

CSC 101

Fluency with Information Technology and Computing

Chapter 3

The Basics of Networking

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Networked Computers, Life Changes

- Single computers are useful, connected ones are even more so
 - Nowhere is remote
 - People are interconnected
 - Social relationships are changing
 - Freedom of speech and assembly have expanded

Nowhere Is Remote

- Internet is a complete information resource no matter where you are
 - Some differences remain because older sources are not yet all online
- Homes are not remote from work
 - Information workers can telecommute and live long distances from their offices

Social Interactions Are Changing

- Time spent online displaces other in-person social activities (*displacement effect*)
- The effects are complicated (pros/cons)
- The Internet is changing social interactions; we don't yet fully understand how

Freedom of Speech and of Assembly Have Expanded

- Internet use is *unmediated*
 - No editorial oversight or significant restrictions
 - Wikis allow collaborative information construction
- *Blogs* record personal thoughts, political, artistic expression for public viewing
- Like-minded people can communicate, even on private topics

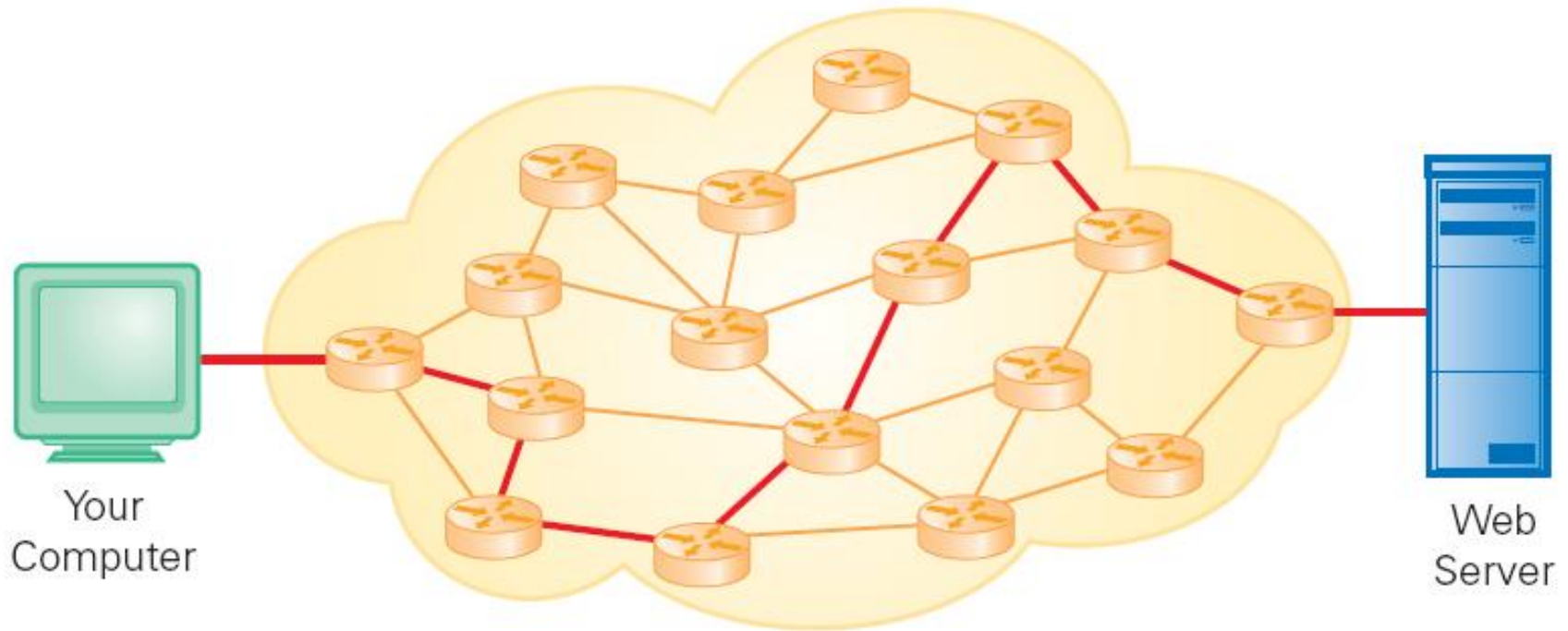


Figure 3.1 A schematic diagram of the Internet.

Communication Types

■ General Communication

- *Synchronous*: sender and receiver are active at the same time
 - ♦ e.g., telephone call, instant messaging (IM)
- *Asynchronous*: sending and receiving occur at different times
 - ♦ e.g., e-mail
- *Broadcast communication* (or multicast): single sender and many receivers
- *Point-to-point communication*: single sender and single receiver

Universal Communication Medium

- Internet provides a general communication "fabric" linking all computers connected to it
- Can be applied in many ways:
 - Point-to-point asynchronous
 - ◆ E-mail is alternative to standard mail
 - Point-to-point synchronous
 - ◆ IM is alternative to telephone
 - Multicasting
 - ◆ Chat rooms are alternatives to magazines
 - Broadcasting
 - ◆ Web pages are alternatives to radio and television

Client/Server Interaction

- *Server* is the computer that stores information
 - Web server, file server, mail server
- *Client* is the computer that wants the information
- When you click a Web link, your computer (the client) enters into a client/server relationship with a web server
- Once the page is sent to you, the client/server relationship ends

