

UNIT - 1

MULTIMEDIA COMPONENTS

Introduction

Multimedia Communication embraces a range of applications networking. It plays a vital role in presentation. It has variety of applications right from entertainment to education.

During 1990s the power of information processing machines emerged and PCs got evolved as multimedia machines and the age of multimedia technology emerged.

The term multimedia is used to indicate that the information / data relating to an application may be composed of a no. of different types of media which are integrated together in many ways.

The different media types are text, images, speech, audio and video.

Eg: Multimedia electronic mail, electronic commerce, web TV, video telephony etc.

Definition

Multimedia is the media that uses multiple forms of information content and information processing to inform or to entertain the user.

To use of electronic media to store and experience multimedia content.

Multimedia is used to indicate that the information / data being transferred over the network may be composed of one or more media type.

Media types are,
Text, Images, Audio, Video.

The appln of multimedia comm may involve either,
person-to-person comm or person-to-sly comm.

In General, two people communicate with each other through suitable Terminal Equipment (TE) while a person interacts with a sly using either a multimedia pc or workstation.

Multimedia Systems
A Multimedia sly is a sly capable of processing -
multimedia data & appln.

It has characteristics by processing, storage, generation,
manipulation & rendition of MM information.

Appln involves text & images which comprises blocks of digital data. In case of text, a typical unit is a block of characters with each other represented by a fixed no. of binary digits (bits) which is known as code word.

In digitized Image \rightarrow a 2D block having a elements, with each element represented by a fixed no. of bits called picture elements.

In Audio & Video sly \rightarrow which vary continuously with time as the amplitude of speech, audio or video sly varies. (This type of sly is known as an alg sly)

Eg: Audio file has a less size it takes several minutes while a movie has more size than the same duration, can last for a no. of hours.

Features of Multimedia Systems

1. Very high processing power
2. Multimedia capable file system
3. Data Representations
4. Efficient and High I/O
5. Special operating system
6. Storage and memory
7. Network support
8. Software tools

Components of a Multimedia System

1. Capture Devices \rightarrow video camera, video recorder, audio microphone, keyboards, graphics tablet, 3D input, digitizing hardware.
2. Storage Devices \rightarrow Hard disks, CD-Roms, DVD-Rom
3. Communication networks \rightarrow Local N/w, Intranet, Internet, Multimedia or other special high speed networks.
4. Computer Systems \rightarrow local MM desktop machines, workstations, MPEG/VIDEO/dsp h/w
5. Display Device \rightarrow CD quality speakers, HDTV, SVGA, Hi-Resolution monitor, colour printers.

Characteristics of a Multimedia System

1. Basic characteristics

1. Must be computer controlled
2. Integrated
3. The information they handle must be rep. digitally
4. The interface to final presentation of media is usually interactive

challenges for multimedia sly

1. Distributed n/w & Difficult to implement in a distributed n/w

2. Difficult to process different data at same time &

Continuously.

3. Sequencing within the media, playing frames in correct/
time frame in video.

4. Synchronization - Inter media scheduling.

Eg. video & Audio - Lip Synchronization is clearly important for humans
to watch playback of audio and video & even animation & audio.

Categories of Multimedia

2 types,

1. Linear

2. Non-linear

1. Linear

The active Content progresses w/o any navigation Control
for the viewer such as Cinema presentation

2. Non-Linear

Also called hypermedia Content

It offers user interactivity to control progress as used
with a Computer game or used in self-paced Computer based training

It can be ~~viewed~~ live or recorded. In a recorded presentation
may allow interactivity via a navigation sly. A live MH presentation may
allow interactivity via interaction with the presenter or performer.

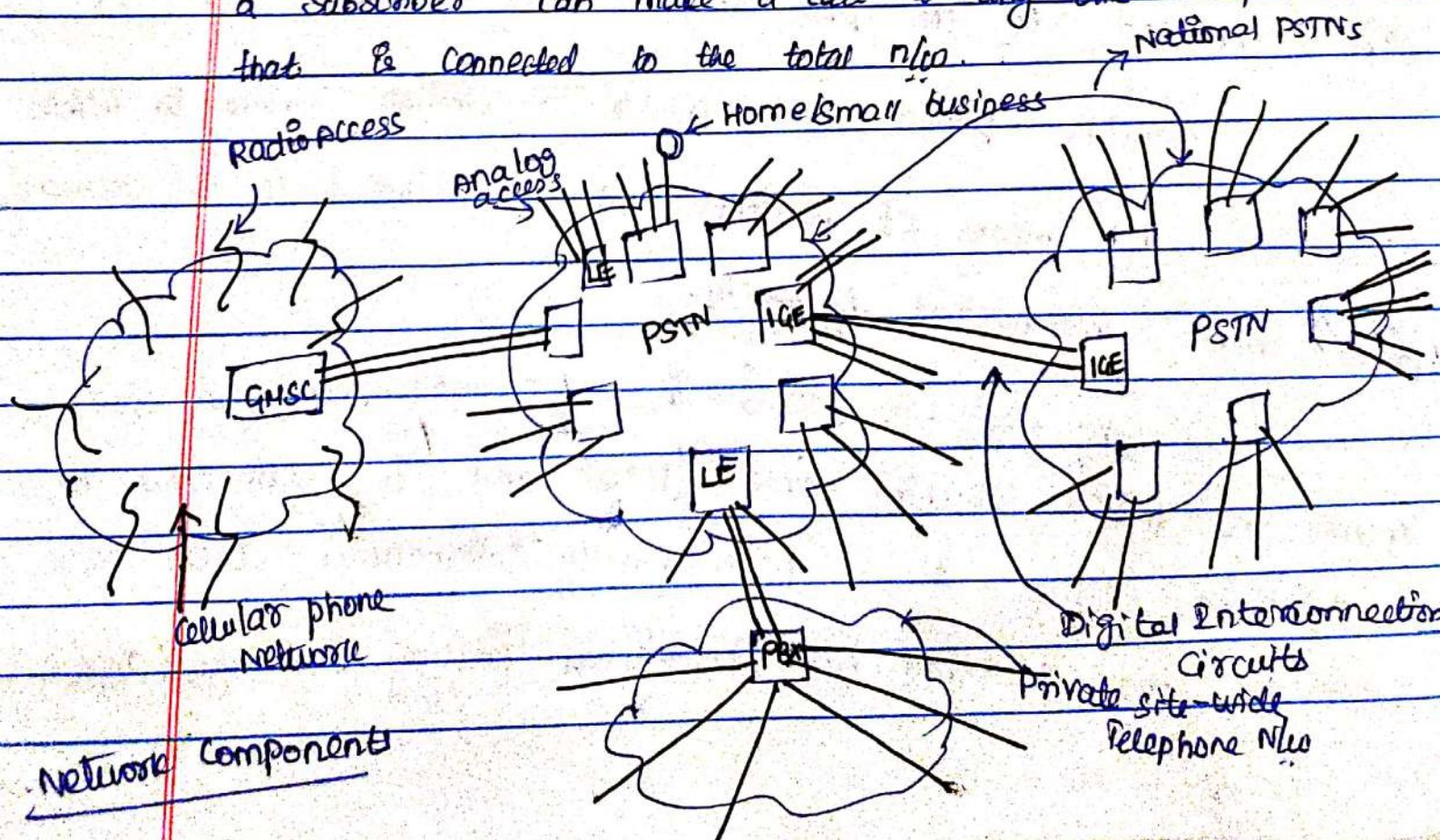
Multimedia Networks,

5 types of Communication Network

1. Telephone Network
2. Data Network
3. Broadcast Television Network
4. Integrated Services digital Network
5. Broadband MultiService Networks

1. Telephone Network

Public Switched Telephone Networks (PSTN) are designed to provide switched telephone service with the advent of other n/w types which known as plain old Telephone Service (POTS). The term "Switched" used to indicates that a subscriber can make a call to any other telephone that is connected to the total n/w.



PSTN - Public Switched Telephone Network

LE - Local Exchange / end office

GMSC - Gateway mobile Switching Center

PBX - Private Branch exchange

IGX - International Gateway Exchange

Telephones which are located in the home or in a small business are connected directly to their nearest local exchange/end office. Those located in a medium or large office/site are connected to a private switching office known as private branch exchange (PBX).

The PBX provides a switched service between any two telephones that are connected to it. The PBX is connected to its nearest local exchange which enables the telephones that are connected to the PBX also to make calls through a PSTN.

Cellular phone networks provide a similar service to mobile subscribers by means of handsets that are linked to the cellular phone network infrastructure by radio.

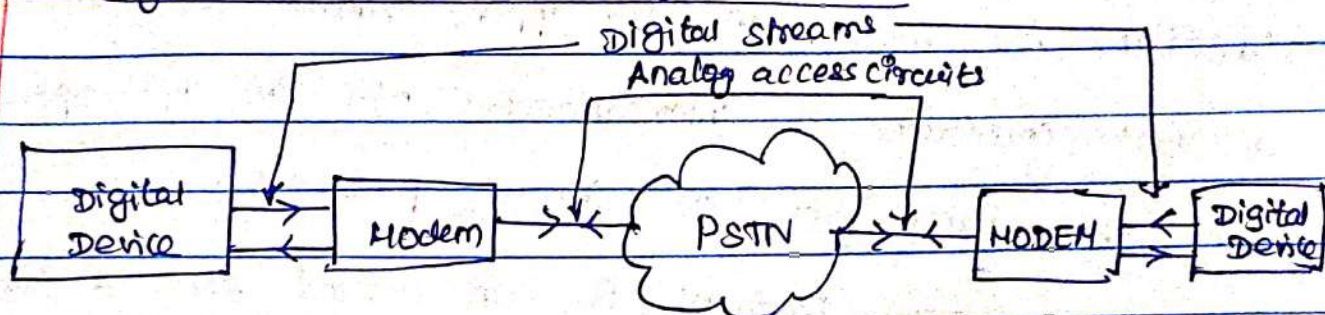
The switches used in a cellular phone network are known as mobile switching centers (MSCs) and are connected to a switching office in a PSTN. Finally, international calls are routed to and switched by International Gateway Exchange (IGEs).

Speech signal is an analog sig it varies continuously with time according to amplitude and freq variations of the sound resulting from the speech.

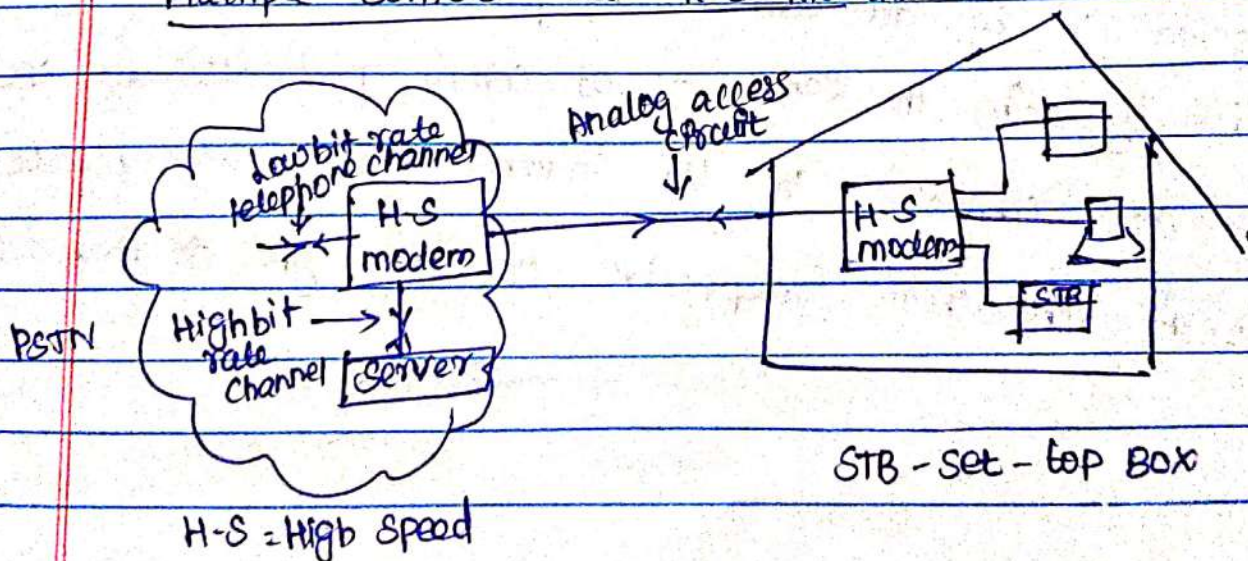
A microphone is used to convert the speech sig into an analog electrical sig. Because of this telephone n/w operate in circuit mode.

Within a PSTN all the switches and the transmission circuits that interconnect them to operate in a digital mode nowadays. To carry a digital sig over the analog access circuits requires a device called as a Modem

Digital transmission using a Modem



Multiple devices via H-S modem



The early modems supported only a very low bit rate service of 300bps, but as a result of advances in digital processing techniques modems are now available in the bit rates up to 56kbps.

2. Data Networks

Data networks were designed to provide basic data communication services such as Electronic mail and general file transfers. The two most widely deployed networks of this type are X.25 n/w and the Internet.

X.25 n/w has low bit rate data appln and it is unsuitable for most multimedia appln. Internet is made up of a vast collection of interconnected n/w all are operated using the same set of comm protocols.

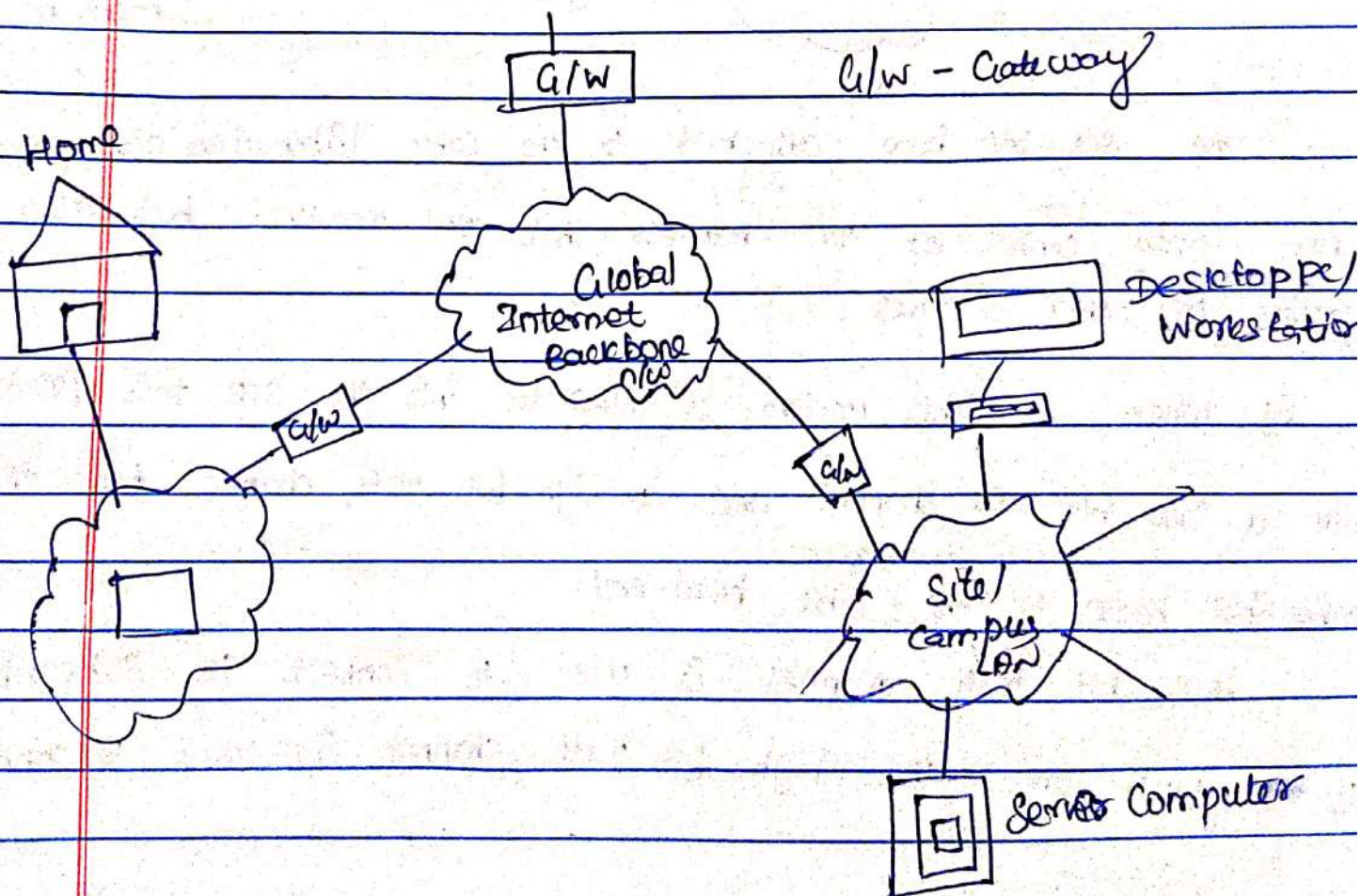
A comm protocol is an agreed set of rules that are agreed to by all communicating parties for the exchange of information. By using the same set of comm protocols all the computers are connected to the Internet can communicate freely with each other irrespective of their type or manufacture.

