Lecture 1 – Operating Systems Basics

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THE UNIVERSITY OF WAIKATO
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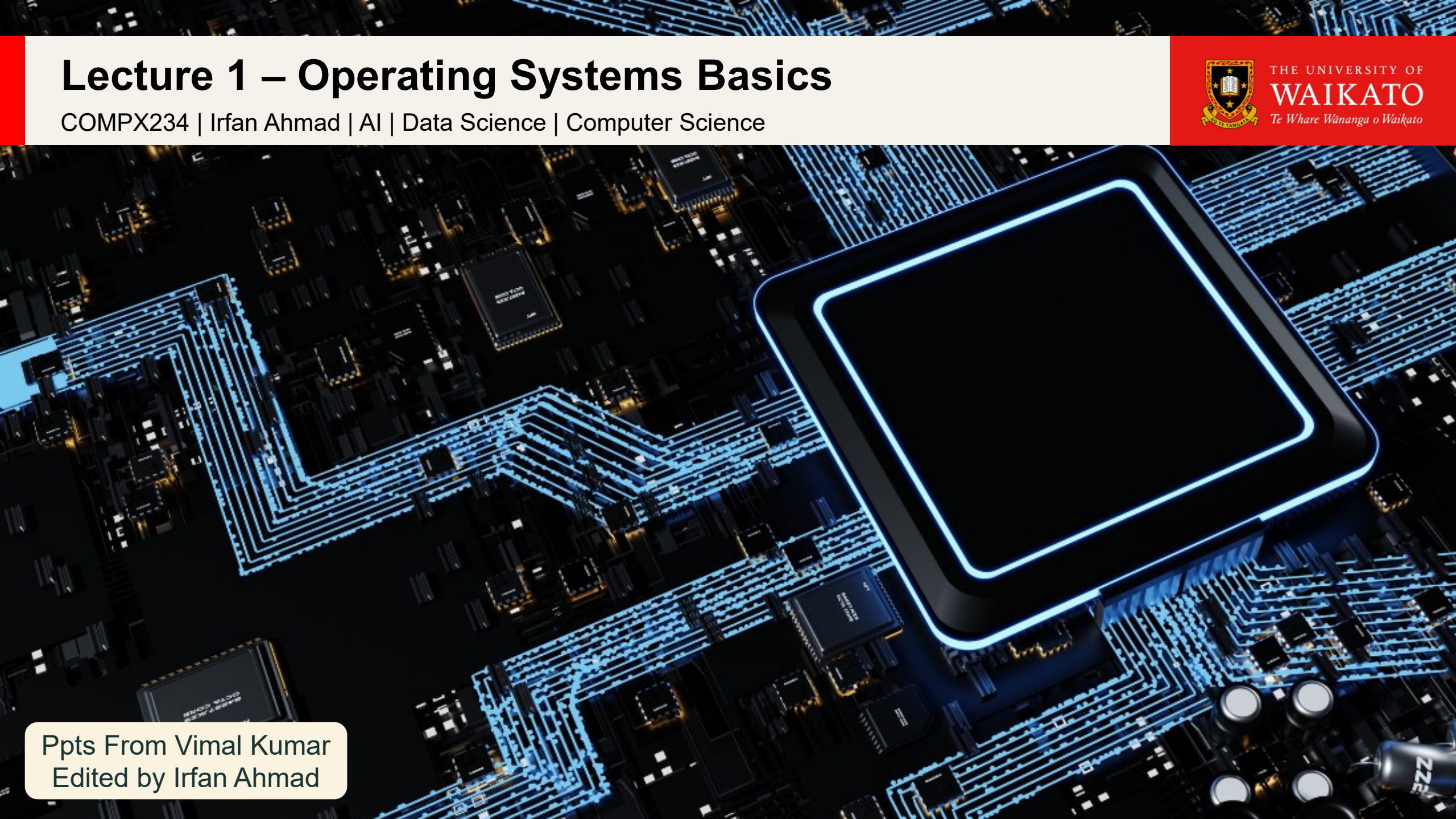
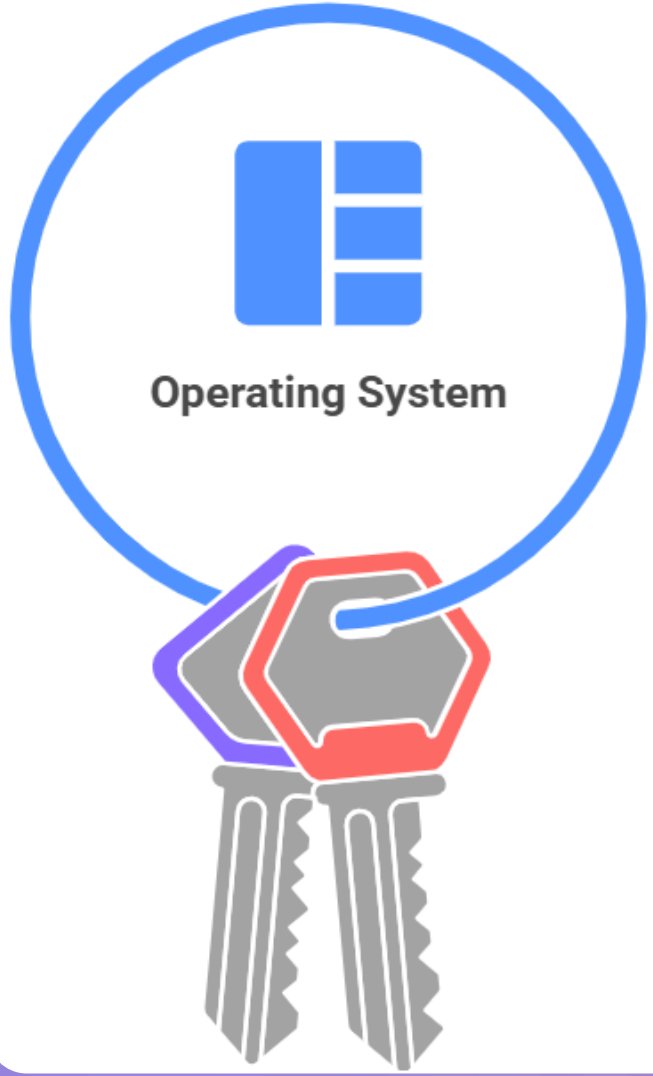


Ppts From Vimal Kumar
Edited by Irfan Ahmad

Outlines



OS Introduction

Provides a foundational understanding of operating systems.

OS Subsystems

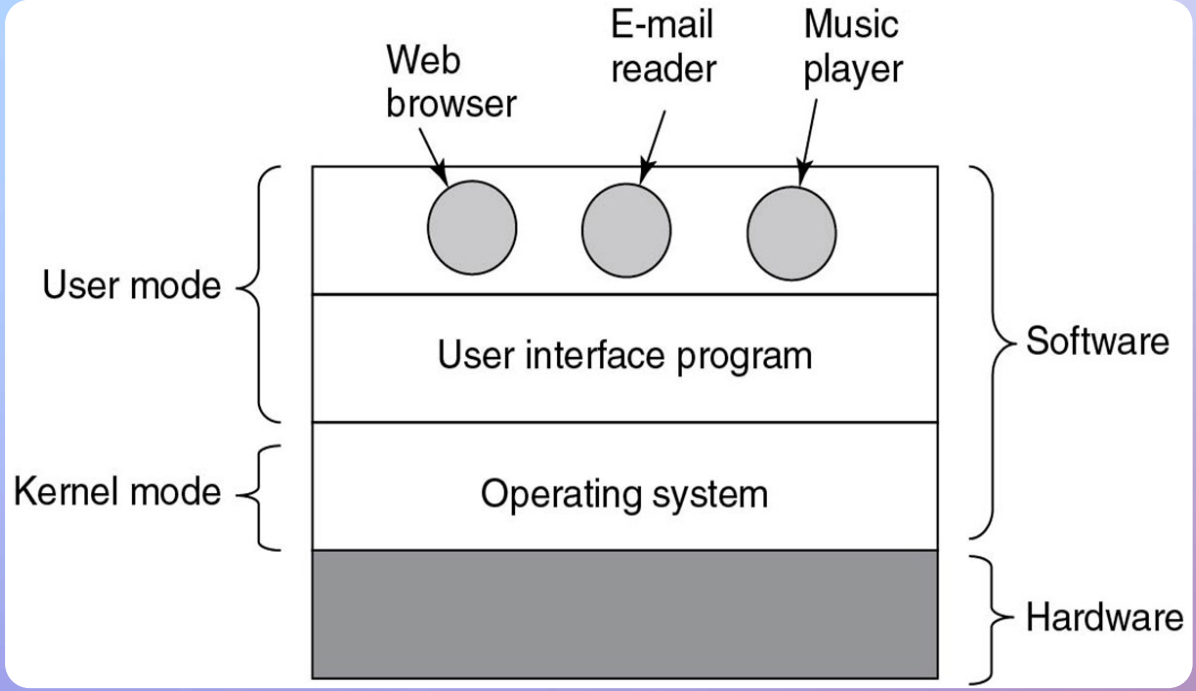
Details the specialized components that make up an OS.

