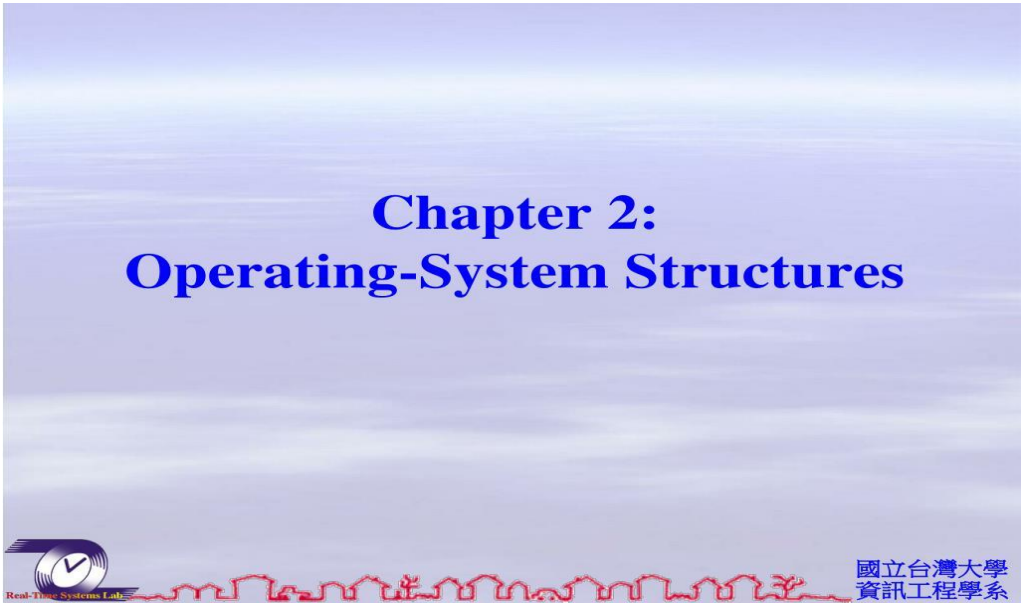
Cyber Security Engineering Department
Lecturs Prepared by Assist. Prof. Imad Matti

Operating Systems Concepts

Chapter 2

Operating - system structures & operations



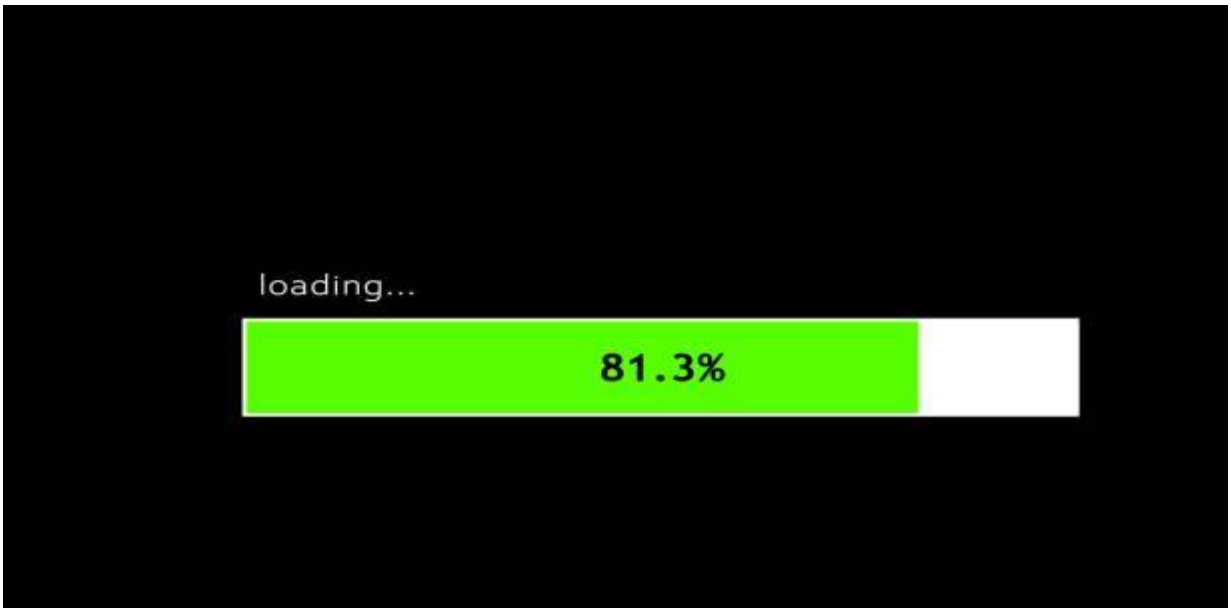
2. Computer System Operation

2.1 Bootstrap program: It is an initial program to run, its loaded at power-up or reboot. (Stored in **ROM** or **EPROM** known as **firmware**)

2.2 Bootstrap program functions:

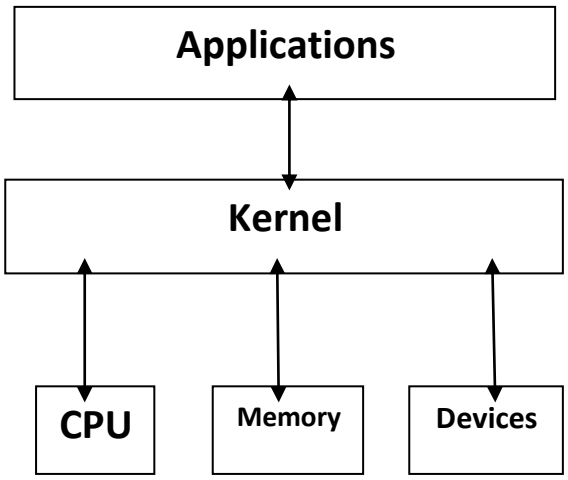
1- Initialize all aspects of the system from CPU registers to device controllers to memory contents.

