

M. S. Ramaiah Institute of Technology
(Autonomous Institute, Affiliated to VTU)

Department of Computer Science and Engineering

Course on
Operating Systems

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Introduction to the course

Syllabus

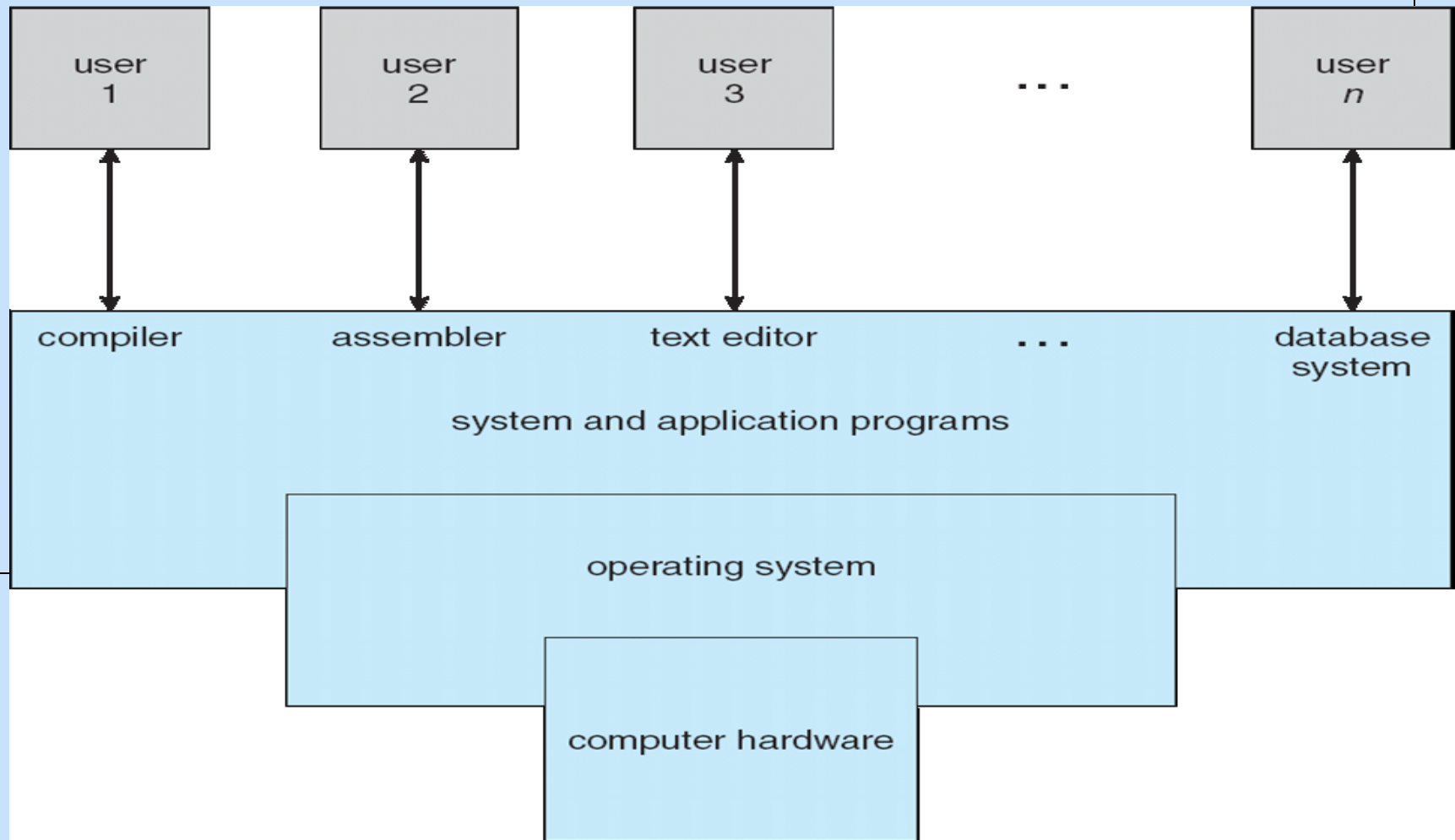
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Overview

1. What operating systems do
2. Operating System operations
3. Operating System Functions
 - Process management
 - Memory management
 - Storage management
 - Protection and security
3. Tutorial-1



Components of a Computer System:



A computer system can be divided roughly into four components:

- The hardware,
- The operating system,
- The application programs,
- The users

Resources of a system:

Hardware, Software, and data.

The operating system provides the means for proper use of these resources in the operation of the computer system.

An operating system is

- *Like a government, it performs no useful function by itself. It simply provides an environment within which other programs can do useful work.*

operating systems views.

