USN

Internal Assessment Test 1 – OCT 2024

Sub:	Multimedia Communications					Sub Code:	21EC745	Branch:		ECE
Date:	16/10/2024	Duration:	90 Minutes	Max Marks:	50	Sem / Sec:	VII - A, B, C, D			OBE

	Answer any FIVE FULL Questions	MARKS	CO	RBT
1	With a neat diagram, explain how voice mail and teleconferencing is supported in relation to speech only interpersonal communication involving both public (PSTN/ISDN) and private network. Also, explain the role of voice mail server and audio bridge.	[10]	CO1	L2
2	Explain the following: (i) Quantization intervals (ii) Pixel Depth (iii) Aspect ratio (iv) SIF (v) CIF.	[10]	CO1	L2
3	With a neat diagram explain audio/sound synthesizer.	[10]	CO4	L2
4	Explain the principle of operation of PCM speech codec with a block diagram. Also explain compressor and expander.	[10]	CO1	L2

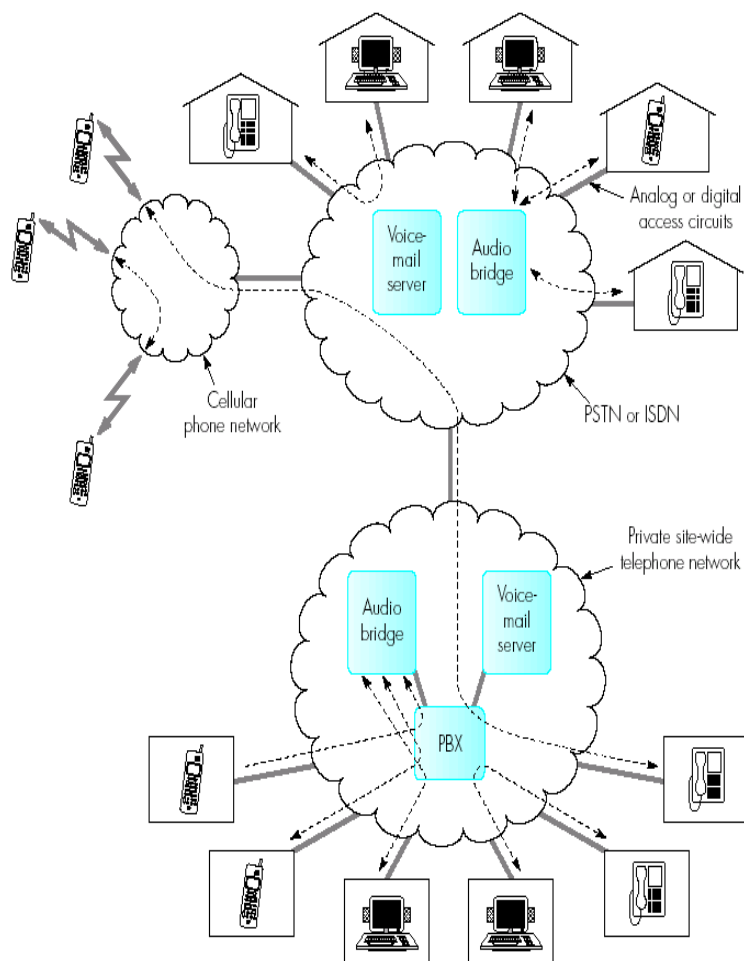| 5	a) Determine the Propagation delay associated with the communication channels (i) A connection through a private telephone network of 1 km (ii) A connection through a PSTN of 200 km (iii) A connection over a satellite channel of 50,000 km. Assume that the velocity of propagation of a signal in the case of (i) and (ii) is 2 x 10^8 m/s and in the case of (iii) is 3 x 10^8 m/s. b) Explain with neat diagrams, the interactive television application for both cable and satellite network.	[3+7]	CO4	L1
6	Derive the bit rate and the memory requirements to store each frame that results from the digitization of both a 525 line and 625 line systems, assuming a 4:2:2 formats. Also find the total memory required to store a 2 hour movie/video.	[10]	CO4	L2
7	Explain the working principle of circuit-mode and packet-mode of operation of multimedia networks. List out salient features of each type of networks.	[10]	CO4	L1

CI   CCI   HOD

- Application that involve multiple media types:

- Interpersonal Communications: May involve speech, image, text or video

- Interactive Applications over the Internet: Browsing through sales, literature, newspapers,

etc.

- Entertainment Applications: Movie/Video on

demand, interactive television

Voice-
mail
server

Audio
bridge

Analog or digital
access circuits

Cellular
phone network

PSTN or ISDN

Private site-wide
telephone network

Audio
bridge

Voice-
mail
server

PBX

PSTN = Public switched telephone network
PBX = Private branch exchange

ISDN = Integrated services digital netwrork

Traditional interpersonal communication involving speech was provided by using telephones connected to either PSTN/ISDN or PBX hub.

