# UNIT – 1

COMPUTER NETWORKS :- A Network is a set of devices or nodes connected by media links.A node can be a computer, printer,scanner,VoIP phone etc.Computer network means an interconnected collection of autonomous computers.Computer networks are generally organized as a series of layers or levels.

Factors like Performance,Reliability,Security etc are highly significant in network communication.

A popular example of a computer network is the Internet, which allows millions of users toshare information.

## Advantages of Computer Networks

 File Sharing: Networks offer a quick and easy way to share files directly.

 Resource Sharing: All computers in the network can share resources such as printers, fax machines, modems and scanners.

 Communication: Those on the network can communicate with each other via e-mail, instant messages etc.

Flexible Access: Networks allow their users to access files from computers throughout the network.

 Sharing of Information: Computer networks enable us to share data and information with the computers that are located geographically large distance apart.

## Uses of Computer Network

- Simultaneous Access
- Shared Peripheral Devices
- Personal Communication
- Easier Backup

•*companies & organisations:-*

• resource sharing: programs, equipment, data…

• high reliability: multiple processors/links/file copies/...

• scalability: gradually improve system performance

• rapid communications & remote cooperation

• saving money

•*private individuals:-*

• access to remote & diverse information sources
• communicating with other people
• entertainment
• education, healthcare, access to government...

# benefits of computer network.

- Resource sharing
- Powerful communication medium
- Higher reliability
- Higher flexibility
- Lower cost
- Incremental expansion

## NETWORK HARDWARE :-

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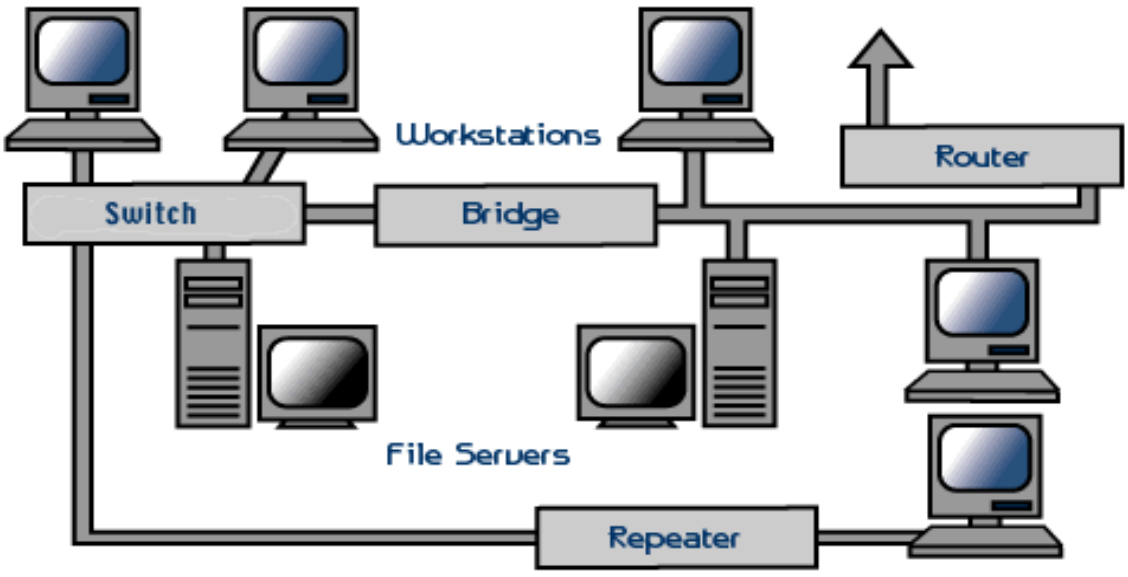



## Networking Hardware:-

- Network Interface Card
- Hub

• Repeater
• Bridge
• Switch
• Gateway

- ***transmission technology:-***

## • broadcast networks:

single communication channel **shared**
by all network nodes
• can send to: one node, all nodes, (maybe) group of nodes
• address field in message specifies receiver(s)

## • point-to-point networks:

many possible connection paths
between any pair of nodes
• message may have to pass through intermediate nodes on the way from sender to receiver
• usually, need a **routing algorithm** to decide ***if*** a path exists from sender to receiver, and -- if multiple such paths exist -- ***which one(s)*** to use

# Introduction to OSI Model:-

The Open System Interconnection (OSI) reference model describes how information from a software application in one computer moves through a network medium to a software application in another computer. The OSI reference model is a conceptual model composed of seven layers, each specifying particular network functions. The model was developed by the International Standardization Organization (ISO) in 1984, and it is now considered the primary architectural model for inter-computer communications.

