Operating System
CS-2006
Lecture 2

Mahzaib Younas
Lecturer Department of Computer Science
FAST NUCES CFD

Process Management

- Program
  - A Passive entity is called the program.
- Process
  - A program in running form is called the process.
  - Process is an active entity,
- Process need resources to accomplish a task like
  - CPU, I/O files and Data Initialization
- Process termination requires reclaim the any reusable resources

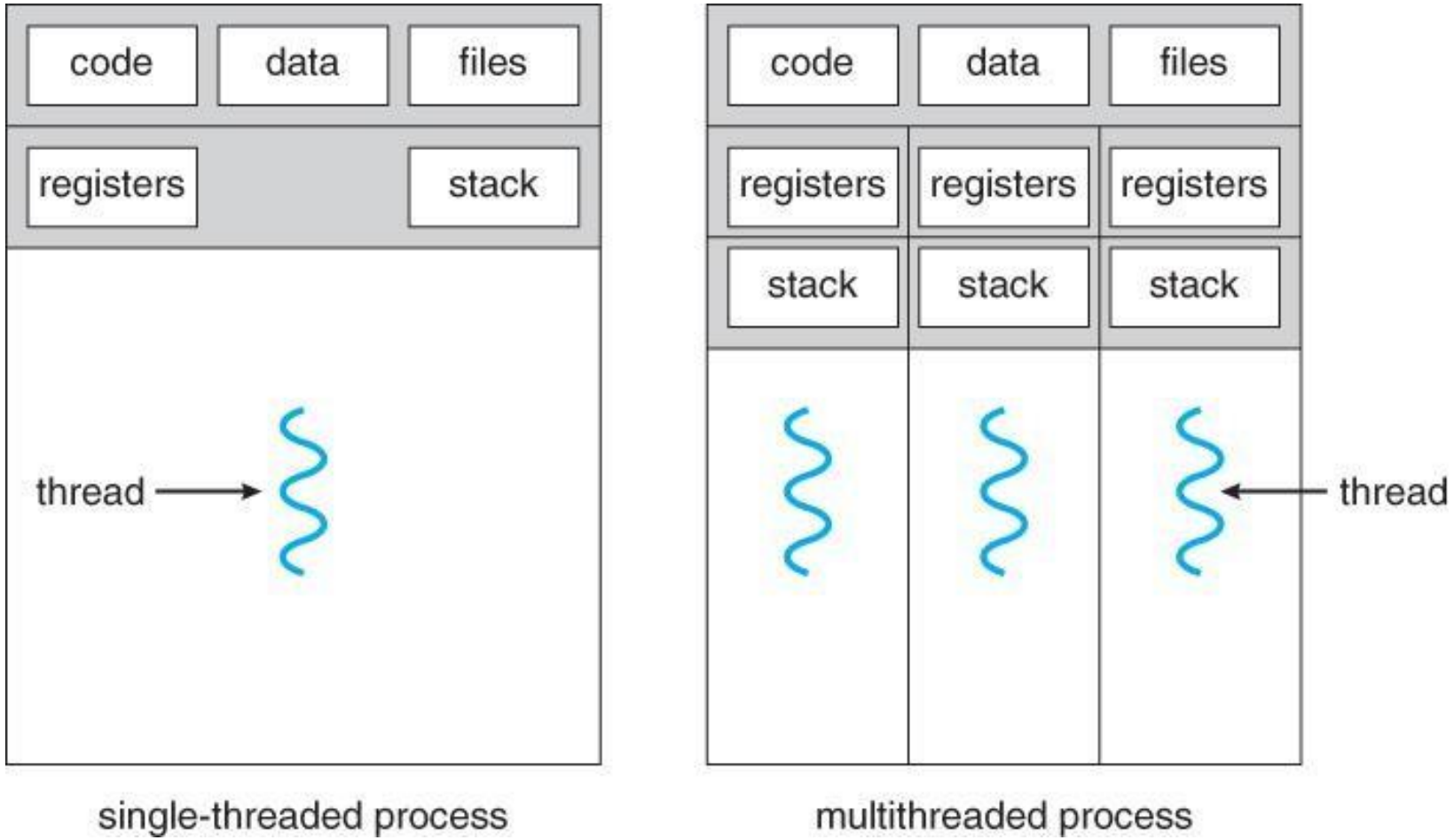
Process Management (Cont…)

- There are two types of process
  - Single Thread Process
  - Multi thread process
- Thread
  - A thread is a flow of execution through the process cod With its own
    - program counter
    - System register
    - Stack
  - Each thread belongs to only one process

Types of Threads

- Single Threading Process
  - Single threaded processes contain the execution of instructions in a single sequence.
  - In other words, one command is processes at a time.
  - Example:
    - MS Dos is an example of Single process and singlethread operating system
- Multi Threading Process
  - Multi threading is ability in OS which support multiple, concurrent path of execution with in single process.
  - Example:
    - Windows and Linux are example of Multi thread Process,

Types of Threads (Cont…)



Process Management Activity

- **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

Memory management is a method in the operating system to manage operations between main memory and disk during process execution.

