Chapter-1 : Multimedia

Multimedia refers to the integration of multiple forms of media elements, such as text, graphics, audio, video, and animations, into a single digital presentation or application. The goal of multimedia is to enhance communication and convey information in a more engaging and interactive manner.

Different types of media used in Multimedia:

- Text: Written content is a fundamental element of multimedia. It includes titles, captions, labels, descriptions, and other textual information that provides context and communicates messages.
- Graphics: Graphics encompass images, illustrations, photographs, icons, logos, and other visual elements that enhance the visual appeal and convey information.
- Audio: Audio elements include sound effects, music, voiceovers, narration, and any other auditory components that add depth and realism to multimedia presentations.
- Video: Video content involves moving images, animations, video clips, and motion graphics that capture dynamic scenes and actions. Video is particularly effective for storytelling and demonstrating processes.
- Animation: Animation involves the manipulation of images or objects to create the illusion of motion. It can range from simple animations to complex visual effects and is often used to explain concepts or add entertainment value.

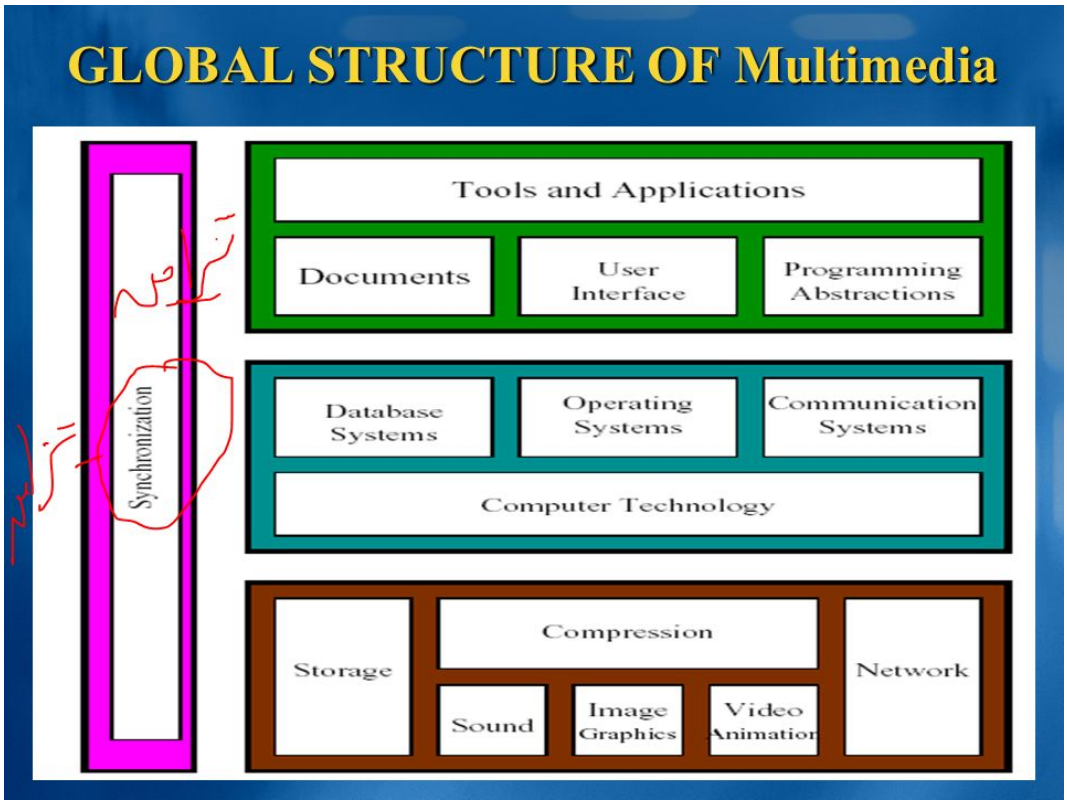
Main Properties/Characteristics of Multimedia System:

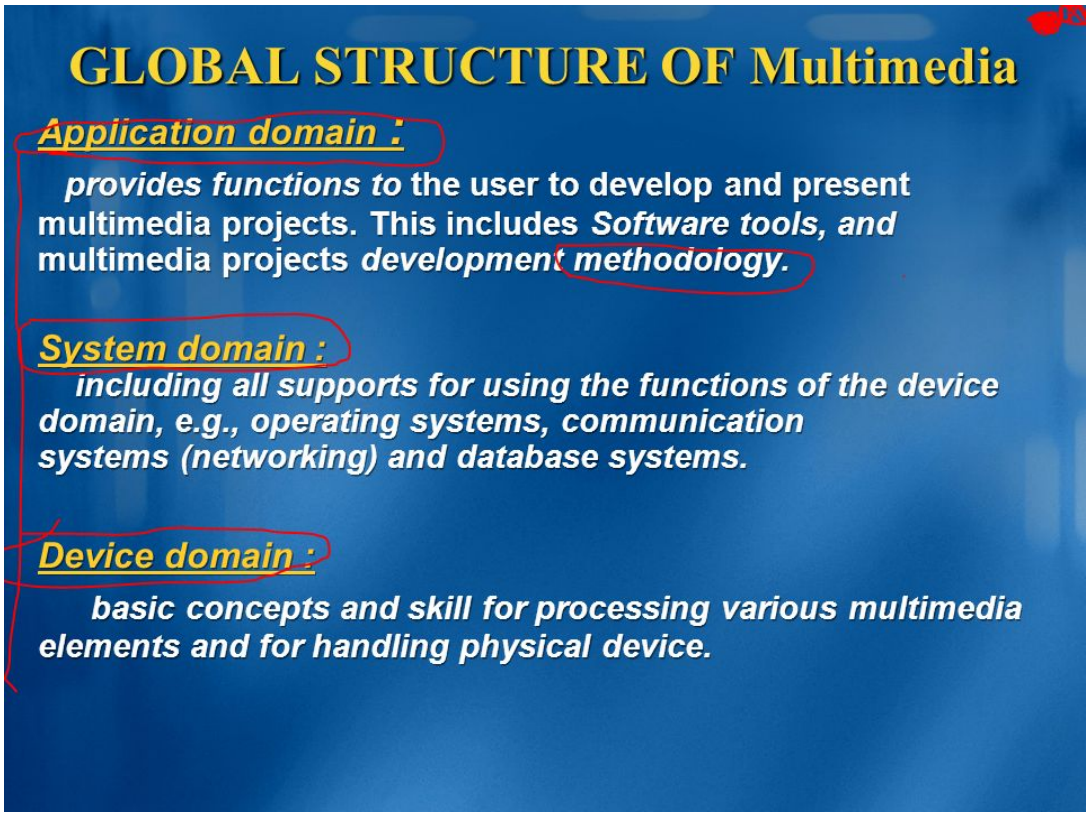
a. Combination of Media. (one media can be combined with other. Ex: text with images, images with sound).
b. Computer support Integration.
c. Communication Systems:
   Communication-capable multimedia systems must be approached. In today's time, everything is interconnected; so it should be communicated and transferred over the internet.
d. Independence.

