Operating Systems – BCS303

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Module 1 – Introduction to operating systems
System structures

Session 2

- Computer System architecture
- Operating Systems Structure

Computer System Architecture

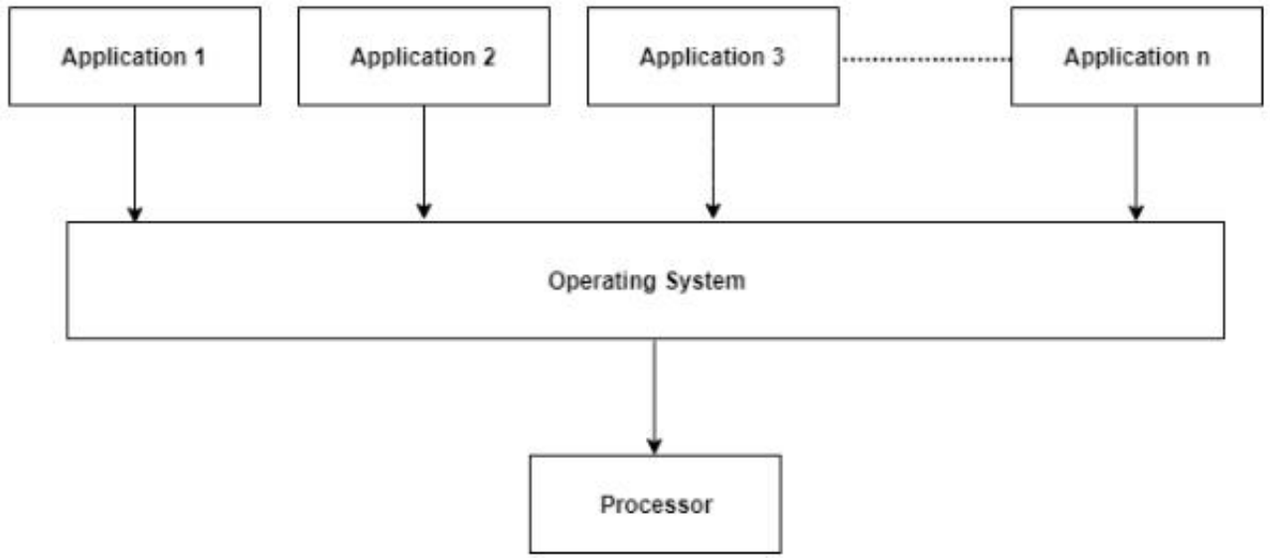
- Categorized roughly according to the number of general-purpose processors used.
    - Single-Processor Systems
    - Multi -Processor Systems (parallel systems or tightly coupled systems)
        1. Asymmetric multiprocessing
        2. Symmetric multiprocessing (SMP)
    - Clustered Systems
        1. Asymmetric clustering
        2. Symmetric clustering

Computer System Architecture - Single-Processor Systems

- **Single-Processor Systems**
  - The variety of single-processor systems range from PDAs through mainframes. On a single-processor system, there is one main CPU capable of executing instructions from user processes. It contains special-purpose processors, in the form of device-specific processors, for devices such as disk, keyboard, and graphics controllers.
  - All special-purpose processors run limited instructions and do not run user processes. These are managed by the operating system; the operating system sends them information about their next task and monitors their status.
  - For example, a disk-controller processor, implements its own disk queue and scheduling algorithm, thus reducing the task of main CPU. Special processors in the keyboard, converts the keystrokes into codes to be sent to the CPU.

Computer System Architecture - Single-Processor Systems

- The use of special-purpose microprocessors is common and does not turn a single- processor system into a multiprocessor. If there is only one general-purpose CPU, then the system is a single-processor system.



Single Processor System

Computer System Architecture - Multi -Processor Systems

- **Multi -Processor Systems (parallel systems or tightly coupled systems)**
  - Systems that have two or more processors in close communication, sharing the computer bus, the clock, memory, and peripheral devices are the multiprocessor systems.

