Electronic Commerce 12th edition Gary Schneider Solutions Manual

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Chapter 2

Technology Infrastructure: The Internet and the World Wide Web

At a Glance

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Lecture Notes

Introduction

A growing number of Internet users, especially in developing countries, use a smartphone or a tablet device instead of a computer to go online. Many companies have developed Web sites that work well on the smaller screens and keyboards of these devices. However, as the number of Internet users connected through mobile telephone networks increases, the volume is taxing existing technologies and threatening to overload networks.

Wireless telephone networks use antennas on towers to collect mobile device signals and transfer them into a wired network through equipment at the base of the towers. As more users operate devices within the range of a particular tower, the speed of service each user experiences slows down, sometimes significantly. Currently the only solution is for telecommunications companies to add more cell towers, which is expensive and requires locations that can be hard to acquire.

With mobile data traffic expected to double in 2017 and triple in 2018, the search for solutions is underway. Steve Perlman, the developer of WebTV is working on pCell, which has been shown in lab tests to operate at 35 times the speed of current wireless network technologies. It is currently being tested with Dish Network in San Francisco.

Instead of cell towers, pCell creates a network of "personal cells" based on each device using a series of small radio transmitters. It is designed to work with existing mobile devices and gives each device access to the full speed of the network.

This chapter addresses technologies that created the Internet and enabled the World Wide Web to emerge as a powerful global business platform. The continuing development of these technologies will make new digital products and services available in the future.

Learning Objectives

In this chapter, students will learn:

- About the origin, growth, and current structure of the Internet
- How packet-switched networks are combined to form the Internet
- How Internet, e-mail, and Web protocols work
- About Internet addressing and how Web domain names are constructed
- About the history and use of markup languages on the Web
- How HTML tags and links work
- About the cost and performance of Internet connection technologies
- About Internet2 and the Semantic Web

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Teaching Tips

The Internet and the World Wide Web

1. Introduce the terms **computer network**, an **internet**, and the **Internet.**

2. Note that networks of computers and the Internet that connects them to each other form the basic technological structure that underlies virtually all electronic commerce.

3. Introduce the term **World Wide Web** (**Web**).

Origins of the Internet

1. Explain the 1960 origins of the Internet by discussing the need for powerful computers for coordination and control of weapons defense systems. Note that the initial research goal was to design a worldwide network that could remain operational, even if parts of the network were destroyed by enemy military action or sabotage.

2. Emphasize that the computer networks that existed at that time used leased telephone company lines for their connections. Note that the Defense Department was concerned about the inherent risk of a single-channel method for connecting computers, and its researchers developed a different method of sending information through multiple channels using packets.

3. Describe the 1969 ARPANET network developed by Defense Department researchers in the Advanced Research Projects Agency (ARPA). Emphasize that the ARPANET was the earliest of the networks that eventually combined to become what we now call the Internet.

4. Note that throughout the 1970s and 1980s, many researchers in the academic community connected to the ARPANET and contributed to the technological developments that increased its speed and efficiency. At the same time, researchers at other universities were creating their own networks using similar technologies.

New Uses for the Internet

1. Students will be very interested to learn that e-mail was born in 1972 when Ray Tomlinson, a researcher who used the network, wrote a program that could send and receive messages over the network.

2. Introduce the terms **mailing list**, **Usenet** (**User's News Network**), and **newsgroups**.

3. Mention that the use of the networks was limited to those members of the research and academic communities who could access them.

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4. Between 1979 and 1989, network applications were improved and tested by an increasing number of users. As the number of people in different organizations using these networks increased, security concerns arose; these concerns continue to be problematic.

Commercial Use of the Internet

1. An important fact to point out is that, in 1989, the National Science Foundation (NSF) permitted two commercial e-mail services, MCI Mail and CompuServe, to establish limited connections to the Internet for the sole purpose of exchanging e-mail transmissions with users of the Internet.

2. Note that as the 1990s began, people from all walks of life (not just scientists or academic researchers) started thinking of these networks as the global resource that we now know as the Internet.

Growth of the Internet

1. Emphasize that the privatization of the Internet was substantially completed in 1995, when the NSF turned over the operation of the main Internet connections to a group of privately owned companies.

2. Introduce the terms **network access points (NAPs)**, **network access providers**, and **Internet service providers (ISPs)**.

3. Define the term **Internet hosts** and refer to Figure 2-1 to illustrate the dramatic growth in the number of Internet hosts.

The Internet of Things

1. Point out that in recent years, devices other than computers have been connected to the Internet, such as mobile phones and tablet devices. The connection of these devices to the Internet serves to connect the users of those devices to each other. However, the connection of devices to the Internet that are not used by persons is increasing rapidly.

2. Explain how computers can also be connected to each other using the Internet to conduct business transactions without human intervention.

3. Define the term **Internet of Things**.

Teaching Tip	To learn more about the Internet of Things, see: http://www.internet-of-things.eu/

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Quick Quiz 1

1. The ____ is a particular internet, which uses a specific set of rules and connects networks all over the world to each other.
   Answer: Internet

2. A(n) ____ is an e-mail address that forwards any message it receives to any user who has subscribed to the list.
   Answer: mailing list

3. ____ sell Internet access rights directly to larger customers and indirectly to smaller firms and individuals through other companies, called Internet service providers (ISPs).
   Answer: Network access providers

4. ____ are computers directly connected to the Internet.
   Answer: Internet hosts

5. The subset of the Internet that includes computers and sensors connected to each other for communication and automatic transaction processing is often called the ____.
   Answer: Internet of Things

Packet-Switched Networks

1. Introduce the terms **local area network (LAN)** and **wide area networks (WANs)**.

2. Note that the early models for WANs were the circuits of the local and long-distance telephone companies of the time, because the first early WANs used leased telephone company lines for their connections.

3. Introduce the terms **circuit**, **circuit switching**, **packet-switched**, and **packets**.

Routing Packets

1. Introduce the terms **routing computers**, **router computers**, **routers**, **gateway computers**, **border routers** (**edge routers**), **routing algorithms**, **routing tables**, and **configuration tables**.

2. Point out that individual LANs and WANs can use a variety of different rules and standards for creating packets within their networks. The network devices that move packets from one part of a network to another are called hubs, switches, and bridges. Emphasize that routers are used to connect networks to other networks.

3. An important concept for students to understand is that when packets leave a network to travel on the Internet, they must be translated into a standard format. Routers usually perform this translation function.

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4. Refer to the diagram in Figure 2-2 to illustrate a small portion of the Internet that shows an organizations router-based architecture. The figure shows only the routers that connect each organization's WANs and LANs to the Internet, not the other routers that are inside the WANs and LANs or that connect them to each other within the organization.

5. Introduce the terms **Internet backbone** and **backbone routers**.

Teaching Tip	To learn more about routing tables, see: http://compnetworking.about.com/od/hardwarenetworkgear/f/routing_table.htm

Public and Private Networks

1. Introduce the terms **public network**, **private network**, and **leased line**.

2. Note that the advantage of a leased line is security.

3. Explain why the largest drawback to a private network is the cost of the leased lines, which can be quite expensive.

Virtual Private Networks (VPNs)

1. Introduce the term **virtual private network** (**VPN**).

2. Introduce the terms **IP tunneling**, **encapsulation**, and **IP wrapper**.

3. Explain that the word *virtual* is used as part of VPN because, although the connection appears to be a permanent connection, it is actually temporary. The VPN is created, carries out its work over the Internet, and is then terminated.

Intranets and Extranets

1. Remind students that in the early days of the Internet, the distinction between private and public networks was clear. However, as networking (and inter-networking) technologies became less expensive and easier to deploy, organizations began building more and more internets (small "i"), or interconnected networks.

2. Distinguish between the terms **intranet** and **extranet**. Point out that "intranet" is used when the internet does not extend beyond the boundaries of a particular organization; "extranet" is used when the internet extends beyond the boundaries of an organization and includes networks of other organizations.

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Quick Quiz 2

1. A network of computers that are located close together is called a(n) ____.
   Answer: local area network (LAN)

2. The combination of telephone lines and the closed switches that connect them to each other is called a(n) ____.
   Answer: circuit

3. (True or False) Although circuit switching works well for telephone calls, it does not work as well for sending data across a large WAN or an interconnected network like the Internet.
   Answer: True

4. The computers that decide how best to forward each packet are called ____.
   Answer: routing computers, router computers, routers, gateway computers, border routers, edge routers

Internet Protocols

1. Define **protocol**. Introduce the terms **Network Control Protocol (NCP)**, **proprietary architecture**, **closed architecture**, and **open architecture**.

2. Review the four key rules for message handling.

3. Explain how the open architecture approach has contributed to the success of the Internet because computers manufactured by different companies (Apple, Dell, Hewlett-Packard, etc.) can be interconnected.

TCP/IP

1. Introduce the terms **Transmission Control Protoco**l (**TCP**) and **Internet Protocol** (**IP**).

2. Explain that the TCP controls the disassembly of a message or a file into packets before it is transmitted over the Internet, and it controls the reassembly of those packets into their original formats when they reach their destinations. The IP specifies the addressing details for each packet, labeling each with the packet's origination and destination addresses.

3. Emphasize that in addition to its Internet function, TCP/IP is used today in many LANs. The TCP/IP protocol is provided in most personal computer operating systems commonly used today, including Linux, Macintosh, Microsoft Windows, and UNIX.

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IP Addressing

1. Introduce the terms **Internet Protocol version 4** (**IPv4**) and **IP address**.

2. Explain that computers do all of their internal calculations using a **base 2** (or **binary**) number system in which each digit is either a 0 or a 1, corresponding to a condition of either off or on.

3. Introduce the term **dotted decimal**.

4. Note that today, IP addresses are assigned by three not-for-profit organizations: the American Registry for Internet Numbers (ARIN), the Reséaux IP Européens (RIPE), and the Asia-Pacific Network Information Center (APNIC).

5. Inform your students on how to use the ARIN Whois page at the ARIN Web site to search the IP addresses owned by organizations in North America.

6. Point out that, in the early days of the Internet, the four billion addresses provided by the Internet Protocol version 4 (IPv4) rules certainly seemed to be more addresses than an experimental research network would ever need.

7. Introduce the terms **subnetting**, **private IP addresses**, and **Network Address Translation (NAT)**.

Teaching Tip	To learn more about TCP/IP and subnetting, see: http://support.microsoft.com/kb/164015.

8. Point out that the Internet Engineering Task Force (IETF) worked on several new protocols that could solve the limited addressing capacity of IPv4 and, in 1997, it approved **Internet Protocol version 6** (**IPv6**) as the protocol that will replace IPv4.

9. Note that the last available IPv4 addresses were allocated in summer 2015. Companies that still need IPv4 addresses can buy them on secondary markets or use subnetting and their NAT devices to adapt their traffic to IPv6.

10. Explain the major advantage of IPv6. It uses a 128-bit number for addresses instead of the 32-bit number used in IPv4.

11. Discuss the IPv6 shorthand notation system for expressing addresses. Introduce the terms **colon hexadecimal** or **colon hex**. Explain the **hexadecimal** (**base 16**) numbering system that uses 16 characters (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, a, b, c, d, e, and f).

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Electronic Mail Protocols

1. Introduce the term **electronic mail** (**e-mail**).

2. Explain that most organizations use a client/server structure to handle e-mail.

3. Introduce the terms **e-mail server** and **e-mail client software**.

4. Emphasize that if e-mail messages did not follow standard rules, an e-mail message created by a person using one e-mail client program could not be read by a person using a different e-mail client program.

5. Introduce the terms **Simple Mail Transfer Protocol (SMTP)**, **Post Office Protocol (POP)**, **Multipurpose Internet Mail Extensions (MIME)**, and **Interactive Mail Access Protocol (IMAP)**.

Web Page Request and Delivery Protocols

1. Introduce the terms **Web client computers**, **Web client software**, **Web browser software**, **Web server software**, **client/server architecture**, **Hypertext Transfer Protocol (HTTP)**, and **Uniform Resource Locator (URL)**.

