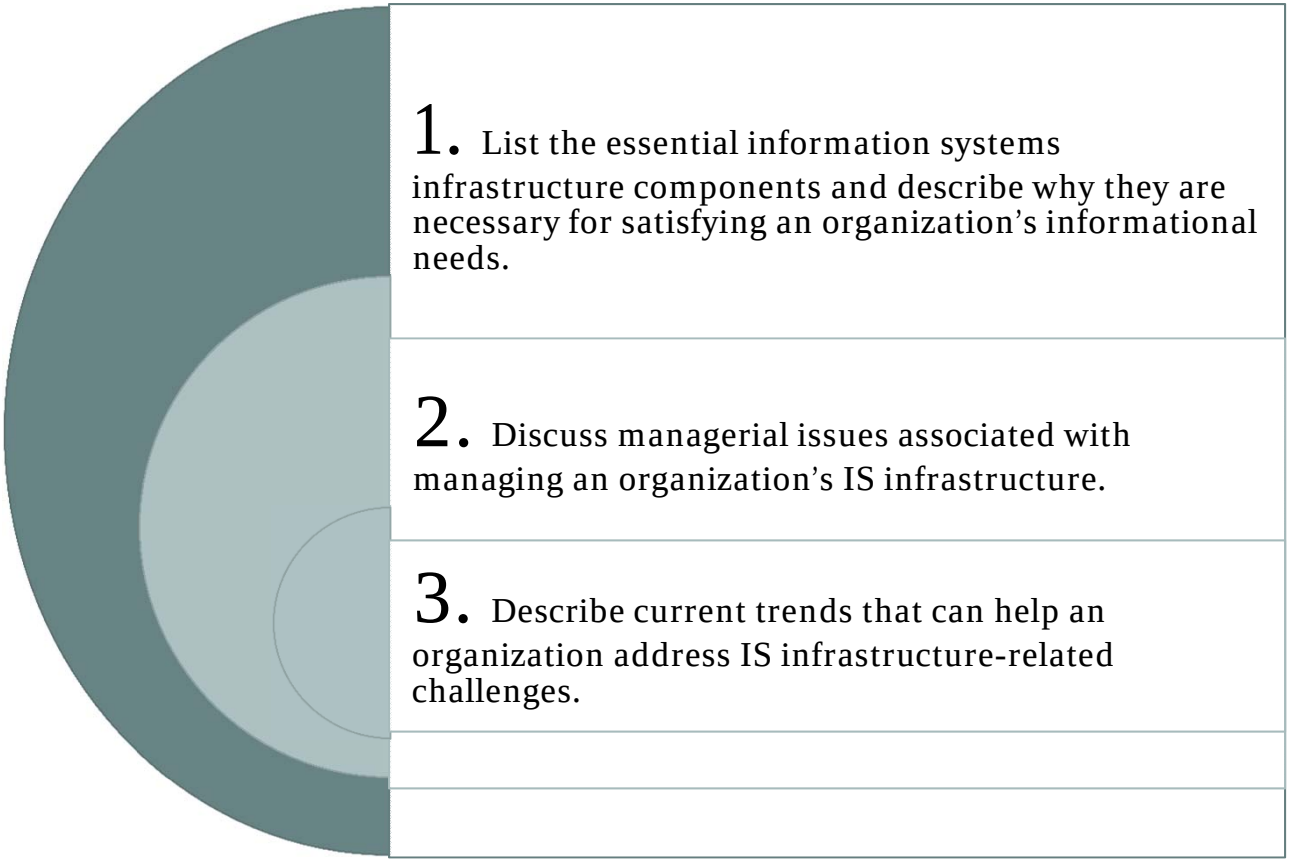
Chapter 3

Managing the Information Systems Infrastructure and Services

Google (v.)- ...to use the Google search engine to obtain information...on the World Wide Web.

Merriam-Webster

Learning Objectives



1. List the essential information systems infrastructure components and describe why they are necessary for satisfying an organization's informational needs.

2. Discuss managerial issues associated with managing an organization's IS infrastructure.

3. Describe current trends that can help an organization address IS infrastructure-related challenges.

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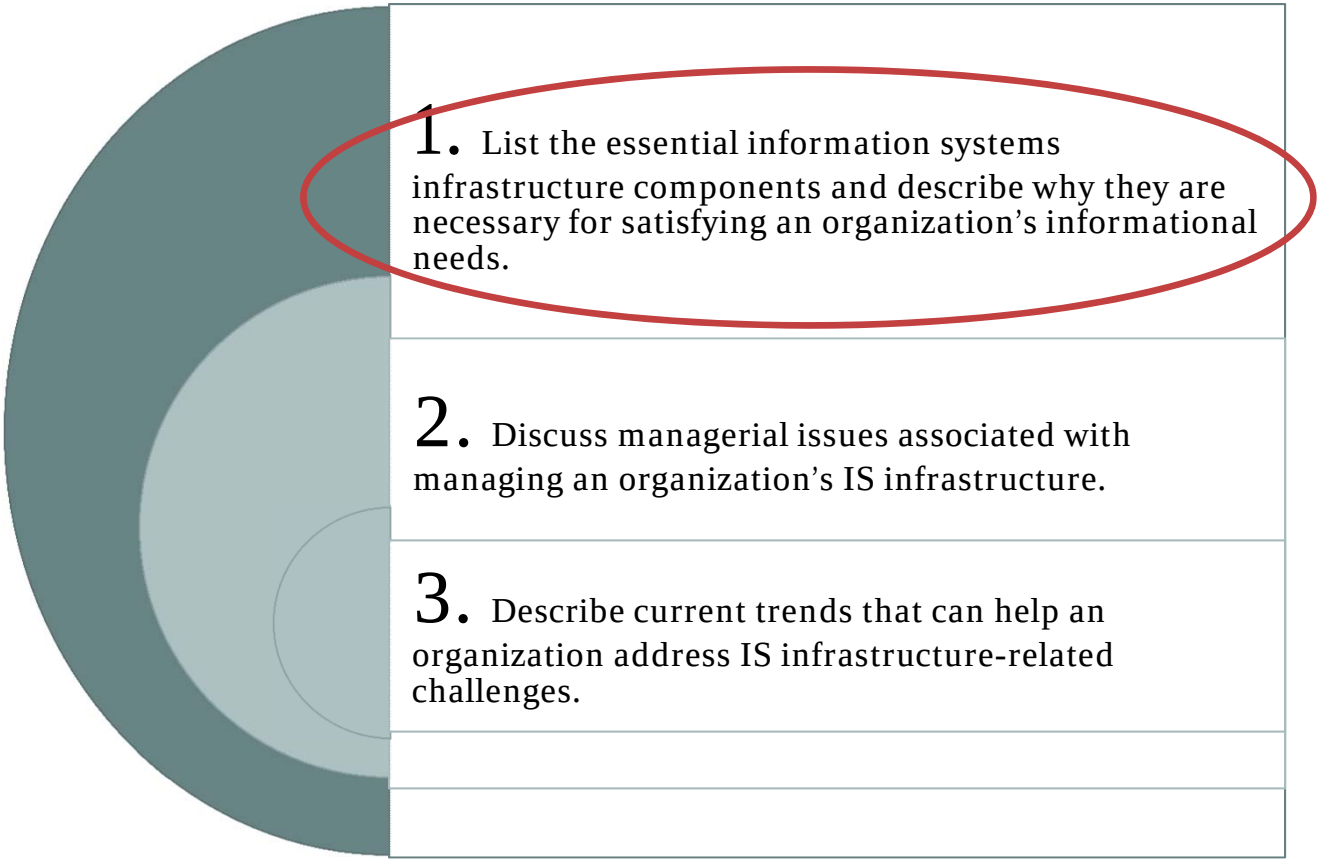

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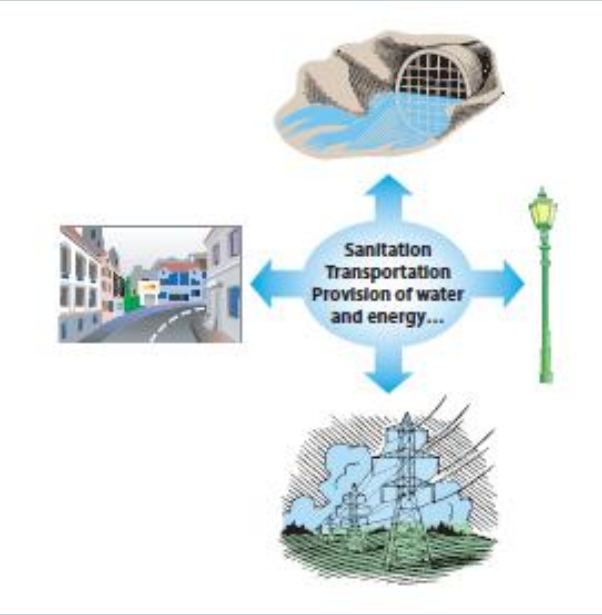
Infrastructure

- Interconnection of basic facilities and services enabling an area to function properly
  - Streets
  - Power, telephone, water, and sewage lines
  - Schools
  - Retail stores
  - Law enforcement

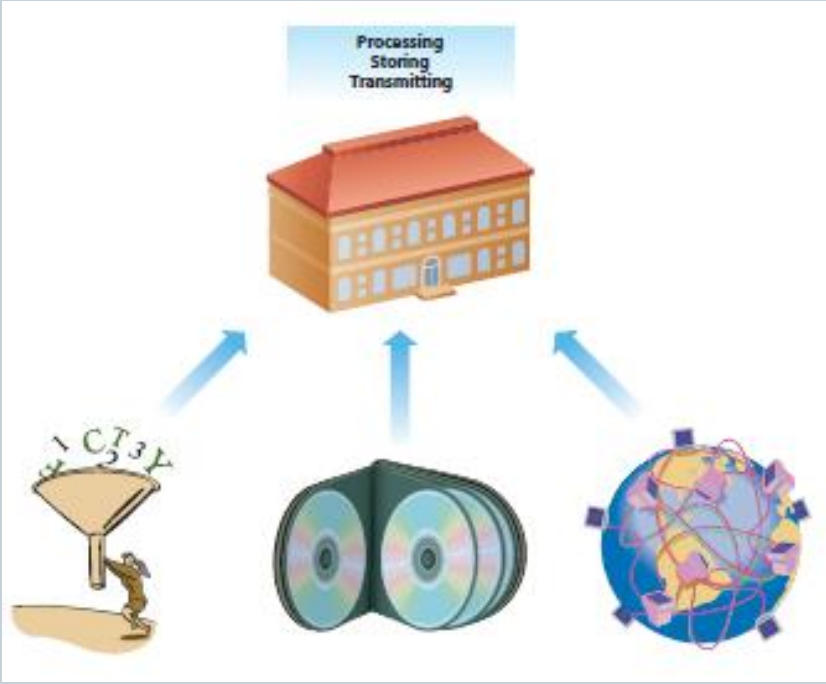


The IS Infrastructure

- Google's newest data center—The Dalles, OR
- Why there?
  - Fiber-optic network connectivity
  - Access to water for cooling needs
  - Cheap, uninterrupted power from a nearby hydroelectric dam

