# Unit 4

# SAQ:

1 .Define CSMA/CP

2. Define topology/How many types of topology are there?

3. List of briefly define services provided by LLC

4. What is MAC?

5. What is difference between bridge &switch

6. List some basic functions performed by MAC layer

7 .Differentiate between routers and gateways

8. What is Ethernet ?What are different types of Ethernet .

9 .Compare bus topology and steer topology.

10.What are the advantages of CSMA/CP over CSMA.

11.What are the key elements of LAN?

# LAQ:

1.Explain briefly CMA/CP.

2.Eplain MAC layer format.

3.Write Ethernet frame format.

Give significance of each field.

4.Explain the functions of Switch, Bridge & Router.

5.Compare fast ,Gigabit-Ethernet.

6.What is Ethernet? What are different types of Ethernet.

7.Write relative merits and demerits of different LAN topologies.

8.Write note on: 1.Layer 2-3 switches

2.Traditional Ethernet

3.Fast Ethernet

4.Gigabit Ethernet

9.What is Briged Ethernet, Switch Ethernet & Full duplex Ethernet

10.Explain physical layer implementations of

1.Traditional Ethernet

2.Fast Ethernet

3.Gigabit Ethernet

Unit 4

# Traditional Ethernet:

Topologies & Transmission media ,LAN protocol architecture ,MAC sub layer-CSMA/CD ,physical layer ,implementation bridged, switched & full duplex Ethernet layer 2 &3 switches.

# Fast Ethernet:

MAC sub layer ,physical layer implementation

# Gigabit Ethernet:

MAC sub layer ,physical layer ,implementation.

# Topologies:

## Network topologies:

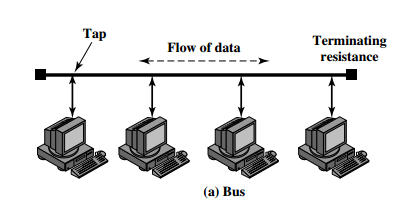
Logical connection of various computers in network.

## Basic topologies are

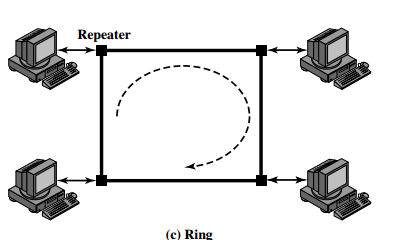
* Bus
* Ring
* Star
* Tree
* Mesh
* Hybrid

# 1.Bus topology

* All computers connected to long cable called bus.
* Node that wants to send data puts data on bus which carries it to destination node.
* Any computer can send data over bus at any time.
* Bus is shared among all computers.
* When two or more computers want to send data at same time ,an arbitration mechanism is needed to prevent simultaneous access to bus.
* Easy to install but not flexible.
* Difficult to add new nodes to bus.
* If position of bus breaks down difficult to isolate fault.

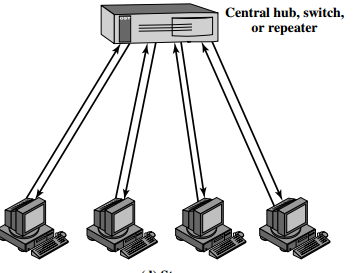


# 2.Ring topology

* Devices are arranged in the form of ring, each having two neighbouring devices.
* To send data to destination node which is far apart, data should be passed through many intermediate node.
* Easy to install &configure.
* Fault isolation is easy because a signal that circulates all the time in ring helps in identifying faulty node.
* Data transmission in only one direction any faulted node can break whole ring.
* Cannot connect large no. of devices.

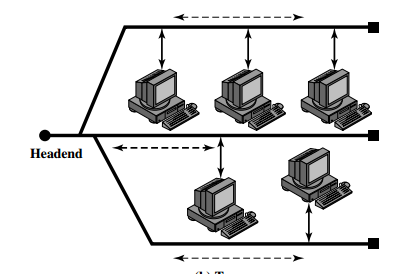
# 3.Star topology

* Nodes are connected to the central nodes called Hub
* Any node which wants to send the data can send it to the Hub which in turn sends it to the destination.
* Easy to install &configure.
* If links fail it separates the node connected to the link from network &network continues to function.
* If Hub goes down ,entire network will collapse.

