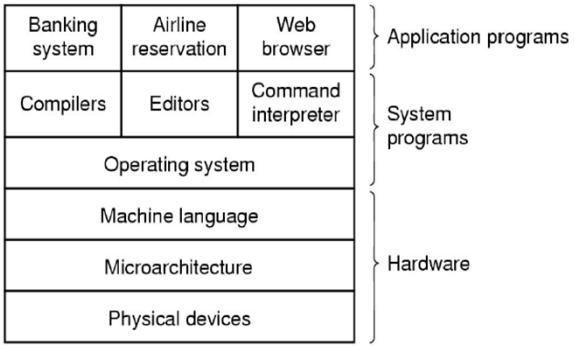
作業系統
Operating Systems

大綱-
軟硬體架構
雙模式運作
什麼是OS？

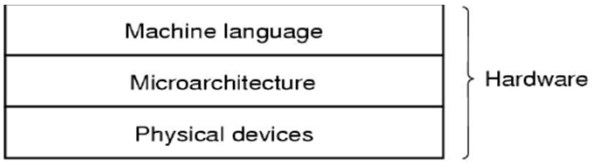
靜宜大學資訊傳播工程學系
劉國有 助理教授
kyliu@pu.edu.tw

Introduction

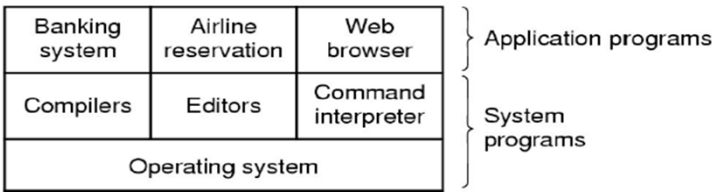
- A computer system consists of
  - Hardware
  - System programs
  - Application programs



- Hardware: the CPU, the memory, and the I/O devices which provides the basic computing resources for the system.
  - Physical devices: consisting of integrated circuit chips, wires, power supplies, cathode ray tubes, and similar physical devices.
  - Microarchitecture: the physical devices are grouped together to form functional units.
  - Machine language: the hardware and instructions visible to an assembly language programmer form the ISA (Instruction Set Architecture) that may use registers or other hardware facilities.

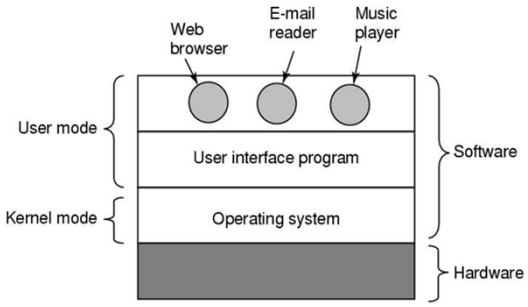


- System programs: a set of programs that organize, utilize and control hardware in a computer system.
  - Operating system: controls and coordinates the use of the hardware among the various application programs for the various users.
  - System software: such as command interpreter, editors and compilers which are definitely not part of the operating system.
- Application programs: such as word processing, spreadsheets, engineering calculations, storing information in a database, and web browsers that define the ways in which these resources are used to solve users' computing problems.



Dual-Mode Operation

- To distinguish between the execution of operating-system code and user-defined code.
  - Kernel mode (supervisor mode or privileged mode): the operating system gains control of the computer.
  - User mode: control is given to a user application.
- Privileged instructions: some of the machine instructions that may cause harm. The hardware allows privileged instructions to be executed only in kernel mode. (e.g., I/O control, timer management, interrupt management)



What is an operating system?

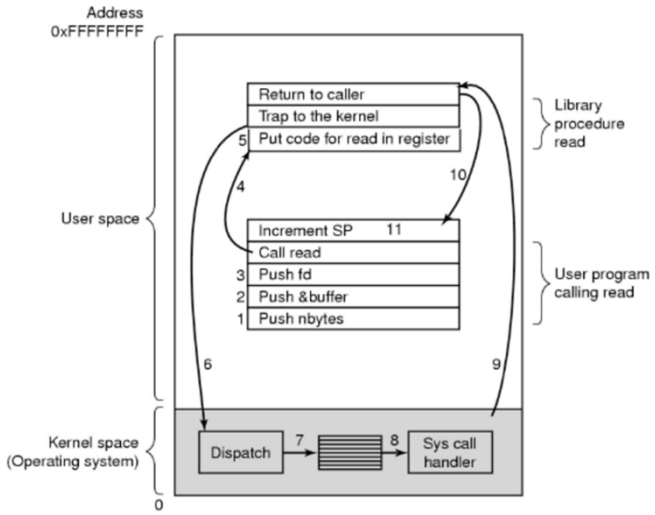
- The one program running at all times on the computer, with all else being systems programs and application programs.
  - Extended machine: (1) hides the messy details which must be performed, and (2) presents the user with a virtual machine that is easier to use.
  - Resource manager: (1) job scheduling- each program gets time with the resource (sharing resources in time). (2) Virtual memory- each program gets space on the resource (sharing resource in space).