2- Locate and **Loads** operating system **kernel** into memory and starts execution.



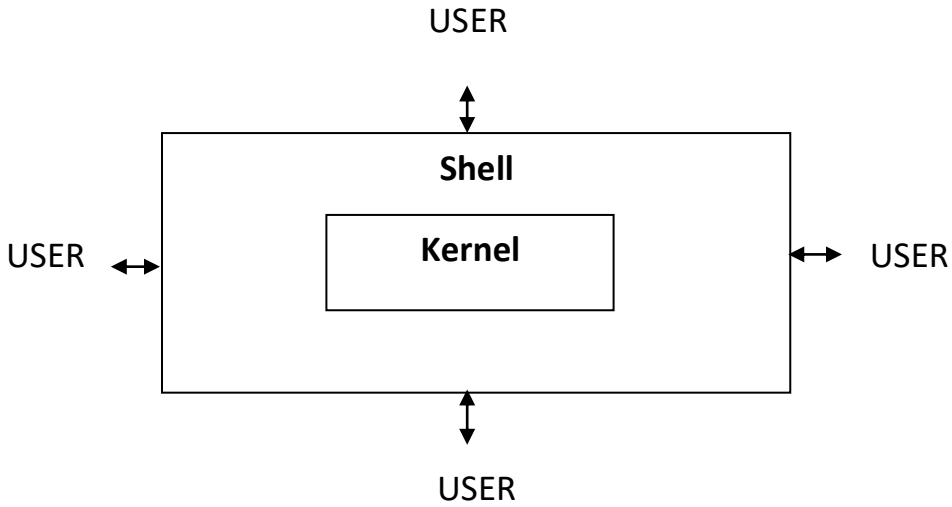
- **Kernel**: Is the part of operating system that mediates access to the computer's resources including:

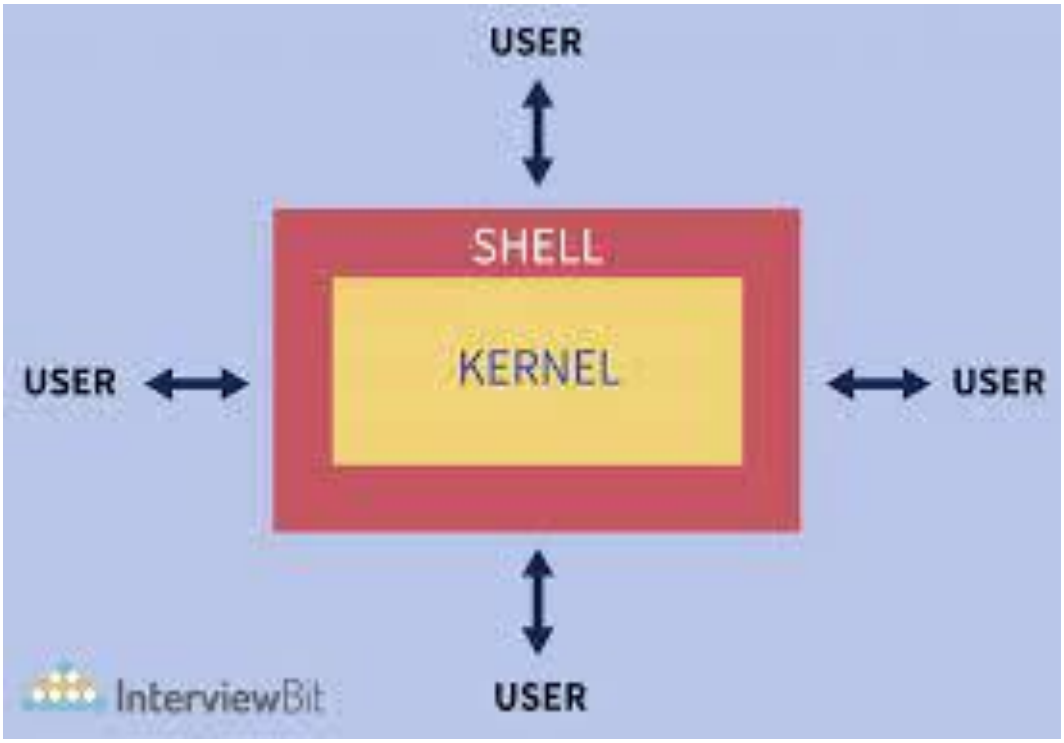
1. The central processing unit (CPU).
2. Random access memory.
3. Input/output (I/O) devices.

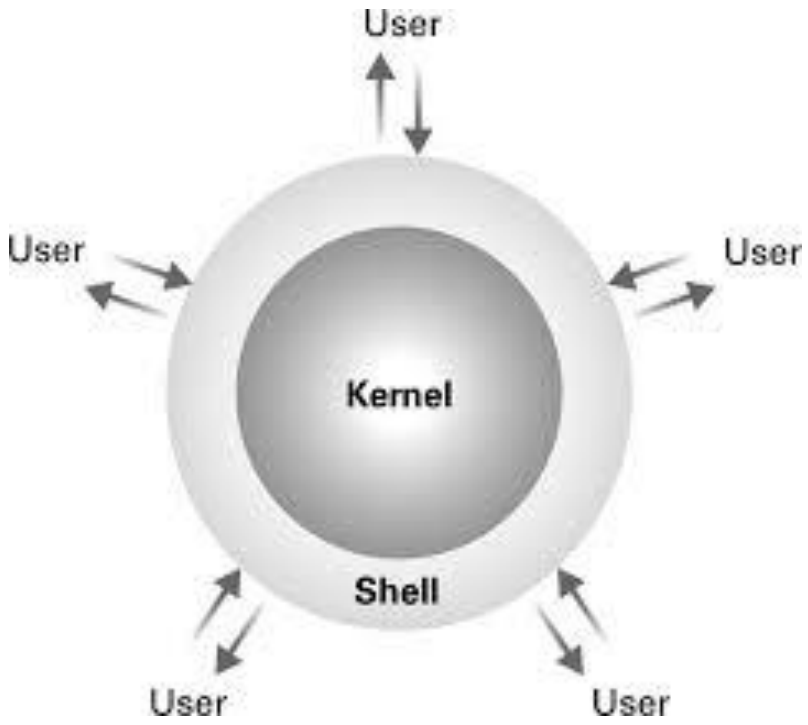


A kernel connects the application software to the hardware of a computer

Shell: Is software that provides an access to operating system services.




