ACS-1803
Introduction to Information Systems

Instructor: Kerry Augustine

Telecommunications & The Internet

Lecture Outline 9-2

1

Network Computing

Computer Networking

- Networks have existed from the early stages of human civilization
  - Ancient Rome: Water supply system serving multiple communities covering large territories
- Network: "*a group or system of interconnected people or things*."
- A computer Network is a group of two or more computing devices that are linked through some medium
- Computer networks use computing and telecommunication technologies
  - Its evolution is at the interface of these two technologies
- What is the reason computer networks exist?

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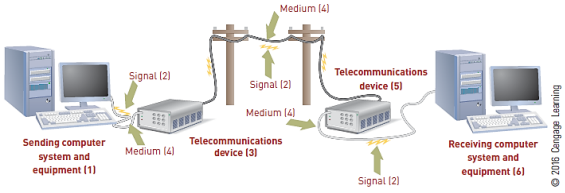
Telecommunications

- Telecommunications is the electronic transmission of signals for communications
- Telecommunications medium: any material substance that carries an electronic signal to support communications between a sending and receiving device



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Computer Network

- A computer network consists of two or more computing devices connected by a medium allowing the exchange of electronic information
- Consists of communications media, devices, and software needed to connect two or more computer systems or devices
  - Can transmit and receive information to improve organizational effectiveness and efficiency
- Network nodes: the computers and devices on the networks
- Organizations can use networks to share hardware, programs, and databases

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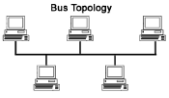
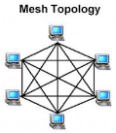
Network Topology

- Refers to how the communication links and the hardware devices are arranged on a network
  - Star Network
    - Connected through a hub node
  - Bus Network:
    - There is a common backbone
  - Mesh Network:
    - All devices are access points and connected to one another





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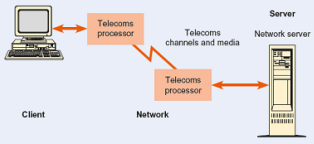
Client/Server Systems

- Client/server architecture features multiple computer platforms dedicated to special functions, e.g., database management, printing, or communications
- A **client** is any computer that sends messages requesting services from the servers on the network
- A database server sends only the data that meets a specific query—not the entire file

Figure 5.2 Components of a client/server system



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Network Types

- **Personal area networks:**
  - Support interconnection of information technology within a range of about 33 feet
- **Local area networks:**
  - Connect computer systems and devices within a small area (e.g., office or home)
  - Computer network in a small area
  - Private cabling (twisted pair or coaxial)
  - Some may be wireless
  - Usually has a file server ("captain")
- **Wide area networks:**
  - Connect large geographic regions
  - WANs consist of:
    - Computer equipment owned by the user
    - Data communications equipment and telecommunications links provided by various carriers and service providers

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Speed of Transmission

- **Channel bandwidth**: the rate at which data is exchanged, measured in bits/sec
- **Broadband communications**: a relative term; a telecommunications system that can transmit data very quickly > 25 Mbps
- Measures in bits per second (bps)
  - Thousands of bite per second - Kbps
  - Millions - Mbps
  - Billions - Gbps

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Transmission Media

- Physical pathways between network members
- Computers send *bits* to each other (+ / -)
- Different media chosen to make up pathways
- Cables: twisted pair, coaxial, fiber optic
- Wireless: infrared line of sight, high frequency radio, microwave
  - Wi-Fi
- Two broad categories
  - **Wired** (guided) transmission media: signals are guided along a solid medium
  - **Wireless**: the signal is broadcast over airwaves as a form of electromagnetic radiation

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Transmission Media

- Twisted-pair wire
  - Shielded or unshielded twisted pairs of copper wire
  - Used for telephone service
  - There are transmission and distance limitations
- Coaxial Cable
  - Inner conductor wire surrounded by insulation
  - Cleaner and faster data transmission than twisted-pair wire
  - More expensive too
- Fiber Optic
  - Thin strands of glass bound together in a shell, uses light beams to transmit signals
  - Smaller diameter than coaxial, less signal distortion, capable of high transmission rates
  - Even more expensive to purchase and install