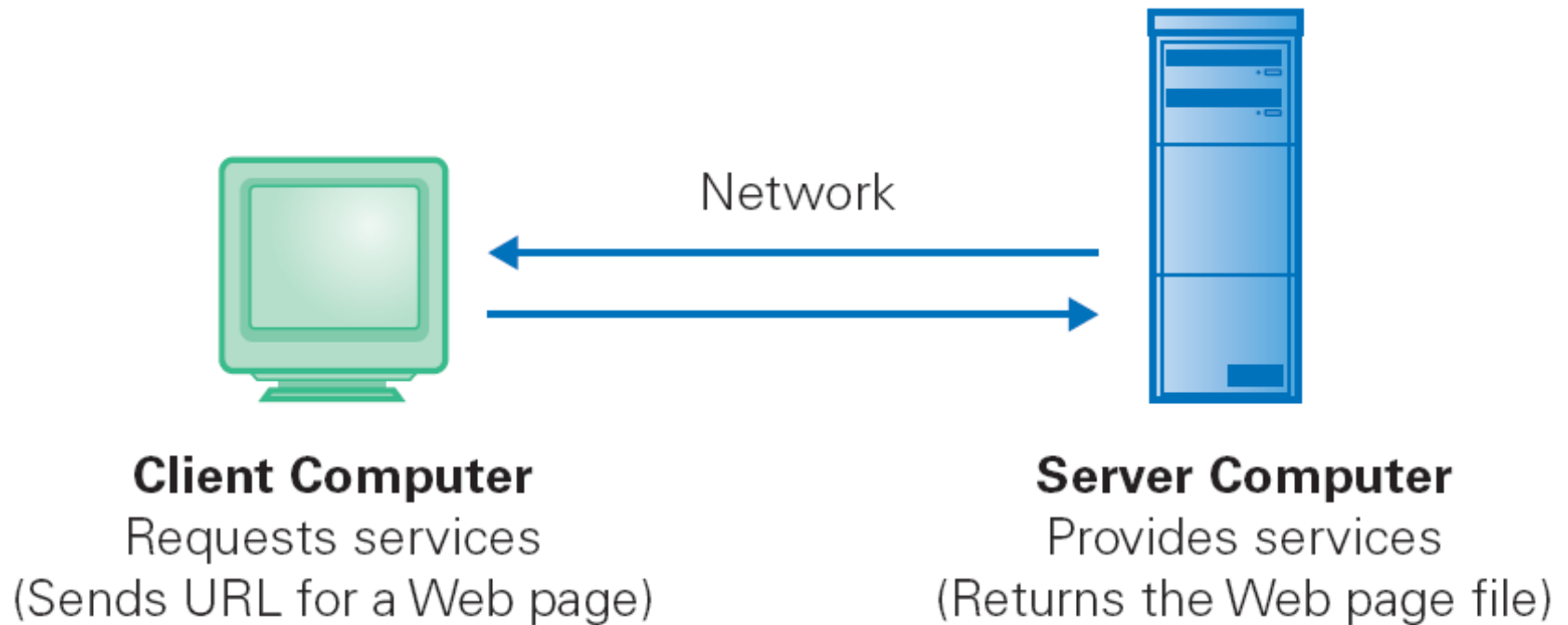


Figure 3.2 The basic client/server interaction, as illustrated by the browser (client) requesting Web pages provided by the Web server.

Client/Server Interaction

- These relationships are brief, so a server can serve many clients “at the same time”
 - Ask, receive, done
- One server can provide information to many clients
 - Yahoo, Google, eBay... a web site can be used by many different people at once, and they all get service when
- One client computer can ask for services from many servers
 - A web page may have many links, each to a different web server

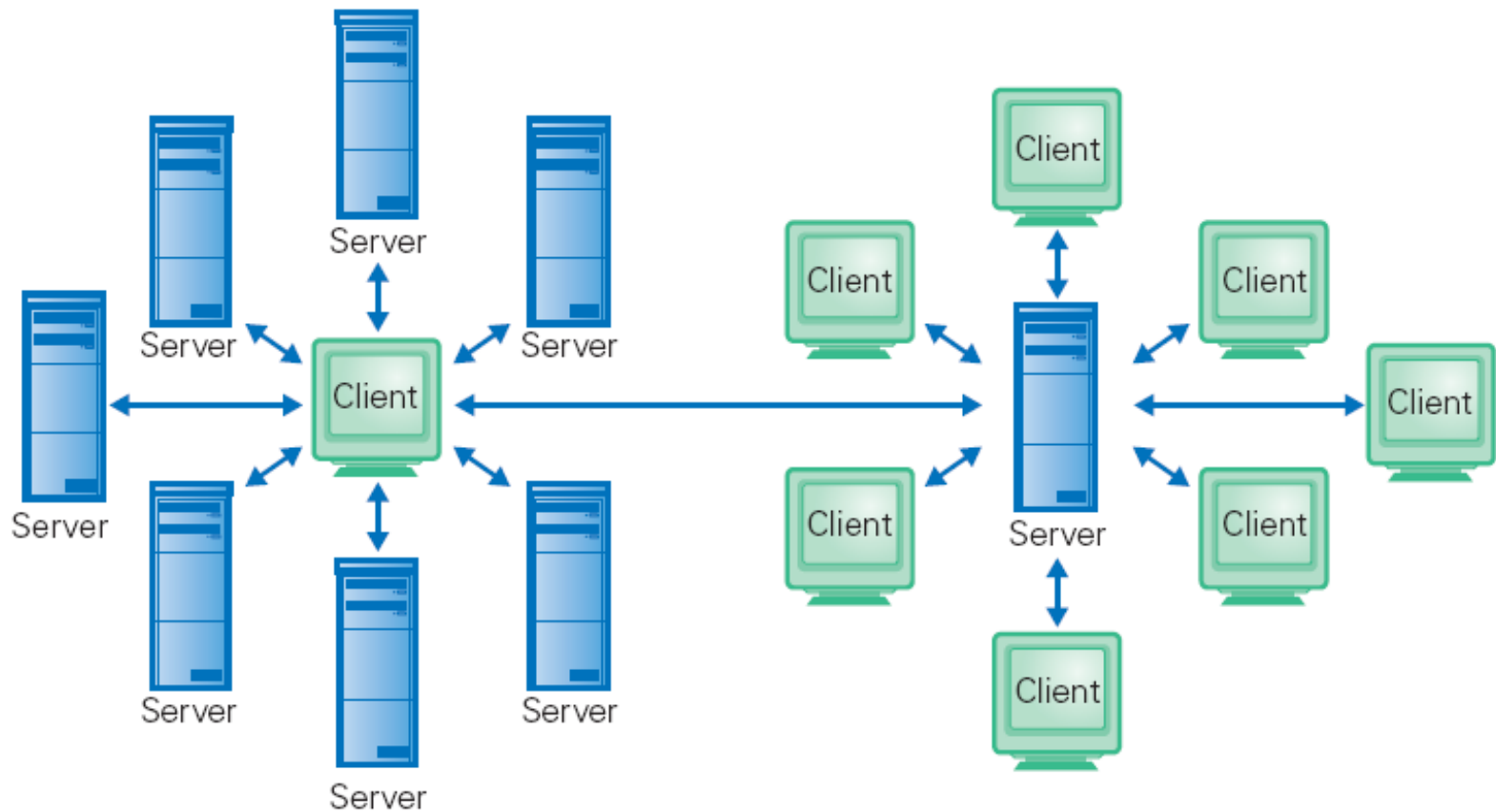


Figure 3.3 Client/server relationships as they might evolve over time.

