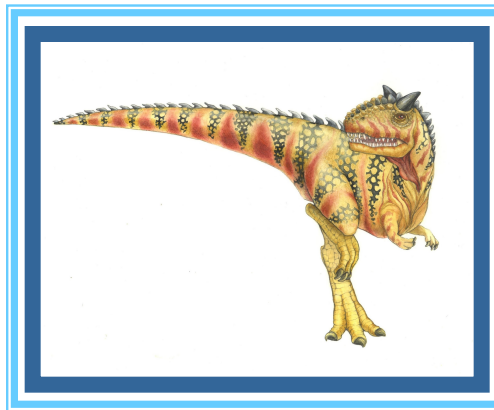


Chapter 1: Introduction





Use of computer

- Web browsing -> Web browser
- Watching video -> Media player
- Text editing -> Office software
- Email -> Web browser

For each use, there is a program.





What is an Operating System?

- A program that acts as an intermediary between a user of a computer and the computer hardware.
- “The one program running at all times on the computer” is the **kernel**. Everything else is either a system program (ships with the operating system) or an application program.





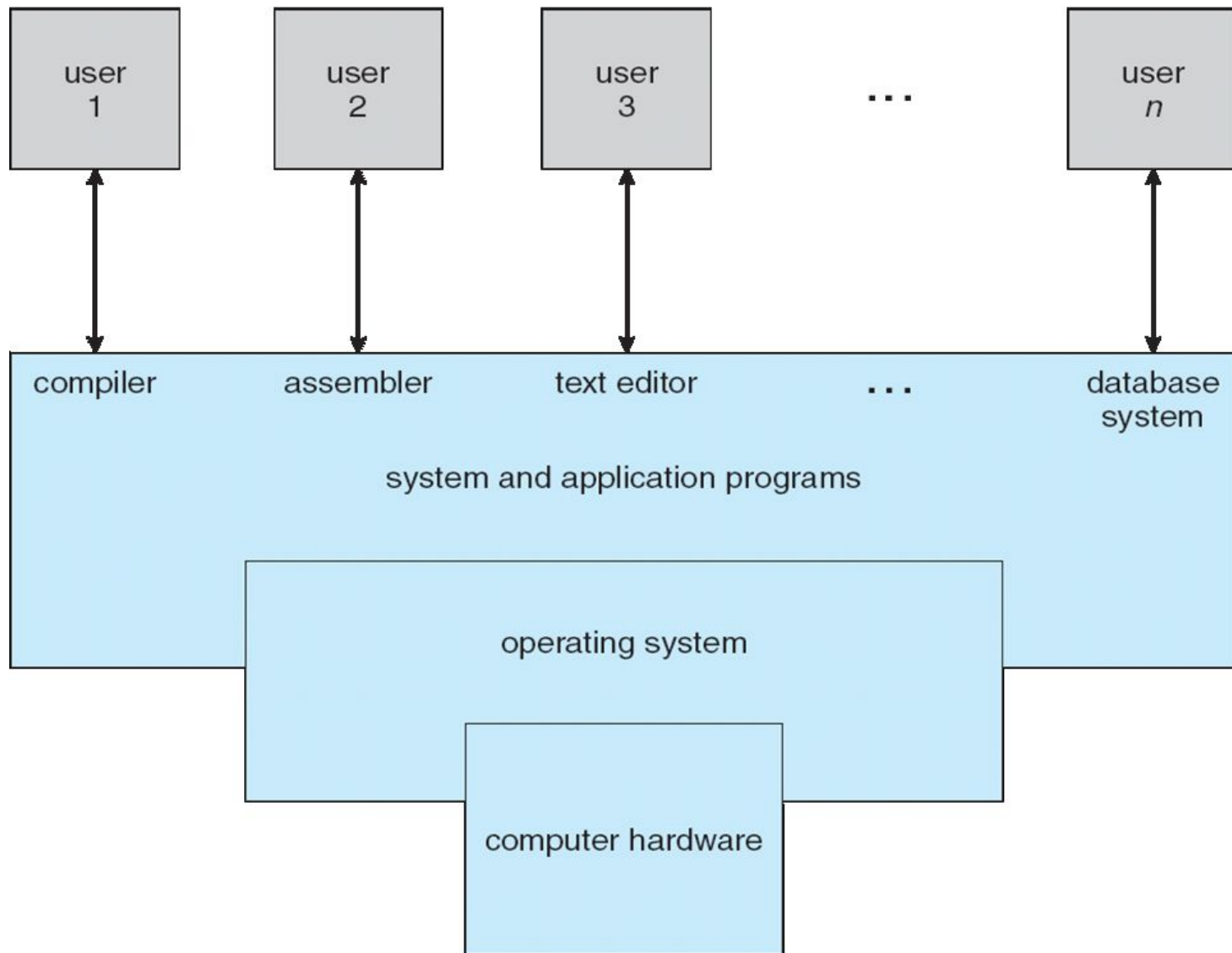
Computer System Structure

- Computer system can be divided into four components:
 - Hardware
 - 4 CPU, memory, I/O devices
