Unit-1

Introduction to Operating System

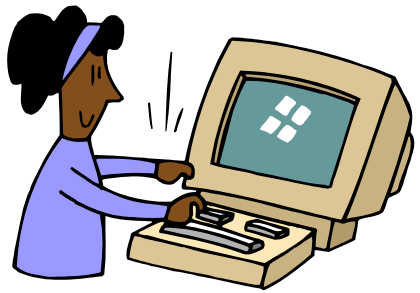
Computer system overview

Section - 1

Dedicated Faculty, Committed Education
Darshan
Institute of Engineering & Technology

Basic elements of computer

- Processor
- I/O Modules
- Memory
- System Bus



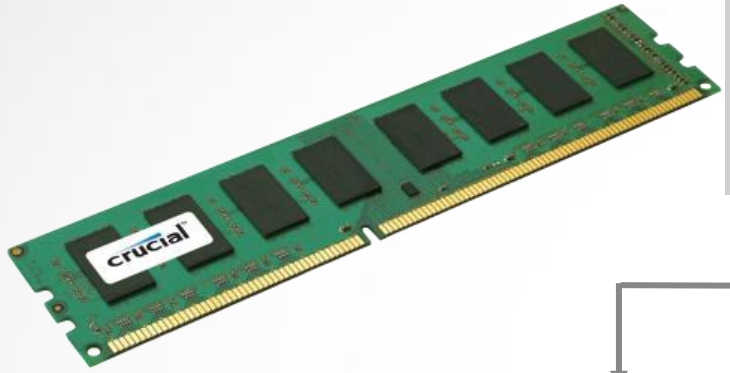
Processor

Referred to as the ***Central Processing Unit*** **(CPU)**

Arithmetic & Logic Unit	Control Unit
Performs the **data processing** functions	**Controls the operation** of the computer

Exercise Which two companies are famous for manufacturing computer processors?

Memory



Memory is device that is used to store data/information

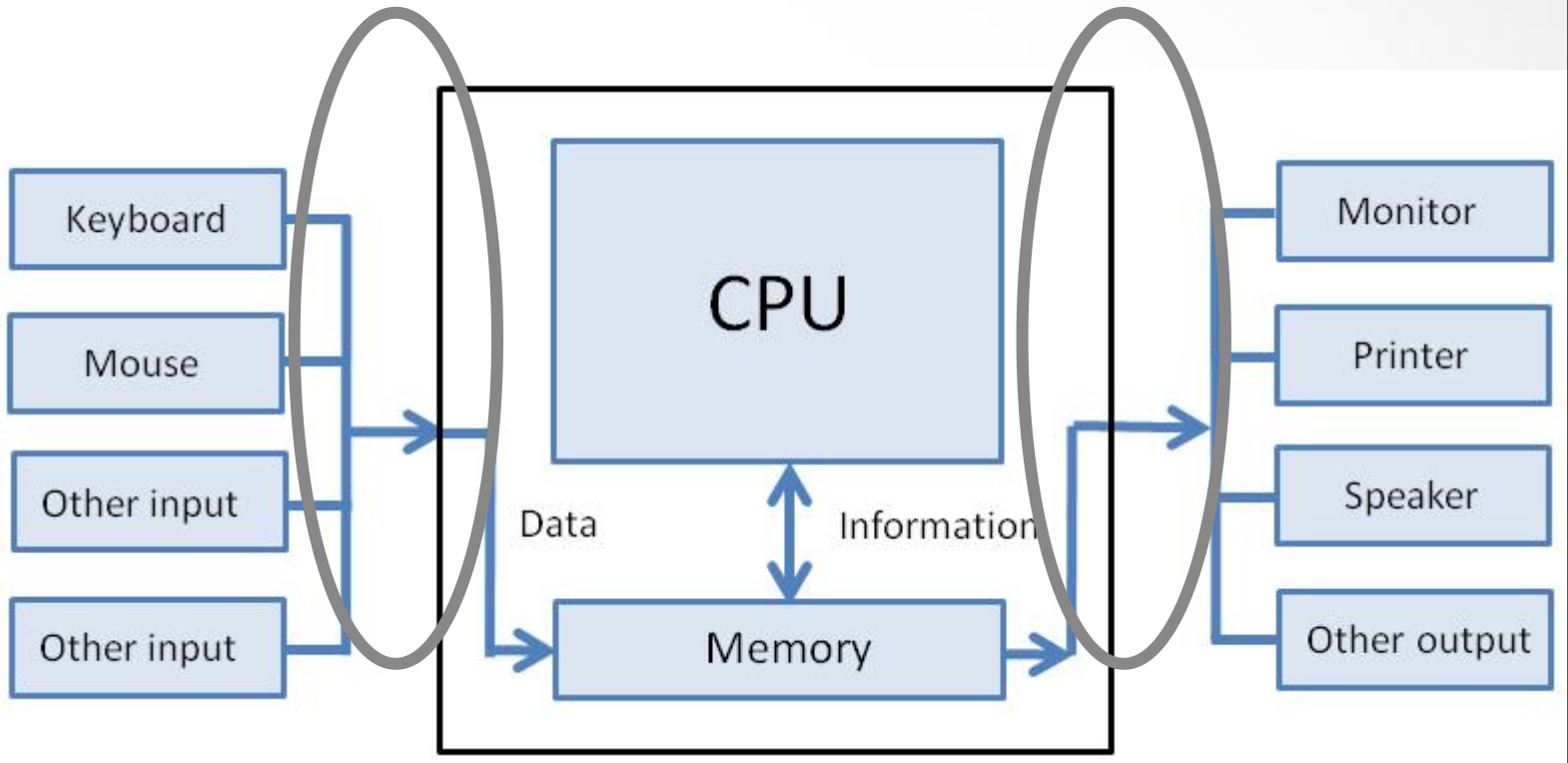
Primary Memory	Secondary Memory
• Volatile • RAM & ROM	• Non-Volatile • HDD, CD & DVD

Exercise Give the difference between primary memory and secondary memory.

I/O Module (Input/Output Module)

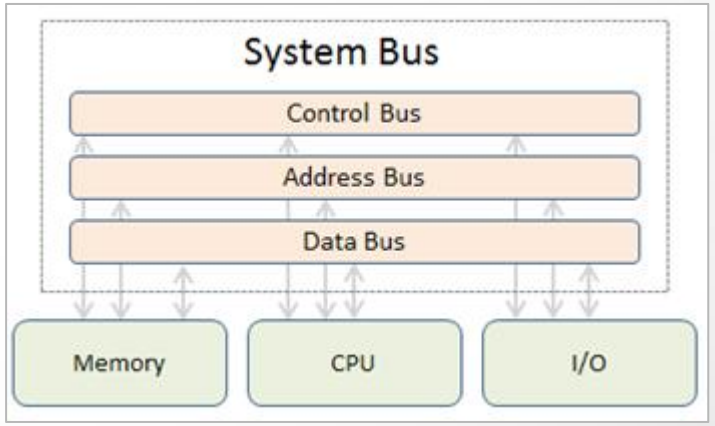
- Input/output module is a **device that acts as the connective bridge between a computer system** at one end **and an I/O or peripheral device** at the other, such as a printer, webcam or scanner.

- An I/O module is a **mediator between the processor/memory and an I/O devices**.
- **It controls the data exchange between the external devices and main memory or external devices and CPU registers**.



System Bus

- **Provides communication among processors, main memory, and I/O devices**.
- The system bus is a pathway **composed of cables and connectors used to carry data** between a computer microprocessor and the main memory.
- Types of buses
  - Address bus - **carries memory addresses** from the processor to other components such as primary storage and input/output devices.
  - Data bus - **carries the data** between the processor and other components.
  - Control bus - **carries control signals** from the processor to other components.



Exercise What are the 3 types of buses?

What is Operating System (OS)

Section - 3

Dedicated Faculty, Committed Education
Darshan
Institute of Engineering & Technology

What is Operating System (OS)?

- A Computer System consists of various hardware's such as

Processor

RAM

Keyboard & Mouse

Hard Disk

Monitor

Printer

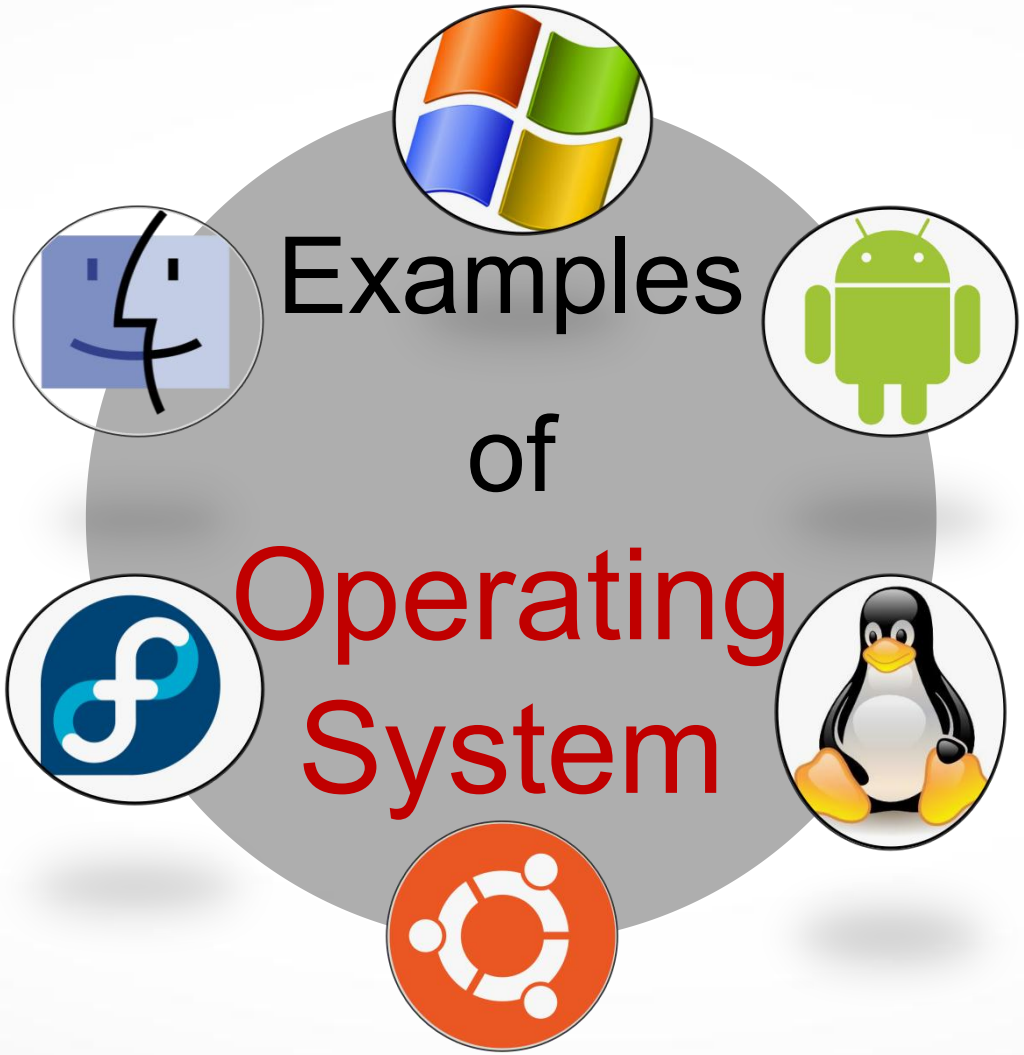
Who manages (controls) these hardwares???

