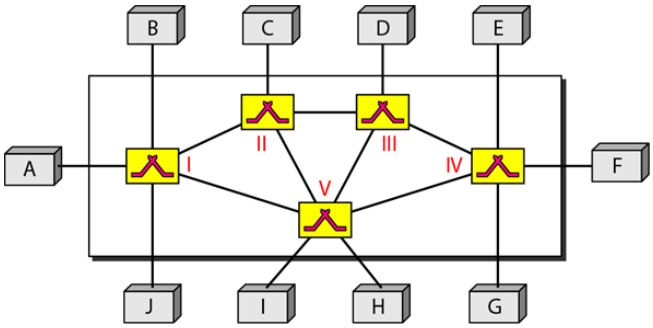
UNIT- 5 SWITCHING

Unit V:

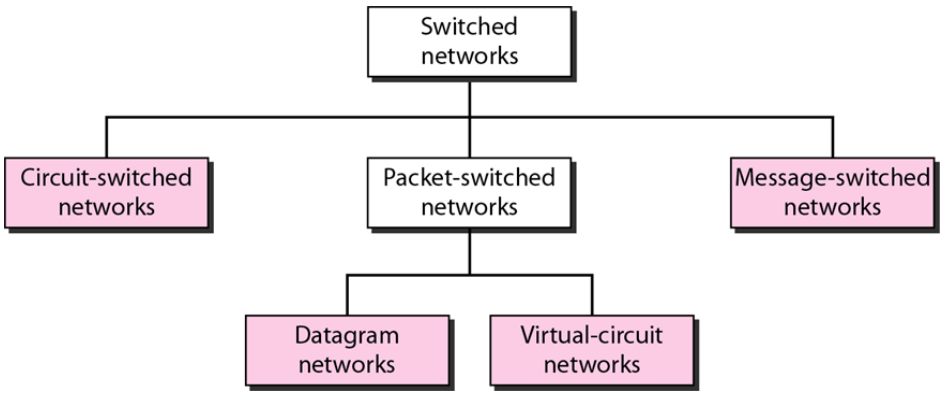
Switching, Circuit-Switched Networks, Three Phases, Packet Switching, Datagram Networks, Virtual-Circuit networks, Three Phases, Connection Oriented and Connectionless Services. Telephone Network :Major Components, Local Loops, Trunks, Switching Offices, Dial-Up service, Digital Subscriber Line, Cable Networks, Traditional Cable Networks, HFC Network, Cable TV for data transfer.

A network is a set of connected devices. To connect multiple devices, we have the problem of how to connect them to make one-to-one communication possible

Better 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.

