Connecting with Computer Science, 2e

Chapter 5
The Internet
Objectives

• In this chapter you will:
  – Learn what the Internet really is
  – Become familiar with the architecture of the Internet
  – Become familiar with Internet-related protocols
  – Understand how TCP/IP protocols relate to the Internet
  – Learn how IP addresses identify devices connected to the Internet
Objectives (cont’d.)

• In this chapter you will (cont’d.):
  – Learn how DHCP can be used to assign IP addresses
  – Learn how routers are used throughout the Internet
  – Learn how a DNS server translates a URL into an IP address
  – Learn how port numbers are used with IP addresses to expand Internet capabilities
  – Learn how NAT is used in networking
Objectives (cont’d.)

• In this chapter you will (cont’d.):
  – Learn how to determine your own TCP/IP configuration
  – Learn how HTML and XML are used with the World Wide Web
  – Learn how to develop a simple Web page by using HTML
  – Learn how search engines make the World Wide Web more usable
Why You Need to Know About…The Internet

• Internet:
  – Revolutionary information technology
  – Impacts everything
    • Business
    • Education
    • Knowledge and learning

• Field of computing:
  – Heavily involved in all aspects of the Internet revolution
What Is the Internet?

• Collection of LANs and WANs
  – Connected to form a giant WAN
• Internet service provider (ISP)
  – Provides access to the Internet and other related services
• No single Internet owner
  – Some groups propose rules
  – Other groups provide management
  – Personal involvement in the Internet often benefits many others
The Architecture of the Internet

• Internet connections
  – Communication lines leased from phone company to an ISP
    • Desktop linked via communication wire, wireless access point, cable TV system
  – Point of presence (POP)
    • An access point to the Internet
    • Connected to larger ISP with larger POP
  – National backbone provider (NBP)
    • Provides high-speed network communication lines for use by ISPs
The Architecture of the Internet (cont’d.)

Figure 5-1, Internet data can pass through several levels of ISPs
Protocols

- Set of rules facilitating communication
- Many protocols are involved with the Internet
  - Hypertext Transfer Protocol (HTTP)
  - Simple Mail Transfer Protocol (SMTP)
  - File Transfer Protocol (FTP)
TCP and IP

- TCP (Transmission Control Protocol)
  - Responsible for reliable delivery of data
  - Separates data into manageable, fixed-size packets
  - Establishes virtual circuit for transmission
  - Manages packet sequencing
  - Retransmits packets received in error
  - Header appended to data segment contains relevant information
TCP and IP (cont’d.)

<table>
<thead>
<tr>
<th>header field</th>
<th>size in bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>source port</td>
<td>16</td>
</tr>
<tr>
<td>destination port</td>
<td>16</td>
</tr>
<tr>
<td>sequence number</td>
<td>32</td>
</tr>
<tr>
<td>acknowledgment (ACK) number</td>
<td>32</td>
</tr>
<tr>
<td>data offset</td>
<td>4</td>
</tr>
<tr>
<td>reserved</td>
<td>6</td>
</tr>
<tr>
<td>flags</td>
<td>6</td>
</tr>
<tr>
<td>window</td>
<td>16</td>
</tr>
<tr>
<td>checksum</td>
<td>16</td>
</tr>
<tr>
<td>urgent pointer</td>
<td>16</td>
</tr>
<tr>
<td>options</td>
<td>32</td>
</tr>
</tbody>
</table>

Table 5-1, TCP header fields
## TCP and IP (cont’d.)

<table>
<thead>
<tr>
<th>header field</th>
<th>size in bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>version</td>
<td>4</td>
</tr>
<tr>
<td>header length</td>
<td>4</td>
</tr>
<tr>
<td>type of service</td>
<td>8</td>
</tr>
<tr>
<td>total length of data packet</td>
<td>16</td>
</tr>
<tr>
<td>packet identification</td>
<td>16</td>
</tr>
<tr>
<td>flags</td>
<td>4</td>
</tr>
<tr>
<td>fragment offset</td>
<td>12</td>
</tr>
<tr>
<td>time to live (TTL)</td>
<td>8</td>
</tr>
<tr>
<td>protocol number</td>
<td>8</td>
</tr>
<tr>
<td>header checksum</td>
<td>16</td>
</tr>
<tr>
<td>source IP address</td>
<td>32</td>
</tr>
<tr>
<td>destination IP address</td>
<td>32</td>
</tr>
<tr>
<td>IP options</td>
<td>32</td>
</tr>
</tbody>
</table>