Operating System

Definition of Operating System (OS)

- An Operating System (OS) is a **collection of software** that
  - **manages hardware resources**
  - **provides various service** to the users

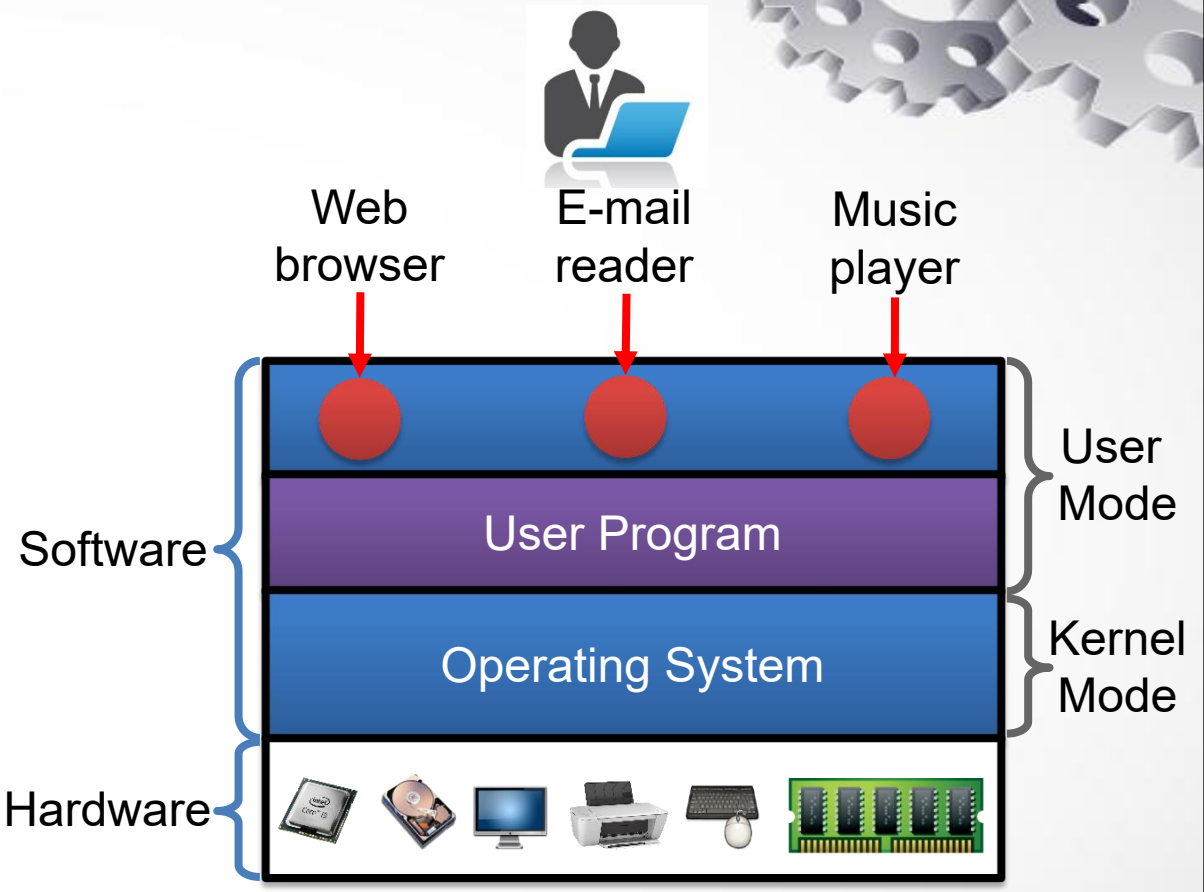
Examples of Operating System (OS)



Where OS lies? (Interaction of OS & Hardware)

- OS **lies between hardware and user program**.
- It **acts as an intermediary** between the user and the hardware.
- Modes of operation of computer

1. Kernel Mode
   - has **complete access** to all the hardware
   - can **execute any instruction** that a machine is capable of executing
   - has **high privileged** (rights)
2. User Mode
   - has **limited access** to limited hardware
   - can **execute only subset (few)** of the machine instructions
   - has **less privileged** (rights)



Roles of Operating System (OS)

Section - 4

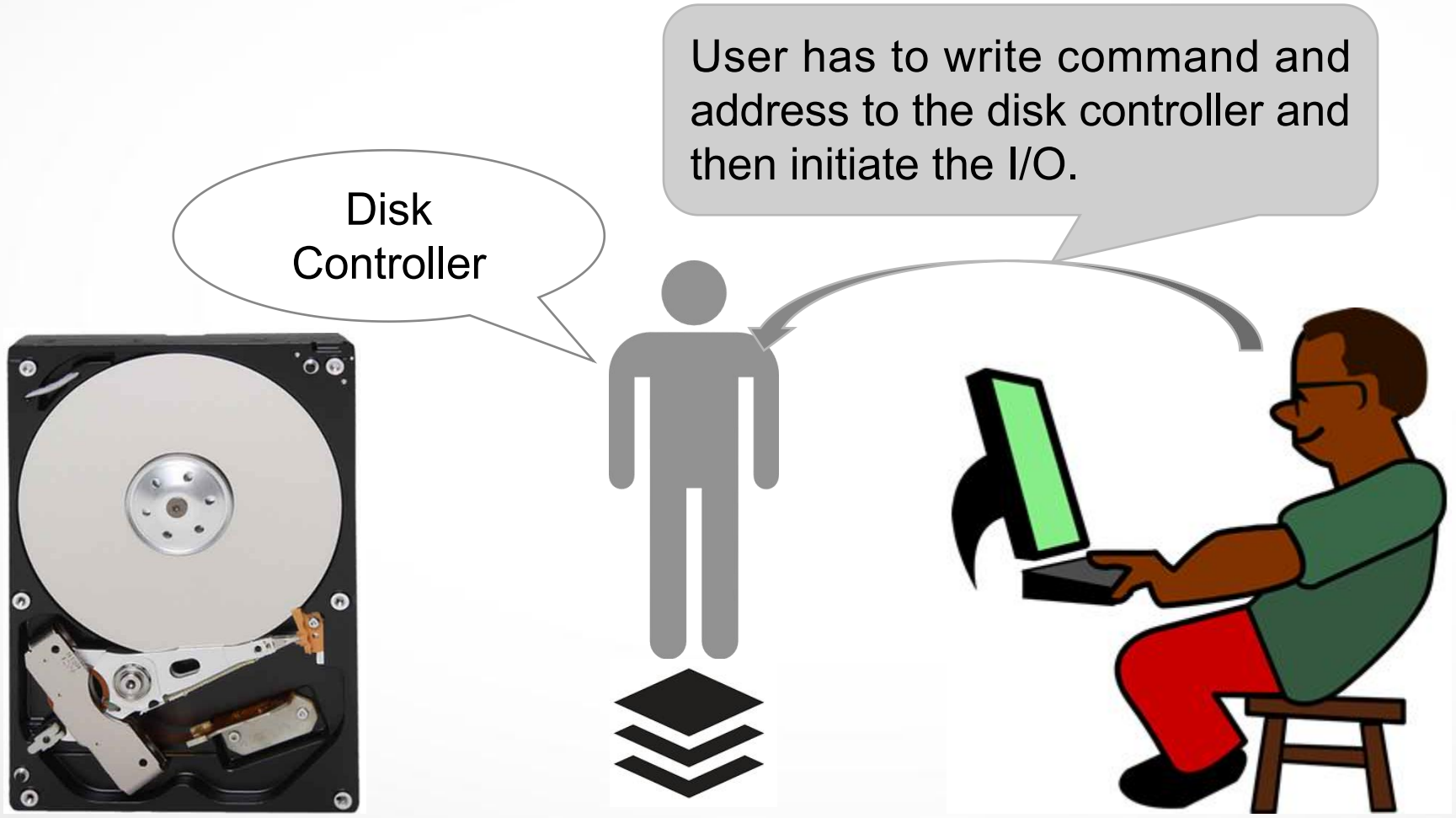
Dedicated Faculty, Committed Education
Darshan
Institute of Engineering & Technology

OS as Extended Machine

- The architecture of a computer is difficult to program
  - Architecture (instruction set, memory organization, I/O, bus structure) of most of computer at the machine level language is primitive and awkward to program.
  - Example: If **user want to read from floppy or hard disk**:

OS as Extended Machine

- Example: If **user want to read from floppy or hard disk**:



OS as Extended Machine

The disk controller will find the requested data in the disk and fetch it from disk to disk controller buffer.

User has to check the status of disk controller operation where it has finished or not.

OS as Extended Machine

If success, the data from disk controller buffer should be moved to main memory (to the application buffer).

