INTRODUCTION & BACKGROUND

CHAPTER # 1

Operating Systems

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Chapter 1 - Outline

- Introduction to operating system
- Application software
- System software
- Machine language
- Microprogramming
- Physical devices
- History of Operating Systems
- Types of Operating Systems
- Introduction to Unix, MS-DOS and Windows

Operating System Definition

- Operating Systems
  - OS is a control program which manages computer resources and allocate these resources among competing tasks
  - OS control and coordinates use of hardware among applications for users
  - OS is the interface between the hardware and software environment
  - OS is a program that acts as an intermediary between the user and computer hardware

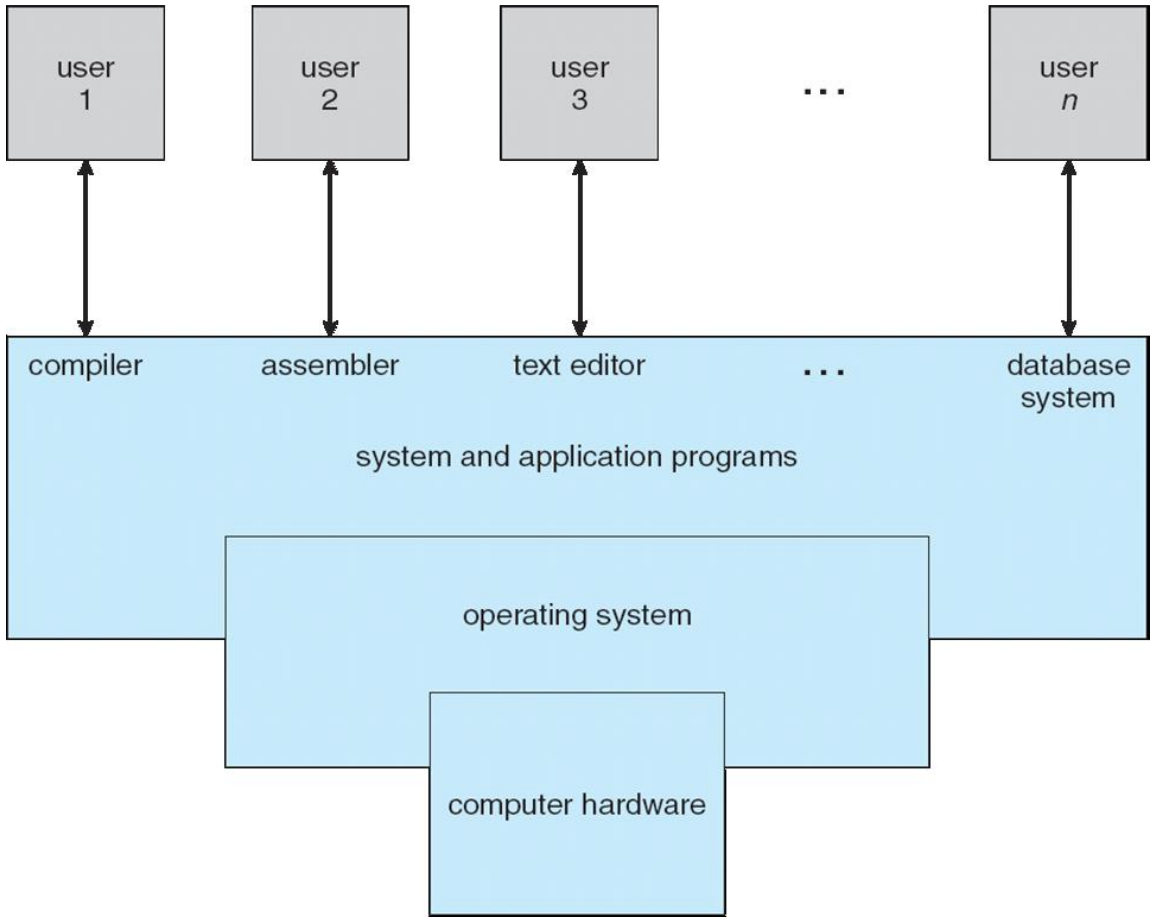
Operating System Goals

- Execute user programs and make solving user problems easier
- Make the computer system convenient to use
- Use the computer hardware in an efficient manner

