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COURSE: OPERATING SYSTEMS

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QUESTION 1

What is a virtual machine? Discuss a few types of Virtual machine available in the computing industry.

VIRTUAL MACHINE:

A virtual machine (VM) serves as a software-based emulation of a physical computer. It allows and provides a platform-independent environment for running multiple operating systems (OS) on a single physical machine. This technology utilizes virtualization techniques, abstracting hardware resources and ensuring isolation between the VM and the host system.

- A VM mimics a physical computer through software.
- It operates in an isolated environment.

Resource Utilization:

It patially utilizes hardware resources such as CPU, RAM, and disk space.

The space is distinct from the host system.

TYPES OF VIRTUAL MACHINES:

1. SYSTEM VIRTUAL MACHINE:

- System virtual machine is fully virtualized to substitute a physical machine.
- It involves a hypervisor for resource sharing, which can run on bare hardware.
- It supports complete virtual operating systems by giving system platform and execution.

- It distributes hardware resources among multiple VMs.
- Examples: VMware ESXi and VirtualBox.

2. PROCESS VIRTUAL MACHINE:

- Process virtual machine allows a single process to run as an application on a host machine.
- It provides a platform-independent programming environment by masking the details of underlying hardware.
- It creates a virtual environment for an OS while running any application or program.
- It will be destroyed as soon as the program terminates
- Examples:
  - Java Virtual Machine (JVM) enables running Java applications on any OS.
  - Wine Software in Linux helps to run windows applications.

QUESTION 2

Explain the concept of hypervisor in the context of operating systems with the help of suitable examples.

HYPERVISOR:

- Definition: A hypervisor is a software or hardware facilitating the creation and operation of virtual machines.
  It is also known as a Virtual Machine Monitor (VM
- Purpose: It enable multiple operating systems to ru on a single physical machine.
  It creates and manages isolated environment for VMs

Hardware Virtualization: The hypervisor is a hardware virtualization technique that allows multiple guest operating Systems to run simultaneously on a single host system.

- Virtualization Support: It abstracts computer software from its hardware. It provides translation between physical and virtual resources.
- Resource Sharing: It shares virtual computing, storage and memory resources.
- Multiple Operating Systems: Hypervisor supports multiple operating systems on a single server (bare-metal hypervisor). It can be installed on top of a standard OS and isolated from it (hosted hypervisor).

Examples Of Hypervisors

1. VMware ESXi (Type 1):

- VMware ESXi is a widely used Type 1 hypervisor for enterprising environments.
- It runs directly on the hardware, providing efficient virtualization for server consolidation.
- It takes the place of a host OS and VM resources are scheduled directly to the hardware by the hypervisor.

Examples: KVM, Microsoft Hyper-V, and VMware vSphere are examples of typ-I hypervisors.

Virtual Box (Type 2):

- Oracle VM Virtual Box is a popular Typ-2 hypervisor that runs on various host operating systems.

- It is commonly used for development, testing, and running virtual machines on desktops or laptops.
- It works by abstracting guest OS from the host OS. VM resources are scheduled against a host OS, which is then executed against the hardware.

Example: VMware workstation and Oracle VirtualBox are examples of type 2 hypervisor.

QUESTION 3

Explain the term "Process Scheduling". Discuss some of the famous process scheduling algorithms.

PROCESS SCHEDULING:

- Definition: Process scheduling is one of the crucial aspect of operating systems. The focus is on managing and allocating system resources to different processes in a multitasking environment.
- Objectives: The primary goal of process scheduling is to utilize CPU time, ensure fairness, and enhance overall system performance.
- Challenges: In a multitasking system, multiple processes compete for the processor, necessiating effective scheduling to determine their execution order.

Main types of Process Scheduling Methods:

① Preemptive Scheduling: A process switches from one process to another running state to ready or waiting state to ready state.

It is used when a process is preempted due to higher priority process

Non-preemptive Scheduling: Process terminates or switches from running to waiting state.
It is applied when a process completes its execution.

COMMON PROCESS SCHEDULING ALGORITHMS

FIRST-COME, FIRST-SERVED: (FCFS):

- Process are scheduled in the order they arrive in the ready queue.
- It is a non-preemptive scheduling algorithm.
- Advantage: Simple and easy to understand.
- Disadvantage: It can lead to the "convoy effect", where shorter process are delayed by longer ones.
- FCFS is considered to be the simplest of all OS scheduling algorithms.
- First come First serve scheduling algorithm states that the process that request CPU first is allocated the CPU first.
- It is implemented using FIFO queue.