USER
SHELL
KERNEL
USER
USER
USER
InterviewBit


User
User
User
Kernel
Shell
User
User

2.3 I/O Structure

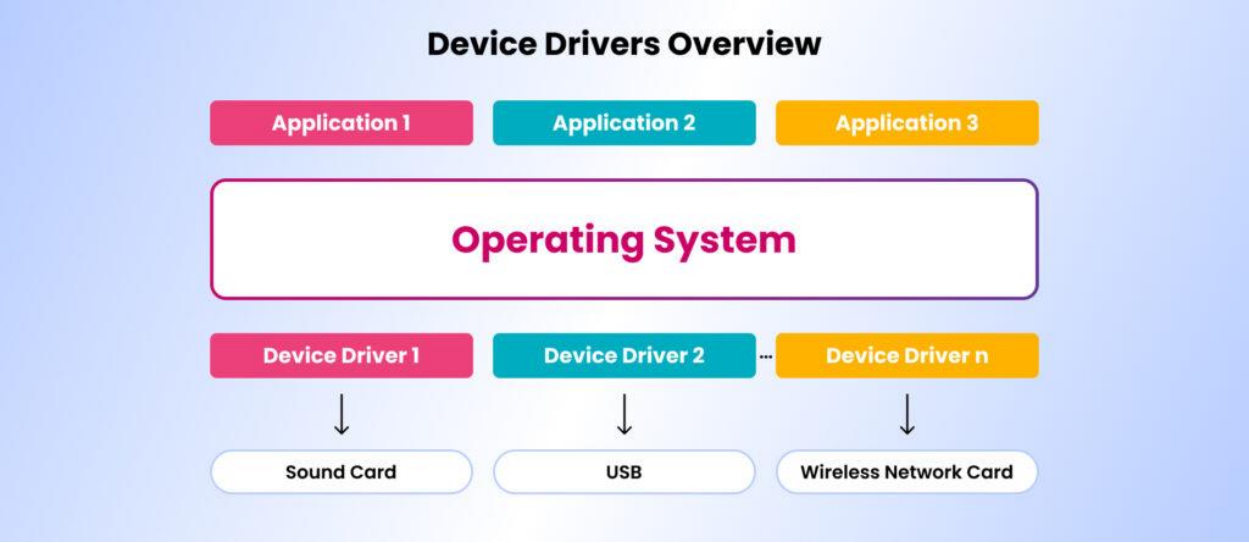
A **device driver** (**controller**): is the link between the operating system and the peripheral device.

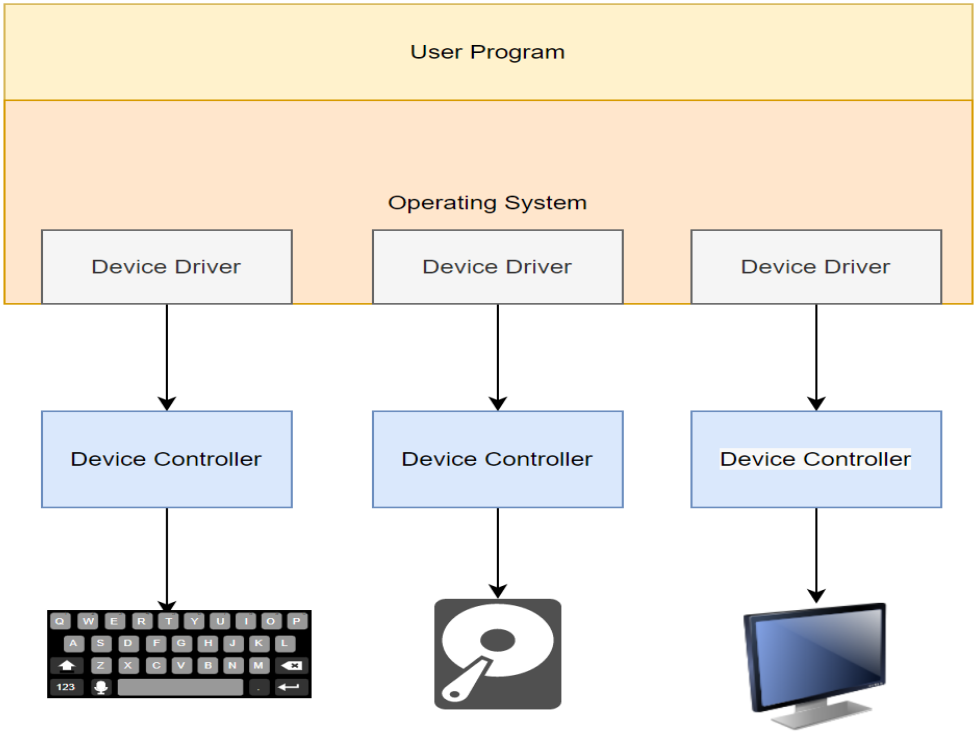
→ Each I/O device is connected to the C/S through its **device driver**.