Computer System Overview

- From hardware and software point of view, a computer system can be divided into six parts
  - Application programs
  - Compliers, editors, interpreters
  - Operating system
  - Machine language
  - Microprogramming
  - Physical devices

Computer System Overview



Computer System Overview

- Application Programs
  - They are used to solve user's problems
  - AP have specific processing's capabilities required for user's applications
  - Examples:
    - Word processor (Microsoft Word, Abi Word)
    - Spread sheet (Microsoft Excel)
    - Presentation tools (MS PowerPoint, ***K***Presenter)
    - Inventory control system
    - Library management system

Computer System Overview

- System Programs
  - They are used to manage operations of computer and to control its resources
  - Oriented to the needs of hardware and facilitate the development and running of applications
  - Examples:
    - Compilers (C Language Compiler)
    - Editors (DOS Editor)
    - Shell (C Shell)
    - Interpreter (VB Interpreter)

Computer System Overview

- Operating Systems
  - OS is an integrated set of programs used to manage the computer resources and its overall operations
  - Provide a layer of services which manage the resources of the hardware and permit the user to drive the system
  - Provide special hardware services in absence of hardware facility using special software routines

Computer System Overview

- Operating System performs
  - Resource Management
    - CPU management
    - Memory management
    - File System management
    - I/O management
  - Resource Sharing
    - Among Users
    - Among CPUs
  - Interfacing between hardware and users

Computer System Overview

- Machine Language
  - Machine language programs are written in binary language
  - Machine language has 50-300 instructions
  - Used for moving data around the machine
  - Only language understandable by hardware
  - Every programming language code has to be converted into machine language

Computer System Overview

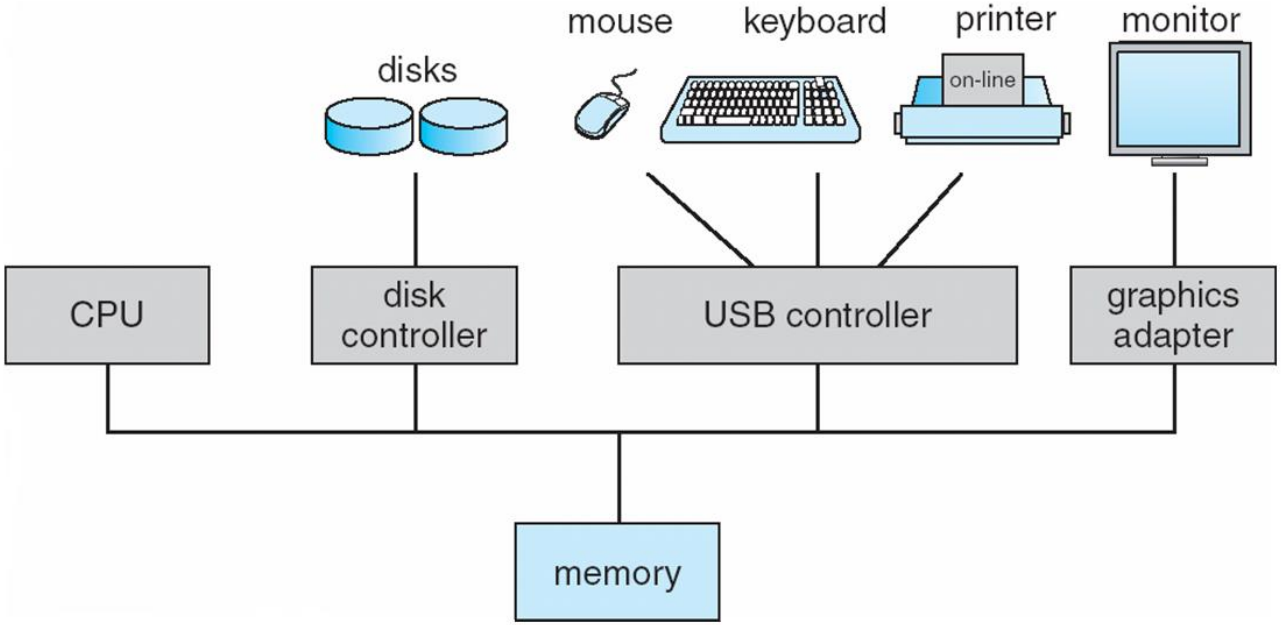
- Micro Programs
  - They are normally permanently located in chips to perform some basic tasks
  - Example is micro program located in ROM
  - An interpreter, fetching the machine language instruction such as ADD, JUMP, MOVE and carrying them out as a series of little steps
    - To carry out an ADD instruction following steps are performed
      - The micro-program determines where the number to be added are located
      - Fetch them
      - Add them
      - Store them in proper location