OS as Extended Machine

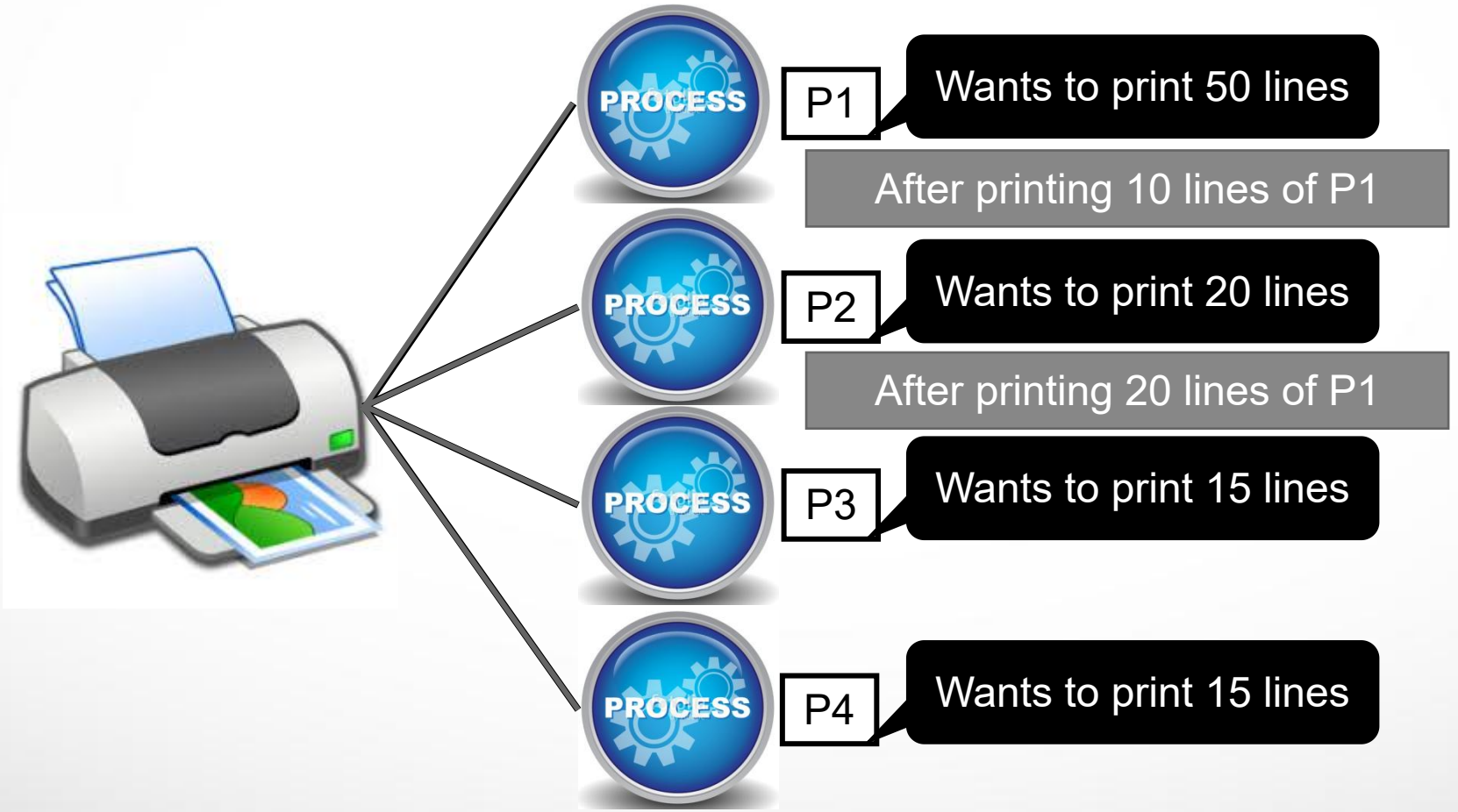
- If all the users will have to do these messy details:
  - The **program will be very difficult to write and quite long**.
  - The **program will be hardware dependent**.
- User **don't want to be involved in programming** of storage devices.
- Therefore, an **OS provides a set of basic commands** or instructions to perform various operations such as read, write, modify, save or close.
- Dealing with these command is easier than directly dealing with hardware.
- Operating system **hides the complexity of hardware** and present a **beautiful interface** to the users.

OS as Resource Manager

- There are lots of resources in computer system
  - CPU (Processor)
  - Memory
  - I/O devices such as hard disk, mouse, keyboard, printer, scanner etc.
- If a computer system is used by **multiple applications (or users)**, then they will **compete for these resources**.

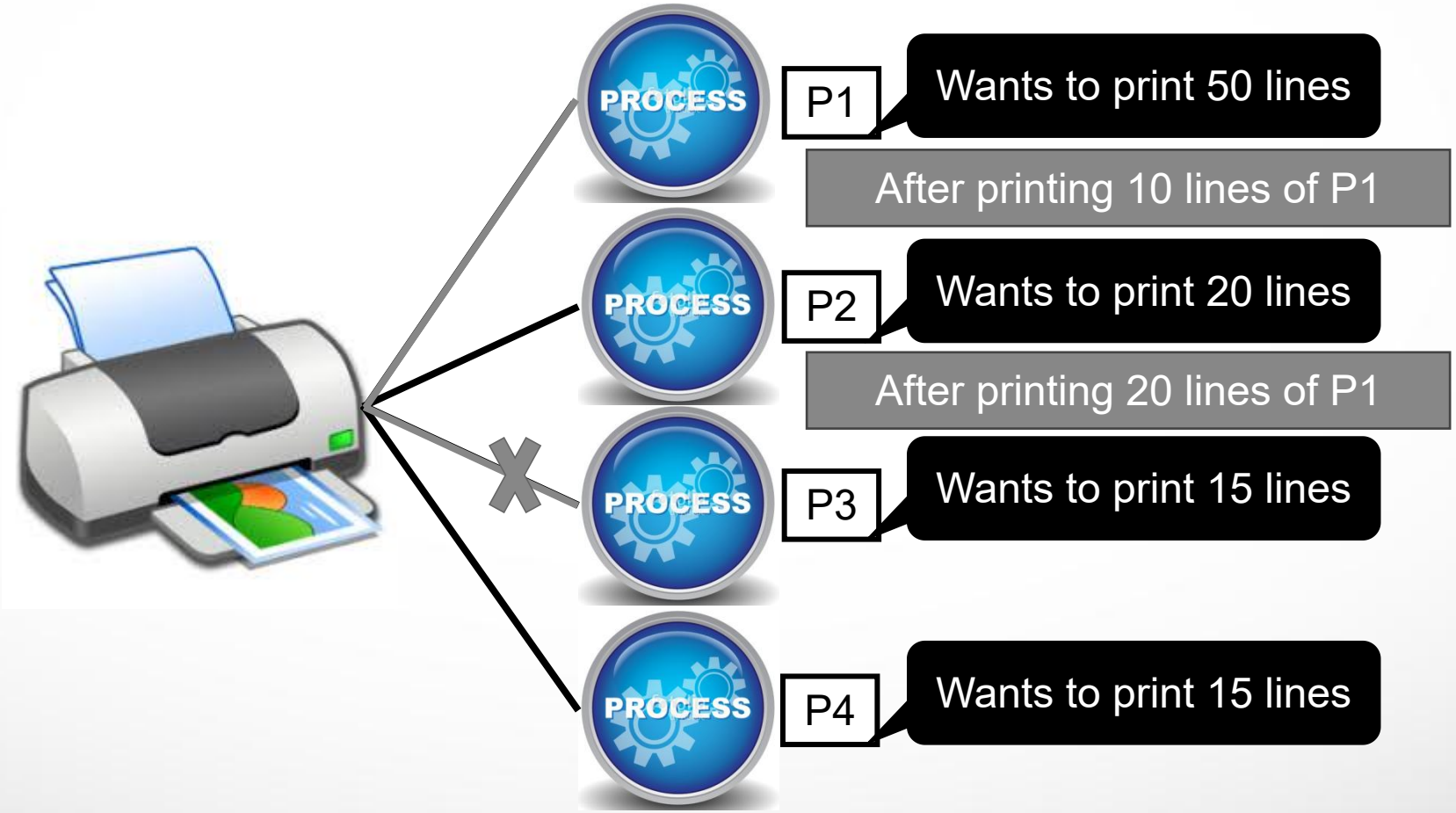
OS as Resource Manager

- It is the job of OS to allocate these resources to the various applications so that:
  - The **resources are allocated fairly** (equally)



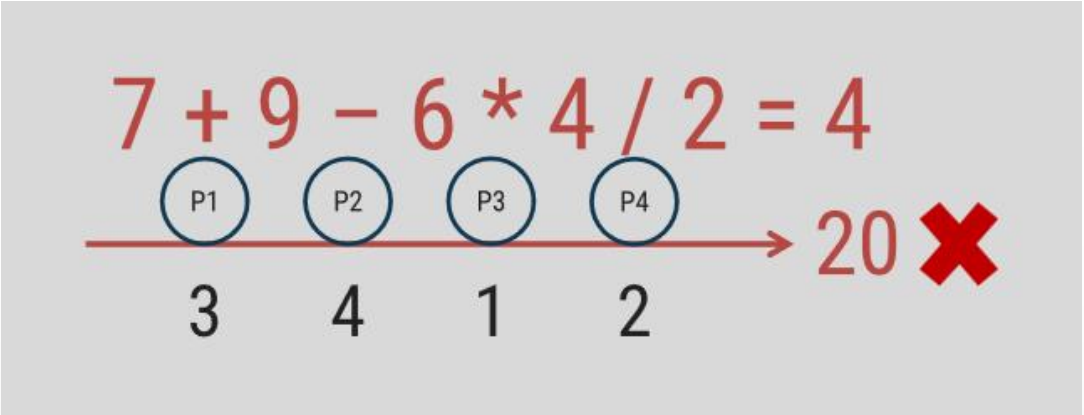
OS as Resource Manager

- It is the job of OS to allocate these resources to the various applications so that:
  - The **resources are protected from cross-access**.



