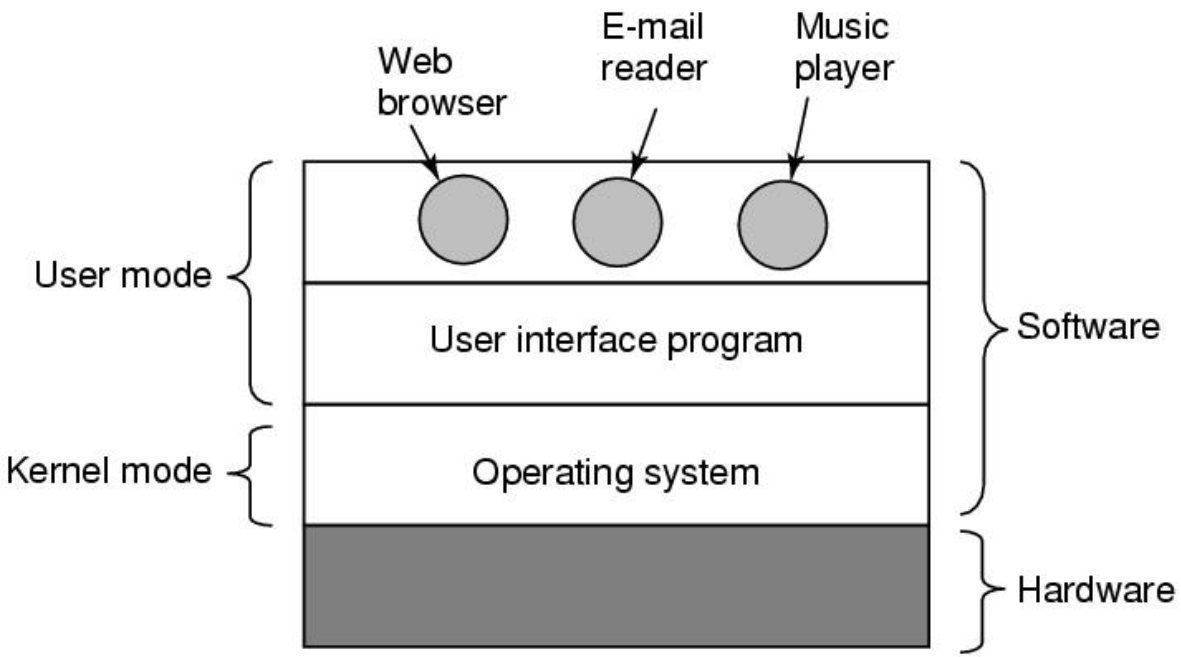
# Introduction

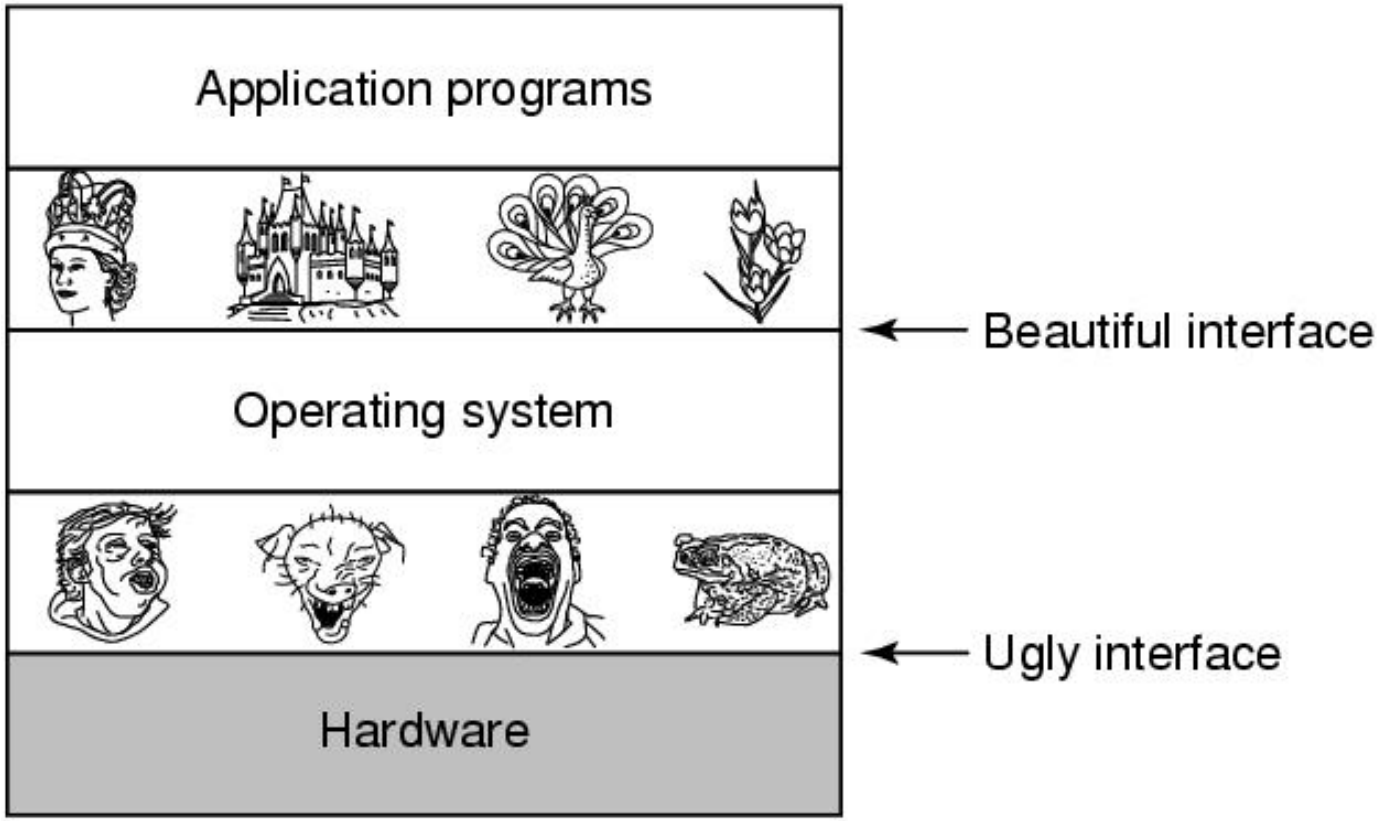
Operating Systems

# What Is An Operating System

- A modern computer consists of:
  - One or more processors
  - Main memory
  - Disks
  - Printers
  - Various input/output devices
- Managing all these components requires a layer of software
  - the **operating system**



# The Operating System as an Extended Machine




Operating systems turn ugly hardware into beautiful abstractions.