Components of an IS Infrastructure

- The IS infrastructure enables processing, storage, and transmitting of data
- Components
  - Hardware
  - Software
  - Communications and collaboration networks
  - Databases

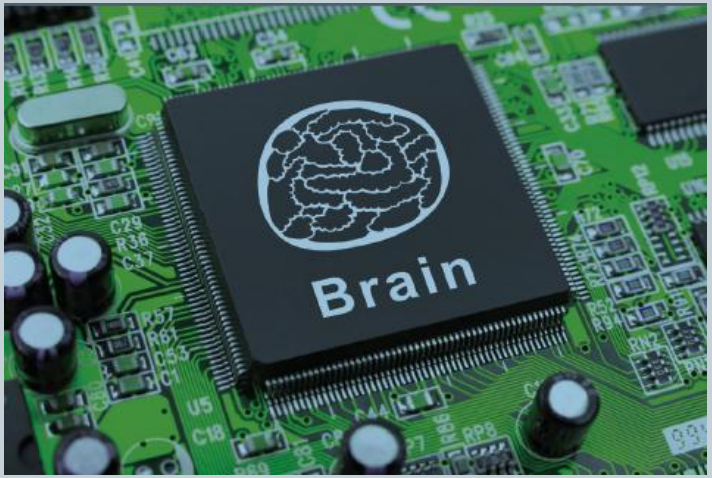


IS Hardware and Software

- Input Technologies
  - Keyboard, mouse, RFID scanner, and so on
  - Enter information into the computer
- Processing Technologies
  - Chips, CPU, RAM
  - Perform computations and store data electronically
  - Transform inputs into outputs
- Output Technologies
  - Computer monitors and printers
  - Deliver information to users

How a Computer Works (Hardware)

- Central Processing Unit (CPU) :
  - Microprocessor, processor, chip
  - Main component of a computer
  - Silicon, millions of transistors
  - Responsible for performing all the operations of the computer (arithmetic, logic)
  - Loads operating system on boot-up



- Storage
  - Primary Storage—Random Access Memory (RAM)—temporary/volatile)
  - Secondary Storage—Hard Drive/Optical Disk/Flash Drive—(permanent/nonvolatile)

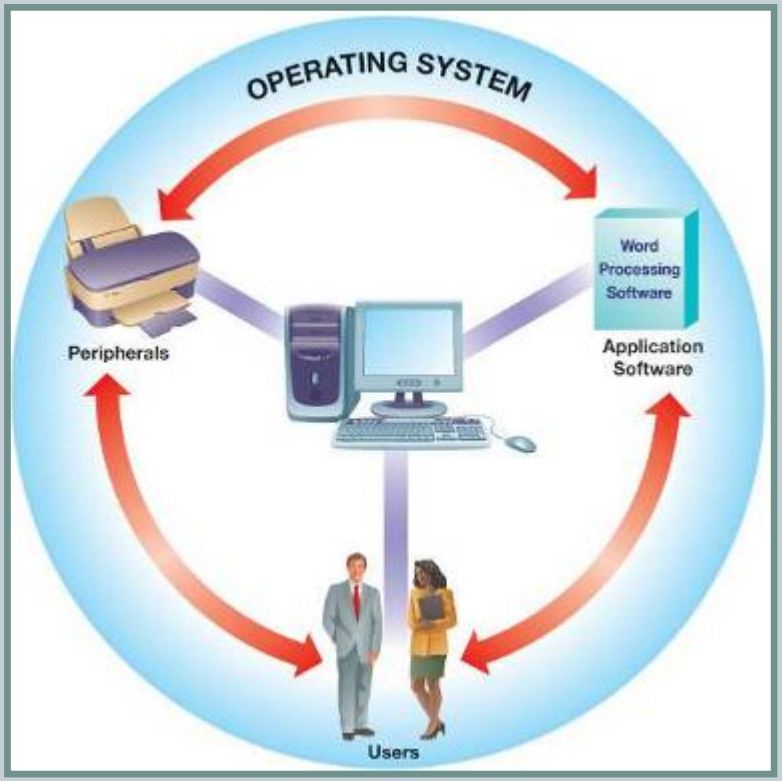
How a Computer Works (Software)

- Programs:
  - Sets of instructions
  - Two types:
    - System Software/Operating System, and
    - Application Software

- Digitizing
  - Any input the computer receives (e.g., a keystroke) is translated into binary code (0s and 1s)

Systems Software/Operating System

- Collection of programs that control the basic operations of computer hardware
- Coordinates interactions between hardware, application software, and users
- Also used in embedded devices
- Often written in assembly language



The OS Acts as a Manager

Application Software

- For performing specific user tasks:
  - writing a business letter,
  - processing payroll,
  - manage a stock portfolio, and so on.
- Application software interacts with systems software.

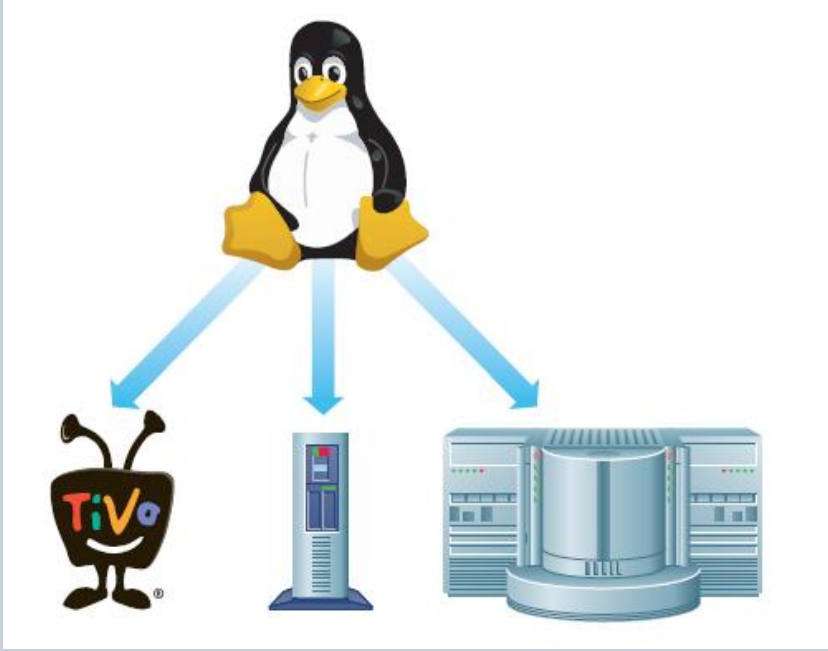
Open Source Software

- Open source movement—a philosophy that promotes developers' and users' access to the source of a product or idea.
- Program source code is freely available for use and modification.
- Advantages: large user base, helping to fix problems or improve software
- Drawback: obtaining customer support may be difficult

Open Source System Software

- Example: **Linux Operating System**
- Developed by

  Linus Torvalds in 1991
- Available to all
  - Users suggest fixes, and committees create official releases.
- Very stable, uses a lot in embedded systems



Open Source Application Software

- Open source application software
  - Apache Web server
  - Firefox Web browser
  - OpenOffice

Types of Computers

- Supercomputer
  - The most expensive and most powerful kind of computer
  - Assists in solving massive scientific problems
- Mainframe
  - Very large
  - Main, central computing system for governmental agencies or major corporations
- Server
  - A computer on a network that makes access to files, printing, communications, and other services available to users of the network
- Workstation
  - Desktop computer, more powerful than microcomputer, used for visualization and rendering 3D models
- Microcomputer
  - Used for personal computing and small business computing

Types of Computers

TABLE 3.1 Characteristics of Computers Currently Being Used in Organizations

Type of Computer	Number of Simultaneous Users	Physical Size	Typical Use	Memory	Typical Cost Range
Supercomputer	One to many	Like an automobile to as large as multiple rooms	Scientific research	5,000+ GB	Low: $1 million; high: more than $20 million
Mainframe	1,000+	Like a refrigerator	Large general purpose business and government	Up to 1,500+ GB	Low: $0.5 million; high: $10 million
Workstation	Typically one	Fitting on a desktop to the size of a file cabinet	Engineering, medical, graphic design	Up to 192 GB	Low: $750; high: $100,000
Microcomputer	One	Handheld to fitting on a desktop	Personal productivity	512 MB to 4 GB	Low: $200; high: $5,000

Data and Knowledge Infrastructure

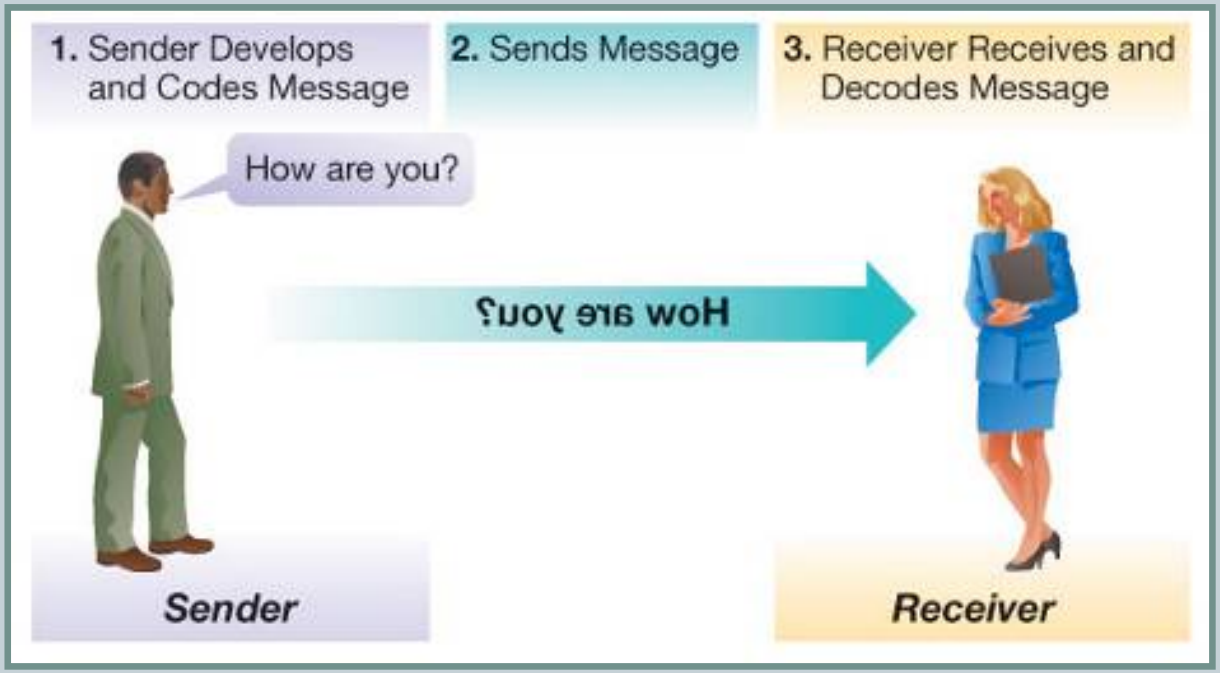
- Data and knowledge are probably among the most important assets an organization has.
- Data are being stored for operational, backup, or archival purposes.
- Operational data—typically stored in:
  - databases—data from transaction processing systems or customer data;
  - files—business documents, images, or company brochures; or
  - on disk storage.
- Archived (back-up) data often stored on magnetic tape (30-year shelf life).

