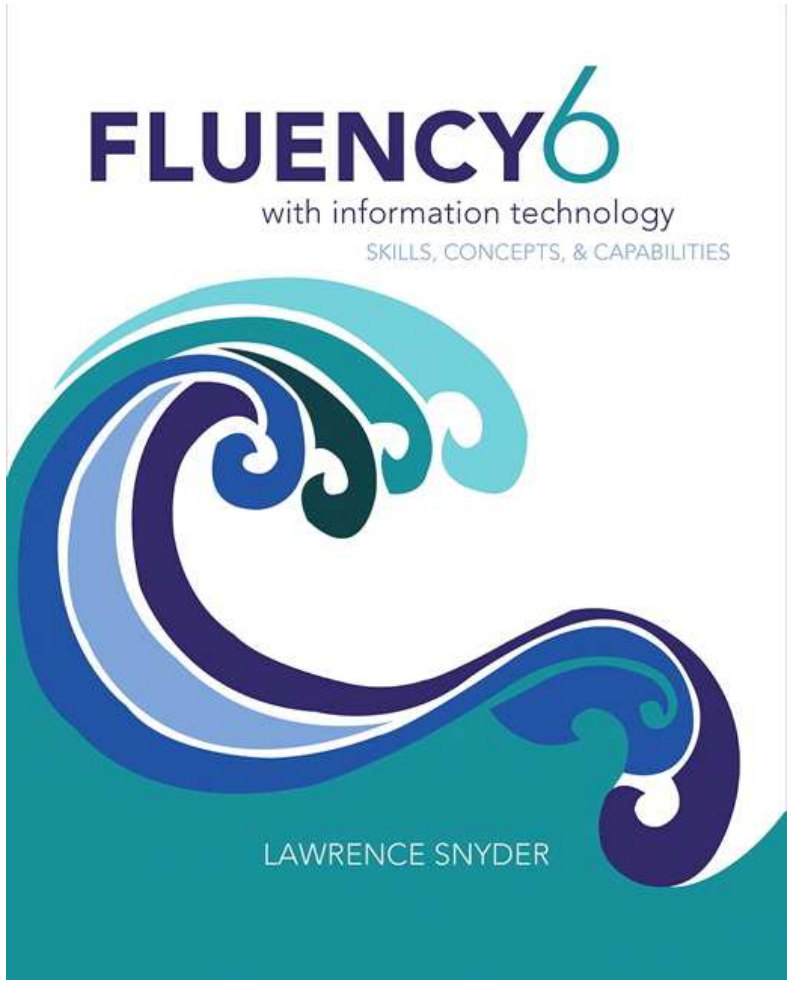



# Chapter 3

## *The Basics of Networking*

# Table of Contents

# Learning Objectives

- Tell whether a communication technology (Internet, radio, LAN, etc.) is synchronous vs asynchronous; broadcast vs point-to-point
- Explain the roles of Internet addresses, domain names, and DNS servers in networking
- Distinguish between types of protocols (TCP/IP and Ethernet)
- Describe how computers are interconnected by an ISP and by a LAN
- Distinguish between the Internet and the World Wide Web
- Explain file structure, and how to navigate up and down the hierarchy

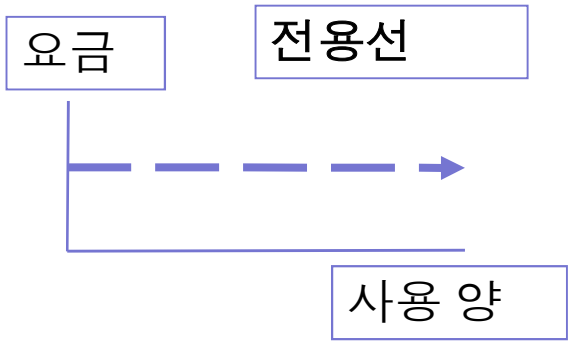
# General Communication Types

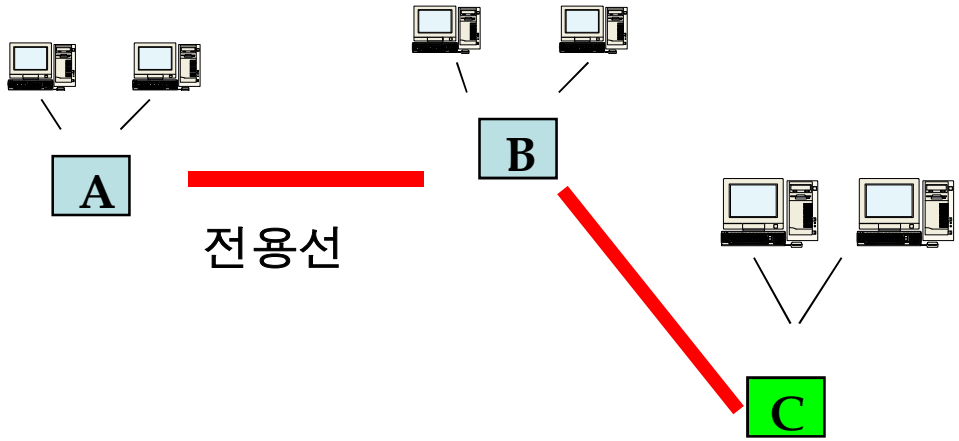
- Synchronous communication:
  - –Both the sender and the receiver are active at the same time (think of talking on a telephone)
- Asynchronous communication:
  - –The sending and receiving occur at different times (think of email and answering machines)
- Another property of communication concerns the number of receivers
  - Broadcast communication: single sender and many receivers (radio and TV)
  - Multicasting is many receivers, but usually a specific group (specialized topics)
  - Point-to-point communication: one specific sender and one specific receiver (telephone call)

# 인터넷의 등장

보조자료

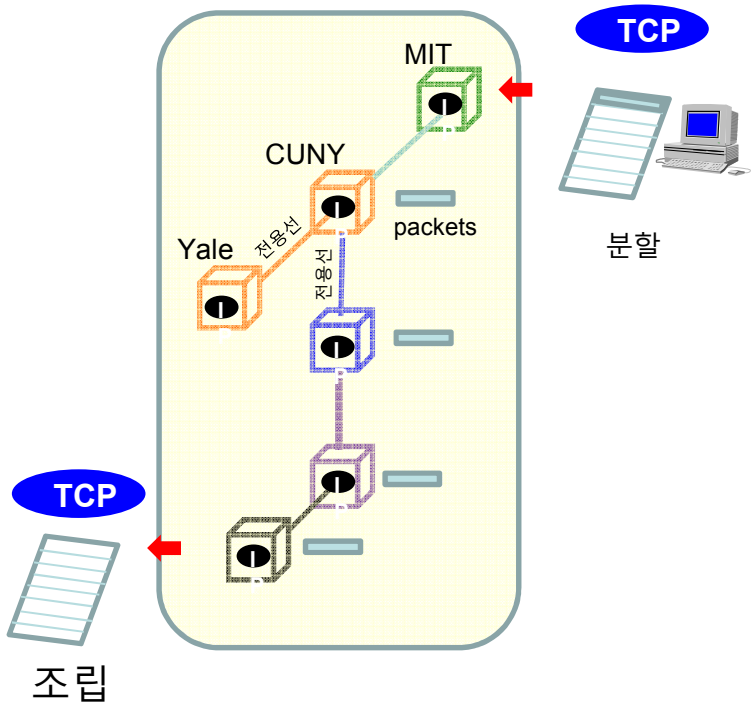
- 60년대 초 미국의 Baran과 프랑스의 Zimmermann 이 각각 제안
  - –1969년 ARPANET 의 구축으로 등장
- 초기 인터넷의 Motivation
  - –당시 부족하던 컴퓨터 자원의 공유
  - –국방성의 요구 : 튼튼한 통신 기반 구조



보조자료

# 인터넷의 원리




- File Transfer Protocol: TCP/IP (VoIP, IPTV …)
- Communication Cost Policy
  - 전용선 (기관 부담)
  - 상호 무료
- 통신 혁명

