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Sri Lanka Institute of Information Technology

Faculty of Computing

IT2130 - Operating Systems and System Administration

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Year 02 and Semester 02

Lecture 01

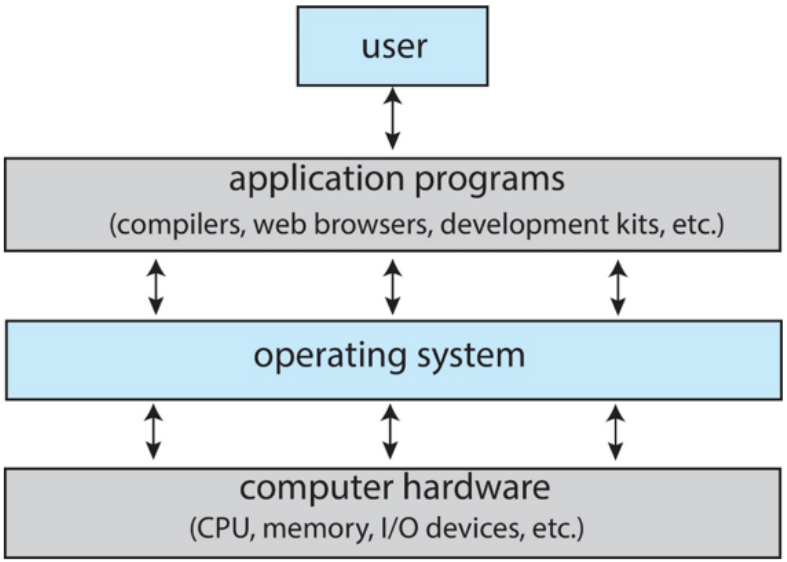
Introduction to Operating Systems Part I

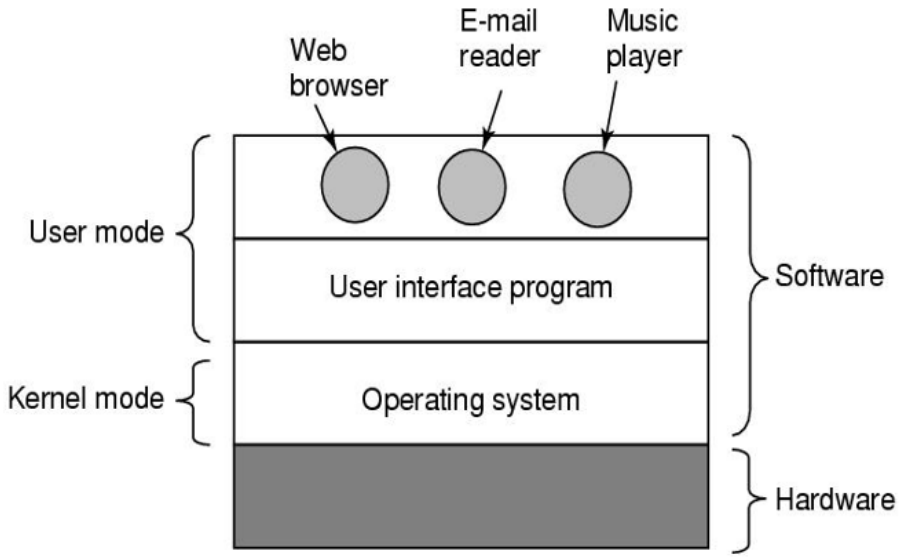
Computer System Structure

Computer system is divided into four components:

