



# Chapter 5

## IT INFRASTRUCTURE AND EMERGING TECHNOLOGIES

### VIDEO CASES

*Case 1: Google and IBM Produce Cloud Computing*

*Case 2: IBM Blue Cloud is Ready-to-Use Computing*

*Case 3: What the Hell is Cloud Computing?*

*Case 4: What is AJAX and How Does it Work?*

*Case 5: Yahoo's FireEagle Geolocation Service*



# Management Information Systems

## CHAPTER 5: IT INFRASTRUCTURE AND EMERGING TECHNOLOGIES

### Learning Objectives

- Define IT infrastructure and describe its components.
- Identify and describe the stages and technology drivers of IT infrastructure evolution.
- Assess contemporary computer hardware platform trends.
- Assess contemporary software platform trends.
- Evaluate the challenges of managing IT infrastructure and management solutions.



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### BART Speeds Up with a New IT Infrastructure

- **Problem:** Aging systems no longer able to provide information rapidly enough for timely decisions; too unreliable for 24/7 operations
- **Solutions:** Replaced and upgraded hardware and software and used leading-edge technology
  - Grid computing
  - Virtualization
  - Blade servers
- **Demonstrates IT's role in using resources more efficiently; reducing computing energy usage, modernizing services**



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### 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
    - Physical facilities management services
    - IT management, standards, education, research and development services
  - **“Service platform” perspective more accurate view of value of investments**

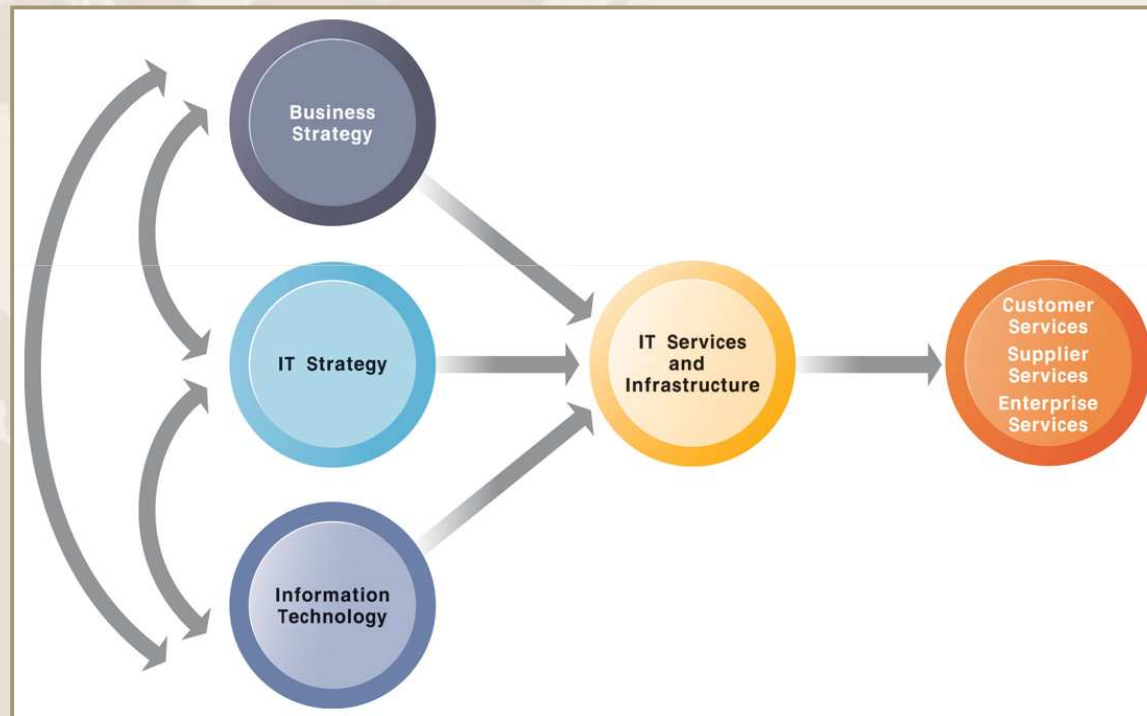


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### IT Infrastructure

#### CONNECTION BETWEEN THE FIRM, IT INFRASTRUCTURE, AND BUSINESS CAPABILITIES



**FIGURE 5-1**

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.



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### IT Infrastructure

- **Evolution of IT infrastructure**
  - **General-purpose mainframe & 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)





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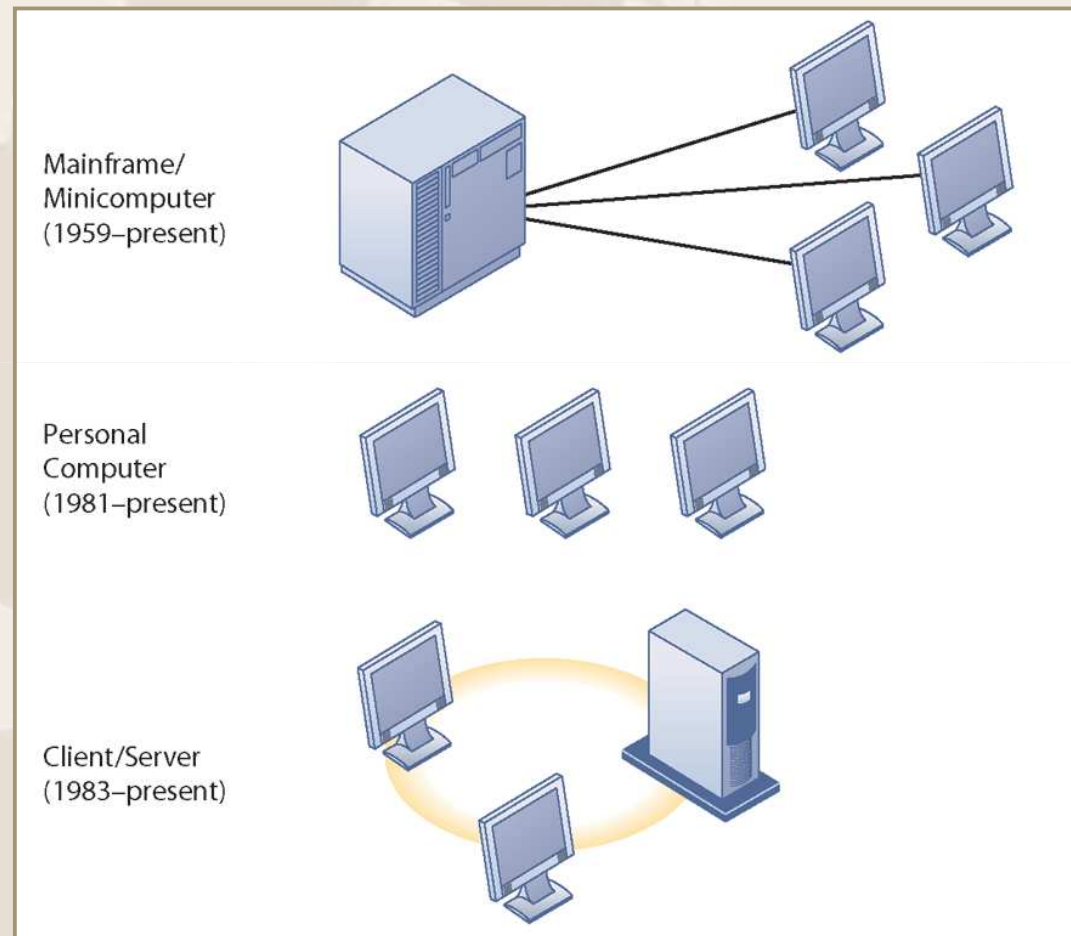
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### IT Infrastructure

