2. Introduction to Computer Systems; Computer Systems Architecture

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  - The Architecture of Computer Hardware, Systems Software & Networking: An Information Technology Approach
    - 5th Edition, Irv Englander; John Wiley and Sons ©2013
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2.1: Computers and Systems

2.1: Computers and Systems

2.2: System Concepts and Architecture

2.3: IT System Architecture

Learning Objectives

- Understand the Input-Process-Output Model (IPO)
- List the components of a computer system
- Explain the purpose of each component
- Describe virtualization
- Explain the purpose of standards

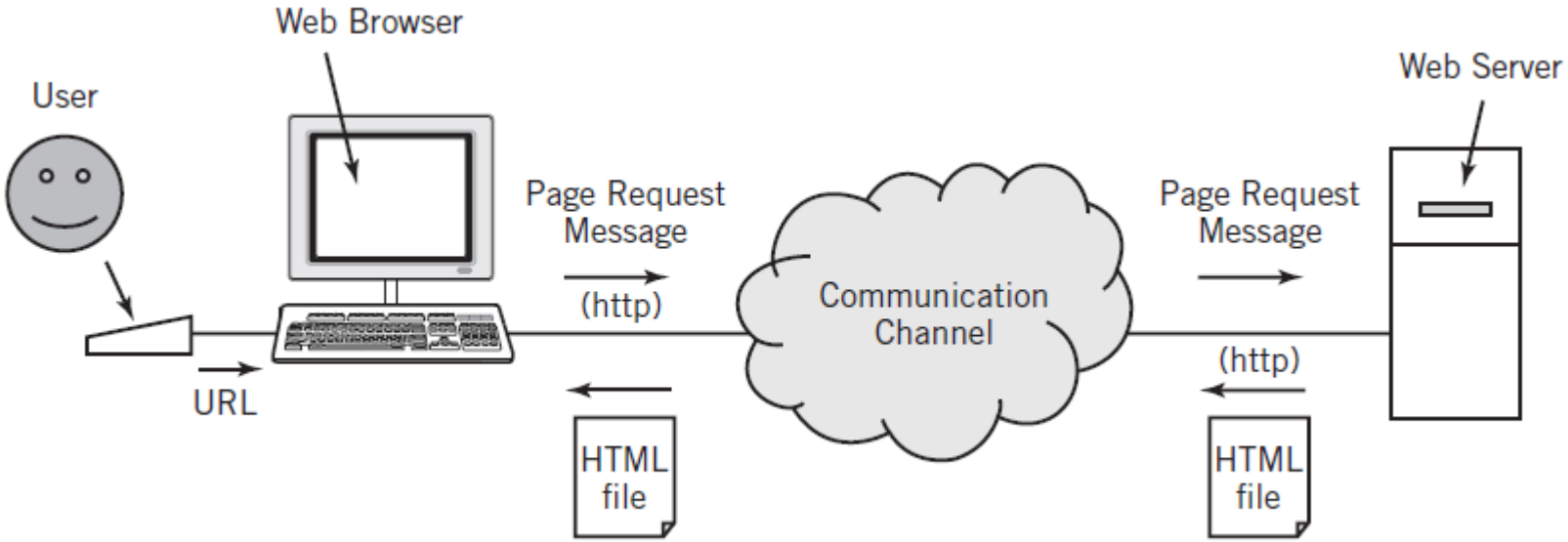
Modern Computing

- Personal computing is ubiquitous
  - It is everywhere and anywhere
  - No longer limited to a traditional ‘computer’
  - Greater variety of computing platforms exist now
- Computing is widespread
  - Embedded in many other types of devices such as appliances and automobiles
  - Users no longer have to understand the details of how they work to operate the device

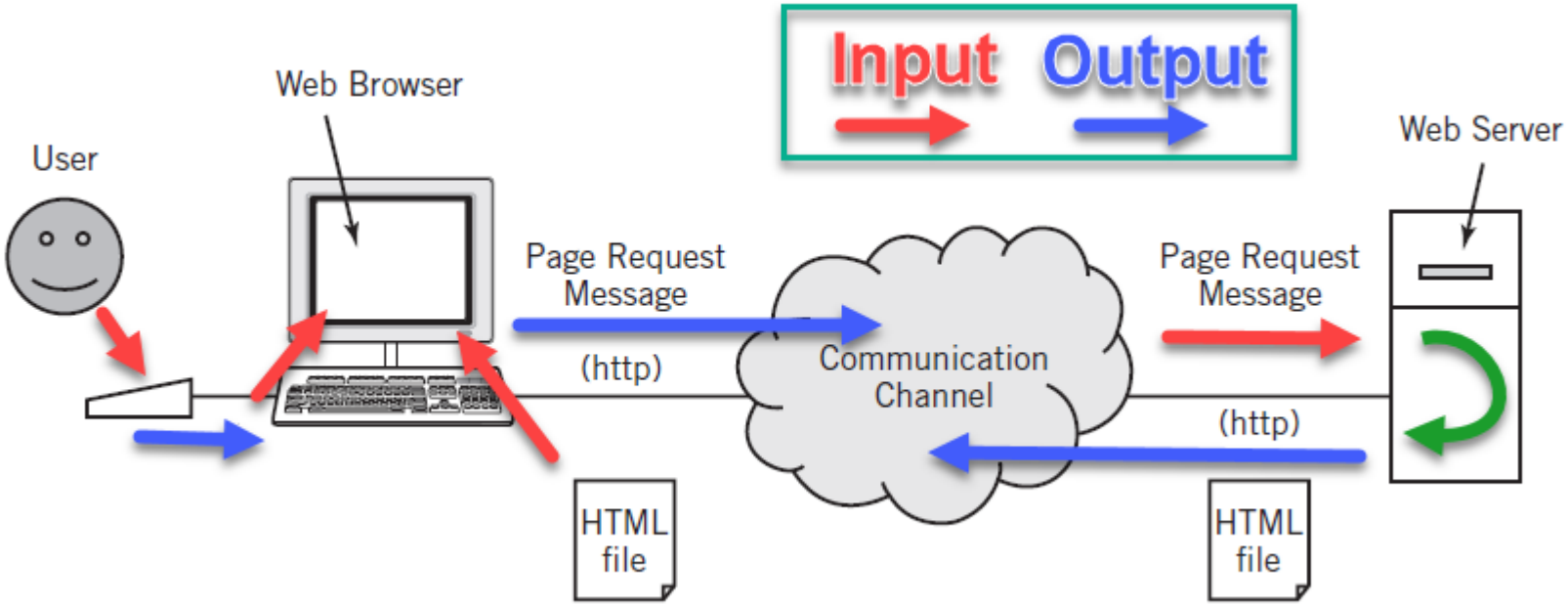
Why Study Computer System Architecture?

- Understand system capabilities, strengths, and limitations
- Make better informed decisions
- Improve communications with information technology professionals

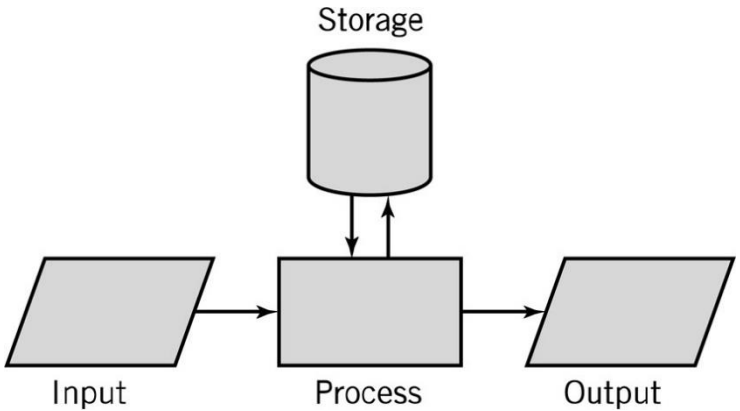
Web Browser Application Example



Web Browser Application IPO



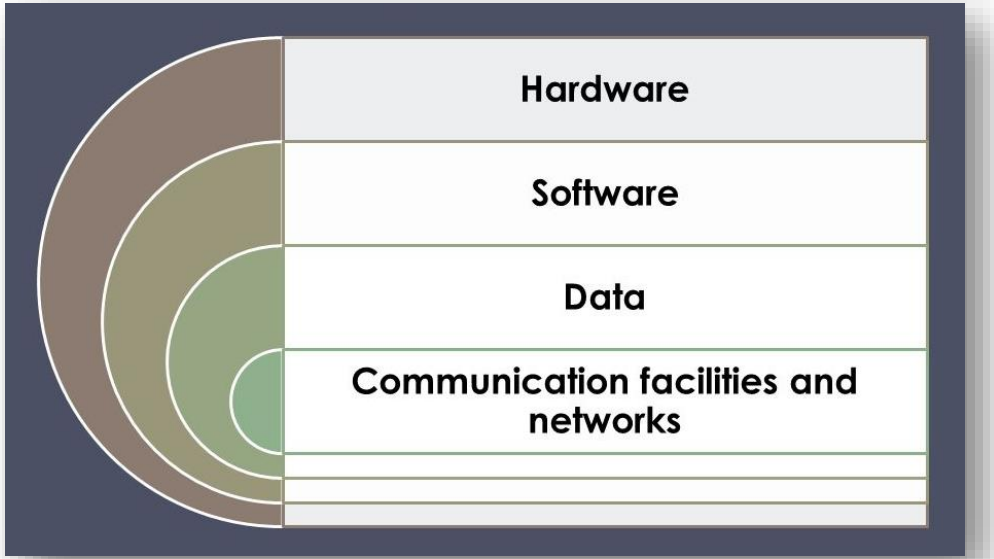
Input-Process-Output Model (IPO)



- **Input**
  - keyboard, mouse, scanner
- **Process**
  - CPU executes the computer program
- **Output**
  - monitor, printer, fax machine
- **Storage**
  - hard drive, optical media, diskettes, magnetic tape

Computer System Components

- Hardware
- Software
- Data
- Communication



Computer System Components

- Hardware
  - Processes data by executing instructions
  - Provides input and output
  - Controls input, output, and storage components
- Software
  - Applications and system software
  - Instructions tell hardware exactly what tasks to perform and in what order