Computer System Overview

- Physical Devices
  - These are basically hardware components used in a computer
  - At the lowest level they have to actually perform the user's tasks
  - Example:
    - Processor
    - Motherboard
    - Memory
    - Keyboard
    - Mouse

Computer System Organization

- Computer-system operation
  - One or more CPUs, device controllers connect through common bus providing access to shared memory
  - Concurrent execution of CPUs and devices competing for memory cycles



Evolution of Operating Systems

- In early systems the programs were entered by using a set of switches to define memory address value
- The program was started by setting the program counter to the first instruction word and pressing a start button
- The execution was progressed by displaying light on console
- The first step towards improvement was to reduce human involvement in this process

Evolution of Operating Systems

- Offline input devices like cards or paper tape reader were introduced later
- A program loader was established in Computer memory to read program from input device and setup it in memory
- New input/output technologies were applied to assist in improving system performance

Evolution of Operating Systems

- Around 1960, a new computer called *Atlas* was developed with the requirements of an operating system in mind
- Batch processing was applied to submit jobs in batches to the computer
- Multiprogramming was introduced to run several programs at the same time
  - The processor should be kept busy for most of the time by switching its attention from one program to another

Evolution of Operating Systems

- Fist time sharing system (support multiple interactive users) was developed at MIT
- Mini Computer took place having multi-user OS
- Spooling (Simultaneous Peripheral Operation On-line) technique was introduced
  - it is used to absorb surplus processor time by performing I/O transfers for other jobs

Types of Operating Systems

- With the passage of time operating systems are divided into different categories. They can be categories as follows
  - Single User OS
  - Distributed OS
  - Network OS
  - Multiprocessor OS
  - Real-time OS
  - Embedded OS

Single User Operating Systems

- These types of OS were commonly used with computer systems referred as Personal Computers in 1980s, 1990s and early 2000s
- Cheaper OS
- Easy to use
- May run several different types of operating systems (Windows, MacOS, UNIX, Linux)
- Supports multiple applications
  - not dedicated for one type of application
- Have centralized resources
- Supports multimedia (images, text, graphics and audio/video)
- Example:
  - Windows 98,ME
  - Linux

Network Operating Systems

- Network Operating Systems are used to connect more than one computer
  - User can login to a remote computer, to share its resources
- Network OS does not follow any transparency (e.g. location, migration)
  - Every operation has to be explicitly specified by the user
- User knows where his job is processing
- Examples:
  - Windows NT
  - Sun Solaris

Distributed Operating Systems

- Distribute computation among several physical processors
- Follows the transparencies
- Requires networking infrastructure
  - Local area networks (LAN) or Wide area networks (WAN)
- May be either client-server or peer-to-peer systems
- Main features of Distributed System
  - Resource sharing
  - Computation speed up
  - Reliability
  - Communication

Distributed Operating Systems

- Two types of Distributed OS
  - Tightly coupled DOS
    - Multiprocessor system
    - Processor share memory
      - Communication takes place through memory
  - Loosely coupled DOS
    - Single processor system
    - Clusters of workstations
      - Do not communicate via memory
      - Communicate via high speed buses, telephone lines
- Examples:
  - Windows 2000
  - Linux
  - Unix

Multiprocessor Operating Systems

- These are actually distributed operating systems which run on machines having more than one processor
- Communication is done via shared memory through message passing, pipes etc.