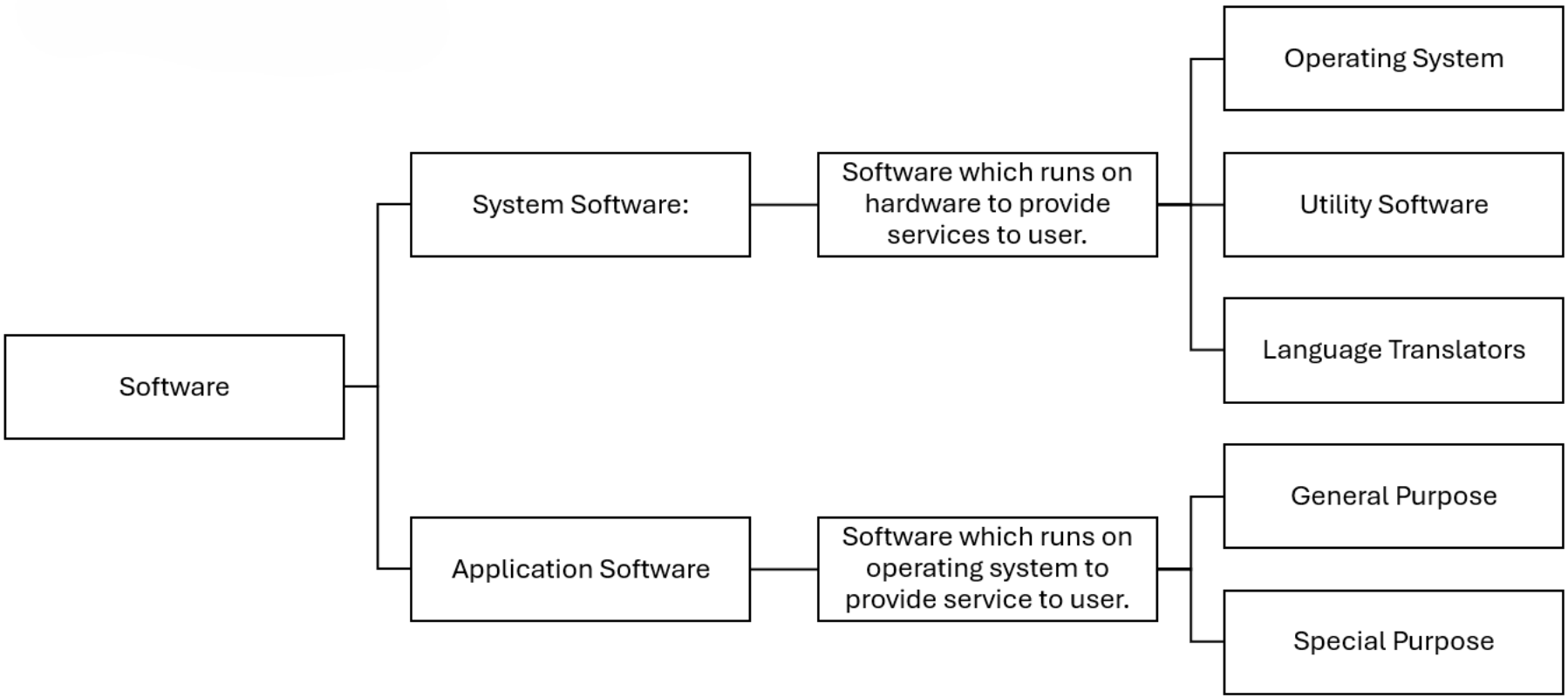
1. **Hardware** – provides basic computing resources (CPU, memory, I/O devices)
2. **Operating system** - Controls and coordinates use of hardware among various applications and users
3. **Application programs** – define the ways in which the system resources are used to solve the computing problems of the users (Word processors, compilers, web browsers, database systems, video games)
4. **Users** - People, machines, other computers

Abstract View of Components of Computer





Software


Software
System Software:
Software which runs on hardware to provide services to user.
Operating System
Utility Software
Language Translators
Application Software
Software which runs on operating system to provide service to user.
General Purpose
Special Purpose

What is an Operating System (OS)?

- An Operating System is a program that acts as an intermediary/interface between a user of a computer and the computer hardware.
- OS goals:
  - Control/execute user/application programs.
  - Make the computer system convenient to use.
  - Ease the solving of user problems.
  - Use the computer hardware in an efficient manner.