- To execute a program all (or part) of the instructions must be in memory
- All (or part) of the data that is needed by the program must be in memory
- Memory management determines what is in memory and when
  - Optimizing CPU utilization and computer response to users

Activities of Memory Management

- 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

File Management System

Processes and techniques involved in creating, organizing, accessing, manipulating, and controlling files stored on storage devices.

- File-System management
  - Files usually organized into directories
  - Access control on most systems to determine who can access what
- OS activities include
  - Creating and deleting files and directories
  - Primitives(Basic operation) to manipulate files and directories
  - Mapping files onto secondary storage
  - Backup files onto stable (non-volatile) storage media

Mass Storage Management System

Disks used to store data that does not fit in main memory or data that must be kept for a “long” period of time

- Proper management is of central importance
- Entire speed of computer operation hinges on disk subsystem and its algorithms

Mass Storage Management System (Cont…)

- OS activities
  1. Mounting and unmounting
  2. Free-space management
  3. Storage allocation
  4. Disk scheduling
  5. Partitioning
  6. Protection

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

Caching (Cont…)

- Cache smaller than storage being cached
  - Cache management important design problem

    Careful selection of the cache size and of a replacement policy can result in greatly increased performance
  - Cache size and replacement policy

    optimizing instructions or algorithms which a computer program or hardware-maintained structure can utilize to manage a cache of information

    Example:

    LRU (Least Recently Used)

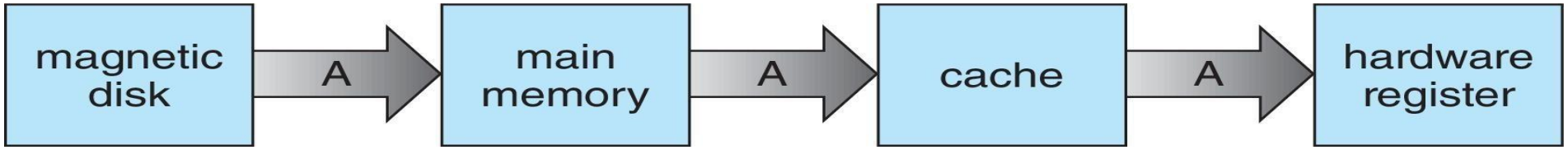
    Randmoly

Characteristics of Various Types of Storages

Level	1	2	3	4	5
Name	registers	cache	main memory	solid-state disk	magnetic disk
Typical size	< 1 KB	< 16MB	< 64GB	< 1 TB	< 10 TB
Implementation technology	custom memory with multiple ports CMOS	on-chip or off-chip CMOS SRAM	CMOS SRAM	flash memory	magnetic disk
Access time (ns)	0.25-0.5	0.5-25	80-250	25,000-50,000	5,000,000
Bandwidth (MB/sec)	20,000-100,000	5,000-10,000	1,000-5,000	500	20-150
Managed by	compiler	hardware	operating system	operating system	operating system
Backed by	cache	main memory	disk	disk	disk or tape

Data Migration from Disk to Register

- Multitasking environments must be careful to use most recent value, no matter where it is stored in the storage hierarchy



- Multiprocessor environment must provide **cache coherency** in hardware such that all CPUs have the most recent value in their cache
- Distributed environment situation even more complex
  - Several copies of a datum(File) can exist

Cache coherence is the discipline which ensures that the changes in the values of shared operands (data) are propagated throughout the system in a timely fashion.

I/O Subsystem

- One purpose of OS is to hide peculiarities of hardware devices from the user
- I/O subsystem responsible for
  - Memory management of I/O including
    - buffering (storing data temporarily while it is being transferred),
    - caching (storing parts of data in faster storage for performance),
    - spooling (the overlapping of output of one job with input of other jobs)
  - General device-driver interface
  - Drivers for specific hardware devices

Security and protection

- 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

Security and Protection (Cont..)