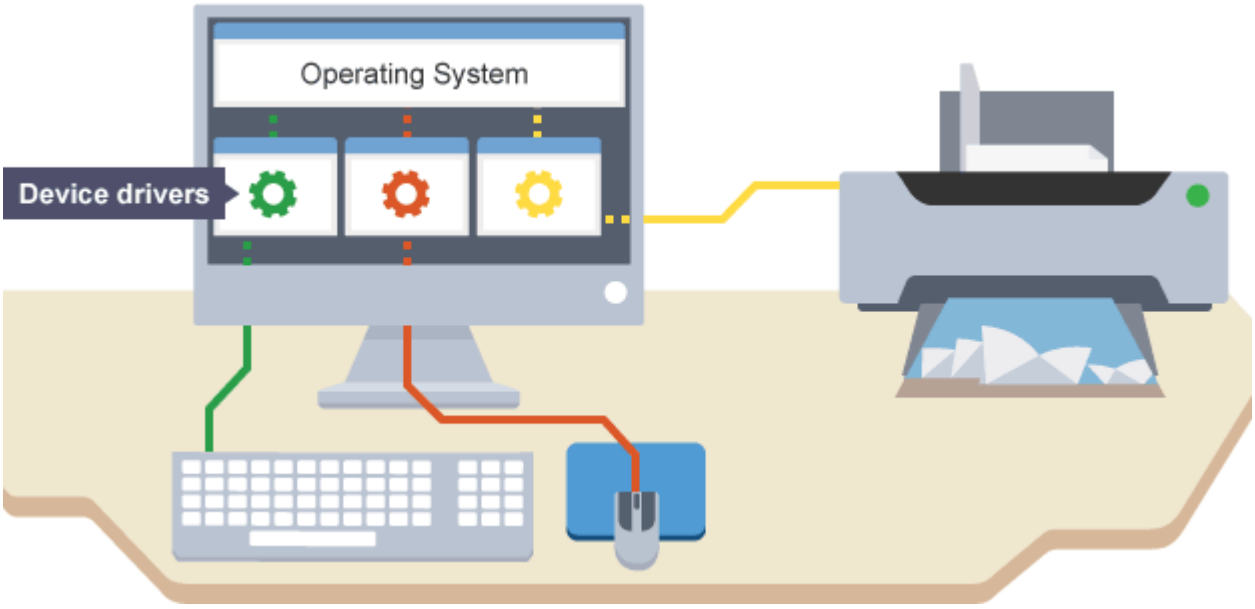
→ A device controller maintains local buffer storage and a set of special- purpose registers.

Device driver function:

The operating system calls the driver, and the driver drives the device.




User Program
Operating System
Device Driver
Device Driver
Device Driver
Device Controller
Device Controller
Device Controller

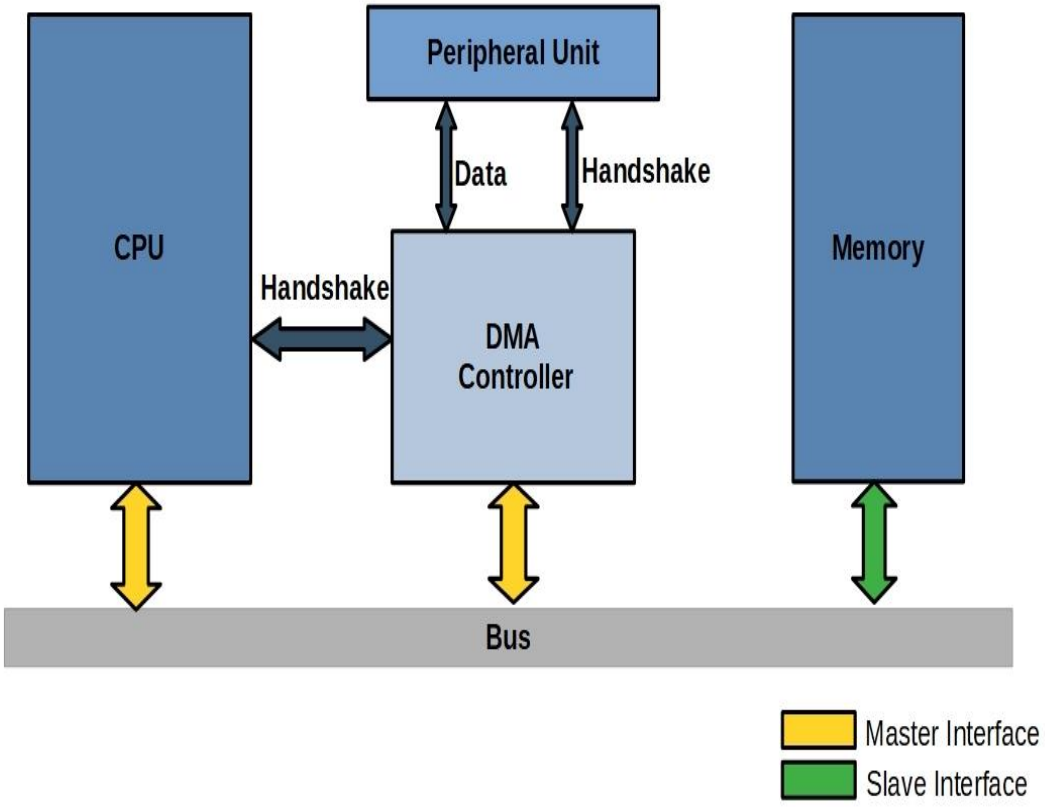

Operating System
Device drivers

2.4 DMA (direct memory access) structure

1- Used for high-speed I/O devices.

2- Transfers **blocks** of data from buffer storage directly to main memory without CPU intervention.

3- Only one interrupt is generated per **block**, rather than one interrupt per **byte**.



