

Operating Systems

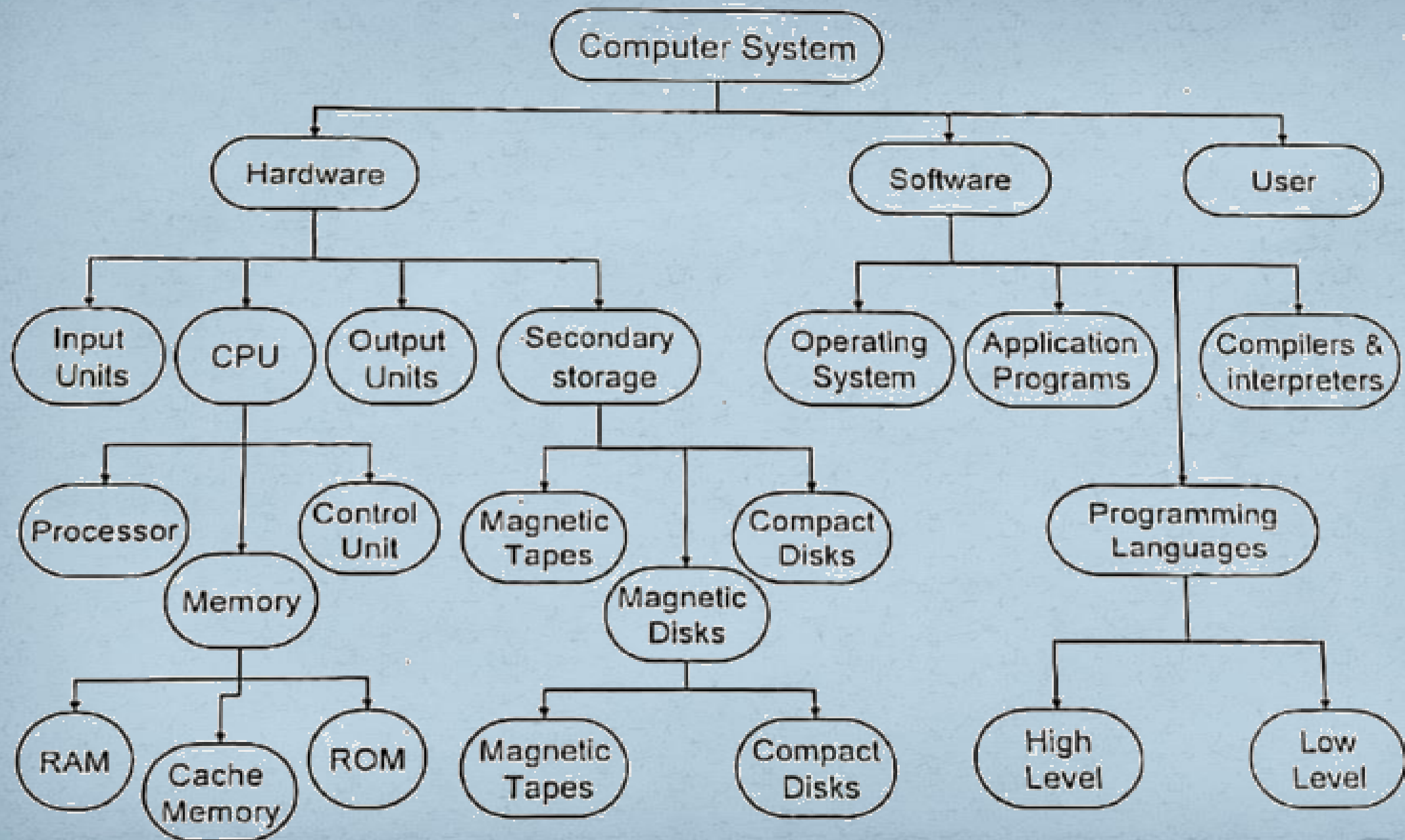
Dr. Arwa E. Abulwafa

Course Content

- **Introduction**
- **File System Management**
- **Storage Management**
- **Process Management**
- **CPU Scheduling**
- **Threading**
- **Memory Management**
- **Virtual Memory Management**

Introduction

Lecture (1)



Computer System Components

- **Hardware**

- Includes; **Input Units, CPU, Output Units and Secondary Storage**
- **Examples**; Monitor, Keyboard, CPU, Disks, Memory, etc.