Multimedia applications :

- Education, Health, Animation Industry,Entertainment Industry(Movie Industry, Gaming), Communication, Business

Global structure of Multimedia





Chapter-2 Sound and Audio

MIDI Devices:
MIDI (Musical Instrument Digital Interface) devices are electronic instruments, equipment, or components that use the MIDI protocol to communicate with each other. MIDI is a standardized protocol that enables electronic musical instruments, computers, and other devices to exchange musical information and commands. It allows for the control of various aspects of sound production, such as pitch, timing, dynamics, and more.

MIDI (Musical Instrument Digital Interface) software encompasses a wide range of applications and tools that allow you to create, edit, play, and manipulate MIDI data.

Speech Generation:

- Generated speech must be understandable and most sound natural.
- The important requirement of speech generation is the generation of the real time signals.
- The easiest method for speech generation is to use pre-coded speech and play it back in the timely fashion.
- Types of speech generation :

a. Time-dependent sound concatenation :

Time-dependent sound concatenation:
CRUM

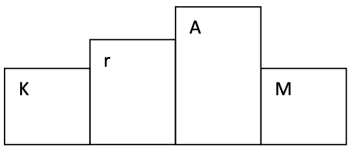


Fig: Phone sound concatenation

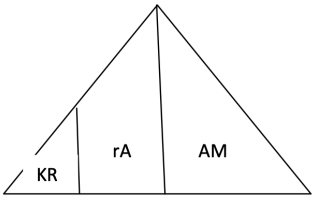


Fig: Di-phone concatenation

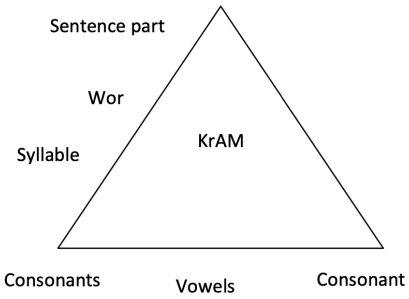
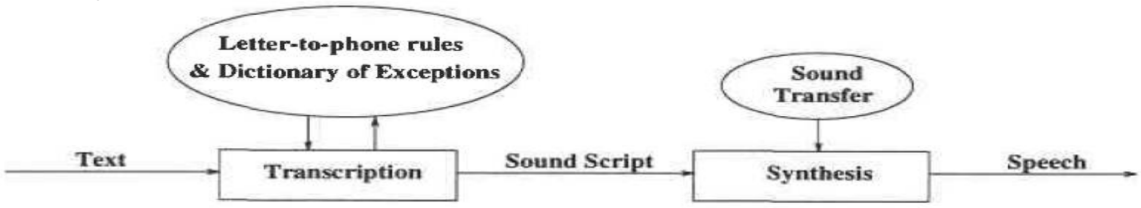


Fig: Word sound concatenation

b. Frequency dependent sound concatenation:



- Speech generation can also be based on frequency dependent sound concatenation. E.g. through formant synthesizing.
- Formants are the frequency maxima in the spectrum of the speech.
- Formants synthesize simulate the vocal track through filter.
- The method used for sound synthesize in order to simulate human speech is called the linear predictive coding (LPC) method.
-

Image Recognition Steps :

Image recognition involves the following six steps:

1. Image formatting
2. Conditioning
3. Labeling
4. Grouping
5. Extracting
6. Matching

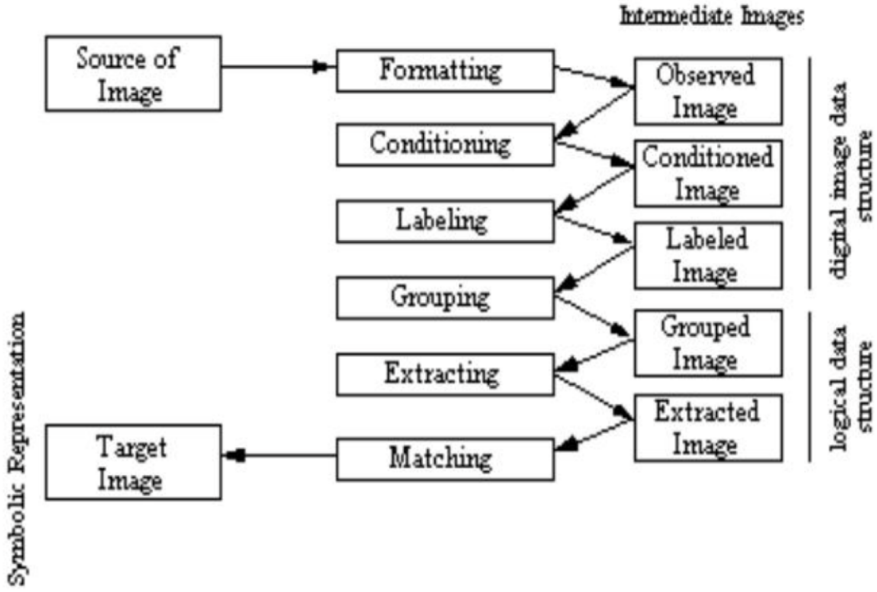


Figure: Image recognition steps

a. Image Formatting
It refers to capturing an image from a camera and bringing it into a digital form, i.e., generating a digital representation of an image in the form of pixels.

b. Conditioning:
The image usually contains some unwanted variations or noise that makes the recognition process difficult and complex. Conditioning is a process in which the image are eliminated or suppressed so that they do not have influence over the recognition process.

c.

Chapter-4 : Video and Animations

Animation :

- Animation is the process of making the illusion of motion and change by means of the rapid display of a sequence of static images that minimally differ from each other. The illusion—as in motion pictures in general—is thought to rely on the phenomenon. Animators are artists who specialize in the creation of animation.
- Animation is the creation of the —illusion of movement ‖ using a series of still images.
- A collection of static images joined together and shown consecutively so that they appear to move.

Steps of Animations.