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Wireless Technologies

- Wireless transmission involves the broadcast of communications in one of three frequency ranges
  - Radio, microwave, or infrared frequencies
- In some cases, use of wireless communications is regulated
  - The signal must be broadcast within a specific frequency range to avoid interference with other wireless transmissions

TABLE 4.2 Frequency ranges used for wireless communications

Technology	Description	Advantages	Disadvantages
Radio frequency range	Operates in the 3 KHz–300 MHz range	Supports mobile users; costs are dropping	Signal is highly susceptible to interception
Microwave—terrestrial and satellite frequency range	High-frequency radio signal (300 MHz–300 GHz) sent through the atmosphere and space (often involves communications satellites)	Avoids cost and effort to lay cable or wires; capable of high-speed transmission	Must have unobstructed line of sight between sender and receiver; signal is highly susceptible to interception
Infrared frequency range	Signals in the 300 GHz–400 THz frequency range	Lets you move, remove, and install devices without expensive wiring	Must have unobstructed line of sight between sender and receiver; transmission is effective only for short distances

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Networking Fundamentals – Media (Wireless)

Cellular Phone
A two-way wireless communication that assigns unique frequencies to calls and can transmit in analog or digital

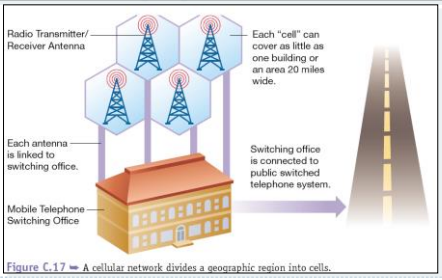

Figure C.17 ➡ A cellular network divides a geographic region into cells.

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Telecommunications Hardware

- Smartphones:
  - Combine the functionality of a mobile phone, camera, Web browser, e-mail tool, MP3 player, and other devices
  - Have their own software operating systems
  - Applications are developed by:
    - The manufacturers of the handheld device
    - The operators of the communications network on which they operate
    - Third-party software developers

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Communications Media

- **3G** wireless communications:
  - Supports wireless voice and broadband speed data communications in a mobile environment
- **4G** wireless communications:
  - 4G will also provide increased data transmission rates in the 20–40 Mbps range
  - LTE – Long Term Evolution
- **5G** is the latest generation of cellular mobile communications.
  - 5G performance targets high data rate, reduced latency, energy saving, cost reduction, higher system capacity, and massive device connectivity.

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Wireless Technologies

- **Near Field Communication (NFC)**
  - Short-range wireless connectivity
  - Used on cellphones and credit cards
- **Bluetooth**
  - Distances of 10-30 feet
  - Speed: 2Mbps
  - Devices must be paired to communicate
- **Wi-Fi**
  - Communication through a wireless adapter on the device (cellphone, Laptop, etc.)
  - The wireless adapter translates data into radio signals
  - Wireless access point connected to the computer
    - Transmitter, antenna, receives signal and decodes it

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Communications Media

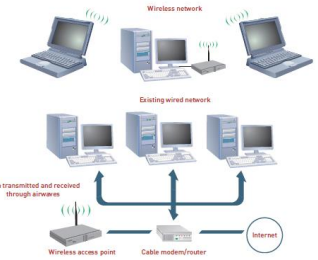

FIGURE 4.7
Wi-Fi network
In a Wi-Fi network, the user's computer, smartphone, or cell phone has a wireless adapter that translates data into a radio signal and transmits it using an antenna.

