CS343 Operating Systems

Lecture 1

Operating Systems – Classifications and Service

John Jose

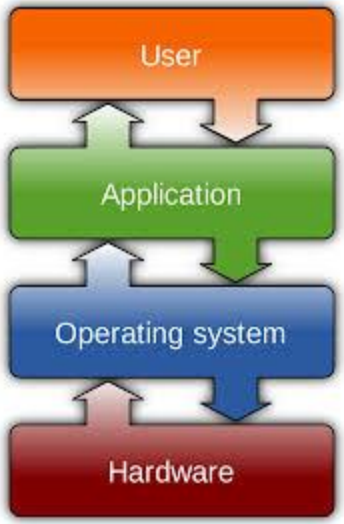
Associate Professor

Department of Computer Science & Engineering

Indian Institute of Technology Guwahati

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:
  - Execute user programs on hardware
  - Make the computer system convenient to use
  - Use the computer hardware in an efficient manner



Types of Operating Systems

- Most systems use a single general-purpose/special purpose processor
- There are several architectures which all require a different OS:
  - Multiprogramming Systems
  - Desktop PCs
  - Parallel Systems
  - Clustered Systems
  - Real-time Systems
  - Embedded Systems

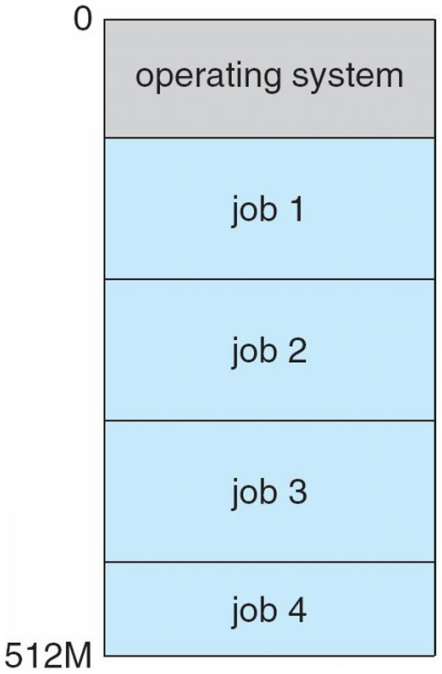
Multiprogramming Systems

- **Multiprogramming** (**Batch system**) needed for efficiency
  - Single user cannot keep CPU and I/O devices busy at all times
  - Multiprogramming organizes jobs (code and data) so CPU always has one to execute
  - A subset of total jobs in system is kept in memory
  - One job selected and run via **job scheduling**
  - When it has to wait (for I/O), OS switches to another job

Timesharing Systems

- **Timesharing** (**multitasking**) is logical extension in which CPU switches jobs so frequently that users can interact with each job while it is running, creating **interactive** computing
  - Multiple programs executing in memory
  - If several jobs ready to run at the same time ⇨ **CPU scheduling**

Memory Layout for Multiprogrammed System

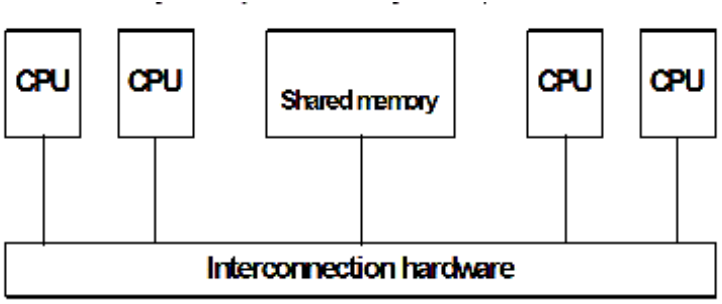


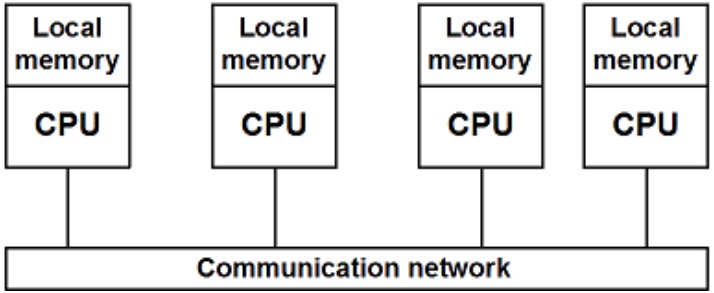
Desktop PCs

- Personal Computers – computer system dedicated to a single user.
- I/O devices – keyboards, mice, display screens, small printers.
- User convenience and responsiveness.
- Mostly single user - do not need advanced CPU utilization or protection features.
- May run several different types of operating systems (Windows, MacOS, UNIX, Linux)

Parallel Systems

- Multiprocessor systems with more than one CPU in close communication.
- **Tightly coupled system** – processors share memory and the internal clock; communication usually takes place through the shared memory.
- **Loosely coupled system** – multiple processors/computers with its own memory connected together for efficiency and throughput.