# The Operating System as a Resource Manager

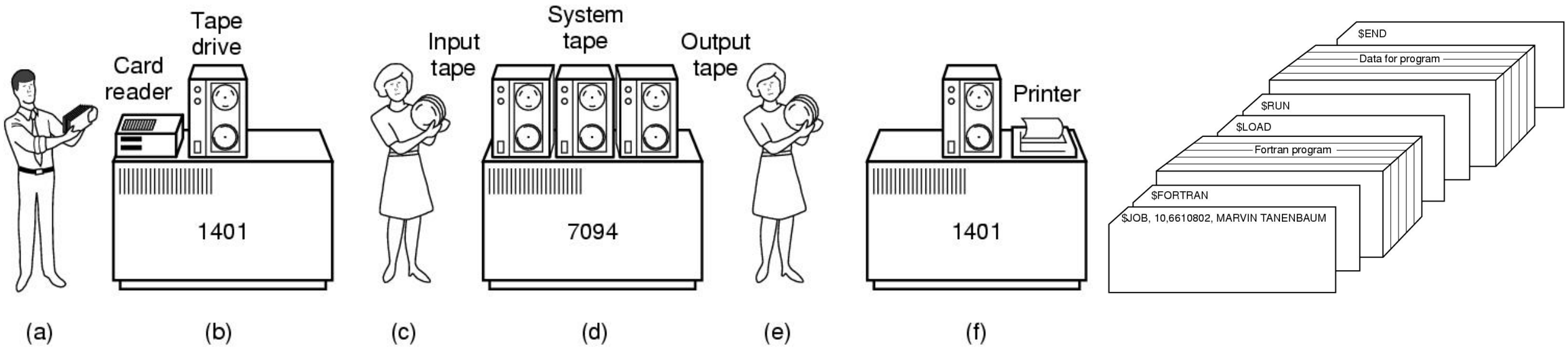
- Allow multiple programs to run at the same time
- Manage and protect memory, I/O devices, and other resources
- Includes multiplexing (sharing) resources in two different ways:
  - In time
  - In space

# History of Operating Systems

Generations of Operating Systems:

1. (1945–55) Vacuum Tubes
   - Punch cards and machine language programming
2. (1955–65) Transistors and Batch Systems
   - Mainframes (IBM 1401, IBM 7094), FORTRAN compiler
3. (1965–1980) ICs and Multiprogramming
   - IBM System/360, OS/360, multiprogramming, timesharing, MULTICS
4. (1980–Present) Personal Computers
   - IBM PC, DOS, Macintosh, Windows, Linux
5. (1990–Present) Mobile Computers
   - PDAs, Symbian OS, Blackberry OS, Smartphones, iOS, Android

# Transistors and Batch Systems




a) Programmers bring cards to 1401.

b) 1401 reads batch of jobs onto tape.

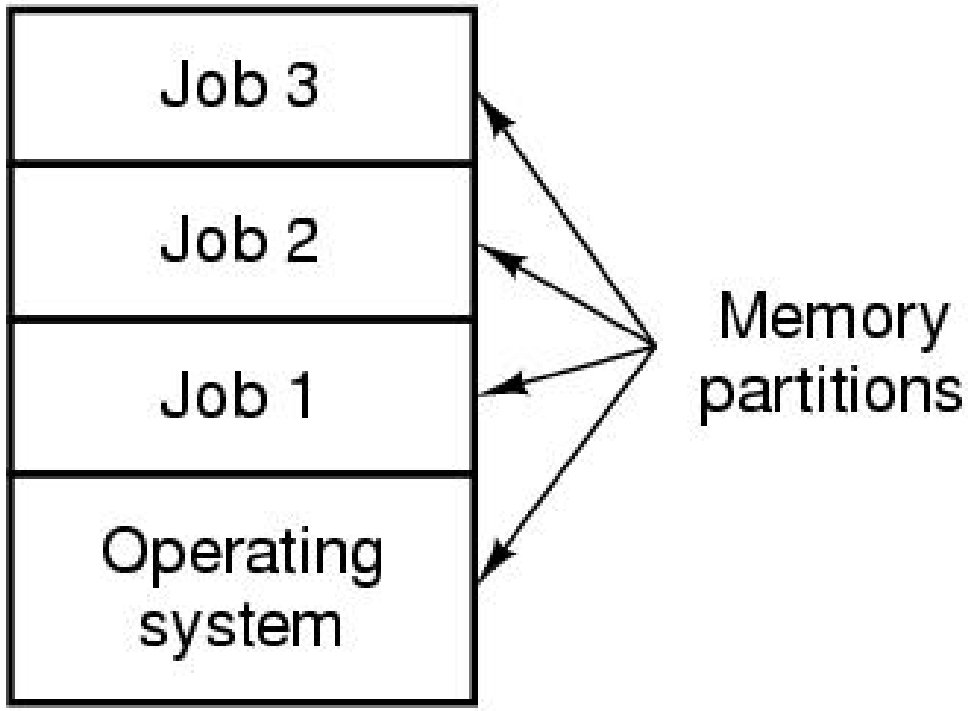
c) Operator carries input tape to 7094.

d) 7094 does computing.

e) Operator carries output tape to 1401.

