Introduction to Operating System (OS)

Course Content:

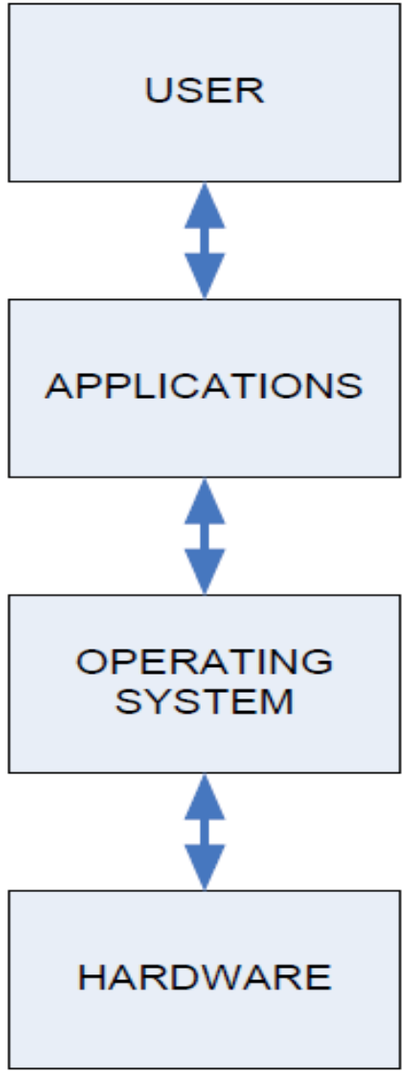
- What is an OS.
- What are its key functions.
- The evaluation of OS.
- What are the popular types of OS.
- Basics of UNIX and Windows.
- Advantages of open source OS like Linux.
- Networks OS.

What is an Operating System?

- Computer System = Hardware + Software
- Software = Application Software + System Software(OS)
- An Operating System is a system Software that acts as an intermediary/interface between a user of a computer and the computer hardware.
- Operating system goals:
  - Execute user programs and make solving user problems easier
  - Make the computer system convenient to use
  - Use the computer hardware in an efficient manner

The Structure of Computer Systems

- Accessing computer resources is divided into *layers*.
- Each layer is isolated and only interacts directly with the layer below or above it.
- If we install a new hardware device
  - ✓ No need to change anything about the user/applications.
  - ✓ However, you do need to make changes to the operating system.
  - ✓ You need to install the device drivers that the operating system will use to control the new device.
- If we install a new software application
  - ✓ No need to make any changes to your hardware.
  - ✓ But we need to make sure the application is supported by the operating system
  - ✓ user will need to learn how to use the new application.
- If we change the operating system
  - ✓ Need to make sure that both applications and hardware will compatible with the new operating system.



Computer Architecture

CPU

Front Side Bus

AGP

Northern Bridge

RAM

Southern Bridge

Keyboard
PS/2

I/O Busses

ISA

COM 1 and 2
LPT

PCI

EIDE
Network adapt
Other adapters

USB

Special busses (roads) connecting all input/output devices to motherboard.