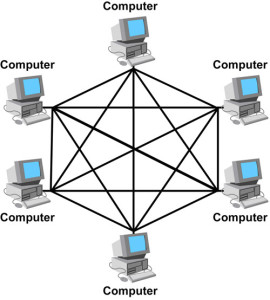


# 4.Tree topology

* Hirerchy of various Hubs .
* All nodes are connected to one Hub or other.
* To central Hub only few nodes are connected directly.
* Central /Active Hub looks at incoming bits &regenerates them so that they can travel longer distances .
* Secondary Hubs in tree Topology may be active or positive Hub.
* Failure of transmission line separates a node from network.

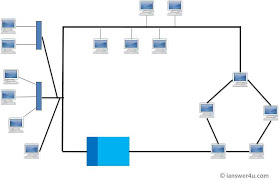
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# 5.Mesh topology

* Also called complete topology.
* Each node is connected to every other node in network.
* For n-nodes ,there are n(n-1)/2 links.
* As ,there is dedicated links, topology does not have congestion problems.
* Further, it does not need a special MAC protocol to prevent simultaneous access to transmission media, since links are dedicated ,not shared.
* Data security is provided.
* Complex network& cost associated with able length

# 6.Hybrid Topology

* Two or more topologies together



# Traditional Ethernet:

* LAN is a computer network that is designed for a limited geographic area such as building or campus.
* Although LAN can be used as an isolated network to connect computers in an organisation for the sole purpose of sharing resources .
* Most LAN today are also linked to a WAN or internet.
* LAN market has seen several technologies such as Ethernet ,token ring, token bus, FDDI(Fibre Distributed Data Interfacing),LAN’S.
* These are designed to regulate manufacturing &interconnectivity between different event LANS.

# IEEE standards : (project 802)

* Enables intercommunication between among equipment from a variety of manufactures.
* Project 802 does not replace any part of OSI or internet model instead ,it is way of specifying functions of physical& data link layer of major LAN protocol.
* IEEE has subdivided data link layer into

-Logical Link Layer .

-Media Access control.

* IEEE has also created several physical layer standard for different LAN protocols.

# IEEE standard for LANS(Protocol Architecture)

# Data link layer: (handles framing ,flow& error control)

* In IEEE std.802,flow,error&part of framing are collected into sublayer called LLC(logical link layer).
* Framing is handled in both LLC&MAC sub layer.
* LLC provide are single data link control protocol for all IEEE LAN’S.
* MAC provides different protocols for different LAN’S.
* Single LLC protocol can provide interconnection between different LAN’S because it makes Mac sub layer transparent.

# Framing :

* LLC defines protocol data unit (PDU) some what similar to HDLC.
* Header contains control field like HDLC .
* Two other header fields define upper layer at source &destination that uses LLC
* These fields are :

DSAP-Destination Service Access Point.

SSAP-Source Service Access Point.

# HDLC Frame Compared With LLC& MAC Frames:

* LLC is used to provide flow & error control for upper layer protocols that actually demand services.
* If LAN or several LAN’S are used in isolates system, LLC may be needed to provide flow and error control for application layer protocols.

## MAC-Media Access Control:

* Defines specific access method for each LAN.
* It defines CSMA/CD –Carrier Sense Multiple Access/Collision Detection as media access method for Ethernet –LAN’S
* Token Ring passing method for token rings &token busses LAN’S.
* MAC contains no. of distinct modules ,each defines access method &framing format specific to corresponding LAN protocol.

## Physical layer:

* Physical layer is dependent on implementations and type of physical media used.
* There is only one MAC sub layer for std. Ethernet but different physical layer specifications for each Ethernet implementation.