- **Software**

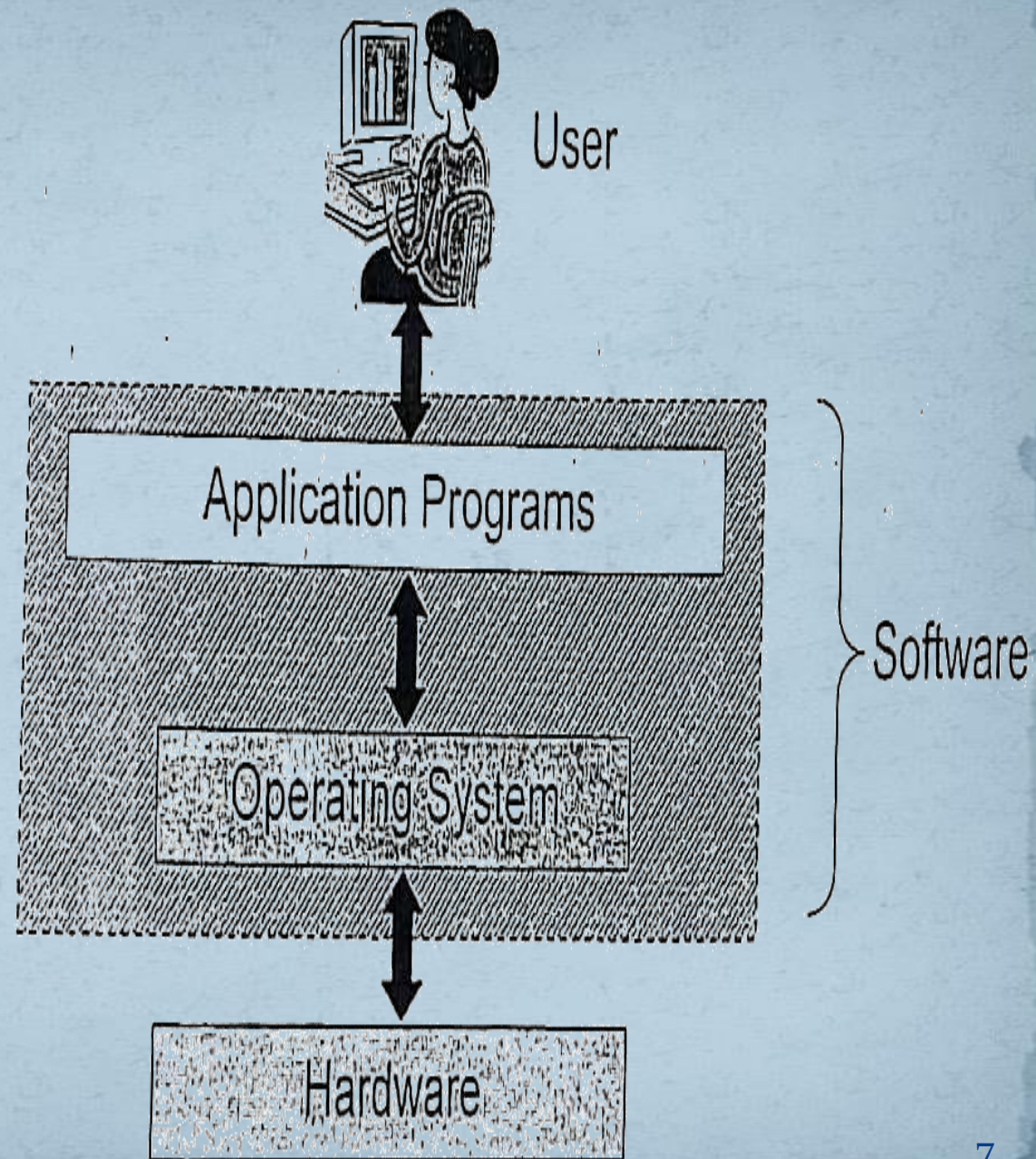
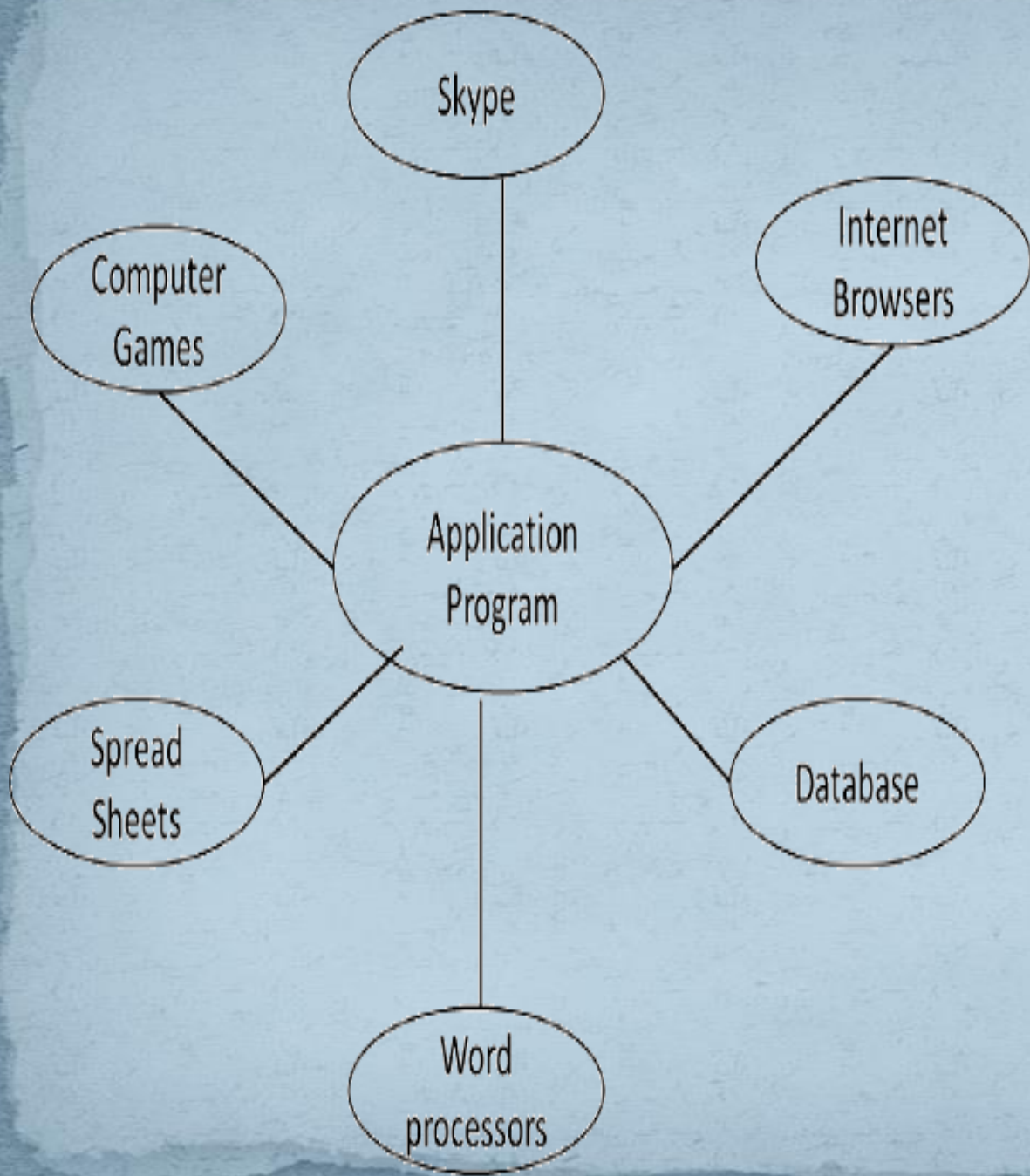
- Includes **Operating Systems, Application Programs and Compiler and Interpreters.**

- **Users**

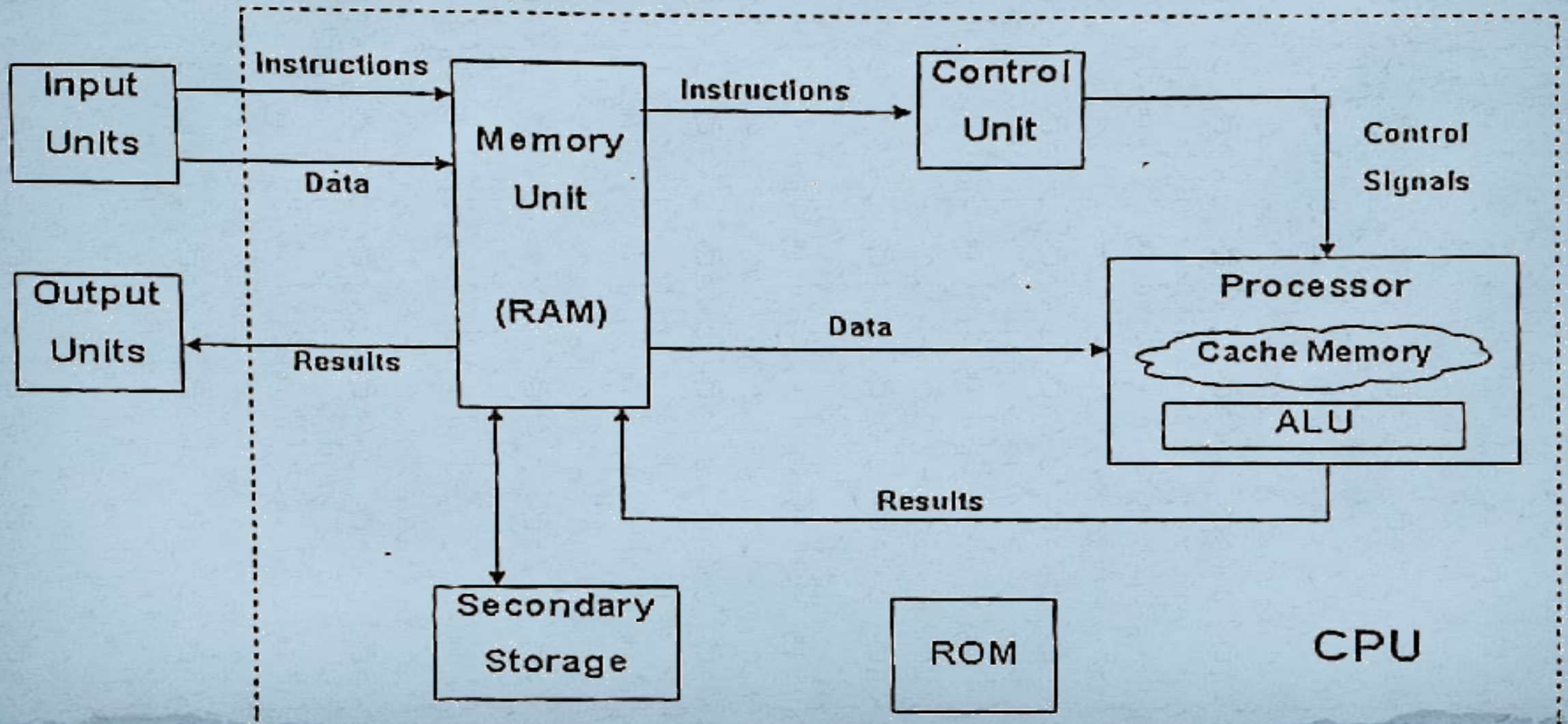
- The users who use the overall computer system.