CPU – Central Processing Unit

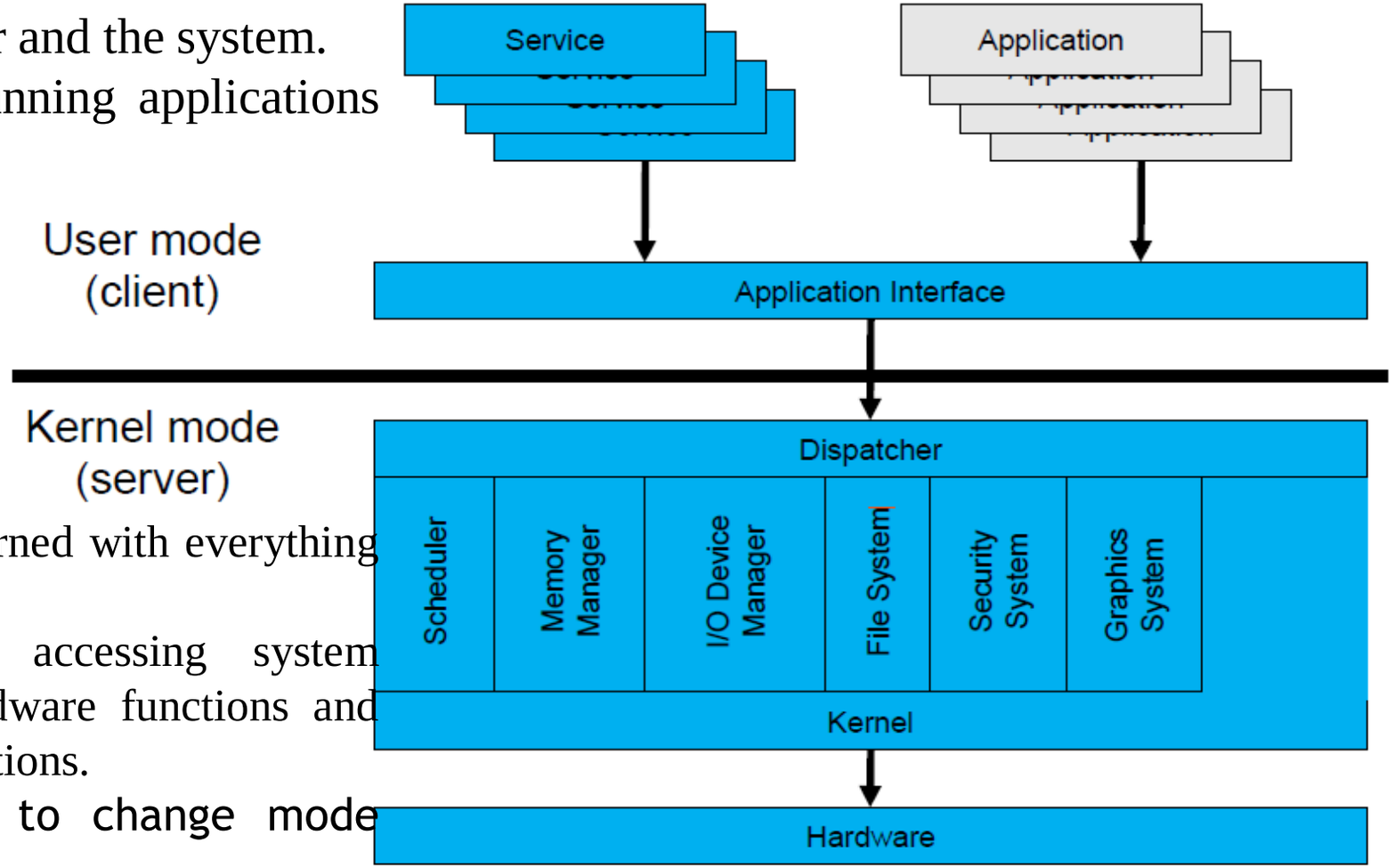
- This is the brain of your computer.
- It performs all of the calculations.
- In order to do its job, the CPU needs commands to perform, and data to work with.
- The instructions and data travel to and from the CPU on the system bus.
- The operating system provides rules for how that information gets back and forth, and how it will be used by the CPU.

RAM – Random Access Memory

- This is like a desk, or a workspace, where your computer temporarily stores all of the information (data) and instructions (software or program code) that it is currently using.
- Each RAM chip contains millions of address spaces.
- Each address space is the same size, and has its own unique identifying number (address).
- The operating system provides the rules for using these memory spaces, and controls storage and retrieval of information from RAM.
- Device drivers for RAM chips are included with the operating system.

Operating System Mode

- The *User Mode* is concerned with the actual interface between the user and the system.
- It controls things like running applications and accessing files.



- The *Kernel Mode* is concerned with everything running in the background.
- It controls things like accessing system resources, controlling hardware functions and processing program instructions.
- System calls are used to change mode from User to Kernel.

Kernel

- Kernel is a software code that reside in central core of OS. It has complete control over system.
- When operation system boots, kernel is first part of OS to load in main memory.
- Kernel remains in main memory for entire duration of computer session. The kernel code is usually loaded in to protected area of memory.
- Kernel performs it's task like executing processes and handling interrupts in kernel space.
- User performs it's task in user area of memory.
- This memory separation is made in order to prevent user data and kernel data from interfering with each other.
- Kernel does not interact directly with user, but it interacts using SHELL and other programs and hardware.

