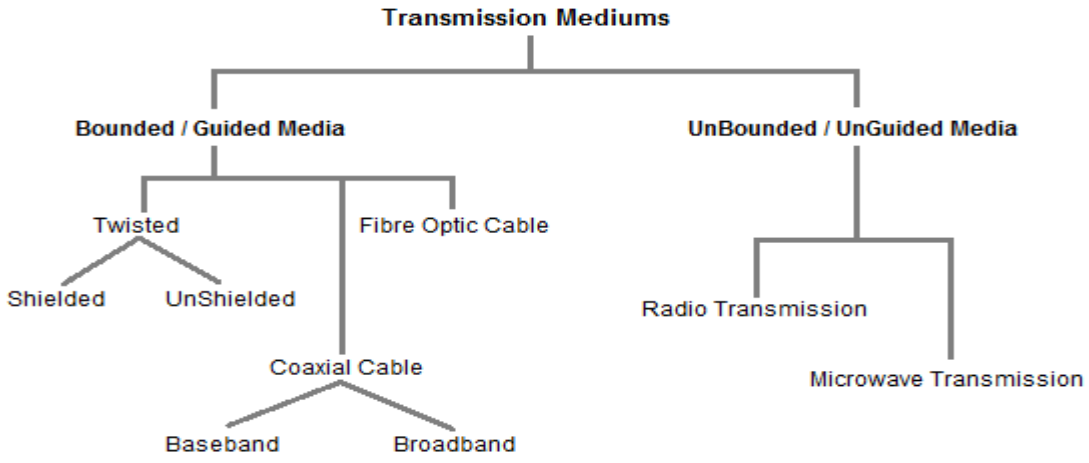
UNIT-2

Transmission Mediums in Computer Networks: Data is represented by computers and other telecommunication devices using signals. Signals are transmitted in the form of electromagnetic energy from one device to another. Electromagnetic signals travel through vacuum, air or other transmission mediums to travel between one point to another (from source to receiver).

Electromagnetic energy (includes electrical and magnetic fields) includes power, voice, visible light, radio waves, ultraviolet light, gamma rays etc.

Transmission medium is the means through which we send our data from one place to another. The first layer (physical layer) of Communication Networks OSI Seven layer model is dedicated to the transmission media, we will study the OSI Model later.



Factors to be considered while choosing Transmission Medium

1. Transmission Rate
2. Cost and Ease of Installation
3. Resistance to Environmental Conditions
4. Distances

Bounded/Guided Transmission Media

It is the transmission media in which signals are confined to a specific path using wire or cable. The types of Bounded/ Guided are discussed below.

Twisted Pair Cable

This cable is the most commonly used and is cheaper than others. It is lightweight, cheap, can be installed easily, and they support many different types of network. Some important points :

- Its frequency range is 0 to 3.5 kHz.
- Typical attenuation is 0.2 dB/Km @ 1kHz.
- Typical delay is 50 µs/km.
- Repeater spacing is 2km.

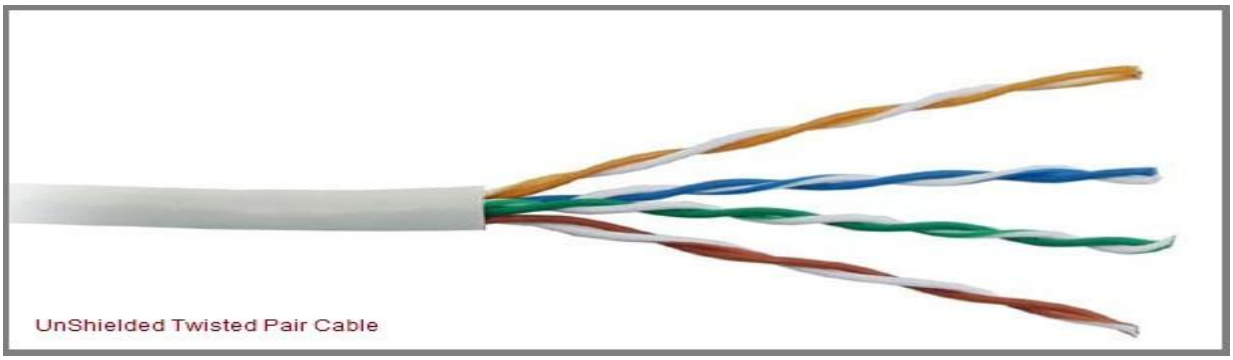
Twisted Pair is of two types :

- **Unshielded Twisted Pair (UTP)**
- **Shielded Twisted Pair (STP)**

Unshielded Twisted Pair Cable

It is the most common type of telecommunication when compared with Shielded Twisted Pair Cable which consists of two conductors usually copper, each with its own colour plastic insulator. Identification is the reason behind coloured plastic insulation.

UTP cables consist of 2 or 4 pairs of twisted cable. Cable with 2 pair use **RJ-11** connector and 4 pair cable use **RJ-45** connector.



Advantages :

- Installation is easy
- Flexible
- Cheap
- It has high speed capacity,
- 100 meter limit
- Higher grades of UTP are used in LAN technologies like Ethernet.

It consists of two insulating copper wires (1mm thick). The wires are twisted together in a helical form to reduce electrical interference from similar pair.

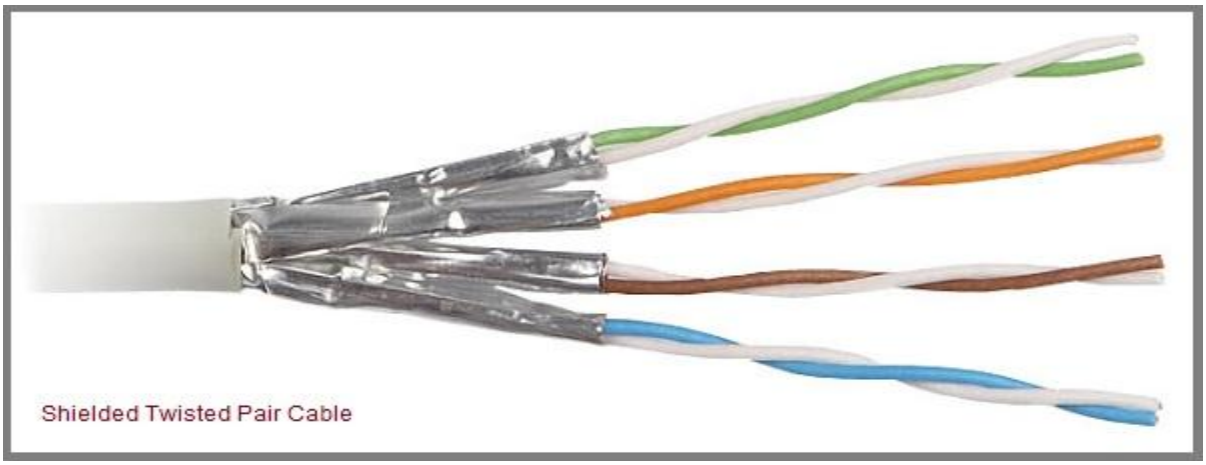
Disadvantages :

- Bandwidth is low when compared with Coaxial Cable
- Provides less protection from interference.

Shielded Twisted Pair Cable

This cable has a metal foil or braided-mesh covering which encases each pair of insulated conductors. Electromagnetic noise penetration is prevented by metal casing. Shielding also eliminates crosstalk (explained in KEY TERMS Chapter).

It has same attenuation as unshielded twisted pair. It is faster the unshielded and coaxial cable. It is more expensive than coaxial and unshielded twisted pair.



Advantages :

- Easy to install
- Performance is adequate
- Can be used for Analog or Digital transmission
- Increases the signalling rate
- Higher capacity than unshielded twisted pair
- Eliminates crosstalk

Disadvantages :

- Difficult to manufacture
- Heavy

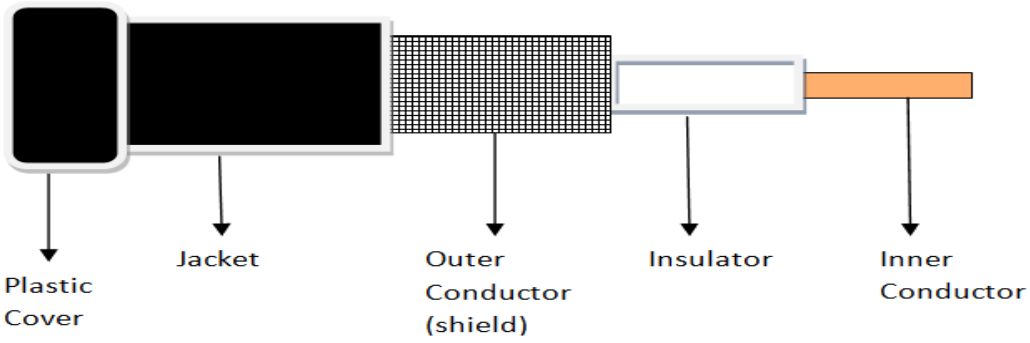
Coaxial Cable

Coaxial is called by this name because it contains two conductors that are parallel to each other. Copper is used in this as centre conductor which can be a solid wire or a standard one. It is surrounded by PVC installation, a sheath which is encased in an outer conductor of metal foil, barid or both.