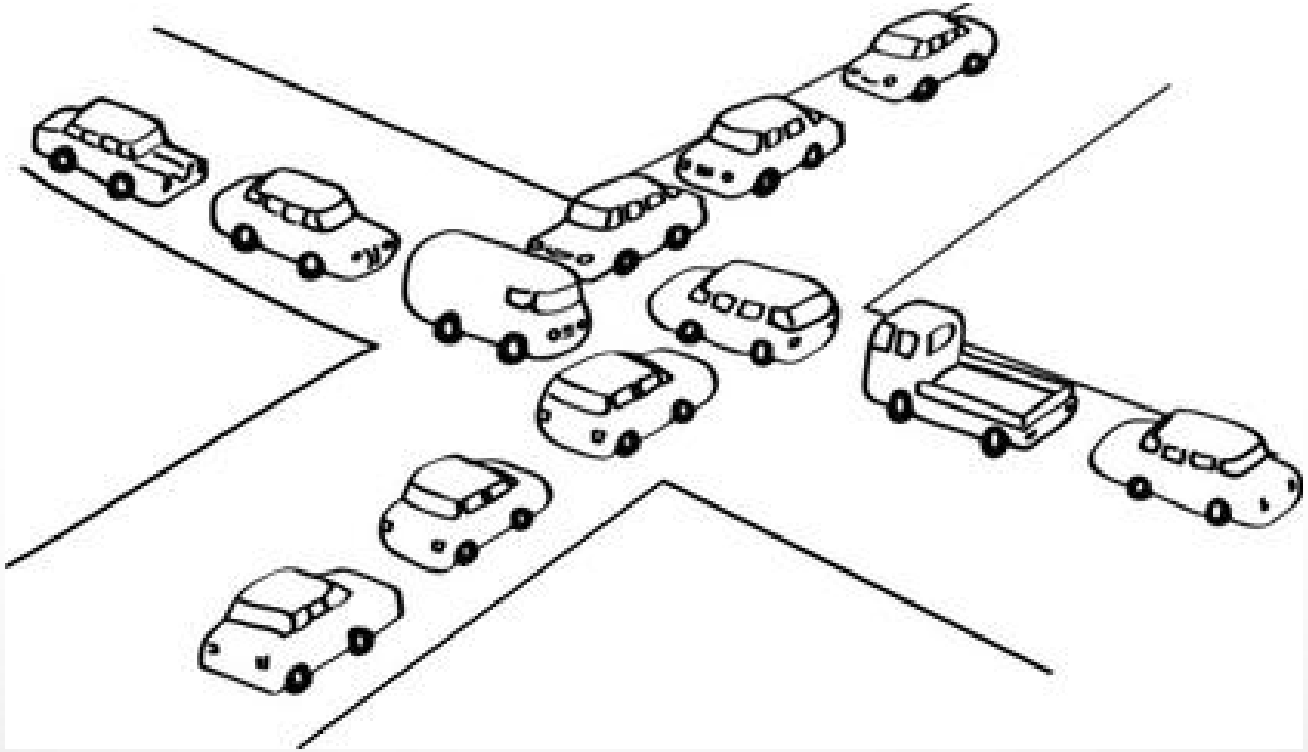
OS as Resource Manager

- It is the job of OS to allocate these resources to the various applications so that:
  - **Access to the resources is synchronized** so that operations are correct and consistent
  - Example: If we write a program to calculate below in C language



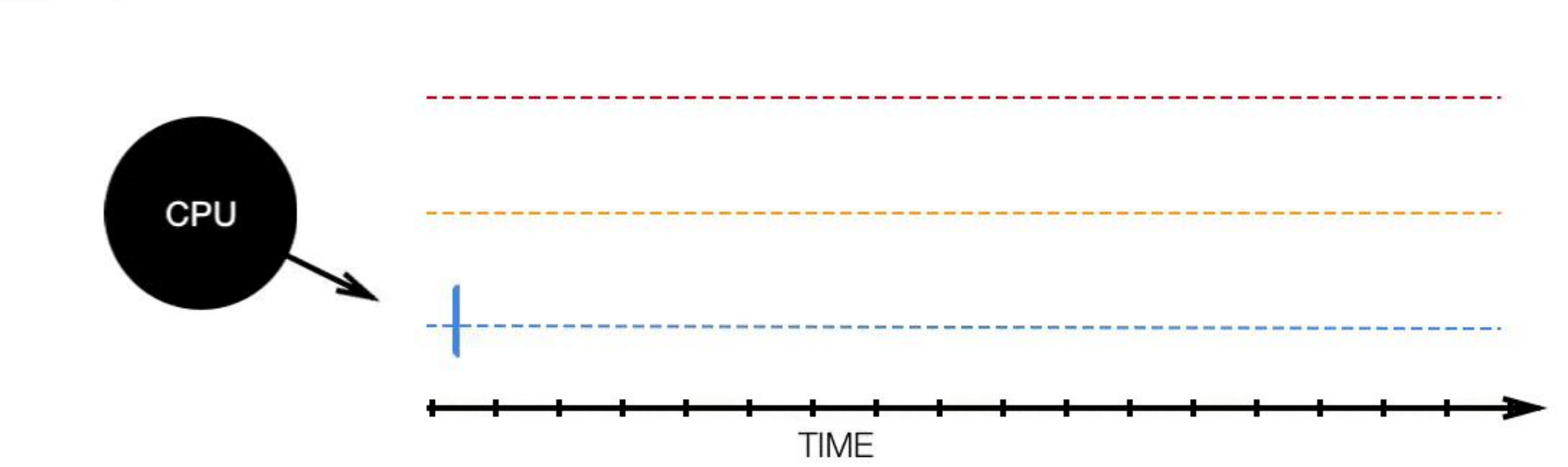
OS as Resource Manager

- It is the job of OS to **proper allocate these resources to the various applications** so that:
  - Deadlock are detected, resolved and avoided.



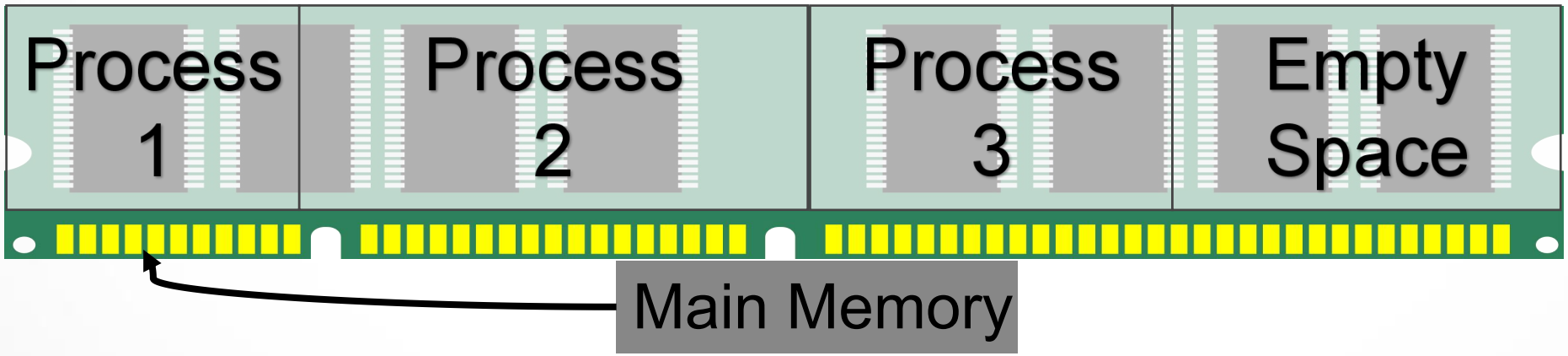
OS as Resource Manager

- Resource manager – sharing resources in two different ways:
  1. In time sharing/multiplexing (i.e **CPU**)



OS as Resource Manager

- Resource manager – sharing resources in two different ways
  2. In space sharing/multiplexing. (i.e Memory)



Objectives / Goals of Operating System (OS)

Section - 5

Dedicated Faculty, Committed Education
Darshan
Institute of Engineering & Technology

Objectives / Goals of Operating System (OS)

- Make the computer system **convenient to use in an efficient manner**.
- **Hide the details of the hardware** resources from the users.
- **Provide** users a **convenient interface** to use the computer system.
- **Act as an intermediary** between the **hardware and its users**, making it easier for the users to access and use other resources.
- **Manage the resources** of a computer system.
- **Keep track** of who is using which resource, granting resource requests, and mediating conflicting requests from different programs and users.
- **Provide efficient** and **fair sharing of resources** among users and programs.

Generations of Operating Systems (OS)

Section - 6

Dedicated Faculty, Committed Education
Darshan
Institute of Engineering & Technology

Generations / History of OS (First generation)

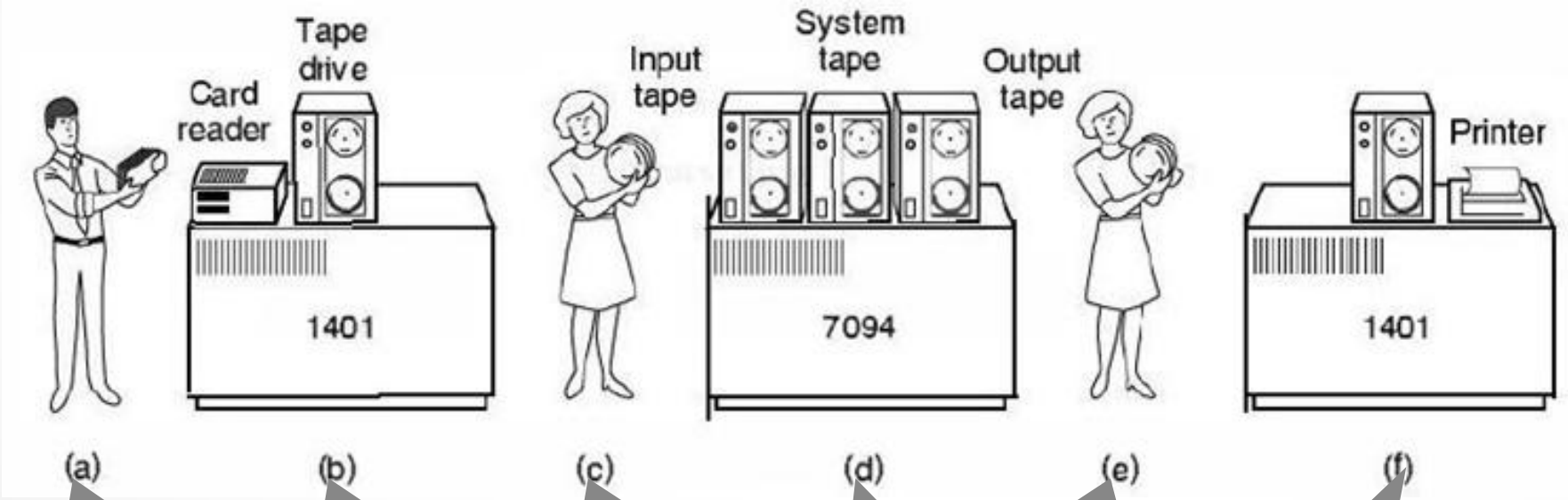
- First generation (1945-1955)
  - Vacuum tubes and plug-boards are used in these systems.

Vacuum tubes

Plug board

Generations / History of OS (Second generation)

- Second generation (1955-1965)
  - Transistors are used in these systems
  - The machine that are produced are called mainframes.
  - Batch systems was used for processing.