- Systems generally first distinguish among users, to determine who can do what
  - User identities (user IDs, security IDs) include name and associated number, one per user
  - User ID then associated with all files, processes of that user to determine access control
  - Group identifier (group ID) allows set of users to be defined and controls managed, then also associated with each process, file

Privilege escalation allows user to change to effective ID with more rights

Virtualization

Virtualization is a technology that allows us to ***abstract the hardware of a single computer*** (the CPU, memory, disk drives, network interface cards, and so forth) into ***several different execution environments***, thereby creating the illusion that each separate environment is running on its own private compute

- Example:
  - Windows and UNIX) that may be running at the same time and may interact with each other.
- Allows operating systems to run applications within other OSes
  - Vast and growing industry

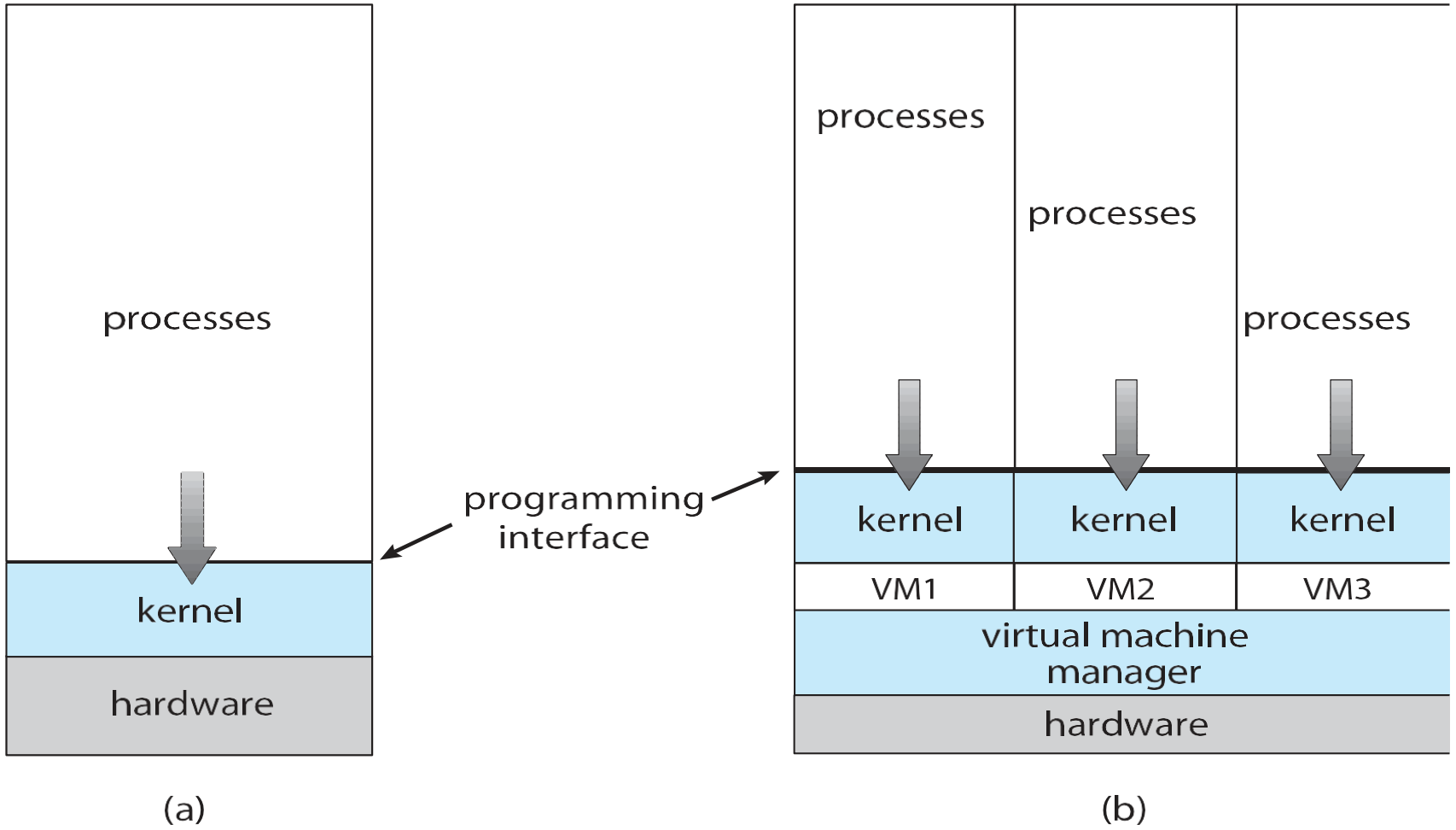
Virtualization

- Virtualization – OS natively compiled for CPU, running guest OSes also natively compiled
  - Consider VMware running WinXP guests, each running applications, all on native WinXP host OS
  - VMM (virtual machine Manager) provides virtualization services
- **Emulations**
  - Emulation, which involves simulating computer hardware in software, is typically used when the source CPU type is different from
  - the target CPU type.
  - Example
    - when Apple switched from the **IBM Power CPU** to the **Intel x86 CPU** for its desktop and laptop computers, it included an emulation facility called “Rosetta,”
    - which allowed applications compiled for the IBM CPU to run on the Intel CP

Virtualization

- Use cases involve laptops and desktops running multiple OSes for exploration or compatibility
  - Apple laptop running Mac OS X host, Windows as a guest
  - Developing apps for multiple OSes without having multiple systems
  - Quality assurance testing applications without having multiple systems
