Introduction

Reading:

Silberschatz

chapter 1

Additional Reading:

Stallings

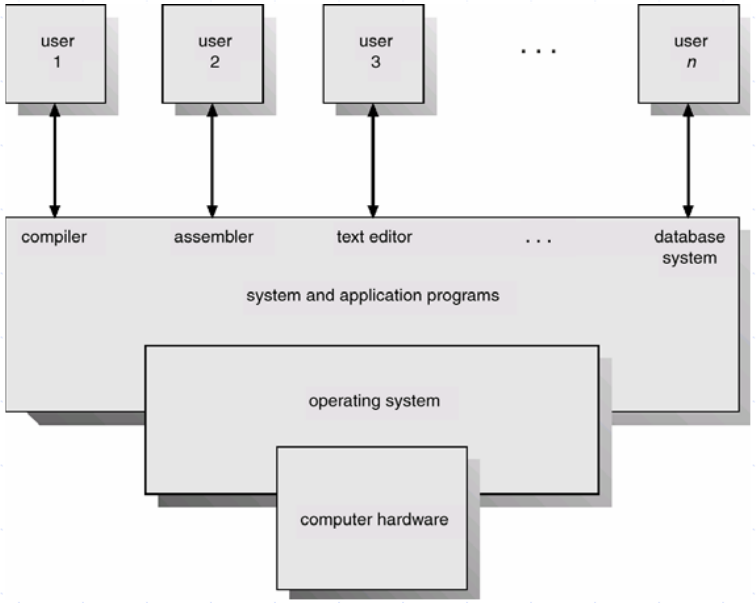
chapter 1

Outline

- Computer System
- What is an Operating System
- Mainframe System
- Desktop System
- Multiprocessor System
- Clustered System
- Real-Time System
  - Hard Real-Time
  - Soft Real-Time
- Handheld System

Computer System

Computer System has roughly four components



- Hardware – Basic computing resources (CPU, memory, I/O devices)
- Users – People, machines and other computers
- Application Programs – Usage of system resources to solve the computing problems (*e.g.* compilers, database systems, video games, business programs)
- Operating System – Controls and coordinates the use of the hardware among the various application programs for the various users

What is an Operating System?

- A program that controls execution of application programs and acts as interface between applications and hardware

- OS Definitions

  Resource allocator – manages and allocates resources

  Control program – controls the execution of user programs and operations of I/O devices

  Kernel – the one program running at all times (all else being application programs)

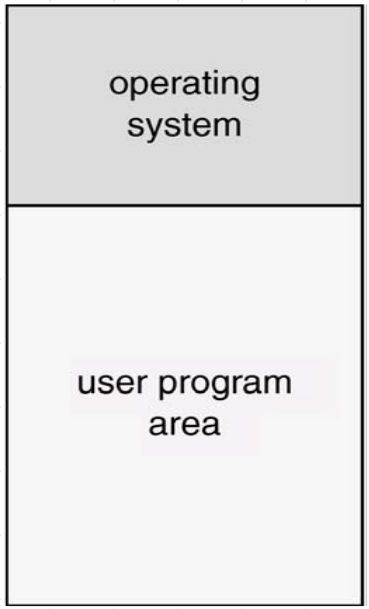
- Operating System Goals
  - Convenience
  - Efficiency
  - Ability to evolve

Mainframe Systems

- Early computers
  - Growth from batch → time-shared systems
- Batch Systems
  - Batch the jobs with similar needs and ran as group
  - First rudimentary operating system
  - Major OS task – transfer control automatically from one job to next
  - Serial Card Reader -1200 CPM
  - Modern OS allow all jobs on disk rather than in serial card reader, job scheduling