  - Multiprocessor systems have three main advantages:

1. **Increased throughput** - In multiprocessor system, as there are multiple processors execution of different programs take place simultaneously. Even if the number of processors is increased the performance cannot be simultaneously increased. This is due to the overhead incurred in keeping all the parts working correctly and also due to the competition for the shared resources. The speed-up ratio with N processors is not N, rather, it is less than N. Thus the speed of the system is not has expected.

Computer System Architecture - Multi -Processor Systems

2. **Economy of scale** - Multiprocessor systems can cost less than equivalent number of many single-processor systems. As the multiprocessor systems share peripherals, mass storage, and power supplies, the cost of implementing this system is economical. If several processes are working on the same data, the data can also be shared among them.

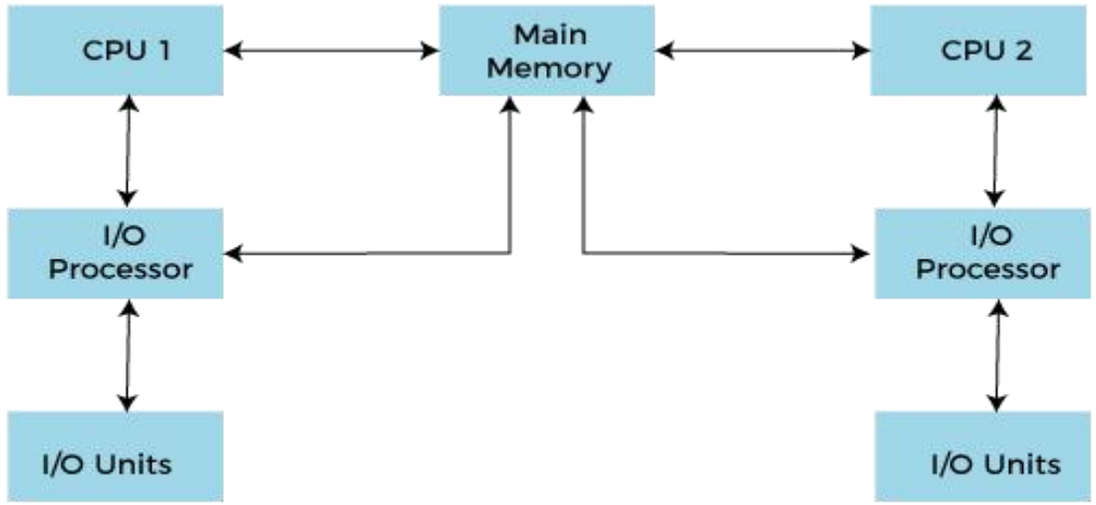
3. **Increased reliability** - In multiprocessor systems functions are shared among several processors. If one processor fails, the system is not halted, it only slows down. The job of the failed processor is taken up, by other processors.

- Two techniques to maintain 'Increased Reliability' –
  1. Graceful degradation
  2. Fault tolerant

Computer System Architecture - Multi -Processor Systems

1. **Graceful degradation –** As there are multiple processors when one processor fails other process will take up its work and the system go down slowly.

2. **Fault tolerant –** When one processor fails, its operations are stopped, the system failure is then detected, diagnosed, and corrected.