Generations / History of OS (Third generation)

- Third generation (1965-1980)
  - Integrated circuits (IC's) are used in place of transistors in these computers.
  - It provides multiprogramming (the ability to have several programs in memory at once, each in its own memory partition).

Generations / History of OS (Forth generation)

- Fourth generation (1980-present)
  - Personal Computers (PC)
  - LSI (Large Scale Integration) circuits, chips containing thousands of transistors are used in these systems.

Operating Systems (OS) services

Section - 7

Dedicated Faculty, Committed Education
Darshan
Institute of Engineering & Technology

Services / Functions / Tasks of Operating System (OS)

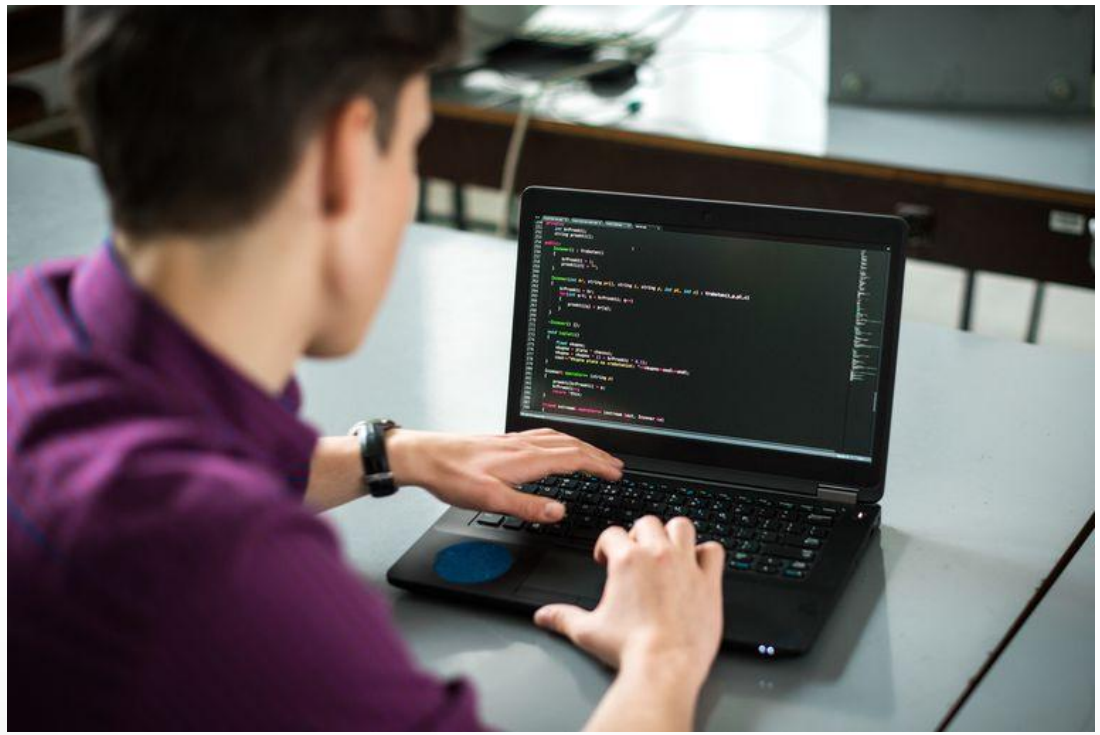
Definition of Operating System

- An Operating System (OS) is a collection of software that
  - manages hardware resources
  - provides various service to the users

Which?

Services / Functions / Tasks of Operating System (OS)

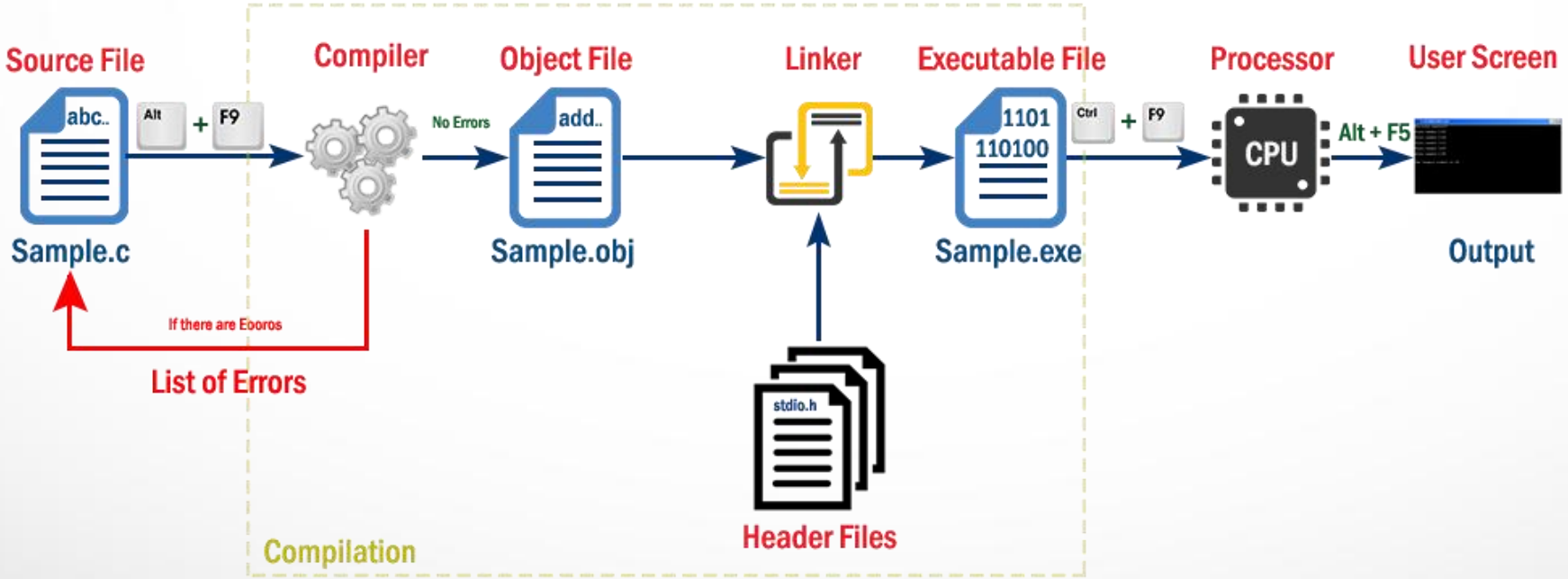
1. Program development
   - It provides editors and debuggers to assist (help) the programmer in creating programs.



Exercise Give the name of any five code editor for windows?

Services / Functions / Tasks of Operating System (OS)

2. Program execution
   - Following tasks need to be perform to execute a program:
     - Instructions and data must be loaded into main memory.
     - I/O devices and files must be initialized.
   - The OS handles all these duties for the user.



Services / Functions / Tasks of Operating System (OS)

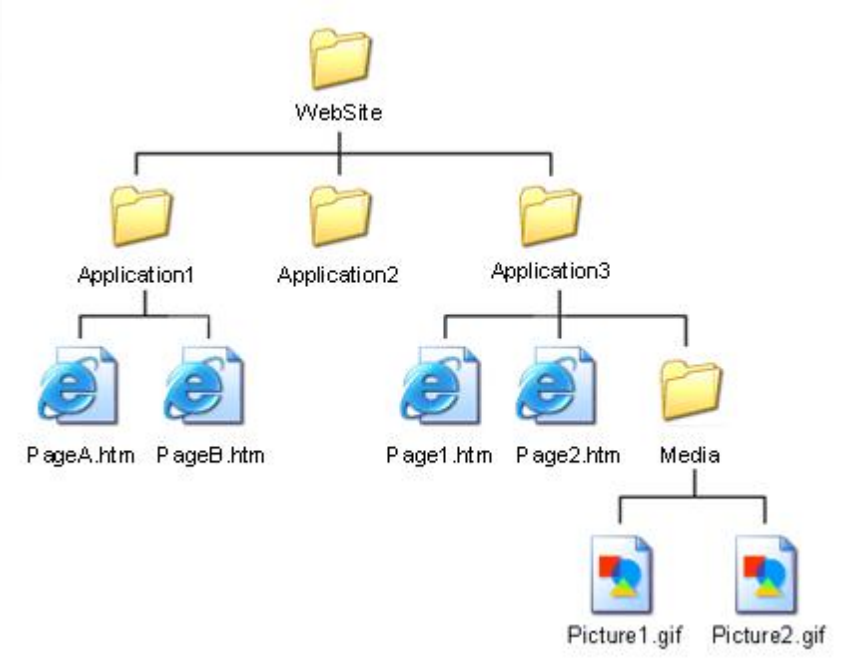
3. Access to I/O devices (Resource allocation)
   - A running program may require I/O, which may involve file or an I/O device.
   - For efficiency and protection, users cannot control I/O devices directly.
   - Therefore, the OS controls these I/O devices and provides to program as per requirement.

Services / Functions / Tasks of Operating System (OS)

4. Memory management
   - OS manages memory hierarchy.
   - OS keeps the track of which part of memory area in use and free memory.
   - It allocates memory to program when they need it.
   - It de-allocate the memory when the program finish execution.

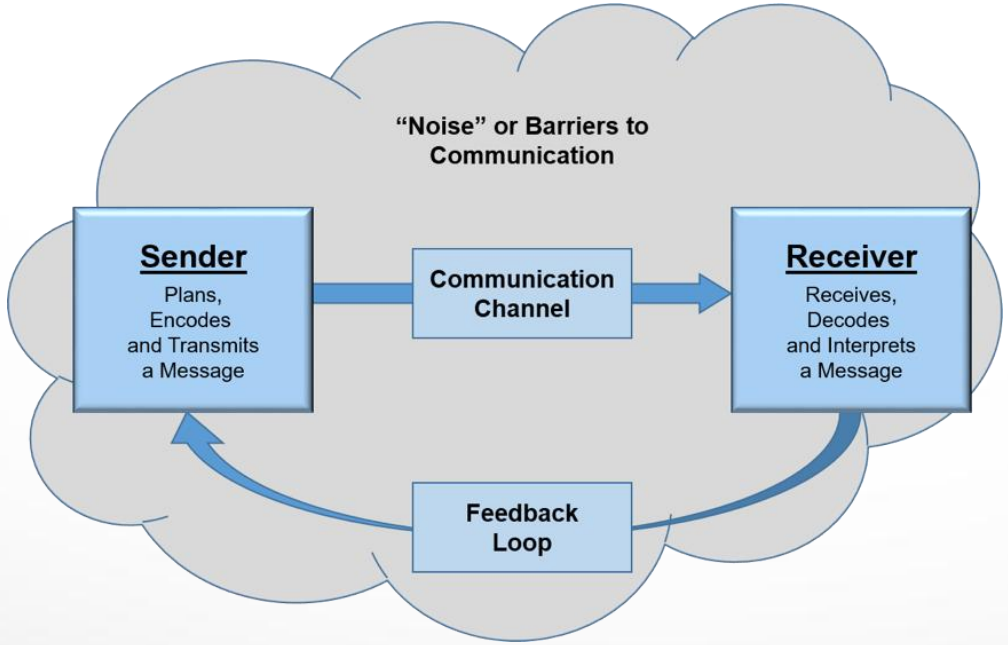
Services / Functions / Tasks of Operating System (OS)

5. Controlled access to file
   - In case of file access, OS provides a directory hierarchy for easy access and management of file.
   - OS provides various file handling commands using which user can easily read, write and modify file.



