Operating System

Outline

- What is an Operating System?
- Operating System Functions
- Operating System features
- Operating System variants

1. Can you name some operating systems you have used?
2. What do you think an operating system does?

Operating System

- A modern computer system consists of:
  - one or more processors,
  - main memory, disks, printers,
  - a keyboard, a display,
  - network interfaces, and
  - other input output devices,
  - All in all, **a complex system**.
- In order to:
  - Manage all these devices for granting proper function and interaction with each other,
  - To create user friendly environment, and
  - User programs with a simpler interface to the hardware,
- there is a program known as **Operating system.**

What is an Operating System?

- A program that acts as an intermediary between a user of a computer and the computer hardware.
- Operating system goals:
  - Manage computer system resources.
  - Make the computer system convenient to use.
- Use the computer hardware in an efficient manner.
  - To manage and share/multiplex resources in time and space (resource manager).
    - Time multiplexing – E.g. sharing CPU, printer...
    - Resource multiplexing – E.g. sharing main memory

What is an Operating System?...

An operating system is:

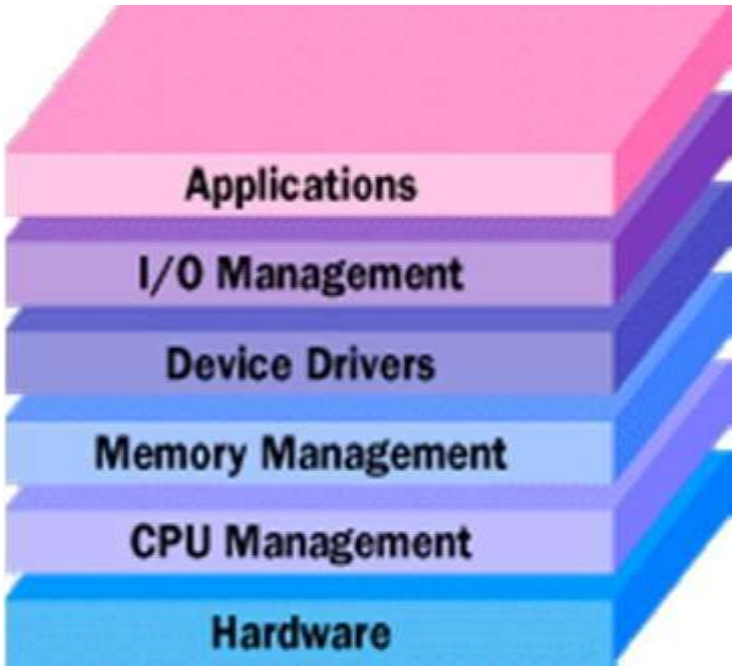
A collection of software components that

- Provides useful abstractions and
- Manages resources to
- Support application programs, and
- Provide an interface for users and programs

Resource allocator – manages and allocates resources.
Control program – controls the execution of user programs and operations of I/O devices.

What does Operating System do?

