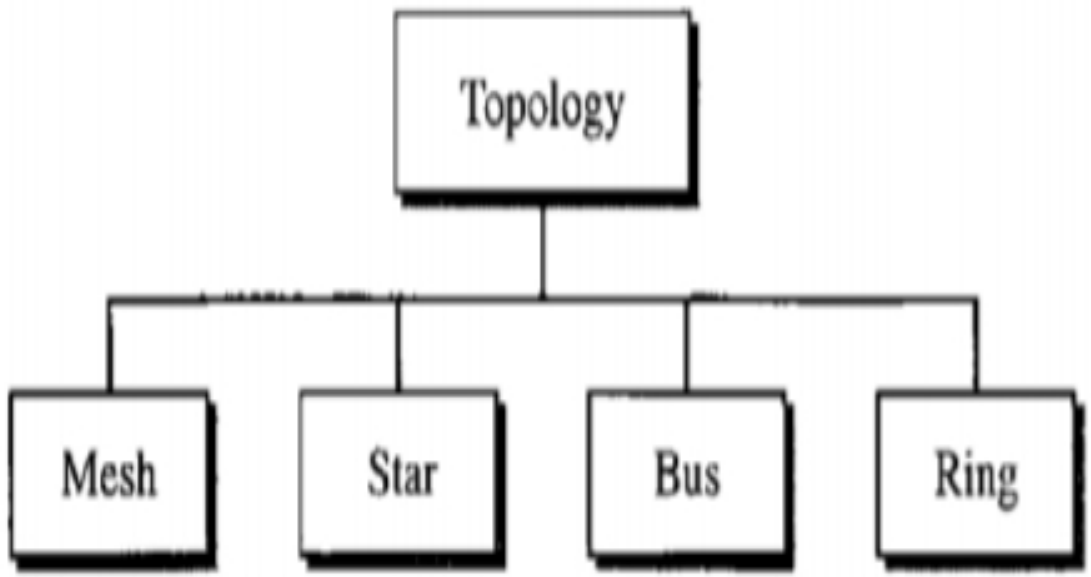
# CN: WEEK 2

# Network Topology

# Network Topology

- **It is the schematic description of a network arrangement, connecting various nodes(sender and receiver) through lines of connection.**

- **It is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to one another**




*Categories of topology*

***Bus topology*** is a network type in which every computer and network device is connected to single cable.

**Features of Bus Topology**

1. It transmits data only in one direction.
2. Every device is connected to a single cable

**Advantages of Bus Topology**

1. It is cost effective.
2. Cable required is least compared to other network topology.
3. Used in small networks.
4. It is easy to understand.
5. Easy to expand joining two cables together.

**Disadvantages of Bus Topology**

1. Cables fails then whole network fails.
2. If network traffic is heavy or nodes are more the performance of the network decreases.
3. Cable has a limited length.
4. It is slower than the ring topology.

***Ring Topology*** is called ring topology because it forms a ring as each computer is connected to another computer, with the last one connected to the first. Exactly two neighbours for each device.

**Features of Ring Topology**

1. A number of repeaters are used for Ring topology with large number of nodes, because if someone wants to send some data to the last node in the ring topology with 100 nodes, then the data will have to pass through 99 nodes to reach the 100th node. Hence to prevent data loss repeaters are used in the network.
2. The transmission is unidirectional.
3. Data is transferred in a sequential manner that is bit by bit. Data transmitted, has to pass through each node of the network, till the destination node.

**Advantages of Ring Topology**

1. Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
2. Cheap to install and expand

**Disadvantages of Ring Topology**

1. Troubleshooting is difficult in ring topology.
2. Adding or deleting the computers disturbs the network activity.
3. Failure of one computer disturbs the whole network.

***Star Topology*** is a type of topology where all the computers are connected to a single hub through a cable. This hub is the central node and all others nodes are connected to the central node.

**Features of Star Topology**

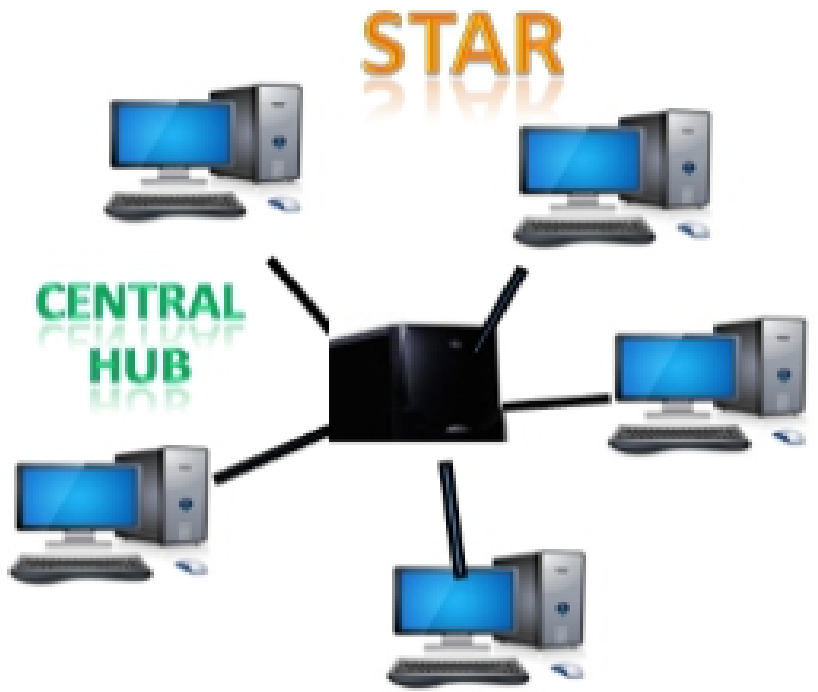
1. Every node has its own dedicated connection to the hub.
2. Hub acts as a repeater for data flow.
3. Can be used with twisted pair, Optical Fibre or coaxial cable.

**Advantages of Star Topology**

1. Fast performance with few nodes and low network traffic.
2. Hub can be upgraded easily.
3. Easy to troubleshoot.
4. Easy to setup and modify.
5. Only that node is affected which has failed, rest of the nodes can work smoothly.

**Disadvantages of Star Topology**

1. Cost of installation is high.
2. Expensive to use.
3. If the hub fails then the whole network is stopped because all the nodes depend on the hub.
4. Performance is based on the hub that is it depends on its capacity



***Mesh Topology*** is a point-to-point connection to other nodes or devices. All the network nodes are connected to each other.

**Features of Mesh Topology**

1. Fully connected.
2. Robust.
3. Not flexible.

**Advantages of Mesh Topology**

1. Each connection can carry its own data load.
2. It is robust.
3. Fault is diagnosed easily.
4. Provides security and privacy.

**Disadvantages of Mesh Topology**

1. Installation and configuration is difficult.
2. Cabling cost is more.
3. Bulk wiring is required.

***Hybrid Topology*** is two different types of topologies which is a mixture of two or more topologies. For example if in an office in one department ring topology is used and in another star topology is used, connecting these topologies will result in Hybrid Topology (ring topology and star topology).