Name Game: Computer Addresses

- *IP addresses:* Each computer on the Internet (a host) is given a unique 4-part numerical address
 - *For example:* 141.216.78.75
- *Hostnames:* Human-readable symbolic names, based on a *domain hierarchy*
 - Easier to read and remember
 - *For example:* <http://www.umflint.edu>

Name Game: Computer Addresses

- *Find your computer's IP address*
 - go to the command prompt
 - ◆ (Start>>All Programs>>Accessories>>Command Prompt)
 - type in *ipconfig/all*
 - what is your computer's IP address?

Taking Apart a Hostname

- Consider the name `bblb.oel.umflint.edu`
- Reading from the left, the individual computer (host) is named “bblb”
- It is a part of the “oel” domain, which is a collection of Internet hosts belonging to the Office of Extended Learning
- The “oel” domain is within the “umflint” domain, which comprises all departmental domains at the Univ. of Michigan - Flint
- This “umflint” domain is within the “.edu” educational domain, along with domains for other universities.

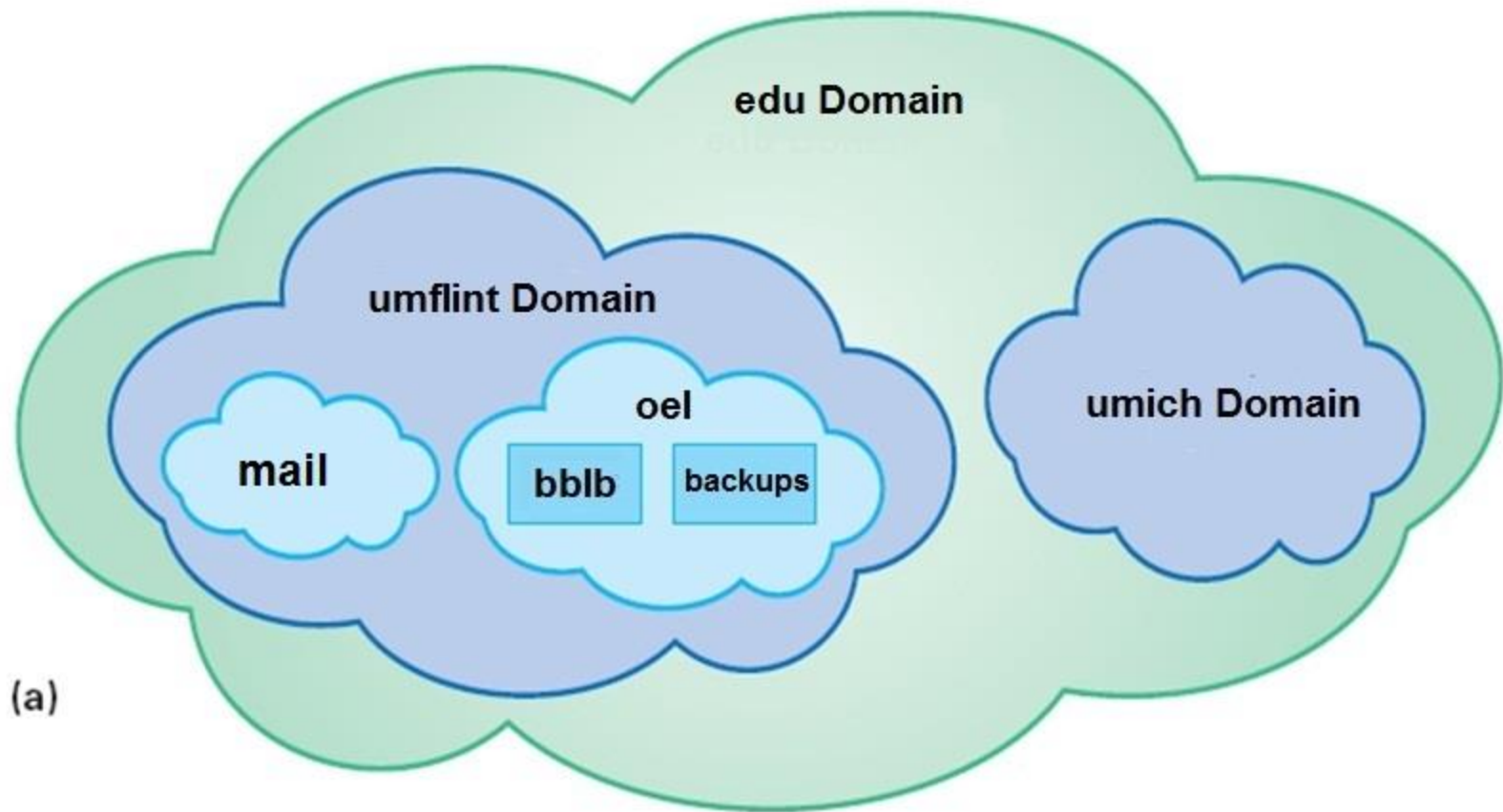


Figure 3.5 Two ways to think of the Internet domain hierarchy.

Domains and Domain Hierarchy

- *Domain* is a related group of networked computers
- Domain names are organized hierarchically
- Top-level domains appear in the last part of domain name:

.edu educational institutions

.org organizations

.net networks

.mil military

.gov government agencies

Mnemonic two-letter country designators such as .ca
(Canada)