1. Shooting reference video.
2. Key Posing.
3. Blocking
4. Splining
5. Smoothing
6. Adding Life

Principles of Animations (12):
(https://www.pluralsight.com/blog/film-games/understanding-12-principles-animation)
(EAT_FAASSSSST)

1. **Timing and spacing.** (maintain frame rates and the animating pause over the time which should ultimately establish the mood, emotion and personality of the character. Also to show relatable law of physics).
2. **Squash and stretch**. (as like in real world of ball bouncing, which has its same volume; it its depth and width changes; likewise a squash and strech is essential; ex: human face character changing emotion)

3. **Anticipation.** (Anticipation is used in animation to set the audience up for an action that is about to happen, and is required to sell believable movements.. Ex; base ball player pitching the ball).
4. **Ease in and Ease out.** (As a car moves away from a stop, it doesn't just reach full speed in an instant. It must first gain speed. As it comes to a stop, it doesn't go from sixty to zero in the blink of an eye. Instead, it slows down until it reaches a complete stop. ; for starting and stopping motion; use easein and ease out)
5. **Follow Through:** It refers to the action which continues to move even after the completion of action. This type of action helps in the generation of more idealistic animations.
   For Example: Even after throwing a ball, the movement of hands continues.
6. **Overlap:** It deals with the nature in which before ending the first action, the second action starts.
   For Example: Consider a situation when we are drinking Tea from the right hand and holding a sandwich in the left hand. While drinking a tea, our left-hand start showing movement towards the mouth which shows the interference of the second action before the end of the first action.
7. **Arcs** (the moving motion of character should be in arc as like of real life; not straight and flat like robot)
8. **Exaggeration. (**Exaggeration is used to push movements further, adding more appeal to an action, and should always be implemented to some degree. ; Ex: pushing of car with force, should show that kind of exaggerated motion in the animation.**)**
9. **Solid Drawing.** (In 2D animation, solid drawing is about creating an accurate drawing in terms of volume and weight, balance, shadow, and the anatomy in a pose.)
10. **Appeal**. (This principle can really come down to adding more appeal (charisma) in many different areas of your animation, such as in posing.)
11. **Secondary Action.**(Secondary action refers to the actions that support or emphasize the main action to breathe more life into the animation and create a more convincing performance. It's important to remember that the secondary action should typically be something subtle that doesn't detract from the main action happening (perhaps even thought of as a subconscious action). For this reason, dramatic movements take priority over things like facial expressions.)
12. **Staging** (Staging is how you go about setting up your scene, from the placement of the characters, to the background and foreground elements, the character's mood, and how the camera angle is set up. Staging is used to make the purpose of the animation unmistakably clear to the viewer. You want to keep the focus on what you want to communicate to the audience (and avoid unnecessary detail) so they don't become confused.)

Chapter - 5 : Data Compression

Data compression is the process of converting an input data stream or the source stream or the original raw data into another data stream that has a smaller size. For example text compression, image compression, audio compression and video compression.
There are two types of data compression:
1. Lossy Compression
2. Lossless Compression

Lossy Compression
Lossy compression algorithms are normally not to reproduce an exact copy of the source information after decompression but rather a version of it which is perceived by the recipient as a true copy.
In lossy compression some information is lost during the processing, where the image data is stored into important and unimportant data. The system then discards the unimportant data.
It provides much higher compression rates but there will be some loss of information compared to the original source file. The main advantage is that the loss cannot be visible to eye or it is visually lossless. Visually lossless compression is based on knowledge about color images and human perception.

Lossless Compression
In this type of compression no information is lost during the compression and the decompression process. Here the reconstructed image is mathematically and visually identical to the original one. It achieves only about a 2:1 compression ratio.
This type of compression technique looks for patterns in strings of bits and then expresses them more concisely.

Source, Entropy and Hybrid Coding

Source Coding
• lossy encoding
• takes into account the semantics of the data
• degree of compression depends on data content.
• E.g. content prediction technique - DPCM, delta modulation, etc.

Entropy Coding
• lossless encoding
• used regardless of media's specific characteristics
• data taken as a simple digital sequence
• decompression process regenerates data completely

• e.g. run-length coding, Huffman coding, Arithmetic coding

Hybrid Coding (used by most multimedia systems)
• combine entropy with source encoding
• E.g. JPEG, H.263, DVI (RTV & PLV), MPEG-1, MPEG-2, MPEG-4

Run Length Encoding :
RLE is a very simple form of lossless data compression.
This encoding works by finding repeated sequences of value ; and storing only a single value and its count.
Example : WWWWWWWWBWWWWWWBBBWWW
Encoded form : 7W1B5W3B3W
Sample Images, Videos , and audio data streams often contains sequence of same Bytes for which RLE are very handy.

Huffman Encoding :
It is another lossless data compression algorithm.

Steps :
Convert the given data in ascending order. (tala ko value : No. of pixel)

JPEG(Joint Photographic Expert Group) and its Compression Process.

- JPEG is a commonly used method of lossy compression for digital photography (image).
- The JPEG lossy compression scheme is one of the most popular and versatile compression schemes in widespread use. It's ability to attain considerable size reductions with minimal visual impact with relative light computational requirements and the ability to fine tune the compression level to suit the image at hand has made it the standard for continuous tone still images.
- JPEG compression uses both type of encoding (lossy and lossless). So its hybrid encodnig.

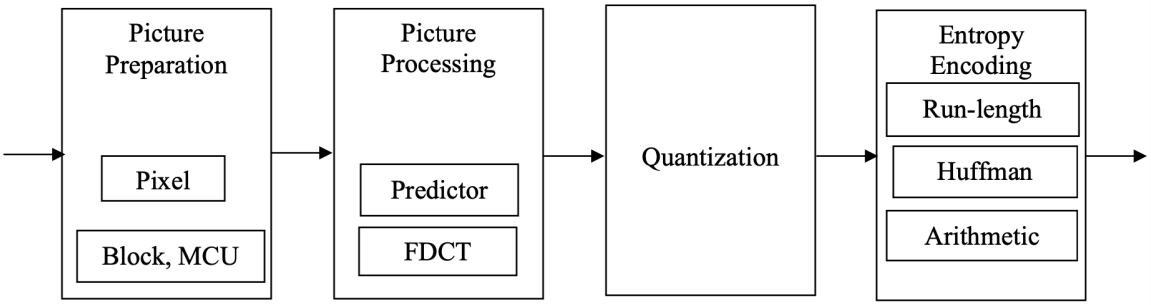


Figure 5.3: Steps of the JPEG compression process.

MCU = Minimum Coded Units
DCT = Discrete Cosine Transformation.

First step:
• Pixel values are shifted (ZERO-SHIFT) into the range [-128,127] with 0 in the center.
Values in the 8x8 pixel are defined by Syx with y,x in the range [0,7] and there are 64 sampled values Syx in each block.
• DCT maps values from time to frequency domain. 1D Forward Discrete Cosine Transformation

$$S(u) = \frac{C(u)}{2}\sum_{x=0}^{7} S(x)\cos\left(\frac{(2x+1)u\pi}{16}\right)$$

$S(x) - 1D\ sampled\ value,$
$C(u) - scaling\ coefficient,$
$S(u) - 1D\ DCT\ coefficient\ (transforrms\ S(x) into\ frequency\ domain)$

Factoring
• By computing the DCT coefficients, we can use factoring; the problem will be reduced to a series of 1D FDCTs.

$$S(v,u) = \frac{1}{4}\sum_{x=0}^{7} C(u)\ cos\left(\frac{(2x+1)u\pi}{16}\right)\left(\sum_{y=0}^{7} C(v)\cos\left(\frac{(2y+1)v\pi}{16}\right)S(y,x)\right)$$

Quantization
GOAL: To throw out bits.