**Features of Hybrid Topology**

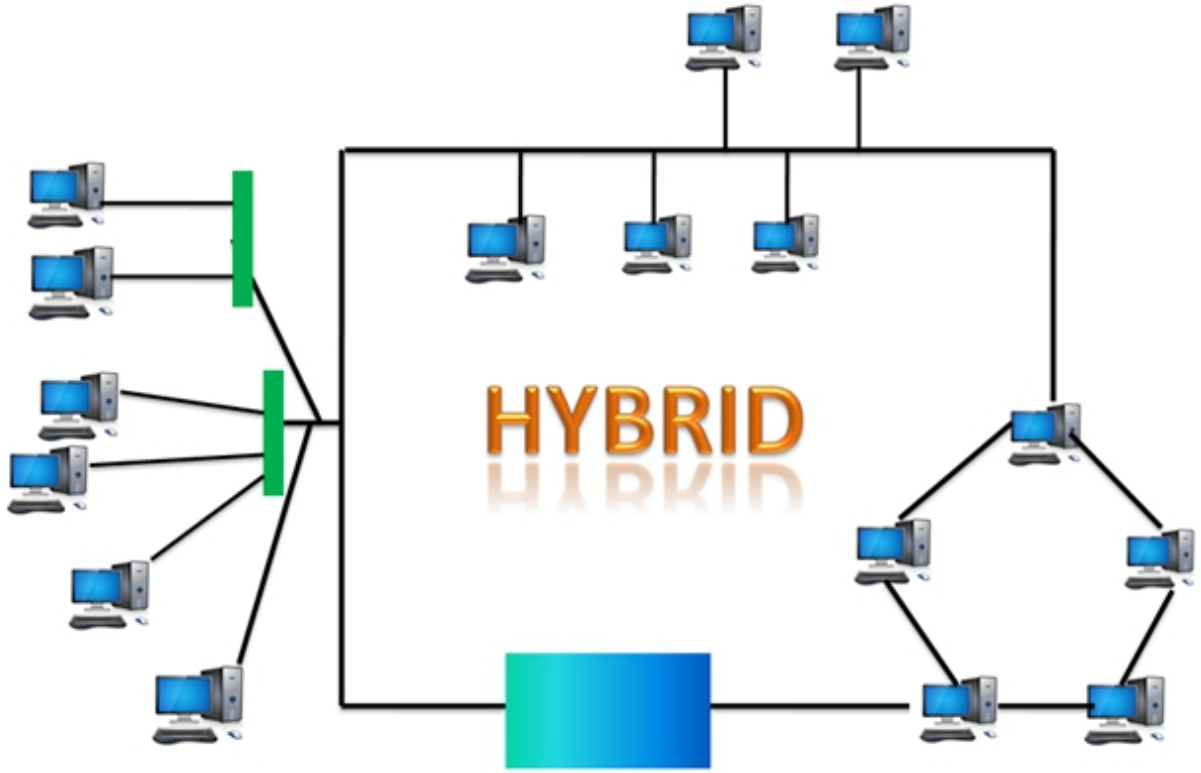
1. It is a combination of two or topologies
2. Inherits the advantages and disadvantages of the topologies included

**Advantages of Hybrid Topology**

1. Reliable as Error detecting and trouble shooting is easy.
2. Effective.
3. Scalable as size can be increased easily.
4. Flexible.

**Disadvantages of Hybrid Topology**

1. Complex in design.
2. Costly.



# Types of Communication Networks

- The Network allows computers to connect and communicate with different computers via any medium.

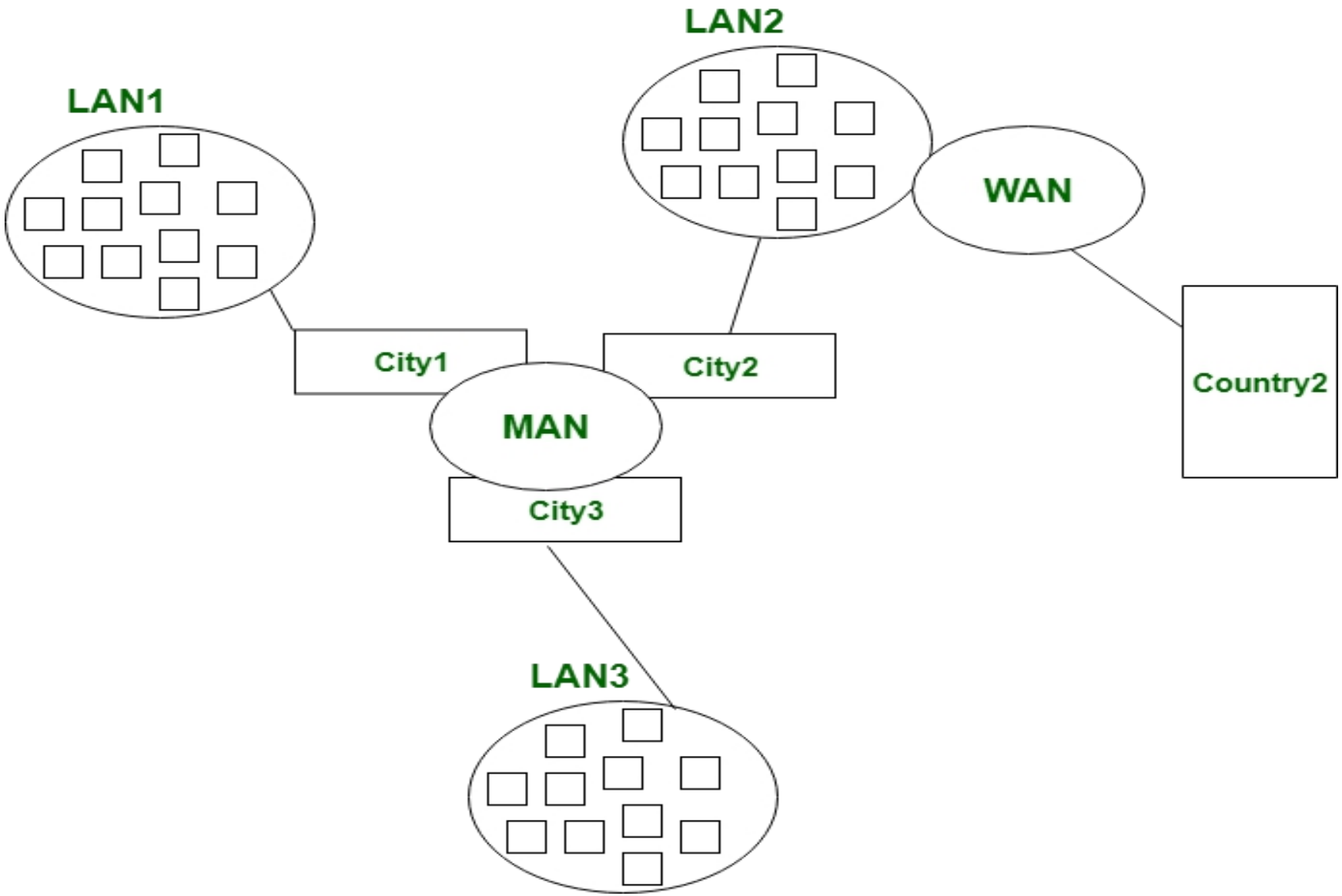
- LAN, MAN, and WAN are the three types of the network designed to operate over the area they cover.

  - A ***Local Area Network (LAN)*** is a private network that connects computers and devices within a limited area like a residence, an office, a building or a campus.

