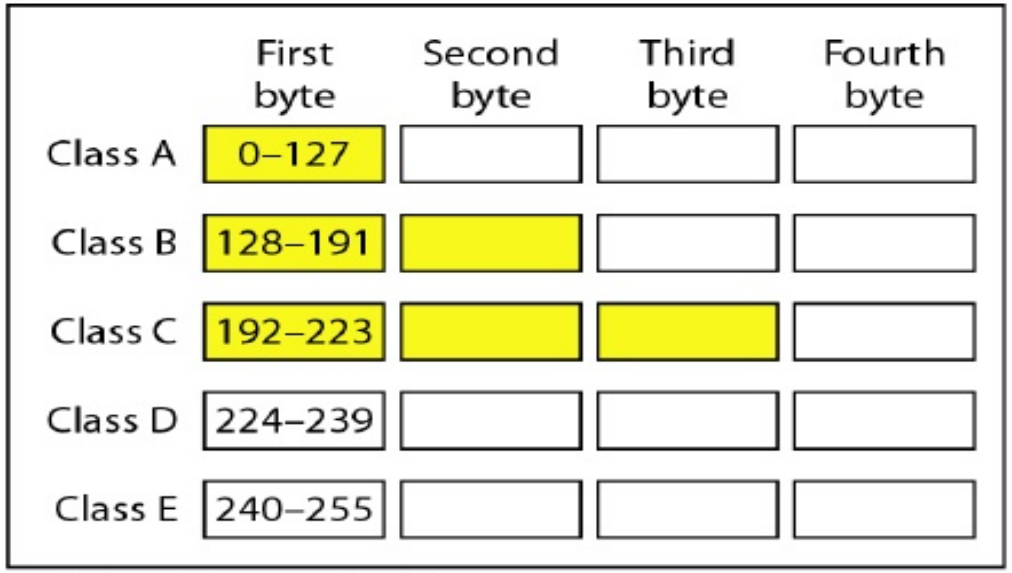
a. There must be no leading zero (045).
b. There can be no more than four numbers.
c. Each number needs to be less than or equal to 255.
d. A mixture of binary notation and dotted-decimal notation is not allowed.

Classful Addressing

- IP is 32 bit means 2^{32} IP Addresses. (more than 4 billion , so many IP Addresses)
- We need to distribute those that's why we have classes.
- In classful addressing, the address space is divided into five classes: A, B, C, D, and E.



