MANAGEMENT INFORMATION SYSTEMS

Chapter 5
IT Infrastructure and Emerging Technologies

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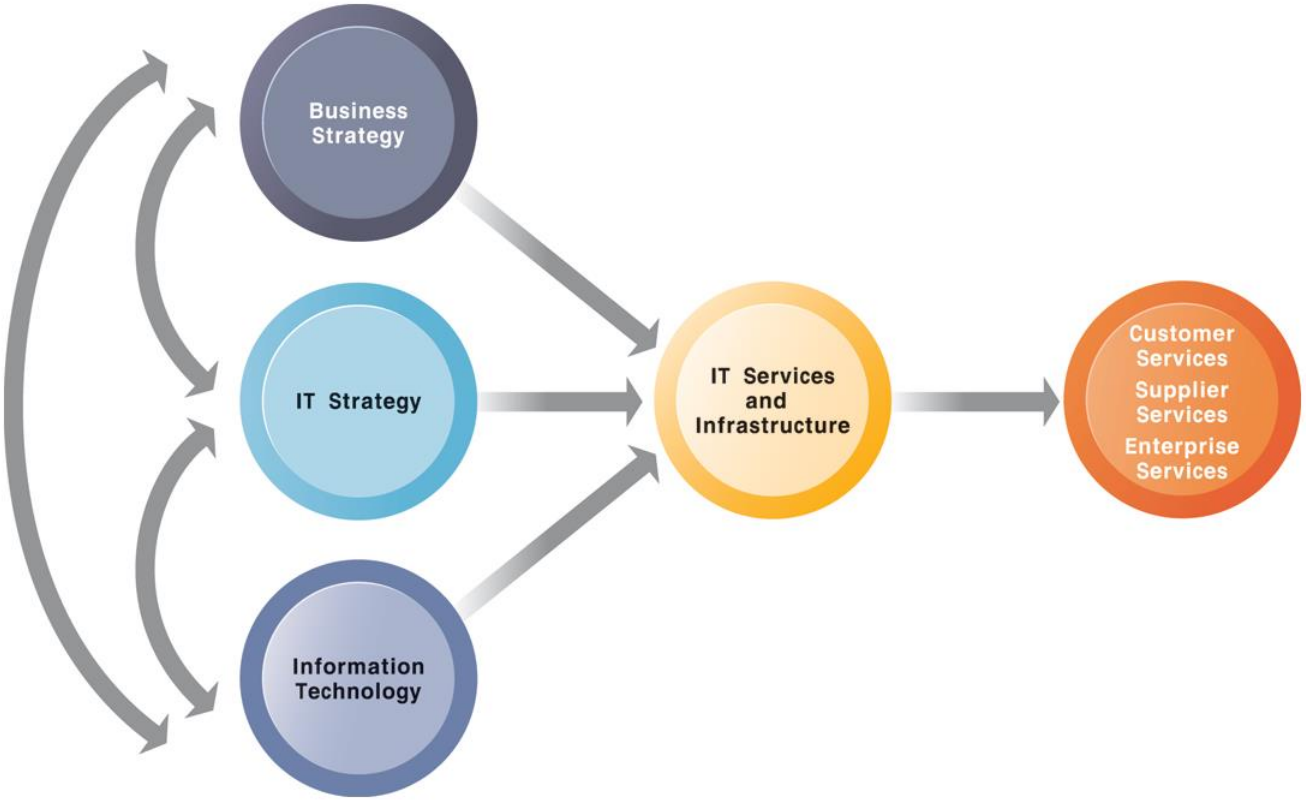
Learning Objectives

1. **Define** IT infrastructure and describe its components.
2. **Identify** and describe the stages and technology drivers of IT infrastructure evolution.
3. **Assess** contemporary computer hardware platform trends.
4. **Assess** contemporary software platform trends.
5. **Evaluate** the challenges of managing IT infrastructure and management solutions

IT Infrastructure

- IT infrastructure:
  - Set of physical devices and software required to operate enterprise
  - Set of firmwide services including:
    - Computing platforms providing computing services
    - Telecommunications services
    - Data management services
    - Application software services
    - IT management, education, and other services
  - "Service platform" perspective
    - More accurate view of value of investments

IT Infrastructure



The services a firm is capable of providing to its customers, suppliers, and employees are a direct function of its IT infrastructure. Ideally, this infrastructure should support the firm's business and information systems strategy. New information technologies have a powerful impact on business and IT strategies, as well as the services that can be provided to customers.

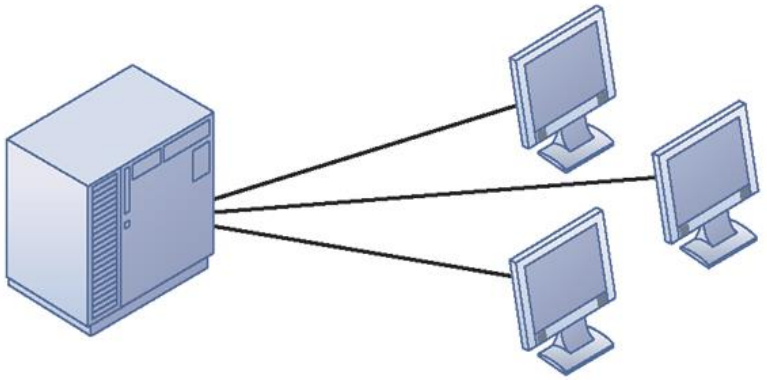
IT Infrastructure

- **Evolution of IT infrastructure**
  - General-purpose mainframe and minicomputer era: 1959 to present
    - 1958: IBM first mainframes introduced
    - 1965: less expensive DEC minicomputers introduced
  - Personal computer era: 1981 to present
    - 1981: Introduction of IBM PC
    - Proliferation in 80s, 90s resulted in growth of personal software
  - Client/server era: 1983 to present
    - Desktop clients networked to servers, with processing work split between clients and servers
    - Network may be two-tiered or multitiered (N-tiered)
    - Various types of servers (network, application, Web)

IT Infrastructure

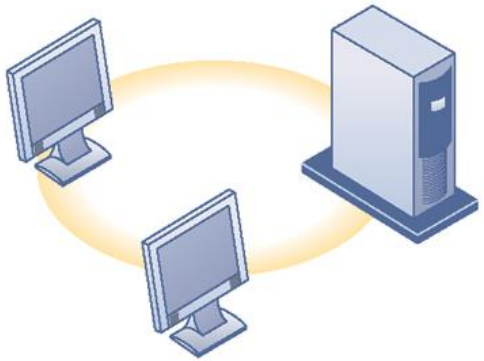
Illustrated here are the typical computing configurations characterizing each of the five eras of IT infrastructure evolution.