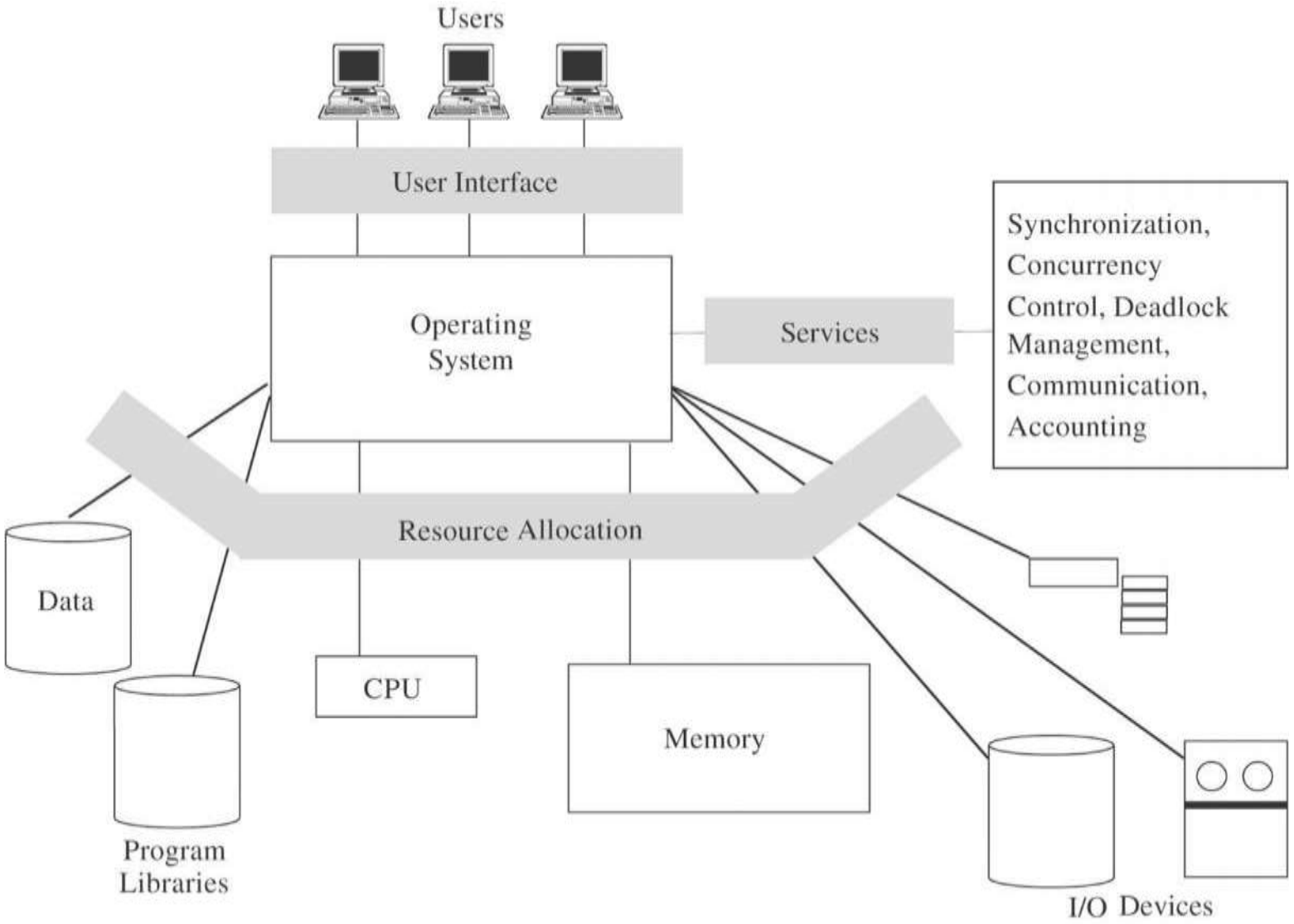
- Manages all the resources in a computer (including processor, memory, i/o devices)
- Provides an interface between the hardware and application software.
- Three layers:
  - Inner layer, computer hardware
  - Middle layer, operating system
  - Outer layer, different software



Operating System Functions

- An operating system's main functions are:
  - Multiprogramming, multiprocessor
  - Computer resource management
  - Provides a user interface
  - Runs software utilities and programs
  - Schedule jobs
  - Provide tools to configure the operating system and hardware
  - Administers user actions and accounts
  - Enforce security measures

Operating System functions



Operating System features

- Authentication of users
  - password, passphrase comparison, biometrics, digital authentication (SSL, CA, PKI, Kerberos, DS)
- Mandatory (enforce multilevel security by classifying the data and users into various security classes) and
- Discretionary Access Control (grant privileges to users)
- Protection of memory
  - user space, paging, segmentations
- File and I/O device access control
  - access control matrix
- Enforcement of sharing resources
  - To preserve integrity, consistency (critical section)