a. Binary notation

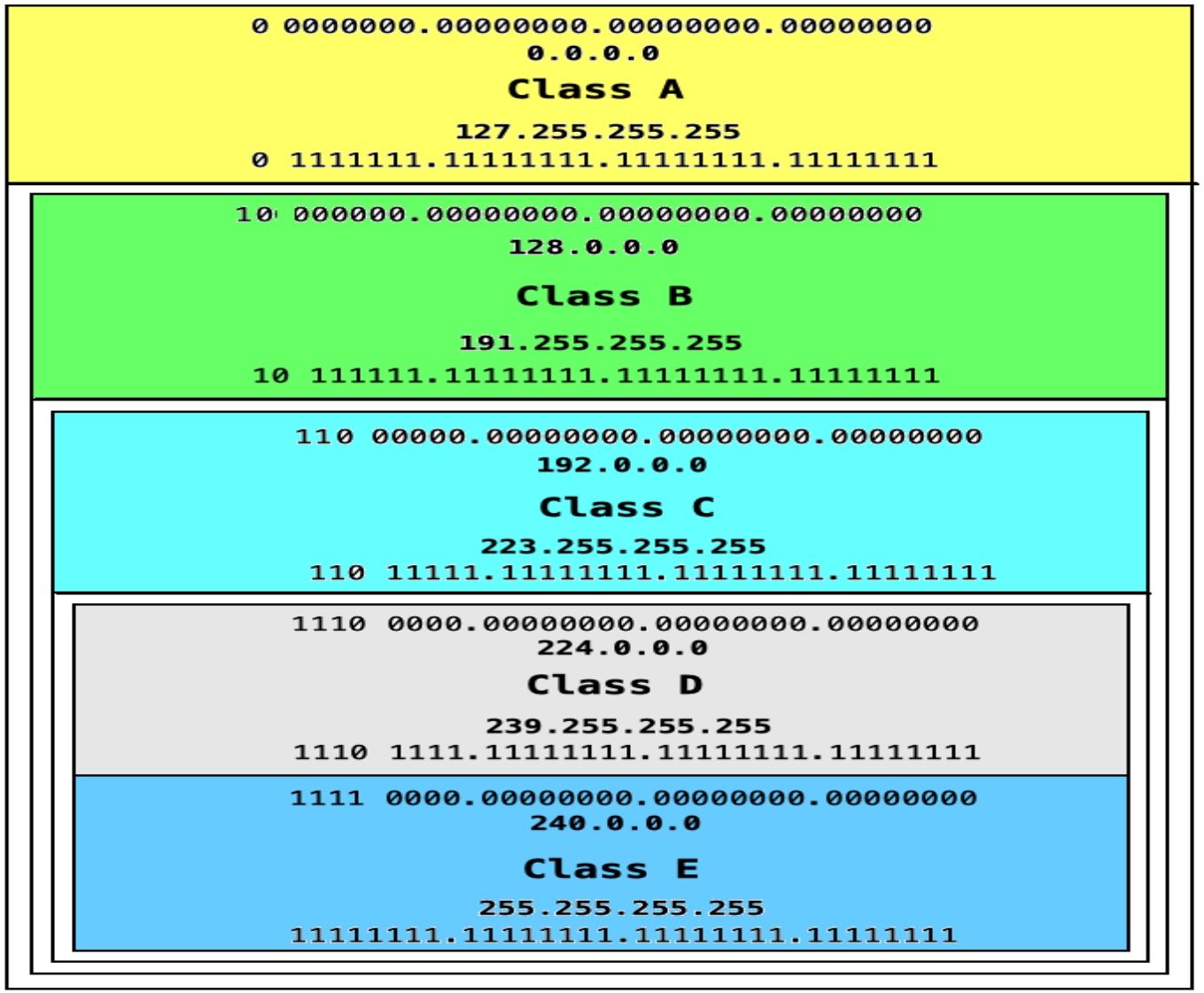


b. Dotted-decimal notation

How range of IP Address is defined

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0		
128	64	32	16	8	4	2	1		Range
0	x	x	x	x	x	x	x	Class A	0-127
1	0	x	x	x	x	x	x	Class B	128-191
1	1	0	x	x	x	x	x	Class C	192-223
1	1	1	0	x	x	x	x	Class D	224-239
1	1	1	1	x	x	x	x	Class E	240-255

IP Classful Addressing



- IP addresses starting with 0
- 0.0.0.0 – 127.255.255.255

- IP addresses starting with 10
- 128.0.0.0 – 191.255.255.255

- IP addresses starting with 110
- 192.0.0.0 – 223.255.255.255

- IP addresses starting with 1110
- 224.0.0.0 – 239.255.255.255

- IP addresses starting with 1111
- 240.0.0.0 – 255.255.255.255

Example

- Find the class of each address.

1. 00000001 00001011 00001011 11101111
2. 11000001 10000011 00011011 11111111
3. 14.23.120.8
4. 252.5.15.111

Example

- Find the class of each address.

1. 00000001 00001011 00001011 11101111
2. 11000001 10000011 00011011 11111111
3. 14.23.120.8
4. 252.5.15.111

Solution

1. The first bit is O. This is a class A address.
2. The first 2 bits are 1; the third bit is O. This is a class C address.
3. The first byte is 14 (between 0 and 127); the class is A.
4. The first byte is 252 (between 240 and 255); the class is E.

