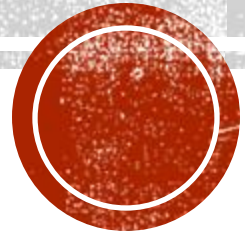
CHAPTER 7: COMPUTER TECHNOLOGY AND MOS



Multimedia Systems

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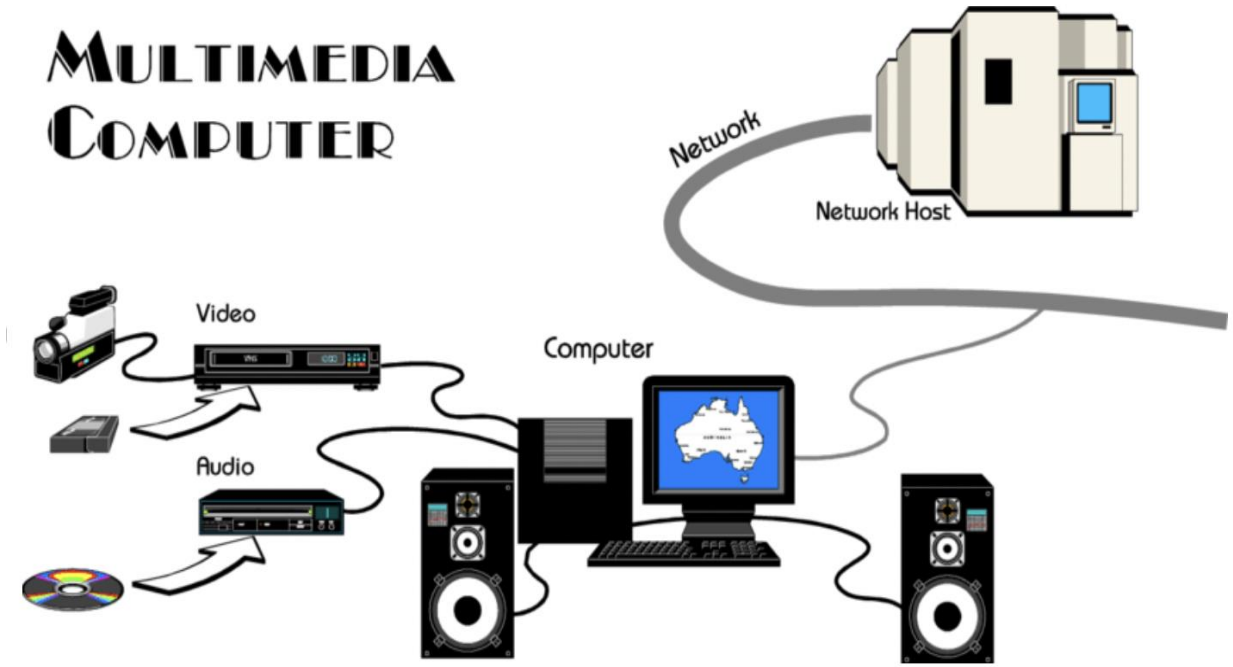
INTRODUCTION

- A multimedia system is comprised of both hardware and software components, but the major driving force behind a multimedia development is research and development in hardware capabilities.
- For example: Compact disks with high storage capacity at a relatively low price provided the first step toward multimedia storage capabilities.
- Multimdia hardware components and their integration with the network to support multimedia communication system plays a major role in the development of multimedia systems.
- Without the necessary hardware, data storage capacity and continious high data throughput, multimedia implementation would be impossible.
- The starting point for multimedia communication systems was the hybrid system where digital and analog components were integrated.