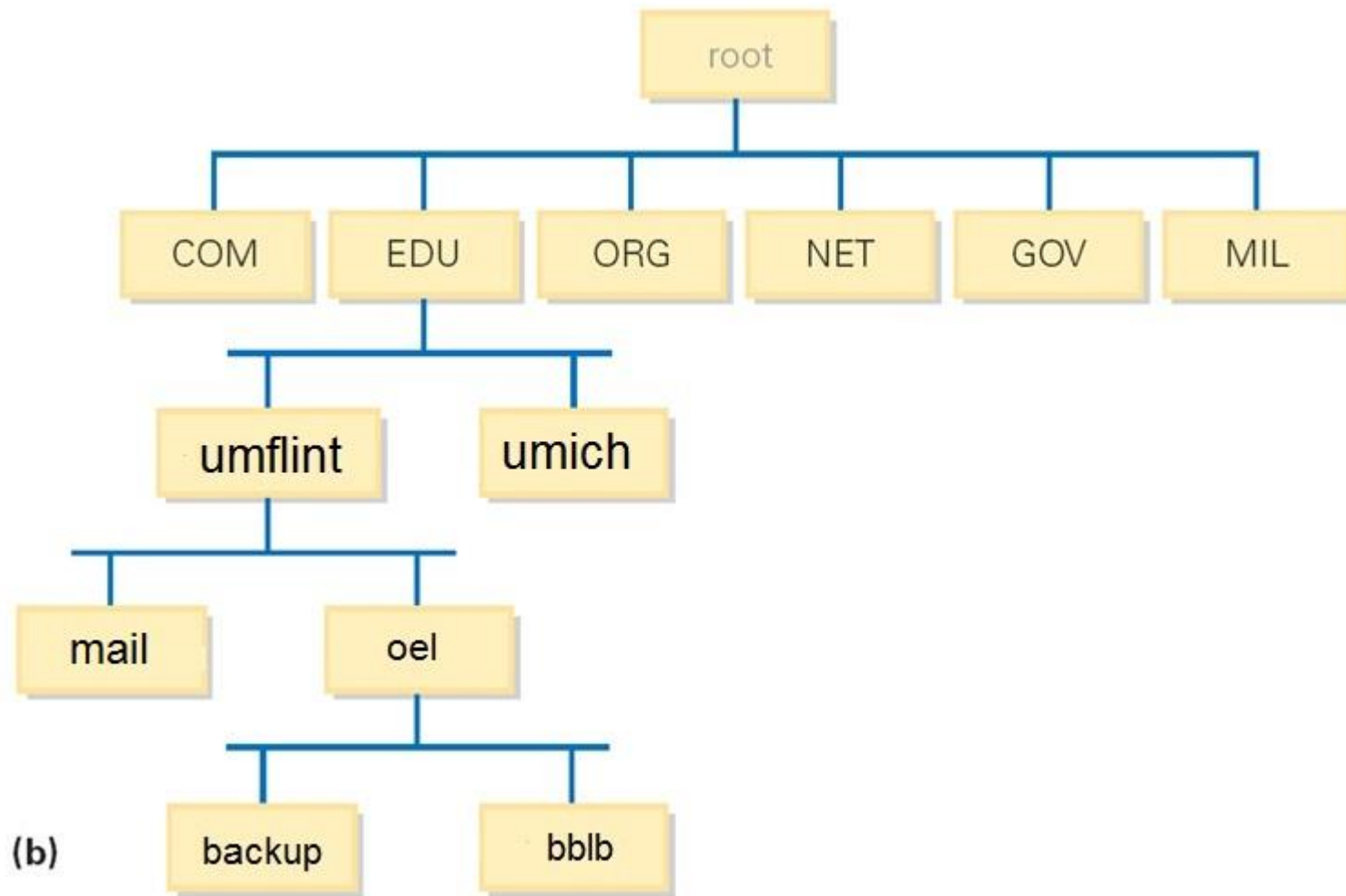


Figure 3.5 Two ways to think of the Internet domain hierarchy.

DNS Servers

- The *Domain Name System* (DNS) translates all the human-readable hostnames into IP addresses
- Each Internet host knows the IP address of its nearest *DNS server*, a computer that keeps a list of host/domain names and corresponding IP addresses
- When you use a hostname to send information, your computer asks the DNS server to look up the IP address (this is a client/server relationship)
- If the closest DNS server doesn't know the IP address, it asks an *authoritative server*, the root of a hierarchy of special DNS servers with more complete name translation information.

DNS Servers

- Resolve these IP address
 - go to the command prompt
 - type in *nslookup 141.216.116.122*
 - what is this IP for?
 - Press the F3 key and check **141.216.10.30**

Sending Information Over the Net

- We know how to specify (address) a specific computer on the Internet... *now how do we send information from one to the other?*
- Vinton Cerf (an Internet pioneer) said that sending information over the Internet is like sending your novel from your home in Tahiti to your publisher in New York, using only postcards.
 - To do this, you would have to break the novel text up into little postcard-sized chunks, and mail each card one at a time.
 - You would number the cards so they could be re-assembled into a novel, as they would not arrive in NY in the order mailed (some delayed, some take longer routes, etc.)



Figure 3.6 The TCP/IP postcard analogy.

Following Protocol

- *A protocol describes the specific technical steps involved in how information is actually transmitted*
- *TCP/IP (Transmission Control Protocol/Internet Protocol)*
 - Information is broken into a sequence of small fixed-size units called *IP packets*
 - Each packet has space for a chunk of data (*e.g., piece of the novel*), the IP addresses of the source and destination computers, and a sequence number
 - The packets are sent over the Internet one at a time using whatever route is available
 - Each packet can take a different route, so congestion and service interruptions do not delay transmissions

