COMP 3410: OPERATING SYSTEMS

Course Description

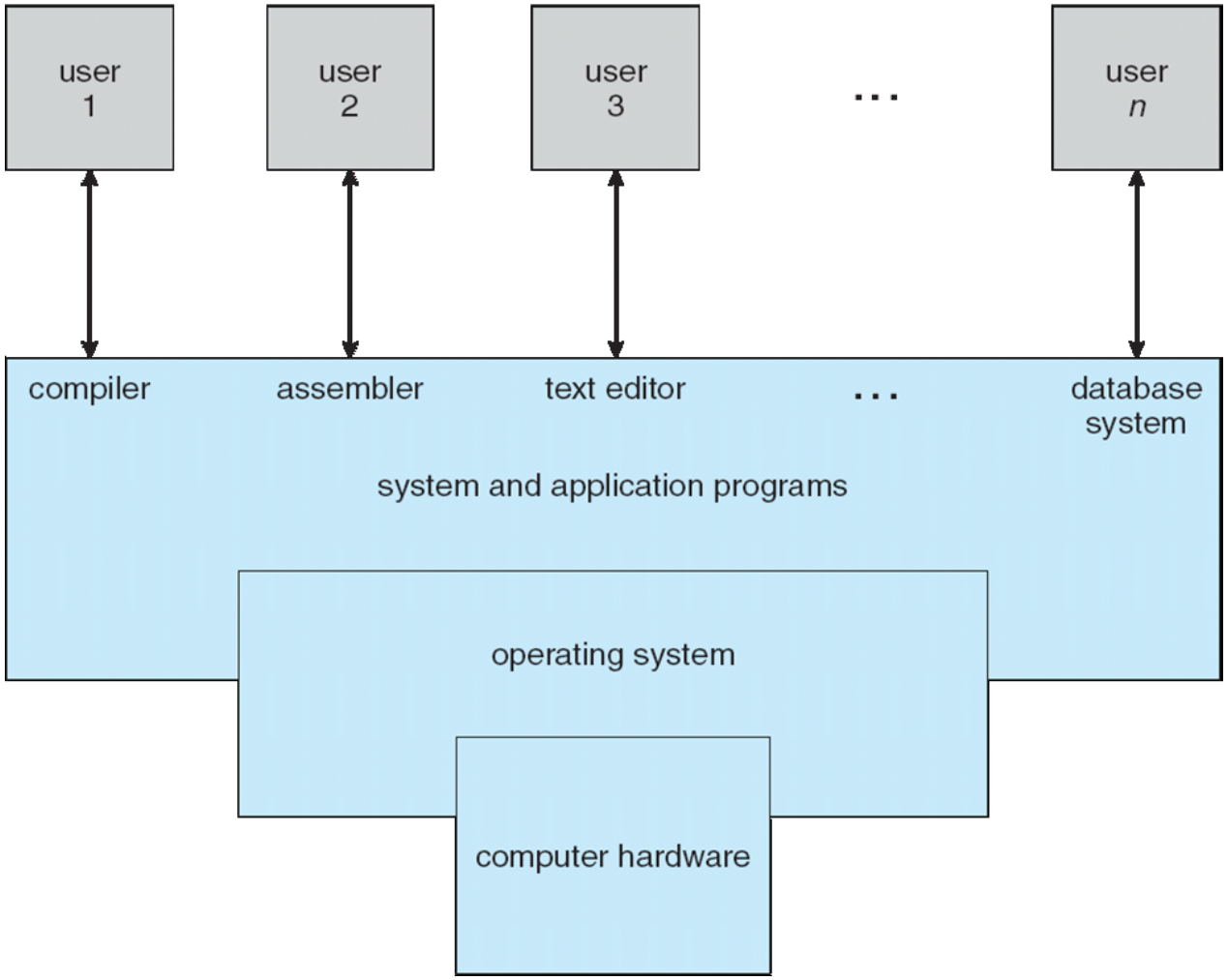
This course discusses principles and techniques for the design and implementation of operating systems: computer resource management (memory management, processor management, I/O management, file management, process management and security management) and process communication.

Chapter 1: Introduction

Objectives

- To provide a tour of the major operating systems components
- To provide coverage of basic computer system organization

Four Components of a Computer System



Computer System Structure

- Computer system can be divided into four components
  - Hardware – provides basic computing resources
    - CPU, memory, I/O devices
  - Operating system
    - Controls and coordinates use of hardware among various applications and users
  - 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
  - Users
    - People, machines, other computers

What is an Operating System?