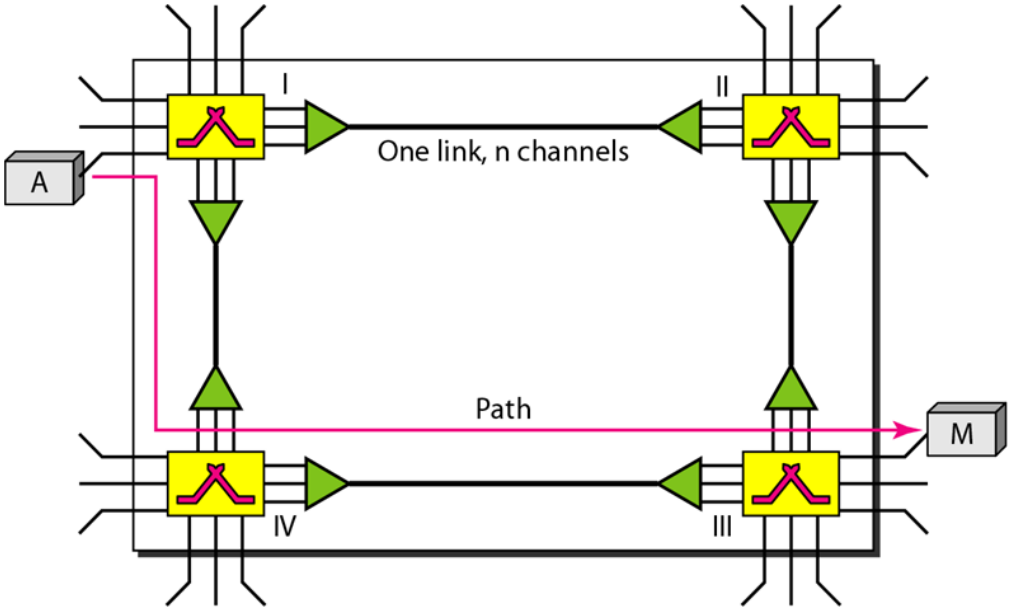


Types of switching



CIRCUIT SWITCHED NETWORK

Circuit switching takes place at the physical layer. It consists of a set of switches connected by physical links. A connection between two stations is a dedicated path made of one or more links. Each connection uses only one dedicated channel on each link.Each link is normally divided into n channels by using FDM or TDM. The end systems, such as computers or telephones, are directly connected to a switch.



Before starting communication, the stations must make a reservation for the resources to be used during the communication. The resources such as channels (bandwidth in FDM and time slots in TDM), switch buffers, switch processing time, and switch input/output ports. This must remain dedicated during the entire duration of data transfer until the connection.

Data transferred between the two stations are not packetized (physical layer transfer of the signal). The data are a continuous flow sent by the source station and received by the destination station (there may be periods of silence).

There is no addressing involved during data transfer. The switches route the data based on their occupied band (FDM) or time slot (TDM).

Three phases: The actual communication in a circuit- switched network requires three phases,

- Connection setup

- Data transfer
- Connection teardown

Connection setup

Before the two parties (or multiple parties in a conference call) can communicate – a **dedicated circuit** (combination of channels in links) needs to be established. Connection setup means creating dedicated channels between the switches

If system A needs to connect to system M:

- it sends a setup request that includes the address of system M, to switch I.
- Switch I finds a channel between itself and switch IV that can be dedicated for this purpose.
- Switch I then sends the request to switch IV, which finds a dedicated channel between itself and switch III.
- Switch III informs system M of system A's intention at this time.
- an acknowledgment from system M needs to be sent in the opposite direction to system A.
- Only after system A receives this acknowledgment is the connection established.

Data Transfer Phase:

After the establishment of the dedicated circuit (channels), the two parties can transfer data

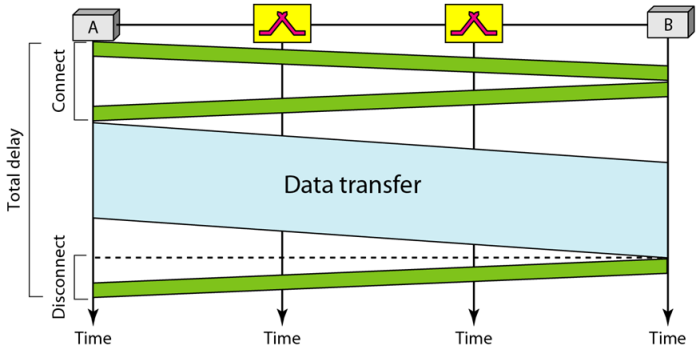
Teardown Phase

When one of the parties needs to disconnect, a signal is sent to each switch to release the resources.

Delay:-

The total delay is due to the time needed to create the connection, transfer data, and disconnect the circuit.

It is the sum of four parts:(a)the propagation time of the source computer request (b) the request signal transfer time (c)the propagation time of the acknowledgment from the destination computer (d) the signal transfer time of the acknowledgment



PACKET SWITCHED NETWORK

Packet switching is a digital network transmission process in which data is broken into suitably-sized pieces or blocks for fast and efficient transfer via different network devices. The size of the packet is determined by the network and the governing protocol.

There is no resource allocation for a packet.This means there is no reserved bandwidth on the links, and there is no scheduled processing time for each packet. Resources allocated on demand. The allocation is done on a first come,first served basis.

When a switch receives a packet, no matter what is the source or destination, the packet must wait if there are other packets being processed. These packets are then routed by network devices to the destination.