Outer metallic wrapping is used as a shield against noise and as the second conductor which completes the circuit. The outer conductor is also encased in an insulating sheath. The outermost part is the plastic cover which protects the whole cable.

Here the most common coaxial standards.

- 50-Ohm RG-7 or RG-11 : used with thick Ethernet.
- 50-Ohm RG-58 : used with thin Ethernet
- 75-Ohm RG-59 : used with cable television
- 93-Ohm RG-62 : used with ARCNET.



There are two types of Coaxial cables :

BaseBand

This is a 50 ohm (Ω) coaxial cable which is used for digital transmission. It is mostly used for LAN's. Baseband transmits a single signal at a time with very high speed. The major drawback is that it needs amplification after every 1000 feet.

BroadBand

This uses analog transmission on standard cable television cabling. It transmits several simultaneous signal using different frequencies. It covers large area when compared with Baseband Coaxial Cable.

Advantages :

- Bandwidth is high
- Used in long distance telephone lines.
- Transmits digital signals at a very high rate of 10Mbps.
- Much higher noise immunity
- Data transmission without distortion.
- The can span to longer distance at higher speeds as they have better shielding when compared to twisted pair cable

Disadvantages :

- Single cable failure can fail the entire network.
- Difficult to install and expensive when compared with twisted pair.
- If the shield is imperfect, it can lead to grounded loop.

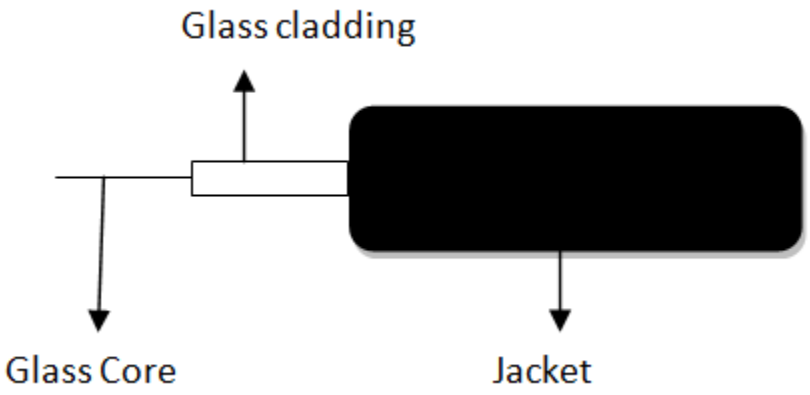
Fiber Optic Cable

These are similar to coaxial cable. It uses electric signals to transmit data. At the centre is the glass core through which light propagates.

In multimode fibres, the core is 50microns, and In single mode fibres, the thickness is 8 to 10 microns.

The core in fiber optic cable is surrounded by glass cladding with lower index of refraction as compared to core to keep all the light in core. This is covered with a thin plastic jacket to protect the cladding. The fibers are grouped together in bundles protected by an outer shield.

Fiber optic cable has bandwidth more than **2 gbps (Gigabytes per Second)**



Advantages :

- Provides high quality transmission of signals at very high speed.
- These are not affected by electromagnetic interference, so noise and distortion is very less.
- Used for both analog and digital signals.

Disadvantages :

- It is expensive
- Difficult to install.
- Maintenance is expensive and difficult.
- Do not allow complete routing of light signals.

UnBounded/UnGuided Transmission Media

Unguided or wireless media sends the data through air (or water), which is available to anyone who has a device capable of receiving them. Types of unguided/ unbounded media are discussed below :

- Radio Transmission
- MicroWave Transmission

Radio Transmission

Its frequency is between 10 kHz to 1GHz. It is simple to install and has high attenuation. These waves are used for multicast communications.

Types of Propogation

Radio Transmission utilizes different types of propogation :

- **Troposphere :** The lowest portion of earth's atmosphere extending outward approximately 30 miles from the earth's surface. Clouds, jet planes, wind is found here.
- **Ionosphere :** The layer of the atmosphere above troposphere, but below space. Contains electrically charged particles.

Microwave Transmission

It travels at high frequency than the radio waves. It requires the sender to be inside of the receiver. It operates in a system with a low gigahertz range. It is mostly used for unicast communication.

There are 2 types of Microwave Transmission :

1. Terrestrial Microwave
2. Satellite Microwave

Advantages of Microwave Transmission

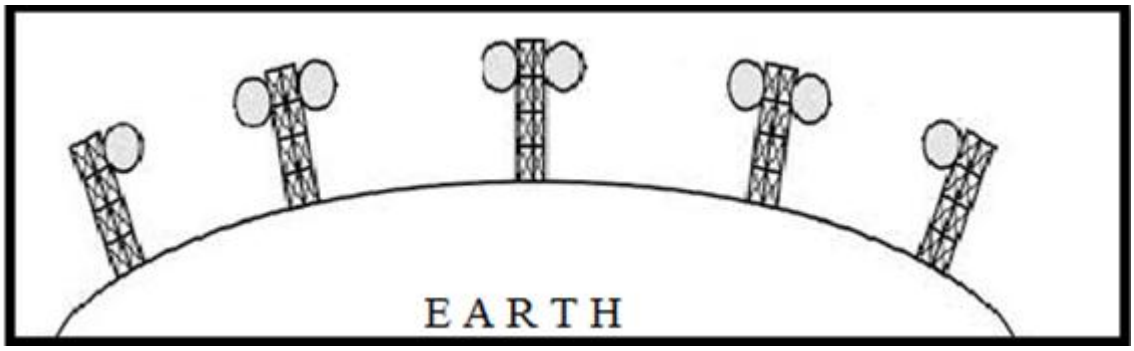
- Used for long distance telephone communication
- Carries 1000's of voice channels at the same time

Disadvantages of Microwave Transmission

- It is Very costly

Terrestrial Microwave

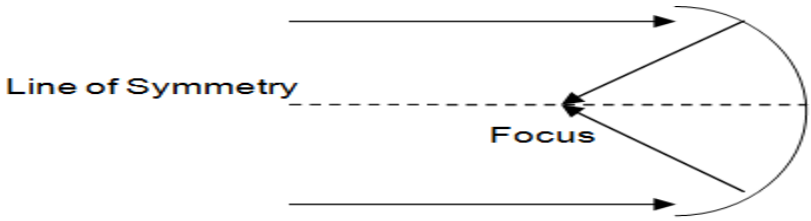
For increasing the distance served by terrestrial microwave, repeaters can be installed with each antenna .The signal received by an antenna can be converted into transmittable form and relayed to next antenna as shown in below figure. It is an example of telephone systems all over the world



There are two types of antennas used for terrestrial microwave communication :

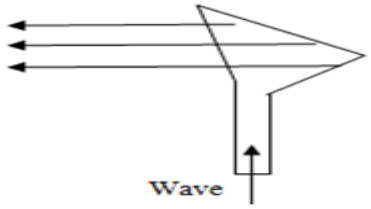
1. Parabolic Dish Antenna

In this every line parallel to the line of symmetry reflects off the curve at angles in a way that they intersect at a common point called focus. This antenna is based on geometry of parabola.