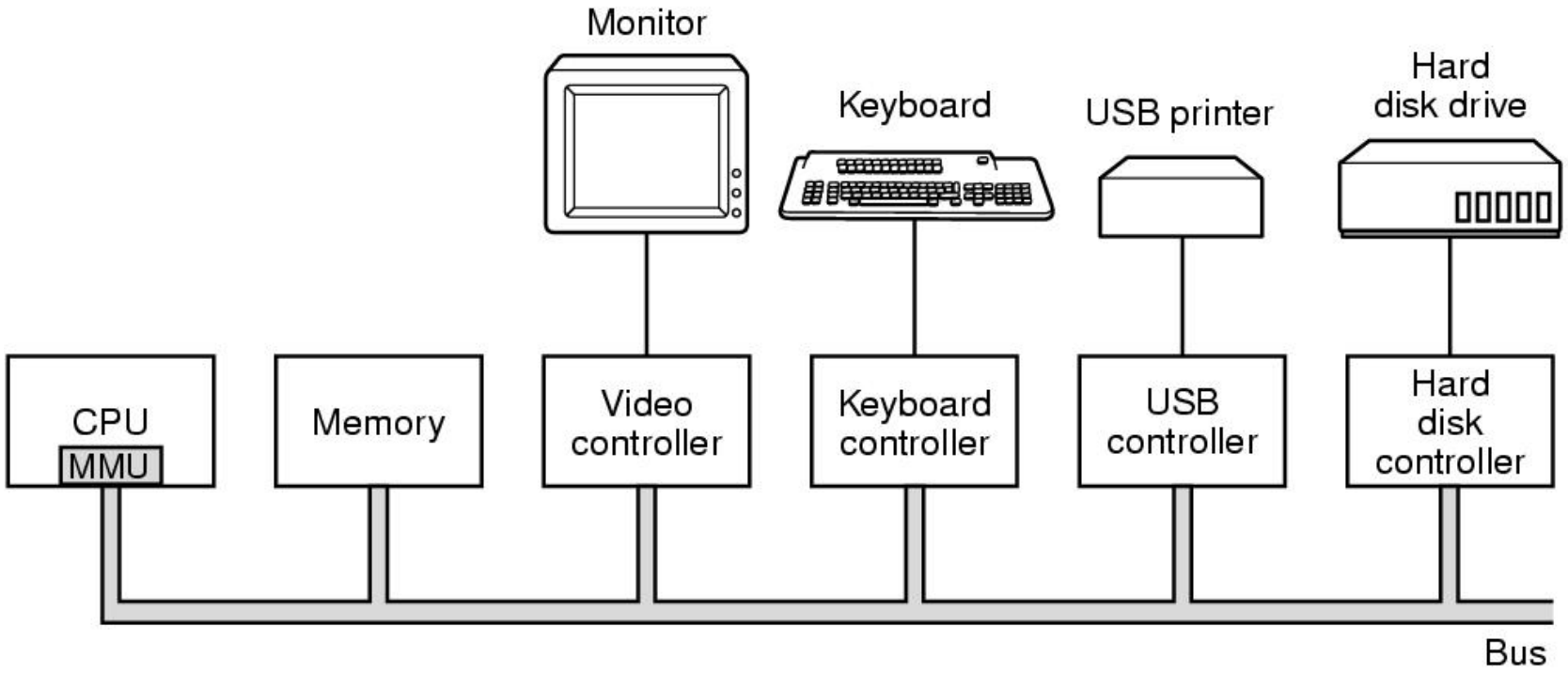
f) 1401 prints output.

# ICs and Multiprogramming



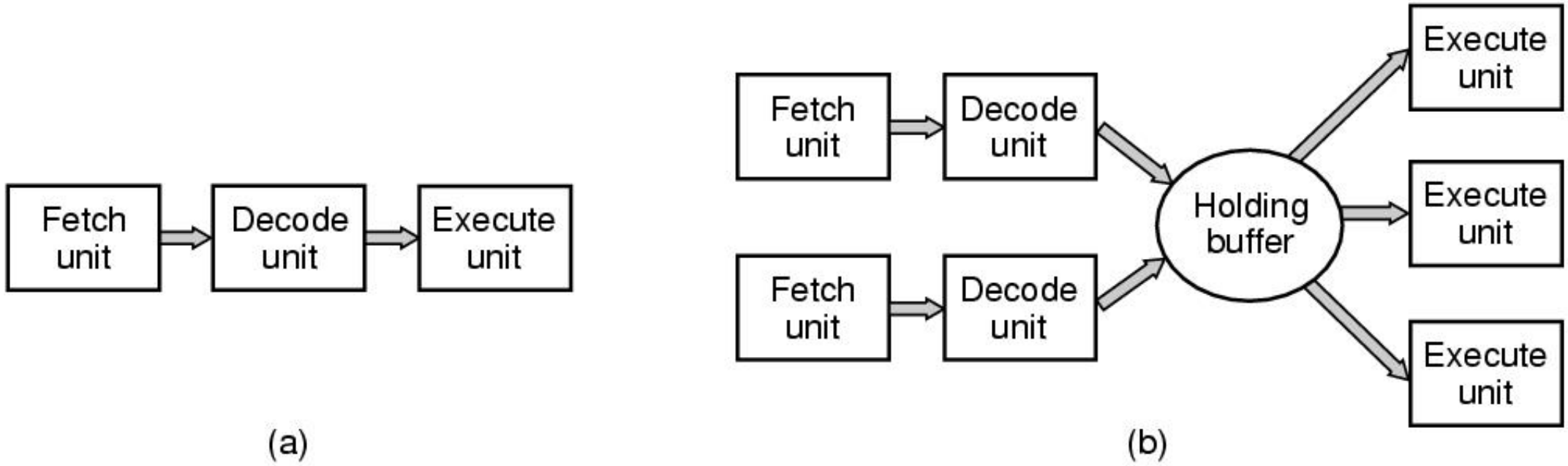

A multiprogramming system with three jobs in memory.