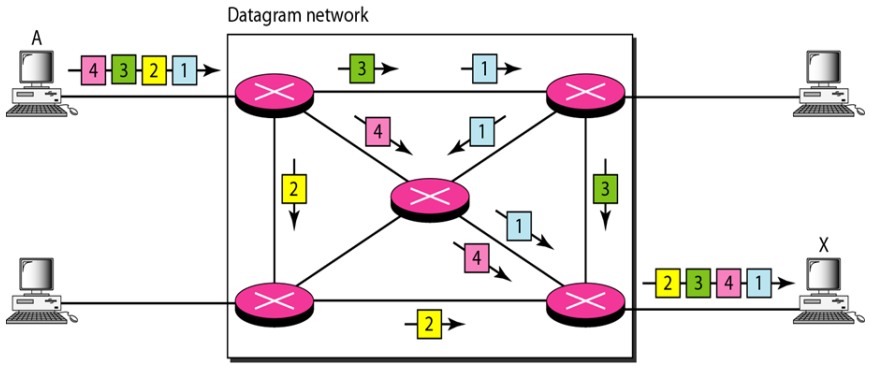
Two types:

- Connectionless (**Datagram Switching**)
- Connection-Oriented (**Virtual Circuit Switching**)

Datagram Switching

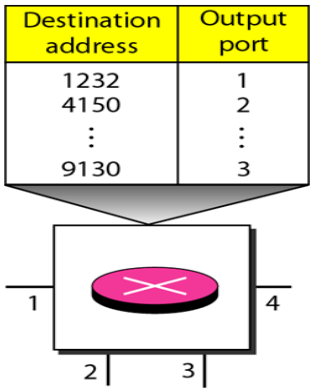
Each packet is treated independently of all others that contains complete addressing or routing information and is routed individually. Switching is normally done at the network layer.

The switches in a datagram network are traditionally referred to as routers. We can see out-of-order delivery and different paths of transmission, depending on the variable loads on different network nodes (adapters, switches and routers) at any given time.



All four packets(datagram) belong to the same message, but may travel different paths to reach their destination.
The datagram network is referred to as a connectionless network because the switch does not keep information about the connection state. There is no setup or teardown phase.Each packet is treated the same by a switch regardless of its source or destination

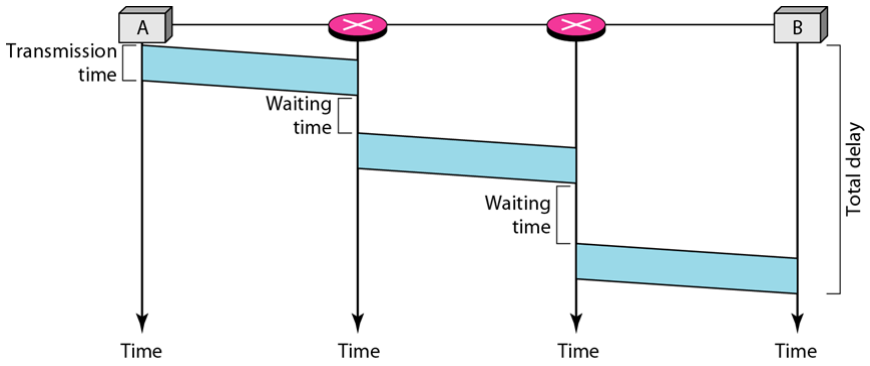
Routing table:- Each switch (or packet switch) has a routing table which is based on the destination address. These tables are dynamic and are updated periodically. The destination addresses and the corresponding forwarding output ports are recorded in the tables.



Destination address:- Every packet in a datagram network carries a header that contains, among other information, the destination address of the packet. When the switch receives the packet, this destination address is examined. Then the routing table is consulted to find the corresponding port through which the packet should be forwarded. This address remains the same during the entire journey of the packet.

Efficiency:- Resources are allocated only when there are packets to be transferred. If a source sends a packet and there is a delay of a few minutes before another packet can be sent. The resources can be reallocated during these minutes for other packets from other sources.