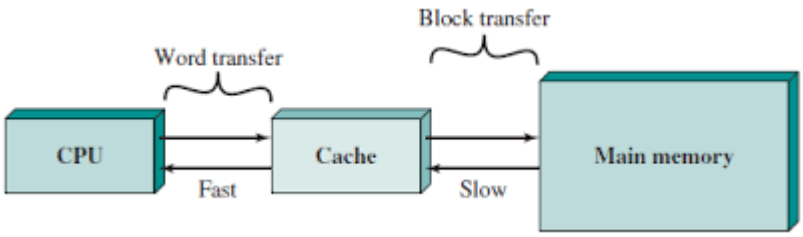
2.5 Storage structure

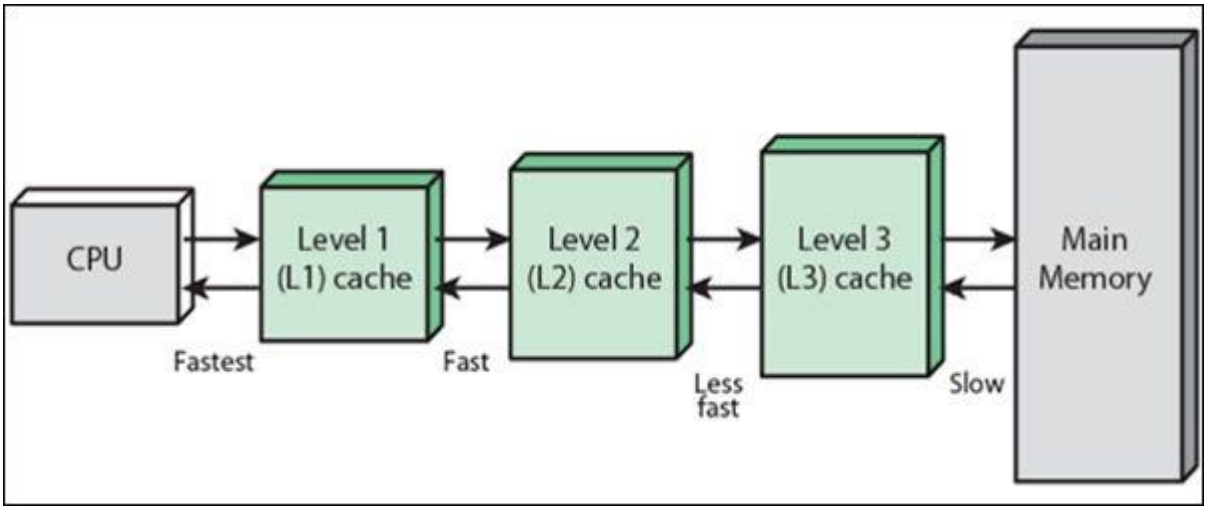
1- Main memory: large storage media that the CPU can access directly.

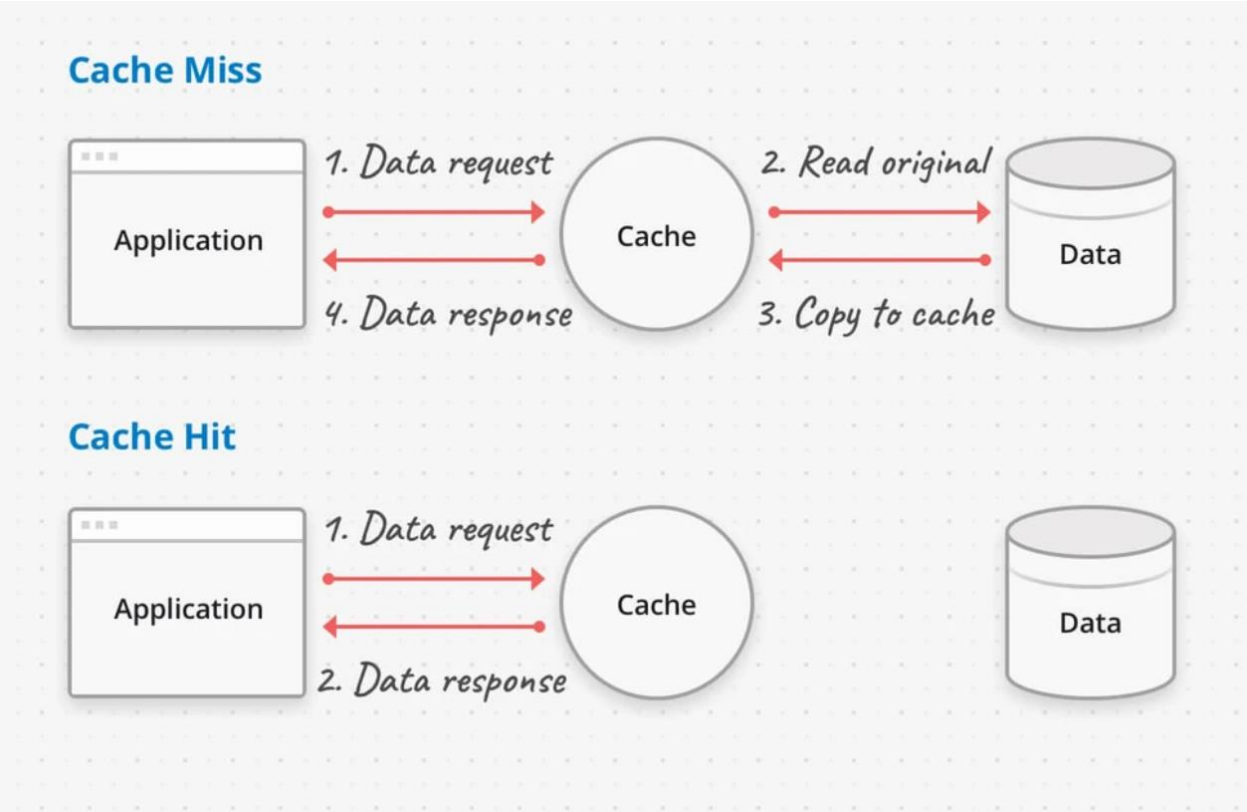
2- **Secondary Storage**: Extension of main memory that provides:

1- large, and 2- **nonvolatile** storage capacity.

