Learning Objectives

- Discuss the origins of the Internet
- Identify the key technology concepts behind the Internet
- Describe the role of Internet protocols and utility programs
- Explain the current structure of the Internet

Learning Objectives

- Understand the limitations of today’s Internet
- Describe the potential capabilities of Internet II
- Understand how the World Wide Web works
- Describe how Internet and Web features and services support e-commerce

The Internet: Technology Background

- **Internet**
  - An interconnected network of thousands of networks and millions of computers linking businesses, educational institutions, government agencies, and individuals together
- **World Wide Web (WWW)**
- One of the Internet's most popular services, providing access to over one billion Web pages
Stages in the Development of the Internet

Innovation 1961 – 1974
Institutionalization 1975 – 1995
Commercialization 1995 –

Development of the Internet: Timeline

Page 110, Figure 3.1

Copyright © 2002 Pearson Education, Inc.

Slide 3-7

Development of the Internet: Timeline

Page 111, Figure 3.2

Copyright © 2002 Pearson Education, Inc.

Slide 3-8

Development of the Internet: Timeline

Page 112, Figure 3.2 continued

Copyright © 2002 Pearson Education, Inc.

Slide 3-9

Development of the Internet: Timeline

Page 113, Figure 3.2 continued

Copyright © 2002 Pearson Education, Inc.

Slide 3-10

Development of the Internet: Timeline

Page 114, Figure 3.2 continued

Copyright © 2002 Pearson Education, Inc.

Slide 3-11

The Internet: Key Technology Concepts

Page 114, Figure 3.3

Copyright © 2002 Pearson Education, Inc.

Slide 3-12
The Internet: Key Technology Concepts

- **Packet switching**
  - A method of slicing digital messages into packets, sending the packets along different communication paths as they become available, and then reassembling the packets once they arrive at their destination.
  - **Packet**
  - The parcels into which digital messages are sliced for transmission over the Internet.

- **Routers**
  - Special-purpose computers that interconnect the computer networks that make up the Internet and route packets to their ultimate destination as they travel the Internet.
  - **Routing algorithm**
  - Computer program that ensures packets take the best available path toward their destination.

Packet Switching

- **TCP (Transmission Control Protocol)**
  - Protocol that establishes the connections among sending and receiving Web computers, handles the assembly of packets at point of transmission, and their reassembly at the receiving end.

- **IP (Internet Protocol)**
  - Protocol that provides the Internet’s addressing scheme.

- **Protocol**
  - A set of rules for formatting, ordering, compressing, and error checking messages.

IP Addresses

- Internet addresses expressed as 32-bit numbers that appear as a series of four separate numbers marked off by periods, such as 201.61.186.227.
- In the current IPv4, each of the four numbers can range from 0 to 255 allowing for up to 4 billion addresses (2 to the 32nd power).
- In IPv6, the next generation IP, the scheme uses 128-bit addresses, or about one quadrillion addresses (10 to the 15th power).
Routing Internet Messages: TCP/IP and Packet Switching

1. The TCP protocol breaks data into packets.
2. The packets travel from router to router over the Internet according to the IP protocol.
3. The TCP protocol reassembles the packets into the original whole.

Domain Names and URLs

- Domain name
- IP address expressed in natural language
- Domain name system (DNS)
- System for expressing numeric IP addresses in natural language
- Uniform resource locator (URL)
- The address used by a Web browser to identify the location of content on the Web

Pieces of the Internet Puzzle: Names and Addresses

<table>
<thead>
<tr>
<th>PIECES OF THE INTERNET PUZZLE: NAMES AND ADDRESSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP addresses</td>
</tr>
<tr>
<td>Domain names</td>
</tr>
<tr>
<td>DNS servers</td>
</tr>
<tr>
<td>Root servers</td>
</tr>
<tr>
<td>ICANN</td>
</tr>
</tbody>
</table>

Client/Server Computing

- Client/server
  - A model of computing in which very powerful personal computers are connected together in a network with one or more servers.
  - Client
    - A very powerful personal computer that is part of a network. They are capable of displaying rich graphics, storing large files, and processing graphics and sound files.
  - Server
    - A networked computer dedicated to common functions that the client machines on the network need, such as storing files, software applications, utility programs such as Web connections, and printers.