Quick Quiz 3

1. A(n) ____ is a collection of rules for formatting, ordering, and error checking data sent across a network.
   Answer: protocol

2. (True or False) The IP controls the disassembly of a message or a file into packets before it is transmitted over the Internet, and it controls the reassembly of those packets into their original formats when they reach their destinations.
   Answer: False

3. The term ____ refers to the use of reserved private IP addresses within LANs and WANs to provide additional address space.
   Answer: subnetting

4. The purpose of a(n) ____ is to respond to requests for Web pages from Web clients.
   Answer: Web server

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Emergence of the World Wide Web

1. Set the stage by mentioning that the ideas behind the Web developed from innovative ways of thinking about and organizing information storage and retrieval.

2. Point out that two important ideas that became key technological elements of the Web are hypertext and graphical user interfaces.

The Development of Hypertext

1. Briefly describe:
    a. Vannevar Bush's Memex hypothetical machine that would include mechanical aids, such as microfilm readers and indexes, that would help users quickly and flexibly consult their collected knowledge.
    b. Ted Nelson's description of a system in which text on one page links to text on other pages.
    c. Doug Englebart's first experimental hypertext system on one of the large computers of the 1960s.
    d. Tim Berners-Lee's project to improve the laboratory research document-handling procedures for his employer.

2. Introduce the terms **hypertext**, **hypertext server**, **Hypertext Markup Language** (**HTML**), **Web servers**, and **hypertext link/hyperlink**.

Graphical Interfaces for Hypertext

1. Introduce the term **Web browser**.

2. Describe the difference between an HTML document and a word-processing document.

3. Define the basic functions of a **graphical user interface** (**GUI**): presenting program control functions and program output to users and accepting their input.

The World Wide Web

1. Note that initially, few people outside the scientific research community had software that could read HTML documents on the World Wide Web.

2. Describe the historical significance of Mosaic, the first GUI program that could read HTML and use HTML hyperlinks to navigate from page to page on computers anywhere on the Internet.

3. Use Figure 2-3 to illustrate the overall rapid growth rate of the Web.

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4. Invite students to offer ideas explaining the increase in the number of Web sites that occurred from 2010 to 2011, with the number of sites doubling.

The Deep Web

1. Using the example of visiting Amazon.com and searching for a book about "online business," computers, briefly describe the concept of the **deep Web**. Explain that the query of the databases' information about books is used to create a Web page that is a customized response to the user's search.

2. Note that the deep Web can be difficult or impossible to search because its information is not stored on the Web, but in databases that are searched only when a user requests that information through the Web site that maintains the database.

Teaching Tip	To learn more about the deep Web, see: http://money.cnn.com/2014/03/10/technology/deep-web/ and http://computer.howstuffworks.com/internet/basics/how-the-deep-web-works.htm

Domain Names

1. Introduce the concept of **domain names** and the term **top-level domain** (**TLD**).

2. Note that, since 1998, the Internet Corporation for Assigned Names and Numbers (ICANN) has had the responsibility of managing domain names and coordinating them with the IP address registrars.

3. Introduce the terms **generic top-level domain (gTLD)** and **sponsored top-level domain (sTLD)**.

4. Use Figure 2-4 to illustrate a list of some commonly used TLDs, including gTLDs and some of the more frequently used country TLDs.

Quick Quiz 4

1. A(n) ____ is a software interface that lets users read (or browse) HTML documents and move from one HTML document to another through text formatted with hypertext link tags in each file.
   Answer: Web browser

2. A(n) ____ is a way of presenting program control functions and program output to users and accepting their input.
   Answer: graphical user interface (GUI)

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3. The store of information that is available through the Web is called the ____.
   Answer: deep Web

4. ____ are sets of words that are assigned to specific IP addresses.
   Answer: Domain names

Markup Languages and the Web

1. Discuss the most important parts of a Web page - the structure of the page and the text that makes up the main part of the page.

2. Introduce the terms **text markup language**, **markup tags (tags)**, **Standard Generalized Markup Language (SGML)**, **Worldwide Web Consortium (W3C)**, and **Extensible Hypertext Markup Language (XHTML)**.

3. Refer to Figure 2-5 to illustrate how HTML, XML, and XHTML have descended from the original SGML specification.

Hypertext Markup Language

1. Introduce the concept of **hypertext elemen**ts.

2. Explain to students that HTML is easier to use than SGML and is the prevalent markup language used to create documents on the Web today. The W3C maintains detailed information about HTML versions and related topics on its W3C HTML Working Group page.

3. The latest version of HTML is 5.0 which was finalized in 2014. You can learn more about it by visiting the W3C HTML 5 page.

4. Introduce the terms **metalanguage** and **Extensible Markup Language (XML)**.

HTML Tags

1. Most HTML tags have an opening tag and a closing tag that format the text between them.

2. Figure 2-6 shows some sample text marked up with HTML tags. Figure 2-7 shows this text as it appears in a Web browser.

HTML Links

1. Note that users can read Web pages in serial order or in whatever order they prefer by following hyperlinks.

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2. Figure 2-8 illustrates the differences between reading a paper catalog in a linear way and reading a hypertext catalog in a nonlinear way.

3. Introduce the terms **linear hyperlink structure**, **hierarchical hyperlink structure**, **home page** or **start page**, and **site map**.

4. Figure 2-9 illustrates three common Web page organization structures: linear, hierarchical and hybrid.

5. Introduce the term **anchor tag**.

Cascading Style Sheets

1. Introduce the terms **style sheet** and **cascading style sheet**.

2. Note that the term cascading is used because designers can apply many style sheets to the same Web page, one on top of the other, and the styles from each style sheet flow (or cascade) into the next.

Extensible Markup Language (XML)

1. As companies began to conduct business online, they turned to XML to help them maintain Web pages that contained large amounts of data.

2. Point out that XML includes data-management capabilities that HTML cannot provide. Use Figures 2-10 and 2-11 to illustrate how HTML might be used to display a Web page that includes a list of countries and some basic facts about each country.

3. Explain that XML differs from HTML in two important respects. First, XML is not a markup language with defined tags. It is a framework within which individuals, companies, and other organizations can create their own sets of tags. Second, XML tags do not specify how text appears on a Web page; the tags convey the meaning (the semantics) of the information included within them.

   - Refer to Figures 2-12 and 2-13 to illustrate the difference between appearance and semantics.

4. Emphasize that the greatest strengths of XML is that allows users to define their own tags, but that this is also its greatest weakness. To overcome that weakness, many companies have agreed to follow common standards for XML tags. These standards, in the form of **data-type definitions (DTDs)** or **XML schemas**, are available for a number of industries including **LegalXML, MathML,** and **Extensible Business Reporting Language (XBRL).**

5. Introduce the term **XML vocabulary**.

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6. Note that although it is possible to display XML files in some Web browsers, XML files are not intended to be displayed in a Web browser.

7. Introduce the terms **Extensible Style sheet Language (XSL)** and **XML parsers**.

8. Use Figure 2-14 to illustrate a diagram showing one way that a Web server might process HTTP requests for Web pages generated from an XML database in different formats for different Web browsing devices.

Teaching Tip	To learn more about XML, see: http://www.w3schools.com/xml/default.ASP

Quick Quiz 5

1. A(n) ____ language specifies a set of tags that are inserted into the text.
   Answer: text markup

2. A(n) ____ structure resembles conventional paper documents in that the reader begins on the first page and clicks the Next button to move to the next page in a serial fashion.
   Answer: linear hyperlink

3. In HTML, hyperlinks are created using the HTML ____.
   Answer: anchor tag

4. (True or False) XML files, like HTML files, can be created in any text editor.
   Answer: True

Internet Connection Options

1. Introduce the term **Internet access providers (IAPs)**.

Connectivity Overview

1. Review the most common connection types ISPs offer: voice-grade telephone lines, various types of broadband connections, leased lines, and wireless.

2. Introduce the term **bandwidth**. Discuss the major distinguishing factors between various ISPs and their connection options - that is, the bandwidth they offer.

3. Introduce the term **net bandwidth**.

4. Note that bandwidth can differ for data traveling to or from the ISP depending on the user's connection type. Connection types include **symmetric connections** and **asymmetric connections**.

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5. Introduce the terms **upstream bandwidth** (**upload bandwidth**) and **downstream bandwidth** (**downstream bandwidth** or **downlink bandwidth**).

Voice-Grade Telephone Connections

1. Introduce the terms **plain old telephone service** (**POTS**) and **broadband** services.

Broadband Services

1. Introduce the terms **Digital Subscriber Line** (**DSL**) and **asymmetric digital subscriber line** (**ADSL**, usually abbreviated **DSL**).

2. Explain that DSL connection methods do not use a modem. Note that unlike DSL, cable modem connection bandwidths vary with the number of other subscribers competing for the shared resource.

Leased-Line Connections

1. Introduce the terms T1 line, T3 line, **frame relay**, **asynchronous transfer mode** (**ATM**), and **optical fiber**.

Wireless Connections

- Note that the Internet was built on telephone company wires and infrastructure but that many Internet users today use some form of wireless connection.

Wireless Ethernet (Wi-Fi)

1. Introduce the terms **Wi-Fi** and **wireless Ethernet**.
2. Note that the technology is also known by its network specification number (802.11) and that the latest version, 802.11ac, is replacing 802.11n because it has greater bandwidth.
3. Introduce the terms **wireless access point** (**WAP**), **roaming**, and **hot spots**.

Personal area networks

1. Introduce the terms **Bluetooth**, **personal area networks** (**PANs**) or **piconets**, **Ultra Wideband** (**UWB**) and **ZigBee**.
2. One major advantage of Bluetooth technology is that it consumes very little power, which is an important consideration for mobile devices.
3. Many observers believe that UWB technologies will be used in future personal area networking applications such as home media centers and in linking mobile phones to the Internet.

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4. An increasing number of applications have been developed to run on ZigBee that control home energy management systems (including lighting, heating, cooling), commercial building automation, security systems, and remote controls for consumer electronic products.

Fixed-Point Wireless

1. Introduce the terms **fixed-point wireless**, **repeaters** (**transceivers**) and **mesh routing**.

Satellite Microwave

1. Satellite microwave transmissions made Internet connection possible for the first time to many people in rural areas and are now used by airlines to provide inflight Internet.
2. While satellite networks were the only option for many years, many types of wireless networks are now available.

Mobile Telephone Networks

1. Introduce the term **short message service** (**SMS**).
2. Review data transmission speeds for mobile data including **third-generation (3G) wireless technology**, **Long Term Evolution** (**LTE**) and **Worldwide Interoperability for Microwave Access** (**WiMAX**), that are generally referred to as **fourth-generation (4G) wireless technology**.
3. Note that most tablet devices, mobile phones, and smartphones have the ability to use either a mobile telephone network or a locally available wireless network.
4. Refer to Figure 2-15 to summarize the speed and cost information for the most commonly available wired and wireless options for connecting a home or business to the Internet.

Teaching Tip	To learn more about WiMAX, see: http://computer.howstuffworks.com/wimax.htm

Quick Quiz 6

1. ____ is the amount of data that can travel through a communication line per unit of time.
   Answer: Bandwidth

2. ____ connections provide the same bandwidth in both directions.
   Answer: Symmetric

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3. The telephone lines used to cover the vast distances between rural customers are usually ____ lines, which cost less than telephone lines designed to carry data, are made of lower-grade copper, and were never intended to carry data.
   Answer: voice-grade

4. The most common wireless connection technology for use on LANs is called ____.
   Answer: Wi-Fi, wireless Ethernet, or 802.11n

5. Many mobile phones have a small screen and can be used to send and receive short text messages using a protocol called ____.
   Answer: short message service (SMS)

Internet2 and the Semantic Web

1. Students will find it interesting to learn that Internet2 is also used by universities to conduct large collaborative research projects that require several supercomputers connected at very fast speeds or that use multiple video feeds, features that would be impossible on the Internet given its lower bandwidth limits.