It defines discrete level or values that the information is allowed to take. This process involves the reduction of precision. The quantization process may be uniform or it may be differential depending upon the characteristics of the picture.

Uniform quantization is achieved by dividing the DCT coefficient value S(v,u) by N and rounding the result.

For every element position in the DCT matrix, a corresponding value in the quantization matrix gives a quantum value indicating what the step size is going to be for that element.

[For calculations we can make use of quantization table]

Entropy Encoding

This is the lossy compression method where the semantics of data is ignored but only its characteristics are considered. It may be run length coding or entropy coding.
After compression, the compressed video stream contains the specification of the image starting point and an identification of the compression technique may be the part of the data stream. The error correction code may also be added to the stream. Decompression is the inverse process of compression.

• After image processing we have quantized DC and AC coefficients.
• Initial step of entropy encoding is to map 8x8 plane into 64 element vector

Chapter 6 : Optical Storage Media.

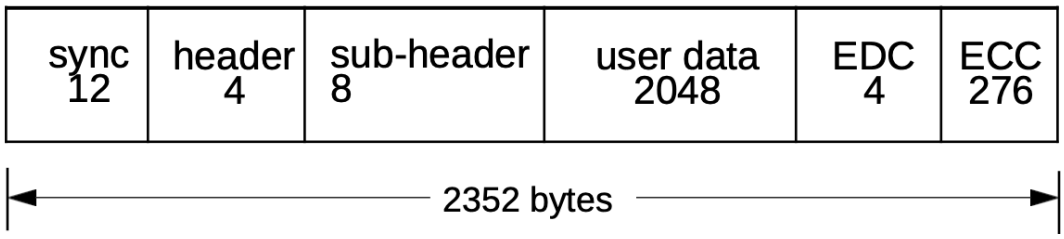
Compact Disc Read Only Memory (CD-ROM) Extended Architecture (CD-ROM/XA)

- CD-ROM/XA (CD-ROM Extended Architecture) is a multimedia format that extends the capabilities of standard CD-ROMs by allowing the inclusion of both data and multimedia content, such as audio, video, and images.
- Computers can read CD-ROMs, but cannot write to CD- ROMs, which are not writable or erasable.
- Storage of:
- • Data, audio, compressed audio and video
- History:
- • N.V. Philips, Sony and Microsoft (announcement in 1988)
- Goal:
- • Simultaneous transfer of various media data

Characteristics:

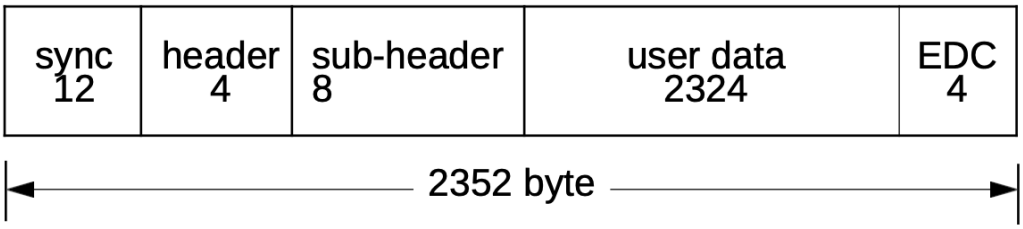
- • Based on CD-ROM mode 2, ISO 9660, CD-I
- • Extension of Yellow Book standard
- • Interleaving of blocks of different media within the same track.
- • Definition of a new type of track used for:
    - • compressed audio (ADPCM) and video data
    - • images
    - • text, programs
- • Distinction between two block formats: “Form 1“, “Form 2“

Form 1



Improved error handling for:
• Text
• Program data
By:
• 4 byte for error detection
• 276 byte for error correction

Form 2



-Storage of compressed data (incl. audio, video)
• Only 4 bytes for error detection
• 13% more data bytes

Drawbacks of CD-ROM/XE :

1. Complexity: CD-ROM/XA's extended architecture introduced complexity to the production process. Creating CD-ROM/XA discs required specialized authoring tools and technical expertise, making it more challenging for content creators to produce multimedia-rich discs.
2. Compatibility: CD-ROM/XA discs were not universally compatible with all CD-ROM drives and players. Some older CD-ROM drives might not fully support the extended architecture, leading to playback issues or limited access to the multimedia content.
3. Storage Constraints: Despite its extended capabilities, CD-ROM/XA still had storage limitations. Multimedia content, especially high-quality video and audio, could consume a significant amount of storage space, limiting the amount of content that could be included on a single disc.

USB Flash Drive :
• A USB flash drive, also variously known as a thumb drive, pen drive, gig stick, flash stick, jump drive, disk key, disk on key (after the original M-Systems DiskOnKey drive from 2000), flashdrive, memory stick (not to be confused with the Sony Memory Stick), USB stick or USB memory, is a data storage device that includes flash memory with an integrated USB interface.
• Most weigh less than 30 g (1 ounce).
• flash drives with anywhere from 8 to 256 GB are frequently sold; less frequent are 512 GB and 1 TB units.
• USB flash drives are often used for the same purposes for which floppy disks or CDs were once used; i.e. for storage, data backup and transfer of computer files.
• They are smaller, faster, have thousands of times more capacity, and are more durable and reliable because they have no moving parts.

• USB flash drives use the USB mass storage device class standard, supported natively by modern operating systems such as Windows, Linux, macOS and other Unixlike systems, as well as many BIOS boot ROMs.

Chapter-7: Computer Technology and Multimedia Operating System (MOS):

Multimedia Workstation

A workstation refers to an individual computer, or group of computers, used by a single user to perform work. For example, a "workstation" may be an average-powered computer connected to a larger network. It can also refer to a powerful computer intended for serious academic or professional computation.

A multimedia workstation is a specialized computer system or workstation that is designed and equipped to handle various aspects of multimedia content creation, editing, and manipulation. It provides the necessary hardware and software tools to work with different types of media, such as graphics, audio, video, and animation, in an integrated and efficient manner.

Features : Powerful Hardware, Graphics and Video Capabilities, Large Storage Capacity, High-Resolution Displays, Rendering Performance, High Networking Capabilities.