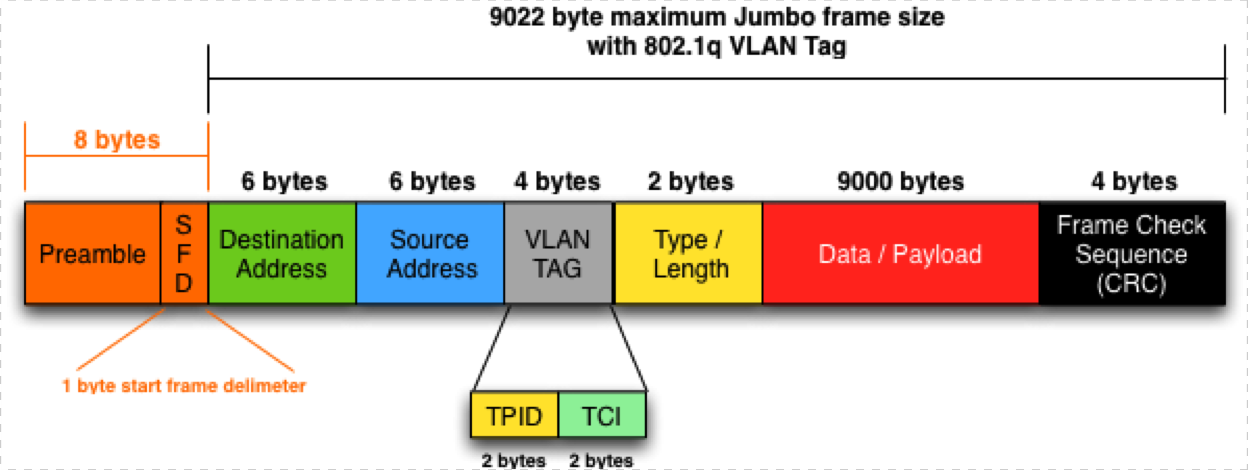
## Standard Ethernet:

* Ethernet evolution through 4 generations.

# MAC sub layer:

* MAC sub layer governs operation of access method .
* It also frames data received from upper layer & passes them to physical layer.

# Frame Format- 802 MAC Frame:



SFD-start Frame de limiter ,flag(10101011)

* No mechanism for ack received frames, so un readable medium.

### Preamble-

* 7 bytes of alternate 0’s & is coming frame & enables it to synchronise its i/p timing.
* Pattern provides only at least & timing pulses.
* Preamble is added at phy. Layer & is not part of frame.

#### SFD-Signals Beginning of frame:

* SFD warns the stations that this last chance for synchronisation.
* Last 2 bits is parallel& alerts receiver that next field is destination address.

#### Destination Address:

* 6 bytes contains physical address of destination station or stations to receive packet.

#### Source Address:

* 6 bytes field contains physical address of sender of packet.

#### Length/type:

* Length field/type field ->to define upper layer protocol using MAC frame .

#### DATA:

* Carries data encapsulated from upper layer protocols.

#### CRC:

* Error detection information CRC-32 is used.

# Frame Length:

* Ethernet has imposed restrictions on both min & max length of frame.
* MIN LENGTH restrictions required for correct operations of CSMA/CD.
* Ethernet frame needs to have min length of 512 bits or 64 bytes.
* Part of this length is header + trailer. If we count 18 byes of header + trailer then min length of data from upper layer =46 bytes.
* If upper layer packet is less than 46 bytes padding is added to make up the difference.
* MAX LENGTH of frame without preamble &SFD field is 1518 bytes.
* If we subtract 18 bytes of header &trailer max length of payload =1500 bytes .

##### MAX LENGTH restriction has two historical reasons

* Max length restriction helped to reduce size of buffer .
* Memory was very expensive when Ethernet was designed.
* Max length restriction prevents one station from mono policing shared medium blocking other station that has to send.

# Addressing :

* Each station on Ethernet n/w has its own n/w interface card .
* NIC fits inside the station &provides station with 6 byte phy. Address.
* Address is in hex form with colon between bytes .

06:01:02:01:2c:4b

6 bytes=12 hex digits =48 bits.

# Unicast ,Multicast &Broadcast Address

* Source address is always unicast address i.e frame comes from only one station.
* Destination address , can be unicast ,multicast broadcast.
* If least significant bit (lst) of first byte in a destination is 0, address is unicast otherwise multicast.