- OSI model is based on the proposal developed by the International Standards Organization (ISO).
- This model is called ISO OSI (Open Systems Interconnection) Reference model because it deals with connecting open systems (systems that are open for communication with other systems)
- We call it as OSI Model.

# Principles on which OSI model was designed:-

- A layer should be created where different level of abstraction is needed.

•Each layer should perform a well defined function.

•The function of each layer should be chosen according to the internationally standardized protocols.

•The number of layers should be large enough that distinct functions should not be put in the same layer and small enough that the architecture does not become very complex.

## The seven layers are:-

**OSI Layers** (Open Systems Interconnect model)

1. Physical - transmits raw data
2. Data Link - checks data, frames, etc.
3. Network - controls subnet, routing
4. Transport - splits data, passes to network
5. Session - manages dialog, synchronizes
6. Presentation - syntax, semantics
7. Application - virtual terminal software


## The OSI Reference Model includes seven layers. Basic functionality of each of them is as follows:-

**1. Physical Layer:** Controls the transmission of the actual data onto the network cable. It defines the
electrical signals, line states and encoding of the data and the connector types used. An example is 10BaseT.

**2. Data-Link Layer:** This layer takes the data frames or messages from the Network Layer and provides for their actual transmission. At the receiving computer, this layer receives the incoming
data and sends it to the network layer for handling. The Data-Link Layer also provides error-free delivery of data between the two computers by using the physical layer. It does this by packaging the
data from the Network Layer into a frame, which includes error detection information. At the receiving computer, the Data-Link Layer reads the incoming frame, and generates its own error detection information based on the received frames data. After receiving the entire frame, it then compares its error detection value with that of the incoming frames, and if they match, the frame has
been received correctly.

**3. Network Layer:** This is responsible for addressing messages and data so they are sent to the correct destination, and for translating logical addresses and names (like a machine name FLAME)
into physical addresses. This layer is also responsible for finding a path through the network to the
destination computer.

**4. Transport Layer:** Ensures that data is delivered error free, in sequence and with no loss, duplications or corruption. This layer also repackages data by assembling long messages into lots of
smaller messages for sending, and repackaging the smaller messages into the original larger message
at the receiving end.

**5. Session Layer**: Allows two applications to establish, use and disconnect a connection between them called a session. Provides for name recognition and additional functions like security, which are
needed to allow applications to communicate over the network.

**6. Presentation Layer:** Determines the format used to exchange data among networked computers.

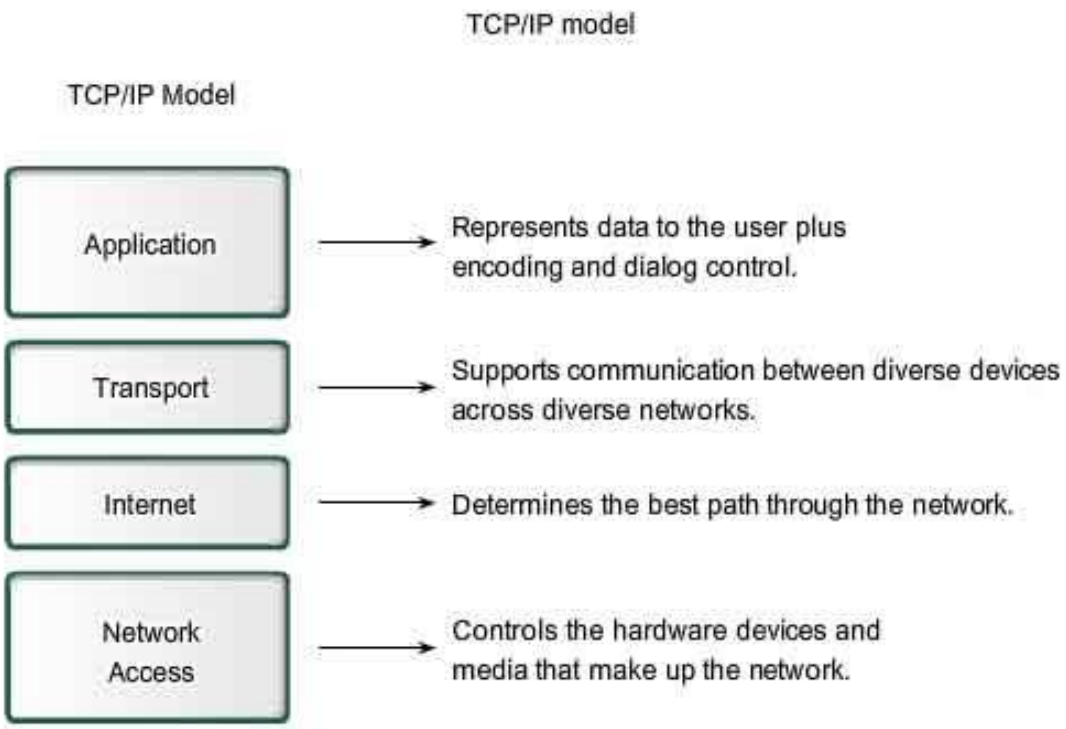
**7. Application Layer:** Provides Applications with access to network services