2. Introduce the terms **Semantic Web**, **software agents**, **resource description framework (RDF)**, and **ontology**.

3. Note that thus far, several areas of scientific inquiry have begun developing ontologies that will become the building blocks of the Semantic Web in their areas.
   - Biology, genomics, and medicine have all made progress toward specific ontologies.
   - Other sciences, such as climatology, hydrology, and oceanography have similar incentives (as many researchers around the world work on common problems such as global warming) and scientists are developing ontologies for their disciplines.

4. Introduce students to the Dbpedia project.

5. Note that current commercial applications of Semantic Web community research include the natural language interfaces of mobile phone search utilities such as Siri and Google Now.

Teaching Tip	To learn more about Internet2, see: http://www.internet2.edu/about-us/

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Quick Quiz 7

1. ____ is used by universities to conduct large collaborative research projects that require several supercomputers connected at very fast speeds, or that use multiple video feeds, features that would be impossible on the Internet given its lower bandwidth limits.
   Answer: Internet2

2. A(n) ____ is a set of standards for XML syntax.
   Answer: resource description framework (RDF)

3. The ____ project envisions words on Web pages being tagged (using XML) with their meanings.
   Answer: Semantic Web

4. A(n) ____ is a set of standards that defines, in detail, the relationships among RDF standards and specific XML tags within a particular knowledge domain.
   Answer: ontology

Class Discussion Topics

1. Is there a practical application for the W3C Semantic Web?

2. What is the difference between the Internet and the World Wide Web?

3. What do you think is the main motivation for the creation of Internet2?

4. What is a software agent and why is it such an integral part of Internet2?

Additional Projects

1. Provide answers for the following questions:
   a. How will Internet2 benefit current Internet users?
   b. Is Internet2 a separate network and will it replace the current commercial Internet?
   c. What kind of technology will be needed to use the advanced Internet applications and technologies?
   d. What are some of Internet2's long-term goals?

2. Describe how a VPN connection using IP tunneling allows company employees in remote locations to send sensitive information to company computers.

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Additional Resources

1. Routing packets: http://computer.howstuffworks.com/router5.htm
2. Frame relay: http://www.arcelect.com/frame_relay-56kbps_ft1-t1.htm
3. Introduction to RDF: http://www.w3schools.com/webservices/ws_rdf_intro.asp

Key Terms

- **ADSL**: one of the newest technologies that uses the DSL protocol to provide service in the broadband range. It provides transmission bandwidths from 100 to 640 Kbps upstream and from 1.5 to 9 Mbps (million bits per second) downstream.
- **Anchor tag**: used to create HTML hyperlinks.
- **Asymmetric connections**: provide different bandwidths for each direction.
- **Asymmetric digital subscriber line (ADSL)**: one of the newest technologies that uses the DSL protocol to provide service in the broadband range. It provides transmission bandwidths from 100 to 640 Kbps upstream and from 1.5 to 9 Mbps (million bits per second) downstream.
- **Asynchronous transfer mode (ATM)**: technology used by NAPs.
- **Backbone routers**: very large computers that can each handle more than 5 billion packets per second.
- **Bandwidth**: the amount of data that can travel through a communication line per unit of time.
- **Base 2 (binary)**: number system in which each digit is either a 0 or a 1, corresponding to a condition of either off or on.
- **Bluetooth**: one of the first wireless protocols, designed for personal use over short distances.
- **Border router**: the computer that decides how best to forward each packet.
- **Broadband**: connections that operate at speeds of greater than about 200 Kbps.
- **Cascading style sheet (CSS)**: a specific type of style sheet that can be applied to each Web page, one on top of the other, and the styles from each style sheet flow (or cascade) into the next.
- **Circuit**: the combination of telephone lines and the closed switches that connect them to each other.
- **Circuit switching**: centrally controlled, single-connection model where a single path of connected circuits switched into each other is maintained for the entire length of the call.
- **Client/server architecture**: combination of client computers running Web client software and server computers running Web server software.
- **Closed architecture**: in the early days of computing, the practice of each computer manufacturer creating its own protocol, so computers made by different manufacturers could not be connected to each other.

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- **Closing tag**: HTML tag that formats text.
- **Computer network**: any technology that allows people to connect computers to each other.
- **Configuration tables**: information stored includes lists of connections that lead to particular groups of other routers, rules that specify which connections to use first, and rules for handling instances of heavy packet traffic and network congestion.
- **Data-type definitions (DTDs):** are common standards for XML tags that are available for many industries including legal, math and science and accounting and finance.
- **Deep Web**: the store of information that is available through the Web.
- **Digital subscriber line (DSL)**: connection methods do not use a modem. They use a piece of networking equipment that is a form of network switch.
- **Domain name**: set of words that are assigned to specific IP addresses.
- **Dotted decimal**: four numbers separated by periods.
- **Downlink bandwidth**: a measure of the amount of information that can travel from the Internet to a user in a given amount of time.
- **Download bandwidth**: a measure of the amount of information that can travel from the Internet to a user in a given amount of time.
- **Downstream bandwidth**: a measure of the amount of information that can travel from the Internet to a user in a given amount of time.
- **DSL**: also known as Asymmetric digital subscriber line (ADSL). It provides transmission bandwidths from 100 to 640 Kbps upstream and from 1 to 15 Mbps (million bits per second) downstream.
- **Edge router**: the computers that decide how best to forward each packet.
- **Electronic mail**: mail sent across the Internet.
- **E-mail**: mail sent across the Internet.
- **E-mail client software**: communicates with the e-mail server software on the e-mail server computer to send and receive e-mail messages.
- **E-mail server**: a computer that is devoted to handling e-mail. Software that runs on the e-mail server stores and forwards e-mail messages.
- **Encapsulation**: placing the encrypted packets inside another packet.
- **Extensible Business Reporting Language (XBRL)**: XML schema for accounting and finance that is one of the most widely used in the world.
- **Extensible Hypertext Markup Language (XHTML)**: a reformulation of HTML version 4.0 as an XML application.
- **Extensible Markup Language (XML)**: another markup language that was derived from SGML for use on the Web. Used to mark up information that companies share with each other over the Internet.
- **Extensible Style Sheet Language (XSL)**: used to write XML formatting instructions.
- **Extranet**: an intranet that has been extended to include specific entities outside the boundaries of the organization, such as business partners, customers, or suppliers.
- **Fixed-point wireless**: uses a system of repeaters to forward a radio signal from the ISP to customers.

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- **Fourth-generation (4G) wireless technology**: wireless technology that offers download speeds up to 14 Mbps and upload speeds up to 8 Mbps.
- **Frame relay**: used by NAPs and the computers that perform routing functions on the Internet backbone.
- **Gateway computers**: the computer that decides how best to forward each packet.
- **Generic top-level domain (gTLD)**: TLDs that are available to specified categories of users (.biz, .info, .name, and .pro.).
- **Graphical user interface (GUI)**: a way of presenting program control functions and program output to users and accepting their input.
- **Hexadecimal (base 16)**: numbering system that uses 16 digits (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, a, b, c, d, e, and f).
- **Hierarchical hyperlink structure**: in this structure, the Web user opens an introductory page called a home page or start page.
- **Home page**: an introductory page. This page contains one or more links to other pages, and those pages, in turn, link to other pages.
- **Hot spots**: WAPs that are open to the public.
- **Hyperlink**: points to another location in the same or another HTML document.
- **Hypertext**: page-linking system.
- **Hypertext element**: text elements that are related to each other.
- **Hypertext link**: points to another location in the same or another HTML document.
- **Hypertext Markup Language (HTML)**: the language used for the creation of Web pages.
- **Hypertext server**: a computer that stores files written in Hypertext Markup Language (HTML).
- **Hypertext Transfer Protocol (HTTP)**: the set of rules for delivering Web page files over the Internet.
- **Interactive Mail Access Protocol (IMAP)**: a newer e-mail protocol that performs the same basic functions as POP, but includes additional features.
- **internet** (small "i"): a group of computer networks that have been interconnected.
- **Internet**: global system of interconnected computer networks.
- **Internet access providers (IAPs)**: companies that provide Internet access to individuals, businesses, and other organizations.
- **Internet backbone**: routers that handle packet traffic along the Internet's main connecting points and the telecommunications lines connecting them.
- **Internet hosts**: computers directly connected to the Internet.
- **Internet of Things**: the subset of the Internet that includes these computers and sensors connected to each other for communication and automatic transaction processing.
- **Internet Protocol (IP)**: specifies the addressing details for each packet, labeling each with the packet's origination and destination addresses.
- **Internet Protocol version 4 (IPv4)**: uses a 32-bit number to identify the computers connected to the Internet.
- **Internet Protocol version 6 (IPv6)**: uses a 128-bit number for addresses instead of the 32-bit number used in IPv4.

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- **Internet service providers (ISPs)**: offer many different types of connections to the Internet.
- **Internet2**: an experimental test bed for new networking technologies that is separate from the original Internet.
- **Intranet**: an internet that does not extend beyond the organization that created it.
- **IP address**: a 32-bit number used to identify the computers connected to the Internet.
- **IP tunneling**: creates a private passageway through the public Internet that provides secure transmission from one computer to another.
- **IP wrapper**: the outer packet of an encrypted packet.
- **Leased line**: a permanent telephone connection between two points.
- **LegalXML:** XML schema for information in the legal profession.
- **Linear hyperlink structure**: resembles conventional paper documents in that the reader begins on the first page and clicks the Next button to move to the next page in a serial fashion.
- **Local area network (LAN**): a network of computers that are located close together.
- **Long Term Evolution (LTE)**: a 4G wireless technology that offers download speeds up to 14 Mbps and upload speeds up to 8 Mbps.
- **Mailing list**: an e-mail address that forwards any message it receives to any user who has subscribed to the list.
- **Markup tags**: provide formatting instructions that Web client software can understand.
- **MathML**: XML schema for mathematical and scientific information.
- **Mesh routing**: directly transmits Wi-Fi packets through hundreds, or even thousands, of short-range transceivers that are located close to each other.
- **Metalanguage**: a language that can be used to define other languages.
- **Multipurpose Internet Mail Extensions (MIME)**: a set of rules for handling binary files, such as word-processing documents, spreadsheets, photos, or sound clips that are attached to e-mail messages.
- **Net bandwidth**: the actual amount of data that is transmitted per second.
- **Network access points (NAPs)**: originally located in San Francisco, New York, Chicago, and Washington, D.C., each operated by a separate telecommunications company.
- **Network access providers**: sell Internet access rights directly to larger customers and indirectly to smaller firms and individuals
- **Network Address Translation (NAT) device**: converts private IP addresses into normal IP addresses when it forwards packets from computers to the Internet.
- **Network Control Protocol (NCP)**: protocol used by ARPANET.
- **Network specification**: the set of rules that equipment connected to the network must follow.
- **Newsgroups**: the more than 1000 different topic areas used by Usenet.
- **Ontology**: a set of standards that defines, in detail, the relationships among RDF standards and specific XML tags within a particular knowledge domain.
- **Open architecture**: included the use of a common protocol for all computers connected to the Internet and four key rules for message handling.