Application Programs

- Application Programs are those **programs** that you can **install** in your **computer** to perform a **specific task**.
- These are usually written in **high-level languages**, such as **Python, Java and C++**.
- **Examples:** Web Browsers, Email, Word, Excel, different Editors, Games etc.



Computer System Internal Structure



Computer System Internal Structure

- **Input Units:**
 - Used to **input data** and **instructions** to **memory**
 - **Examples**; keyboard, mouse, scanner, microphone, camera, etc.
- **Output Units:**
 - Used to **display** the output
 - **Examples**; printer, monitor, speaker, etc.
- **Main Memory:**
 - **RAM**: to store user's **programs** and **data**.
 - **ROM**: to store **fixed programs** used by the computer.
 - **Cache Memory**: used to **increase** processor **speed**.

Computer System Internal Structure

- **Control Unit:**
 - Used to control the sequence of operations.
 - It receives **instructions** or **information directly** from the **main** memory.
- **Processor:**
 - Used to perform the required task by the **Arithmetic and Logic Unit (ALU)**.
- **Secondary Storage Unit:**
 - Used to store data permanently.
 - **Examples;** hard disk, optical disk and floppy disk.

Computer System Internal Structure

- **Arithmetic and Logical Unit (ALU)**
 - The **arithmetic and logical unit** is the **combinational digital electronic circuit** that can perform **arithmetic** operations on integer binary numbers and also perform **logical** operation.
 - The **outputs** of **ALU** will change **asynchronously** in response to the input.

Memory Components

- It is the **Primary Storage** and also known as the **Main Memory** and is the memory **directly** accessible by the **CPU**.
- **Types:**
 - **RAM**
 - It is **Random Access Memory**.
 - It is **volatile** i.e. it loses its contents when power is off.
 - Can be **modified** by the **user**
 - It is **quite fast**.
 - It is also **quite expensive**.

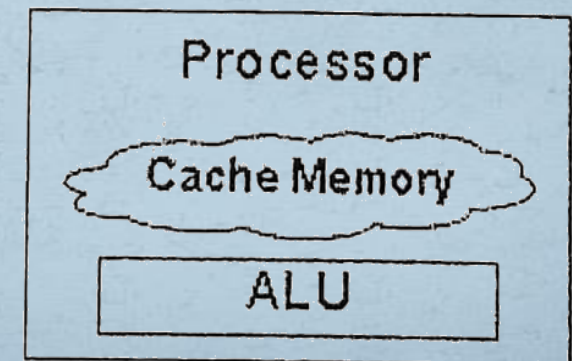
Memory Components

- **ROM**

- It is **Read Only Memory**.
- It is a **Non Volatile**; it **cannot** be **changed**, it can only be read as required.
- It contains **fixed** programs used by the computer, like the system **boot** program.

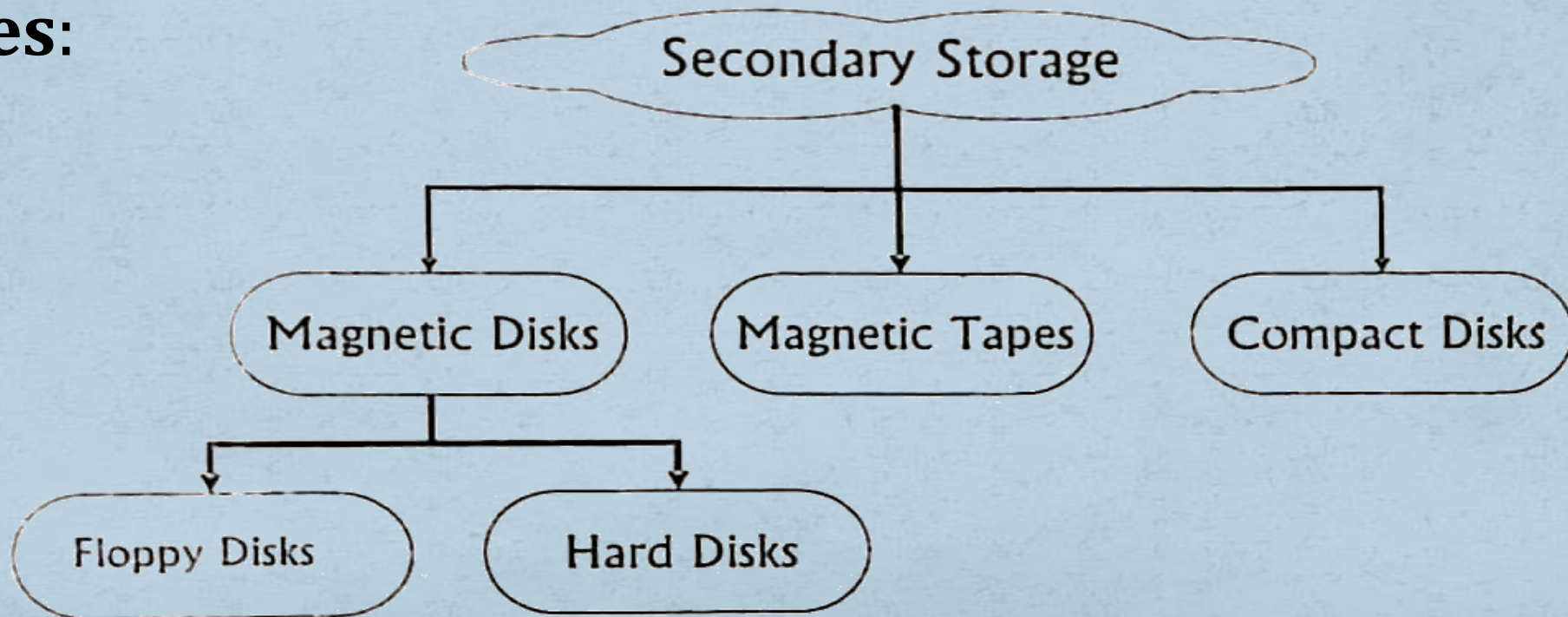
- **Cache Memory**

- It is a memory **inside** the **processor** chip.
- Used to store **frequently** used **data**.
- Used to **increase** the processor **speed**.



Secondary Storage Units

- Secondary Storage Units are the units used to store data **permanently**, and are **not directly** accessible by the **CPU**.
- **Types:**



Secondary Storage Units

- **Magnetic Disk:**

- A surface of **metal** (in case of **Hard Disk**) or **plastic** (in case of **Floppy Disks**) coated with **magnetic** material.
- It rotates with a **high speed**.
- It is divided into **tracks** and **sectors**.
- **Magnetic Disks** may be:
 - **Hard Disk:** **large** size (120 Giga Byte) and **fixed**.
 - **Floppy Disk:** **small** size (1.44 Mega Byte) and **movable**.

Secondary Storage Units

- **Magnetic Tapes:**

- Used to store **large** volume of data in **large** computers like; **mainframes** for **long** time.

- Consists of a **plastic film** coated by **magnetic** material.

- **Advantages:**

- Compact (can store huge amount of data).
- Economical (low cost).
- No loss of data.

- **Disadvantages:**

- Sequential storage.

Secondary Storage Units

- **Compact Disks (CD-ROM):**
 - CD-ROM (Compact **D**isk/**R**ead **O**nly **M**emory).
 - A **plastic** surface coated by a **reflective** material.
 - A **laser** beam is used to **write** on CD-ROM.
 - It can store up to **600** Mega Byte.

Secondary Storage Units

- **Another Types:**

- **Flash Drive**

- This is also known as a **pen drive**.
 - It helps in **easy transportation** of data from one system to another.
 - A pen drive is **quite compact** and comes with various features and designs.