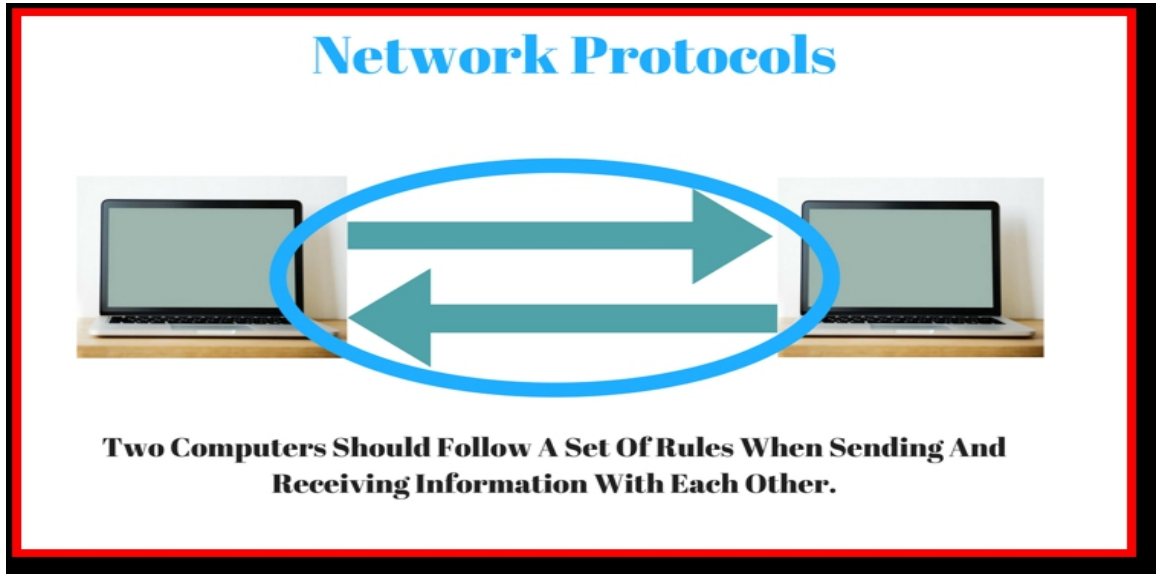
  - A ***Metropolitan Area Network (MAN)*** is a larger network than LAN. It often covers multiple cities or towns.

  - A ***Wide Area Network (WAN)*** is a much larger network than LAN and MAN. It often covers multiple countries or continents.

| Key | LAN | MAN | WAN |
|---|---|---|---|
| Definition | LAN stands for Local Area Network. | MAN stands for Metropolitan Area Network. | WAN stands for Wide Area Network. |
| Ownership | LAN is often owned by private organizations. | MAN ownership can be private or public. | WAN ownership can be private or public. |
| Speed | LAN speed is quiet high. | MAN speed is average. | WAN speed is lower than that of LAN. |
| Delay | Network Propagation Delay is short in LAN. | Network Propagation Delay is moderate in MAN. | Network Propagation Delay is longer in WAN. |
| Congestion | LAN has low congestion as compared to WAN. | MAN has higher congestion than LAN. | WAN has higher congestion than both MAN and LAN. |
| Fault Tolerance | Fault Tolerance of LAN is higher than WAN. | Fault Tolerance of MAN is lower than LAN. | Fault Tolerance of WAN is lower than both LAN and MAN. |
| Maintenance | Designing and maintaining LAN is easy and less costly than WAN. | Designing and maintaining WAN is complex and more costly than LAN. | Designing and maintaining WAN is complex and more costly than both LAN and MAN. |


LAN2
LAN1
WAN
City1
City2
Country2
MAN
City3
LAN3

# Protocols




*In computer networks, communication occurs between entities in different systems. However, two entities can not simply send bit streams to each other and expect to be understood.*

*For communication to occur, the entities must agree on a protocol. A protocol is a set of rules that govern data communications.*

*A protocol defines what is communicated, how it is communicated, and when it is communicated.*

***The key elements of a protocol are syntax, semantics, and timing.***

**Syntax** refers to the structure or format of the data, meaning the order in which they are presented. For example, a simple protocol might expect the first 8 bits of data to be the address of the sender, the second 8 bits to be the address of the receiver, and the rest of the stream to be the message itself.

**Semantics** refers to the meaning of each section of bits. How is a particular pattern to be interpreted, and what action is to be taken based on that interpretation? For example, does an address identify the route to be taken or the final destination of the message?

**Timing** refers to two characteristics: when data should be sent and how fast they can be sent. For example, if a sender produces data at 100 Mbps but the receiver can process data at only 1 Mbps, the transmission will overload the receiver and some data will be lost.

# Computer Network Models

# Network Models and Design

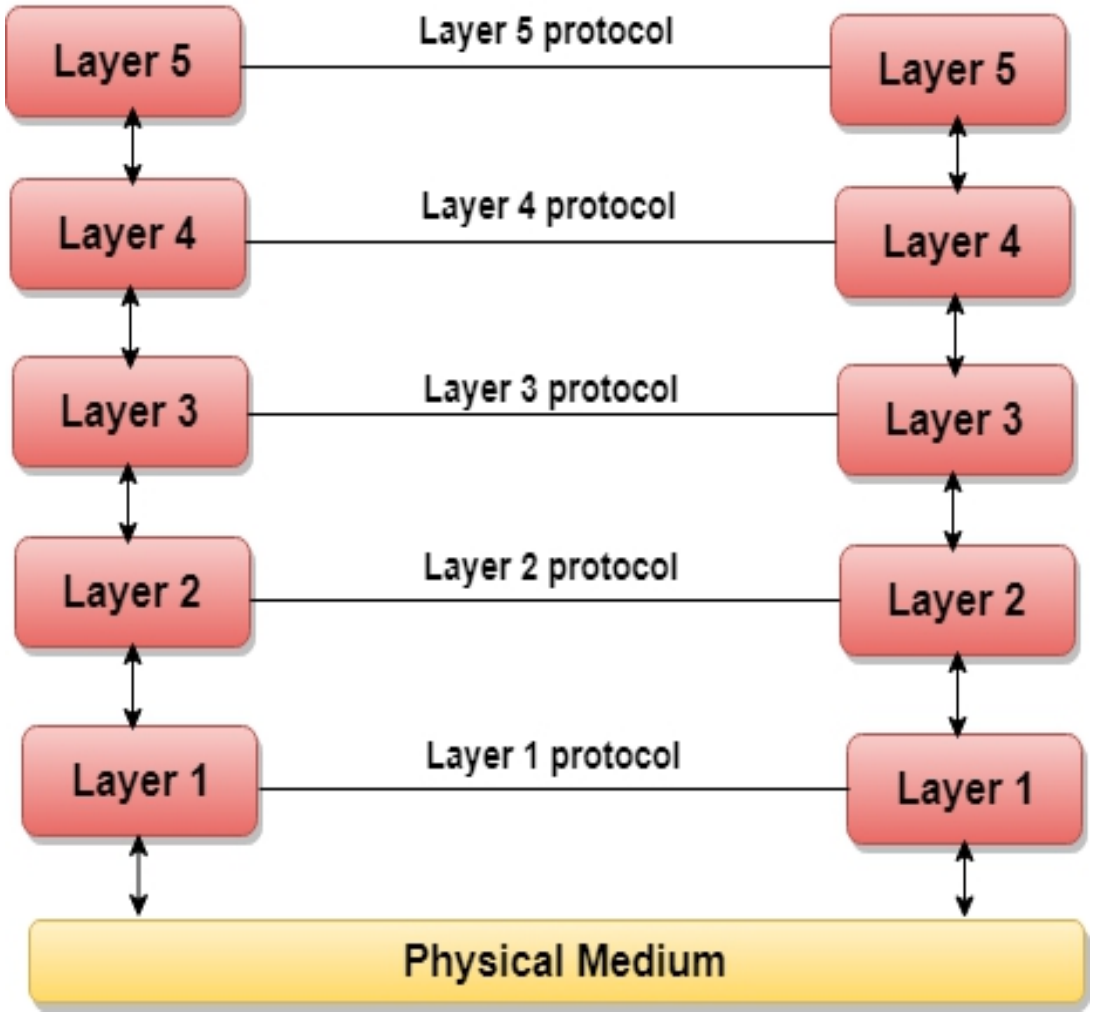
## Modelling the Design of Computer Networks for Effective Management

A communication subsystem is a complex piece of Hardware and software.

Early attempts for implementing the software for such subsystems were based on a single, complex, unstructured program with many interacting components.

The resultant software was very difficult to test and modify. To overcome such problem, the ISO has developed a layered approach.

In a layered approach, networking concept is divided into several layers, and each layer is assigned a particular task.



# Why do we require Layered architecture?

**Divide-and-conquer approach:** Divide-and-conquer approach makes a design process in such a way that the unmanageable tasks are divided into small and manageable tasks. In short, we can say that this approach reduces the complexity of the design.