  - 무료(개인)

  - 모든 형태 정보의 공유와 교환 (소리 영상 등)

# Internet Host & IP Address & Domain Name

보조자료

- Internet Host:
  - –Internet에 전용선으로 직접 연결된 Server
  - –Web server SW 가 작동하며 WWW site를 지원하는 server
  - – IP Address & Domain Name를 가짐

- IP 주소(IP Address)
  - – 32비트 (4 parts) (예, 147.46.114.115 : 8비트 4개로 나누어 10진수로 표시)
  - – 사람들이 기억하기 어렵기 때문에 Domain Name이 필요
- Domain Name: arts.snu.ac.kr (서울대 미대 서버 이름)
- Name Server: Domain Name ←→ IP Address

# WWW의 등장

보조자료

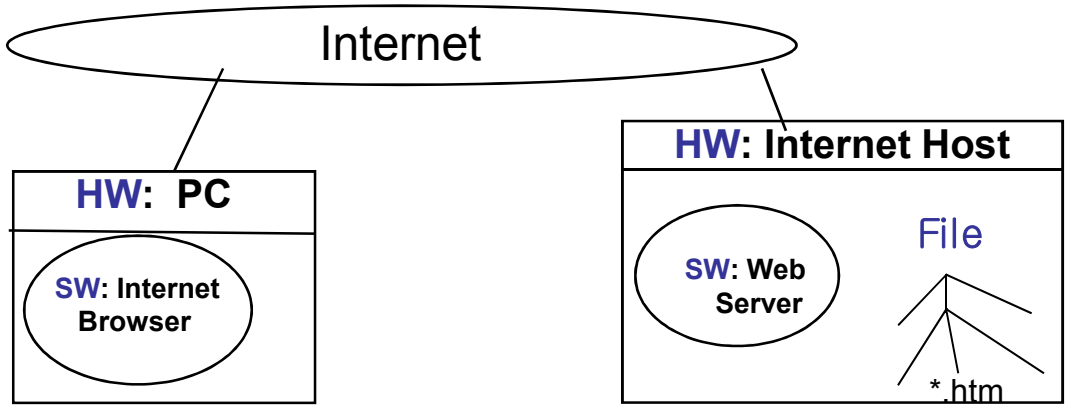
- 93 년도경 Home Page와 Web Browser 등장
  - Mosaic, Netscape, Internet Explorer, 등등
- Internet에서 각 file마다의 주소 ➔ URL (Universal Resource Locator)

  http://snu.ac.kr/a/b/c

- PC 에서 단어를 click ➔ PC send URL (http://snu.ac.kr/doc1.htm)

➔ 상대방 Internet Host 수신 요청된 HTML file 을 꺼내옴

➔ PC에게 file 송신 ➔ PC는 display (글씨, 소리, 영상, ...)



# Internet's Communication Properties [1/2]

- The Internet supports point-to-point asynchronous communication
- The Internet provides a general communication "fabric" linking all computers connected to it
- Computers and the network become a single medium
- The Internet is fast enough to mimic synchronous communication (like using a phone)
- Multicasting is also possible, allowing groups to communicate in chat rooms
- You can post video that can be accessed by anyone, as a form of broadcasting (compares with radio or television)
- Fabric: (1) 직물,옷감 (2) 조직, 구조

# Internet's Communication Properties [2/2]

- The Internet is a universal communication medium
- The Internet also becomes more effective with each additional computer added
  - If x computers are already attached to the Internet, adding one more results in x potential new connections!

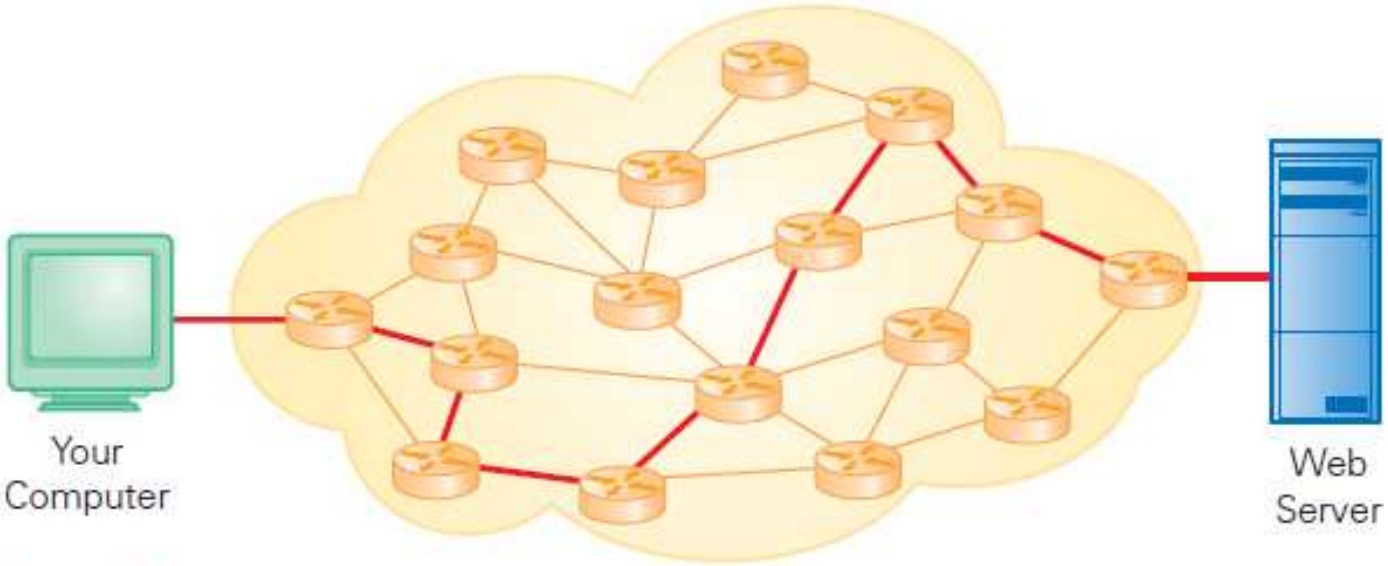



Figure 3.1 A schematic diagram of the Internet.

# Client/Server Structure

- Most interactions over the Internet use the client/server interaction protocol:
  - When you click a Web link, your computer gets the page for you ... beginning the client/server interaction
    - Your computer is the client computer and the computer with the Web page is the server (Web server)
    - The client, gets services from the server
  - When the page is return, the operation is completed … the client/server relationship ends

# Client/Server Structure

- The client/server structure is fundamental to Internet interactions
- A key aspect is that only a single service request and response are involved
- The relationship is very brief relationship, lasting from the moment the request is sent to the moment the service is received