Today multimedia PC equipped with a microphone and speakers can be used to make telephone calls. This technology is known as computer telephony integration (CTI)

- The users can create their own private directory of numbers and can initiate a call simply by selecting the desired numbers from the PC screen

- Provides access circuit to the network with more capacity known as the **bandwidth**
- Integration of the PC based network services with the telephony is possible

- **Voice mail**: Used in the event of the called party being unavailable. The voice mail is saved in the server mailbox and can be read by the owner next time they contact the server
- **Teleconferencing**: Involves multiple interconnected telephones/PCs. Each person can talk to all the others involved in the call. This is known as a conference call. A central unit called an audio bridge provides the necessary support to set up the call automatically

Q2) Solution:

Quantization Intervals

Representation of the analogue samples require an infinite number of digits

(a)
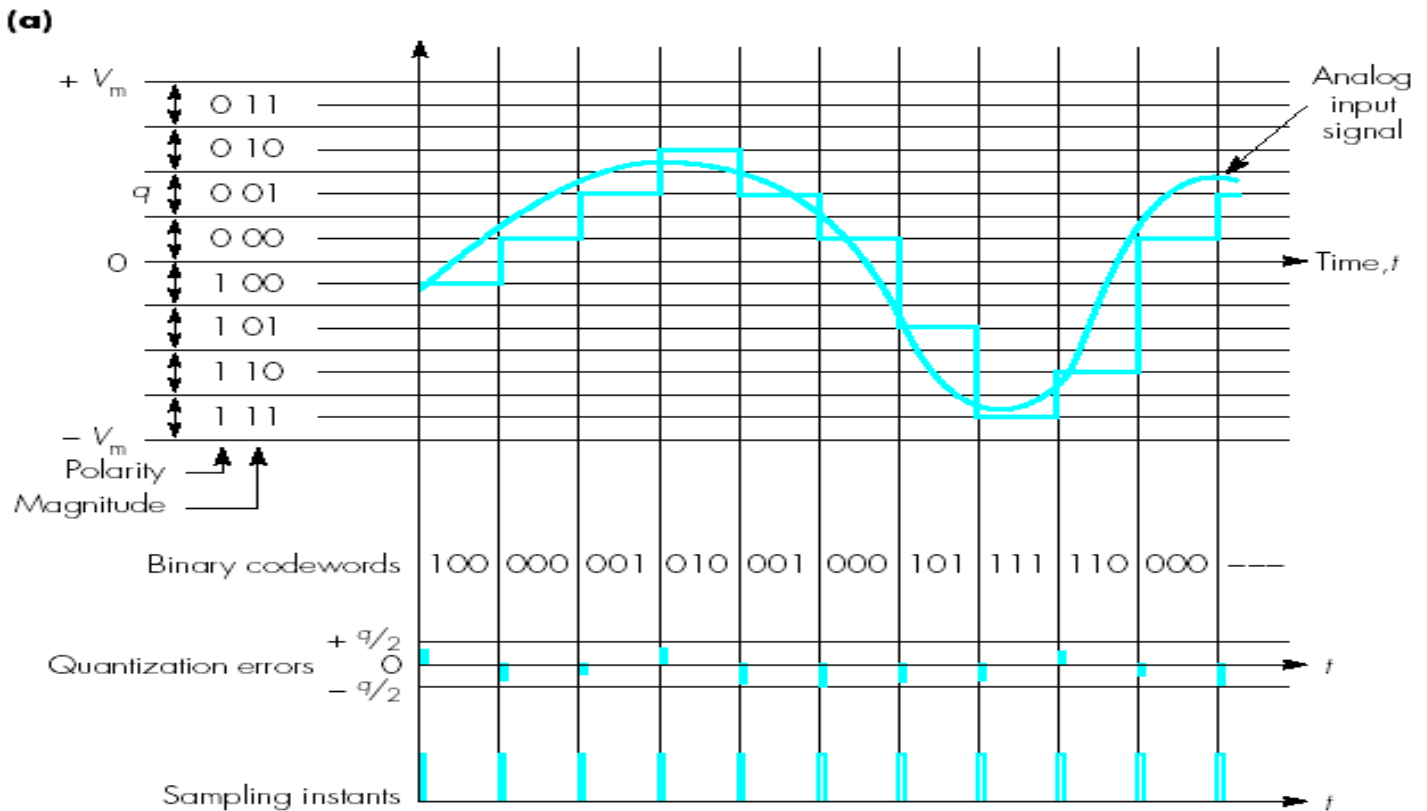
Three bits are used to represent each sample (1 bit for the sign and two bits to represent the magnitude)

If V_{max} is the maximum positive and negative signal amplitude and **n** is the number of binary bits used then the *quantization interval, q,* is defined as

$$q = 2V_{max} / 2^n$$

A signal anywhere within the quantization interval will be represented by the same binary codeword

Each codeword is at the centre of the corresponding quantization interval

Therefore a difference of $\pm q/2$ from the actual signal level is present. This difference is known as the quantization error

