Introduction to Information Systems

Data Science Education Program

Chapter #3

Information and communications technologies: the enterprise architecture

Chapter #3 Overview

LEARNING OBJECTIVES

1. Describe the four hardware components of a computer, giving examples of each component.
2. Identify and provide examples of the two major types of software, and describe how software is created.
3. Describe the major types of networks and the transmission media they use, and give examples of network protocols.
4. Explain the importance of the enterprise architecture, describing trends in ICT architecture over time.

Online Simulation

An online, interactive decision-making simulation that reinforces chapter contents and uses key terms in context can be found in MyMISLab™.

Key Terms and Concepts

KEY TERMS AND CONCEPTS

enterprise architecture (EA)
computer
ASCII code
optical scanners
optical character recognition (OCR)
radio frequency identification (RFID)
central processing unit (CPU)
transistor
Moore's Law
byte
random access memory (RAM)
in-memory computing
software
application software
system software
operating system (OS)
utility software
programming language
legacy systems
source code
object-oriented programming
commercial off-the-shelf (COTS)
software as a service (SaaS)
open source software
network
bits per second (bps)
bandwidth
twisted pair wires
coaxial cables
optical fiber
wavelength
hertz (Hz)
microwave transmission
wifi
wireless router
Bluetooth
digital subscriber lines (DSL)
local area network (LAN)
circuit-switched network
packet switching
voice over IP (VoIP)
client-server network
n-tier
peer-to-peer network
Ethernet
TCP/IP
Internet Protocol Version 6 (IPv6)
WiMax
virtualization
private branch exchange (PBX)
cloud computing

Introduction

Chapter #3 Topics

- The hardware
  - Input and output
  - Processing
  - Storage
- The software
  - Types of software
  - How is software created?
- Networks and telecommunications
  - Transmission media and protocols
  - Types of networks
  - Network protocols
- The enterprise architecture
  - Trends in enterprise architectures
  - Guiding the architecture

Overview

- Hardware, software, and telecommunications work together to create the *enterprise architecture* (EA):
  - For a new company like Devil's Canyon:
    - The EA is a guide on what to purchase and install, how long it will take, how everything will work together, why certain decisions were made, and what it will cost
  - For existing organizations:
    - The EA also describes the current situation, and how the EA should be changed or upgraded to support the mission, focusing especially on business strategy and the related technologies
  - A roadmap describing how to get from the present to that future state guides decision making about technology directions:
    - The EA helps managers navigate through all the choices as they add new information systems and retire older ones

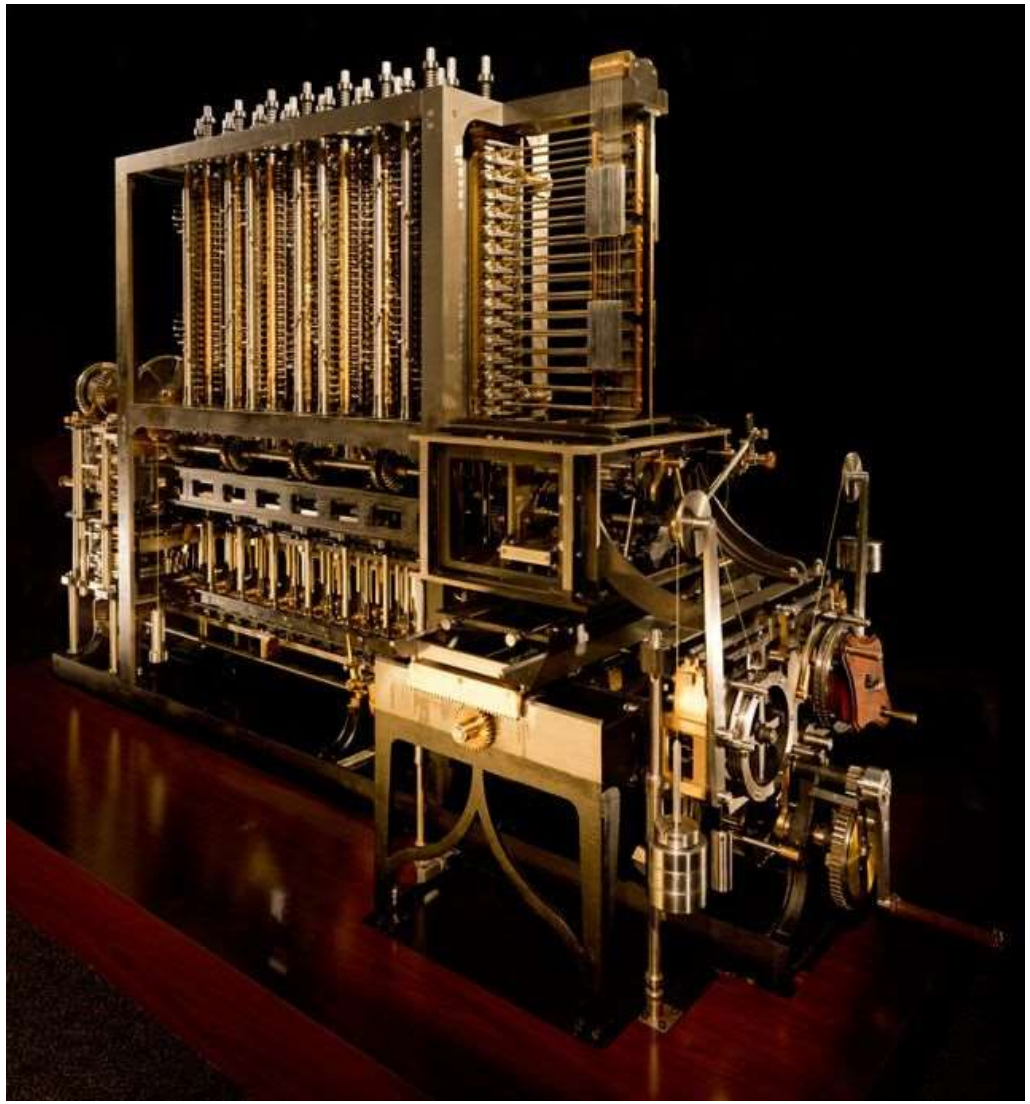
An historical perspective

Computers historically

- The course textbook fails to provide an incorrect interpretation of computers from an historical perspective:
  - The first mechanical computer was the *Analytical engine*
  - It is agreed that the first computer program was written by *Ada Lovelace*
  - The first electronic computer was built by *Alan Turing* and his team in the early 1940's during the second world war to decode German signals
  - The ENIAC electronic computer was not the first example of it's kind as incorrectly stated in the book
- The following slides provide a brief overview of:
  - The *Analytical engine*
  - *Ada Lovelace*
  - The second world war *Colossus* electronic computer

The Analytical Engine

- The *Analytical Engine* was:
  - The first design for a general-purpose computer that could be described in modern terms as *Turing-complete*
  - The *logical structure* of the *Analytical Engine* was essentially the same as that which has dominated computer design in the electronic era



The Analytical Engine

- The *Analytical Engine* was a proposed mechanical general-purpose computer designed by English mathematician and computer pioneer Charles Babbage:
  - Assisted by *Ada Lovelace* It was first described in 1837 as the successor to the Babbage difference engine (a design for a simpler mechanical computer)
- The Analytical Engine incorporated an:
  - Arithmetic logic unit
  - Control flow in the form of conditional branching and loops
  - Integrated memory
  - These features make it the first design for a general-purpose computer that could be described in modern terms as *Turing-complete*
- In other words:
  - The *logical structure* of the *Analytical Engine* was essentially the same as that which has dominated computer design in the electronic era

Ada Lovelace – the first programmer?

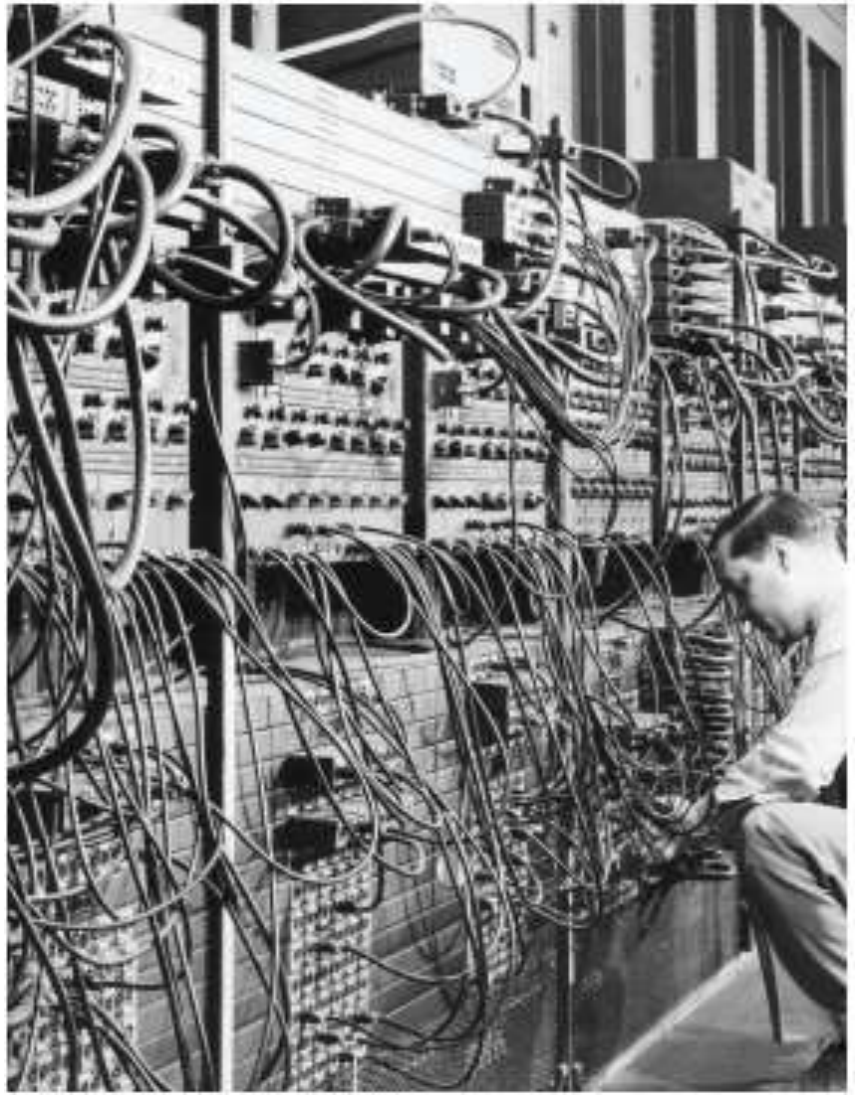
- Between 1842 and 1843 Ada translated an article on the calculating engine, supplementing it with an elaborate set of notes, simply called "Notes"
- Lovelace's notes are important in the early history of computers
  - The notes set out what many consider to be the first computer program
  - A program is an algorithm designed to be carried out by a machine
  - Her mindset of "poetical science" led her to ask questions about the *Analytical Engine* (as shown in her notes) examining how individuals and society relate to technology as a collaborative tool
- The programming language *Ada* programming language is named after *Ada Lovelace*

The Colossus electronic computer

- *Colossus* was a set of computers developed by British codebreakers in the years 1943–1945 to help in the cryptanalysis of the (German) Lorenz cipher
  - Colossus used thermionic valves (vacuum tubes) to perform Boolean and counting operations
  - Colossus is regarded as the world's first programmable, electronic, digital computer (it was programmed by switches and plugs and not by a stored program)
- Colossus:
  - Was designed by research telephone engineer *Tommy Flowers*
  - The aim was to solve a problem posed at *Bletchley Park*
  - *Alan Turing's* use of probability in cryptanalysis contributed to its design

The ENIAC electronic computer

- Figure 3.1.
- *ENIAC*:
  - Was ***NOT*** the first electronic digital computer
  - ENIAC was a programmable, electronic, general-purpose digital computer
  - It was Turing-complete
  - It could solve a large class of numerical problems through reprogramming