System Calls

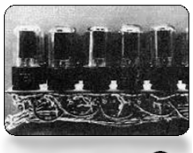
- The interface between the operating system and the user programs is defined by the set of "extended instructions" that the operating system provides.
- How system calls are performed?
  - count = read(fd, buffer, nbytes);

count = read(fd, buffer, nbytes);

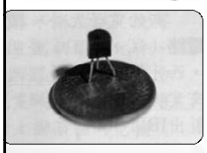
1. Push third parameter on to the stack.
2. Push second parameter on to the stack.
3. Push first parameter on to the stack.
4. Call the library routine, which involves pushing the return address on to the stack and jumping to the routine.
5. Machine/OS dependent actions. One is to put the system call number for read in a well defined place, e.g., a specific register.
6. Trap to the kernel. This enters the operating system proper and shifts the computer to privileged mode.
7. The envelope uses the system call number to access a table of pointers to find the handler for this system call.
8. The read system call handler processes the request.
9. Some magic instruction returns to user mode and jumps to the location right after the trap.
10. The library routine returns (there is more; e.g., the count must be returned).
11. The stack is popped (ending the function call read).



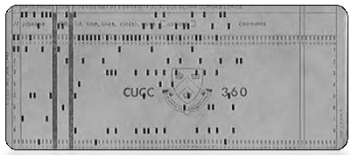
History of operating systems (1)



- **1st generation (1945-1955):** the main component is vacuum tubes. All programming was done by wiring up plugboards to control the machine's basic functions.

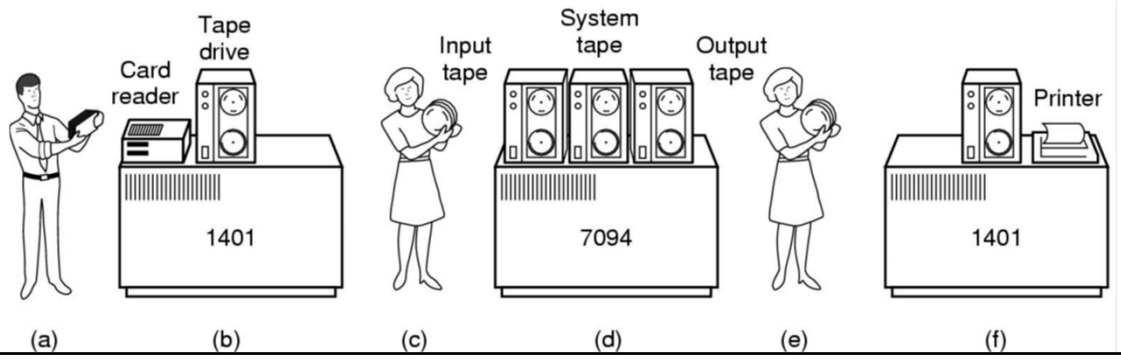


- **2nd generation (1955-1965):** the main component is transistors. It was possible to write programs on punched cards and read them in instead of using plugboards.



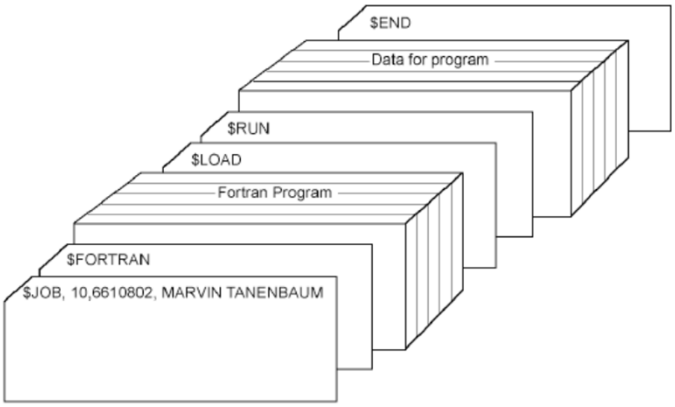
History of operating systems (2)

- **2nd generation (1955-1965):**
  - Batch system: (a) programmers bring cards to 1401, (b) 1401 reads batch of jobs onto tape, (c) Operator carries input tape to 7094, (d) 7094 does computing, (e) Operator carries output tape to 1401, (f) 1401 prints output.