- **Memory Card**

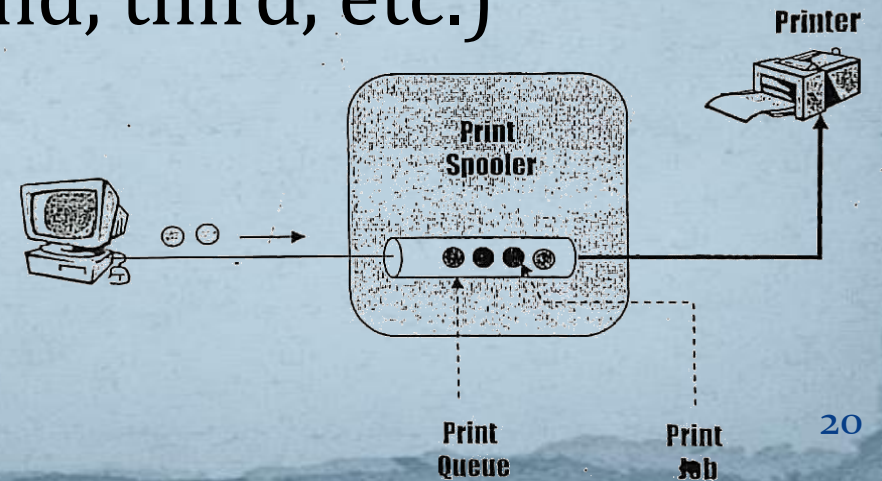
- This has **similar** functionality to a **flash drive** but is in a **card** shape.
 - It can **easily** plug into a port and removed after its work is done.
 - A memory card is available in various sizes such as 8MB, 16MB, 64MB, 128MB, 256MB etc.

Operating System

- It is the **program running all the time** on the computer to communicate all computer components (usually called **Kernel**).
- It does **not** perform a **useful task** by it self, but it creates a **suitable environment** so that other programs can operate efficiently.
- **OS Goals:**
 - **Convenient** for the user.
 - **Efficient** for the system components.

Spooling

- **Spooling** (Simultaneous Peripheral Operation On-Line)
- It is a way to process data **serially**.
- **Example**; printer; it can receive **more than one** print request, so the operating system uses what is called the **Print Spooler**, which puts those requests in a **queue** and executes them sequentially (first, second, third, etc.)

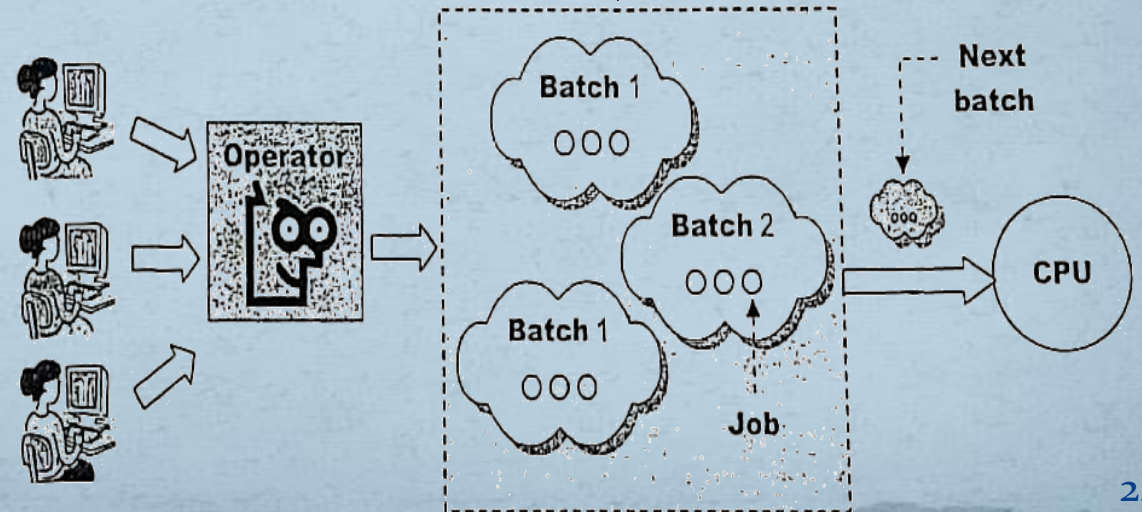


Operating System Types

- Batch System.
- Multi-Programming System.
- Multi-Tasking (**Time Sharing**) System.
- Multi-Processor (**Parallel**) System.
- Network Operating Systems.
- Real-Time Systems.

Batch System

- Users **send** their **jobs** to the computer **operator**.
- **Operator** **organize** jobs into a set of **batches** (each contains **similar jobs**).
- Each batch runs **separately** as a set of jobs.
- **Examples**; Payroll Systems, Bank Statements, etc.



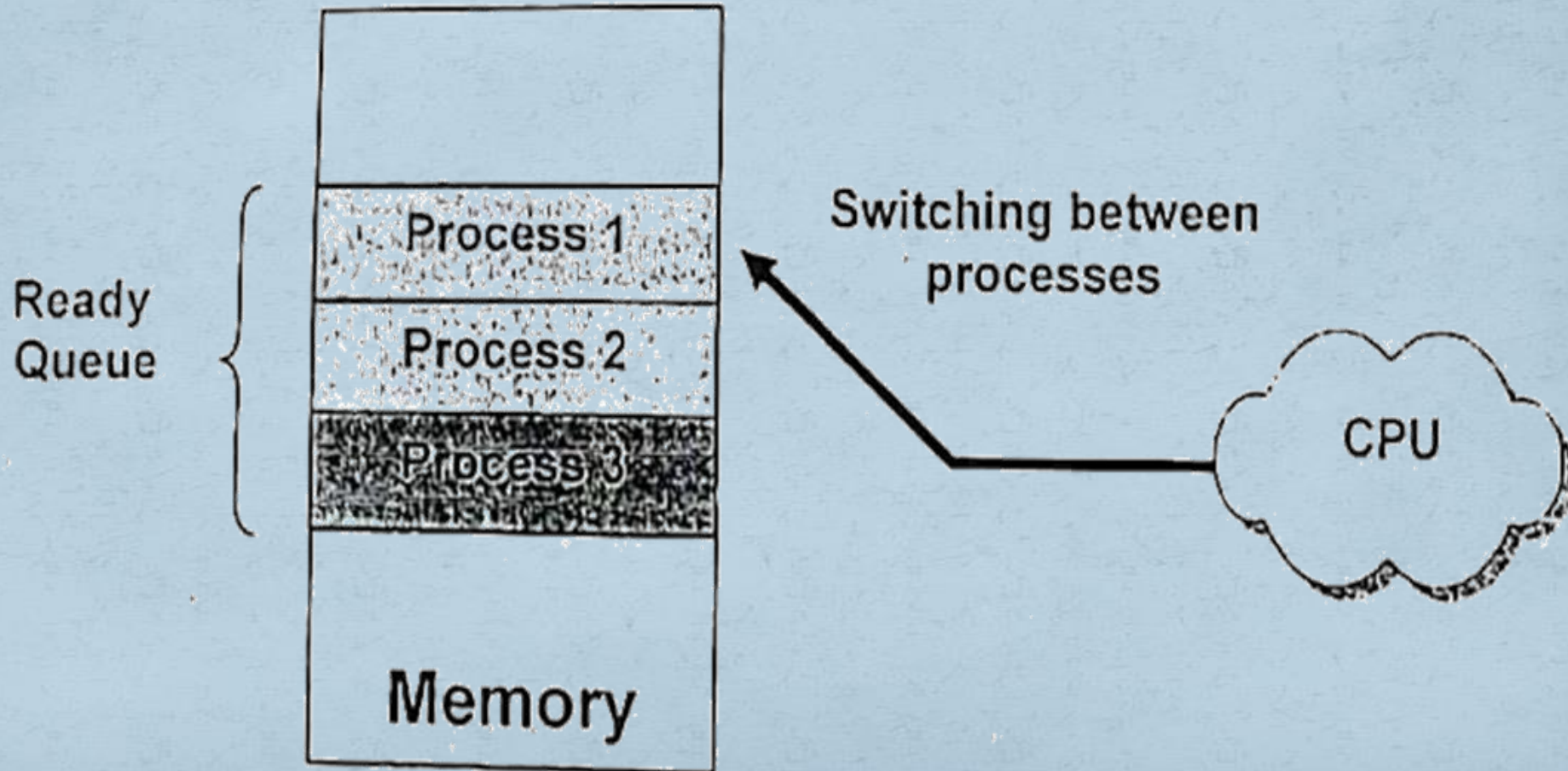
Batch System

- This system is one of the **oldest** types of systems, as there is **no direct interaction** between the **user** and the **computer**.
- The **user sends** the **job** to be executed to a **person** who **operates** the computer, called an **operator**, who collects the **jobs of all users** and **classifies** them into **batches**, so that each batch contains a **group of similar jobs** that are executed on the computer as a **single batch**.