Introduction to Operating System

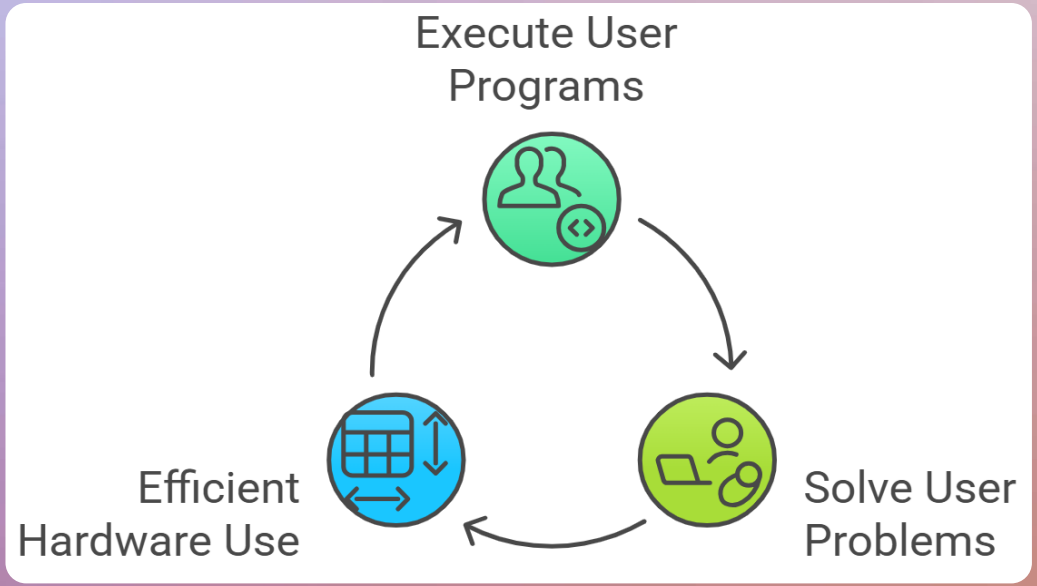
What is an Operating System?

What is an Operating System?

- A **program** that **acts as an intermediary** between a **user of a computer** and the **computer hardware**.



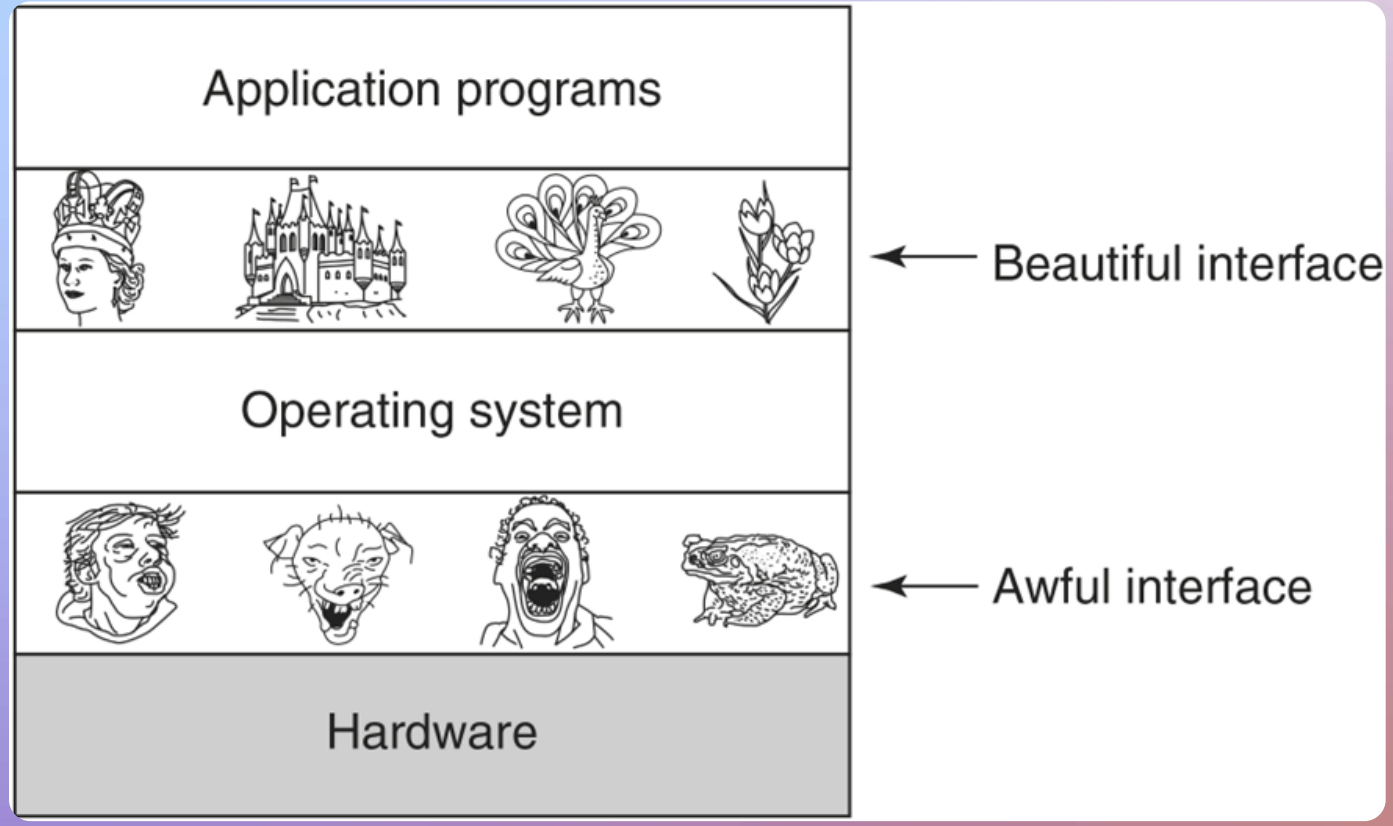
Where the operating system fits in



Goals of operating system

What is an Operating System?