##### Multicast address in which all bits are 1’s broadcast address .

Examples

1. 4A:30:10:21:10:1A
2. 47:20:1B:2E:08:EF
3. FF:FF:FF:FF:FF:FF

How address is sent on the line:

47:20:1B:2E:08:EE is sent out on line.

Address sent left →right byte by byte→ for each byte, it is sent right→ left bit by bit

1110 0010 0000 0100

7 4 0 2

Access Method CSMA/CD

CSMA/CD and its precursors can be termed random access or contention, techniques, they are random access in the sense that there is no predictable or scheduled time for any station to transmit; station transmissions are ordered randomly.

They exhibit contention in the sense that stations struggle for time on shared medium.

Earliest of these techniques known as ALOHA or pure ALOHA.

It specifies that station may transmit a frame at any time.

It does not sense the common channel before initiating transmission because of which it does not have any information bout states of other users.

Later CSMA protocol were developed that sensed the channel before initiating the transmission in order to achieve quarter efficiency.

Using CSMA protocol each of device that are connected to N/W are able to examine states of channel before, sending information transmission takes place only if the communication channel is idle.

# Different versions of the CSMA Protocol

1. Non – Persistent CSMA

In this type of CSMA device first senses the communication channel if it is ideal then transmission is initiated but if the channel is busy, station waits for a period of time before starting the transmission.

1. P-persistent csma

This type of csma is basically used in slotted aloha ,where a packet is transmitted into slots ,that is available then packet is transmitted to next slot with probability i-p.

1. I- persistent csma.

Every device in network that wish to transmit first sense if channel is free or not ,it transmit the pack longer delays .

Back off algorithm can be used to facilitate longer delays .

1. CSMA/CA(Carrier Sense Multiple Access with Collision Avoidance)

* It is a scheme of access defined in std.IEEE802.3.
* It is generally used in mobile LAN’S.
* Back off algorithm is combined with carrier sensing scheme in order to gain efficiency among devices that are completing with each other when channel is busy.

# CSMA/CD(carrier sense multiple access with collision detection )

* Later versions CSMA/CD is CSMA/CD rules of CSMA/CD are:

1. Transmission should be initiated only if channel is idle.
2. Station should continue to sense the channel ,until it is free .If channel is idle ,only then transmission can take place.
3. Jamming signal is to be transmitted to each station ,if collision is detected ,to that every station in N/W get know that a collision have been detected.
4. Back off scheme is applied after transmission jamming signal .According to this approach ,device waits for random period of time after sensing that station is busy ,after that duration of time transmission is again started by listening to channel.
5. Using CSMA /CD access scheme capacity that was wasted using CSMA scheme is decreased depending on time taken to detect collision.
6. Another important rule of CSMA/CD is that frame should be very large so that collisions can be detected before transmission ends.

Slot Time:

Round trip + time reg to send Jam sequence

It is time required for a station to send 512 bits.

Actual slot time depends on data rate.

For traditional 10 Mbps Ethernet is 51.2 µs.

Slot Time and Collision :

The choice of 512 bit slot time was chosen for proper functioning of CSMA/CD.

To understand the situation, let us consider two cases:

Case 1 :

We assume the sender ends minimum size packet of 512 bits.

Before sender can send entire packet out, signal travels through n/w and reaches end of n/w.

If there is another signal at end of n/w collision occurs.

Sender has opportunity to abort sending of frames to send again sequence to inform other station collision.

Round trip time + time required to send jam sequence should be less than time required for sender to send min. frame 512 bits.

Sender needs to be aware of collision before entire frame is sent.

##### Case 2:

Sender sends a frame larger than minimum .

* If station has sent out first-512 bits & has not heard a collision it is guaranteed
* That collision will never occur during the transmission of this frame.
* The reason is that signal will reach the end of N/Win less than one –half slot time.
* If all stations follow CSMA/CD protocol ,they have already sensed existence of signal.
* If they want sent a signal on the line before one half slot time expired ,a collision has occurred &sender has sensed the collision.
* In other words ,collision can only occur during first half of slot time &if it does it can sensed by sender during slot time.
* This means that after sender sends the first 512 bits, it is guaranteed that collision will not occur during transmission of this frame.
* Medium belongs to sender & no other station will use it.
* Sender needs to Listen to collision only during first -512 are sent.