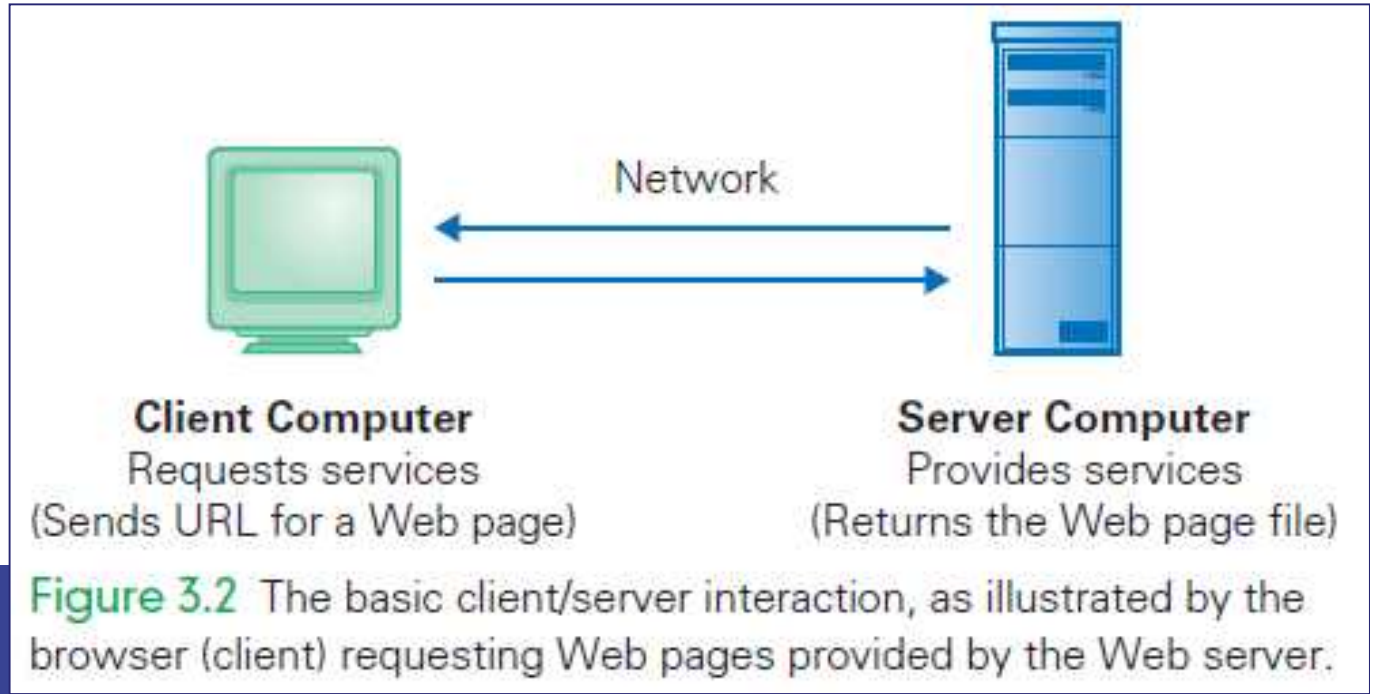



Figure 3.2 The basic client/server interaction, as illustrated by the browser (client) requesting Web pages provided by the Web server.

# Many Brief Relationships

- This approach means that the server can handle many clients at a time
- For example, between 2 consecutive client requests from your browser (getting a page and asking for another), that server could have serviced hundreds of other clients
- The server is busy only for as long as it takes to perform your request

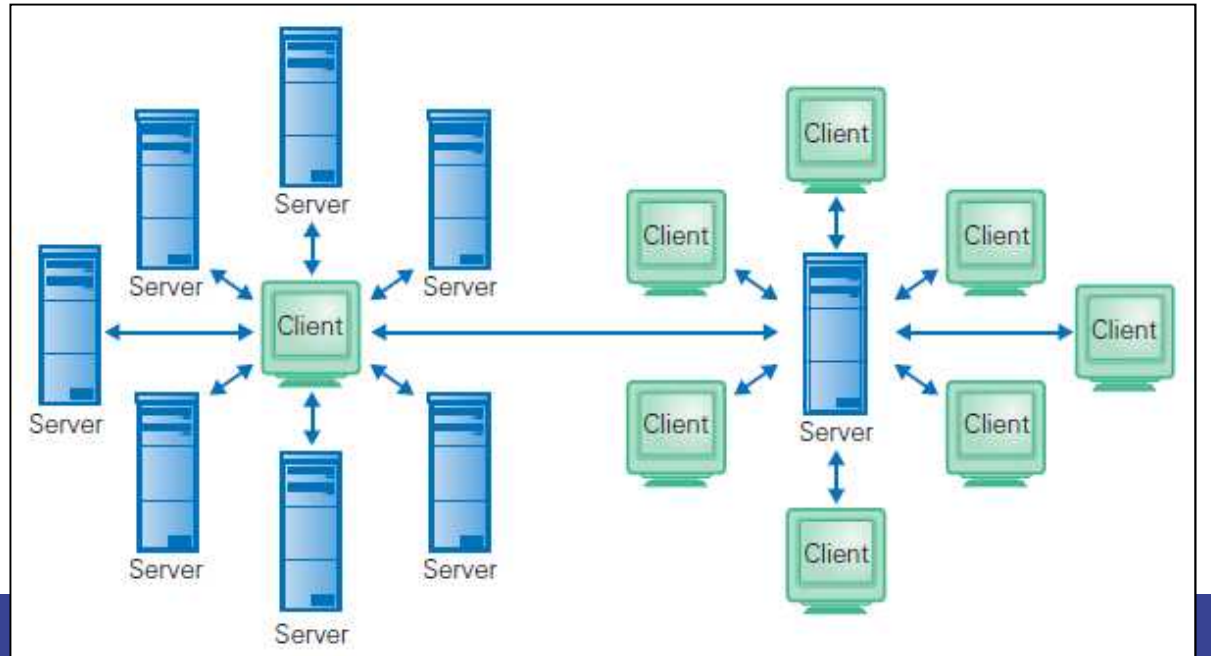



Figure 3.3 Client/server relationships as they might evolve over time.

# Getting More Connected

- This Internet Protocol is generally fast and reliable enough to work
  - A point-to-point asynchronous communication system
  - A fast and reliable transmission to make it seem like a direct connection

- Packet-based
  - Client software “slices up” the signals coming from the computer’s microphone and video camera into packet-size blocks
  - Content is transferred to the other party, whose client reassembles the sound and image for display

# Computer Addresses [1/3]

- IP Addresses
  - Each computer connected to the Internet is given a unique address called its IP address
  - An IP address is a series of four numbers (one byte each) separated by dots
  - The range of each of these numbers (0–255) allows for billions of IP addresses
  - New IP addresses are in short supply (공급이 딸리는)

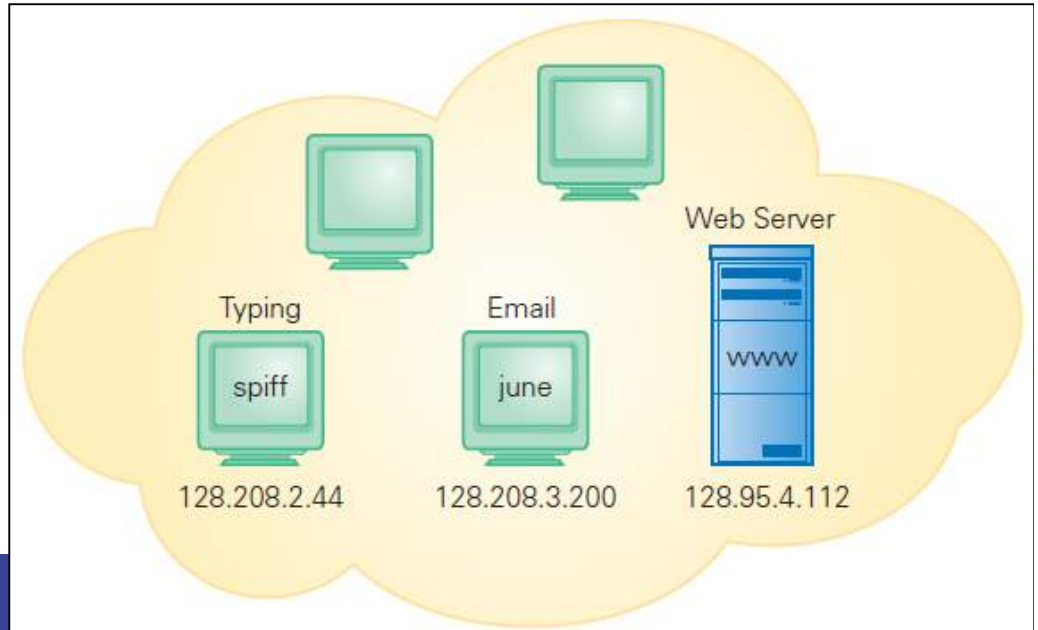



Figure 3.4 Computers connected to the Internet are given IP addresses.