**Table 5-2, IPv4 header fields**
IP Addresses

• Central to the operation of Internet Protocol
  – Provide a unique identifying device number
  – Most widespread version (IPv4): 32-bit value
    • Represented as a set of four decimal numbers separated by periods
  – New version of IP (IPv6): 128-bit addresses

• Each IP address decimal number represents 8 bits

• Pool of IPv4 addresses are separated into groups
  – Classes designated by A, B, C, D, and E

• Several reserved addresses
# IP Addresses (cont’d.)

## Figure 5-2, IP address classes

<table>
<thead>
<tr>
<th>bits</th>
<th>class type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>hosts (126 possible)  first number 1–126</td>
</tr>
<tr>
<td>0</td>
<td>nodes (16,777,214 possible)</td>
</tr>
<tr>
<td>10</td>
<td>hosts (16,382 possible)  first number 128–191</td>
</tr>
<tr>
<td></td>
<td>nodes (65,534 possible)</td>
</tr>
<tr>
<td>110</td>
<td>hosts (2,097,150 possible)  first number 192–223</td>
</tr>
<tr>
<td></td>
<td>nodes (254 possible)</td>
</tr>
<tr>
<td>1110</td>
<td>broadcast</td>
</tr>
<tr>
<td>11110</td>
<td>future use</td>
</tr>
</tbody>
</table>
IP Addresses (cont’d.)

- **ISPs**
  - Allocate IP addresses to other ISPs and home users
- **Internet Assigned Numbers Authority (IANA)**
  - Maintains global high-level registry of IP addresses
- **American Registry for Internet Numbers (ARIN)**
  - Allocates IP addresses to NBPs and ISPs
- **IP supports subnetting**
  - Block of IP addresses forming a separate network from a routing standpoint
DHCP

• Dynamic Host Configuration Protocol (DHCP)
  – Used between a computer and a router
  – Allows for automatic assignment of IP addresses
  – Computer uses DHCP to get IP address from router
• Time saving for the network administrator
  – Sets up server to allocate block of addresses
  – After configuration:
    • Nodes moved around
    • New computers added without determining available IP addresses
Routers

• Device or software in a computer
  – Determines the next network point to which a packet should be forwarded
    • IP packets routed to correct destination via a number of different routes
    • Packet sent on another line if original line damaged or busy
• Specialized computer used to join networks
• Make the Internet possible
• Work in a manner similar to post office
Routers (cont’d.)

Figure 5-3, Routers provide many alternative routes for packets
Routers (cont’d.)

- Time to live (TTL) field in the IP header
  - Enables routers to discard packets traversing the network for too long
- TCP
  - Ensures reliable delivery of data
  - Verifies data received in the packet
  - Uses sequence numbers to order packets
- Combination of TCP and IP
  - Ensures data sent from one computer to another gets there in a fast, orderly, reliable manner
    - Basis for the Internet
High-Level Protocols

• Protocol suite compares to OSI layers
  – TCP and IP span Session, Transport, Network layers
  – SMTP, HTTP, FTP, and Telnet are “above” TCP and IP in the networking model

• High-level protocols use TCP/IP
  – TCP splits messages into packets, if necessary
  – TCP layer adds header and forwards to IP for address
  – IP sends packets to Data Link and Physical layers
## High-Level Protocols (cont’d.)

**Figure 5-4, TCP/IP protocols compared with the OSI model**

<table>
<thead>
<tr>
<th>OSI model</th>
<th>TCP/IP protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Physical layer</td>
<td>electrical signals and cabling</td>
</tr>
<tr>
<td>2 Data Link (MAC) layer</td>
<td>transmits packets from node to node based on station address</td>
</tr>
<tr>
<td>3 Network layer</td>
<td>routes data to different LANs and WANs based on network address</td>
</tr>
<tr>
<td>4 Transport layer</td>
<td>ensures delivery of entire file or message</td>
</tr>
<tr>
<td>5 Session layer</td>
<td>starts or stops session; maintains order</td>
</tr>
<tr>
<td>6 Presentation layer</td>
<td>encryption, data format conversions</td>
</tr>
<tr>
<td>7 Application layer</td>
<td>type of communication: e-mail, file transfer, Web page</td>
</tr>
</tbody>
</table>

| | TCP (delivery ensured) UDP (delivery not ensured) |
| | IP |

- FTP
- SMTP
- HTTP
- Telnet
SMTP

• Simple Mail Transfer Protocol (SMTP)
  – Used to send e-mail messages over the Internet
  – Establishes link from e-mail client to e-mail server
  – Handshaking creates parameters of communication