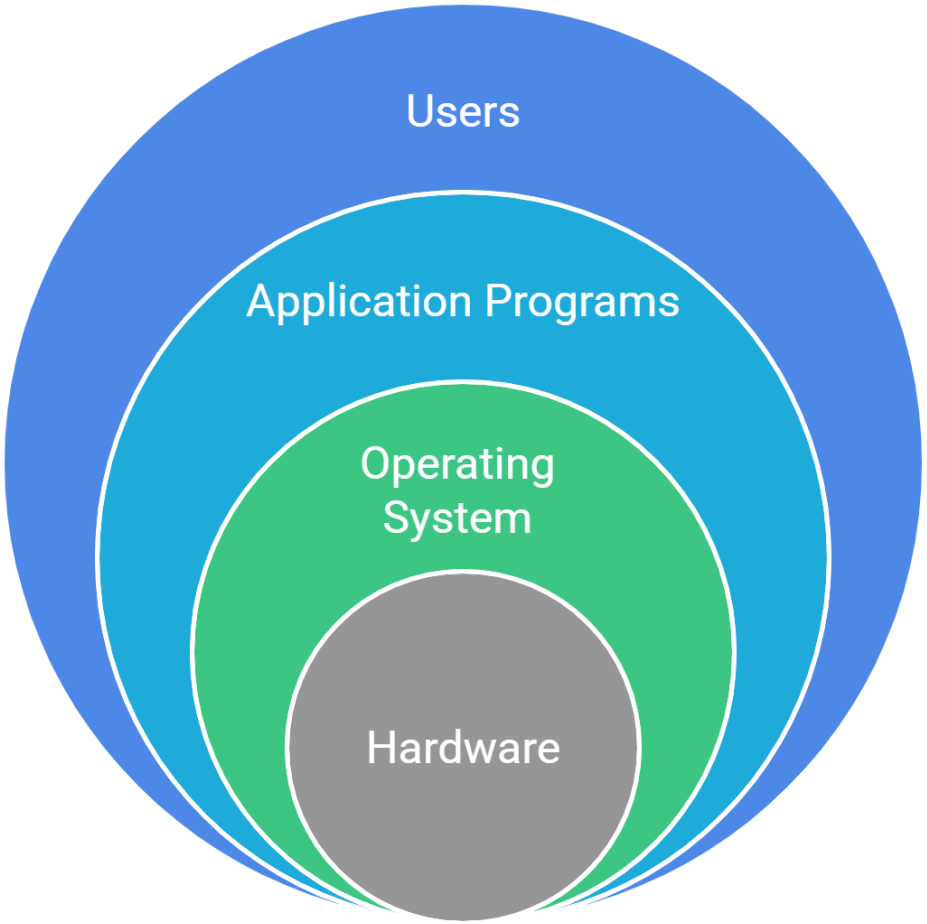
- The **OS hide the details of the hardware** from the programmer and provides the programmer with a convenient interface for using the system.
- **Turn the awful** into the **beautiful**.



Operating systems turn the awful into the beautiful

Computer System Structure

- **Hardware** – provides basic computing resources
  - CPU, memory, I/O devices
- **Operating system**
  - Controls and coordinates use of hardware among various applications and users
- **Application programs** – Software solving user problems
  - Word processors, compilers, web browsers, database systems, video games
- **Users -** Individuals and entities interacting with the system
  - People, machines, other computers



Computer System Structure

What Operating Systems Do

- Depends on the point of view
- Users want convenience, **ease of use** and **good performance**
  - Don't care about resource utilization
- But shared computer such as **mainframe or minicomputer** must keep all users happy
- **Handheld computers** are **resource poor**, optimized for usability and battery life
- Some computers have **little or no user interface**, such as **embedded computers** in **devices and automobiles**

User

Shared Computer

Handheld device

Embedded System

Operating System Definition

- No universally accepted definition
- "Everything a vendor ships when you order an operating system" is a good approximation
  - But varies wildly
- "The one program running at all times on the computer" is the **kernel (Core of the OS)**.
- Everything else is either
  - a *system program* (ships with the operating system) e.g., Task Manager, network managers,

OR

  - an *application program*, e.g., Microsoft Word, Excel.

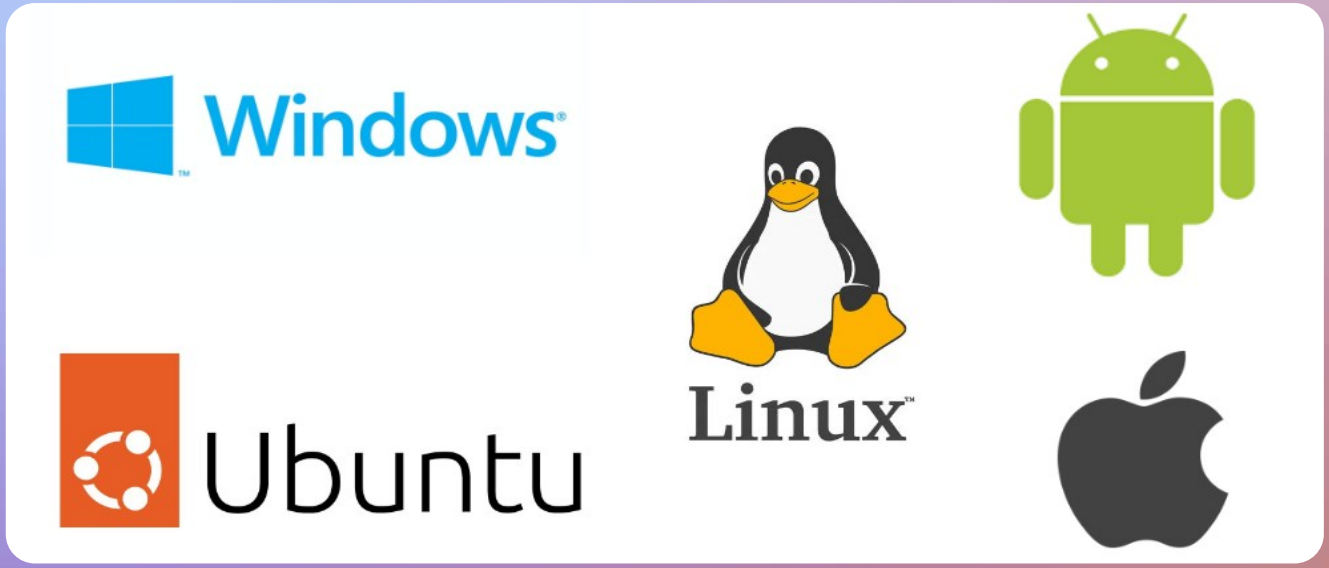
Vendor

System Program

Application Program

Operating System Definition

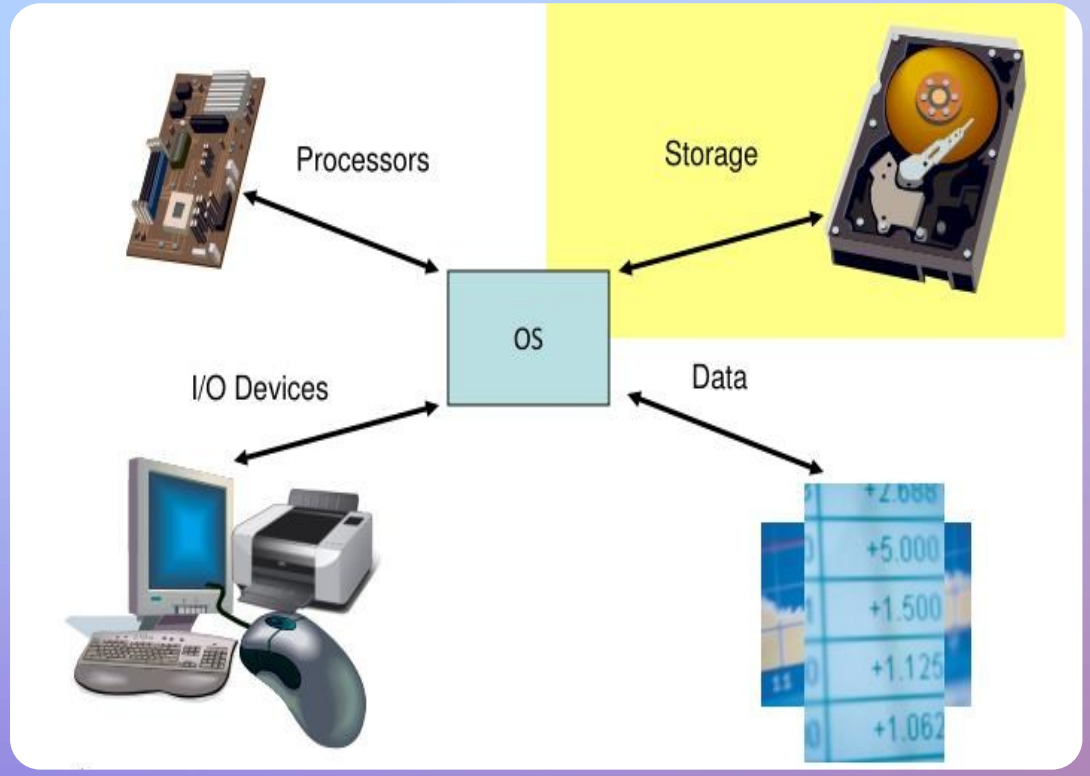
- OS is a **resource allocator**
  - Manages all resources
  - Decides between conflicting requests for efficient and fair resource use
- OS is a **control program**
  - Controls execution of programs to prevent errors and improper use of the computer