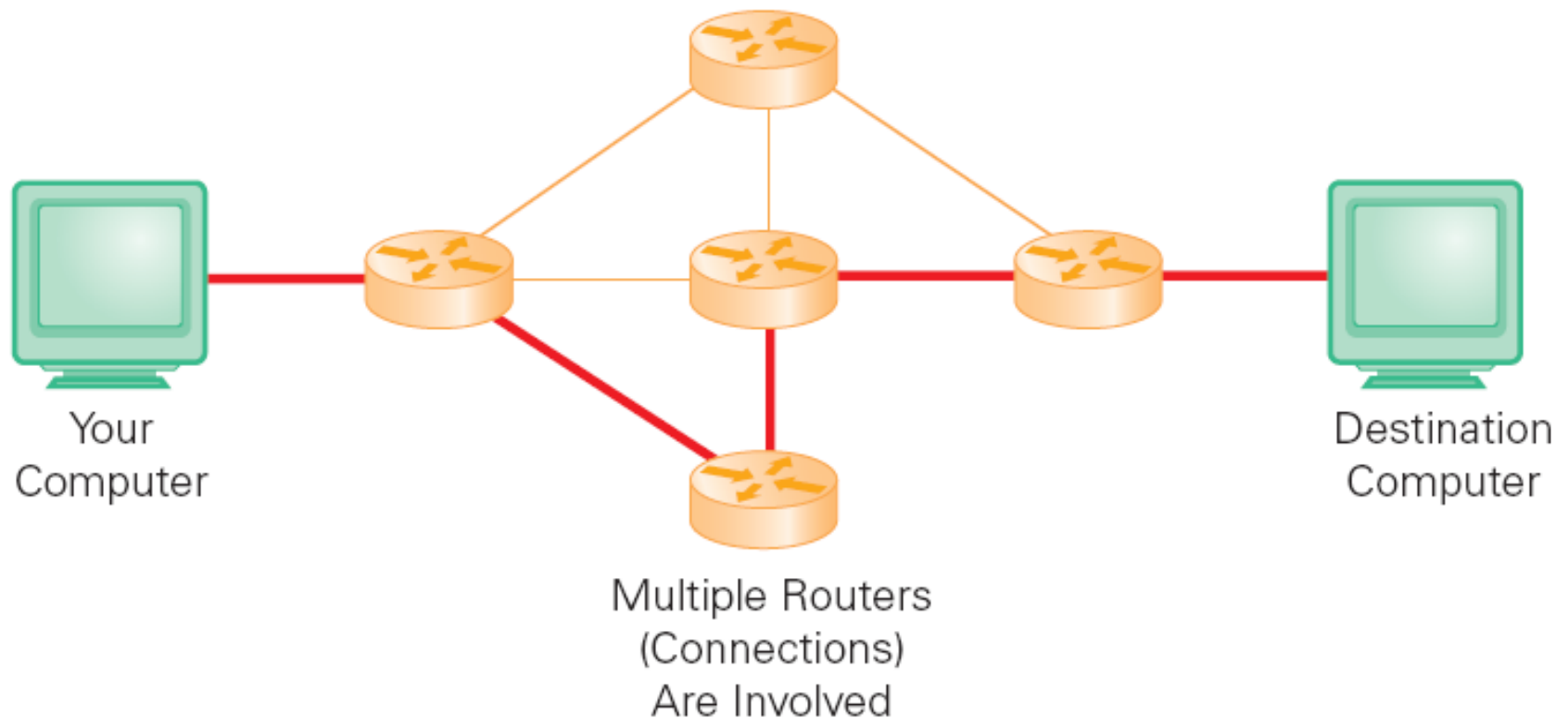


Figure 3.7 The Internet makes use of whatever routes are available to deliver packets.

Ping

- Tests reachability of Internet Hosts
- ping
 - go to the command prompt
 - type in *ping 139.130.4.5*
 - any lost packets?
 - what was the average round trip packet time?

Ping

- Tests reachability of Internet Hosts
- ping
 - open new command prompt
 - type in *ping 8.8.4.4*
 - any lost packets?
 - what was the average round trip packet time?

Why is there a Difference?

- open web browser
 - enter the url *139.130.4.5.ipaddress.com*
 - what is this ip?
 - where is this ip?
 - enter the url *8.8.4.4.ipaddress.com*
 - what is this ip?
 - where is this ip?
 - enter the url *141.216.116.122.ipaddress.com*
 - what is this ip?
 - where is this ip?

Moving Packets: Wires and More

- Internet uses electrical, electronic, and optical communication means for physical sending
 - Telephone lines, dedicated fiber optic lines, cable, wireless radio, etc.
- The technology used to move the packet is independent from the protocol; transmission of a single file may use multiple technologies
- Computers at the send and receive ends don't care what medium was used to move the bits

Far and Near: WAN and LAN

- Internet is a collection of *Wide Area Networks (WAN)*, designed to send information between widely separated locations
 - Multiple *hops*, each packet visits many computers
 - Ping, traceroute tools show the hops in a transmission
- *Local Area Networks (LAN)* are computers close enough to be linked by a single cable or wire pair
 - *Ethernet* is the main technology for LAN

Trace Route

- Trace the route to google.com
 - go to the command prompt
 - type in *tracert google.com*
 - How many hops did it take?
 - Can you identify any of these hops?
 - Did any packets time out?

Ethernet Network Structure

- Channel (wire, wire pair, or optical fiber) that winds past a set of computers; limited distance (ok for LAN)
- Each computer is connected to the channel, allowing it to send a signal that can be detected by all computers on the channel
- The channel supports broadcast communications, but typically a message is sent to one computer on the channel (even though all hear it)
- Only one computer may use the channel at a time or messages will be garbled