Multi-Programming System

- A number of processes are in memory inside the ready queue waiting for the CPU (there is one user).
- **Example; Windows OS.**
- In this system, there are **many processes** inside the computer that are ready to be executed inside what is called **Ready Queue**.
- Thus, the **CPU distributes** its **time** among those **processes** which are for one user.

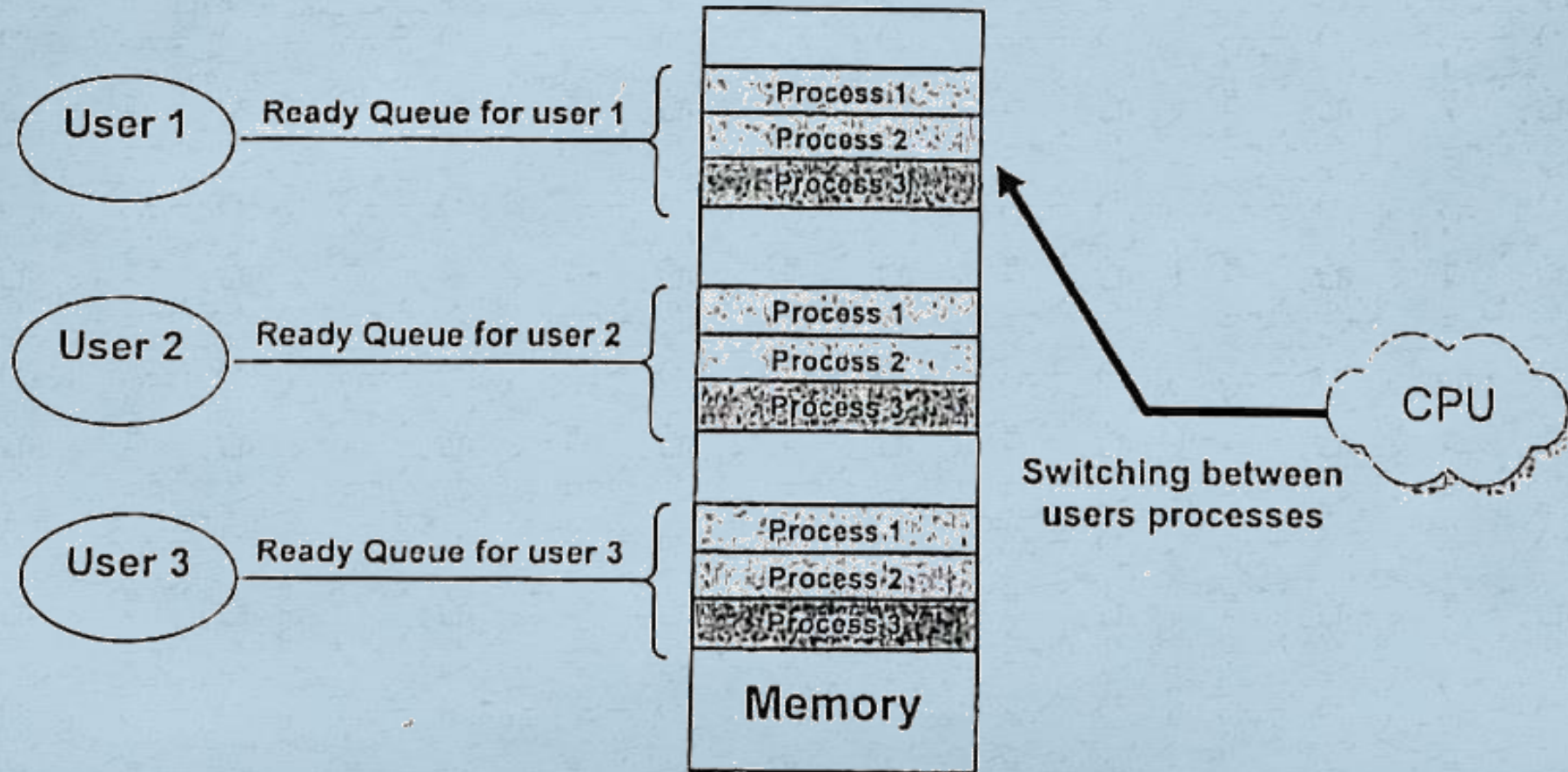
Multi-Programming System



Multi-Tasking (Time Sharing) System

- Allow a number of users to **share** the **CPU** in the **same** time.
- This concept is used in the **mainframe** computers.
- In this system there are **many users** so the **processor distributes itself** among these users so that it serves them all at the **same** time.
- **Examples;**
 - **IBM VM/CMS**
 - **TSO** (Time Sharing Option)
 - **Windows Terminal Services**