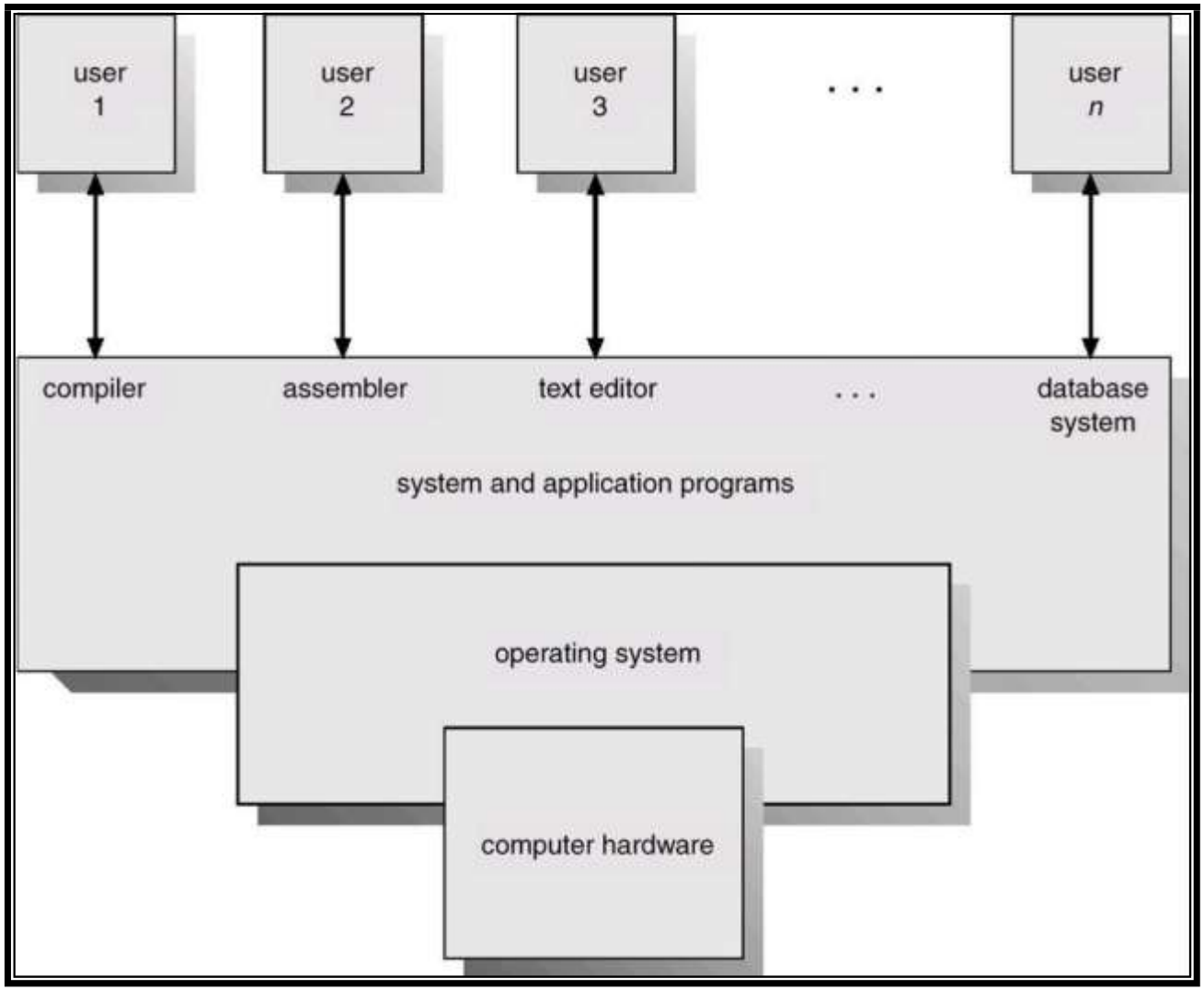
Operating System features…

- Fair service
  - no starvation and deadlock
- Inter-process communication & synchronization
  - Shared variable (e.g, using semaphores)
- Protection of data
  - encryption, isolation
  - …

Computer System Components

1. Hardware – provides basic computing resources (CPU, memory, I/O devices).
2. Operating system – controls and **coordinates** the use of the hardware among the various application programs for the various users.
3. Applications programs – define the ways in which the system resources are used to solve the computing problems of the users (compilers, database systems, video games, business programs).
4. Users (people, machines, other computers).

