Operating Systems

Lecture 5

Overview of Computer System & Operating System role

-by
Ms. Minal Rajwar

Personal Computers

What is a PC?

PC is an electronic device used for personal tasks like work, school, gaming, and internet browsing. It includes:

- Motherboard - the main circuit board
- Processor (CPU)
- Memory (RAM)
- Storage (HDD/SSD)
- Input/ Output Devices (monitor, keyboard, mouse,etc.)

Types of PCs

1. **Desktop PCs** - Bigger, powerful computers that stay on a desk.
2. **Laptops** - Portable computers with a built-in screen and keyboard.
3. **Netbooks** - Smaller, lightweight laptops for basic tasks like web browsing.
4. **All-in-one PCs** - Desktops where the computer and monitor are combined into one unit.

Advantages of PCs

- Can do many task(writing, designing, coding, gaming).
- Easy to upgrade and customize.
- Usually cheaper than other computers (like Macs).

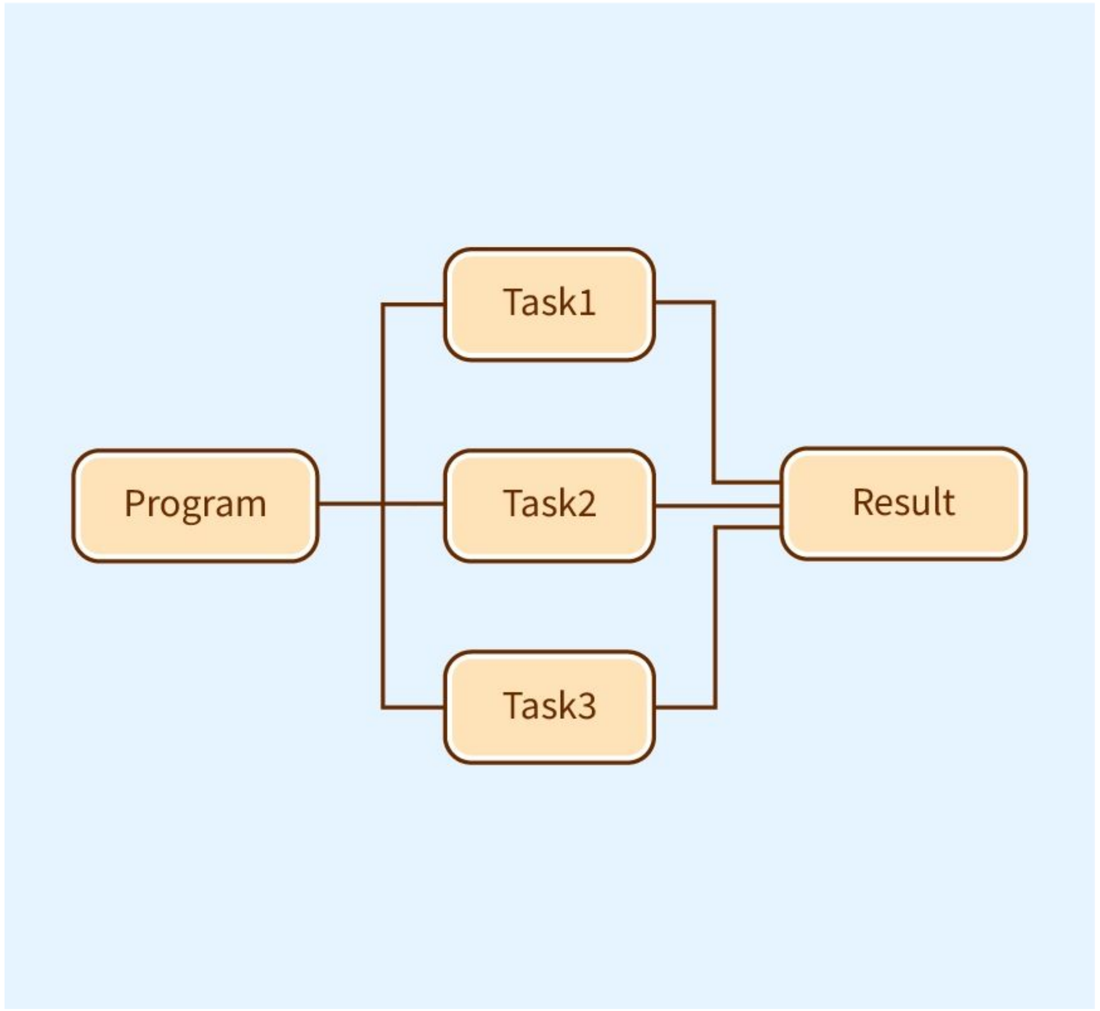
Disadvantages of PCs

- Can get viruses or malware if not protected.
- May be harder to set up and maintain.
- Some software may not work on PCs.

