

CHAPTER I

INTRODUCTION

Computer System Structure

OS Goals

Calculation of Resources Utilization (RU)

Types of Computer Systems

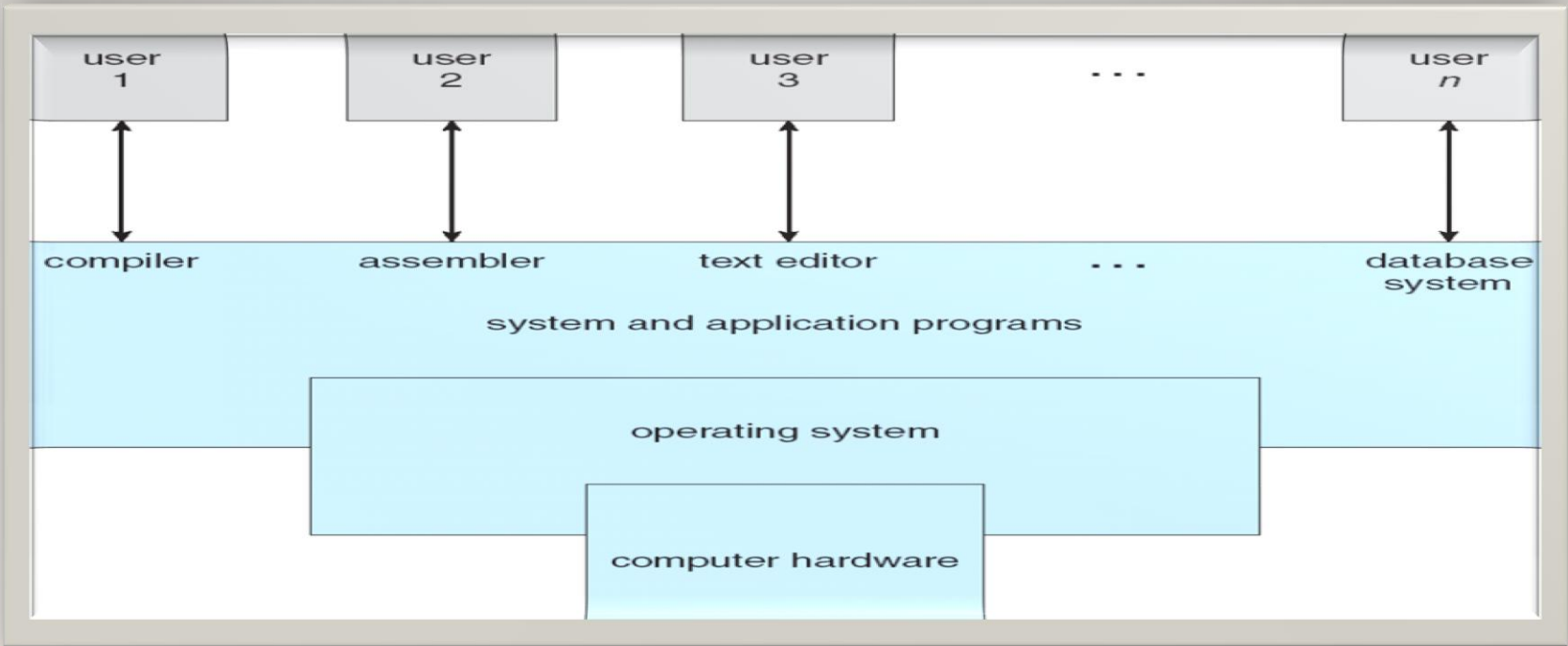
Main Roles of an OS

Structure of an OS

The Bootstrap Program

Computer Architecture

COMPUTER SYSTEM STRUCTURE



A computer System can be divided roughly into three components:

- (1) **Hardware:** CPU, memory, I/O devices, etc...
- (2) **Software:** Operating System and Application Programs
- (3) **Users:** people or other machines

The Operating System (OS) provides the means for proper use of these resources in the operation of the computer system.