Mainframe Systems

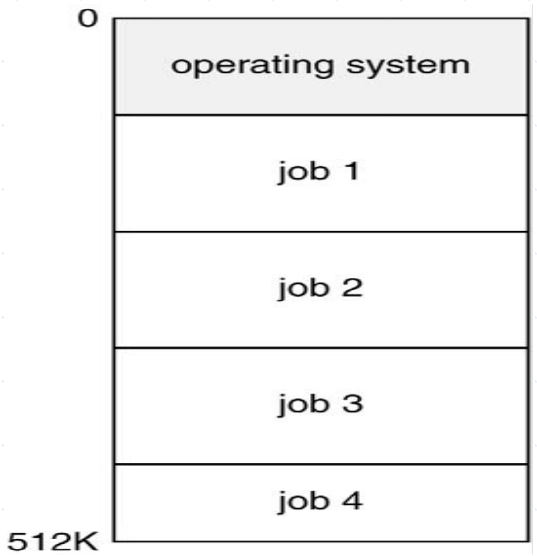
- Monitor
  - Resident Monitor → Always in main memory
  - Each job → Instructions in *JCL* ($LOAD, $RUN)



Memory layout for a simple batch system

Mainframe Systems

- Generally a single user cannot keep either CPU or I/O devices busy at all times
- Multiprogrammed Systems
  - Increases CPU utilization
  - Several jobs are kept in main memory at the same time and CPU is multiplexed among them



Memory layout for multiprogramming system

Mainframe Systems

- Slow I/O

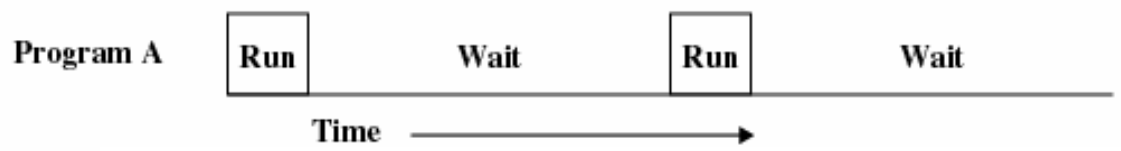
Read one record from file	15 µs
Execute 100 instructions	1 µs
Write one record to file	15 µs
TOTAL	31 µs

Percent CPU Utilization $= \frac{1}{31} = 0.032 = 3.2\%$

Mainframe Systems

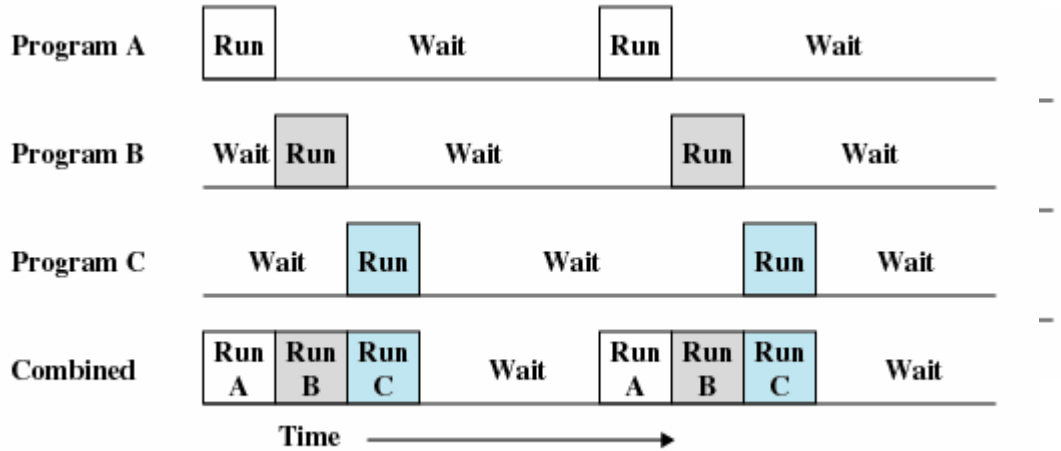
Uniprogramming

- Processor must wait for I/O instruction to complete before preceding



Multiprogramming

- When one job needs to wait for I/O, the processor can switch to the other job



Mainframe Systems

- OS features for multiprogramming system
  - Job Scheduling
  - Memory Management – the system must allocate the memory to several jobs
  - CPU Scheduling
  - Process Scheduling

Mainframe Systems

- Time-Sharing → Logical extension of multiprogramming

- Time-Sharing Systems
  - Time-shared OS allows many users to share the computer simultaneously
  - Response time
  - Jobs swapped in and out of memory to the disk
  - Common feature – Virtual Memory