#### STAGES IN IT INFRASTRUCTURE EVOLUTION

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

**FIGURE 5-2**





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### 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 Computing: 2000 to present**
    - Refers to a model of computing where firms and individuals obtain computing power and software applications over the Internet or other network
    - Fastest growing form of computing





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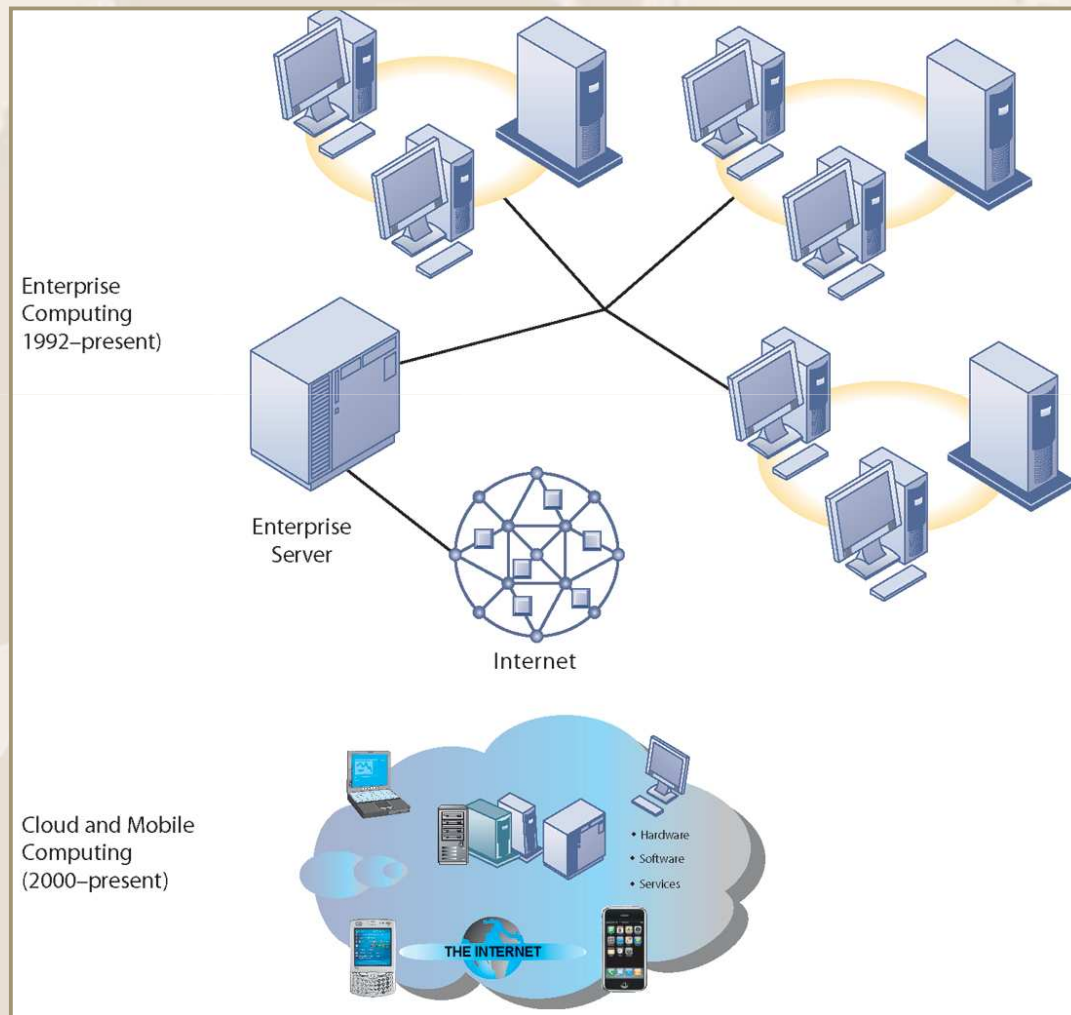
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### IT Infrastructure