**Modularity:** Layered architecture is more modular. Modularity provides the independence of layers, which is easier to understand and implement.

**Easy to modify:** It ensures the independence of layers so that implementation in one layer can be changed without affecting other layers.

**Easy to test:** Each layer of the layered architecture can be analyzed and tested individually.

# The OSI Model

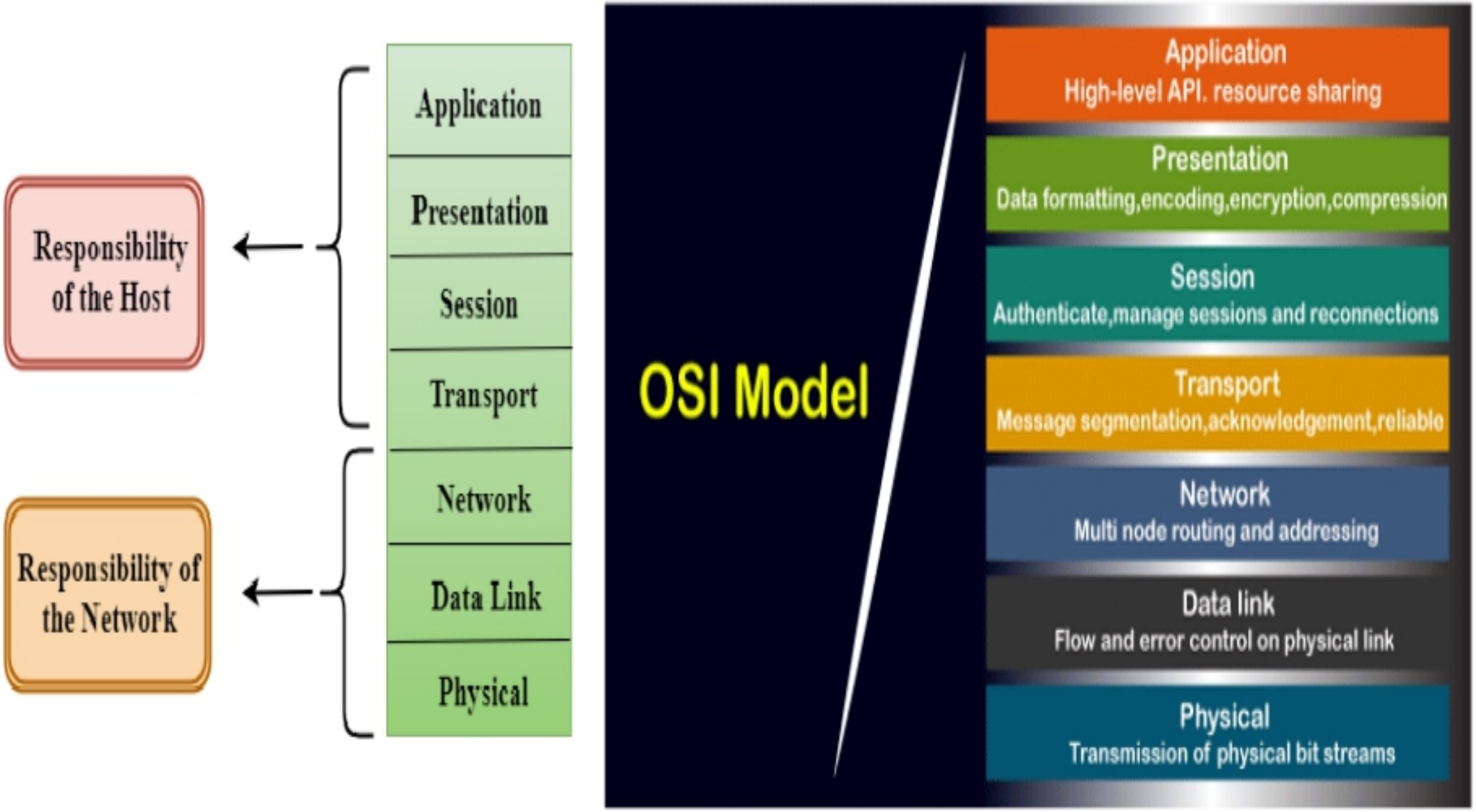
# OSI Model

**There are numbers of users who use computer network and are located over the world. So to ensure, national and worldwide data communication, systems must be developed which are compatible to communicate with each other.**

**ISO developed a standard. ISO stands for International organization of Standardization. This is called a model for Open System Interconnection (OSI) and is commonly known as OSI model.**

**The purpose of the OSI model is to show how to facilitate communication between different systems without requiring changes to the logic of the underlying hardware and software.**

**OSI consists of seven layers, and each layer performs a particular network function. OSI model divides the whole task into seven smaller and manageable tasks. Each layer is assigned a particular task.**


Responsibility of the Host
Application
Presentation
Session
Transport
Responsibility of the Network
Network
Data Link
Physical
OSI Model
Application
High-level API. resource sharing
Presentation
Data formatting,encoding,encryption,compression
Session
Authenticate,manage sessions and reconnections
Transport
Message segmentation,acknowledgement,reliable
Network
Multi node routing and addressing
Data link
Flow and error control on physical link
Physical
Transmission of physical bit streams

# Functions of a Physical layer:

- ***Line Configuration:*** **It defines the way how two or more devices can be connected physically.**

- ***Data Transmission:*** **It defines the transmission mode whether it is simplex, half-duplex or full-duplex mode between the two devices on the network.**

- ***Topology:*** **It defines the way how network devices are arranged.**

- ***Signals:*** **It determines the type of the signal used for transmitting the information.**

# Functions of the Data-link layer

- ***Framing:*** **The data link layer translates the physical's raw bit stream into packets known as Frames. The Data link layer adds the header and trailer to the frame. The header which is added to the frame contains the hardware destination and source address.**
- ***Physical Addressing:*** **The Data link layer adds a header to the frame that contains a destination address. The frame is transmitted to the destination address mentioned in the header.**
- ***Flow Control:*** **Flow control is the main functionality of the Data-link layer. It is the technique through which the constant data rate is maintained on both the sides so that no data get corrupted. It ensures that the transmitting station such as a server with higher processing speed does not exceed the receiving station, with lower processing speed.**
- ***Error Control:*** **Error control is achieved by adding a calculated value CRC (Cyclic Redundancy Check) that is placed to the Data link layer's trailer which is added to the message frame before it is sent to the physical layer. If any error seems to occur, then the receiver sends the acknowledgment for the re-transmission of the corrupted frames.**
- ***Access Control:*** **When two or more devices are connected to the same communication channel, then the data link layer protocols are used to determine which device has control over the link at a given time.**

# Functions of Network Layer:

- ***Internetworking:*** **An internetworking is the main responsibility of the network layer. It provides a logical connection between different devices.**

- ***Addressing:*** **A Network layer adds the source and destination address to the header of the frame. Addressing is used to identify the device on the internet.**

- ***Routing:*** **Routing is the major component of the network layer, and it determines the best optimal path out of the multiple paths from source to the destination.**

- ***Packetizing:*** **A Network Layer receives the packets from the upper layer and converts them into packets. This process is known as Packetizing. It is achieved by internet protocol (IP).**

# Functions of Transport Layer:

- ***Service-point addressing:*** **Computers run several programs simultaneously due to this reason, the transmission of data from source to the destination not only from one computer to another computer but also from one process to another process. The transport layer adds the header that contains the address known as a service-point address or port address. The responsibility of the network layer is to transmit the data from one computer to another computer and the responsibility of the transport layer is to transmit the message to the correct process.**

- ***Segmentation and reassembly:*** **When the transport layer receives the message from the upper layer, it divides the message into multiple segments, and each segment is assigned with a sequence number that uniquely identifies each segment. When the message has arrived at the destination, then the transport layer reassembles the message based on their sequence numbers.**