# Introduction to TCP/IPModel:-

•The current Internet is based on a TCP/IP reference model.

•TCP and IP are two protocols of this model. TCP stands for Transmission Control Protocol and IP stands for Internet Protocol.

•The architecture or model was defined by the US department of defense and is used by ARPANET (Advanced Research Project Agency Network).




# Goals on which TCP/IP model was designed:-

•The network should connect multiple networks together.

•The connection should withstand till the source and destination machines are functioning.

•The architecture should be so flexible that it should be able to transfer data among different hardware or software platforms.

# Comparison between OSI and TCI/IP :-

| OSI | TCP/IP |
|---|---|
| OSI stands for OpenSystem Interconnection because it allows any two different systems to communicate regardless of their architecture. | TP/IP stands for Transmission Control Protocol/Internet Protocol. It is named after these protocols, being part of this model. |
| OSI model has seven layers. | TCP/IPhas four layers. |
| This model providesclear distinction between services, interfaces and protocols | It does not clearly distinguish between services, interfaces & protocols. |
| In this model,Protocols do not fit well into the model. | TCP and IP protocols fit well in the model. |
| Session & Presentation layers are present in this layer. | There is no session & presentation layer in this model. |
| OSI model supports both connection oriented & connectionless in network layer but connection oriented comm.In transport layer. | TCP/IP supports only connectionless comm. In network layer but supports both in transport layer. |

# Categories of Networks :-

- **Local Area Network**
- **Metropolitan Area Network**
- **Wide Area Network**
- **Internet-work (internet)•Internet**
- **Intranet**

Local Area Network are privately owned networks with in a single building or a campus.Metropolitan Area Network is basically a bigger version of a LAN that is it covers various offices of a company in a city. Wide Area Network covers a large geographical country or a continent area , a.

Internet-work(internet) is the connection of two or more networks. The internet is an example for Internet-work.

The most prominent internet is the Internet(Uppercase letter I) is a collection of more than hundreds of thousands inter connected networks.

Intranet is a private network that is contained with in an enterprise.Intranet may consist of many interlinked Local Area Networks.

History of Computer Network

In the 1960's Computers from different manufactures were unable to communicate with one another. The advanced Research Project Agency(ARPA) in the Department of Defense (DOD) has taken interest in connecting computers so that the computers can communicate with one another.

In 1967 ARPA came up with its ideas for ARPANET a small network of connected computers. It suggest that each host computer(from any manufacturer)would be attached to a specialized computer called an Interface Message Processor(IMP).The IMP's inturn connected to other IMP's also.That is the IMP's can communicate with other IMP's as well as with its own attached hosts.

In 1969 the ARPANET has become a reality. Software called Network Control protocol(NCP) provided communication between hosts using IMP's.

In 1972 two core members of the ARPANET group collaborated on a project called Internetting project.And in 1973 they outlined the protocols for the end-to-end delivery of packets(Transmission control protocol :TCP).

Later the authorities decided to split TCP into two protocols:Tranmission control protocol(TCP) and Internet Protocol(IP).

## Network Topologies:-

Network Topology Refers to the way a network is laid out either physically or logically.Network Topology can be viewed as a geometric representation of all the links in a network.