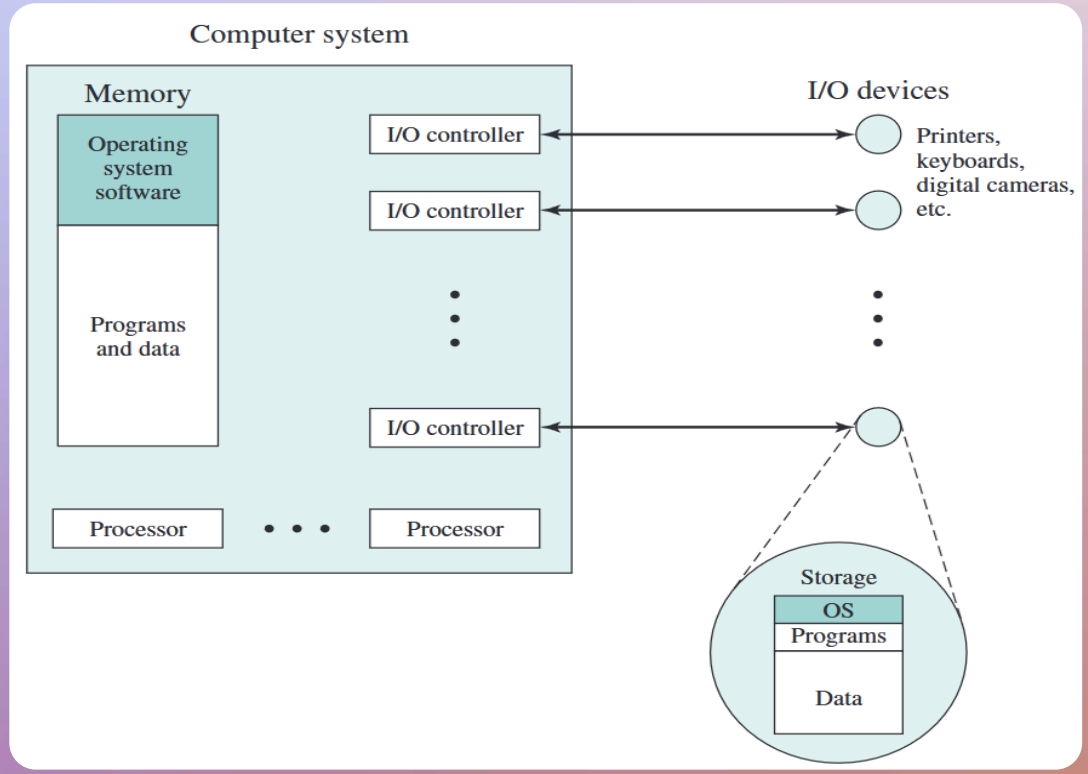


Different Operating Systems

The Operating System as Resource Manager

- **Resource allocation** - When multiple users or multiple jobs running concurrently, resources must be allocated to each of them
  - Many types of resources - CPU cycles, main memory, file storage, I/O devices.



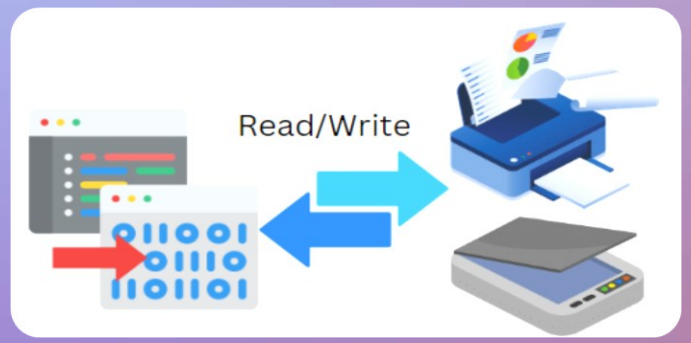


OS managing the resources

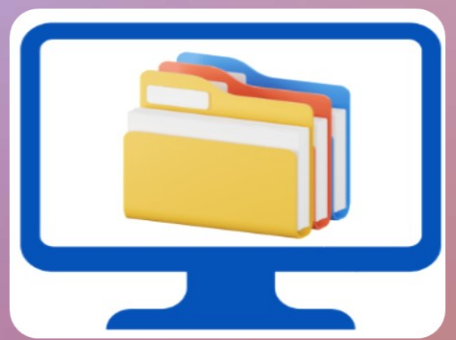
The Operating System as a Control Program (1/3)

- **Program execution** - The system must be able to load a program into memory and to run that program, end execution, either normally or abnormally (indicating error).
- **I/O operations** - A running program may require I/O, which may involve a file or an I/O device.
- **File-system manipulation** - The file system is of particular interest. Programs need to read and write files and directories, create and delete them, search them, list file Information, permission management.
- **Communications** – Processes may exchange information, on the same computer or between computers over a network.

Program execution



I/O operations



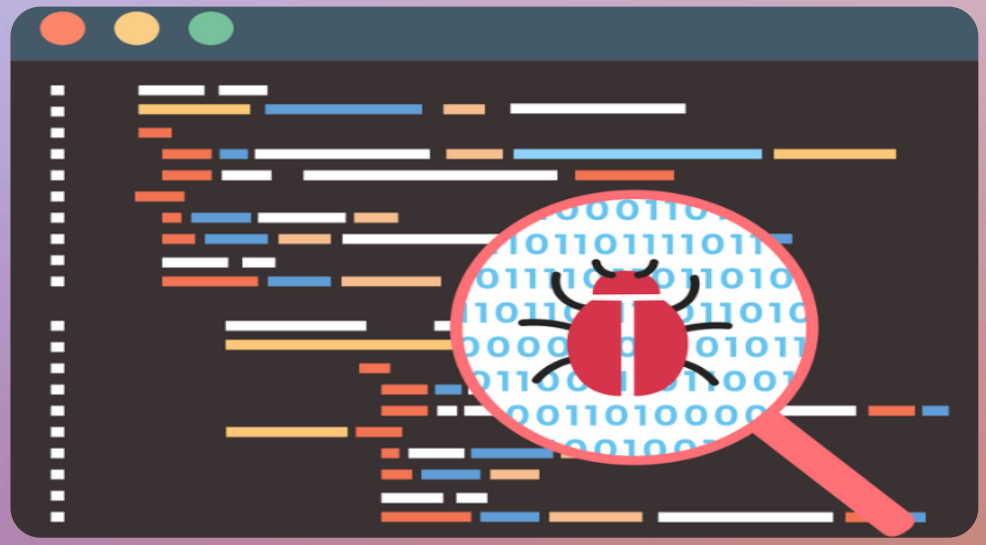
File system

Communication

The Operating System as a Control Program (2/3)

- **Error Detection** – OS needs to be constantly aware of possible errors
  - May occur in the CPU and memory hardware, in I/O devices, in user program
  - For each type of error, OS should take the appropriate action to ensure correct and consistent computing
  - Debugging facilities can greatly enhance the user's and programmer's abilities to efficiently use the system