# Computer Addresses [2/3]

- Domain Names
  - It is hard to remember the numeric IP address of all the computers we communicate with
  - The Internet uses human-readable symbolic names for computers that are based on a hierarchy of domains
  - A domain is a related group of networked computers
  - Example: spiff.cs.washington.edu
    - The name of the computer is spiff
    - Which is part of the Computer Sci and Eng Department domain (cs)
    - Which is part of the University of Washington domain (washington)
    - Which is part of the educational domain (edu)

# Computer Addresses [3/3]

- The example shows a hierarchy of domains: spiff.cs.washington.edu
- Each is a member of the next larger domain
- "edu" is a peer of other top-level domains such as "com"
- These names are symbolic and meaningful, making them easier to read than numbers (and easier to remember)

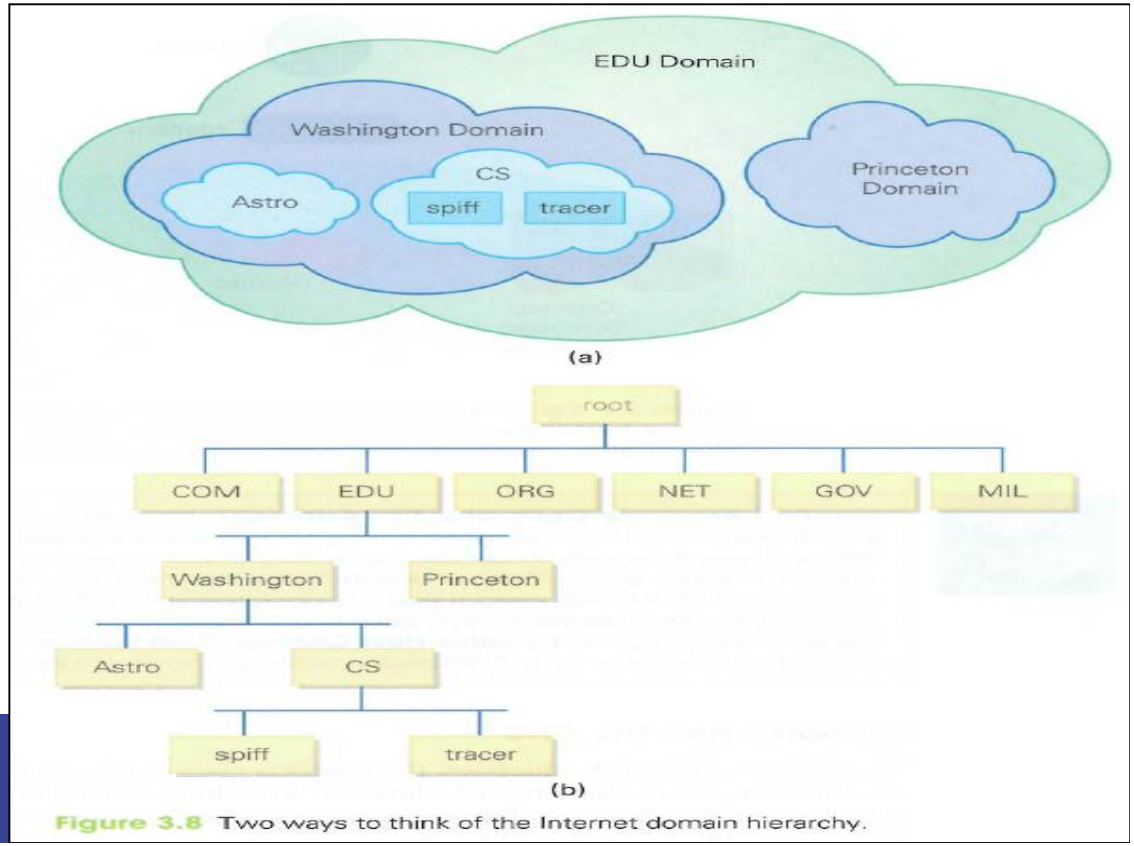


Figure 3.8 Two ways to think of the Internet domain hierarchy.

# DNS Servers [1/3]

- The Domain Name System (DNS) servers translates the hierarchical, human-readable names into the 4-number IP address
- Every Internet host knows the IP address of its nearest DNS name server
- Whenever the hierarchical symbolic name (such as http://snu.ac.kr/a/b/c) is used to send information to a destination, your computer asks the DNS server looks up the corresponding IP address
  - This request is in another client/server relationship
- If the address is new (and not stored on the DNS server), the server asks an authoritative name server (ANS)
  - The domain server keeps the complete list of the IP addresses and corresponding domain names for all authoritative name servers and computers in its domain

# DNS Servers [2/3]

- The DNS servers' addresses are preprogrammed into your computer's network software.
- Notice that computers change their client and server roles all the time. Sometimes they are servers, sometimes they are clients.

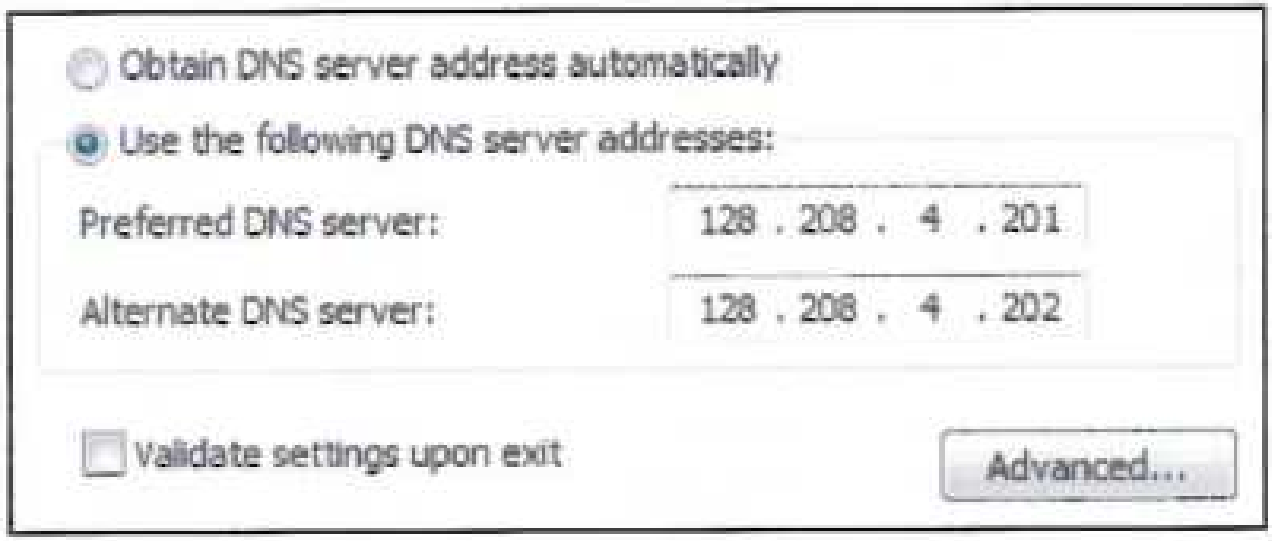



Figure 3.9 The DNS servers displayed for a computer running the Windows 7 OS.

# DNS Servers [3/3]

- There are 13 root name servers for each top level domains
  - letter.root-servers.net where letter ranges from A to M

- The root domain contains all top-level domains of the Internet.

- As of July 2015, it contains 1058 TLDs, including 730 generic top-level domains (gTLDs) and 301 country code top-level domains (ccTLDs) in the root domain

- They are listed at www.rootservers.org together with their mirror sites (helper name servers with identical information).


**Figure 3.10** The map of root name servers and their "mirrors;" for example, there is a copy of Root K in Reykjavik, Iceland.