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- **Opening tag**: HTML tag that formats text.
- **Optical fiber**: technology used by NAPs.
- **Packet-switched (network)**: on this network, files and e-mail messages are broken down into small pieces, called packets, that are labeled electronically with their origins, sequences, and destination addresses.
- **Packets**: files and e-mail messages are broken down into small pieces.
- **pCell**: a system that creates a network of "personal cells" for each mobile device that allows each device access to the full speed of the network.
- **Personal area networks (PANs)**: small Bluetooth networks.
- **Piconets**: small Bluetooth networks.
- **Plain old telephone service (POTS)**: uses existing telephone lines and an analog modem to provide a bandwidth of between 28 and 56 Kbps.
- **Post Office Protocol (POP)**: used by an e-mail client program running on a user's computer to request mail from the organization's e-mail server.
- **Private IP addresses**: a series of IP numbers that are not permitted on packets that travel on the Internet.
- **Private network**: a leased-line connection between two companies that physically connects their intranets to one another.
- **Proprietary architecture**: in the early days of computing, each computer manufacturer created its own protocol, so computers made by different manufacturers could not be connected to each other.
- **Protocol**: a collection of rules for formatting, ordering, and error checking data sent across a network.
- **Public network**: any computer network or telecommunications network that is available to the public.
- **Repeaters**: transmitter-receiver devices (also called transceivers) that receive the signal and then retransmit it toward users' roof-mounted antennas and to the next repeater.
- **Resource description framework (RDF)**: a set of standards for XML syntax. It would function as a dictionary for all XML tags used on the Web.
- **Roaming**: shifting from one WAP to another, without requiring intervention by the user.
- **Router computers**: the computers that decide how best to forward each packet.
- **Routers:** the computer that decides how best to forward each packet.
- **Routing algorithms**: rules in programs on router computers that determine the best path on which to send each packet.
- **Routing computers**: the computers that decide how best to forward each packet.
- **Routing tables**: information stored includes lists of connections that lead to particular groups of other routers, rules that specify which connections to use first, and rules for handling instances of heavy packet traffic and network congestion.
- **Semantic Web**: project envisions words on Web pages being tagged (using XML) with their meanings.
- **Short message service (SMS)**: protocol used by many mobile phones have a small screen and can be used to send and receive short text messages.

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- **Simple Mail Transfer Protocol (SMTP)**: specifies the format of a mail message and describes how mail is to be administered on the e-mail server and transmitted on the Internet.
- **Software agents**: intelligent programs used to read XML tags to determine the meaning of words in their contexts.
- **Sponsored top-level domain (sTLD)**: a TLD for which an organization other than ICANN is responsible.
- **Standard Generalized Markup Language (SGML)**: used for many years by the publishing industry to create documents that needed to be printed in various formats and that were revised frequently.
- **Start page**: contains one or more links to other pages, and those pages, in turn, link to other pages.
- **Style sheet**: a set of instructions that gives Web developers more control over the format of displayed pages.
- **Subnetting**: the use of reserved private IP addresses within LANs and WANs to provide additional address space.
- **Symmetric connection**: provides the same bandwidth in both directions.
- **Tags**: provide formatting instructions that Web client software can understand.
- **TCP/IP**: the rules that govern how data moves through the Internet and how network connections are established and terminated.
- **Text markup language**: specifies a set of tags that are inserted into the text.
- **Third-generation (3G) wireless technology:** offers download speeds up to 2 Mbps and upload speeds up to 800 Kbps.
- **Top-level domain (TLD)**: the rightmost part of a domain name.
- **Transceivers**: transmitter-receiver device that receives a signal and then retransmits it toward users' roof-mounted antennas and to the next repeater.
- **Transmission Control Protocol (TCP)**: controls the disassembly of a message or a file into packets before it is transmitted over the Internet, and it controls the reassembly of those packets into their original formats when they reach their destinations.
- **Ultra Wideband (UWB)**: provides wide bandwidth (up to about 480 Mbps in current versions) connections over short distances (30 to 100 feet).
- **Uniform Resource Locator (URL)**: the combination of the protocol name and the domain name.
- **Upload bandwidth**: a measure of the amount of information that can travel from the user to the Internet in a given amount of time.
- **Upstream bandwidth**: a measure of the amount of information that can travel from the user to the Internet in a given amount of time.
- **Usenet**: allows anyone who connects to the network to read and post articles on a variety of subjects.
- **User's News Network**: allows anyone who connects to the network to read and post articles on a variety of subjects.
- **Virtual private network (VPN)**: a connection that uses public networks and their protocols to send data in a way that protects the data as well as a private network would, but at a lower cost.

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- **Web**: a subset of the computers on the Internet that are connected to one another in a specific way that makes them and their contents easily accessible to each other.
- **Web browser**: a software interface that lets users read (or browse) HTML documents and move from one HTML document to another through text formatted with hypertext link tags in each file.
- **Web browser software**: software that sends requests for Web page files to other computers, which are called Web servers.
- **Web client computers**: run software called Web client software or Web browser software.
- **Web client software**: software that sends requests for Web page files to other computers, which are called Web servers.
- **Web server software**: receives requests from many different Web clients and responds by sending files back to those Web client computers.
- **Web servers**: runs software called Web server software.
- **Wide area networks (WANs)**: networks of computers that are connected over greater distances.
- **Wi-Fi**: the most common wireless connection technology for use on LANs.
- **Wireless access point (WAP)**: a device that transmits network packets between Wi-Fi-equipped computers and other devices that are within its range.
- **Wireless Ethernet**: the most common wireless connection technology for use on LANs.
- **World Wide Web**: subset of the computers on the Internet that are connected to one another in a specific way that makes them and their contents easily accessible to each other.
- **World Wide Web Consortium (W3C)**: a not-for-profit group that maintains standards for the Web.
- **Worldwide Interoperability for Microwave Access (WiMAX)**: a 4G wireless technology that offers download speeds up to 14 Mbps and upload speeds up to 8 Mbps.
- **XML parsers**: programs that can format an XML file so it can appear on the screen of a computer, a tablet device, a smartphone, an Internet capable mobile phone, or some other device.
- **XML schemas**: common standards for XML tags that are available for a number of industries.
- **XML vocabulary**: a set of XML tag definitions.
- **ZigBee**: a short-range wireless technology that was developed to be low cost and run on very little power.

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CHAPTER 2

Technology Infrastructure: The Internet and the World Wide Web

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Learning Objectives

In this chapter, you will learn:

- About the origin, growth, and current structure of the Internet
- How packet-switched networks are combined to form the Internet
- How Internet, e-mail, and Web protocols work
- About Internet addressing and how Web domain names are constructed

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Learning Objectives (cont'd.)

- About the history and use of markup languages on the Web
- How HTML tags and links work
- About the cost and performance of Internet connections technologies
- About Internet2 and the Semantic Web

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Introduction

- More Internet users are using smartphones or tablets
  - High mobile device usage is taxing existing technologies and threatening to overloading networks
- Current solution is for wireless providers to add more cell phone towers
  - Expensive and locations can be hard to find
- With mobile data traffic expected to triple by 2018, the search for alternatives is underway
  - pCell technology creates a network of personal cells based on each device

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The Internet and the World Wide Web

- Computer network is any technology allowing people to connect computers to each other
- internet (small “i”) is a group of interconnected computer networks
- Internet (capital “I”) connects networks all over the world
- World Wide Web (Web) is a subset of Internet computers that are connected to each other
  - Includes easy-to-use interfaces

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Origins of the Internet

- Early 1960s
  - Defense Department nuclear attack concerns
  - Powerful computers (large mainframes)
  - Leased telephone company lines established a single connection between sender and receiver
  - Single connection risk solution
    - Communicate using multiple channels (packets)
- 1969 Advanced Research Projects Agency (ARPA)
  - Packet network connected four computers
    - ARPANET: earliest network (became the Internet)
    - Academic research use (1970s and 1980s)

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New Uses for the Internet

- E-mail (1972) became widely used quickly
- Military and education research users continued to grow and mailing lists first appeared
- 1979: Usenet (User's News Network) created
  - Continues today with newsgroups
- Network applications improved and tested by an increasing number of users from 1979 to 1989
  - Security problems recognized
- 1980s: personal computer use explosion
  - Academic and research networks merged into the Internet

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Commercial Use of the Internet

- National Science Foundation (NSF)
  - Provided funding
  - Prohibited commercial network traffic so businesses turned to commercial e-mail providers
- Larger firms built networks (leased telephone lines)
- 1989: NSF permitted two commercial e-mail services (MCI Mail and CompuServe)
  - Commercial enterprises could send e-mail
  - Research, education communities sent e-mail directly to MCI Mail and CompuServe

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Growth of the Internet

- In 1991 the NSF further eased commercial Internet activity restrictions
- Privatization of the Internet completed in 1995
  - Operations turned over to privately owned companies
    - Internet based on four network access points (NAPs)
- Network access providers sell Internet access rights directly and through Internet service providers (ISPs)
- Consistent and dramatic growth in the number of Internet hosts (computers directly connected to the Internet) to more than 1 billion today

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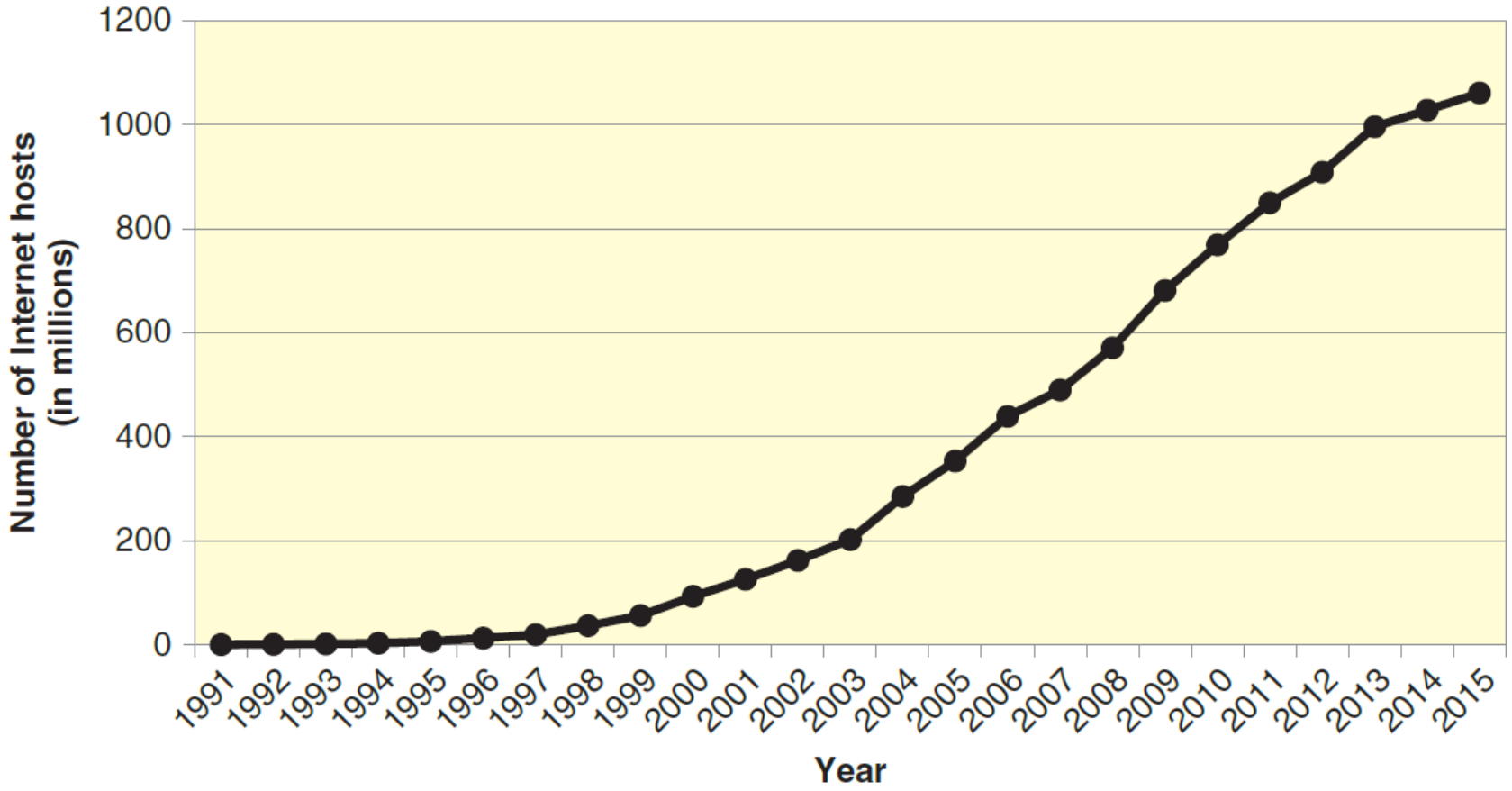

Source: Internet Software Consortium (http://www.isc.org/) and author's estimates

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FIGURE 2-1 Growth of the Internet

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The Internet of Things

- Connection of devices not used by persons is rapidly increasing
  - Switches, optical scanners, and sensors can be connected to the Internet and used to automatically manage environmental or security issues
  - Some business transactions can be conducted without human intervention
- The Internet of things is the term used for these devices and automatic transaction processing
  - Estimated 10 billion devices now and expected to reach 40 billion by 2020

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Packet-Switched Networks

- Local area network (LAN) is a network of computers located close together
- Wide area network (WAN) is a network of computers connected over greater distances
- Telephone call establishes a single connection path between caller and receiver then transmits data along that single path or circuit
  - Circuit switching is centrally controlled, single-connection model
  - Not resistant to failure because a break in any circuit causes interruption and data loss

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Packet-Switched Networks (cont'd.)