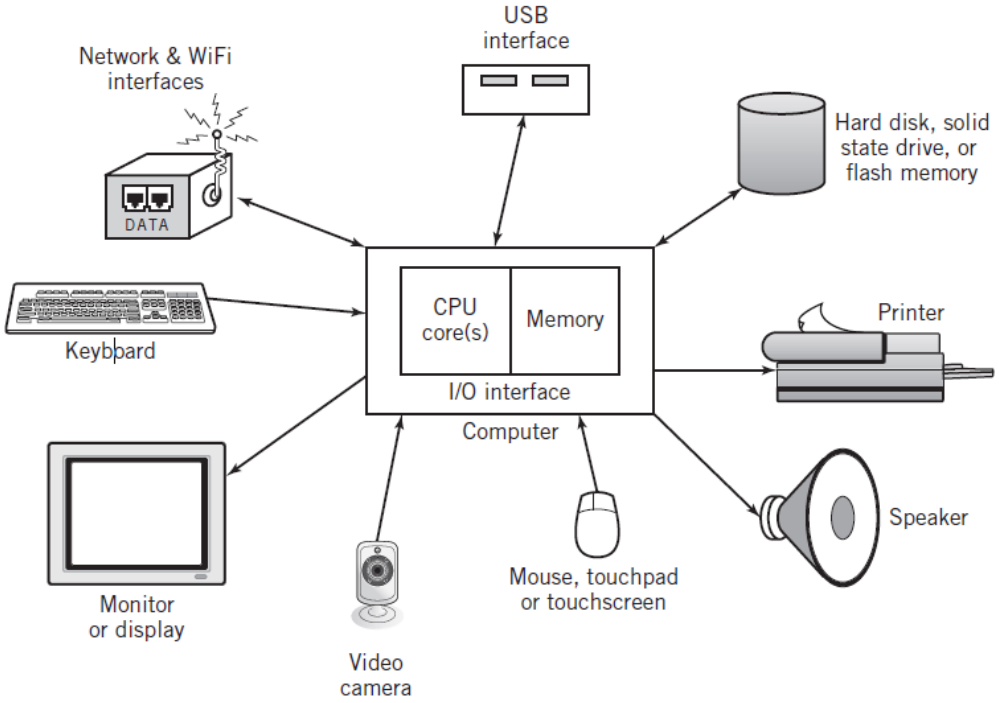
Computer System Components

- Data
  - Fundamental representation of facts and observations
- Communications
  - Sharing data and processing among different systems

Hardware Component

- Input/output devices
- Storage Devices
- CPU – Central Processing Unit
  - ALU: arithmetic/logic unit
  - CU: control unit
  - Interface unit
- Memory
  - Short-term storage for CPU calculations

Hardware Components of a PC



CPU: Central Processing Unit

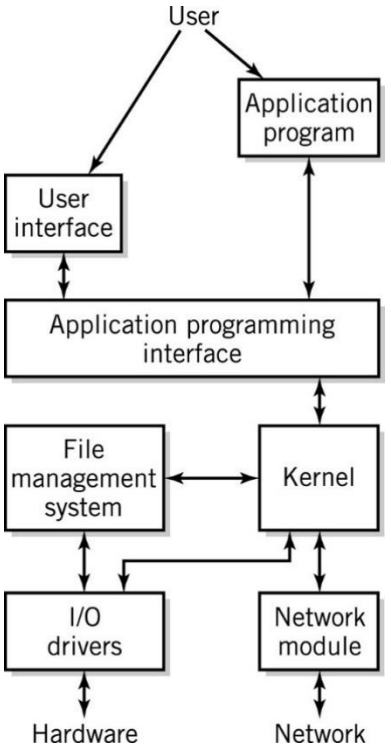
- ALU: arithmetic/logic unit
  - Performs arithmetic and Boolean logical calculations
- CU: control unit
  - Controls processing of instructions
  - Controls movement of data within the CPU
- Interface unit
  - Moves instructions and data between the CPU and other hardware components
  - Bus: bundle of wires that carry signals and power between different components

Memory

- Also known as primary storage, working storage, and RAM (random access memory)
- Consists of bits, each of which hold a value of either 0 or 1 (8 bits = 1 byte)
- Holds both instructions and data of a computer program (stored program concept)

Software Component

- Applications
- Operating System
  - API: application program interface
  - File management
  - I/O
  - Kernel
    - Memory management
    - Resource scheduling
    - Program communication
    - Security
  - Network Module



Communication Component (1 of 2)

- Hardware
  - Communication channels
    - Physical connections between computer systems
    - Examples: wire cable, phone lines, fiber optic cable, infrared light, radio waves
  - Interface hardware
    - Handles communication between the computer and the communication channel
    - Modem or network interface card (NIC)

Communication Component (2 of 2)

- Software
  - Establish connections
  - Control flow of data
  - Directs data to the proper applications for use

Computer Systems

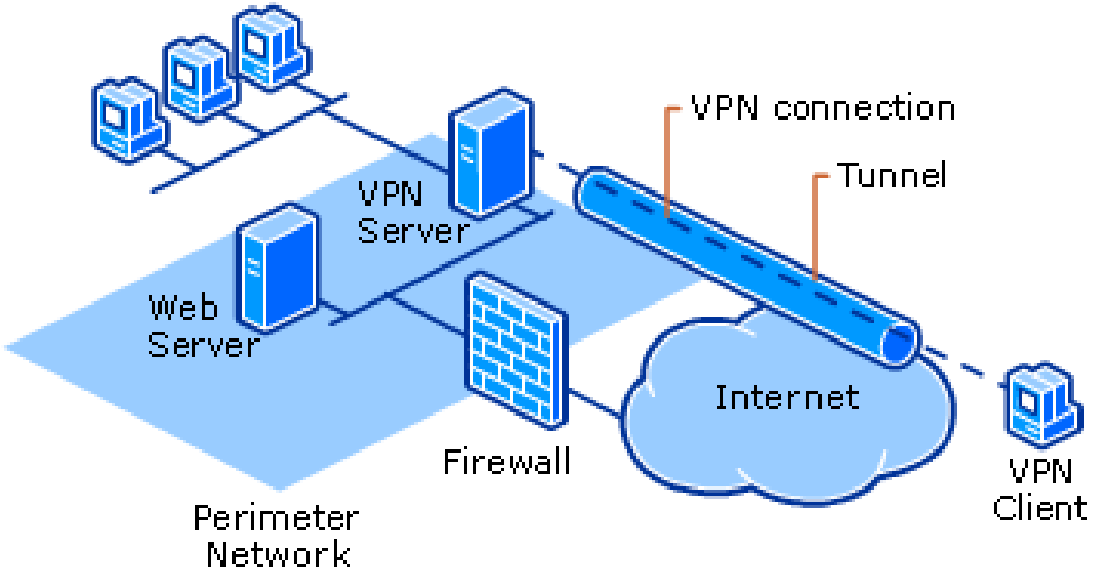
- All computer systems, no matter how complex, consists of the following:
  - At least one CPU
  - Memory to hold programs and data
  - I/O devices
  - Long-term storage

Computer Systems Examples

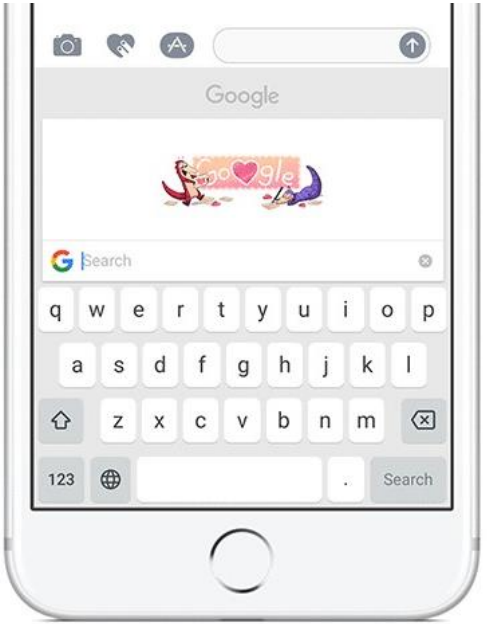
Virtualization

- Virtual
  - not physically existing as such but **made by software** to appear to do so
  - Created, simulated, or carried on by means of a computer or computer network
- Virtual computer systems examples
  - memory, networks, and operating systems

Virtual Private Network (VPN)



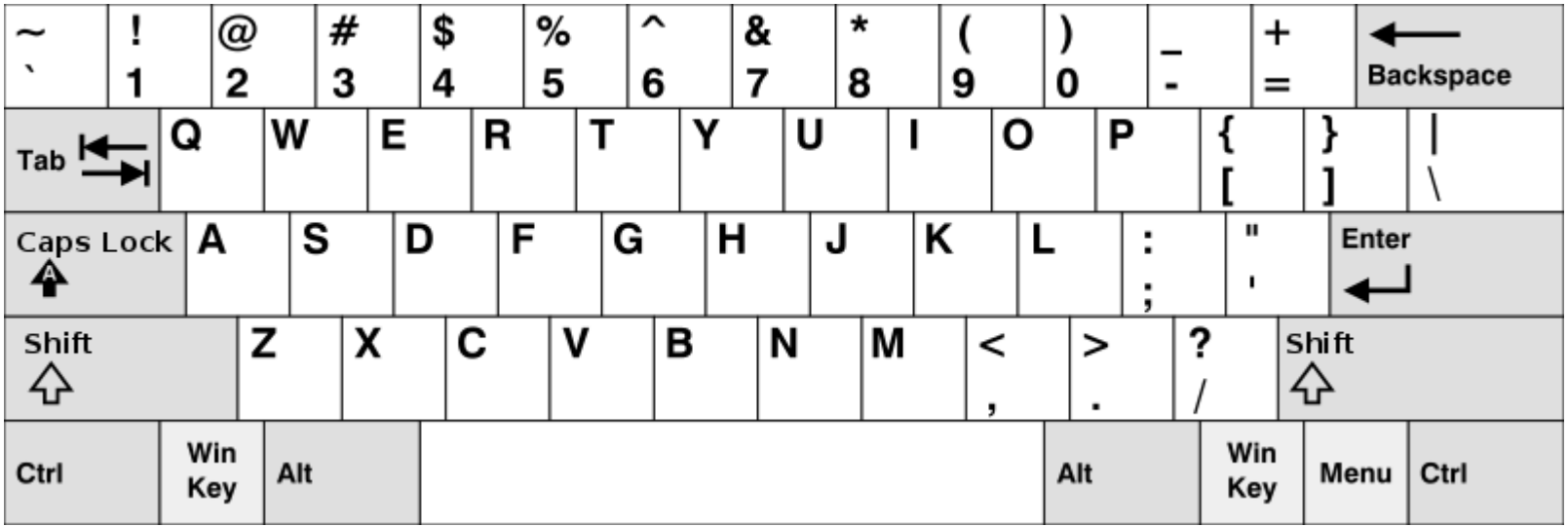
Real vs. Virtual Keyboard



Standards

- Created to ensure **universal compatibility** of data formats and protocols
- Examples:
  - Computer languages: Java, SQL, C, JavaScript
  - Display standards: Postscript, MPEG-2, JPEG, PNG
  - Character set standards: ASCII, Unicode, EBCDIC
  - Multimedia standards: MPEG-2, MPEG-4, MP3, DVD-ROM

QWERTY Keyboard Layout



Protocols

- Common **ground rules of communication** between computers, I/O devices, and many software programs
- Examples
  - HTTP: between Web servers and Web browsers
  - TCP/IP: between computers on the Internet and local area networks
  - SATA: between storage devices and computers
  - XML,RSS, SIP: new protocols developed to meet new demands

TCP and UDP: Internet Protocols

- **TCP**: Transmission Control Protocol
  - Ensures delivery of data
  - If data is corrupt or not delivered, the data is resent
- **UDP**: User Datagram Protocol
  - Data is sent with no confirmation of delivery
  - If data is corrupted, the receiver discards the data

Summary

- Input-process-output (IPO) model is a fundamental design of computer system architecture
- A computer is a self-contained system composed of hardware, software, and data that communicates
  - CPU, memory, input/output devices, and storage
- Virtualization is a software-based computer system
- Protocols are standards that define communication rules

2.2: System Concepts and Architecture

2.1: Computers and Systems

2.2: System Concepts and Architecture

2.3: IT System Architecture

Learning Objectives

- Describe a system
- List the components of a system
- Describe each component in detail
- Explain system decomposition
- Discuss the difference between system architecture and abstraction