• Receipt of e-mail handled by another protocol
  – Post Office Protocol version 3 (POP3)
  – Internet Message Access Protocol (IMAP)
FTP

• File Transfer Protocol (FTP)
  – Reliable and efficient transmission of data files
  – Requires client and server programs
  – Most OSs include command-line FTP client
    • Windows: type FTP at the command prompt or specify server address in Web browser address bar
FTP (cont’d.)

Figure 5-5, Command-line FTP session
SSH

- Secure Shell (SSH)
  - Primarily used with Linux and UNIX operating systems
  - Designed as a secure replacement for Telnet
  - Connects users to a remote host computer
    - Issue commands
    - Transfer data
  - Numerous SSH clients available
HTTP

• Hypertext Transfer Protocol (HTTP)
  – Developed in 1990 by Tim Berners-Lee
  – Allows Web browsers and Web servers to communicate
  – Central to World Wide Web
  – Example, http://www.course.com
    • “http” tells browser you are retrieving Web page with Hypertext Transfer Protocol
URLs and DNS

• Domain name
  – Locates IP address of an organization or other Internet entity

• Domain Name System (DNS)
  – Method of translating Internet domain names into IP addresses

• Uniform Resource Locator (URL)
  – Domain name followed by specific folder and filenames

• DNS server
  – Translates domain names from URLs into IP addresses
URLs and DNS (cont’d.)

![Diagram of URL structure]

Figure 5-6, Structure of a URL

http://www.cengage.com/myfolder/myfile.html
## URLs and DNS (cont’d.)

- **DNS server**: computer maintained by ISP
  - Performs lookup on URL (Uniform Resource Locator)
  - Responsible for a portion of the world’s domains
  - Communicates with other DNS servers

- **Domain levels**
  - Top-level domains (TLDs):
    - .com, .edu, .gov, .net, .org, and .mil
  - Server at each level has knowledge of lower level
  - Example: faculty.weber.edu

- **DNS servers communicate and stay updated**
### URLS and DNS (cont’d.)

<table>
<thead>
<tr>
<th>TLD</th>
<th>meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>.aero</td>
<td>air-transport industry</td>
</tr>
<tr>
<td>.arpa</td>
<td>Address and Routing Parameter Area</td>
</tr>
<tr>
<td>.biz</td>
<td>business</td>
</tr>
<tr>
<td>.com</td>
<td>commercial</td>
</tr>
<tr>
<td>.coop</td>
<td>cooperative</td>
</tr>
<tr>
<td>.edu</td>
<td>U.S. educational</td>
</tr>
<tr>
<td>.gov</td>
<td>U.S. government</td>
</tr>
<tr>
<td>.info</td>
<td>information</td>
</tr>
<tr>
<td>.int</td>
<td>international organization</td>
</tr>
<tr>
<td>.mil</td>
<td>U.S. military</td>
</tr>
<tr>
<td>.museum</td>
<td>museum</td>
</tr>
<tr>
<td>.name</td>
<td>individuals, by name</td>
</tr>
<tr>
<td>.net</td>
<td>network</td>
</tr>
<tr>
<td>.org</td>
<td>organization</td>
</tr>
<tr>
<td>.pro</td>
<td>profession</td>
</tr>
<tr>
<td>.ca, .mx</td>
<td>Canada, Mexico, and other countries are represented by two-letter codes</td>
</tr>
</tbody>
</table>

*Table 5-3, Top-level domains on the Internet*
Port Numbers

- Address specification below IP layer
- Port functions like apartment number in address
- Most protocols have a standard port number
  - 65,636 possible port numbers for each IP address
  - Specifying a port: append number to domain or IP address
  - Example: http://192.168.2.33:8080
    - 192.168.2.33 specifies the IP address
    - 8080 specifies the port number
### Port Numbers (cont’d.)