- Packet-switched network breaks files and e-mail messages into small pieces called packets
  - Labelled electronically with origin, sequences and destination addresses
  - Travel along interconnected networks until reaching destination
    - Can take different paths
    - May arrive out of order
  - Destination computer
    - Collects packets
    - Reassembles original file or e-mail message

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Routing Packets

- Routing computers forward each packet
  - Routers, gateway computers, border or edge routers
- Routing algorithms are applied to information stored in routing tables or configuration tables
- Hubs, switches, and bridges move packets from one part of the network to another
- Routers connect networks to other networks and usually perform the required translation function
- Internet backbone are telecommunication lines and routers between Internet's main collecting points

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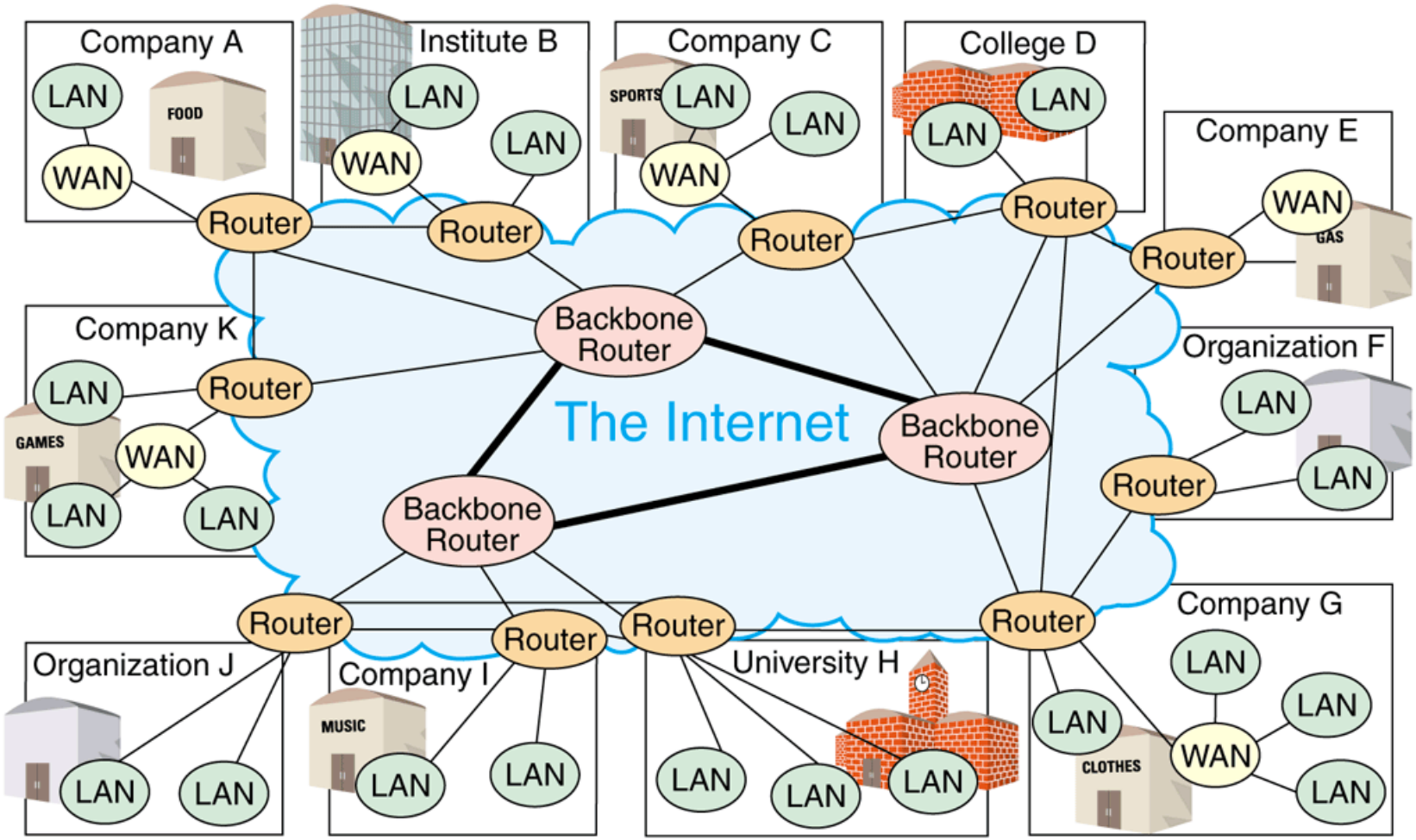

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FIGURE 2-2 Router-based architecture of the Internet

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Public and Private Networks

- Public network is available to the public and does not provide much security as part of its basic structure
- Private network is a leased-line connection between two companies that physically connects their computers or networks together
- Leased line is a permanent telephone connection between two points
  - Advantage: security
  - Drawback: cost

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Virtual Private Network (VPN)

- Connection via public networks to send data in a way that protects it as well as a private network at a lower cost
  - Uses IP tunneling (encapsulation) system to create a private passageway through public Internet
- Encapsulation encrypts packet content and places it inside another packet
  - IP wrapper: outer packet
- “Virtual” since connection seems permanent but is actually a temporary connection

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Intranets and Extranets

- Intranet
  - An Internet within the boundaries of the organization
  - Interconnected private networks
- Extranet
  - An Internet that extends beyond the organization and incorporates networks of outside entities
- Technologies (public networks, private networks, or VPNs)
  - Independent of organizational boundaries

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Internet Protocols

- Protocol is a collection of rules across a network
  - Computers that communicate with each other must use same protocol for data transmission
- ARPANET: Network Control Protocol (NCP)
- Proprietary architecture (closed architecture)
  - Manufacturer creates own protocol
- Open architecture (Internet core)
  - Uses common protocol
  - Four key message-handling rules
  - Contributed to the Internet's success

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TCP/IP

- Refers to the two main protocols used by the Internet today
- Transmission Control Protocol (TCP)
  - Controls message or file disassembly into packets before Internet transmission
  - Controls packet reassembly into original formats at destinations
- Internet Protocol (IP)
  - Specifies addressing details for each packet
  - Labels packet with origination and destination addresses

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IP Addressing

- Internet Protocol version 4 (IPv4) used since 1981
- IP address is a 32-bit number identifying computers
- Computers use base 2 (binary) number system
  - Digit: 0 or a 1 (on or off condition)
  - Four billion different addresses
- Router breaks message into packets that contain source and destination IP address
- With dotted decimal notation IP addresses appear as four numbers separated by periods
- Three NFP organizations assign IP addresses

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IP Addressing (cont'd.)

- ARIN Whois server returns IP address list owned by an organization in North America
- New devices creating high demand for IP addresses
  - Subnetting is the use of reserved private IP LAN (WAN) addresses to provide more space
- Last IPv4 addresses allocated summer 2015
- Internet Protocol version 6 (IPv6) replaces IPv4 and uses 128-bit number for addresses
  - Available addresses: 34 followed by 37 zeros
  - More complex hexadecimal (16) notation system

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Electronic Mail Protocols

- Electronic mail (e-mail) must be formatted according to common set of rules
  - Most organizations use a client/server structure
- E-mail server computer devoted to e-mail handling
  - Software stores and forwards e-mail messages
- E-mail client software reads and sends e-mail
  - Communicates with e-mail server software
  - Many e-mail services are offered by Web sites
- Standardization and rules are essential
- Two common protocols are used for e-mail

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Electronic Mail Protocols (cont'd.)

- Simple Mail Transfer Protocol (SMTP) specifies mail message format, and describes mail administration and transmission
- Post Office Protocol (POP) messages send mail to user's computer and either deletes or does not delete it or asks if new mail has arrived
- Multipurpose Internet Mail Extensions (MIME) is a set of rules for handling binary files
- Interactive Mail Access Protocol (IMAP) performs the same basic POP functions but has some additional features

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Web Page Request and Delivery Protocols

- Web client computers run Web client software (Web browser software)
  - Examples include Google Chrome, Microsoft Internet Explorer, Apple Safari and Mozilla Firefox
    - Sends Web page file requests to other computers (Web servers)
- Web server computer runs Web server software
  - Receives requests from many different Web clients and send back files
- Client/server architecture
  - Combination: client and Web server computers

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Web Page Request and Delivery Protocols (cont'd.)

- Hypertext Transfer Protocol (HTTP)
  - Internet Web page file delivery rules
- Web page request using Web browser
  - User types protocol name
    - Followed by "//:" characters before the domain name
  - Uniform Resource Locator (URL)
    - Combination: protocol name, domain name
    - Locates resources (Web page) on another computer (Web server)

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Emergence of the World Wide Web

- Web
  - Software running on Internet-connected computers
  - Generates network traffic
    - Web software: largest single traffic category
    - Outpaces: e-mail, file transfers, and other data transmission traffic
  - Web resulted from new ways of thinking about information storage and retrieval
- Key technological Web elements
  - Hypertext
  - Graphical user interfaces

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The Development of Hypertext

- 1945: Vannevar Bush: The Atlantic Monthly article
  - Visionary ideas: future technology uses (Memex)
- 1960s: Ted Nelson described a page-linking system
  - Douglas Engelbart: experimental hypertext system
- 1987: Nelson published Literary Machines
  - Outlined project Xanadu an online global hypertext publishing and commerce system
- 1989: Tim Berners-Lee proposed development project to provide data-sharing functionality
  - Developed hypertext server program code

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The Development of Hypertext (cont'd.)

- Hypertext server stores files written in Hypertext Markup Language (HTML) which is used for the creation of Web pages
  - Called Web servers today
- HTML is a language that includes a set of codes (tags) attached to text
  - Describes relationships among text elements
- Hypertext link (hyperlink)
  - Points to another location
  - Same or another HTML document

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Graphical Interfaces for Hypertext

- Web browser
  - Software lets users read (browse) HTML documents and move from one HTML document to another through text formatted with hypertext link tags in file
- Graphical user interface (GUI)
  - Presents program control functions, output to users, and input from users
  - Pictures, icons, and other graphical elements

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The World Wide Web

- World Wide Web: Berners-Lee's name for system of hyperlinked HTML documents
  - Quick acceptance in scientific research community
- 1993: GUI program (Mosaic) that could read HTML
  - Used HTML hyperlinks for page-to-page navigation
  - First Web browser widely available for personal computers and still in use today
- Easy access to Internet information through system of pages connected by hypertext links
  - Profit-making potential recognized by businesses

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The World Wide Web (cont'd.)