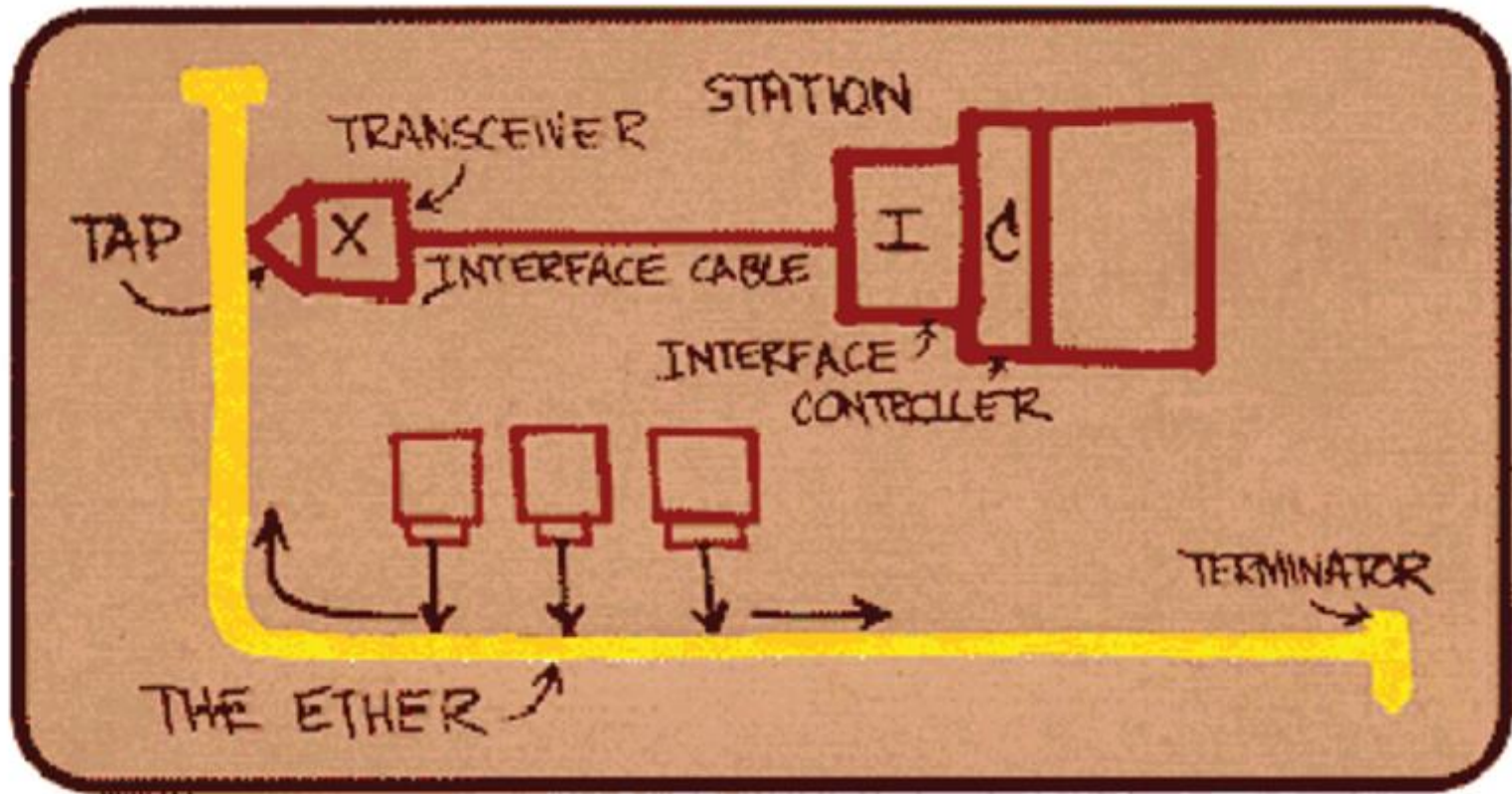


Figure 3.9 Robert Metcalfe's original drawing of the Ethernet design; the unlabeled boxes (computers), "tap" onto the wire that Metcalfe labeled "The Ether."

Ethernet Network Protocol

- Rough analogy: conversation at a cocktail party
 - One person talks, everyone listens
 - When talker stops, it is briefly quiet, and someone else starts
 - If two persons start talking, they hear the conflict and pause briefly, until one begins talking again
- Decentralized scheme (no plan or schedule control)
 - Each computer listens to the channel, and if it's quiet, it's free.
 - A computer starts to transmit; if another starts at the same time, they hear garbled message; both stop for a random time and then try again.
 - Shortest random wait gets the channel

Ethernet vs. Internet

- Internet uses point-to-point network to implement point-to-point communications
- Ethernet uses broadcast network to implement point-to-point communications
- Internet allows multiple communications taking place concurrently along its different paths
- Ethernet allows only one communication going on at a time

Connecting a Computer to Internet

Three Common Ways

- Via Internet Service Provider (ISP)
 - An ISP sells connections to the Internet (like Comcast and Earthlink, many others)
 - User plugs a computer into the telephone system or a dedicated line to ISP (DSL, cable)
 - User's computer talks to ISP's computer
 - ISP's computer is a constantly connected host on the Internet, and relays information for its customers

Connecting a Computer to Internet

- Via Enterprise Network Connections (LAN)
 - Used by large networked organizations such as schools, businesses, or governmental units
 - The organization creates a LAN, or *intranet*
 - The intranet connects to the Internet by a gateway
 - Information from a Web computer is sent across Internet, through gateway, then across LAN to user's computer

Connecting a Computer to Internet

■ Via wireless (variation on a LAN)

- A specialized computer (access point, hub, or router) is physically connected to the Internet (wired)
- Mobile computers use radio signals to connect wirelessly with the router and initiate network transmissions through it
- Router assigns temporary IP addresses via DHCP (Dynamic Host Configuration Protocol)
- Wireless mobile computers and the router do an Ethernet-like protocol, acting as a LAN
- Router then uses Internet protocols to the broader physical network and relays transmissions from the mobile computers