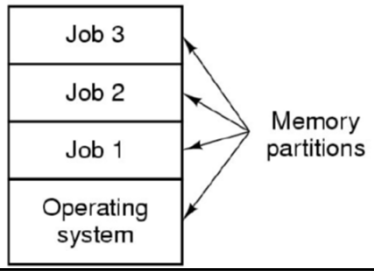
History of operating systems (3)

- Typical operating systems were FMS (Fortran Monitor System) and IBSYS (IBM's operating system) for the 7094.
- Structure of a typical FMS job



History of operating systems

- **3rd generation (1965-1980):** the main component is Integrated Circuits (ICs).
  - Multiprogramming
    - Idea: to partition memory into several pieces, with a different job in each partition. While one job was waiting for I/O to complete, another job could be using the CPU.
    - Purpose: to increase CPU utilization by organizing jobs so that the CPU always has one to execute.

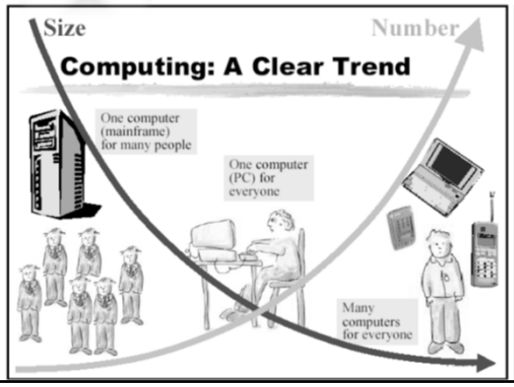


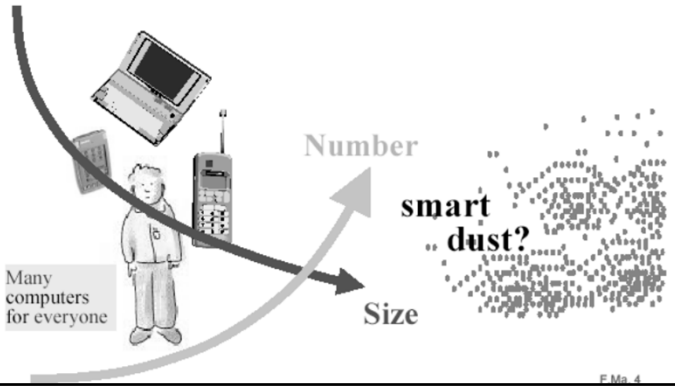
History of operating systems

- **3rd generation (1965-1980):**
  - Spooling (Simultaneous Peripheral Operation On Line): to read jobs from cards onto the disk. Whenever a running job finished, the operating system could load a new job from the disk into the now-empty partition and run it.
  - Time sharing (multitasking): the CPU executes multiple jobs by switching among them, but the switches occur so frequently that the users can interact with each program while it is running.

History of operating systems

- **4th generation (1980-Present)** :
  - the main component is VLSI circuits, chips containing thousands of transistors. The age of the microprocessor-based personal computer dawned.



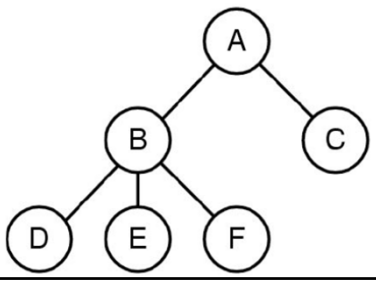


Operating system concepts

- **Process:** a process is basically a program in execution. Associated with each process is its address space and some set of registers.
  - Address space: a list of memory locations from some minimum to some maximum, which the process can read and write. Address space contains the executable program, the program's data, and its stack.
  - Registers: include the information needed to run the program, such as program counter, stack pointer, and other hardware registers.