#### STAGES IN IT INFRASTRUCTURE EVOLUTION (cont.)

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

FIGURE 5-2



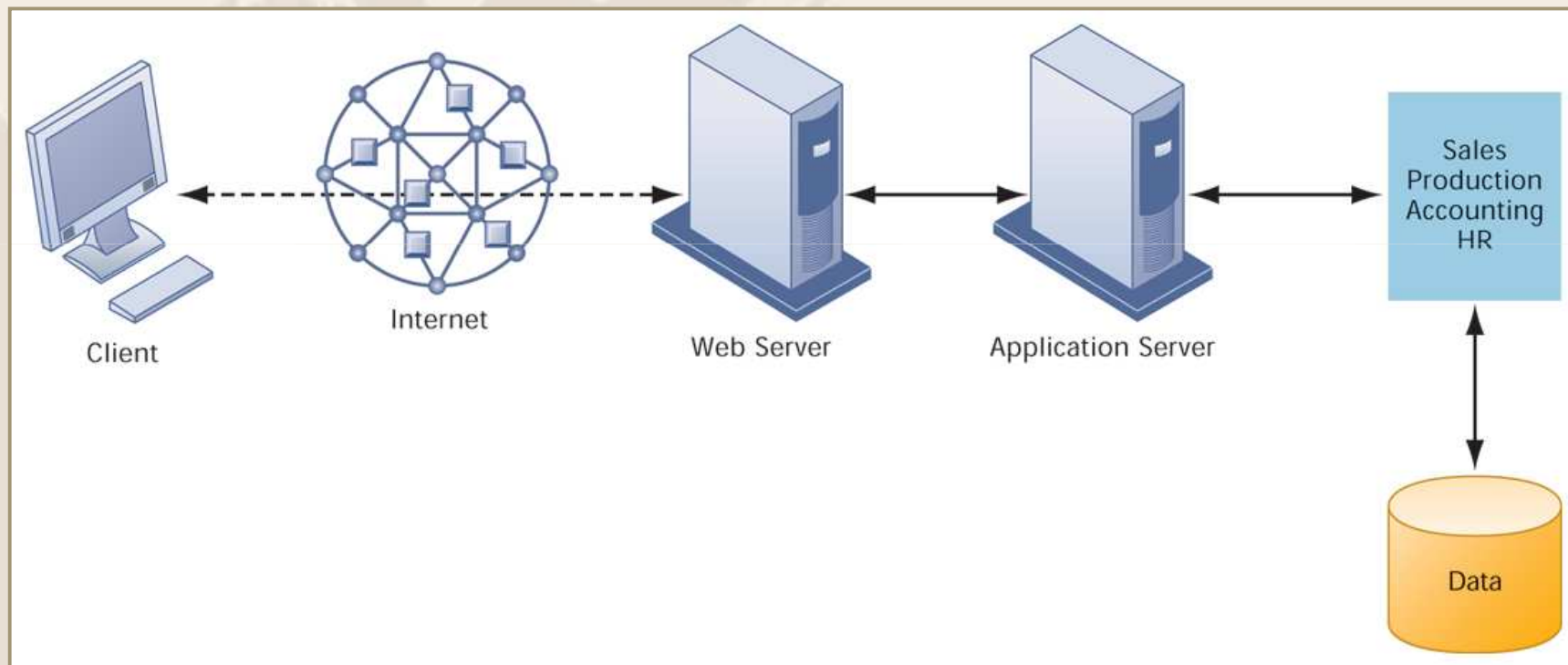


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### IT Infrastructure

#### A MULTITIERED CLIENT/SERVER NETWORK (N-TIER)



**FIGURE 5-3**

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



### 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



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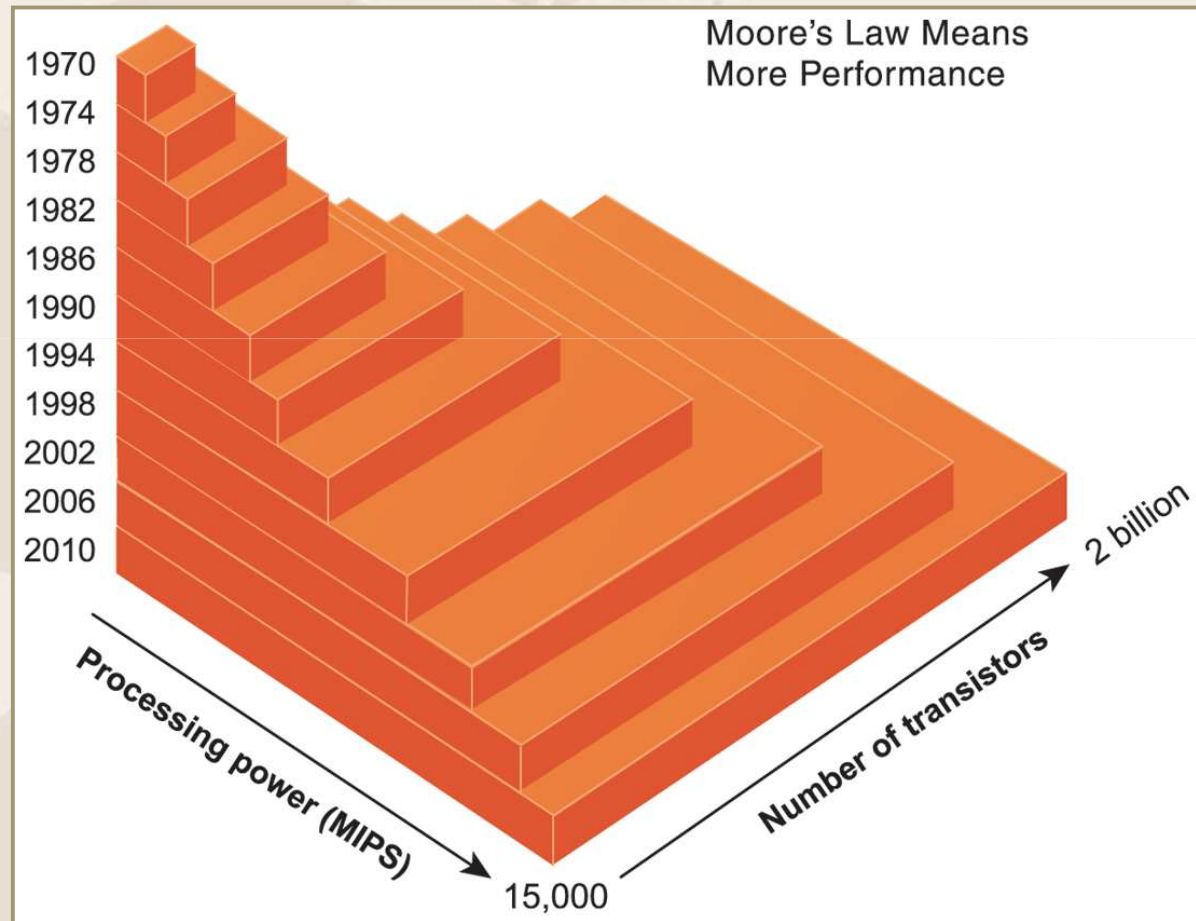
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#### MOORE'S LAW AND MICROPROCESSOR PERFORMANCE