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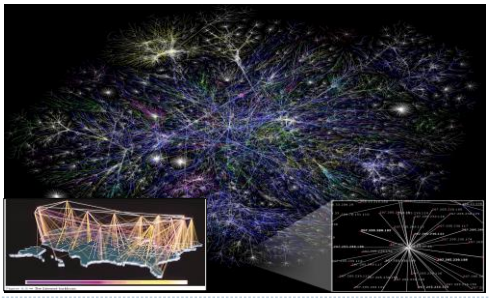
The Internet

The Internet "Network of Networks"

- Large, worldwide collection of networks that use a common protocol to communicate with each other



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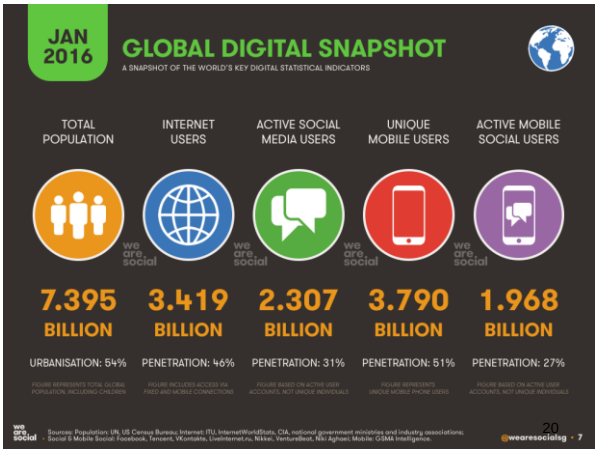

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How the Internet Works – Connecting to the Internet

ARPANET (Advanced Research Project Agency Network)
- Created in the 1960s by **DARPA** (Defense Advance Research Projects Agency)
- Used by **government** and **universities** for **research purposes**

Modem (stands for Modulate/Demodulate)
- A **modem** converts signals back and forth from **digital to analog** for transmission and receipt between computers
- A computer requires a modem to get access to the Internet

Internet Service Provider (ISP)
- These companies provides access to the **Internet** for a fee *(i.e. MTS, Shaw)*
- A computer is connected to an **ISP** through a **modem** to allow **Internet** access

Network Access Points (NAPs)
- NAP's connect ISPs together
- They serve as Internet **access points** for the ISPs and serve as **exchange points** for Internet traffic

Internet Backbone
- Collection of main **network connections** and **telecommunications lines** that make up the Internet

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Internet Backbone

- Network hardware that makes internet connections possible.
- Special technology for the construction of transmission lines. These networks do not serve end users, they connect equipment of each of the networks that participate.
- Internet service providing companies own this network hardware and they interconnect it to make worldwide communications possible.
  - Cables, routers, switches, antenna towers, satellites, etc…

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Network Protocols

- In general:
  - Protocol – set of rules on HOW to do something
- Here:
  - *agreed upon formats for transmitting data between connected computers*
- How to arrange data packets, how to signal end of message, how to specify destination address etc.

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TCP/IP & Routers

TCP/IP Approach

TCP – Transmission Control Protocol
- Breaks information into small chucks called data packets
- Manages the transfer of the packets from computer to computer
- Reassembles data packets into a message at the destination

IP – Internet Protocol
- Controls how data packets are formed
- Addresses each packet with the source and destination address
- A data packet conforming to the IP spec is called an **IP datagram**

Routers

Connect one network to another
- Identify each device on a network as unique using IP protocol
- Serve as the "Traffic Cop" directing packets to their destination

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Packet Switching

I want to communicate with you.	Original text message
00101101100010011011100011101	Text message digitized into bits
01100010 10101100 11000011	Digital bits broken into packets
0011001 10101100 11000011	Header information added to each packet indicating destination, and other control information, such as how many bits are in the total message and how many packets

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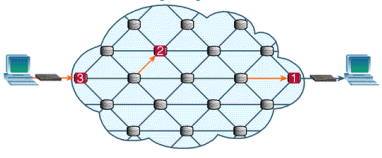
Packet Switching vs Circuit Switching

- Internet uses packet switching to enable users to transmit across it concurrently
- What is to be sent down the network is 'sliced up' into packets
- Each packet has header with source and destination address
- *Each computer attached to a network has a unique network address*

Packet routing through WAN/Internet



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The World Wide Web

The World Wide Web

- Developed by Tim Berners-Lee at CERN (c. 1980)
- Originally conceived of as an internal document-management system
- The Web has grown to become:
  - A primary source of news and information
  - An indispensible conduit for commerce
  - A popular hub for social interaction, entertainment, and communication