2. Horn Antenna

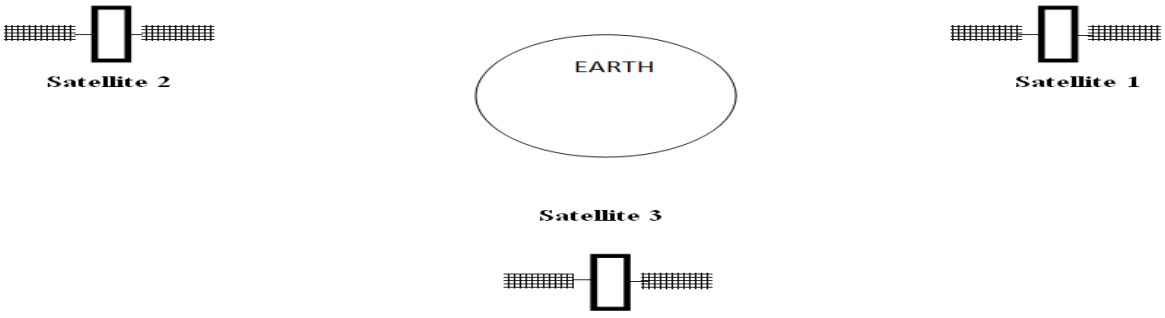
It is a like gigantic scoop. The outgoing transmissions are broadcast up a stem and deflected outward in a series of narrow parallel beams by curved head.



Satellite Microwave

This is a microwave relay station which is placed in outer space. The satellites are launched either by rockets or space shuttles carry them.

These are positioned 3600KM above the equator with an orbit speed that exactly matches the rotation speed of the earth. As the satellite is positioned in a geo-synchronous orbit, it is stationery relative to earth and always stays over the same point on the ground. This is usually done to allow ground stations to aim antenna at a fixed point in the sky.



Features of Satellite Microwave :

- Bandwidth capacity depends on the frequency used.
- Satellite microwave deployment for orbiting satellite is difficult.

Advantages of Satellite Microwave :

- Transmitting station can receive back its own transmission and check whether the satellite has transmitted information correctly.
- A single microwave relay station which is visible from any point.

Disadvantages of Satellite Microwave :

- Satellite manufacturing cost is very high
- Cost of launching satellite is very expensive
- Transmission highly depends on whether conditions, it can go down in bad weather

Digital Transmission

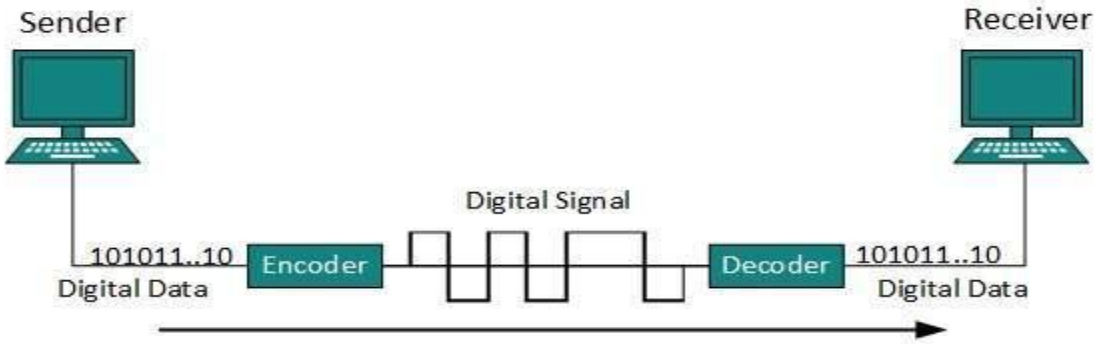
Data or information can be stored in two ways, analog and digital. For a computer to use the data, it must be in discrete digital form. Similar to data, signals can also be in analog and digital form. To transmit data digitally, it needs to be first converted to digital form.

Digital-to-Digital Conversion

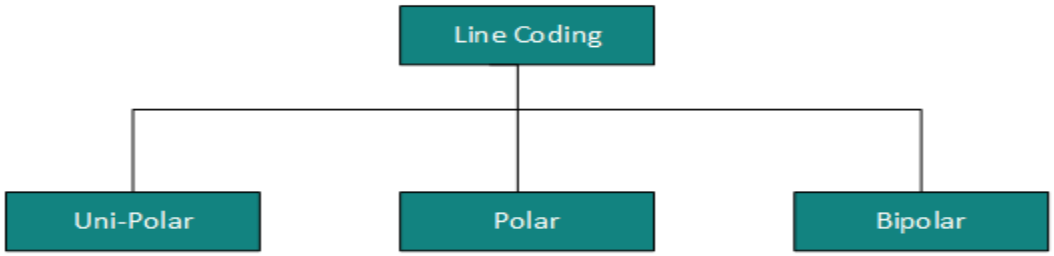
This section explains how to convert digital data into digital signals. It can be done in two ways, line coding and block coding. For all communications, line coding is necessary whereas block coding is optional.

Line Coding

The process for converting digital data into digital signal is said to be Line Coding. Digital data is found in binary format. It is represented (stored) internally as series of 1s and 0s.

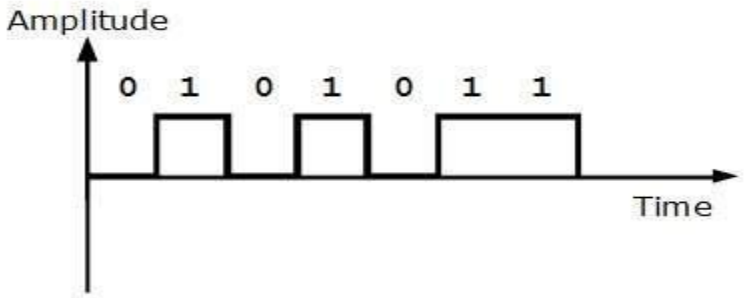


Digital signal is denoted by discreet signal, which represents digital data.There are three types of line coding schemes available:



Uni-polar Encoding

Unipolar encoding schemes use single voltage level to represent data. In this case, to represent binary 1, high voltage is transmitted and to represent 0, no voltage is transmitted. It is also called Unipolar-Non-return-to-zero, because there is no rest condition i.e. it either represents 1 or 0.



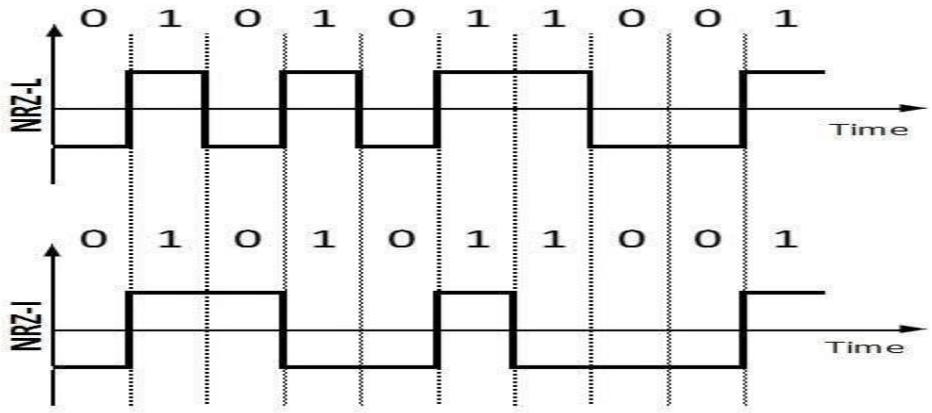
Polar Encoding

Polar encoding scheme uses multiple voltage levels to represent binary values. Polar encodings is available in four types:

- Polar Non-Return to Zero (Polar NRZ)

  It uses two different voltage levels to represent binary values. Generally, positive voltage represents 1 and negative value represents 0. It is also NRZ because there is no rest condition.

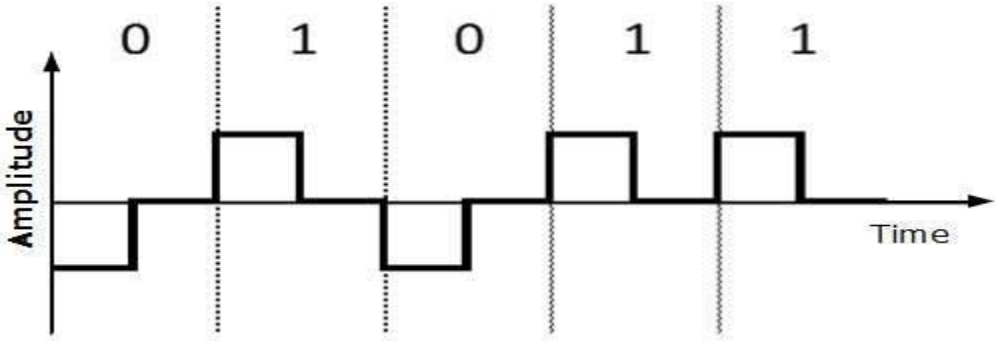
  NRZ scheme has two variants: NRZ-L and NRZ-I.