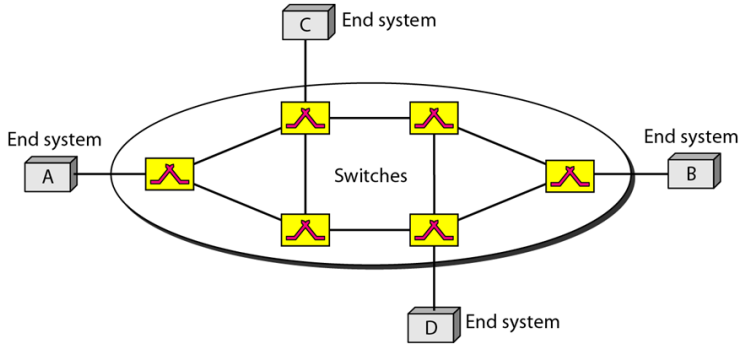
Delay:- Each packet may experience a wait at a switch before it is forwarded – higher than circuit switching. Also since not all packets in a message necessarily travel through the same switches, the delay is not uniform for the packets of a message



Virtual Circuit Switching

A Virtual-circuit network is a cross between a circuit-switched network and a datagram network. It has some characteristics of both.

- There are setup and teardown phases in addition to the data transfer phase.
- Resources can be allocated during the setup phase or on demand.
- Data is packetized and each packet carries an address in the header.
- The address in the header will be of the next switch in the channel on which the packet is being carried.
- All packets follow the same path established during the connection.
- A virtual-circuit network is normally implemented in the data link layer.

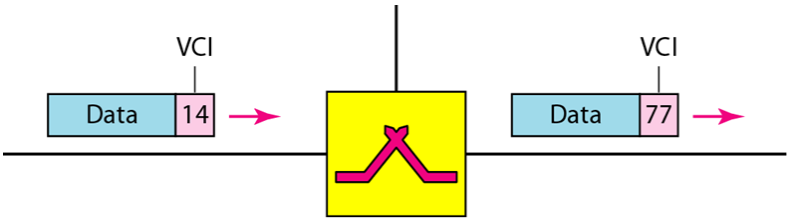


Addressing:- In a virtual circuit network, two types of addressing are involved:

- ➔ Global
- ➔ Local (Virtual Circuit Identifier)

Global Addressing:- A source or a destination needs to have a global address - an address that can be unique in the scope of the network or internationally if the network is part of an international network. A global address in virtual-circuit networks is used only to create a virtual-circuit identifier.

Local(Virtual Circuit Identifier):- The identifier that is actually used for data transfer is called the virtual-circuit identifier (VCI). A VCI, is a small number that has only switch scope and is used by a frame between two switches. When a frame arrives at a switch, it has a VCI; when it leaves, it has a different VCI. VCI does not need to be a large number since each switch can use its own unique set of VCI's.



Three phases:- In a virtual circuit network, a source and destination need to go through three phases: setup, data transfer and teardown. In the setup phase, the source and destination use their global addresses to help switches make table entries for the connection. In the teardown phase, the source and destination inform the switches to delete the corresponding entry. Data transfer occurs in between these two phase.It transfers data though the path.

Setup phase

In the setup phase, a switch creates an entry for a virtual circuit. If source A needs to create a virtual circuit to B, then two steps are required:

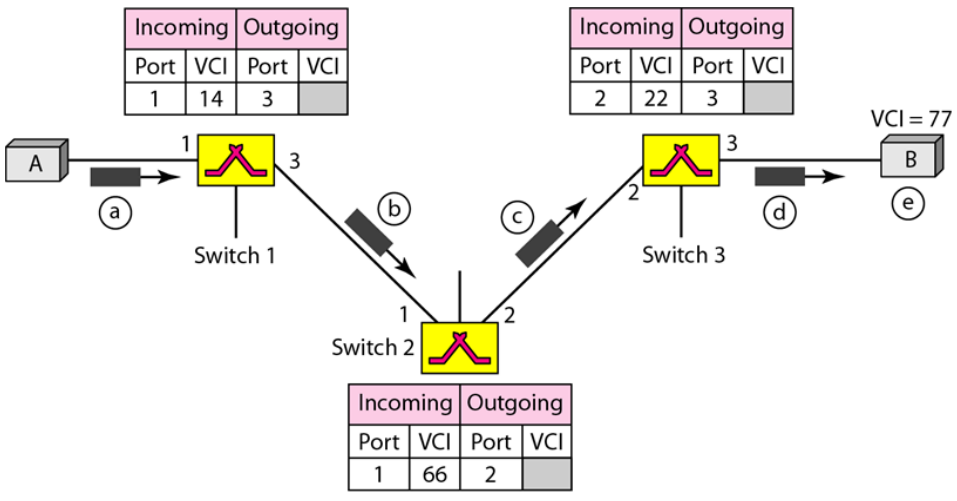
- Setup request
- Acknowledgment

Setup Request:-

A setup request frame is sent from the source to the destination.