All data n/w operated in a packet mode. A packet is a container for a block of data and at its head is the address of intended recipient computer which is used to route the packet to the n/w.

In case of a user at home or in small business access the Internet to an Internet Service Provider (ISP) n/w.

Business users access the Internet to a site/campus n/w for single site and access the Internet to an enterprise wide private n/w for multiple sites.

single site/campus n/w is known as Local Area n/w (LAN) & enterprise wide area n/w (WAN) is known as Intranet.



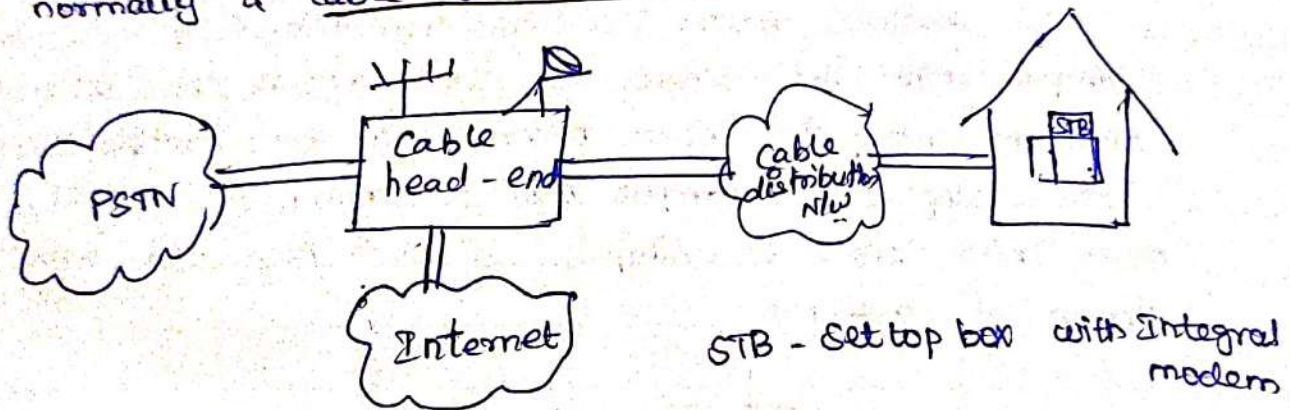
3. Broadcast Television Networks

Broadcast television networks were designed to support the diffusion of analog television programs throughout wide geographical areas.

Two formats,

1. Cable N/w
2. Satellite N/w

In case of a large town or city, the broadcast medium is normally a cable distributed N/w



STB - Set top box with Integral modem

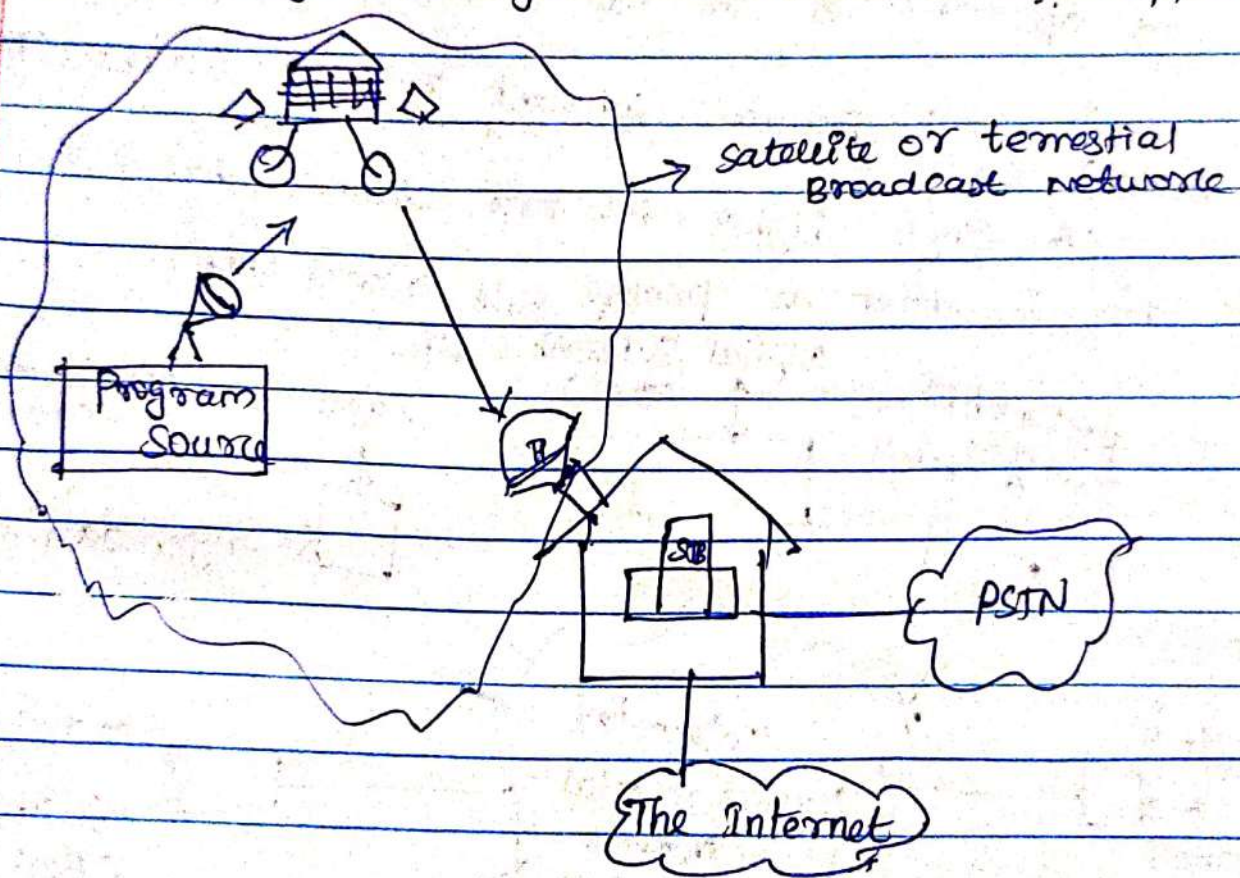
The set-top box attached to the cable distribution N/w provides not only control of TV channels that are received but also access to other services.

Eg: when a cable modem is integrated into the STB this provides both a low bit rate channel and a high bit rate channel from the subscriber back to the cable head-end.

Low bit rate channel is used to connect the subscriber to a PSTN and the high bit rate channel is used to connect

the subscriber to the Internet.
Cable distribution n/w also provide access to the range of multimedia comm services that are available with both a PSTN & Internet.

In case of larger areas, a Satellite n/w is used. When a high speed PSTN modem is integrated into STB this provides the subscriber with an interaction channel. So enhancing the range of services these n/w support.



4. Integrated Services Digital Networks (ISDN)

To provide PSTN users with additional services it will be achieved in two ways,

1. By converting the access circuit that connect user equipment to the n/w

2. By providing two separate comm channels over these

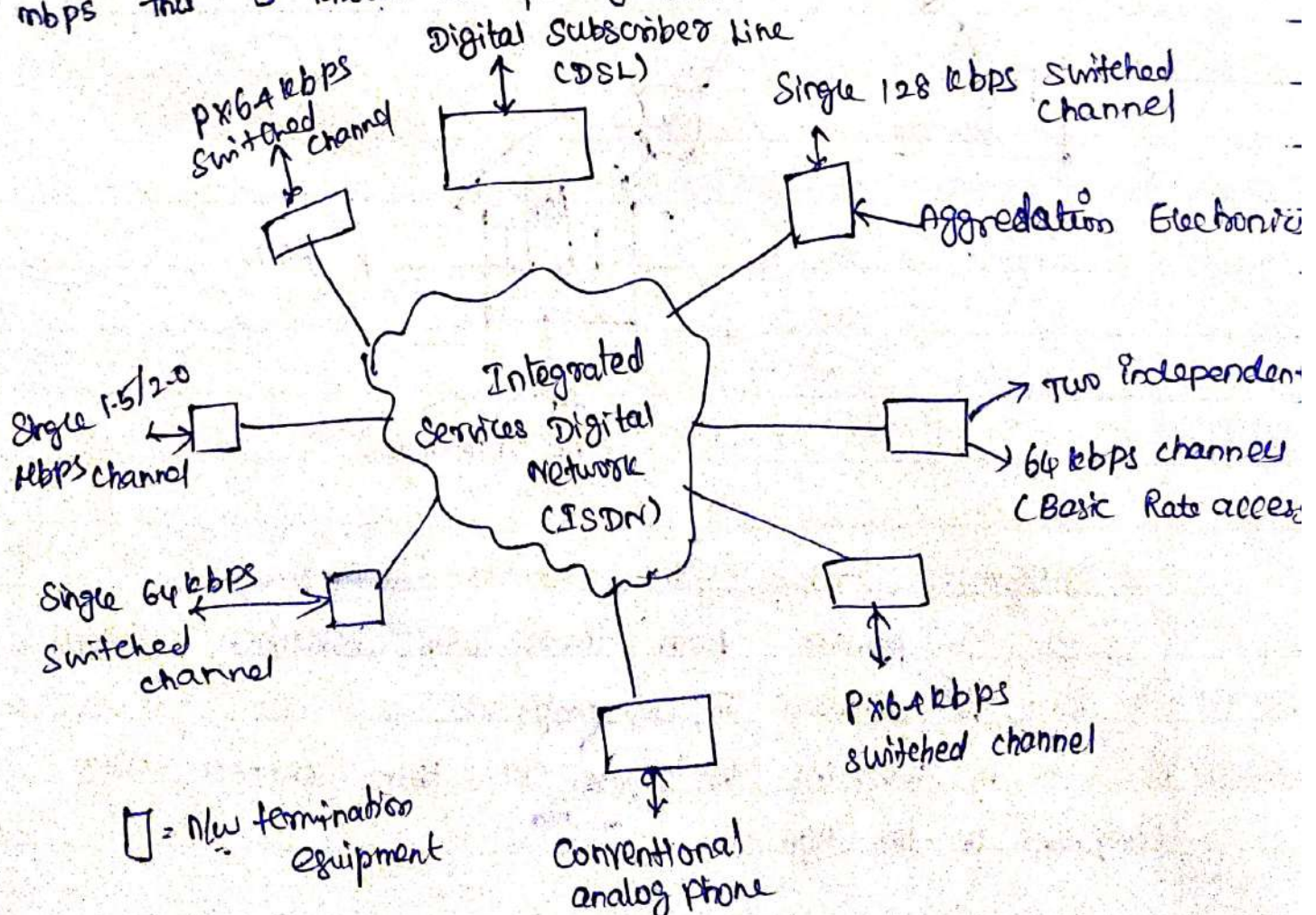
ckt

The subscriber telephone can be either a digital phone or analog. In case of digital phone, the electronics are needed to convert the analog voice and call setup sig into a digital form are integrated into phone handset.

In case of analog phone, the same electronics are located in the new Termination Equipment so making the digital mode of operation of the new transparent to the subscriber phone.

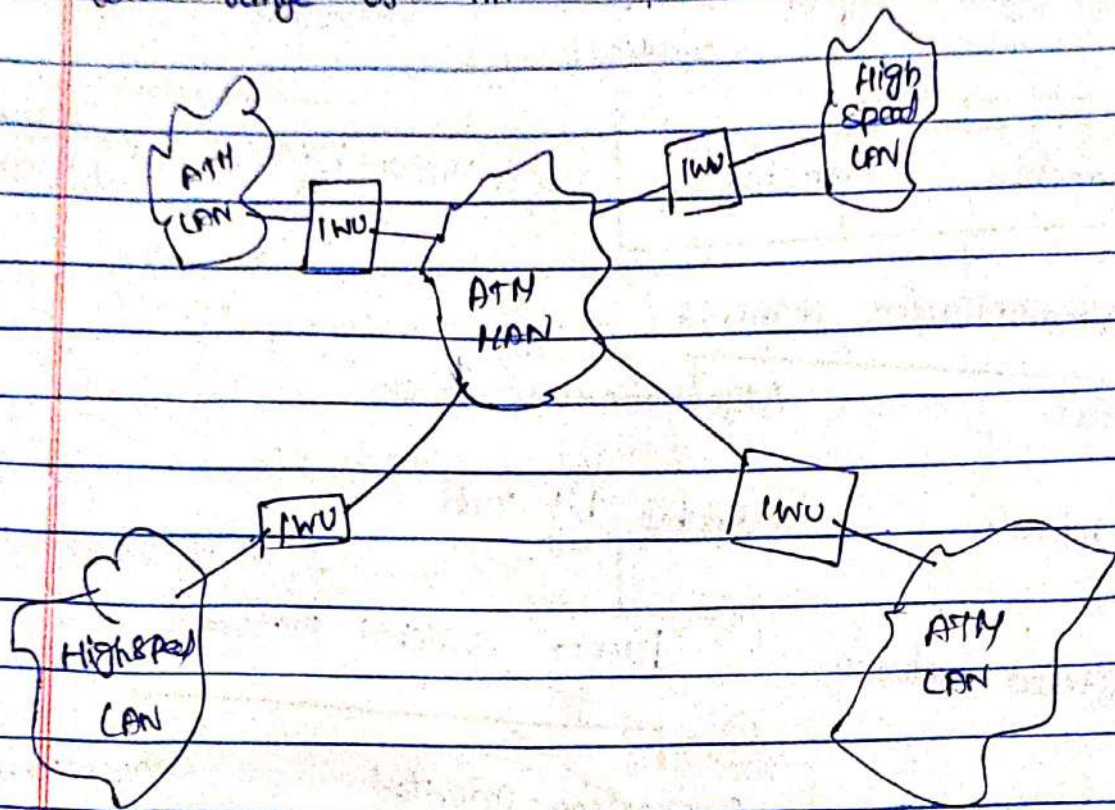
It will produce constant rate of 64 kbps (BRA - Basic Rate Access).