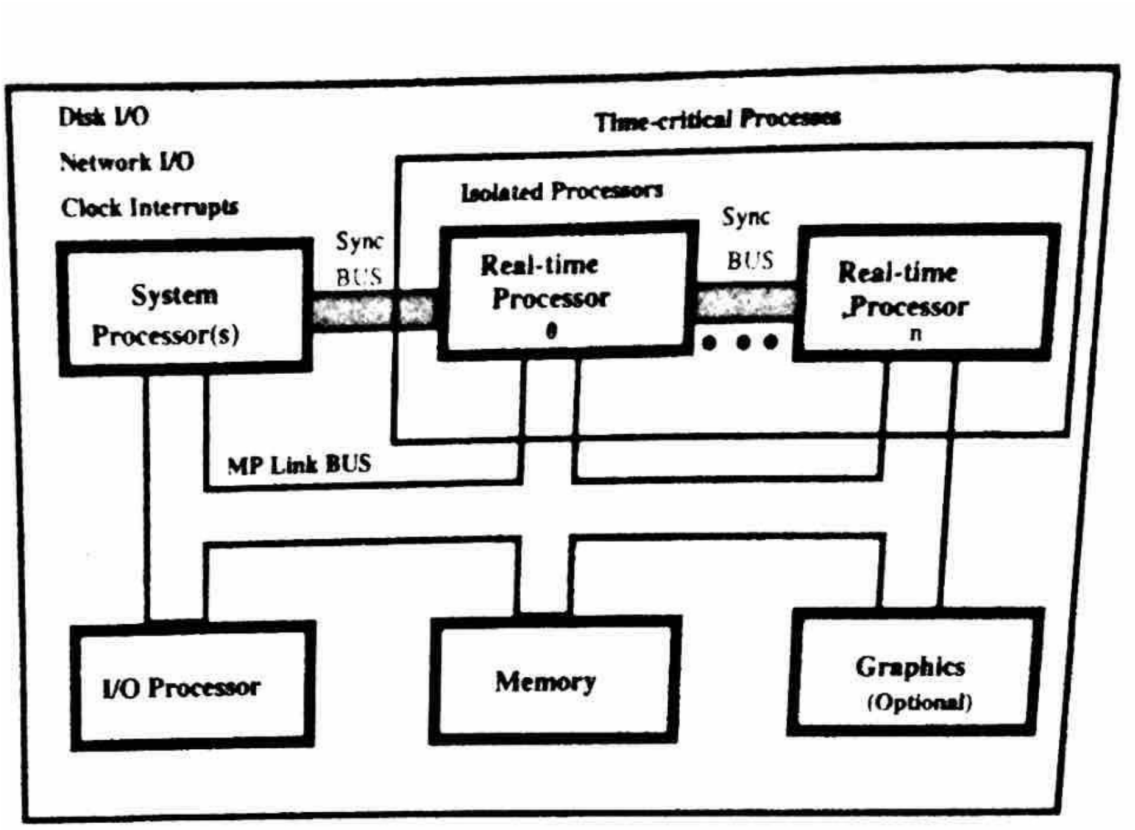


Fig : Multimedia workstation components.

Real-time systems

Usecase : Missile guidance, Payment Processing, Traffic Systems, Radar systems, etc.

Types:

A hard real-time operating system is used when we need to complete tasks by a given deadline. If the task is not completed on time then the system is considered to be failed.

A soft real-time operating system is used where few delays in time duration are acceptable. That is if the given task is taking a few seconds more than the specified time then also no critical damage takes place.

A firm real-time operating system lies between the hard and soft real-time operating system. A firm real-time system is one in which a few missed deadlines will not lead to total failure, but missing more than a few may lead to complete or catastrophic system failure. However, unlike a hard real-time task, even if a firm real-time task does not completed within its deadline, the system doesn't fail but the late results are merely discarded.

Characteristics of Real time systems :

1. Fault tolerance: Real-time systems must be designed to tolerate and recover from faults or errors. The system should be able to detect errors and recover from them without affecting the system's performance or output.
2. Concurrency: Real-time systems are concurrent that means it can respond to a several number of processes at a time. There are several different tasks going on within the system and it responds accordingly to every task in short intervals. This makes the real-time systems concurrent systems.
3. Resource management: Real-time systems must manage their resources efficiently, including processing power, memory, and input/output devices. The system must ensure that resources are used optimally to meet the time constraints and produce correct results.
4. Security: Real-time systems may handle sensitive data or operate in critical environments, which makes security a crucial aspect. The system must ensure that data is protected and access is restricted to authorized users only.

Chapter-8: Documentation, Hypertext and MHEG

Document :

- A multimedia document is a document which is composed of information coded in at least one continuous (time-dependent) medium and in one discrete (time independent) medium. The media are synchronized. A multimedia document is closely related to its environment of tools, data abstractions, basic concepts and document architecture.
- Continuous and discrete data are processed differently: text is processed within an editor program as a type of a programming language; a motion picture can be manipulated.
- In order to exchange documents the content of the document as well as its structure needs to be communicated. This requires the use of standard format for the documents so that it can be communicated to a wide range of users.
- The current formats on the process of standardization are Standard Generalized Markup Language (SGML) and the Open Document Architecture (ODA). It means a standard architecture of document is required.
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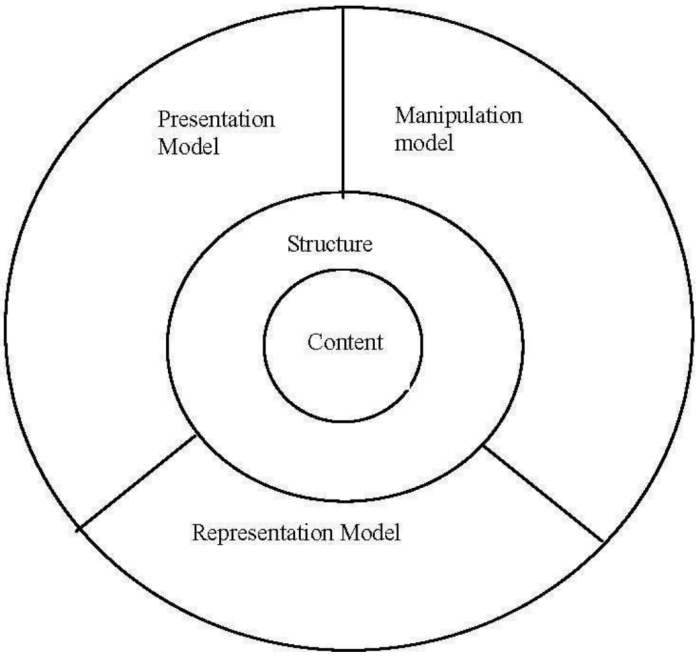


Figure: Document architecture and its elements

- The presentation model describes how the content of the document is displayed or presented before the users. The Structure is described by the links and the synchronization parameters of the document. The content is the actual information that the document carries.