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Web Browsers

- A software program used to locate and display Web pages
- Includes text, graphics, and multimedia content

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World Wide Web - Architecture

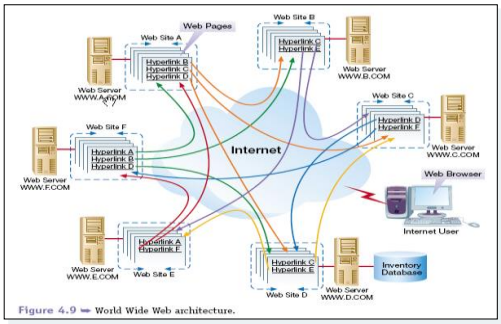

Figure 4.9 — World Wide Web architecture.

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Internet Protocol (IP) Addresses

- Each domain name
  - uwinnipeg.ca
- is associated with an IP Address
  - Number assigned to each device (e.g., computer, printer) participating in a network that uses the internet protocol (IP)
  - 32-bit numeric address (4.29 Billion IP addresses)
  - written as 4 numbers separated by periods (IPv4)
  - Domain name is translated to IP Address by a special server on the Internet
  - e.g.. 1.160.10.240

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IPv6

- June 6, 2012, Internet Society launched IPv6
- 128-bit addresses, able to handle up to 1 quadrillion addresses
- written as 6 sets of numbers marked by colons
- e.g.. 2001:db8:85a3::8a2e:370:7334

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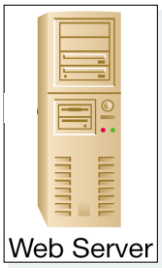
World Wide Web



Web Servers
- A **special** computer that is specifically designed to **store** and **"serve up"** Web pages
- This machine contains special **hardware** and **software** to perform its many specialized functions

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World Wide Web

Web Browser

Hypertext
- A Web page stored on a Web server
- Contains **information** and **links** to other related information (hyperlinks)

HTML (Hypertext Markup Language)
- A standard method used to **specify the format** of Web pages
- Uses **codes/tags** which stipulate how the content should appear to the user

Web Browser
- A software program used to **locate** and **display** Web pages
- Includes **text, graphics,** and **multimedia** content

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How the Internet Works – Web Addresses & Domains

Domain
- Identifies the Website (host)
- Comes in many **suffixes** such as:
  - .edu (educational institutions)
  - .org (organizations; non-profit)
  - .mil (military)
  - .net (network organizations)

Example: microsoft.com
uwinnipeg.ca

IP Address
- Each **domain** is associated with one or more **IP addresses**
- Format: a 32-bit address written as 4 numbers (from 0-255) separated by periods

Example: 1.160.10.240

(URL) Uniform Resource Locator
- Identifies particular Web pages within a domain

Example: http://www.microsoft.com/security/default.mspx

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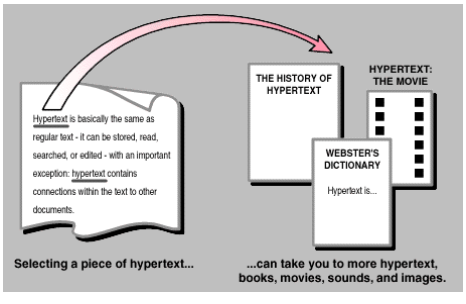
Web Browser and Hypertext



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HTML (Hypertext Markup Language

```
<html>
<head>
<link rel=File-List href="Index_files/filelist.xml">
<title>ACS 1803 Introduction to Information Systems</title>
</head>
<body lang=EN-CA link=blue vlink=purple style='tab-interval:36.0pt'>
   <h1><Welcome to Section 053</h1>
…
</body>
</html>
```

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A Website

- Collection of interlinked web pages created by the same author(s) for common purpose
- Respond to requests over the Internet from browsers according to the hypertext transfer protocol (http)
- URL (Uniform Resource Locator)
  - Each site has a URL address
  - http://www.uwinnipeg.ca

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Web addresses

- Website: http://www.yyy.zz
- Page on that site: http://www.yyy.zz/xx
- Domain name: yyy.zz
- Prefix: *yyy* e.g. *uwinnipeg*
- Suffix: zz
- e.g.
  - *.com* – business
  - .org – nonprofit organization
  - .ca - Canada