Abstract View of System Components



Operating System variants

- When you open multiple applications on your computer, how does it handle them?
- Have you ever noticed your computer slowing down when too many programs are running? Why do you think that

1. Batch Operating System

- Executes a series of jobs without user interaction.
- Jobs are collected, grouped, and processed in batches.
- Efficient for large repetitive tasks but lacks real-time interaction
- Used in payroll processing, bank statements, and data processing

Con…

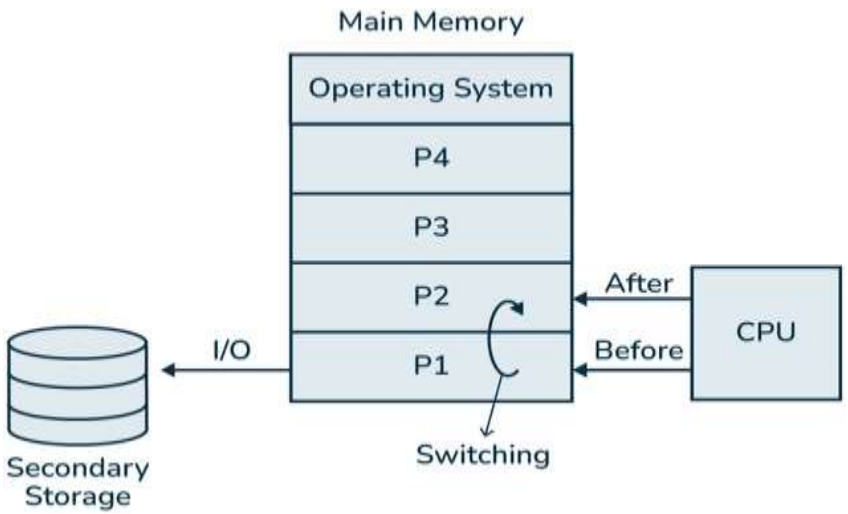
Example: A bank processes all daily transactions at night in one batch rather than processing them in real-time.

2. Multiprogramming Operating System

- Multiple programs are loaded into memory and executed concurrently.
- CPU switches between programs to maximize utilization.
- Reduces idle CPU time but does not provide user interaction.
- Used in **scientific computing** and **large-scale processing**.

Con..

Example : A user runs a compiler while downloading a file in the background on a UNIX system.



3. Multiprocessing Operating System

- Supports multiple processors working together.
- Distributes tasks among processors for faster execution.
- Increases system speed and reliability.
- Used in supercomputers, servers, and high-performance computing.

Os : Linux, Windows Server

Example : A research lab using a supercomputer with multiple processors for complex calculations in climate modeling.

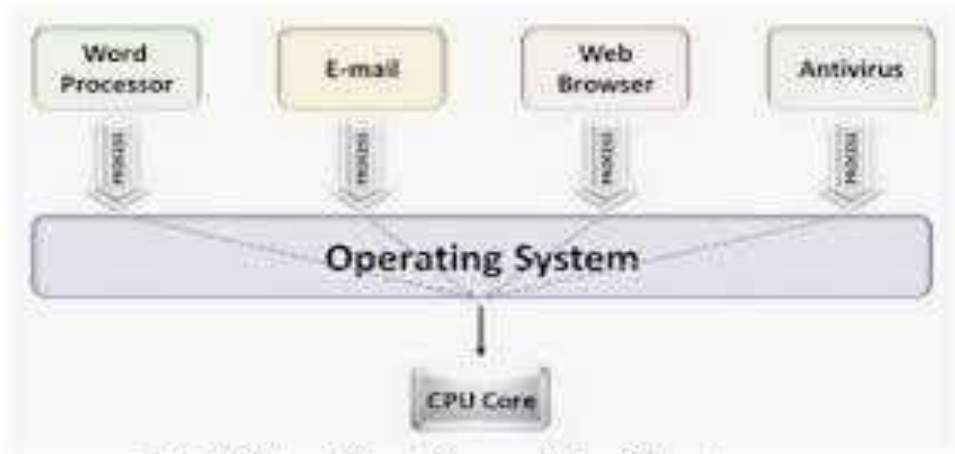
4. Multitasking Operating System

- Allows multiple tasks to run simultaneously on a single CPU.
- Uses time-sharing to switch between tasks efficiently.
- Provides a smooth user experience by running applications in parallel.
- Used in **desktops**, **laptops**, and **mobile devices.**

Con..