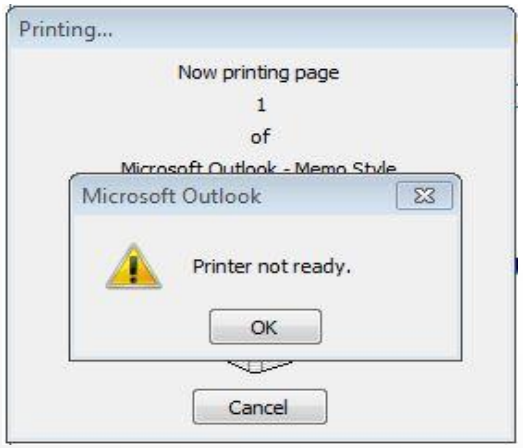
Services / Functions / Tasks of Operating System (OS)

6. Communication
   - In multitasking environment, the processes need to communicate with each other and to exchange their information.
   - Operating system performs the communication among various types of processes in the form of shared memory.



Services / Functions / Tasks of Operating System (OS)

7. Error detection and response
   - An error may occur in CPU, in I/O devices or in the memory hardware.
   - Following are the major activities of an operating system with respect to error handling −
     - The OS constantly checks for possible errors.
     - The OS takes an appropriate action to ensure correct and consistent computing.



Services / Functions / Tasks of Operating System (OS)

8. Accounting
   - Keeping a track of which users are using how much and what kinds of computer resources can be used for accounting or simply for accumulating usage statistics.
   - Usage statistics is used to reconfigure the system to improve computing services.

Services / Functions / Tasks of Operating System (OS)

9. Protection & Security
   - Protection involves ensuring that all accesses to system resources is controlled.
   - To make a system secure, the user needs to authenticate himself or herself to the system.

Types of Operating Systems (OS)

Section - 8

Dedicated Faculty, Committed Education
Darshan
Institute of Engineering & Technology

Types of Operating Systems (OS)

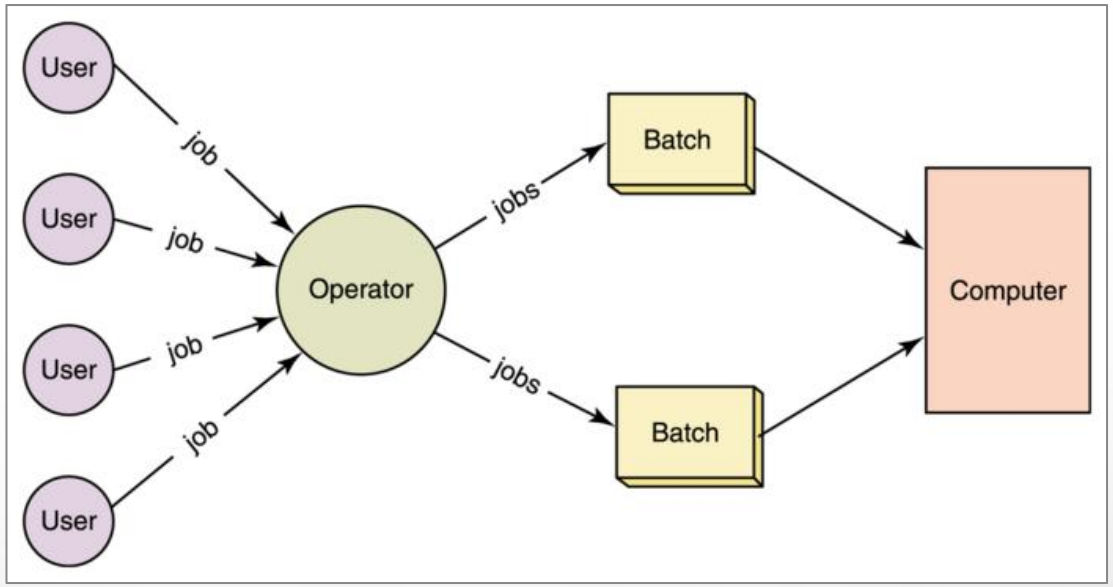
1. Mainframe operating systems
   - OS found in room sized computers which are still found in major corporate data centers.
   - They typically have a single, powerful central processing unit (CPU) that manages and executes tasks.
   - They offer three kinds of services:
     1. Batch OS
     2. Transaction processing
     3. Timesharing
   - Examples: OS/390, OS/360.

Mainframe systems

Mainframe Operating Systems services

Batch OS – A batch processing operating system is a type of operating system that is designed to process and execute a series of tasks or jobs in a batch, without manual intervention.
In a batch processing system, users submit their tasks or jobs in the form of batches, and the operating system executes them in a sequential or parallel manner.
These systems are well-suited for scenarios where large volumes of data need to be processed in a systematic and efficient way.

Example: IBM's z/OS, Unisys MCP, and Burroughs MCP/BCS 1

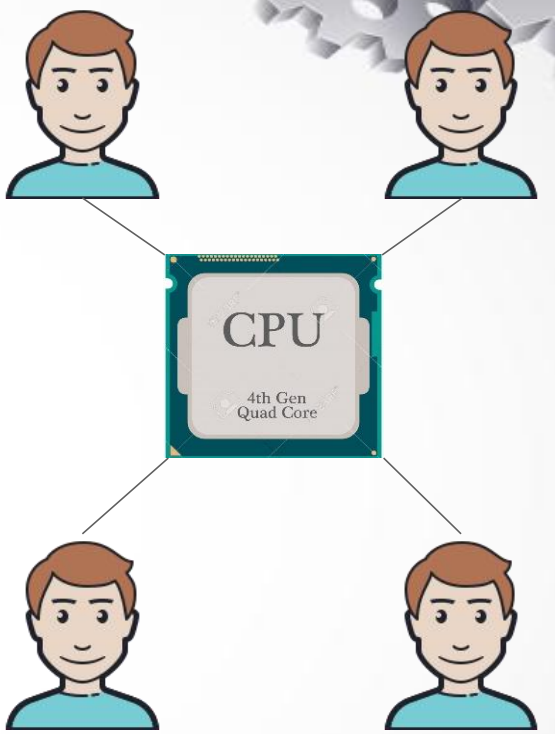


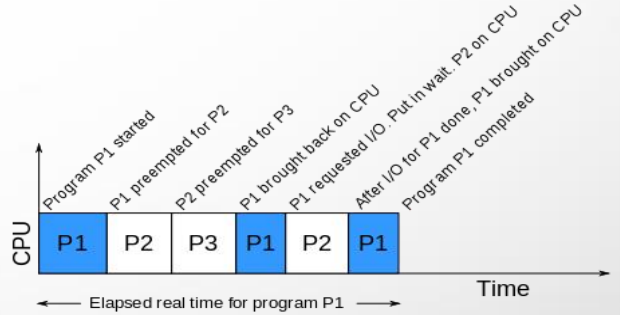
Transaction processing –A transaction processing operating system is designed to manage and facilitate transaction-oriented applications.
Transactions, in this context, refer to discrete units of work or operations that need to be executed reliably and efficiently.
These systems are optimized for handling a large number of short, independent tasks, typically associated with business and financial applications. The primary focus is on ensuring data integrity, consistency, and reliability,

Example: IBM's CICS (Customer Information Control System) and Microsoft's Transaction Server (now part of Microsoft Transaction Integrator, MTI).

Timesharing – allows multiple remote users to run their jobs at once i.e. querying a database, airline booking system

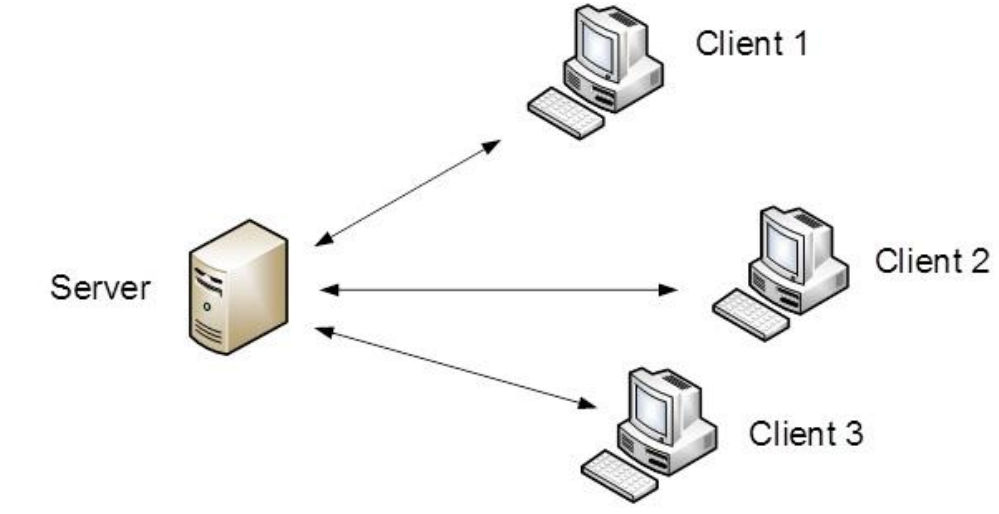
A time sharing operating system **allows many users to share the computer resources simultaneously**.
In other words, time sharing refers to the **allocation of computer resources in time slots to several programs simultaneously**.
For example a **mainframe computer that has many users logged on to it**.
Each user uses the resources of the mainframe i.e. memory, CPU etc.