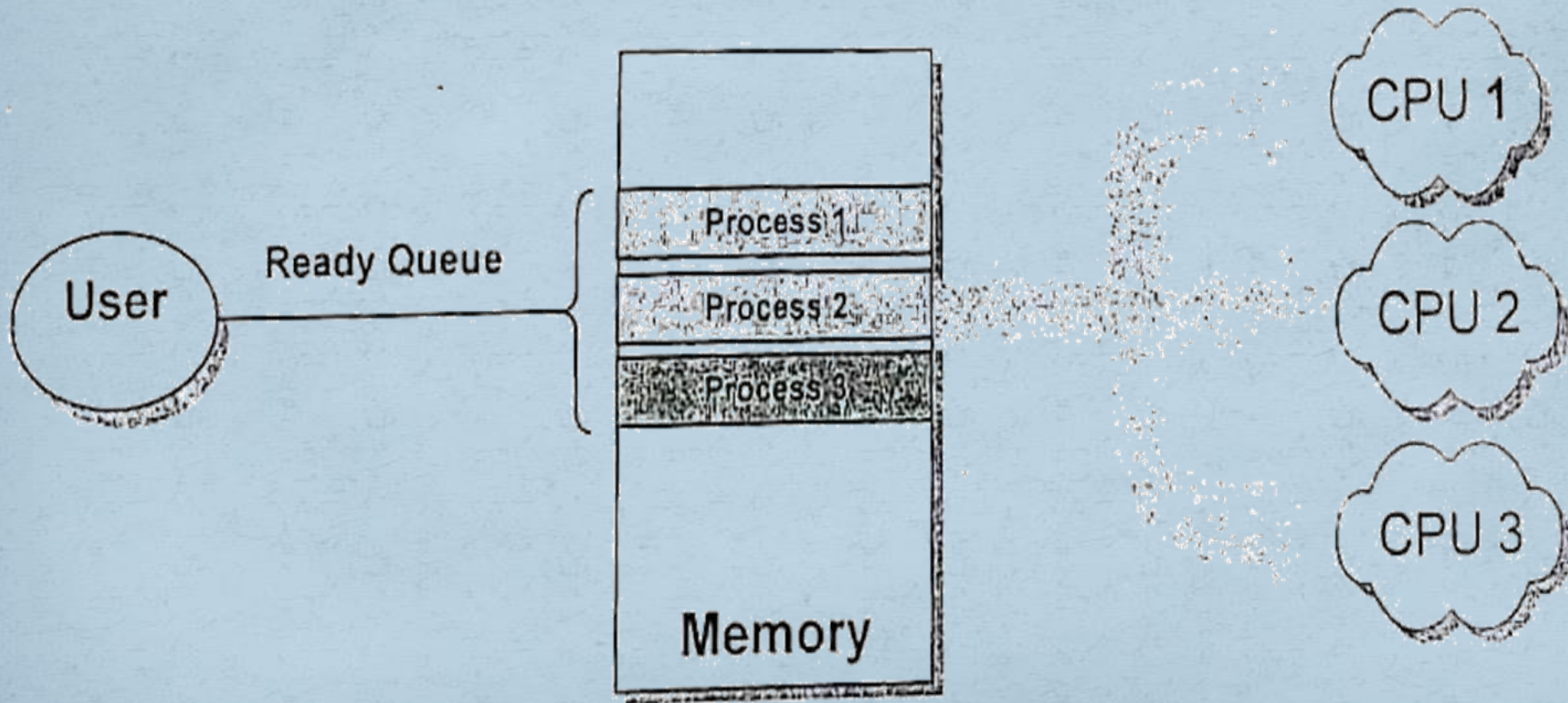
Multi-Tasking Operating System



Multi-Processor System

- It is a system with **more than one processor** to **maximize** the system **speed**.
- This system is characterized by the presence of **many processors**, and thus the **user's active processes** are **distributed** among those processors, which increases the speed of completing those processes.

Multi-Processor System



Network Operating System

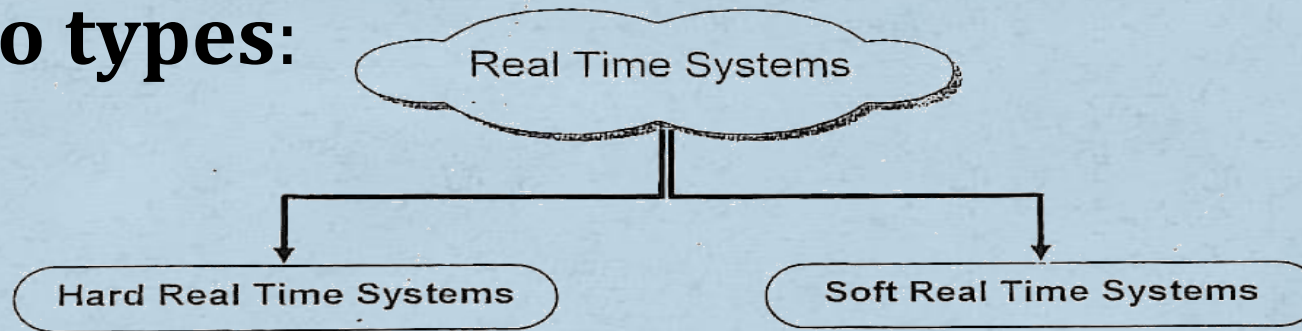
- Systems that operate networks in order to achieve:
 - Resource sharing.
 - Computation speedup.
 - Load balancing.
 - Communication between hosts.
- This type is a **network management** and **operation** system that **relies** on many network management **protocols** such as the **TCP/IP** protocol used in managing the **Internet**.

Real-Time System

- Systems that performs **critical** tasks.
- **Real-time Systems** are systems that are sometimes required to perform **critical** tasks that do **not** require **delay** in execution, such as operating systems for **surgical devices**, **satellite control** devices, or **robot** operating systems.
- These **critical** tasks need to be executed **on time**, and any delay in them can expose the entire system to **collapse**.

Real-Time System

- There are **two types**:



- **Hard Real Time Systems:**
 - **critical** tasks must be performed **on time**.
- **Soft Real Time Systems:**
 - **critical** task may be a **little late without** any **effect**,
 - But, it must get **priority** over other tasks.

Real-Time Operating System

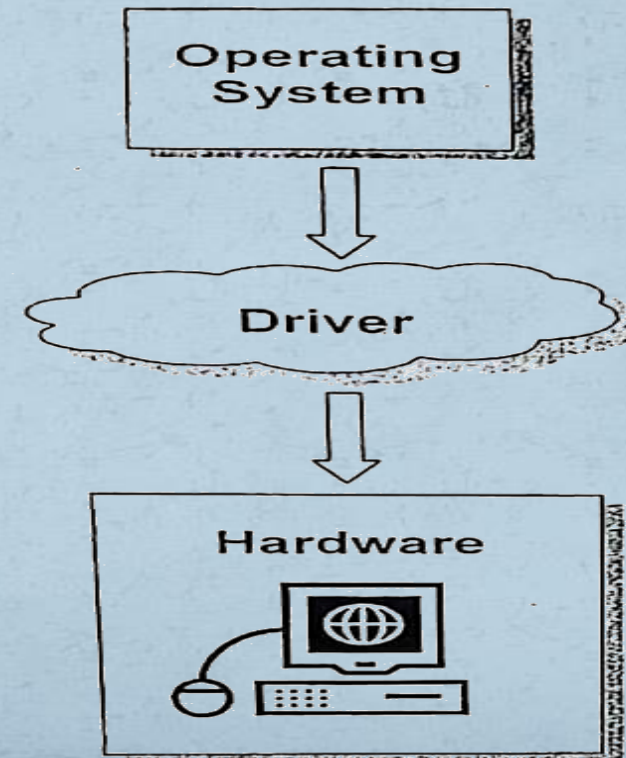
- **Examples:**
 - Scientific Experiments,
 - Medical Imaging Systems,
 - Industrial Control Systems,
 - Weapon Systems,
 - Robots,
 - Air Traffic Control Systems, etc.

Operating System Functions

- Different **activities** supported by modern **OS** are:
 - **Process** Management
 - **Memory** Management
 - **File** Management
 - **Storage** Management
 - **I/O** Management
 - **Protection** Management
 - **Networking** Management

Driver Programs

- It is a program introduced by the company that produce the hardware, so that the operating system can communicate with the hardware.



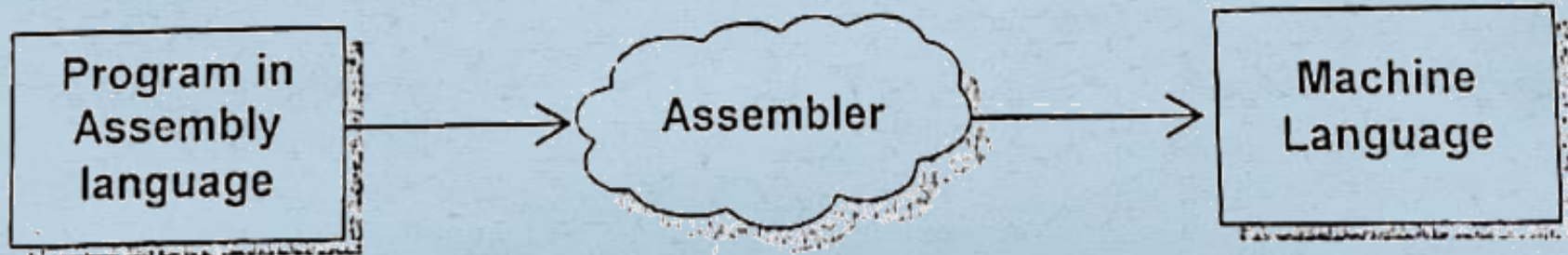
Programming Languages

- There are **two** types of programming languages:
 - **High Level Languages:**
 - Similar to **natural** languages.
 - Need **Compilers** (or **Interpreters**) to be converted to machine language.
 - **Example**; Visual Basic, Java, C, etc.