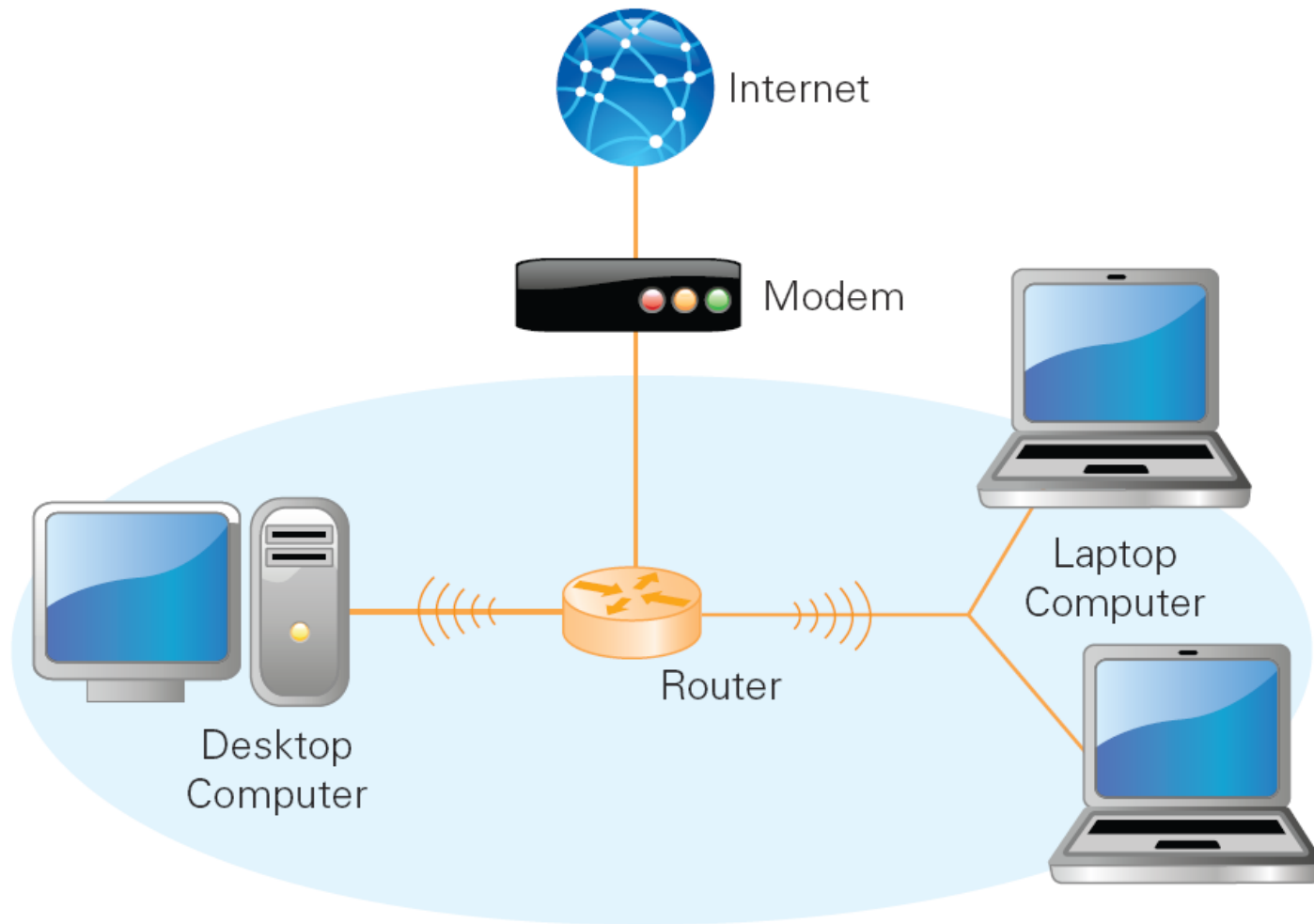


Figure 3.10 Standard Wi-Fi network configuration. A wireless router is connected via the modem to the ISP's Internet modem; laptops and other wireless-enabled devices connect by radio signals to the router.

The World Wide Web

- The Web and the Internet are not the same thing
- *Web servers*: Computers programmed to send files to browsers running on other computers connected to the Internet
- Web servers and their files make up the World Wide Web
- The Web is made from a *subset* of all the computers on the Internet
- The Internet is the “road,” the Web is just one form of “traffic” on the road

Requesting a Web Page

- Web request creates a client/server interaction
- Uniform Resource Locator (URL) has three main parts

<http://www.widgets.com/hardware/support/faq.html>

1. Protocol:

- ♦ http:// indicates Hypertext Transfer Protocol (HTTP)
- ♦ Tells the computers how to handle the file

2. Server computer's name:

- ♦ Server's IP address given by the domain hierarchy

3. Page's pathname:

- ♦ Tells the server which file (page) is requested and where to find it.

Describing a Web Page

- Pages are stored as *descriptions* of how they should appear on screen (called *page markup*)
- A web browser creates the viewable image from the description file (the *source*)
 - Browser can adapt the page image more easily (scale to your screen, scroll it, etc.) from source
- You can see the page description by selecting "view source" in the browser

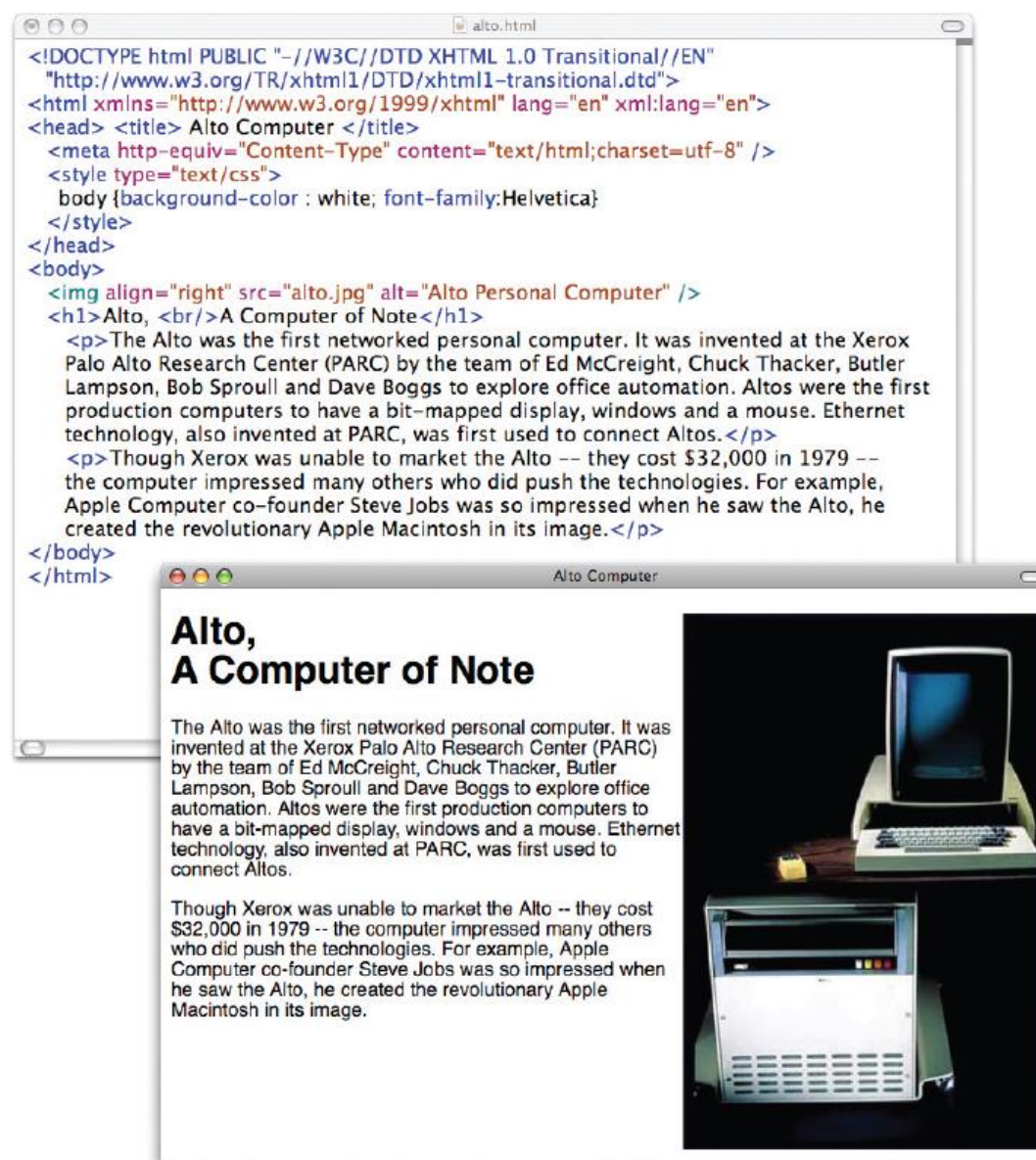


Figure 3.11 A Web page and the HTML source that produced it. Notice that an additional image file, `alto.jpg`, is also required to display the page.