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

FIGURE 5-4







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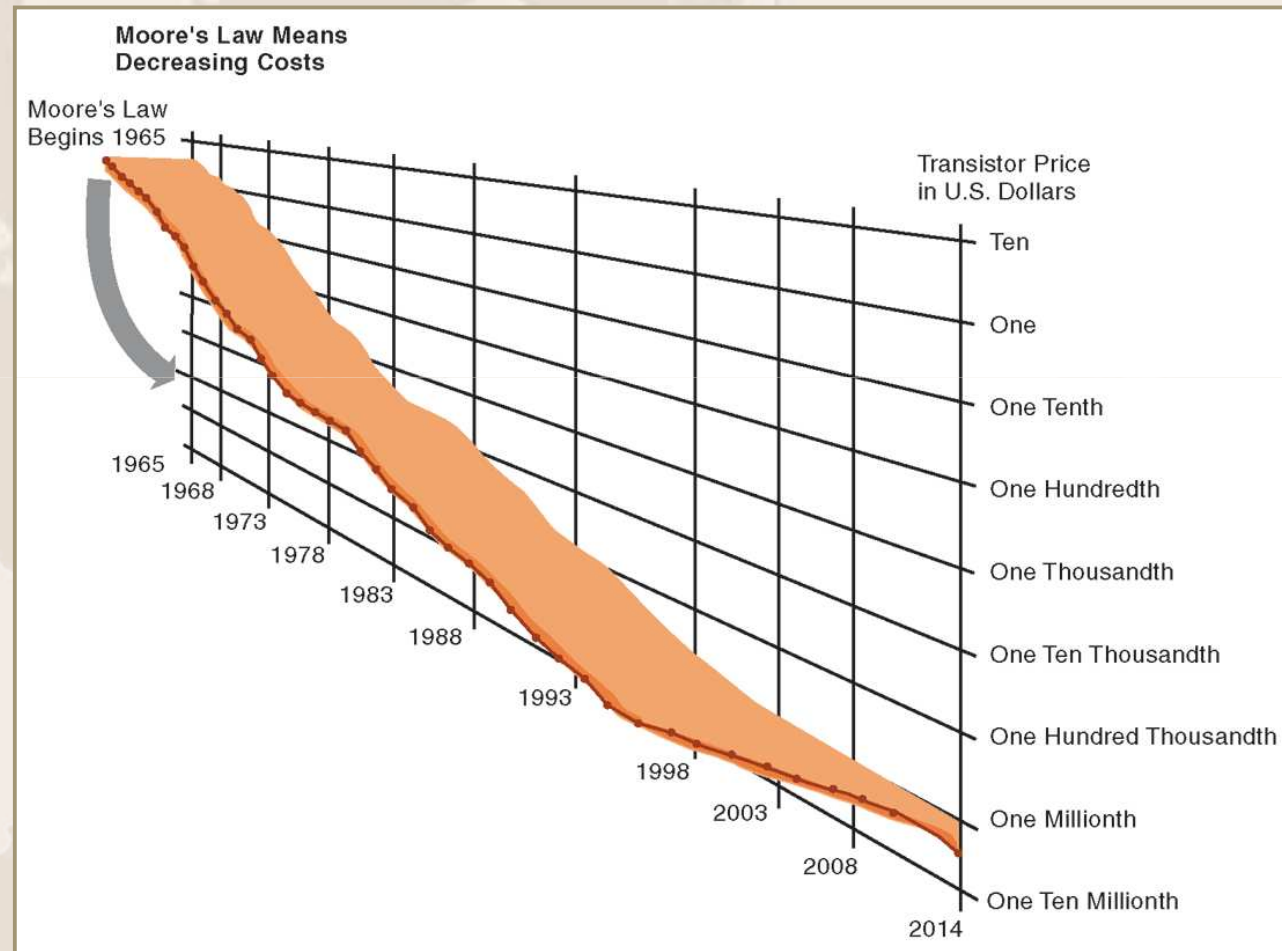
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#### FALLING COST OF CHIPS

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.

**FIGURE 5-5**







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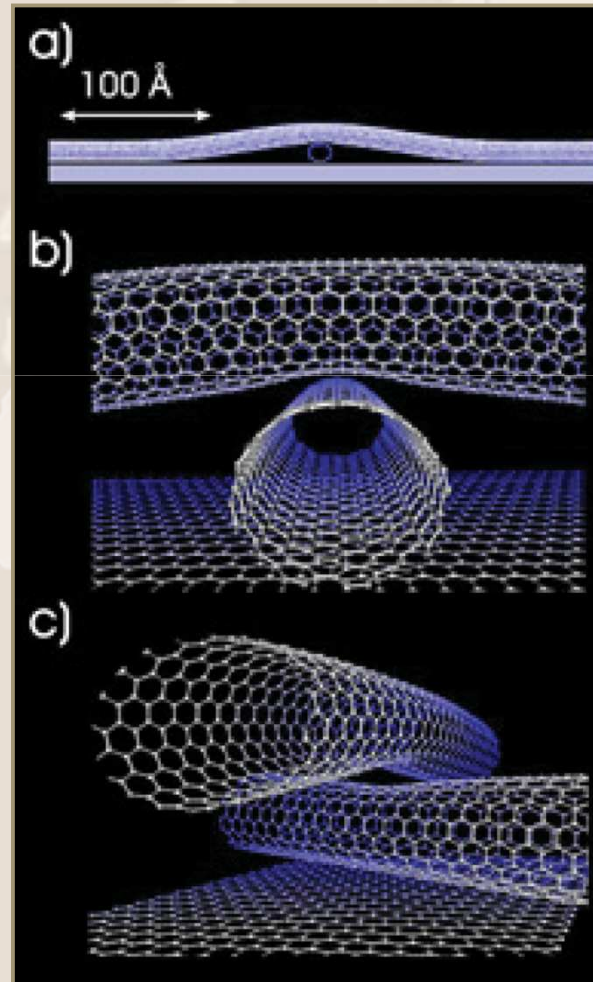
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### IT Infrastructure