A single higher bit rate channel has either 1.5 or 2 mbps this is known as primary rate access (PRA).



5. Broadband Multiservice Network

It is designed to use PSTN to support a wide range of HH Comm.



It has designed to be an enhanced ISDN and hence were called broadband ISDN (B-ISDN) and for the same reason an ISDN is sometimes referred as narrow band ISDN (N-ISDN).

ATM - Asynchronous Transfer Mode

LAN - Local Area Network

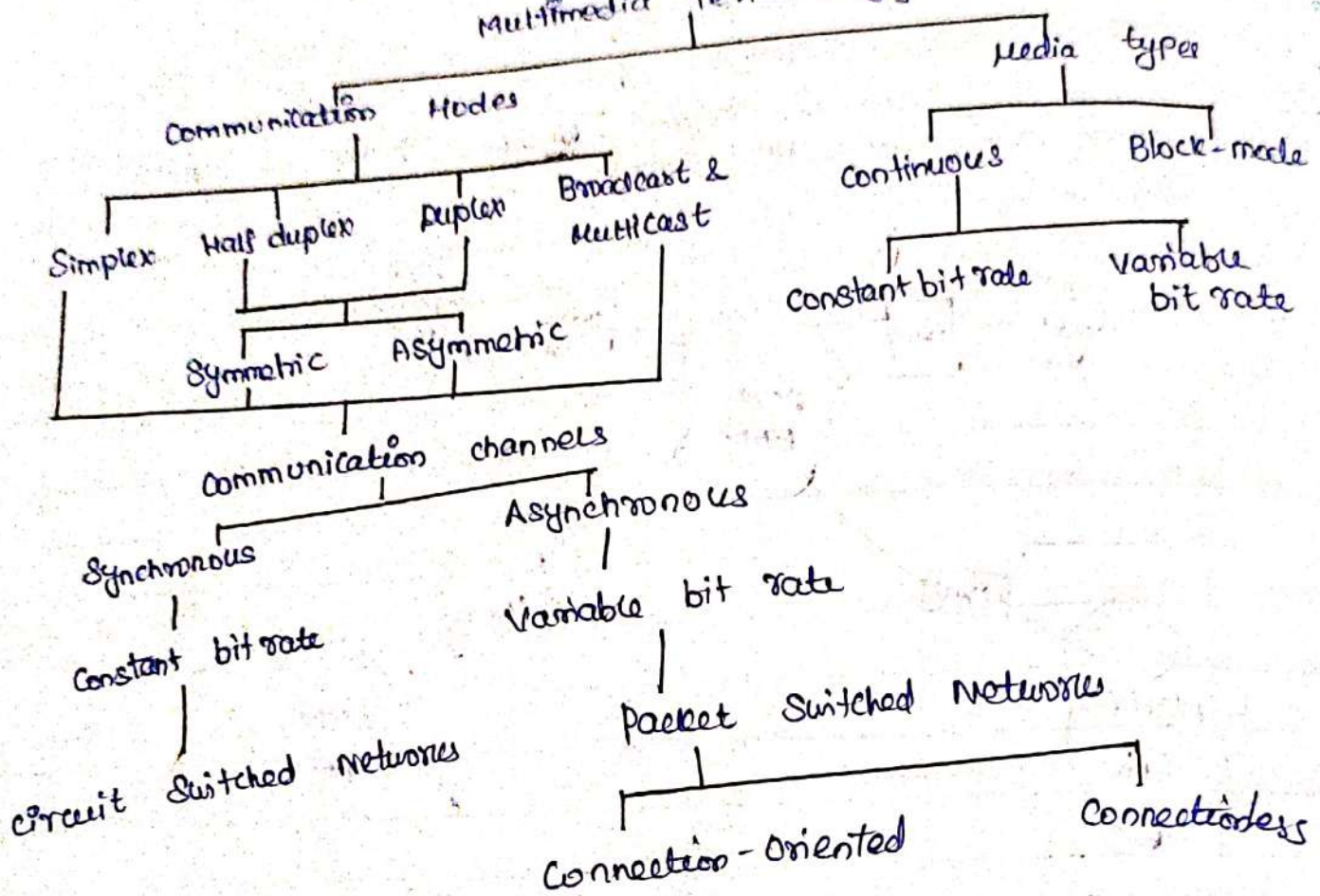
MAN - Metropolitan Area Network

IWU - Interconnecting Unit

ATM MAN is used as a high speed backbone network to interconnect a no. of LAN's distributed around a large town or city.

Media types / classification

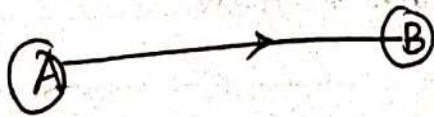
Multimedia Terminology



Simplex

Information associated with the appen flows in one direction.

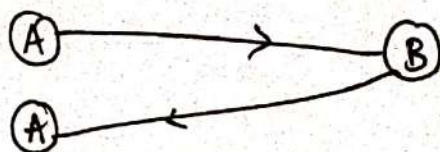
Eg: Transmission of photographic images from probe.



Half-Duplex

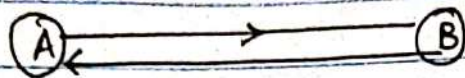
Information flows in both directions but alternately.

Eg: user make use of some information from a remote server and latter returning the requested information



Duplex

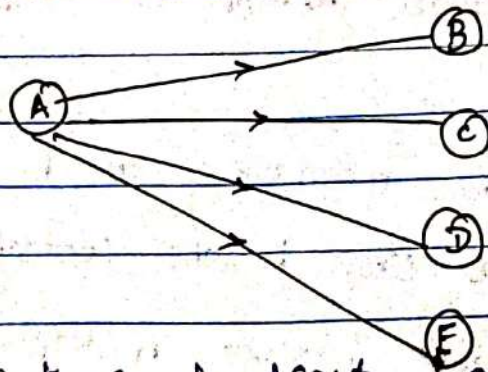
Information flows in both directions simultaneously.
Eg: Two way flow of digitized speech and video associated with a video telephony application.



Broadcast

Information o/p by a single source node is received by all the other nodes.

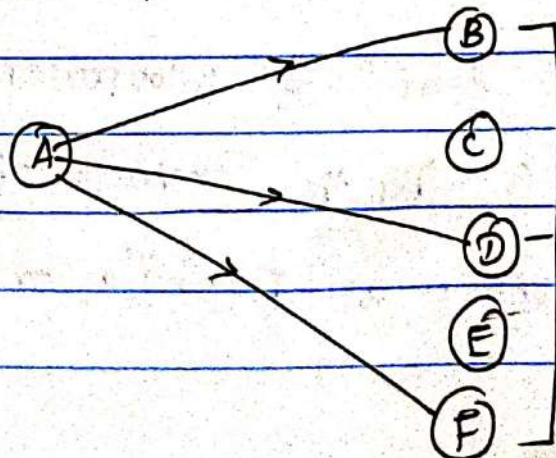
Eg: Broadcast of a TV program over a cable n/w.



Multicast

Similar to a broadcast except that the information o/p by the source is received by only a specific subset of the nodes that are connected to the n/w.

Eg: Video Conferencing which involves a predefined group of terminals / computers connected to a n/w exchanging Integrating Speech & Video Streams.



B, D & F are members of same multicast group.

Multimedia Applications

1. Interpersonal Communications
2. Interactive applications over the Internet
3. Entertainment applications

1. Interpersonal Communications

It may involve speech, image, text or video.

Speech only

- Eg:
1. Telephony,
 2. Voice-mail,
 3. Teleconferencing

In Telephony speech sig \Rightarrow Requires a telephone interface card and associated software known as Computer Telephony

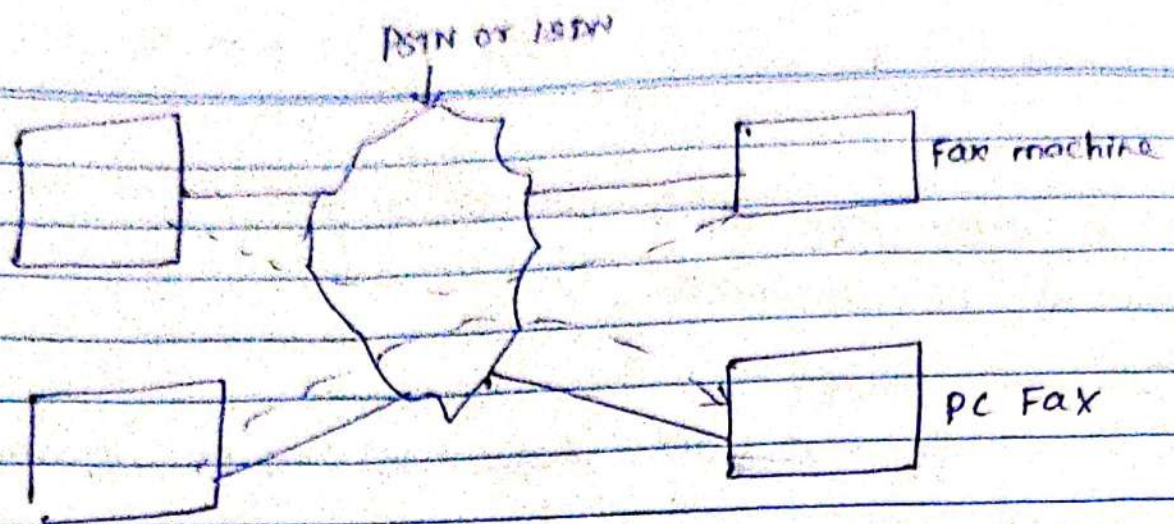
Integration (CTI)

In voice-mail \Rightarrow The message can be read by the owner of the mailbox the next time he/she contacts the server.

In Teleconferencing \Rightarrow It involves multiple interconnected telephones/PCs. Each person can hear and talk to all of the others involved in the call. This type of call is called Conference call.

Image only

An alternative form of interpersonal communication over PSTN or an ISDN is by the exchange of electronic images of documents. This is known as Facsimile or simply Fax.

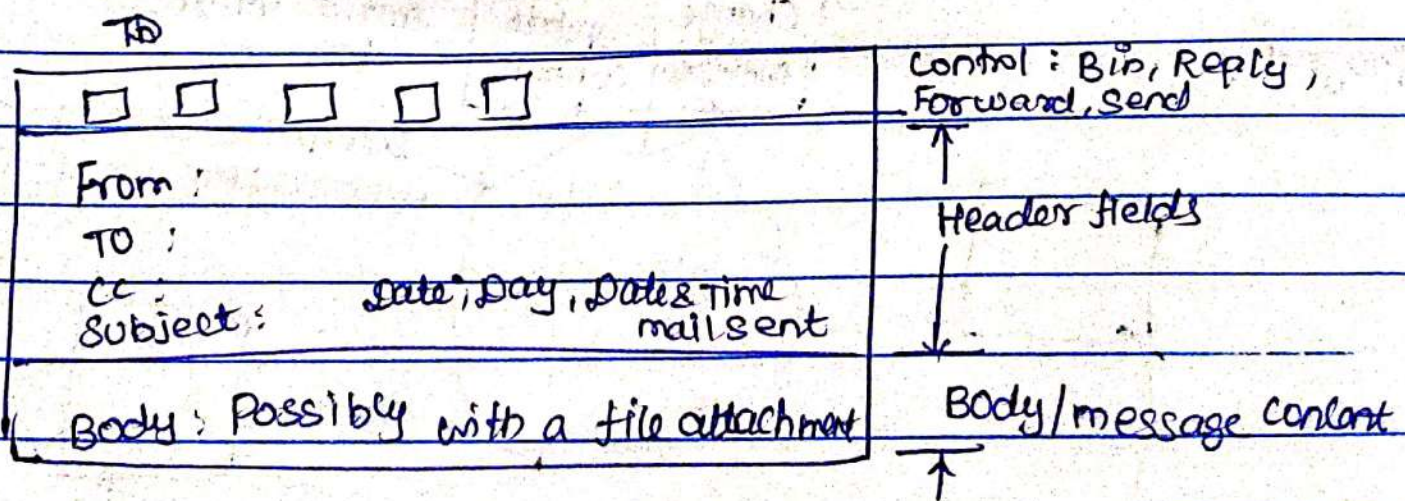


use a pair of Fax machines. Both Fax machines have an integral modem within them and as each page is scanned, its digitized image is simultaneously transmitted over the n/w.

Also possible to use pc instead of Fax machine this type is known as pc Fax
Text only

Electronic mail (e-mail)

Each n/w is a set of one or more server computers and each is known as an email server. Email server has a mailbox for each user connected to the n/w



Head is unique internet wide name of both sender & recipient of the mail.

cc is a copy of the mail can be sent to multiple recipients each of its listed in cc part of the mail header.

cc is Carbon copy which was the original means of making copies of the documents.

Text and Images

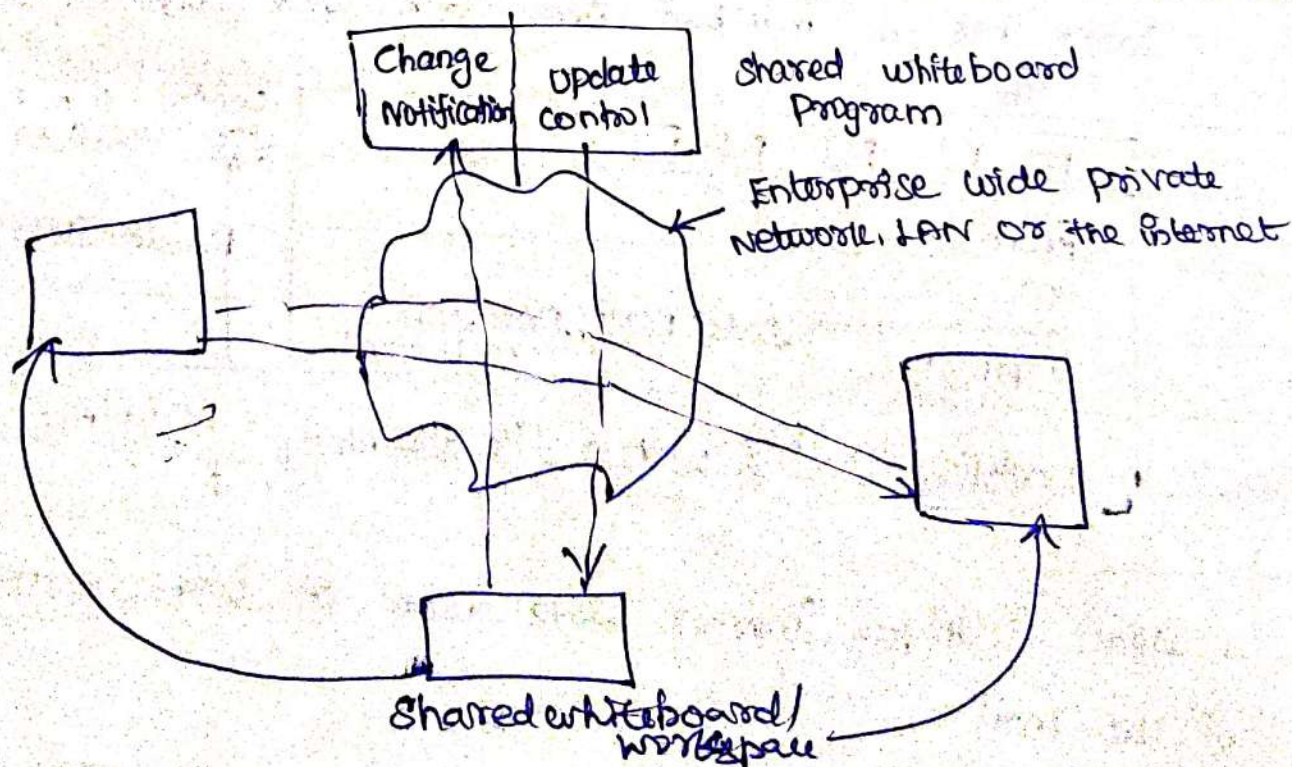
for text and images eg: Computer Supported Cooperative working (CSCW).