□ User view:

- Maximize the work
- Ease of use
- Least attention to resource utilization (single user)
- Maximize resource utilization (Multi user)

□ System view

- OS is a **resource allocator**
 - Manages all resources
 - Decides between conflicting requests for efficient and fair resource use
- OS is a **control program**
 - Controls execution of programs to prevent errors and improper use of the computer



Definition of Operating Systems

- ❑ No universally accepted definition
- ❑ A more common definition is that the operating system is the one program running at all times on the computer (usually called the **kernel**), **with all else being** systems programs and application programs.
- ❑ An operating system is a program that manages the computer hardware. It also provides a basis for application programs and acts as an intermediary between the computer user and the computer hardware
- ❑ An operating system provides the environment within which programs are executed.

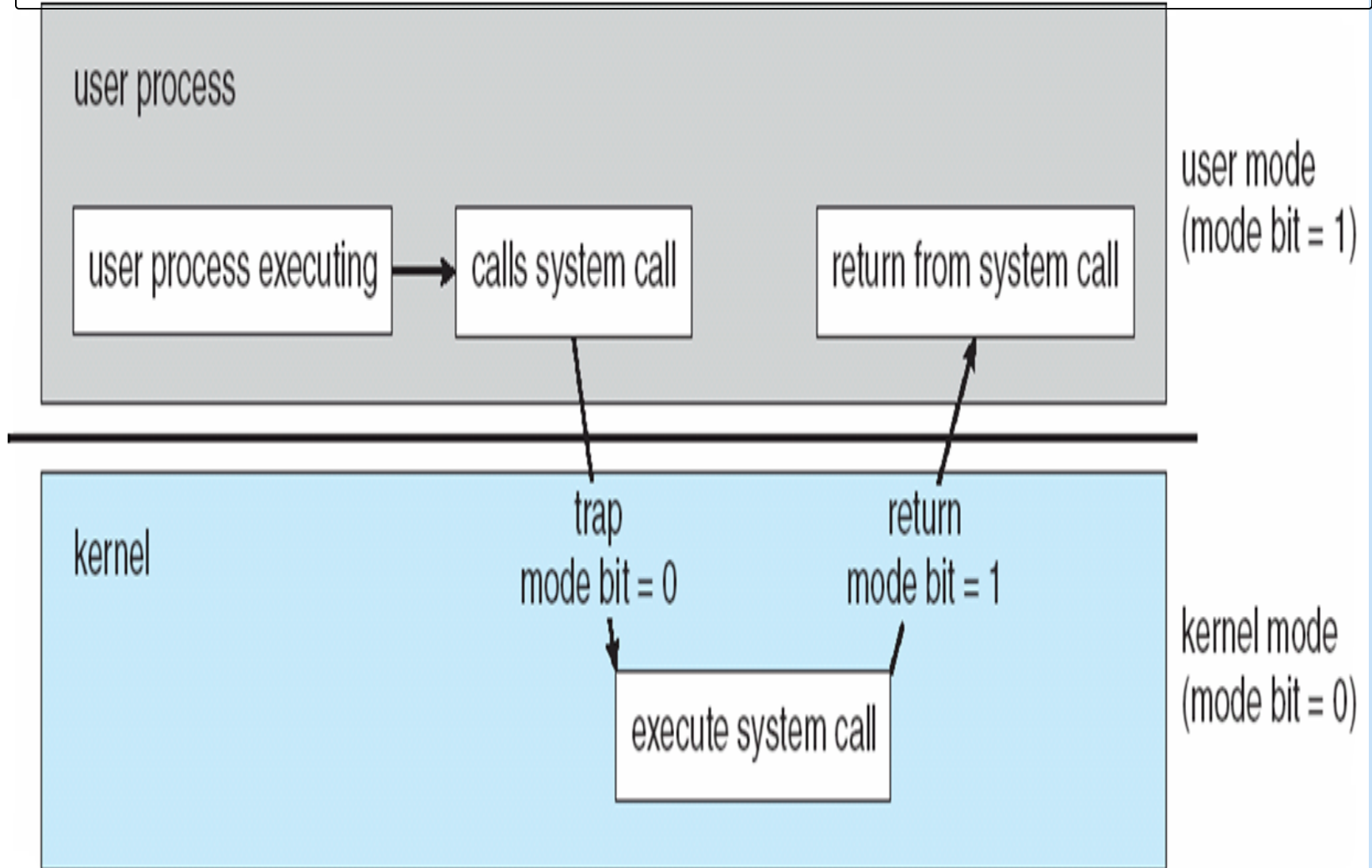
Operating System operations:



- **Dual-mode** operation allows OS to protect itself and other system components
 - **User mode** and **kernel mode**
 - **Mode bit** provided by hardware
 - Provides ability to distinguish when system is running user code or kernel code
 - Some instructions designated as **privileged (I/O control, timer management, and interrupt management.)**, only executable in kernel mode
 - System call changes mode to kernel, return from call resets it to user



Transition from User to Kernel Mode



- **Two modes of operation:**

User mode

Kernel mode (Supervisor mode, system mode, or privileged mode).