Multiprocessor/Parallel Systems

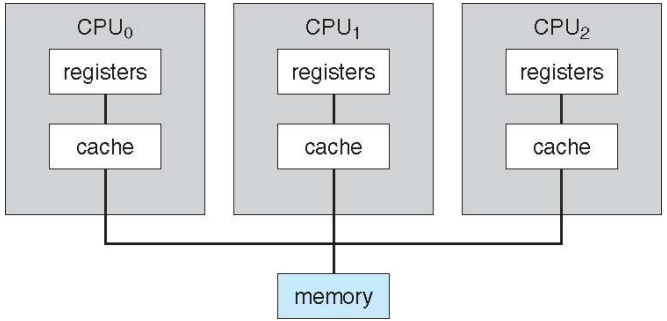
- **Multiprocessors** systems growing in use and importance
  - **Increased throughput**
  - **Economy of scale**
  - **Increased reliability** – graceful degradation or fault tolerance
  - **Asymmetric Multiprocessing**
  - **Symmetric Multiprocessing**

Multiprocessor Systems

- **Asymmetric Multiprocessing**
- Each processor is assigned a specific task; master processor schedules and farms work to slave processors.
- More common in extremely large systems like mainframes with hundreds of processors.

Multiprocessor Systems

- **Symmetric Multiprocessing**
- Each processor runs an identical copy of the operating system.
- The OS code is usually shared.
- Many processes can run at once without performance deterioration.
- Most modern operating systems have SMP support.
- OS has to cater for protection of data.

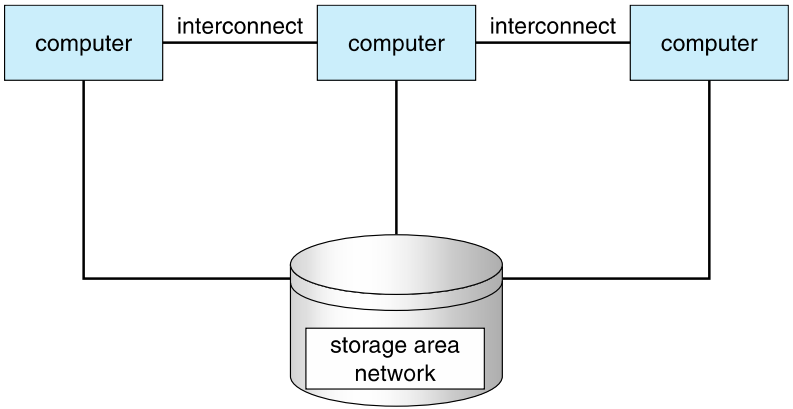


Clustered Systems

- Like multiprocessor systems working together
  - Usually sharing storage via a **storage-area network (SAN)**
  - Provides a **high-availability** service which survives failures
    - **Asymmetric clustering** has one machine in hot-standby mode
    - **Symmetric clustering** has multiple nodes running applications, monitoring each other

Clustered Systems

- Some clusters are for **high-performance computing (HPC)**
  - Applications must be written to use **parallelization**
- Some have **distributed lock manager** (**DLM**) to avoid conflicting operations



Real-Time Systems

- Often used as a control device in a dedicated application such as controlling scientific experiments, medical imaging systems, industrial control systems, and some display systems.
- Well-defined fixed-time constraints.
- Real-Time systems may have either hard or soft real-time.