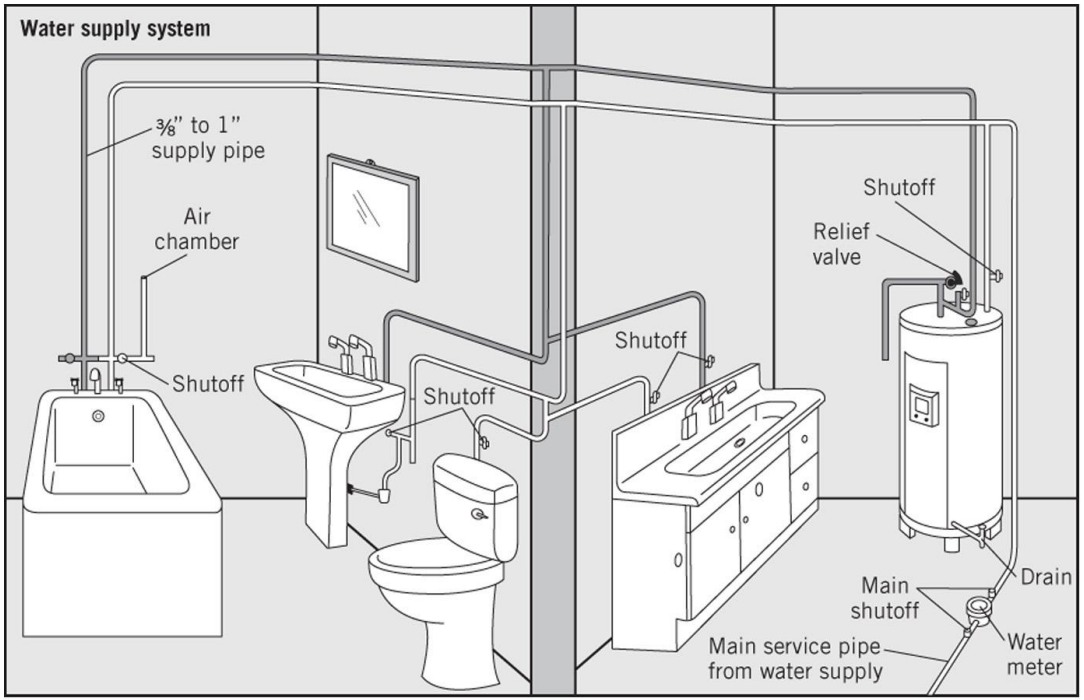
What is a system?

- What do the following systems have in common?
  - Plumbing system
  - Solar system
  - Home network system
  - Inventory control system

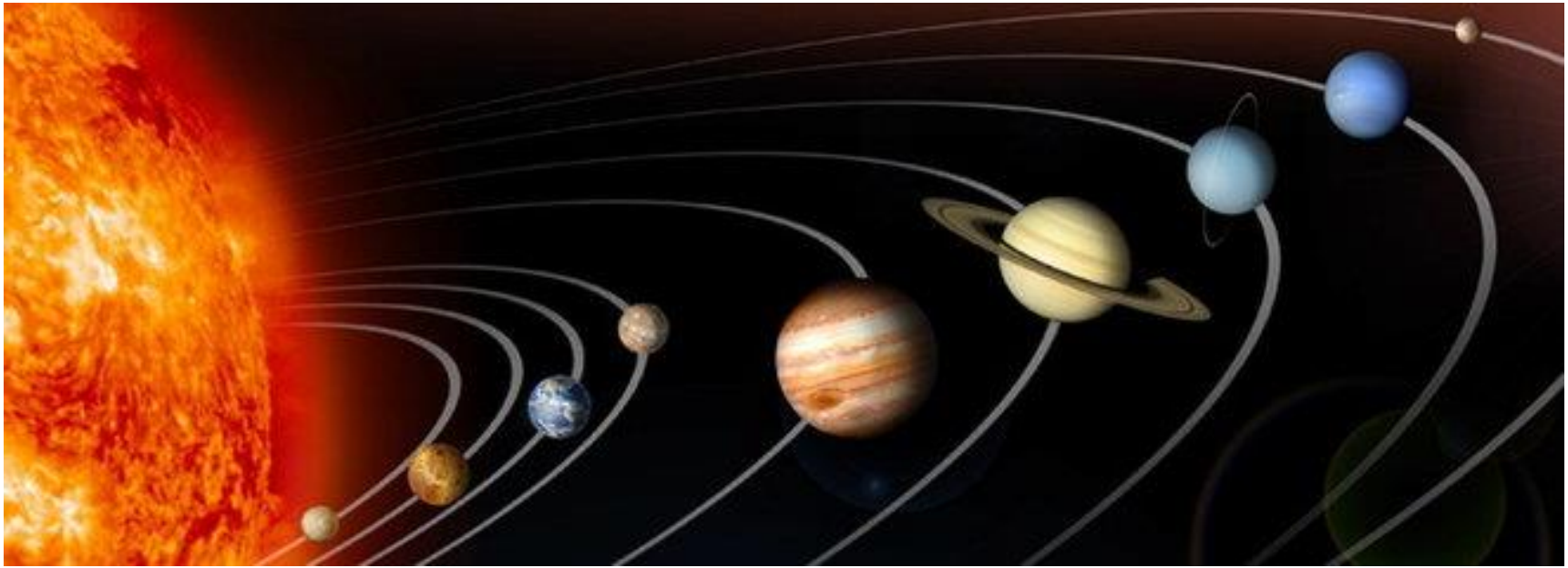
What is a system?

- What do the following systems have in common?
- Each is built up from a set of **components** that are **linked** together to form what we think of as a **single unit.**