Real-time Operating Systems

- These OS run on Real-time systems
- Very fast operating system
- Normally designed for a set of specific applications
- A real-time system is any information processing system which has to respond to externally generated input stimuli within a finite and specified period
  - the correctness depends not only on the logical result but also the time it was delivered
  - failure to respond is as bad as the wrong response
- In a real time system emphasis is on timely execution of tasks than speed of execution
- Often used as a control device in a dedicated application such as controlling scientific experiments, medical imaging systems, industrial control systems, and some display systems
- Real-Time systems may be either hard or soft real-time

Real-time Operating Systems

- Hard real-time system
  - systems where it is absolutely imperative that responses occur within the required deadline
  - E.g. Flight control systems
  - Secondary storage limited or absent, data stored in short term memory, or read-only memory (ROM)
- Soft real-time system
  - systems where deadlines are important but which will still function correctly if deadlines are occasionally missed
  - E.g. Data acquisition system
  - Limited utility in industrial control of robotics
  - Useful in applications (multimedia, virtual reality) requiring advanced operating-system features

Embedded Operating Systems

- These operating systems are dedicated for devices
- These are normally built-in with devices
- Example:
  - Mobile set OS
  - PDA OS (personal digital assistant, a handheld device that combines computing, telephone/fax, Internet and networking features.)
- Issues:
  - Limited memory
  - Slow processors
  - Small display screens

Computing Environments - Traditional

- Stand-alone general purpose machines
- But 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

Computing Environments - Mobile

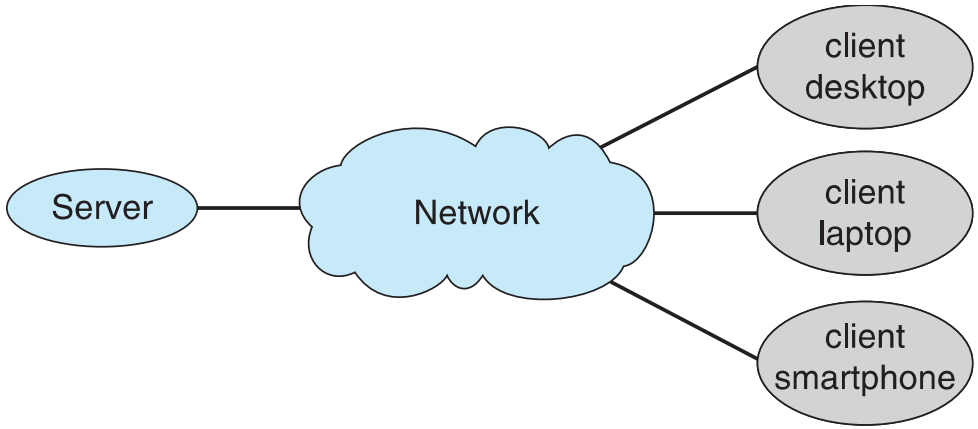
- Handheld smartphones, tablets, etc
- What is the functional difference between them and a "traditional" laptop?
- Extra feature – more OS features (GPS, gyroscope)
- Allows new types of apps like ***augmented reality***
- Use IEEE 802.11 wireless, or cellular data networks for connectivity
- Leaders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

Computing Environments – Distributed

- Distributed
  - Collection of separate, possibly heterogeneous, systems networked together
    - **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** provides features between systems across network
    - Communication scheme allows systems to exchange messages
    - Illusion of a single system

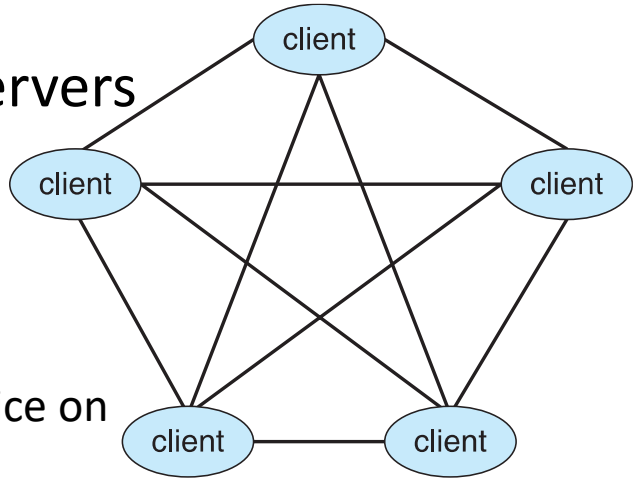
Computing Environments – Client-Server

- Client-Server Computing
  - Dumb terminals supplanted by smart PCs
  - 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