  - Executing and managing compute environments within data centers
- VMM can run natively, in which case they are also the host
  - There is no general-purpose host then (VMware ESX and Citrix XenServer)

Virtualization Computer Environment



Distributed System

- Collection of separate, possibly heterogeneous, systems networked together

heterogeneous computing system refers to a system that contains different types of computational units, such as multicore CPU, GPUs.

- Network is a communications path, TCP/IP most common
  - Local Area Network (LAN)
  - Wide Area Network (WAN)
  - Metropolitan Area Network (MAN)
  - Personal Area Network (PAN)

Network Operating System

- Network operating system is an operating system that provides ***features such as file sharing across the network,*** along with a communication scheme that allows different processes on different computers to exchange messages
- Functions of network operating system
  - Creating and managing user accounts on the network.
  - Controlling access to resources on the network.
  - Provide communication services between the devices on the network.
  - Monitor and troubleshoot the network.
  - Configuring and Managing the resources on the network.

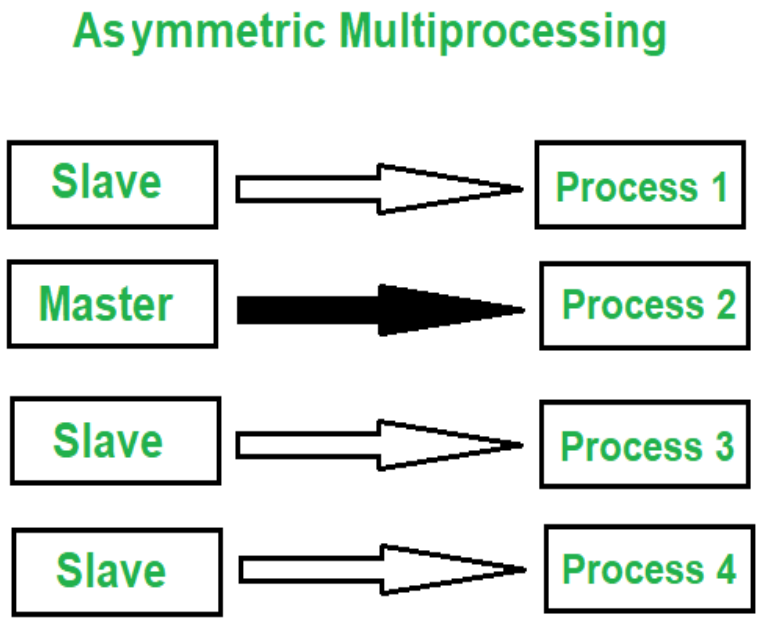
Computer System Architecture

- Most systems use a single general-purpose processor
  - General purpose processors, also known as central processing units (CPUs), are processors that are designed to be capable of executing a wide range of tasks
- Most systems have special-purpose processors as well
  - special-purpose processor, (such as a DMA controller) performs a specific function.
- Multiprocessors systems growing in use and importance Also known as parallel systems,
  - tightly-coupled systems
    - (system architecture and computing method in which all hardware and software components are linked together)
- Advantages include:
  - Increased throughput (how many units of information a system can process in a given amount of time)
  - Economy of scale
  - Increased reliability (correctness)