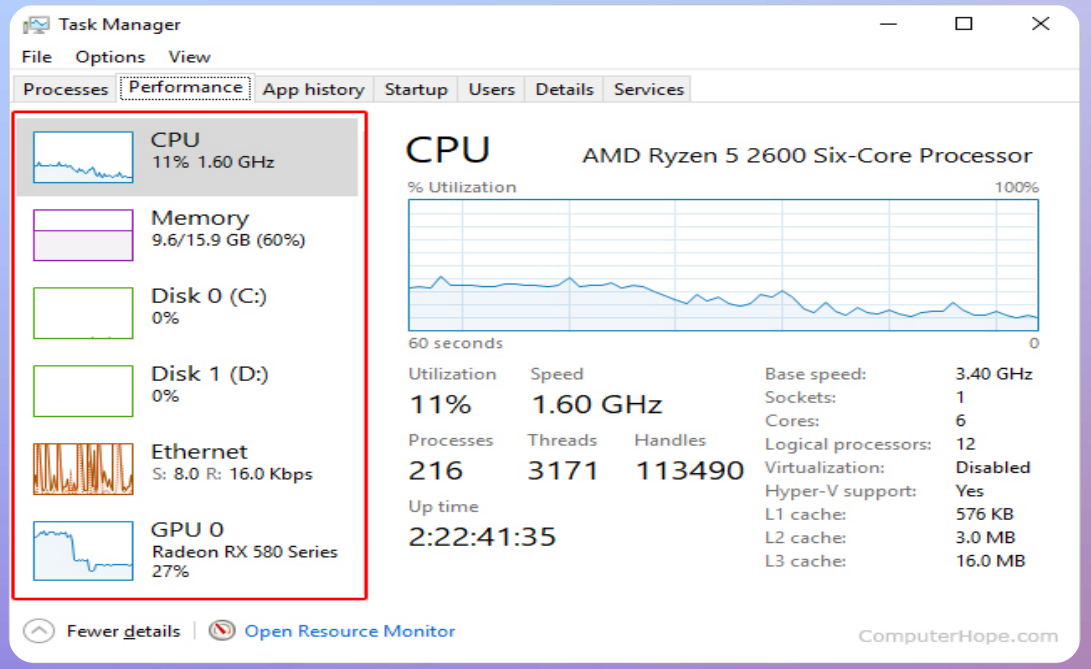
Bugs



Debugging

The Operating System as a Control Program (3/3)

- **Accounting** - To keep track of which users use how much and what kinds of computer resources
- **Protection and security** - The owners of information stored in a multiuser or networked computer system may want to control use of that information, concurrent processes should not interfere with each other



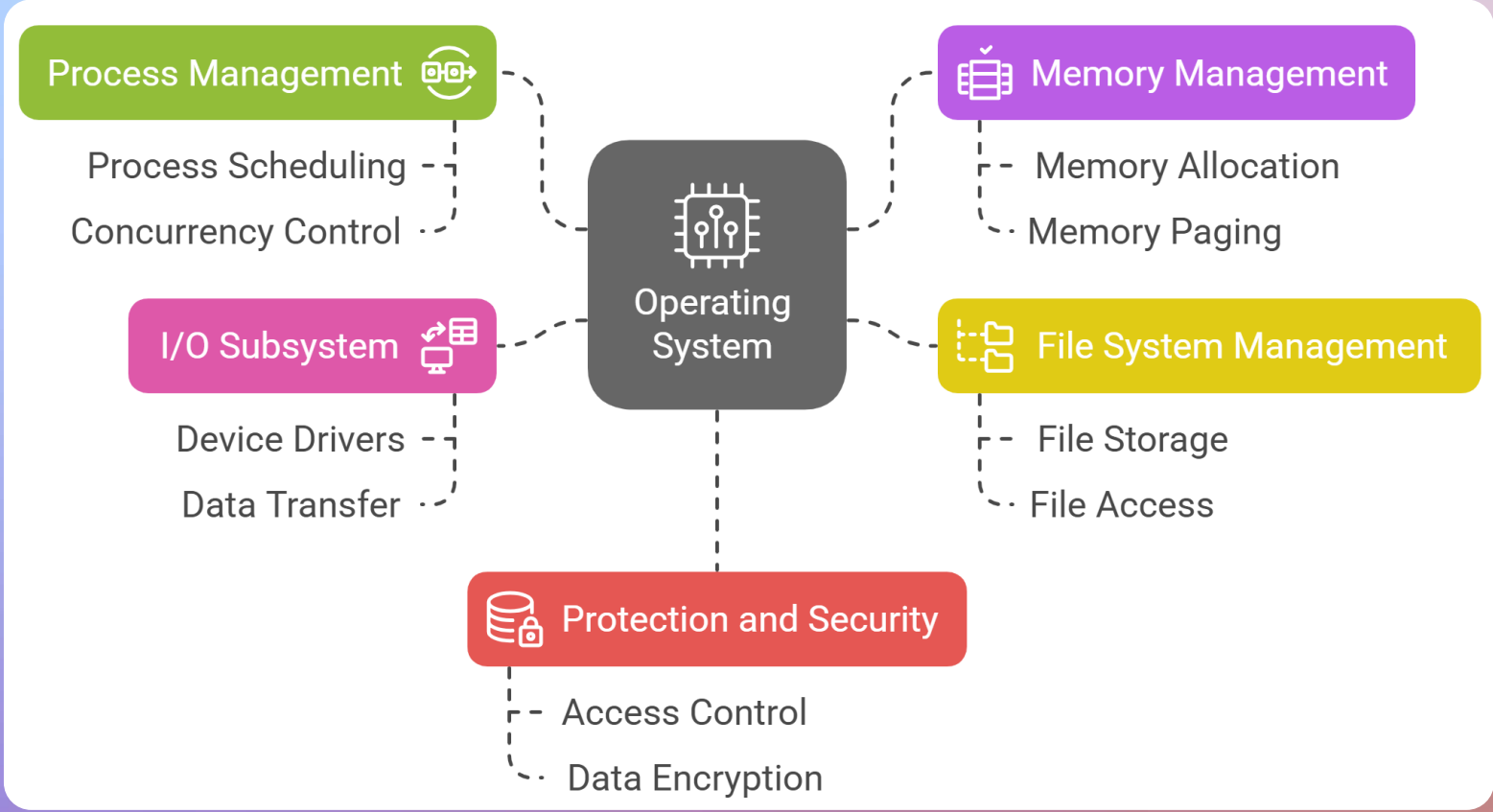
Accounting to keep track of computer resources

Protection and security

OS Subsystems

OS Subsystems

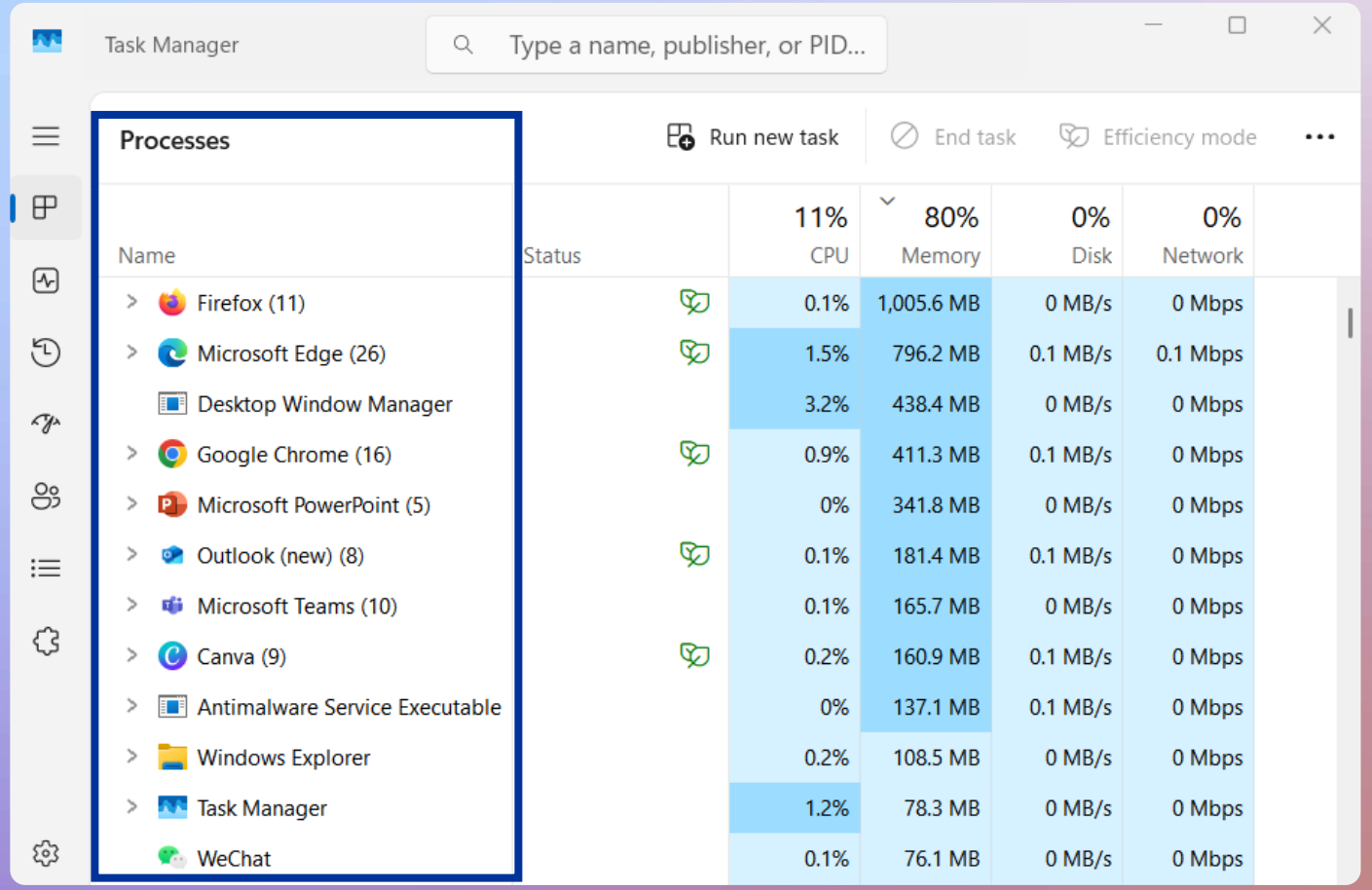
- An operating system is a **resource manager**.
- The operating system must manage the resources such as **system's CPU, memory space, file-storage space, and I/O devices.**