The hardware

digital equipment

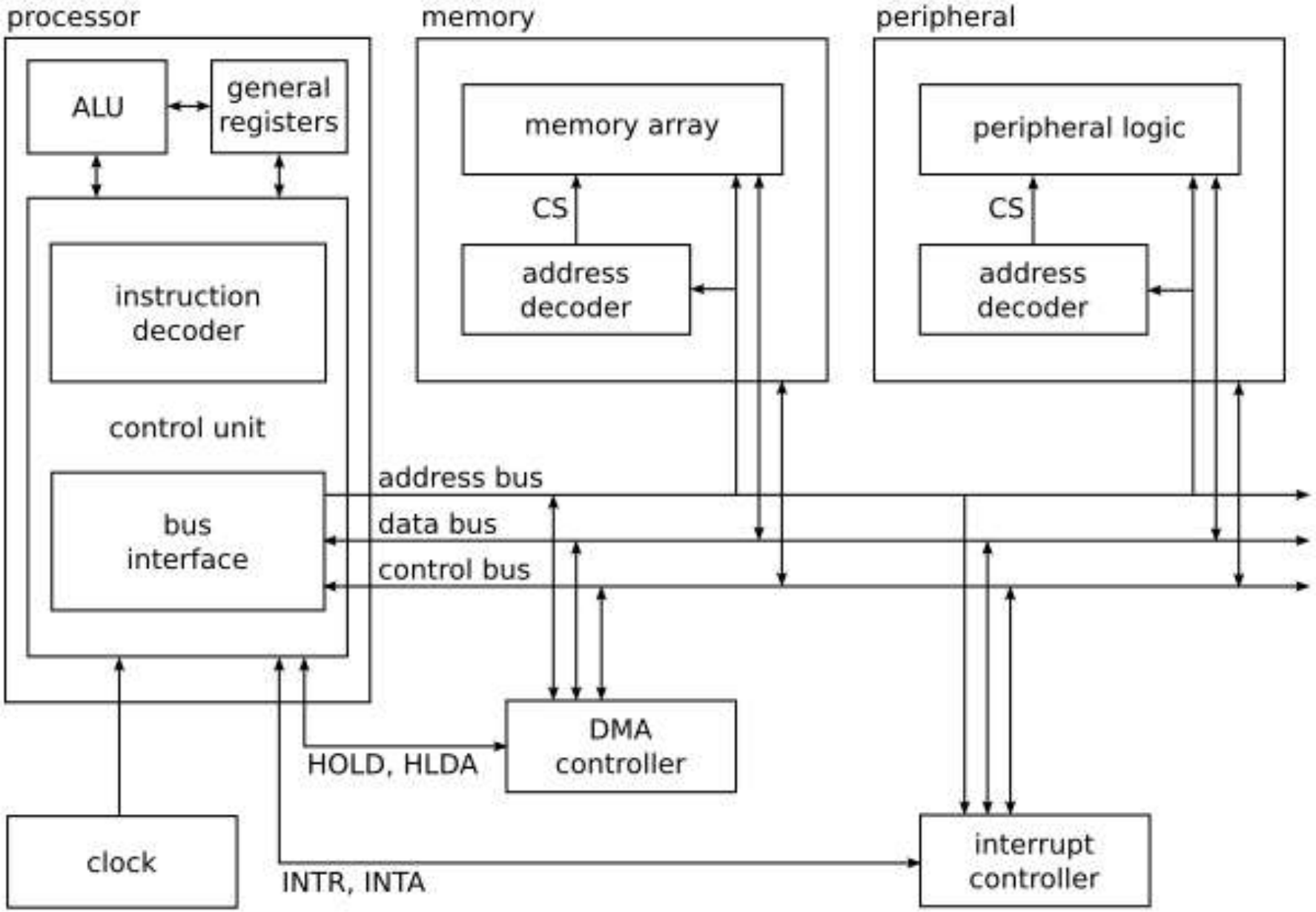
- We have given a brief overview of computing from an historical perspective
- Digital computation has a long history but what is a digital device (or computer) in this information age
  - Viewed from an IS perspective a computer covers a large range of digital devices and systems (see Figure 3.10.)
  - Moreover, we may view robotic systems and sensory devices as computers
- Viewed from a technical perspective a computer is any programmable electronic device that can:
  - Accept, manipulate, store (see Figure 3.11.), and output data
  - An example of a typical computer architecture is shown on a later slide

the hardware

- Computational devices (see Figure 3-10):
  - Human input
  - Scanners and sensors:
    - Optical character recognition
    - RFID
  - Output devices
- Processing
- Storage (see Figure 3-11):
  - Primary data storage (RAM – *in-memory*)
  - Secondary data storage (*persistent*)

Basic Computer Architecture

- The figure depicts a basic architecture of a desktop computer available in the late 1970s
- The architecture shown is a simple model but remains representative of current computational devices



Processing

- In week #1 and in this lecture we have introduced the basics of processing:
  - At the heart of digital devices lies the central processing unit (or CPU)
  - Figures 3.09 and 3.10. provide an overview of the CPU and computer architectures

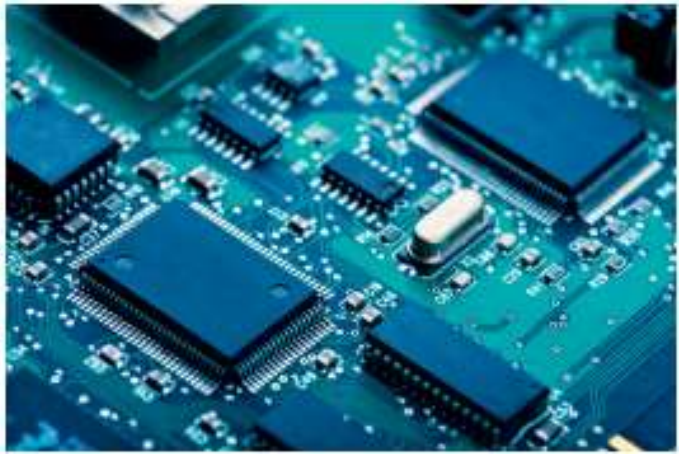


FIGURE 3-9
Integrated circuits.

Computing Architectures	Description
Mainframe	Developed for large businesses in the 1960s and often called "big iron," mainframes are still used for massive bulk processing tasks and financial transactions requiring high reliability. They are also deployed as servers for large networks. The mainframe market is dominated by IBM.
Supercomputer	Introduced in the 1960s, these high-end computers feature the fastest processors for calculation-intensive tasks in areas such as physics, weather modeling, and molecular analyses.
Minicomputer	Designed to be smaller in size and less expensive than mainframes, minicomputers and the terminals connected to them worked well for small and midsized businesses through the 1990s, after which many were replaced by PC servers. Now they are called "midrange computers," and are used as servers.
Microcomputer	Called PCs for short, these devices proliferated in organizations in the 1990s, replacing the dumb terminals and offering far more capability on the desktop. Powerful PCs are widely used as servers as well.
Laptop	Valued for their integrated display screens and portability, these battery-powered PCs became popular in the late 1980s, facilitating mobility. They could run much of the same software as their desktop cousins, though more slowly. Many newer laptops offer touchscreen sensitivity, similar to tablets.
Netbook	Engineered to be even smaller and less expensive than laptops, netbooks gained attention in the late 2000s as a cost-effective means to wirelessly connect to the Internet. Their low cost also facilitates widespread distribution, especially in developing countries.
Smartphones	Offered initially in the 1990s, these devices combine cell-phone capabilities with data communications for web browsing, email, and text messaging.
Tablet	A mobile device with a large touchscreen and virtual keyboard, a tablet is smaller and thinner than a laptop but larger than a smartphone. They gained popularity with the introduction of Apple's iPad, and many people add a regular keyboard.

FIGURE 3-10
Computing architectures.

Storage

- The storage of data forms an essential component in computing and there are two types of data storage:
  - *Persistent* (secondary) and *in-memory* (primary – RAM) storage
- Moreover: there is a relationship between processing speed and data storage:
  - Moore's law has been a fundamental theory and remains relevant to current computation

Name	Abbreviation	Capacity	Description
Kilobyte	KB	1,024 bytes	A short, text-only email message
Megabyte	MB	1024^2 bytes	A digital song runs about 3 MB
Gigabyte	GB	1024^3 bytes	About 1 hour of TV recording (not HD)
Terabyte	TB	1024^4 bytes	About 150 hours of HD video recording
Petabyte	PB	1024^5 bytes	eBay's database: 52 PB (2012)

FIGURE 3-11
Measures of storage capacity.

Moore's Law
A principle named for computer executive Gordon Moore, which states that advances in computer technology, such as processing speed or storage capabilities, doubles about every 2 years.

byte
Measurement unit for computer storage capacity; a byte holds eight zeros and ones and represents a single character.

random access memory (RAM)
A computer's primary temporary storage area accessed by the CPU to execute instructions.

in-memory computing
Refers to the use of primary storage as the main place information is stored, rather than in secondary storage devices such as hard drives, to vastly increase speed.

THE ETHICAL FACTOR Ethical Implications of Big Data

The revelations about how the National Security Agency (NSA) collects immense quantities of data from phone records and Internet activity focused attention on the ethical issues surrounding surveillance. The debate about the balance between privacy rights and national security grew much more heated as people began to comprehend what "big data" is and how it could be used.[5]

For business, big data offers valuable opportunities to find patterns and preferences that will help with marketing. A math whiz at Target, for instance, found that pregnant women tend to buy certain products such as unscented lotion, vitamin supplements, and large purses (that might double as diaper bags). His calculations are based on so much data that they can be used to estimate the likelihood that a particular customer is pregnant, and also the approximate due date.[6]

Relying on that finding, the company began sending discount coupons for cribs and baby clothes to shoppers most likely to be pregnant. But one outraged father in Minneapolis complained that his teenage daughter was receiving these promotions. "She's still in high school!" he barked at the manager, who had no idea why the company sent those promotions to her. Later, the father admitted that he talked with his daughter and found that she actually was pregnant. Target's estimated due date was eerily close.

Most consumers don't know how much data companies actually collect on their behavior, and how sophisticated the analysis of big data has become. (Chapter 7 explores techniques used to tease valuable information out of the mountains of data now available.) Studies suggest that if consumers did know, they would find it creepy, and many would be downright angry about it. Clearly, consumers are uncomfortable about the use of big data to tailor advertising, especially when the consumers don't really understand how it works.[7] But targeted advertising is extremely important to reduce marketing costs in very competitive industries, so big data will only get bigger and more valuable.

Human input

input and output

- Computers generally have four components as shown in Figure 3.2.
- The figure models:
  - The interaction(s) between the CPU, input, and output
  - Shown is the storage component which may be:
    - Local data storage (RAM, a traditional hard disk, or solid state)
    - Remote data storage

FIGURE 3-2
Hardware components.

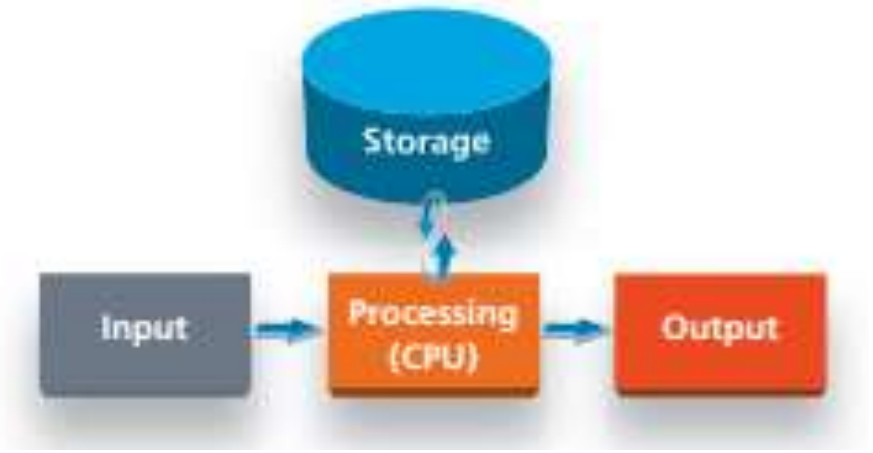


Figure 3.3.

FIGURE 3-3
Input and output devices.

Figure 3.3.
shows a range of general input and output devices and methods

PRODUCTIVITY TIP
Adding a second monitor can improve your productivity and also reduce the need to print documents.[3] Sales figures show that corporations are buying at least two monitors for more than a third of their employees, and research confirms that most people work more efficiently with more screen real estate. You'll appreciate the second monitor even more if you work with a laptop on a desk.

The ASCII keyboard

- The ASCII keyboard:
  - Explains why some countries adopted computing much earlier than others
  - Although a standard keyboard handily encodes languages that use the Roman alphabet with its 26 letters, 10 numerals, and punctuation marks – it it is very cumbersome for languages like Chinese and Japanese, which use thousands of characters
  - Characters in the Korean language (called Hangul) are grouped as syllables and positioned in different locations
  - . Arabic, Urdu, and Hebrew are written from right to left
- These obstacles are overcome with more intelligent software
  - However, they certainly made faxes more useful in those countries compared to email, and delayed widespread computer use

speech input

- Why hasn’t speech input overtaken fingers and hands?
  - While spoken commands are valuable when the hands are needed for something else (like driving) or the user may be visually impaired
- Most applications still rely heavily on keyboards and touchscreens
  - A reason is that speech recognition is less accurate, but many people also prefer typing to speaking, and reading to listening
  - Texting, email, and instant messaging have outpaced voice mail
  - In some organizations, voice mail is all but dead and those are usually marketing calls or automated messages
  - Human preferences like these play an important role when designing the enterprise architecture

Scanners and sensors

Optical Scanners

- There are many well known optical scanners which include:
  - Bar codes (see Figure 3.5.)
  - QR codes (see Figure 3.6.)
  - RFID tags (see Figure 3.7.)

FIGURE 3-5
Sample barcode.

Swiping a touchscreen is easier than using a mouse and keyboard, but now you can even input commands with gestures—without touching the screen. Leap Motion's tiny controller senses hand and figure motions in 8 cubic feet of space, so you can input touch-free commands in 3 dimensions. Many applications will benefit: surgeons need not remove their gloves to rotate medical images, and gamers can crush foes with their bare hands.[2]

PRODUCTIVITY TIP
Add a QR Code reader app to your smartphone so you can see how businesses are using them to reach out to mobile customers. Some uses will add to your productivity and enjoyment, such as a menu with QR Codes that lead to nutrition information or discount coupons. Others may be mainly ads, though.

FIGURE 3-7
RFID tag.

FIGURE 3-6
QR Code. If you have a smartphone, download a QR reader for it and scan the image below. Recognize what is in the picture?

Output Methods

- Output uses many methods:
  - Monitors and screens
  - Printers and speakers
  - Controllers
  - Optical scanners and digital cameras
  - Radio frequency identification (RFID)
  - Environmental sensors

optical scanners
Electronic devices that capture text or images and convert them to digital format.

optical character recognition (OCR)
The capability of specialized software to interpret the actual letters and numbers on a page to create a digital document that can be edited, rather than a flat picture.