Mainframe/
Minicomputer
(1959–present)

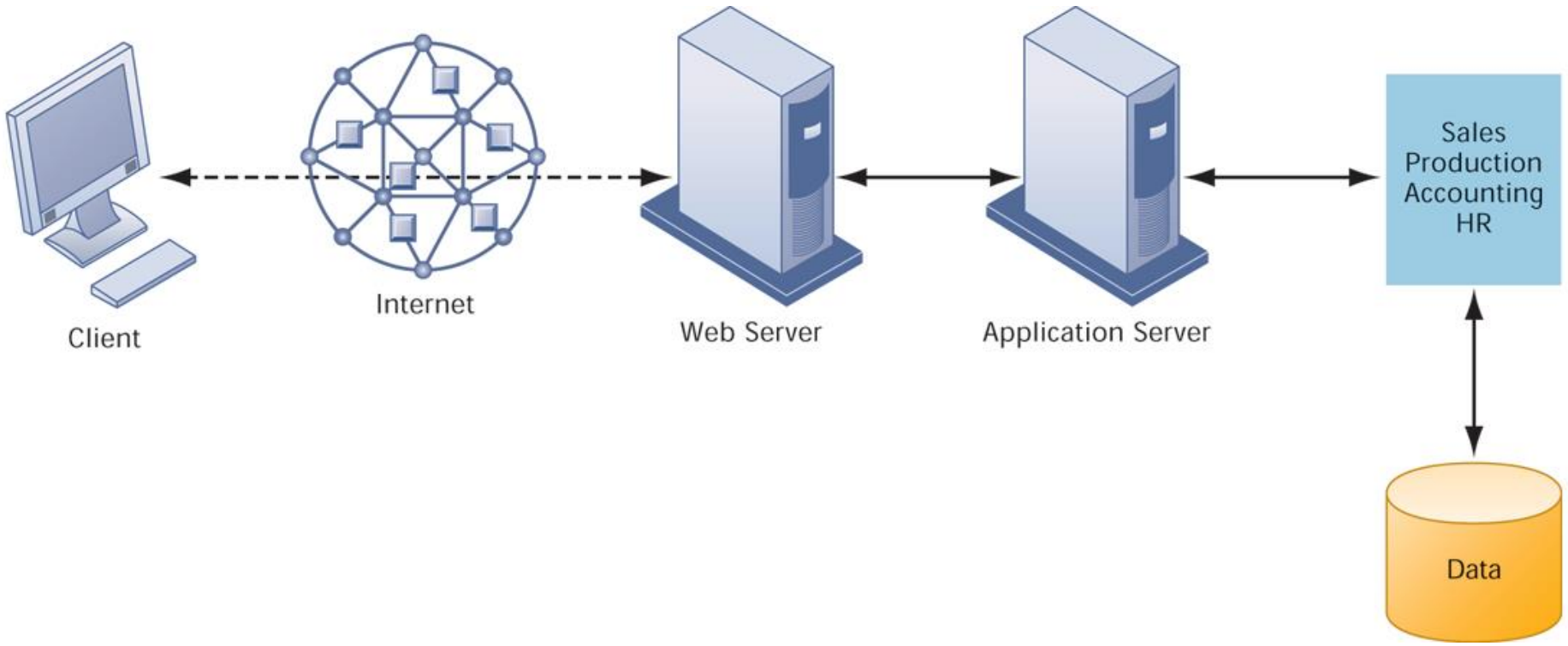


Personal
Computer
(1981–present)

Client/Server
(1983–present)



IT Infrastructure



In a multitiered client/server network, client requests for service are handled by different levels of servers.

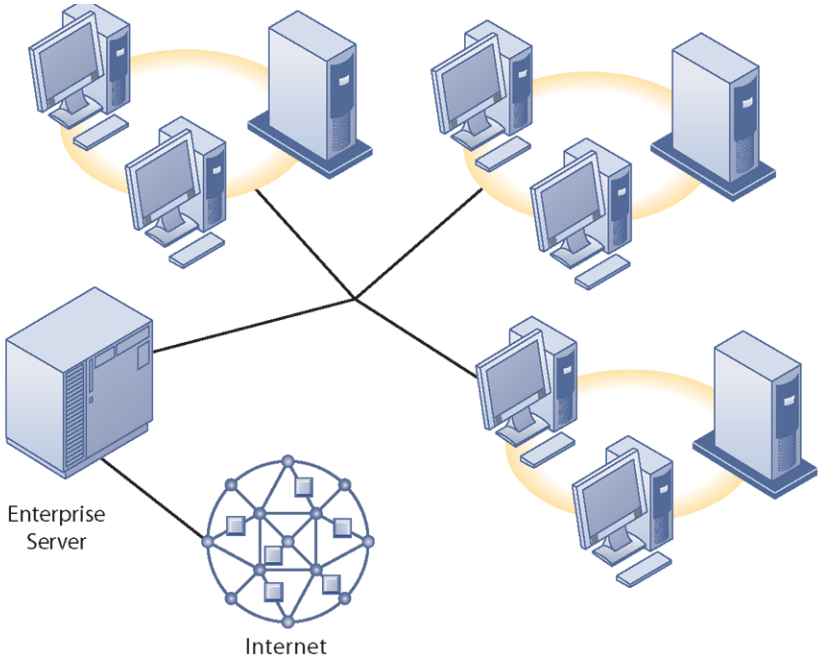
IT Infrastructure

- **Evolution of IT infrastructure (cont.)**
  - Enterprise computing era: 1992 to present
    - Move toward integrating disparate networks, applications using Internet standards and enterprise applications
  - Cloud and mobile computing: 2000 to present
    - Cloud computing: computing power and software applications supplied over the Internet or other network
      - Fastest growing form of computing

IT Infrastructure

Illustrated here are the typical computing configurations characterizing each of the five eras of IT infrastructure evolution.

Enterprise Computing 1992–present)