Points to be noted

- Any IP Address start with 127, That is : 127.x.x.x means its **a loop back series** that is used for **self testing**.
- E.g. Ping 127.0.0.1 (ping to yourself)
- That is 127.0.0.1 is **Universal IP** ,
- We can not configure **universal IP**. Its by default configured.
- PING (Packet Internet Groper) is a tool used to troubleshoot networking issues .

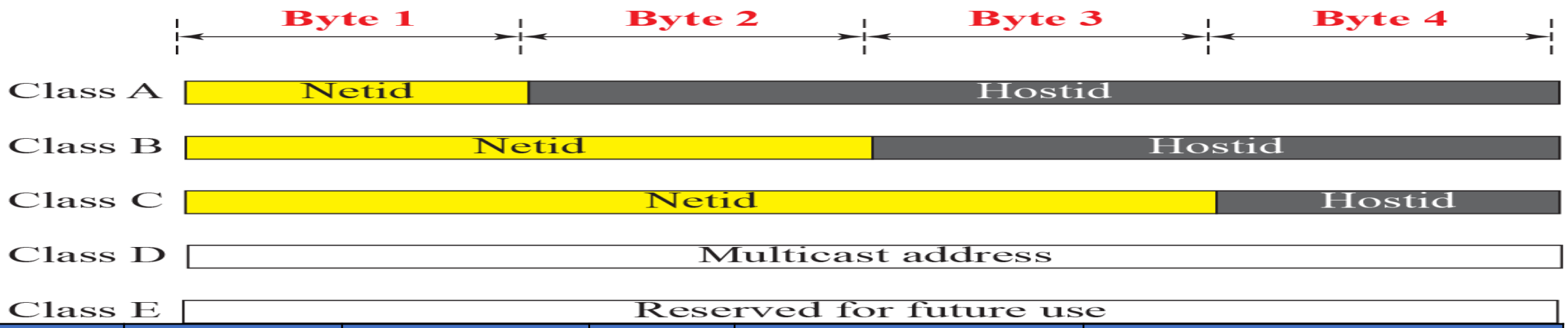
IANA(Inter Associated Number Association) manages private IP's.

Regular Private IP Addresses

Address Class	Reserved Private IP Addresses
Class A	10.0.0.0 - 10.255.255.255
Class B	172.16.0.0 - 172.31.255.255
Class C	192.168.0.0 - 192.168.255.255

Private network will have private IP's means devices that we connect to our router will get private IP addresses provided by IANA.

Netid and hostid of A, B, and C Classes



Class	Network bits	Networks	Host bits	Hosts Per Network	Suitable for
Class A	8	2^8=256	24	2^{24} - 2* =16,777,214 maximum hosts	For large organizations like Apple/Google/MS/Amazon
Class B	16	2^{16}=65536	16	2^{16} - 2* = 65,534 maximum hosts	for medium scaled organizations like Sunbeam
Class C	24	2^{24}=16million	8	2^8 - 2* = 254 maximum hosts	for small organizations/home network

**** Subtracting the network and broadcast address***

Example: What is the type of the given IP address

1. 11.34.56.66
2. 10.46.34.67
3. 156.46.36.46
4. 172.20.34.56
5. 172.45.66.77
6. 192.168.2.5
7. 192.169.34.6

Example (Solution): What is the type of the given IP address

1. 11.34.56.66 : public
2. 10.46.34.67 : private
3. 156.46.36.46 : public
4. 172.20.34.56 : private
5. 172.45.66.77 : public
6. 192.168.2.5 : private
7. 192.169.34.6 : public

Example : which class needs to be used for following number of Devices?

1. 200 devices
2. 3000 devices
3. 50000 devices
4. 200000 devices

Example (Solution) : which class needs to be used for following number of Devices?

1. 200 devices : class C
2. 3000 devices : class B
3. 50000 devices : class B
4. 200000 devices : class A

Thank You