Multi processing

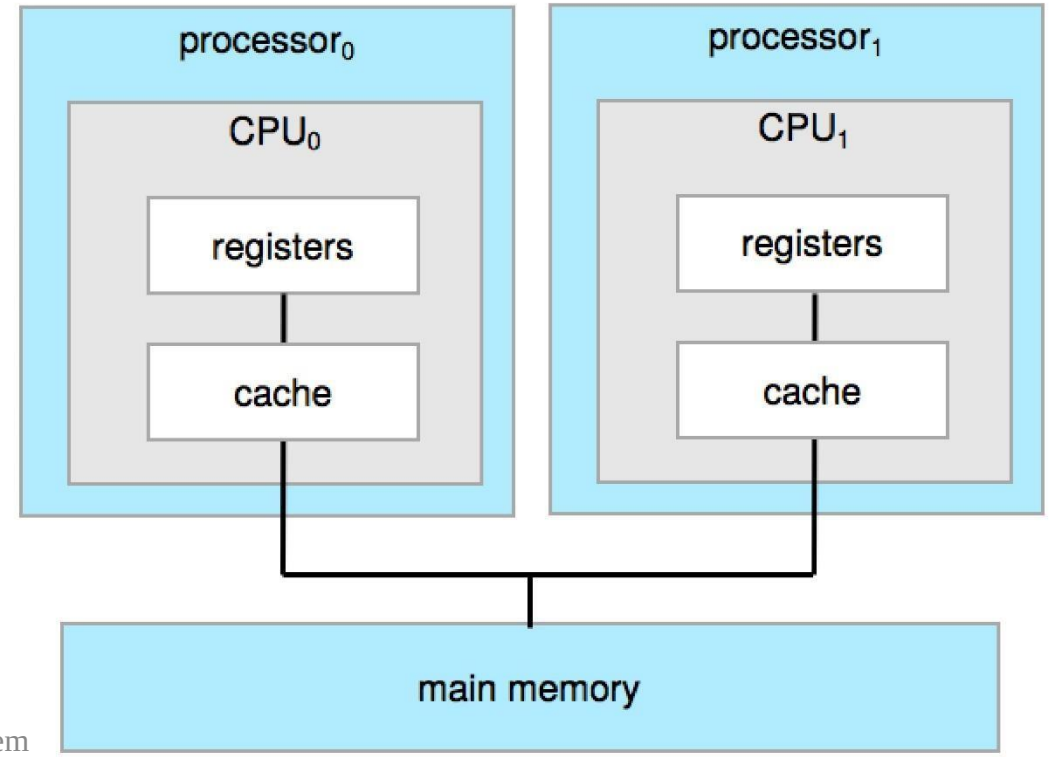
Asymmetric Multiprocessing

- each processor is assigned a specie task.



Symmetric Multiprocessing

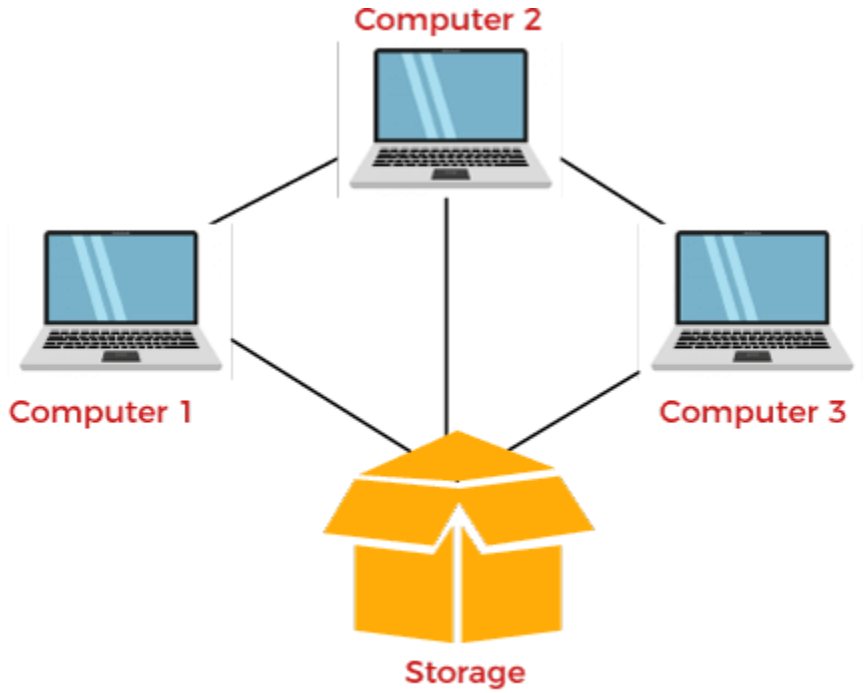
- each processor performs all tasks



Clustered System

- Like multiprocessor systems, but multiple systems working together
  - Usually sharing storage via a storage-area network (SAN)
- Provides a high-availability service which survives failures
  - Asymmetric clustering has one machine in hot-standby mode
  - Symmetric clustering has multiple nodes running applications, monitoring each other
- Some clusters are for high-performance computing (HPC)
- Applications must be written to use parallelization
  - Some have distributed lock manager (DLM) to avoid conflicting operations