Pixel depth: Number of bits per pixel that determines the range of different colours that can be produced
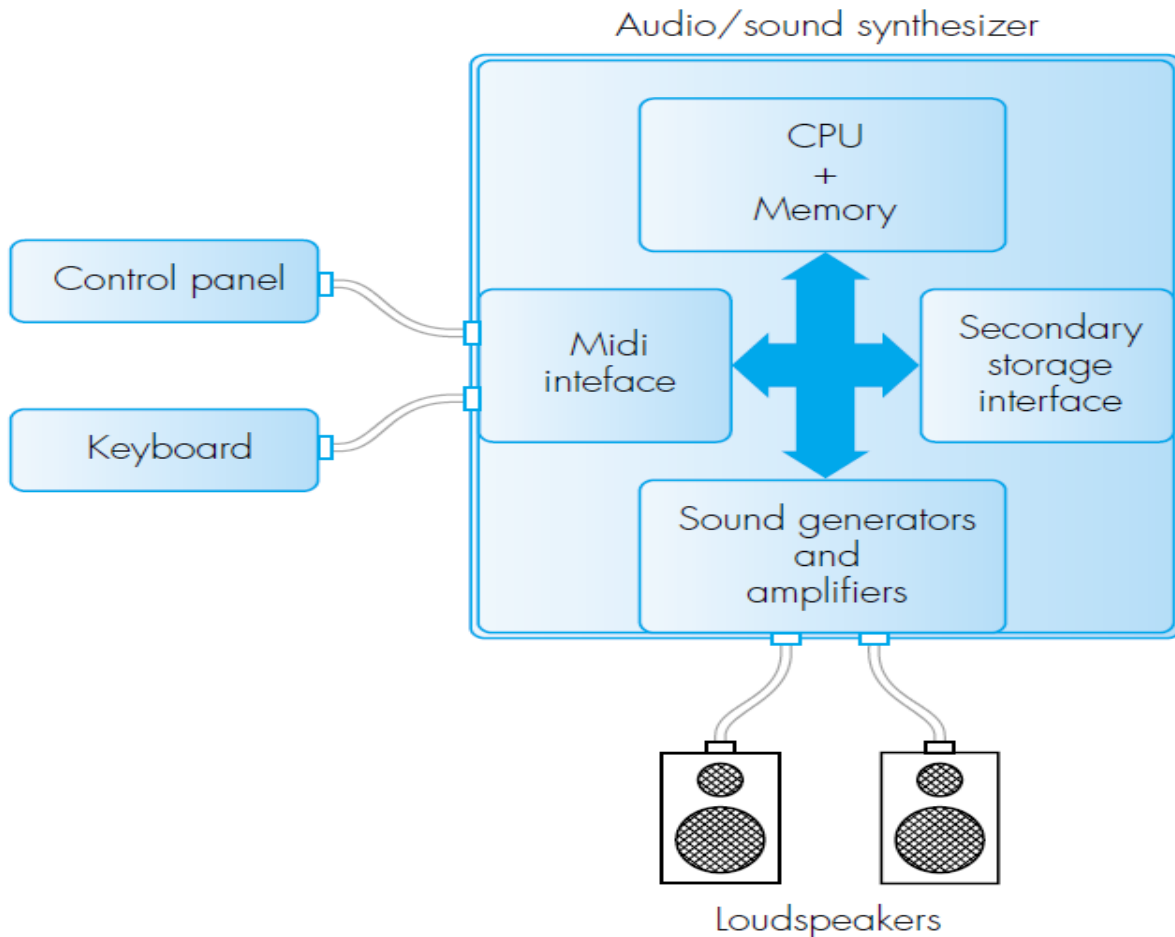
Aspect Ratio: This is the ratio of the screen width to the screen height (television tubes and PC monitors have an aspect ratio of 4/3 and wide screen television is 16/9)

The source intermediate format (SIF) give a picture quality comparable with video recorders(VCRs)

- The common intermediate format (CIF) for use in videoconferencing applications

Q3) Solution :

Audio/sound synthesizer

CPU
+
Memory

Control panel

Midi
inteface

Secondary
storage
interface

Keyboard

Sound generators
and
amplifiers

Loudspeakers

CD- QUALITY AUDIO
STANDARD FOR CD PLAYERS AND CDROMS –CD-DA STANDARD
SYNTHESIZED AUDIO:
Synthesized audio uses less memory
It is easier to edit synthesized audio
Mix several passages together
Three components are- computer, keyboard, sound generators
Keyboard sends commands to computer which is sent to sound generators
which produces
Sound waveform via DAC to drive speakers

For each key different codeword known as the message with a synthesizer keybord is generated and read by the computerprogram
The control panel has switches and sliders which indicate the volume and sound effects for the prog.