- The manipulation model describes all the operations allowed for creation, change and deletion of multimedia information.
- The representation model includes the relations between the individual information elements which need to be considered during presentation. It defines:
    - protocols for exchanging information among different computers
    - formats for storing the data

[Syntax = rules and regulations; semantic = meaning]

SGML (Standard Generalized Markup Language)

SGML was evolved from an IBM internal project, and was strongly supported by American publishers:
• Authors define titles, tables, etc. inside a document in a uniform way, without any description of the actual representation.
• Publisher determines layout
Basic ideas:
• Author uses tags (markups) to mark parts of the text to be e.g. a title or a table
• SGML determines how tags have to look like
• User groups agree on the meaning of the tags
• Formatter generates document layout from tags
SGML defines syntax, not semantics!

Relationship between:
- Document
    - _ Data content
    - _ Tags (markups)
- Document Type Definition (DTD):
    - _ Set of markup declarations, define
        - Element types
        - Attributes of elements
        - Hierarchical relationships between elements
- Procedures
    - _ Specify the document processing
    - _ Correspond to functions of the formatter

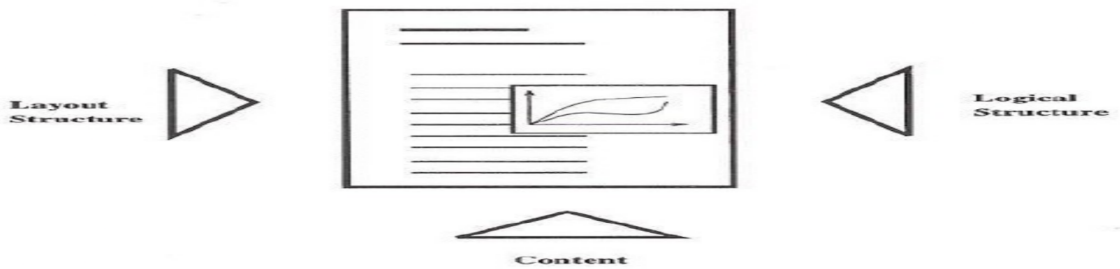
Sample SGML Document

```
<!DOCTYPE REPORT PUBLIC "-//KonaExample//DTD Prescription 970926//EN" [
]>
<PRESCRIPTION>
    Amoxicillin
    <FORM>250 mg. capsule</FORM>
    <DISPENSE>30</DISPENSE>
    <DOSAGE>1 cap(s) </DOSAGE>
    <INSTRUCTIONS>3 times daily until gone </INSTRUCTIONS>
     <REFILL>0</REFILL>
    <SUBSTITUTE>may substitute</SUBSTITUTE>
    <NUMBER NOTYPE="DEA">AB1234567</NUMBER>
</PRESCRIPTION>
```

ODA (Open Document Architecture):

The Open Document Architecture (ODA) was initially called the Office Document Architecture because it supports mostly office-oriented applications. The main goal of this document architecture is to support the exchange, processing and presentation of documents in open systems. ODA has been endorsed mainly by the computer industry, especially in Europe.

Details of ODA
The main property of ODA is the distinction among content, logical structure and layout structure. This is in contrast to SGML where only a logical structure and the contents are defined. ODA also defines semantics.



ODA : Content layout and logical view

A content architecture describes for each medium:
(1) the specification of the elements,
(2) the possible access functions and,
(3) the data coding.
ODA has content architectures for media text, geometrical graphics and raster graphics. Contents of the medium text are defined through the Character Content Architecture. The Geometric Graphics Content Architecture allows a content description of still images.

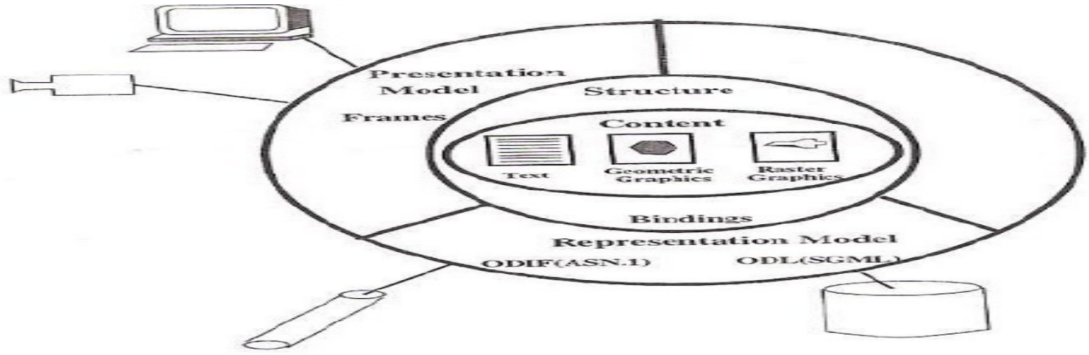
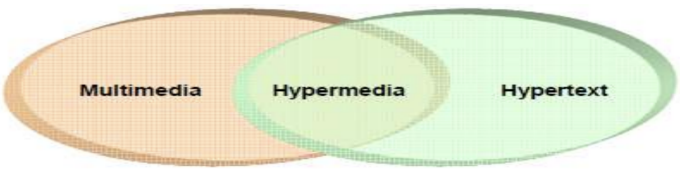


Fig : ODA Architecture.

Multimedia, HyperMedia and HyperText :

HyperText : Hypertext is a digital information system that enables non-linear navigation and linking between text or content elements. In a hypertext system, words or phrases in a document are linked to other documents, allowing users to navigate and access related information by clicking on these links. This concept of interconnected text was popularized by Ted Nelson, and the World Wide Web is a prime example of a hypertext system. Hypertext facilitates a more dynamic and flexible way of accessing information compared to linear text.

Hypermedia is an extension of hypertext that includes not only text-based links but also links to other forms of media, such as images, audio, and video. In a hypermedia system, users can navigate between different types of media using hyperlinks. Hypermedia adds an additional layer of interactivity and richness to the browsing experience, allowing users to explore related content in various formats. The World Wide Web, with its combination of text, images, videos, and other media, is a prime example of a hypermedia environment.