- Mesh Topology
- Star Topology
- Tree Topology
- Bus Topology
- Ring Topology
- Hybrid Topology

•In Mesh topology every node has a dedicated point to point link to every other node.

•In star topology each device has a dedicated point-to-point link only to a central controller, usually called a hub.The devices are not directly linked together.

•In Tree topology nodes in a tree are linked to a central hub.Not every device connect directly to the central hub.Nodes can also connect to a secondary hub that in turn connect to the central hub.

•In Bus topology one cable acts as a backbone to link all the nodes in the network.

•In Ring topology each node has a dedicated point-to-point link on either side of it.

•Hybrid topology is a combination of several topologies of sub-networks linked together in the large topology. Different topologies are connected to each other via star topology

**Connection-oriented** :-

communication includes the steps of setting up a call from one computer to another, transmitting/receiving data, and then releasing the call, just like a voice phone call. However, the network connecting the computers is a packet switched network, unlike the phone system's circuit switched network. Connection-oriented communication is done in one of two ways over a packet switched network: with and without virtual circuits.

***Without virtual circuits****:* This is what TCP does in the Internet. The only two machines in the Internet that are aware a connection is established are the two computers at the endpoints. The Internet itself--its routers and links--have no information about the presence of a connection between the two computers. This means that all of the packets flowing between the two computers can follow different routes. One benefit of establishing the connection is that the flow of packets from the source to the destination can be slowed down if the Internet is congested and speeded up when congestion disappears. Another benefit is that the endpoints can anticipate traffic between them, and agree to cooperate to ensure the integrity and continuity of the data transfers. This allows the network to be treated as a "stream" of data, as we will study later.

***Virtual circuit:*** This is not used in the Internet, but is used in other types of networks (eg. the "X.25" protocol, still popular in Europe). The routers within the network route all packets in one connection over the same route. The advantage is that video and voice traffic are easier to carry, because routers can reserve memory space to buffer the transmission.

***Connectionless:-***

**Connectionless** communication is just packet switching where no call establishment and release occur. A message is broken into packets, and each packet is transferred separately. Moreover, the packets can travel different route to the destination since there is no connection. Connectionless service is typically provided by the **UDP (User Datagram Protocol)**, which we will examine later. The packets transferred using UDP are also called **datagrams**.

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**Comparison between Connection-oriented and Connectionless Communication**

| Feature | Connectionless | Connection-oriented |
|---|---|---|
| How is data sent? | one packet at a time | as continuous stream of packets |
| Do packets follow same route? | no | virtual circuit: yes<br>without virtual circuit: no |
| Are resources reserved in network? | no | virtual circuit: yes<br>without virtual circuit: no |
| Are resources reserved in communicating hosts? | no | yes |
| Can data sent can experience variable latency? | yes | yes |
| Is connection establishment done? | no | yes |
| Is state information stored at network nodes? | no | virtual circuit: yes<br>without virtual circuit: no |

| | | |
|---|---|---|
| What is impact of node/switch crash? | only packets at node are lost | all virtual circuits through node fail |
| What addressing information is needed on each packet? | full source and destination address | virtual circuit: a virtual circuit number<br>without virtual circuit: full source and destination address |
| Is it possible to adapt sending rate to network congestion? | hard to do | virtual circuit: easy if sufficient buffers allocated<br>without virtual circuit: harder to do |

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# difference between full duplex and half duplex:-

| Full-duplex | Half-duplex |
|---|---|
| A connection that allow traffic either a way but only one way at a time is called half-duplex. | A connection that allow traffic in both direction simultaneously is called uplex. |
| In half-duplex mode the communication is from one side at a time. | In full-duplex mode the communication is from both side simultaneously |
| Half-duplex channel can either sendiang or receiving at a time | Full-duplex channel can both send and receive at a time |
| A method of using a communication channel in which a signal can be transmitted simultaneously in both directions between source and destination. | It is a method of using a communication channel in which a signal can be transmitted in both directions between source and destination, but at a time only in one direction it must wait for the transmitter to stop transmitting, before replying |
| Examples: Telephone, Mobile Phone, etc. | Examples:walki-talki the cops use |