MULTIMEDIA WORK-STATION

REFER TO BOOK: RALF STEINMETZ [PG.219-223]

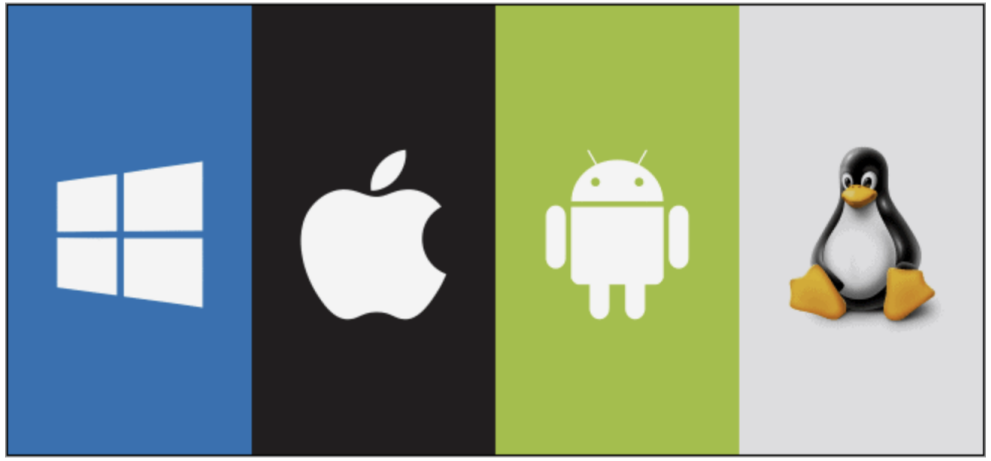
- Current workstations are designed for the manipulation of discrete media information.
- The data should be exchanged in a resonable time between the involved components.
- The main components of multimedia workstation are:
  - Standard processor
  - Main Memory and Secondary Storage
  - Special purpose Processors designed for audio/video media
  - Graphics and Video Adapters
  - Communication Adapters for Synchronous and Asynchronous data transfer

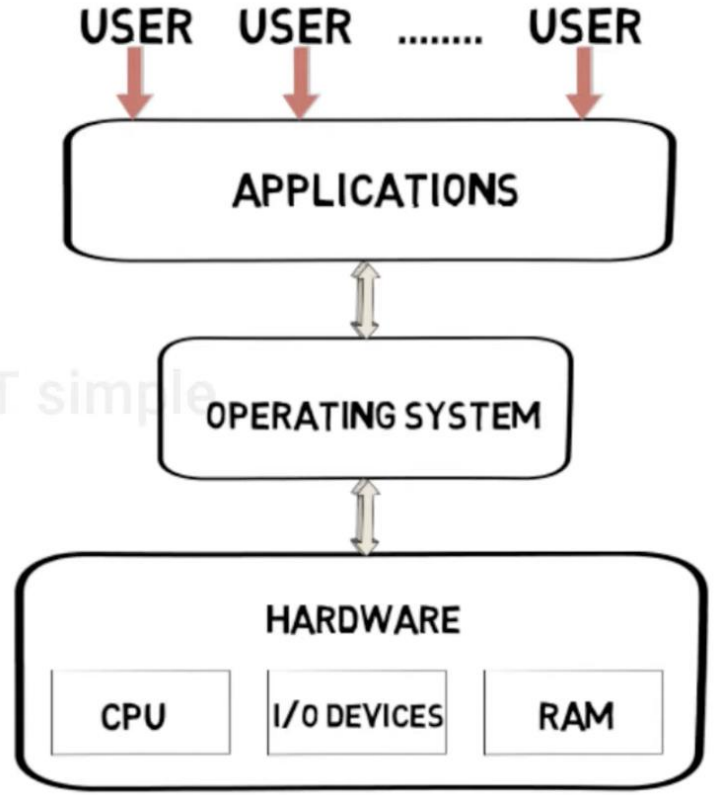


Multimedia computer hardware environment.

MULTIMEDIA OPERATING SYSTEM

- Operating System: A System software that acts as an interface between the user and the computer hardware and controls the exectuion of all kinds of program..
- It makes the interaction with the hardware more easy and efficient.





OPERATING SYSTEM

- 1. Process Management:
  - Which process will be executed?
  - How much time required for the process?
  - Allocating process to processor.
  - De-allocating the process from the processor.
- 2. Memory Management
  - How much to memory allocation to a process
  - De-allocate the memory
  - Usage of memory, how much is free?
- 3. I/O Device Management
  - Which devices are needed and for how much time?
  - Managing the Connections.
- 4. File management
  - Keeping track of the files location, status.