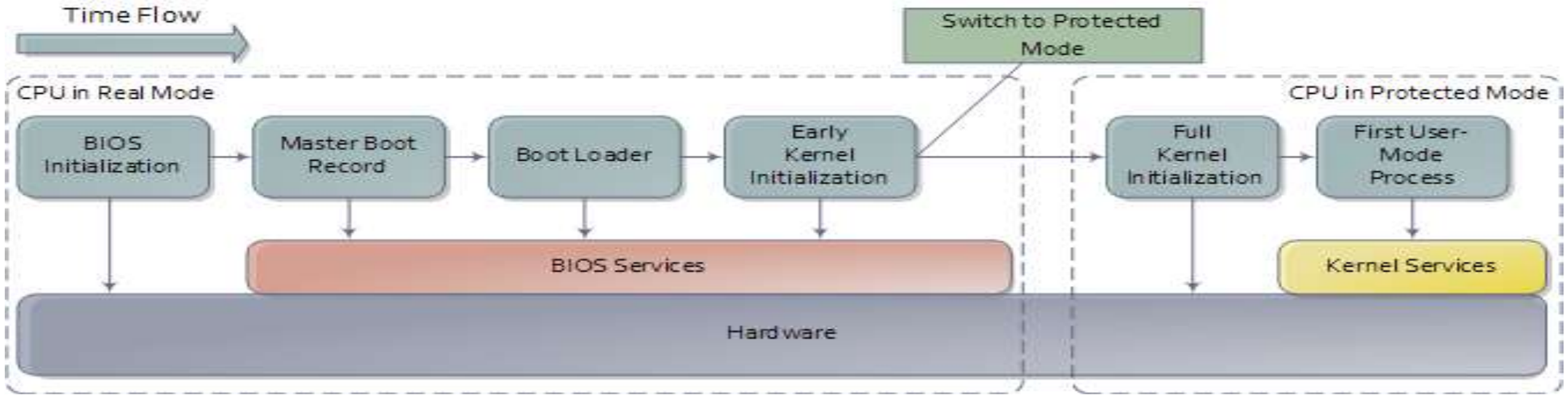
Kernel cont…

- Kernel includes:-
  1. Scheduler: It allocates the Kernel's processing time to various processes.
  2. Supervisor: It grants permission to use computer system resources to each process.
  3. Interrupt handler : It handles all requests from the various hardware devices which compete for kernel services.
  4. Memory manager : allocates space in memory for all users of kernel service.
- kernel provides services for process management, file management, I/O management, memory management.
- System calls are used to provide these type of services.

System Call

- **System call** is the programmatic way in which a computer program/user application requests a service from the kernel of the operating system on which it is executed.
- Application program is just a user-process. Due to security reasons , user applications are not given access to privileged resources(the ones controlled by OS).
- When they need to **do any I/O** or have **some more memory** or **spawn a process** or wait for **signal/interrupt,** it requests operating system to facilitate all these. This **request is made through System Call.**
- System calls are also called **software-interrupts.**

Starting an Operating System(Booting)



- ✓ Power On Switch sends electricity to the motherboard on a wire called the *Voltage Good* line.
- ✓ If the power supply is good, then the BIOS (Basic Input/Output System) chip takes over.
- ✓ In Real Mode, CPU is only capable of using approximately 1 MB of memory built into the motherboard.
- ✓ The BIOS will do a Power-On Self Test (POST) to make sure that all hardware are working.

- ✓ BIOS will then look for a small sector at the very beginning of your primary hard disk called MBR.
- ✓ The MBR contains a list, or map, of all of the partitions on your computer‘s hard disk (or disks).
- ✓ After the MBR is found the Bootstrap Loader follows basic instructions for starting up the rest of the computer, including the operating system.
- ✓ In Early Kernel Initialization stage, a smaller core of the Kernel is activated.
- ✓ This core includes the device drivers needed to use computer‘s RAM chips.