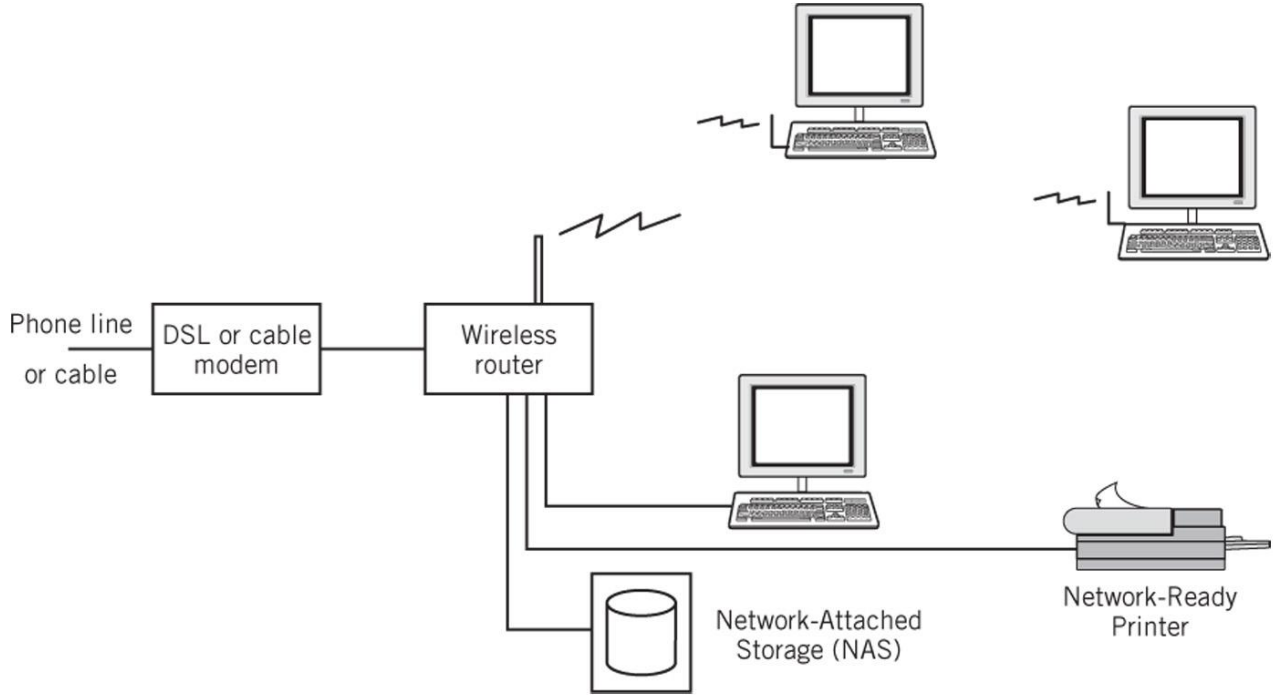
Plumbing System



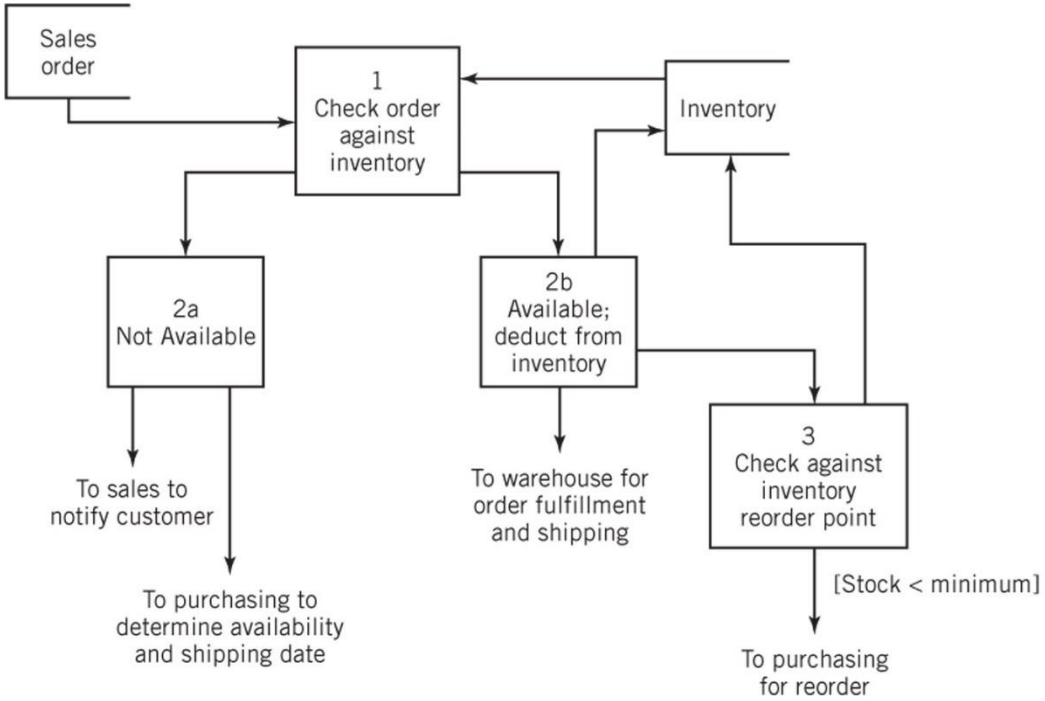
Solar System



Home Network System



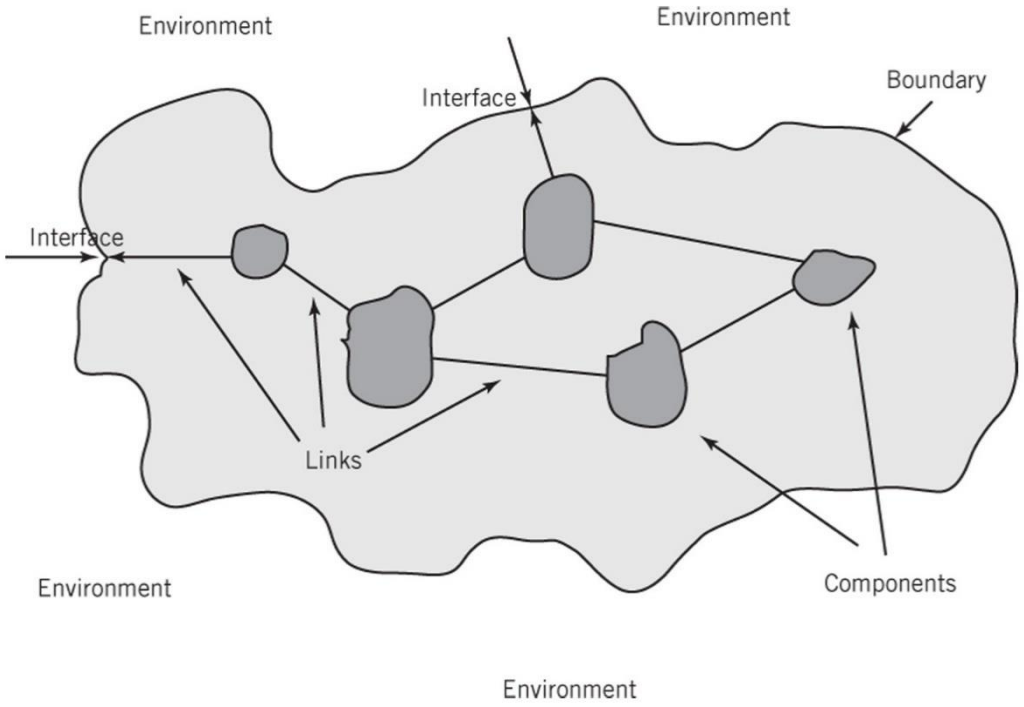
Inventory Control System



Definition of a System

- "A system is a **collection** of components **linked** together and organized in such a way as to be recognizable as a **single unit**"
- Linked components of a system also define a **boundary** for the system
- The **environment** is anything **outside** of the system

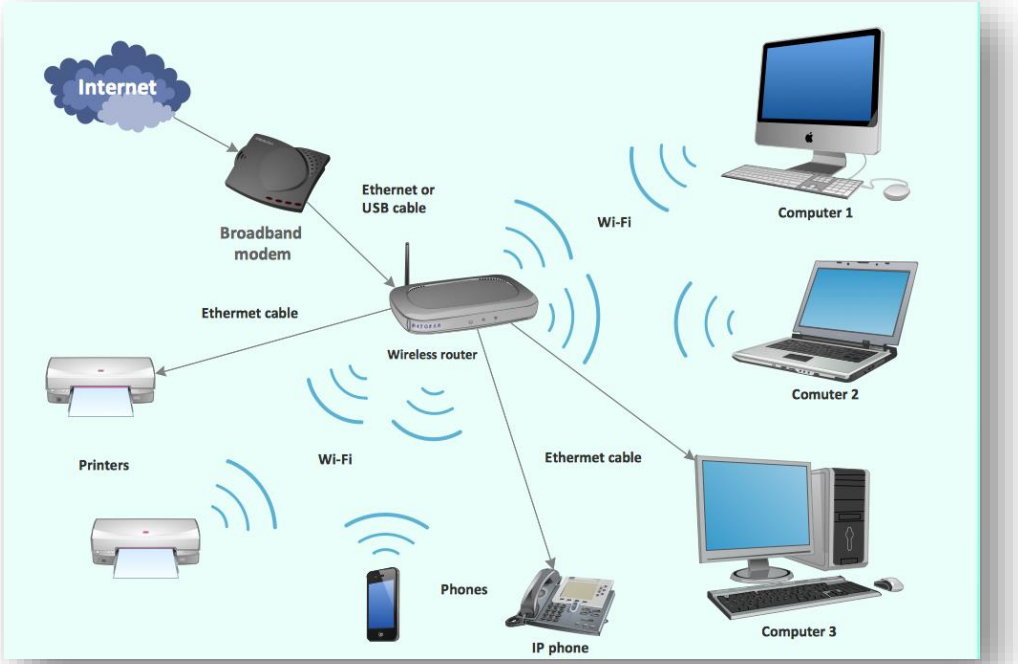
General Representation of a System



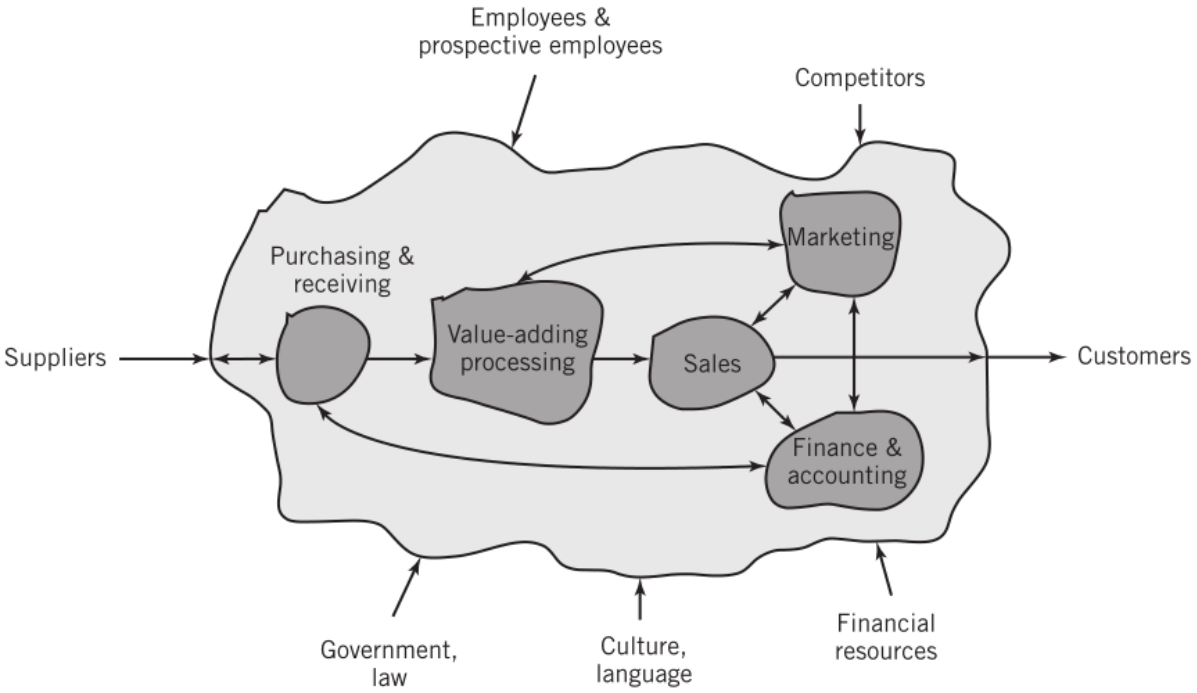
Definition of an Interface

- In computing, an **interface** is a shared boundary across which two or more separate components of a computer system exchange information.

Different Interfaces

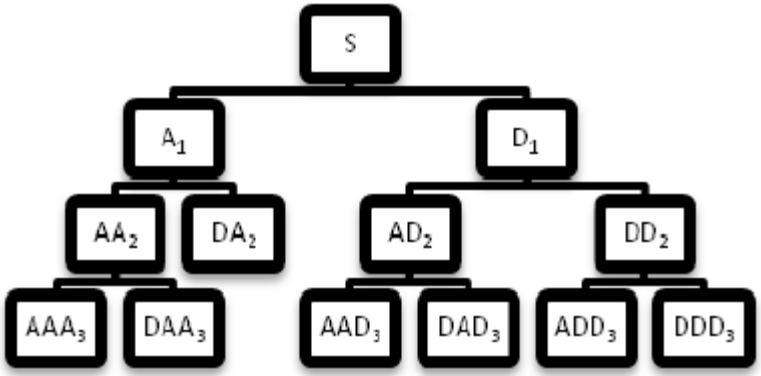


A Simple E-Business System

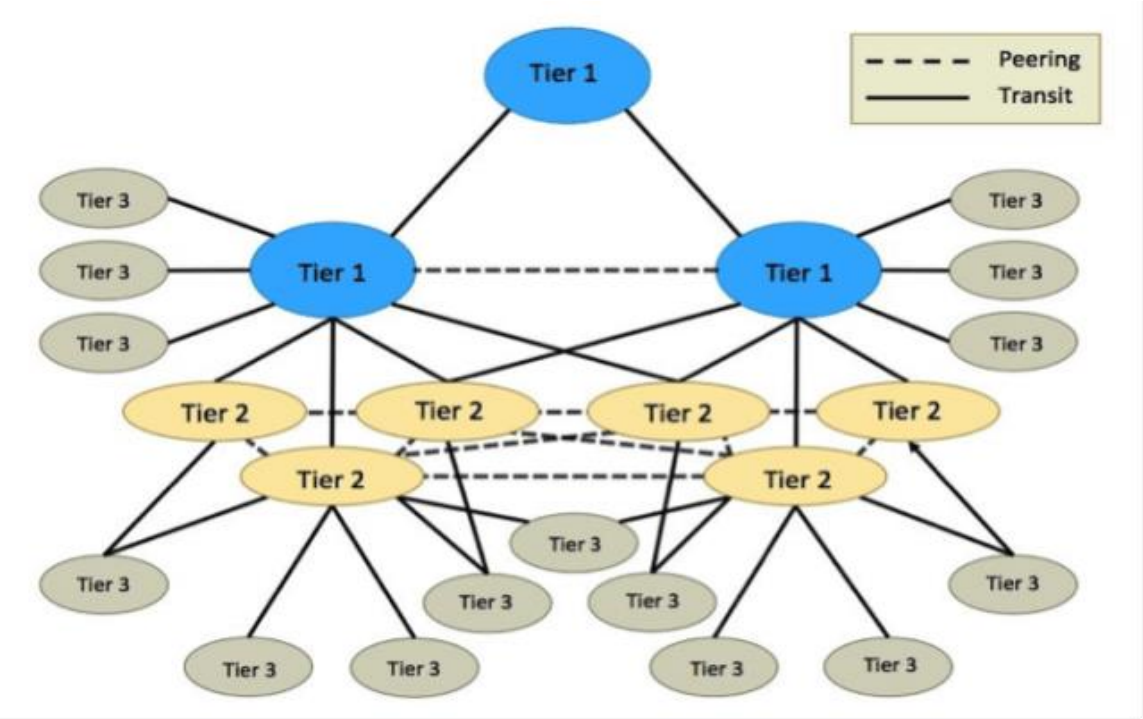


System Decomposition

- Components
  - May be irreducible or
  - May be subsystems
- Decomposition
  - The division of a system into its components and linkages
  - Hierarchical