# Computer Hardware Review



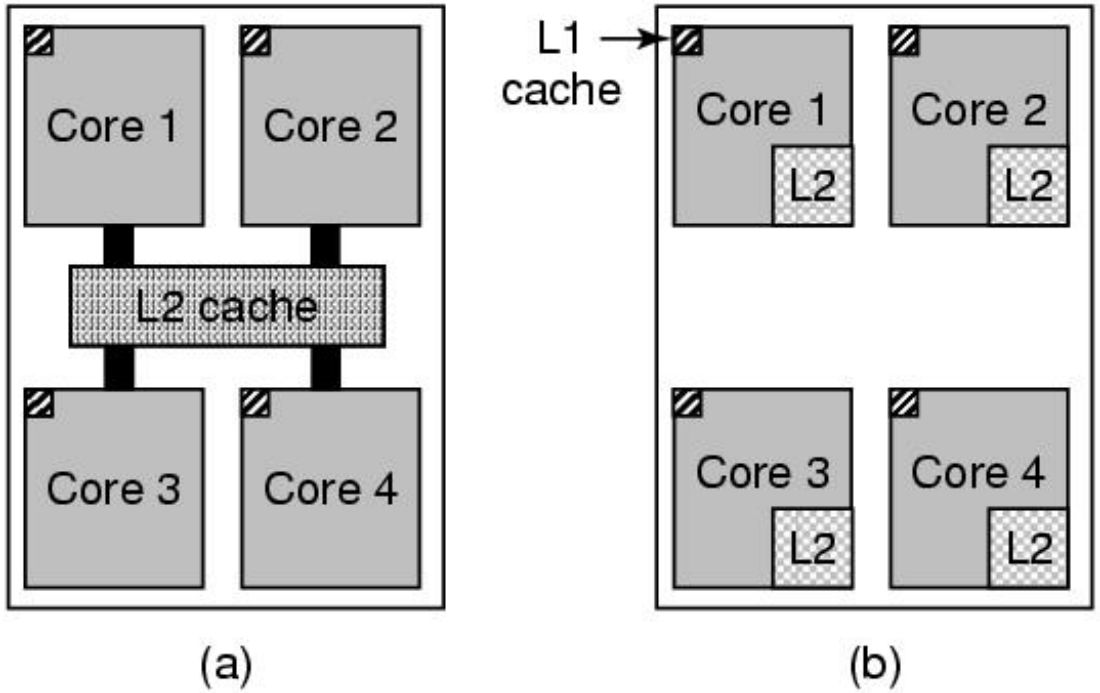

Some of the components of a simple personal computer.

# CPU Pipelining




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

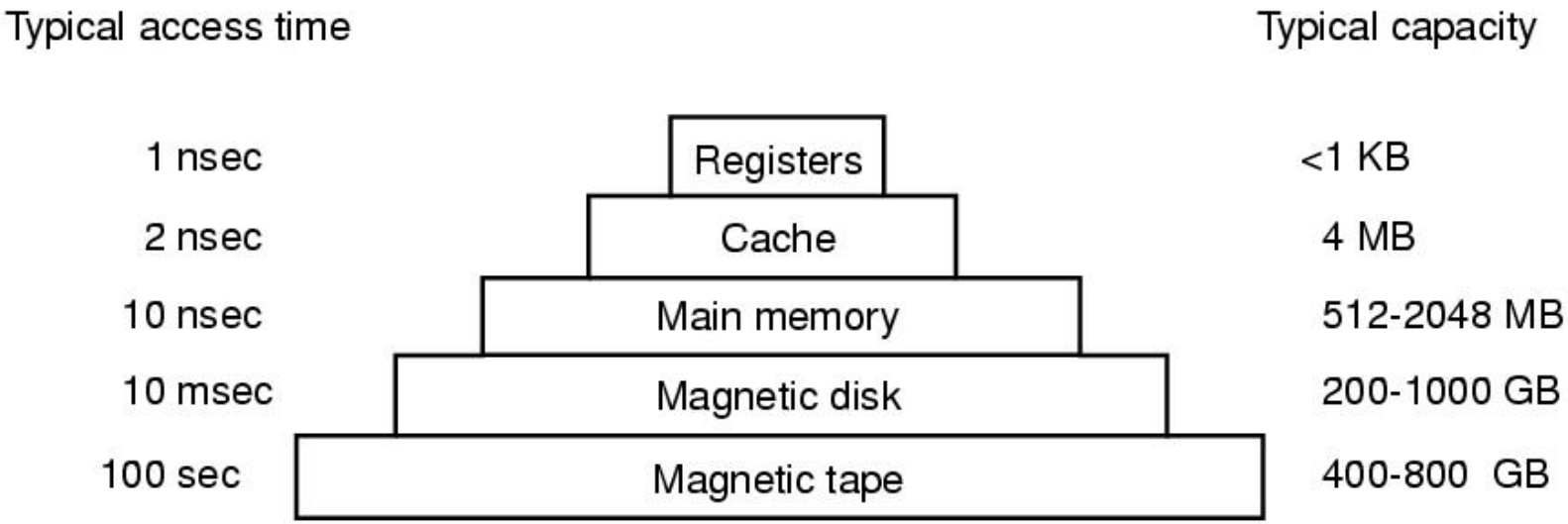
# Multithreaded and Multicore Chips




(a) A quad-core chip with a shared L2 cache.

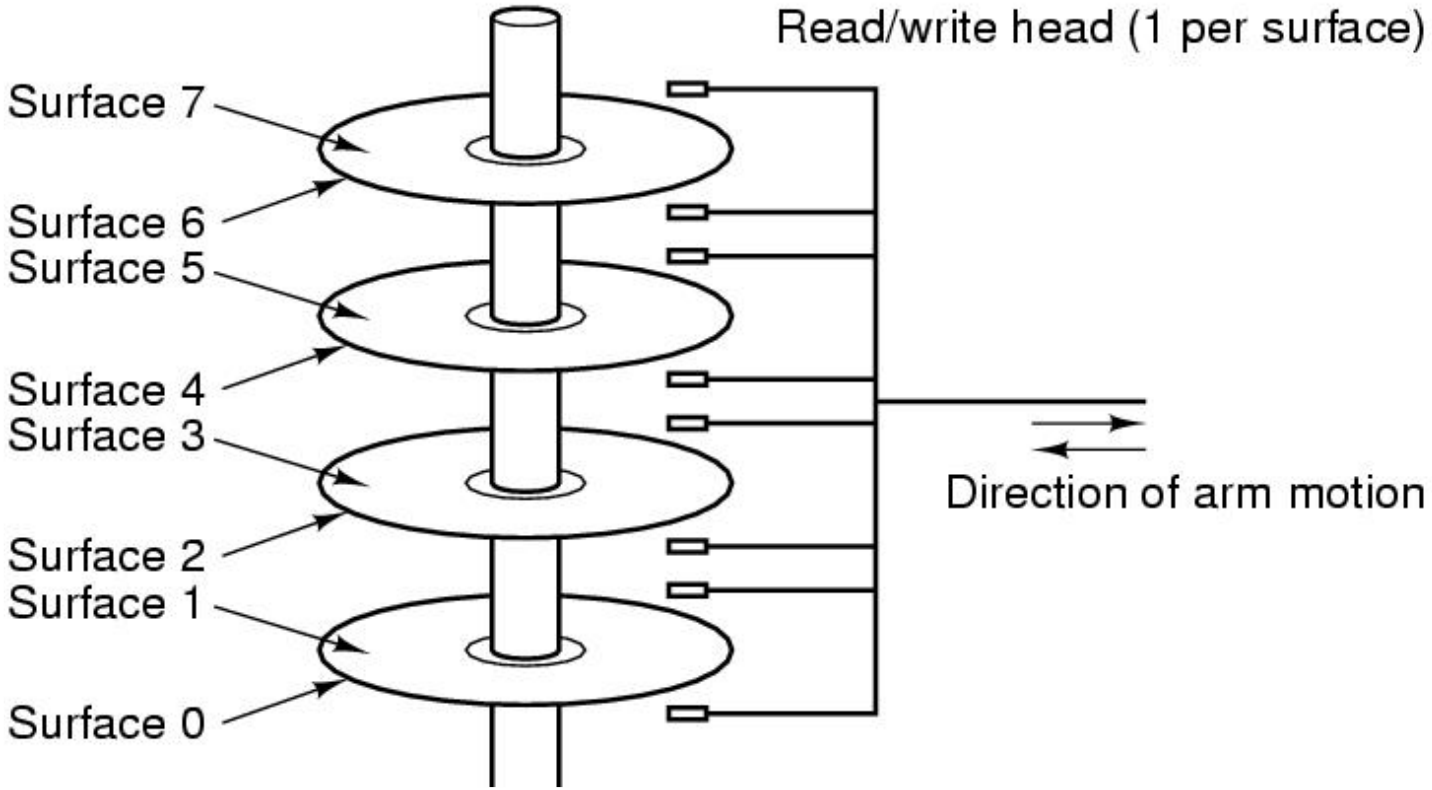
(b) A quad-core chip with separate L2 caches.