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Internet email address

john@uwinnipeg.ca
e–mail address has @ symbol

user name @ domain name
Domain names (general areas):
.com commercial organization
.edu educational organization
.gov government organization

.ca Canada
.us U.S.
.hk Hong Kong

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Types of Websites

1. Static: collection of static documents created in HTML and tied together with links
2. Static with forms: 90% is pure document delivery, but also has fill-in forms to collect information from the user
3. Dynamic Data Access: via a Web page, users can search a catalogue or perform queries on the contents of a database, e.g. University Course Registration
4. Web-based Software Applications: facilitate business processes beyond voiding information; have a business information system on a Web-site, e.g., inventory tracking, sales force automation

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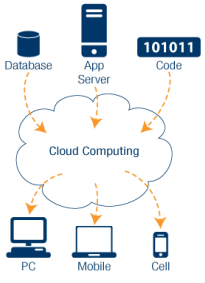
Cloud Computing

- Software and storage provided as an internet service and accessed within a web browser
- Example: Email, Data storage, skydrive, tax software, flicker, facebook.
- Soon most computing will take place on the internet



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Cloud Computing – Advantages to Businesses

- Outsourcing Resources – Saves on system design, installation, and maintenance
- Provides an ability to access corporate systems from any Internet-connected device
- Increases the data storage capabilities of the firm
- Data safeguarding responsibility of service provider

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Google Cloud Centre

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Search Engines

- Search engines are programs that search documents for specified keywords and returns a list of the documents (web pages) where the keywords were found
- Biggest application on the web
- Web Search is such a profitable business (Google $136.8B annual revenue) because it is an application that is of use to everybody
- Search engines are an important contributor to the development of the Web and the Internet
- Today businesses build their websites using `*Search Engine Optimization (SEO)*`

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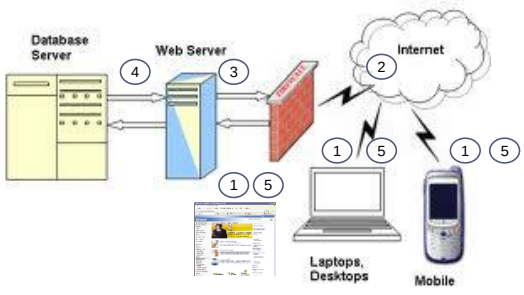
Overview of a Web Session



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Overview of a Web Session

1. User, with browser software, requests a document from a remote Web server on the Internet
   - enters desired address as Uniform Resource Locator (URL) e.g., http://www.irwin.com
2. Actual address is determined from a domain name server (computer) on the Internet
3. Once the machine has been located, a request can be sent to the server
   - discussion between the Web browser and the Web server is handled by HTTP (hypertext transfer protocol - defines how a client must ask for data (pages) from the server and how the server responds when it returns what was asked for

{HTTP does not specify how the data is transferred, that is up to TCP/IP, at a lower level}

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Overview of a web session (cont`d)

4. Server attempts to process request (is it valid?)
   - they send data from disk onto the network; it uses **Web Server software**, such as Apache
5. The browser, on the client, reads what has been sent to it, identifies it as an HTML document, and places the page in the browser window
   - information moves from the network or modem to the client system
   - once in the client computer, information goes along a bus to the hard disk or into main memory (browser might temporarily put info onto disk)
   - it is then processed by the browser software only)

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The Internet Summary

- Three important concepts:
  1. Client/server computing
  2. Packet switching
  3. TCP/IP communications protocol

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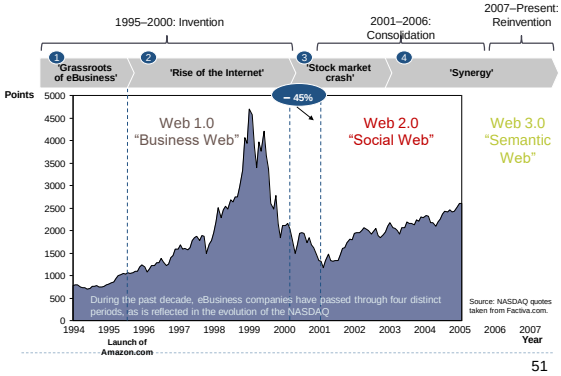
Web 1.0 -> 2.0 -> 3.0