  NRZ-L changes voltage level at when a different bit is encountered whereas NRZ-I changes voltage when a 1 is encountered.

- **Return to Zero (RZ)**

  Problem with NRZ is that the receiver cannot conclude when a bit ended and when the next bit is started, in case when sender and receiver's clock are not synchronized.



  RZ uses three voltage levels, positive voltage to represent 1, negative voltage to represent 0 and zero voltage for none. Signals change during bits not between bits.

- **Manchester**

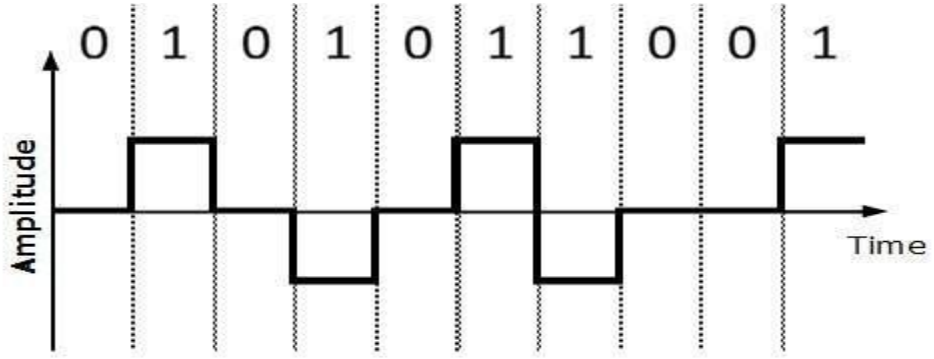
  This encoding scheme is a combination of RZ and NRZ-L. Bit time is divided into two halves. It transits in the middle of the bit and changes phase when a different bit is encountered.

- **Differential Manchester**

  This encoding scheme is a combination of RZ and NRZ-I. It also transit at the middle of the bit but changes phase only when 1 is encountered.

Bipolar Encoding

Bipolar encoding uses three voltage levels, positive, negative and zero. Zero voltage represents binary 0 and bit 1 is represented by altering positive and negative voltages.



Block Coding

To ensure accuracy of the received data frame redundant bits are used. For example, in even-parity, one parity bit is added to make the count of 1s in the frame even. This way the original number of bits is increased. It is called Block Coding.

Block coding is represented by slash notation, mB/nB.Means, m-bit block is substituted with n-bit block where n > m. Block coding involves three steps:

- Division,
- Substitution
- Combination.

After block coding is done, it is line coded for transmission.

Analog-to-Digital Conversion

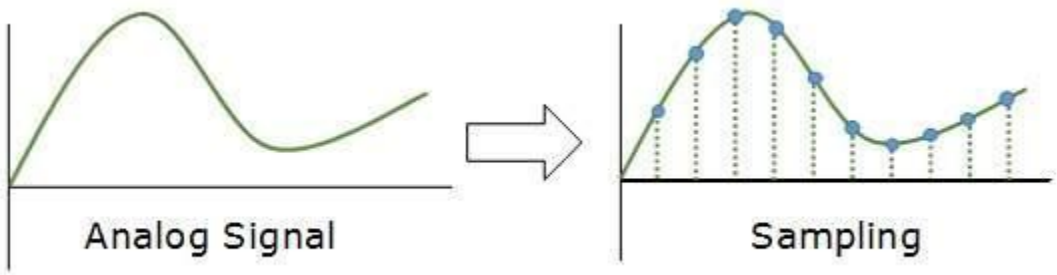
Microphones create analog voice and camera creates analog videos, which are treated is analog data. To transmit this analog data over digital signals, we need analog to digital conversion.

Analog data is a continuous stream of data in the wave form whereas digital data is discrete. To convert analog wave into digital data, we use Pulse Code Modulation (PCM).

PCM is one of the most commonly used method to convert analog data into digital form. It involves three steps:

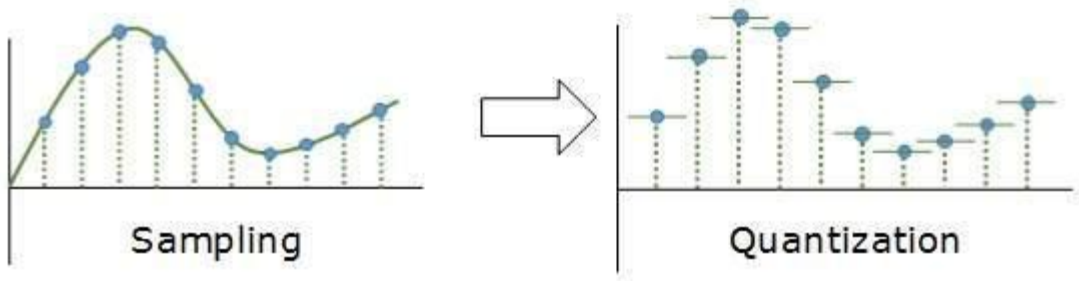
- Sampling
- Quantization
- Encoding.

Sampling



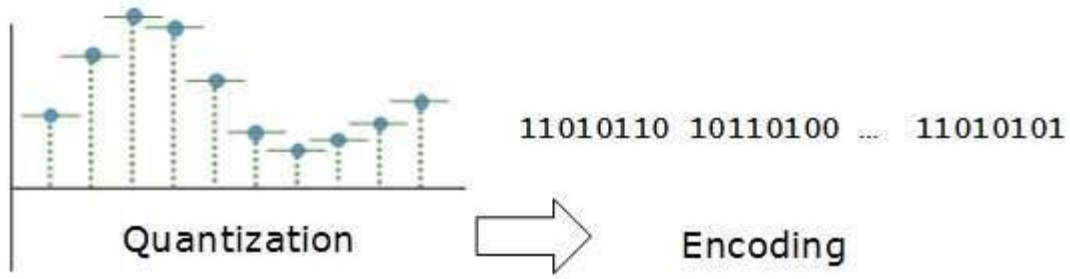
The analog signal is sampled every T interval. Most important factor in sampling is the rate at which analog signal is sampled. According to Nyquist Theorem, the sampling rate must be at least two times of the highest frequency of the signal.

Quantization



Sampling yields discrete form of continuous analog signal. Every discrete pattern shows the amplitude of the analog signal at that instance. The quantization is done between the maximum amplitude value and the minimum amplitude value. Quantization is approximation of the instantaneous analog value.

Encoding

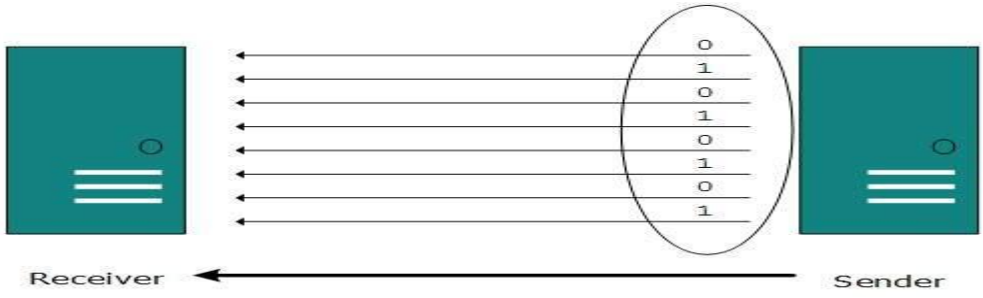


In encoding, each approximated value is then converted into binary format.

Transmission Modes

The transmission mode decides how data is transmitted between two computers.The binary data in the form of 1s and 0s can be sent in two different modes: Parallel and Serial.

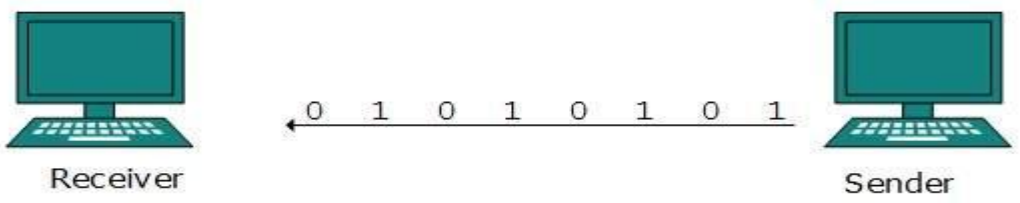
Parallel Transmission



The binary bits are organized in-to groups of fixed length. Both sender and receiver are connected in parallel with the equal number of data lines. Both computers distinguish between high order and low order data lines. The sender sends all the bits at once on all lines.Because the data lines are equal to the number of bits in a group or data frame, a complete group of bits (data frame) is sent in one go. Advantage of Parallel transmission is high speed and disadvantage is the cost of wires, as it is equal to the number of bits sent in parallel.