Secondary interface stores audio in secondary
Storage devices
There are programs to allow the users to edit a previously enterred passage or mix several stored passages together
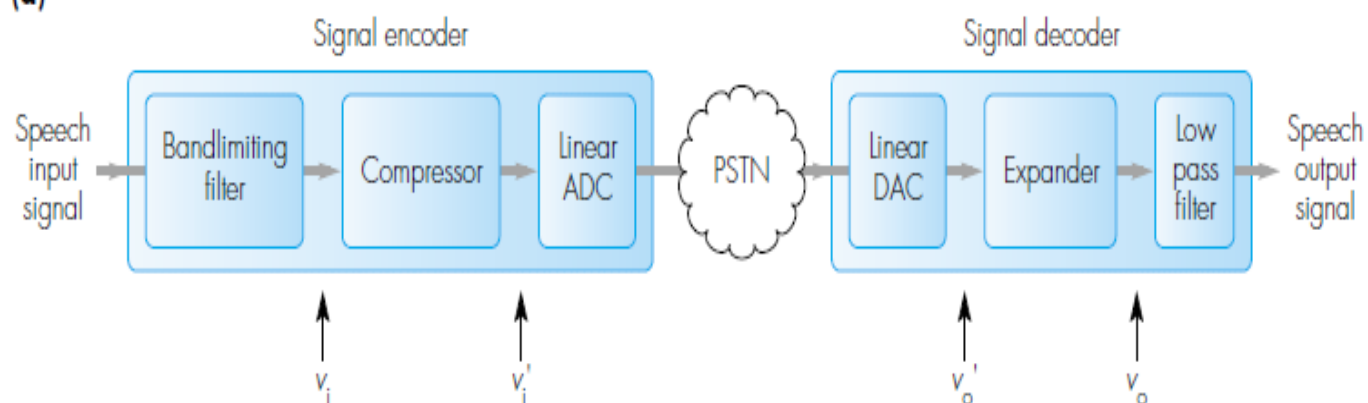There is a range of other inputs from instruments
To discriminate between inputs from different possible sources a standard messages are defined for corresponding sound generators
These are defined in a standard – music instrument digital interface-MIDI
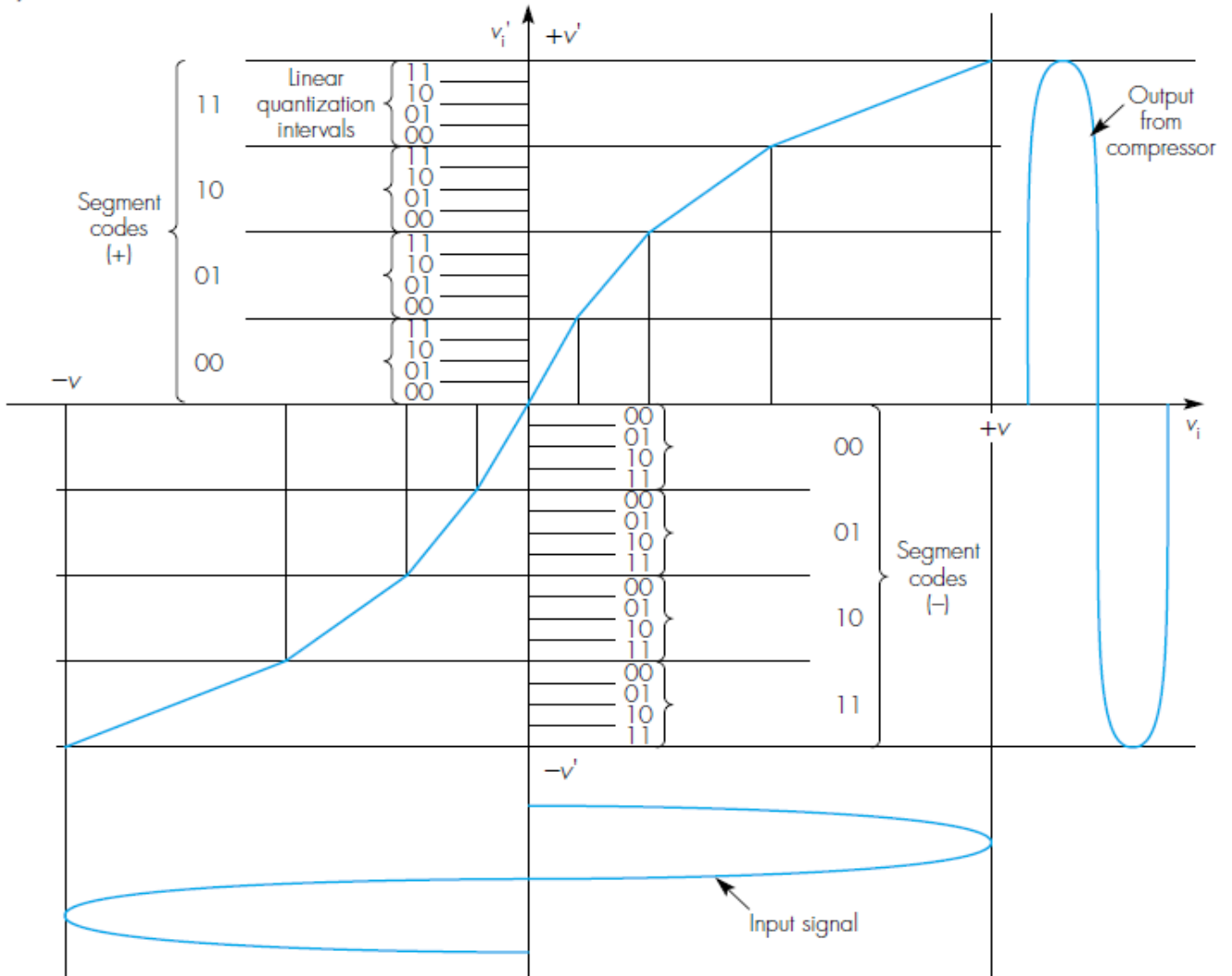It defines format of standardized set of messages used by synthesizer, types of connectors,cables and electrical signals .