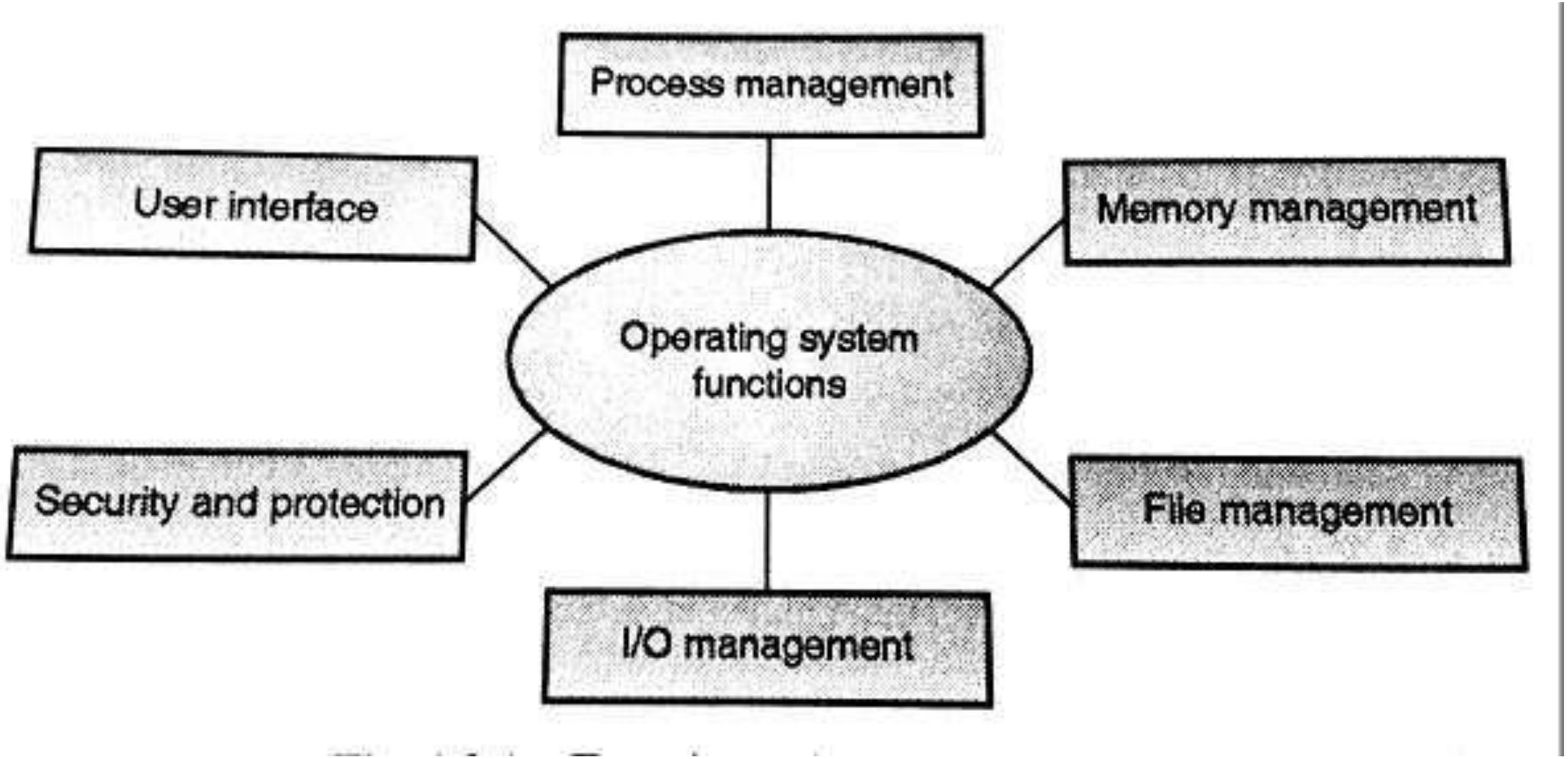
BIOS

- BIOS firmware was stored in a ROM/EPROM (Erasable Programmable Read-Only Memory) chip known as **firmware** on the PC motherboard.
- BIOS can be accessed during the initial phases of the boot procedure by pressing del, F2 or F10.
- Finally, the firmware code cycles through all storage devices and looks for a boot-loader. (usually located in first sector of a disk which is 512 bytes)
- If the boot-loader is found, then the firmware hands over control of the computer to it.

UEFI

- UEFI stands for Unified Extensible Firmware Interface. It does the same job as a BIOS, but with one basic difference: it stores all data about initialization and startup in an .efi file, instead of storing it on the firmware.
- This .efi file is stored on a special partition called EFI System Partition (ESP) on the hard disk. This ESP partition also contains the bootloader.
- UEFI was designed to overcome many limitations of the old BIOS, including:
  - UEFI supports drive sizes upto 9 zettabytes, whereas BIOS only supports 2.2 terabytes.
  - UEFI provides faster boot time.
  - UEFI has discrete driver support, while BIOS has drive support stored in its ROM, so updating BIOS firmware is a bit difficult.
  - UEFI offers security like "Secure Boot", which prevents the computer from booting from unauthorized/unsigned applications. This helps in preventing rootkits.
  - UEFI runs in 32bit or 64bit mode, whereas BIOS runs in 16bit mode. So UEFI is able to provide a GUI (navigation with mouse) as opposed to BIOS which allows navigation only using the keyboard.

Functions of Operating System



1. Process Management

- **A *process* is a program in execution.**
- A process needs certain resources, including CPU time, memory, files, and I/O devices to accomplish its task.
- Simultaneous execution leads to multiple processes. Hence creation, execution and termination of a process are the most basic functionality of an OS
- If processes are dependent, than they may try to share same resources. thus task of process synchronization comes to the picture.
- If processes are independent, than a due care needs to be taken to avoid their overlapping in memory area.
- Based on priority, it is important to allow more important processes to execute first than others.

2. Memory management

- Memory is a large array of words or bytes, each with its own address.
- It is a repository of quickly accessible data shared by the CPU and I/O devices.
- Main memory is a **volatile** storage device. When the computer made turn off everything stored in RAM will be erased automatically.
- In addition to the physical RAM installed in your computer, most modern operating systems allow your computer to use a *virtual memory system. Virtual memory allows your computer to use part of a permanent storage device (such as a hard disk) as extra memory.*
- The operating system is responsible for the following activities in connections with memory management:
  - Keep track of which parts of memory are currently being used and by whom.
  - Decide which processes to load when memory space becomes available.
  - Allocate and de-allocate memory space as needed.