Databases

- Databases—Collections of related data organized in a way that facilitates data searches.
- Database technology fuels electronic commerce, from tracking available products for sale to providing customer service.
- **Database management system**—program that allows organizations to more easily retrieve, store, and analyze information.
- More in Chapter 6

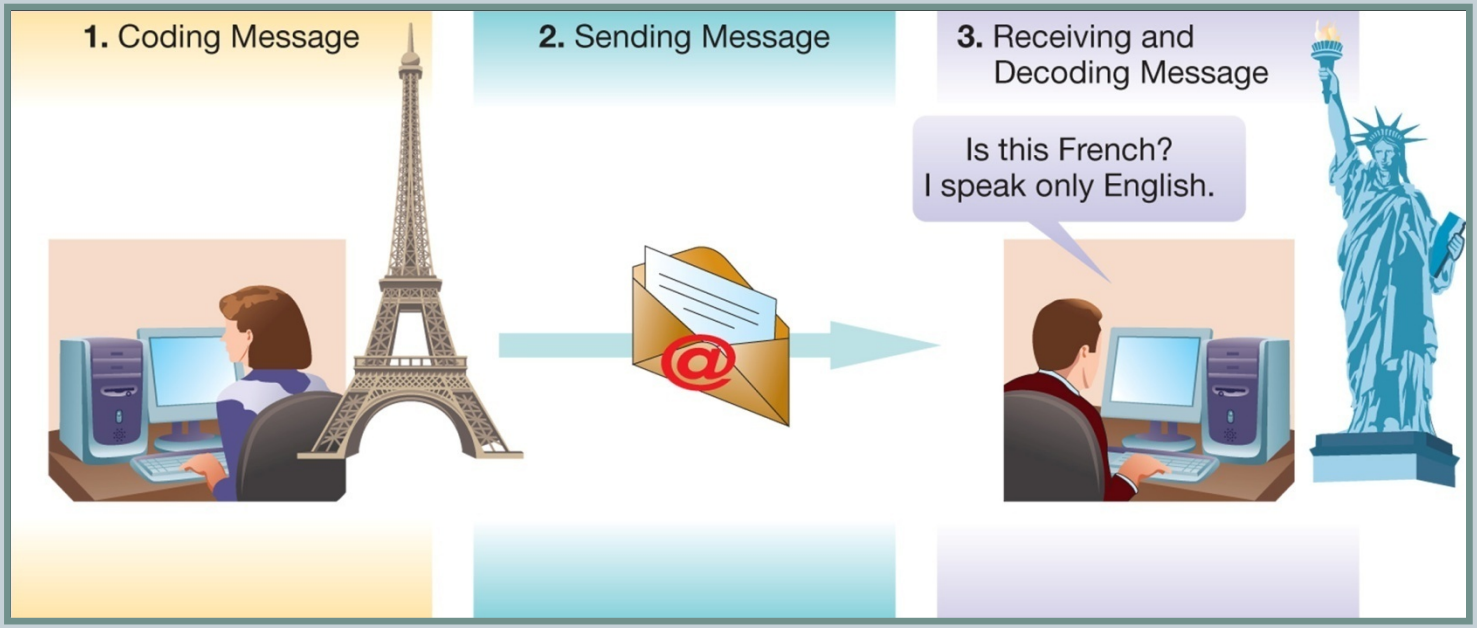
Human Communication and Computer Networking

- Sharing of information or services
- Requires senders, a message to share, and receivers



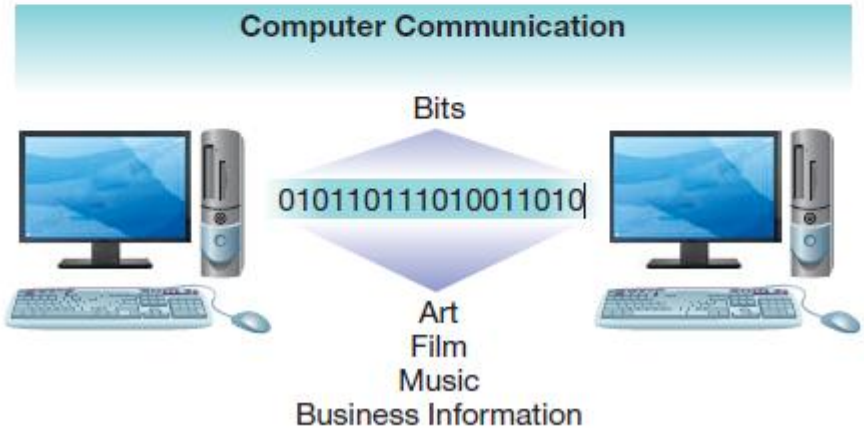
Messages, Senders, and Receivers

- Components of communication:
  - **Senders and receivers** with something to share
  - A **transmission medium** (cable, wireless) to send the message
  - **Protocols** (rules) dictating communication



Computer Networks

- Human communication consists of words, whereas computer communication consists of bits
- **Bandwidth**: transmission capacity, measured in bits per second (bps)



Bandwidth Requirements for Different Types of Information

Type of Information	Raw Size	Compressed Size
Voice		
Telephone	64 Kbps	16–32 Kbps
Teleconference	96 Kbps	32–64 Kbps
Compact disc	1.41 Mbps	63–128 Kbps
Data		
Single screen of text	14.4 KB	4.8–7 KB
Typed page, single-spaced	28.8 KB	9.6–14.4 KB
Faxed page (low to high resolution)	1.68–3.36 MB	130–336 KB
Super VGA screen image	6.3 MB	315–630 KB
Digital X-ray	50.3 MB	16.8–25.1 MB
Publication-quality photograph	230.4 MB	23–46 MB
Video		
Video telephony	9.3 Mbps	64–384 Kbps
Video teleconferencing	37.3 Mbps	384 Kbps–1.92 Mbps
Studio-quality digital TV	166 Mbps	1.7 Mbps
High-definition television	1.33 Gbps	20–50 Mbps

Note: KB = kilobytes, MB = megabytes; Kbps = kilobits per second; Mbps = megabits per second; Gbps = gigabits per second.

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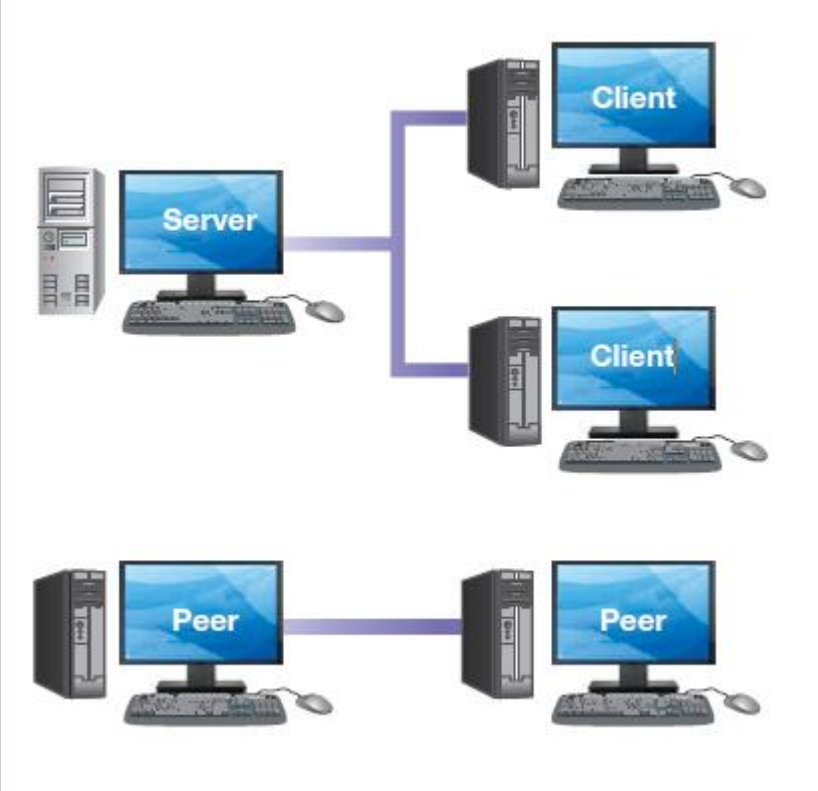
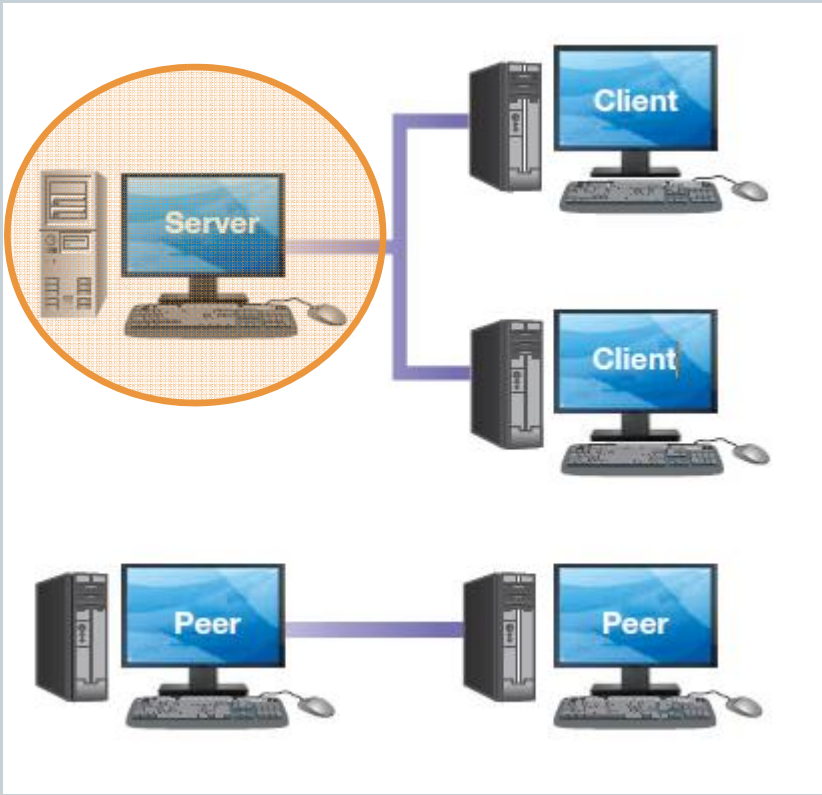
Networking Fundamentals