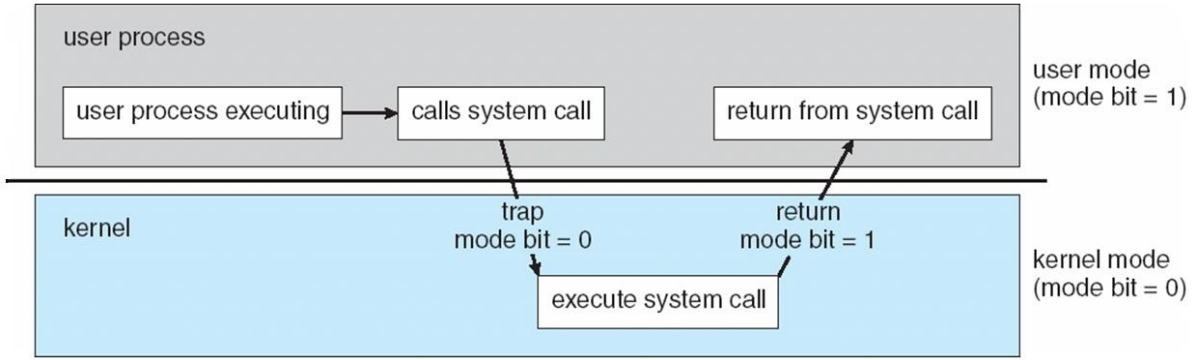
Embedded Systems

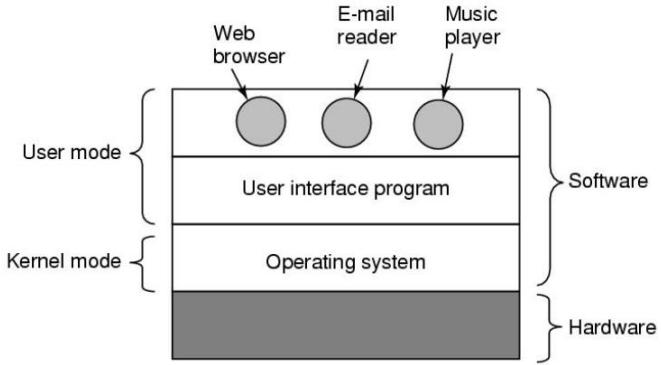
- Personal Digital Assistants (PDAs)
- Smart telephones
- Issues:
  - Limited memory, Slow processors, Small display screens.
  - Emphasis is on I/O operations.
  - Limited memory management and protection

Operating System in Dual Mode

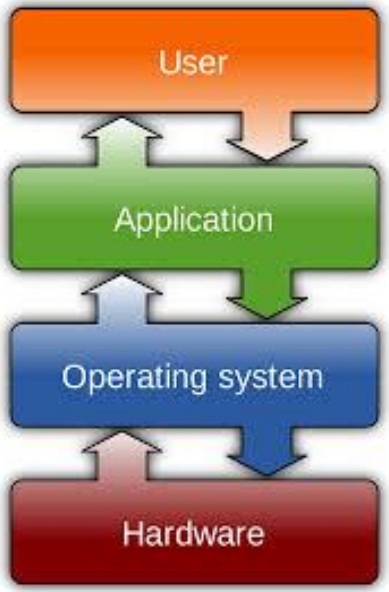
- **Dual-mode** operation allows OS to protect itself and other system components
  - **User mode** and **kernel mode**
  - **Mode bit** provided by hardware
  - Provides ability to distinguish when system is running user code or kernel code
  - Some instructions designated as **privileged**, only executable in kernel mode
  - System call changes mode to kernel, return from call resets it to user