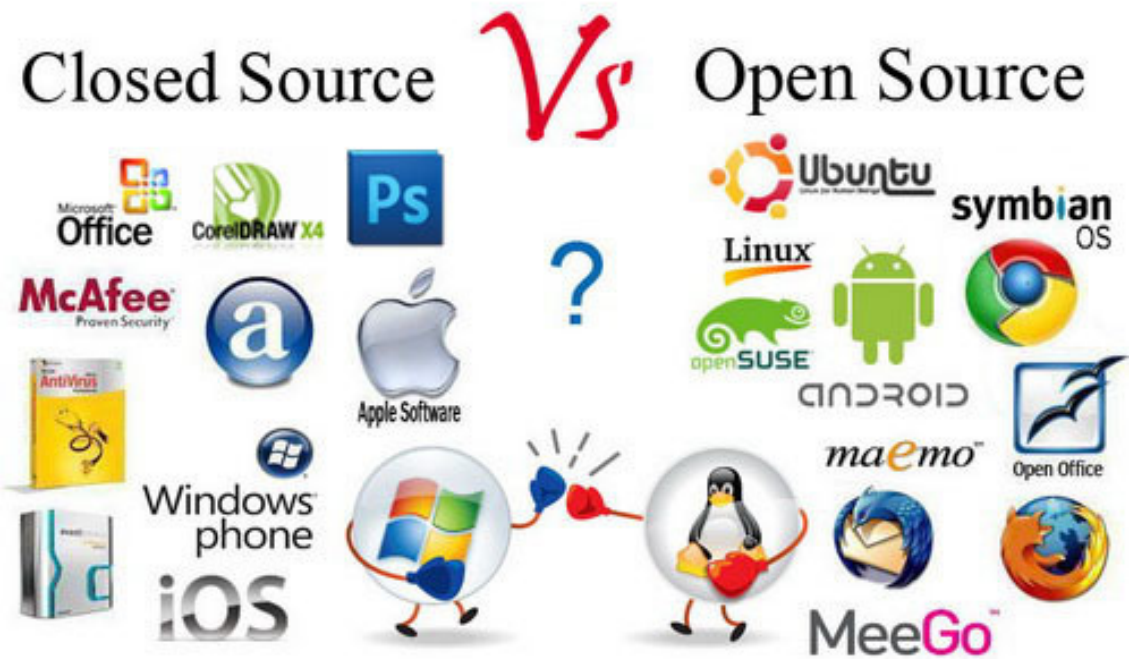
Purposes of using an Operating System

- Provide the environment for program execution and development
- Manage the resources of the computer (CPU, memory, IO devices, hard disk, files etc..)
- Provide the access controlling (username and password)

Main Types of Operating Systems

There are two types of Operating systems

1. **Open-Source OS** – Code is open and anyone can freely download the OS
2. **Closed-Source OS** – Code is locked and need to buy the OS.