- Three different roles:
  - Servers
  - Clients
  - Peers



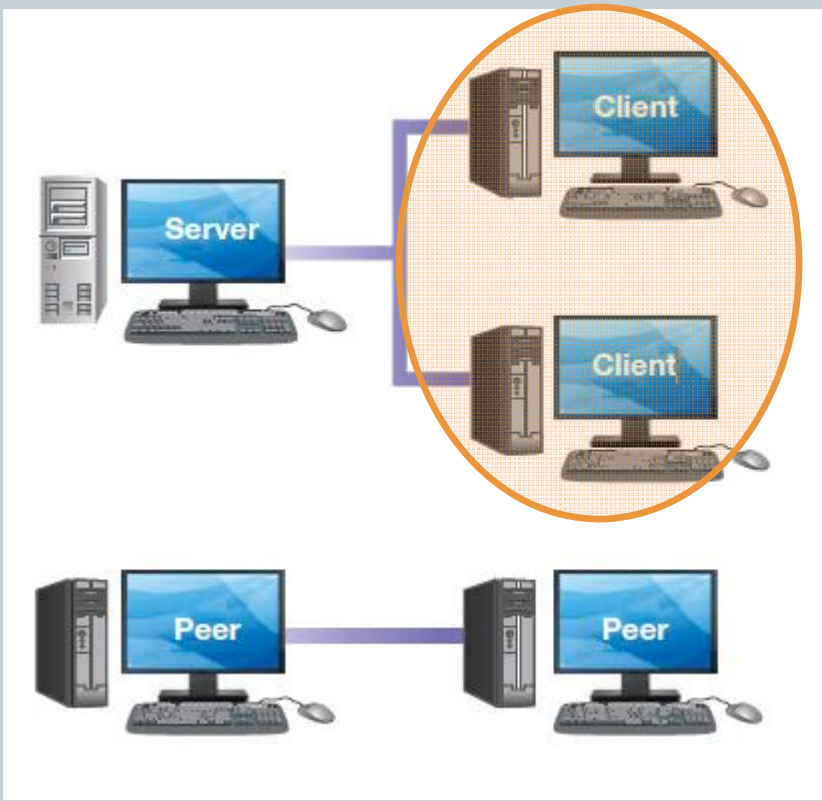
Servers

- Computers on the network that make access to files, printing, communications, and other services available to users of the network
- Only provide services
- Trend in business is to use server-centric networks.



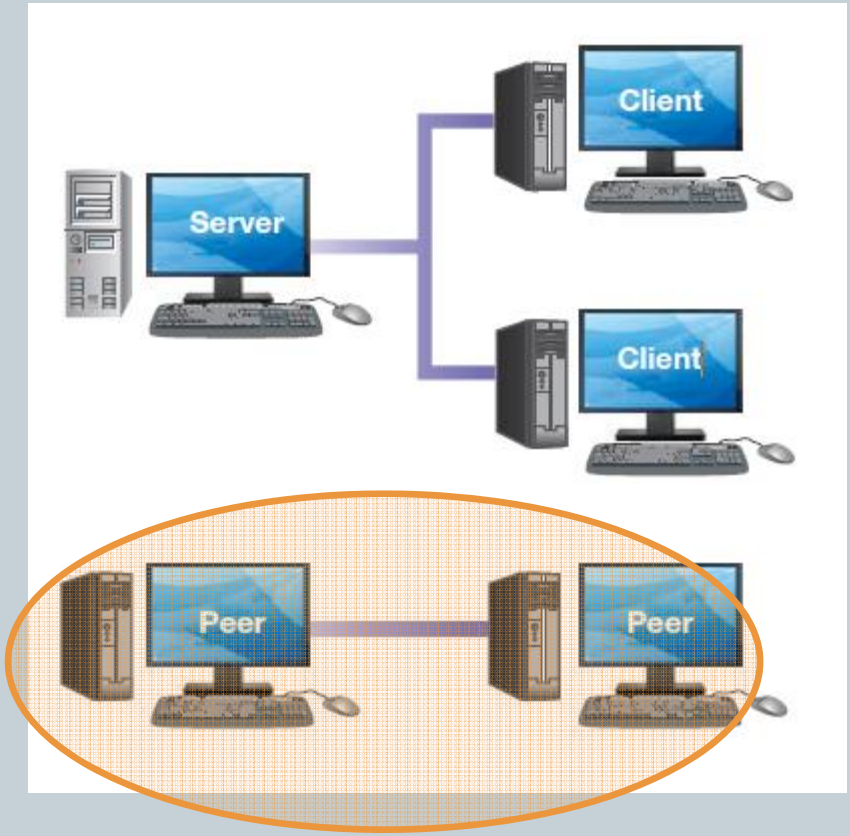
Clients

- Use the services provided by the server.
- Only request services.
- Usually one user per client.



Peers

- May request and provide services
- Peer-to-peer (P2P) networks
  - Peers are able to connect directly to the hard drives of other peers.
- Usually found in small offices and homes
- Popular for telephony and file sharing
  - Examples: Skype, BitTorrent



Types of Networks

TABLE 3.2 Types of Networks

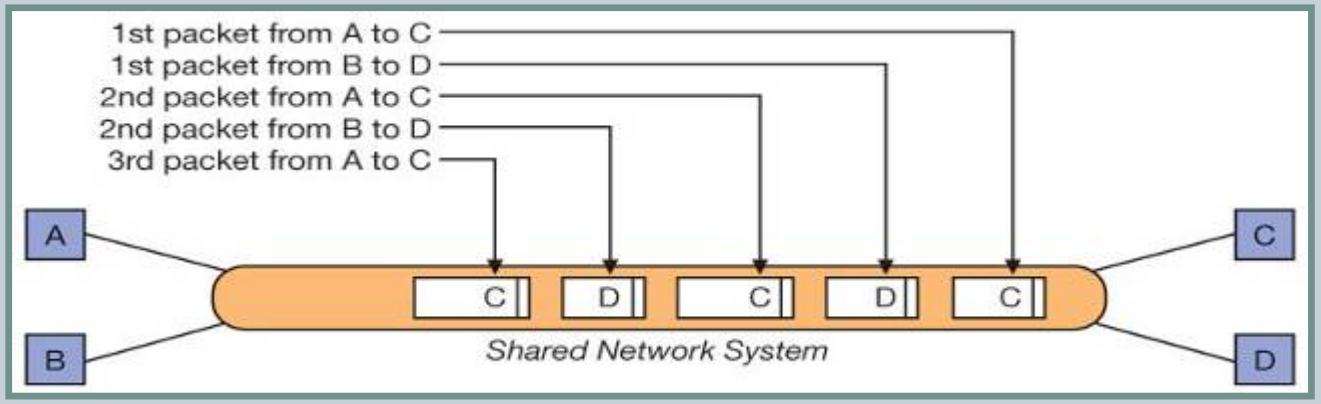
Type	Usage	Size
Private branch exchange (PBX)	Telephone system serving a particular location	Within a business
Personal area network (PAN)	Wireless communication between devices, using technologies such as Bluetooth	Under 10 meters
Local area network (LAN)	Sharing of data, software applications, or other resources between several users	Typically within a building
Campus area network (CAN)	Connect multiple LANs, used by single organization	Spanning multiple buildings, such as a university or business campus
Metropolitan area network (MAN)	Connect multiple LANs, used by single organization	Larger than LAN or CAN, such as covering the area of a city
Wide area network (WAN)	Connect multiple LANs, distributed ownership and management	Large physical distance, up to worldwide (Internet)

How Did the Internet Get Started?

- 1960s—U.S. Defense Advanced Research Project (**DARPA**)
  - **ARPANET**—WAN that linked universities and research centers
- 1986—U.S. National Science Foundation
  - NSFNET—became major component of the Internet
- Worldwide support for Internet comes from federal and state governments, universities, research organizations, and industry.

Packet-Switching Technology

- Problem: Concurrent data transmission
  - One wire and several users
- Solution: Turn taking
- Messages are divided into packets and sent.
- Packets travel independently.
- Reassembled by receiver
- Header contains address of source and destination.



TCP/IP

- Protocol of the Internet
- TCP (Transmission Control Protocol)
  - Breaks information into packets
  - Manages transfer of packets between computers
- IP (Internet Protocol)
  - Defines how the packet must be formed
  - Contains destination address
- Routers forward packets between networks.

IP Datagram

- Data packet that conforms to the IP specifications
- Relies on IP address
  - Unique address assigned to computers and routers
- TCP helps IP deliver packets:
  - checks for lost datagrams,
  - puts received datagrams in correct order, and
  - discards duplicate datagrams.

World Wide Web

- World Wide Web (WWW)
  - System of interlinked documents on the Internet
  - Graphical user interface to the Internet
  - One of the most powerful uses of the Internet
- Web browser
  - Software application used to locate and display Web pages
    - Microsoft Internet Explorer, Mozilla Firefox, Google Chrome

History of the World Wide Web

- Gopher—early menu driven tool.
- Web was invented by Tim Berners-Lee in 1991.
  - Introduced hypertext
  - Hyperlinks—links to other related documents.
  - HTML—standard method for specifying Web pages
    - Tags specify formatting.
  - Web pages are stored on Web servers.
    - HTTP protocol—used for processing requests.
    - Web pages have unique URL address.