3- **Caching**: faster storage system.






Cache Miss
Application
1. Data request
Cache
2. Read original
Data
4. Data response
3. Copy to cache
Cache Hit
Application
1. Data request
Cache
Data
2. Data response

2.5.1 Storage systems factors organized in hierarchy

1- Speed **2- cost** **3- capacity**

2.5.2 Storage-Device Hierarchy

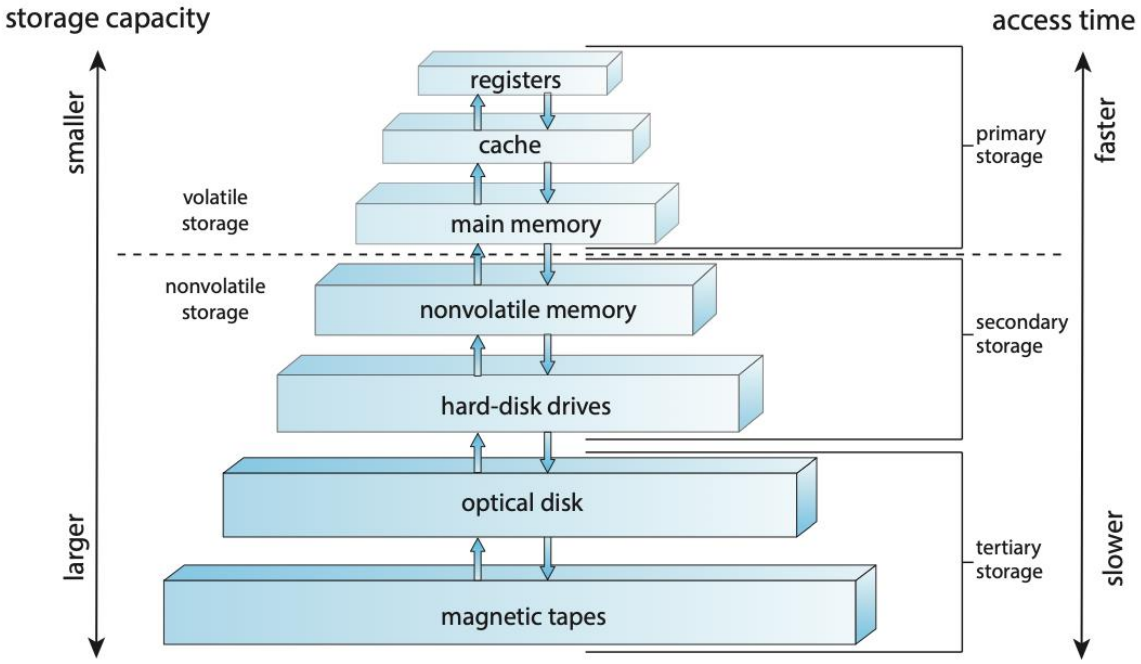


Figure 1.6 Storage-device hierarchy.

- Protection and security are required for the protection of computer resources such as the CPU, memory, etc.

Protection and security requires that computer resources such as **CPU**, **softwares**, **memory** etc. are protected. The system must be protecting against unauthorized access, viruses, worms etc.

2.6 Hardware Protection

To **improve** system utilization, the O/S share system resources among several programs simultaneously (Multi programming put several programs in memory at the same time).

This sharing create both **improve utilization** and **increase problems**.

2.6.1 Dual- Mode Operation

To ensure proper operation we must protect the O/S and all programs and their data from malfunctioning program.

Therefore we need two separate modes of operation:

1- User Mode.

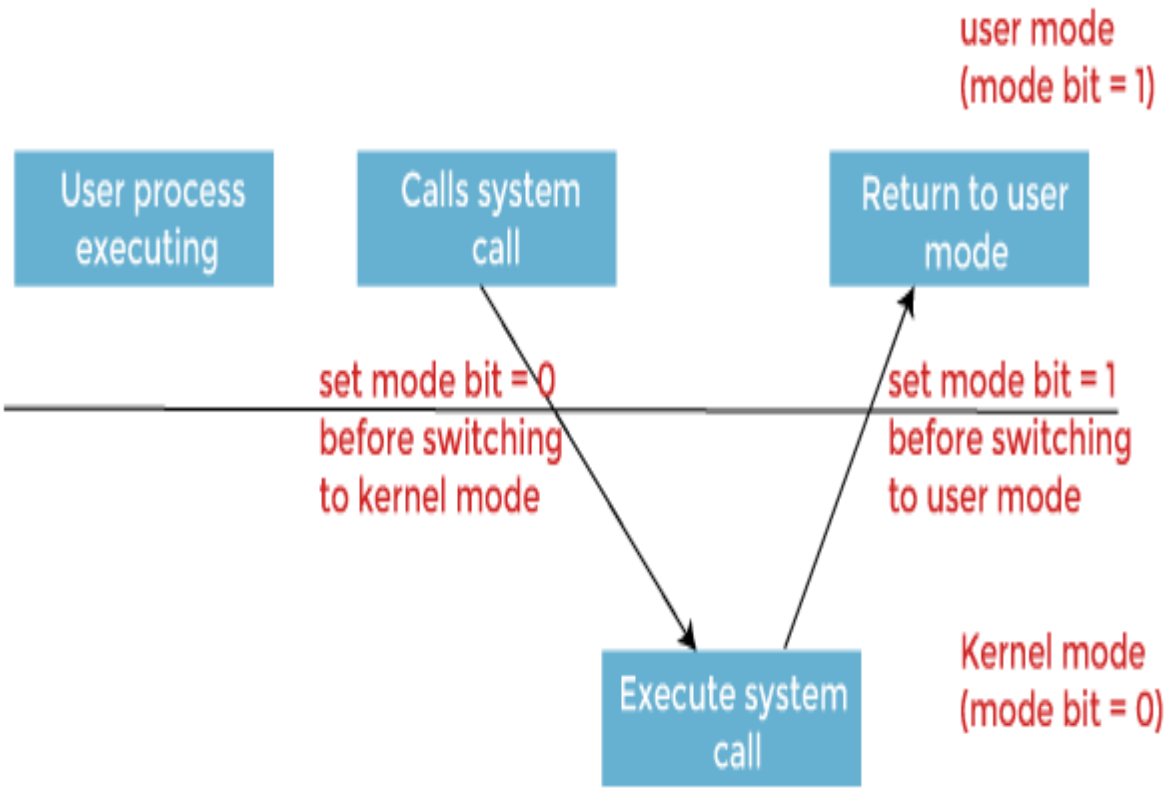
2- Monitor Mode (system mode, supervisor mode, kernel mode).