Parallel Systems

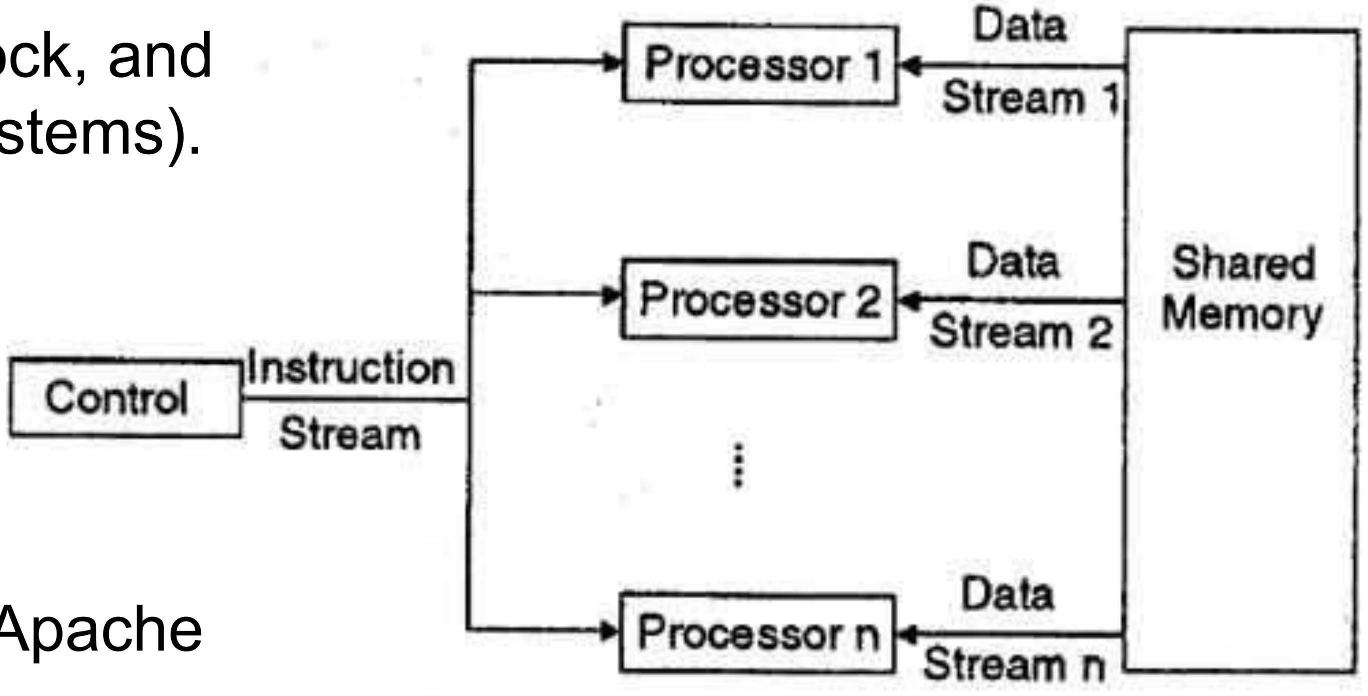
What are Parallel Systems?

Parallel systems speed up programs by breaking them into smaller parts and processing those parts at the same time. This makes tasks run much faster than on a single processor.



How do Parallel Systems Work?

- ➢ They use multiple processors in a single computer.
- ➢ All processors share memory, clock, and devices (called tightly coupled systems).
- ➢ Tasks are split and processed simultaneously for faster results.
- ➢ Example: Hadoop, MapReduce, Apache Cassandra



Types of Parallel Systems

Computers can be grouped into four types based on how they handle instructions and data:

- ➢ **SISD** (Single Instruction, Single Data) - One task at a time (traditional computers).
- ➢ **SIMD** (Single Instruction, Multiple data) - One instructions, but multiple data processes together (e.g., graphic cards).
- ➢ **MISD** (Multiple Instruction, Single Data) - Rare; multiple instructions work on the same data.
- ➢ **MIMD** (Multiple Instruction, Multiple Data) - Different tasks run on different data at the same time (most modern parallel systems.)