<table>
<thead>
<tr>
<th>port number</th>
<th>protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>FTP (File Transfer Protocol)</td>
</tr>
<tr>
<td>22</td>
<td>SSH (Secure Shell)</td>
</tr>
<tr>
<td>25</td>
<td>SMTP (Simple Mail Transfer Protocol)</td>
</tr>
<tr>
<td>53</td>
<td>DNS (Domain Name System)</td>
</tr>
<tr>
<td>68</td>
<td>DHCP (Dynamic Host Configuration Protocol)</td>
</tr>
<tr>
<td>80</td>
<td>HTTP (Hypertext Transfer Protocol)</td>
</tr>
<tr>
<td>110</td>
<td>POP3 (Post Office Protocol version 3)</td>
</tr>
<tr>
<td>139</td>
<td>NetBIOS</td>
</tr>
</tbody>
</table>

**Table 5-4, Commonly used TCP/IP port number assignments**
NAT

• Network Address Translation (NAT)
  – Translates an inside IP address to an outside IP address
  – Allows multiple computers to share one Internet connection
  – Dependent on DHCP and port numbers

• NAT structure
  – Internal range: 192.168.0.0 to 192.168.255.255
    • Only presented to the Internet: 192.168
  – TCP routes messages to node with matching port
Checking Your Configuration

• Type IPCONFIG command in console window
  – Screen reflects:
    • Current IP address
    • Subnet mask
    • Address of the gateway to the Internet

• More information
  – Type IPCONFIG /ALL

• Help
  – Type IPCONFIG /H
Checking Your Configuration (cont’d.)

Figure 5-7, Results of using the IPCONFIG command

Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Windows>IPCONFIG

Windows IP Configuration

Ethernet adapter Belkin Connect Ethernet:

    Connection-specific DNS Suffix . .
    IP Address . . . . . . . . . . . . . . . . . . . . . . : 192.168.0.33
    Subnet Mask . . . . . . . . . . . . . . . . . . . . . . : 255.255.255.0
    Default Gateway . . . . . . . . . . . . . . . . . . . . : 192.168.0.1

C:\Windows>
HTML

• Web server
  – Computer programmed to respond to HTTP requests
  – Sends back the requested Web page
  – Default page names: index.htm or default.htm
  – Webmaster is responsible for the Web server

• HTML
  – Markup symbols or codes inserted in a file
    • Specifies how material is displayed on a Web page
HTML (cont’d.)

- HTML tags
  - Formatting commands
  - Browser uses tags to display graphical content
  - Knowledge needed to use Web page design tools
### HTML (cont’d.)

<table>
<thead>
<tr>
<th>tag</th>
<th>purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;HTML&gt; &lt;/HTML&gt;</code></td>
<td>Used to provide a boundary for the HTML document; everything between <code>&lt;HTML&gt;</code> and <code>&lt;/HTML&gt;</code> is considered part of the Web page.</td>
</tr>
<tr>
<td><code>&lt;HEAD&gt; &lt;/HEAD&gt;</code></td>
<td>The <code>&lt;HEAD&gt;</code> tags are placed inside the <code>&lt;HTML&gt;</code> tags; they provide a boundary for items that aren’t part of the document but are used to direct the browser to do certain things, such as displaying a page title in the title bar.</td>
</tr>
</tbody>
</table>