Process:

- Source A sends a setup frame to switch 1.
- Switch 1 receives the setup request frame. It knows that a frame going from A to B goes out through which port number (here it is port 3). Switch 1 creates an entry in its table for this virtual circuit, but it is only able to fill three of the four columns.
- It does not yet know the outgoing VCI, which will be found and be filled during the acknowledgment step. The switch then forwards the frame through port 3 to switch 2
- Switch 2 receives the setup request frame and does the same process.
- Switch 3 receives the setup request frame and also does the same process.
- Destination B receives the setup frame. if it is ready to receive frames from A, it assigns a VCI to the incoming frames that come from A, This VCI lets the destination know that the frames come from A, and not other sources.

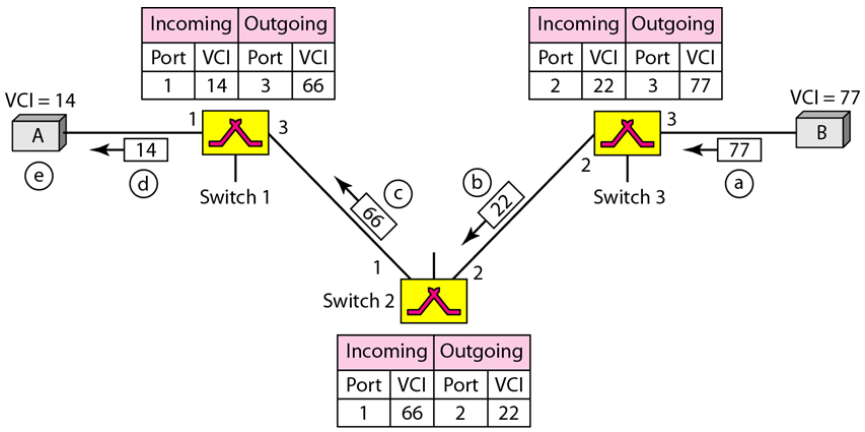


Acknowledgement:

A special frame, called the acknowledgment frame, completes the entries in the switching tables.

Process:

- The destination sends an acknowledgement to switch 3.The acknowledgment carries the global source and destination addresses so the switch knows which entry in the table is to be completed.The frame also carries VCI(here it is 77), chosen by the destination as the incoming VCI for frames from A. Switch 3 uses this VCI to complete the outgoing VCI column
- Switch 3 sends an acknowledgment to switch 2 that contains its incoming VCI in the table, chosen in the previous step. Switch 2 uses this as the outgoing VCI in the table.
- Switch 2 sends an acknowledgment to Switch 1 that contains its incoming VCI in the table, chosen in the previous step.Switch 1 uses this as the outgoing VCI in the table.
- Finally, Switch 1 sends an acknowledgment to source A that contains its incoming VCI in the table, chosen in the previous step.
- The source uses this as the outgoing VCI for the data frames to be sent to destination B.



Data Transfer Phase

To transfer a frame from a source to its destination, all switches need to have a table entry for this virtual circuit. The switch holds four pieces of information for each virtual circuit that is already setup. The data transfer phase is active until the source sends all its frames to the destination. The procedure at the switch is the same for each frame of a message. The process creates a virtual circuit, not a real circuit, between the source and destination.

Tear down phase

In this phase, source A, after sending all frames to B, sends a special frame called a *teardown request.* Destination B responds with a *teardown confirmation* frame. All switches delete the corresponding entry from their tables

Efficiency:- Resource reservation in a virtual-circuit network can be made during the setup or can be on demand during the data transfer phase. In the first case, the delay for each packet is the same. But in the second case, each packet may encounter different delays. There is one big advantage in a virtual-circuit network even if resource allocation is on demand.The source can check the availability of the resources, without actually reserving it.

Delay:- There is a one-time delay for setup and a one-time delay for teardown. If resources are allocated during the setup phase, there is no wait time for individual packets.

Uses:- Virtual-circuit networks are used in switched WANs such as Frame Relay and ATM networks. The data link layer of these technologies is well suited to the virtual-circuit technology.