The user terminal is either a pc or a workstation and a window on each person's display is used as a shared workspace. This is known as shared whiteboard.

The software associated with CSCW is called whiteboard

Program. It has central program. whenever a member of the group updates the contents of his/her white board, the change notification part sends details of the changes to the whiteboard

Program.



This delays the changes to the update control in each of the other p's workstations and these in turn proceed to update the contents of their copy of the whiteboard.
Speech and Video

Eg: for speech and video appn is video Telephony. Remote lecture and video Conferencing uses both speech and video and it has to be supported by all the network types.

2. Interactive applications over the Internet

Most widely used appn of Internet is WWW (World wide web) or simply web server.

This has a linked set of HM Information Servers that are geographically distributed around the Internet.

Total information stored on all the Servers is equivalent to a vast library of documents.

Each document has a linked set of pages and the linkages b/w the pages are called hyperlinks.

Hyper Text Markup Language (HTML) is the standard document format used for writing documents. It is also used for writing client software to explore the total contents of the web.

3. Entertainment Applications

1. Movie/ video on demand

2. Interactive Television

1. Movie/video on demand
Movies/videos information's are stored in the
Server. Normally the subscribe terminal has conventional
TV device for interaction purpose (set-top box).

2. Interactive Television
It uses the return channel for voting, participation
in games, home shopping and so on.

Digitization Principles

All types of HM information are stored and processed
within a computer in a digital form.

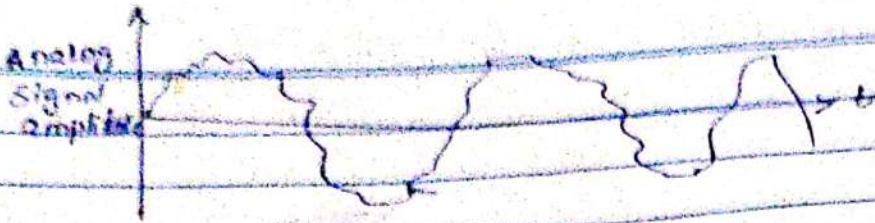
1. Analog signals

A signal whose amplitude varies continuously with time
& known as an analog signal. In order to store and process
analog signals within a computer, it is necessary first to convert
any time varying analog signals into a digital form.

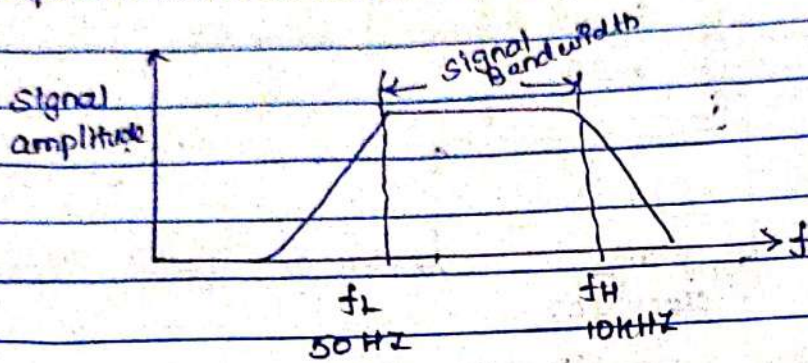
The conversion of an analog signal into a digital
form is carried out using an electrical circuit known as

Signal Encoder.

Fourier Analysis can be used as any time-varying
analog signal is made up of a possibly infinite no. of single
freq sinusoidal signals whose amplitude and phase vary continuously
with time relative each other.



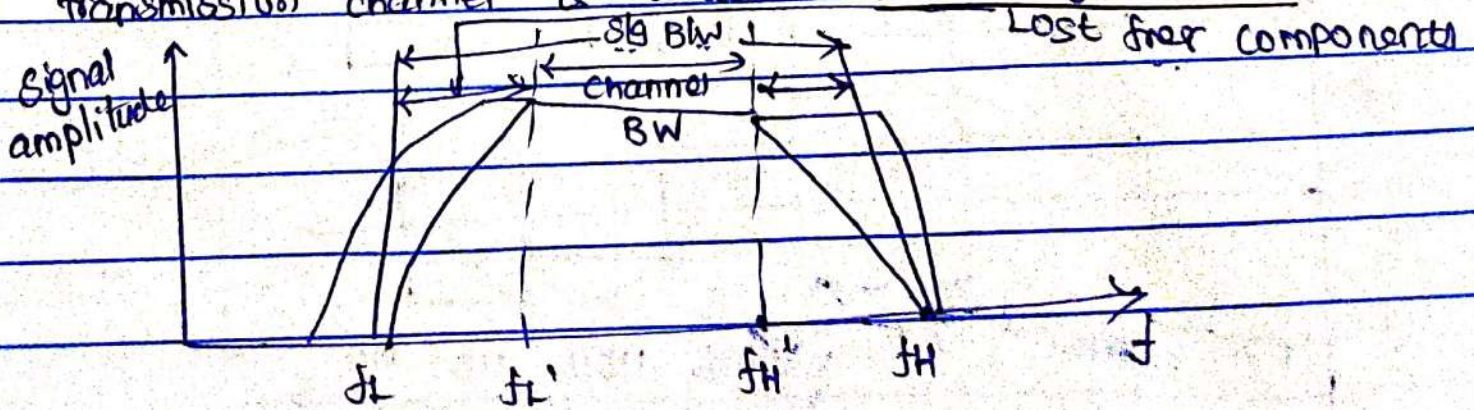
The range of frequencies of the sinusoidal components that make up signal is called Signal Bandwidth.



For speech humans produce sounds which are converted into electrical signals by a microphone. For speech, the frequency range is 50 Hz to 10 kHz.

When analog signal is transmitted through a n/w, BW of transmission channel should be equal or greater than the BW of the signal.

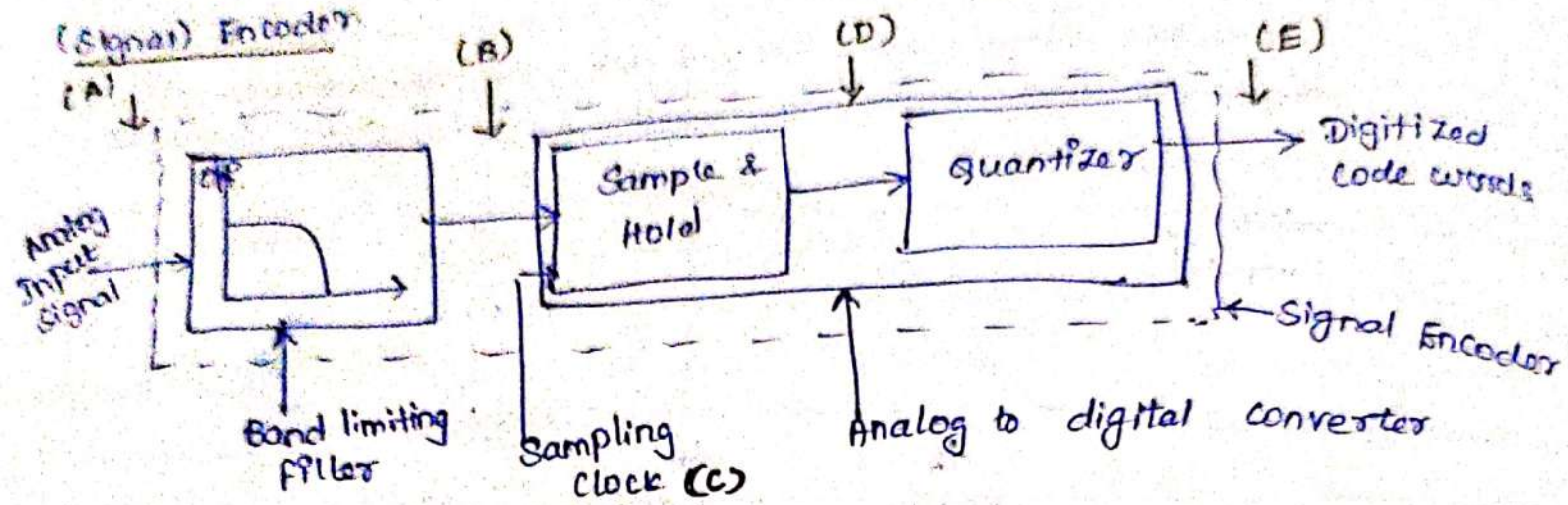
If the BW of the channel is less than the signal BW, then some of low or high frequency components will be lost. Hence it results in degrading the quality of the received signal. This type of transmission channel is called a Bandlimiting channel.



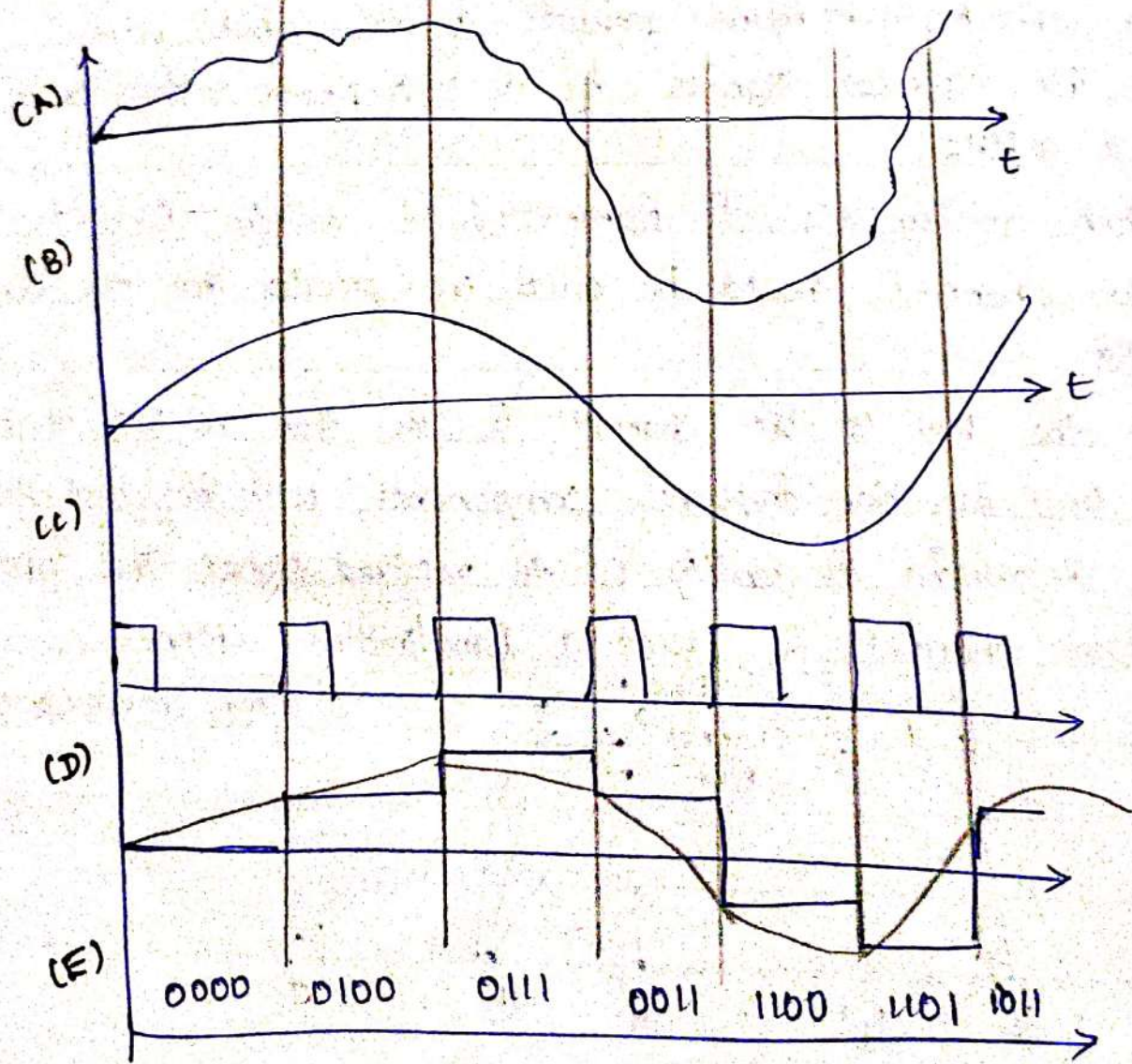
2. Encoder Design

The conversion of an analog sig into a digital form is carried out using an electrical circuit known as

(Signal) Encoder



Two main circuits, 1. Band limiting Filter 2. Analog to Digital Converter (ADC)



Analog input signal is given to band limiting filter and the task of band limiting filter is to remove selected higher frequency components from the source signal (A). The output of filter (B) is then passed to the sample and hold ckt and it is used to sample the amplitude of the filtered signal at regular time intervals (C) and to hold the sample amplitude constant between samples (D). Quantizer circuit which converts each sample amplitude into a binary value known as code word (E).

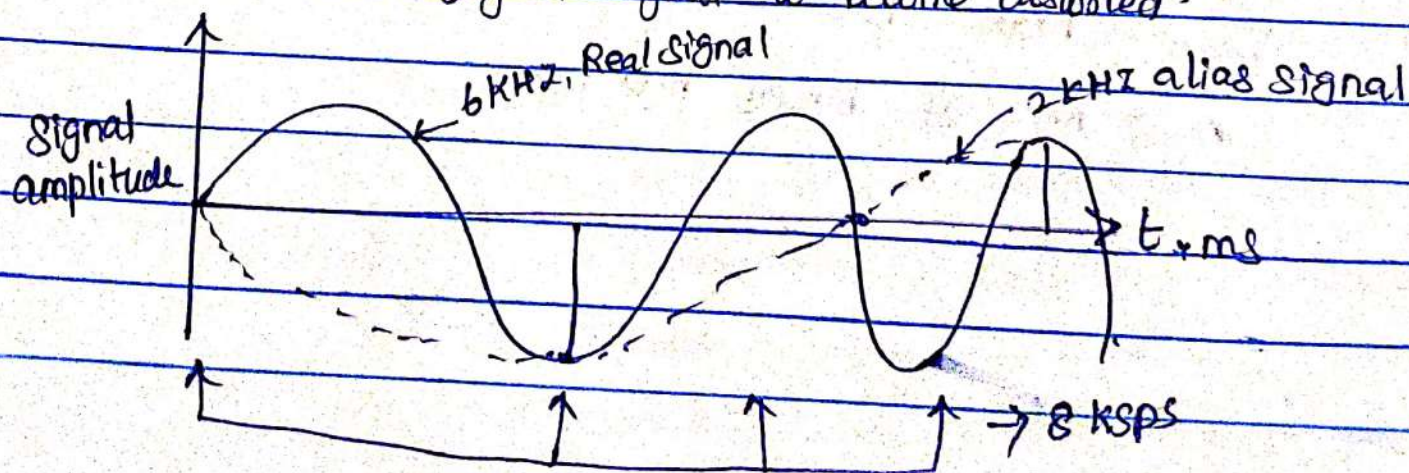
Binary 0 indicates positive value & Binary 1 indicates negative value.