 - Operating system
 - 4 Controls and coordinates use of hardware among various applications and users
 - Application programs
 - 4 Word processors, compilers, web browsers, database systems, video games
 - Users
 - 4 People, machines, other computers





Four Components of a Computer System





Operating System Functions

- 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
 - Error in one program should not affect other programs





Computer Startup

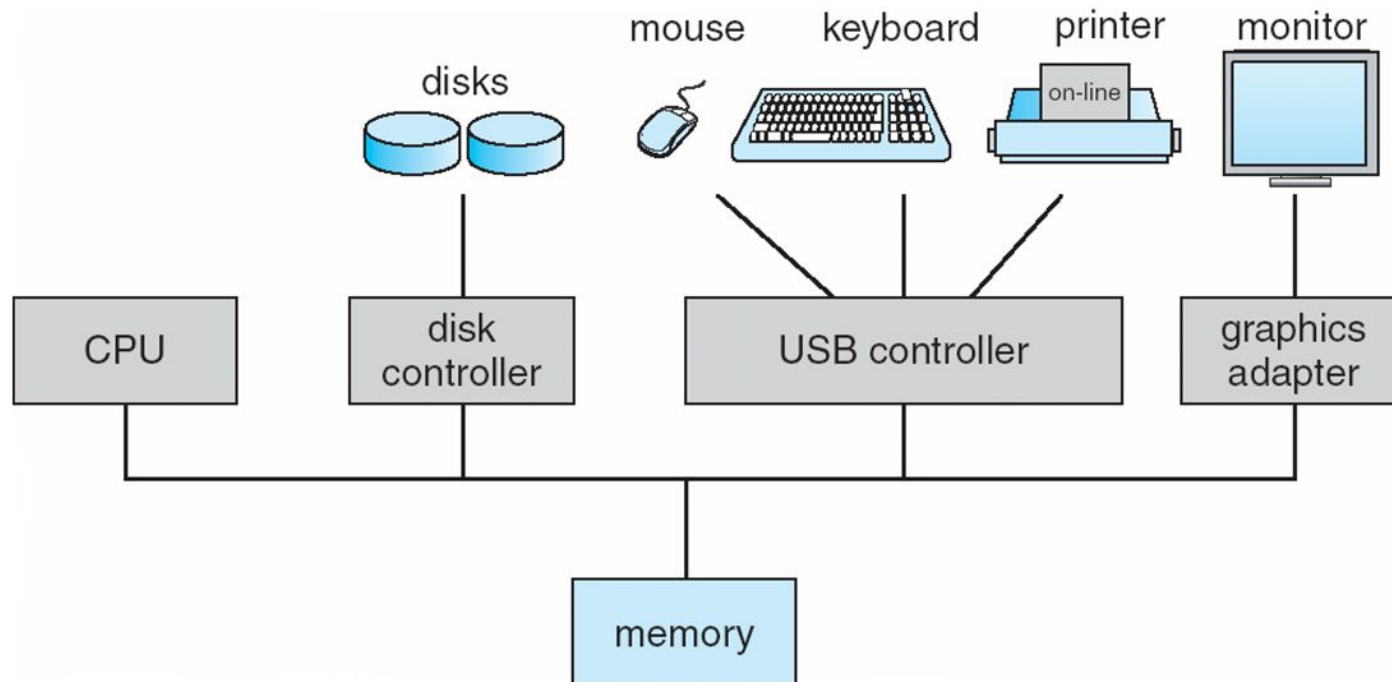
- **bootstrap program** is loaded at power-up or reboot
 - Typically stored in ROM or EPROM, generally known as **firmware**
 - Initializes all aspects of system
 - Loads operating system kernel and starts execution