Mainframe Systems

- Birth of UNIX in 1960s; CTSS → MULTICS → UNIX

Dennis Ritchie (standing) and Ken Thompson begin porting UNIX to the PDP-11 via two Teletype 33 terminals
http://www.bell-labs.com

Desktop Systems

- *Personal computers* → Computer system dedicated to a single user
- Neither multiuser nor multitasking
  - Earlier Goals →Maximize CPU & Peripheral utilization
  - Now → *User convenience and responsiveness*
- Earlier I/O devices – keyboards, mice, display screens, small printers
- May run several different types of operating systems (Windows, MacOS, UNIX, Linux)

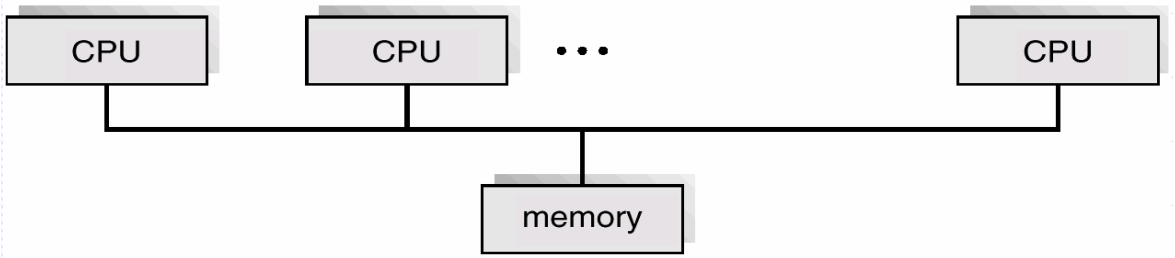
Parallel Systems

- Also known as *multiprocessor systems* or *tightly coupled systems*
- Operate with more than one CPU in close communication
- Processors share memory and a clock; communication usually takes place through the shared memory

- Advantages of Parallel Systems:
  - Higher throughput – increases but less than *N*
  - Economical – *Sharing*
  - Higher reliability - graceful degradation, fault tolerant

Parallel Systems

- Symmetric multiprocessing (SMP)
  - Each processor runs and identical copy of the operating system
  - Many processes can run at once without performance deterioration
  - Most modern operating systems support SMP (*Windows NT, Solaris, Digital UNIX, OS/2, Linux*)



Architecture of general SMP system

Parallel Systems

- Asymmetric multiprocessing
  - Each processor is assigned a specific task
  - Master processor schedules and allocated work to slave processors
  - More common in extremely large systems

Clustered Systems

- Unlike multiprocessor systems, two or more individual systems coupled together
- Clustering allows two or more systems to share storage, *definitions*
- Service even if one or more cluster fails
- Higher *reliability* by adding *redundancy*

- Asymmetric clustering
  - One machine is in *hot-standby* while other running applications
  - *Hot-standby* machine only monitors the active server
  - If server fails, *hot-standby* machine $\rightarrow$ active server

- Symmetric clustering
  - Two or more hosts are running applications and *monitoring each other*
  - More efficient

- Rapid advances in Cluster Technology, clustering over *WANs*, *SANs*

Real-Time Systems

- Special purpose OS with rigid time constraints
- Used in dedicated application, *e.g*. control systems, imaging systems, display systems
- Fixed time constraints, returns the correct results within its time-constraints
- Time-sharing systems, desirable but NOT mandatory
- Real-Time systems may be either *hard* or *soft* real-time