Hierarchy of the Internet

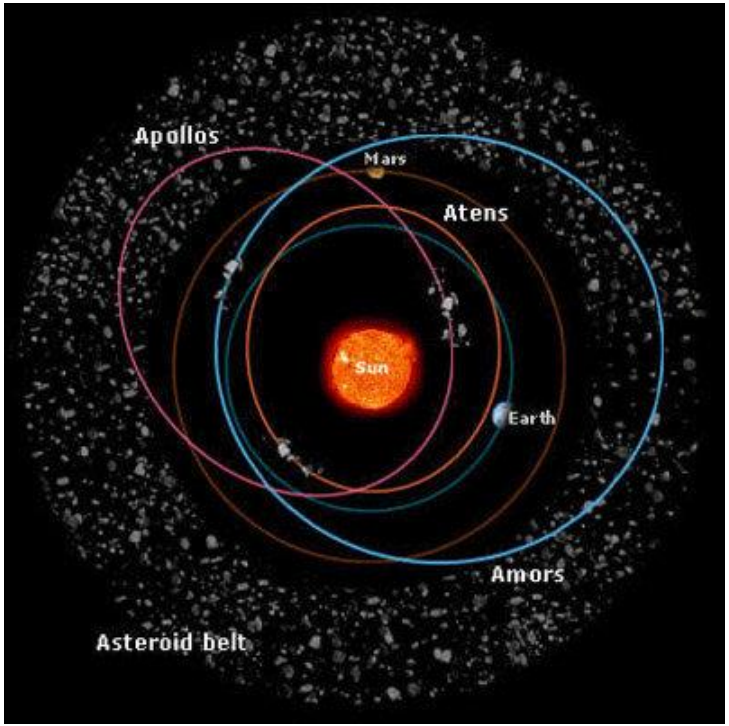


System Architecture

- “The fundamental properties and the patterns of relationships, connections, constraints, and linkages among the components and between the system and its environment are known collectively as the **architecture** of the system”

Abstractions of Systems

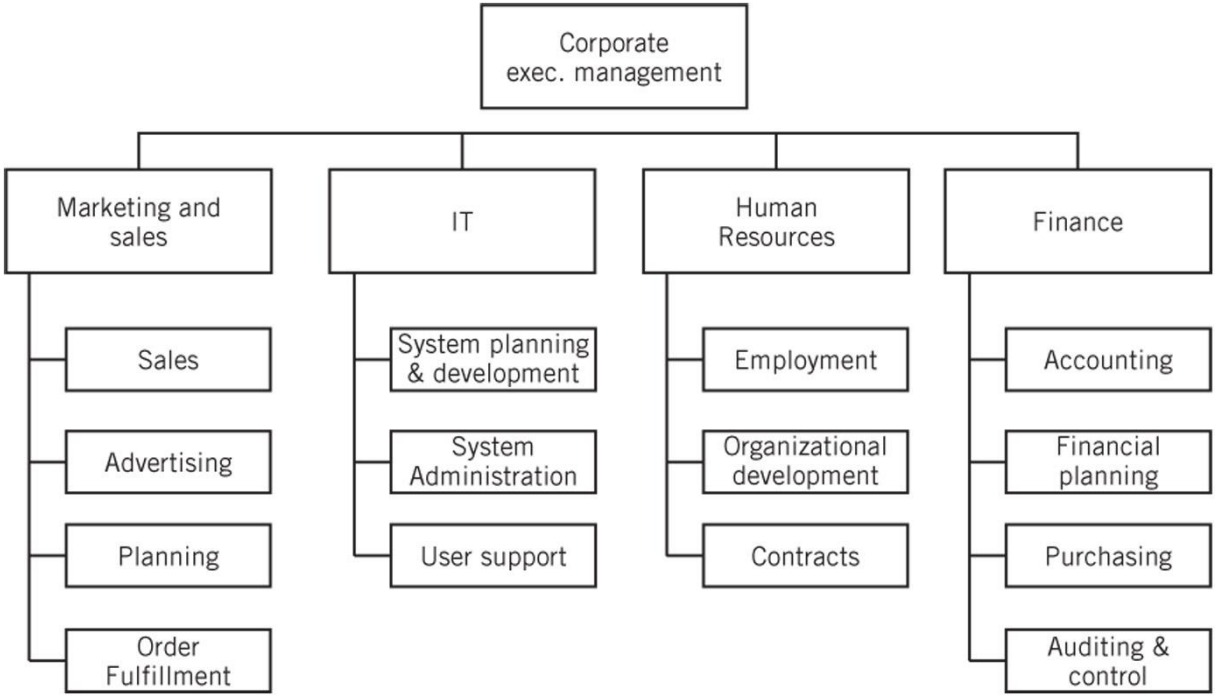
- Abstractions are not the real system
  - Representation
  - Organization
  - Simplification



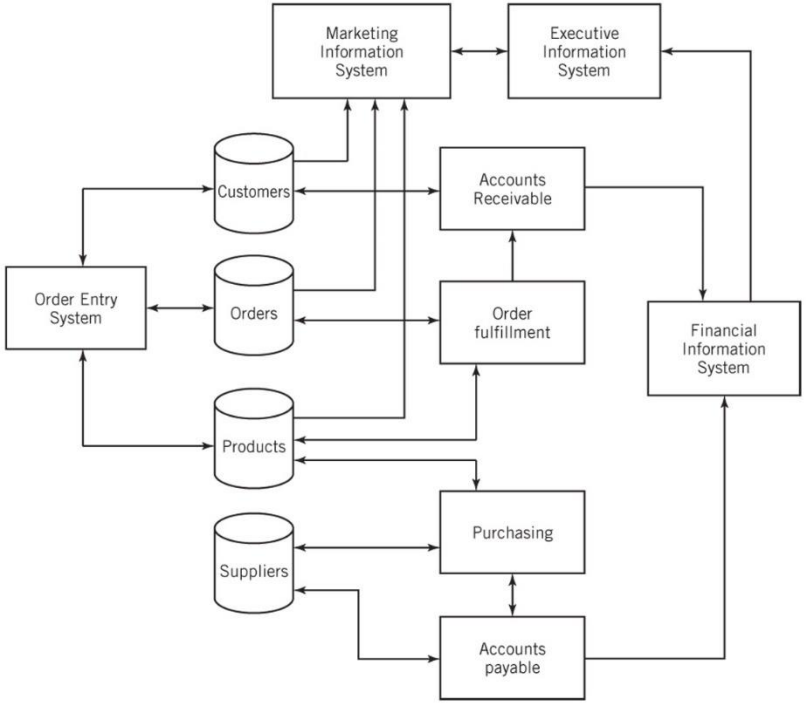
Abstractions of Systems

- How are the following two abstractions of a business system different from one another?
- How are these abstractions different from the real business system?

Business Organization Chart



Business Application Architecture



Summary

- A system is a set of **components** that are **linked** together to form what we think of as **a single unit.**
  - Components may be a single unit or a subsystem
  - The links could be permanent, temporary, tangible, intangible
  - The environment interacts with the system through interfaces
- System architecture is the **fundamental properties** and the patterns of relationships and connections **among the components** and between the system and **its environment.**
- System abstraction is a **representation** of the architecture

2.3: IT System Architecture

2.1: Computers and Systems

2.2 System Concepts and Architecture

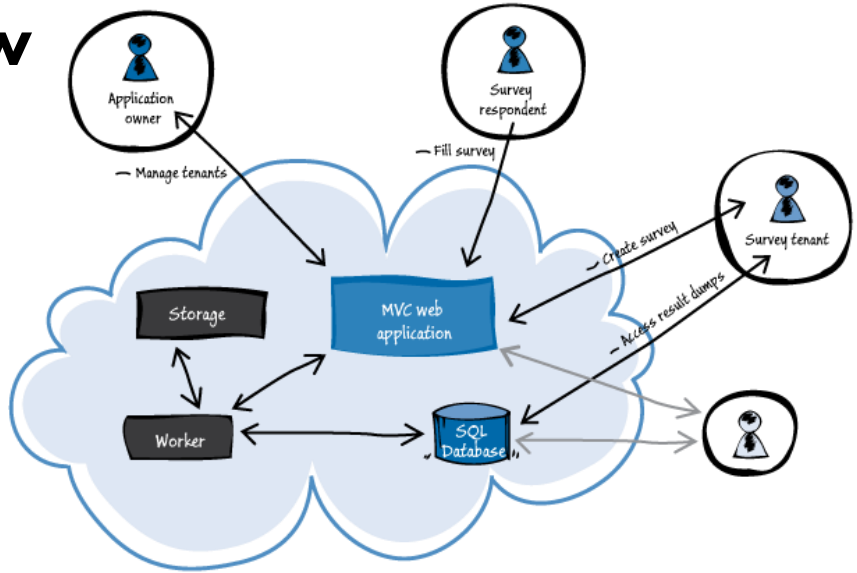
2.3: IT System Architecture

Learning Objectives

- Explain the purpose IT system architectures
- List three types of distributed processing systems
- Describe client-server, cloud, and peer-to-peer computing
- Gives examples of client-server architecture
- Compare the three types of cloud-computer services

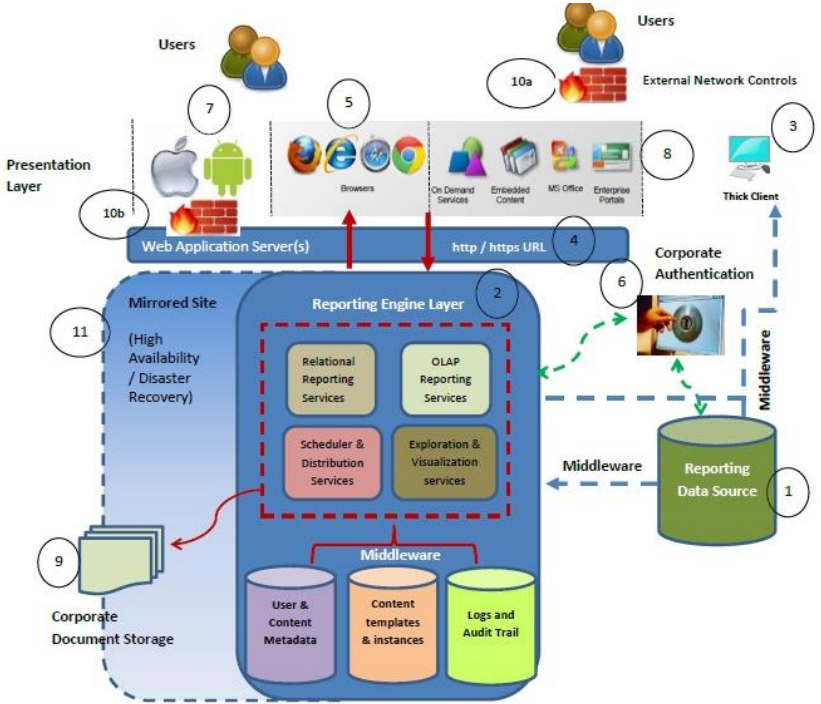
Application Architecture

- Characterized by the **flow** and **processing** of data
  - Within an organization
  - Between organizations
  - Between an organization and its environment