- ***Connection control:*** **Transport layer provides two services Connection-oriented service and connectionless service. A connectionless service treats each segment as an individual packet, and they all travel in different routes to reach the destination. A connection-oriented service makes a connection with the transport layer at the destination machine before delivering the packets. In connection-oriented service, all the packets travel in the single route.**

- ***Flow control:*** **The transport layer also responsible for flow control but it is performed end-to-end rather than across a single link.**

- ***Error control:*** **The transport layer is also responsible for Error control. Error control is performed end-to-end rather than across the single link. The sender transport layer ensures that message reach at the destination without any error.**

# Functions of Session layer:

- ***Dialog control:*** **Session layer acts as a dialog controller that creates a dialog between two processes or we can say that it allows the communication between two processes which can be either half-duplex or full-duplex.**

- ***Synchronization:*** **Session layer adds some checkpoints when transmitting the data in a sequence. If some error occurs in the middle of the transmission of data, then the transmission will take place again from the checkpoint. This process is known as Synchronization and recovery.**

# Functions of Presentation layer:

- ***Translation:*** **The processes in two systems exchange the information in the form of character strings, numbers and so on. Different computers use different encoding methods, the presentation layer handles the interoperability between the different encoding methods. It converts the data from sender-dependent format into a common format and changes the common format into receiver-dependent format at the receiving end.**

- ***Encryption:*** **Encryption is needed to maintain privacy. Encryption is a process of converting the sender-transmitted information into another form and sends the resulting message over the network.**

- ***Compression:*** **Data compression is a process of compressing the data, i.e., it reduces the number of bits to be transmitted. Data compression is very important in multimedia such as text, audio, video.**

# Functions of Application layer:

- ***File transfer, access, and management:*** **An application layer allows a user to access the files in a remote computer, to retrieve the files from a computer and to manage the files in a remote computer.**

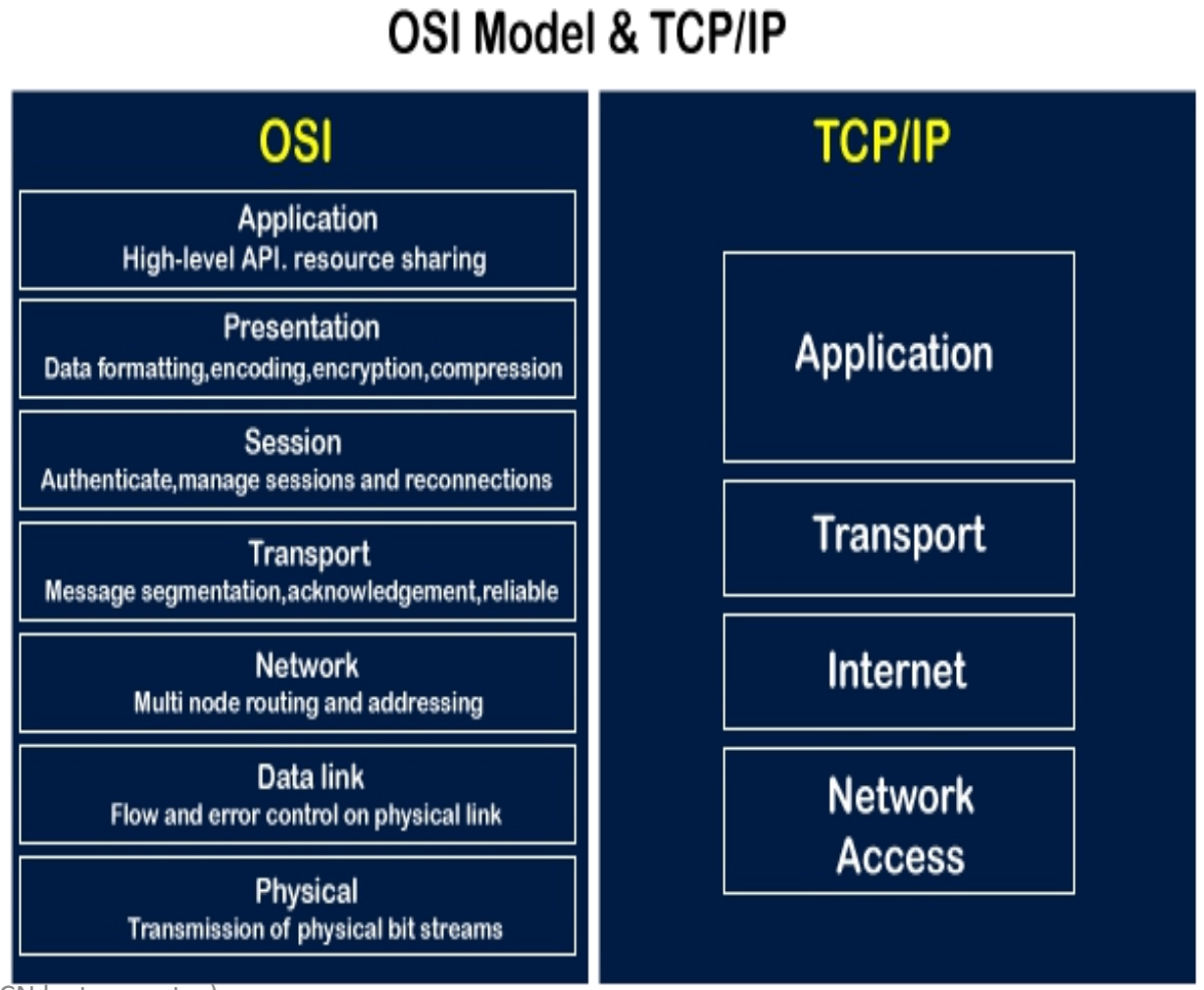
- ***Mail services:*** **An application layer provides the facility for email forwarding and storage.**

- ***Directory services:*** **An application provides the distributed database sources and is used to provide that global information about various objects.**