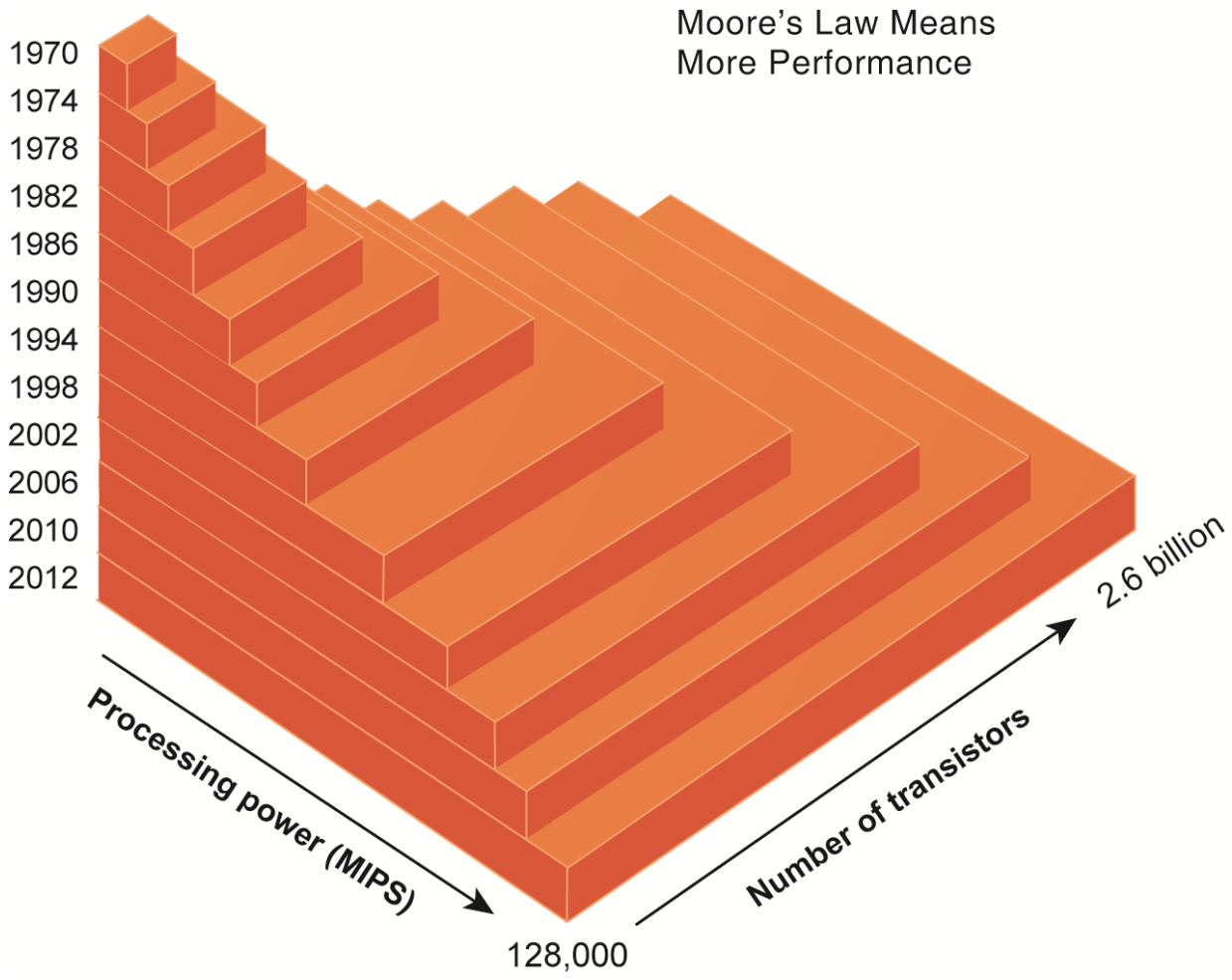
Cloud and Mobile Computing (2000–present)

IT Infrastructure

- **Technology drivers of infrastructure evolution**
  - Moore's law and microprocessing power
    - Computing power doubles every 18 months
    - Nanotechnology:
      - Shrinks size of transistors to size comparable to size of a virus
  - Law of Mass Digital Storage
    - The amount of data being stored each year doubles

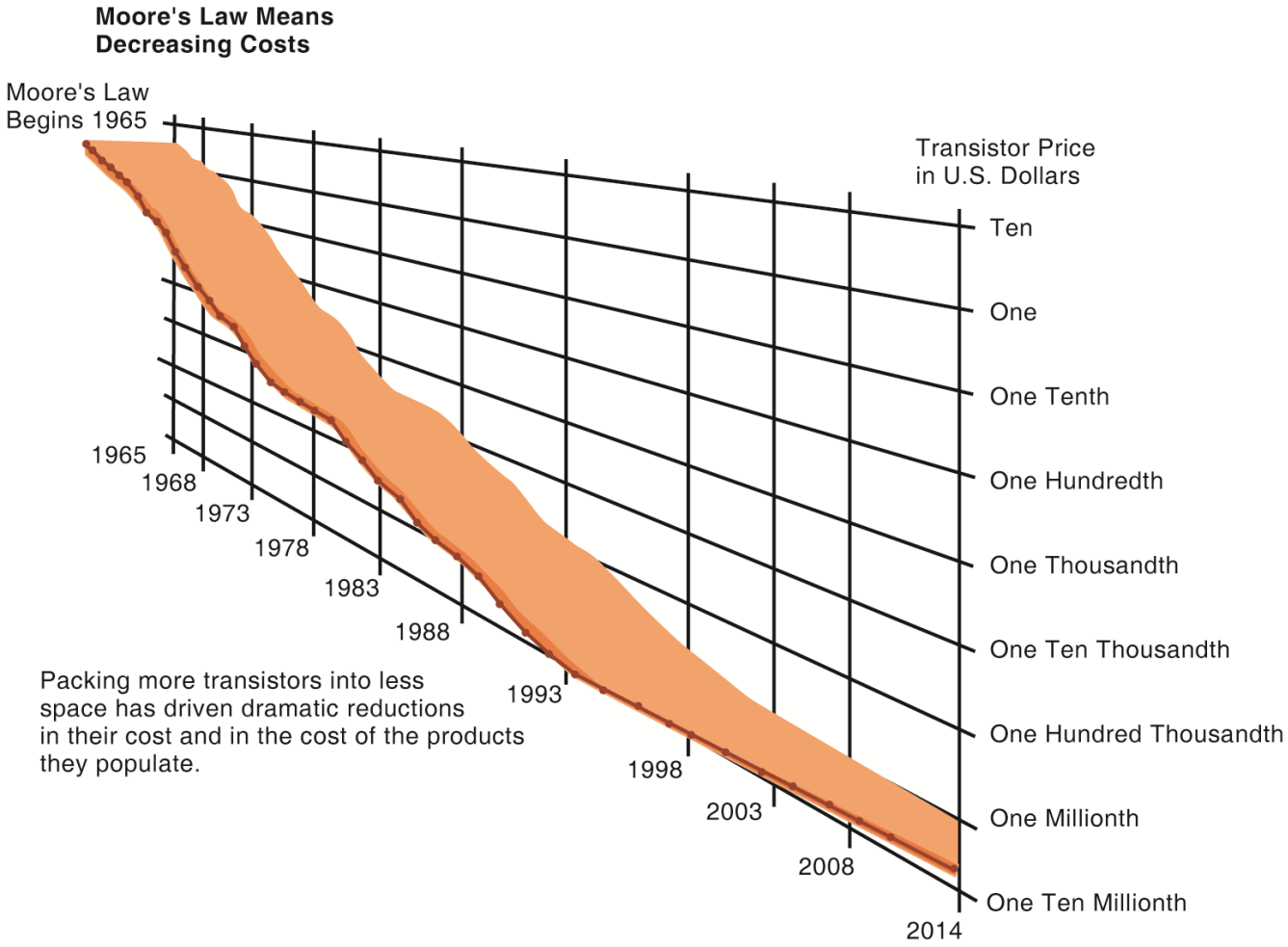
IT Infrastructure

Packing more than 2 billion transistors into a tiny microprocessor has exponentially increased processing power. Processing power has increased to more than 500,000 MIPS (millions of instructions per second).