Programming Languages

- There are **two** types of programming languages:
 - **Low Level Languages:**
 - Similar to **machine** languages.
 - Need **Assemblers** to be converted to machine language.
 - **Example**; Assembly Language.



Compilers vs. Interpreters

- Both **Compilers** and **Interpreters** are used to **convert** the programs written in **high** level languages to the **machine** languages.
- But there are some **differences** between them as following:
 - **Interpreters** convert the program written in **high** level language to language **line by line**.
 - **Compilers** convert the **whole** program written in **high** level language to machine language in **one step**.

Compilers vs. Interpreters

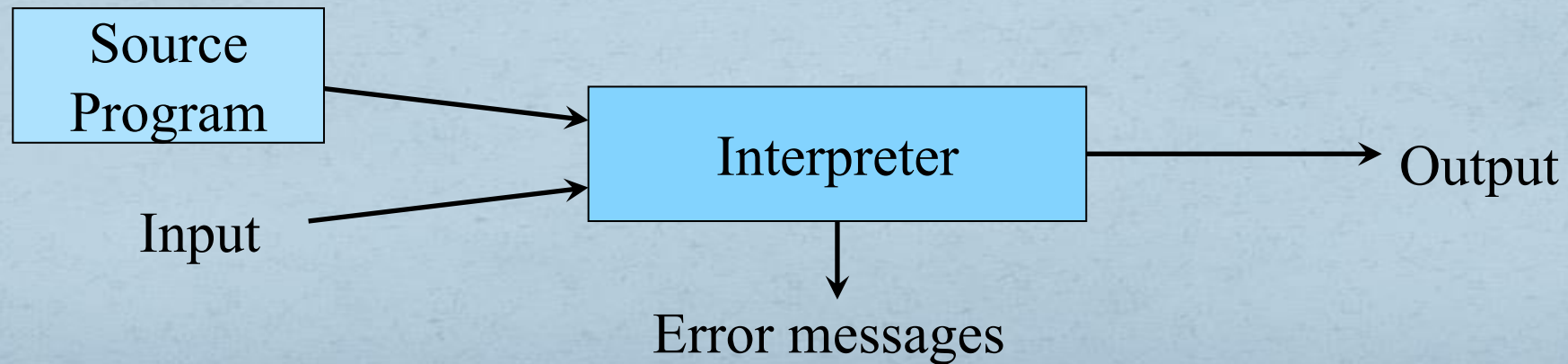
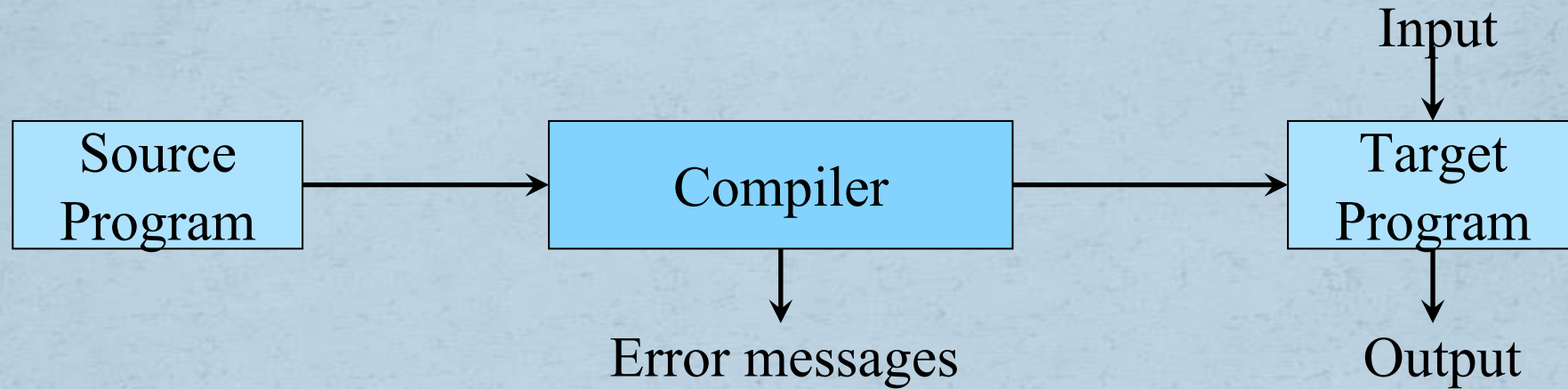
Compiler

- Compiled code run **faster**
- Compiler displays all errors and warning at the **compilation time**; Therefore, you can't run the program without fixing errors
- It takes an **entire** program
- It generates **intermediate machine code**.
- Display all errors **after compilation**, all at the same time.
- C, C++, C#, Scala, Java.

Interpreter

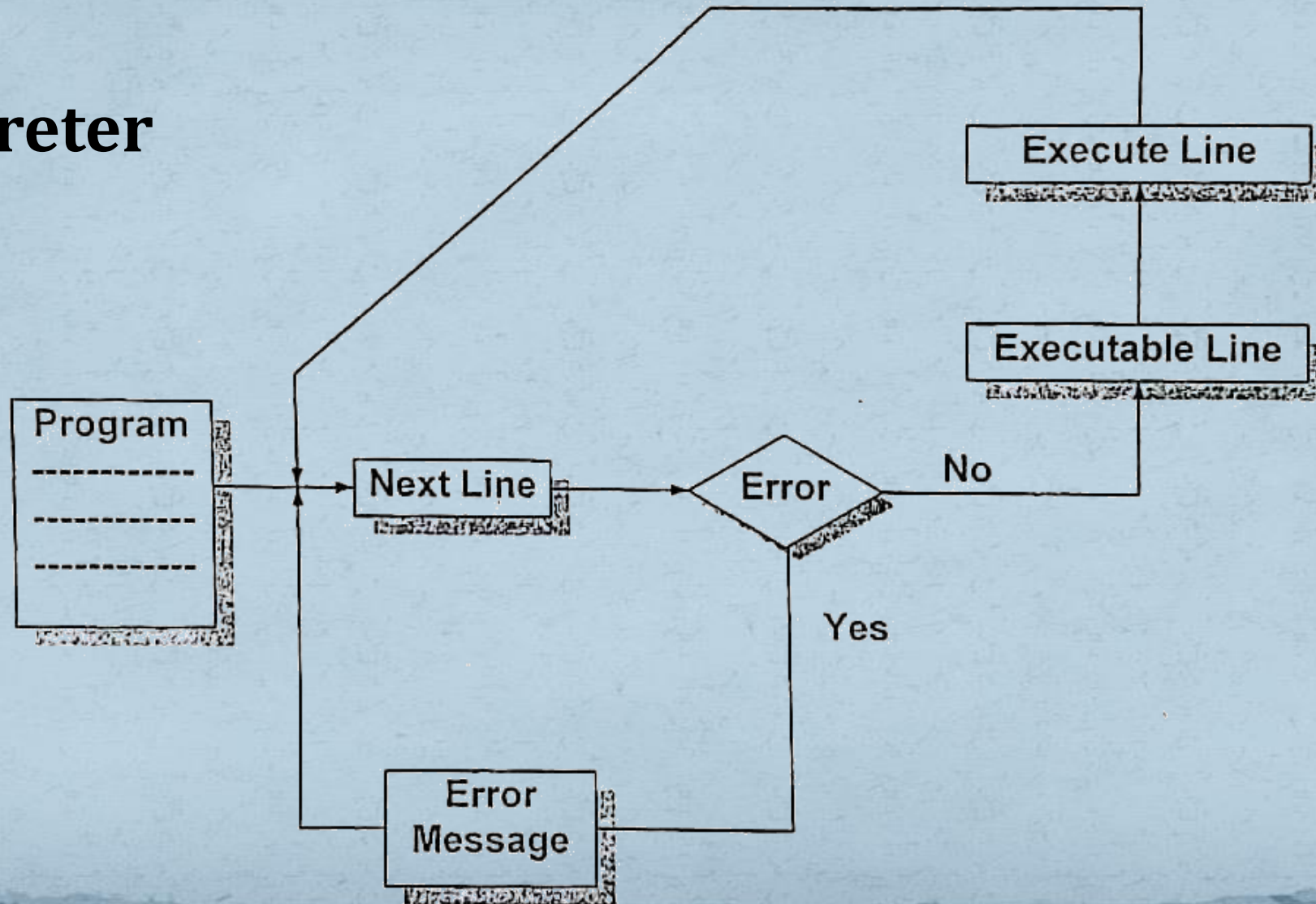
- Interpreted code run **slower**
- The interpreter reads a **single statement** and shows the error if any; therefore you must correct the error to interpret next line.
- It takes a **single line** of code.
- It **never** generate any **intermediate machine code**.
- Displays all errors of each line **one by one**.
- PHP, Perl, Ruby.