The Client/Server Computing Model

- Server Computer
- Shared Database Applications Files

Other Internet Protocols and Utility Programs

- HTTP is the Internet protocol used for transferring Web pages.
- FTP is one of the original Internet services. Part of TCP/IP protocol that permits users to transfer files from the server to their client machine, and vice versa.
- SSL is a protocol that provides secure communications between the client and the server.
Other Internet Protocols and Utility Programs

- **Sending E-mail**
  - SMTP (Simple Mail Transfer Protocol) is the Internet protocol used to send mail to a server
  - POP (Post Office Protocol) is a protocol used by the client to retrieve mail from an Internet server
  - IMAP (Internet Mail Access Protocol) is a more current e-mail protocol that allows users to search, organize, and filter their mail prior to downloading it from the server

- **Telnet** is a terminal emulation program that runs in TCP/IP
- **Finger** is a utility program supported by UNIX computers that tells who is logged in, how long they have been attached, and their user name
- **Ping** is a program that allows you to check the connection between your client and the server
- **Tracert** is one of several route-tracing utilities that allow you to follow the path of a message you send from your client to a remote computer on the Internet

Tracing the Route a Message Takes on the Internet

Page 124, Figure 3.10

The Hourglass Model of the Internet

Page 125, Figure 3.11

Internet I Network Architecture

Page 126, Figure 3.12

The Internet Backbone

- **Backbone**
  - high-bandwidth fiber optic cable that transports data across the Internet
- **Network Service Provider (NSP)**
  - owns and controls one of the major networks comprising the Internet’s backbone
**Major U.S. Internet Backbone Owners**

<table>
<thead>
<tr>
<th>Table 3.2 MAJOR U.S INTERNET BACKBONE OWNERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;T</td>
</tr>
<tr>
<td>Cable &amp; Wireless</td>
</tr>
<tr>
<td>Genuity</td>
</tr>
<tr>
<td>MCI WorldCom</td>
</tr>
<tr>
<td>Sprint</td>
</tr>
<tr>
<td>PSI Net</td>
</tr>
<tr>
<td>Qwest</td>
</tr>
<tr>
<td>Level 3</td>
</tr>
<tr>
<td>Williams</td>
</tr>
<tr>
<td>Global Crossing</td>
</tr>
<tr>
<td>Broadband</td>
</tr>
</tbody>
</table>

**The Internet Backbone**

- **Bandwidth**
  - Measures how much data can be transferred over a communications medium within a fixed period of time; is usually expressed in bits per second (bps), kilobits per second (Kbps), or megabits per second (Mbps)
- **Redundancy**
  - Multiple duplicate devices or paths in a network

**Network Access Points and Metropolitan Area Exchanges**

- **Network Access Point (NAP)**
  - One of the hubs where the backbone intersects with regional and local networks, and where the backbone owners connect with one another
- **Metropolitan Area Exchanges (MAEs)**
  - Another name for one of the hubs where the backbone intersects with regional and local networks

**Internet NAPS and MAES**

<table>
<thead>
<tr>
<th>Table 3.13 INTERNET NAPS AND MAES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
</tr>
<tr>
<td>Owner/Operator</td>
</tr>
<tr>
<td>Chicago-MAP</td>
</tr>
<tr>
<td>Charlotte-MAE</td>
</tr>
<tr>
<td>Denver-MAE</td>
</tr>
<tr>
<td>Dallas-MAE</td>
</tr>
<tr>
<td>San Jose-MAE</td>
</tr>
<tr>
<td>Atlanta-MAE</td>
</tr>
<tr>
<td>Washington DC-MAE</td>
</tr>
<tr>
<td>Chicago-South-MAE</td>
</tr>
<tr>
<td>New York East-MAE</td>
</tr>
<tr>
<td>San Francisco-MAE</td>
</tr>
</tbody>
</table>

**Campus Networks**

- Generally local area networks operating with a single organization that leases access to the Web directly from regional and national carriers
Internet Service Providers