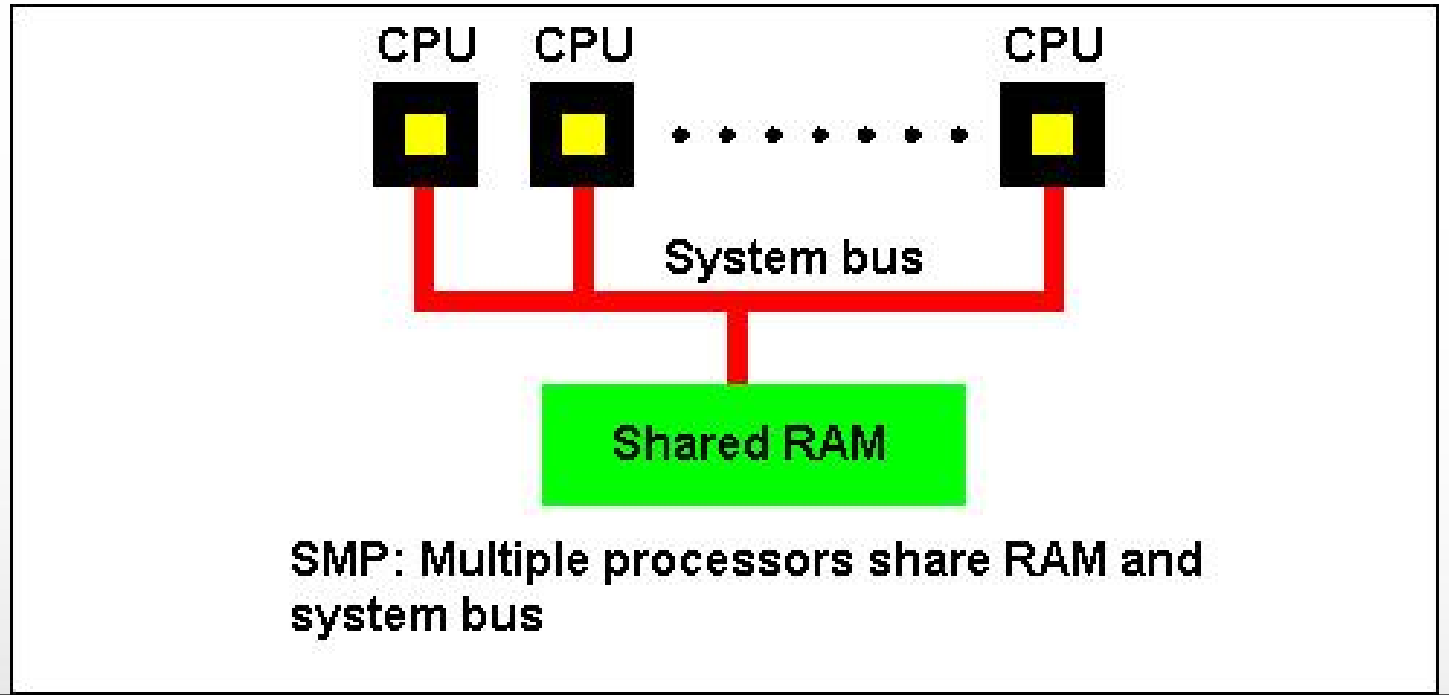
Types of Operating Systems (OS)

2. Server operating systems
   - This OS runs on servers which are very large PC, workstations or even mainframes.
   - They serve multiple users at once over a network and allow the users to share hardware & software resources.
   - It provides print services, file service or web service.
   - It handles the incoming requests from clients.
   - Examples: Solaris, FreeBSD, and Linux and Windows Server 200x.



Types of Operating Systems (OS)

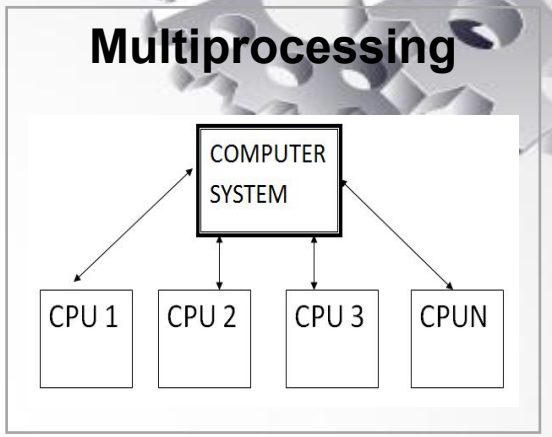
3. Multiprocessor operating systems
   - A computer system consist two or more CPUs is called multiprocessor.
   - It is also called parallel computers, multicomputer or multiprocessor.
   - They need special OS or some variations on server OS with special features for communication, connectivity and consistency.
   - Examples: Windows and Linux.

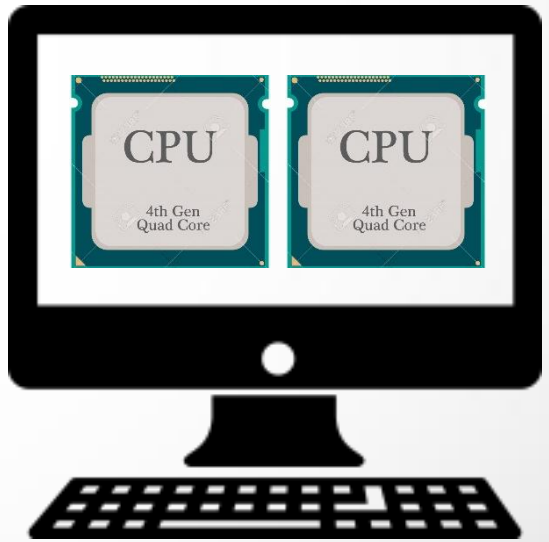


SMP: Multiple processors share RAM and system bus

Parallel Processing Operating System

- Parallel Processing Operating Systems are **designed to speed up the execution of programs by dividing the program into multiple fragments and processing these fragments simultaneously**.
- Such systems are multiprocessor systems.
- Parallel systems deal with the **simultaneous use of multiple computer resources that can include a single computer with multiple processors**.





Types of Operating Systems (OS)

4. Personal computer operating systems
   - The operating systems installed on our personal computer and laptops are personal OS.
   - Job of this OS is to provide good support to single user.
   - This OS is widely used for word processing, spreadsheet and internet access.
   - Examples: Linux, Windows vista and Macintosh.

Types of Operating Systems (OS)

5. Embedded operating systems
   - This OS is installed in ATMs, printers, calculators and washing machine.
   - It runs on the computer that control devices.
   - It neither allow to download new software nor accept user installed software. So there is no need for protection.
   - Examples: QNX, VxWorks.

Types of Operating Systems (OS)

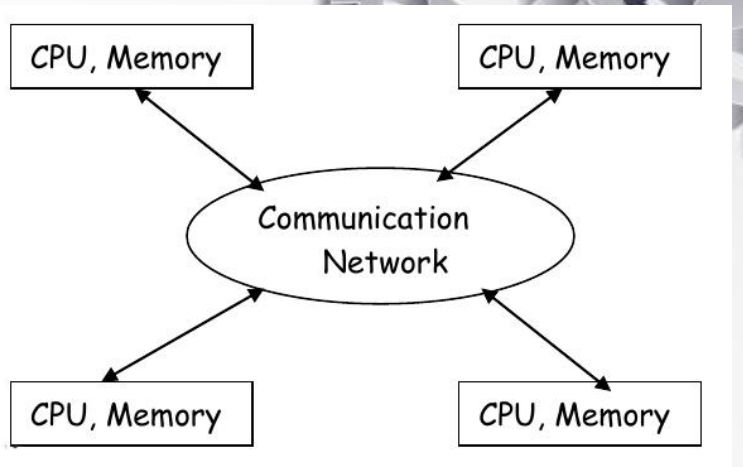
6. Real time operating systems
   - These systems having time as a key parameter.
   - Real time OS has well defined fixed time constraints.
   - Processing must be done within defined time constraints otherwise system fails.
   - Two types of real time OS:
     - Hard real time – missing an occasional deadline can cause any permanent damage. Many of these are found in industrial process control, car engine control system.
     - Soft real time – missing an occasional deadline does not cause any permanent damage. Used in digital audio, multimedia system.

Types of Operating Systems (OS)

7. Smart card operating systems
   - Smallest OS run on smart cards which are credit card sized devices containing CPU chip.
   - These OS are installed on electronic payments cards such as debit card, credit card etc.
   - They have limited processing power.
   - Some smart cards are Java oriented. ROM on smart card holds an interpreter for the JVM – small program.

8. Distributed Operating System

- Distributed Operating System is a **model where distributed applications are running on multiple computers linked by communications**.
- A distributed operating system is an **extension of the network operating system** that **supports higher levels of communication and integration of the machines on the network**.

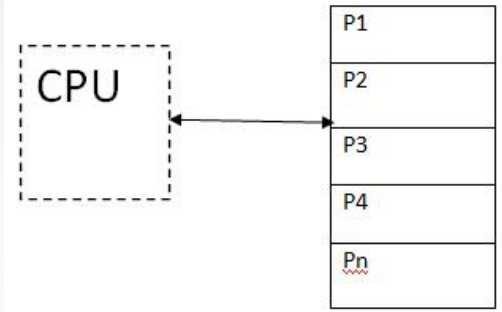


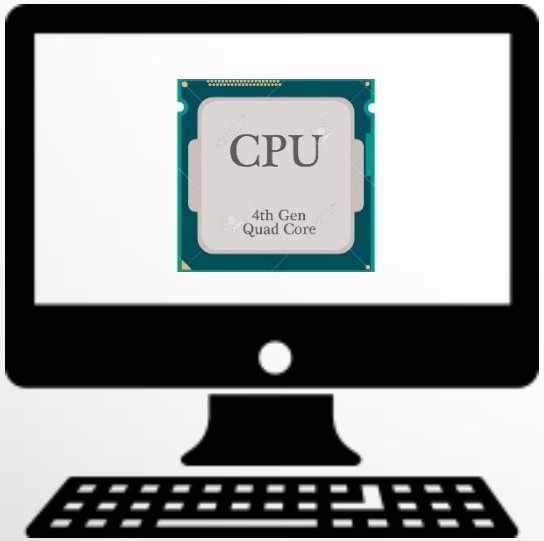
Multiprogramming v/s Multiprocessing v/s Multitasking

Dedicated Faculty, Committed Education
Darshan
Institute of Engineering & Technology