Serial Transmission

In serial transmission, bits are sent one after another in a queue manner. Serial transmission requires only one communication channel.



Serial transmission can be either asynchronous or synchronous.

Asynchronous Serial Transmission

It is named so because there'is no importance of timing. Data-bits have specific pattern and they help receiver recognize the start and end data bits.For example, a 0 is prefixed on every data byte and one or more 1s are added at the end.

Two continuous data-frames (bytes) may have a gap between them.

Synchronous Serial Transmission

Timing in synchronous transmission has importance as there is no mechanism followed to recognize start and end data bits. There is no pattern or prefix/suffix method. Data bits are sent in burst mode without maintaining gap between bytes (8-bits). Single burst of data bits may contain a number of bytes. Therefore, timing becomes very important.

It is up to the receiver to recognize and separate bits into bytes.The advantage of synchronous transmission is high speed, and it has no overhead of extra header and footer bits as in asynchronous transmission.

Broadband I SDN and ATM

The telephone companies are faced with fundamental problem: multiple networks. Telephone and Telex use old circuit-switched networks. Each of the new data services as frame relay uses its own packet-switched network. DQDB (MAN) is different from these, and there is also the internal telephone call management network. Maintaining all these separate networks is a major headache,

and there is another network, cable television, that the telephone companies do not control and would like to.
The solution of this problem is to invent a single new network for the future that will replace all the specialized networks with a single integrated network for all kinds of information transfer. This new network will have a huge data rate compared to all existing networks and services and will make it possible to offer a large variety of new services. This big project is now under way.
The new wide area service is called B-ISDN (Broadband Integrated Services Digital Networks). It will offer:
· video on demand,
· live television from many sources,
· multimedia electronic mail,
· CD-quality music,
· LAN interconnection,
· high-speed data transport for science and industry,
· many other services, all over the telephone line.
The underlying technology that makes B-ISDN possible is called ATM (Asynchronous Transfer Mode) because it is not synchronous (tied to a master clock).
A great deal of work has already been done on ATM and on B-ISDN system, although there is more ahead.
The basic idea behind ATM is to transmit all information in small, fixed-size packet called cells. The cells are 53 bytes long, of which 5 bytes are header and 48 bytes are data. ATM as a service is sometimes called cell relay.
ATM networks are connection-oriented.
ATM networks are organized like traditional WANs, with lines and switches. The intended speeds for
ATM networks are 155 Mbps and 622 Mbps, with possible gigabit speeds later. The 155 Mbps speed was chosen because this is about what is needed to transmit high definition television. The exact choice of 155.52 Mbps was made for the compatibility with AT&T's SONET transmission system (the 622 Mbps are 4 155 Mbps channels).
It is worth pointing out that different organizations involved in ATM have different (financial) interests
(the long-distance telephone carriers and PTTs vs. computer vendors). All these competing interests
do not make the ongoing standardization process any easier, faster, or more coherent. Also, politics within the organization standardizing ATM (The ATM Forum) have considerable influence on where
ATM is going.

The B-I SDN ATM Reference Model

Broadband ISDN using ATM has its own reference model (Fig. 1-30). It consists of three layers, plus whatever the users want to put on top of that. The three layers are:
· Physical layer. It deals with the issues of the physical medium. ATM cells may be sent on a wire or fiber by themselves, but they may be also be packaged inside the data of other carrier systems. In other words, ATM has been designed to be independent of the transmission medium.
· ATM layer. It deals with cells and cell transport. It defines the layout of a cell. It also deals with establishment and release of virtual circuits. Congestion control is also located here.

· AAL (ATM Adaptation Layer). I t allows users to send packets larger than a cell. The ATM layer interface segments these packets, transmits the cells individually, and reassembles them at the other end.

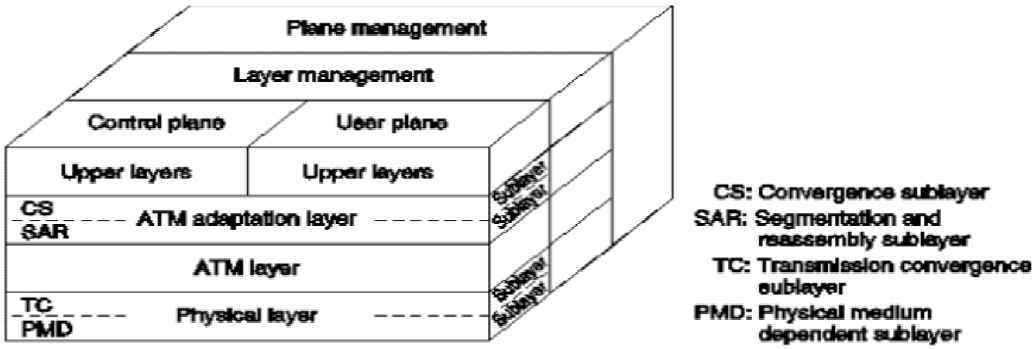


Fig. 1-30. The B-ISDN ATM reference model.

ATM model is defined as being three-dimensional. The user plane deals with data transport, flow control, error correction, and other user functions. The control plane is concerned with connection management. The layer and plane management functions relate to resource management and interlayer coordination.

The physical and AAl layers are each divided into two sublayers (Fig. 1-31):

OSI layer	ATM layer	ATM sublayer	Functionality
3/4	AAL	CS	Providing the standard interface (convergence)
		SAR	Segmentation and reassembly
2/3	ATM		Flow control Cell header generation/extraction Virtual circuit/path management Cell multiplexing/demultiplexing
2	Physical	TC	Cell rate decoupling Header checksum generation and verification Cell generation Packing/unpacking cells from the enclosing envelope Frame generation
1		PMD	Bit timing Physical network access

Fig. 1-31. The ATM layers and sublayers, and their functions.

The PMD (Physical Medium Dependent) sublayer interfaces to the actual cable. It moves the bits on and off. For different carriers and cables, this layer will be different.

The TC (Transmission Convergence) sublayer sends the transmitted cells as a string to the PMD sublayer. At the other end, the TC converts a pure incoming bit stream from the PMD sublayer into a cell stream for the ATM layer (the task of data link layer of the OSI model).

ATM layer is a mixture of the OSI data link and network layers.

The SAR (Segmentation And Reassembly) sublayer breaks packets up into cells on the transmission side and puts them back together again at the destination.

The CS (Convergence Sublayer) makes it possible to have ATM systems offer different kinds of services to different applications (e.g. file transfer and video on demand have different requirements concerning error handling, timing , etc.).

Narrowband ISDN

Anticipating user demand for end-to-end digital services the world's telephone companies agreed in 1984 under the auspices of CCITT to build a new, fully digital, circuit-switched telephone system by the early part of the 21st century. This system was called ISDN (Integrated Services Digital Network) and its primary goal was to integrate the voice and non-voice services. It is already available in many locations and its use is growing slowly.

ISDN Services

The key ISDN service will continue to be voice but with many enhanced features.

Some of them are:

· buttons for instant call setup to arbitrary telephones anywhere in the world,

· displaying the caller's telephone number, name and address while ringing,

· connecting the telephone to a computer enabling the caller's database record to be displayed on the screen as the call comes in,

· call forwarding,

· conference calls worldwide,

· on line medical, burglar, and smoke alarms giving the address to speed up response.

ISDN System Architecture

The key idea behind ISDN is that of the digital bit pipe between the customer and the carrier through which bits flow in both directions. Whether the bits originate from a digital telephone, a digital terminal, a digital facsimile machine, or some other device is irrelevant.