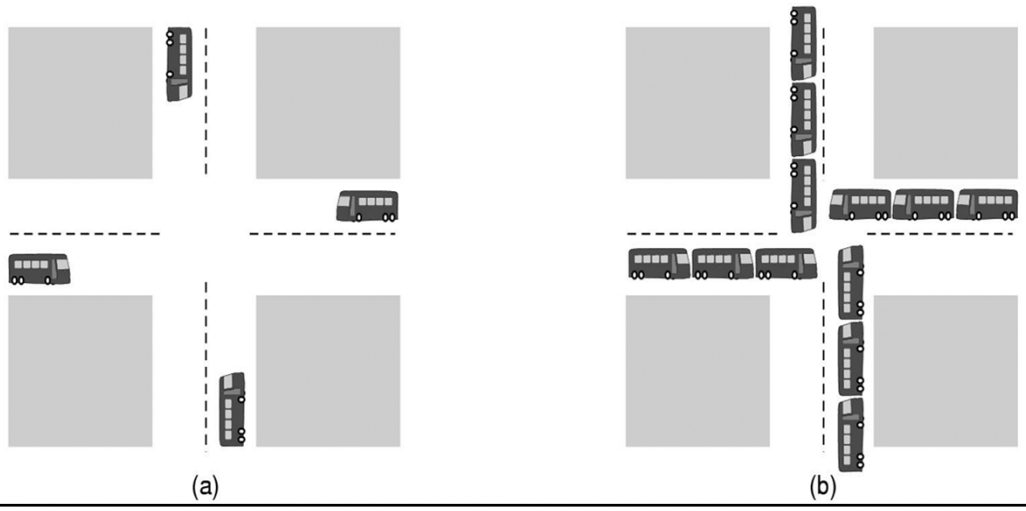
Operating system concepts

- Process table (Process Control Block, PCB): Each process is represented in the os by a process table, which stores all the information about the process.
- Process management: dealing with the creation and termination of processes.
- Process communication: related processes need to communicate with one another and synchronize their activities.
- Process tree: (1) A created two child processes, B and C, (2) B created three child processes, D, E and F



Operating system concepts

- (a) A potential deadlock. (b) an actual deadlock.



The Operating System Zoo

- **Mainframe operating systems:** are heavily oriented toward processing many jobs at once, most of which need prodigious amounts of I/O.
- **Server operating systems:** design to provide platforms for multi-user, frequently business-critical, and networked applications, which tends to be security, stability and collaboration.
- **Multiprocessor systems:** have two or more processors in close communication, sharing the computer bus and sometimes the clock, memory, and peripheral devices.

The Operating System Zoo

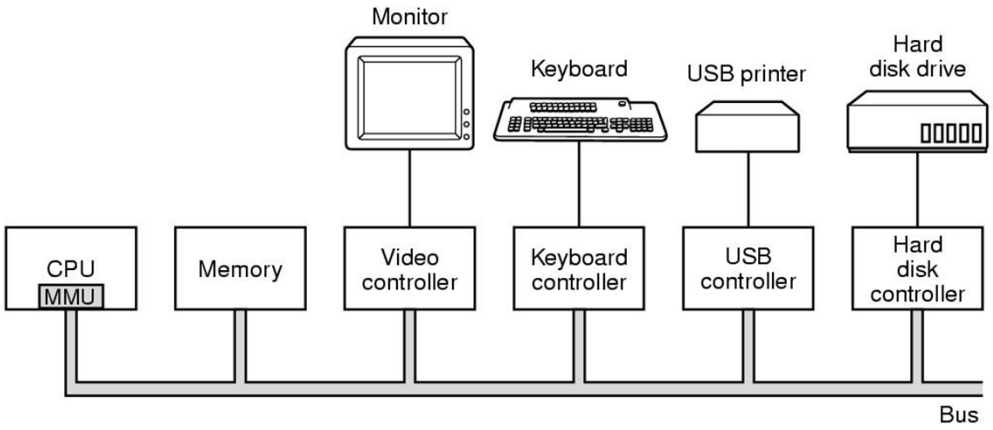
- **Personal computer operating systems:** all support multiprogramming, often with dozens of programs started up at boot time.
- **Handheld computer operating systems:** with the ability to handle telephony, digital photography, and other functions.
- **Embedded operating systems:** run on computers that control devices that do not accept user-installed software.