Working of Multiprocessor System

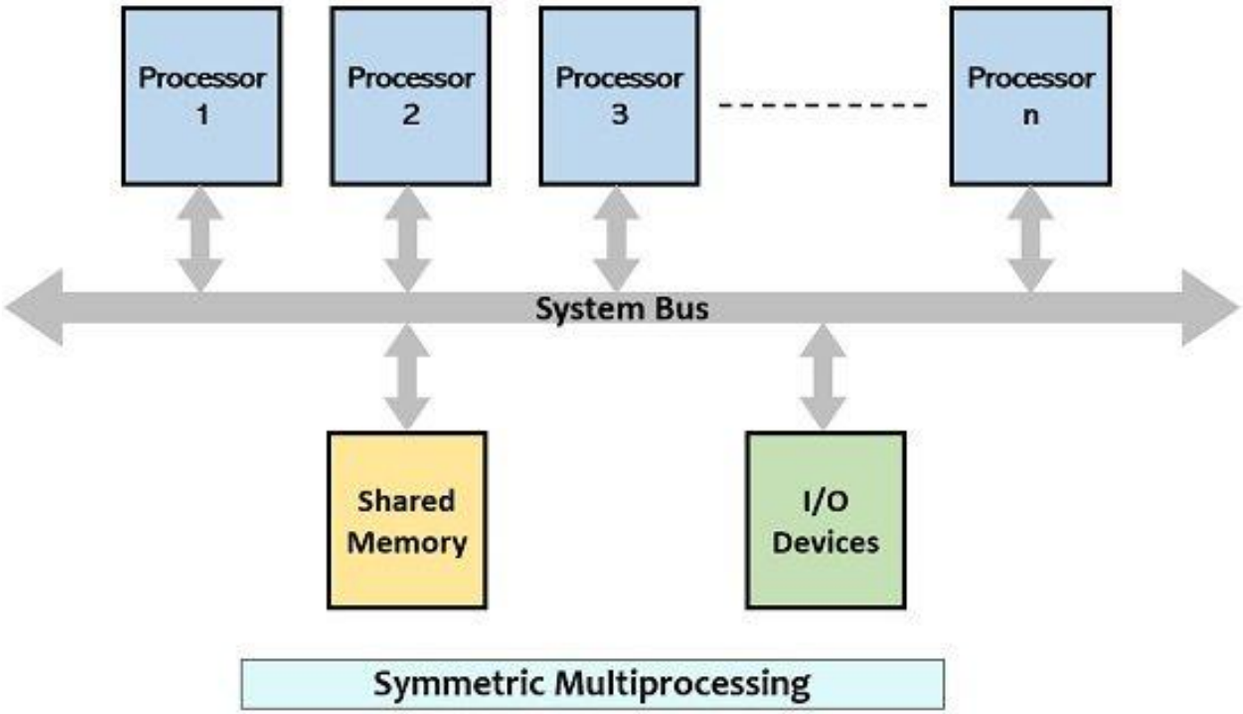
Computer System Architecture - Multi -Processor Systems

- Different types of multiprocessor systems
  1. Asymmetric multiprocessing
  2. Symmetric multiprocessing

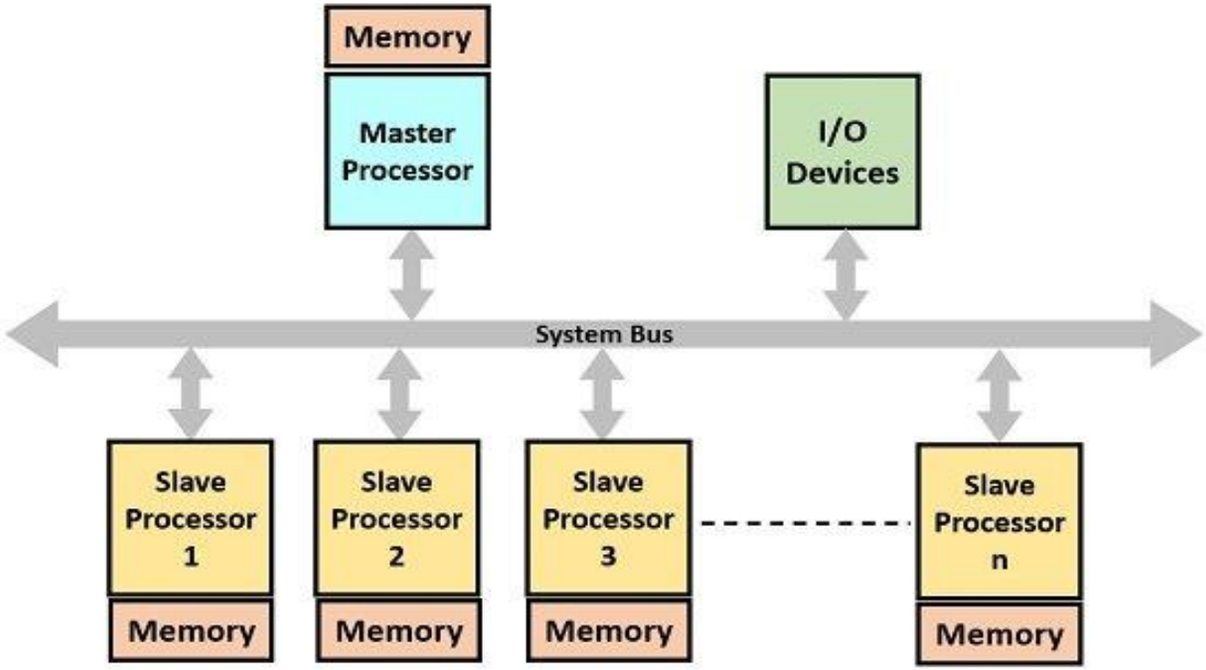
- **Asymmetric multiprocessing – (Master/Slave architecture)**
  - Here each processor is assigned a specific task, by the master processor. A master processor controls the other processors in the system. It schedules and allocates work to the slave processors.