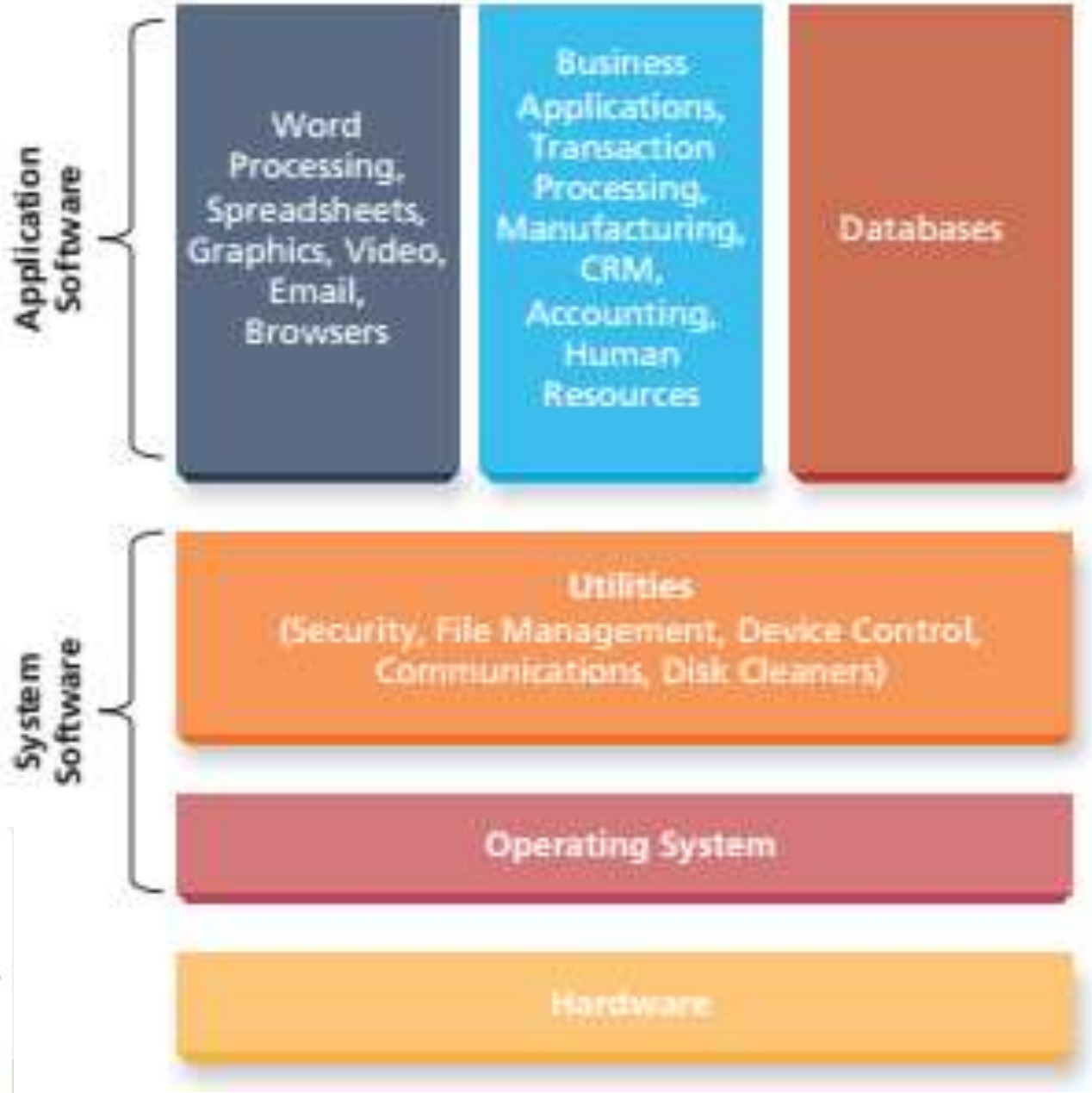
radio frequency identification (RFID)
A technology placed on tags with small chips equipped with a microprocessor, a tiny antenna to receive and transmit data, and sometimes a battery that stores information on the tagged object's history.

FIGURE 3-8
Buoy sensors collect live data that is made available on the Internet.

Software

Types of Software

- There are essentially two types of software:
  - *Systems* software
  - *Application* software
- Figure 3.12.:
  - Models and describes the software types and their relationship



utility software
The category of system software that includes programs to perform specific tasks that help manage, tune, and protect the computer hardware and software.

programming language
An artificial language used to write software that provides the instructions for the computer about how to accept information, process it, and provide output.

legacy systems
Older information systems that remain in use because they still function and are costly to replace.

source code
All the statements that programmers write in a particular programming language to create a functioning software program.

object-oriented programming
A type of software programming that focuses on "objects" rather than lists of instructions and routines to manipulate data.

commercial off-the-shelf (COTS)
Commercially available computer software that is ready to buy, install, and use.

software as a service (SaaS)
A type of commercially available software that is owned, hosted, and managed by a vendor, and accessed by customers remotely, usually via the Internet.

FIGURE 3-15
Examples of utility software.

Utility Software	Description
Antivirus software	Protects against viruses and other malicious code
Disk defragmenter	Optimizes disk performance by moving parts of the same file to contiguous sectors on the hard drive
Compression software	Reduces file sizes to conserve disk space
Shredder	Makes deleted files completely unrecoverable
Recovery	Assists with the recovery of deleted files
File management	Assists with tasks such as renaming groups of files, changing file attributes, and others

FIGURE 3-16
Examples of programming languages.

Programming Language	Description
COBOL	One of the oldest languages, but more than 200 billion lines of code are still in use for legacy business applications
FORTRAN	Older language used in special projects involving intensive calculations
C++	Widely used object-oriented language with considerable support from vendors
Java	Object-oriented language widely used in web development projects, and designed to run on many different platforms
.NET	Microsoft's proprietary language used in its development environment
Python	Dynamic object-oriented language that runs on a variety of platforms, including smartphones; it is growing in popularity
PHP	Open source programming language that can be embedded in HTML that helps create dynamic web pages in software such as WordPress

Operating systems

- There is historically one predominant operating system:
  - The generally accepted market penetration is:
    - Microsoft (Windows): 85%
    - Apple (Mac OS): 10%
    - Linux and others: 5%
  - The proportions can vary over time but have remained constant
  - The statistics shown in Figures 2.13. and 2.14. are from 2013 and are not current

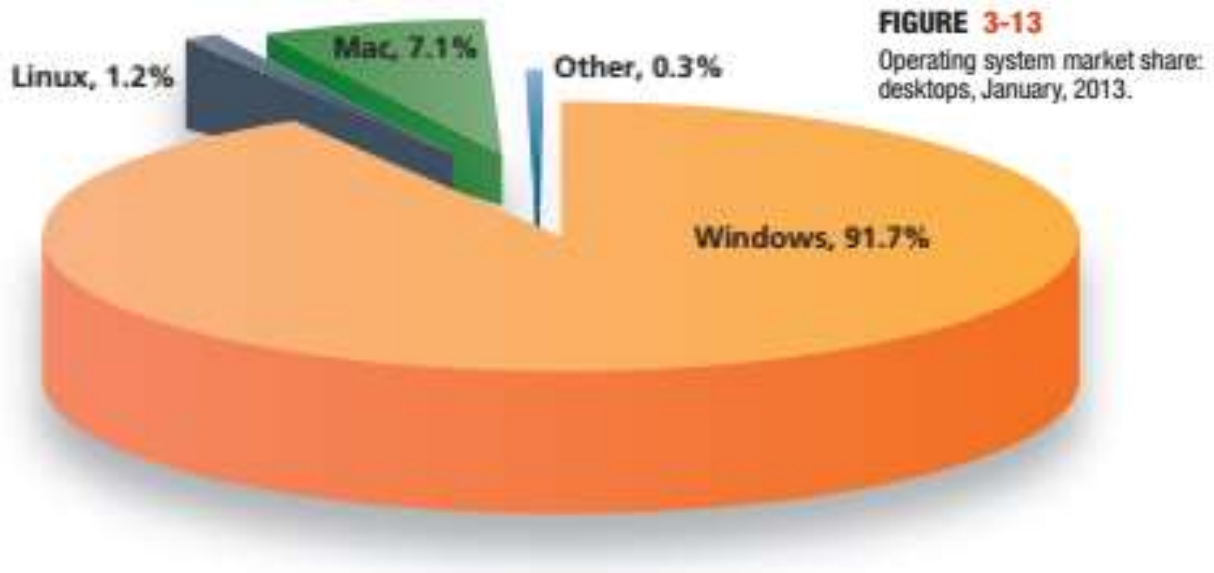


FIGURE 3-13
Operating system market share: desktops, January, 2013.

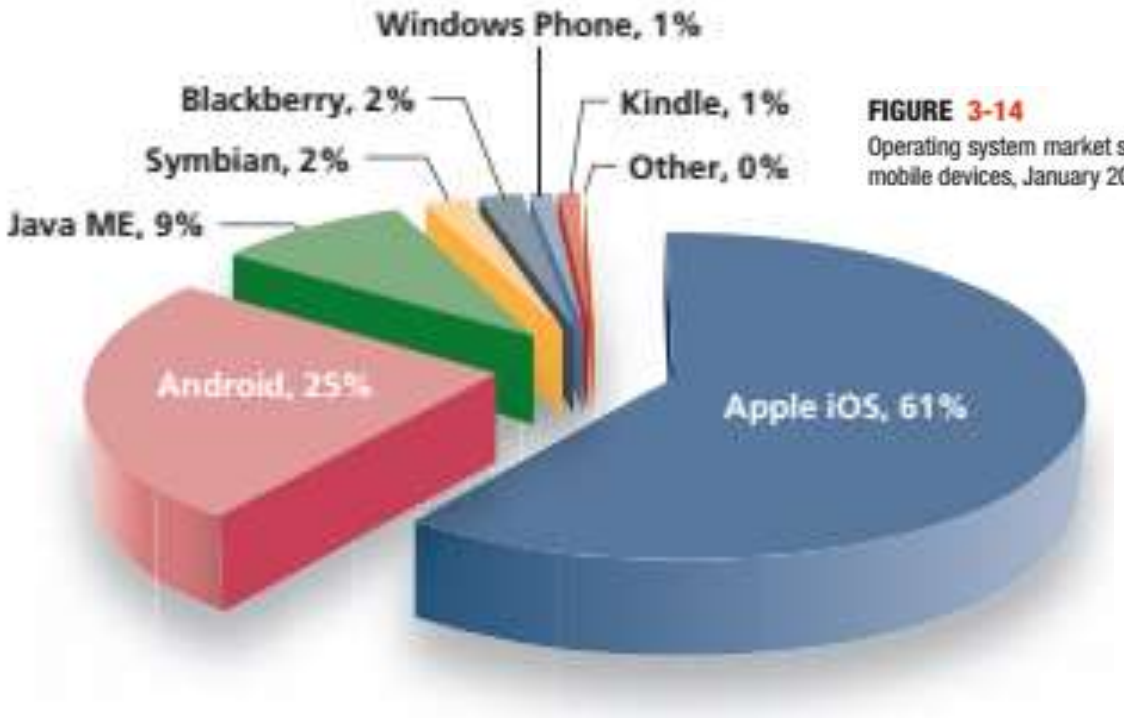


FIGURE 3-14
Operating system market shares: mobile devices, January 2013.

software
The computer component that contains the instructions that directs computer hardware to carry out tasks.

application software
The type of software used to support a wide range of individual and business activities, such as transaction processing, payroll, word processing, and video editing.

system software
The type of software that controls basic computer operations such as file management, disk storage, hardware interfaces, and integration with the application software.

operating system (OS)
The category of system software that performs a variety of critical basic tasks, such as handling device input and output, maintaining file structures, and allocating memory.

Creating Software

- How Is Software Created?
- Software is created by teams of programmers working with *business analysts*, *end users*, and other *stakeholders* who envision what the software is intended to do
  - Creating something like *Salesforce.com* or *TurboTax* takes intensive collaboration among people with very different areas of expertise.
- While Chapter #11 explores the systems development process in detail
  - This section introduces the technical side of the process and shows how software fits into the larger picture of an organization's overall architecture

Programming Languages

- Programming languages and source code may be:
  - Current languages
  - Older languages (legacy systems)
  - Object-oriented languages
  - Developments of older languages
    - e.g., Visual basic 6 is now visual basic.net
    - It will be necessary to ‘port’ the old code into the new format

Software development and deployment strategies

Software Development Strategies

- Domain specific (bespoke) software
  - Custom design and development
- Commercial of the shelf (COTS) software
- Open source software:
  - Free open source software (FOSS)
  - Free for personal use
  - Use by organizations (requires a license with attendant costs)
- Cloud-based software systems
  - Software-as-a-Service (SaaS)

Software-as-a-Service (SaaS)

- SaaS systems include:
  - Customer Relationship Management (CRM) Software (Manage customer data, track customer interactions, compile business information and automate sales)
  - Enterprise Resource Planning (ERP) Software (Integrate various functions into one complete system to improve efficiency and empower information sharing)
  - Accounting Software (Keep your finances organized and properly tracked to ensure your business is growing as it should.
  - Project Management Software (Plan projects, manage schedules, allocate resources and communicate deadlines to complete projects on budget and on time)
  - Email Marketing Software (Optimize message delivery while automating marketing emails)

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Networks and telecommunications

Transmission Media and Protocols

- Transmission media and protocols principally include:
  - Wired media
    - Twisted copper pairs
    - Coaxial cable
    - Optical fiber
  - Wireless media
    - Microwave transmission
    - Wi-Fi
    - Bluetooth
- The spectrum and the 'last mile'
  - Systems may be a combination of transmission media
  - May use a digital subscriber line (DSL) or asynchronous digital subscriber line (ADSL)

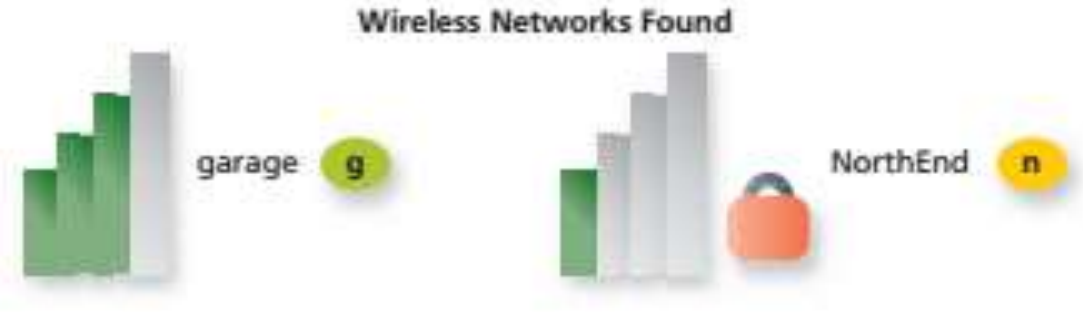


FIGURE 3-17
Example of wireless networking connection display. The colored bars indicate the strength of the signal, and the lock symbol indicates that the secured network requires password authentication.