Compilers vs. Interpreters



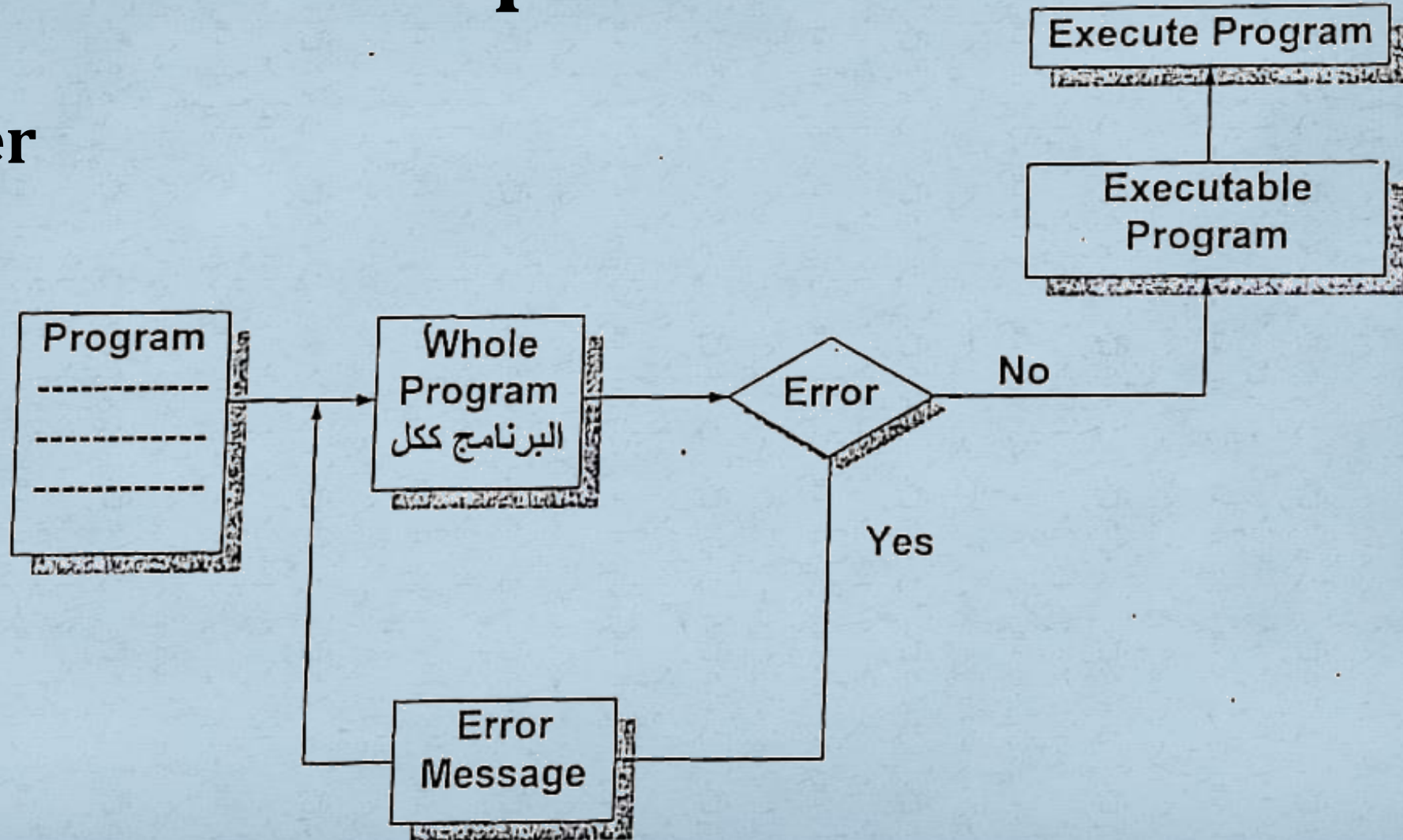
Compilers vs. Interpreters

Interpreter



Compilers vs. Interpreters

Compiler



Operating System – Examples

- There are plenty of Operating Systems available in the market which include paid and unpaid (Open Source).
- Following are the **examples** of the few most popular Operating Systems:
 - **Windows:**
 - This is one of the most popular and commercial operating systems developed and marketed by Microsoft.
 - It has different versions in the market like Windows 8, Windows 10, etc. and most of them are paid.

Operating System – Examples

- **Linux:**

- This is a Unix based and the most loved operating system first released on September 17, 1991 by Linus Torvalds.
- Today, it has 30+ variants available like Fedora, OpenSUSE, CentOS, Ubuntu, etc.
- Most of them are available free of charges though you can have their enterprise versions by paying a nominal license fee.

- **Mac OS:**

- This is again a kind of Unix operating system developed and marketed by Apple Inc. since 2001.

Operating System – Examples

- **iOS:**
 - This is a mobile operating system created and developed by Apple Inc. exclusively for its mobile devices like iPhone and iPad etc.
- **Android**
 - This is a mobile Operating System based on a modified version of the Linux kernel and other open source software, designed primarily for touchscreen mobile devices such as smartphones and tablets.
- Some other old but popular Operating Systems include Solaris, VMS, OS/400, AIX, z/OS, etc.

Operating System – History

- Operating Systems have been evolving through the years.
- In the **1950s**, computers were limited to running one program at a time like a calculator,
- But **later** in the following decades, computers began to include more and more software programs, sometimes called libraries, that formed the basis for today's operating systems.
- The first Operating System was created by General Motors in **1956** to run a single **IBM** mainframe computer, its name was the IBM 704.
- **IBM** was the **first** computer manufacturer to develop operating systems and distribute them in its computers in the **1960s**.

Operating System – History

- There are few **facts** about Operating System evaluation:
 - Stanford Research Institute developed the **ON-Line System (NLS)** in the late 1960s,
 - which was the first operating system that resembled the desktop operating system we use today.
 - Microsoft bought **QDOS** (Quick and Dirty Operating System) in 1981 and branded it as Microsoft Operating System (**MS-DOS**).
 - As of 1994, Microsoft had stopped supporting MS-DOS.

Operating System – History

- **Unix** was developed in the mid-1960s by the Massachusetts Institute of Technology,
 - AT&T Bell Labs, and General Electric as a joint effort. Initially it was named MULTICS, which stands for Multiplexed Operating and Computing System.
- **FreeBSD** is also a popular UNIX derivative, originating from the BSD project at Berkeley.
 - All modern Macintosh computers run a modified version of FreeBSD (OS X).

Operating System – History

- **Windows 95** is a consumer-oriented graphical user interface-based operating system built on top of MS-DOS.
 - It was released on August 24, 1995 by Microsoft as part of its Windows 9x family of operating systems.
- **Solaris** is a proprietary Unix operating system originally developed by Sun Microsystems in 1991.
 - After the Sun acquisition by Oracle in 2010 it was renamed Oracle Solaris.

Thank
you