Hypertext

- *Hypertext Markup Language (HTML)*
- *Markup languages* describe the layout, formatting, and look applied to a document's abstract structure
 - Margin width, indentations
 - Font, text style, size, color
 - Image placement, etc.
- Hyperlinks allow jumping from point to point in documents (non-linear); links show as highlighted words and images
- HTML realization of hypertext, and the Web, from Tim Berners-Lee (1990s)
 - Term "hypertext" is from Ted Nelson (1960s)
 - Concept comes from Vannevar Bush (1940s)

Web Pages and File Structure

- Web sites are organized collections of HTML files
 - URL points into this organization to select a file
- *Directory*, or *folder*, is a named collection of files, other directories, or both
- *Directory Hierarchy*. Directories can contain other directories, which can contain other directories, etc.
 - Down, or lower in the hierarchy, means moving into subdirectories
 - Up, or higher in the hierarchy, means into enclosing (parent) directories

File Structure (cont'd)

- Part of the directory hierarchy is shown in the pathnames of URL's.

`http://www.nasm.si.edu/exhibitions/ga1100/pioneer.html`

- Page is given by pathname:

`/exhibitions/ga1100/pioneer.html`

- Each time we pass a slash (/), we move into a subdirectory or into the file (lower in the hierarchy)

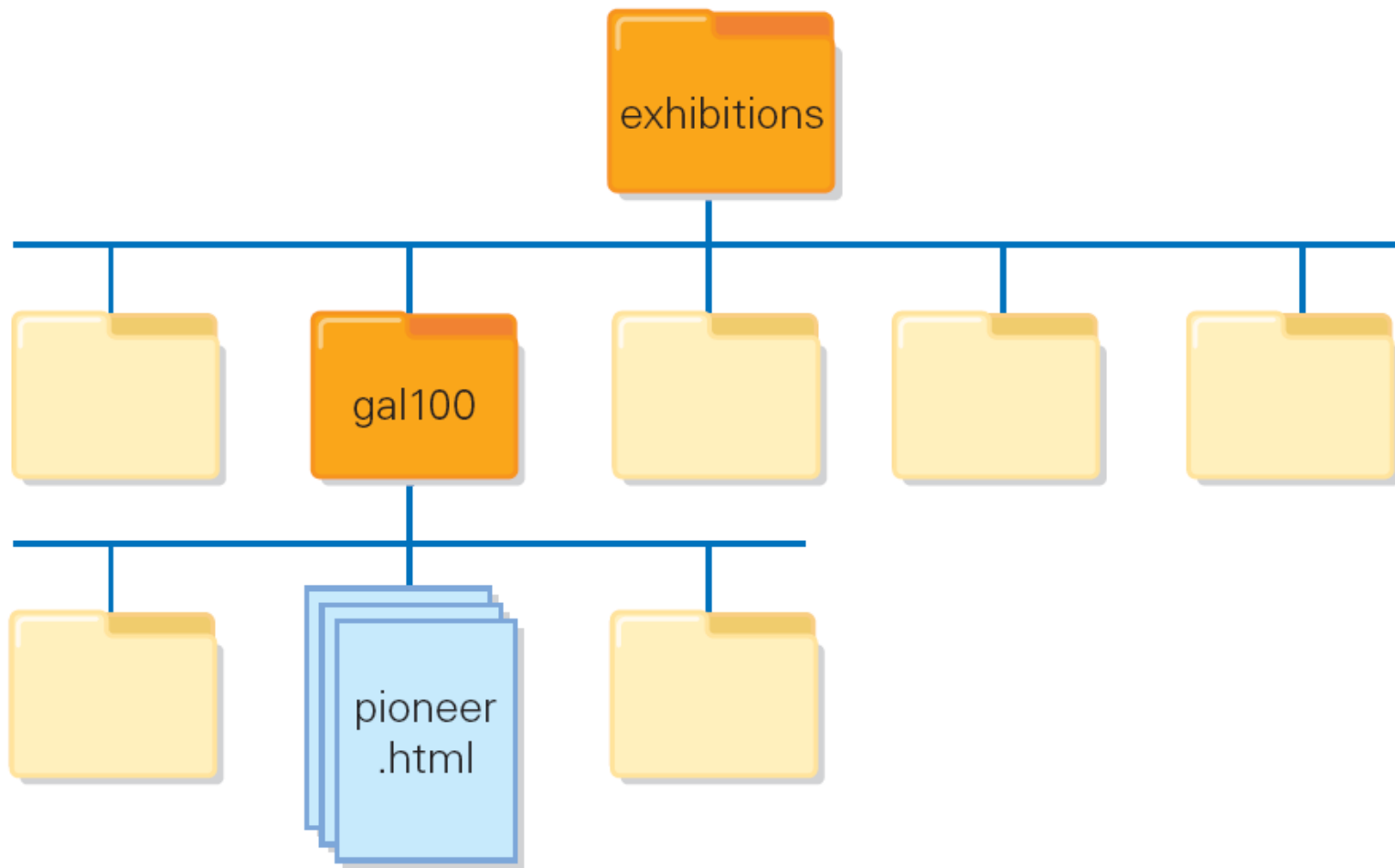


Figure 3.13 The pathname hierarchy ending in `pioneer.html`.

Organizing the Directory

- When a URL ends in a slash, the browser looks for a file called *index.html* in that directory
 - <http://www.widget.com/> and <http://www.widget.com/index.html> are the same
- If the browser does not find an *index.html* file, the browser automatically tries to display a directory listing (index) of the files there
- Why are hierarchies important?
 - People use them to organize their thinking and work
 - Directories are free; there is no reason not to use them

Summary

- Basic types of communication include: point-to-point, multicast, broadcast, synchronous, and asynchronous
- Networking concepts: IP addresses, domains, IP packets, IP protocol, WANS and LANS, Ethernet protocol, ISPs, enterprise networks, and wireless networks
- Discussed the differences between the Internet and the World Wide Web (WWW)
- Discussed the history of HTML; reviewed file hierarchies in prep for further study and HTML