# Physical layer implementation for standard Ethernet:

* Standard Ethernet defines several physical layer implementation.

# Encoding & Decoding:

* All standard implementation use digital signals at 10 Mbps.
* At sender ,data are converted to digital signal using Manchester scheme & at receiver the received signal is interpreted as Manchester & decoded into data .

#### 1.IOBASE 5:

Name devices from size of cable ,which is roughly in size of garden hose & too stiff to bend with our hands.

IOBASE 5 was first Ethernet specification to use a bus topology with external transceiver connected via thick tap to coaxial cable.

Transceiver is responsible for transmitting ,receiving & detecting collisions.

Transceiver is connected to station via a transceiver cable that provides separate paths for sending &receiving.

This means that collision can only happen in coaxial cable .

## 2.IOBASE 2:

* Cable is much thinner and more flexible.
* Cable can be bent to pass very close to stations.
* Transceiver is installed inside station normally it is past of N/W.
* Collision occurs in thin coaxial cable
* Cost effective than thick co axial cable.
* Tee connections are much cheap than taps.
* Length of segment can exceed 185m.Due to high level of attenuation in thin co axial cable.

## 3.IOBASE T:

* Two pairs of twisted pairs cables create two paths.
* Sending or receiving data between stations & hubs.
* Max length of twisted cable is defined 100m to minimize effect of attenuation in cable.

## IOBASE F: Fibre Ethernet

* IOBASE F uses star topology to connect to stations to hub.
* Stations are connected to hub using two fibre optic cables .

# Bridged Ethernet :

* 10 mbps std. Ethernet has gone through changes before moving to higher data rates.
* These changes actually opened road to evolution of Ethernet to be compatible with higher data rate LAN’S.
* First step in Ethernet evolution was division of LAN by bridges.
* They raised the bandwidth & they separate collision domains .

### Raising the Bandwidth

* In an bridge Ethernet N/W, total 10 Mbps capacity is shared among all stations with a frame to send.
* If only one station has frame to send it benefits from total capacity ,but if more stations has frame to send, capacity is shared .
* Ex :For two stations avg rate is 5 Mbps.
* Bridge divides N/W into two or more N/W.
* In N/W with heavy load each station theoretically is offered 10/4 Mbps instead 10/8 Mbps assuming traffic is not going through bridge.

### Separating Collision domains

* Another advantage of bridge is separation of collision .
* Collision domain base becomes more smaller & probability of collision is reduced.

# Switched Ethernet

* Idea of bridged LAN can be extended to switched LAN .
* Instead of having 2 N/W why not have N- network .

N- no. of Stations of LAN .

* Using N port switch band width is only shared between station & switch .
* Collision domain is also divided into N domains.

## Full duplex Ethernet :

* One of limitation of 10 Base5& 10Base 2 is that communication is Half duplex.
* Next step to evolution was to move from switch Ethernet to full duplex Ethernet .
* Full duplex mode increases capacity of each domain from 10 to 20 Mbps.
* Instead of using one link between station & switch ,configuration uses links.
* One to transmit &one to receive .
* NO NEED FOR CSMA/CD.
* In full duplex switched Ethernet ,there is no need for CSMA/CD method.
* Each station is connected to switch via two separate link
* Each station or switch can send & receive independently with out worrying of collision.
* There is no need for carrier sensing as each link is point to point ,no longer a need for collision detection.

### MAC Control Layer :

* Std. Ethernet was designed as connectionless protocol at MAC sub layer .
* There Is no explicit flow error control to inform the sender that frame has to arrived at destination without error .
* When receiver receives frame it does not send any +ve or –ve ack.
* To provide for flow & error control in full duplex switched Ethernet ,new sub layer called MAC control is added between LLC sub layer MAC control MAC sub layer.

### FAST Ethernet

* Transmit data 10 times faster at rate of 100 Mbps .
* Goals of fast Ethernet

1. Upgrade data rate to 100 Mbps .
2. Make it compatible with std. Ethernet .
3. Keep same 48 bit address ,frame format ,& min & max frame length.