The Operating System Zoo

- **Sensor node operating systems:** it is usually event driven.
- **Real-time system:**
  - Hard real-time system: requires not only that the computing results be “correct” but also that the results be produced within a specified deadline.
  - Soft real-time system: allow to miss deadline occasionally.
- **Smart card operating system:** usually can handle only a single function.

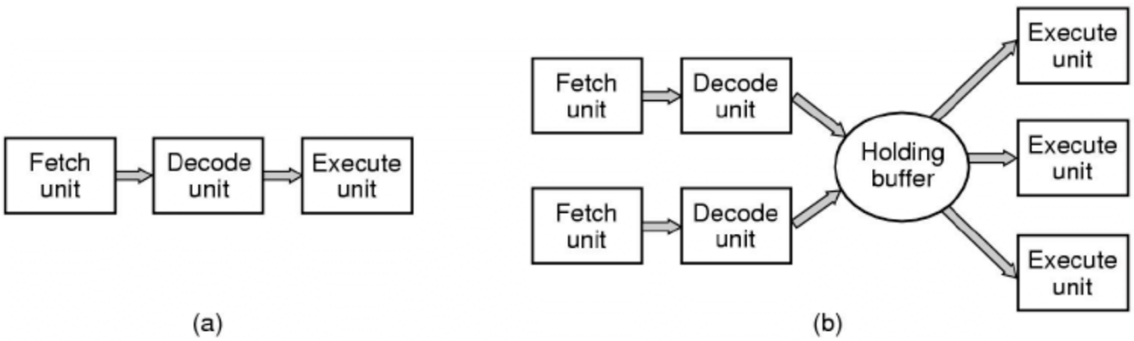
Computer Hardware Review

- Components of a simple personal computer



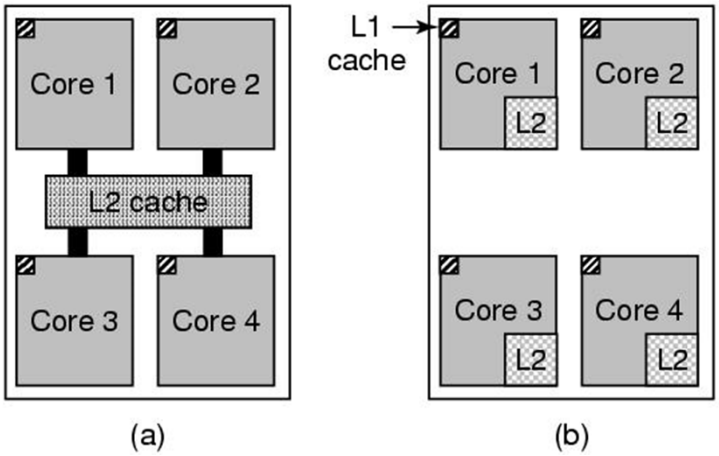
Computer Hardware Review

- (a) A three-stage pipeline
- (b) A superscalar CPU



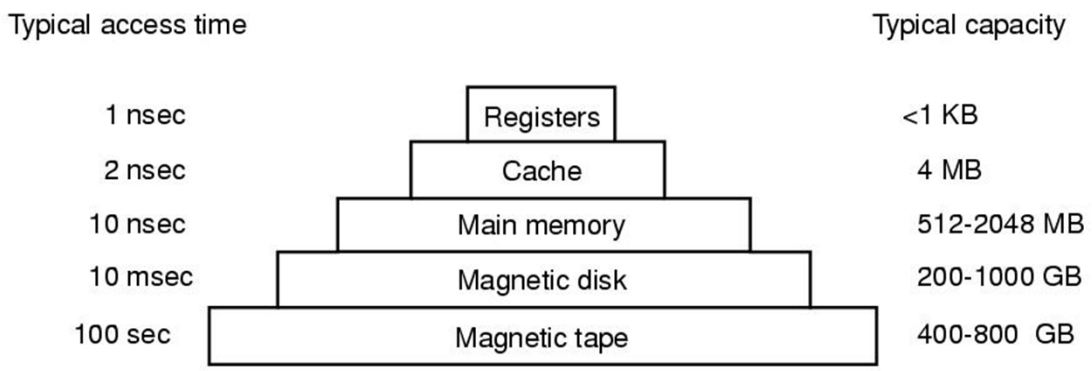
Computer Hardware Review

- Multithreaded and Multicore Chips



Computer Hardware Review

- Typical memory hierarchy



Computer Hardware Review

- Structure of a disk drive