Advantages of Parallel System

- ➢ **Faster Performance** - Handles heavy tasks quickly by using multiple processors.
- ➢ **Cost-Efficient** - Cheaper than distributed systems since they don’t need extra networking hardware.

Disadvantages of Parallel Systems

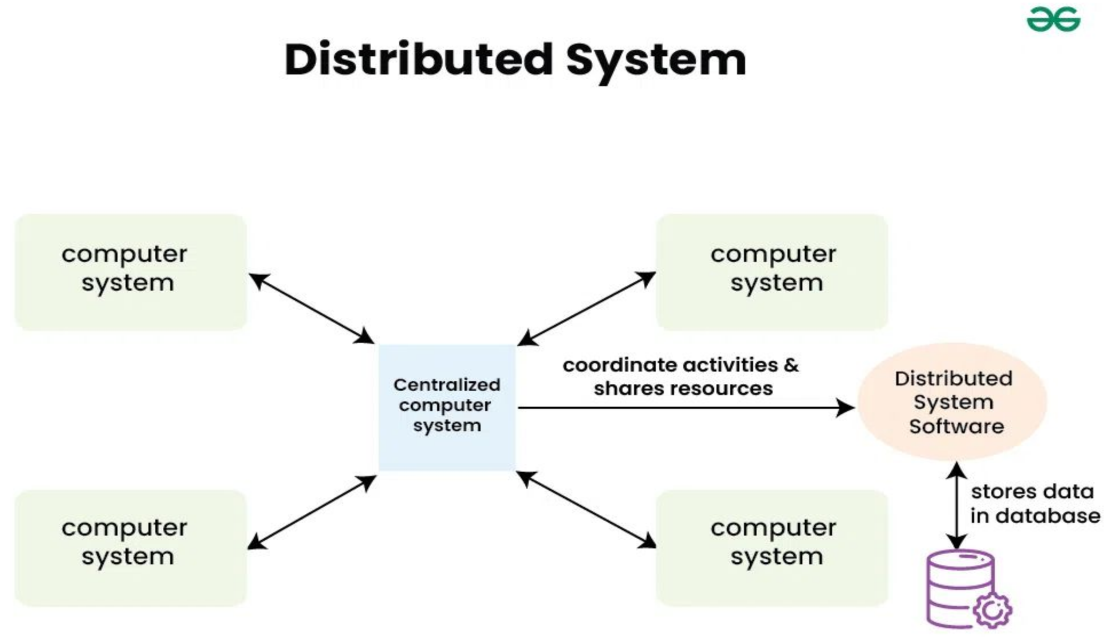
- ➢ **Limited Growth** - Can’t add unlimited processors to a single system.
- ➢ **Harder to Program** - Managing multiple processors is more complex than single processor system.
- ➢ **Synchronization Issues** - Extra time is needed to keep processors working together smoothly.

Distributed System

What is a Distributed System?

- is a network of multiple computers working together to run applications
- each computer in a distributed system has its own memory and processor, making it “loosely coupled.”

Example: LOCUS, MICROS (Distributed OS).



How Does a Distributed System Work?

- ➢ Multiple computers (nodes) are connected via a network (like the internet or a local network).
- ➢ Each computer works independently but collaborates to complete tasks.
- ➢ They do not share memory or a clock (unlike parallel systems).
- ➢ Uses synchronization algorithms (since there’s no single global clock).

Advantages of Distributed System

- **Scalability -** Easily expand by adding more computers.
- **Fault Tolerance** - If one computer fails, others can take over.
- **Geographical Flexibility** - computers can be in different locations, improving performance and reliability.

Disadvantages of Distributed Systems

- **Complexity -** Harder to design and maintain than single-computer systems.
- **Communication Overhead** - Network delays can slow down performance.
- **Security Risks** - Data moving between computers can be intercepted.

Key Differences between Parallel and Distributed Systems

Feature	Parallel Systems	Distributed Systems
Coupling	Tightly coupled (Shared memory)	Loosely coupled (own memory)
Speed	Faster Processing	Slower due to network delays
Scalability	Limited by hardware	Highly scalable (add more nodes)
Examples	Hadoop, Multi-core CPUs	Cloud computing, HPC dusters

Real Time Operating System (RTOS)

- is a special operating system that guarantees tasks finish on time every time.
- unlike regular os, and RTOS focuses on predictable timing rather than just speed.