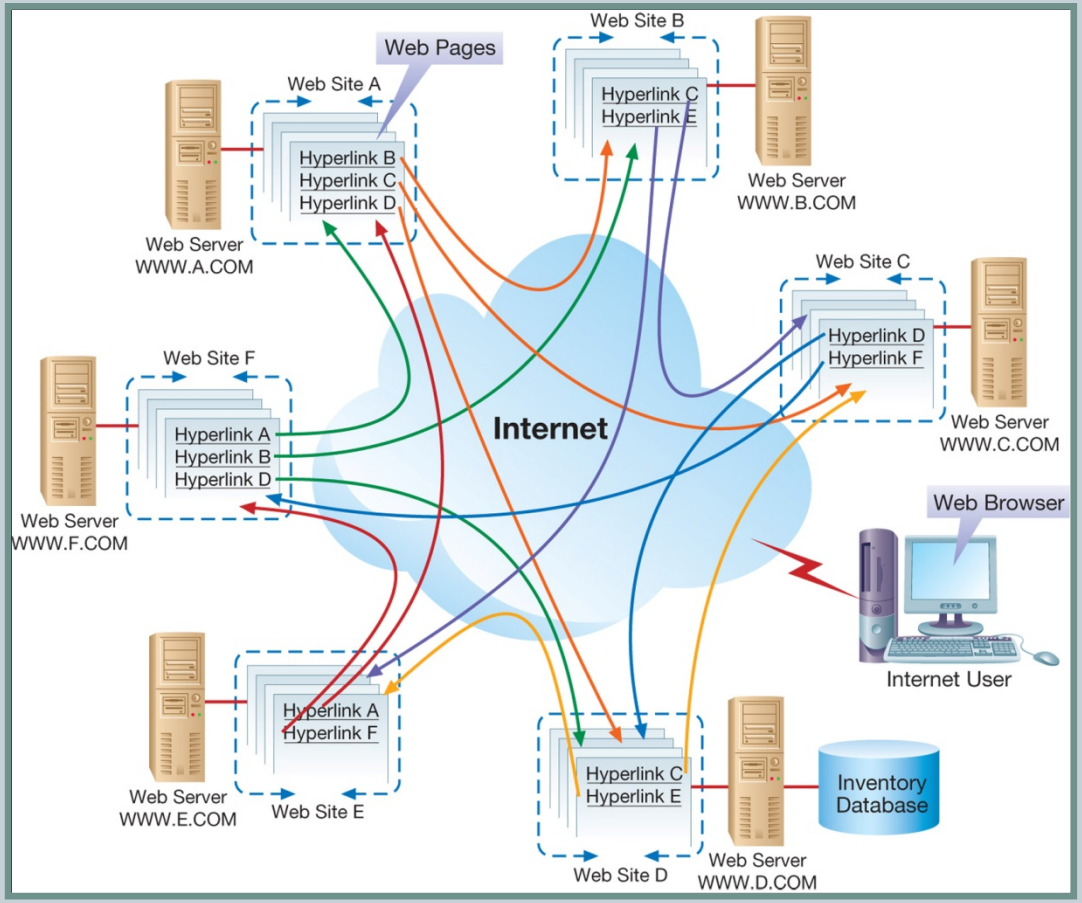
Web Domain Names and Addresses

- Domain name
- Top-level domain
- Host name

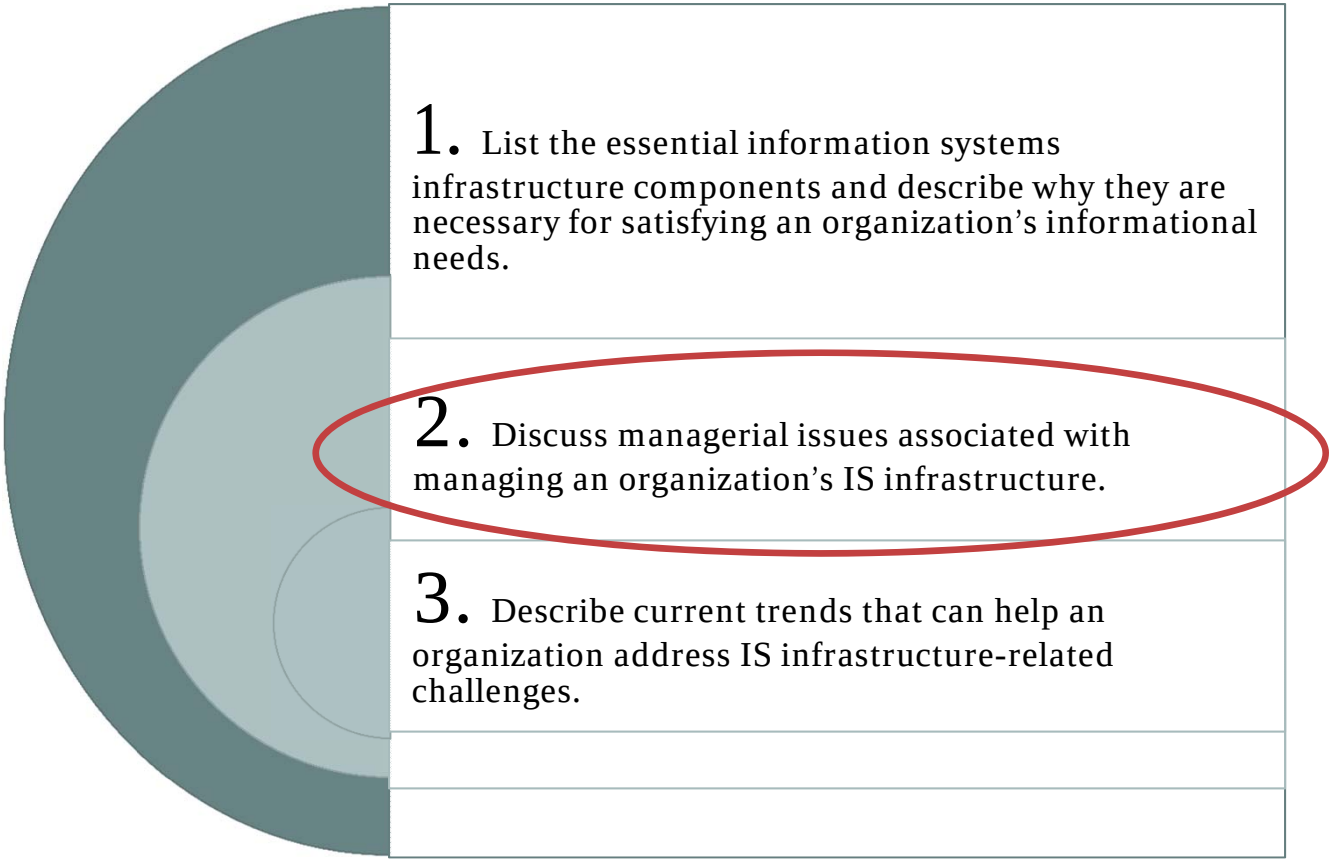
- **.com**—commercial organizations
- **.edu**—educational institutions
- **.org**—organizations (nonprofit)
- **.gov**—U.S. government entity
- **.net**—network organizations
- **.de**—Germany (over 240 two-letter country code top-level domains)

World Wide Web Architecture

- Web uses:
  - Web browser,
  - Web server, and
  - TCP/IP.



Learning Objectives



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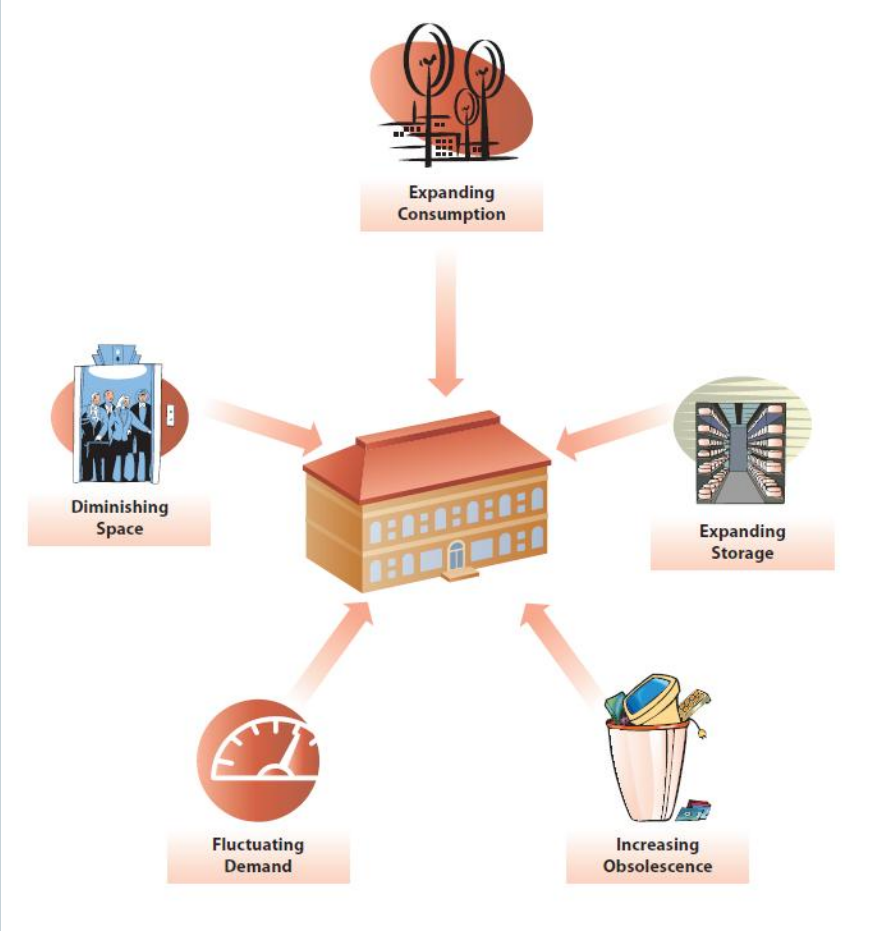
Issues with Managing the IS Infrastructure

- Obsolescence
- Storage Needs
- Space and Facility Requirements
- Energy Consumption
- Demand Fluctuations