- **Symmetric multiprocessing (SMP)**
  - All the processors are considered peers. There is no master-slave relationship. All the processors have their own registers and CPU, only memory is shared.

Computer System Architecture - Multi -Processor Systems



Symmetric Multiprocessing

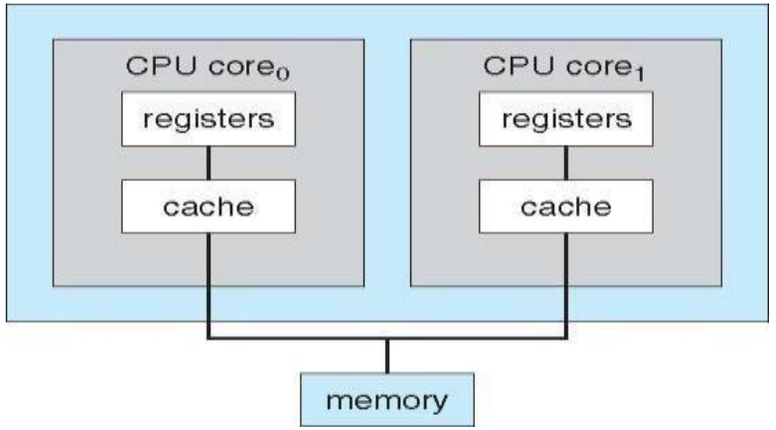


Asymmetric Multiprocessing

Computer System Architecture - Multi -Processor Systems

- The benefit of this model is that many processes can run simultaneously. N processes can run if there are N CPUs—without causing a significant deterioration of performance. Operating systems like Windows, Windows XP, Mac OS X, and Linux—now provide support for SMP. A recent trend in CPU design is to include multiple compute cores on a single chip.

- The communication between processors within a chip is faster than communication between two single processors.



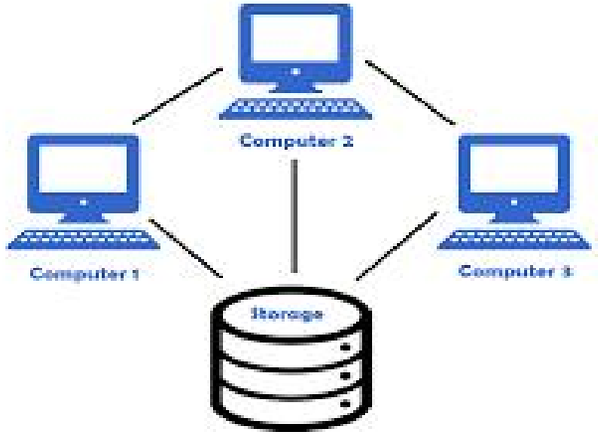
Computer System Architecture - Clustered Systems