#### EXAMPLES OF NANOTUBES

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

FIGURE 5-6





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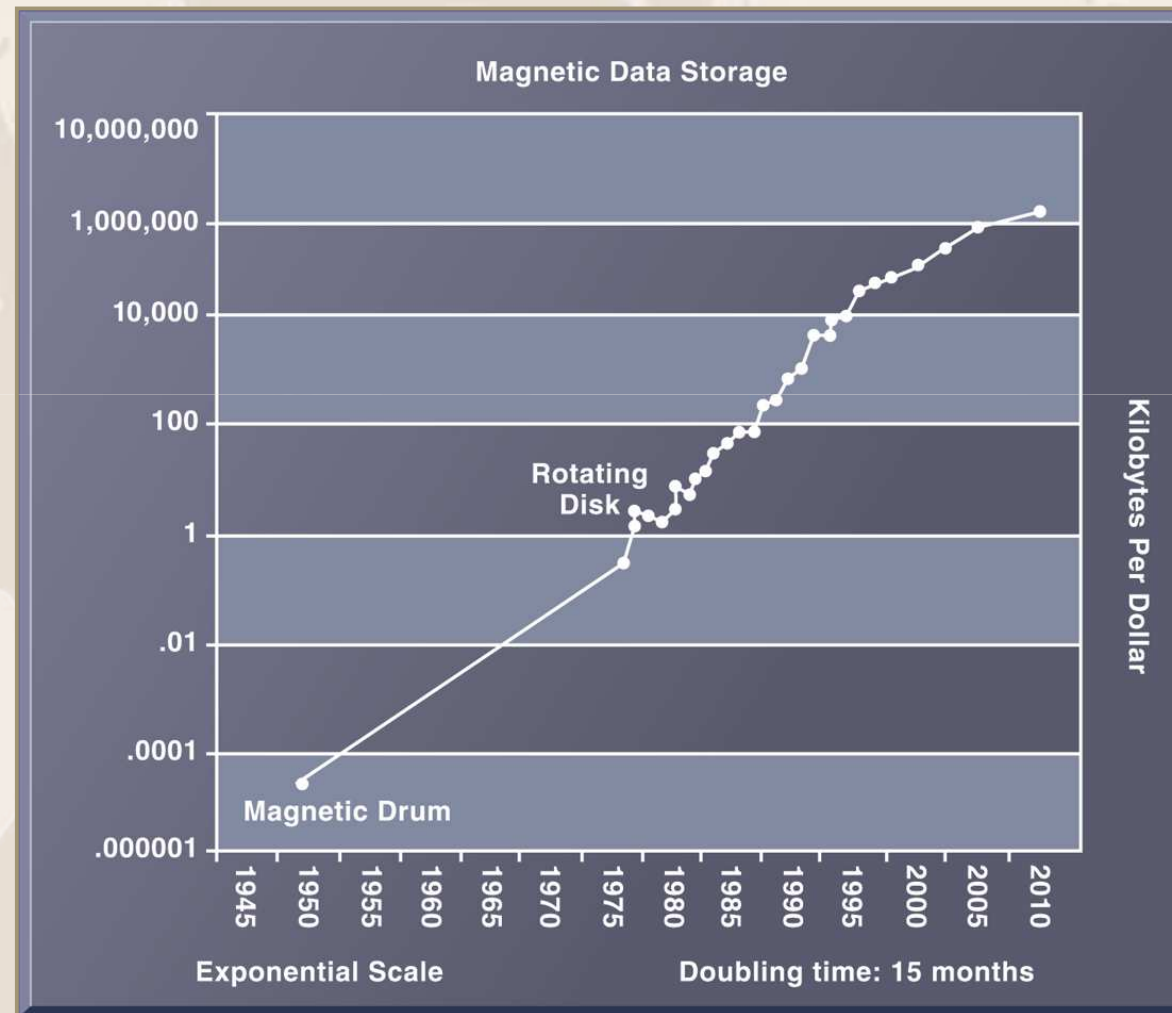
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#### THE COST OF STORING DATA DECLINES EXPONENTIALLY 1950–2010

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.

FIGURE 5-7





### 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 1.5 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

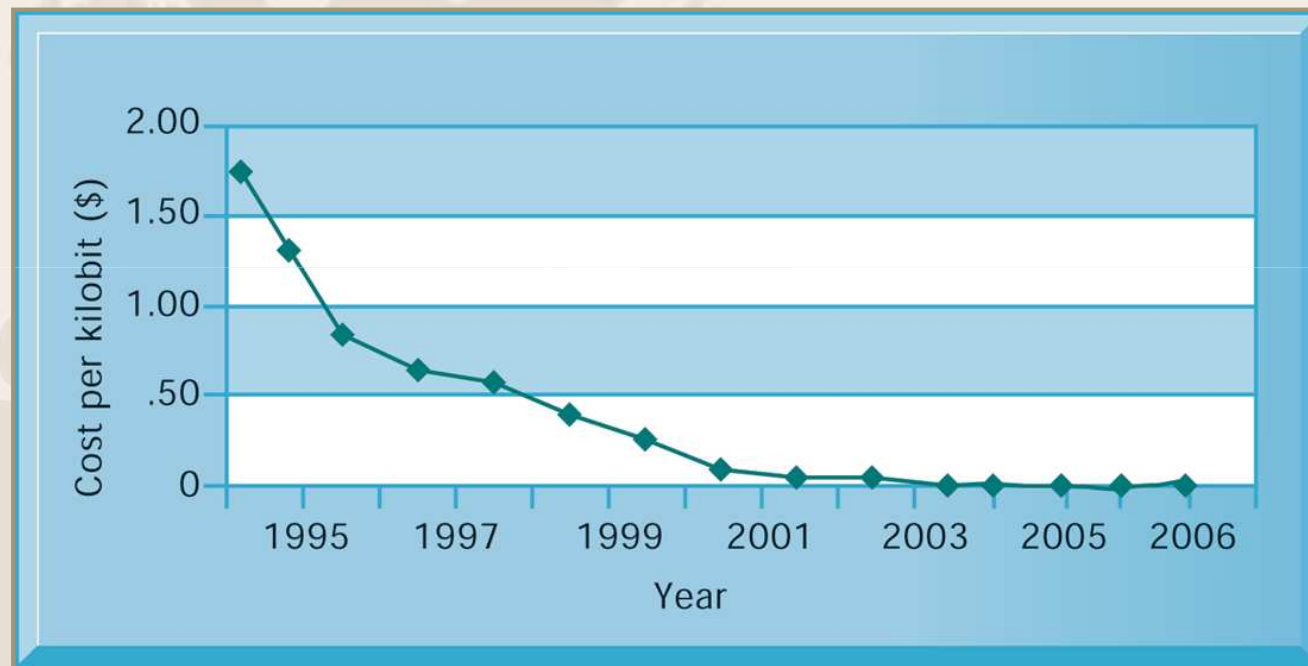


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### IT Infrastructure

#### EXPONENTIAL DECLINES IN INTERNET COMMUNICATIONS COSTS



**FIGURE 5-8**

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



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### **Infrastructure Components**

- **IT Infrastructure has 7 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**