FIGURE 3-18
Types of wired media.

Type	Description		Pros and Cons
Twisted pair wire	Insulated copper wires that are also used for telephones.		Somewhat fragile, but flexible enough to wind through ceilings and walls.
Coaxial cable	Thick cables with a single inner conductor core, usually copper, and a surrounding a mesh.		Faster transmission compared to twisted pair, and already installed in many homes served by cable TV.
Optical fiber	Transmit signals with light pulses along a glass or plastic fiber, rather than electrical signals over a conductor.		Fastest transmission speed and highest bandwidth; ideal for long distances because signals do not degrade. Requires a different adapter if fiber is connected to a PC.

The Electromagnetic Spectrum

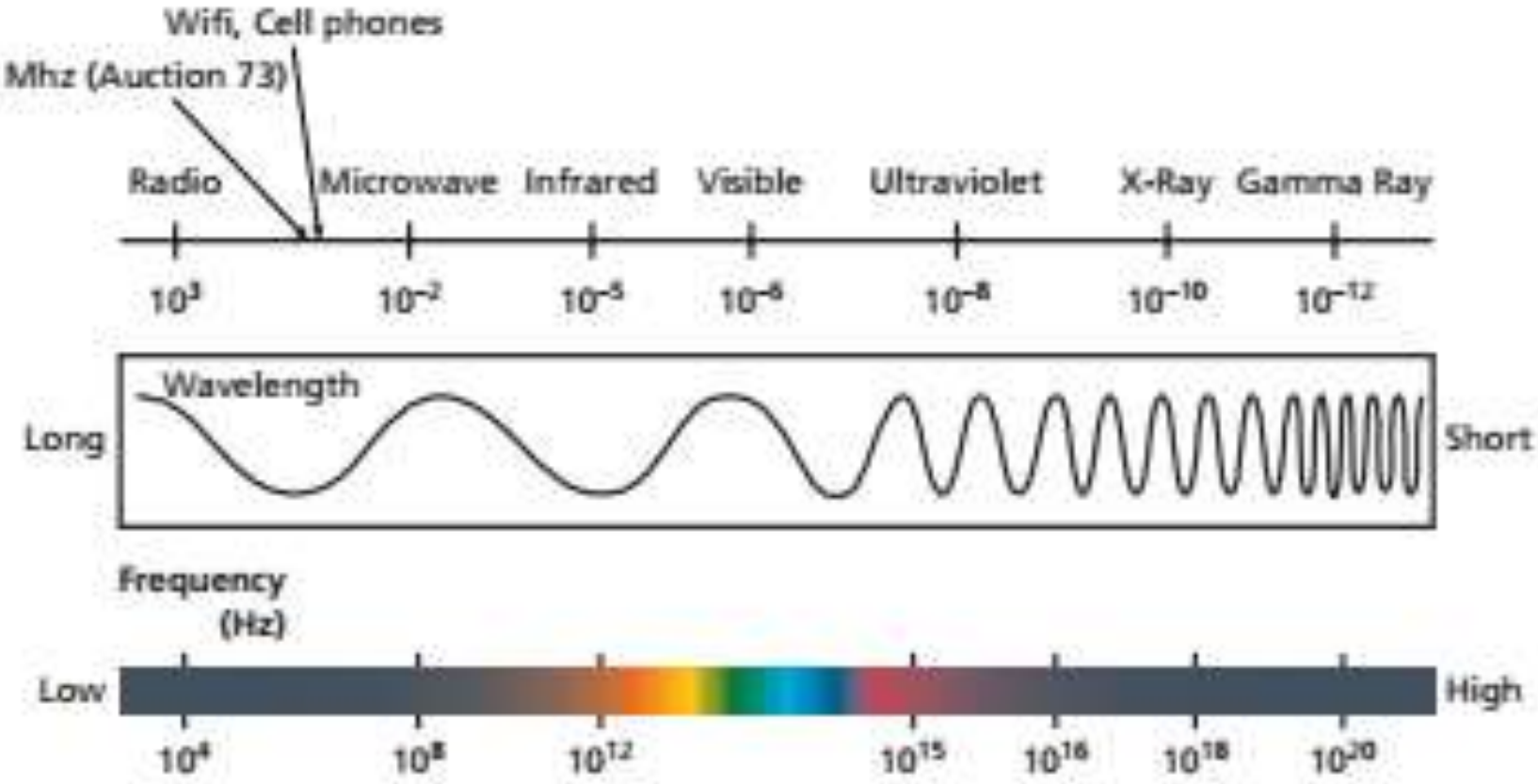


FIGURE 3-19
The electromagnetic spectrum.

Key Terms

wavelength
The distance between one peak of an electromagnetic wave to the next.

hertz (Hz)
The number of cycles per second of a wave.

microwave transmission
The technology involving signals in the gigahertz range that are transmitted to relays in the line of sight.

wifi
Short for wireless fidelity; it refers to a computer network in which connections rely on radio waves at frequencies of 2.4 GHz or 5 GHz for transmission.

wireless router
A device connected to a computer network that emits signals from its antenna and enables wireless connectivity to the network.

Bluetooth
A technology that uses radio waves for connectivity, commonly used for wireless connections over very short distances.

digital subscriber lines (DSL)
Technology that supports high speed two-way digital communication over twisted pair phone lines.

local area network (LAN)
A network that connects devices such as computers, printers, and scanners in a single building or home.

circuit-switched network
A type of network in which the nodes communicate by first establishing a dedicated channel between them.

open source software
A type of software whose licensing terms comply with criteria such as free distribution, so other people can access the source code to improve it, build upon it, or use it in new programs.

network
A group of interconnected devices, such as computers, phones, printers, or displays, that can share resources and communicate using standard protocols.

bits per second (bps)
The measurement of transmission speed, defined as the number of bits transmitted each second; each bit is a single zero or one, and a string of 8 bits makes up a byte.

bandwidth
The maximum amount of information in bits per second that a particular channel can transmit.

twisted pair wires
The most common form of wired media, these wires consist of thin, flexible copper wires used in ordinary phones.

coaxial cables
Wired medium, initially used for cable TV, consisting of a single inner conductor wire (typically copper) surrounded by insulation, which is then surrounded by a mesh-like conductor.

optical fiber
Cables that transmit bits by means of light pulses along a glass or plastic fiber instead of electrical signals over a conductor; ideally suited for long distances.

Network Types (1)

- Circuit switched networks
  - Maintains a channel of communication
  - A typical example is a telephone for voice traffic
- Packet switched networks
  - Digital messages are broken up into small ‘packets’
  - typical examples include:
    - VoIP (e.g., Skype)
    - Software downloads
- Client-server (and) peer-to-peer networks

Network Types (2)

Type of Network	Geographic Area
Personal area network (PAN)	20–30 feet, for devices within reach
Local area network (LAN)	Home, office, school, building
Campus (or Corporate) area network (CAN)	Interconnected LANs encompassing several buildings for a university or a corporate campus
Metropolitan area network (MAN)	Interconnected LANs or CANs for a city
Wide area network (WAN)	Interconnected LANs, CANs, MANs covering a wide geographic area
Global area network (GAN)	Supports mobile communications across the globe, using a mix of satellite or other strategies

FIGURE 3-21
Types of networks.

Cellular Networks

- Cellular (or mobile) networks are arguably the future:
- Such networks are characterised by:
  - 3G
  - 4G
  - 5G
- The benefits of 5G:
  - Data speeds are as fast as (or faster than) traditional wired networks
  - 5G is more flexible and convenient

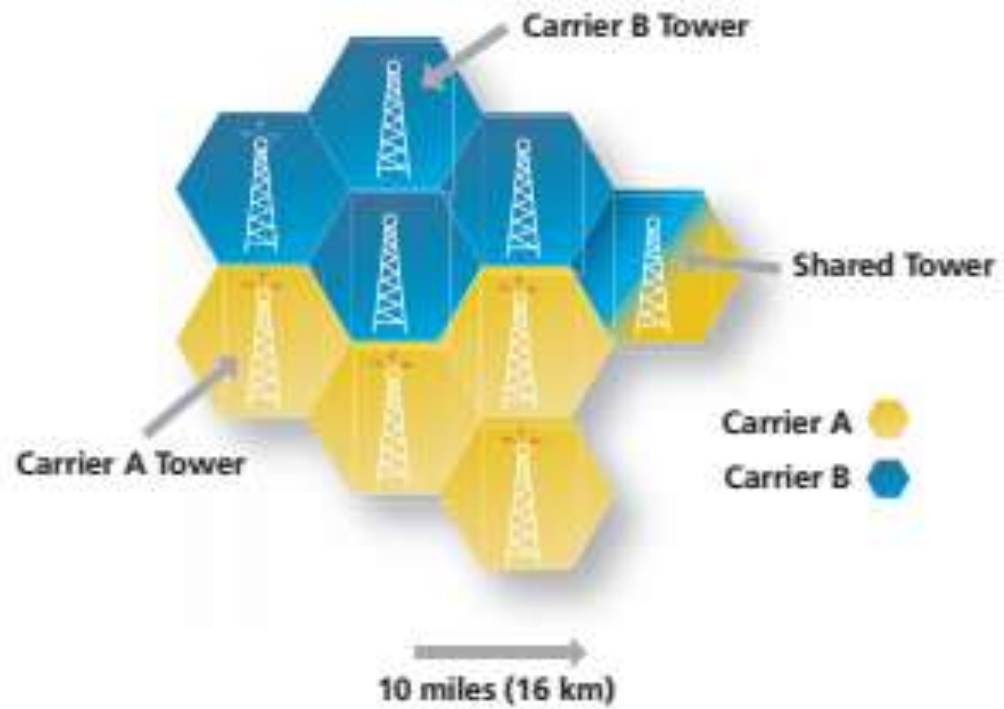


FIGURE 3-20
Cellular infrastructure.

Types of Network Architecture

- Network architectures:
  - Client server
  - Peer-to-peer
- Network protocols:
  - Ethernet
  - TCP/IP and Internet channels of communication
  - Wireless protocols