# Memory



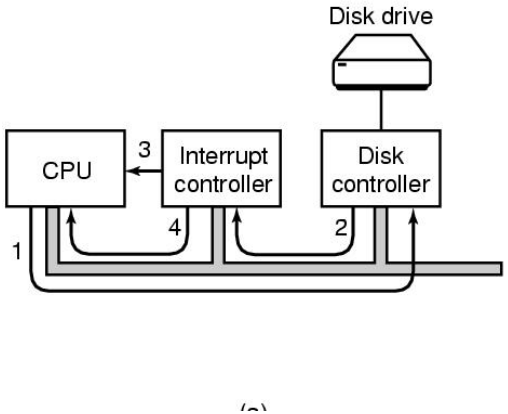

- Questions when dealing with cache:
  - When to put a new item into the cache.
  - Which cache line to put the new item in.
  - Which item to remove from the cache when a slot is needed.
  - Where to put a newly evicted item in the larger memory.

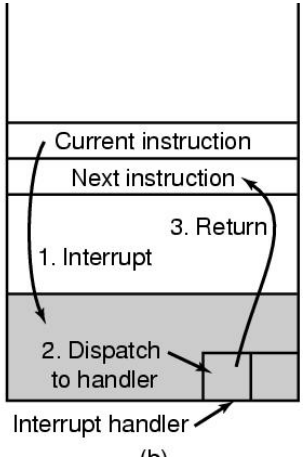
# Disks




Structure of a disk drive.

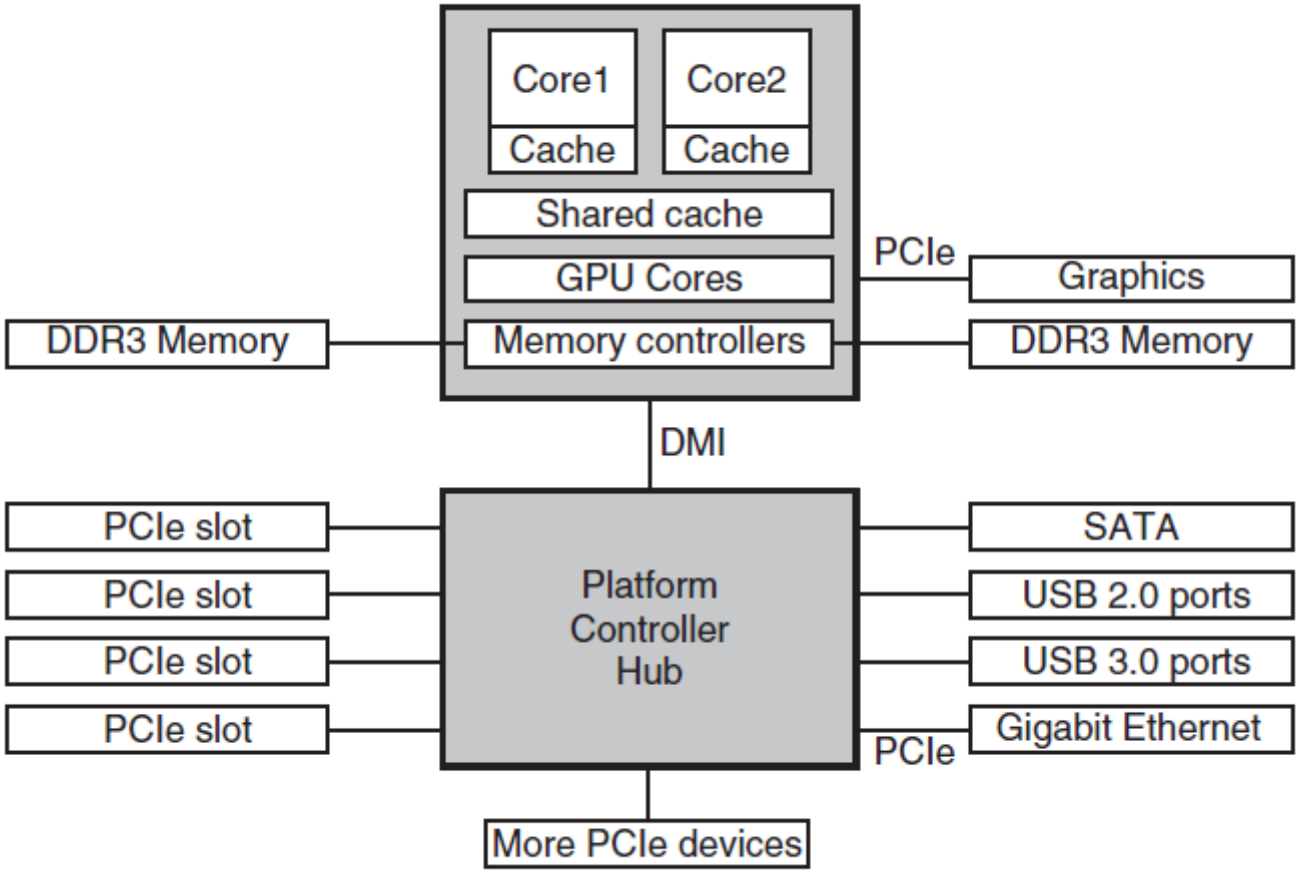
# I/O Devices




- (a) The steps in starting an I/O device and getting an interrupt.
- (b) Interrupt processing involves taking the interrupt, running the interrupt handler, and returning to the user program.