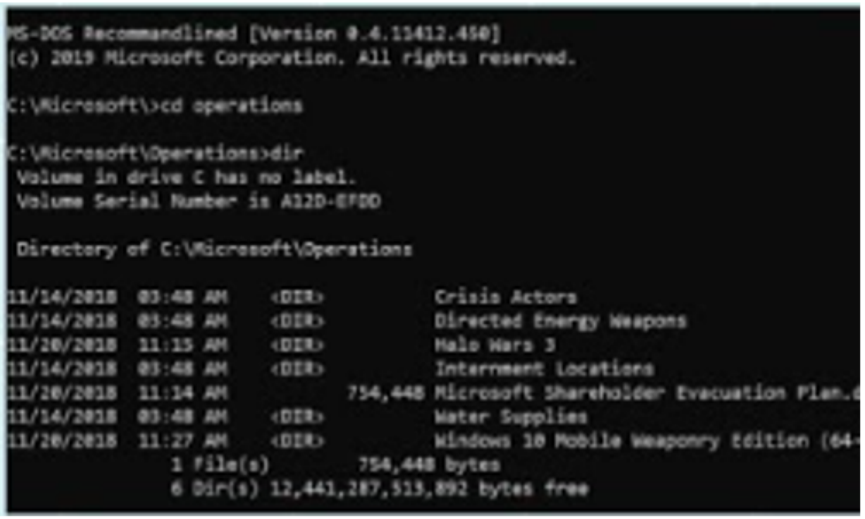


What is the User Interface of the Operating System

- A user interface of an operating system is the layer that allows users to interact with the computer's hardware and software.
- Users can provide inputs and displaying system responses in an understandable form.
- There are two types of User interfaces.
  - Command Line Interface - CLI
  - Graphical User Interface - GUI

Graphical User Interface and Command Line Interface

Graphical User Interface



Command Line Interface

Command line Interface Vs. Graphical User Interface

Command Line interface (CLI)

- Operates via commands and user has to remember those commands
- Not much user-friendly
- Less resources are need and thus, comparatively faster
- Command interpreter is the main component

Graphical User Interface (GUI)

- Provides a user-friendly environment
- Easy to get familiar with for a novice user
- Require more resources to function. Thus, comparatively slow
- Main components are icons, menus and pointer

Components of Operating Systems

- Process Management
- Main-memory management
- Secondary-storage management
- File Management
- I/O System Management
- Protection System
- Networking (Distributed Systems)
- Command-interpreter System

Services provided by Operating Systems

- Provide a user interface to work with the computer (UI)
  - Command line interface (CLI)
  - Graphical user interface (GUI)
- Provide environment for program execution.
  - OS loads programs and run them
  - OS handles the completion of program execution, normally or abnormally.

Services provided by Operating Systems

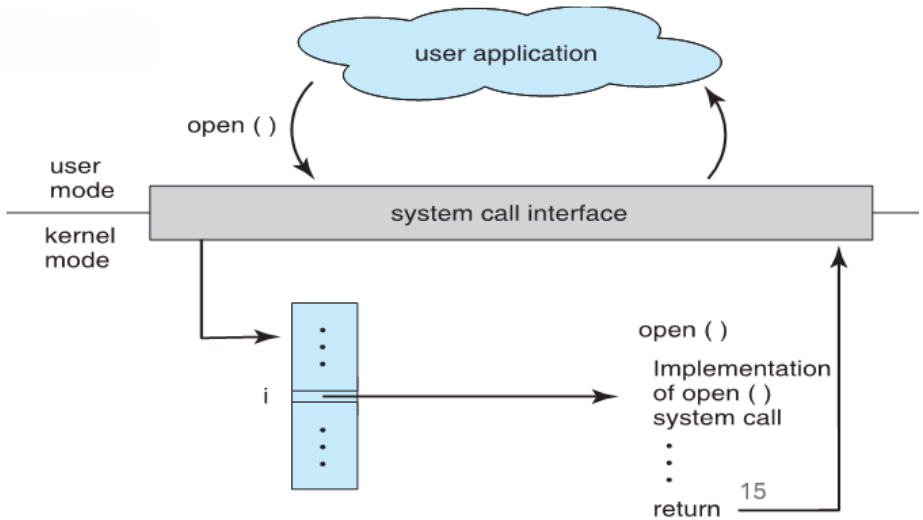
- Provide support to execute I/O operations
  - user programs cannot execute I/O operations directly.
- Provide mechanism to do file-system manipulation.
  - Capability to read, write, create, and delete files, directory trees etc.
- Provide mechanism for process communication.
  - Exchange information between processes executing on the same computer or on different systems through a network.
- Detect device errors and program errors and take appropriate actions to ensure correct and consistent computing.