#### MAC sub layer

MAC sub layer is same .

however ,a decision was made to drop the bus topology & keep only star topology .

for star topology,

there are two choices :

1. Half duplex – connection via hub.
2. Full duplex-connection via switch with buffer at each port.

The access method is some CSMA/CD for half duplex approach, for full duplex fast Ethernet there is no need for CSMA/CD.

However ,the implementation keep CSMA/CD for backward compatibility with Ethernet.

## Auto Negotiation :

* New feature added to fast Ethernet is fast negotiation .
* It allows station or a hub range of capabilities.
* Auto negotiation allows two station /devices to negotiate on mode or data rate operation .

#### Purpose of Auto negotiation:

1. To allow incompatible device to connect to each .
2. To allow one device to have multiple other capabilities .

# Physical layer :

* physical layer in fast is more complicated than in std. Ethernet
* topology – fast Ethernet is designed to connect two or more stations together .
* if there are only stations ,they can be point to point.
* Three or more stations need to be connected in star topology with hub or switch in centre.

Implementation:

* Fast Ethernet phy layer implementation can be categorised as either two wire or four wire.
* Two wire ,5 utp (100 base TX)
* Four wire -3 utp (100 Base T4)

# Encoding

* Manufacture encoding needs 200M band width for 100 Mbps data rate.
* But this is unsuitable for twisted pair cable
* For this reason some alternative encoding /decoding is designed.

## 100 Base TX

### MLT Encoding –

Uses three levels +v,0,-v

* If next bit is zero –no transition .
* If bit is 1 & current level is not 0,next level is 0.

# Gigabit Ethernet :

* The need for even higher data rate resulted in designed of gigabit Ethernet protocol (1000 Mbps)
* Goals of gigabit Ethernet design .

1.upgrade data rate to 1 gbps .

2. Make it compatible with std. or fast Ethernet

3. Use same 48 Bit address , frame format .

4. Keep same min & max frame length to support auto negotiation as in fast Ethernet

# Half Duplex mode:

* Gigabit Ethernet can also be used in half duplex mode.
* In this case a switch can be replaced by hub which acts as common cable in which a collision might Occur .
* Half duplex mode uses CSMA/CD.
* However, max length of N/W in this approach is totally dependent on min frames .
* These are three methods defined

1. Traditional
2. Carrier extension
3. Frame bursting

## Traditional

* In traditional approach min length 512 bits we keep same length.
* However because the length of a bit is 1/100 sorter in gigabit Ethernet than in 10 Mbps Ethernet ,slot time for gigabit Ethernet is 512\*1/1000 ms, which is equal to 0.512 ms.
* Reduced slot time means that collision is detected 100 times earlier.
* This means that max length of N/W is 25m.
* This length can be suitable if all the stations are in one room ,but it may not even be long enough to connect the computers in the single office.

## Carrier extension:

* To allow for longer N/W ,we increase min frame length.
* Carrier extension approach defines min length of frame as 512 bytes .
* This means that min length is 8 times longer .
* This method forces station to add extension bits to any frame that is less than 4096 bits.
* In this way max length of N/w can be increased 8 times to length of 200m.

## Frame bursting:

* Carrier extension is very in efficient if we have a series of short frames to send.
* To improve efficiency frame was proposed instead of adding an extension to each frame ,multiple frames are sent.
* To make these multiple frames look like single frame padding is added between frames so that channel is not idle..

# Physical layer:

## Topology:

* Gigabit Ethernet is designed to connect two or more stations.
* F only two stations ,they can be connected point to point.
* Three or more stations need to be connected in star topology with hub or switch at centre .
* Another possible configuration is to connect several star topologies or let a star topology be part of another .