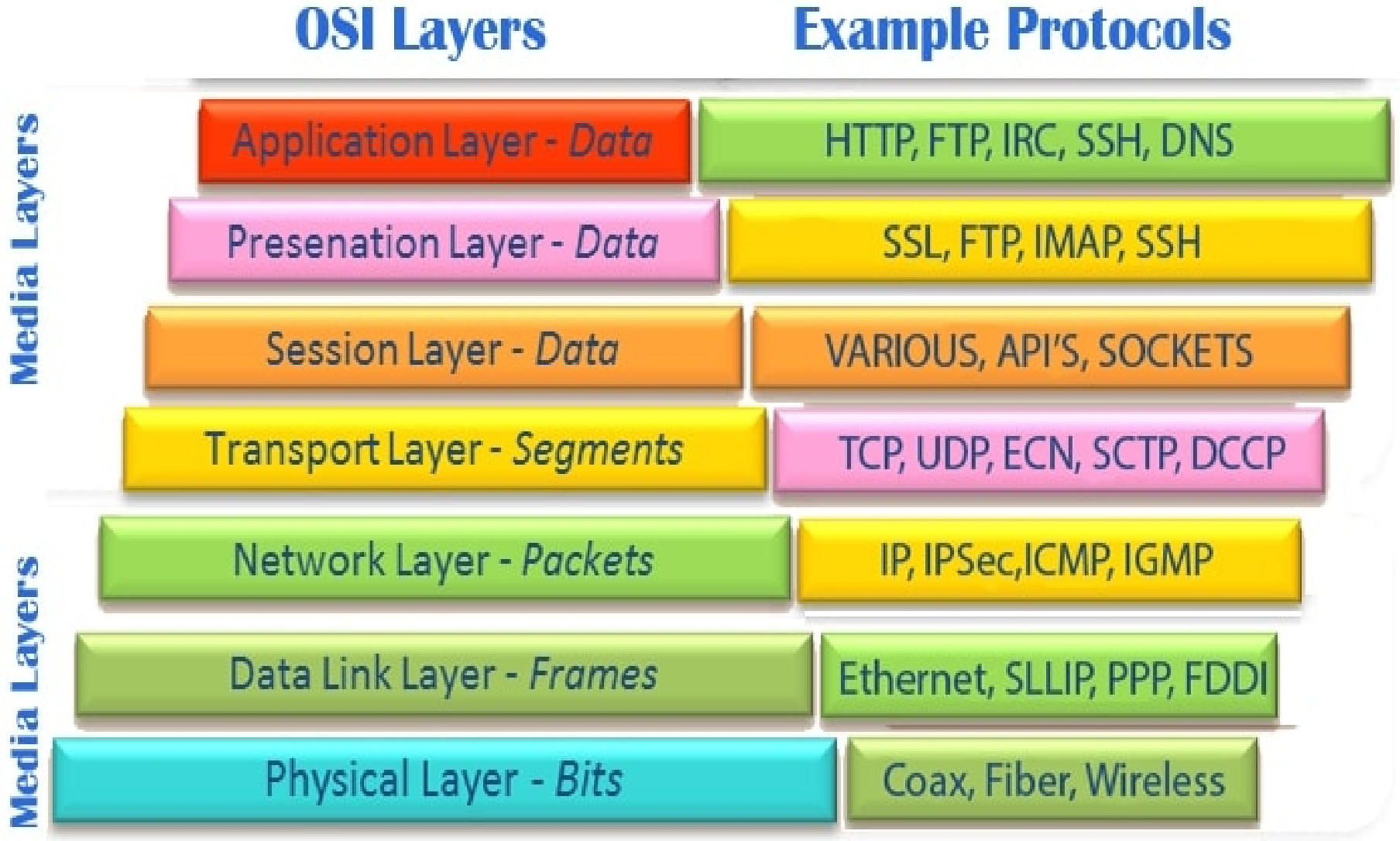
# TCP/IP model

❖ *TCP/IP means Transmission Control Protocol and Internet Protocol. It is the network model used in the current Internet architecture as well.*

- **The TCP/IP model was developed prior to the OSI model.**
- **The TCP/IP model consists of four layers: the application layer, transport layer, Internet layer, network access layer.**
- **TCP/IP is a hierarchical protocol made up of interactive modules, and each of them provides specific functionality.**



| TCP/IP | OSI |
| --- | --- |
| TCP refers to Transmission Control Protocol. | OSI refers to Open Systems Interconnection. |
| TCP/IP has 4 layers. | OSI has 7 layers. |
| TCP/IP is more reliable | OSI is less reliable |
| TCP/IP does not have very strict boundaries. | OSI has strict boundaries |
| TCP/IP follow a horizontal approach. | OSI follows a vertical approach. |
| TCP/IP uses both session and presentation layer in the application layer itself. | OSI uses different session and presentation layers. |
| TCP/IP developed protocols then model. | OSI developed model then protocol. |
| Transport layer in TCP/IP does not provide assurance delivery of packets. | In OSI model, transport layer provides assurance delivery of packets. |
| TCP/IP model network layer only provides connection less services. | Connection less and connection oriented both services are provided by network layer in OSI model. |
| Protocols cannot be replaced easily in TCP/IP model. | While in OSI model, Protocols are better covered and is easy to replace with the change in technology. |


OSI Layers
Example Protocols
Media Layers
Application Layer - Data
HTTP, FTP, IRC, SSH, DNS
Presenation Layer - Data
SSL, FTP, IMAP, SSH
Session Layer - Data
VARIOUS, API'S, SOCKETS
Transport Layer - Segments
TCP, UDP, ECN, SCTP, DCCP
Media Layers
Network Layer - Packets
IP, IPSec,ICMP, IGMP
Data Link Layer - Frames
Ethernet, SLLIP, PPP, FDDI
Physical Layer - Bits
Coax, Fiber, Wireless

# Delays in Computer Network

**Transmission Delay:** The time taken to transmit a packet from the host to the transmission medium is called Transmission delay.

Let B bps is the bandwidth and L bit is the size of the data
then transmission delay is, `Tt = L/B`

**Propagation delay:** After the packet is transmitted to the transmission medium, it has to go through the medium to reach the destination. Hence the time taken by the last bit of the packet to reach the destination is called propagation delay.

```
Tp = Distance / Velocity
```

**Queueing delay:** After packet reaches destination, it will not be processed by the destination immediately. It has to wait in queue in something called as buffer. So the amount of time it waits in queue before being processed is called queueing delay.

**Processing delay:** Time taken to process the data packet by processor that is time required by intermediate routers to decide where to forward the packet, update TTL, perform header checksum calculations.

***Both queueing delay and processing delay doesn't have any formula because they depend on the speed of the processor***

```
Ttotal = Tt + Tp + Tq + Tpro


Ttotal = Tt+Tp
(when taking Tq and Tpro equals to 0)
```

# Switching in Computer Networks

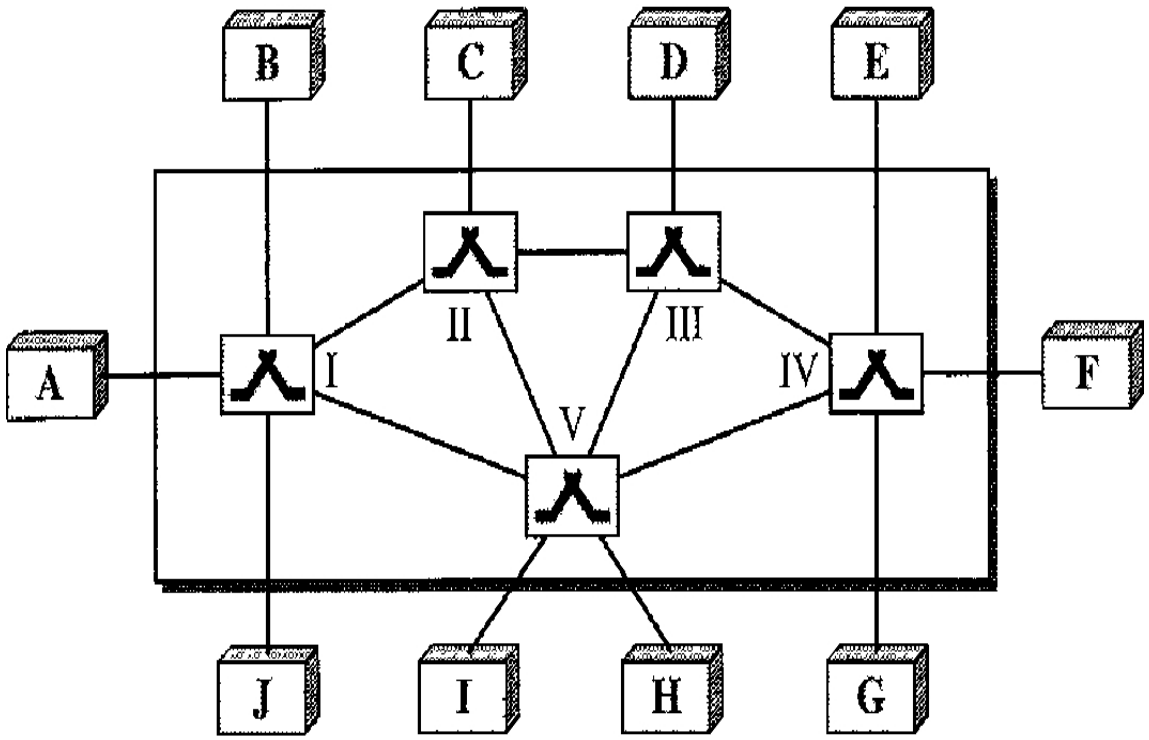
- Whenever we have multiple devices, we have the problem of how to connect them to make one-to-one communication possible.
- One solution is to make a point-to-point connection between each pair of devices (a mesh topology) or between a central device and every other device (a star topology). These methods, however, are impractical and wasteful when applied to very large networks.
- The number and length of the links require too much infrastructure to be cost-efficient, and the majority of those links would be idle most of the time.
- Other topologies employing multipoint connections, such as a bus, are ruled out because the distances between devices and the total number of devices increase beyond the capacities of the media and equipment.