# Buses




The structure of a large x86 system.

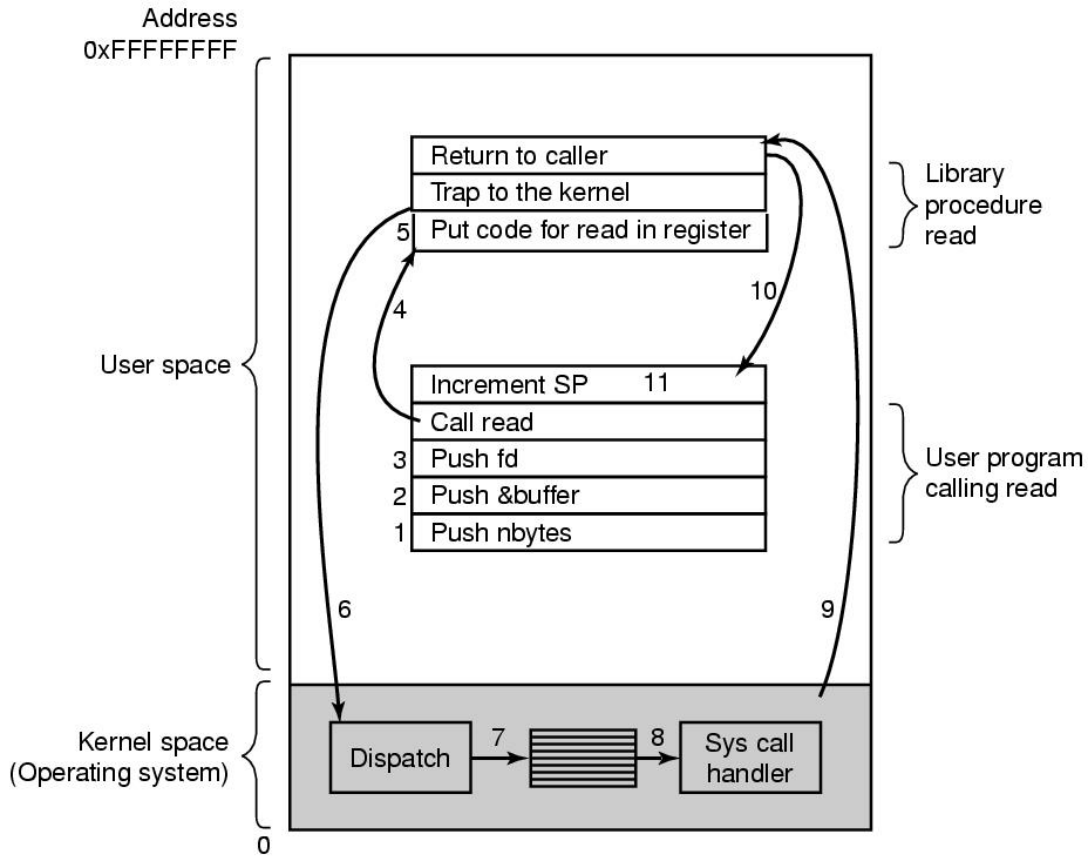
# Types of Operating Systems

- Mainframe operating systems
- Server operating systems
- Multiprocessor operating systems
- Personal computer operating systems
- Handheld operating systems
- Embedded operating systems
- Sensor node operating systems
- Real-time operating systems
- Smart card operating systems

# Operating System Concepts

- Processes
- Address spaces (Memory)
- Files
- Input/Output
- Protection
- The shell
- Development in computing over time
  - Large memories
  - Protection hardware
  - Disks
  - Virtual memory

# System Calls




- The 11 steps in making the system call
  - read(fd, buffer, nbytes).

# System Calls

**Process management**

| Call | Description |
|---|---|
| pid = fork( ) | Create a child process identical to the parent |
| pid = waitpid(pid, &statloc, options) | Wait for a child to terminate |
| s = execve(name, argv, environp) | Replace a process' core image |
| exit(status) | Terminate process execution and return status |

**File management**

| Call | Description |
|---|---|
| fd = open(file, how, ...) | Open a file for reading, writing, or both |
| s = close(fd) | Close an open file |
| n = read(fd, buffer, nbytes) | Read data from a file into a buffer |
| n = write(fd, buffer, nbytes) | Write data from a buffer into a file |
| position = lseek(fd, offset, whence) | Move the file pointer |
| s = stat(name, &buf) | Get a file's status information |

# System Calls

**Directory- and file-system management**

| Call | Description |
|---|---|
| s = mkdir(name, mode) | Create a new directory |
| s = rmdir(name) | Remove an empty directory |
| s = link(name1, name2) | Create a new entry, name2, pointing to name1 |
| s = unlink(name) | Remove a directory entry |
| s = mount(special, name, flag) | Mount a file system |
| s = umount(special) | Unmount a file system |

**Miscellaneous**

| Call | Description |
|---|---|
| s = chdir(dirname) | Change the working directory |
| s = chmod(name, mode) | Change a file's protection bits |
| s = kill(pid, signal) | Send a signal to a process |
| seconds = time(&seconds) | Get the elapsed time since Jan. 1, 1970 |