# Top-Level Domains [1/2]

- Top-Level Domain names (TLDs): Initially 7 TLDs in 1985
  - .edu for educational groups
  - .com for commercial enterprises
  - .org for organizations
  - .int for international organizations
  - .net for networks
  - .mil for the military
  - .gov for government agencies

# Top-Level Domains [2/2]

- The top-level domains were expanded to include biz, info, name, travel, and others
- The original top-level domains listed all apply to organizations in the US
- There is also a set of 2-letter country designators (ca (Canada), uk (United Kingdom), fr (France), de (Germany, as in Deutschland), etc.)
- As of July 2015, it contains 1058 TLDs, including 730 generic top-level domains (gTLDs) and 301 country code top-level domains (ccTLDs) and so on.
- The full list can be found at www.icann.org

  (ICAAN is Internet Corporation for Assigned Names and Numbers)

Table 3.1 Top-level country domain names.

| Code | Country Name | Code | Country Name | Code | Country Name | Code | Country Name |
|---|---|---|---|---|---|---|---|
| AF | Afghanistan | DK | Denmark | LS | Lesotho | LC | Saint Lucia |
| AL | Albania | DJ | Djibouti | LR | Liberia | WS | Samoa |
| DZ | Algeria | DM | Dominica | LY | Libya | SM | San Marino |
| AS | American Samoa | DO | Dominican Republic | LI | Liechtenstein | ST | Sao Tome and Principe |
| AD | Andorra | EC | Ecuador | LT | Lithuania | | |
| AO | Angola | EG | Egypt | LU | Luxembourg | SA | Saudi Arabia |
| AI | Anguilla | SV | El Salvador | MO | Macao | SN | Senegal |
| AQ | Antarctica | GQ | Equatorial Guinea | MK | Macedonia | RS | Serbia |
| AG | Antigua and Barbuda | ER | Eritrea | MG | Madagascar | SC | Seychelles |
| AR | Argentina | EE | Estonia | MW | Malawi | SL | Sierra Leone |
| AM | Armenia | ET | Ethiopia | MY | Malaysia | SG | Singapore |
| AW | Aruba | FK | Falkland Islands | MV | Maldives | SX | Sint Maarten (Dutch Part) |
| AU | Australia | FO | Faroe Islands | ML | Mali | | |
| AT | Austria | FJ | Fiji | MT | Malta | SK | Slovakia |
| AZ | Azerbaijan | FI | Finland | MH | Marshall Islands | SI | Slovenia |
| BS | Bahamas | FR | France | MQ | Martinique | SB | Solomon Islands |
| BH | Bahrain | GF | French Guiana | MR | Mauritania | SO | Somalia |
| BD | Bangladesh | PF | French Polynesia | MU | Mauritius | ZA | South Africa |
| BB | Barbados | GA | Gabon | MX | Mexico | GS | S Georgia S Sandwich Islands |
| BY | Belarus | GM | Gambia | FM | Micronesia | | |
| BE | Belgium | GE | Georgia | MD | Moldova | SS | South Sudan |
| BZ | Belize | DE | Germany | MC | Monaco | ES | Spain |
| BJ | Benin | GH | Ghana | MN | Mongolia | LK | Sri Lanka |
| BM | Bermuda | GI | Gibraltar | ME | Montenegro | SD | Sudan |
| BT | Bhutan | GR | Greece | MS | Montserrat | SR | Suriname |
| BO | Bolivia | GL | Greenland | MA | Morocco | SZ | Swaziland |
| BA | Bosnia and Herzegovina | GD | Grenada | MZ | Mozambique | SE | Sweden |
| | | GP | Guadeloupe | MM | Myanmar | CH | Switzerland |
| BW | Botswana | GU | Guam | NA | Namibia | SY | Syria |
| BV | Bouvet Island | GT | Guatemala | NR | Nauru | TW | Taiwan |
| BR | Brazil | GG | Guernsey | NP | Nepal | TJ | Tajikistan |
| BN | Brunei Darussalam | GN | Guinea | NL | Netherlands | TZ | Tanzania |
| BG | Bulgaria | GW | Guinea-Bissau | NC | New Caledonia | TH | Thailand |
| BF | Burkina Faso | GY | Guyana | NZ | New Zealand | TG | Togo |
| BI | Burundi | HT | Haiti | NI | Nicaragua | TK | Tokelau |
| KH | Cambodia | HN | Honduras | NE | Niger | TO | Tonga |
| CM | Cameroon | HK | Hong Kong | NG | Nigeria | TT | Trinidad and Tobago |
| CA | Canada | HU | Hungary | NU | Niue | TN | Tunisia |
| CV | Cape Verde | IS | Iceland | NF | Norfolk Island | TR | Turkey |
| KY | Cayman Islands | IN | India | MP | Mariana Islands | TM | Turkmenistan |
| CF | Central African Republic | ID | Indonesia | NO | Norway | TC | Turks and Caicos Islands |
| | | IR | Iran | OM | Oman | | |
| TD | Chad | IQ | Iraq | PK | Pakistan | TV | Tuvalu |
| CL | Chile | IE | Ireland | PW | Palau | UG | Uganda |
| CN | China | IM | Isle of Man | PS | Palestine | UA | Ukraine |
| CX | Christmas Island | IL | Israel | PA | Panama | AE | United Arab Emirates |
| CC | Cocos (Keeling) Islands | IT | Italy | PG | Papua New Guinea | GB | United Kingdom |
| | | JM | Jamaica | PY | Paraguay | US | United States |
| CO | Colombia | JP | Japan | PE | Peru | UY | Uruguay |
| KM | Comoros | JE | Jersey | PH | Philippines | UZ | Uzbekistan |
| CG | Congo | JO | Jordan | PN | Pitcairn | VU | Vanuatu |
| CD | Congo, Drc | KZ | Kazakhstan | PL | Poland | VE | Venezuela |
| CK | Cook Islands | KE | Kenya | PT | Portugal | VN | Viet Nam |
| CR | Costa Rica | KI | Kiribati | PR | Puerto Rico | VG | Virgin Islands, British |
| CI | CÔTE D'Ivoire | KP | Korea, DPR | QA | Qatar | VI | Virgin Islands, U.S. |
| HR | Croatia | KR | Korea | RE | Réunion | EH | Western Sahara |
| CU | Cuba | KW | Kuwait | RO | Romania | YE | Yemen |
| CW | Curaçao | KG | Kyrgyzstan | RU | Russia | ZM | Zambia |
| CY | Cyprus | LA | Lao | RW | Rwanda | ZW | Zimbabwe |
| CZ | Czech Republic | LV | Latvia | SH | Saint Helena | | |
| | | LB | Lebanon | KN | Saint Kitts and Nevis | | |

# TCP/IP

- TCP/IP Postcard Analogy
  - The Internet is like sending a novel to your publisher using postcards
  - The novel is broken into small units that fit on a numbered postcard
  - As each postcard is completed, it is mailed
  - Sooner or later, your publisher received the postcards, but not necessarily in sequential order, nor do they take the same route
  - The numbered postcards are finally arranged in order
  - These “postcards” are really IP packets
    - IP Packets hold: one unit of information, the destination IP, and their sequence number (which packet they are)


Figure 3.6 The TCP/IP postcard analogy.