OPERATING SYSTEM

- 5. Network Management
  - Managing all network connections and devices.
  - Control the network interface card (NIC), which is the hardware component that connects a computer to a network.
  - In addition to managing the NIC, the OS also controls the network protocols.
- 6. Security Management
  - Managing all users.
  - Who is authorized user?
  - Restricting unauthorized users and activity.

REAL TIME/REAL TIME OS

- *"A Real-time process is one which delivers the result in a given time span"*
  - The term "real-time system" refers to any information processing system with hardware and software components that perform real-time application functions and can respond to events within predictable and specific time constraints.
  - The Oxford Dictionary defines a real-time system as "any system in which the time at which output is produced is significant.
  - The main characteristics of the real time system is the correctness of the computation and the time in which the result is presented.
  - The time doesn't always mean as quickly as possible in real time systems. Rather it refers to "in the exact time defined".
  - Hence timing and logical dependencies among different related tasks must also be considered.

TIME-CONSTRAINTS

- Every real-time task is associated with some time constraints.
- Time constraints can be classified into the following three types;

1. Delay constraint: A delay constraint captures the minimum time (delay) that must elapse between the occurrence of two arbitrary events e1 and e2.

2. Deadline constraint: A deadline constraint captures the permissible maximum separation between any two arbitrary events e1 and e2.

3. Duration constraints: A duration constraints on an event specifies the time period over which the event acts.
   - The minimum type duration constraint requires that once the event starts, the event must not end before a certain minimum duration.
   - The maximum type duration constraint requires that once the event starts, the event must end before a certain maximum duration elapses.

CORRECTNESS CRITERION

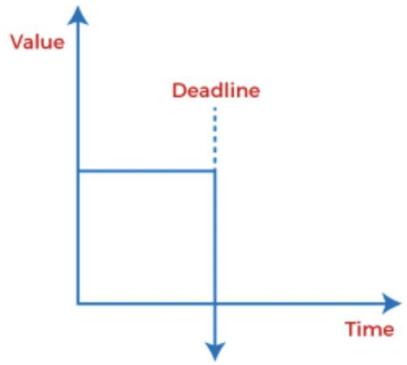
- In real-time systems, correctness implies not only logical correctness of the results, but the time at which the results are produced is important.
- A logically correct result produced after the deadline would be considered as an incorrect result.

TYPES OF REAL-TIME SYSTEMS

Hard Real Time System

- Hard real-time is when a system will cease to function if a deadline is missed, which can result in catastrophic consequences.
- A hard real-time system considers timelines as a deadline, and it should not be omitted in any circumstances.
- A hard real-time system is a purely deterministic.

- Flight Control Systems, Missile Guidance Systems
- Weapons Defense, Medical System
- Railway signaling system
- Air traffic control systems
- Nuclear reactor
- Chemical plant control
- Autopilot System in Plane

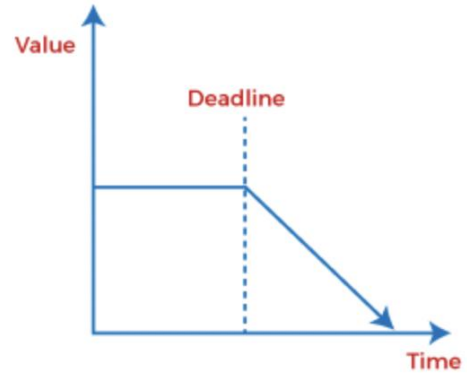


Hard Deadline

Soft Real Time System

- Soft real-time is when a system continues to function even if it's unable to execute within an allotted time.
- If the system has missed its deadline, it will not result in critical consequences.
- The system can continue to function, though with undesirable lower quality of output.

- Multimedia system
- Web browsing
- Online transaction systems
- Telephone switches
- Virtual reality
- Mobile communication



Soft Deadline

RESOURCE MANAGEMNET

- Multimedia systems with integrated audio and video processing are at the limit of their capacity, even with data compression and utilization of new technology.
- Current computers do not allow processing of data without any resource reservation and real-time process management.
- The actual requirements depends upon the type of media and the nature of application.E.g. for A video should not be presented without exceeding certain threshold time value.
- In an integrated distrubuted multimedia system, several application compete for system resources which requires careful allocation.
- For this purpose, to deliver a QoS(Quality of Service), the system management must employ adequate scheduling algorithms to server the requirements of the application

WHY IS RESOURCE MANAGEMENT NECESSARY?