Circuit switching	**Packet switching (Datagram)**	**Packet switching (virtual circuit)**
Dedicated path	No Dedicated path	Dedicated path
Path is established for entire conversation	Route is established for each packet	Path is established for entire conversation
Call setup delay	Packet transmission delay	set up delay as well as packet delay

Overload may block call setup	Overload increases packet delay	Overload block call setup and increases packet delay
Fixed bandwidth	Dynamic bandwidth	Dynamic bandwidth
No overhead bits after call setup	overhead bits after call setup	overhead bits after call setup

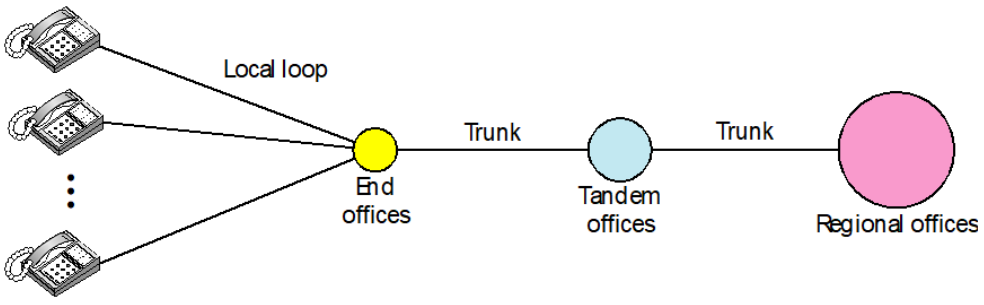
TELEPHONE NETWORK

When a call is made from one telephone to another, switches within the telephone exchanges create a continuous wire circuit between the two telephones, for as long as the call lasts.

To connect one phone to another, the phone call is routed through numerous switches operating on a local, regional, national or international level. The connection established between the two phones is called a circuit.

Telephone network is made up of three major components:

- Local loops
- Trunks
- Switching offices



Local Loops

A twisted-pair cable that connects the subscriber telephone to the nearest end office or local central office. The local loop, when used for voice, has a bandwidth of4000 Hz (4 kHz). The first three digits are the **area code** or **national destination code (NDC)**,

which helps route the call to ther regional switching station, next three digits of a local telephone number **define the office**, and the next four digits define the **local loop number**

Trunk

Trunks are transmission media (optical fibers or satellite links) that handle the communication between offices. A trunk normally handles hundreds or thousands of connections through multiplexing.

Switching Office

To avoid having a permanent physical link between any two subscribers, the telephone company has switches located in a switching office. A switch connects several local loops or trunks and allows a connection between different subscribers.

Destination routing is a sequential pathway that messages must pass through to reach a target destination, where the destination stations are identified by a station address or a destination telephone number.

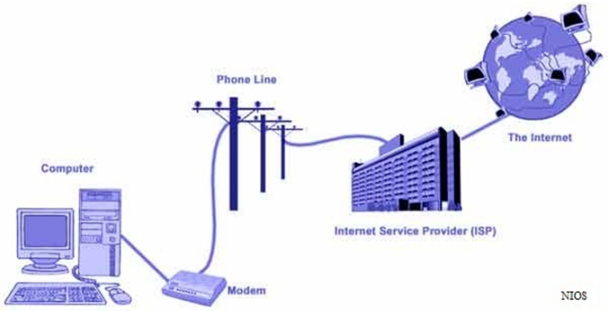
There are various classes of switching systems.

End office switch: connects directly to the stations. It knows which circuit to activate (ring) when given a destination number.

Tandem switch: these are switches in the network and are for transport only.

Dial Up Service

Dial-up Internet access is a form of Internet access that uses the facilities of the public switched telephone network (PSTN) to establish a connection to an Internet service provider (ISP) by dialing a telephone number on a conventional telephone line. Traditional phone lines can carry frequencies between 300 and 3300Hz. All this range is used for transmitting voice. Signal bandwidth must be smaller than the cable bandwidth.The effective bandwidth of a telephone line being used for data transmission is 2400 Hz.ie, range from 600 to 3000Hz.



Dial-up connections use modems to decode audio signals into data to send to a router or computer, and to encode signals from the latter two devices to send to another modem. Modem stands for modulator/ demodulator. A modulator creates a band pass analog signal from binary data. A demodulator recovers the binary data from a modulated signal.