Os: Windows, macOS, Linux

Example : A user edits a document in MS Word while listening to music on Spotify and browsing the internet.



Multitasking Operating System

5. Time-Sharing Operating System

- Multiple users share system resources simultaneously.
- Uses time slices to allocate CPU to different users.
- Prevents resource monopolization by any single user.
- Used in mainframes, multi-user environments, and remote servers.

OS: UNIX, Linux with SSH access

Example: University students access a remote UNIX server for coding assignments, each getting a time slot.

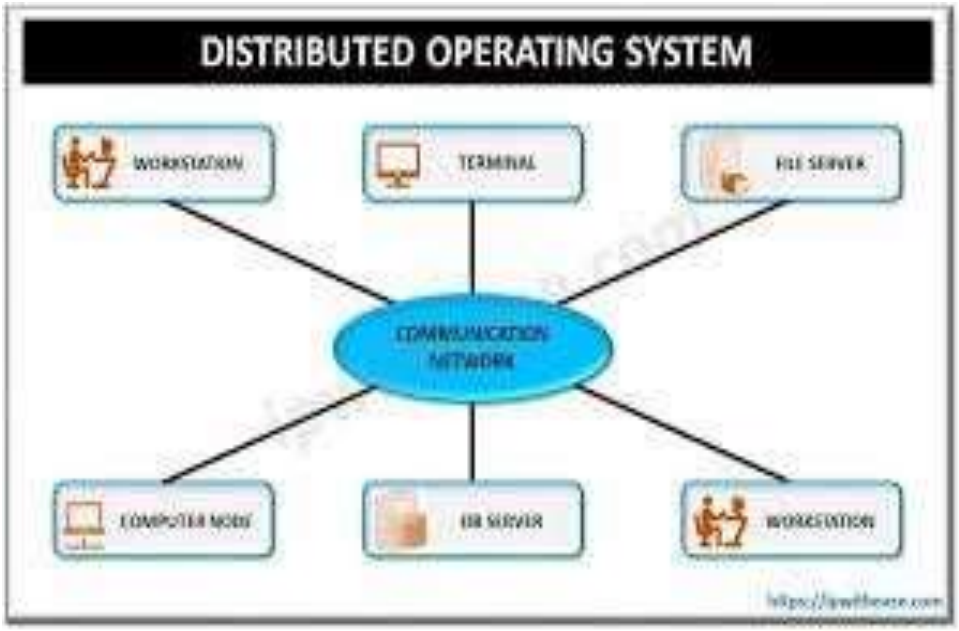
6. Distributed Operating System

- Connects multiple computers to work as a single system.
- Enhances resource sharing and load balancing.
- Offers fault tolerance and better efficiency.
- Used in cloud computing and large-scale networks.

Con..

Os : Google's Borg, Apache Hadoop

Example : A company uses cloud-based distributed OS to store and process customer data across multiple servers worldwide.