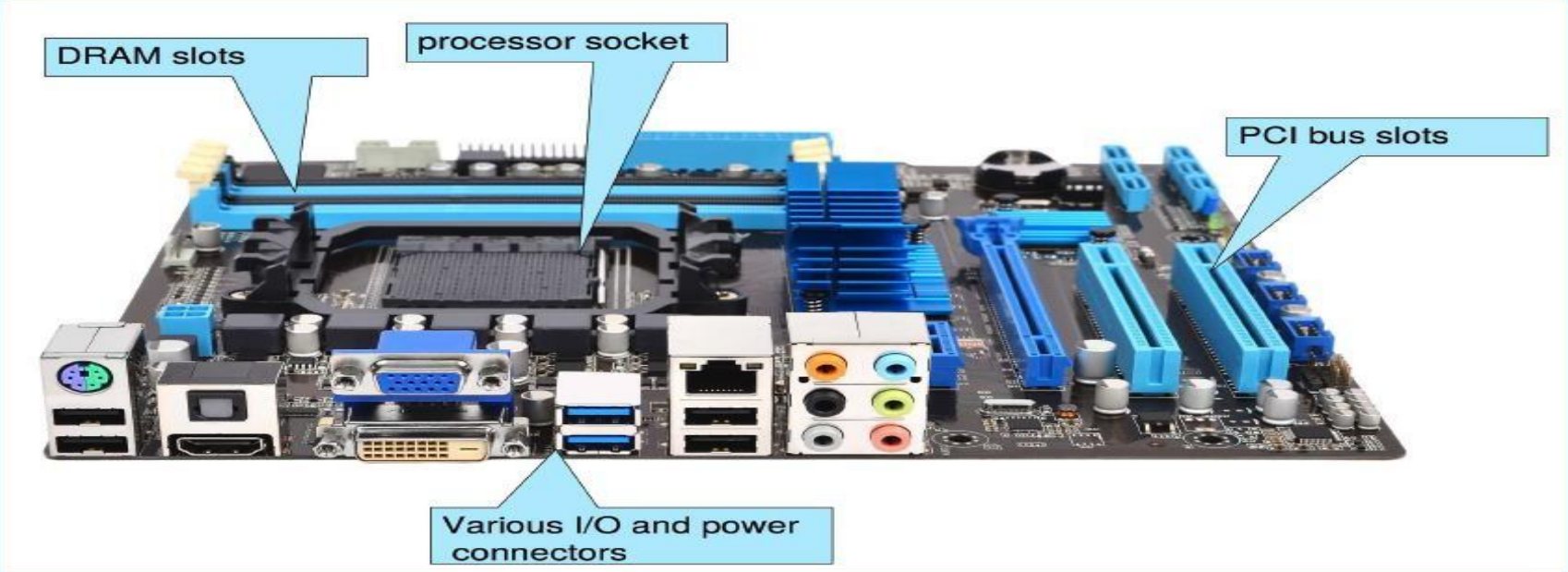
Clustered System



Clustered System

PC MotherBoard

Consider the desktop PC motherboard with a processor socket shown below:



This board is a fully-functioning computer, once its slots are populated. It consists of a processor socket containing a CPU, DRAM sockets, PCIe bus slots, and I/O connectors of various types. Even the lowest-cost general-purpose CPU contains multiple cores. Some motherboards contain multiple processor sockets. More advanced computers allow more than one system board, creating NUMA systems.