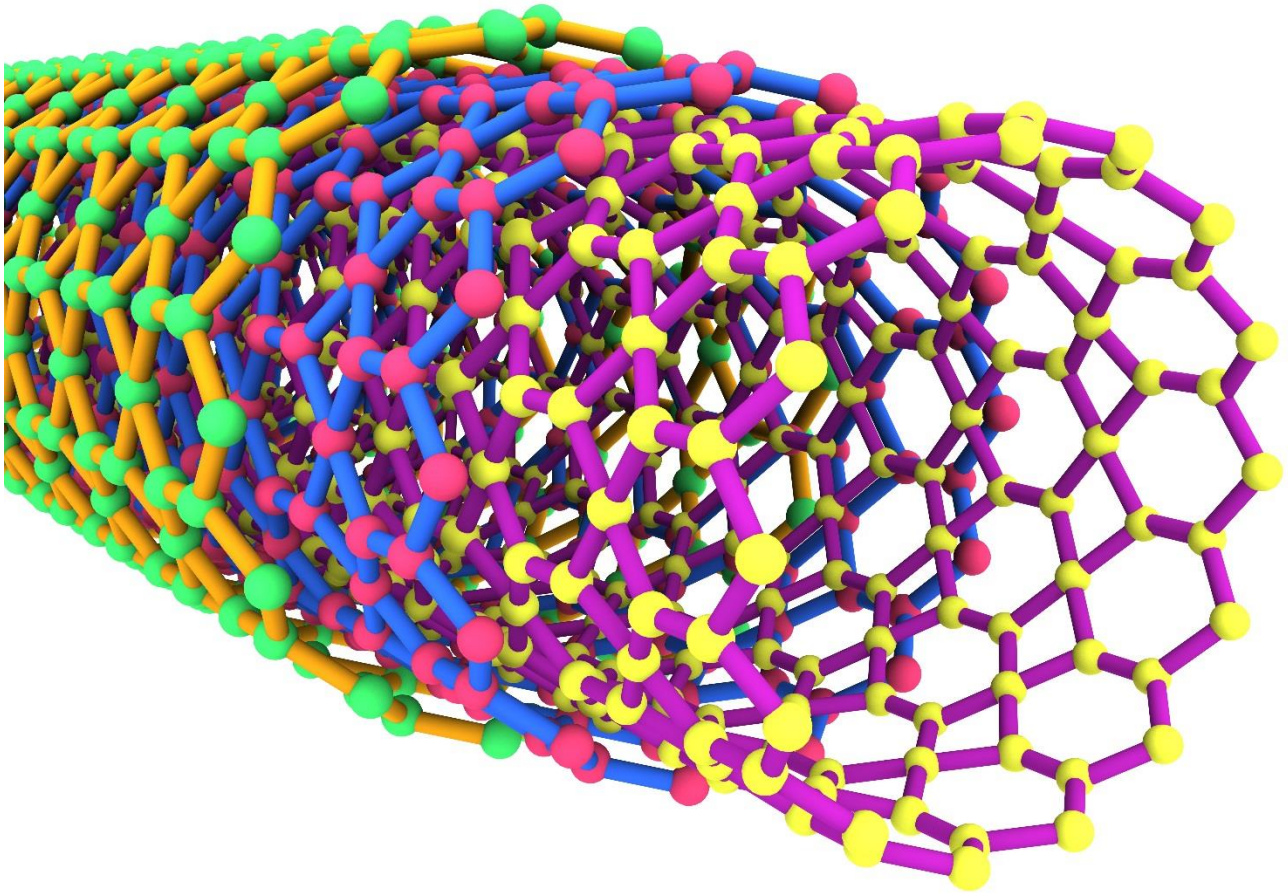
IT Infrastructure

Packing more transistors into less space has driven down transistor cost dramatically as well as the cost of the products in which they are used.



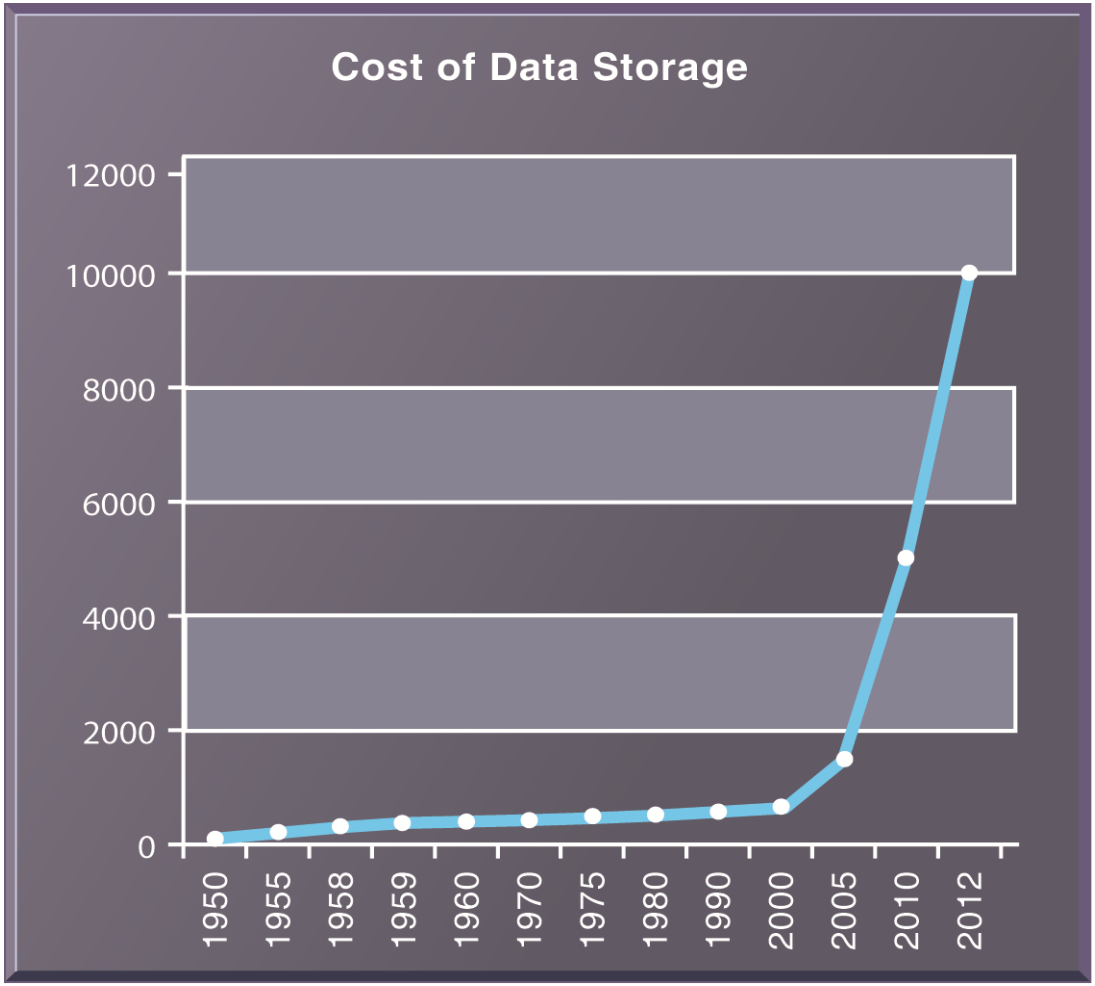
IT Infrastructure

Nanotubes are tiny tubes about 10,000 times thinner than a human hair. They consist of rolled up sheets of carbon hexagons and have the potential uses as minuscule wires or in ultrasmall electronic devices and are very powerful conductors of electrical current.