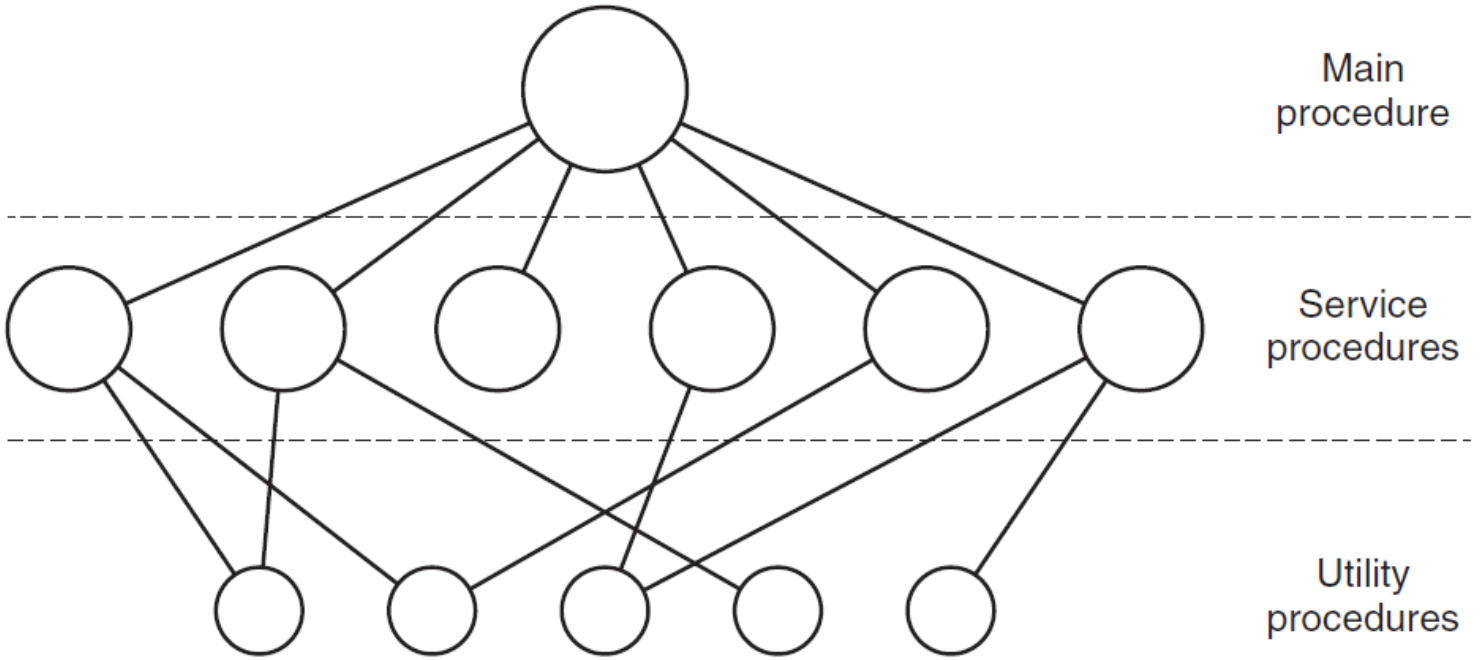
# Windows Win32 API

| UNIX | Win32 | Description |
|---|---|---|
| fork | CreateProcess | Create a new process |
| waitpid | WaitForSingleObject | Can wait for a process to exit |
| execve | (none) | CreateProcess = fork + execve |
| exit | ExitProcess | Terminate execution |
| open | CreateFile | Create a file or open an existing file |
| close | CloseHandle | Close a file |
| read | ReadFile | Read data from a file |
| write | WriteFile | Write data to a file |
| lseek | SetFilePointer | Move the file pointer |
| stat | GetFileAttributesEx | Get various file attributes |
| mkdir | CreateDirectory | Create a new directory |
| rmdir | RemoveDirectory | Remove an empty directory |
| link | (none) | Win32 does not support links |
| unlink | DeleteFile | Destroy an existing file |
| mount | (none) | Win32 does not support mount |
| umount | (none) | Win32 does not support mount |
| chdir | SetCurrentDirectory | Change the current working directory |
| chmod | (none) | Win32 does not support security (although NT does) |
| kill | (none) | Win32 does not support signals |
| time | GetLocalTime | Get the current time |

# Operating Systems Structures

- Monolithic systems
- Layered systems
- Microkernels
- Client-server systems
- Virtual machines
- Exokernels