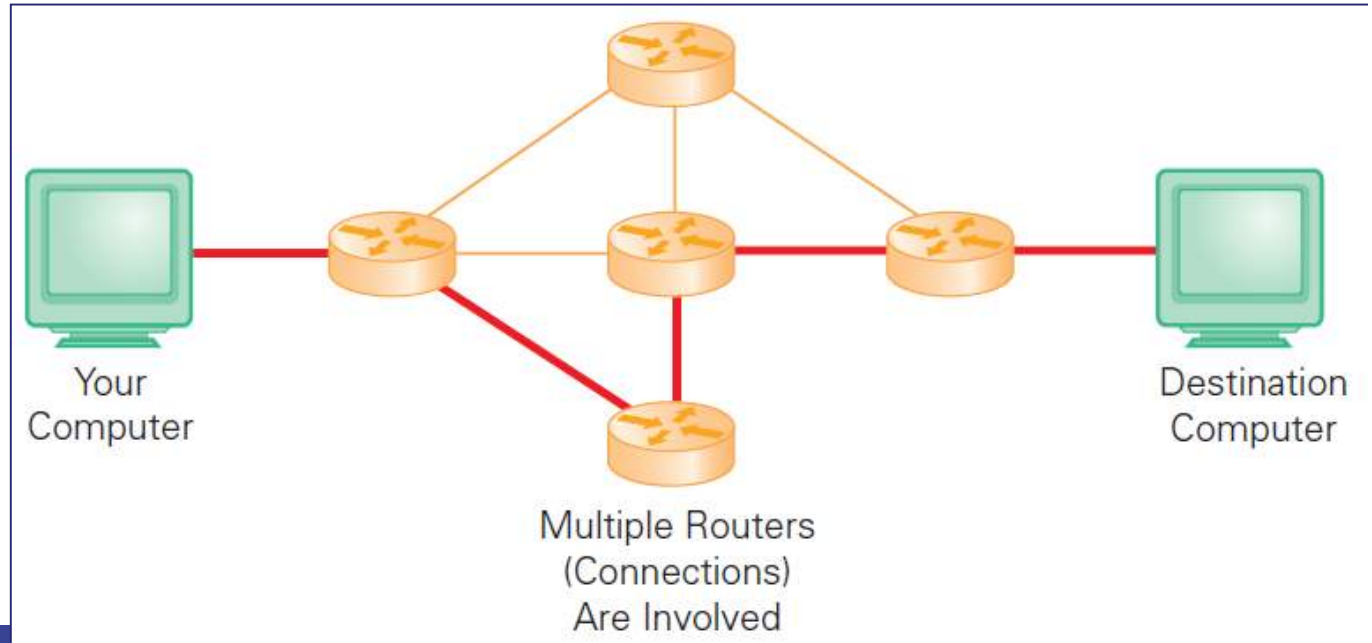



Figure 3.7 The Internet makes use of whatever routes are available to deliver packets.

# Packets are Independent

- Because each packet can take a different route, congestion and service interruptions do not delay transmissions
  - Each TCP/IP packet is independent
- The TCP/IP protocol works under adverse conditions
  - If traffic is heavy and the packet progress is slow, the protocol allows the packet to be thrown away
- If a packet is killed for whatever reason, the recipient will request a resend
- Packets can arrive out of order because they take different routes

# Moving Packets: Wires & More

- Internet uses telephone carriers for long-distance connections, fiber optics, and separate dedicated lines for connections
- The computers do not know or care how the packet is sent, as long as it can be sent and received
- Transmissions may rely on multiple technologies as the packets move across the Internet

*A ping is a "please reply" message*
*Tracing route to 192.33.92.189*

Trace: My Computer to http:// eth.ch port 80

Table: Traceroute to eth.ch

| Hop | IP Address | Node Name | Location | Network |
|---|---|---|---|---|
| 0 | 128.208.2.44 | spiff.cseresearch.cs.washington.edu | Seattle, WA, USA | University of Washington |
| 1 | 128.208.2.102 | acar-atg-02-vlan75.cac.washington.edu | Seattle, WA, USA | University of Washington |
| 2 | 205.175.108.21 | vl3805.uwcr-ads-01.infra.washington.edu | Seattle, WA, USA | University of Washington |
| 3 | 205.175.101.157 | uwcr-ads-01-vlan1839.cac.washington.edu | Seattle, WA, USA | University of Washington |
| 4 | 205.175.101.2 | vl1800.uwbr-chb-01.infra.washington.edu | Seattle, WA, USA | University of Washington |
| 5 | 209.124.191.134 | ge-2-0-0--4013.iccr-sttlwa01-03.infra.pnw-gig | Seattle, WA, USA | Pacific Northwest Gigapop |
| 6 | 209.124.179.45 | iccr-sttlwa01-02-ge-0-2-0--0.infra.pnw-gigapc | Seattle, WA, USA | Pacific Northwest Gigapop |
| 7 | 209.124.179.46 | nlr-packetnet.trans.pnw-gigapop.net | Seattle, WA, USA | Pacific Northwest Gigapop |
| 8 | 216.24.186.6 | denv-seat-58.layer3.nlr.net | Cypress, usa | National LambdaRail |
| 9 | 216.24.186.4 | chic-denv-36.layer3.nlr.net | Cypress, usa | National LambdaRail |
| 10 | 216.24.186.33 | newy-chic-100.layer3.nlr.net | Cypress, usa | National LambdaRail |
| 11 | 216.24.184.86 | - | Cypress, usa | National LambdaRail |
| 12 | 62.40.112.57 | so-6-2-0.rt1.fra.de.geant2.net | Frankfurt, Germany | IP allocation for GEANT network |
| 13 | 62.40.112.21 | so-6-2-0.rt1.gen.ch.geant2.net | Geneva, Switzerland | IP allocation for GEANT network |
| 14 | 62.40.124.22 | swiCE2-10GE-1-1.switch.ch | Chur, Switzerland | DANTE Ltd. |
| 15 | 130.59.37.2 | swiLS2-10GE-1-3.switch.ch | *(Switzerland)?* | SWITCH, The Swiss Education and |
| 16 | 130.59.36.206 | swiEZ2-10GE-1-1.switch.ch | Wetzikon, Switzerland | SWITCH, The Swiss Education and |
| 17 | 192.33.92.1 | rou-rz-gw-giga-to-switch.ethz.ch | Zurich, Switzerland | ETHZ, Swiss Federal Institute of Tec |
| 18 | 192.33.92.169 | rou-fw-rz-rz-gw.ethz.ch | Zurich, Switzerland | ETHZ, Swiss Federal Institute of Tec |
| ? | ... | - | | - |
| ? | **129.132.97.15** | eth.ch | *(Switzerland)?* | ETH/UNIZH Camp Net |

**Figure 3.4** A packet's route from the University of Washington, Seattle, to ethz.ch, the Swiss National Technical University in Zurich (note that the figure doesn't show the local hops 18–20). Try it: **whatismyipaddress.com/traceroute-tool.**

# Far and Near: WAN and LAN

- The Internet is a collection of wide area networks (WAN)
  - These are networks that are not geographically close
- The Internet is a collection of point-to-point channels
  - Meaning packets must visit a sequence of computers (or hops) before they reach their destination
- A local area network (LAN) is when computers are geographically close
  - Usually they can be linked by a single cable or pair of wires
- Ethernet is the main technology for local area networks
  - Used for connecting all the computers in a lab or building

# Ethernet

- The physical setup for an Ethernet network is a wire, wire pair, or optical fiber, called the channel
- Engineers "tap" into the channel to connect a computer:
  - This allows it to send a signal or an electronic pulse or light flash onto the channel
  - All computers, including the sender, can detect the signal

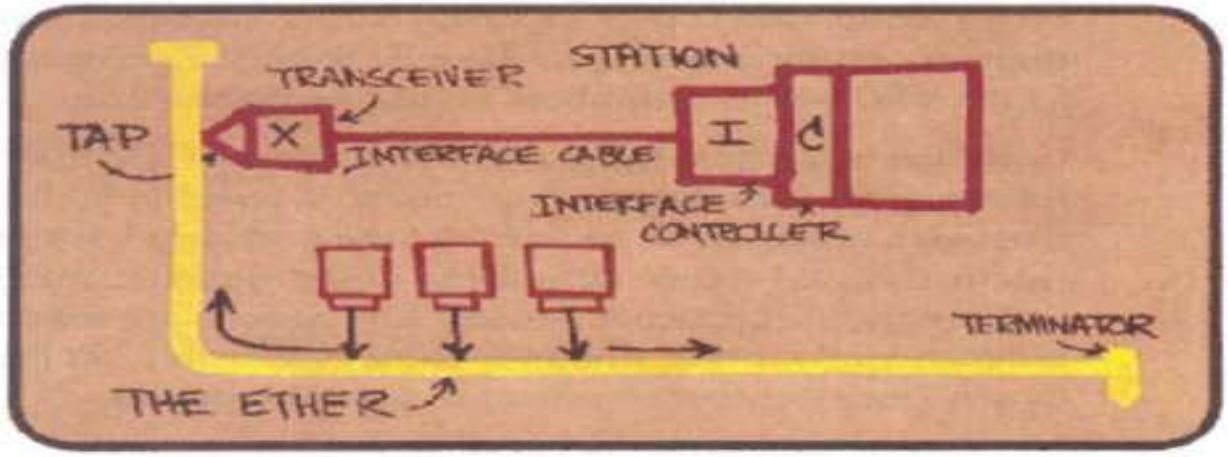



Figure 3.5 Robert Metcalfe's original drawing of the Ethernet design; the unlabeled boxes (computers) "tap" into the wire (yellow) that Metcalfe labeled "The Ether." He described the Ethernet (in 1973) as a "multipoint data communication channel with collision detection."