In other words, the OS provides an environment within which other programs can do useful work.

OS GOALS

Performance:

The computer **does not hang**

The computer **gives correct results**

The computer runs at a **reasonable speed**

Convenience:

The computer should be **user-friendly**.

The Graphical User Interface (GUI) is a means to make the OS easy to use.

Efficient Resources Utilization:

Any device connected to a computer – internally or externally – is a **resource**. Examples include CPU, memory, hard disk (internal), printers, USB flash memory, mouse (external).

An OS should make the **most use** of the available resources

This is measured as the percentage of the time a resource is actually operating to the total available time.

In a **multi-user environment**, an efficient resources utilization entail that all sharing users are assigned resources in a fair way. No user should monopolize any resource.

The next slide illustrates how to calculate the Resource Utilization (RU)

CALCULATION OF RESOURCES UTILIZATION (RU)

$$RU = \frac{\text{Operation time}}{\text{Total available time}} \times 100\%$$

Example:

Your PC is switched on for 10 hours. The processor worked only 2 hours. What is the RU of the processor?

Solution:

$$RU \text{ of the processor} = \frac{2 \text{ hours}}{10 \text{ hours}} \times 100\% = 20\%$$

TYPES OF COMPUTER SYSTEMS

Single-user environment

Personal Computers (PCs)

Mobile Phones

Embedded Systems

Multi-user environment

Mainframe: handle thousands of programs at the same time with high speed

Minicomputers: same as mainframes but with less storage capacity

Supercomputers: handle one program at a time with a higher speed as compared to mainframe/minicomputers

Workstations: PCs on a LAN with no disk drives. Users store their files on a connected server.

THE OS OF A COMPUTER TYPE IS MORE TARGETED TOWARDS A SPECIFIC GOAL

~ **PCs** (laptops and desktops) are used in programming or playing games. Should be easy to use.

~ **Mobile phones**: these are characterized by short battery life. Therefore, their OS should be as efficient as possible.
Also, almost all recent mobiles have a touch screen. Therefore, the OS should be able to handle this.

~ **Embedded computers**: these are chips embedded in machines such as automobiles, microwaves and other home appliances, etc... There is no interface between the user and the OS in such environment. Should work efficiently.

~ **Mainframe/minicomputer**: This is a multi-user environment; multiple users contend (compete) for the usage of its resources.

~ **Supercomputers**: This is a multi-user environment; however, in this case, the sharing users are the program instructions that execute in parallel and compete for the available resources.

~ **Workstations**: This is a multi-user environment; fair resources assignment between different users is of high concern.

MATCHING OS GOALS TO COMPUTER TYPES

OS Goal	PC	Multi-user environment	Mobiles	Embedded Systems
Performance	Medium	High	High	High
Convenience	High	Medium/High ⁽¹⁾	High	N/A ⁽²⁾
Security ⁽³⁾	N/A	High	High ⁽⁴⁾	N/A
Resources Utilization	None	High	None	None

⁽¹⁾ **Mainframes** users are usually experts: a medium level of convenience is enough. **Minicomputer** users are of lower level of expertize: this OS goal is of higher importance. **Supercomputer** users are usually scientists: this aspect may not be needed at all.

⁽²⁾ N/A = Not Applicable

⁽³⁾ Security involves (1) the fairness in using resources, and (2) privacy of data

⁽⁴⁾ Security is an important aspect in mobiles since these are connected to the Internet. So, they may be considered a multi-user environment.

MAIN ROLES OF AN OS

Resource Allocator

Manage all resources

Resolves conflicts between users' requests

Assigns resources to individuals in a multi-user environment according to a specific policy

Program Controller

Controls execution of programs

Prevents errors and improper use of the computer

Ensures that the I/O devices are connected correctly

Prevents user's monopoly in a multi-user environment

THE STRUCTURE OF AN OS

An OS consists of the following components:

Kernel

This is the core of the OS

It consists of a single program running as long as the computer is switched on

Examples of the functions included in the kernel are the **clock** and the **exception handling** (to be explained later)

System Programs

Associated with the OS, but are not necessarily part of the kernel

Therefore, they are not running all the time

They are called when needed

Examples include formatting a disk or restoring a file from the Recycle Bin

THE BOOTSTRAP PROGRAM

What is a bootstrap program?