IT Infrastructure

Since the first magnetic storage device was used in 1955, the cost of storing a kilobyte of data has fallen exponentially, doubling the amount of digital storage for each dollar expended every 15 months on average.



IT Infrastructure

Technology drivers of infrastructure evolution (cont.)

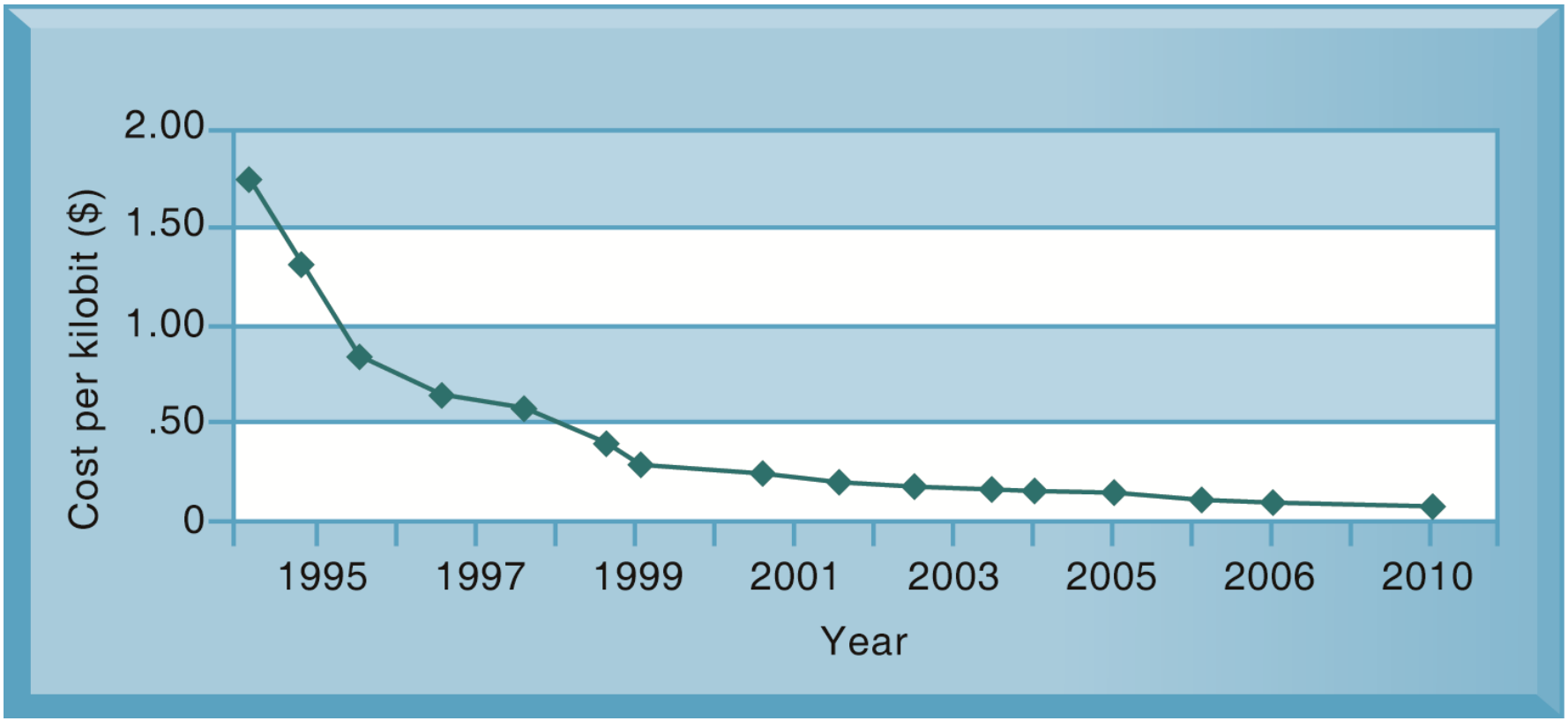
- Metcalfe's Law and network economics
  - Value or power of a network grows exponentially as a function of the number of network members
  - As network members increase, more people want to use it (demand for network access increases)

IT Infrastructure

Technology drivers of infrastructure evolution (cont.)

- Declining communication costs and the Internet
  - An estimated 2.3 billion people worldwide have Internet access
  - As communication costs fall toward a very small number and approach 0, utilization of communication and computing facilities explodes

IT Infrastructure



One reason for the growth in the Internet population is the rapid decline in Internet connection and overall communication costs. The cost per kilobit of Internet access has fallen exponentially since 1995. Digital subscriber line (DSL) and cable modems now deliver a kilobit of communication for a retail price of around 2 cents.

IT Infrastructure

Technology drivers of infrastructure evolution (cont.)