# Ethernet Party Analogy [1/2]

- To understand how an Ethernet network works, consider this:
  - A group of friends is standing around at a party telling stories.
  - While someone is telling a story, everyone is listening.
  - When the story is over, here may be a pause before the next one speaks
  - Then, someone typically just begins talking and the cycle starts again

- Now, insert computer instead of friend:
  - A group of computers is standing around at a party telling stories.
  - While a computer is telling a story, computers are listening.
  - When the story is over, here may be a pause before the next computer speaks
  - Then, a computer typically just begins talking and the cycle starts again

# Ethernet Party Analogy [2/2]

- We assumed that all “friends” were equal
  - No one had a more import status & Everyone spoke with the same voice
- There are differences, however:
  - Only one computer typically keeps the transmitted information
  - This broadcast medium is being used for point-to-point communication
- A computer wanting to transmit a message:
  - It starts sending signals and also starts listening to see if the message it gets is the one it sent
  - If it is, the computer knows it’s the only computer sending, and it completes the transmission
  - If it isn’t, the computer stops transmitting immediately

# Connecting to the Internet

- Today there are 2 basic methods:
  - –Connection via an Internet service provider (ISP)
  - –Connection provided by a campus or enterprise network
- Most of us use both kinds of connections

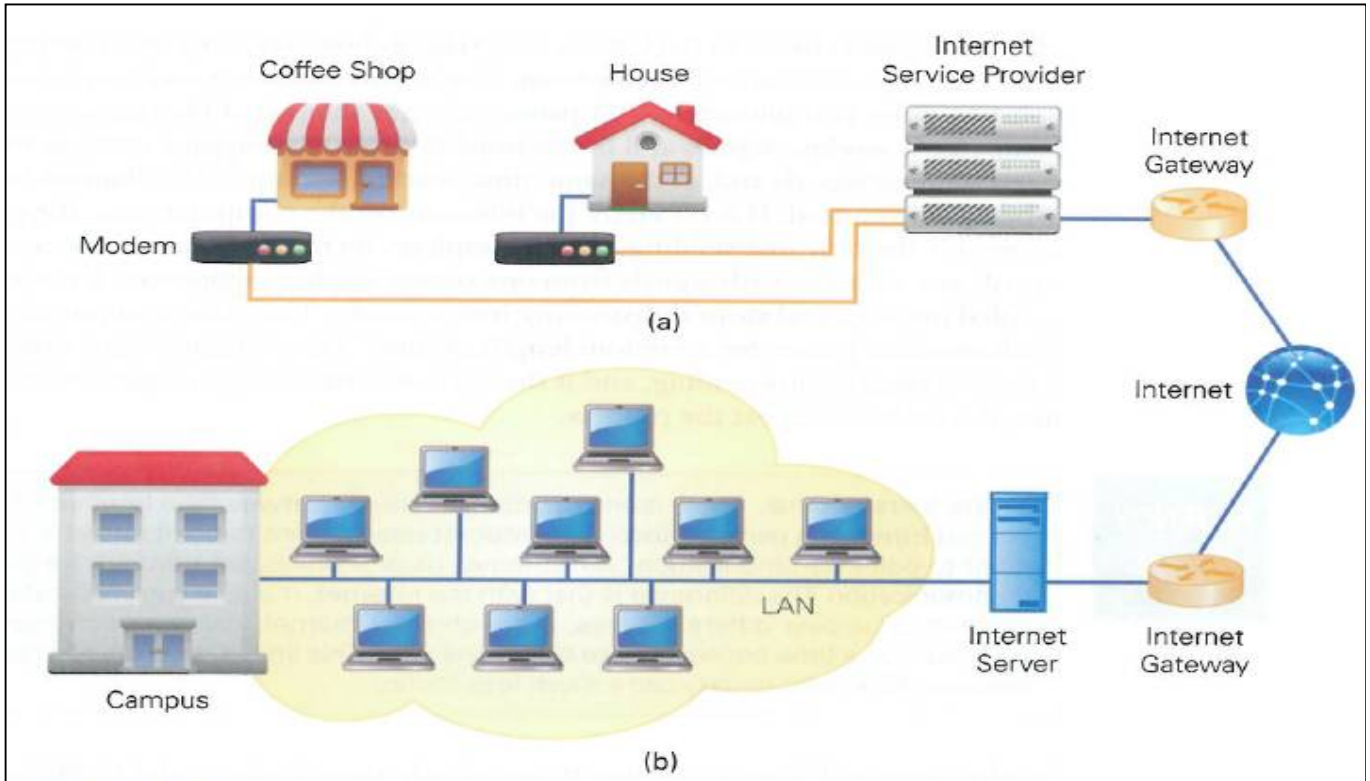



**Figure 3.6** Schematic diagram of connecting to the Internet. (a) An ISP's modem converts the computer's bits to signals the carrier's technology (phone lines, cable, microwave, etc.) can use; their servers connect to the Internet gateway. (b) On campus (or at another enterprise), the local network's server connects directly to the Internet gateway.

# 1. Connections by ISP

- Most home users connect to the Internet by ISPs which are companies that sell connections to the Internet
- The company places a modem at your house
  - Modems convert the bits a computer outputs into a form that is compatible with the carrier
  - The signals are sent to the carrier's business
  - They are converted (via modem) into a form for the server that connects to the Internet via the Internet Gateway
- Digital subscriber line (DSL or ADSL) and cable TV are two common providers
- Your smart phone also has a modem for connecting to network

# 2. Enterprise Network Connections

- The other way to connect is as a user of a larger networked organization (school, business, or governmental unit)
- The organization connects to the Internet by a gateway (관문)

# Wireless Networks

- Variation of a LAN connection
- Referred to by its protocol name 802.11
- The router ( Mobile Access Point(AP) ) is needed:
  - Physically connected to an ISP's modem which is connected to the Internet
  - Capable of broadcasting and receiving signals, usually radio frequency (rf ) signals

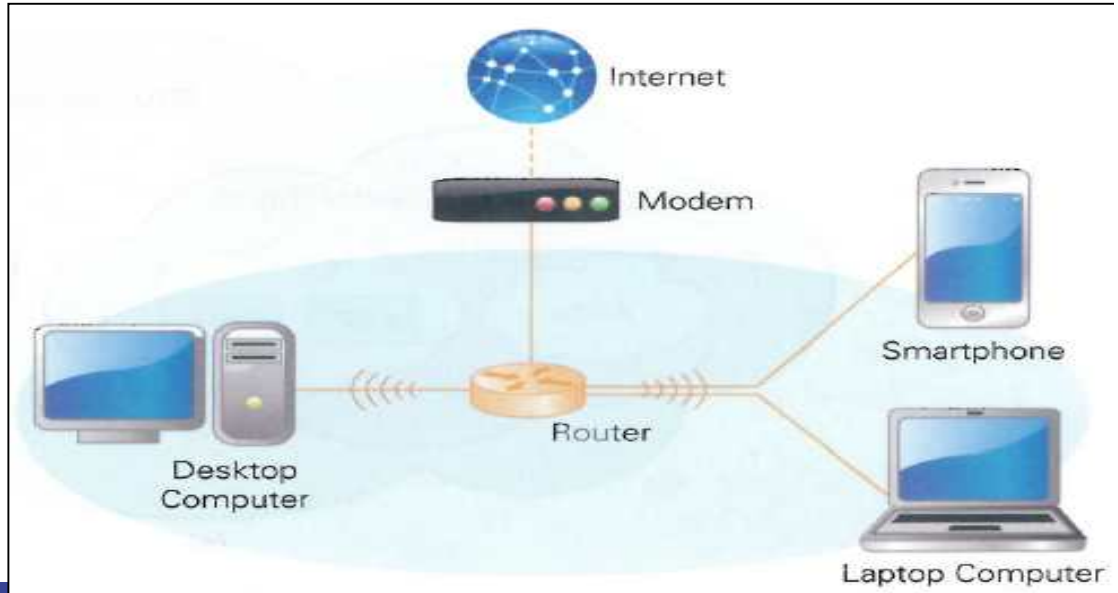



Figure 3.7 Standard Wi-Fi network configuration. A wireless router is connected via the modem to the ISP's Internet modem; laptops and other wireless-enabled devices connect by radio signals to the router.