Computing Environment

- Traditional
- Mobile
- Client Server
- Peer-to-Peer
- Cloud computing
- Real-time Embedded

Traditional System

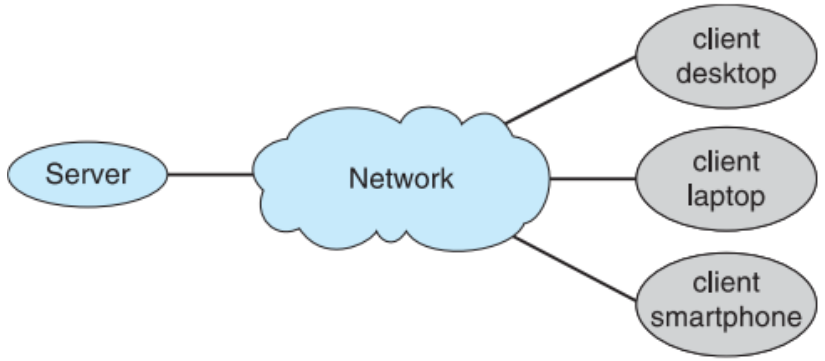
- Stand-alone general-purpose machines
- computer that is used on its own without requiring a connection to a local area network (LAN)
- Blurred as most systems interconnect with others (i.e., the Internet)
- Portals provide web access to internal systems
- Network computers (thin clients) are like Web terminals
- Mobile computers interconnect via wireless networks
- Networking becoming ubiquitous – even home systems use firewalls to protect home computers from Internet attacks

Mobile

- Handheld smartphones, tablets, etc.
- What is the functional difference between them and a “traditional” laptop?
- Extra feature – more OS features (GPS, gyroscope)
- Allows new types of apps like augmented reality
- Use IEEE 802.11 wireless, or cellular data networks for connectivity
- Leaders are Apple iOS and Google Android

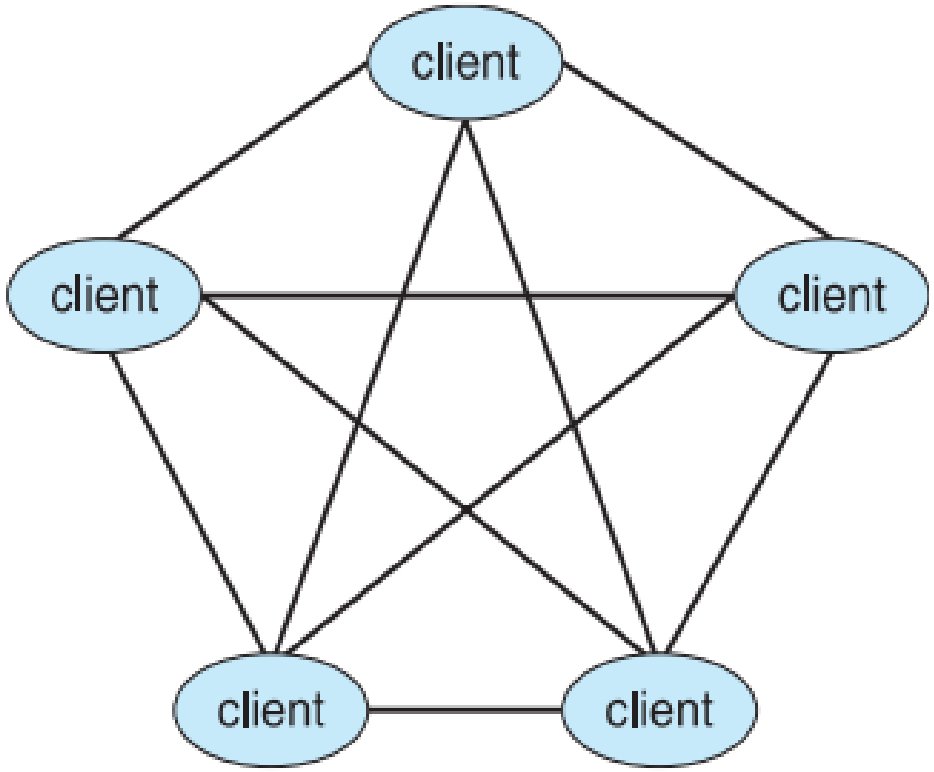
Client Server System

- Client-Server Computing
  - Many systems now servers, responding to requests generated by clients
  - Compute-server system provides an interface to client to request services (i.e., database)
  - File-server system provides interface for clients to store and retrieve files



Peer to Peer System

- Another model of distributed system
- P2P does not distinguish clients and servers
  - Instead all nodes are considered peers
  - May each act as client, server or both
  - Node must join P2P network
    - Registers its service with central lookup service on network, or
    - Broadcast request for service and respond to requests for service via discovery protocol
- Examples include Voice over IP (VoIP) such as Skype



Cloud Computing

Cloud computing is the delivery of different services through the ***Internet, including data storage, servers, databases, networking, and software.***

- Delivers computing, storage, even apps as a service across a network

  - Logical extension of virtualization because it uses virtualization as the base for it functionality.