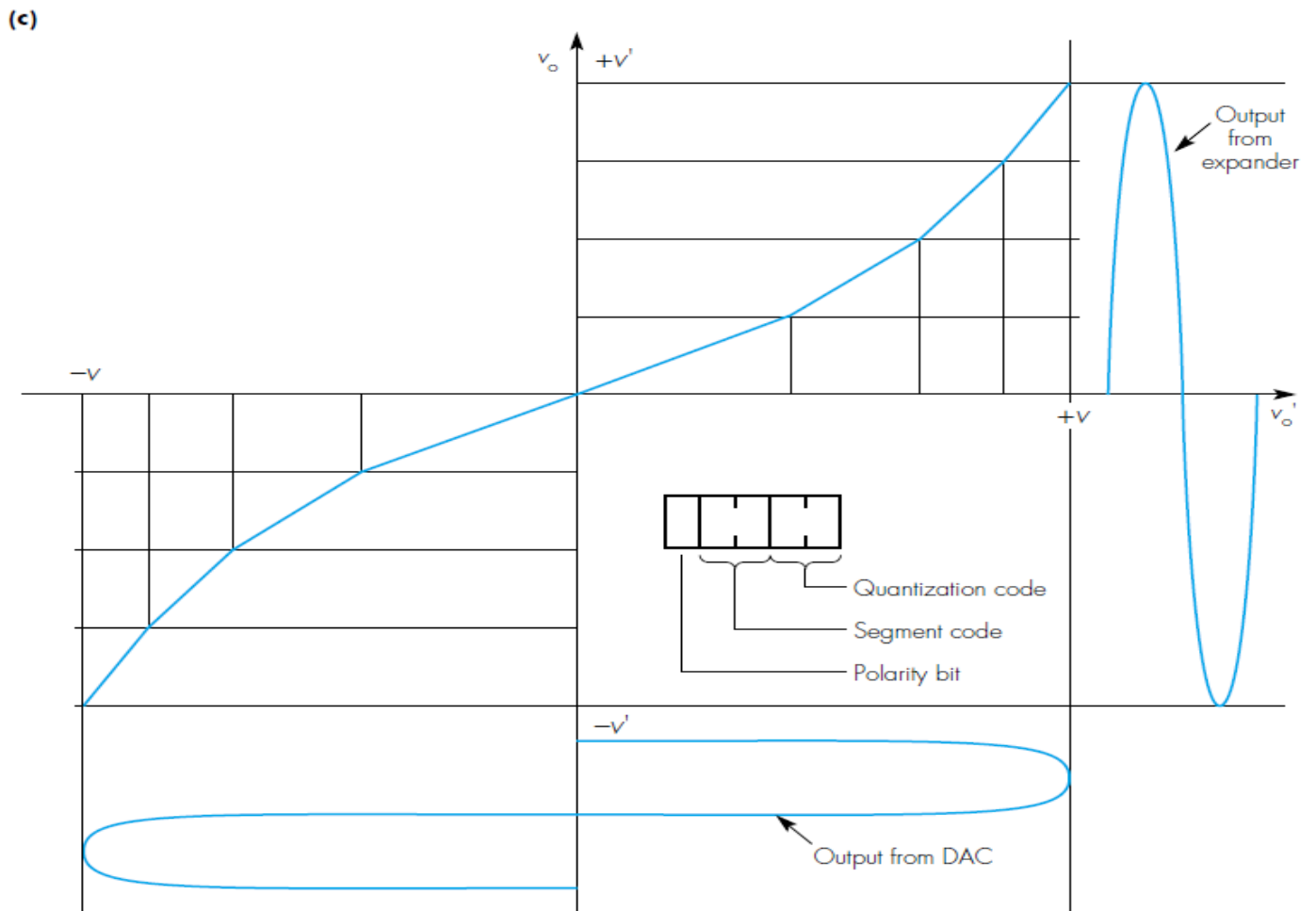# Q4) Solution:

(a)

Signal encoder

Signal decoder

Speech input signal → Bandlimiting filter → Compressor → Linear ADC → PSTN → Linear DAC → Expander → Low pass filter → Speech output signal

v_i v_i' v_o' v_o

(b)

(c)

Output from expander

Quantization code
Segment code
Polarity bit

Output from DAC

Note that in the G.711 standard a 3-bit segment code and 4-bit quantization code are used.

