Unit-II
**Lecture: 1**
(Operating System Organization)

The most fundamental of all system software is the **operating system**. It has three main tasks to perform:

- The operating system must shield the details of the hardware from the application programs, and thus from the user.
- The operating system has to *substitute* a set of abstract services to the application programs, to replace the physical hardware services. When applications use these abstract services, the operations must be translated into real hardware operations.
- Finally, the resources in a computer (CPU, memory, disk space) are limited. The operating system must act as a resource manager, optimizing the use of the resources, and protecting them against misuse and abuse. When a system provides multiuser or multitasking capabilities, resources must be allocated fairly and equitably amongst a number of competing requests.

Operating System Services:
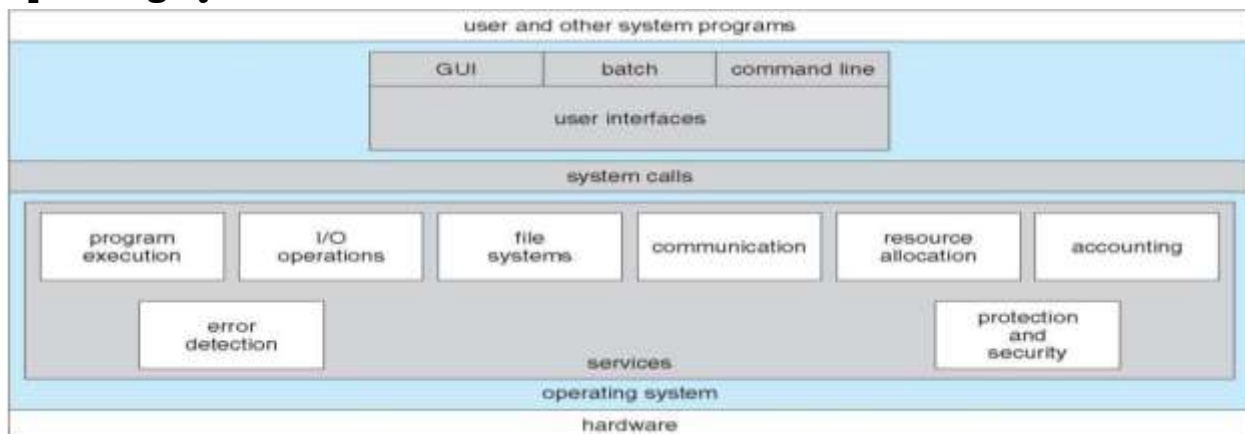
Following are the services provided by operating systems to the convenience of the users:

1. **Program Execution:** The purpose of computer systems is to allow the user to execute programs. So the operating system provides and environment where the user can conveniently run programs. Running a program involves the allocating and deallocating memory, CPU scheduling in case of multiprocessing.
2. **I/O Operations:** Each program requires an input and produces output. This involves the I/O and the operating system provides this service to make it convenient for the users to run programs.
3. **File System Manipulation:** The output of a program may need to be written into new files or input taken from some files. The operating system provides this service.
4. **Communications:** The processes need to communicate with each other to exchange information during execution. It may be between processes running on the same computer or running on the different computers. Communication can occur in two ways:
   a. Shared Memory
   b. Message Passing
5. **Error Detection:** An error in one part of the system may cause malfunctioning of the complete system. To avoid such a situation operating system constantly monitors the system for detecting the errors. This relieves the user of the worry of errors propagating to various part of the system and causing malfunctioning.

Following are the three services provided by operating systems for ensuring the efficient operation of the system itself:
1. **Resource Allocation:** When multiple users are logged on the system or multiple jobs are running at the same time, resources must be allocated to each of them. Many different types of resources are managed by the operating system.
2. **Accounting:** The operating system keep track of which users use how many and which kinds of computer resources. This record keeping may be used for accounting (so that users can be billed) or simply for accumulating usage statistics.
3. **Protection:** When several disjointed processes execute concurrently, it should not be possible for one process to interfere with the others, or with the operating system itself. Protection involves ensuring that all access to system resources is controlled. Security of the system from outsiders is also important. Such security starts with each user having to authenticate him to the system, usually by means of a password, to be allowed access to the resources.

Process Modes:

Because an operating system must hide the computer's hardware and manage the hardware resources, it needs to prevent the application software from accessing the hardware directly. Without this sort of protection, the operating system would not be able to do its job.

There are two modes of operation in the operating system to make sure it works correctly. These are:

- **Kernel Mode**
- **User Mode**
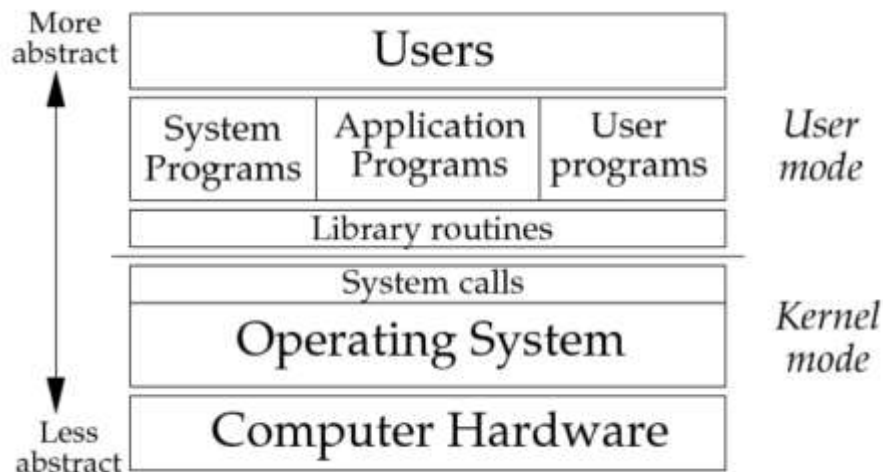
- **Kernel Mode:**
  - In Kernel mode, the executing code has complete and unrestricted access to the underlying hardware.
  - It can execute any CPU instruction and reference any memory address.
  - Kernel mode is generally reserved for the lowest-level, most trusted functions of the operating system.
  - Crashes in kernel mode are catastrophic i.e. they will halt the entire PC.

- **User Mode:**
  - In User mode, the executing code has no ability to directly access hardware or reference memory.
  - Code running in user mode must delegate to system APIs to access hardware or memory.
  - Due to the protection afforded by this sort of isolation, crashes in user mode are always recoverable. Most of the code running in your computer will execute in user mode.