Sampling Rate

The Nyquist Sampling theorem states that "in order to obtain an accurate representation of a time varying analog signal, its amplitude must be sampled at a minimum rate that is equal to or greater than twice the highest sinusoidal frequency component that is present in the signal".

Represented by Hz or Samples Per second (SPS).

Nyquist Rate results in additional frequency components being generated that are not present in the original signal which cause the original signal to become distorted.



The distortion caused by sampling a signal at a rate lower than the Nyquist rate is produced alias signal under sampling process.

Alias Signals

The original signal is assumed to be 6 kHz sine wave which is sampled at a rate of 8 kbps. This is lower than the Nyquist rate $\Rightarrow 12$ kbps ($2 \times 6k$) which results a lower frequency 2 kHz signal. Such signals are called alias signals.

Since they replace the corresponding original signals.

$$f_s = 2 f_m$$

Antialiasing filter

The source signal is passed th' the bandlimiting filter, it allows the signal those have the freq less than the Nyquist rate and any sig has higher freq than the Nyquist rate are removed before the signal is sampled. Hence Bandlimiting filter is also known as Antialiasing Filter.

Quantization Intervals (q)

$$q = \frac{2V_{max}}{2^n}$$

where

$V_{max} \Rightarrow$ Max. positive and negative signal amplitude

$n \Rightarrow$ No. of binary bits used.

Quantization Error

The difference b/w the actual sig amplitude and corresponding normal amplitude is called quantization Error. The error values will vary randomly from sample to sample and hence quantization error is also called quantization noise.

Dynamic Range (D)

The ratio of peak amplitude of the signal to its minimum amplitude is known as dynamic range of the signal.

$$D = 20 \log_{10} \left(\frac{V_{\max}}{V_{\min}} \right) \text{ dB}$$

- 1) An analog signal has a dynamic range of 40dB. Determine the magnitude of the quantization noise relative to the minimum signal amplitude if the quantizer uses (i) 6 bits & (ii) 10 bits

$$D = 20 \log_{10} \left(\frac{V_{\max}}{V_{\min}} \right) \text{ dB}$$

$$\text{Quantization Noise} = \pm \frac{q}{2} = \pm \frac{V_{\max}}{2}$$

$$\text{Hence } 40 = 20 \log_{10} \left(\frac{V_{\max}}{V_{\min}} \right) \quad \& \quad V_{\min} = \frac{V_{\max}}{100}$$

(i) $n = 6 \text{ bits}$

$$\frac{q}{2} = \pm \frac{V_{\max}}{2^6} = \pm \frac{V_{\max}}{64}$$

(ii) $n = 10 \text{ bits}$

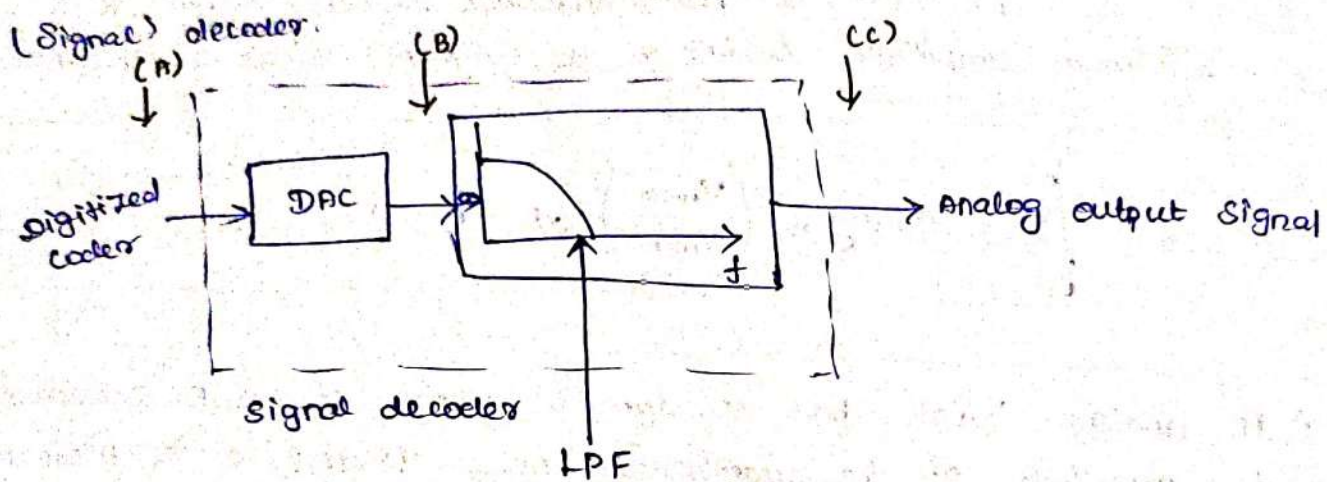
$$\frac{q}{2} = \pm \frac{V_{\max}}{2^{10}} = \pm \frac{V_{\max}}{1024}$$

with 6 bits the quantization noise is greater than V_{\min} & hence

It is an acceptable with 10 bits, quantization noise is less than V_{min} & hence will have a much reduced effect.

3. Decoder Design

The conversion of the stored digitized samples relating to a particular media type into their corresponding time varying analog form is performed by an electrical circuit known as

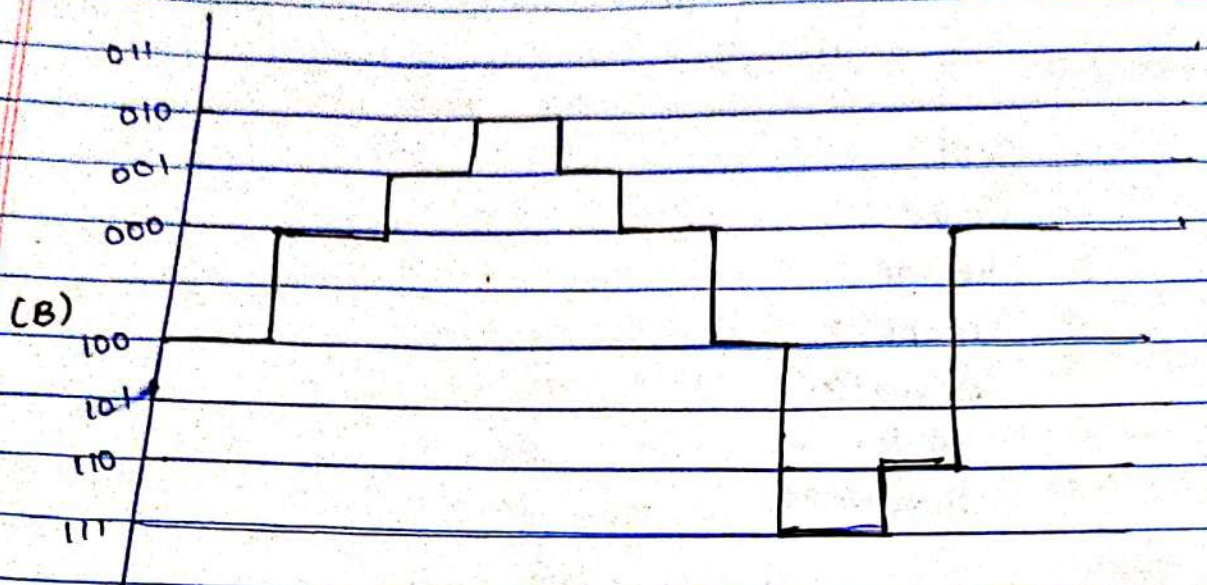


Each digitized code word (A) is converted into an equivalent analog samples using a ckt called a DAC. The sig produced by the DAC is shown in (B).

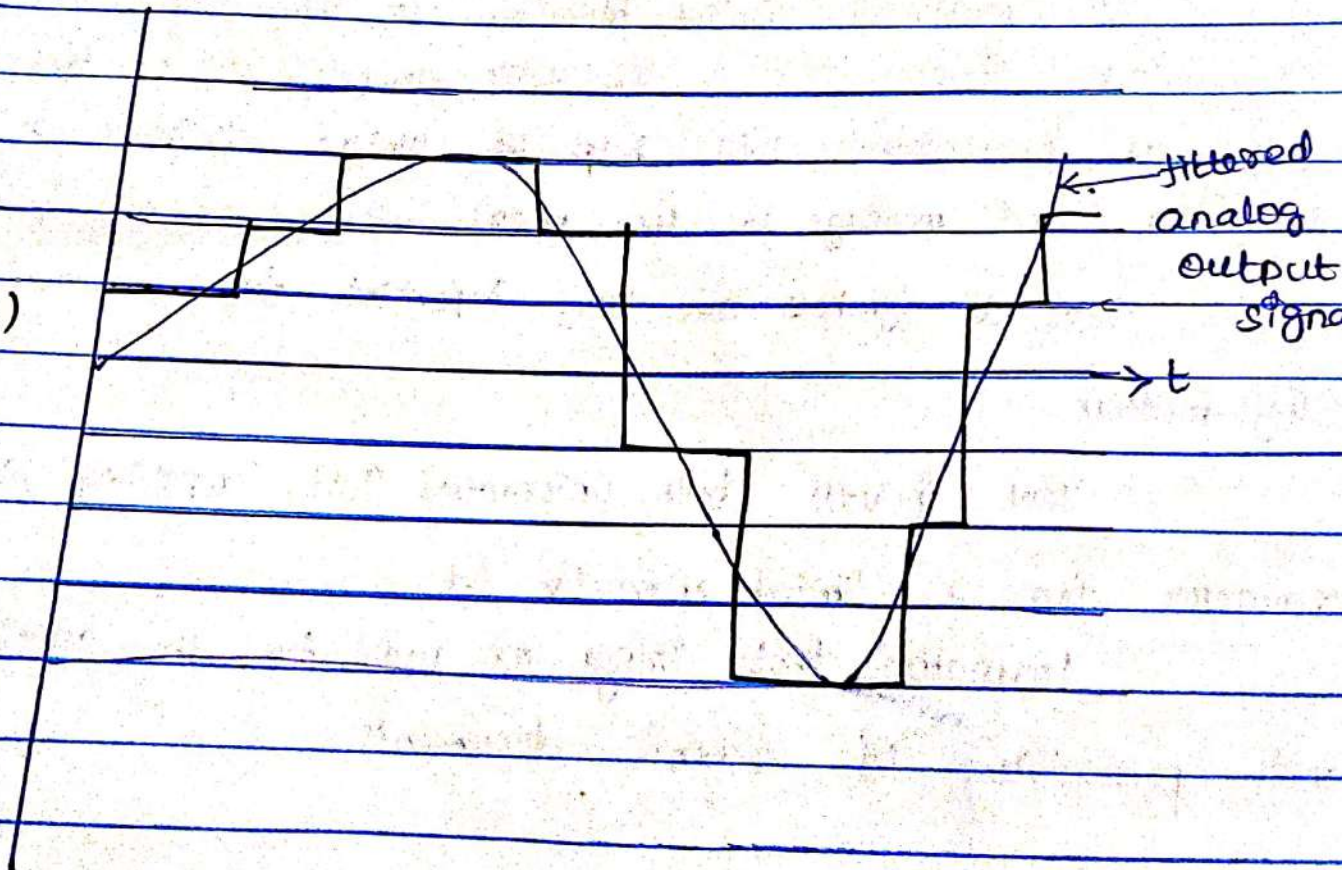
In order to reproduce the original signal, the o/p of DAC is passed th' LPF. It passes only original filtered sig (C).

LPF is made same as that used in the Band limiting filter of the encoder. Because of its fn, the LPF is also known as Recovery or Reconstruction filter.

(A) $\boxed{100} \boxed{000} \boxed{001} \boxed{010} \boxed{001} \boxed{000} \boxed{101} \boxed{111} \boxed{110} \boxed{000}$ $\rightarrow t$



(C)



Multimedia components & their characteristics

The term MM is used to indicate that the information/data being transferred over the net may be composed of one or more media type. These media type are called as Components of Multimedia.

1. Text
2. Sound
3. Image
4. Graphics
5. Animation
6. Video &
7. Hardware

1. Text

All Multimedia Content has text in some form. It is used to communicate information to the user. proper use of text and words in MM presentation will help the content developer to communicate the idea and message to the user.

Text & Symbols are very important for communication in any medium.

Text includes both unformatted text, comprising strings of character from a limited character set.

Formatted text strings are used for the structuring, access and presentation of electronic documents.

The source of text data are keyboard, speech i/p, Optical character recognition, data stored on disk.

3 types of text,

1. Unformatted text

2. Formatted text

3. Hyper text

1. Unformatted Text

Also called as plain text and enables pages to be created which comprise strings of fixed-sized characters from a limited character set.

Eg: ASCII - It has collection of alphabetic, numeric and punctuation characters.

ASCII \Rightarrow American Standard Code for Information Interchange

In ASCII character set each character has its own binary code words which represented by a unique 7-bit binary code word.

In addition to that it includes,

1. Format Control characters: BS (Backspace), LF (Line Feed), CR (Carriage Return), SP (Space), DEL (Delete), ESC (Escape), & FF (Form Feed).

2. Information Separators: FS (File Separator) & RS (Record Separator)

3. Transmission Control Characters: SOH (Start of Heading), STX (Start of Text), ETX (End of Text), ACK (Acknowledge), NAK (Negative Acknowledge), SYN (Synchronous Idle) and DLE (Data Link Escape).

Applications of unformatted Text

1. Videotex
2. Teletex

2. Formatted Text

Also called as rich text and enables pages and complete documents to be created which comprise of strings of characters of different styles, size and shape with tables, graphics and images inserted at appropriate points.

Eg: word processing packages - used in publishing sector for the preparation of papers, books, magazines, Journals & so on.

It has collection of characters with different styles & variable size, shape. Each of which can be plain, bold or italicized.

In addition to that variety of document formatting options such as structure a document into chapters, sections & paragraphs, each with tables, graphics & pictures inserted at appropriate points.

3. Hyper Text

HyperText is a type of Formatted text that enables a related set of documents to be created which have defined linkage points between each other.

Eg: HTML - Hyper text Markup language designed for creation of web pages.

HTML is an eg. of markup languages. Markup is the term used by a copy editor when the printing of documents was carried out manually. other markup languages are,

1. postscript - page description language
2. SGML - Standard Generalized Mark-up language
3. Tex
4. latex

Hyper text is mainly used for creation of web pages and mostly with the www using hypertext only universities and colleges other private organizations are creating their own webpage based on their requirements.