TWO TYPES OF AUDIO SIGNALS- SPEECH SIGNALS AND MUSIC QUALITY AUDIO

AUDIO IS PRODUCED - MICROPHONE / SYNTHESISER

SYNTHESIZER PRODUCES AUDIO IN DIGITAL FORMAT WHICH CAN STORE IN COMPUTER

PCM SPEECH:

It is a digitization process

Defined in ITU-T Recommendations G.711

PCM CONSISTS OF ENCODER AND DECODER

IT CONSISTS OF EXPANDER AND COMPRESSOR

AS COMPARED TO EARLIER WHERE LINEAR QUANTIZTION IS USED – NOISE LEVEL SAME FOR BOTH LOUD AND LOW SIGNALS.

AS EAR IS MORE SENSITIVE TO NOISE ON QUITE SIGNALS THAN LOUD
SIGNALS, PCM SYSTEM CONSISTS OF NON-LINEAR QUANTIZATION WITH
NARROW INTERVALS THROUGH COMPRESSOR
AT THE DESTINATION EXPANDER IS USED
THE OVERALL OPERATION IS COMPANDING
BEFORE SAMPLING AND USING ADC, SIGNAL PASSED THROUGH
COMPRESSOR FIRST AND PASSED TO ADC AND QUANTIZED.
AT THE RECEIVER, CODEWORD IS FIRST PASSED TO DAC AND EXPANDER
TWO COMPRESSOR CHARACTERISTICS – A LAW AND MU LAW

Q5) Solution:

a)

Determine the propagation delay associated with the following communication channels:

(i) a connection through a private telephone network of 1 km,

(ii) a connection through a PSTN of 200 km,

(iii) a connection over a satellite channel of 50 000 km.

Assume that the velocity of propagation of a signal in the case of (i) and (ii) is 2×10^8 ms^{-1} and in the case of (iii) 3×10^8 ms^{-1}.

Answer:

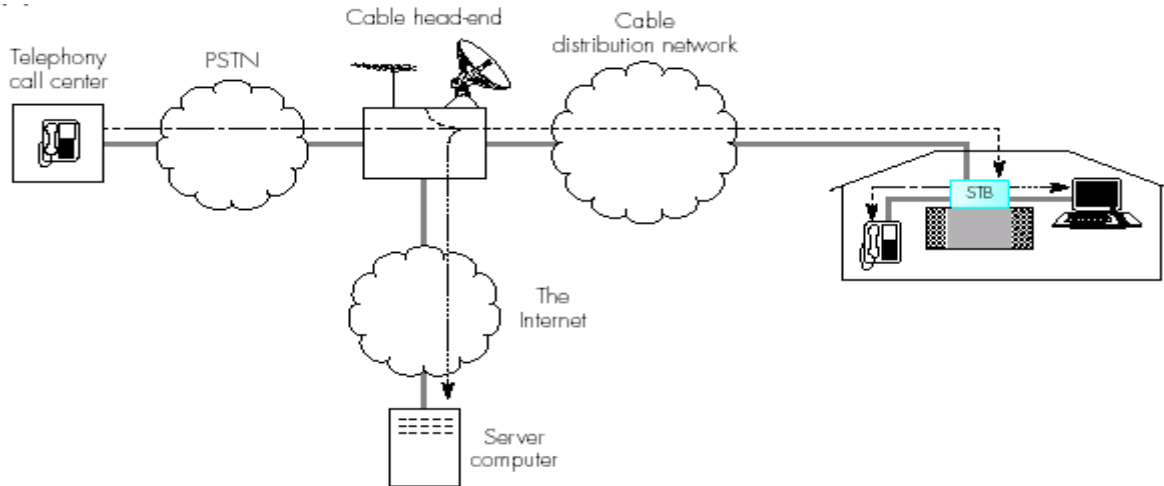Propagation delay T_p = physical separation/velocity of propagation