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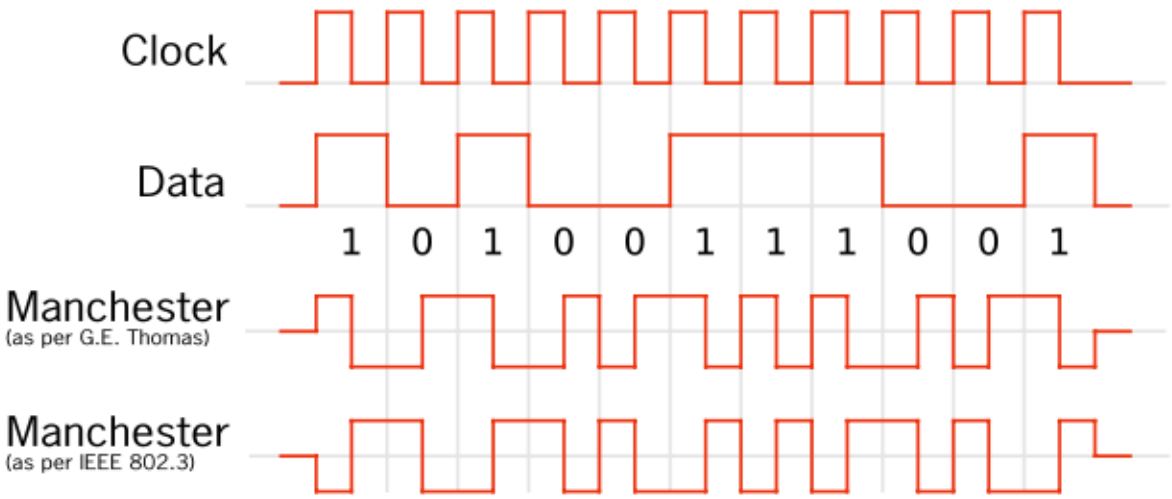
## Manchester Encoding:-

In a Manchester encoding, the transition at the middle of the bit is used for both synchronization and bit representation

In a differential Manchester encoding, the transition at the middle of the bit is used only for synchronization.

The bit is representation is define dy the inversion of noninversion at the beginning of the bit.

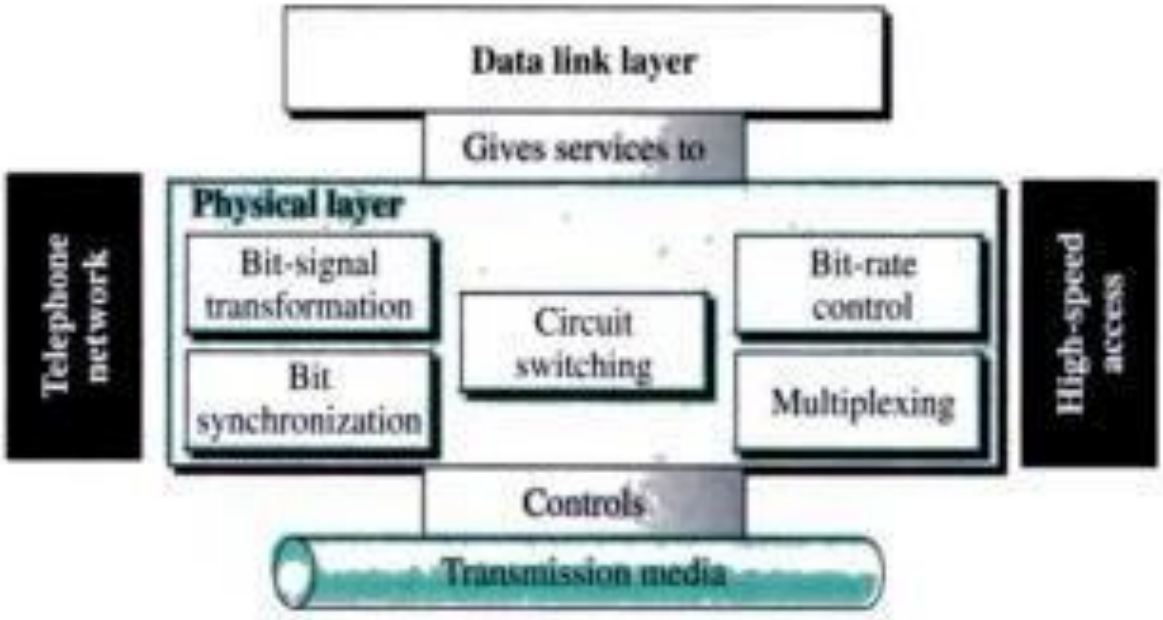
In bipolar encoding, we use tree levels:- positive, zero, and negative



## Physical layer:-

We start the discussion of the Internet model with the bottom-most layer, the physical layer. It is the layer that actually interacts with the transmission media, the physical part of the network that connects network components together. This layer is involved in physically carrying information from one node in the network to the next. Figure 1 shows the position of the physical layer in the 5-layer Internet model.