2. SHORTEST JOB NEXT (SJN) OR SHORTEST JOB FIRST (SJF):

- This algorithm also follows non-preemptive scheduling, that selects the waiting process with the smallest execution time to execute next.
- Advantage: Reduces the average waiting time. It reduces waiting time for smaller processes.
- Disadvantages: One of it is starvation. It requires knowledge of future CPU burst time, it makes it complicated to predict the length of the next CPU request.
- It is associated with each task as a unit time to complete.

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3. PRIORITY SCHEDULING:

- A preemptive method of CPU scheduling that works based on the priority of a process.
- It assigns priorities to processes, and the process with the highest priority is scheduled next.
- If there are more than one process with equal priority then they are managed using First come first save algorithm.
- Lower is the number assigned, higher is the priority.
- Advantage: It allows prioritization of critical process and average waiting time is decreased.
- Disadvantage: It may lead to starvation if low-priority processes are continually preempted.

4. ROUND ROBBIN (RR):

- It is a preemptive version of First come first serve scheduling algorithm.
- It focuses of time-sharing technique, allocates a fixed time slot (time quantum) to each process in a circular order.
- It is a widely used scheduling method, simple & easy to use, starvation free as all process get the balanced processor allocation.
- Advantage: Fairness in resource allocation, every process gets an equal share of processor (time).
- Disadvantage: High turnaround time for long processes, it may not be suitable for real-time applications.

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QUESTION 4

What is meant by the term Distributed Systems Computing? List and explain some of the commonly used Distributed Operating Systems available in the marketplace.

DISTRIBUTED SYSTEMS COMPUTING:

Definition: Distributed Systems Computing involves multiple interconnected computers working together to achieve common goals.

Framework: Tasks and data are distributed across nodes (computers), communicating or coordinating for computations, resource sharing, and service provisions.

- Objective: The primary goals are improved performance, and scalability.
- Composition: Multiple software components span across various computers, operating collectively as a single system.
- Connectivity: Computers can be physically closed with local area connections or geographically distant linked by wide area networks.
- Configurations: Various setups, mainframes, PCs, workstations etc.

DISTRIBUTED OPERATING SYSTEMS:

- It is an essential OS type where multiple central processors handle ~~various~~ diverse real-time applications and users.
- Data processing tasks are distributed among processors.
- Multiple systems with individual processors and memory communicate via high-speed buses or telephone lines

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Commonly Used Distributed Operating Systems

1. Client-Server System:

- Clients request resources, and savers provide the requested resources.
- They are "tightly coupled system" suitable for multiproce and homogenous multicomputers.
- There is a centralized server managing all requests from client systems. There can be multiple clients.

2. Peer-to-Peer System:

- Nodes play a crucial role, evenly distributing tasks and sharing data and resources.
- The system is known as a "loosely coupled system", ideal for computer network applications.
- Nodes interact via various methods like telephone lines or high-speed buses.

3. Three-tier Architecture:

The information about client is stored in the intermediate tier rather than the client, simplifying development. It is widely used in online applications.

Question 5

Differentiate between a Real Time Operating Systems and Time Sharing Operating Systems with the help of of suitable examples

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DIFFERENCE

REAL-TIME OPERATING SYSTEMS	TIME SHARING OPERATING SYSTE
DEFINITION	
Real-time operating system (RTOS) is designed for systems that require real-time processing and response. It guarantees to complete tasks in a specific time frame.	Time sharing operating systems allow multiple users to share a computer simultaneously. The OS allocates CPU time to users and users interact with the system.
Ex: VxWorks, FreeRTOS, QNX	Ex: Unix, Linux, Windows.
PURPOSE	
For the applications, where the stringent timing requirements, where tasks must be completed within the deadlines.	Primarily designed for maximize CPU utilization. Allowing multiple users to share resources or use them concurrently.
They are used in embedded systems.	They are used for general purpose computing.
SCHEDULING	
Priority-based scheduling, ensuring high-priority tasks executing before low-priority.	Uses time-slicing or round-robin methods to allocate CPU time among the users.
RESPONSE TIME	
Guarrantees quick and predictable response time to external events, minimizing latency.	Time may vary depending on system load or number of concurrent users, prioritizing fairnes
SWITCHING	
There is switching from one process to another.	There is minimal switching from one process to another.

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Computer Resources.

• Resources are shared among all the users and it can run several applications simultaneously.	Resources are allotted to each process for a fixed time eg: only one application can be run at a time.

EXAMPLES

• VxWorks, widely used in embedded systems, aerospace & industrial automation. FreeRTOS: Open-source RTOS for small embedded systems. QNX: Reliable, applied in automotive & medical devices.	Unix: time-sharing OS with a multi-user environment. Linux: Open-source Unix-like OS supporting time-sharing capabilities. Windows: widely used, facilitates time-sharing for PCs & servers.

USE CASES

• Tasks with strict deadlines e.g. control systems, robotics, critical embedded applications.	General-purpose computing, business applications, multiple users requiring concurrent access