A **bit** called mode bit is added to the H/W to indicate the current mode:

User mode → bit = **1**

Monitor mode → bit = **0**

The mode bit provides ability to distinguish when system is running user code or monitor mode.



2.6.2 I/O Protection

To prevent a user from performing illegal I/O, I/O instructions designed as **privilege** instructions.

- Privilege instructions are executed only in monitor mode.

Thus users cannot issue I/O instructions directly, they must do it through the O/S.

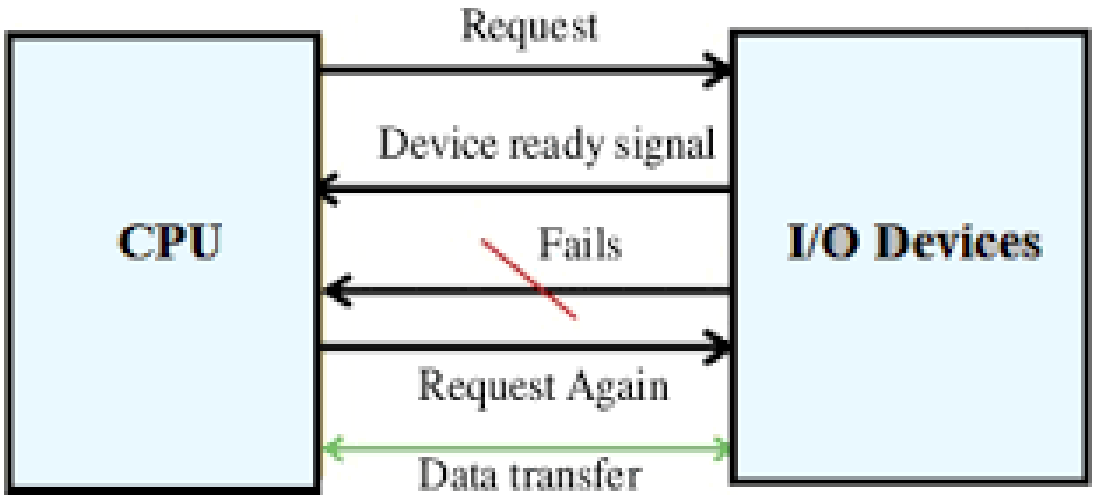


Figure: polling working

2.6.3 Memory Protection

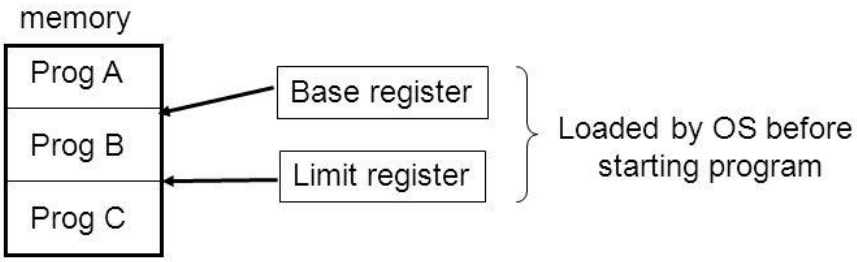
We can provide this protection by using two registers:

1- **Base register** : holds the smallest physical memory address.

2- **Limit register** : contains the size of the range.

Protecting Memory

- Protect program from accessing other program's data
- Protect the OS from user programs
- Simplest scheme is base and limit registers:



- Virtual memory and segmentation are similar

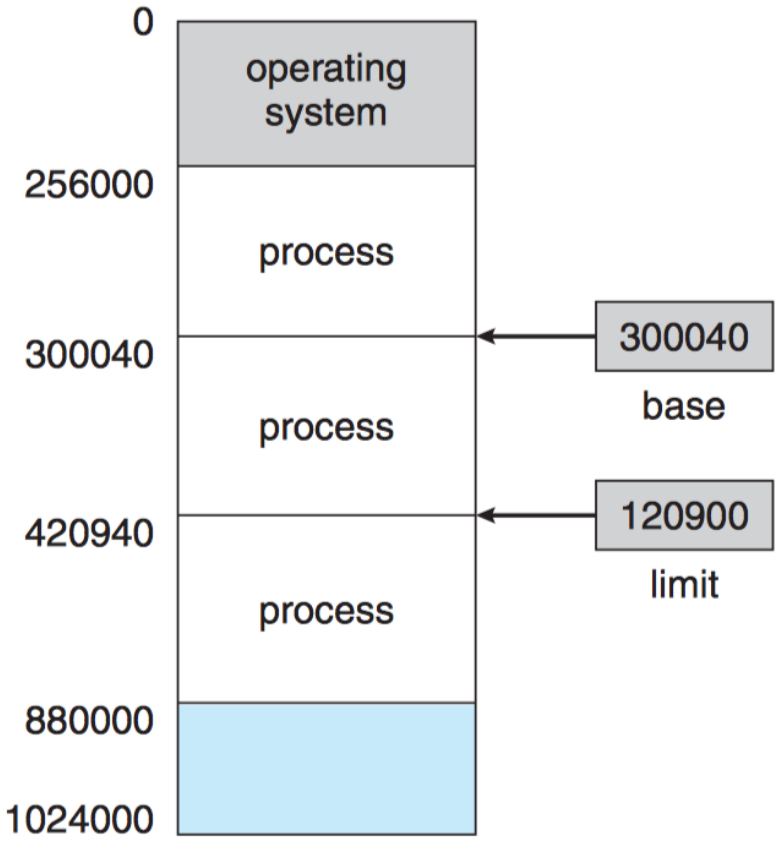
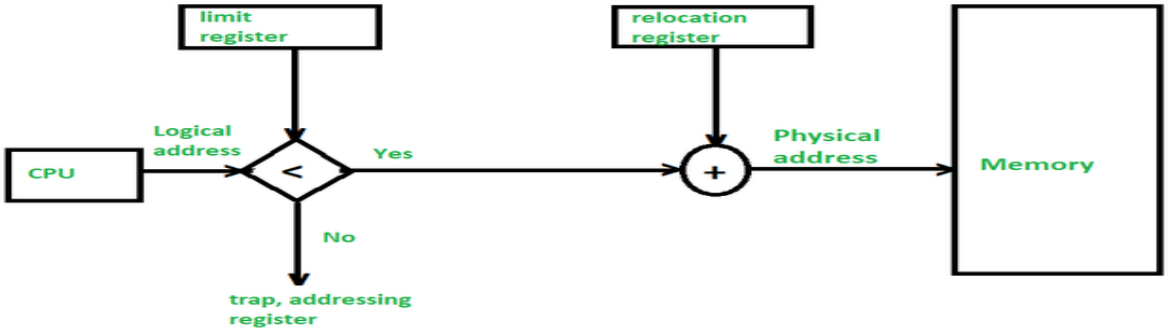
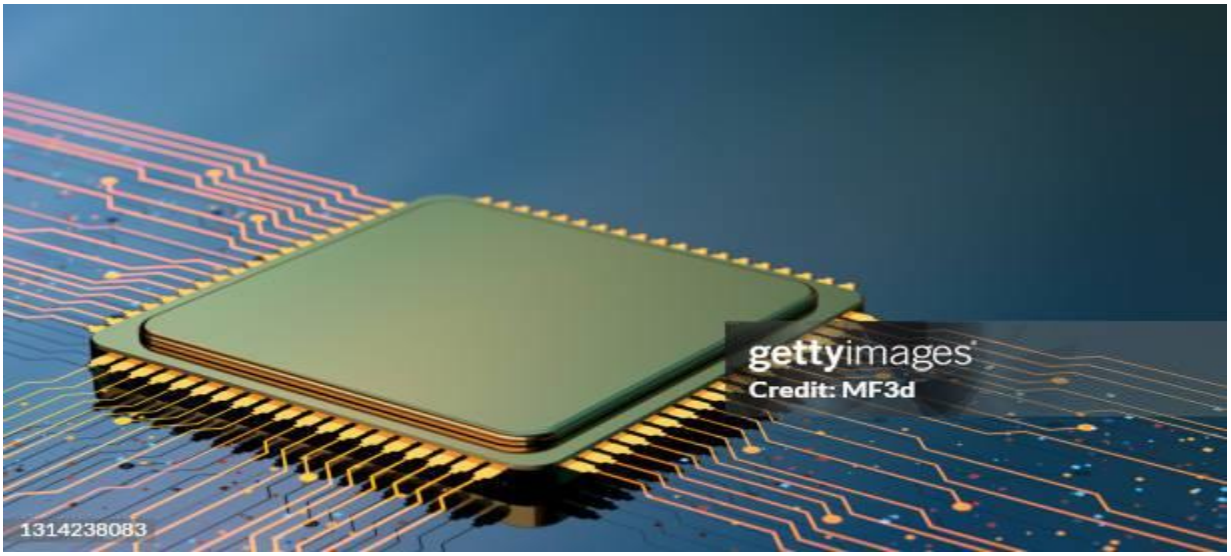


Figure 8.1 A base and a limit register define a logical address space.



2.6.4 CPU Protection

To provide this protection, we must prevent a user program from an infinite loop.



2.7 Operating System Services

2.8 The User View

There are two methods of providing services:

a- System calls.

b- System programs.

2.8.1 System calls

Provides the interface between a running program and O/S.

a- File manipulation.

b- Device manipulation.

c- Communication.

2.8.2 System programs

Solve common problems.

a- File manipulation.

b- Programming languages support.

c- programming loading and execution.

d- Communication.

2.9 The O/S View

1. O/S is event driven program:

If there are no jobs to execute, no I/O devices to service, and no user to respond, the O/S will sit quiet waiting for something to happen.

2. O/S is interrupt driven:

When an interrupt (or trap) occurs the H/W transfer control to O/S.

CHAPTER 2 QUESTIONS

1. What is Bootstrap program ? What are its functions ? **(2016 وزاري)**

2. Draw the Storage-device Hierarchy? What are the factors that affect the organization in a hierarchy ? (2016 وزاري).

3. Explain how the Dual-Mode operation protect the Hardware? (وزاري) 2016

4. Explain Memory protection with drawing. (2016 وزاري)

5. What is DMA ? What is its function?

6. What is Kernel (nucleus)? Why its ordinary maintained in primary storage?

(2002 وزاري)

7. What is Shell?