56K Modem (V.90)

Traditional modems have a data rate limitation o f33.6 kbps, as determined by the Shannon Capacity.Modern modems with a bit rate of 56000 bps are available,these are called 56K modems. It allowed 56 Kbps downloads without the need to demodulate an analog signal. It also allowed 33.6 Kbps uploads requiring an analog signal to modulate over a 4 KHz analog voice grade channel.

The V.90 standard provides for full-duplex asynchronous transmissions, but in order to achieve speeds of up to 56 Kbps for downloads, transmissions must be put through a fully digital public switched telephone network (PSTN) that originates and terminates at the telephone company offices, all tandem offices and all transmission facilities.

V.90 is also designed as a standard to digitally attach Internet service providers and online services to the telephone system. Typically, these services were provided through T1 or T3 connections.

Digital Subscriber Line(DSL)

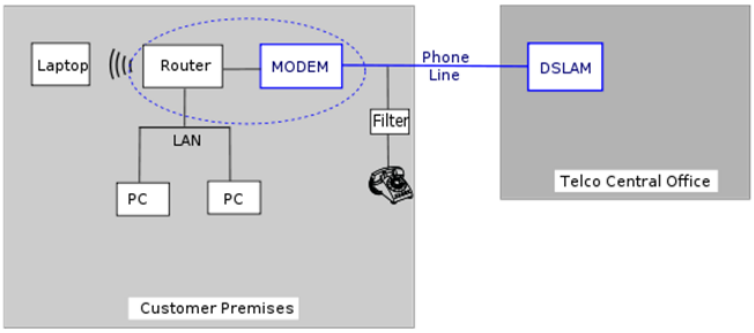
It is a technology used to provide high speed access to the Internet. The motivation for digital subscriber line technology was the ISDN specification proposed in 1984. This technology supports high speed digital communication over the existing local loops. This is possible because DSL uses higher frequency bands for data. On the customer premises, a DSL filter is used for simultaneous use of the voice and DSL services.

The bit rate of DSL services typically ranges from 256 kb/s to over 100 Mb/s downstream, depending on DSL technology, line conditions, and others. DSL takes advantage of unused bandwidth of the local loop. This creates 4312.5 Hz wide channels starting between 10 and 100 kHz. The pool of usable channels is then split into two different frequency bands for upstream and downstream traffic, based on a preconfigured ratio.

DSL transceivers constantly monitor the quality of each channel and will add or remove them from service depending on whether they are usable.Once upstream and downstream circuits are established, a subscriber can connect to a service such as an Internet service provider or other network services.DSL modems modulate frequencies from 4000 Hz to as high as 4 MHz. DLS technology is a set of technologies, ADSL,VDSL,HDSL,SDSL.

ADSL(Asymmetric Digital Subscriber Line) **:**This is a DSL technology that provides higher speed (bit rate) in downstream direction than in the upstream direction. That's the reason it is called asymmetric. Here the available bandwidth of the local loop is unevenly divided for residential customers . This service is not suitable for business customers who need large bandwidth in both directions.

ADSL uses the existing telephone lines(local loop). But how (twisted pair – 1.1 MHz – bandwidth) – traditional modem – has a filter installed at its end office that limits its bandwidth to 4kHz (this filter is removed in ADSL). 1.1 MHz is also affected by factors – distance to switching office, cable size, type of signaling used – so ADSL uses an adaptive technology that tests the condition and bandwidth availability of the line before sending – hence data rate is not fixed.



A digital subscriber line access multiplexer (DSLAM) is a networking device that connects multiple DSL subscribers to one Internet backbone. DSLAM is used by Internet service providers (ISP) or telecommunication providers to share high-caliber Internet bandwidth between DSL subscribers through multiplexing techniques.

CABLE NETWORK

Cable TV networks were originally created to provide access to TV programs for those subscribers who had no reception because of natural obstructions such as mountains. Later the cable networks became popular with people who just wanted a better signal. Cable TV also found a good market in internet access.