Sound (or) Audio

All MM appns require sound or audio sig with text and videos.

Two types of audio signals,

1. Speech signal - used in variety of inter-personal appns which
 2. Music signal - includes telephony & video telephony
- used in appns such as CD & Broadcast Television

Audio sig can be produced in two forms,

1. Naturally
2. using synthesizer

↓

Audio produced naturally by means of a microphone & electrically using some form of synthesizer

Microphone
Generates a time varying analog sig & it has to be converted into a digital form using an audio sig encoder

Synthesizer
Audio is created in digital form and can be readily stored within the computer memory.

Bandwidth
BW of speech sig & music sig are varied. Eg: BW is from 50Hz to 10KHz for speech & music 15Hz to 20KHz.

Sampling Rate
In speech sig the BW of the n/w used in many interpersonal appn is much less than BW of source sig.
In music sig, the sampling rate is often lowered in order to reduce the amount of mem that is required to store a particular passage of music.

3 kinds of digitization parameters

1. PCM Speech
2. CD-quality audio
3. Synthesized audio

1. PCM Speech

Most of the appn use for comm purposes of a PSTN. Initially, a PSTN is operated with analog sig & later analog

CKTs are replaced by digital circuits.

Adv of dig CKTs instead of analog transmission CKT

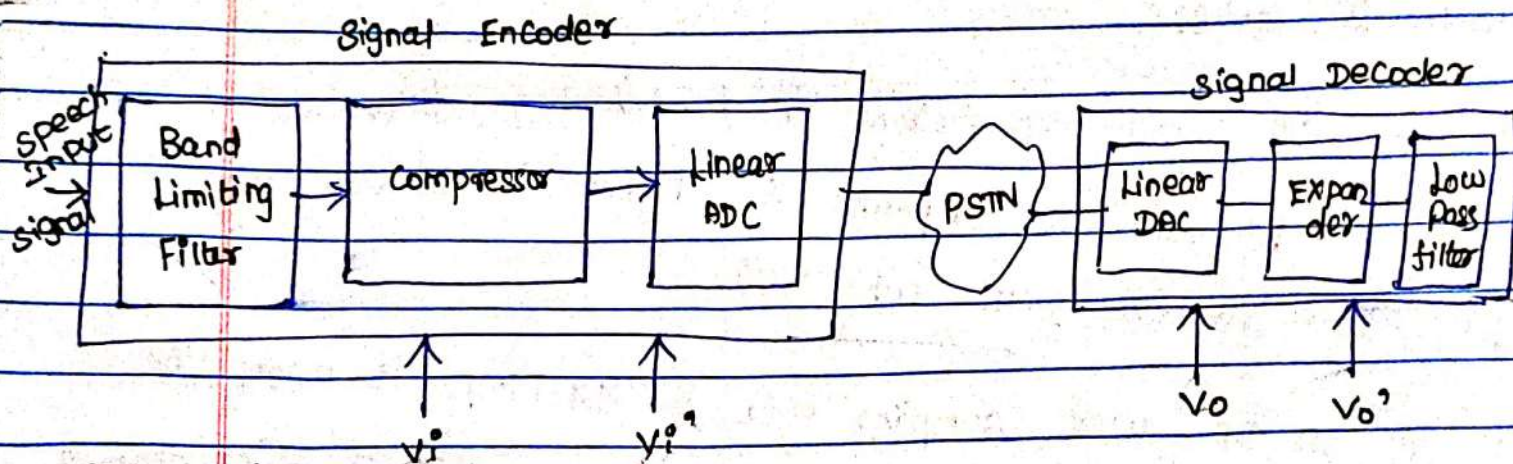
1. BW of speech CKT was limited to 300Hz to 3.4KHz

2. Nyquist rate 6.8KHz

3. Sampling rate of 8KHz to avoid aliasing

4. Has minimize bit rates

The digitization procedure is known as pulse code Modulation (PCM)



Input signal is being sampled & converted into dig form by ADC, it is passed to compressor CKT.

Compressor CKT \Rightarrow produces the sample level of quantization noise irrespective of magnitude of i/p sig

produce sample level of noise for both low amplitude & high amplitude sig.

In a PCM sys \Rightarrow quantization intervals are made non-linear. ADC CKT performs a linear quantization on the compressed sig. Similarly, at destination, each received code word/

is just fed into a linear DAC

Analog signal from DAC is passed to the expander circuit which performs the reverse operation of compressor circuit.

2. CD-Quality Audio

The disk used in CD-player and CD-ROMs are digital storage devices for stereophonic music. CD-digital audio is a standard associated with these devices.

for music signal BW is 15 Hz to 20 kHz. min sampling rate is 40 kbps.

1. To allow imperfections in band limiting filter used?

2. Bit rate is compatible for higher transmission channel

bit rates available with public network.

In CD-DA used sampling rate is 44.1 kbps. It means the signal is sampled at 23 μ sec intervals. BW of recording channel on a CD is large.

for 16 bits per sample, Quantization intervals = 65536.

$$\begin{aligned}\text{Bit rate per channel} &= \text{Sampling rate} \times \text{bits/sample} \\ &= 44.1 \times 10^3 \times 16 = 705.6 \text{ kbps}\end{aligned}$$

$$\text{Total bit rate} = 2 \times \text{Bit rate/channel}$$

$$= 2 \times 705.6 = 1.411 \text{ Mbps}$$

Total bit rate used in CD-ROMs are widely used for the distribution of multimedia data files.

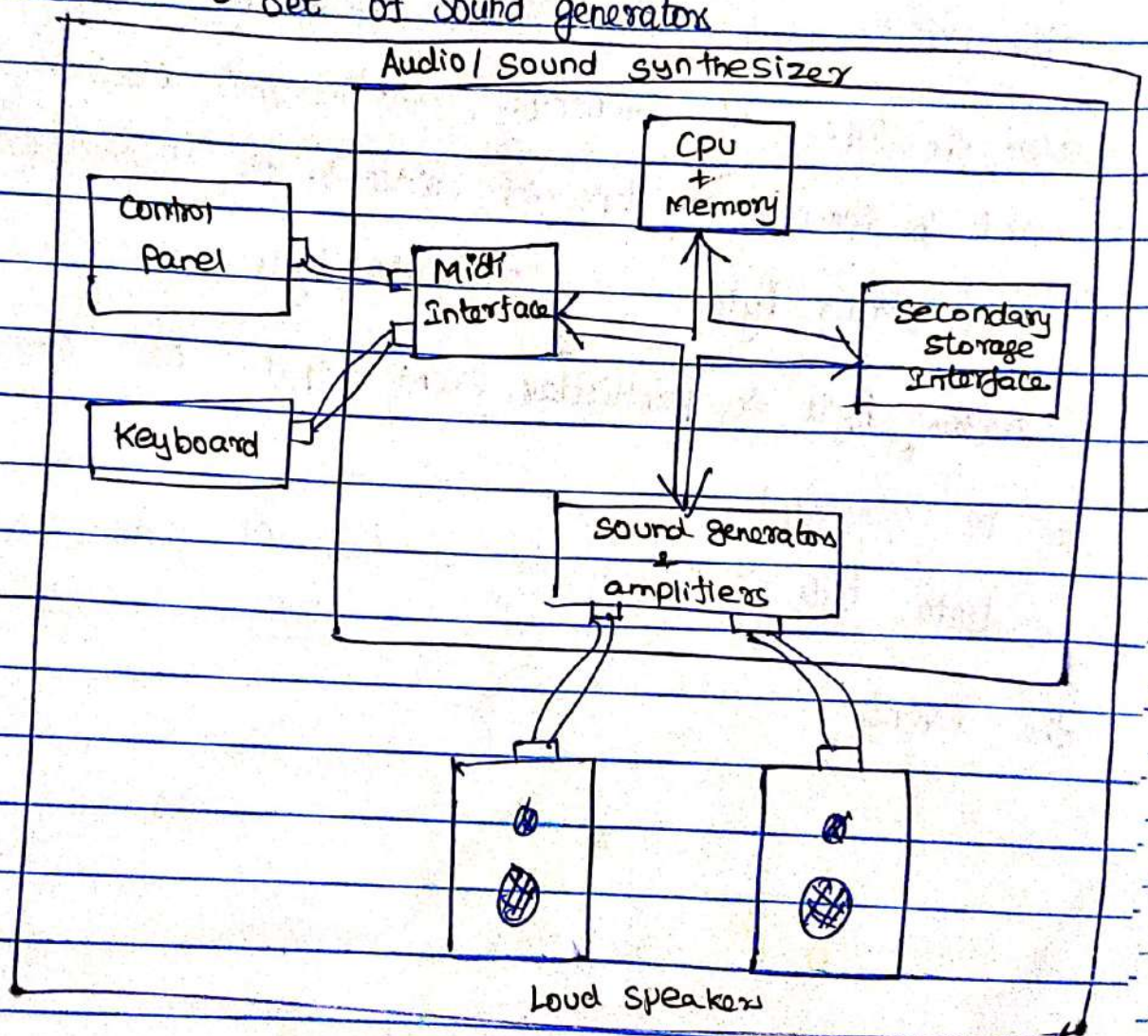
3. Synthesized Audio

The amount of memory required to store a digitized audio waveform can be very large even for short passages also.

Synthesized audio is much easier to edit & mix several passages together.

Audio Synthesizer has 3 main components,

1. Computer
2. Keyboard
3. Set of Sound generator



Computer takes input command from keyboard & passes it to the sound generation produced the corresponding sound waveform via DACs to drive speakers.

pressing a key on the keyboard of a synthesizer has a similar effect to press a key on keyboard of computer. For each key is pressed different code word with synthesizer keyboard is generated and ready by the computer program.

Music Instrument Digital Interface (MIDI) \Rightarrow format of the standardized set of messages used by a synthesizer but also the type of connectors, cables and electrical sig that are used to connect any type of device to the synthesizer.

1. Status byte
2. Data byte

Status byte \Rightarrow particular event that has caused the message to be generated.

Data byte \Rightarrow It defines a set of parameters associated with the event.

Images

3 kinds of format:

1. Graphics
2. Digitized documents
3. Digitized pictures

All three types of image are displayed & printed in the form of 2D matrix of individual picture elements known as pixels or pels.

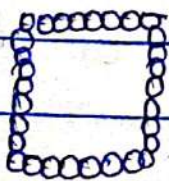
1. Graphics

There is a range of software package and programs available for the creation of Computer Graphics. It provides easy to use tools to create graphics that are composed of visual objects like lines, arcs, squares, rectangles, circles, ovals, diamonds, stars as ^{well as} any forms of hand drawn objects.

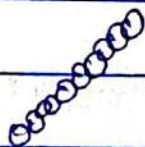
Eg: we can change the object shape, color & size. Textual information can also be included in a graphic.

Objects can overlap each other with selected object nearer to the front than another.

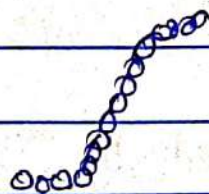
Square



Line



Curve

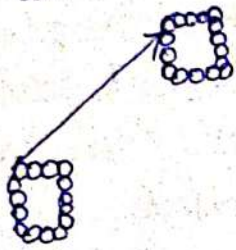


A computer's display screen can be made up of a 2D-matrix of individual picture elements and each of it has a range of colors.

VGA - Video Graphics Array is a common type of display used and it has matrix of 640 horizontal pixels by 480 vertical pixels.

Each object has a no. of attributes in hand-drawn objects. It includes shape. Eg: a line, a circle, a square and so on. Object size in terms of pixel positions of its border. Attributes: Co-ordinates, the color of the border, its shadow and so on.

Editing of an object involves simply changing selected attributes associated with the object.



We can move a square to a different location on the screen by simply changing border coordinates and leaving the remaining attributes unchanged.

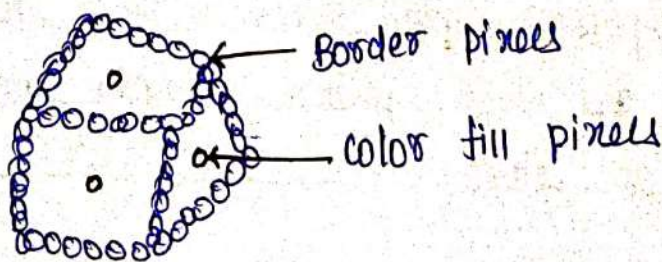
An object shape is said to be either open or closed.

Open object

The start of first line and end of the last line that make up the object's border are not connected as they do not start and end on the same pixel.

Closed object

The pixels enclosed by its border can all be assigned the same color that is known as color fill.



Process of creating solid objects are known as rendering. All objects are drawn on the screen by the user. Simply specify the name of the objects, its attributes and color fill values.

A Graphics consists of the set of commands each has its own attributes that are necessary to draw different object that make up the graphic.

The commands associated with each objects use the lower-level commands to display the objects on the screen.

Representation of Graphic

1. High level version \Rightarrow Similar to the source code of a high level program. The actual pixel image of graphic is similar to byte string corresponds to the low level machine code of the program.

2. Actual pixel image of the graphic \Rightarrow Also known as bit-map format.

Merits of High-level Language Form

1. Much more compact
2. Requires less memory to store the image
3. Requires less BW for its transmission

There are no. of standardized forms used to convert the high level language to pixel image form such as

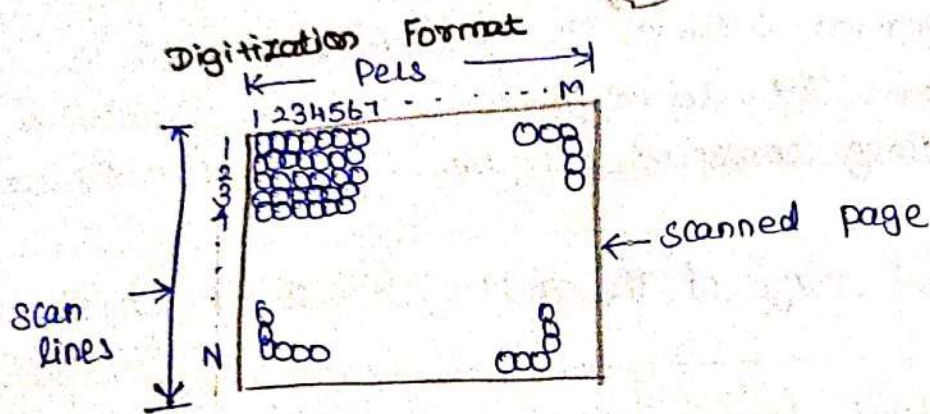
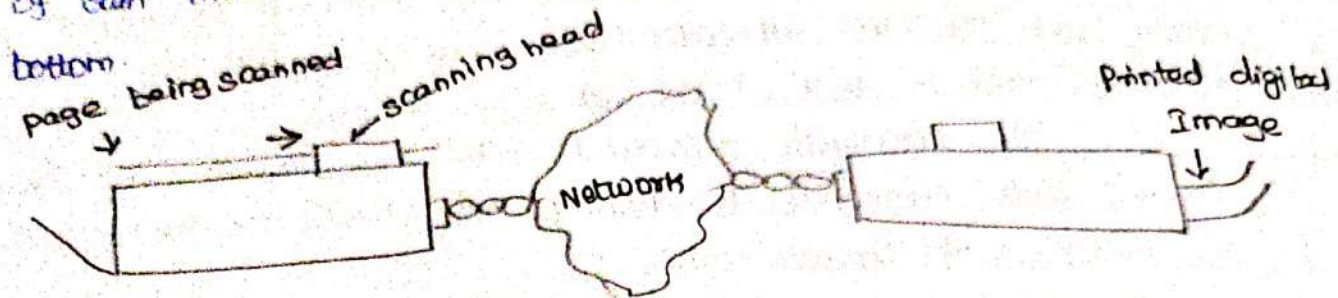
- (i) GIF - Graphical Interchange Format
- (ii) TIFF - Tagged Image File Format

2. Digitized Documents

Eg: Facsimile (Fax) machine

Working principle

The scanner associated with a fax machine operates by scanning each complete page from left to right to produce a series of scan lines that start at the top of the page and end at bottom.



pel - picture element
Resolution = $M \times N$

Vertical Resolution \Rightarrow 3.85 or 7.7 lines / millimeter.

approx 100 or 200 lines / inch.