(i) $T_P = \dfrac{10^3}{2 \times 10^8} = 5 \times 10^{-6}$ s

(ii) $T_P = \dfrac{200 \times 10^3}{2 \times 10^8} = 10^{-3}$ s

(iii) $T_P = \dfrac{5 \times 10^7}{3 \times 10^8} = 1.67 \times 10^{-1}$ s
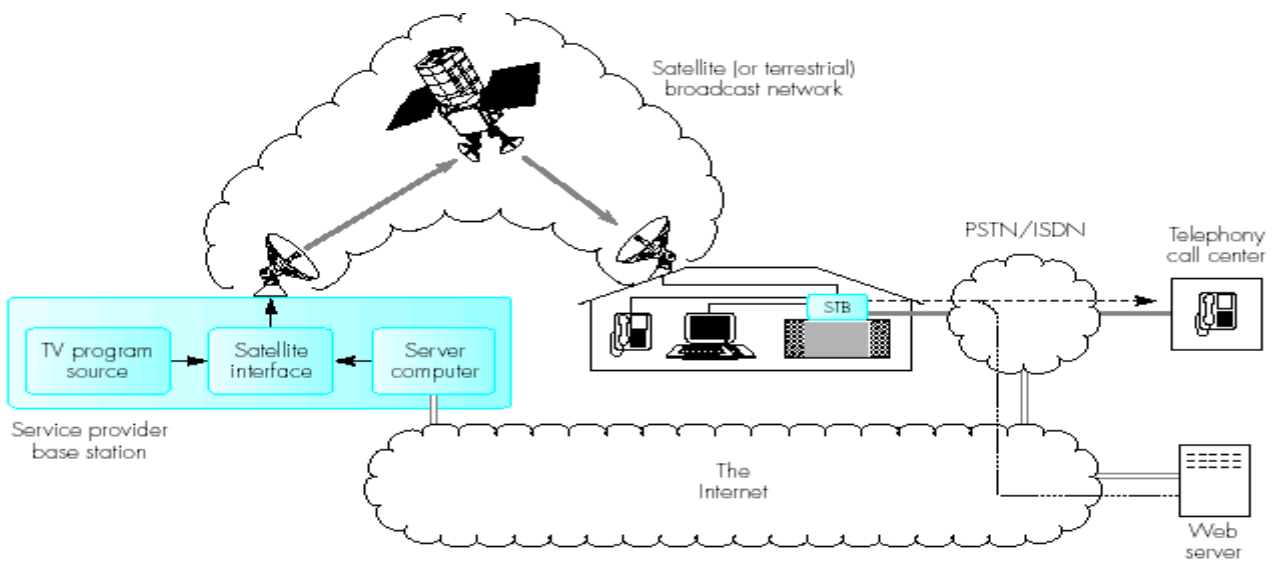
b)
Interactive television (Cable network)

The set-top box (STB) provides both a low bit rate connection to the PSTN and a high bit rate connection to the internet

Through the connection to the PSTN, the subscriber is able to actively respond to the information being broadcast

Interactive television (Satellite/terrestrial broadcast network)

The STB associated requires a high speed modem to provide the connections to the PSTN and the Internet.

Q6) Solutions :

Derive the bit rate and the memory requirements to store each frame that result from the digitization of both a 525-line and a 625-line system assuming a 4:2:2 format. Also find the total memory required to store a 1.5 hour movie/video.

Answer:

525-line system: The number of samples per line is 720 and the number of visible lines is 480. Hence the resolution of the luminance (Y) and two chrominance (C_b and C_r) signals are:

$$Y = 720 \times 480$$
$$C_b = C_r = 360 \times 480$$

Bit rate: Line sampling rate is fixed at 13.5 MHz for Y and 6.75 MHz for both C_b and C_r, all with 8 bits per sample.

Hence: Bit rate $= 13.5 \times 10^6 \times 8 + 2\,(6.75 \times 10^6 \times 8) = 216\,\text{Mbps}$

Memory required: Memory required per line $= 720 \times 8 + 2\,(360 \times 8)$
$$= 11\,520 \text{ bits or } 1440 \text{ bytes}$$

Hence memory per frame, each of 480 lines $= 480 \times 11\,520$
$$= 5.5296 \text{ Mbits or } 691.2 \text{ kbytes}$$

and memory to store 1.5 hours assuming 60 frames per second:
$$= 691.2 \times 60 \times 1.5 \times 3600 \text{ kbytes}$$
$$= 223.9488 \text{ Gbytes}$$

625-line system: Resolution: $Y = 720 \times 576$
$$C_b = C_r = 360 \times 576$$

Bit rate $= 13.5 \times 10^6 \times 8 + 2\,(6.75 \times 10^6 \times 8) = 216\,\text{Mbps}$

Memory per frame $= 576 \times 11\,520 = 6.635\,55$ Mbits or 829.44 kbytes

and memory to store 1.5 hours assuming 50 frames per second:
$$= 829.44 \times 50 \times 1.5 \times 3600 \text{ kbytes}$$
$$= 223.9488 \text{ Gbytes}$$

It should be noted that, in practice, the bit rate figures are less than the computed values since they include samples during the retrace times when the beam is switched off. Nevertheless, as we can deduce from the computed values, both the bit rate and the memory requirements are very large for both systems and it is for this reason that the various lower resolution formats have been defined.