- Firm that provides the lowest level of service in the multi-tiered Internet architecture by leasing Internet access to home owners, small businesses, and some large institutions
- Narrowband
  - The traditional telephone modem connections, now operating at 56.6 Kbps
- Broadband
  - refers to any communication technology that permits clients to play streaming audio and video files at acceptable speeds – generally above 100 Kbps

ISP Service Level Choices

- Digital Subscriber Line (DSL)
  - a telephone technology for delivering high-speed access through ordinary telephone lines found in homes and businesses
- cable modem
  - a cable television technology that piggybacks digital access to the Internet on top of the analog video cable providing television signals to a home

<table>
<thead>
<tr>
<th>ISP SERVICE LEVEL CHOICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE 3.3</td>
</tr>
<tr>
<td>BANDWIDTH CHOICES</td>
</tr>
<tr>
<td>Service</td>
</tr>
<tr>
<td>Telephone Modern</td>
</tr>
<tr>
<td>DSL Lite</td>
</tr>
<tr>
<td>DSL Regular</td>
</tr>
<tr>
<td>Cable Modem</td>
</tr>
<tr>
<td>Satellite Dish</td>
</tr>
<tr>
<td>T1</td>
</tr>
</tbody>
</table>

ISP Service Level Choices

- T1
  - an international telephone standard for digital communication that offers guaranteed delivery at 1.54 Mbps
- T3
  - an international telephone standard for digital communication that offers guaranteed delivery at 43 Mbps

Time to Download a 10 Megabyte File by Type of Internet Service

<table>
<thead>
<tr>
<th>TYPE OF INTERNET SERVICE</th>
<th>TIME TO DOWNLOAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrowband Services</td>
<td>25 minutes</td>
</tr>
<tr>
<td>Telephone modem</td>
<td>9 minutes</td>
</tr>
<tr>
<td>DSL Lite</td>
<td>3.5 minutes</td>
</tr>
<tr>
<td>Cable Modem</td>
<td>57 seconds</td>
</tr>
<tr>
<td>T1</td>
<td>2 seconds</td>
</tr>
</tbody>
</table>

Intranets and Extranets

- Intranet
  - a TCP/IP network located within a single organization for purposes of communications and information processing
- Extranet
  - formed when firms permit outsiders to access their internal TCP/IP networks
Who Governs the Internet?

- Internet Architecture Board (IAB)
- Internet Corporation for Assigned Names and Numbers (ICANN)
- Internet Engineering Steering Group (IESG)
- Internet Engineering Task Force (IETF)
- Internet Society (ISOC)
- World Wide Web Consortium (W3C)

Internet II

- A consortium of more than 180 universities, government agencies, and private businesses that are collaborating to find ways to make the Internet more efficient

Internet II Goals

- Create a leading edge network capability for the national research community.
- Enable revolutionary Internet applications.
- Ensure the rapid transfer of new network services and applications to the broader Internet community.

Internet II Pursuits

- Advanced Network Infrastructure
  - gigaPop
- New Networking Capabilities
  - deploying IPv6 addressing protocol
  - developing and implementing new quality of service technologies
  - developing more effective routing practices
  - coordinating the interconnection of the different components of the Internet2 infrastructure
  - creating an infrastructure to efficiently handle one-to-many communications

Internet II Pursuits

- Middleware
  - standardize middleware that incorporates identification, authentication, authorization, directory, and security services
- Advance Applications
  - distributed computation, virtual laboratories, digital libraries, distributed learning, tele-immersion, and a synthesis of all these working in combination
The Larger Internet II Technology Environment

- Next Generation Internet (NGI): another project initiated and sponsored by the federal government focused on developing advanced applications and networking capabilities needed by U.S. government agencies.
- Fiber Optics and Bandwidth Explosion: replacing older transmission line with fiber-optic cable.
- Improving fiber-optic-based communications technology.
- Improving fiber-optic switching speeds.

Worldwide Optical Fiber Market Growth

Page 138, Figure 3.15

Photonics Technologies

- Photonics: the study of communicating with light waves.
- Dense Wave Length Division Multiplexing: an optical technology used to increase bandwidth over existing fiber optic backbones.
- Big Band: can accommodate upwards of 10 Gbps, enabling high bandwidth applications.