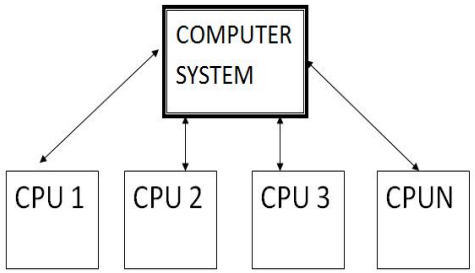
Multiprogramming v/s Multiprocessing v/s Multitasking

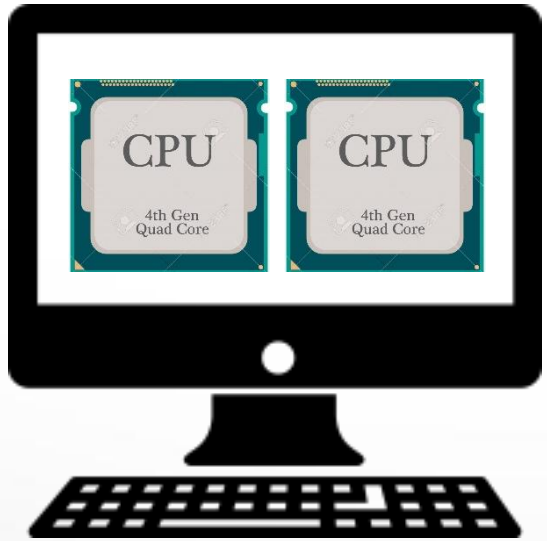
Multiprogramming



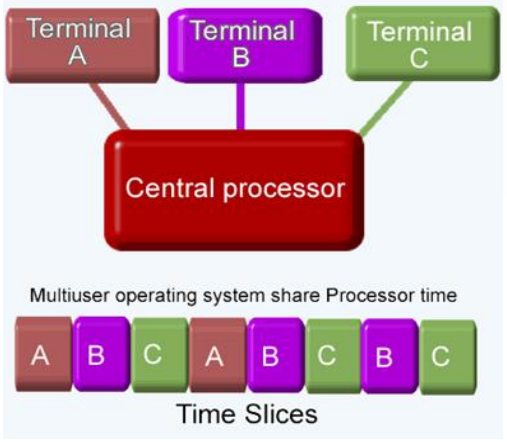


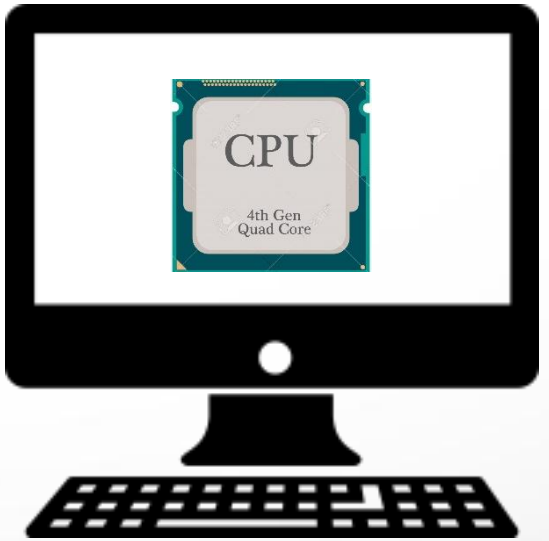
Multiprocessing





Multitasking





Multiprogramming v/s Multiprocessing v/s Multitasking

Multiprogramming	**Multiprocessing**	**Multitasking**
The concurrent residency of more than one program in the main memory is called as multiprogramming.	The availability of more than one processor per system, which can execute several set of instructions in parallel is called as	The execution of more than one task simultaneously is called as multitasking.
Number of processor: one	Number of processor: more than one	Number of processor: one
One process is executed at a time.	More than one process can be executed at a time.	One by one job is being executed at a time.

Multitasking is a logical extension of multi programming. The major way in which multitasking differs from multi programming is that **multi programming works solely on the concept of context switching whereas multitasking is based on time sharing alongside the concept of context switching**.

Operating Systems (OS) structure

Dedicated Faculty, Committed Education
Darshan
Institute of Engineering & Technology

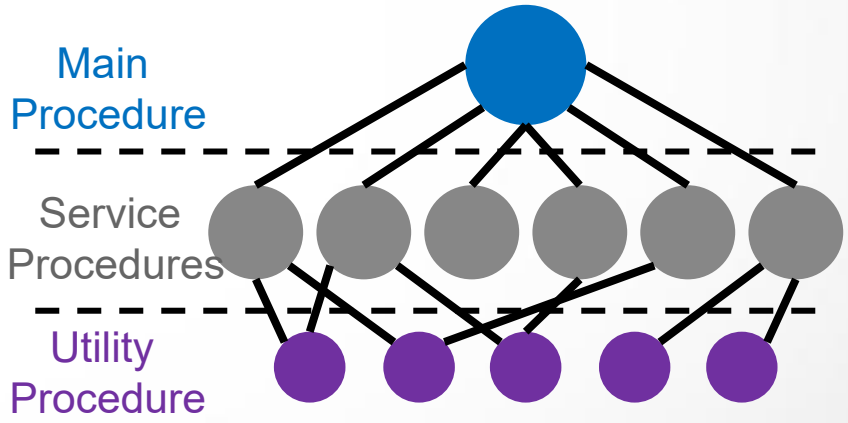
Operating Systems (OS) structure

1. Monolithic systems
2. Layered systems
3. Microkernel
4. Client-server model
5. Virtual machines
6. Exokernels

Monolithic systems

- The entire OS **runs as a single program in kernel mode**.
- OS is written as a **collection of procedures, linked together into a single large executable binary program**.
- Each procedure has well defined interface in terms of parameter and results, and each one is free to call any other one.

- ✓ A main program that invoke the requested service procedure.
- ✓ A set of service procedures that carry out the system calls.
- ✓ A set of utility procedures that help the service procedure.



Layered systems

- In this system, the OS is organized as a **hierarchy of layers**.

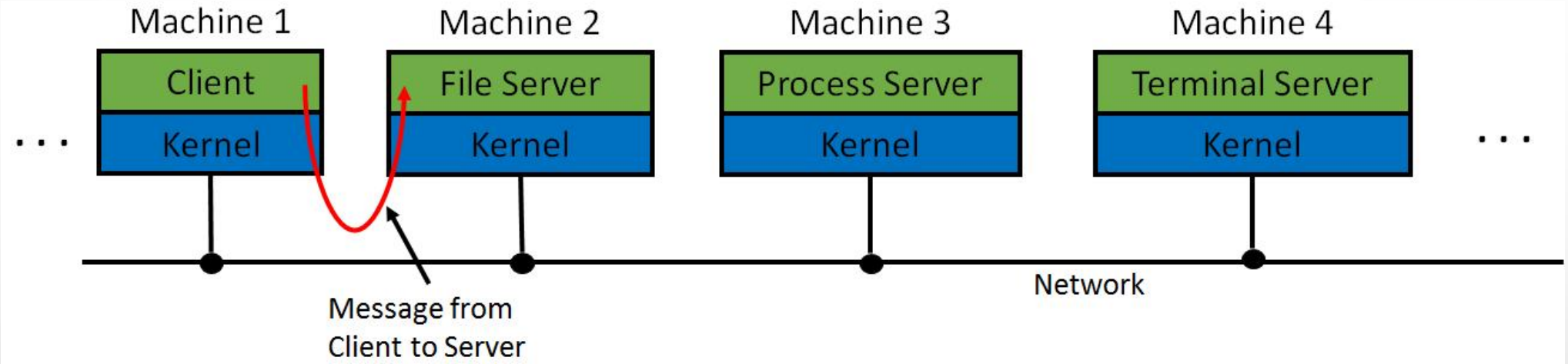
Layer	Function	Description
5	Operator	**Operator** was located.
4	User programs	**User programs** were found.
3	Input / Output management	Takes care of **managing the I/O devices**. Buffering the information.
2	Operator-process communication	**Handles communication** between each process and the operator console (i.e. user).
1	Memory and drum management	Did the **memory management**. Allocated space for process in main memory and on a 512K word drum used for holding parts of processes for which there was no room in memory.
0	Processor allocation and multi-programming	Provided the **basic multiprogramming** of the CPU. Dealt with allocation of the processor, switching between processes when interrupts occurred or timers expired.

Microkernel

- This structure designs the operating system by removing all non-essential components from the kernel and implementing them as system and user programs. This results in a smaller kernel called the micro-kernel. Advantages of this structure are that all new services need to be added to user space and does not require the kernel to be modified. Thus it is more secure and reliable as if a service fails, then rest of the operating system remains untouched. Mac OS is an example of this type of OS.
- **Advantages of Micro-kernel structure**
  - It makes the operating system portable to various platforms.
  - As microkernels are small so these can be tested effectively.
- **Disadvantages of Micro-kernel structure**
  - Increased level of inter module communication degrades system performance.

Client-Server model

- Processes are divided into two categories
  - **Servers**: provide services
  - **Clients**: uses services
- Client and server **run on different computers, connected by LAN or WAN and communicate via message passing**.
- To obtain a service, **a client construct a message** saying **what it wants and send it to server**.
- The **server then does the work and send back the answer**.



Virtual machines

- A virtual machine (VM) is a **virtual environment that functions as a virtual computer system with its own CPU, memory, network interface, and storage, created on a physical hardware system**.
- Rather than cloning (copying) the actual machine, **another strategy is partitioning it** (giving each user a subset of the resource).
- For example one virtual machine might get disk blocks 0 to 1023, the next one might get block 1024 to 2047, and so on.

Exokernels

- An exokernel is a type of operating system kernel that provides only the most basic services. By separating resource management from protection, the exokernel architecture aims to enable application-specific customization. Due to its limited operability, exokernel size typically tends to be minimal. This makes exokernels highly modular and flexible, but also very complex to implement.

- The exokernel structure is an alternative operating system design that is quite different from traditional monolithic or microkernel architectures. In an exokernel, the kernel provides a minimal interface to applications and exposes hardware resources directly, allowing applications to manage these resources.

Questions asked in examination

1. What is Kernel? Differentiate between Monolithic Kernel and Micro Kernel.
2. Explain different service/functions provided by operating system.
3. Discuss role of OS as a resource manager.
4. Explain the features of Time sharing system.
5. What is operating system? Give the view of OS as a resource manager.
6. What is system call? Explain steps for system call execution.
7. Write different types of system call.
8. List out types of operating system and explain batch OS and time sharing OS in brief.