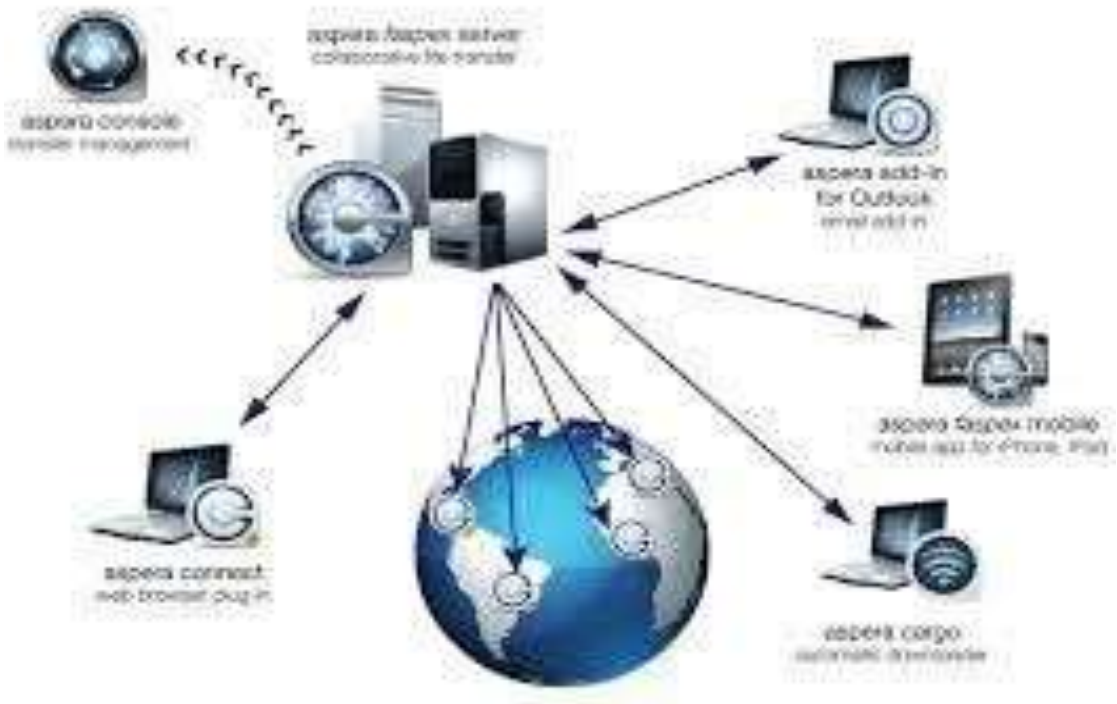
7. Network Operating System

- Manages network resources and allows multiple computers to communicate.
- Provides centralized user management and file sharing.
- Offers security and access control.
- Used in business environments for file and printer sharing.

Con..

Os: Windows Server, Novell NetWare

Example : An office with 50 employees shares files and printers using a centralized network OS.



8. Real-Time Operating System (RTOS)

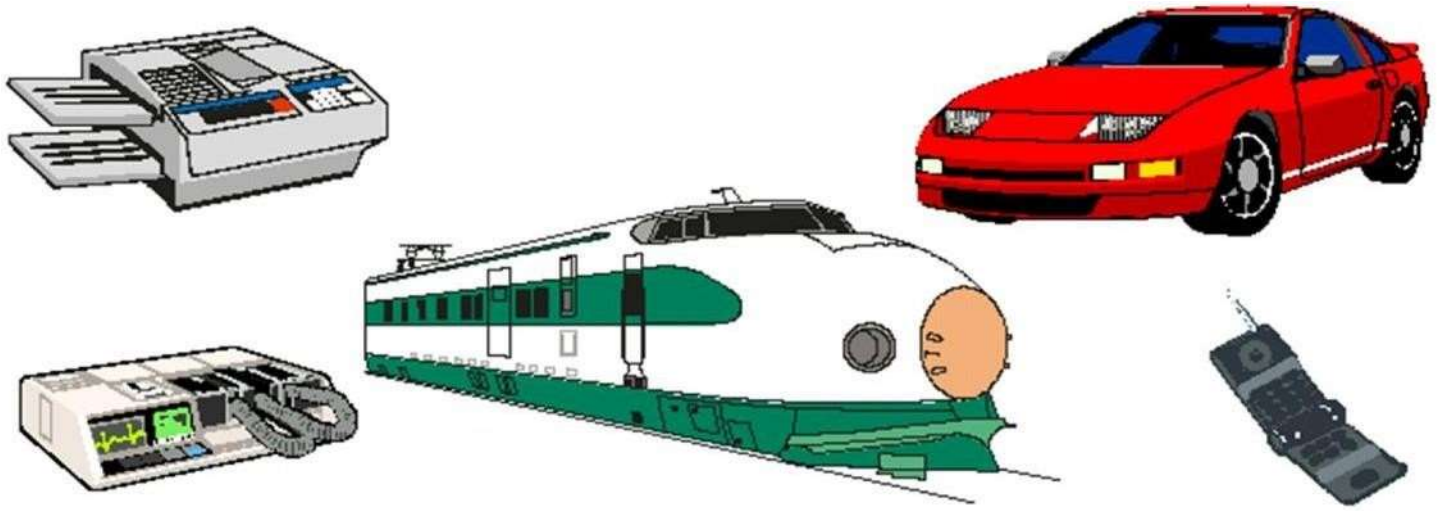
- Processes data within a strict time constraint.
- Used in mission-critical applications requiring immediate responses.
- Ensures predictable execution times.
- Used in medical devices, robotics, and industrial automation.