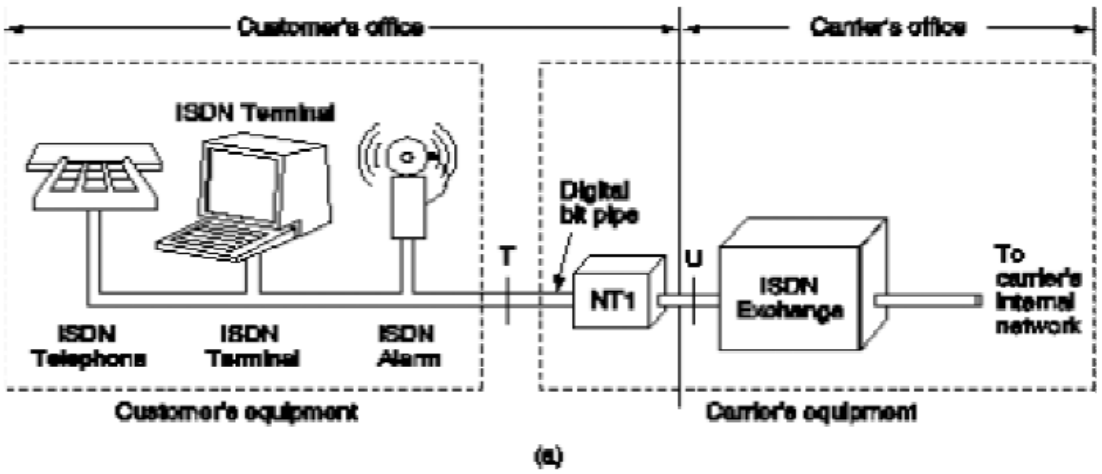
The digital bit pipe can support multiple independent channels by time division multiplexing of the bit stream. Two principal standards for the bit pipe have been developed:

· a low bandwidth standard for home use, and

· a higher bandwidth standard for business use that supports multiple channels identical to the home use channels.

Normal configuration for a home consists of a network terminating device NT1 (Fig. 2-41(a)) placed on the customer's premises and connected to the ISDN exchange in the carrier's office using the twisted pair previously used to connect the telephone. The NT1 box has a connector into which a bus cable can be inserted. Up to 8 ISDN telephones, terminals, alarms, and other devices can be connected to the cable. From the customer's point of view, the network boundary is the connector on

NT1.



(a) Example ISDN system for home use.

CCITT defined four reference points (Fig. 2-41):

· U reference point = connection between the ISDN exchange and NT1,
· T reference point = connector on NT1 to the customer,
· S reference point = interface between the ISDN PBX and the ISDN terminal,
· R reference point = the connection between the terminal adapter and non-ISDN terminal.

The ISDN Interface

The ISDN bit pipe supports multiple channels interleaved by time division multiplexing. Several channel types have been standardized:

· A - 4 kHz analog telephone channel
· B - 64 kbps digital PCM channel for voice or data
· C - 8 or 16 kbps digital channel for out-of-band signaling
· D - 16 kbps digital channel for out-of-band signaling
· E - 64 kbps digital channel for internal ISDN signaling
· H - 384, 1536, or 1920 kbps digital channel.

Perspective on N-I SDN

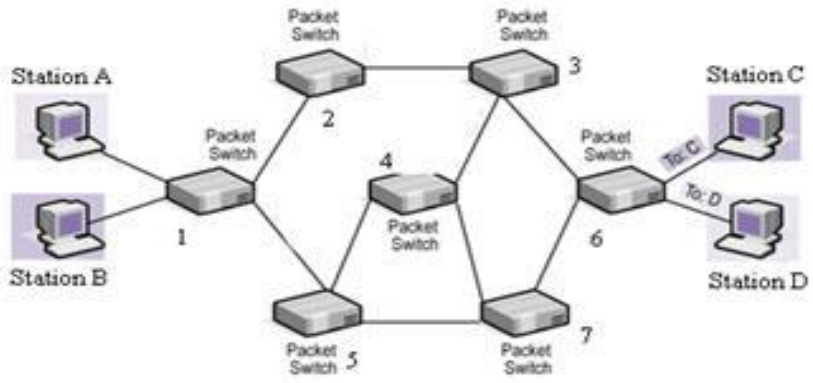
N-ISDN was an attempt to replace the analog telephone system with a digital one. Unfortunately, the standardization process was too long and regarding to the technology progress in this area, once the standard was finally agreed, it was obsolete.

N-ISDN basic rate is too low so for home as for business today. N-ISDN may be partly saved, but by an unexpected application: Internet access. Various companies now sell ISDN adapters that combine the 2B + D channels into a single 144 kbps digital channel. Many Internet providers also support these adapters. So the people can access Internet over a 144 kbps digital link, instead of a 28.8 kbps analog modem link and for affordable price that may be a niche for N-ISDN for the next few years.

Switching:

Communication is typically achieved by transmitting data from source to destination through a network of intermediate switching nodes. A switched network design is typically used to implement LAN's as well. Switching nodes are not concerned with the content of the data; rather their purpose is to provide a switching facility that wills more the data from node to node until they reach their destination. The device attached to the network may be referred as stations.

Stations may be computers, terminals, telephones or other communication devices. In a switched communication network, data entering the network from a station are routed to the destination by being switched from node to node. Nodes are connected to one another is some topology by transmission Link.



Now for wide area networking two different technologies are used.

- Circuit Switching
- Packet Switching.

Circuit Switching network

- Communication Via Circuit switching implies that there is a dedicated communication path between two stations. Path is a connected sequence of links between network nodes.
- On each physical link a logical channel is dedicated to the connection.

How to send data from one station to another station?

- Before sending data from end to end a circuit must be established.
- Station A sends a request to node 3 requesting a connection to station C connection from node B to A is dedicated connection so part of the connection is already exists.
- Now node 3 must find the next route leading to C, Based on Routing information and based on measures of availability and perhaps cost node 3 select the link to node 5 and then node 5 allocated the channel to node 6 then the node 6 completes the link with station C.

Data Transfer

- The transmission may be analog or digital, depending on the nature of the network
- As the carriers en to fully integrated digital networks the use ;of digital transmission for both (Dalvi, 2013) voice and data is becoming the dominant method.

Use of circuit- Switching Networks.

- Circuit Switching was used to developed to handle voice traffic, but is now also used for data traffic.
- Best Example of circuit switching is the public Telephone network.
- This is a collection of national networks interconnected to form ;the international services

The substantial data traffic is handle Via modem and the analog telephone signal is converted into digital

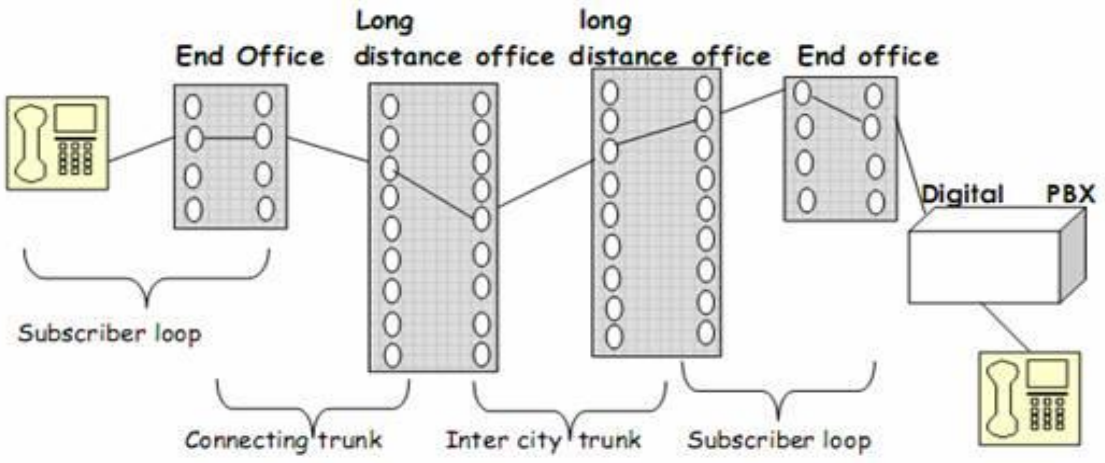


Figure 2.2 Example of connection over a public circuit-switching network

Circuit –Switching Concept.

- A technology of circuit switching is between operations of a single circuit- switching node.
- A network built around a single circuit-switching node consists of a collection of stations attached to a central switching unit.
- The central switch establishes a dedicated path betwee3n any two devices that wish to communicate.
- The function of the digital switch is to provide a transparent signal path between any pair of attached devices.
- The path is transparent in that it appears to the attached pair of devices that there is a direct connection between them. Typically the connection must allow full - duplex transmission.