Computer System Organization

- Computer-system operation
 - One or more CPUs, device controllers connect through common bus providing access to shared memory
 - Concurrent execution of CPUs and devices competing





Computer-System Operation

- I/O devices and the CPU can execute concurrently
- Each device controller is in charge of a particular device type
- Each device controller has a local buffer
- CPU moves data from/to main memory to/from local buffers
- I/O is from the device to local buffer of controller
- Device controller informs CPU that it has finished its operation by causing an **interrupt**





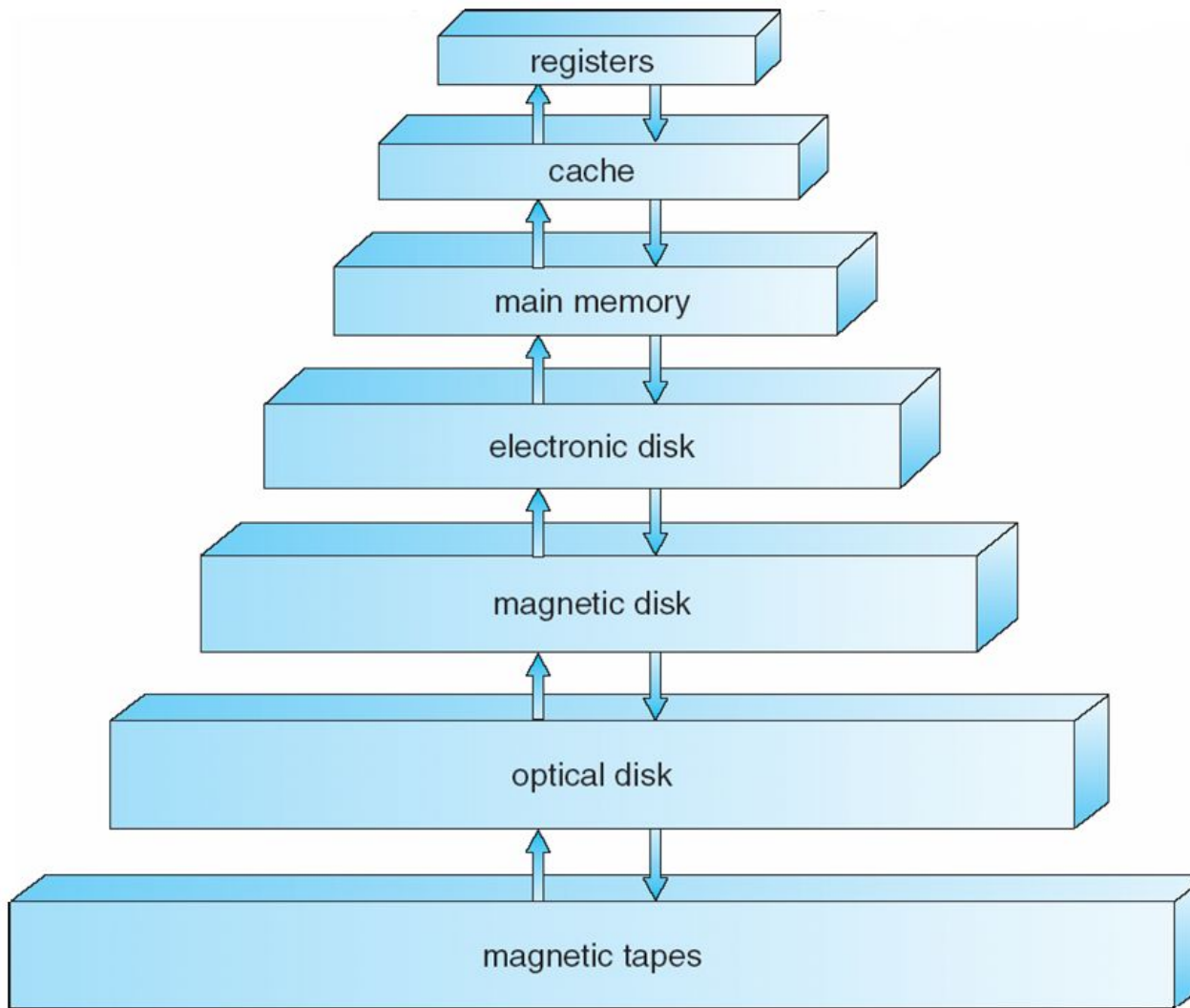
Storage Hierarchy

- Storage systems organized in hierarchy
 - Speed
 - Cost
 - Volatility
- **Caching** – copying information into faster storage system; main memory can be viewed as a *cache* for secondary storage





Storage-Device Hierarchy





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 smaller than storage being cached
 - Cache management important design problem
 - Cache size and replacement policy





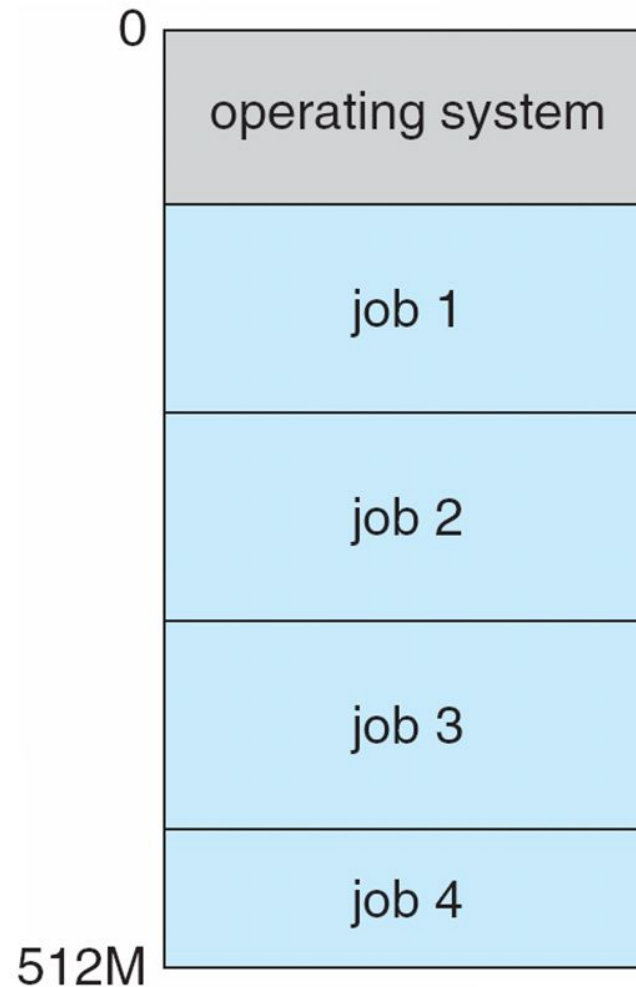
Operating System Structure

- **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
- **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
 - **Response time** should be < 1 second
 - Each user has at least one program executing in memory □ **process**
 - If several jobs ready to run at the same time □ **CPU scheduling**
 - If processes don't fit in memory, **swapping** moves them in and out to run
 - **Virtual memory** allows execution of processes not completely in memory





Memory Layout for Multiprogrammed System





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
- Multi-threaded process has one program counter per thread





Process Management Activities

The operating system is responsible for the following 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
- Memory management activities
 - 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)
 - 4 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 activities include
 - 4 Creating and deleting files and directories
 - 4 Primitives to manipulate files and dirs
 - 4 Mapping files onto secondary storage
 - 4 Backup files onto stable (non-volatile) storage media





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



End of Chapter 1