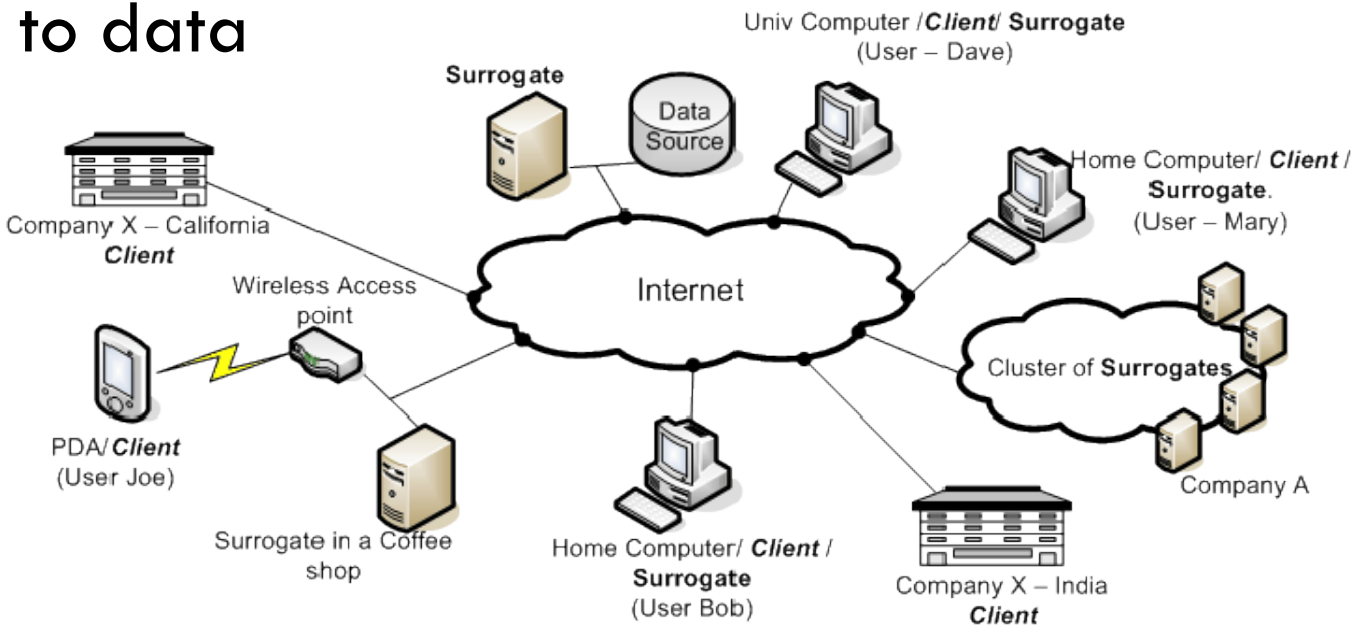
IT System Architectures

- System concepts are applicable to IT systems
- IT systems
  - Complex
  - Multi-layered (with numerous subsystems)



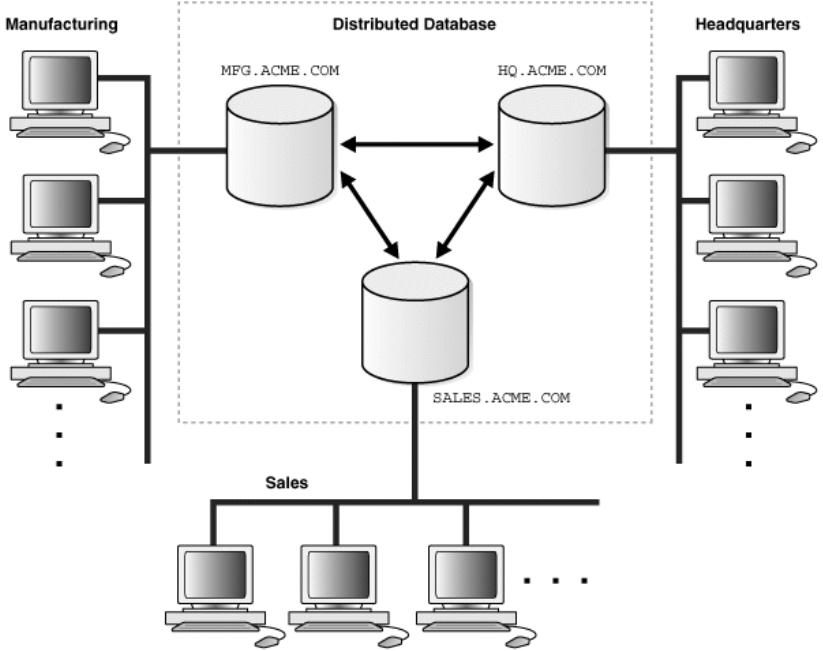
Distributed processing systems

- Today's organizations rely on communication and access to data



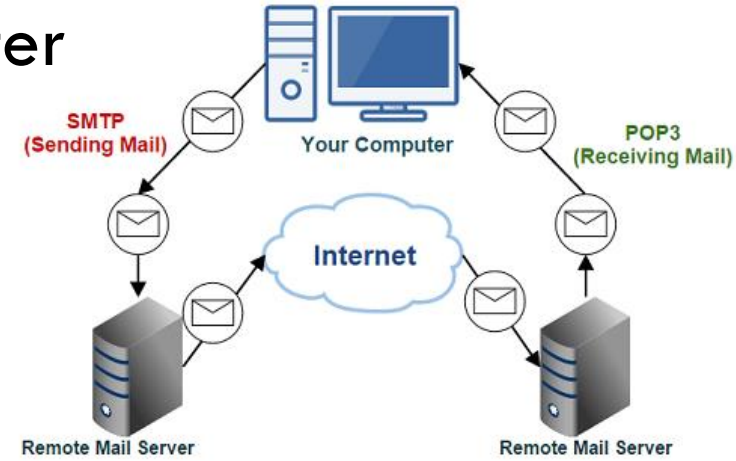
Distributed Processing Systems

- Client-Server Computing
  - Two-tier architecture
  - Three-tier architecture
  - N-tier architecture
- Cloud Computing
- Peer-to-Peer Computing



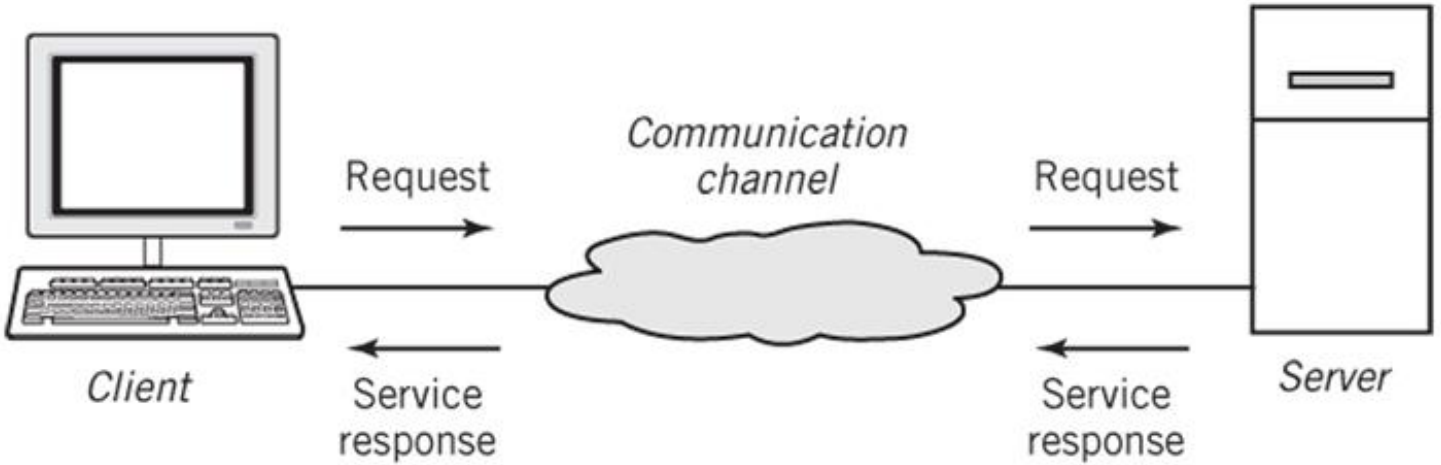
Client-Server Computing

- A program on a client computer requests services from a server computer
- Examples of services:
  - Email, file, print, directory, web, database, application, remote access services

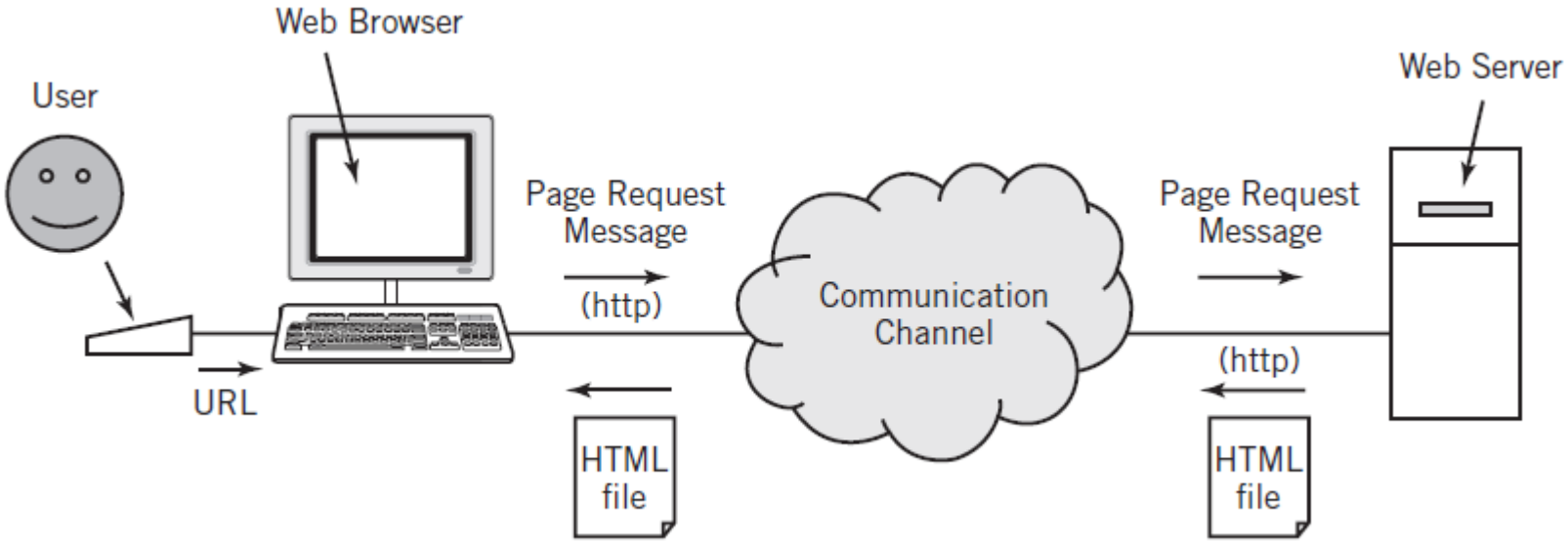


Basic Two-tier Client-Server Architecture

- **Two-tier architecture** simply means that there are **two computers** involved in the service.