As each line is scanned, the o/p of scanner is digitized to a resolution of approx 8 picture elements known as pels.

for Fax machine. @ 0 \Rightarrow white pel
1 \Rightarrow Black pel

3 Digital pictures

256 different levels of gray / element

color principles

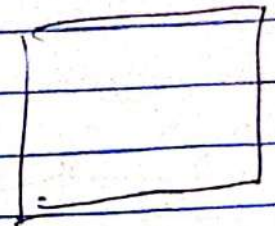
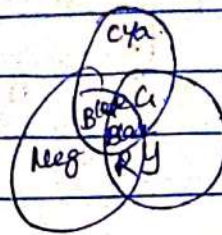
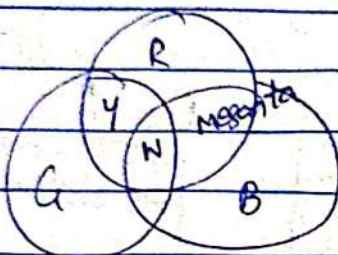
3 colours used \rightarrow R (Red), G (Green),

B (Blue) - RGB color mode

2 mixing techniques

1. Additive

2. Subtractive

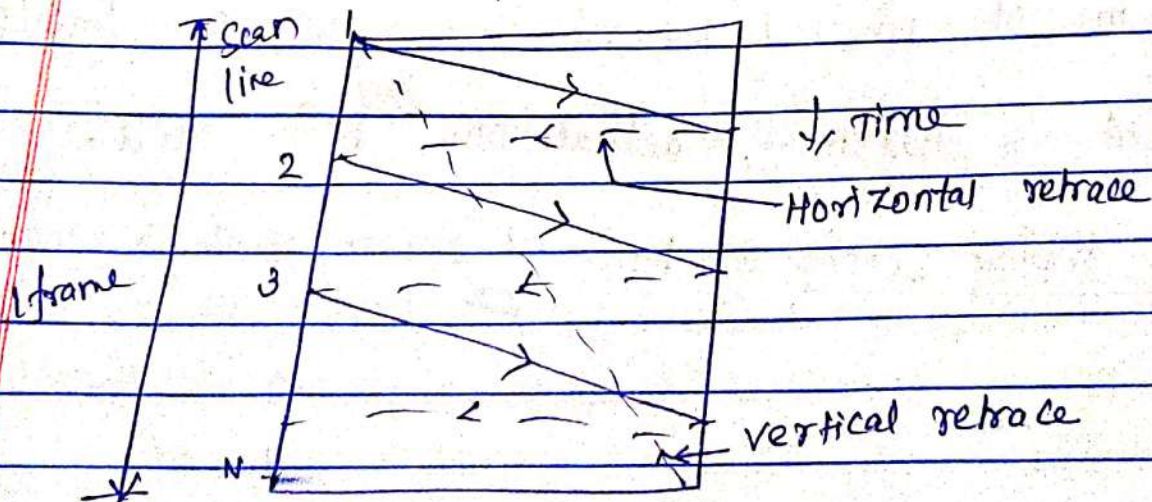


Raster-Scan principles

used in TV sets.

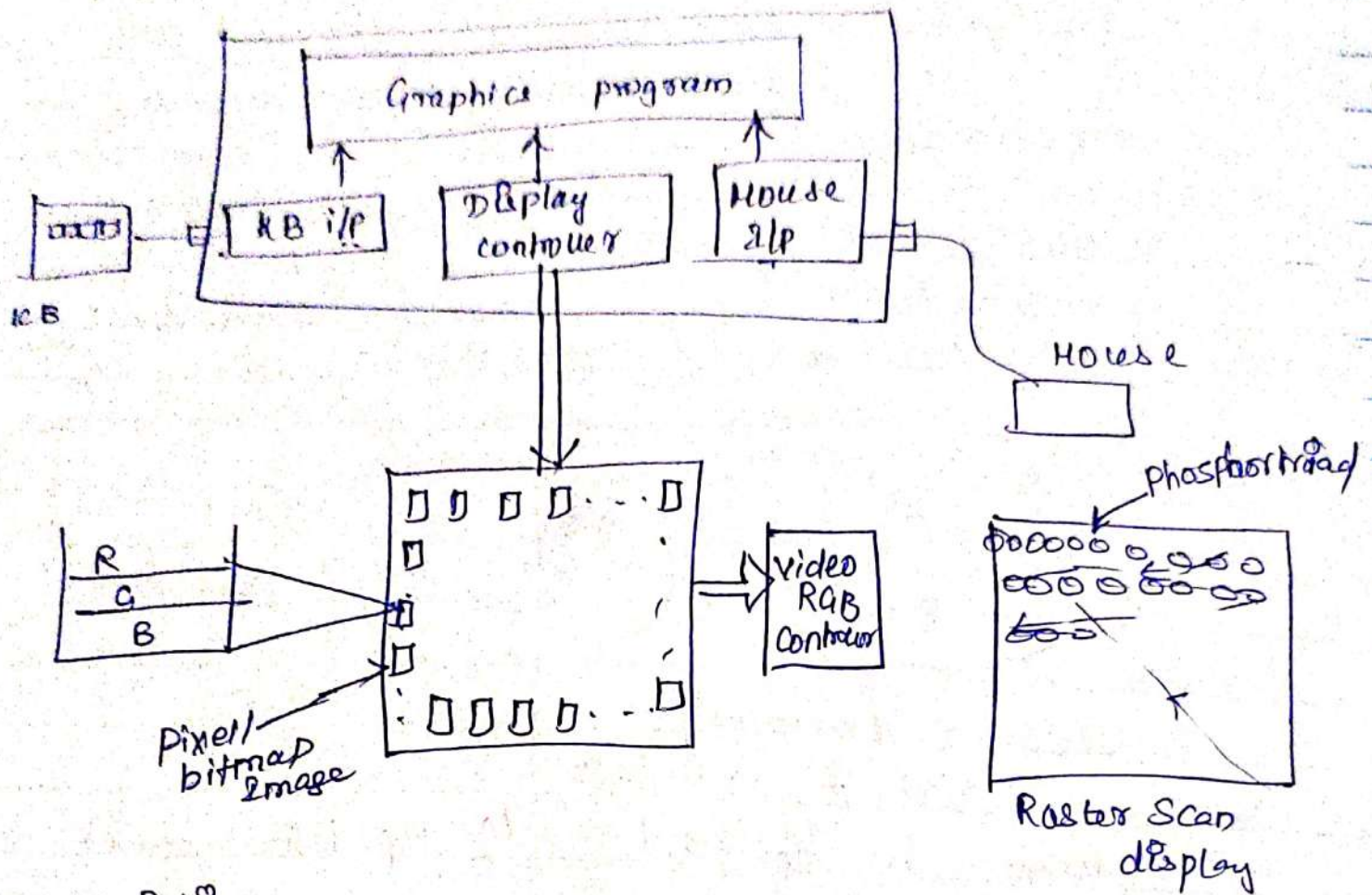
Beam is deflected - to top left corner &

Scanning Opⁿ repeats.



The set of three phosphors \Rightarrow associated with each pixel \rightarrow phosphor triad

Phosphor traces R, G, B
 R', G', B'



Aspect Ratio

No. of pixels / scanned line & no. of lines/frame
 used to determine actual nos. being used.

for display screen \Rightarrow Ratio of screen width to screen
 height.

The picture tubes used in most TV sets operate using raster scan. This involves finely focussed e^- beam is the raster that is being scanned over the complete screen.

Each complete scan comprises a no. of discrete horizontal lines. the first line starts at the top left corner of the screen and last line ends at the bottom right corner.

At this point the beam is deflected back again to the top left corner and the scanning operation repeats in the same way. This type of scanning is called progressive scanning.

Each complete set of horizontal scan lines is called a frame and each frame is made up of N individual scan lines where N is either 525 (North & South America & most of Asia) or 625 (Europe & no. of other countries).

The inside of the display screen of the picture tube is coated with light sensitive phosphor that emits light when energized by e^- beam.

The amount of light emitted is determined by the power in e^- beam at that instant. During each horizontal & vertical retrace period the e^- beam is turned off and to create an image on the screen. The level of power in the beam is changed as each line is scanned.

In case of black and white picture tubes a single e^- beam is used with a white sensitive phosphor.

Color tubes use 3 separate closely located beams

and 2D matrix of pixels

Each pixel comprises a set of three related color sensitive phosphors one each for Red, green and blue signals. The set of three phosphors associated with each pixel is called a Phosphor triad.

$$\text{Phosphor triads} = \frac{R, G, B}{R', G', B'}$$

TV picture tubes were designed to display moving images. The persistence of light / color produced by phosphor is designed to decay very quickly and is necessary to continuously refresh the screen.

In case of moving image, the light signals associated with each frame change to reflect the motion that has taken place during the time required to scan the preceding frame and for a still image also the same set of light signals are used for each frame.

The frame refresh rate must be high. A low refresh rate is called as flicker it is caused by previous image fading from eye retina before the image is displayed. To avoid this a refresh rate of at least 50 times/sec is required.

Most current picture tubes operate in analog mode. In case of digital TV the digitized picture are stored within the memory of a computer and color signals are in a digital form and comprise a string of pixels with a fixed no of pixels / scan line.

To store the pixel image the computer has a separate known as Video Ram. So graphics program needs only Video Ram.

Graphics program is used to create the high level version of the image and display controller contains program; in that part of program interprets sequences of display commands and converts them into displayed objects by writing appropriate pixel values into the Video Ram.

Video controller is a hardware subsystem that reads the pixel values stored in the Video Ram in time synchronism with the scanning process.

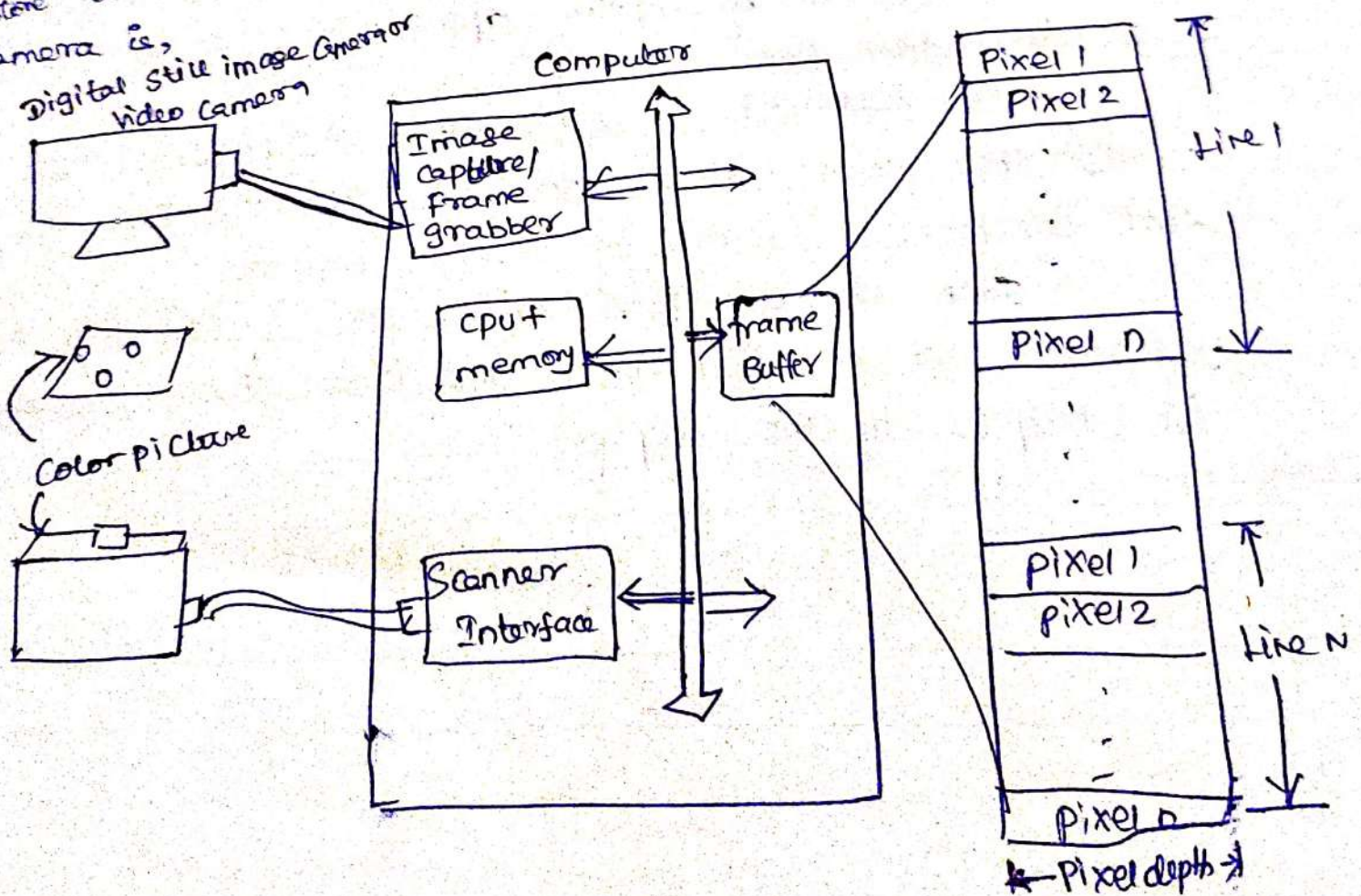
Each set of pixel values are converted into its equivalent set of Red, green and blue analog signal for output to the display.

Pixel Depth
 No. of bits per pixel
 it determines the range of different colors that
 can be produced.

Aspect Ratio
 Ratio of screen width to screen height

Digital Cameras & Scanners

A typical arrangement is used to capture and
 store a digital image produced by a scanner or a digital
 camera is,



Captured img is transferred to computer directly

An img. is captured within the camera/sensor using solid-state device called an Image Sensor.

Image sensor \Rightarrow Silicon chip. It consists of 2D grid of light sensitive cells called photosites.

When the camera shutter is activated, each photosite stores the level of intensity of the light that falls on it.

Most widely used image sensor is a charge coupled device (CCD). It comprises an array of photosites on its surface and operates by converting the level of light intensity that falls on each photosite into an equivalent electrical charge.