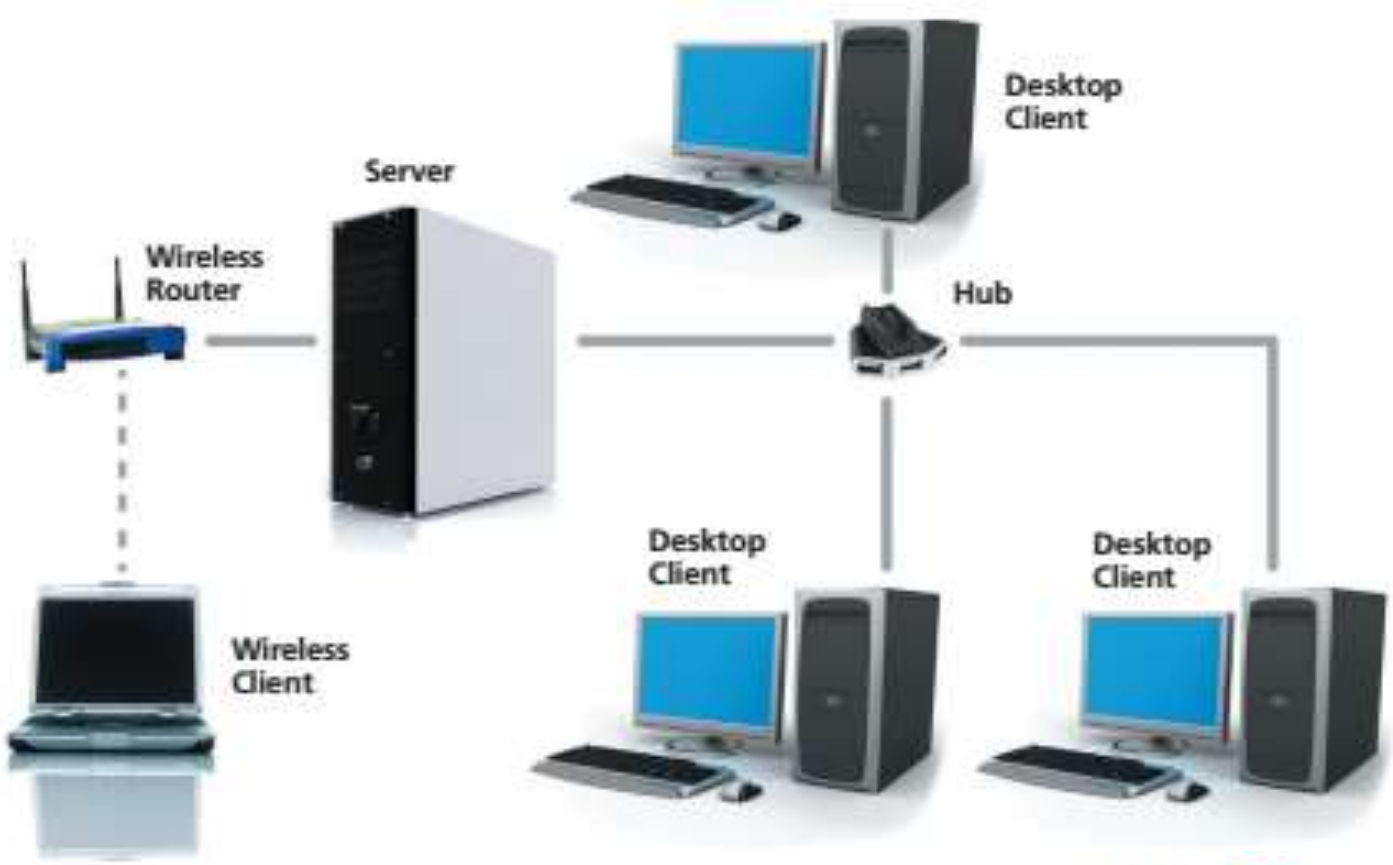
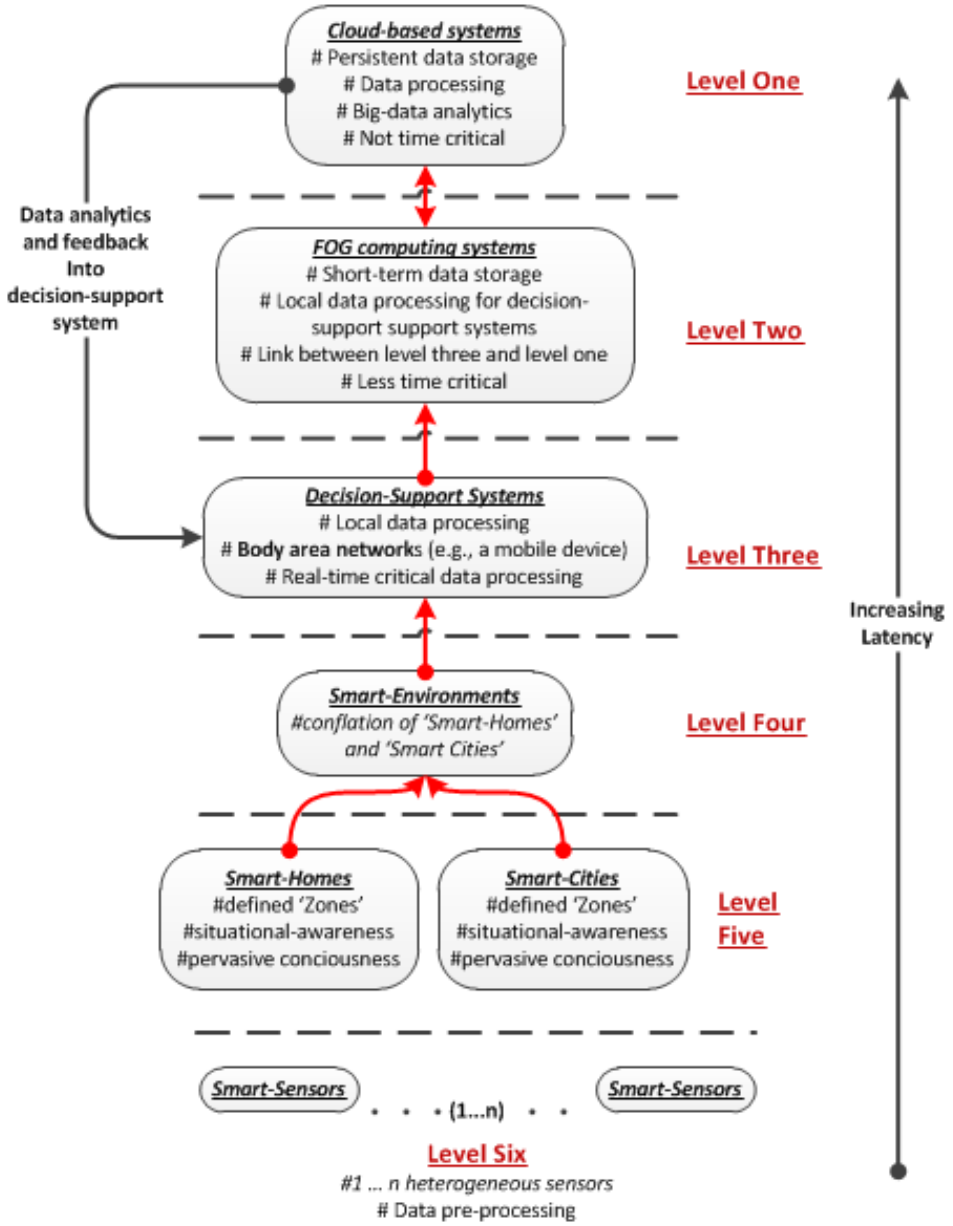


FIGURE 3-22
Client-server network.

Fog Computing

- A developing paradigm is fog computing
- This paradigm has many aspects including:
  - The traditional fog computing model
  - Edge computing and the *Internet-of-things* (IoT)
  - Latency can be an issue:
    - The architectural model shows a fog computing model
- Fog computing can be used in:
  - Decision-support systems



Network Protocols

- Network protocols:
  - Ethernet
  - TCP/IP and Internet channels of communication
  - Wireless protocols
- Figure 3.23. models the TCP/IP and the Internet hourglass architecture
  - The structure defines the is the core design principle for the Internet
  - Provided bits are transmitted using the Internet's standardized protocols:
    - New applications for the top end and new communications technologies for the bottom can all be incorporated

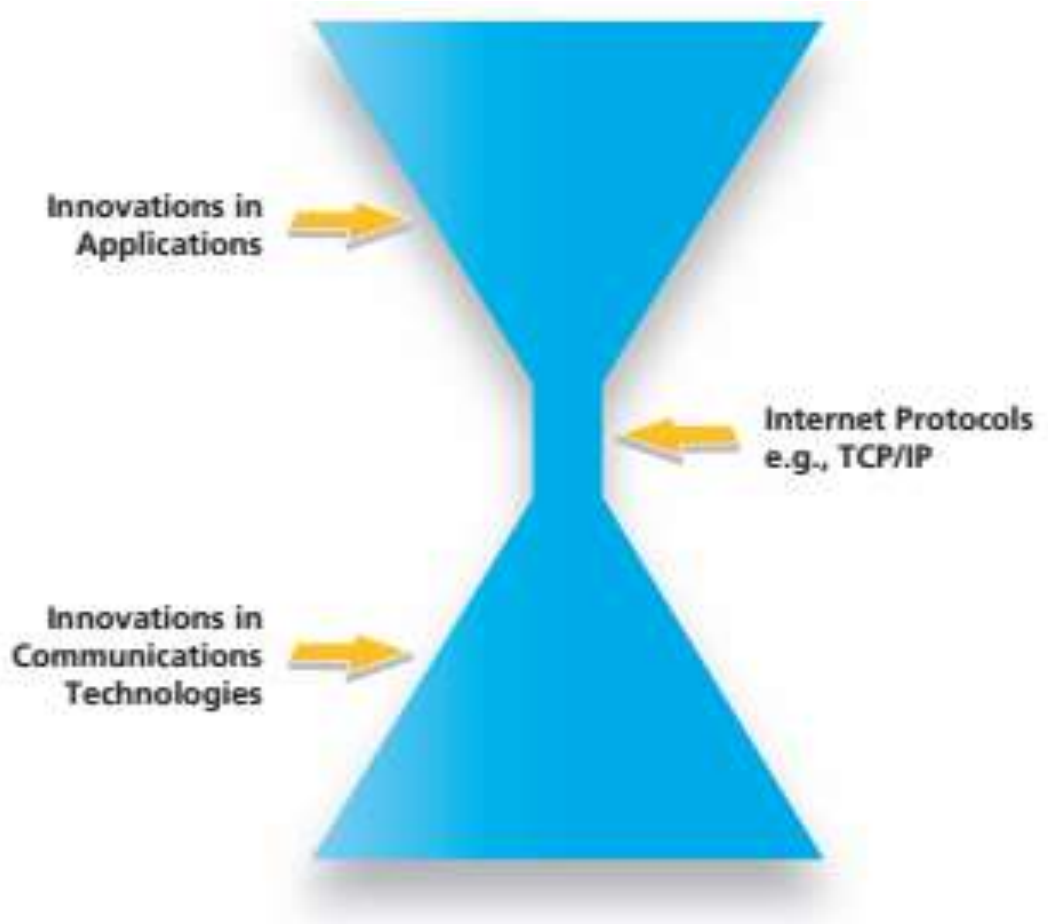


FIGURE 3-23
The Internet's hourglass structure.

802.11 Standards

- Figure 3.24. provides a comparative analysis of the 802.11 wireless standards

FIGURE 3-24
Comparing 802.11 standards.

Standard	Indoor Range	Frequency	Maximum Data Rate
802.11a	~35 meters	3.7 or 5 GHz	54 Mb/s
802.11b	~38 meters	2.4 GHz	11 Mb/s
802.11g	~38 meters	2.4 GHz	54 Mb/s
802.11n	~70 meters	2.4 or 5 GHz	600 Mb/s
802.11ac	In draft; final version expected late 2013	5 GHz	At least 1 Gb/s
802.11ad	In draft	60 GHz	Up to 7 Gb/s

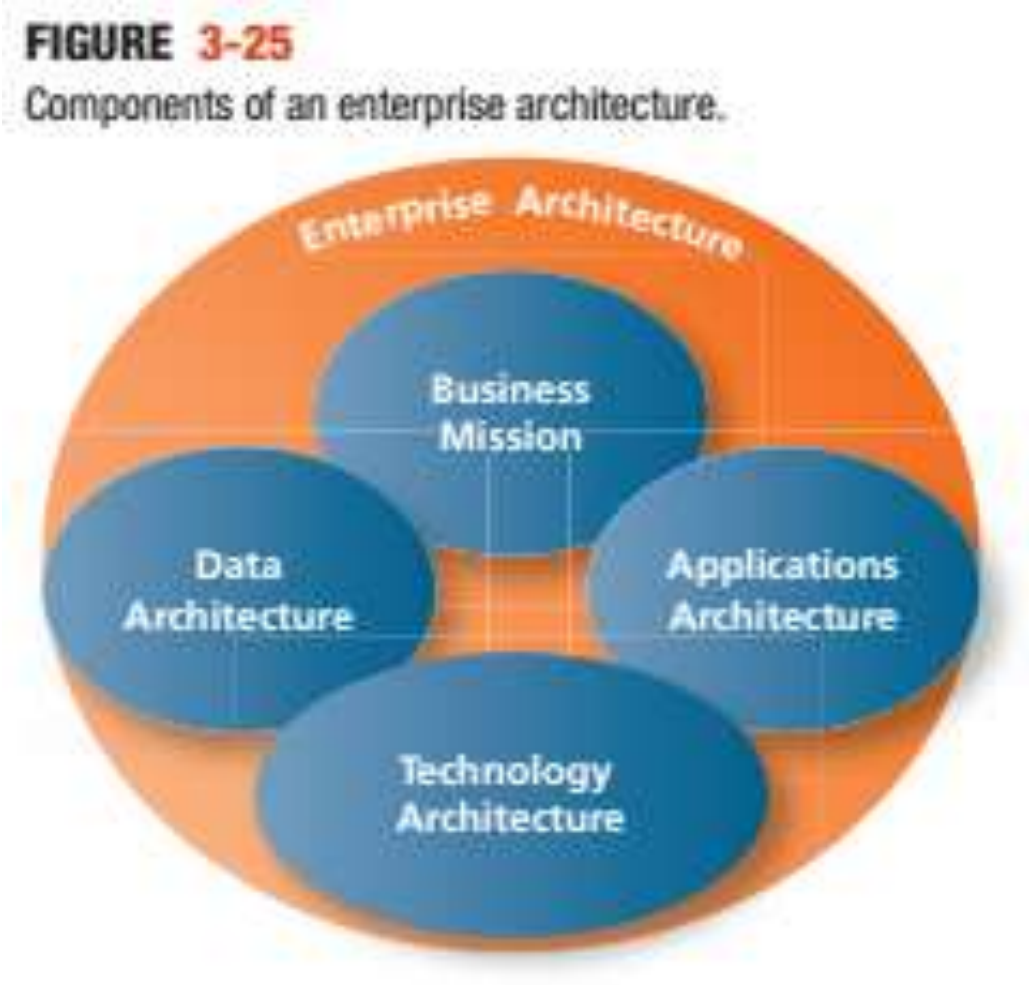
The enterprise architecture

The Enterprise Architecture (EA)

- The EA:
  - Is the big picture for an organization
  - It is the blueprint that describes the current environment and the target environment the organization hopes to reach to achieve its mission
  - It also includes a roadmap for moving from the baseline to the target, to help managers make better decisions that focus on long-term benefits and not just short-term gains
- The EA does not focus on hardware, software, and telecommunications assets (though these components are key)
  - It encompasses the people, technology, processes, and data that make up information systems
  - The EA should be driven by business requirements and the organization's mission