Computing Environments – Peer-to-Peer

- 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 Napster and Gnutella, **Voice over IP** (**VoIP**) such as Skype



Computing Environments - Virtualization

- It treats hardware and the operating system kernel as though they were all hardware
- A virtual machine provides an interface identical to the underlying bare hardware
- The operating system creates the illusion of multiple processes, each executing on its own processor with its own (virtual) memory
- The resources of the physical computer are shared to create the virtual machines
  - CPU scheduling can create the appearance that users have their own processor
  - Spooling and a file system can provide virtual card readers and virtual line printers

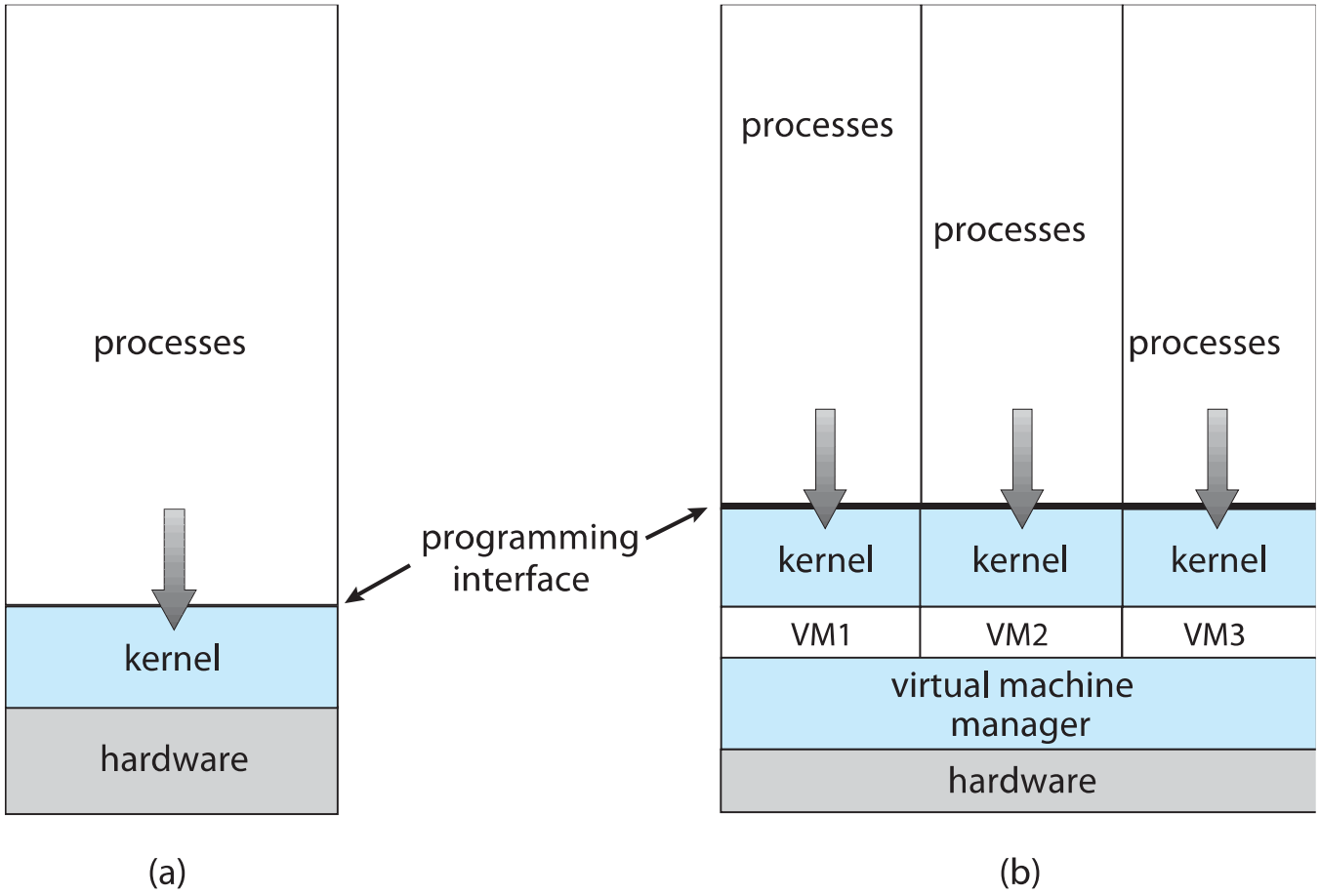
Computing Environments - Virtualization

- Allows operating systems to run applications within other OSes
  - Vast and growing industry
- **Emulation** used when source CPU type different from target type (i.e. PowerPC to Intel x86)
  - Generally slowest method
  - When computer language not compiled to native code – **Interpretation**
- **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** provides virtualization services

Computing Environments - 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
  - QA 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)