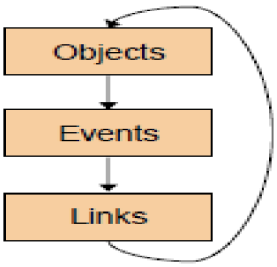
MHEG :

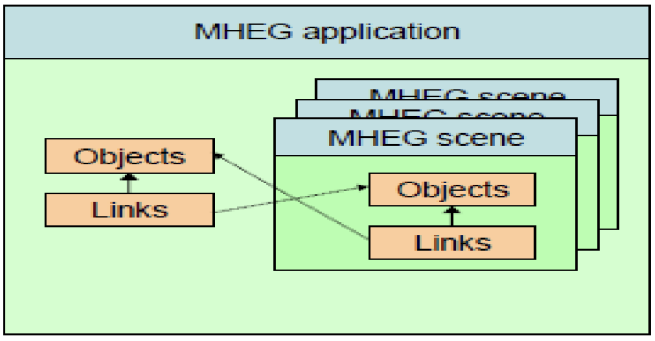
- Stands for Multimedia and Hypermedia Informing Coding Expert Group.
- It is an “umbrella standard” for multimedia objects.
- MHEG is designed to specify the presentation and interaction behavior of multimedia and hypermedia content across various devices, including digital television (DTV) systems, set-top boxes, and interactive multimedia systems.
- It defines a programming language and runtime environment that enable the creation of interactive applications, such as electronic program guides, interactive TV services, and multimedia-rich educational content.
- Suitable for real-time (distributed) multimedia/hypermedia applications (no complex parsing and interpretation required)
- MHEG Family

  Outdated standards:
  - • MHEG-1: MHEG Object Representation, Base Notation (ASN.1)
  - • MHEG-2: MHEG Alternate Notation (SGML)
  - • MHEG-3: MHEG Extension for Scripting Language Support
  - • MHEG-4: Registration Procedures for Format Identifiers

  Current standards:
  - • MHEG-5: Support for Base-Level Interactive Applications
  - • MHEG-6: Support for Enhanced Interactive Applications: JavaVM
  - • MHEG-7: Conformance Testing
  - • MHEG-8: XML

MHEG 5- Objects, Events and Links

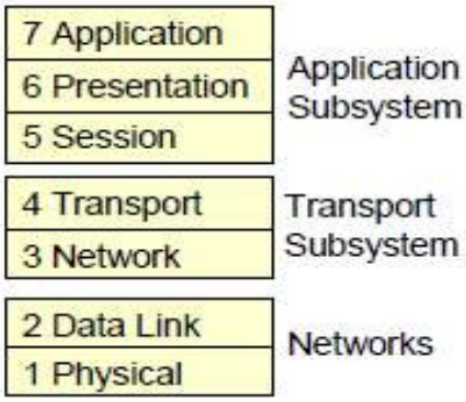




Chapter 9 : Multimedia Communications Systems

Multimedia applications have several requirements – as well for the data transmission as for controlling interactivity. For structuring control and transmission functionality and implement common protocols.
From the communication perspective, we can divide the higher layers of the Multimedia Communication System (MCS) into two architectural subsystems:

1. Application subsystem.
2. Transport Subsystem.



Application Subsystem
This subsystem includes the software and the tools with which the end user directly interacts. E.g. applications can be email, video conferencing software etc.
• Responsible for the management and service issues for group cooperation and session orchestration.
• Supporting a large scale of multimedia applications, e.g.
• Multimedia Mail
• Virtual Reality Applications
• Video Conferencing
• CSCW (Computer Supported Cooperative Work)

Group Communication Architecture.

Group communication is a cooperative activity which may be synchronous or asynchronous which may be central control or a distributed control. A group communication architecture consists of:

- Support model
- System model
- Interface model

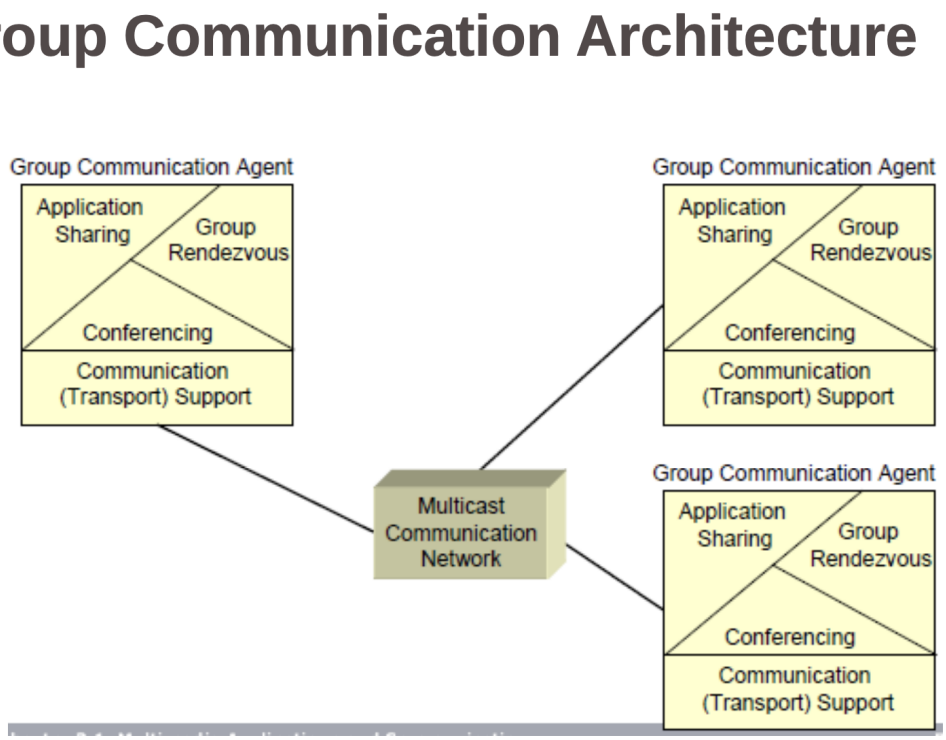


Figure: Communication Support Model

Group communication:

• Synchronous communication

• Asynchronous communication

Support Model:

It includes group communication agents that communicate via a multi-point multicast communication network as shown in the figure above. Group communication agents may use the following for their

• Group rendezvous (organization of meetings and delivering information (informations such as static or dynamic))

• Shared applications (simultaneous replication and modification of information to multiple users, e.g. telepointing, joint editing)

• Conferencing (audio/video)

• System Model:
- Client/server model

Interface Model:

• Exchanging information within the support model (object oriented)

It includes the *user presentation protocols* and *group work management protocols*. User presentation protocol is the interface available to the end users from which they can initiate, join, manage,communicate and terminate the conference. Group work management protocols specify the communication between the client and the servers for services like registration and querying the status of the conference.

Transport Subsystem

Requirements

• User and Application Requirements Networked multimedia applications by themselves impose new requirements onto data handling in computing and communication because they need: Sustainable data throughput, fast data forwarding, service guarantees, and multicasting.

• Data Throughput

This requirement wants the processing of the system to be fast and effective.

• Fast Data Forwarding

The users or application wants very low end to end delay and jitter when communicating multimedia data. The holding time should be very less due to the real time requirement.

• Service Guarantees: The loss of the information is undesired and the system or protocol used must ensure that the information is delivered to the intended destination.

• Multicasting : It is important for sharing the bandwidth and the communication protocol processing at end systems.