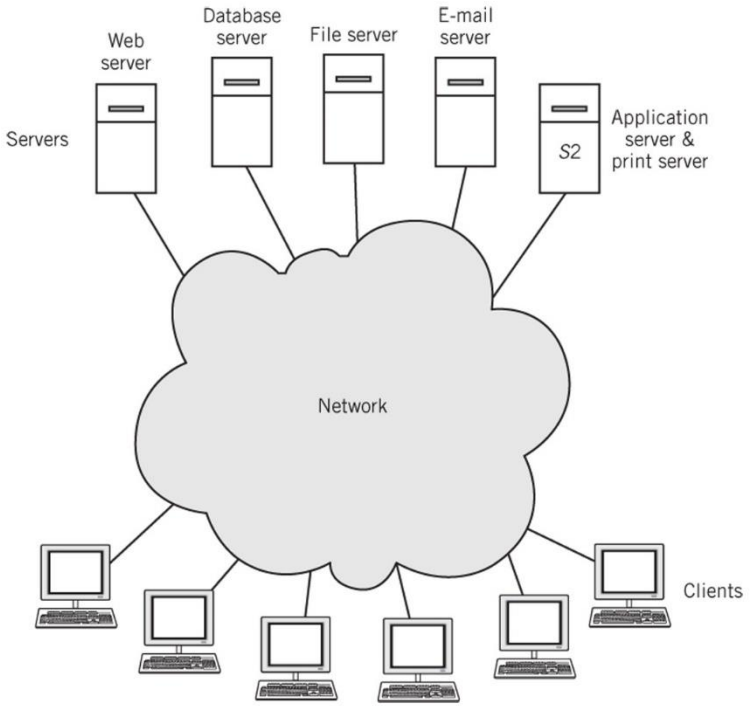


Web browser-Web server Model



Clients and Servers on a Network

- Dedicated server
  - Running a single service
- Shared server
  - Running multiple services
  - S2 is a shared server



Advantages of Client-Server Architecture

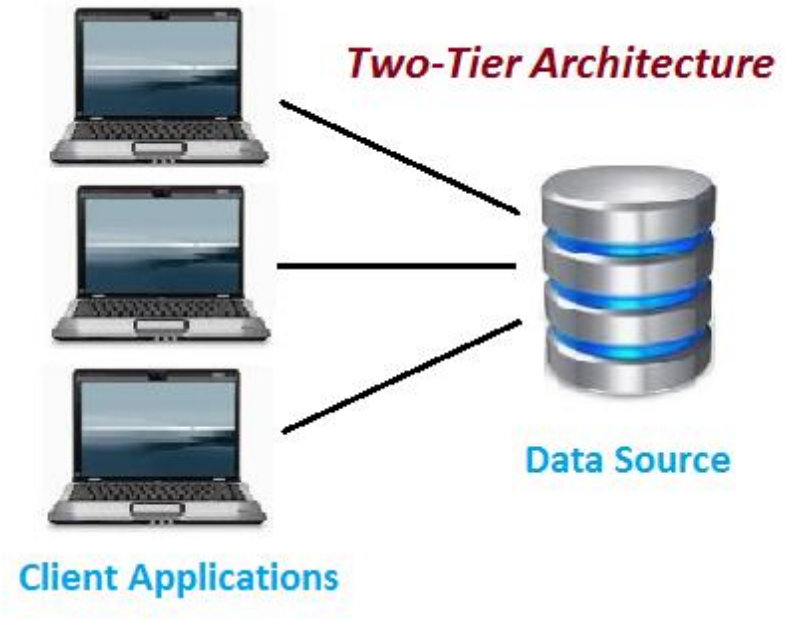
- Centralization of services permits
  - easier administration of services by IT professionals
  - easier availability and location by users
  - consistency of resources, such as files and data, can be managed and assured

Multi-tier Architectures

- Two-tier architecture
  - Two computers are involved in a service
- Three-tier architecture
  - Three computers are involved in a service
- N-tier architecture
  - N number of computers involved in a service

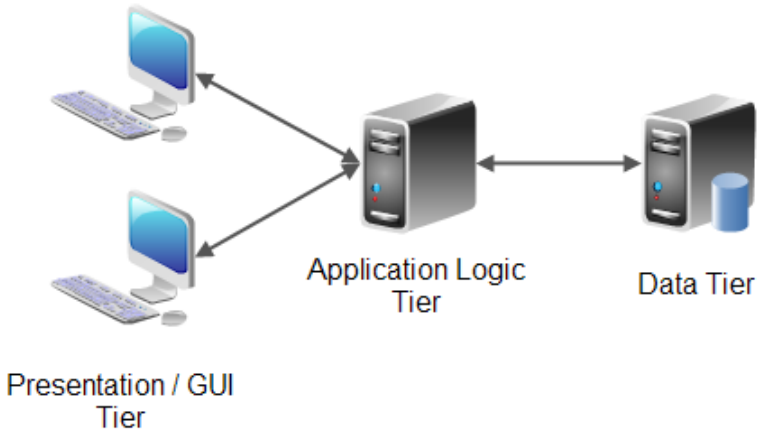
Multi-tier Architectures: Two-tier

- Two-tier architecture
  - Two computers are involved in a service
  - Web browser and Web server model used in intranets and on the Internet

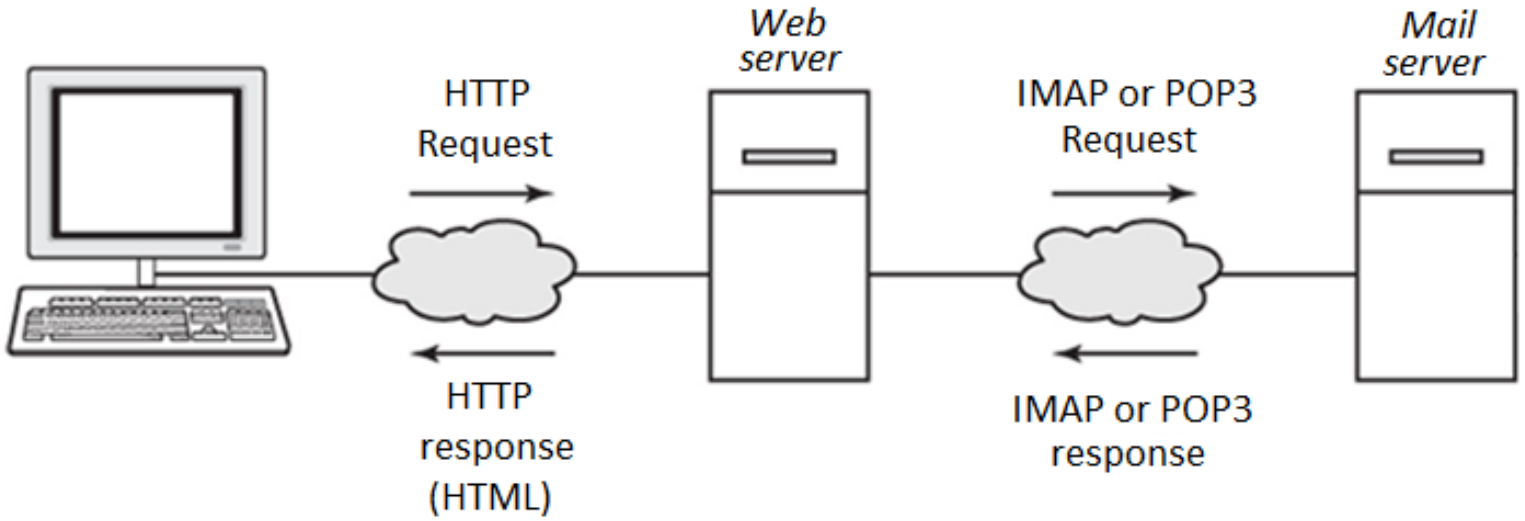


Multi-tier Architectures: Three-tier

- Three-tier architecture
  - Three computers are involved in a service
  - Example: a client computer, a web server, and a database server

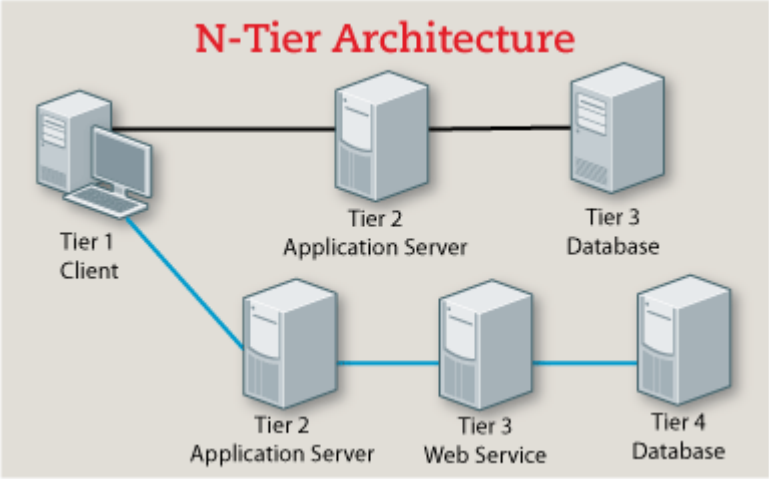


Three-tier Web-based Email Architecture



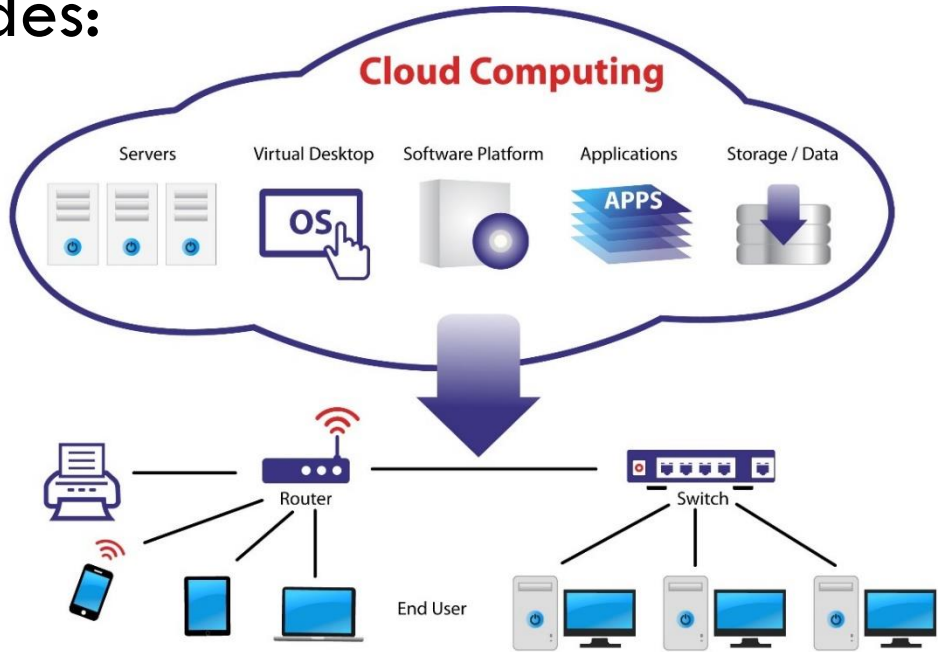
Multi-tier Architectures: N-tier

- N-tier architecture can:
  - Result in better overall control
  - Simplify system upgrades
  - Minimize scalability issues
- Tiers can be added or removed to meet demand