- Clustered systems are two or more individual systems connected together via a network and sharing software resources. Clustering provides high availability of resources and services.
- The service will continue even if one or more systems in the cluster fail.
- High availability is generally obtained by storing a copy of files (s/w resources) in the system.
- There are two types of Clustered systems
  1. Asymmetric
  2. Symmetric

Computer System Architecture - Clustered Systems

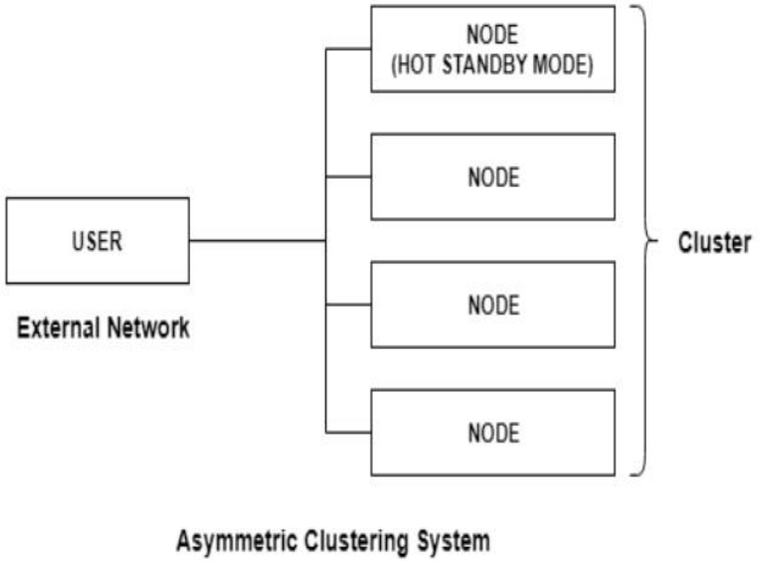
- **Asymmetric clustering** – one system is in hot-standby mode while the others are running the applications. The hot-standby host machine does nothing but monitor the active server. If that server fails, the hot-standby host becomes the active server.

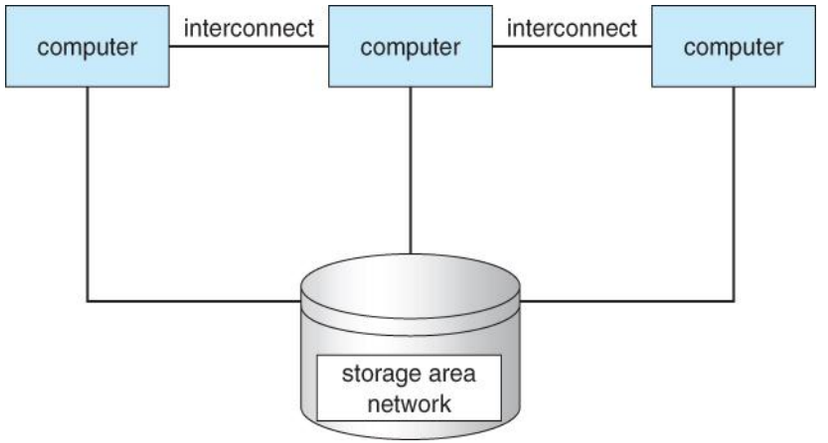
- **Symmetric clustering** – two or more systems are running applications, and are monitoring each other. This mode is more efficient, as it uses all of the available hardware. If any system fails, its job is taken up by the monitoring system.



Clustered System

Computer System Architecture - Clustered Systems





- Other forms of clusters include parallel clusters and clustering over a wide-area network (WAN). Parallel clusters allow multiple hosts to access the same data on the shared storage. Cluster technology is changing rapidly with the help of SAN (storage-area networks). Using SAN resources can be shared with dozens of systems in a cluster, that are separated by miles.

Operating System Structure

- **Multiprogramming**
  - One of the most important aspects of operating systems is the ability to multiprogram.
  - A single user cannot keep either the CPU or the I/O devices busy at all times.
  - Multiprogramming increases CPU utilization by organizing jobs, so that the CPU always has one to execute.