3. File Management

- A file is a collection of related information defined by its creator.
- *File systems provide the conventions for the encoding, storage and management of data on a storage device such as a hard disk.*
  - FAT12 (floppy disks)
  - FAT16 (DOS and older versions of Windows)
  - FAT32 (older versions of Windows)
  - NTFS (newer versions of Windows)
  - EXT3 (Unix/Linux)
  - HFS+ (Max OS X)
- The operating system is responsible for the following activities in connections with file management:
  - ✦ File creation and deletion.
  - ✦ Directory creation and deletion.
  - ✦ Support of primitives for manipulating files and directories.
  - ✦ Mapping files onto secondary storage.
  - ✦ File backup on stable (nonvolatile) storage media.

4. Device Management or I/O Management

- *Device controllers are components on the motherboard (or on expansion cards) that act as an interface between the CPU and the actual device.*
- *Device drivers, which are the operating system software components that interact with the devices controllers.*
- A special device (inside CPU) called the Interrupt Controller handles the task of receiving interrupt requests and prioritizes them to be forwarded to the processor.
- Deadlocks can occur when two (or more) processes have control of different I/O resources that are needed by the other processes, and they are unwilling to give up control of the device.
- It performs the following activities for device management.
  - Keeps tracks of all devices connected to system.
  - Designates a program responsible for every device known as Input/output controller.
  - Decides which process gets access to a certain device and for how long.
  - Allocates devices in an effective and efficient way.
  - Deallocates devices when they are no longer required.

5. Security & Protection

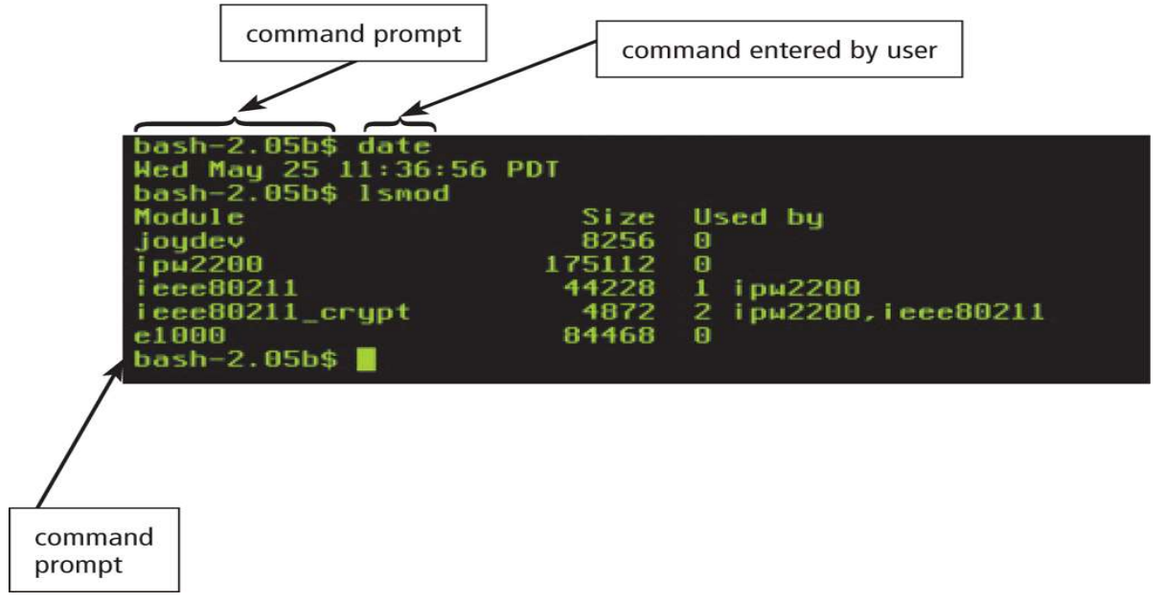
- The operating system uses password protection to protect user data and similar other techniques.
- It also prevents unauthorized access to programs and user data by assigning access right permission to files and directories.
- The owners of information stored in a multiuser or networked computer system may want to control use of that information, concurrent processes should not interfere with each other.

6. User Interface Mechanism

- A **user interface** (**UI**) controls how you enter data and instructions and how information is displayed on the screen
- There are two types of user interfaces
  1. Command Line Interface
  2. Graphical user Interface

1. Command-line interface

- In a command-line interface, a user types commands represented by short keywords or abbreviations or presses special keys on the keyboard to enter data and instructions



2. Graphical User Interface

- With a graphical user interface (GUI), you interact with menus and visual images