**Table 5-5, Common HTML tags**
## HTML (cont’d.)

<table>
<thead>
<tr>
<th>Tag</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;TITLE&gt;</code></td>
<td>The <code>&lt;TITLE&gt;</code> tags surround the Web document’s title, which appears in the browser’s title bar when the page is displayed. The <code>&lt;TITLE&gt;</code> tags go inside the <code>&lt;HEAD&gt;</code> tags.</td>
</tr>
<tr>
<td><code>&lt;BODY&gt;</code></td>
<td>The <code>&lt;BODY&gt;</code> tags enclose the part of the Web page document that’s displayed in the browser; they’re placed inside the <code>&lt;HTML&gt;</code> tags but not inside the <code>&lt;HEAD&gt;</code> tags.</td>
</tr>
<tr>
<td><code>&lt;BR /&gt;</code></td>
<td><code>&lt;BR /&gt;</code> forces the browser display area to go to a new line. Note that there’s no closing tag.</td>
</tr>
<tr>
<td><code>&lt;P&gt;</code></td>
<td>The <code>&lt;P&gt;</code> tags define a paragraph in the Web document and cause a paragraph break.</td>
</tr>
<tr>
<td><code>&lt;SPAN&gt;</code></td>
<td>The <code>&lt;SPAN&gt;</code> tags replaced a number of formatting tags. They define an area of the document and specify the way this area should be formatted.</td>
</tr>
<tr>
<td><code>&lt;A&gt;</code></td>
<td>The <code>&lt;A&gt;</code> tags specify a link to another Web page or a specific location on the current page; the opening <code>&lt;A&gt;</code> tag has arguments that reference the linked page or position.</td>
</tr>
<tr>
<td><code>&lt;IMG /&gt;</code></td>
<td>The <code>&lt;IMG&gt;</code> tag is used to insert an image in the document; it has arguments for specifying the location and size of the image.</td>
</tr>
<tr>
<td><code>&lt;FORM&gt;</code></td>
<td>The <code>&lt;FORM&gt;</code> tags provide the boundaries for an input form on the Web page; other tags are placed inside the <code>&lt;FORM&gt;</code> tags to create items such as input boxes and buttons on the Web page.</td>
</tr>
<tr>
<td><code>&lt;INPUT /&gt;</code></td>
<td>The <code>&lt;INPUT&gt;</code> tag specifies data input objects inside the <code>&lt;FORM&gt;</code> tags; this tag allows users to enter data on a Web page.</td>
</tr>
<tr>
<td><code>&lt;TABLE&gt;</code></td>
<td>The <code>&lt;TABLE&gt;</code> tags define an area on the Web page that displays data in rows and columns.</td>
</tr>
<tr>
<td><code>&lt;TR&gt;</code></td>
<td>The <code>&lt;TR&gt;</code> tags are placed inside the <code>&lt;TABLE&gt;</code> tags to signify the start of a table row.</td>
</tr>
<tr>
<td><code>&lt;TD&gt;</code></td>
<td>The <code>&lt;TD&gt;</code> tags are placed inside the <code>&lt;TR&gt;</code> tags to define a column in a table row.</td>
</tr>
</tbody>
</table>

### Table 5-5, Common HTML tags (cont’d.)
Creating a Simple Web Page

• Open Notepad window
  – Type in the HTML document shown in Figure 5-8
  – Save file to disk with .htm or .html extension
  – Use Windows Explorer to locate file
  – Double-click the file
  – Browser displays document formatted in HTML code

• HTML
  – Not case sensitive
  – Most Web designers use Web design tools
Creating a Simple Web Page (cont’d.)

```html
<html>
<head>
<title>My First Web Page</title>
</head>
<body>
<p>My First Web Text<br>
   <span style="font-weight:bold; font-size:16px; font-family:Arial, Helvetica, sans-serif">My First Table</span>
</p>
<table width="30%" border="1">
  <tr>
    <td><b>Protocol</b></td><td><b>Purpose</b></td>
  </tr>
  <tr>
    <td>TCP</td><td>Reliable Delivery</td>
  </tr>
  <tr>
    <td>IP</td><td>Addressing</td>
  </tr>
  <tr>
    <td>HTTP</td><td>Web Pages</td>
  </tr>
</table>
</body>
</html>
```

Figure 5-8, HTML tags for a simple Web page
Creating a Simple Web Page (cont’d.)

Figure 5-9, Simple Web page displayed in a browser
Hyperlinks

• Links to other pages
  – HTML <A></A> tags

```html
<html>
<head>
<title>My Second Web Page</title>
</head>
<body>
<p><span style="font-weight:bold">My Set of Hyperlinks to News Sources</span>
   <a href="http://cnn.com">CNN</a><br/>
   <a href="http://foxnews.com">FOX NEWS</a><br/>
   <a href="http://www.nbc.com/nbc/NBC_News/">NBC</a><br/>
   <a href="http://abcnews.go.com/">ABC</a><br/>
   <a href="http://www.cbsnews.com/sections/home/main100.shtml">CBS</a></p>
</body>
</html>
```

Figure 5-10, Using the <A> tag to create hyperlinks in a Web document
Hyperlinks (cont’d.)