1. Efficient Utilization of Resources:
   - Resources like CPU, memory, and storage are finite. Proper management ensures these are used efficiently to maximize performance and minimize waste.
2. Fair Allocation:
   - In multi-user or multi-tasking systems, resource management ensures fair distribution of resources among competing processes, users, or applications.
3. Avoidance of Deadlock:
   - Without proper resource allocation policies, systems can enter a **deadlock** state where multiple processes wait indefinitely for resources held by each other.
4. System Stability and Reliability:
   - Poor resource management can lead to crashes, slowdowns, or unresponsiveness. Managing resources ensures the system remains stable and reliable.
5. Improved Performance:
   - By prioritizing tasks and allocating resources efficiently, resource management can reduce response time, improve throughput, and enhance overall system performance.

CONTD..

6. Support for Multi-Tasking:

- Modern operating systems allow multiple applications to run simultaneously. Resource management ensures that each application gets the required resources without interfering with others.

7. Cost Savings:

- Proper resource management helps reduce hardware requirements by maximizing the use of available resources. This is particularly important in cloud computing and server environments.

8. Security and Isolation:

- Effective resource management prevents unauthorized access and ensures that processes running in isolation do not interfere with each other.

EXAMPLES OF RESOURCE MANAGEMENT:

1. CPU Scheduling Algorithms:
   - First-Come-First-Served (FCFS),
   - Shortest Job Next (SJN),
   - Round-Robin, etc.
2. Memory Management Techniques:
   - Paging, segmentation, and virtual memory.
3. Disk Scheduling Algorithms:
   - FCFS, SSTF (Shortest Seek Time First), and SCAN.

PHASES OF RESOURCE RESERVATION AND ITS MANAGEMENT

- 1. Schedulability Test:
  - The resource manager checks with the given QoS parameter(Throughput & Reliability) to determine if there is enough resource capacity available to handle the request.
  - It ensures that all tasks in a system can execute successfully without missing deadlines, given the available system resources such as CPU, memory, or network bandwidth.
- 2. Quality of Service Calculation:
  - After the Schedulability test, the resource management checks the best possible perfomance for the request.
  - QoS is especially critical in systems where performance directly impacts user experience or system functionality, such as real-time applications, multimedia systems, cloud computing, and network communication.

    Latency ≤50 ms

    Throughput ≥10 Mbps

    Packet loss ≤0.5%

CONTD..

- 3. Resource Reservation:
  - The resource management allocates/reserves the required capacity to meet the QoS parameter for the request.
  - Can be Hard reservation(For Real-time) and Soft Reservation
- 4. Resource Scheduling:
  - When finally the data arrives, the resouce management will start to schedule the allocated resource using various algorithms such as RMS, EDF.
  - This step involves deciding the order of execution, the time slots, and the priority of tasks that utilize the reserved resources, while ensuring compliance with the reservation agreements.

EDF (EARLIEST DEADLINE FIRST)

- Earliest Deadline First (EDF) prioritizes tasks with the nearest deadlines.
- Task priorities are determined dynamically at runtime based on their absolute deadlines. A task's priority increases as its deadline approaches.
- EDF allows preemption, meaning a task currently running can be interrupted if a new task with an earlier deadline arrives.
- EDF can utilize the processor up to 100% without causing deadline misses.

  - *<Refer to numerical done in class for EDF and RMA>*

RMS (RATE MONOTONIC SCHEDULING)

- Rate Monotonic Scheduling (RMS) assigns priorities based on task periods.
- The Rate Monotonic Scheduling (RMS) algorithm is a fixed-priority, preemptive scheduling technique used in real-time systems.
- It assigns priorities to tasks based on their periodicity: tasks with shorter periods are given higher priorities.
- RMS is particularly suited for systems where tasks are periodic and their characteristics (period, execution time) are known in advance.
- CPU utilization is comparitively less than EDF scheduling algorithms.

END OF CHAPTER 7