Os: VxWorks, FreeRTOS

Example : An autonomous vehicle's braking system uses RTOS to process sensor data in real time, ensuring safety.

What is an embedded system?

Embedded System = *Computer Inside a Product.*



Embedded systems…

- Embedded computing systems
  - Computing systems embedded within electronic devices
  - Billions of units produced yearly, versus millions of desktop units
  - Perhaps >50 per household and per automobile
  - A lot more programming is done for embedded systems than desktop computers or servers

Embedded Operating Systems…

- Many different platforms:
  - J2ME
  - Android
  - Apple iPhone
  - Microsoft Windows Mobile
  - Blackberry
  - PalmWebOS
  - Nokia (C/C++, Python)
    - Symbian (S60, S80)

symbian OS

J2ME CDC Java

palm

Windows Mobile

android

BlackBerry

NOKIA Connecting People

Product: Pavion Portable GPS Navigation & Multimedia System

Microprocessor: ARM , DSP

OS: Windows CE

Also plays MP3s and Videos

Product: Cannon EOS 3D Digital Camera

Microprocessor: DIGIC II Image Processor

Media players are embedded systems.
Microsoft's Zune Multimedia player uses an ARM processor and the Windows CE Operating System.

Product: Microsoft's Zune Portable Media Device

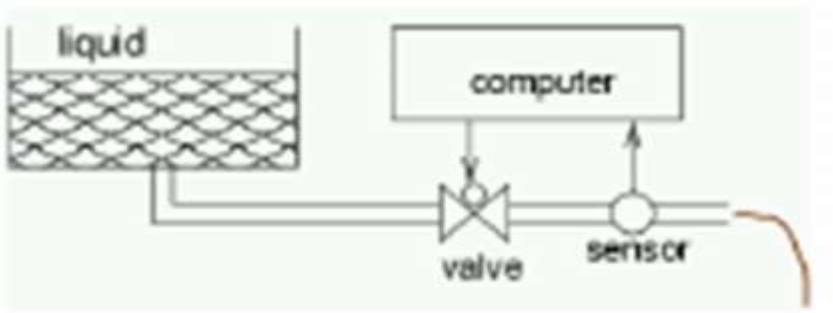
Microprocessor: ARM

OS: Windows CE

Embedded OS…

Industrial Automation

- Process and plant control systems in nuclear power plants, Hydro power plants, industries.



Embedded OS…

Automotive Electronics

Product: S class Mercedes
Microprocessors: around
100 embedded processors !

- Dashboard electronics such as the radio, air conditioning, and satellite navigation system, Airbags,…

Efficient automatic gearboxes, media, safety …

Embedded OS…

Aircrafts

- Flight control systems,
- Pilot information systems,
- Power supply system,
- Entertainment system,

Embedded Mobile Technologies

- **Technologies:**
  - SMS
    - Communication layer for local apps
    - SMS applications
  - Local Applications:
    - Java 2 Micro Edition (J2ME)
    - Python (Nokia)
    - Android
    - Etc, etc, etc…
    - Apple
  - Mobile Web
    - Internet Communications over 2G/3G/4G
    - Communication layer for local apps
  - Telephony Apps
    - Phone menus
    - Voice recognition

Local Embedded Mobile Applications

- Fast, rich user interfaces
  - Forms, menus, alerts, buttons, pictures, videos, textboxes, touch screen, orientation
- Access to device features
  - Location (GPS, Google maps, compass, …)
  - Voice / speaker
  - Storage
  - Camera
  - Wi-fi (local networking)
  - Bluetooth,IR, RFID, NFC
  - Mobile network (SMS, data)

Smart card operating system

- The smallest operating system runs on smart card.
- Contains CPU chip.
- Processing power and memory constraints.
- They handle a single function like electronic payment
- Some of them are java oriented.

Questions ?

- If you had to design a system for a hospital that monitors patients' vital signs in real-time, what kind of operating system would be needed?
- Imagine running a website that handles millions of users at the same time. What kind of OS features would be important?