Mode bit, indicate the current mode: kernel (0) or user (1).

When the computer system is executing on behalf of a user application, the system is in user mode.

However, when a user application requests a service from the operating system (via a system call), it must transition from user to kernel mode to fulfill the request.

- Operating system maintains control over the CPU
- When a user program gets stuck in an infinite loop or not calling system services and never returning control to the operating system then system uses a timer.
- A timer can be set to interrupt the computer after a specified period.

OS Functions:

- Process management
- Memory management
- Storage management
- Protection and security



□ Process Management

- A process is a program in execution. It is a unit of work within the system. Program is a ***passive entity***, process is an ***active entity***.
- Process needs resources to accomplish its task
 - CPU, memory, I/O, files
 - Initialization data
- Process termination requires reclaim of any reusable resources



- Single-threaded process has one **program counter** specifying location of next instruction to execute
 - Process executes instructions sequentially, one at a time, until completion
- Multi-threaded process has one program counter per thread
- Typically system has many processes, some user, some operating system running concurrently on one or more CPUs
 - Concurrency by multiplexing the CPUs among the processes / threads

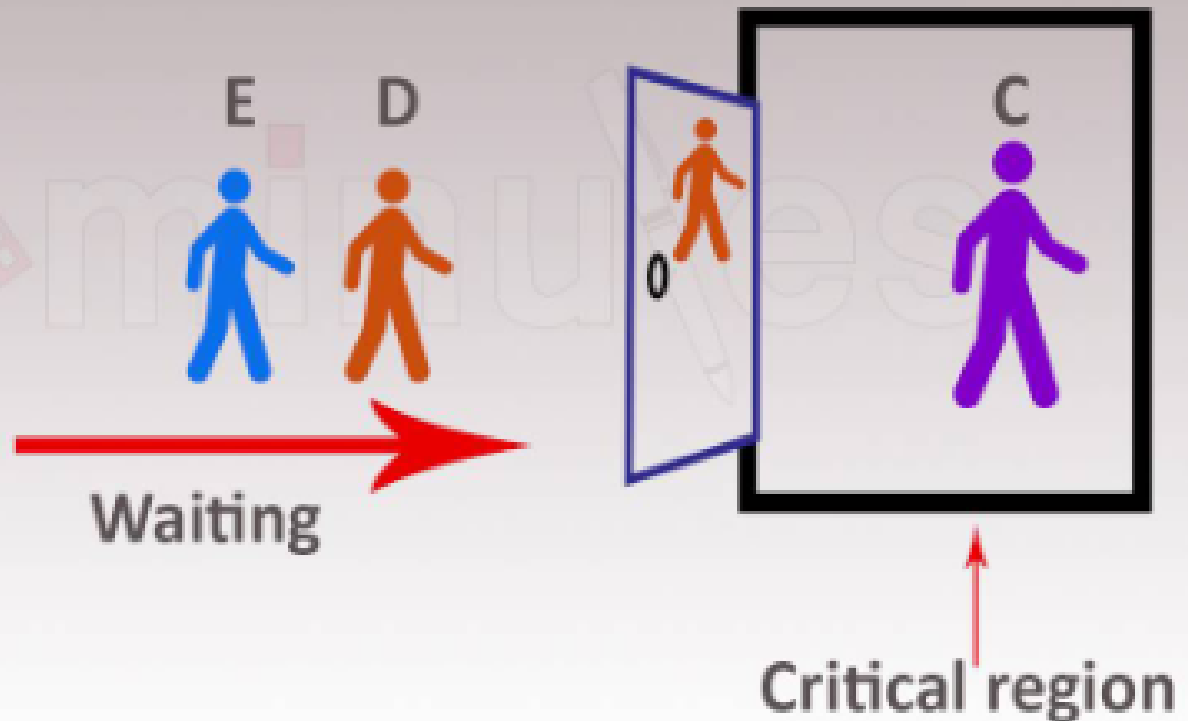
The operating system is responsible for the following activities in connection with process management:

- Creating and deleting both user and system processes
- Suspending and resuming processes
- Providing mechanisms for process Synchronization
- Providing mechanisms for process communication
- Providing mechanisms for deadlock handling