Different OS subsystems

Process Management

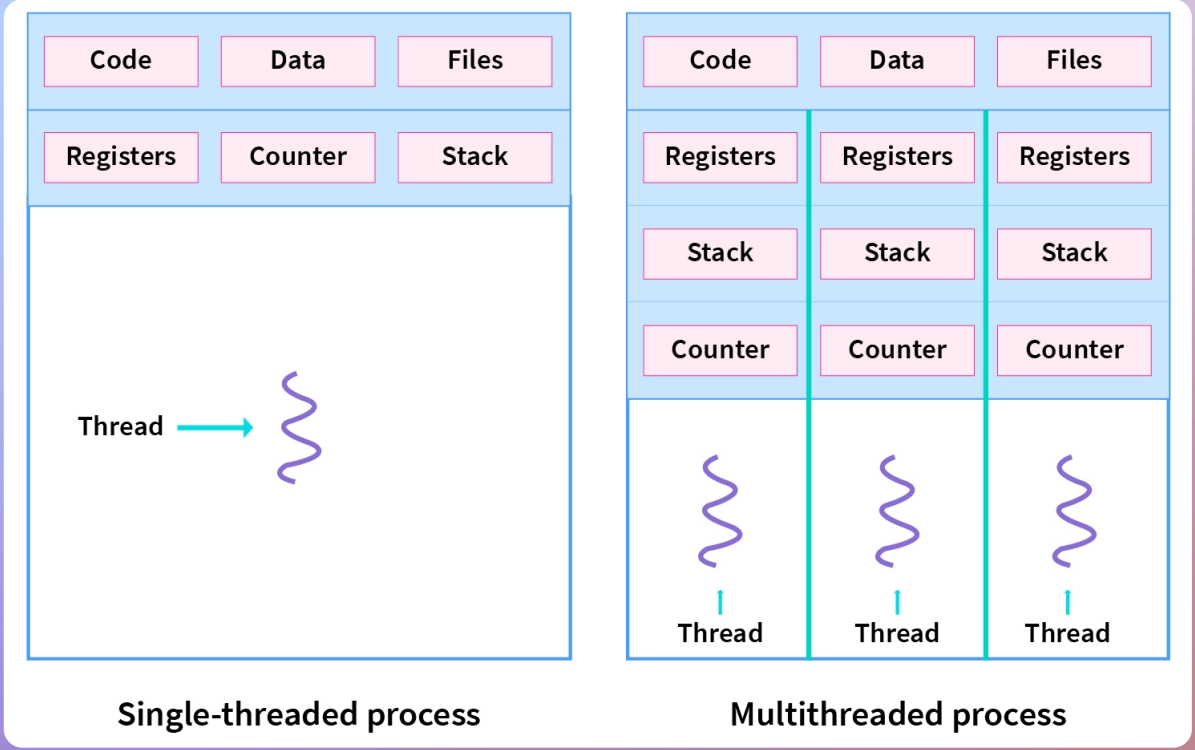
- ***A process is a program in execution***. It is a unit of work within the system. Program is a **passive entity;** process is an **active entity.**