The Enterprise Architecture (EA)

- Figure 3.25.:
  - Illustrates the EA as layers in which the business mission at the top drives decisions about data and applications architectures
  - These layers should then shape the ICT architecture, to include hardware, software, and communications



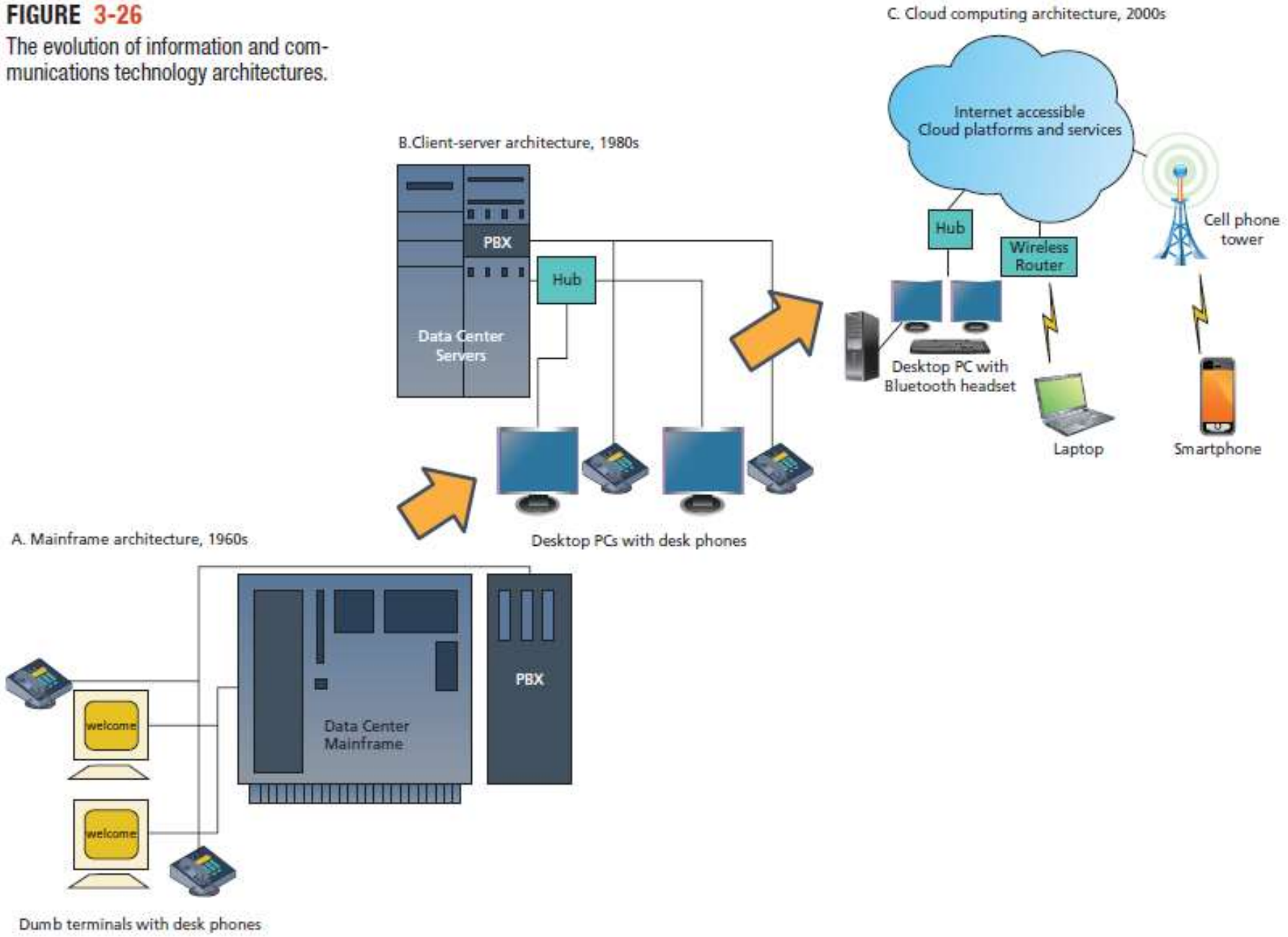
Trends Enterprise Architectures

- The ICT component of the EA changes over time as new technologies emerge and businesses build more effective and efficient processes to achieve their objectives and missions
- Figure 3.26:
  - Shows some of the major architectural approaches
  - Most organizations have mixed versions
- Viewed from an historical perspective:
  - From mainframe systems to minicomputers (the name is misleading as they were large machines) beginning in the 1960s, mainframes were the foundation of the architecture
  - In a client-server approach, dumb terminals accessed the data center's mainframe, and private leased lines were used to transmit information between corporate sites

Figure 3.26.

- Mainframes to micro computers (Personal computers)
- Client server
- Virtualization
- Cloud computing (See Figure 3.27)

FIGURE 3-26
The evolution of information and communications technology architectures.



Trends in EA (microcomputers)

- The term microcomputer is perhaps better known as the personal computer (PC)
- When microcomputers entered businesses in the 1980s:
  - They swiftly replaced typewriters, even though the word processing software was very clunky.
  - They replaced the dumb terminals, too, largely because the electronic spreadsheet was such a useful breakthrough.
  - The PC could work like a dumb terminal to access the mainframe's applications, but it could also run its own software locally.
  - Client-server architectures, LAN, ever more powerful PCs, and the development of PC operating systems that could support multiple users opened the path for the client-server architecture described earlier
  - Software applications that tap the resources of both server and client emerged, with more user-friendly, colorful, and graphical interfaces replacing the dull black screens so familiar to mainframe users.

Trends in EA (microcomputers)

- Businesses made major savings by retiring expensive mainframes with their costly software and peripherals
  - Aging systems with were replaced with new software that ran on PC-based servers and local area networks
  - Because PC hardware could be obtained from many manufacturers (Dell and H-P, for example), prices stayed competitive
- Organizations settled on Ethernet as the local area networking standard and adopted strategies for using the Internet for communications rather than leasing private lines from the telecommunications carriers
  - They also focused on a handful of server operating systems, namely:
    - Windows Server, Unix, and Linux.
  - These trends initially introduced many cost savings. virtualization

Trends in EA (microcomputers)

- The organization's data center, once home to a mainframe computer and all its components, quickly became jammed with rack after rack of PC servers
  - Server sprawl was rampant, and the numbers kept rising as new applications were implemented.
  - Because many servers in n-tier client-server architectures specialize in one kind of task or one software application, much capacity remains unused.
  - The CPUs might sit idle much of the time, though still drawing electricity and generating heat. To address this, companies implement virtualization using software that allows multiple operating systems to run on a single physical PC server.
  - To the users, each one appears as a separate, self-contained server that may handle only one software application, but they are actually virtual servers. Virtualization can cut costs dramatically, not just by lowering electricity bills and hardware expenses, but also through reduced maintenance.
- IT staff must tend every server in the data center, and each one needs backup, communications, software installations, upgrades, virus protection, and patches
  - Mazda, for instance, once had 200 physical servers in its data center, but the company used virtualization to knock that number down to just 28 servers hosting 490 virtual machines

Trends in EA

- Virtualization is also an important element in the drive toward environmentally friendly information systems:
  - With improved use of capacity energy consumption is reduced
- Integration of voice and data:
  - Since the mainframe era, the infrastructure for voice communications was separated from data.
  - Buildings have been constructed with two sets of cabling to each office or cubicle (one for data communications and the other for voice (see Figure 3.26.)
- The twisted copper pair wiring for voice:
  - Typically leads to private branch exchange (PBX) equipment in the data center or off site, which manages all the office phone lines, voice mail, call transfers and forwarding, conference calling, and other voice services
  - Many organizations buy such services from phone companies, although larger ones might purchase and maintain their own PBX

Trends in EA

- Figure 3-26 shows a PBX right next to the mainframe, and then later, as a smaller, rack-based model
- With VoIP, however, organizations can design the enterprise architecture quite differently:
  - Voice communications can be integrated with data, traveling over the same networks and managed by software applications on the same servers.
  - Video conferencing and screen sharing can easily be added as well, as the old PBX is replaced with IP-based solutions
- An important advantage for business is that communications can be closely integrated with the other software that a company uses, and can tap into the company's databases:
  - For example, the system could bring up a customer's record when that customer calls in, without having to ask the customer to key in an account number
  - Additionally, integration helps to avoid duplication of contact information for customers, suppliers, and employees
- Voice and data integration is an area ripe for a great many innovations that will improve productivity (Chapter 8 describes this trend toward "unified communications" in more detail)

The Enterprise Architecture (Cloud Computing)

- The architecture termed *cloud computing* draws on IT resources outside of the corporation's own data centers and local desktops (see Figure 3.27.)
  - With an Internet connection, employees can access virtual servers, storage space, video streaming, specialized software, and other cloud-based services from any location, using many different devices
- The services are not in a cloud, of course:
  - The physical hardware that supports them is located in very large data centers operated by Amazon, eBay, Google, and other providers
  - Google cuts hardware costs to the bone by building its own servers from inexpensive parts, and distributing the applications over a large number of them
  - They share the load, and if one goes down, another just takes over

Figure 2.17.

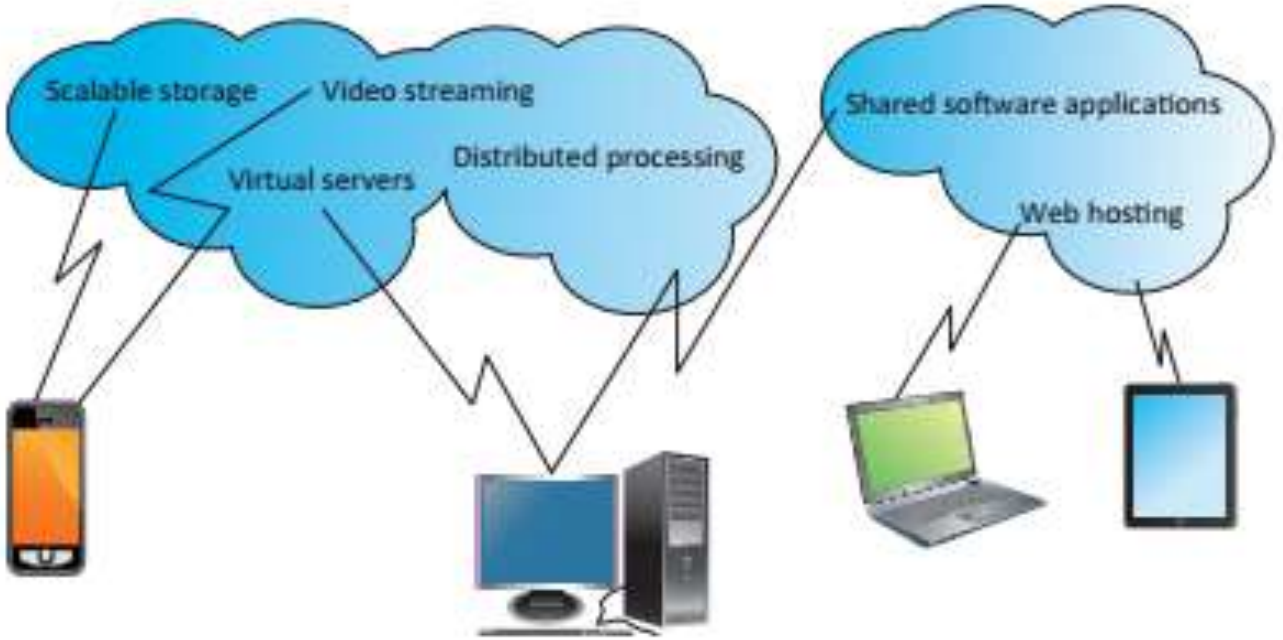


FIGURE 3-27
Cloud-based services.

virtualization
Cost-cutting approach to servers in which multiple operating systems run concurrently on a single physical PC server.

private branch exchange (PBX)
Technology that manages all the office phone lines, voice mail, internal billing, call transfers, forwarding, conferencing, and other voice services.

cloud computing
ICT architecture in which users access software applications and information systems remotely over the Internet, rather than locally on an individual PC or from servers in the organization's data center.