Services provided by Operating Systems

- **Resource allocation**
  - Allocating resources to multiple users or multiple jobs running at the same time (CPU scheduling, etc.)
- **Accounting**
  - Keep track of and record which users use how much and what kinds of computer resources for account billing or for accumulating usage statistics
- **Protection and security**
  - Ensuring that all access to system resources is controlled (access permissions, etc.).

System Calls

- A system call is a user interface to the OS services
- System call result/termination.
  - Normal termination (exit or return).
  - Terminate current program and return to the command interpreter.
  - Abnormal termination (trap) program error.



Examples for System Calls

Name and the task of the System Call	Examples
Process control End, abort (running program), load, execute, create, terminate, signal event	fork(), exit(), wait(),
File management Create, delete, open, close; read, write, reposition, get and set file attributes,	open(), read(), write(), close(),
Device management (memory, tape drives etc.) Request device, release device, read, write, reposition,	ioctl(), read(), write(),
Information maintenance Get or set time or date, Get or set process attributes	getpid(), alarm(), sleep(),
Communications Create, delete communication connection, Send and receive messages	pipe(), shmget(), mmap()
Protection Resource access control	chmod(), umask(), chown(),

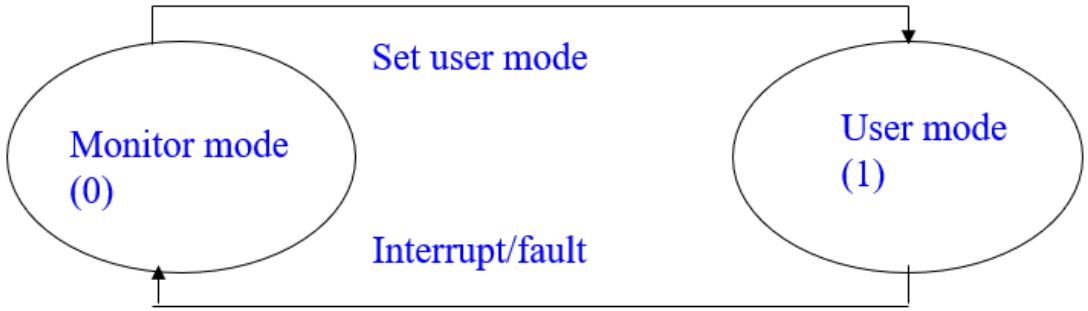
System programs or utilities

- Set of tools provided by the operating system to help users manage files, devices, and system settings easily.

- System programs can be divided into:
  - **File manipulation**: Create, delete, copy, rename, print, dump, list.
  - **Status information**: Date, time, memory, disk space, number of users.
  - **File modification**: Text editors to create and modify content of files.
  - **Programming-language support**: Compilers, interpreters, assemblers.
  - **Program loading and execution**: Absolute, Relocatable, Overlay loaders.
  - **Communication**: Programs that provide the mechanism for creating virtual connections among processes, users, and different computer systems.

Operations of Operating Systems

- **Dual Mode Operation** - Hardware provides least two modes of operations.
  - **User mode** – The mode the user programs run.
  - **Monitor mode** – known as Supervisor, System, or privileged mode. This mode is for the operating system's core.
- Mode bit is provided by the hardware to indicate the current mode: monitor (0) or user (1).