Q7) Solutions :

Telephone Networks

- **Circuit mode –** Telephone networks operate in this mode in which a separate circuit is set up through the network for each call for the duration of the call
- **Access Circuits –** Link the telephone handsets to a PSTN or PBX and carry two-way analogue signals associated with a call
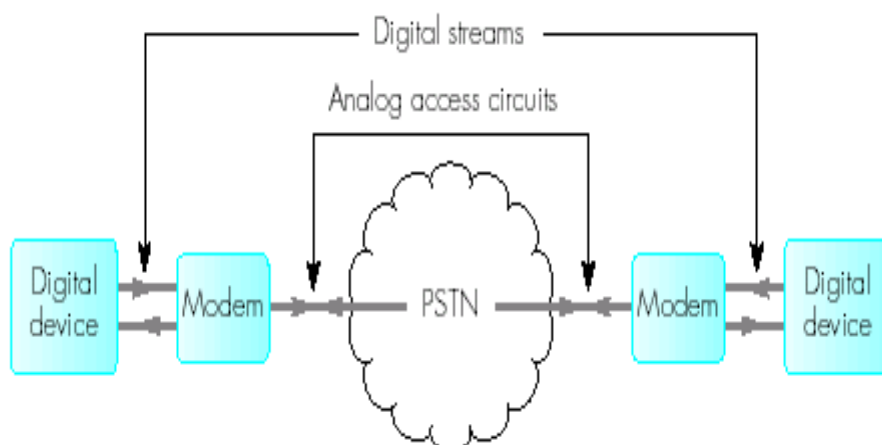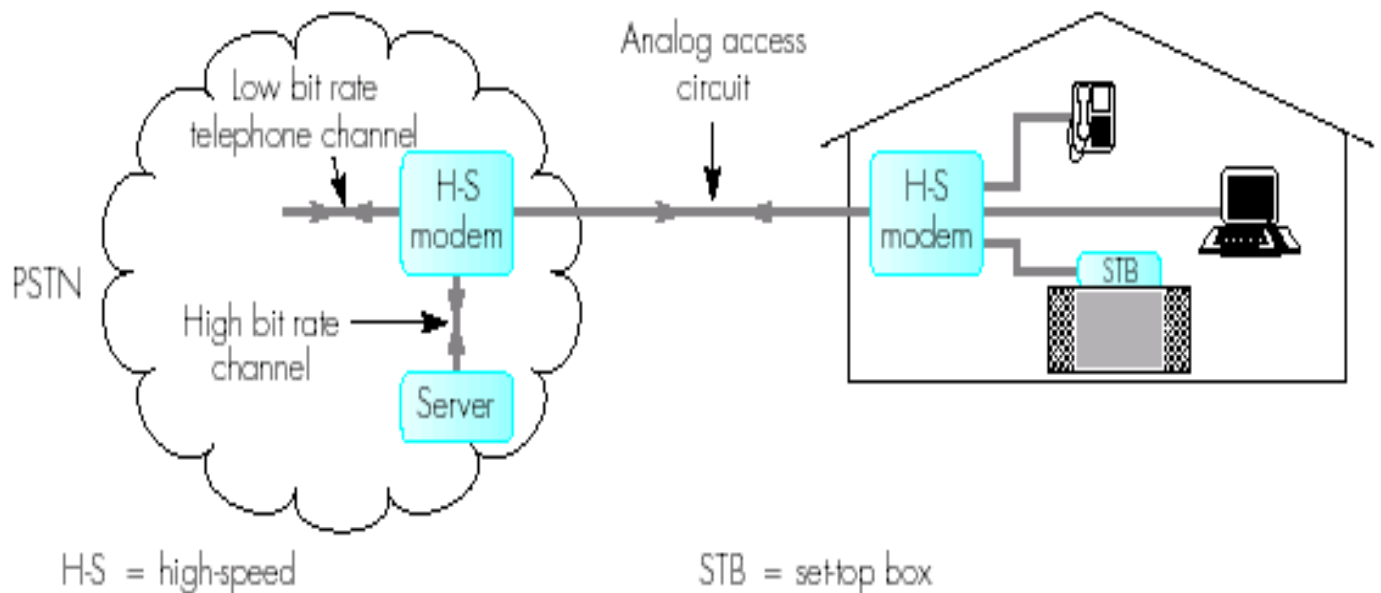
Today with *high bit-rate channels* in addition to the voice using the same access networks high resolution audio and video can be downloaded from a range of entertainment related servers.

Data Networks

- Designed to provide basic data communication services such as email and general file transfer
- Most widely deployed networks: **X.25 network** (low bit rate data) not suitable for multimedia and the **Internet** (Interconnected Networks)
- *Communication protocol*: set of rules (defines the sequence and syntax of the messages) that are adhered to by all

communicating parties for the exchange of information/data
- *Packet*: Container for a block of data, at its head, is the address of the intended recipient computer which is used to route the packet through the network.

- **Packet mode** – Operates by transfer of packets as defined earlier
- This mode of operation is chosen because normally the data associated with data applications is in discrete block format.
- With the new multimedia PCs packet mode networks are used to support in addition to the data communication applications a range of multimedia applications involving audio video and speech.