The level of charge and light intensity stored at each photosite position is read out and converted into digital value using an ADC.

A similar technique is used in scanners also but except the image sensor it has a single row of photosites.

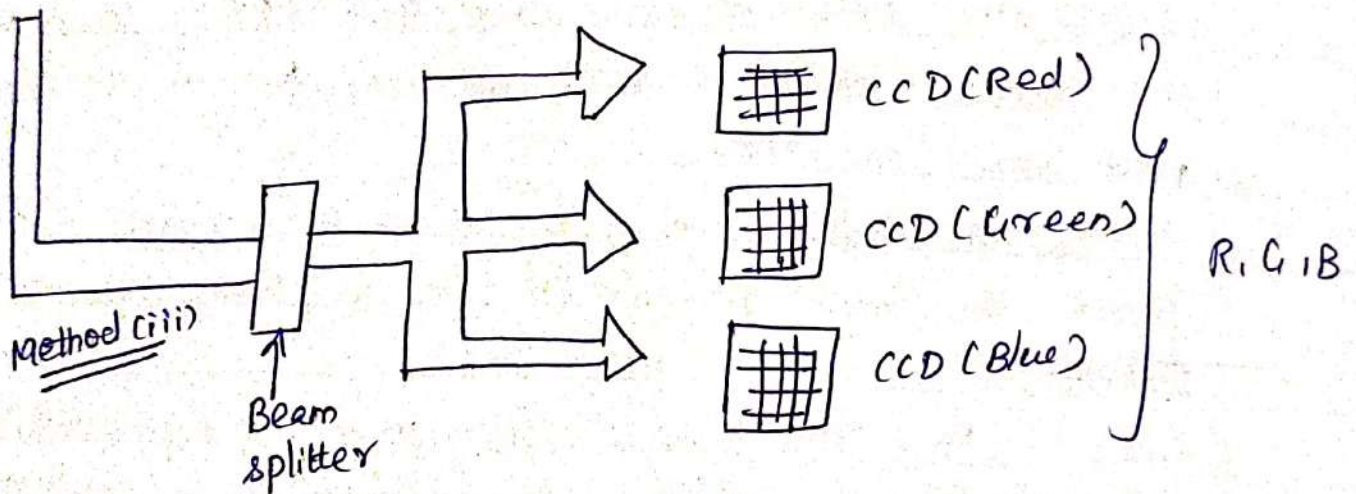
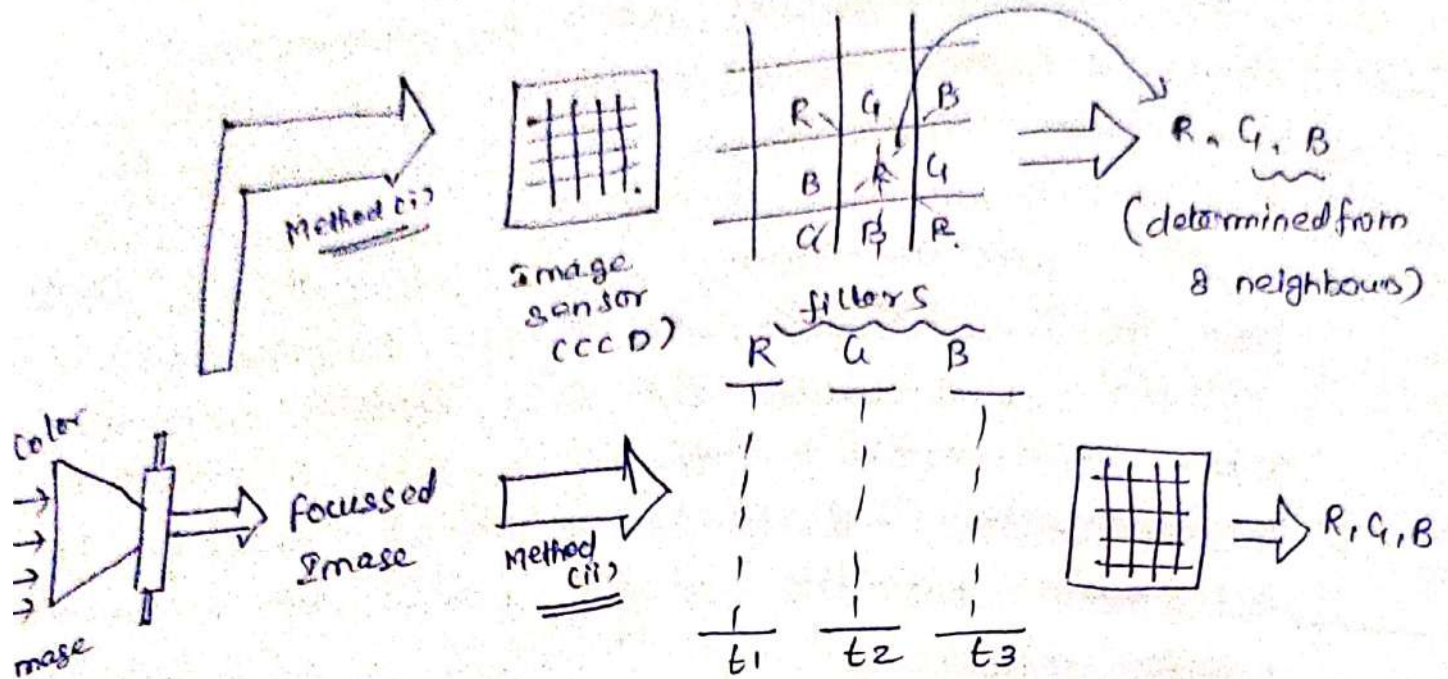
For color images each photosite are associated with color & pixel position is obtained in a no. of ways.

3 Methods,

Method 1 :- Surface of each photosite is coated with either a red, green and blue filter so that its charge is determined by the level of red, green or blue light falls on it.

The coatings are arranged in a 3×3 grid structure. The color associated with each photosite/pixel is

determined only by the level o/p. of photosite - R, G or B.
used in most consumer quality cameras.



Method (ii)

Three separate exposures of a single image sensor can be used. The filter through a Red filter, second through a green filter, third through a blue filter. The color associated with each pixel position is determined by the charge obtained with each of three filters R, G and B.

Three separate exposures are required for each image and this approach cannot be used with video cameras.

used primarily with high resolution still image cameras.

Method 2112

uses three separate image sensors.

A single exposure is used with the incoming light split into 3 beams and each of it exposes a separate img. sensor.

Used in professional quality high resolution still and moving img. cameras because use of three separate sensors has more cost.

photo editing software can be used to manipulate a stored img. for eg: to change its size or color.

There are many file formats used to store set of img.

One of the most popular is a version of tagged img file format (TIFF).
Called for Electronic photography (EP).

This allows many different types of image data to be stored in the image file including data associated with each image.

Video

It is easy way to represent any kind of info. & it can be mixed with other components to rep. a message.

Appln: Entertainment, Interpersonal, Interactive

1. Broadcast video

It also use the same principles to display color videos (TV picture tube already ^{explained in Images} in Images)

3 electron beams are scanned across the screen from left to right with a resolution of either 525 lines / 625 lines.

3 digitized color sigs are stored in computer mem in a long format.

Color Signals

3 properties

1. Hue

2. Brightness

3. Saturation

1. Hue

Represents actual color of the source; each color has a different wavelength and eye determines the color.

2. Brightness

Amount of energy that stimulates the eye and varies on a gray scale from black to white

3. Saturation

Strength of the color.

$$Y_s = 0.299 R_s + 0.587 G_s + 0.144 B_s$$

$Y_s \Rightarrow$ amplitude of Luminance sig

Brightness of a source

R_s, G_s & $B_s \Rightarrow$ mag of 3 color component sig

Digital video

Format

1. 4:2:2

2. 4:2:0

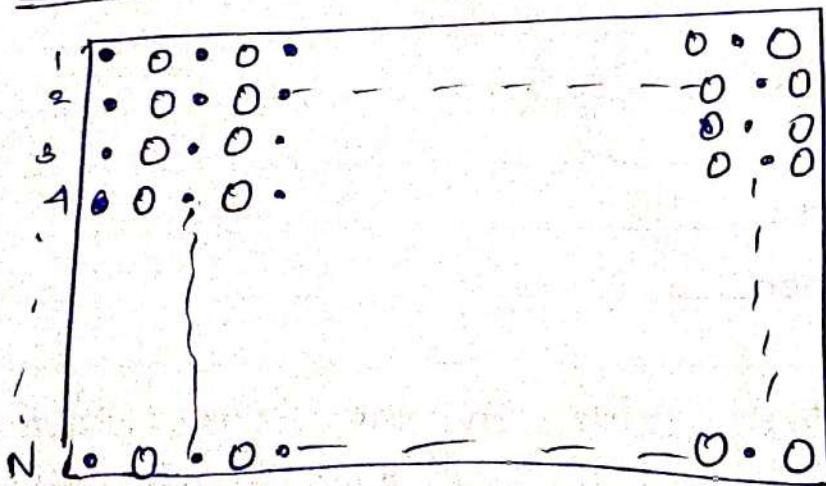
3. HDTV

4. SIF

5. CIF

6. QCIF

4:2:2

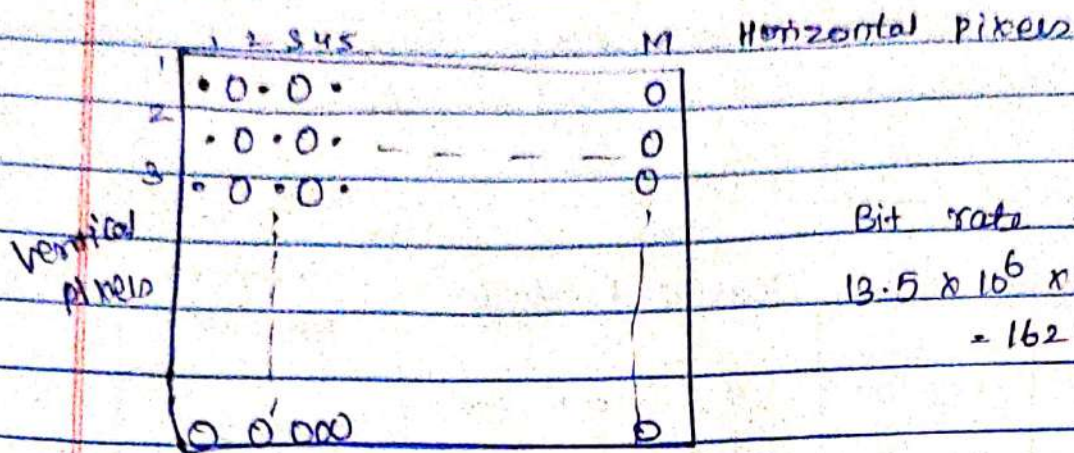


Intended to use in

TV studios, non-interlaced scanning is used at a frame refresh rate of either 60Hz for 525 line sig or 50Hz for 625 line sig

525 line sig $M = 720, N = 480, 60 \text{ Hz}$ refresh rate

4:2:0



Bit rate =

$$13.5 \times 10^6 \times 8 + 2(3.375 \times 10^6) \\ = 162 \text{ Mbps.}$$

3. HDTV Formats

High Definition Television.

1. Older 4/3 aspect ratio 1440 x 1152 pixels

2. Newer 16/9 aspect ratio 1920 x 1152 pixels.

In both cases No. of visible lines/frame = 1080

4. SIF

Source Intermediate Format

It uses half spatial resolution in both Horizontal & Vertical directions. used in 4:2:0 format.
Subsampling

5. CIF

Common Intermediate Format

video Conferencing app.

It is combination of spatial resolution
Used for SIF is 625 line sly & Temporal resolution
used in 525 line sly

Pc video

Multimedia apn involves mixing live video with other info on pc screen for that line sampling rate is modified in order to obtain required horizontal resolution.

Digitization Format	sls	Spatial Resolution	Temporal Resolution
A:2:0	525 line 625 line	$Y = 640 \times 480$ $Cb = Cr = 320 \times 240$ $Y = 768 \times 576$ $Cb = Cr = 384 \times 288$ $Y = 320 \times 240$	60 Hz 50 Hz
SIF	525 line 625 line	$Cb = Cr = 160 \times 144$ $Y = 384 \times 288$ $Cb = Cr = 192 \times 144$	30 Hz 25 Hz
CIF		$Y = 384 \times 288$ $Cb = Cr = 192 \times 144$	30 Hz
Q CIF		$Y = 192 \times 144$ $Cb = Cr = 96 \times 72$	15/7.5 Hz

Hardware

1. Connecting devices
2. I/p devices
3. O/p "
4. Storage "
5. Communicating "

1. Connecting Devices

1. SCSI (Small Computer System Interface)

Set of standards for physically connecting & transferring data b/w computers & peripheral devices

2. MCI (Media Control Interface)

AVI video, CD audio, Sequencer, wave Audio.

3. IDE (Integrated Drive Electronics)

Standard way for a storage device to connect to a computer

Blue Connected → mother board

Black " → Primary drive

Gray " → Secondary drive

4. USB (Universal Serial Bus)

Standard to interface devices

2. I/O devices

Hardware mechanism that transform into the external world for consumption by a computer

KB, pointing devices

or

Mouse, Track ball, Touch pad,

Touch screen, light pen.

3. Imaging & Video I/O devices

eg: Scanners, webcam, Barcode reader, 3D Scanner

4. Audio I/O Devices

eg: Microphone, Speech recognition

5. Output Devices

It is a h/w used to communicate and data processing work carried out by the user.

Monitors

High end & large screen graphical display.

Audio devices

amplifiers, speakers.

4. Storage devices

RAM, ROM.

5. Comm Devices

eg: LAN, WAN, modems, ISDN.

Animation

Rapid display of a sequence of images of 2D artwork.

Steps

1. Gather up in mind all the activities ^{with} to provide
2. Choose animation tool
3. Build & test experiments with lighting effects

4. Allow time for running
5. post process (By doing any special and adding sound effects)

1) Cell animation

The term cel animation is from ~~cello~~ clear celluloid sheets that were used for drawing each frame, which have been replaced today by acetate or plastic.

Cel animation starts with key frames.

Eg: when an animated figure of a man walks across the screen, he balances the weight of his entire body on one foot and then other in a series of fall and recoveries with the opposite foot and leg catching up to support the body.

This animation technique made famous by Disney uses a series of progressively different poses on each frame of movie film which plays at 24 frames/second.

2) Computer animation

We use the vocabulary of classic cel animation, key frame and tweening techniques.

Special methods can be used to compute RGB pixel values, provide edge detection and layering so that images can blend or otherwise mix their colors to produce special transparencies, inversions and effects.

Point & most often tested or drawn with
using functions such as gradients and anti-aliasing

3. Kinematics

Kinematics is the study of movement and motion of structures that have joints, such as a walking man.

Inverse Kinematics is in high end 3D programs it is the process by which you link objects such as hands to arms and defines their relationship and limits.

Once those relationships are set you can drag these parts around and let the computer calculate the result.

4. Morphing

Morphing is a popular effect in which one image transforms into another. Morphing application and other modeling tools that offer this effect can perform transition not only between still images but often between moving images as well.

The morphed images were built at a rate of 8 frames/sec with each transition taking a total of 4 sec.

Morphing features are,

1. Black belt's easy morph and win images
2. Human software's squizz.