Examples of different processes in OS

Process Management

- 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

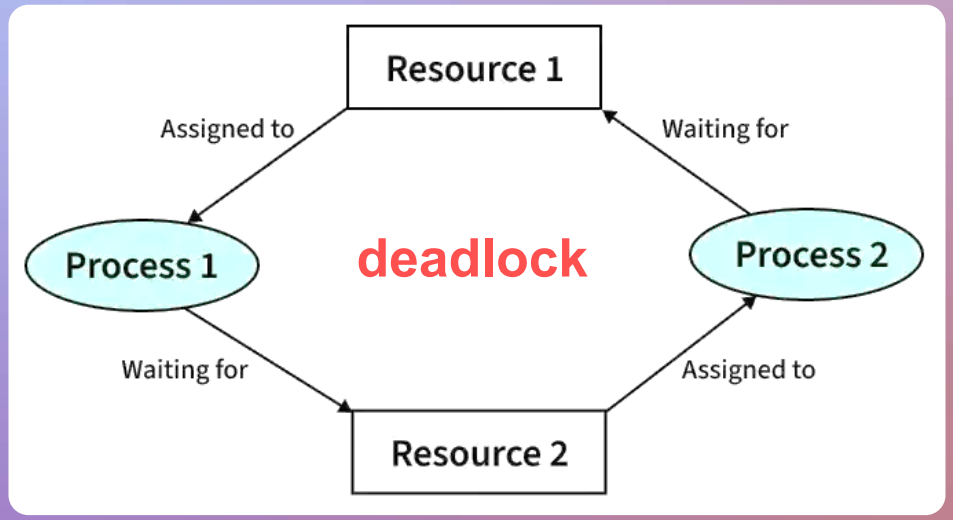


Single-thread vs multithreaded process

Process Management

- 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 deadlock handling

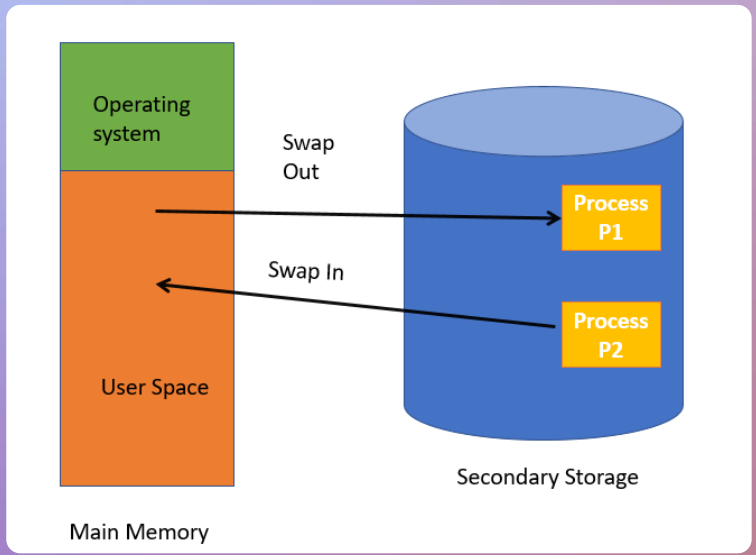
Example of deadlock



Memory Management

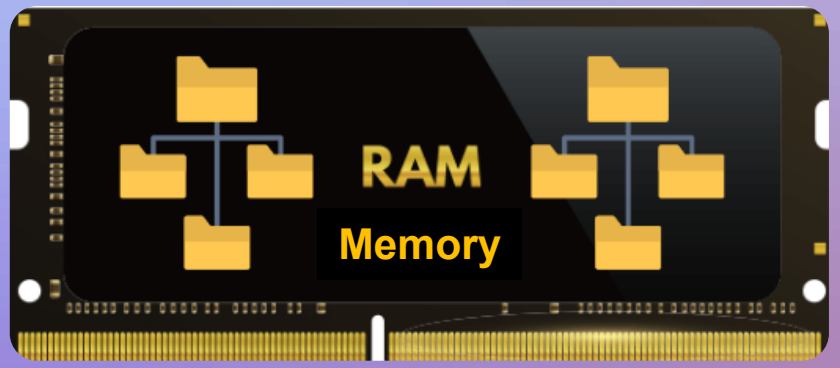
- To execute a program all (or part) of the instructions must be in memory.
- All (or part) of the data that is needed by the program must be in memory.
- The **operating system** performs the following **memory management activities**:
  - Keeping track of which parts of memory are currently being used 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

Example of memory management



File System Management

- **File:** abstraction of (possibly) real storage device (e.g., disk)
- Files usually organized into directories
- Access control on most systems to determine who can access what
- OS **file system management 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