Brief History of Computing

- Five generations, spanning 75 years

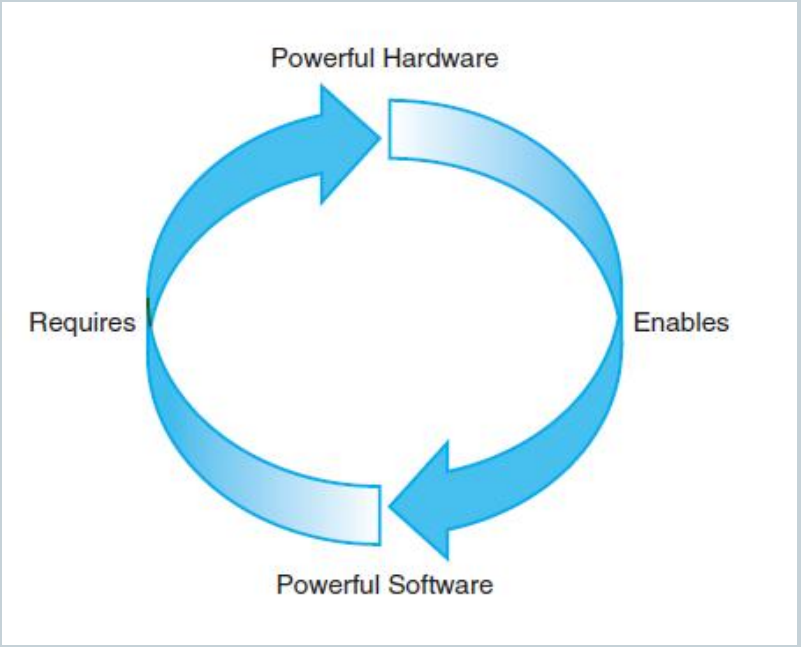
Generation	Time Line	Major Event	Characteristics
1	1946–1958	Vacuum tubes	• Mainframe era begins • ENIAC and UNIVAC were developed
2	1958–1964	Transistors	• Mainframe era expands • UNIVAC is updated with transistors
3	1964–1990s	Integrated circuits	• Mainframe era ends • Personal computer era begins • IBM 360 with general purpose operating system • Microprocessor revolution: Intel, Microsoft, Apple, IBM PC, MS-DOS
4	1990s–2000	Multimedia and low-cost PCs	• Personal computer era ends • Interpersonal computing era begins • High-speed microprocessor and networks • High-capacity storage • Low-cost, high-performance integrated video, audio, and data
5	2000–present	Widespread Internet accessibility	• Interpersonal computing era ends • Internetworking era begins • Ubiquitous access to Internet with a broad variety of devices • Prices continue to drop; performance continues to expand

Moore's Law

- In 1965, Dr. Gordon Moore from Intel hypothesized that processing performance would double every two years.
- First CPU had 2,200 transistors.
- Current CPUs have over 2 billion transistors.
- See www.intel.com/technology/mooreslaw

Software Obsolescence

- Companies like Microsoft are continuously developing new and improved software.
- New operating systems often require new hardware.
- Older-generation application software are incompatible with new operating system.
- **planned obsolescence**
  - Product is designed to last only for a certain life span.
- Therefore, organizations are constantly faced with the decision of when and how to upgrade.



Environmental Impact of Hardware Obsolescence

- The rapid obsolescence of computer hardware carries a high price tag for the environment.

Storage Needs

- Today, organizations can collect and analyze vast amounts of data for *business intelligence.*
- Capturing this data requires ever more storage space.
- Internet bandwidth grew tremendously during the dot-com bubble, allowing organizations to provide customers with richer (and more bandwidth-hungry) information.
- "Vicious circle"—enhanced capabilities enable new applications, which require increased capabilities in both data and communications infrastructure.

Space and Facility Requirements

- Large organizations need hundreds or even thousands of servers.
- Requirements to consider are: connectivity, floor space, provision of energy and cooling, and security.
- Organizations typically house this part of their IS infrastructure in large **data centers.**
- The facilities infrastructure has to grow along with any increase in computing resources.
- Facilities and space can be expensive.

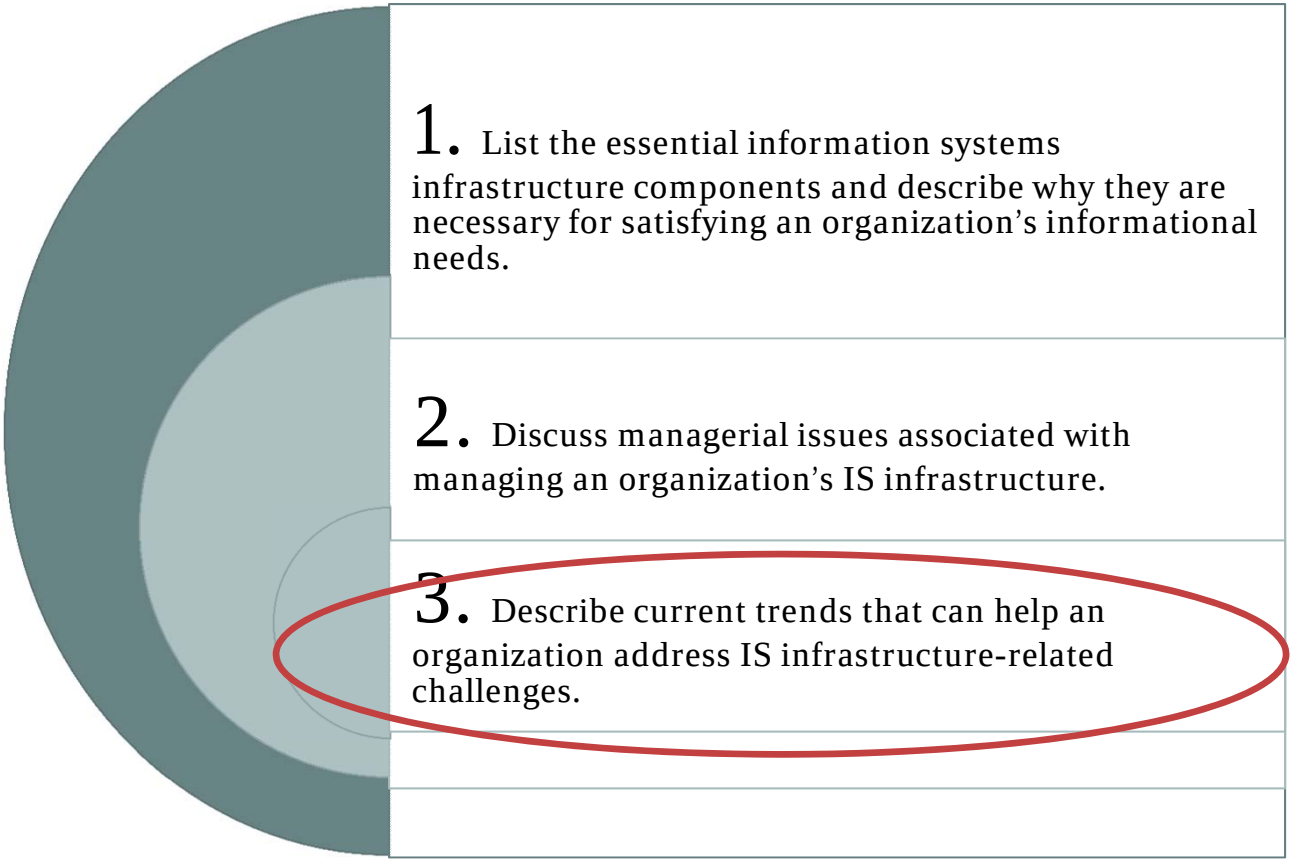
Energy Consumption

- Worldwide increase in demand for energy
- Various components generate heat, requiring air conditioning.
- A typical desktop uses :
  - Idling: between 40 and 170 watts, and
  - Full load: 300 watts or more.
- Google has invested many resources into developing more efficient data centers.
  - “Efficient Data Center Summit” in 2009
  - Google introduced modular data centers, optimizing airflow, cooling, power transformation.

Demand Fluctuations

- The demands for computing resources are often fluctuating.
- Either too few resources at some times or too many idle resources most of the time
- Example: large spikes in demand during the pre-holiday season in December

Learning Objectives



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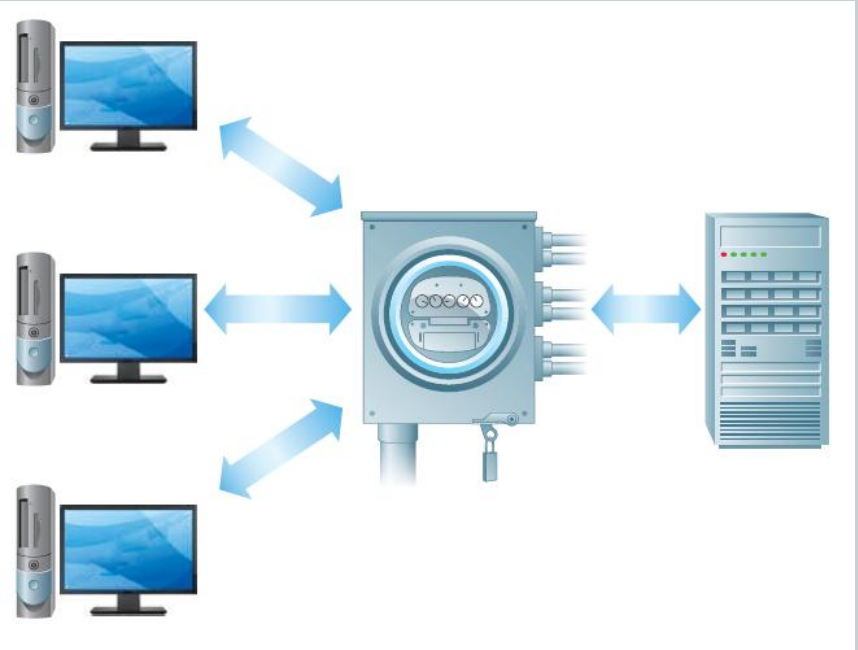
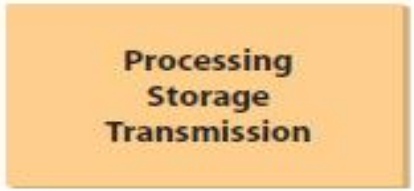
Utility Computing

- **Utility computing model**
  - Organizations "rent" resources (processing, data storage, networking) from an external provider on an as-needed basis.
- Tremendous **scalability** benefits
- Options:
  - Rent time/space on physical resources
  - **Virtualization** —virtual machines running on a single powerful computer.



Cloud Computing

The "cloud" is a metaphor for the Internet.



Cloud computing: a model for enabling convenient, on-demand network access to shared computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction.
— National Institute of Standards and Technology (NIST).