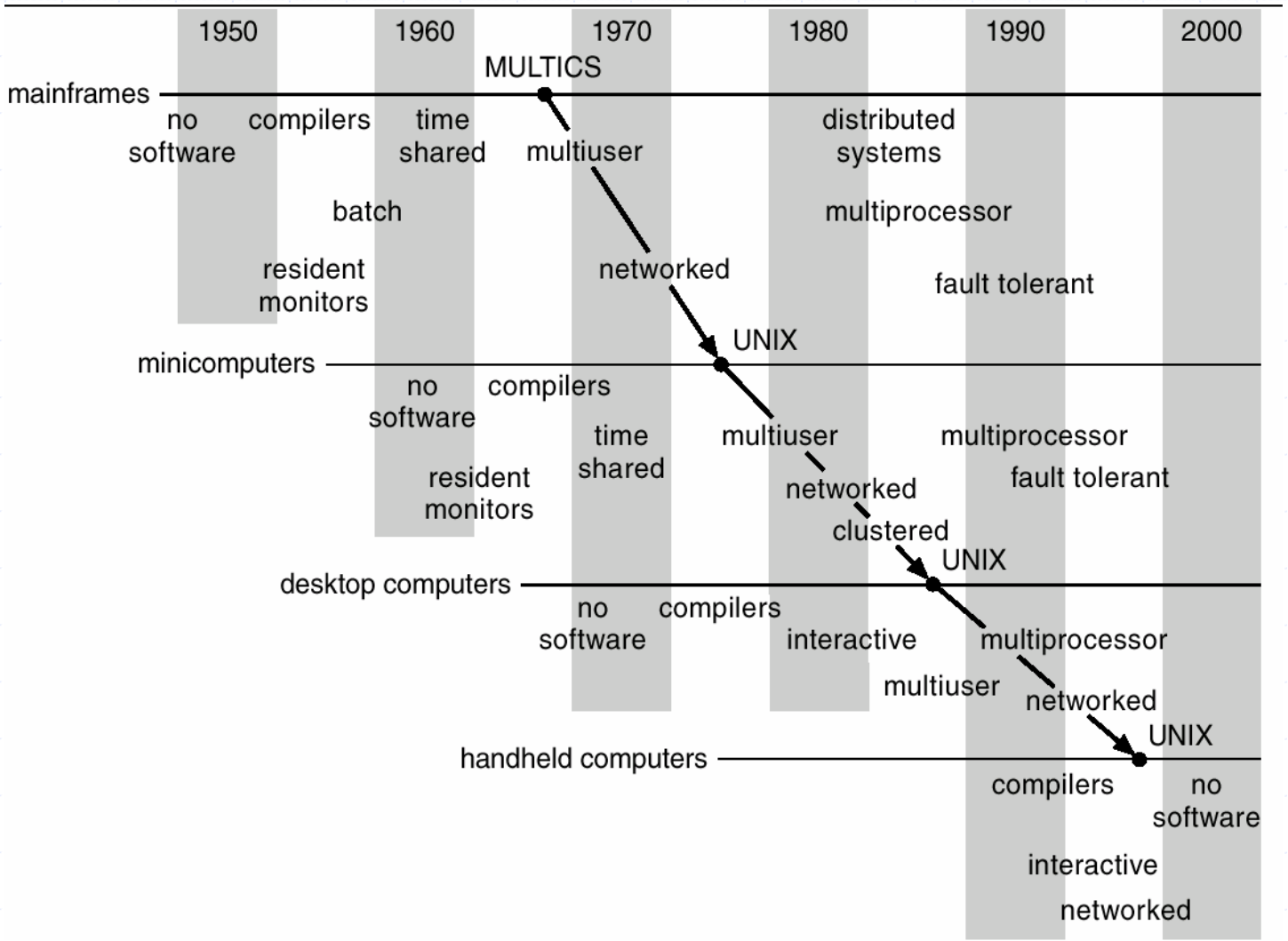
Real-Time Systems

- Hard real-time
  - *Guarantees* completion of critical task in time
  - Secondary storage limited or absent, data stored in short term memory, or read-only memory (ROM)
  - Conflicts with time-sharing systems, not supported by general-purpose operating systems
- Soft real-time
  - Less restrictive, critical real-time task has priority
  - Retains this priority until its completion
  - Lack of deadline support, risky for robotics/control
  - Useful in applications (multimedia, virtual reality) requiring advanced OS features (not supported in hard real-time systems)

Handheld Systems

- Personal Digital Assistants (PDAs)
- Connectivity to Internet, cellular telephones
- Limited size (typically 5’×3’)
- Issues:
  - Limited memory, no VM, 512KB - 8MB
  - Slow processors, Less power availability
  - Small display screens, web clipping

Migration of OS Concepts and Features



Computing Environments

- Traditional Computing
- Web-Based Computing
- Embedded Computing