The bootstrap program is stored on the ROM

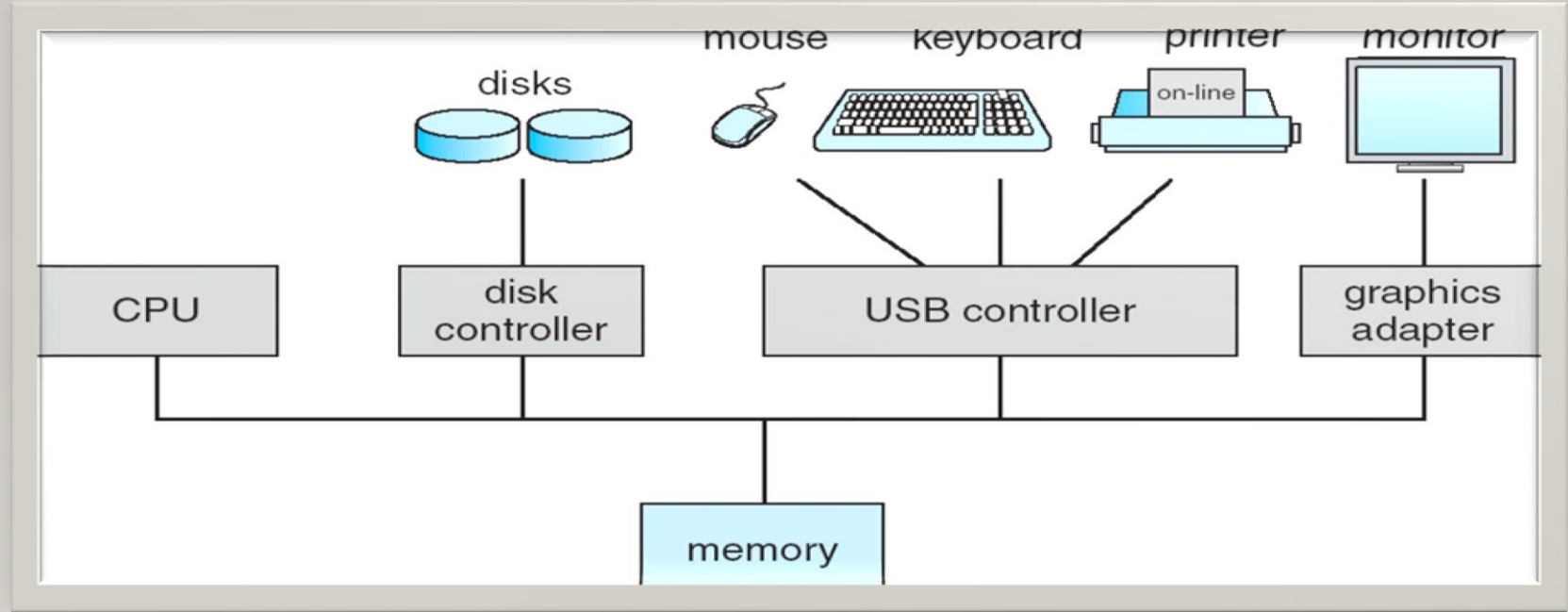
As soon as the computer is switched on, the bootstrap program is automatically loaded into memory to be executed

What does it do?

Initializes all aspects of system such as checking the connected devices

Loads the OS kernel into the memory to start execution

COMPUTER ARCHITECTURE



A modern general-purpose computer system consists of one or more CPUs and a number of device controllers connected through a common bus that provides access to shared memory.

This may cause conflicts between devices. The OS includes an **Interrupt Handler** to overcome this problem.