- Netscape Communications founded in 1994
  - Netscape Navigator Web browser (based on Mosaic)
  - Microsoft: Internet Explorer (most widely used)
  - Mozilla Firefox: Netscape Navigator descendant
- Number of Web sites has grown more rapid growth than the Internet itself
  - More than 800 million Web sites
  - Over a trillion individual Web pages
  - 2010 to 2011: number of Web sites doubled

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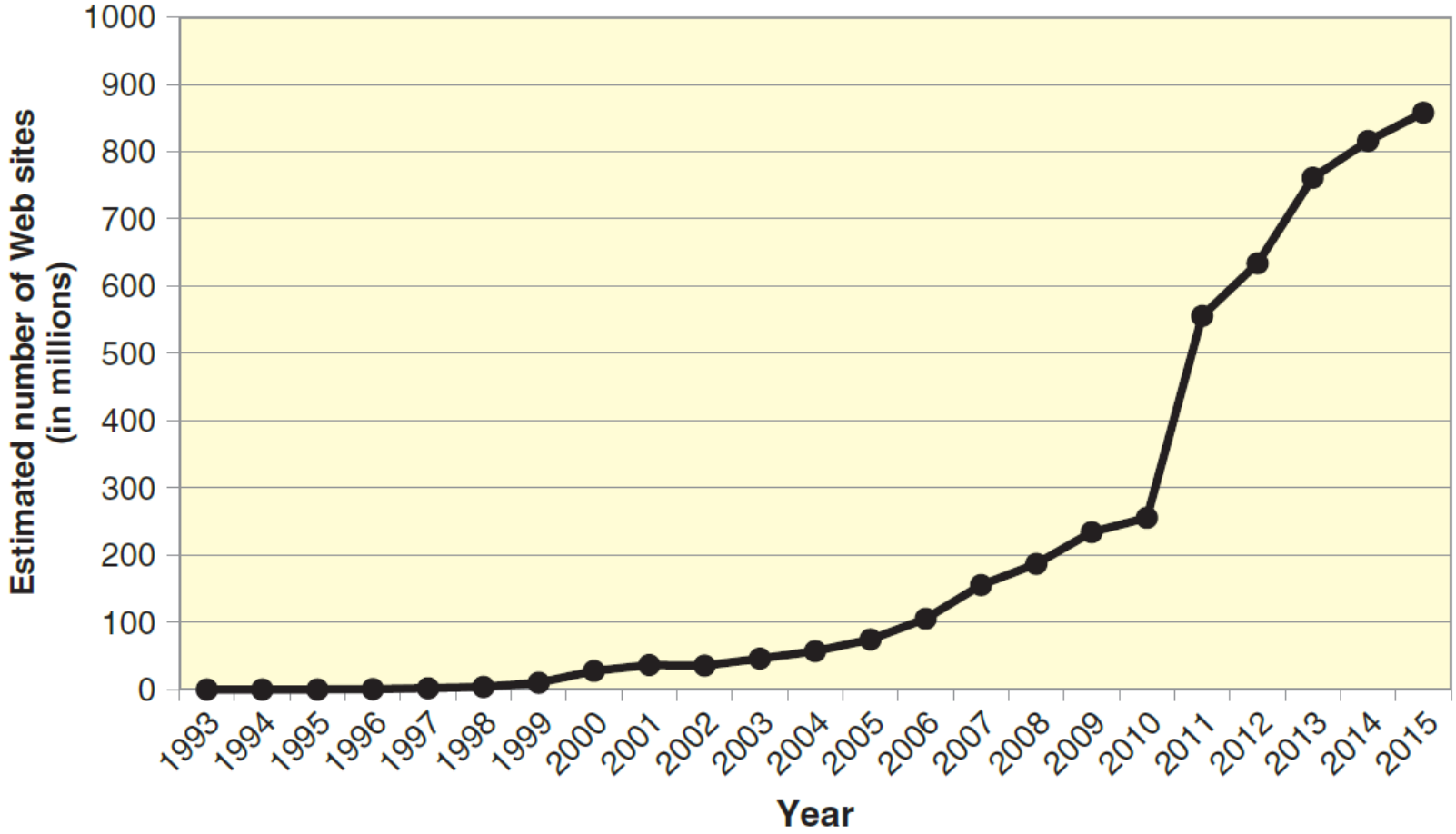

Adapted from Netcraft Web Server Surveys (http://www.netcraft.com) and author's estimates

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FIGURE 2-3 Growth of the World Wide Web

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The Deep Web

- Web provides access to customized pages created in response to a user's query
  - Pull content from databases
  - Example: search for "online business" book on Amazon.com
- Deep Web: Store of information available through the Web
  - Potentially trillions of Web pages available using deep Web
  - Difficult or impossible to search because available data that is never requested remains hidden

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Domain Names

- Dotted decimal notation difficult to remember
- Domain names are sets of words assigned to specific IP addresses
  - Example: www.sandiego.edu
    - Contains three parts separated by periods
    - Top-level domain (TLD): rightmost part
    - Generic top-level domains (gTLDs)
    - Sponsored top-level domains (sTLD)
- Internet Corporation for Assigned Names and Numbers (ICANN)

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TLD	Use
.com	U.S. commercial
.edu	Four-year educational institution
.gov	U.S. federal government
.mil	U.S. military
.net	U.S. general use
.org	U.S. not-for-profit organization
.us	U.S. general use
.asia	Companies, individuals, and organizations based in Asian–Pacific regions
.biz	Businesses
.info	General use
.name	Individual persons
.pro	Licensed professionals (such as accountants, lawyers, physicians)
.au	Australia
.ca	Canada
.de	Germany
.fi	Finland
.fr	France
.jp	Japan
.se	Sweden
.uk	United Kingdom

Source: Internet Assigned Numbers Authority Root Zone Database, http://www.iana.org/domains/root/db/

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FIGURE 2-4 Commonly used domain names

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Markup Languages and the Web

- Text markup language specifies a set of tags inserted into text
- Markup tags (tags) provide formatting instructions Web client software understands
- Most commonly used markup language is HTML
  - Subset of Generalized Markup Language (SGML)
- World Wide Web Consortium (W3C) maintains Web standards
- Extensible Hypertext Markup Language (XHTML)
  - HTML version 4.0 reformulation as XML application

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Hypertext Markup Language

- Hypertext elements are text elements related to each other
- HTML is the prevalent markup language to create Web documents
  - W3C HTML Working Group page maintains detailed HTML versions and related topic information
  - HTML version 5.0 was released in 2014
- SGML is a metalanguage that can be used to define other languages
  - Extensible Markup Language (XML) was derived from SGML and is used to tag shared information

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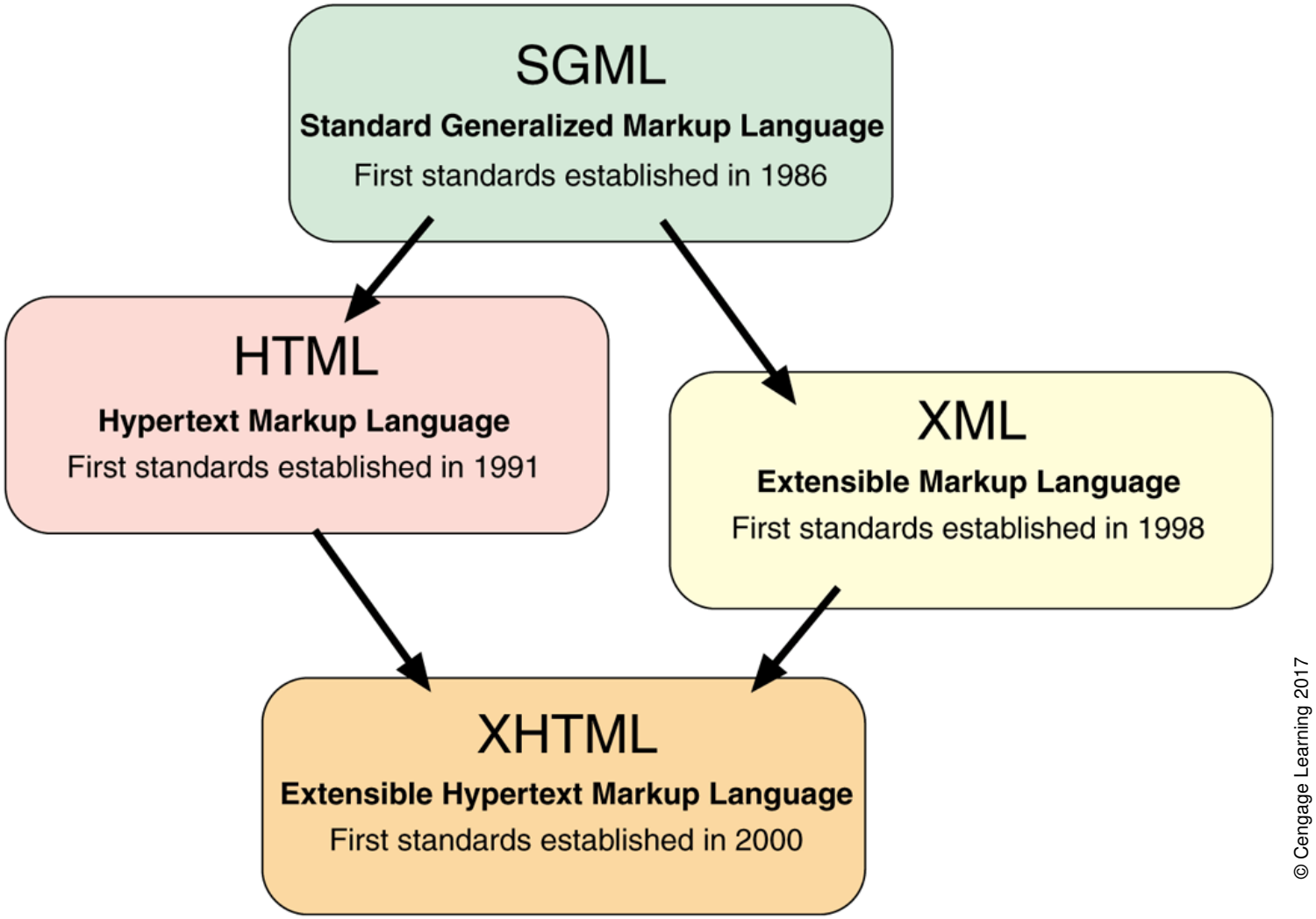

FIGURE 2-5 Development of markup languages

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HTML Tags

- Interpreted by the Web browser and used to format the display of text enclosed by the tags
  - Enclosed in angle brackets (<>)
  - Most have an opening tag and closing tag that format the text between them
  - Closing tag is preceded by slash within the angle brackets (</>)
- User may customize tag interpretations so that different browsers display tagged text differently
- Tags are generally written in lowercase letters

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HTML Tags (cont'd.)

- One-sided tags require opening tag only
  - Common example is the tag that creates a line break
- Some two-sided tags have an optional closing tag
  - Common example is the paragraph tag
- Opening tag may contain one or more property modifiers that refines how the tag operates
- Other frequently used HTML tags allow Web designers to include graphics and format text as tables

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FIGURE 2-6 Text marked up with HTML tags

```
<html>

    <head>

        <title>HTML Tag Examples</title>

    </head>

    <body>

    <h1>This text is set in Heading one tags</h1>
    <h2>This text is set in Heading two tags</h2>
    <h3>This text is set in Heading three tags</h3>

    <p>
    This text is set within Paragraph tags. It will appear as one paragraph: the
    text will wrap at the end of each line that is rendered in the Web browser no
    matter where the typed text ends. The text inside Paragraph tags is rendered
    without regard to extra spaces typed in the text, such as these:
    Character formatting can also be applied within Paragraph tags. For
    example, <strong>the Strong tags will cause this text to appear bolded in
    most Web browsers</strong> and <em>the emphasis tags will cause this to
    appear italicized in most Web browsers</em>.
    </p>

    <pre>
    HTML includes tags that instruct the Web browser to render the text
    Exactly    the    way    it    is    typed,
    as in this example.
    </pre>

    <p>
    HTML includes tags that instruct the Web browser to place text in bulleted or
    numbered lists:
    </p>

    <ul>
        <li>Bulleted list item one</li>
        <li>Bulleted list item two</li>
        <li>Bulleted list item three</li>
    </ul>

    <ol>
        <li>Numbered list item one</li>
        <li>Numbered list item two</li>
        <li>Numbered list item three</li>
    </ol>

    <p>
    The most important tag in HTML is the Anchor Hypertext Reference tag,
    which is the tag that provides a link to another Web page (or another location
    in the same Web page). For example, the underlined text
    <a href="http://www.w3c.org/">World Wide Web Consortium</a>
    is a link to the not-for-profit organization that develops Web technologies.
    </p>

    </body>

</html>
```

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This text is set in Heading one tags

This text is set in Heading two tags

This text is set in Heading three tags

This text is set within Paragraph tags. It will appear as one paragraph: the text will wrap at the end of each line that is rendered in the Web browser no matter where the typed text ends. The text inside Paragraph tags is rendered without regard to extra spaces typed in the text, such as these: Character formatting can also be applied within Paragraph tags. For example, **the Strong tags will cause this text to appear bolded in most Web browsers** and *the emphasis tags will cause this to appear italicized in most Web browsers.*

```
HTML includes tags that instruct the Web browser to render the text
Exactly     the     way      it      is       typed,
as in this example.
```

HTML includes tags that instruct the Web browser to place text in bulleted or numbered lists:

- Bulleted list item one
- Bulleted list item two
- Bulleted list item three

1. Numbered list item one
2. Numbered list item two
3. Numbered list item three

The most important tag in HTML is the Anchor Hypertext Reference tag, which is the tag that provides a link to another Web page (or another location in the same Web page). For example, the underlined text World Wide Web Consortium is a link to the not-for-profit organization that develops Web technologies.