History of Operating System

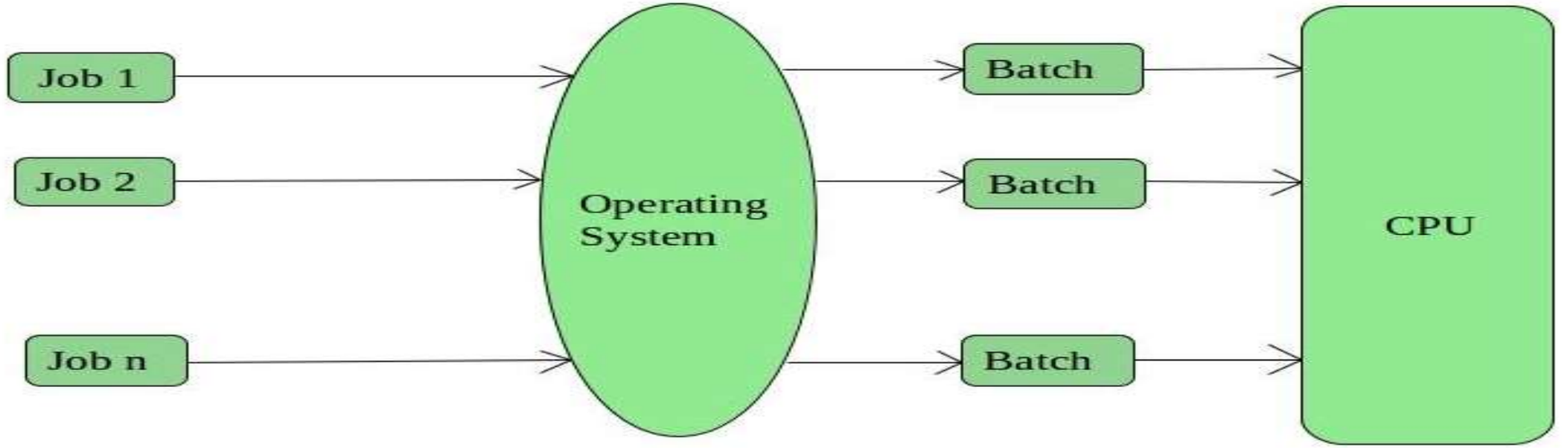
- **The First Generation (1940's to early 1950's)**
  - No Operating System
  - All programming was done in absolute machine language, often by wiring up plug-boards to control the machine’s basic functions.
- **The Second Generation (1955-1965)**
  - First operating system was introduced in the early 1950's.It was called GMOS
  - Created by General Motors for IBM's machine the 701.
  - Single-stream batch processing systems
- **The Third Generation (1965-1980)**
  - Introduction of multiprogramming
  - Development of Minicomputer
- **The Fourth Generation (1980-Present Day)**
  - Development of PCs
  - Birth of Windows/MaC OS

Types of Operating Systems

1. Batch Operating System
2. Multiprogramming Operating System
3. Time-Sharing OS
4. Multiprocessing OS
5. Distributed OS
6. Network OS
7. Real Time OS
8. Embedded OS

1. Batch Operating System

- The users of this type of operating system does not interact with the computer directly.
- Each user prepares his job on an off-line device like punch cards and submits it to the computer operator
- There is an operator which takes similar jobs having the same requirement and group them into batches



1. Batch Operating System cont..

Advantages of Batch Operating System:

- Processors of the batch systems know how long the job would be when it is in queue
- Multiple users can share the batch systems

Disadvantages of Batch Operating System:

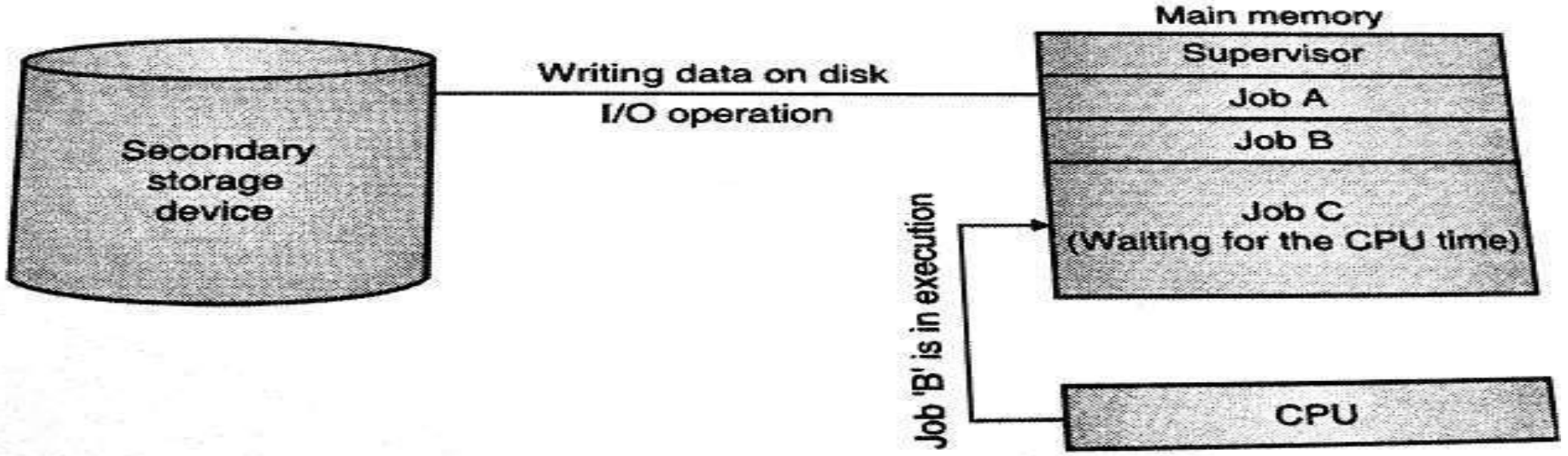
- The computer operators should be well known with batch systems
- Batch systems are hard to debug
- It is sometimes costly
- The other jobs will have to wait for an unknown time if any job fails