### 

### Implementation :

* Gigabit Ethernet can be categorised as two wire or four wire implementation .
* Gigabit Ethernet cannot use Manchester encoding scheme because it involves a very high bandwidth.
* The two wire implementations use NRZ scheme but NRZ does not show self synchronisation.properly.
* To synchronise bits ,particularly at this rate 8B/10B block encoding is used.
* This block encoding prevents long sequence of 0’s & 1’s in the stream but resulting stream is 1.25 Gbps.
* One wire is used for sending &one wire is used for receiving .
* In four wire implementation it is not possible to have 2 wires for i/p & 2 for o/p because each wire would need to carry 500 Mbps which exceeds capacity for category 5 utp.
* A solution 4dpam5 encoding iss used to reduce the bandwidth.
* Thus all 4 wires are involved in both i/p & p/p each wire carries 250 Mbps which is in range for category 5 UTP cable

# Ten gigabit Ethernet :

* IEEE created ten gigabit Ethernet & called id STD 802.3 9e

#### Goals:

1. Upgrade data rate to 14 Gbps.
2. Make it compatible with other Ethernet.
3. Use same 48 bit address
4. Use same frame format.
5. Keep same min & max frame length
6. Allow interconnection of exiting LAN into metropolitan area N/w or WAN
7. Make Ethernet compatible with technologies such as frame relay & ATM .

## MAC sub layer:

Ten gigabit Ethernet operates only in full duplex mode which means there is no need for contension; CSMA/CD

## Physical layer:

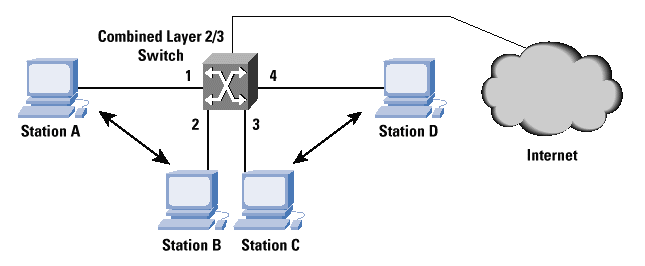
Physical layer in ten gigabit Ethernet is designed using Fibre optics cable over long distances

10 G Base S-Short wave length |850 nm multimode |300m max length

10 G Base L- Long wave length |1310 nm single mode |10 km

10 G Base E-extended max length|1550nm single mode|40 km

### Layer 2-3 switches

Five categories of connecting devices based on layer which they operate in N/w. 

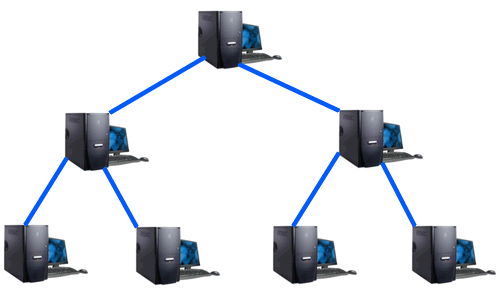
#### Passive hub

* It is just a connector .
* Connects wires coming from different branches .
* Its location in internet model is below physical layer

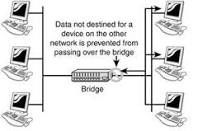
#### Repeaters :

* Operates at physical layer.
* A repeater receives a signal & before it becomes too weak or corrupted ,regenerates the original bit pattern.
* Repeaters then sends refreshed signal.
* Repeater can extend physical length of LAN

### Active Hubs:

* It is multiport repeater.
* It is used to create connections between stations in physical star topology.
* Hubs can also be used to create multiple levels of hierarchy.
* Hubs are implemented in some Ethernet . 

### Bridges :

* A bridge operates in both physical & data link layer.
* As physical layer device –it generates signal.
* As data link layer –check physical (MAC) address source & destination contained in frame. 

### 2-Layer switches:

* 2- layer switch performs at physical & data link layer.
* It is a bridge, a bridge with many ports & design that allows better performance.
* Bridge with few ports can connect few LANS together.

## Routers:

* A router is 3-layer device that routes packets based on their logical address .
* Router normally connects LAN’S & WAN’S in internet & has routing table that is used for making decisions about route.
* Routing tables are normally dynamic & are updated using routing protocols .

## 3- layer – Switches

* 3 layer switch is router ,but faster & more sophisticated.
* The switching fabric in 3 layer switch allows faster table faster table 100 kbps& forwarding.

## Gateway:

* A gateway is normally a computer that operates in all 5 layers of internet or 7 layer of OSI model.
* A gateway takes application msg, reads it, interprets it.

Can be used as connecting device between two internets networks that use diff models.