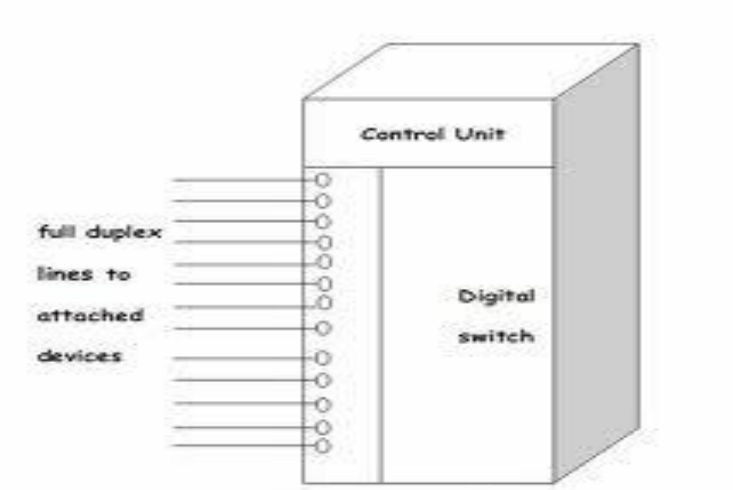


Figure 2.3 Elements of a Circuit-Switch node

Task of Control Unit

The control performs three general tasks.

First :

It establishes connection; this is generally done a demand, that is, at the request of an attached device. To establish the connection, the control unit must handle and acknowledge the request, determine if the intended destination is free, and construct a path through the switch.

Second :

The control unit must maintain the connection.

Third :

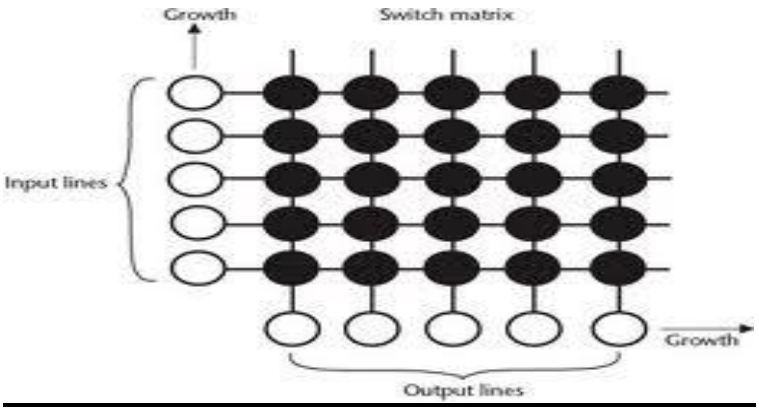
The control unit must tear down the connection, either in response to a request from one of the parties or for its own reasons.

Characteristic of a circuit switching device

- Blocking or Non-Blocking
  Blocking – It is occur when the network is unable to connect two stations because all possible paths between them are already in use.
- Non –Blocking network permits all stations to be connected at once and grants all possible connection requests as long as the called party is free.

Space Division Switching

1. Space Division Switching was originally developed for the analog or digital realm
2. Space Division switch is one in which the signal paths are physically separated from one another (divided in space)
3. Each connection requires the establishment of a physical path through the switch that is dedicated solely to the transfer of signals between the two endpoints.
4. The basic building block of the switch is a metallic cross point or semiconductor gate that can be enabled and disabled by a control unit



- The number of cross points grows with the square of the number of attached station. This is costly for a large switch.
- The loss of a cross point prevents connection between the two devices whose lines intersect at that cross point.

Three- Stage Space Division Switch.

The cross points are inefficiently utilized; even when all the attached devices are active, only a small fraction of the cross points are engaged.

To overcome these limitations multiple-stage switches are employed.

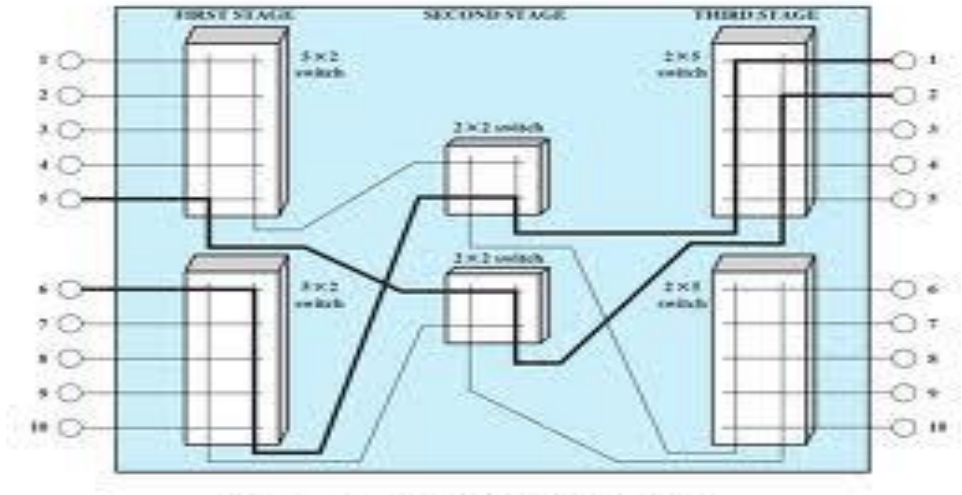


Figure 10.6 Three-Stage Space-Division Switch

This type of arrangement has two advantages over a single-stage crossbar matrix.

- The number of cross point is reduced, increasing crossbar utilization for 10 stations cross-point is reduced from 100 to 48.
- There is more than one path through the network to connect two endpoints increasing reliability.

A multistate network requires a more complex control scheme. To establish a path in single-stage network, it is only necessary to enable a single gate.

- A single state cross-bar matrix is non-blocking, that is, a path is always available to connect an input to an output.
- In Multistage is blocking one, even though output is available and the second stage path is blocked the connection cannot be done.

We can able to make it non-blocking by increasing the number or size of the intermediate switches, but of course this increase the cost.

TIME DIVISION SWITCHING

With the advent of digitalize voice and synchronous time division multiplexing techniques both voice and data can be transmitted Via digital signals.

- Instead of relatively dump space division systems, modern digital systems rely on intelligent control of space and time division elements.

Soft Switch Architecture.

The latest trend in the development of circuit switching technology is generally referred to as the soft switch.

- A soft switch is a general purpose computer running specialized software that turns into smart phone switch
- A soft switch can convert a stream of digitized voice bits into packets.
- This can opens up a number of options for transmission, including the increasing popular voice over IP (Internet protocol) approach.
- In any telephone network switch, the most complex element is the software that controls call processing.
- The software performs call routing and implements call-processing logic for hundreds of custom calling features.
- Typically this software runs on a proprietary processor that is integrated with public switching Hardware.
- A more flexible approach is to physically separate the call processing function from the hardware switching function.
- In soft switch terminology, the physical switching function is performed by a media gateway (N/G) and call processing logic resides in a media gate way controller (MGC).

PACKET SWITCHING:

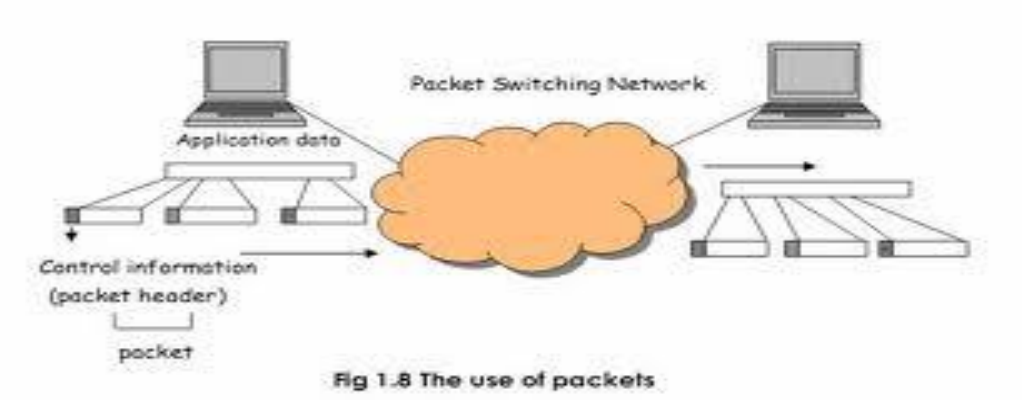


Fig 1.8 The use of packets

Packet Switching Principles

i. Circuit switching telecommunications networks was to handle voice traffic.
ii. The key characteristic of circuit switching is network is that resources within the network are dedicated to a particular call
iii. Circuit switching network began to be used increasingly for data connections.
iv. In a circuit-Switching network the connection provides for transmission at a constant data rate. Thus each of the two devices that are connected must transmit and receive at the same data rate as the other. This limits the utility of the networks in interconnecting a variety of host computers and work stations.
v. Packet switching address these problems
    a. Data are transmitted in short packets. A typical upper bound on packet length is 1000 octets. If the source has a longer message to send, the message is broken into a series of packets.
    b. Each packet contains a portion of the user's data plus some control information.
    c. The control information at a minimum includes the minimum, includes the information that the network requires to be able to route the packet through the network and deliver it to the intended destination.