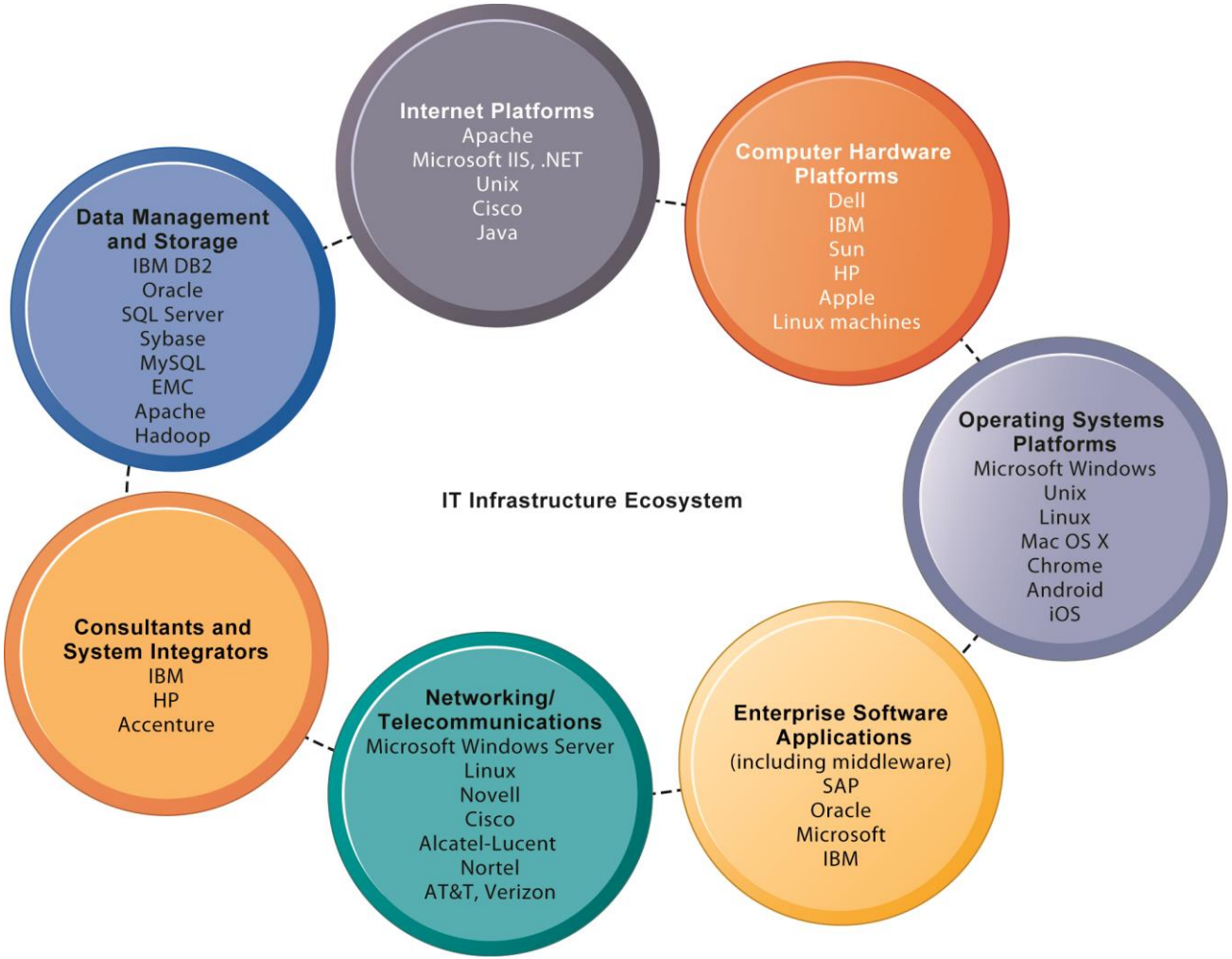
- Standards and network effects
  - Technology standards:
    - Specifications that establish the compatibility of products and the ability to communicate in a network
    - Unleash powerful economies of scale and result in price declines as manufacturers focus on the products built to a single standard

Infrastructure Components

- IT Infrastructure has seven main components
  1. Computer hardware platforms
  2. Operating system platforms
  3. Enterprise software applications
  4. Data management and storage
  5. Networking/telecommunications platforms
  6. Internet platforms
  7. Consulting system integration services

Infrastructure Components

There are seven major components that must be coordinated to provide the firm with a coherent IT infrastructure. Listed here are major technologies and suppliers for each component.



Infrastructure Components

- Computer hardware platforms
  - Client machines
    - Desktop PCs, mobile devices—PDAs, laptops
  - Servers
    - Blade servers: ultrathin computers stored in racks
  - Mainframes:
    - IBM mainframe equivalent to thousands of blade servers
  - Top chip producers: AMD, Intel, IBM
  - Top firms: IBM, HP, Dell, Sun Microsystems

Infrastructure Components

- Operating system platforms
  - Operating systems
    - Server level: 65% run Unix or Linux; 35% run Windows
    - Client level:
      - 90% run Microsoft Windows (XP, 2000, CE, etc.)
      - Mobile/multitouch (Android, iOS)

Infrastructure Components

- Enterprise software applications
  - Enterprise application providers: SAP and Oracle

Infrastructure Components

- Data management and storage
  - Database software:
    - IBM (DB2), Oracle, Microsoft (SQL Server), MySQL
  - Physical data storage:
    - EMC Corp (large-scale systems), Seagate, Maxtor, Western Digital
  - Storage area networks (SANs):
    - Connect multiple storage devices on dedicated network

Infrastructure Components

- Networking/telecommunications platforms
  - Telecommunication services
    - Telecommunications, cable, telephone company charges for voice lines and Internet access
    - AT&T, Verizon, Hadara
  - Network hardware providers:
    - Cisco, Alcatel-Lucent, Nortel, Juniper Networks

Infrastructure Components

- Internet platforms
  - Hardware, software, management services to support company Web sites, (including Web-hosting services) intranets, extranets
  - Internet hardware server market: IBM, Dell, Sun (Oracle), HP
  - Web development tools/suites: Microsoft (Expression Studio, .NET) Oracle-Sun (Java), Adobe, Real Networks

Infrastructure Components

- Consulting and system integration services
  - Even large firms do not have resources for full range of support for new, complex infrastructure
  - Software integration: ensuring new infrastructure works with legacy systems
  - Legacy systems: older TPS created for mainframes that would be too costly to replace or redesign
  - Accenture, IBM Global Services, EDS, Infosys, Wipro

Contemporary Hardware Platform Trends

- The mobile digital platform
  - Cell phones, smartphones (iPhone, Android, and Blackberry)
    - Data transmission, Web surfing, e-mail
  - Netbooks:
    - Small lightweight notebooks optimized for wireless communication and core tasks
  - Tablets (iPad)
  - Networked e-readers (Kindle)

