

Introduction

Reading:

Silberschatz

chapter 1

Additional Reading:

Stallings

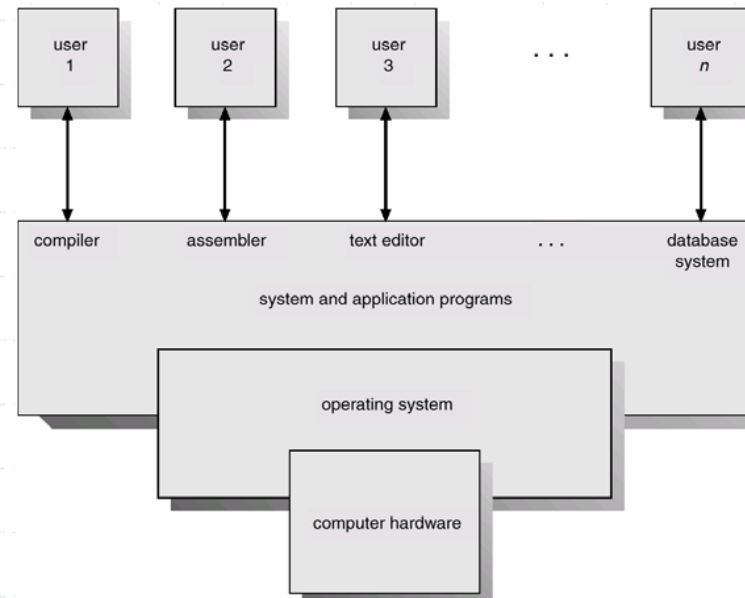
chapter 1

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

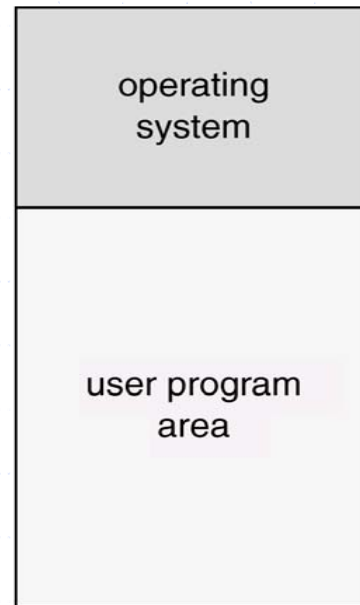
➤ Batch Systems

- 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

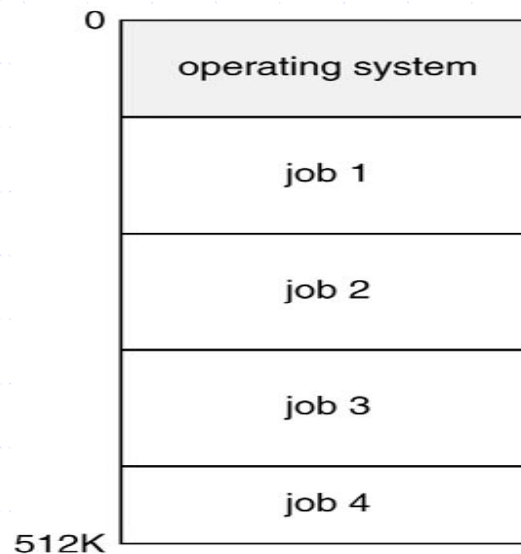
- Resident Monitor → Always in main memory
- Each job → Instructions in *JCL* (*\$LOAD*, *\$RUN*)



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

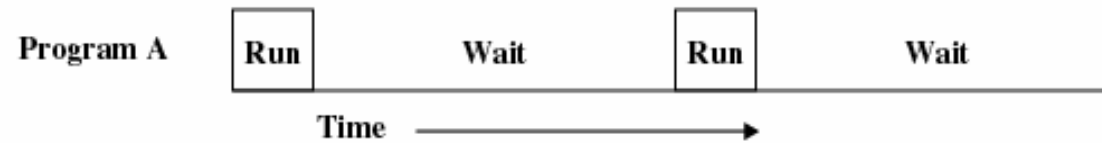
Read one record from file	15 μ s
Execute 100 instructions	1 μ s
Write one record to file	<u>15 μs</u>
TOTAL	31 μ s