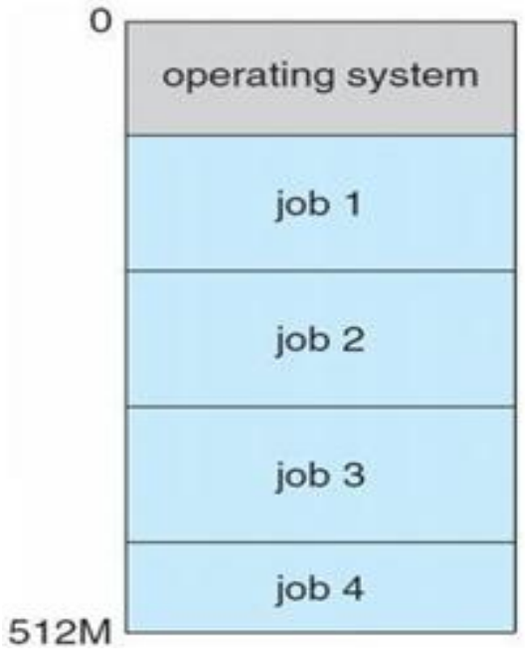


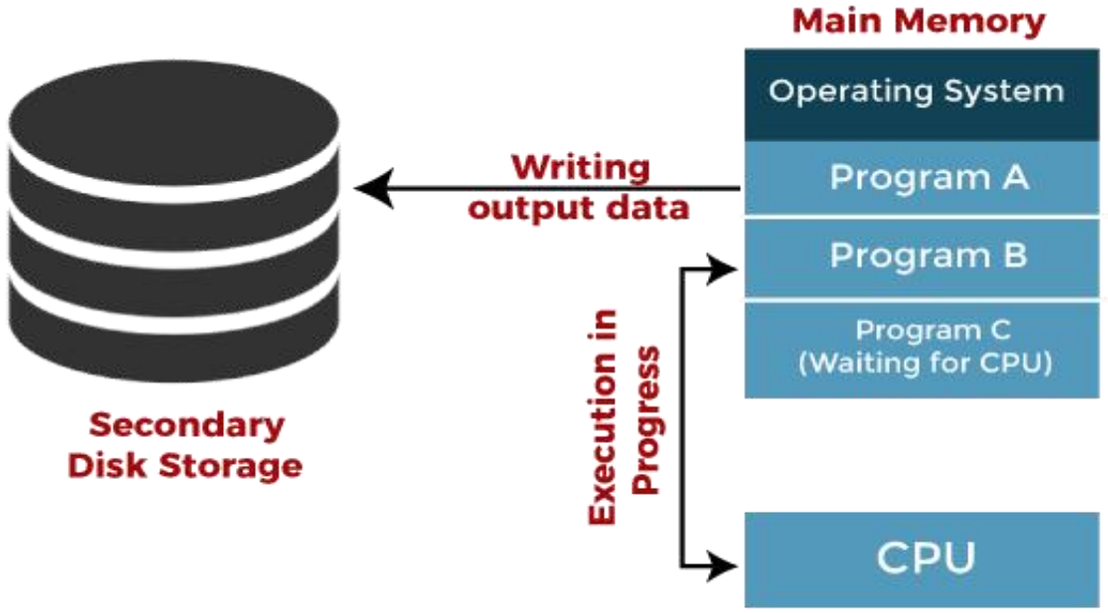
Fig - Memory layout for a multiprogramming system

Operating System Structure

- The operating system keeps several jobs in memory simultaneously as shown in figure. This set of jobs is a subset of the jobs kept in the job pool. Since the number of jobs that can be kept simultaneously in memory is usually smaller than the number of jobs that can be kept in the job pool (in secondary memory).
- The operating system picks and begins to execute one of the jobs in memory. Eventually, the job may have to wait for some tasks, such as an I/O operation, to complete.
- In a non-multiprogram system, the CPU would sit idle.
- In a multiprogrammed system, the operating system simply switches to, and executes, another job. When that job needs to wait, the CPU is switched to another job, and so on.
- Eventually, the first job finishes waiting and gets the CPU back. Thus, the CPU is never idle.