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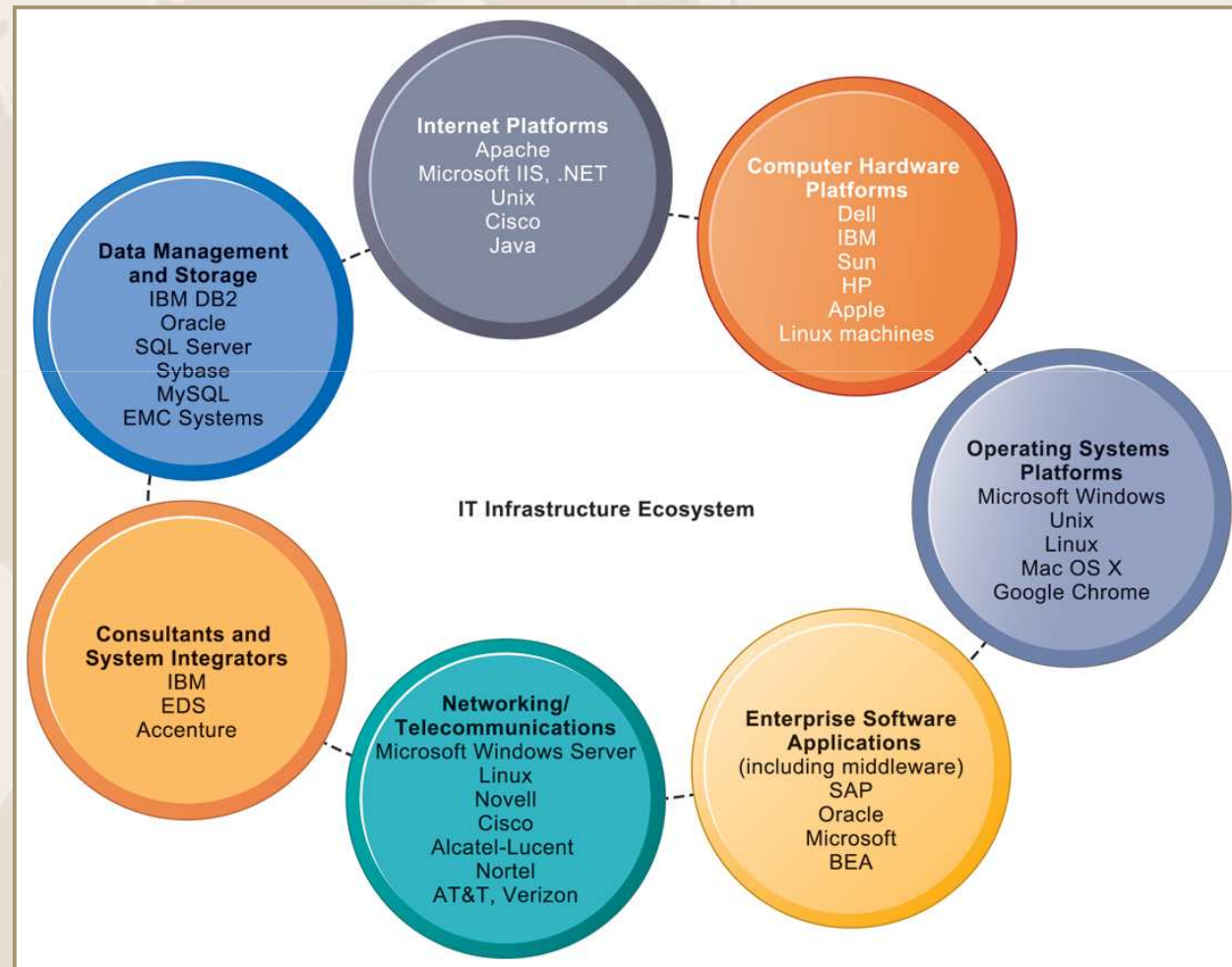
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#### THE IT INFRASTRUCTURE ECOSYSTEM

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.

FIGURE 5-9





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### 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**



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### Infrastructure Components

- **Operating system platforms**
  - **Operating systems**
    - Server level: 75% run Windows; 25% run Unix or Linux
    - Client level:
      - 90% run Microsoft Windows (XP, 2000, CE, etc.)
      - Handheld device OS's (Android, iPhone OS)
      - Cloud computing OS's (Google's Chrome OS)
- **Enterprise software applications**
  - **Enterprise application providers: SAP and Oracle**
  - **Middleware providers: BEA**





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### Infrastructure Components

#### NEW TO THE TOUCH

*Read the Interactive Session and discuss the following questions*

- **What problems does multitouch technology solve?**
- **What are the advantages and disadvantages of a multitouch interface? How useful is it? Explain.**
- **Describe three business applications that would benefit from a multitouch interface.**
- **What management, organization, and technology issues must be addressed if you or your business was considering systems and computers with multitouch interfaces?**



### Infrastructure Components

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



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### Infrastructure Components

- **Networking/telecommunications platforms**
  - **Telecommunication services**
    - Telecommunications, cable, telephone company charges for voice lines and Internet access
    - AT&T, Verizon
  - **Network operating systems:**
    - Windows Server, Novell, Linux, Unix
  - **Network hardware providers:**
    - Cisco, Alcatel-Lucent, Nortel, Juniper Networks



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### Infrastructure Components

- **Internet platforms**
  - Hardware, software, management services to support company Web sites, (including Web hosting services) intranets, extranets
  - Internet hardware server market: Dell, HP/Compaq, IBM
  - Web development tools/suites: Microsoft (FrontPage, .NET) IBM (WebSphere) Sun (Java), independent software developers: Adobe, RealMedia



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### Infrastructure Components

- **Consulting and system integration services**
  - Even large firms do not have resources for a 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





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### Contemporary Hardware Platform Trends

- **The emerging mobile digital platform**
  - **Cell phones, smartphones (BlackBerry, iPhone)**
    - Have assumed data transmission, Web surfing, e-mail and IM duties
  - **Netbooks:**
    - Small, low-cost lightweight notebooks optimized for wireless communication and core computing tasks
  - **Tablets (iPad)**
  - **Networked e-readers (Kindle)**



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### **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



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### Contemporary Hardware Platform Trends

- **Cloud computing**
  - **On-demand (utility) computing services obtained over network**
    - Infrastructure as a service
    - Platform as a service
    - Software as a service
  - **Cloud can be public or private**
  - **Allows companies to minimize IT investments**
  - **Drawbacks: Concerns of security, reliability**



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### Contemporary Hardware Platform Trends

- **Green computing**
  - Practices and technologies for manufacturing, using, disposing of computing and networking hardware
- **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
- **High performance, power-saving processors**
  - Multi-core processors