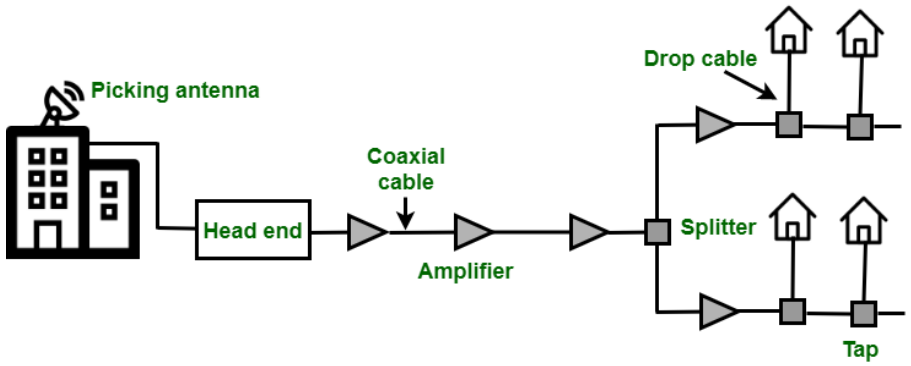
Cable TV started its business only as a video service provider, but with the new advancement in technology, it's moved to the business of Internet access. It also refers to the system that distributes Television signals with the utilization of transmission media. Types of Cable TV Networks are a follows –

1. Traditionally Cable Networks
2. Hybrid Fiber-Coaxial Network

Traditional Cable Networks

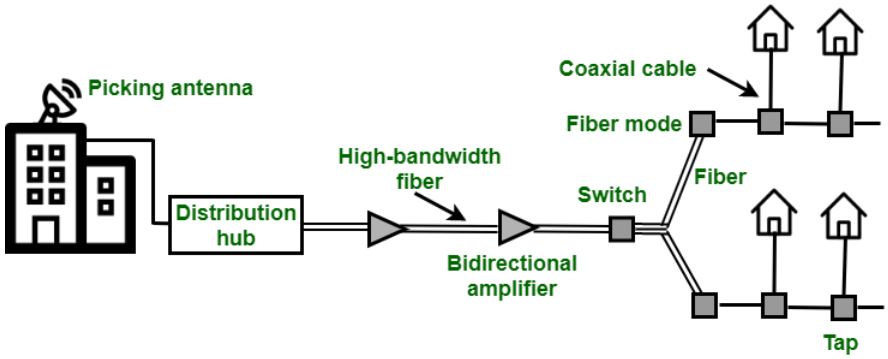
Cable TV started to distribute broadcast video signals to the locations with poor or no reception. It was called community antenna television(CATV) because an antenna at the top of a tall hill or building received the signals from TV stations and distributed these signals via coaxial cables to the community. The following is the schematic diagram of the traditional cable TV network.

The cable TV office,called the head end, received video signals from broadcasting station and fed the signal, into coaxial cables. The signals became weaker and weaker with distance, so amplifiers were installed throughout the network to renew the signals. At the other end, splitters split the cable and taps and drop cables made the connections to the subscriber premises. The traditional cable TV system used coaxial cable end to end. Here communication is unidirectional.



Hybrid Fibre-Coaxial(HFC) Network

Hybrid Fiber-Coaxial Network is the second generation of the cable network. The network uses a combination of fiber-optic and coaxial cable. The transmission medium from the cable TV office to a box, called the fiber node, is optical fiber; from the fiber node through the neighbourhood and into the house is still coaxial cable.



There are nearly 400, 000 subscribers served by Regional Cable Head (RCH). Modulation and demodulation of the signal are done through the distribution hubs after these signals are sent to the fiber nodes through fiber-optic cables. The fiber node split the analog signal so that the same signal is sent to each coaxial cable. Approx. 1000 subscribers are served by coaxial cable. Communication in this is bidirectional.

Cable TV for Data Transfer

Cable companies are now competing with telephone companies for the residential customer who wants high speed data transfer.DSL technology provides high data rate connections for residential customers over local loop. However, DSL uses the existing unshielded twisted pair cable, which is very susceptible to interference. This imposes an upper limit on the data rate. A solution is the use of the cable TV network.

Even in an HFC system, the last part of the network, from the fiber node to the subscriber premises, is still a coaxial cable. This coaxial cable has a bandwidth that ranges from 5 to 750 MHz. To provide Internet acess cable company has divided this bandwidth intothree bands: video, downstream and upstream data.