**Figure 1** *Position of the physical layer*



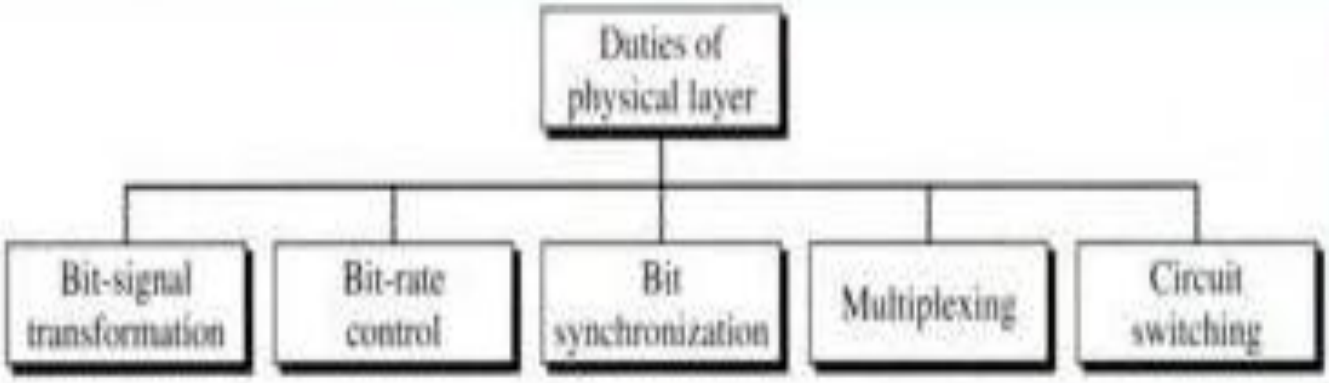
The physical layer has complex tasks to perform. One major task is to provide services for the data link layer. The data in the data link layer consists of 0s and 1s organized into frames that are ready to be sent across the transmission medium. This stream of 0s and 1s must first be converted into another entity: signals. One of the services provided by the physical layer is to create a signal that represents this stream of bits.

The physical layer must also take care of the physical network, the transmission medium. The transmission medium is a passive entity; it has no internal program or logic for control like other layers. The transmission medium must be controlled by the physical layer. The physical layer decides on the directions of data flow. The physical layer decides on the number of logical channels for transporting data coming from different sources.

## Services

The physical layer transfers a stream of bits (in the form of a signal) from the sender to the receiver. The transfer is node-to-node, from one node to the next. The physical layers of the two adjacent nodes provide a logical pipe through which the bits can travel. Figure 2 shows the general services offered by the physical layer.

**Figure 2** *Physical layer services*




## *Bit-to-Signal Transformation*

The logical pipe under the physical layer is the transmission media (cable or air). Since a transmission medium cannot carry bits, we need to represent the bits by a signal, electromagnetic energy that can propagate through a medium.

## *Bit-Rate Control*

Although the transmission medium determines the upper limit of the data rate, the physical layer is the controller. The design of the physical-layer hardware and software determine the data rate.

## *Bit-Synchronization*

The timing of the bit transfer is crucial in data communications. The physical layer governs the synchronization of the bits by providing clocking mechanisms that control both the sender and the receiver.

## *Multiplexing*

Multiplexing is the process of dividing a link, the physical medium, into logical channels for better efficiency. The physical layer, using different techniques, can do this. Although the medium itself is not actually changed, the result is several channels instead of one. Multiplexing defined in this section of the text is needed to understand access methods in later chapters.

## *Switching*

Switching in data communications can be done in several layers. We have circuit-switching, packet-switching, and message switching. Circuit switching, a method that allows two nodes to have a dedicated link, is mostly a function of the physical layer.