Operations of Operating Systems

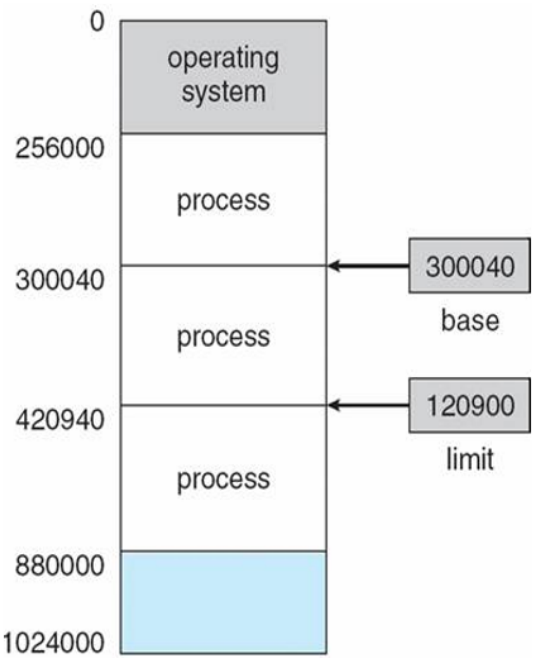
- Some machine instructions that may cause harm are known as **privileged instructions**.
- A privileged instruction can be executed only in monitor mode.
- At system boot-time (While the OS loads) the hardware starts in monitor mode
- OS starts user processes in user mode; a user process could never gain control of the computer in monitor mode.
- When an interrupt or fault occurs hardware switches to monitor mode.

Operations of Operating Systems

- Operating System performs I/O device protection - privileged instructions.
- User programs perform I/O operations using system call.
  - Usually takes the form of a trap to a specific location in the interrupt vector.
  - Control passes through the interrupt vector to a service routine in the OS, and the mode bit is set to a monitor mode.
  - The monitor verifies that the parameters are correct and legal, executes the request, and returns control to the instruction following the system call.

Operations of Operating Systems

- Operating System provides memory protection
  - It has unrestricted access to monitor and user memory
  - Use two registers that determine the range of legal addresses a program
  - **Base register** – holds the smallest legal physical memory address.
  - **Limit register** – contains the size of the range.
  - Memory outside the defined range is protected.
  - The load instructions for the base and limit registers are privileged instructions.



Operations of Operating Systems

- Operating System provides CPU protection.
  - It has to prevent using the CPU by one user all the time
  - Use *timer* interrupt after specified period to ensure OS maintains control
    - Timer is decremented every clock tick.
    - When timer reaches value 0, an interrupt occurs.
  - Timer is commonly used to implement time sharing.
  - Loading timer value is a privileged instruction.

Interrupts and it's Types

- Interrupts are signals sent to the CPU by external devices, normally I/O devices.
- It suspends the execution of one program and begins the execution of another program.

- There are three types of interrupts:
  - **Hardware Interrupts**: These are generated by hardware devices to signal that they need some attention from the OS.
  - **Software Interrupts**: These are generated by programs when they want to request a system call to be executed by the operating system.
  - **Traps**: These are generated by the CPU itself to indicate that some error or condition occurred for which assistance from the operating system is needed.

Interrupt Handling

- Interrupt suspends the running program in the CPU and handover the control to the OS.
- The OS keeps the state about the suspended program in the registers (Program Counter).
- Each interrupt has a separate segments of code (Interrupt Service Routine - ISR) in the OS that must determine what action should be taken.
- The address of the ISR for the interrupts are available in the Interrupt Vector – IV in memory.
- Operating system provides memory protection at least for the ISR and the IV.

Operating System Design Goals

- Design of the OS is affected by the hardware choice, and system type.
  - **User goals**
    OS should be convenient to use, easy to learn, reliable, safe, and fast.
  - **System goals**
    OS should be easy to design, implement, and maintain, as well as flexible, reliable, error-free, and efficient

Operating System Design Goals

- Separation of *policy* and *mechanism* is a very important principle
  - Mechanisms determine how to do something
  - Policies decide what will be done.

- Policies are likely to change from place to place and time to time, and therefore a general mechanism would be more desirable.

- Example: A mechanism for ensuring CPU protection is the timer construct; and the decision on how long the timer is set for a particular user is a policy decision.

End of Lecture 1

Weekly plan

- **Practical**: Introducing C programming
- **Workshop**:
  - Summary - Introduction to Operating Systems
  - Discussion of Tutorial 1


THANK
YOU!