Examples of Batch based Operating System:

IBM's MVS

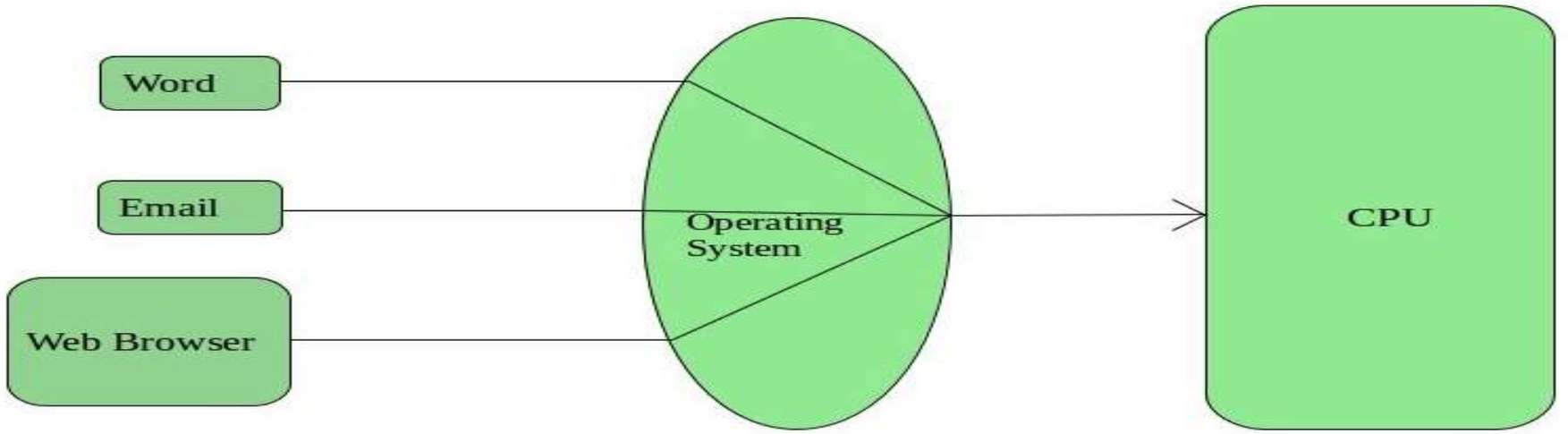
2. Multiprogramming Operating System:

- It increases CPU utilization by organizing jobs so that the CPU always has one job to execute.
- Multiprogramming operating systems use the mechanism of job scheduling and CPU scheduling.



3. Time-Sharing Operating Systems

- Each task is given some time to execute so that all the tasks work smoothly.
- These systems are also known as **Multi-tasking Systems.**
- The task can be from a single user or different users also.
- The time that each task gets to execute is called quantum.
- After this time interval is over OS switches over to the next task.



3. Time-Sharing Operating Systems cont..

- **Advantages of Time-Sharing OS:**
  - Each task gets an equal opportunity
  - Fewer chances of duplication of software
  - CPU idle time can be reduced
- **Disadvantages of Time-Sharing OS:**
  - Reliability problem
  - One must have to take care of the security and integrity of user programs and data
  - Data communication problem
- **Examples of Time-Sharing Oss**