Computing Environments - Virtualization

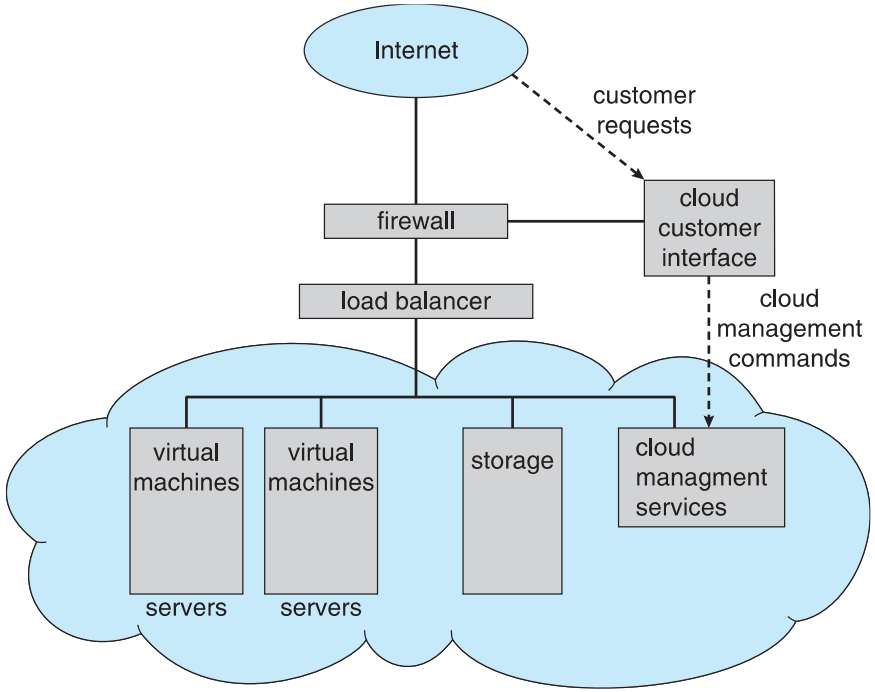


Computing Environments – Cloud Computing

- Delivers computing, storage, even apps as a service across a network
- Logical extension of virtualization as based on virtualization
  - Amazon **EC2** has thousands of servers, millions of VMs, PBs of storage available across the Internet, pay based on usage
- Deployment Types
  - **Public cloud** – available via Internet to anyone willing to pay
  - **Private cloud** – run by a company for the company's own use
  - **Hybrid cloud** – includes both public and private cloud components
- Service Types
  - Software as a Service (**SaaS**) – one or more applications available via the Internet (i.e. word processor)
  - Platform as a Service (**PaaS**) – software stack ready for application use via the Internet (i.e a database server)
  - Infrastructure as a Service (**IaaS**) – servers or storage available over Internet (i.e. storage available for backup use)

Computing Environments – Cloud Computing

- Cloud compute environments composed of traditional OSes, plus VMMs, plus cloud management tools
  - Internet connectivity requires security like firewalls
  - Load balancers spread traffic across multiple applications



Computing Environments – 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