The Enterprise Architecture (Cloud Computing)

- Cloud computing is somewhat confusing because it refers to many different styles and technologies and some are not actually new:
  - One option, for example, involves leasing IT resources such as storage capacity or virtual servers, rather than adding more servers to the company's own data center
- Leased services are also easy to scale up or down based on need.
  - For example, companies that analyze big data need enormous storage space, and these flexible leasing arrangements are cost effective.
  - They also need considerable processing power, which can come from distributing the work to many different computers in the cloud.
  - Virtualization also helps reduce costs.
- Companies that lease these resources may never even know who their *neighbors* are on the same physical server
  - Beyond hardware capacity, vendors offer software as a service (SaaS) through cloud computing, described in the previous chapter

The Enterprise Architecture (EA)

- Companies like Salesforce.com build software applications in a way that allows many "tenants" to use it for their own organizations, so organizations may not even need their own data center at all
- A drawback of cloud computing is that an extremely reliable Internet connection is a must.
  - Organizations that can't count on that for their operations would find themselves without access to their mission critical systems when the net connection failed.
- Another drawback is that cloud services tend to be "one size fits all" and may not work as well for companies that need special configurations
  - To address this issue organisations can negotiate contracts for bespoke solutions using *private*, *public*, and *hybrid* clouds
- For individuals:
  - Personal cloud services like Google Drive, Dropbox, or OneDrive can offer file storage that you can access from any device anywhere
  - File sharing is also a feature of such systems

The Enterprise Architecture (EA)

- To some extent, the drive to rebrand some familiar services as “cloud computing” is more about marketing hype than a brand new architecture:
  - However, improvements in virtualization, security, and mobile access are very real, and they may offer compelling opportunities to reduce costs and empower the workforce
  - Eliminating even one corporate data center, for example, can offer substantial savings. For employees and customers, the switch can mean far more freedom of mobility
  - Blue Cross of Northeastern Pennsylvania, for example, is switching to cloud computing for its 300,000 members, so they can access medical histories and claims information on their smartphones.
- As the shift to the cloud gathers momentum:
  - The variety of services will continue to grow
  - However: there is a need for vendors to satisfy customer concerns that their data and applications are safe, secure, and reliable

Guiding the architecture

The EA(guiding the architecture)

- Creating the roadmap to guide the enterprise from its current architecture to its target is a challenge, especially for organizations that have a mix of platforms already in place
- For example consider:
  - A counter at a dentist's office: the practice may use a PC emulating a dumb terminal, with an old-fashioned text-based display showing your last three appointments
  - On another desk, you see someone logging into a graphical software application to check on insurance for your dental visit
  - In the dentists you might watch your dentist pull up vivid X-ray images and medical records on a flat screen
  - In a few days, you may be able to check on the insurance claim yourself with your smartphone

The EA(guiding the architecture)

- Many organizations:
  - Have a mix of architectures, implemented over time, and with limited integration among them
  - The task of creating and guiding the architecture is often led by an enterprise architect (Figure 3-28).
  - This new (and well-paid) position requires a person with deep knowledge of the organization's mission and strategy, and a clear understanding of how different architectures can support the company's goals
  - The architect's role is to lead the effort, promote the value of EA concepts, and coordinate decision making so the organization stays on track
  - The online simulation called Devil's Canyon that accompanies this chapter gives you a chance to work with a team of entrepreneurs, understand their goals, and make recommendations about the architecture that will work best for them

Example Job Opportunity

- Figure 3.28. shows a typical advertisement for an *enterprise architect*:
  - The role requires a range of competencies and qualifications but the human element is important

Job Opening: Enterprise Architect

As enterprise architect, you will lead the effort to analyze our company's business strategy, define the ICT architecture to support it, and create the roadmap for getting there. You must be familiar with business objectives and how technology solutions align with them. Superb communications and negotiation skills are essential. You will interact with business leaders in every department to understand needs, and develop a governance structure to guide decision making about technology investments. Salary in the low to mid $100s. Bachelor's degree in business with strong background in information systems required. MBA preferred.

FIGURE 3-28
Job opening: Enterprise architect.

The Enterprise Architecture (summary)

- The trends in enterprise architecture now underway have a major impact on industries, organizations, their employees, and their customers:
  - Cloud computing offers many capabilities and the potential for cost savings
  - However: drafting a blueprint that erases the underground data center is far easier than actually dismantling it and reconfiguring it in the cloud
- Managers:
  - Worry about the safety of their data and the reliability of the services
    - Amazon has issued apologies for outages at its data centers
  - Wonder whether their old legacy applications will still run, or whether they can get the help they need if the IT department shrinks.
- IT staff:
  - Struggle with reduced budgets, and also a loss of control over the company's mission-critical systems

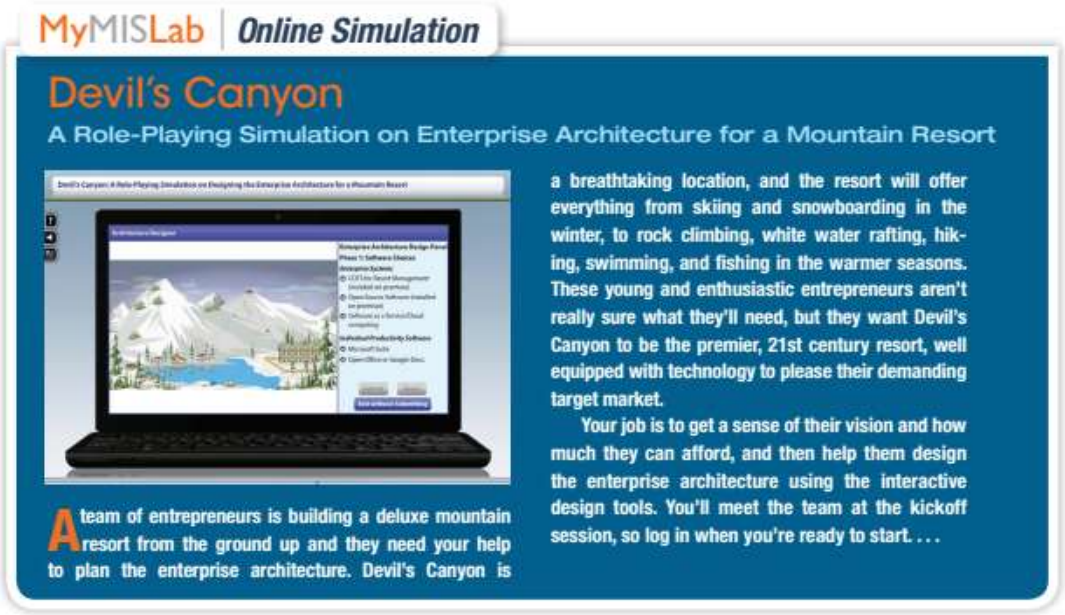
The Enterprise Architecture (summary)

- The enterprise architect:
  - Must consider and take into account these human elements when designing a road map that will guide the organization into a successful future
- With this brief overview of the EA has considered:
  - Information and communications technologies
  - The main types of EA which can be created
- We can now move deeper into information systems and the data architecture

Summary

Chapter #3 Review

- We have introduced:
  - *The hardware and software components*
  - *Networking*
  - *The enterprise architecture*
  - The online simulation applies these components in a practical scenario



1 The four hardware components of every computer are input, output, the central processing unit (CPU), and storage. Input devices convert signals such as a key press on a keyboard or finger motion on a touchscreen into digital information and transmit it to the CPU. Output devices include display screens and printers, and many devices serve both purposes. Scanners and sensors play a large role as input and output, involving technologies such as barcodes, RFID, QR Codes, digital cameras, and optical character recognition. Computing architectures vary in terms of size, processing speed and capacities, portability, and other factors. They include mainframes, minicomputers, supercomputers, microcomputers, laptops, netbooks, smartphones, and tablets. Primary storage includes random access memory (RAM), and secondary storage includes hard drives, solid state drives, optical disks, and magnetic tape. Declining costs for primary storage technologies support in-memory computing, which is much faster compared to secondary storage.

2 Two types of software are (1) application software, which supports all personal activity, business processes, and specific tasks; and (2) system software, which includes the operating system and utilities. Operating systems are important in business because many applications work on only one of them, so business users choose the one that has the most useful software available. Windows dominates the operating system market for desktops and laptops, but operating systems for smartphones and tablets are much more varied. Software is written in various programming languages and software development environments. Managers make choices by taking into consideration staff skills; the availability of training, support, and tools; and other factors. Software created by IT companies such as Microsoft or Oracle and licensed to customers is called commercial off-the-shelf (COTS). Increasingly, web-based applications are licensed as software as a service (SaaS). Unique applications or business processes sometimes call for custom software development. Open source software, with licensing terms that call for free redistribution, is developed by volunteer communities and carries no licensing costs.

3 Networks connect computers and other devices, and their transmission media can be wired or wireless. Wired media include twisted pair, coaxial cable, and optical fiber. Wireless transmission relies on the electromagnetic spectrum, using segments that are either licensed or unlicensed. Wifi, for example, relies on radio waves at frequencies of either 2.4 GHz or 5 GHz. The spectrum is extremely valuable for companies developing new mobile and wireless services, and auctions are held in which companies bid on whatever bandwidth is available. Networks can be classified by their geographic areas (such as LAN or WAN), by whether they use packet or circuit switching, and by their degree of centralization (client-server and peer-to-peer). To connect, devices rely on protocols, such as Ethernet and TCP/IP. The 802.11 family of protocol standards is widely used for wifi. These protocols determine how different layers address connection issues, from the physical layer to the application layer. The Internet's protocols support ongoing innovation because they address mainly the middle layers.

4 The enterprise architecture is the organization's master blueprint that describes its current environment, its future state, and the roadmap for achieving it. It is driven by business needs and helps define and guide the ICT architecture needed to support it. ICT architectures have evolved over time with changes in business needs and technological innovations. Emerging trends include virtualization, the integration of voice and data, and cloud computing. Developing and guiding the enterprise architecture requires a keen understanding of the business mission and how ICT architectures can support it.

Reading and coursework

Reading and Coursework

- Read and understand the key terms and concepts on page 119
- Work through the:
  - Chapter review questions (page 119)
  - Projects and discussion questions (page 119-120)
  - Application exercises (page 121-121)
- Apply the concepts introduced to the *Devils Canyon Online Simulation* exercise
- Read and consider the (two) case studies (pages 121-122) and answer the related discussion questions
- Review the (two) e-projects on page 124

KEY TERMS AND CONCEPTS

enterprise architecture (EA)
computer
ASCII code
optical scanners
optical character recognition (OCR)
radio frequency identification (RFID)
central processing unit (CPU)
transistor
Moore's Law
byte
random access memory (RAM)
in-memory computing
software
application software
system software
operating system (OS)
utility software
programming language
legacy systems
source code
object-oriented programming
commercial off-the-shelf (COTS)
software as a service (SaaS)
open source software
network
bits per second (bps)
bandwidth
twisted pair wires
coaxial cables
optical fiber
wavelength
hertz (Hz)
microwave transmission
wifi
wireless router
Bluetooth
digital subscriber lines (DSL)
local area network (LAN)
circuit-switched network
packet switching
voice over IP (VoIP)
client-server network
n-tier
peer-to-peer network
Ethernet
TCP/IP
Internet Protocol Version 6 (IPv6)
WiMax
virtualization
private branch exchange (PBX)
cloud computing

CHAPTER REVIEW QUESTIONS

3-1. What is the function of each of the four components of a computer? Give an example of each component.

3-2. What is the meaning and significance of Moore's Law?

3-3. Discuss potential ethical problems which can arise due to the usage of QR code reader apps on smartphones.

3-4. What are the different strategies for creating and deploying software?

3-5. Discuss why optical fiber–based networks and wireless transmission media are a threat to carriers offering landline services.

3-6. What are two types of networks and how are they used?

3-7. What is a network protocol? What are the roles of Ethernet, TCP/IP, and wireless protocols?

3-8. What is an enterprise architecture and what is its role in an organization?

3-9. Which kind of firms will benefit from integration of voice and data (like use of VoIP)?

3-10. What is cloud computing? How does it support business objectives?

PROJECTS AND DISCUSSION QUESTIONS

3-11. Why did people stand in ridiculously long lines for hours in hopes of buying a $300 iPhone 4? Despite widespread reports of reception issues, Apple struggled to meet the demand for that smartphone model. Describe the latest iPhone in terms of hardware components (input, processing, storage, output) and its operating system and application software.

3-12. When the "StudentNet" wireless Internet signal did not appear on the list of nearby connections (Figure 3-17), Becca Wells used the "garage" network to check her email. What issues should Becca have considered before connecting to that unknown network? For example, is it ethical to connect through someone's service without permission, even if they didn't password protect the access point? What security issues should she be concerned about? Search the web to learn more about "wardriving" and prepare a brief summary of your findings.

3-13. Twenty years ago, analysts predicted the death of mainframe computers. Today, however, many public and private enterprises throughout the world rely on the mainframe as the backbone of large-scale computing. For example, the U.S. Census Bureau uses mainframe computers to process data about the nation's people and economy. On the other hand, many of today's data centers run on racks of PC servers or large-scale PC server farms. How are mainframe computers different from PCs? How are they similar? Search the web or visit websites such as opensourcemainframes.org and ibm.com to learn more about how mainframes support an IT infrastructure. List and discuss the major uses of mainframe systems.

3-14. Although vendors describe the cloud as a cost-effective solution to increase IT capabilities, some critics describe it as marketing hype. The implementation

of cloud computing to replace in-house computing generally requires:

a. Leasing IT resources

b. Depending on a third party to store data

c. Depending on a third party to provide services

List the positive and negative results of these factors as they affect organizations that adopt cloud computing. Outline several reasons why a company might decide to use cloud computing. Are there other issues related to cloud computing? In your opinion, what is the strongest argument against cloud computing?

3-15. Consider the many types of computer input devices available today. Identify two general categories of input devices and provide several examples of each. List and describe several input devices that also serve as output devices. List several input/output devices that you own. Which are your favorites? Why? Which are your least favorites? Why?

3-16. Why are there different programming languages? What is the fundamental difference between Java and .NET? Search the web to learn the origin of the name "COBOL." How is COBOL used today? How strong is the case that "COBOL is dead"? Why or why not?

3-17. Jackson Real Estate is relocating to new office space and owner Bella Jackson must decide between a wired or wireless network for 35 on-the-go agents. What are the pros and cons of each type of network for this business environment? Consider the cost, security, and mobility issues of this decision and make a recommendation.

3-18. Work in a small group with classmates to compare three office productivity applications: Microsoft Office, a commercial off-the-shelf software product; Google Docs, software as a service; and Open Office, a free, open source office suite (available at openoffice.org). What are the benefits, costs, and risks of each application? Discuss why a small business or nonprofit organization may prefer one application instead of another.

3-19. Work in a small group with classmates to explain the effects of Moore's Law on information and communications technology. What is the impact of Moore's Law on your life? Prepare a 5-minute presentation on your findings.