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FIGURE 2-7 Text marked up with HTML tags as it appears in a Web browser

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HTML Links

- Hyperlinks on interlinked pages form a “web” of those pages
- Linear hyperlink structure reads Web page in serial fashion
  - Works well when customer fills out form
- Hierarchical hyperlink structure uses an introductory page (home page, start page) that links to other pages
  - Site map often available for hierarchical sites
- HTML creates hyperlinks using HTML anchor tags

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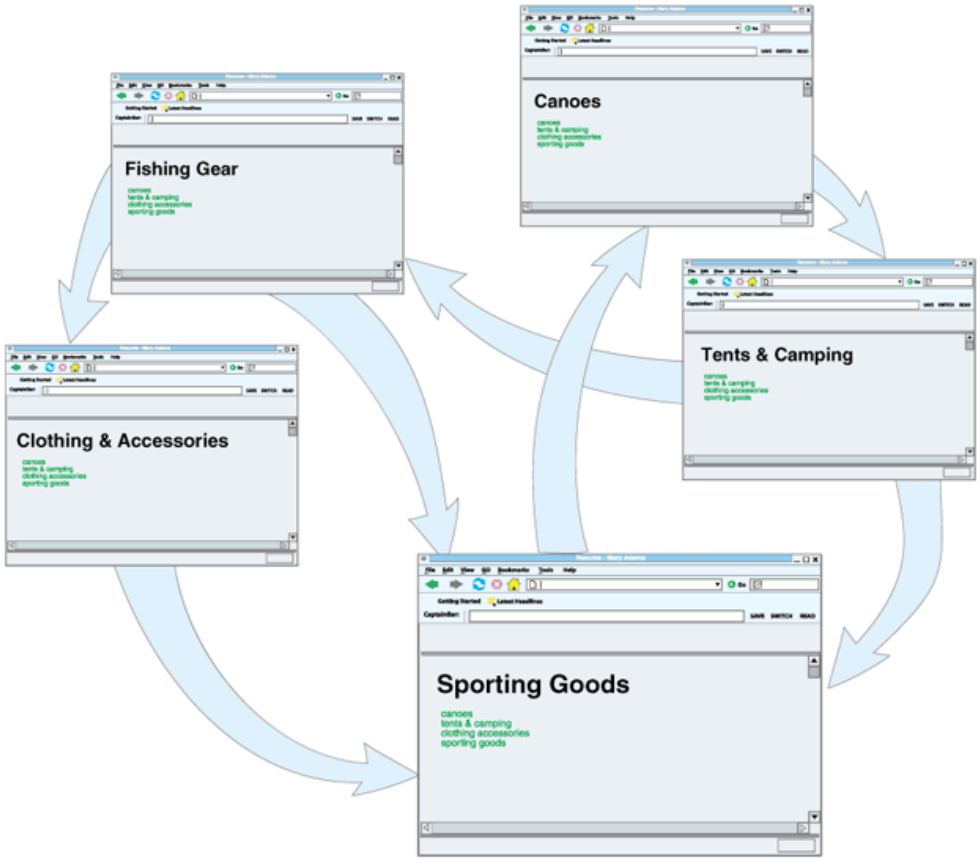
Reading a linear document



Reading a hypertext document

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FIGURE 2-8 Linear vs. nonlinear paths through documents

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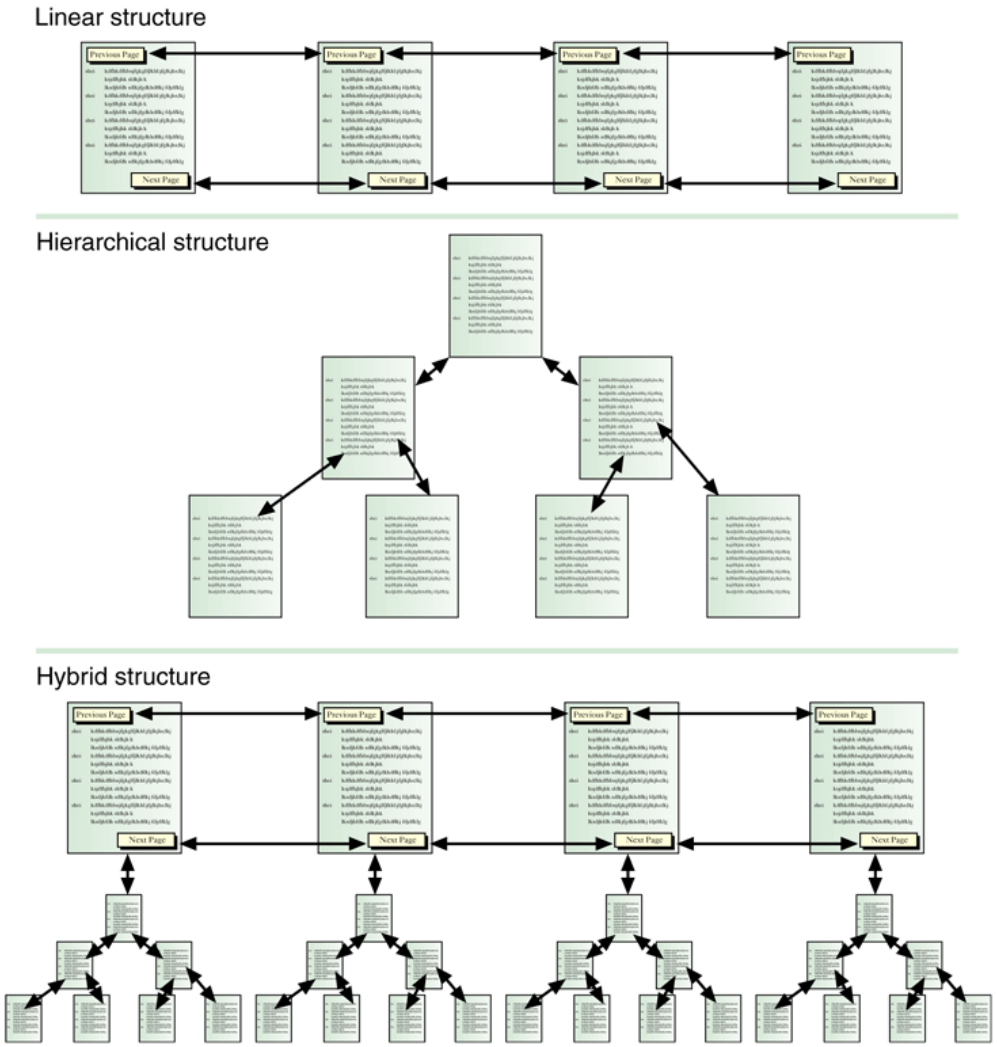

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FIGURE 2-9 Three common Web page organization structures

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Cascading Style Sheets

- Style sheet is a set of instructions that gives Web developers control over displayed page formatting
  - Usually stored in a separate file and referenced using HTML style tag
  - May be included in Web page's HTML file
- Cascading style sheets (CSS) can be applied to each Web page, one on top of the other

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Extensible Markup Language (XML)

- HTML not a good tool for presenting large amounts of business data so designers turned to XML
  - Uses paired start and stop tags to define the structure of a collection of data
  - Includes data-management capabilities HTML cannot provide
- Greatest strength (and weakness) of XML is that it allows users to define their own tags
  - Many companies have agreed to common standards for XML tags (data-type definitions (DTDs) or XML schemas) which are available for many industries

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FIGURE 2-10 Country list data marked up with HTML tags

```
<html>

   <head>

     <title>Countries</title>

   </head>

   <body>

     <h1>Countries</h1>

     <h2>CountryName</h2>
     <h3>CapitalCity</h3>
     <h4>AreaInSquareKilometers</h4>
     <h5>OfficialLanguage</h5>
     <h6>VotingAge</h6>

     <h2>Argentina</h2>
     <h3>Buenos Aires</h3>
     <h4>2,766,890</h4>
     <h5>Spanish</h5>
     <h6>18</h6>

     <h2>Austria</h2>
     <h3>Vienna</h3>
     <h4>83,858</h4>
     <h5>German</h5>
     <h6>19</h6>

     <h2>Barbados</h2>
     <h3>Bridgetown</h3>
     <h4>430</h4>
     <h5>English</h5>
     <h6>18</h6>

     <h2>Belarus</h2>
     <h3>Minsk</h3>
     <h4>207,600</h4>
     <h5>Byelorussian</h5>
     <h6>18</h6>

   </body>

</html>
```

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FIGURE 2-11 Country list data as it appears in a Web browser

Countries

CountryName

CapitalCity

AreaInSquareKilometers

OfficialLanguage

Voting Age

Argentina

Buenos Aires

2,766,890

Spanish

18

Austria

Vienna

83,858

German

19

Barbados

Bridgetown

430

English

18

Belarus

Minsk

207,600

Byelorussian

18

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declaration

root element

```
<?xml version="1.0"?>

<CountriesList>

  <Country Name = "Argentina">
    <CapitalCity>Buenos Aires</CapitalCity>
    <AreaInSquareKilometers>2,766,890</AreaInSquareKilometers>
    <OfficialLanguage>Spanish</OfficialLanguage>
    <VotingAge>18</VotingAge>
  </Country>

  <Country Name = "Austria">
    <CapitalCity>Vienna</CapitalCity>
    <AreaInSquareKilometers>83,858</AreaInSquareKilometers>
    <OfficialLanguage>German</OfficialLanguage>
    <VotingAge>19</VotingAge>
  </Country>

  <Country Name = "Barbados">
    <CapitalCity>Bridgetown</CapitalCity>
    <AreaInSquareKilometers>430</AreaInSquareKilometers>
    <OfficialLanguage>English</OfficialLanguage>
    <VotingAge>18</VotingAge>
  </Country>

  <Country Name = "Belarus">
    <CapitalCity>Minsk</CapitalCity>
    <AreaInSquareKilometers>207,600</AreaInSquareKilometers>
    <OfficialLanguage>Byelorussian</OfficialLanguage>
    <VotingAge>18</VotingAge>
  </Country>

</CountriesList>
```

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FIGURE 2-12 Country list data marked up with XML tags