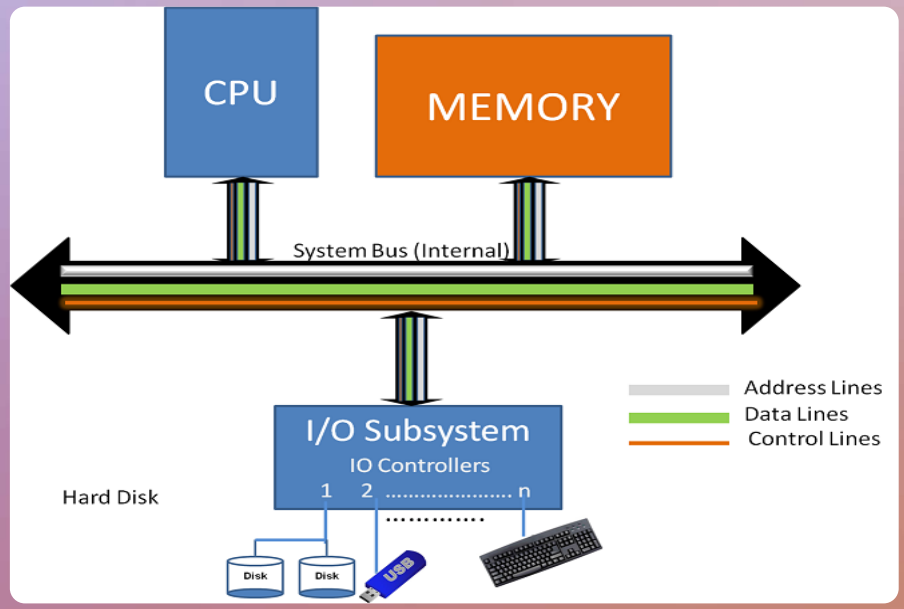
Files in memory

Access control to files

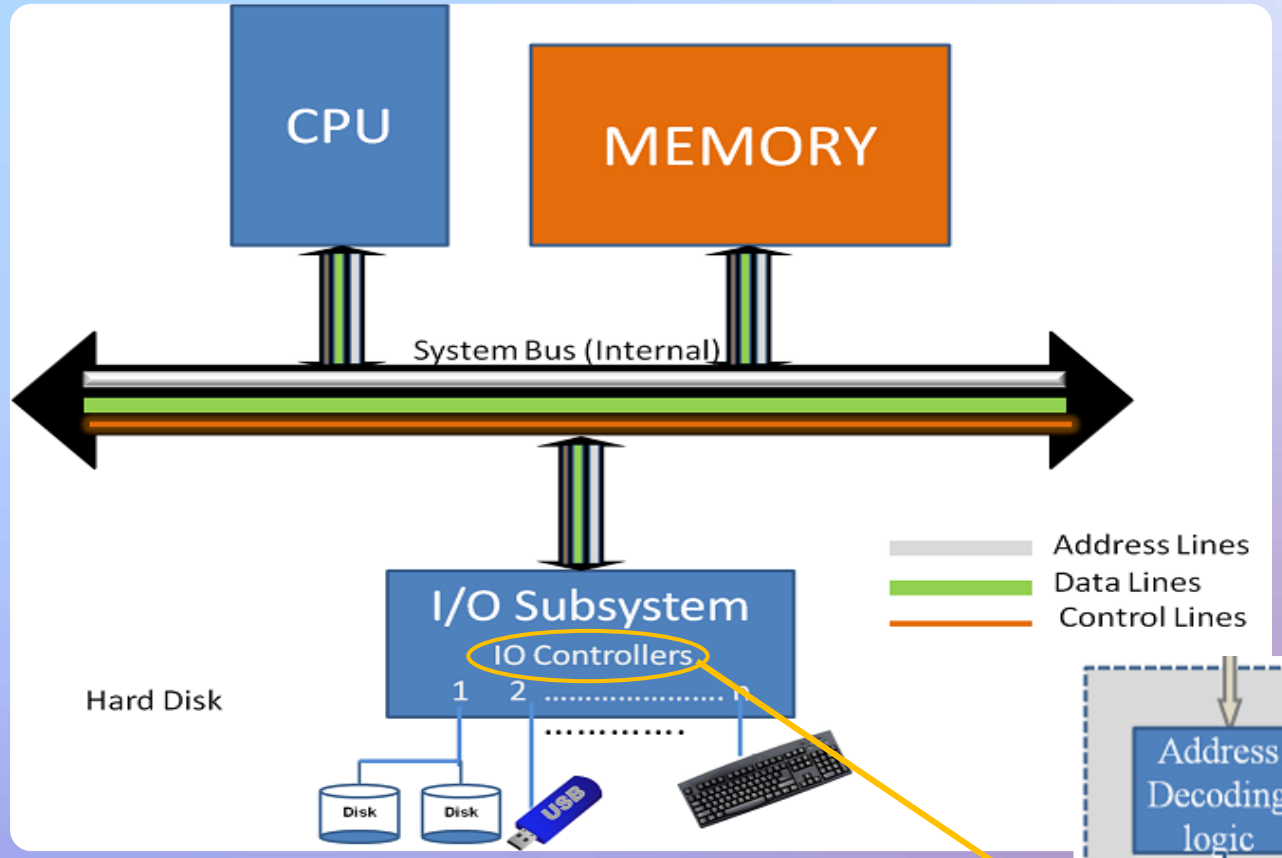
I/O Subsystem

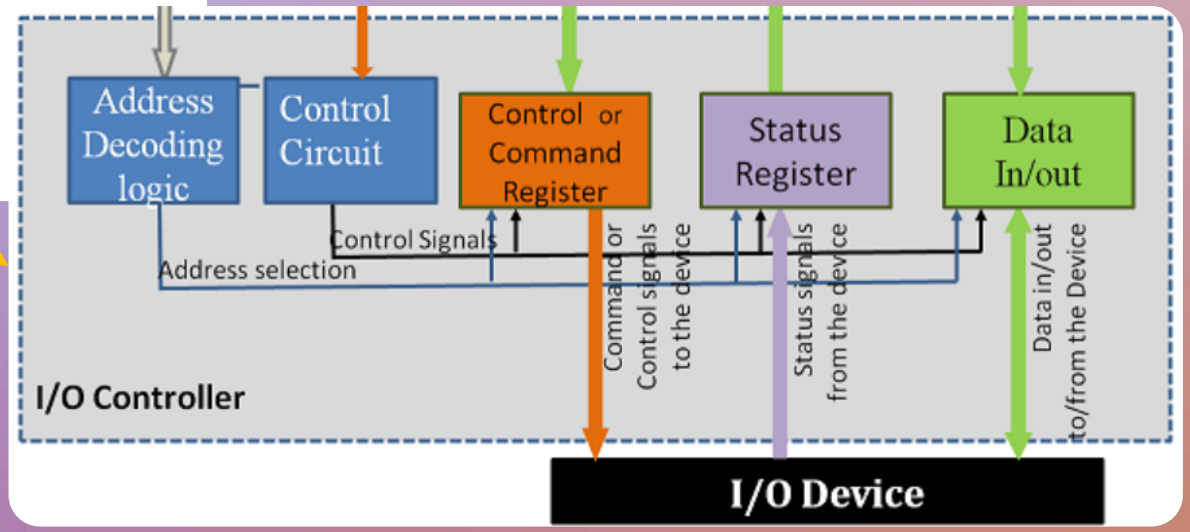
- **I/O subsystem** responsible for
  - Memory management of I/O including **buffering** (storing data temporarily while it is being transferred), **caching** (storing parts of data in faster storage for performance), **spooling** (the overlapping of output of one job with input of other jobs)
  - General device-driver interface
  - Drivers for specific hardware devices

Example of I/O subsystem



I/O Subsystem

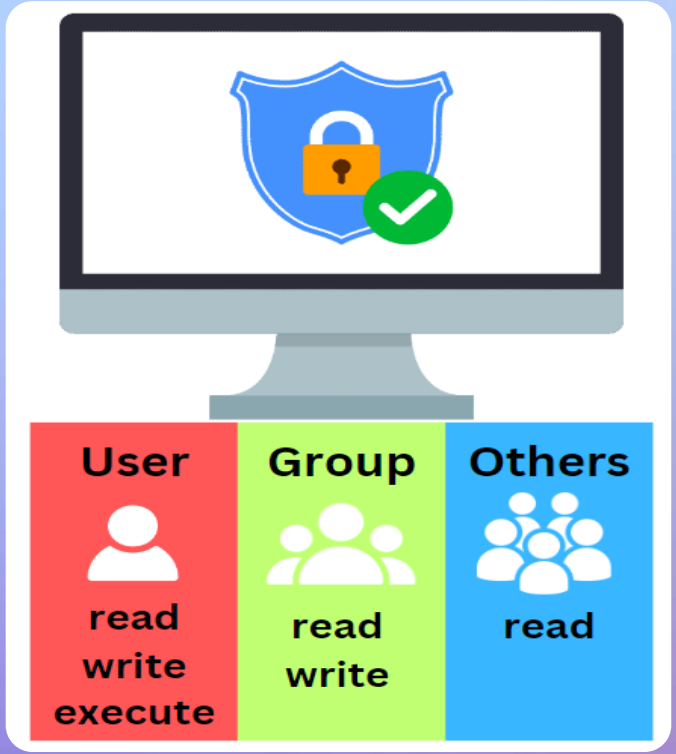




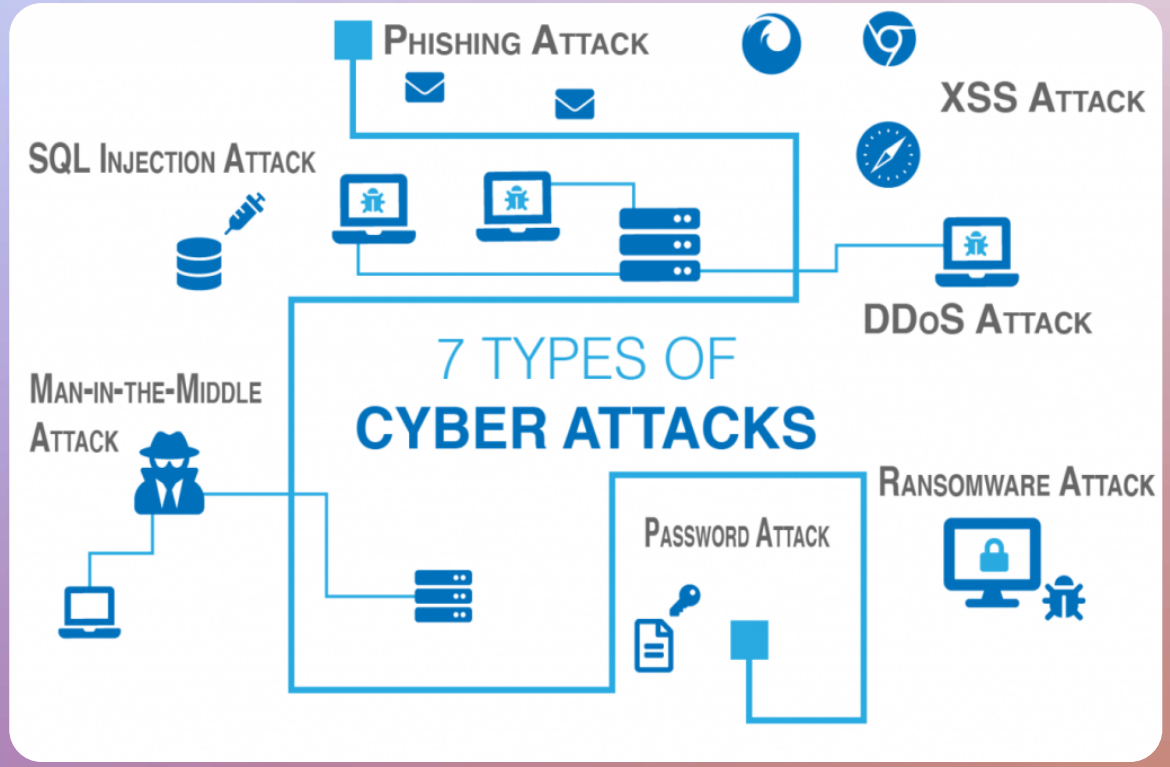
Inside I/O controller

Protection and Security

- **Protection** –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



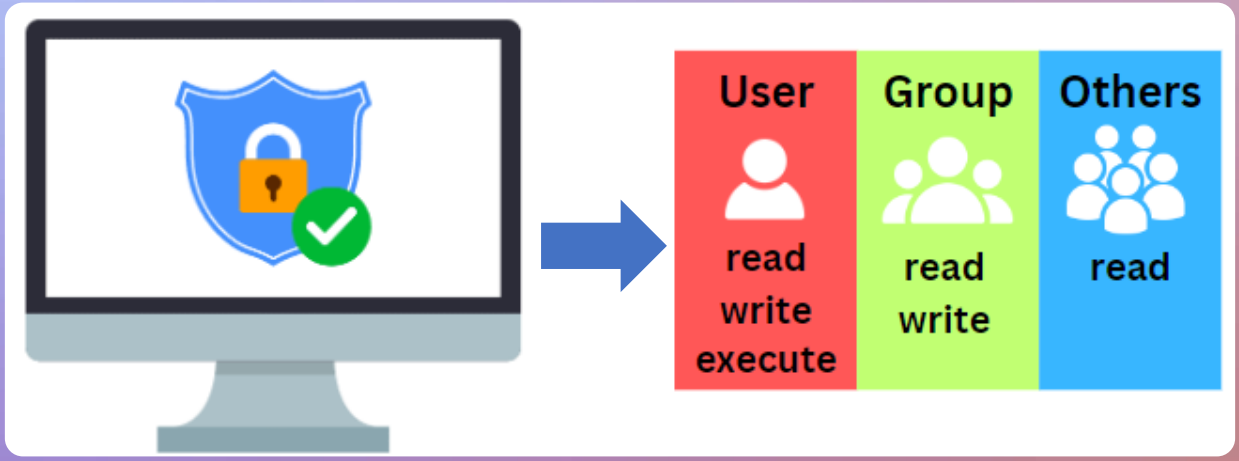
Protection for Controlled Access



Security Against Attacks

Protection and Security

- 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



Users with different permissions

How confident are you in your understanding about operating system and its different subsystems.


Questions are Welcomed