# **Chapter 2**

**Technology Infrastructure: The Internet and the World Wide Web**

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| **At a Glance** |

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# **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

# **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.
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**.

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

**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

1. 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

1. \_\_\_\_ 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

1. \_\_\_\_ are computers directly connected to the Internet.

Answer: Internet hosts

1. 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.
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**.

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| ***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**

## 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.

1. 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.

**Quick Quiz 2**

1. A network of computers that are located close together is called a(n) \_\_\_\_.

Answer: local area network (LAN)

1. The combination of telephone lines and the closed switches that connect them to each other is called a(n) \_\_\_\_.

Answer: circuit

1. (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

1. 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.

# **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)**.

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

1. 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.
2. 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.
3. Explain the major advantage of IPv6. It uses a 128-bit number for addresses instead of the 32-bit number used in IPv4.
4. 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).

# **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

1. (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

1. The term \_\_\_\_ refers to the use of reserved private IP addresses within LANs and WANs to provide additional address space.

Answer: subnetting

1. The purpose of a(n) \_\_\_\_ is to respond to requests for Web pages from Web clients.

# Answer: Web server

# **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:
   1. 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.
   2. Ted Nelson’s description of a system in which text on one page links to text on other pages.
   3. Doug Englebart’s first experimental hypertext system on one of the large computers of the 1960s.
   4. 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.
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.

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| ***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**).

1. 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.
2. Introduce the terms **generic top-level domain (gTLD)** and **sponsored top-level domain (sTLD)**.
3. 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

1. A(n) \_\_\_\_ is a way of presenting program control functions and program output to users and accepting their input.

Answer: graphical user interface (GUI)

1. The store of information that is available through the Web is called the \_\_\_\_.

Answer: deep Web

1. \_\_\_\_ 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**

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

# 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.

# 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.

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

**HTML Tags**

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

# 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**

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

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

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

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

# 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.

1. 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).**
2. Introduce the term **XML** **vocabulary**.
3. 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.
4. Introduce the terms **Extensible Style sheet Language (XSL)** and **XML parsers**.
5. 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.

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| ***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

1. 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

1. In HTML, hyperlinks are created using the HTML \_\_\_\_.

Answer: anchor tag

1. (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**.
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.
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.

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| ***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

1. \_\_\_\_ connections provide the same bandwidth in both directions.

Answer: Symmetric

1. 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

1. The most common wireless connection technology for use on LANs is called \_\_\_\_.

Answer: Wi-Fi, wireless Ethernet, or 802.11n

1. 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.

1. Introduce students to the Dbpedia project.
2. 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.

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

**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

1. A(n) \_\_\_\_ is a set of standards for XML syntax.

Answer: resource description framework (RDF)

1. The \_\_\_\_ project envisions words on Web pages being tagged (using XML) with their meanings.

Answer: Semantic Web

1. 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:
   1. How will Internet2 benefit current Internet users?
   2. Is Internet2 a separate network and will it replace the current commercial Internet?
   3. What kind of technology will be needed to use the advanced Internet applications and technologies?
   4. 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.

# **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.
* **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.
* **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.
* **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.
* **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.
* **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.
* **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.