Major Photonics Opportunities and Players

Page 139, Table 3.5

Wireless Web and 3G Technologies

- Global System for Mobile Communications: mobile communications system widely used in Europe and Asia that uses narrowband Time Division Multiple Access (TDMA).
- Code Division Multiple Access: mobile communications system widely used in the United States that uses the full spectrum of radio frequencies and digitally encrypts each call.

Bandwidth Demand of Various Web Applications

Page 140, Figure 3.16
Wireless Web and 3G Technologies

- General Packet Radio Switching
  - next generation technology carries data in packets, just like the Internet, but over radio frequencies that make wireless communications possible
  - Wireless Application Protocol
  - a relatively new protocol that can support virtually any wireless network and is supported by every operating system
  - Wireless Markup Language
  - programming language for devices using WAP

- iMode
  - wireless standard that is a proprietary service of the Japanese company NTT DoCoMo

- 3G
  - new generation of cellular phone standards that can connect users to the Web at 2.4 Mbps

Wireless LANs

- Bluetooth
  - new technology standard for short-range wireless communication under 100 meters

- Wireless Fidelity
  - Wireless standard for Ethernet networks with greater speed and range than Bluetooth. Also referred to as 802.118

Internet Applications: The Changing Client Computer

- Thin Client Computing
  - where the receiving device--the client--relies totally on the Internet server to handle all information processing; the device itself has no processing ability

Wireless Web Products and Players

<table>
<thead>
<tr>
<th>TABLE 3.6</th>
<th>WIRELESS WEB PRODUCTS AND PLAYERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPANY</td>
<td>PRODUCT</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovative Global Solution</td>
<td>Neopoint 1000</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>Mobile-Access 120 Series</td>
</tr>
<tr>
<td>Motorola</td>
<td>i1000iPhX</td>
</tr>
<tr>
<td>Nokia</td>
<td>9000i Communicator</td>
</tr>
<tr>
<td>Palm Computing</td>
<td>Palm M1</td>
</tr>
<tr>
<td>Qualcomm</td>
<td>PDA Smart Phone, Thin Phone</td>
</tr>
<tr>
<td>Samsung</td>
<td>Duette</td>
</tr>
</tbody>
</table>

Benefits of Internet II Technologies

- IP Multicasting
  - a set of technologies that enables efficient delivery of data to many locations on a network

- Latency Solutions
  - Differentiate between high-priority and low-priority packets.
  - diffserve -- a new technology that assigns levels of priority to packets based on the type of data being transmitted
Benefits of Internet II Technologies

- Guaranteed Service Levels
  - possible to purchase the right to move data through the network at a guaranteed speed in return for higher fees
- Lower Error Rates
  - improved capacity and packet switching will inevitably impact the quality of data transmission
- Declining Costs
  - more users means lower cost, as products and technology catch on in the mass market

Development of the Web

- Mosaic
  - Web browser with a graphical user interface that made it possible to view documents on the Web graphically
- Universal Computing
  - the sharing of files, information, graphics, sound, video, and other objects across all computer platforms in the world, regardless of operating system
  - Netscape Navigator
    - the first commercial Web browser
  - Internet Explorer (IE)
    - Microsoft’s Web browser

Hypertext

- A way of formatting pages with embedded links that connect documents to one another, and that also link pages to other objects such sound, video, or animation files
- Uses Hypertext Transfer Protocol (HTTP) followed by the universal resource locator (URL) to locate an document or object

Top-Level Domains

- .com
  - Commercial organizations of businesses
- .edu
  - Educational institutions
- .gov
  - U.S. government agencies
- .mil
  - U.S. military
- .net
  - Network computers
- .org
  - Nonprofit organizations and foundations
- .biz
  - business firms
- .info
  - information providers
- .aero
  - Air transport industry
- coop
  - Cooperatives
- .museum
  - Museums
- .name
  - Individuals
- .pro
  - Professionals