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```
<?xml version="1.0" ?>
<CountriesList>
- <Country Name="Argentina">
    <CapitalCity>Buenos Aires</CapitalCity>
    <AreaInSquareKilometers>2,766,890</AreaInSquareKilometers>
    <OfficialLanguage>Spanish</OfficialLanguage>
    <VotingAge>18</VotingAge>
  </Country>
- <Country Name="Austria">
    <CapitalCity>Vienna</CapitalCity>
    <AreaInSquareKilometers>83,858</AreaInSquareKilometers>
    <OfficialLanguage>German</OfficialLanguage>
    <VotingAge>19</VotingAge>
  </Country>
- <Country Name="Barbados">
    <CapitalCity>Bridgetown</CapitalCity>
    <AreaInSquareKilometers>430</AreaInSquareKilometers>
    <OfficialLanguage>English</OfficialLanguage>
    <VotingAge>18</VotingAge>
  </Country>
- <Country Name="Belarus">
    <CapitalCity>Minsk</CapitalCity>
    <AreaInSquareKilometers>207,600</AreaInSquareKilometers>
    <OfficialLanguage>Byelorussian</OfficialLanguage>
    <VotingAge>18</VotingAge>
  </Country>
</CountriesList>
```

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FIGURE 2-13 Country list data marked up with XML displayed in a Web browser

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Extensible Markup Language (XML) (cont'd.)

- Available DTDs or XML schemas include
  - LegalXML for the legal profession
  - MathML for mathematical and scientific information
  - Extensible Business Reporting Language (XBRL) for accounting and financial information standards
- Set of XML tag definitions called an XML vocabulary
- XML files usually not intended to display in browser
  - Extensible Stylesheet Language (XSL) contains formatting instructions
  - XML parsers format XML file for device screen

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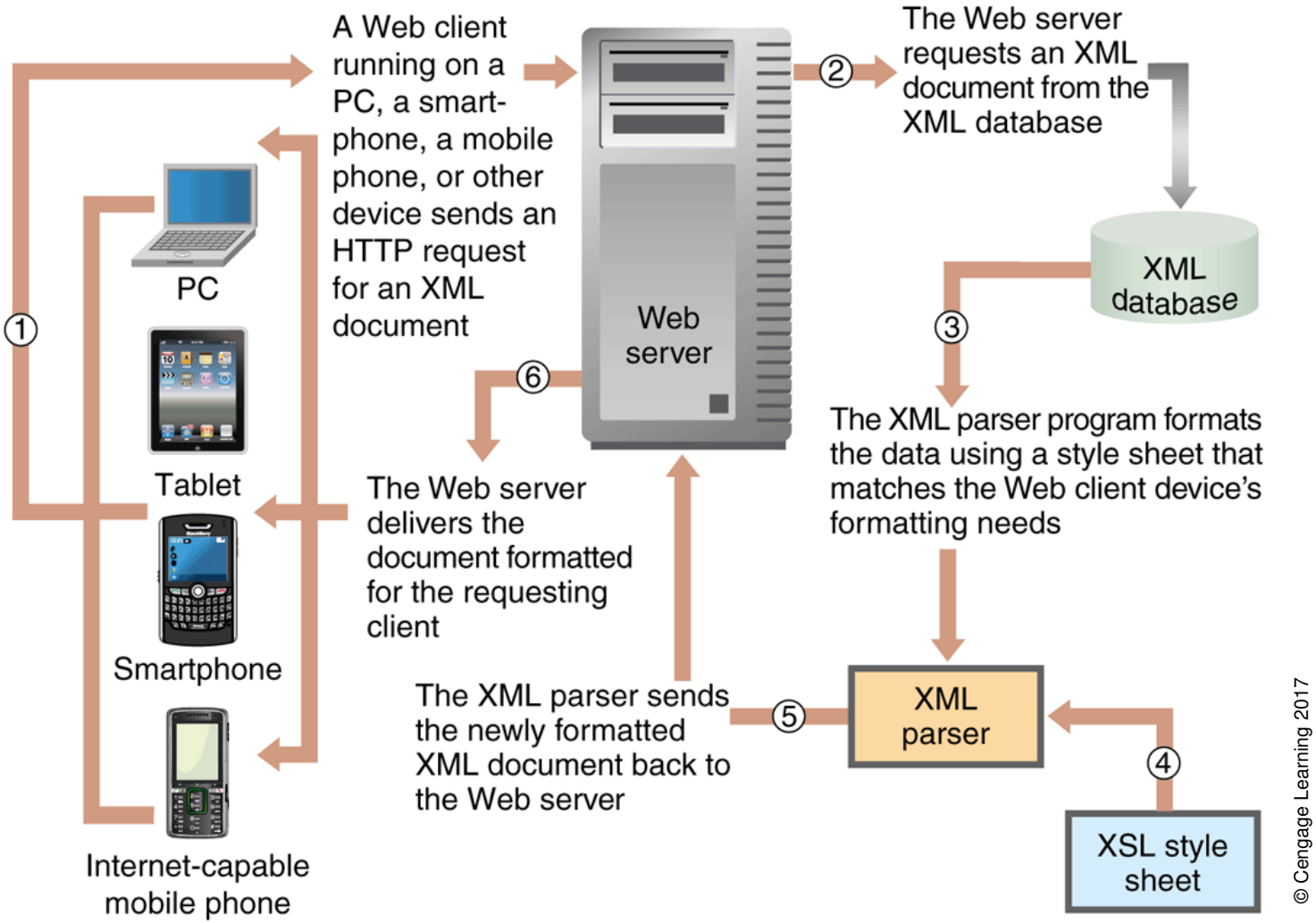

FIGURE 2-14 Processing requests for Web pages from an XML database

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Internet Connection Options

- Internet is a set of interconnected networks
- Organizations connect computers using a network
- Many families have their home computers connected using a network
- Mobile phones are connected to the wireless phone service provider's network
- Internet access providers (IAPs) or ISPs
  - Provide Internet access to individuals, businesses, other organizations
  - Offer several connection options

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Connectivity Overview

- Common connection options are voice-grade telephone lines, various types of broadband connections, leased lines, wireless
- Bandwidth is the amount of data traveling through communication medium per unit of time
  - Net bandwidth is actual data transmitted per second
  - Symmetric connections provide the same bandwidth both directions
  - Asymmetric connections provide different bandwidths for each direction

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Connectivity Overview

- Two bandwidth types in an asymmetric connection are
  - Upstream bandwidth (upload bandwidth) is a measure of amount of information that can travel from the user to the Internet in a given amount of time
  - Downstream bandwidth (download, downlink bandwidth) is a measure of amount of information from the Internet to user in a given amount of time

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Voice-Grade Telephone Connections

- Used in early days of Web
- Plain old telephone service (POTS) uses existing telephone lines, analog modem
  - Bandwidth between 28 and 56 Kbps
- Total most people use higher bandwidth connection options
  - Speeds greater than 200 Kbps are called broadband services

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Broadband Services

- Digital Subscriber Line (DSL) is a higher grade of telephone service that does not use a modem
  - Asymmetric digital subscriber line (ADSL) bandwidths from 100 to 640 Kbps upstream and 1 to 15 Mbps downstream
  - DSL: Private line with no competing traffic
- Cable modems connect to the television cable
  - Bandwidths from client to server: 500 Kbps to 15 Mbps with downstream as high as 10 Mbps
  - Connection bandwidths vary with number of subscribers competing for shared resource

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Leased-Line Connections

- Large firms can connect to an ISP using higher bandwidths leased from telecommunications carriers
  - Classified by equivalent number of telephone lines included which are more expensive than other options
    - DS0 (digital signal zero) carries one digital signal (56 Kbps); T1 line (DS1) carries 24 DS0 lines (1.544 Mbps); T3 (DS3): 44.736 Mbps
- Technologies used include frame relay, asynchronous transfer mode (ATM) and optical fiber (instead of copper wire)
  - Bandwidth determined by fiber-optic cable class

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Wireless Ethernet (Wi-Fi)

- Most common wireless connection technology that is also called 802.11
  - Latest version is 802.11ac with bandwidth ranges up to 2.5 Gbps and a range of 500 feet
  - Speed impacted by objects the signals pass through
- Wireless access point (WAP) transmits packets between Wi-Fi-equipped computers and other devices within range
  - Devices capable of roaming or shifting from one WAP to another without human intervention
  - Hot sports are WAPs open to the public

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Personal Area Networks (Piconets)

- Bluetooth is a low-bandwidth technology (722 Kbps) designed for personal use over short distances
  - Useful for wireless synchronization and printing
  - Devices consume very little power and can discover one another and exchange information automatically
- Ultra Wideband (UWB) provides bandwidth up to 480 Mbps and connections over short distances
  - Future personal area networking applications
- ZigBee is a low bandwidth technology with applications designed for energy management and remote controls for consumer electronics

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Fixed-Point Wireless

- Used in rural areas without cable service
- System of repeaters used to forward radio signal from ISP to customers
- Repeaters are transmitter-receiver devices (transceivers)
- Uses mesh routing
  - Directly transmits Wi-Fi packets through short-range transceivers (hundreds or thousands)
  - Located close to each other

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Satellite Microwave

- Made connections to the Internet possible for the first time in many rural areas
- Use microwave transmitters that provide upload bandwidths in the range of 120 Kbps to 5 Mbps and downloads in the 1-16 Mbps range
- Installation cost has decreased due to improved technologies that allow self-installation
- Offered by airlines
- Once the only wireless Internet access available, but many other options now exist

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Mobile Telephone Networks

- Number of mobile phones in 2014 (almost 8 billion) exceeded population for the first time in history
- Short message service (SMS) protocol
  - Send and receive short text messages
- Third-generation (3G) wireless technology
  - 2 Mbps download/800 Kbps upload speeds
- Fourth-generation (4G) technology
  - Long Term Evolution (LTE) and Worldwide Interoperability for Microwave Access (WiMAX) offer 14 Mbps download/ 8Mbps upload speeds

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Service	Upstream Bandwidth (Kbps)	Downstream Bandwidth (Kbps)	Capacity (Number of Simultaneous Users)	One-Time Start-Up Costs	Continuing Monthly Costs
Residential-Small Business Services					
POTS	28–56	28–56	1	$0–$20	$9–$20
Wireless 3G network	10–800	10–2000	1	$0–$120	$30–150
DSL	100–640	1000–15,000	4–20	$50–$100	$20–$300
Cable	300–1500	500–15,000	4–10	$0–$100	$35–$200
Satellite	120–5000	1000–16,000	1–3	$0–$800	$40–$100
Fixed-point wireless	250–1500	500–3000	1–4	$0–$350	$50–$150
Wireless 4G network	500–5000	1000–12,000	1	$0–$200	$80–$200
Business Services					
Leased digital line (DS0)	64	64	1–50	$50–$200	$40–$150
Fixed-point wireless	500–10,000	500–10,000	5–1000	$0–$500	$150–$4000
T1 leased line	1544	1544	100–1000	$100–$2000	$200–$300
T3 leased line	44,736	44,736	1000–10,000	$500–$5000	$2500–$3000
Large Organizations					
OC3 leased line	156,000	156,000	1000–50,000	$3000–$12,000	$5000–$20,000
OC12 leased line	622,000	622,000	Backbone	Negotiated	$25,000–$100,000
Network Access Providers					
OC48 leased line	2,500,000	2,500,000	Backbone	Negotiated	Negotiated
OC192 leased line	10,000,000	10,000,000	Backbone	Negotiated	Negotiated
OC768 leased line	40,000,000	40,000,000	Backbone	Negotiated	Negotiated

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FIGURE 2-15 Internet connection options

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Internet2 and the Semantic Web

- Internet2 is an advanced research network created in 1996 as a replacement for ARPANET laboratory
  - Experimental networking technologies test bed
  - High end of the bandwidth spectrum (10 Gbps)
  - Used by universities, medical schools, CERN
  - Focus: mainly technology development

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Internet2 and the Semantic Web (cont'd.)

- Semantic Web project has a goal of blending technologies and information
  - Web pages tagged (using XML) with meanings
  - Uses software agents (intelligent programs) to read XML tags, determine meaning of words
- Resource description framework (RDF)
    - Set of XML syntax standards
  - Development of Semantic Web will take many years
    - Start with ontologies for specific subjects

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