Examples of RTOS:

➔ VxWorks (used in spacecraft, cars and medical devices)
➔ Nucleus (used in embedded systems)
➔ Zephyr (used in IOT devices)

Types of Real-time Systems

Type	Deadline Strictness	Consequence of Missing Deadline	Example
Hard Real Time	Never miss deadline	Disastrous Failure (e.g., plane crash)	Flight control systems, pacemakers
Soft Real Time	Occasional delays allowed	Reduced performance but no disaster	video streaming, phone calls
Firm Real Time	Deadline missed = Useless result	Tolerable but degrades over time	Stock trading, online auctions

Advantages of Real - Time Systems

- ➢ **Instant Response** - Critical tasks (like stopping a machine in an emergency) happen without delay.
- ➢ **Automation** - Replaces humans in dangerous or ultra precise tasks (e.g., robotic surgery).
- ➢ **Reduces Errors** - Minimizes mistakes in tasks needing perfect timing (e.g., missile guidance).
- ➢ **Cost Saving** - Fewer human operators needed in high-risk environments (e.g., nuclear plants).

Disadvantages of Real - Time Systems

- ➢ **Hard to Build -** Needs specialized engineers and expensive hardware.
- ➢ **Inflexible** - Can’t easily change once set up (must always meet strict deadlines).
- ➢ **Risk of failure** - A small bug can cause catastrophic failure (e.g., a self driving car crash).
- ➢ **Expensive** - Requires high-end processors, sensors, and testing.

Real World Examples

- **Hard RT :** Airbag systems (must deploy in milliseconds).
- **Soft RT :** Video calls (small delays are annoying but not deadly).
- **Firm RT:** Online stock trading (late data = lost money).

Resouce Management in OS

What is Resource Management?

➔ An Os manages all the hardware and software resources of computer such as:

- CPU (Processor time)
- Memory (RAM & Storage)
- I/O Devices (Keyboard, Mouse, Printer, etc.)
- Network Bandwidth

Since resources are limited, the OS ensures fair and efficient distribution among different programs and users.

Key Terminologies

Term	Definition	Example
Resource Allocation	Assigning resources (CPU, memory) to programs.	Giving more RAM to a game than a background app.
Process	A running program (e.g., Chrome, Word).	Each tab in Chrome is a separate process.
Scheduling	Decoding which process gets CPU time first.	Like a traffic light managing cars.
Deadlock	Two programs waiting for each other forever.	Two people refusing to move in a narrow hallway.
Semaphore	A “traffic signal” preventing conflicts in resource access.	Only one printer job runs at a time.

Term	Definition	Example
Mutual Exclusion	Preventing two programs from using the same resource at once.	Only one user can edit a file at a time.
Memory Management	Managing RAM & storage efficiently.	Swapping unused apps to disk when RAM is full.

How Does an OS Manage Resources?

- **Resource Scheduling**
  - Decides which process gets CPU, memory,etc.
  - Example: A video editor gets more CPU than a music player.
- **Resource Monitoring**
  - Tracks which program uses what.
  - Stops greddy programs from hogging all resources.
- **Resource Protection**
  - Block unauthorized access (e.g., a virus trying to take over RAM).
- **Resource Sharing**
  - Allows multiple apps to share printers, internet, etc.

- **Deadlock Prevention**
  - Uses techniques like timeouts or resource preemption to avoid freezes.
- Performance Optimization
  - Balances load (e.g., distributes tasks across CPU cores).

Why is Resource Management Important?

- ➢ **Prevents crashes** (e.g., stops one app from using all RAM).
- ➢ **Improves speed** (e.g., prioritizes your game over background updates).
- ➢ **Avoid deadlocks** (no infinite waiting).
- ➢ **Security** (blocks unauthorized access).

Quiz & Revision

1. Name two things and OS does to manage your computer’s RAM efficiently.
2. If you wanted to connect 100 computers across different cities to work together, which system would you use and why?
3. What’s one big security risk with distributed systems that parallel systems don’t have?
4. What is the main difference between desktop computers and all-in-one PC?
5. Why can’t we use a regular Windows OS for controlling a spacecraft?What special OS would we need instead?