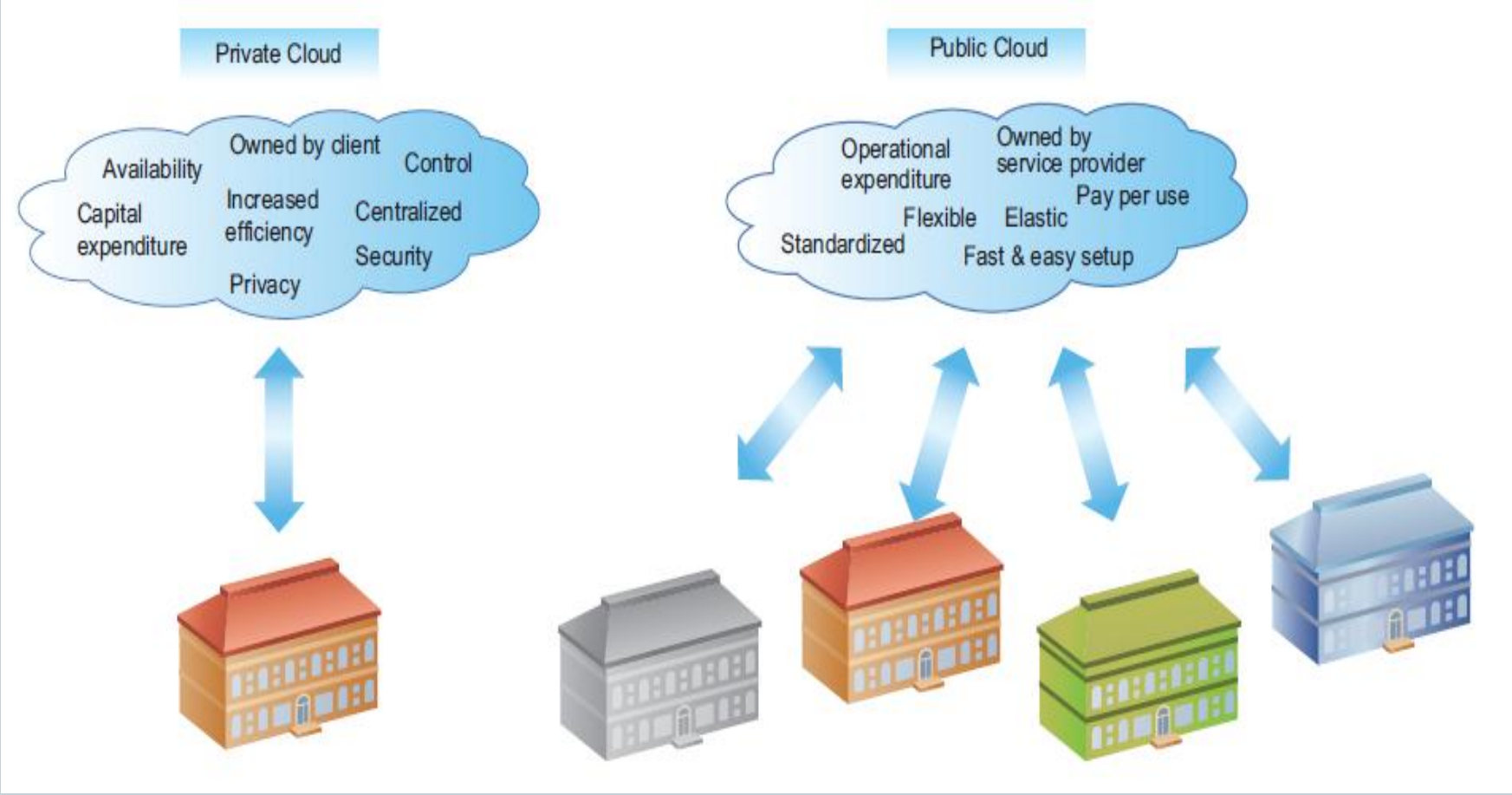
Cloud Computing (Cont.)

- Cloud Characteristics:
  - On-demand self-service
  - Rapid elasticity
  - Ubiquitous network access
  - Resource pooling
  - Measured Service

- Cloud Service Models:
  - Software as a Service (SaaS)
  - Platform as a Service (Paas)
  - Infrastructure as a Service (Iaas)

- Types of Clouds
  - Public clouds
  - Private clouds

Public vs. Private Clouds



Management Issues with Cloud Computing

- Strategic Issues
  - Scalability
  - Viability
  - Diversity of Offerings
  - Support Policies

- Technical Issues
  - Availability/reliability
  - Security
  - Compliance
  - Privacy
  - Openness

- These issues are often covered in **service-level agreements.**

Advanced Cloud Applications

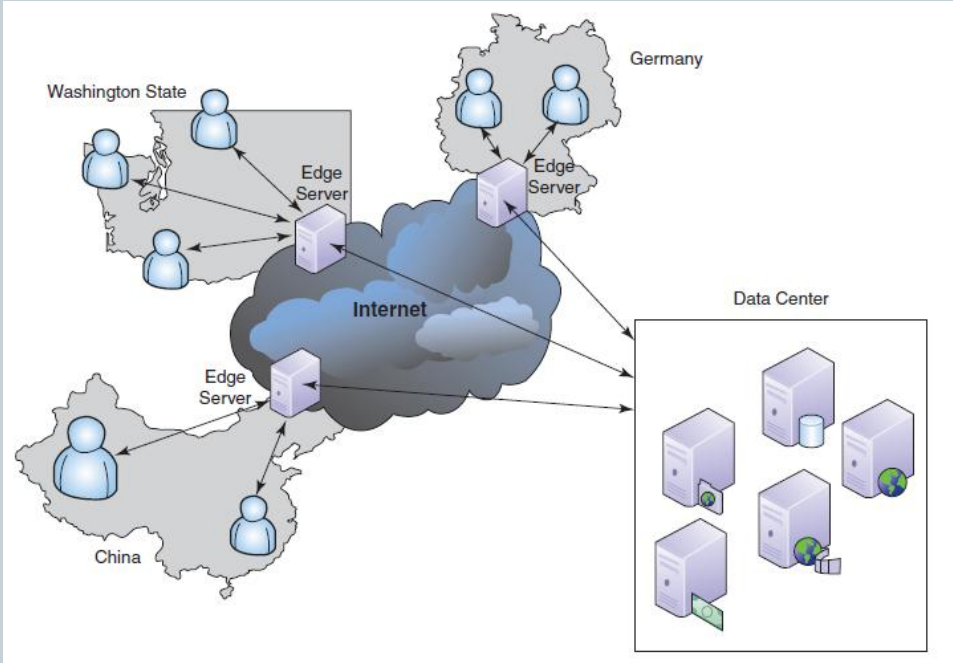
- Grid Computing
  - Solving large-scale computing problems
- Edge Computing
  - Increasing Web application performance
- Convergence of Computing and Telecommunications
  - Transmitting voice and video communication over the Internet
  - Voice over IP (VoIP)
  - Videoconferencing over IP

Grid Computing

- Very complex tasks may require supercomputers.
- Alternative: Grid computing:
  - Combining the computing power of a large number of smaller, independent, networked computers
- Large computing tasks are broken into small chunks, each of which can then be completed by individual computer.
- Example—grid computing application: searching for extraterrestrial intelligence (SETI@home)

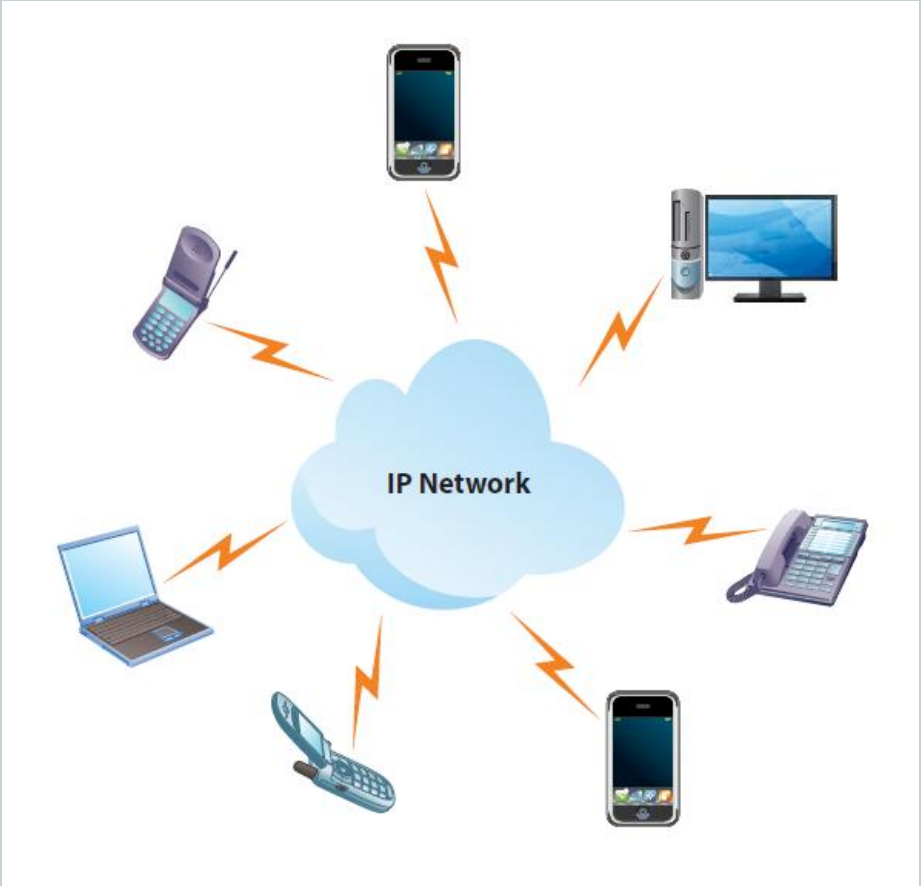
Edge Computing

- Moving processing and data storage away from a centralized location to the edges of the network
- Can improve performance of online commerce sites
- Example—edge computing service provider: Akamai
  - Services utilized by NBC, Fox Sports, BMW, Victoria's Secret