**Solution is Switching**

*A switched network consists of a series of interlinked nodes, called switches.*

*Switches are devices capable of creating temporary connections between two or more devices linked to the switch.*

*In a switched network, some of these nodes are connected to the end systems (computers or telephones, for example). Others are used only for routing.*




**The end systems (communicating devices) are labeled A, B, C, D, and so on, and the switches are labeled I, II, III, IV, and V. Each switch is connected to multiple links.**

## Why is Switching Concept required?

**Bandwidth:** It is defined as the maximum transfer rate of a cable. It is a very critical and expensive resource. Therefore, switching techniques are used for the effective utilization of the bandwidth of a network.

**Collision:** Collision is the effect that occurs when more than one device transmits the message over the same physical media, and they collide with each other. To overcome this problem, switching technology is implemented so that packets do not collide with each other.

## Advantages

- Switch increases the bandwidth of the network.
- It reduces the workload on individual PCs as it sends the information to only that device which has been addressed.
- It increases the overall performance of the network by reducing the traffic on the network.
- There will be less frame collision as switch creates the collision domain for each connection.

## Disadvantages

- A Switch is more expensive than network bridges.
- A Switch cannot determine the network connectivity issues easily.
- Proper designing and configuration of the switch are required to handle multicast packets.

**In large networks, there can be multiple paths from sender to receiver. The switching technique will decide the best route for data transmission.**

# Circuit Switching

- ✓ **It is a switching technique that establishes a dedicated path between sender and receiver. Circuit switching takes place at the physical layer.**
- ✓ **Once the connection is established then the dedicated path will remain to exist until the connection is terminated.**
- ✓ **Circuit switching in a network operates in a similar way as the telephone works.**
- ✓ **A complete end-to-end path must exist before the communication takes place.**
- ✓ **In case of circuit switching technique, when any user wants to send the data, voice, video, a request signal is sent to the receiver then the receiver sends back the acknowledgment to ensure the availability of the dedicated path. After receiving the acknowledgment, dedicated path transfers the data.**

**3 phases:**

1) Circuit establishment (a dedicated circuit which is a combination of channels in links needs to be established.)
2) Data transfer (After the establishment ofthe dedicated circuit (channels), the two parties can transfer data.)
3) Circuit Disconnect (When one of the parties needs to disconnect, a signal is sent to each switch to release the resources.)

**Advantages**

The communication channel is dedicated & has fixed bandwidth.

**Disadvantages**

It takes a long time to establish a connection approx 10 seconds during which no data can be transmitted.

It is more expensive than other switching techniques as a dedicated path is required for each connection.

It is inefficient to use because once the path is established and no data is transferred, then the capacity of the path is wasted.

# Formulas for Circuit Switching

Total time taken to transmit a message in circuit switched network

= Connection set up time + Transmission delay + Propagation delay + Tear down time

where-

- Transmission delay = Message size / Bandwidth
- Propagation delay = (Number of hops on way x Distance between 2 hops) / Propagation speed

```
Transmission rate = Link Rate or Bit rate /
                    no. of slots = R/h bps
Transmission time = size of file /
                    transmission rate
                  = x / (R/h) = (x*h)/R second
Total time to send packet to destination =
                Transmission time + circuit setup time
```

**Problem:**
Consider all links in the network use TDM with 24 slots and have a data rate of 1.536 Mbps. Assume that host A takes 500 msec to establish an end to end circuit with host B before begin to transmit the file. If the file is 512 kilobytes, then how much time will it take to send the file from host A to host B?

**Solution:**
Given-
Total bandwidth = 1.536 Mbps
Bandwidth is shared among 24 slots
Connection set up time = 500 msec
File size = 512 KB

Total bandwidth = Number of users x Bandwidth per user
So, Bandwidth per user
= Total bandwidth / Number of users
= 1.536 Mbps / 24
= 0.064 Mbps
= 64 Kbps

Transmission delay (Tt)
= File size / Bandwidth
= 512 KB / 64 Kbps
= (512 x 210 x 8 bits) / (64 x 103 bits per sec)
= 65.536 sec
= 65536 msec

**Time taken to send a file in circuit switched network**
= Connection set up time + Transmission delay
= 500 msec + 65536 msec
= 66036 sec
= 66.036 msec

**Example 2 :** How long it takes to send a file of 'x bits' from host A to host B over a circuit switched network that uses TDM with 'h slots' and have a bit rate of 'R Mbps', circuit establish time is k seconds.Find total time?

**Explanation :**

Transmission rate = Link Rate or Bit rate / no. of slots = R/h bps

Transmission time = size of file/ transmission rate = x / (R/h) = (x*h)/R

Total time = transmission time + circuit setup time = (x*h)/R secs + k secs

# Packet Switching

- ✓ **Here message is sent in one go, but it is divided into smaller pieces, and they are sent individually.**
- ✓ **The message splits into smaller pieces known as packets and packets are given a unique number to identify their order at the receiving end.**
- ✓ **Every packet contains some information in its headers such as source address, destination address and sequence number.**
- ✓ **Packets will travel across the network, taking the shortest path as possible.**
- ✓ **All the packets are reassembled at the receiving end in correct order. If any packet is missing or corrupted, then the message will be sent to resend the message.**
- ✓ **If the correct order of the packets is reached, then the acknowledgment message will be sent.**

**Advantages**

*Cost-effective:* In packet switching technique, switching devices do not require massive secondary storage to store the packets, so cost is minimized to some extent.

*Reliable:* If any node is busy, then the packets can be rerouted.

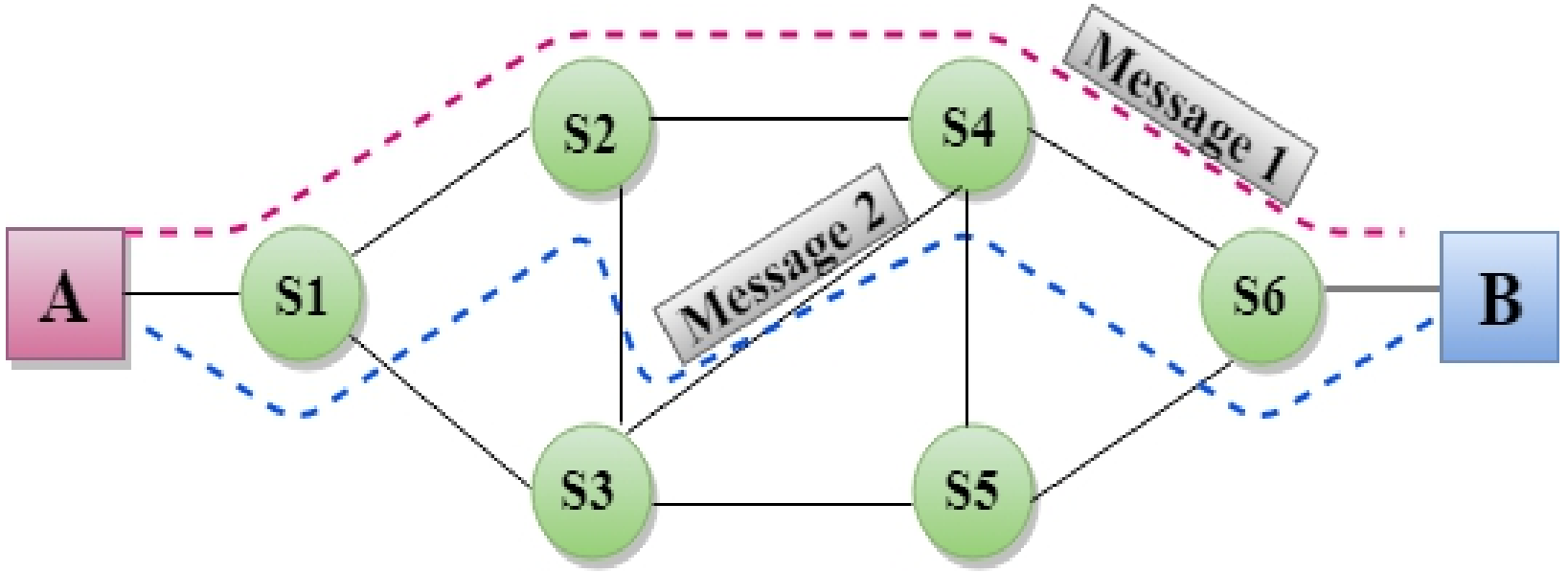
*Efficient:* It does not require any established path prior to the transmission, and many users can use the same communication channel simultaneously, hence makes use of available bandwidth very efficiently.