Markup Languages

- Standard Generalized Markup Language (SGML)
  - a early version of Generalized Markup Language
- Hypertext Markup Language (HTML)
  - one of the next generation of GMLs that is relatively easy to use in Web page design. HTML provides Web page designers with a fixed set of markup “tags” that are used to format a Web page
  - Extensible Markup Language
    - a new markup language specification developed by W3C that is designed to describe data and information
Web Servers and Clients

- Web server software enables a computer to deliver Web pages written in HTML to client machines on a network that request this service by sending an HTTP request
- **Basic capabilities**
  - Security services
  - File Transfer Protocol
  - Search engine
  - Data capture

---

**Sample XML Code for a Medical Record**

```xml
<?xml version="1.0"?>
<medical-record>
  <patient id="466453488">
    <name>John G. Williams</name>
    <address>S2 Oregon Road</address>
    <city>Ann Arbor</city>
    <state>Michigan</state>
    <zip>48108</zip>
    <doctor name="Frank Lucretius"/>
    <time>
      <appointment time="3:30pm" date="05/12/2003"/>
    </time>
  </patient>
</medical-record>
```

---

**HTLM Tools**

<table>
<thead>
<tr>
<th>SOFTWARE TOOL</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text editor, e.g. Notepad or WordPad</td>
<td>Suitable for creating simple Web pages, text.</td>
</tr>
<tr>
<td>FrontPage</td>
<td>Solid basic page editor.</td>
</tr>
<tr>
<td>Dreamweaver</td>
<td>Strong candidate for Web page creation, design, and site management tool. Good at creating and integrating graphics and other objects.</td>
</tr>
</tbody>
</table>

---

**Sample HTML Code**

(a) HTML Code

(b) Web Page
Web Servers and Clients

- Types of servers on the Web
  - database server -- designed to access specific information with a database
  - ad server -- designed to deliver targeted banner ads
  - mail server -- provides mail messages
  - video server -- serves video clips
- Web Client
  - any computing device attached to the Internet that is capable of making HTTP requests and displaying HTML pages, most commonly a Windows PC or Macintosh

The Internet and the Web: Features

- E-Mail
  - The most-used application of the Internet. Uses a series of protocols to enable messages containing text, images, sound, and video clips to be transferred from one Internet user to another.
  - Attachment is a file inserted within the e-mail message
  - Spam is unsolicited e-mail

Types of Web BOTS

- Search engines
  - identifies Web pages that appear to match keywords, also called queries, typed by the user and provides a list of the best matches
  - Intelligent agents (BOTS)
  - software programs that gather and/or filter information on a specific topic and then provide a list of results for the user
- Instant messaging
  - displays words typed on a computer almost instantaneously, making the communication more like a live conversation that is possible through e-mail
  - Chat
  - enables users to communicate via computer in real time, that is, simultaneously.

Music, Video, and Other Standard Files

- Streaming Media
  - enables music, video, and other larger files to be sent to users in chunks so that when received and played, the file comes through uninterrupted
- Cookies
  - a tool used by Web sites to store information about a user
  - a small text file stored on the user’s computer with information about the user to more quickly load the site in the future

Internet II and E-commerce: Emerging Features and Services

- IP Telephony
  - a general term for the technologies that use VOIP and the Internet’s packet-switched network to transmit voice and other forms of audio communication over the Internet
  - Voice Over Internet Protocol (VOIP)
  - protocol that allows for transmission of voice and other forms of audio communication over the Internet
- Digital Libraries
  - Distribution of application software, multimedia, and other services on a fee basis by Application Service Providers (ASP)
- Distributed Storage
  - ASPs can assist both in processing data and storing it, dispersing it to multiple servers rather than having it reside on one
Internet II and E-commerce: Emerging Features and Services

- Distance Learning
  - one of the biggest education initiatives in recent years, distance learning provides courses and degree programs online

- Digital Video
  - deliver better-than-broadcast quality video over the Internet on demand

- Video Teleconferencing
  - significantly reduce the cost of video teleconferencing, making it affordable for most workers to share information that involves either an image or audio component

Internet II and E-commerce: Emerging Features and Services

- Tele-immersion
  - a merger of virtual reality and video conferencing, where participants can see each other and collaborate on visual projects

- M-commerce Applications
  - combining voice, data, images, audio, and video on one wireless device