Figure 5-11, Browser view of the sample hyperlink Web page
Web Server Programs

• Provide dynamic Web pages
  – DHTML (Dynamic Hypertext Markup Language)
  – HTML/DHTML and scripting code
    • JavaScript or VBScript

• Completely dynamic Web pages
  – CGI, ASP, JSP, PHP, and Python

• Server-side Web technologies
  – Used heavily on the Internet
    • Examples: Internet banking, shopping, television program guides
Web Services

• Server-based Web program
  – Outgrowth of dynamic server-side Web page programming
  – Contains data to be used by other programs or Web pages (instead of being viewed)
  – Becoming popular in business to provide information to other programs
    • Example: stock quotes
XML

- SGML
  - Specification source for HTML and XML
- HTML limitation
  - Does not affect Web page content
- Extensible Markup Language (XML)
  - Similar to HTML in structure
  - Provides data and metadata
  - Can be used to display Web pages
  - Most important use: transfer data
<xml version="1.0" encoding="ISO-8859-1"?>
  <xml-stylesheet type="text/xsl" href="sample.xsl"/>
  <dvd_library>
    <dvd>
      <id>D0146</id>
      <title>The Lord of the Rings: The Return of the King</title>
      <rating>PG-13</rating>
      <price>24.95</price>
      <review>****</review>
    </dvd>
    <dvd>
      <id>D3218</id>
      <title>Dumb and Dumber</title>
      <rating>PG-13</rating>
      <price>14.95</price>
      <review>****</review>
    </dvd>
    <dvd>
      <id>D4482</id>
      <title>Mom and Dad Save The World</title>
      <rating>PG</rating>
      <price>8.95</price>
      <review>*****</review>
    </dvd>
  </dvd_library>

**Figure 5-12, An example of an XML data document**
Using the Internet

- Tremendous resource
- Invest time to develop searching skills
- Internet information:
  - Replaced newsgroups for research
Search Engines

• Program accessed on the Web
  – Gathers and reports information available on the Internet
• Preferred method for finding information
• Many opportunities to benefit from the power of search engines
Search Engines (cont’d.)

Figure 5-13, A search engine provides capabilities for Web searching
Search Engines (cont’d.)

<table>
<thead>
<tr>
<th>search engine</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google</td>
<td><a href="http://www.google.com">www.google.com</a></td>
</tr>
<tr>
<td>AlltheWeb</td>
<td><a href="http://www.alltheweb.com">www.alltheweb.com</a></td>
</tr>
<tr>
<td>Yahoo!</td>
<td><a href="http://www.yahoo.com">www.yahoo.com</a></td>
</tr>
<tr>
<td>Bing</td>
<td><a href="http://www.bing.com">www.bing.com</a></td>
</tr>
<tr>
<td>Ask</td>
<td><a href="http://www.ask.com">www.ask.com</a></td>
</tr>
</tbody>
</table>

Table 5-6, Some popular Web search engines
One Last Thought

• Internet
  – Grown into global forum
  – Used for information gathering and communication
  – Issues:
    • Anonymity and reliability of information
    • Identity theft
    • Virus replication
  – It is here to stay
    • Computing professionals develop and use new Internet-related technologies continually
Summary

• Internet: collection of LANs and WANs
  – No single entity controls the Internet
  – Hierarchy of ISPs and NBPs manage connections

• Protocols: critical in Internet operation

• TCP/IP: heart of protocol suite
  – TCP manages data delivery
  – IP provides for addressing

• Every Internet node has a unique address
  – DHCP automatically assigns addresses

• Routers: key Internet hardware component
Summary (cont’d.)

• High-level protocols
  – HTTP, FTP, SMTP, POP3, and IMAP
• Uniform resource locator (URL) specifies address
• DNS server resolves domain name to IP number
• Hypertext Markup Language (HTML) is the language of the World Wide Web
  – Web page: content formatted with HTML tags
  – Scripting languages: generate dynamic pages
  – Hyperlink: connection to another Web page
  – Search engines: generate database of Web sites