- A program that acts as an intermediary between a user of a computer and the computer hardware.
- **Every computer must have an Operating System (Supervisor, controller, Manager)**
- 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

What Operating Systems Do

- Depends on the point of view (User's view)
- Users want convenience, **ease of use** and **good performance**
  - Don't care about **resource utilization**
- But shared computer such as **mainframe** or **minicomputer** must keep all users happy
- Users of dedicate systems such as **workstations** have dedicated resources but frequently use shared resources from **servers**
- Handheld computers are resource poor, optimized for usability and battery life
- Some computers have little or no user interface, such as embedded computers in devices and automobiles

Operating System Definition

- OS is a **resource allocator**
  - Manages all resources
  - Decides between conflicting requests for efficient and fair resource use
- OS is a **control program**
  - Controls execution of programs to prevent errors and improper use of the computer

Common Functions of Interrupts

- The occurrence of an event is usually signalled by an interrupt from either the hardware or the software.
- Hardware may trigger an interrupt at any time by sending a signal to the CPU, usually by way of the system bus.
- Software may trigger an interrupt executing a special operation called a system or monitor call.

Common Functions of Interrupts

- Interrupt transfers control to the interrupt service routine generally, through the **interrupt vector**, which contains the addresses of all the service routines
- Interrupt architecture must save the address of the interrupted instruction
- Incoming interrupts are *disabled* while another interrupt is being processed to prevent a *lost interrupt*
- A ***trap*** **i**s a software-generated interrupt caused either by an error or a user request
- An operating system is **interrupt driven**

Caching

- Important principle, performed at many levels in a computer (in hardware, operating system, software)
- Information in use copied from slower to faster storage temporarily
- Faster storage (cache) checked first to determine if information is there
  - If it is, information used directly from the cache (fast)
  - If not, data copied to cache and used there
- Cache management is an important problem to deal with the limited size of cashe. Careful selection of the cache size can result in greatly increased performance.

Operating System Structure

- **Multiprogramming** 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 for example), OS switches to another job

Process Management

- 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*.
- Process needs resources to accomplish its task
  - CPU, memory, I/O, files
  - Initialization data
- Process termination requires reclaim of any reusable resources
- Single-threaded process has one **program counter** specifying location of next instruction to execute
  - Process executes instructions sequentially, one at a time, until completion

Process Management Activities

- The operating system is responsible for the following **FIVE** activities in connection with 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

- All data in memory before and after processing
- All instructions in memory in order to execute
- Memory management determines what is in memory when
  - Optimizing CPU utilization and computer response to users
- **THREE** memory management activities of operating system
  - Keeping track of which parts of memory are currently being used and by whom
  - Deciding which processes (or parts thereof) and data to move into and out of memory
  - Allocating and deallocating memory space as needed

Storage Management

- OS provides uniform, logical view of information storage
  - Abstracts physical properties to logical storage unit - **file**
  - Each medium is controlled by device (i.e., disk drive, tape drive)
    - Varying properties include access speed, capacity, data-transfer rate, access method (sequential or random)
- **File-System management**
  - Files usually organized into directories
  - Access control on most systems to determine who can access what
  - OS responsibilities include these **FIVE** activities
    - Creating and deleting files
    - Creating and deleting directories to organize files
    - Supporting primitives to manipulate files and directories
    - Mapping files onto secondary storage
    - Backup files onto stable (non-volatile) storage media

Mass-Storage Management

- Usually disks used to store data that does not fit in main memory or data that must be kept for a “long” period of time
- Proper management is of central importance
- Entire speed of computer operation hinges on disk subsystem and its algorithms
- OS is responsible for these **THREE** activities:
  - Free-space management
  - Storage allocation
  - Disk scheduling

Protection and Security

- **Protection** – any mechanism for controlling access of processes or users to resources defined by the OS
- **Security** – defence of the system against internal and external attacks
  - Huge range, including denial-of-service, worms, viruses, identity theft, theft of service
- Systems generally first distinguish among users, to determine who can do what
  - User identities (**user IDs**, security IDs) include name and associated number, one per user
  - User ID then associated with all files, processes of that user to determine access control
  - Group identifier (**group ID**) allows set of users to be defined and controls managed, then also associated with each process, file
  - **Privilege escalation** allows user to change to effective ID with more rights

Review

- Introduction
- Computer System Structure
- Computer system organization
- Interrupts
- Cashing
- OS structure and Functions

End of Chapter 1

Quiz

1. …….. is a program that acts as an intermediary between a user of a computer and the computer hardware.
2. Four components of a computer system are ……., …….., …… and ……..
3. Text editor is an example for ……?
4. In general, the functions of OS are to act as a …….. and ……
5. …….. is a software-generated interrupt caused either by an error or a user request.
6. What are the main functions of OS?