3-20. Work in a small group with classmates to consider the differences between commercial off-the-shelf software and custom software. What are the advantages and disadvantages of each type of software? Why would a company decide to develop its own software rather than use COTS? Investigate the student information system used by your college or university to learn whether the software was custom developed or purchased.

APPLICATION EXERCISES

3-21. EXCEL APPLICATION: Analyzing Growth in Computer Storage Capacities

Since the computer hard drive was invented in 1956, a constantly increasing data storage capacity has been available at an ever-decreasing cost. Use the historical data of hard drive capacities and prices shown in Figure 3-29 to create an Excel spreadsheet that includes formulas to calculate a common measure of disk size (GB) and the cost per GB for each year. You can also download the Excel file that contains this data, named Ch03Ex01. Recall 1 gigabyte = 1,024 megabytes; 1 terabyte = 1,024 gigabytes. Create two line charts to present trends in the cost of data storage, using the data for years 1980–1999 for one chart and the data for years 2000–2010 for the second chart. Write a brief summary of the trends you found. What factors have contributed to these trends? What are the implications of these trends?

FIGURE 3-29
Hard drive capacities and costs by year.

Year	Size	Price
1980	26 MB	$5,000
1983	20 MB	$3,495
1984	20 MB	$2,399
1987	40 MB	$1,799
1989	20 MB	$ 899
1995	1.7 GB	$1,499
1996	3.2 GB	$ 469
1997	7.0 GB	$ 670
1998	8.4 GB	$ 382
1999	19.2 GB	$ 512
2000	27.3 GB	$ 375
2001	40 GB	$ 238
2002	100 GB	$ 230
2003	120 GB	$ 168
2004	250 GB	$ 250
2006	390 GB	$ 106
2008	1 TB	$ 200
2010	1.5 TB	$ 220

3-22. ACCESS APPLICATION: Managing ICT Assets with a Database

Steve Adams Design is an architectural design firm specializing in corporate design projects such as commercial building architecture, interior design, master planning, and sustainable design and consulting. As part of its ICT asset management program, the IT director has asked you to build an Access database to manage the devices used by employees. The database will contain information about each device, such as manufacturer, model, date acquired, condition, purchase price, and current value.

Create an empty database named "Adams." Download the Excel file Ch03Ex02 and import the two worksheets to tables in your database. Create a totals query to summarize the current value of equipment for each category. Create a report displaying the names and locations of employees who use laptop computers. Create a report displaying the names and locations of employees who use CAD systems.

CASE STUDY #1

Google Glass and Wearable Technologies

Moore's Law is helping companies like Google develop wearable technologies that have considerable computing power, from smartphone watches to heart rate monitors. "Google Glass" breaks new ground in this technology category with a headset that resembles a pair of lightweight glasses. The device connects to the Internet wirelessly via wifi, but to be fully mobile, the wearer also needs to carry a smartphone that can work as a hotspot, relying on the carrier's mobile 4G network to stay connected.

Google Glass is a work in progress, but developers envision it as an "always on" device that people can use to take spontaneous pictures and videos, send and receive phone calls and text messages, and post messages on social networks. The small display in the upper corner of the wearer's visual field adds another critical capability, to conduct Google searches, for instance. Air travelers can call up current flight data as they race to the gate. With GPS, the wearer can view navigation maps that match the current position. The device has most of what it needs to function as a standalone computer, including a high powered processor running the Android operating system.

How does the wearer communicate with Glass? Users can speak a variety of commands, such as "OK Glass, take a picture," or "OK Glass, share this with my network." There is also a tiny touchpad on the headset's frame.

Wearable technologies like this face enormous challenges, however, particularly as head-mounted devices that offer a visual display. Human eyes are not designed to view details on anything so close, so the display has to fool the person's retina with an image that appears to be much further away. Google Glass uses a prism and mirrors positioned over the wearer's right eye to accomplish that.

Another concern is that a visual display could be a safety hazard, especially while driving. Little is known about how this kind of technology may affect people's visual attention and depth perception, although some argue that glancing away from the road to view a smartphone's navigation display is also distracting. In any case, the device certainly permits and encourages more multitasking, which often reduces human performance.

The fashion conscious may reject the Spartan look of Google Glass, which resembles the headset worn by Levar Burton in Star Trek: The Next Generation. *The device comes in different colors, and versions are also available for people who wear prescription lenses.*

Some privacy advocates have voiced concerns about Google Glass as well. What does it mean when people are always equipped to record whatever they see and instantly upload it to the Internet, without others knowing they are doing it? To some extent, mobile devices already offer that capability, but Google Glass raises the stakes even further. Some have resisted the technology. For example, a bar in Seattle banned customers from wearing the device, and other businesses may follow.

Lawmakers are especially concerned because Google has the capability to embed its increasingly sophisticated facial recognition software. At some point, the Glass wearer may be able to identify strangers on the street by matching the face to tagged photos on social networks. A group launched the website called StopTheCyborgs.org to draw attention to the many privacy issues surrounding Google Glass, comparing the devices to "human spy drones."

Google encourages developers to create new apps for Glass, ones that match the device's capabilities and don't just copy existing smartphone apps. One might want to read headlines on Glass, for instance, but not whole articles. The goal, according to Google, is to "complement" a person' life, rather than interfere with it.

Discussion Questions

3-23. Identify the major hardware, software, and communications components of Google Glass.

3-24. What are some of the advantages to using Google Glass and how will they add value to a customer's life?

3-25. What are the major risks associated with Google Glass?

3-26. If students wear Google Glass to attend lectures, will it have any negative impact on their performance?

Sources: Cohen, E. (March 13, 2013). The eyes have it: Google Glass and the myth of multitasking. *Scientific American*, http://blogs.scientificamerican.com/guest-blog/2013/03/13/the-eyes-have-it-google-glass-and-the-myth-of-multitasking/, accessed March 23, 2013.

Guarino, M. (2013, March 25). Google Glass already has some lawmakers on high alert. *Christian Science Monitor*. http://www.csmonitor.com/USA/Society/2013/0325/Google-Glass-already-has-some-lawmakers-on-high-alert.

Newton, C. (March 8, 2013). Seattle dive bar becomes first to ban Google Glass. cjnet, http://news.cnet.com/8301-1023_3-57573387-93/seattle-dive-bar-becomes-first-to-ban-google-glass/, accessed March 24, 2013.

Pachal, P. (March 22, 2013). Google Glass and the future of head-mounted displays. *Mashable*, http://mashable.com/2013/03/21/google-glass-technology/, accessed March 24, 2013.

CASE STUDY #2

Rolling Out Its 4G Network, Sprint Nextel Competes with Rivals

Sprint Nextel, AT&T, and Verizon play leapfrog as they upgrade their networks with new technologies that offer faster speeds, more bandwidth, and better coverage for mobile smartphones. While Sprint has about 56 million customers, AT&T and Verizon each have over 100 million.

Sprint initially invested heavily in WiMax, pinning its strategy to an early-to-market advantage with the nation's first 4G offering. However, WiMax is slower than 4G services based on a different technology called "LTE" (long-term evolution), and Sprint is phasing out its WiMax networks. It is also phasing out the Nextel network to reduce costs.

To attract customers, Sprint Nextel must provide distinctive services. For example, the company is working with radio broadcasters so that its smartphone users can receive local FM stations. Sprint would be the first wireless carrier to offer this live FM radio to the handset, a feature that many customers will find attractive.

Customers also want faster service, in more geographic areas. For Sprint, that means installing the towers and equipment that will send and receive the wireless signals. As of 2013, its 4G LTE network lagged behind AT&T and Verizon, both in terms of speed and geographic coverage, so the company has some catching up to do.

Before installing 4G antennas, the company has to identify the sites that will provide the best coverage for the area. For cities with tall buildings, large bodies of water, many hills and valleys, and high foliage, those choices are engineering brainteasers. In New York City, for instance, the urban "canyons" create dead spots that cause coverage problems. Sprint Nextel needs thousands of sites to provide adequate service.

Once sites are identified, Sprint must navigate a labyrinth of government agencies, local building codes, citizens' groups, and landowners to obtain approvals. In San Francisco, multiple bureaucracies may be involved, depending on the tower's location. The company may need approval from the California Coastal Commission for sites near the ocean, or from the California Department of Transportation. Municipalities may also compete with one another for towers, since they are a source of revenue, or they might insist they be constructed on city-owned property.

Some community and homeowner associations may also protest tower construction. Although Californians want 4G, they may value neighborhood aesthetics even more. The "NIMBY" mentality (Not In My Back Yard) further delays rollouts. Sprint Nextel and other carriers deal with this human element by hiding their equipment in church steeples or masking their appearance in other ways. Some are built to resemble trees (Figure 3-30). Sprint is widely known for its "green" environmental initiatives, and the tree-shaped towers support those corporate goals.

Some communities welcome the towers because of the revenue they will earn. For example, a struggling school district in California began negotiating with cell phone companies to see which one would offer the best deal. Some citizens objected because of possible health risks from radiation, but researchers point out that radiation from the handsets is a much larger factor. In fact, handset radiation drops as the number of towers increases because less power is needed to connect.

Despite all these technical and nontechnical hurdles, Sprint is making good progress and continues to expand coverage. Although the 4G LTE network may not be "real" 4G, defined by the nonprofit International Telecommunications Union (ITU) as an all IP packet-switched network with speeds in the 1 GB/s range, smartphone users eagerly anticipate more service in their cities. Step by step, Sprint is jumping through all the hoops to regain lost customers and compete with rivals.

Discussion Questions

3-27. What is the relationship between physical infrastructure and services as described in this case study?

3-28. What is the relationship between regulatory considerations and wireless services?

3-29. In the placement of infrastructure, how do the interests of an individual as a customer conflict with the interests of the same individual as a homeowner?

3-30. What components should Sprint inculcate in its EA to attract customers?

Sources: Carducci, A. (January 25, 2012). Cell-phone towers on California schools to enhance district's bottom line. *Heartland News*, http://news.heartland.org/newspaper-article/2012/01/25/cell-phone-towers-california-schools-enhance-districts-bottom-line, accessed March 29, 2013.
Cella, J. (2013). Sprint Nextel Corporation, Hoover's Online Database, accessed April 4, 2013.
Furchgott, R. (March 20, 2013). Who has the fastest LTE service? *New York Times*, http://gadgetwise.blogs.nytimes.com/2013/03/20/who-has-the-fastest-lte-service/, accessed March 24, 2013.
Sprint beats rivals on green initiatives. (March 8, 2013). *Environmental Leader*, http://www.environmentalleader.com/2013/03/08/sprint-beats-competitors-on-green-initiatives/, accessed March 24, 2013.
Sprint Nextel to Bring FM Service to Smartphone Users. (2013). *Telecommunications Reports, 79* (2), 18. Available from: Business Source Complete, Ipswich, MA. Accessed April 4, 2013.

FIGURE 3-30
A cell tower disguised as a pine tree.

E-PROJECT 1 Voluntary Distributed Computing

Sharing Some of Your Computer Time for a Worthy Goal

The voluntary distributed computing architecture model relies on the participation of millions of people who offer some spare computer time in exchange for an interesting screen saver and, of course, the good feeling that comes with contributing to a worthy goal. The University of California at Berkeley hosts BOINC, which lists projects that need volunteers (http://boinc.berkeley.edu).

3-31. Visit several BOINC project sites and examine the ways in which the project leaders are engaging volunteers and sustaining commitment. What strategies are they using and how well do they appear to be working?

3-32. Trust is a significant element for voluntary distributed computing, especially because users are warned about the dangers of downloading executable programs to their computers from unknown sources. Pick two BOINC projects, compare their privacy policies, and look for other ways in which they attempt to convince potential participants that their computer will not be harmed and their privacy will not be violated. How do the two projects compare?

E-PROJECT 2 Using Excel to Analyze Cost Effectiveness for 4G Rollouts

For this e-project, you will analyze data on U.S. municipalities to estimate approximately how many cell-phone towers the city will need and how many people will be able to access each tower. This kind of information helps the carriers decide which markets are most cost effective.

Download the Excel file called Ch03_Cities and answer the following questions.

3-33. Sort the cities by land area in square miles, largest to smallest. Which city has the largest land area? Which has the smallest?

3-34. Insert a column after Land Area in Square Miles and label it "Cell Towers Needed." For the first city in that column, enter the formula to divide the Land Area in Square Miles by 10, assuming that one tower will serve about 10 square miles. Copy the formula down to the remaining cities. About how many cell towers will Baltimore require?

PRODUCTIVITY TIP

If you live in the United States, visit www.antennasearch.com and enter your own address. The program will map the locations of all the nearby cell towers. Click on the towers nearest your home to obtain some information about them, such as the building they are on or their owner. Knowing their locations will help you avoid unpleasant call interruptions for important conversations.

3-35. Insert another column to the right of Cell Towers Needed, labeled "Estimated Cost." Enter the formula for the first city as "Cell Towers Needed" * 150000. Format the cell to currency with no decimals, and copy it down the whole column. About how much will it cost to build out the cell tower infrastructure in Chicago?

3-36. Insert one more column to the right of Population, labeled "Cost Per Customer." Insert the formula Estimated Cost/Population for the first city, and then copy the formula down the column. What is the estimated cost per customer for Houston?

3-37. Sort the table on Cost Per Customer, from smallest to largest.

a. Which city would have the lowest cost per customer, and what is the cost?
b. Which city has the highest cost per customer?
c. If you live in the United States and your city is listed, which one is it, and what is the estimated cost per customer? If your city is not listed, please select the closest city that is listed.
d. What is the main factor that accounts for the dramatic differences in cost per customer?