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

Mainframe Systems

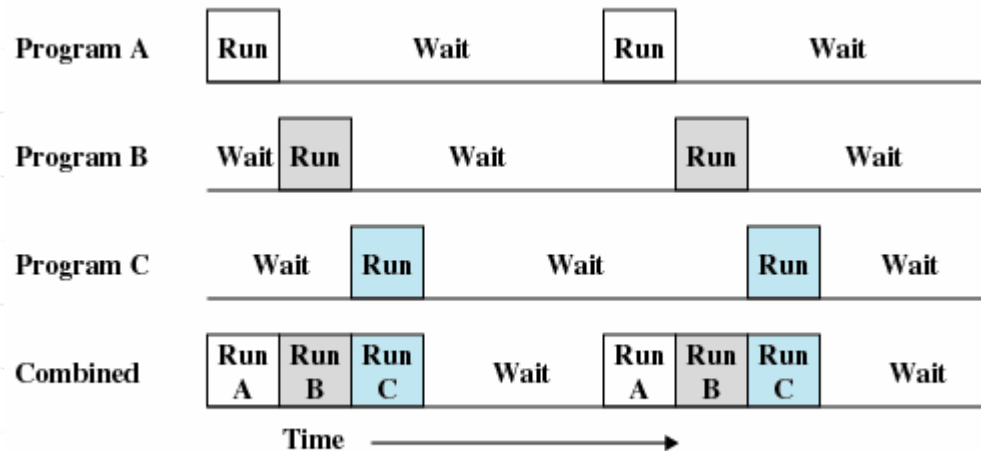
➤ Uniprogramming

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



➤ 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

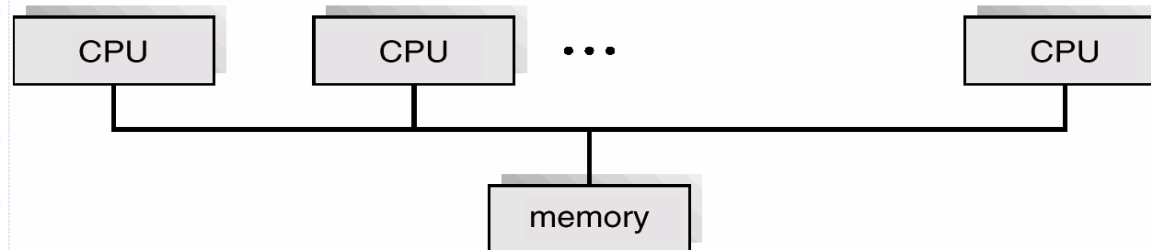
- Also known as *multiprocessor systems* or *tightly coupled systems*
- Operate with more than one CPU in close communication
- Processors share memory and a clock; communication usually takes place through the shared memory

- 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 an 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 → 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

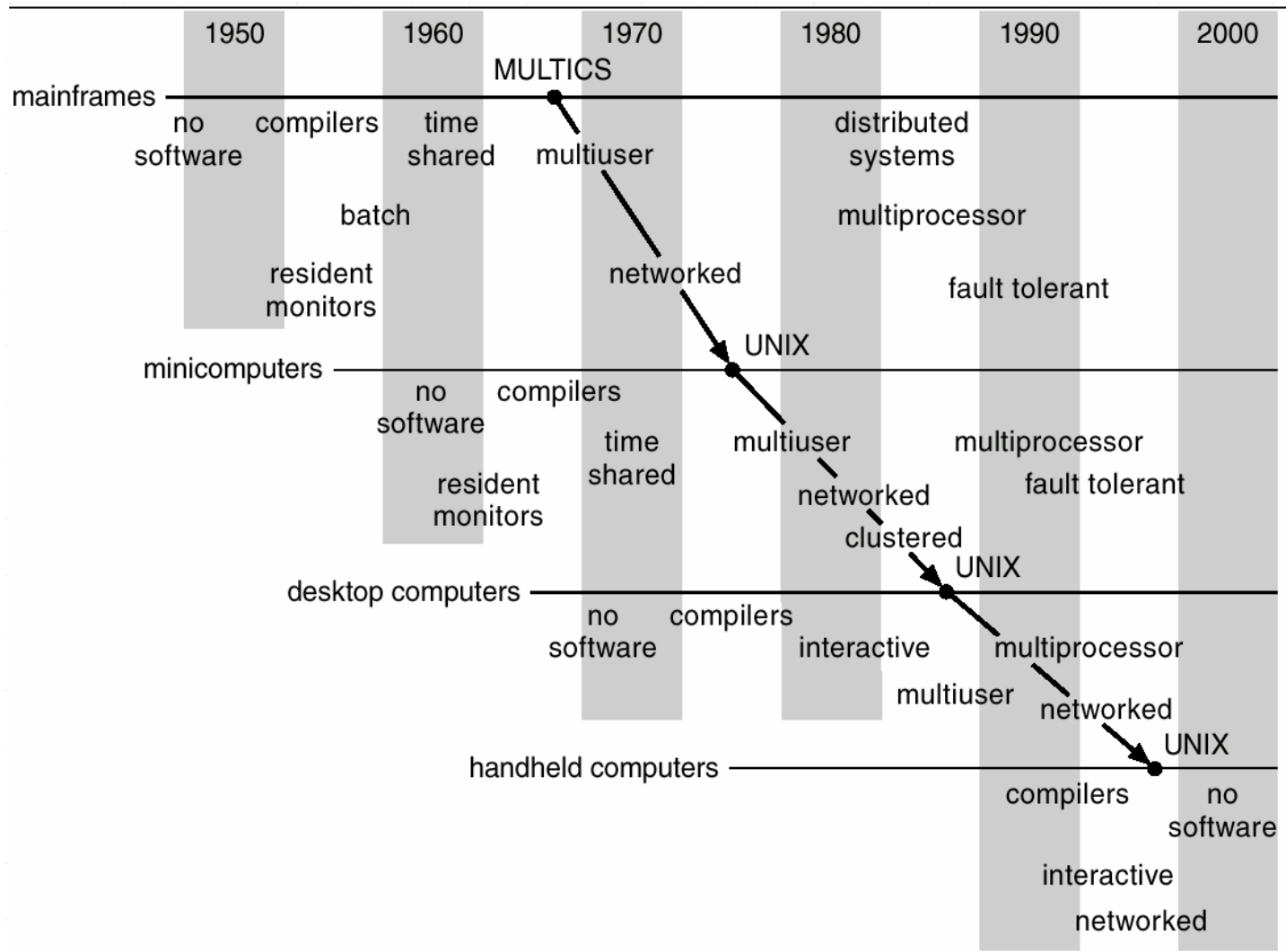
➤ Soft real-time

- 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