  - Amazon EC2 has thousands of servers, millions of virtual machines, petabytes of storage available across the Internet, pay based on usage

Cloud Computing

- **Three types of cloud computing**

1. **Private cloud**
   - run by a company for the company's own use
   - Example: WMware

2. **Public Cloud**
   - available via Internet to anyone willing to pay
   - AWS (Amazon Web Services)

3. **Hybird Cloud**
   - includes both public and private cloud components
   - Nutanix Cloud Clusters, VMware Cloud Foundation

Cloud Computing (Cont...0

Software as a Service (SaaS) (use it)

One or more applications available via the Internet

Example: word processor

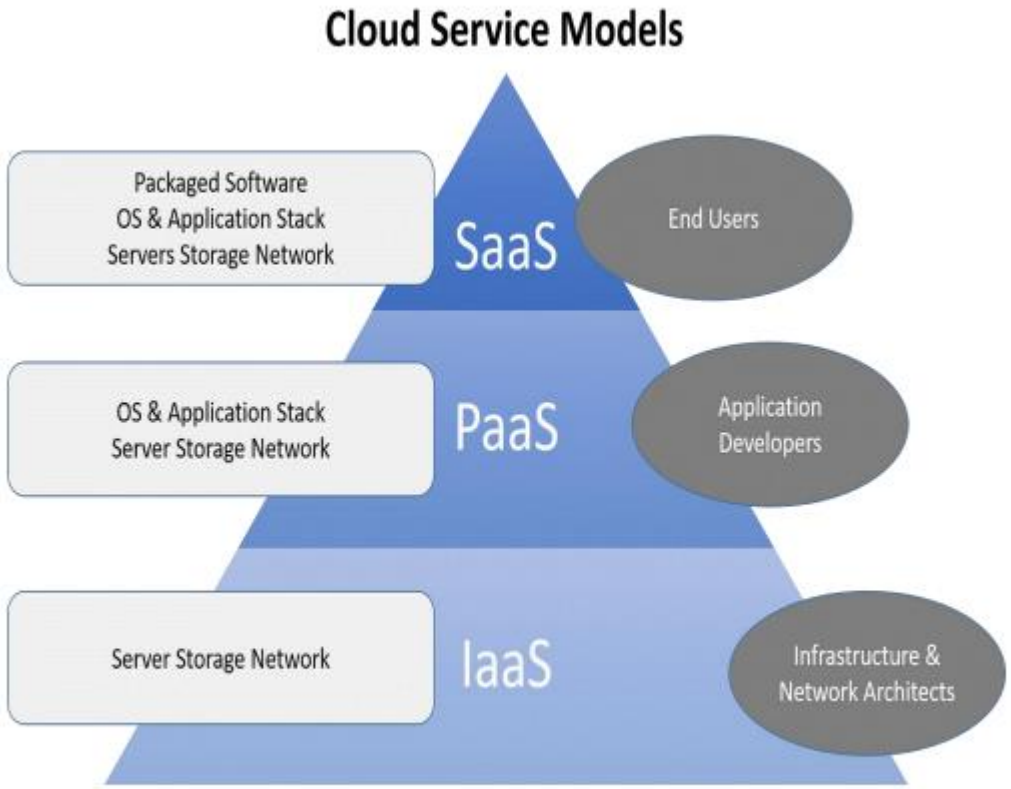
Platform as a Service (PaaS) (Build with it)

Software stack ready for application use via the Internet

Example: database servers

Infrastructure as a Service (IaaS) (Move to it)

Servers or storage available over Internet storage available for backup use



Real Time Embedded Systems

- Real-time embedded systems most prevalent form of computers
  - Vary considerable, special purpose, limited purpose OS, real-time OS
  - Use expanding

- Many other special computing environments as well
  - Some have OSes, some perform tasks without an OS

- Real-time OS has well-defined fixed time constraints
  - Processing must be done within constraint
  - Correct operation only if constraints met

Free and Open Source Operating System

- Operating systems made available in source-code format rather than just binary closed source and proprietary
- Counter to the copy protection and Digital Rights Management (DRM) movement
- Started by Free Software Foundation (FSF), which has “copyleft” GNU Public License (GPL)
  - Free software and open-source software are two different ideas championed by different groups of people
  - Examples include GNU/Linux and BSD UNIX (including core of Mac OS X), and many more
- Can use VMM like VMware Player (Free on Windows), Virtualbox (open source and free on many platforms - http://www.virtualbox.com)
  - Use to run guest operating systems for exploration