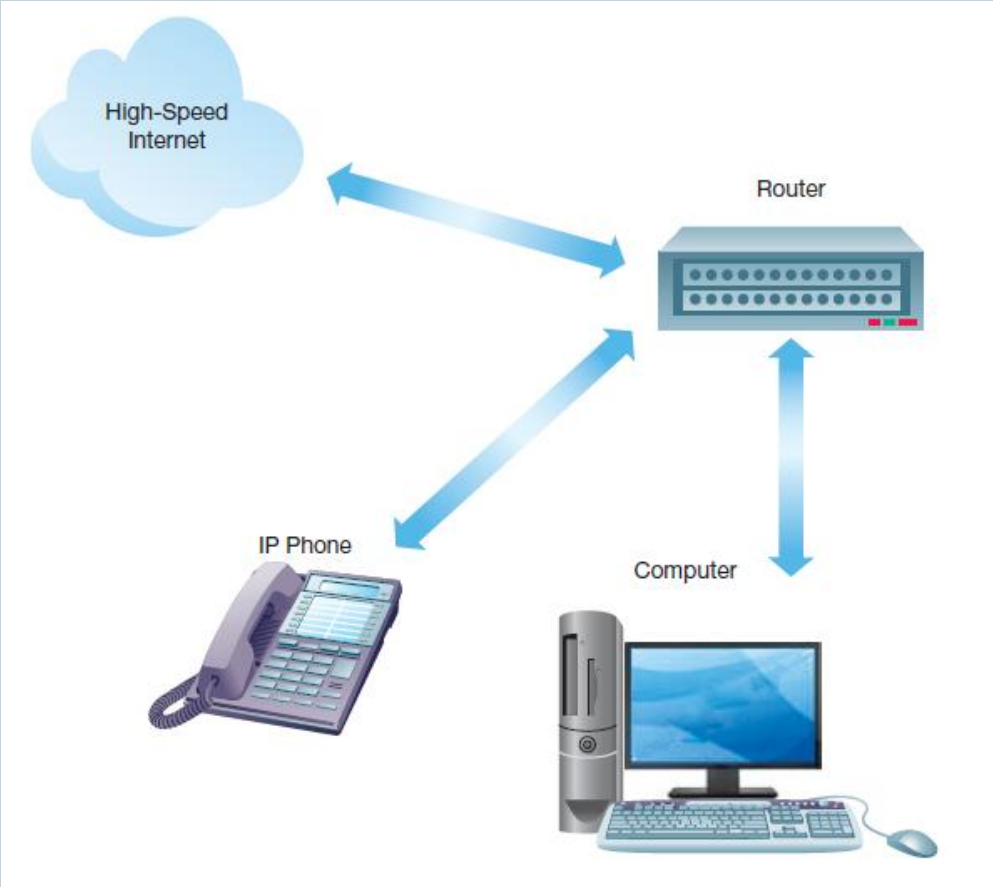
IP Convergence

- Allows various devices to communicate using IP technologies



VoIP Technology

- IP telephony (e.g., Skype)
- Enables organizations and individuals to reduce their telecommunications costs



Videoconferencing over IP

- IP used to transmit video data
- Example—Hewlett-Packard's HALO meeting room

Green Computing

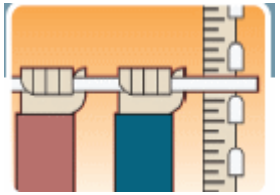
- Contribute to energy savings by using computers more efficiently
- Large organizations with significant computing needs now portraying “greener image” regarding costs and savings on resources.
  - Save money using:
    - Virtualization
    - Virtual machines can be configured to run on a single computer

End of Chapter Content

Managing in the Digital World: "I Googled You!"

- The term "google" has become so familiar to Internet users that it's often used as a verb.
- Company founders
  - Larry Page
  - Sergey Brin
  - Stanford University grad students
  - Collaborated on search engine "BackRub" (1996)
- Google is a play on the word googol (a huge number)

- Google filed with SEC for IPO in 2004
- As of March 2010, 20,000 employees and $23 billion revenues
- Many additional services (e.g., Google Docs, Chrome, Android)



POWERFUL PARTNERSHIPS

Google's Larry Page and Sergey Brin

- Brin is from Russia, and holds a bachelors in math and computer science from U. Maryland
- Page earned a bachelors in engineering from U. Michigan
- They met at Stanford, where they are on leave from their PhD programs
- They argued a lot when they first met in 1995.
- Google corporate lore:
  - "Healthy disregard for the impossible"
  - "Anticorporate culture"
  - Among top five in Fortune's "100 Best Companies to Work For."
  - Foster green technology and causes

Brief Case

The Battle of the Giants

- Microsoft—traditional market leader of operating systems
  - Market share over 90 percent
  - Windows 7 is Microsoft's newest OS
  - Can be installed on any compatible computer
- Apple
  - OS X operating system, optimized for Apple hardware
  - Smaller market share, but very loyal customer base
- Smart phone operating systems
  - Symbian—Nokia, Sony
  - RIM—Blackberry (35 percent market share)
  - Windows Mobile—HTC, LG (19 percent market share)
  - Android—9 percent market share
  - Apple iOS4—iPhone, iPad (28 percent market share)
  - Google—developing Chrome OS

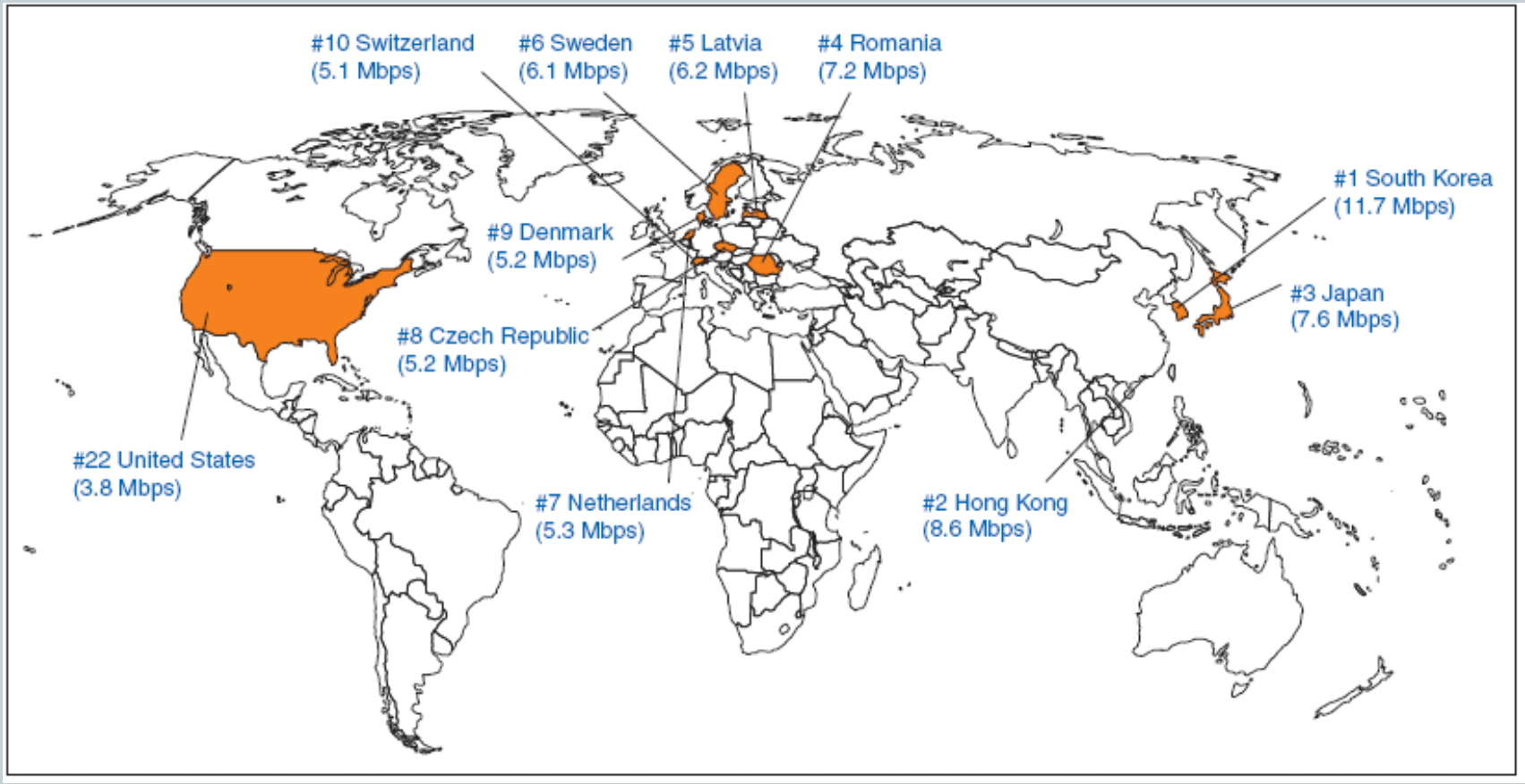
ETHICAL DILEMMA

The Ethics of Collecting Public Data

- Google Maps' "Street View"—allows user to zoom down to an actual 360-degree photographic view of a street.
- Great value, but Google has been criticized for invasion of privacy.
- Street view captures pictures of people in the street, including compromising positions (entering adult bookstores, leaving strip clubs, and so on).
- Google also mapped locations of public WiFi, inadvertently collecting e-mail and Web-surfing data.
- Some people question whether this was really inadvertent.

NET STATS

Broadband Access Increases



- Average measured broadband connection speeds.
- Source: Based on http://www.akamai.com/dl/whitepapers/Akamai_State_Internet_Q4_2009.pdf.

WHEN THINGS GO WRONG

Google Buzz: A Privacy Fiasco

- Buzz is a social networking and messaging add-on to Gmail.
- When Buzz went live, every Gmail user was automatically enrolled.
- It automatically linked all members of every Gmail user address book.
- It led to many protests for invasion of privacy.
- Google responded by making it easy to opt out.
- People were still unsatisfied, so Google changed it to an “opt-in” system; by default Gmail users are not on Buzz unless they choose to be.

COMING ATTRACTIONS

Autonomic Computing

- Increasing complexity of information systems make it difficult and costly to manage IS resources (updates, software patches, and so on).
- Researchers have been working on autonomic computing to overcome these issues.
- How?
  - Autonomic system must know its configuration, capacity, status, and resources to draw on.
  - Autonomic system must be self-configuring.
  - Autonomic system must recognize malfunctions and be self-healing.
- Example: 3PAR's autonomic storage tier system, geared for cloud service providers

Movie Industry

- Tremendous increase in computing power provides capability for outstanding special effects and animations using computer-generated imagery (CGI).
- Digital editing software is much more affordable and easier to use than before.
- This allows independent studios to compete with major studios.
  - Thirty percent of Sundance Film Festival submissions are in digital format.
- 3D film is becoming more popular.
  - In 2010, Avatar used specialized 3D cameras and software.
  - In 2009, there were 3000 3D screens in the United States.
  - Autostereoscopic displays are currently being developed (no need for 3D glasses).