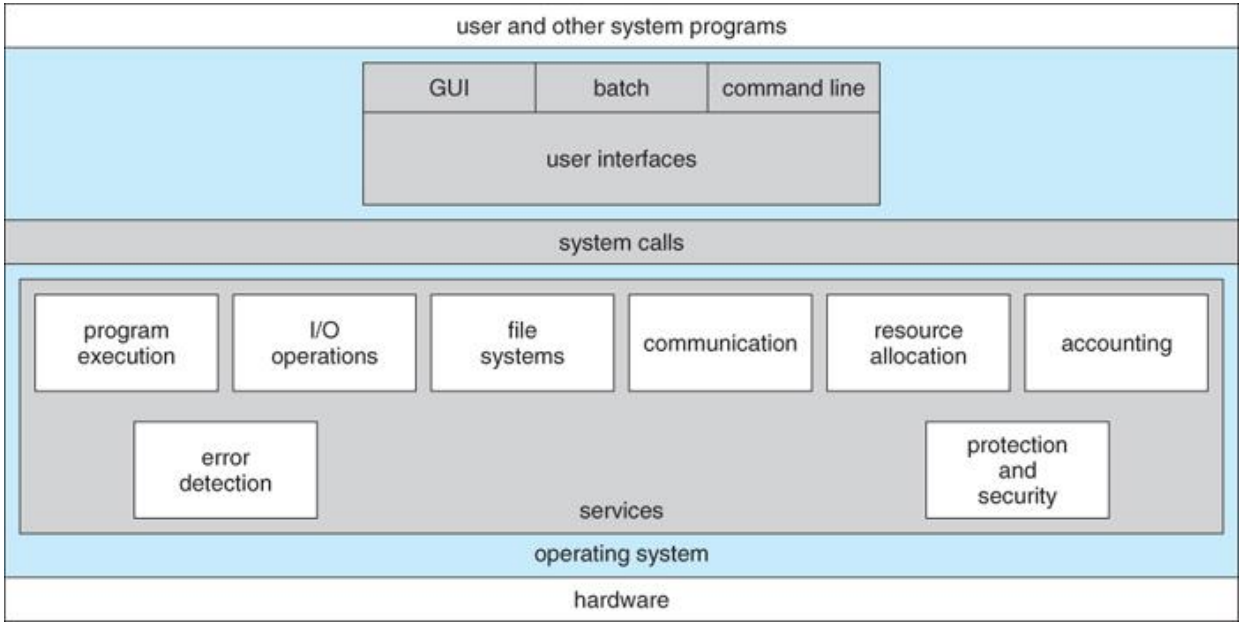
Operating System in Dual Mode





Operating System Services





Operating System Services

- The OS structure is divided into many sub-components.
  - Process Execution
  - Process Management
  - Memory Management
  - File Management
  - Storage Management
  - I/O Sub-system Management
  - Protection and Security
  - User Interface

Process Execution

- A process is a program in execution
- It is a unit of work within the system
- Program is a passive entity, process is an active entity.
- OS must be able to load a program into memory, run that program, and end execution
- Assign resources like CPU, memory, I/O, files, data to accomplish its task
- Process termination requires reclaim of any reusable resources

Process Management

- Creating and deleting both user and system processes
- Suspending and resuming processes
- Providing mechanisms for process synchronization
- Providing mechanisms for process communication
- Providing mechanisms for deadlock handling

Memory Management

- To execute a program all (or part) of the instructions must be in memory
- All (or part) of the data that is needed by the program must be in memory
- Memory management determines what is in memory and when
- Keeping track of which parts of memory are currently being used and by whom
- Deciding which processes and data to move into and out of memory
- Allocating and deallocating memory space as needed

File Management

- OS provides uniform, logical view of information storage
- Abstracts physical properties of storage to logical storage unit - file
  - Files are usually organized into directories
  - OS determines access control on files/directories that determine who can access what
- File-System management include
  - Creating and deleting files and directories
  - Primitives to manipulate files and directories
  - Mapping files onto secondary storage
  - Backup files onto stable (non-volatile) storage media

Storage Management

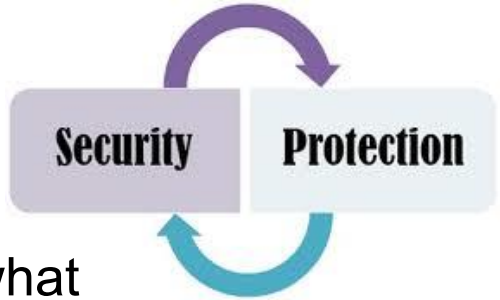
- Mass storage devices (disks/ tape drives) store data that does not fit in main memory or data that must be kept for a long period of time
- Devices vary in access speed, capacity, data-transfer rate, access method
- OS activities in disk management includes
  - Free-space management
  - Storage allocation
  - Disk scheduling

I/O Subsystem Management

- OS hides peculiarities of hardware devices from the user
- I/O subsystem responsible for
  - Buffering (storing data temporarily while it is being transferred)
  - Caching (storing parts of data in faster storage for performance)
  - Spooling (the overlapping of output of one job with input of other jobs)
  - Providing device-driver interface

Protection and Security

- **Protection** – any mechanism for controlling access of processes or users to resources defined by the OS
- **Security** – defense of the system against internal and external attacks
  - Huge range, including denial-of-service, worms, viruses, identity theft, theft of service



- Distinguish among users, to determine who can do what
  - User identities (user IDs) and associated access controls on resources
  - Group identifier (group ID) associated access controls on resources
  - Privilege escalation to change to give more rights

User Interface

- Provides a user-friendly platform to initiate actions from user side.
- The UI primarily receives command from user and executes it
- Command-Line Interface (CLI) allows direct command entry
- User-friendly desktop Graphical User Interface (GUI)
  - Usually mouse, keyboard, and monitor used for giving inputs.
  - Icons represent files, programs, actions, etc
  - Various mouse buttons over objects in the interface cause various actions (provide information, options, execute function, open directory)
- Many systems (Microsoft, Apple-Mac OS, UNIX) now include both CLI and GUI interfaces

johnjose@iitg.ac.in
http://www.iitg.ac.in/johnjose/