• Processing and Protocol Constraints Processing system and protocols have constraints which need to be considered while processing and transmitting multimedia information.

• Following the “shortest possible path” for quicker delivery
• Buffer management
• Segmentation and reassembly
• Re-transmission on error
• Error-recovery
• Asynchronous transfer

Transport Layer

Transport protocols, to support multimedia transmission, need to have new features and provide the following functions:

• Timing information
• Semi-reliability
• Multicasting
• NAK (none-acknowledgement)-based error recovery mechanism
• Rate control

Internet Transport Protocols :

1. TCP
2. UDP
3. RTP (Real-time Transport Protocol):
   • RTP is a UDP protocol used in the client server environment and in real-time multimedia applications.
   • The multimedia application consists of multiple audio,video, text, and possibly other streams. These are fed into the RTP library, which is in the user space along with the application. This library then multiplexes the streams and encodes them in RTP packets, which it then stuffs into a socket. At the other end of the socket, UDP packets are generated and embedded in IP packets
4. Xpress Transport Protocol (XTP) :
   XTP integrates transport and network protocol functionalities to have more control over the environment in which it operates. XTP is intended to be useful in a wide variety of environments, from real-time control systems to remote procedure calls in distributed operating systems and distributed databases to bulk data transfer.
   • It defines for this purpose six service types: connection,transaction, unacknowledged data gram, acknowledged datagram, isochronous stream and bulk data.

Network Layer

Internet Protocol In the TCP/IP protocol stack the network layer protocol is the Internet Protocol (IP) and, in order to transfer packets of information from one host to another, it is the IP in the two hosts, together with the IP in each Internet gateway and router involved that perform the routing and other harmonization functions necessary.The IP in each host has a unique Internet-wide address assigned to it.

• This is known as the host s " Internet address or, more usually, its IP address. Each IP address has two parts: a network identifier and a host identifier.

QoS (Quality of Service)

• During a multimedia communication, the services in the multimedia systems need to be parameterized.
• Parameterization of the services is defined in ISO standards through the notion of Quality of Service (QoS).
• Each service can be characterized by a quality of service. As a simple example some services are reliable i.e. they do not lose data while some are unreliable as they may lose data.
• The parameters can be bandwidth, maximum and minimum end to end delay, jitter *(jitter is a variance in latency, or the time delay between when a signal is transmitted and when it is received.)*, buffer allocation etc.

QoS Layering

The QoS requirement is associated with each layer of the OSI model, or the TCP/IP model. However the QoS for multimedia communication system (MCS) consists of three layers: application, system and devices.
Application means the software and the program parameters, where as system refers to the overall system of communication and then in the network.
The **system** QoS parameters describe requirements on the communication services and OS services resulting from the application QoS. They may be specified in terms of both quantitative (bandwidth, PDU size, buffer size) and qualitative criteria (level of synchronization, order of data delivery, recovery).
The **network** QoS parameters describe requirements on network services. They may be specified in terms of network load (packet size, service time) and network performance (congestion, delay).
The **device** QoS parameters typically specify timing and throughput demands for media data units.

QoS-layered model for the MCS

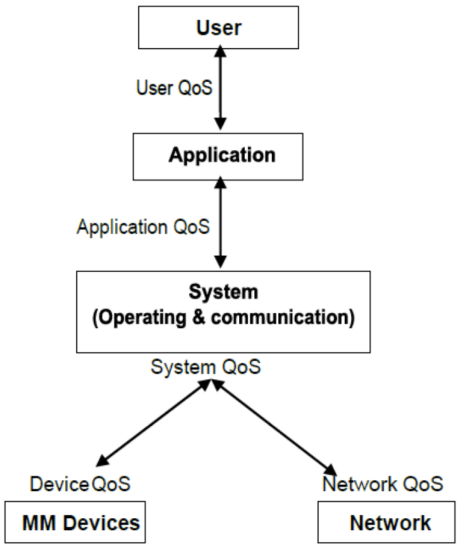


Figure: QoS-layered model for the MCS

Resource Management :

- Resource is a system used for processing, storing, manipulating data.
- • The resource can be active and passive. The active resource can be a CPU which processes data or manipulates data whereas the passive resource is a bandwidth which only serves a particular purpose.
- A resource can be exclusive i.e. used by a single process or it may be shared where it is shared between various processes.
- The resource may be single or it may be multiple.

Resource Management Architecture

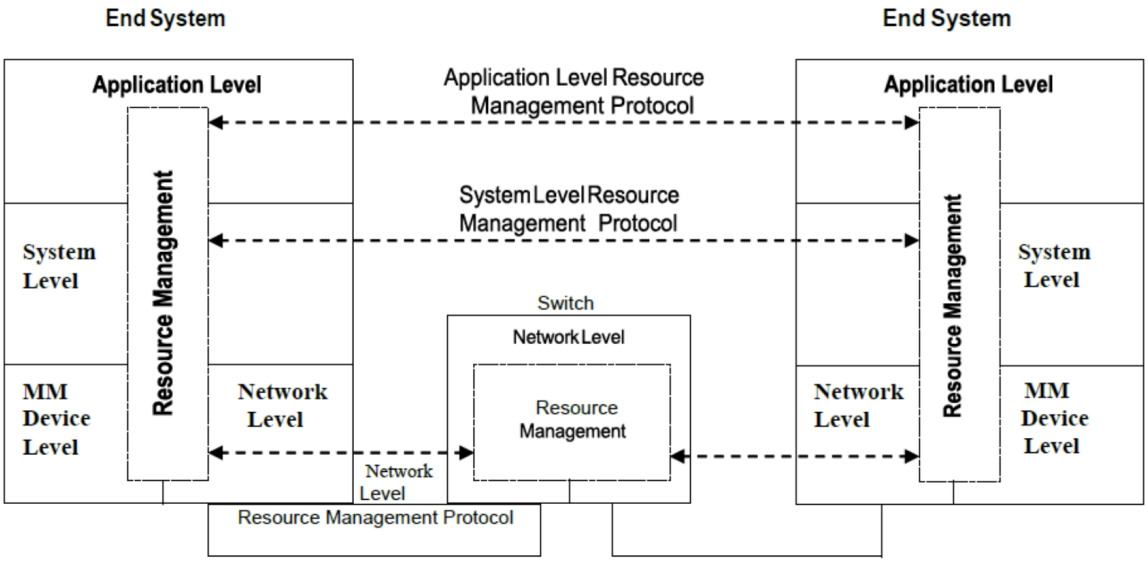


Figure: Resource Management in MCSs

The main goal of resource management is to offer guaranteed quality of service. It addresses three main actions

- Reserve and allocate resource
- Provide resources according to QoS specification
- Adapt to resource changes during on-going multimedia data processing.