Operating System Structure

- Multiprogrammed systems provide an environment in which the various system resources (for example, CPU, memory, and peripheral devices) are utilized effectively, but they do not provide for user interaction with the computer system.



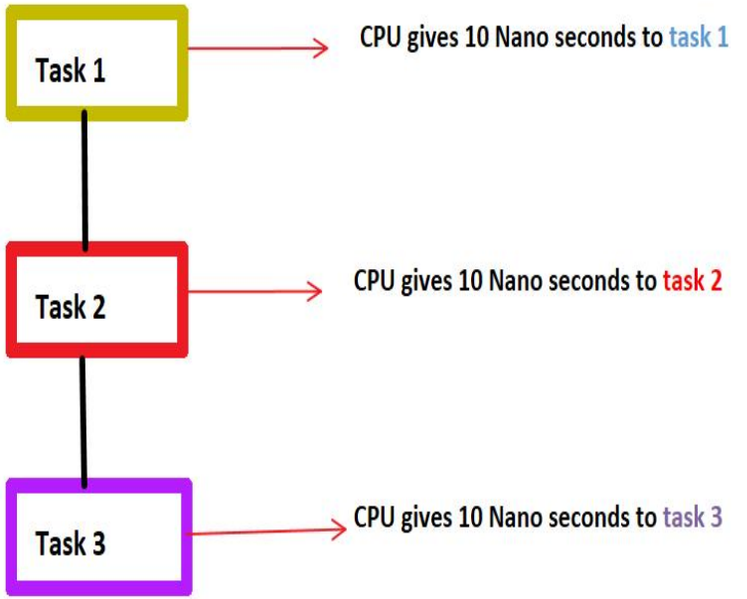
Jobs in multiprogramming system

Operating System Structure

- **Multitasking Systems**

  - In **Time sharing (or multitasking) systems**, a single CPU executes multiple jobs by switching among them, but the switches occur so frequently that the users can interact with each program while it is running. The user feels that all the programs are being executed at the same time.

  - Time sharing requires an **interactive (or hands-on)** computer system, which provides direct communication between the user and the system.



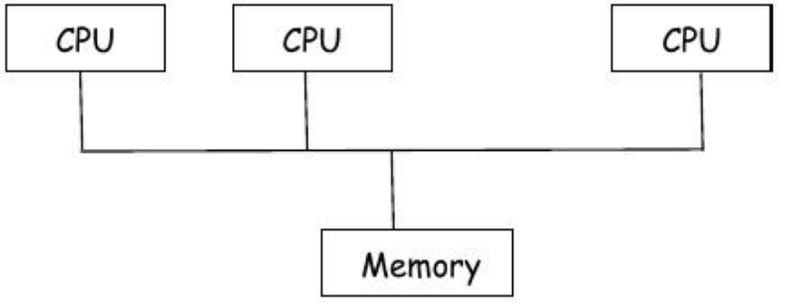
Multi-Tasking In Operating System

Operating System Structure

- The user gives instructions to the operating system or to a program directly, using a input device such as a keyboard or a mouse, and waits for immediate results on an output device. Accordingly, the response time should be short— typically less than one second.

- A time-shared operating system allows many users to share the computer simultaneously. As the system switches rapidly from one user to the next, each user is given the impression that the entire computer system is dedicated to his use only, even though it is being shared among many users.

- A **multiprocessor system** is a computer system having two or more CPUs within a single computer system, each sharing main memory and peripherals. Multiple programs are executed by multiple processors parallel.



Summary

- In today's session, you all have gone through the following topics
  - Computer System architecture
  - Operating System structure

Discussion and Interaction

Topics for Next Session

Module 1: Introduction to operating systems, System structures

Session 3

- Operating System operations
- Process Management
- Memory Management
- Storage Management
- I/O System


Thank
you