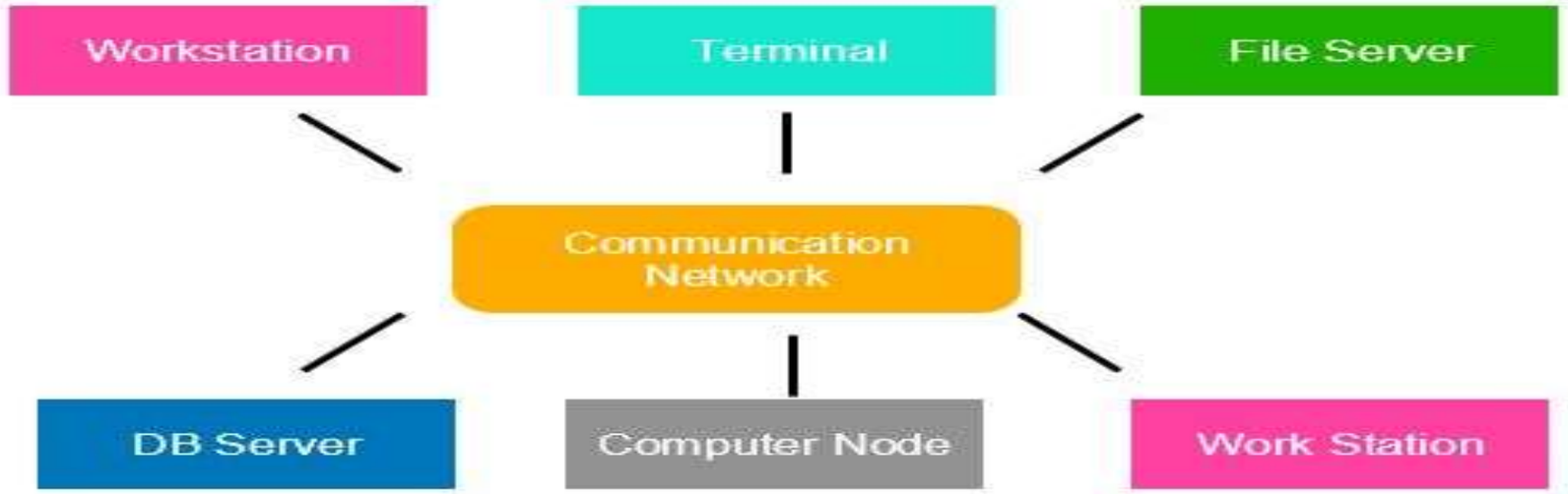
  Multics, Unix, etc.

4. Multiprocessor operating systems

- Multiprocessor operating systems are also known as parallel OS or tightly coupled OS.
- Such operating systems have more than one processor in close communication that sharing the computer bus, the clock and sometimes memory and peripheral devices.
- It executes multiple jobs at the same time and makes the processing faster.
- It supports large physical address space and larger virtual address space.
- If one processor fails then other processor should retrieve the interrupted process state so execution of process can continue.
- Inter-processes communication mechanism is provided and implemented in hardware.

5. Distributed Operating System

- Various autonomous interconnected computers communicate with each other using a shared communication network.
- Independent systems possess their own memory unit and CPU.
- These are referred to as **loosely coupled systems**.
- Examples:- Locus, DYSEAC



6. Network Operating System

- These systems run on a server and provide the capability to manage data, users, groups, security, applications, and other networking functions.
- These types of operating systems allow shared access of files, printers, security, applications, and other networking functions over a small private network.
- The “ other" computers arc called client computers, and each computer that connects to a network server must be running client software designed to request a specific service.
- popularly known as **tightly coupled systems**.

6. Network Operating System

Advantages of Network Operating System:

- Highly stable centralized servers
- Security concerns are handled through servers
- New technologies and hardware up-gradation are easily integrated into the system
- Server access is possible remotely from different locations and types of systems

Disadvantages of Network Operating System:

- Servers are costly
- User has to depend on a central location for most operations
- Maintenance and updates are required regularly

Examples of Network Operating System are:

Microsoft Windows Server 2003/2008/2012, UNIX, Linux, Mac OS X, Novell NetWare, and BSD, etc.

7. Real-Time Operating System

- These types of OSs serve real-time systems.
- The time interval required to process and respond to inputs is very small.
- This time interval is called **response time**.
- **Real-time systems** are used when there are time requirements that are very strict like
  - missile systems,
  - air traffic control systems,
  - robots, etc.

8. Embedded Operating System

- An embedded operating system is one that is built into the circuitry of an electronic device.
- Embedded operating systems are now found in automobiles, bar-code scanners, cell phones, medical equipment, and personal digital assistants.
- The most popular embedded operating systems for consumer products, such as PDAs, include the following:
  - Windows XP Embedded
  - Windows CE .NET:- it supports wireless communications, multimedia and Web browsing. It also allows for the use of smaller versions of Microsoft Word, Excel, and Outlook.
  - Palm OS:- It is the standard operating system for Palm-brand PDAs as well as other proprietary handheld devices.
  - Symbian:- OS found in " smart" cell phones from Nokia and Sony Ericsson

Popular types of OS

- Desktop Class
  - ❖ Windows
  - ❖ OS X
  - ❖ Unix/Linux
  - ❖ Chrome OS
- Server Class
  - ❖ Windows Server
  - ❖ Mac OS X Server
  - ❖ Unix/Linux
- Mobile Class
  - ❖ Android
  - ❖ iOS
  - ❖ Windows Phone