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### Contemporary Hardware Platform Trends

#### IS GREEN COMPUTING GOOD FOR BUSINESS?

*Read the Interactive Session and discuss the following questions*

- **What business and social problems does data center power consumption cause?**
- **What solutions are available for these problems? Which are environment-friendly?**
- **What are the business benefits and costs of these solutions?**
- **Should all firms move toward green computing? Why or why not?**





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### Contemporary Software Platform Trends

- **Linux and open-source software**
  - Open-source software: Produced by community of programmers, free and modifiable by user
  - Linux: Open-source software OS
- **Software for the Web**
  - **Java:**
    - Object-oriented programming language
    - Operating system, processor-independent
  - **Ajax**
    - Asynchronous JavaScript and XML
    - Allows client and server to exchange small pieces of data without requiring the page to be reloaded



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### 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
    - Tagging allows computers to process data automatically
  - **SOAP: Simple Object Access Protocol**
    - Rules for structuring messages enabling applications to pass data and instructions
  - **WSDL: Web Services Description Language**
    - Framework for describing Web service and capabilities
  - **UDDI: Universal Description, Discovery, and Integration**
    - Directory for locating Web services



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### 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
    - Example: an “invoice service” to serve whole firm for calculating and sending printed invoices
  - **Dollar Rent A Car**
    - Uses Web services to link online booking system with Southwest Airlines’ Web site

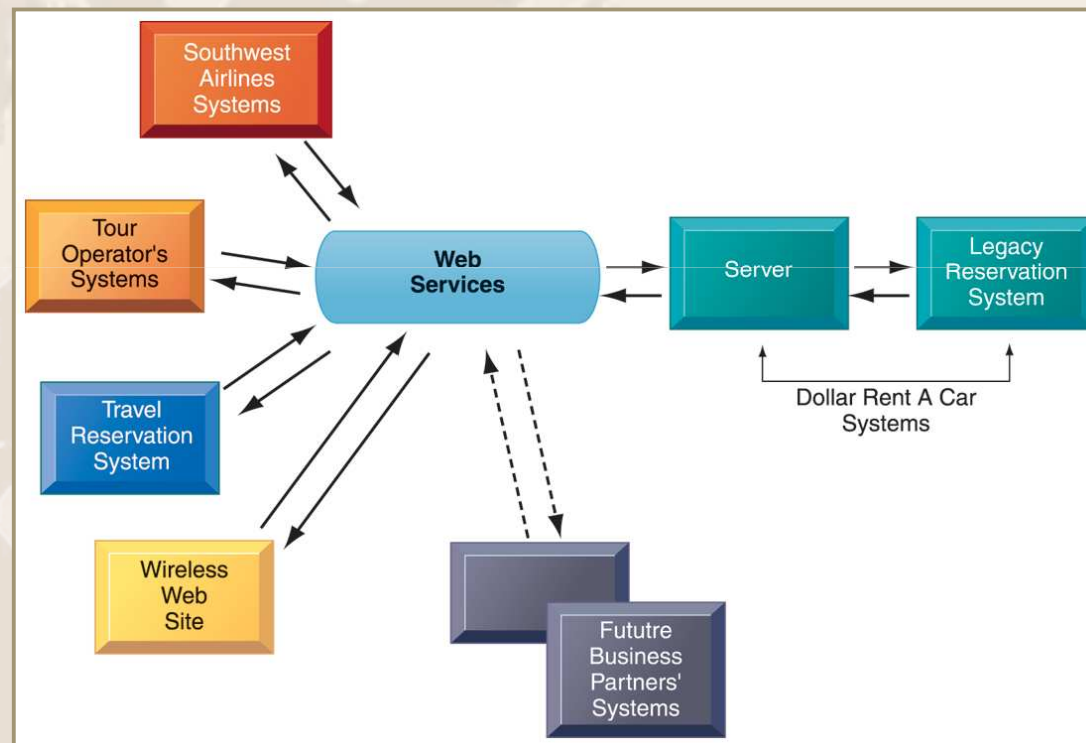


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### Contemporary Software Platform Trends

#### HOW DOLLAR RENT A CAR USES WEB SERVICES



**FIGURE 5-10**

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.



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### Contemporary Software Platform Trends

- **Software outsourcing and cloud services**
  - **Three external sources for software:**
    1. Software packages and enterprise software
    2. Software outsourcing (domestic or offshore)
      - Domestic:
        - » Primarily for middleware, integration services, software support
      - Offshore:
        - » Primarily for lower level maintenance, data entry, call centers, although outsourcing for new-program development is increasing





### Contemporary Software Platform Trends

- **Three external sources for software (cont.)**
  - 3. Cloud-based software services**
    - Software as a service (SaaS)
    - Accessed with Web browser over Internet
    - Ranges from free or low-cost services for individuals to business and enterprise software
    - Users pay on subscription or per-transaction
    - E.g. Salesforce.com
    - Service Level Agreements (SLAs): formal agreement with service providers