# Monolithic systems

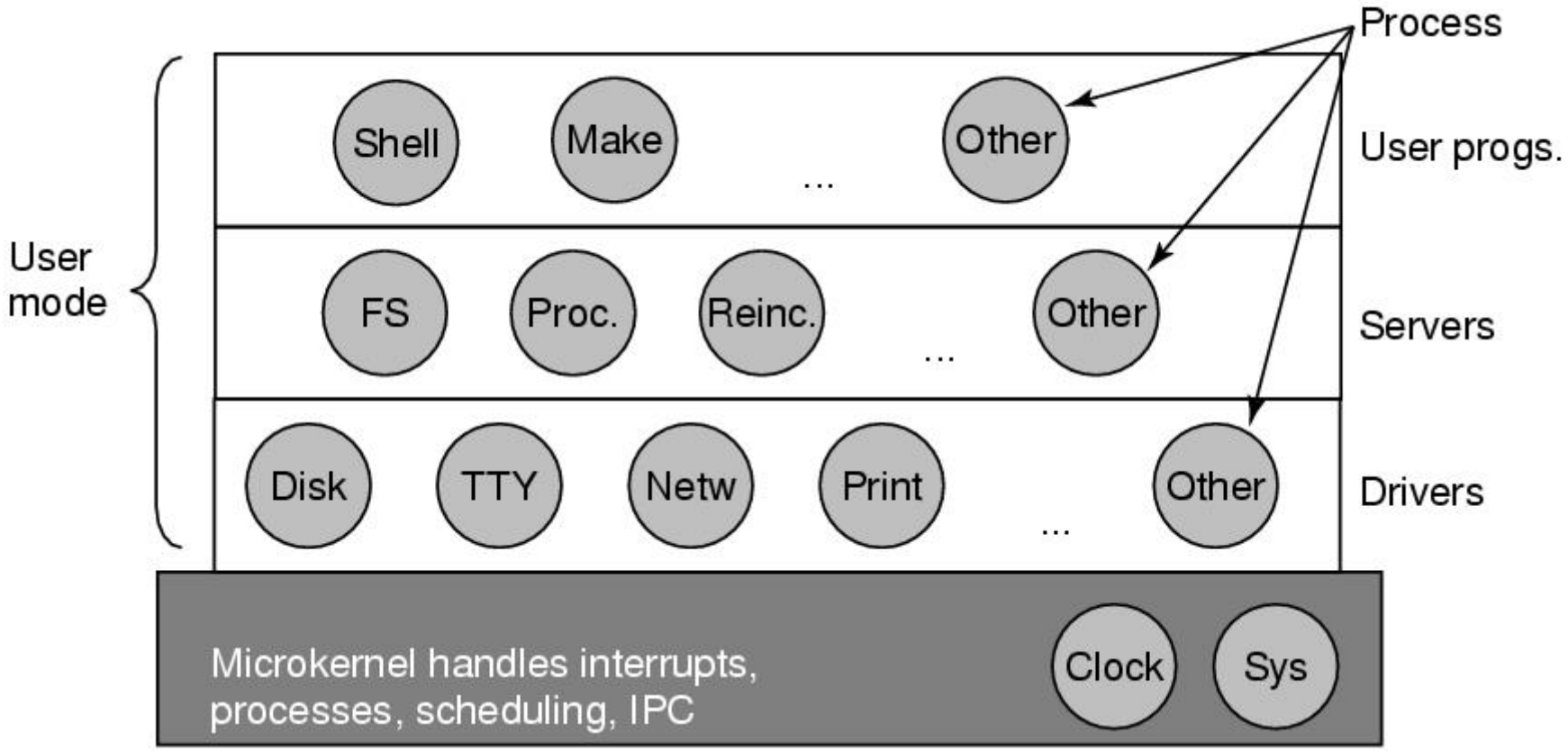



- A main program that invokes the requested service procedure.
- A set of service procedures that carry out the system calls.
- A set of utility procedures that help the service procedures.

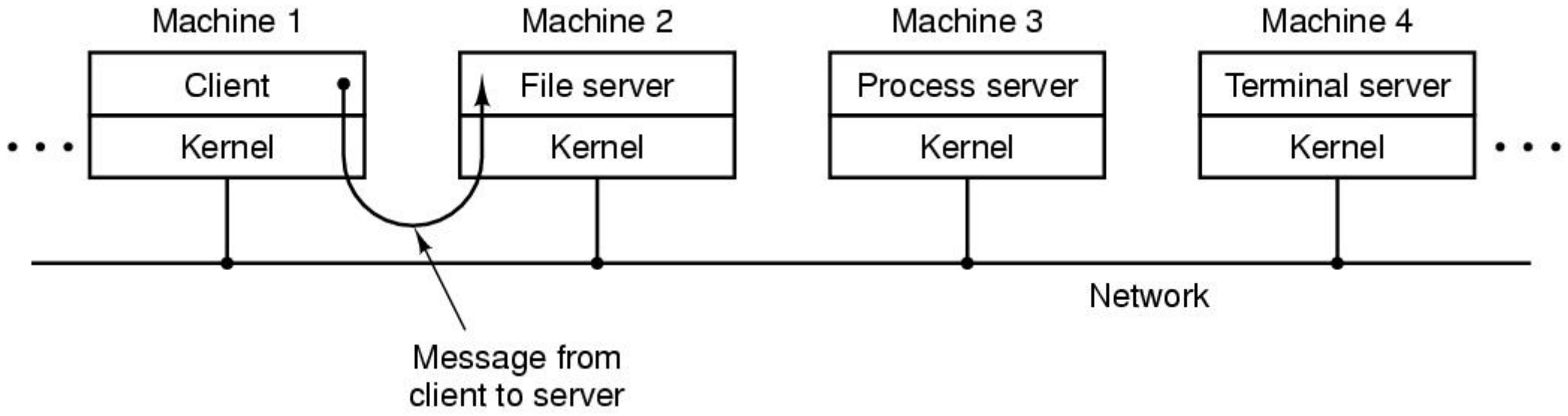
# Layered Systems

| Layer | Function |
|---|---|
| 5 | The operator |
| 4 | User programs |
| 3 | Input/output management |
| 2 | Operator-process communication |
| 1 | Memory and drum management |
| 0 | Processor allocation and multiprogramming |

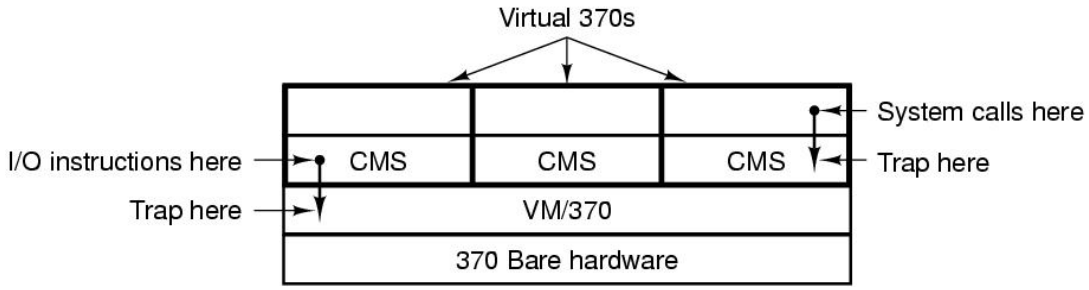
# Microkernels

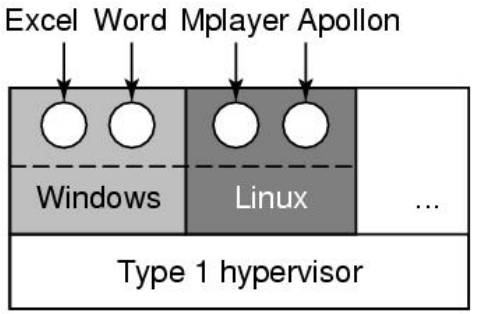


# Client-Server Model

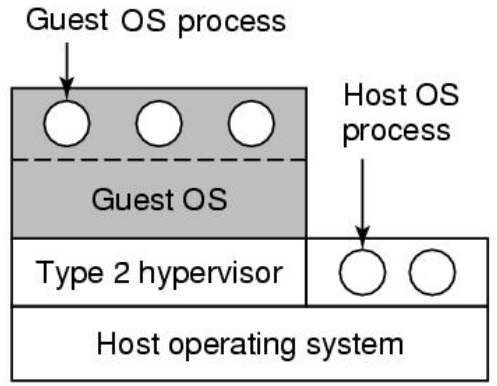


# Virtual Machines




(a)




(b)

# Course Details

- Moodle – soon
- Course Page:
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- Contact:
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