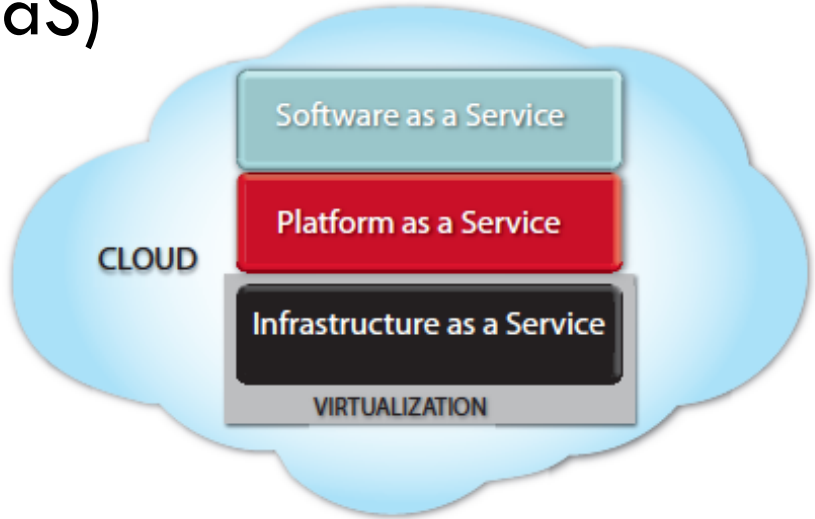
Cloud Computing (1 of 2)

- Cloud computing includes:
  - Server
  - Virtual desktops
  - Software platforms
  - Applications
  - Storage



Cloud Computing (2 of 2)

- Software as a service (SaaS)
- Platform as a service (PaaS)
- Infrastructure as a service (IaaS)

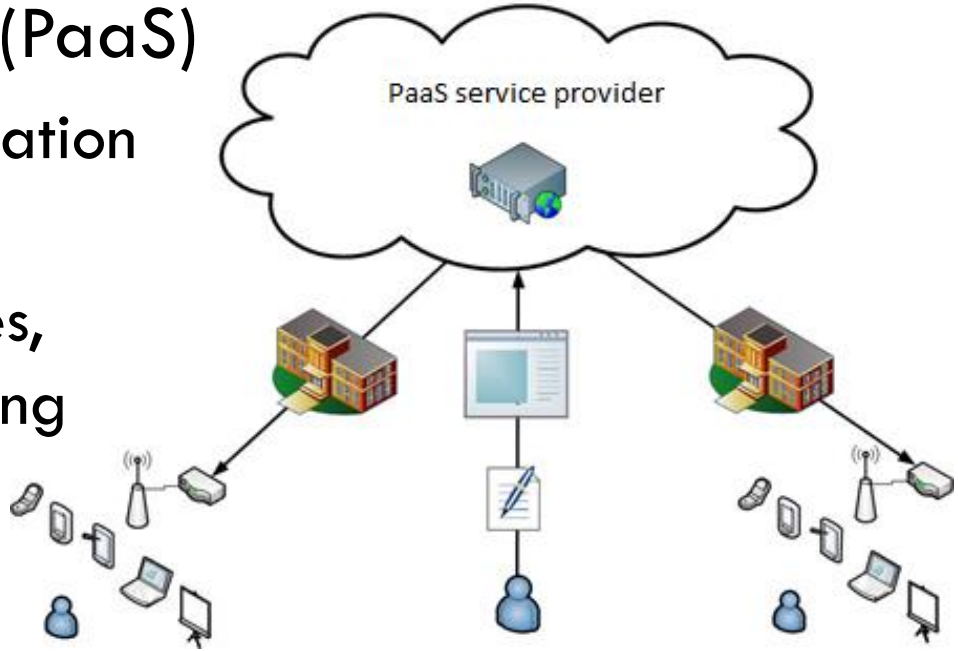


Software as a service (SaaS)

- Software as a service (SaaS)
  - applications that run on a server
  - data processing may be divided on server and client

Platform as a Service (PaaS)

- Platform as a service (PaaS)
  - used to host an application or service
  - Virtually hosts websites, databases, or operating systems

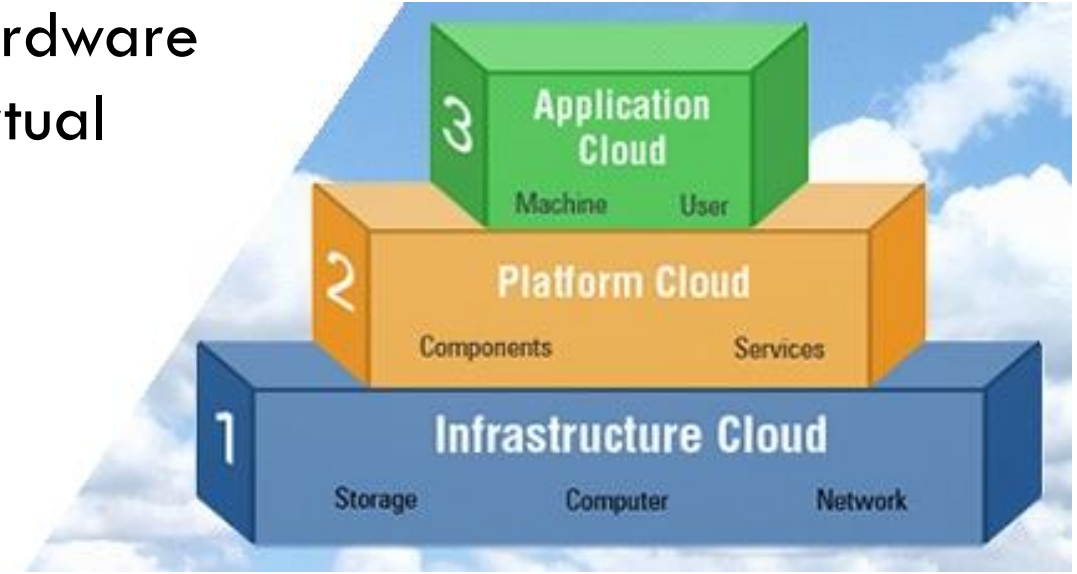


Infrastructure as a Service (IaaS)

- Infrastructure as a service (IaaS): Virtualized hardware systems
- Infrastructure is composed of resources that support the flow, storage, processing, and analysis of data.

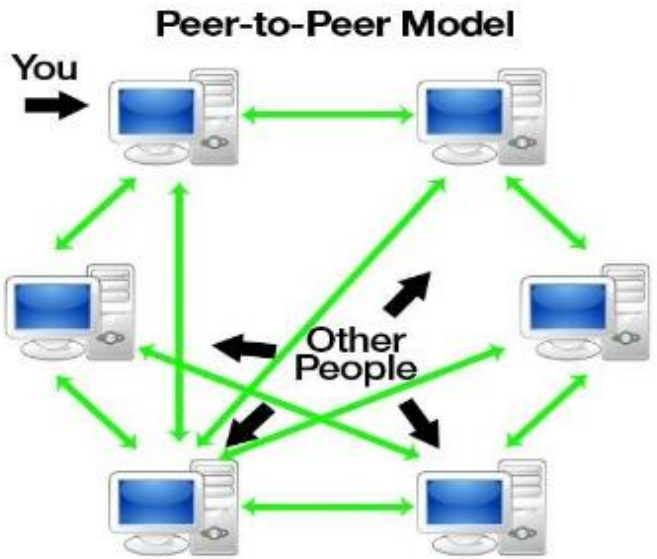
Infrastructure as a Service (IaaS)

- Infrastructure as a service (IaaS)
  - cloud-based hardware emulation of virtual machines and networking



Peer-to-Peer Computing

- Computers on a network are treated as equals
- Each computer can share resources with the other computers on the network

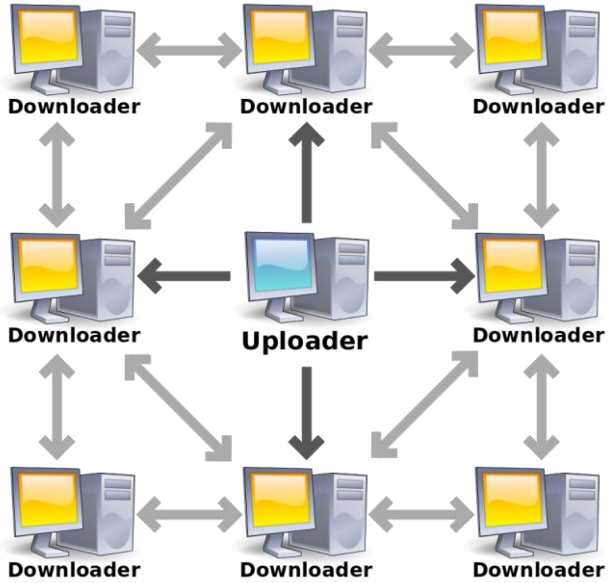


Peer-to-Peer Computing: Disadvantages

- Disadvantages
  - Difficult to locate services
  - Difficult to synchronize versions of files or software
  - Difficult to secure network from unauthorized access and from viruses

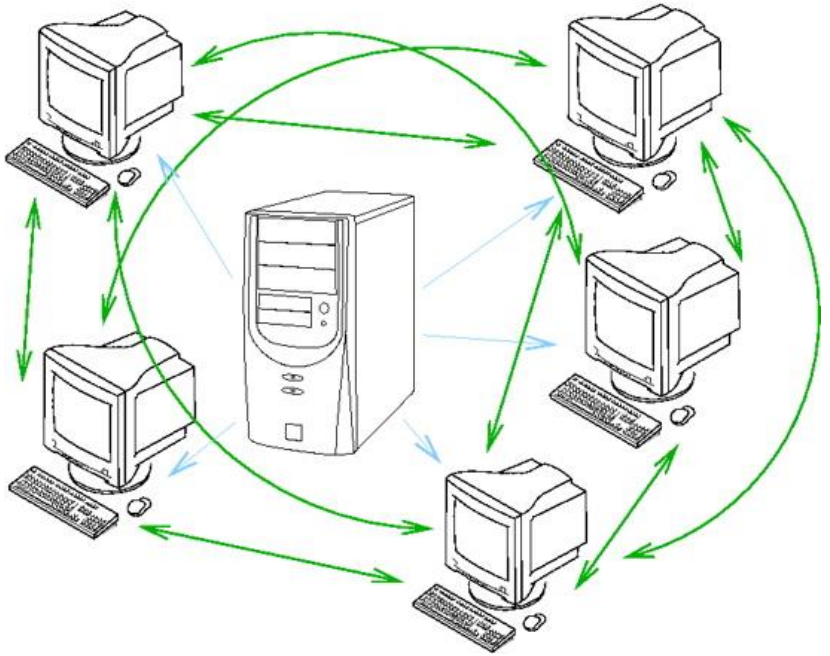
Peer-to-Peer Computing: Advantages

- Advantages
  - Easy to set up, no need for a server
  - Sharing files between personal computers
  - If a client goes offline, the files are still available on another



Hybrid Model of Computing

- Client-server technology used to locate systems and files
- Then systems can participate in peer-to-peer transactions



Summary

- Application architecture is characterized by the **flow** and **processing** of data
- **Distributed processing systems** are examples of application architecture. DPS Computing models:
  - **Client-server:** a client requesting information from a server
  - **Cloud:** using virtualized servers and systems on the internet
  - **Peer-to-peer:** clients communicate to each other without a server

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