Contemporary Hardware Platform Trends

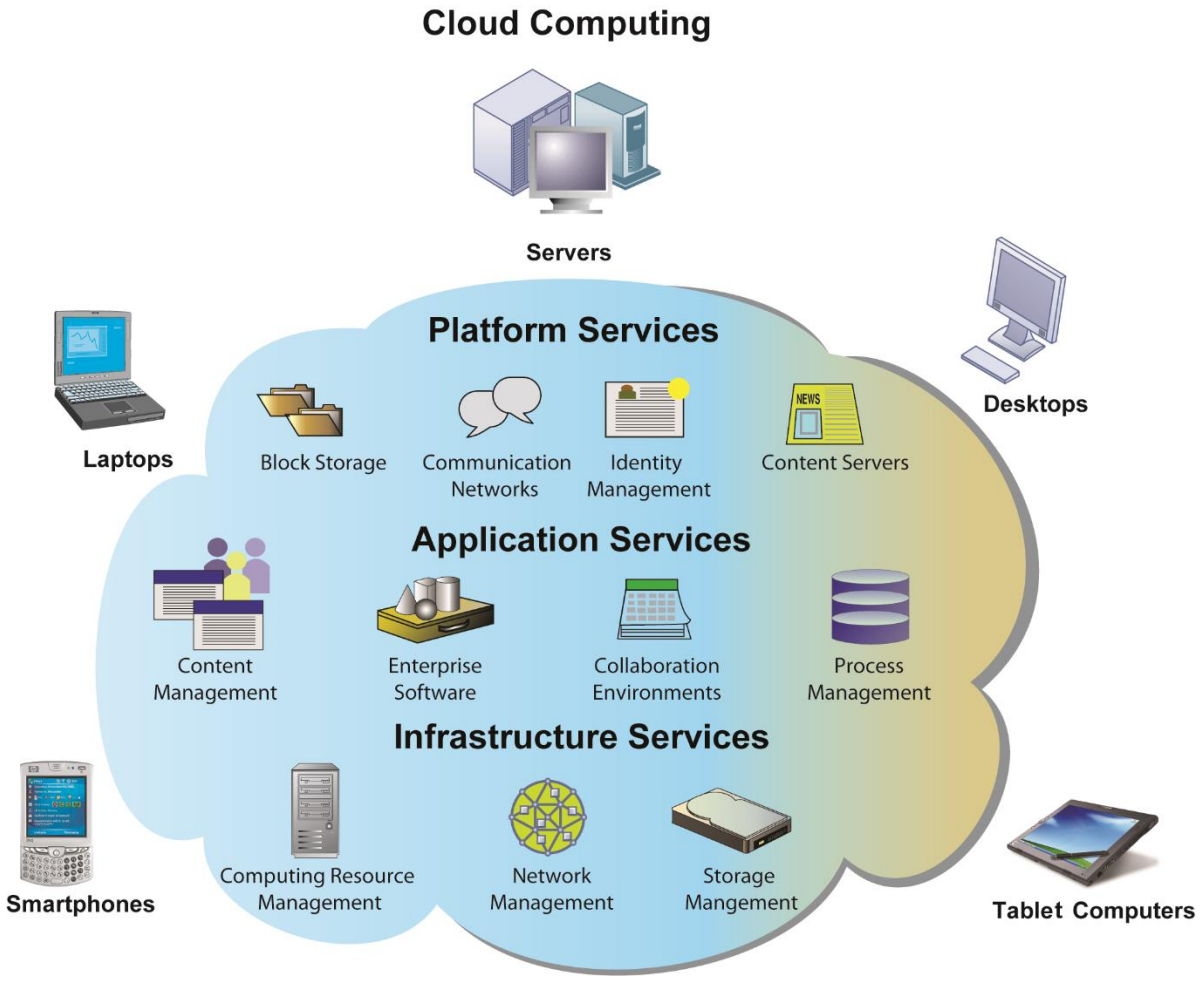
- Grid computing
  - Connects geographically remote computers into a single network to combine processing power and create virtual supercomputer
  - Provides cost savings, speed, agility
- Virtualization
  - Allows single physical resource to act as multiple resources (i.e., run multiple instances of OS)
  - Reduces hardware and power expenditures
  - Facilitates hardware centralization

Contemporary Hardware Platform Trends

- Cloud computing
  - Computing services obtained over network
    - Infrastructure as a service
    - Platform as a service
    - Software as a service
  - Allows companies to minimize IT investments
  - Drawbacks: Concerns of security, reliability

Contemporary Hardware Platform Trends

In cloud computing, hardware and software capabilities are a pool of virtualized resources provided over a network, often the Internet. Businesses and employees have access to applications and IT infrastructure anywhere, at any time, and on any device.



Contemporary Hardware Platform Trends

- Green computing
  - Practices and technologies for manufacturing, using, disposing of computing and networking hardware, i.e. protect the environment, environmental responsibility
- High performance, power-saving processors
  - Is an integrated circuit to which two or more processor cores have been attached for enhanced performance, reduced power consumption, and more efficient simultaneous processing of multiple tasks.
- Autonomic computing
  - Industry-wide effort to develop systems that can configure, heal themselves when broken, and protect themselves from outside intruders
  - Similar to self-updating antivirus software; Apple and Microsoft both use automatic updates

Contemporary Software Platform Trends

- Open-source software:
  - Produced by community of programmers
  - Free and modifiable by user
  - Examples: Apache web server, Mozilla Firefox browser, OpenOffice
- Linux
  - Open-source OS
  - Used in mobile devices, local area networks, Web servers, high-performance computing

Contemporary Software Platform Trends

- Software for the Web
  - Java:
    - Object-oriented programming language
  - HTML/HTML5
    - Web page description language
    - Specifies how text, graphics are placed on Web page
    - HTML5 is latest evolution
      - Includes animation and video processing functionality previously provided by third party add-ons such as Flash

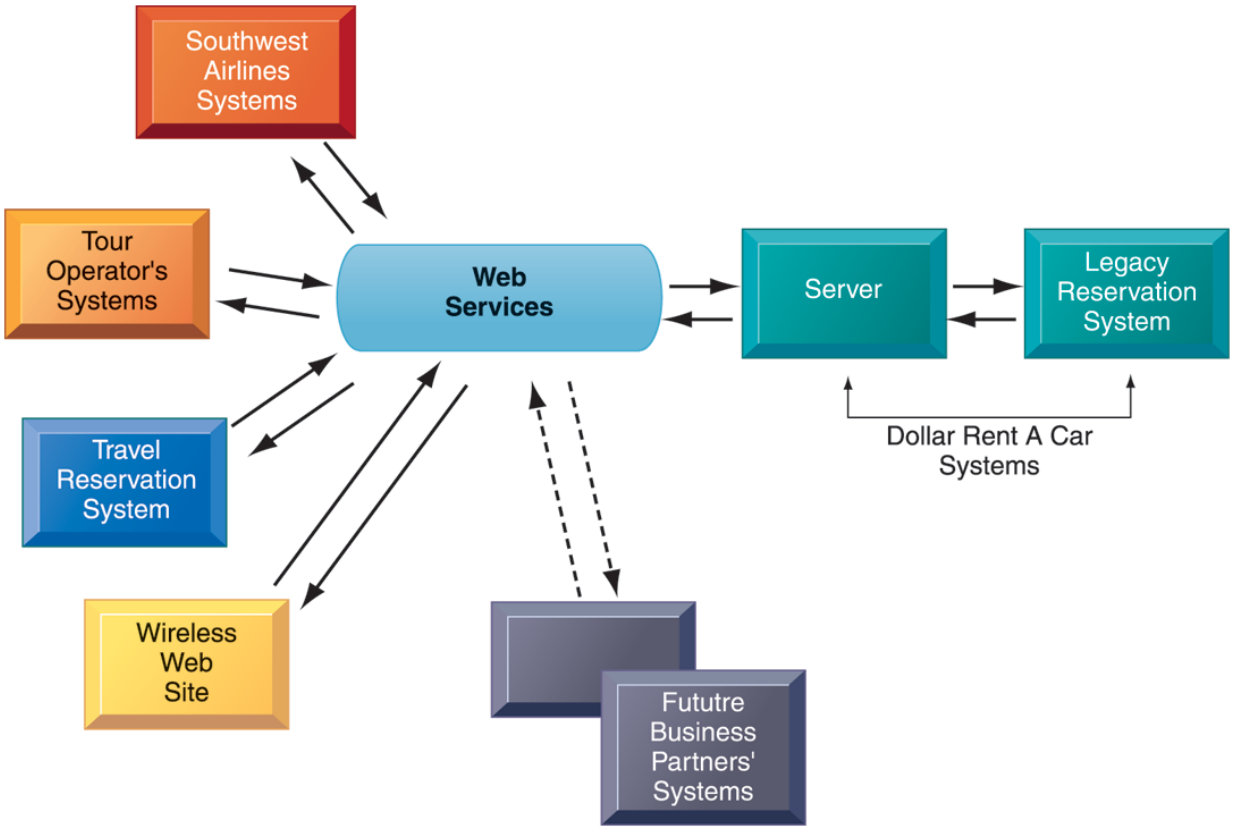
Contemporary Software Platform Trends

- Web Services
  - Software components that exchange information using Web standards and languages
  - XML: Extensible Markup Language
    - More powerful and flexible than HTML