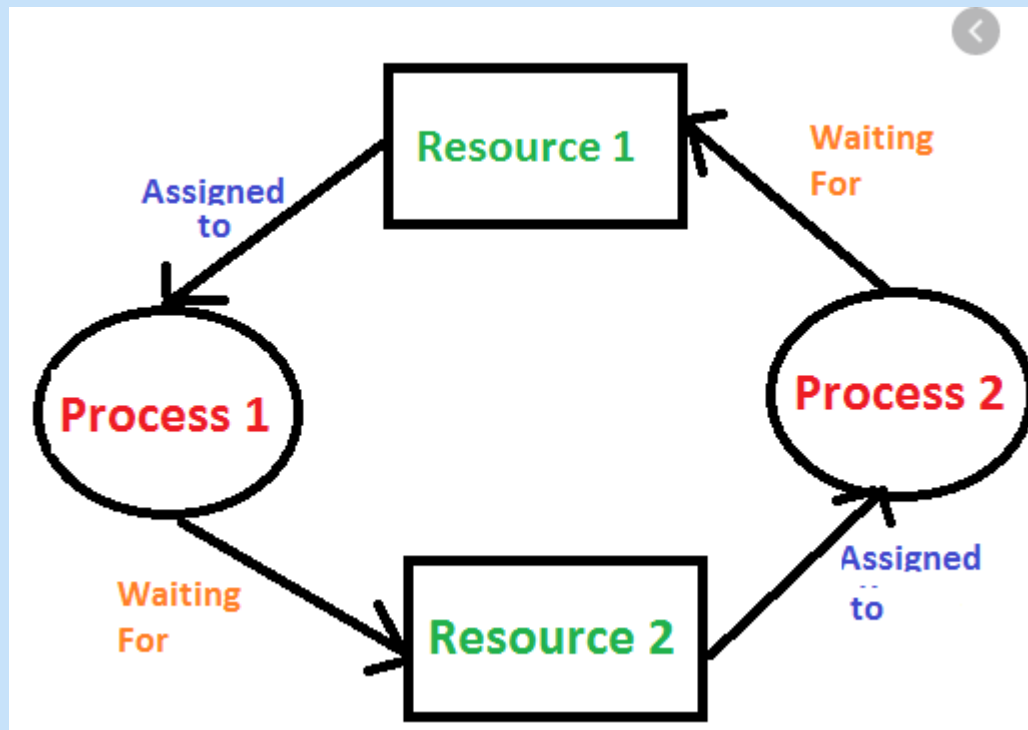


PROCESS SYNCHRONIZATION

THE CRITICAL REGION



- Deadlock



□ Memory Management

- To execute a program all (or part) of the instructions must be in memory
- All (or part) of the data that is needed by the program must be in memory.
- Memory management determines what is in memory and when
 - Optimizing CPU utilization and computer response to users



- Memory management activities
 - Keeping track of which parts of memory are currently being used and by whom
 - Deciding which processes (or parts thereof) and data to move into and out of memory
 - Allocating and deallocating memory space as needed



□ Storage Management

- OS provides uniform, logical view of information storage
 - Abstracts physical properties to logical storage unit - **file**
 - Each medium is controlled by device (i.e., disk drive, tape drive)
- Varying properties include access speed, capacity, data-transfer rate, access method (sequential or random)



- File-System management
 - Files usually organized into directories
 - Access control on most systems to determine who can access what
 - OS activities include
 - Creating and deleting files and directories
 - Primitives to manipulate files and directories
 - Mapping files onto secondary storage
 - Backup files onto stable (non-volatile) storage media



□ Mass-Storage Management

- Usually disks used to store data that does not fit in main memory or data that must be kept for a “long” period of time
- Proper management is of central importance
- Entire speed of computer operation hinges on disk subsystem and its algorithms



- OS activities
 - Free-space management
 - Storage allocation
 - Disk scheduling
- Some storage need not be fast
 - Tertiary storage includes optical storage, magnetic tape
 - Still must be managed – by OS or applications
 - Varies between WORM (write-once, read-many-times) and RW (read-write)

□ Protection and Security

- **Protection** – any mechanism for controlling access of processes or users to resources defined by the OS
- **Security** – defense of the system against internal and external attacks
 - Huge range, including denial-of-service, worms, viruses, identity theft, theft of service



- Systems generally first distinguish among users, to determine who can do what
 - User identities (**user IDs**, security IDs) include name and associated number, one per user
 - User ID then associated with all files, processes of that user to determine access control
 - Group identifier (**group ID**) allows set of users to be defined and controls managed, then also associated with each process, file
 - **Privilege escalation** allows user to change to effective ID with more rights

- Tutorial -1

Answer the following questions

1. What are the different types of operating systems?
2. What are the basic functions of an operating system?
3. What is user space and kernel space?
4. What are the different kinds of kernels?

5. Differentiate between program and a process.
6. Define the following:
 - a) Multiprogramming system, b) Parallel system, c) Distributed systems
7. What is context switching?
8. What is a time-sharing system?
9. What are real-time systems?
10. Define the following:
 - a) Loader b) Linker c) Scheduler