**Disadvantages**

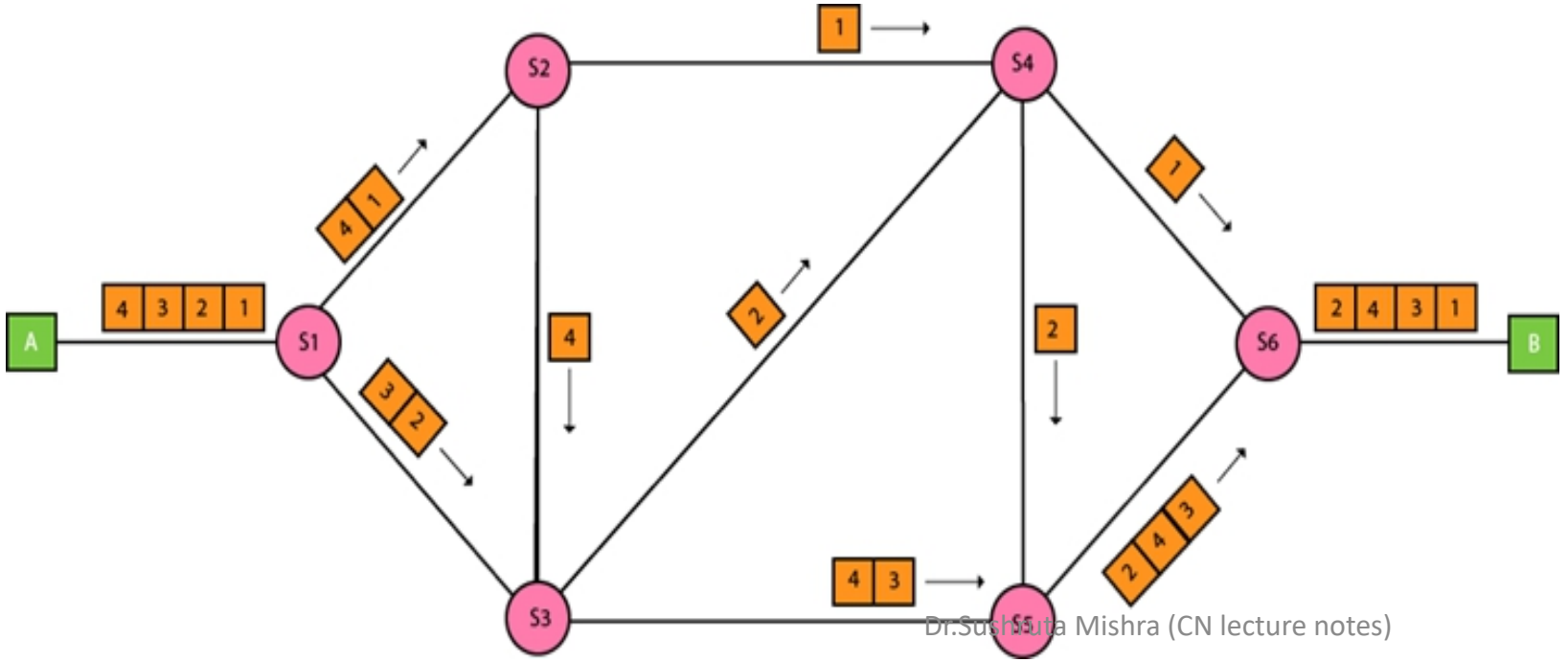
Packet Switching technique cannot be implemented in those applications that require low delay and high-quality services.

The protocols used in a packet switching technique are very complex and requires high implementation cost.

If the network is overloaded or corrupted, then it requires retransmission of lost packets. It can also lead to the loss of critical information if errors are nor recovered.



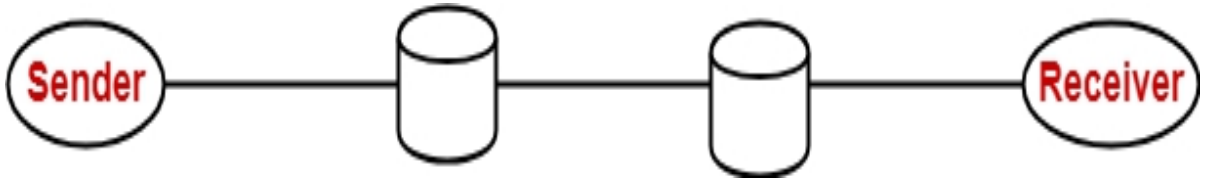

# Circuit Switching




# Packet Switching

**Consider-**

**There is a network having bandwidth of 1 MBps.**
**A message of size 1000 bytes has to be sent.**
**Packet switching technique is used.**
**Each packet contains a header of 100 bytes.**




**Find the total time taken if in 10 packets the message must be divided.**

Data sent in one packet
= Total data to be sent / Number of packets
= 1000 bytes / 10
= 100 bytes

Packet size
= 100 bytes of data + 100 bytes of header
= 200 bytes

Transmission delay
= Packet size / Bandwidth
= 200 bytes / 1 MBps
= 200 x 10-6 sec
= 200 µsec = 0.2 msec

Time taken by the first packet to reach from sender to receiver
= 3 x Transmission delay
= 3 x 0.2 msec
= 0.6 msec

Time taken by the remaining packets to reach from sender to receiver
= Number of remaining packets x Transmission delay
= 9 x 0.2 msec
= 1.8 msec

Total time taken to send the complete message from sender to receiver
= 0.6 msec + 1.8 msec
= 2.4 msec

| Circuit Switching | Packet Switching |
| --- | --- |
| In circuit switching there are 3 phases:<br>i) Connection Establishment.<br>ii) Data Transfer.<br>iii) Connection Released. | In Packet switching directly data transfer takes place . |
| In circuit switching, each data unit know the entire path address which is provided by the source. | In Packet switching, each data unit just know the final destination address intermediate path is decided by the routers. |
| In Circuit switching, data is processed at source system only | In Packet switching, data is processed at all intermediate node including source system. |
| Delay between data units in circuit switching is uniform. | Delay between data units in packet switching is not uniform. |
| Resource reservation is the feature of circuit switching because path is fixed for data transmission. | There is no resource reservation because bandwidth is shared among users. |
| Circuit switching is more reliable. | Packet switching is less reliable. |
| Wastage of resources are more in Circuit Switching | Less wastage of resources as compared to Circuit Switching |
| It is not a store and forward technique. | It is a store and forward technique. |
| Transmission of the data is done by the source. | Transmission of the data is done not only by the source, but also by the intermediate routers. |
| Congestion can occur during connection establishment time, there might be a case will requesting for channel the channel is already occupied. | Congestion can occur during data transfer phase, large number of packets comes in no time. |
| Circuit switching is not convenient for handling bilateral traffic. | Packet switching is suitable for handling bilateral traffic. |
| In Circuit switching, charge depend on time and distance, not on traffic in the network. | In Packet switching, charge is based on the number of bytes and connection time. |

# END