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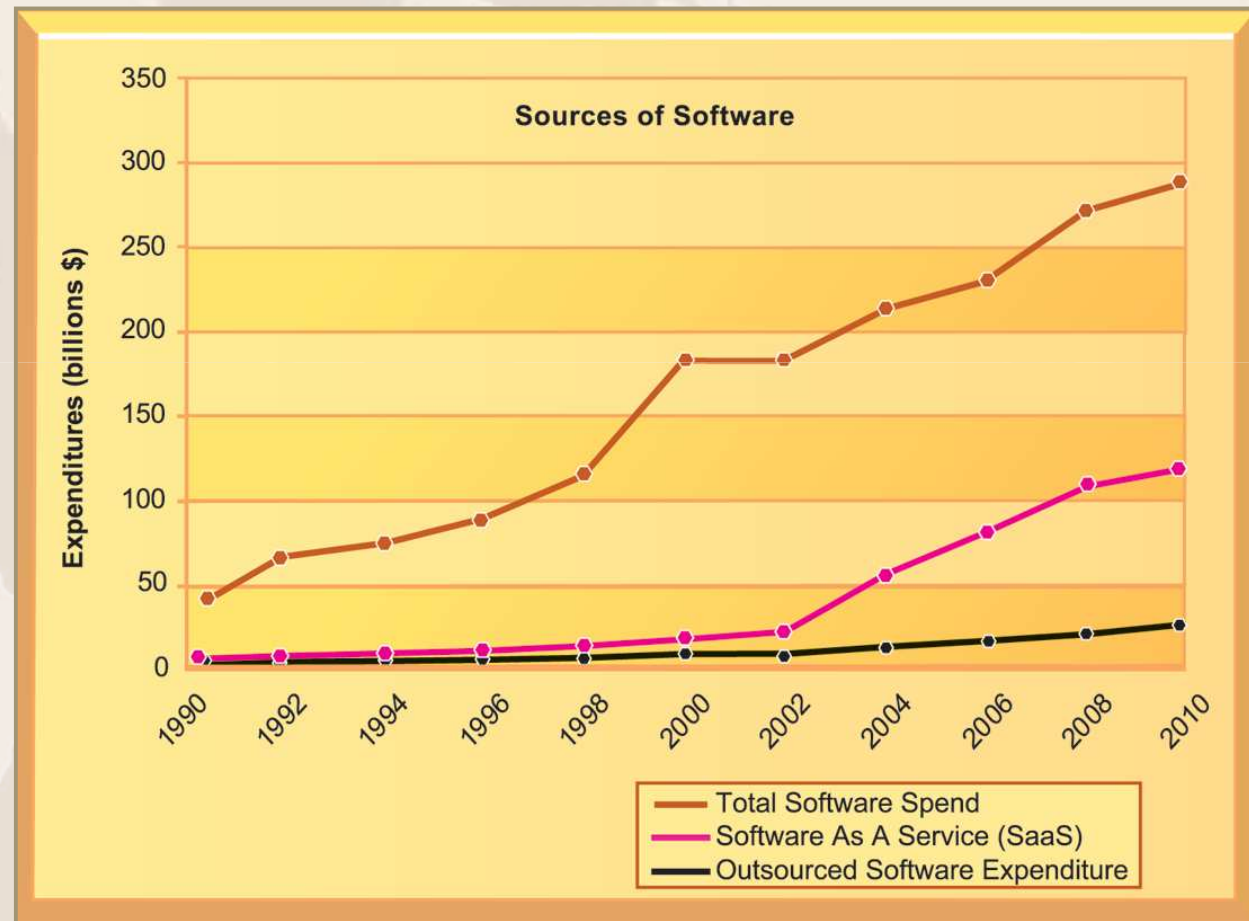
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### Contemporary Software Platform Trends

#### CHANGING SOURCES OF FIRM SOFTWARE

In 2010, U.S. firms will spend over \$265 billion on software. About 40 percent of that (\$106 billion) will originate outside the firm, either from enterprise software vendors selling firmwide applications or individual application service providers leasing or selling software modules. Another 10 percent (\$10 billion) will be provided by SaaS vendors as an online cloud-based service.

FIGURE 5-11





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### Contemporary Software Platform Trends

- **Software outsourcing and cloud services (cont.)**
  - **Mashups**
    - Combinations of two or more online applications, such as combining mapping software (Google Maps) with local content
  - **Apps**
    - Small pieces of software that run on the Internet, on your computer, or on your cell phone
      - iPhone, BlackBerry, Android
    - Generally delivered over the Internet



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### 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 numbers 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



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### 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?**





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### Management Issues

- **Making wise infrastructure investments**
  - **Amount to spend on IT is complex question**
    - Rent vs. buy, 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 through use of cloud services, greater centralization and standardization of hardware and software resources



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### **Management Issues**

- **Competitive forces model for IT infrastructure investment**
  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**

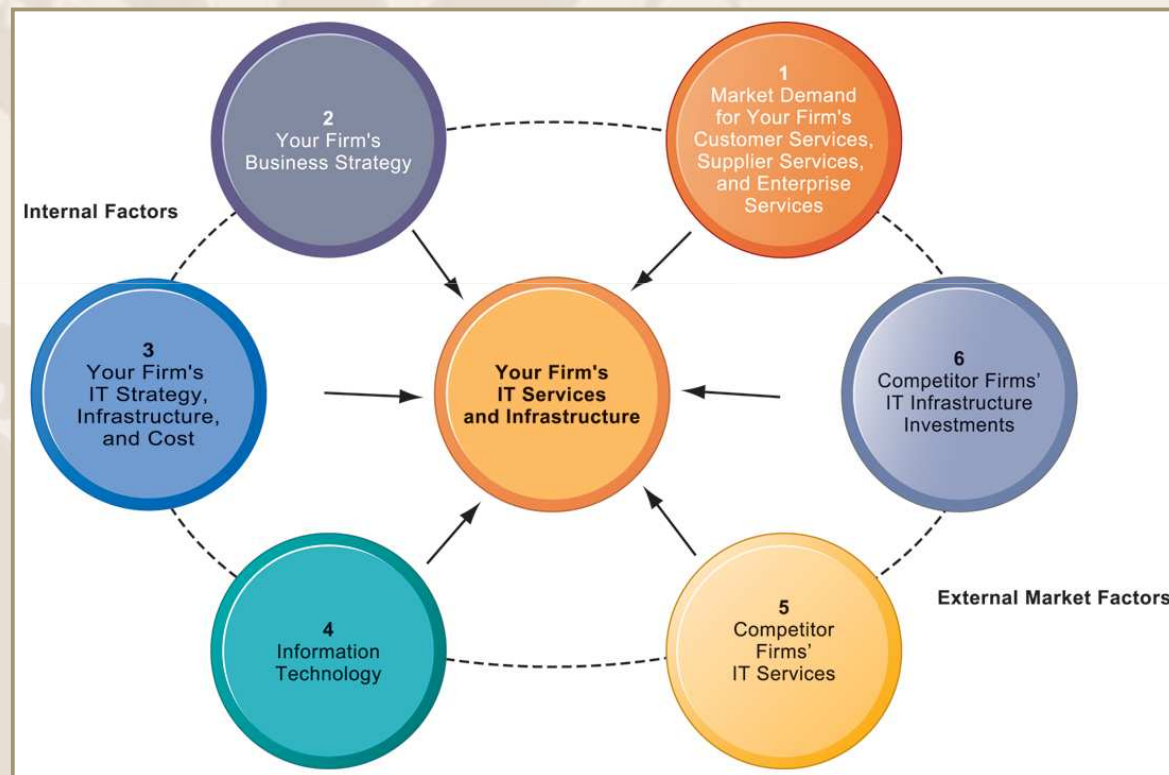


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### Management Issues

#### COMPETITIVE FORCES MODEL FOR IT INFRASTRUCTURE



**FIGURE 5-12**

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



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