Contemporary Software Platform Trends

- SOA: Service-oriented architecture
  - Set of self-contained services that communicate with each other to create a working software application
  - Software developers reuse these services in other combinations to assemble other applications as needed
  - Dollar Rent-A-Car (next example)
    - For example: Dollar Rent a Car uses Web services to link online booking system with Southwest Airlines' Web site

Contemporary Software Platform Trends



Dollar Rent A Car uses Web services to provide a standard intermediate layer of software to "talk" to other companies' information systems. Dollar Rent A Car can use this set of Web services to link to other companies' information systems without having to build a separate link to each firm's systems.

Contemporary Software Platform Trends

- Software outsourcing and cloud services
  - Sources for software:
    - Internal development
    - Software outsourcing
      - Contracting outside firms to develop software
    - Cloud-based software services
      - Software as a service (SaaS)
      - Accessed with Web browser over Internet
      - Service Level Agreements (SLAs): formal agreement with service providers

Management Issues

- Dealing with platform and infrastructure change
  - As firms shrink or grow, IT needs to be flexible and scalable
    - Scalability:

      Ability to expand to serve larger number of users
  - For mobile computing and cloud computing
    - New policies and procedures for managing these new platforms
    - Contractual agreements with firms running clouds and distributing software required

Management Issues

- Management and governance
  - Who controls IT infrastructure?
  - How should IT department be organized?
    - Centralized
      - Central IT department makes decisions
    - Decentralized
      - Business unit IT departments make own decisions
  - How are costs allocated between divisions, departments?

Management Issues

- Making wise infrastructure investments
  - Amount to spend on IT is complex question
    - Rent vs. buy, cloud computing
    - Outsourcing
  - Total cost of ownership (TCO) model
    - Analyzes direct and indirect costs
    - Hardware, software account for only about 20% of TCO
    - Other costs: Installation, training, support, maintenance, infrastructure, downtime, space, and energy
  - TCO can be reduced
    - Use of cloud services, greater centralization and standardization of hardware and software resources

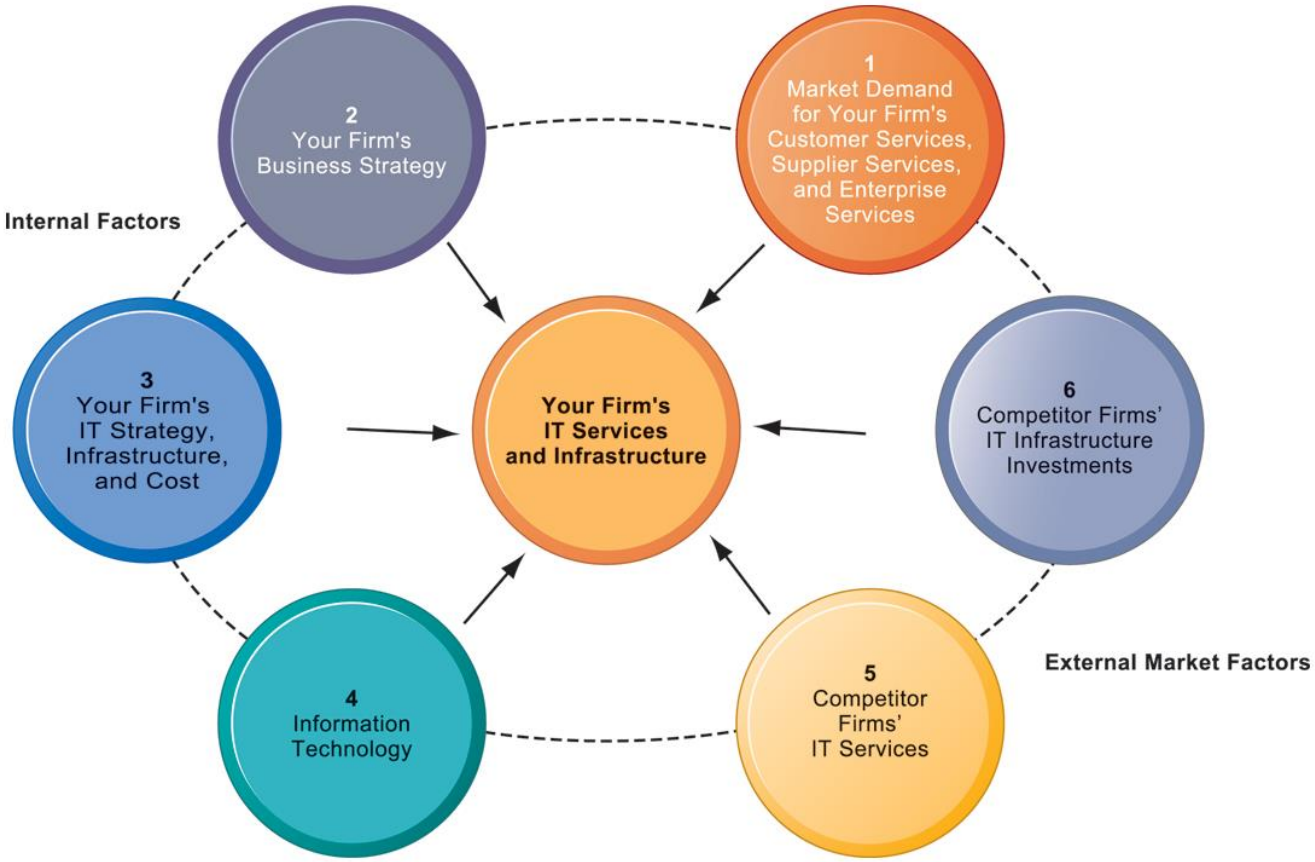
Management Issues

- How much we need to invest in IT?

We can use the Competitive forces model for IT infrastructure investment to decide:

1. Market demand for firm's services
2. Firm's business strategy
3. Firm's IT strategy, infrastructure, and cost
4. Information technology assessment
5. Competitor firm services
6. Competitor firm IT infrastructure investments

Management Issues



There are six factors you can use to answer the question, "How much should our firm spend on IT infrastructure?"

Source:

>> Management Information Systems, Managing the Digital Firm, 13 Edition (2014), Laudon and Laudon.