At each node packet is received and stored it to the next node. Let us consider simple switching network. Consider a packet to be sent from A station to station C.

1) The packet includes control information that the intended destination is B.

2) The packet is sent from A to node 3 Node 3 stores the packet and determine the next route and queues the packet to go to that link B-4 link

3) When the link is available the packets sends the data from (4 to 5) and finally node 5 to destination B

4) The packets are queued up and transmitted as rapidly as possible over the link.

5) Packets switching network can perform data-rate conversion. Two different data rates can exchange packets because each connects to its node at its proper data rate.

When traffic becomes heavy on a circuit – switching network, some calls are blocked, i.e. the network refuses to accept additional connection request until the load on the network decrease. In jacket switching network, packets are still accepted, but delivery delay increases. Priority can be uses if a node has a number of packets queued for transmission it can transmit the higher priority packet first. These packets will therefore experiences less delay than lower priority packets.

Switching Technique

If a station has a message to send through a packet switching network that is of length greater than the maximum packet size, it breaks the message up into packet.

These packets are sending one by one into packets. There are two networks are used in contemporary networks they are

1. Datagram 2. Virtual circuit.

Datagram.

1. In the Datagram approach each packets is treated independently, with no reference to packets that have gone before.
2. This approach shows a time sequence of snapshots of the progress of three packets through the network.
3. Each node choose the next node and pockets path taking into account information received from neighboring nodes on traffic, line failure and soon.
4. So the packet with same destination address do not all follow the same route, and they may drive out of sequence at the exits point
5. In this example, the exits node restores the packet to their original order before delivering them to the destination.
6. In some datagram network it is up to the destination rather than the exit node to do the recording.
7. It is possible for a packet to be destroyed in the network for e.g. if a packet- switching node crashes momentarily all its queued packets may be lost.
8. It is up to either the exit node or the destination to detect the loss of a packet and decide now to recover it.
9. In datagram technique, each packet, treated independently.

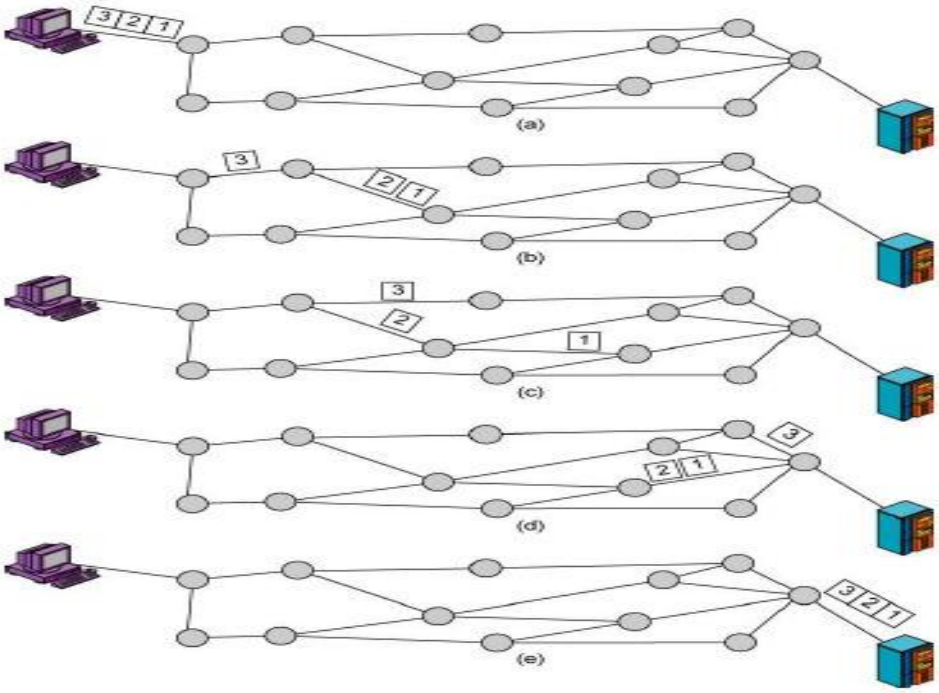
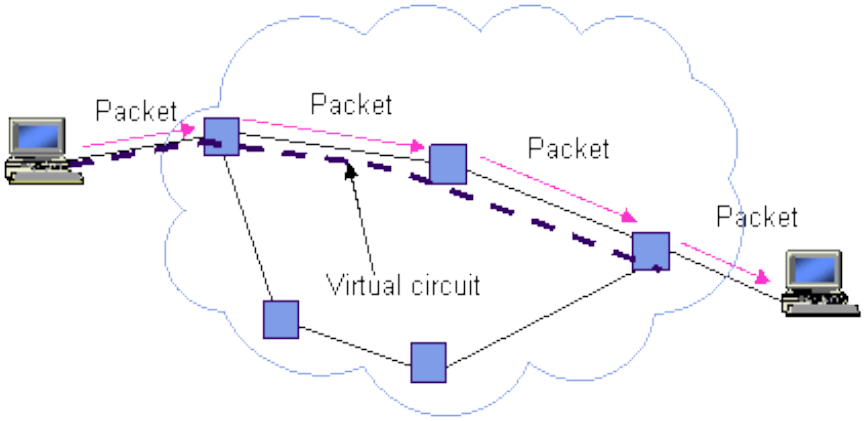


Figure 1 Packet Switching: Datagram approach

Virtual Circuit.

1. In the virtual circuit approach, a preplanned route is established before any packets are sent.
2. Once the route is established all the packets between a pair of communicating parties follow the same route through the network.
3. The route is fixed for the duration of the logical connection it is somewhat similar to a circuit in a circuit switching network and it is referred to a virtual circuit.
4. Each node on the pre-established route knows where to direct such packets no routing decisions are required.
5. Each station can have more than one virtual circuit to any other station and can have virtual circuits to more than one station.

Packet Switching – Virtual Circuit



- Call set-up phase sets ups pointers in fixed path along network
- All packets for a connection follow the same path
- Abbreviated header identifies connection on each link
- Packets queue for transmission
- Variable bit rates possible, negotiated during call set-up
- Delays variable, cannot be less than circuit switching

Main characteristic of the virtual circuit technique is that the route between stations is set up prior to data transfer.

(Note:- It does not mean that this is a dedicated path, as in circuit

Switching)

I. A transmitted packet is buffered at circuits may share the use of the line.
II. The difference from the datagram approach is that with virtual circuits, the node need not make a routing decision for each packet. It is made only once for all packets using that virtual circuit.
III. If two stations wish to exchange data over on extended period of time there are certain advantages to virtual circuits.
    a. First the network may provide services related to the virtual circuit including sequencing and error control.
    b. Sequencing means all packets follow she same route, they arrive in the original order.
    c. Node 6 can request a retransmission of that packet from node 4
    d. Another advantage is that packets should transmit the network more rapidly with a virtual circuit, it is not necessary to make a routing decision for each packet at each node.

Advantages of Datagram Approach.

i. The call setup phase is avoided If a station wishes to send only one or a few packets datagram delivery will be quicker.
ii. It is more primitive more flexible.

Comparison of Communication Switching Network

Circuit Switching	Datagram Packet Switching	Virtual circuit Packet switching
Dedicate transmission path	No dedicate path	No dedicate path
Continuous transmission of data	Transmission of packets	Transmission of packets
Fast enough for interactive	Fast enough for interactive	Fast enough for interactive
Message are not stored	Packets may be stored until delivered	Packets stored until delivered
The path is established for entire conversation	Route established for each packet	Route established for entire conversation
Call setup delay; negligible transmission delay	Packet transmission delay	Call setup delay; Packet transmission delay
Busy signal if called party busy	Sender may be notified if packet not delivered	Sender notified of connection denial
Overload may block call setup; no delay for established calls	Overload increases packet delay	Overload may block call setup; increases packet delay
Electromechanical or computerized switching nodes	Small switching nodes	Small switching nodes
User responsible for message loss protection	Network may be responsible for individual packets	Network may be responsible for packet sequences
Usually no speed or code conversion	Speed and code conversion	Speed and code conversion
Fixed bandwidth	Dynamic use of bandwidth	Dynamic use of bandwidth
No overhead bits after call setup	Overhead bits in each packet	Overhead bits in each packet

Figure 4 Comparison of Communication switching technique