The Evolution of the Web



Web 1.0 - Web 2.0 - Web 3.0

- **Web 1.0** = display simple pages, allow non-linear navigation
- **Web 2.0** = user-centered applications and social media technologies
  - User-generated content and communication
  - Highly interactive, social communities
  - Large audiences; yet mostly unproven business models
  - Examples: Twitter, YouTube, Instagram, Wikipedia, Tumblr
- **Web 3.0** = Semantic Web = The Intelligent Web = Internet of Things
  - Convergence of several emerging technology trends: Ubiquitous Connectivity (i.e. mobile devices); Network Computing (SaaS); Open Technologies (i.e. open API's, open data, open source); Open Identity (i.e. portable identity and personal data)

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Transforming Web 2.0 to Web 3.0

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The Future Internet – Web 3.0

- The Internet2 Project
  - Consortium of 350+ institutions collaborating to facilitate revolutionary Internet technologies
  - Guaranteed service levels and lower error rates
    - Ability to purchase the right to move data through network at guaranteed speed in return for higher fee
- The Internet of Things (IoT)
  - Objects connected via sensors/RFID to the Internet
  - 8 ways the Internet of things will change the way we live and work
  - 16 Stunning Statistics that Forecast the Future of the Internet of Things

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The Internet of Things (IoT)

- Internet of Things (IoT)
  - A network of physical objects (things) embedded with sensors, processors, software, and network connectivity capability to enable them to exchange data with the manufacturer of the device, device operators, and other connected devices
- Sensor: a device that is capable of sensing something about its surroundings such as
  - Pressure, temperature, humidity, pH level, motion, vibration, or level of light

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The Internet of Things (IoT)

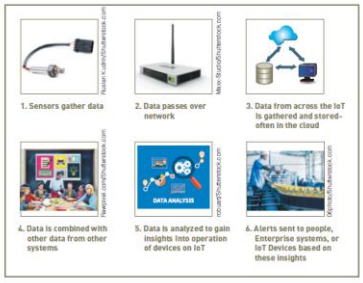

FIGURE 4.25
The Internet of Things
The IoT is a network of physical objects or "things" embedded with sensors, processors, software, and network connectivity capability to enable them to exchange data with the manufacturer of the device, device operators, and other connected devices.

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The Internet of Things (IoT)

- Examples of using sensors and the IoT to monitor and control key operational activities:
  - Asset monitoring
  - Construction
  - Agriculture
  - Manufacturing
  - Monitoring parking spaces
  - Predictive Maintenance
  - Retailing
  - Traffic monitoring

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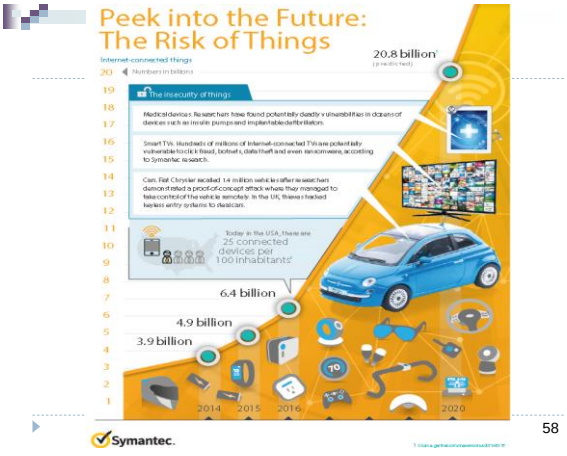
Peek into the Future:
The Risk of Things
Internet-connected things
Numbers in billions
20.8 billion
The insecurity of things
Today in the USA, there are 25 connected devices per 100 inhabitants
6.4 billion
4.9 billion
3.9 billion
2014
2015
2016
2020
Symantec.

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