# The World Wide Web

- Some computers connected to the Internet are Web servers
  - Computers programmed to send files to browsers running on other computers connected to the Internet.
- These Web servers and their files comprise the World Wide Web (WWW)
  - Those files are Web pages
  - Web servers store and send other kinds of files, too
- The files are often used to:
  - Create the Web page (images or animations)
  - Help with other Web services (play audio or video)

# Requesting a Web Page

- Web requests use client/server interaction
- Requesting a Web page means your browser is a client asking for a file from a Web server
- The file can be found in looking at the URL (Universal Resource Locator)
- Web browsers and Web servers both "speak" HTTP
- http://www.cs.washington.edu/homes/snyder/index.html
- The URL has 3 main parts:
  - Protocol: tells the computers how to handle the file
  - Server computer's name: or the name given by the domain hierarchy
  - Page's pathname: tells the server which file (page) is requested and where to find it

# Describing a Web Page

- Servers do not store Web pages in the form seen on our screens
- The pages are stored as a description of how they should appear on the screen (in HTML form)
- The browser receives the description/source file in HTML form and creates the Web page image that is described
- There are 2 advantages to storing and sending the source rather than the image itself:
  - A description file usually requires less information
  - The browser can adapt the source image to your computer more easily

```
<!doctype html>
<html>
<head> <title> Alto Computer </title>
  <meta charset="UTF-8" />
  <style>
   body {background-color : white; font-family:Helvetica}
  </style>
</head>
<body>
  <img style="float:right" src="alto.jpg" alt="Alto Personal Computer"
       height="300"/>
  <h1>Alto, <br/>A Computer of Note</h1>
    <p>The Alto was the first networked personal computer. It was invented
    at the Xerox Palo Alto Research Center (PARC) by the team of Ed McCreight,
    Chuck Thacker, Butler Lampson, Bob Sproull and Dave Boggs to explore
    office automation. Altos were the first production computers to have a
    bit-mapped display, windows and a mouse. Ethernet technology, also
    invented at PARC, was first used to connect Altos.</p>
    <p>Though Xerox was unable to market the Alto -- they cost $32,000
    in 1979 -- the computer impressed many others who did push the technologies.
    For example, Apple Computer co-founder Steve Jobs was so impressed when
    he saw the Alto, he created the revolutionary Apple Macintosh in its image.</p>
  </body>
</html>
```


**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.

# The Web Address in the Internet

- The DNS server requires you to give the name (URL) exactly because the DNS responds to that exact name
  - An incorrect name/URL and you either access the wrong IP address or the DNS lookup fails ( “404 Not Found” )
  - Computers can be programmed to notice http:// and to redirect you automatically to the correct page
- Some Web servers have www as part of their domain name, some don’t
  - Some Web servers seem to add the www if you leave it out
  - Some Web servers work either way (both www.moma.org and moma.org display the same Web site)
  - When is the www required and when is it optional?
  - Web administrators may also register all forms of a URL (with and without the “www”)

# File Structure in the Computer and the WWW

- Folders (also, called directory) are collection of files or other folders (or both)
- Directory Hierarchy is the file structure of the computer and forms the directory hierarchy
  - All hierarchies have branch points and leaves
  - Directories and files are often drawn sideways or upside down
  - Two terms are standard, however:
    - Down in the hierarchy means into subfolders (towards the leaves)
    - Up in the hierarchy means into folders (toward the root)

- Part of the directory hierarchy is shown in the pathnames of URLs:

  www.nasm.si.edu/exhibitions/gal100/pioneer.html

- Fluency
  - Part 1
    - Chapter 1
    - Chapter 2
    - Chapter 3
      - Comparing Communication Types
      - The Medium of the Message
      - The World Wide Web
      - The Internet and the Web
      - File Structure
        - Directory Hierarchy
          - Figure 3.12
          - Figure 3.13
          - Figure 3.14
          - Figure 3.15
        - Organizing the Folder
      - Summary
      - Try It Solutions
      - Review Questions
    - Chapter 4
    - Chapter 5
    - Chapter 6
  - Part 2
  - Part 3
  - Part 4

**Figure 3.12** The hierarchy of this book highlighting the path to this figure; downward-pointing triangles are expanded; right-pointing triangles are not.

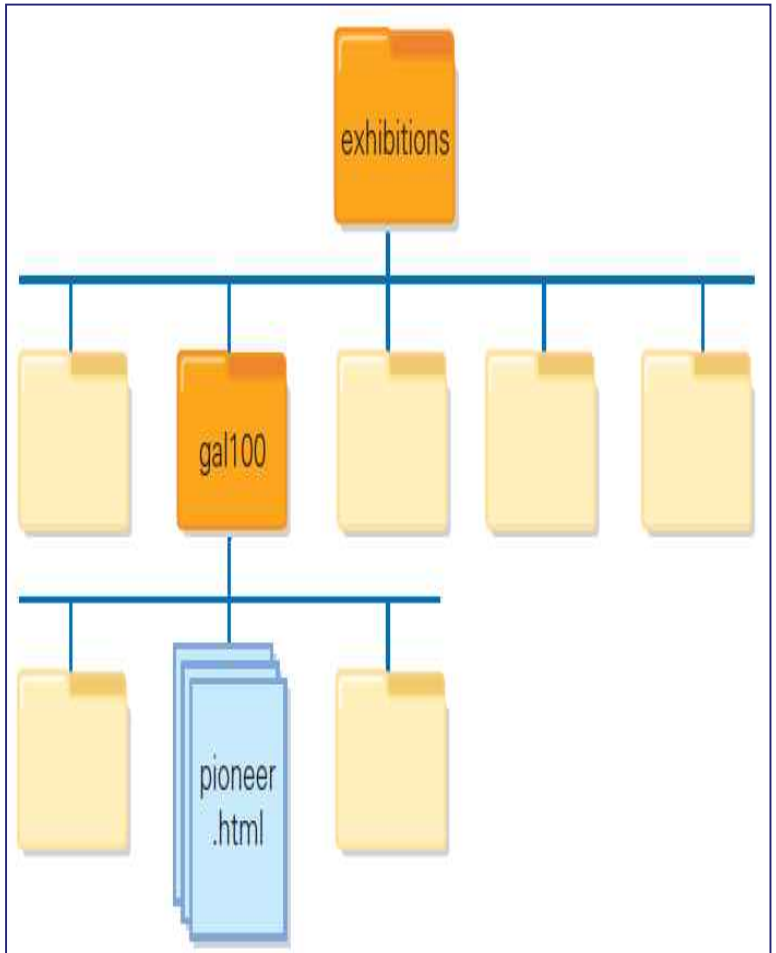



Figure 3.14 The pathname hierarchy ending in pioneer.html.

# Organizing the Folder in the WWW

- Normally the last item in the sequence is a file name
- This is not always necessary or true
- When a URL ends in a slash, the browser automatically looks in that folder for a file called index.htm
  - The index.html file exists only if it was built
- Why have a hierarchy?
  - Most people build hierarchies to organize their own thinking and work
  - Directories cost nothing
  - There is no reason not to use them
  - It is highly recommended

http://www.nps.gov/yell/photosmultimmedia/webcams.htm


Figure 3.13 Yellowstone National Park's Old Faithful Geyser Webcam.

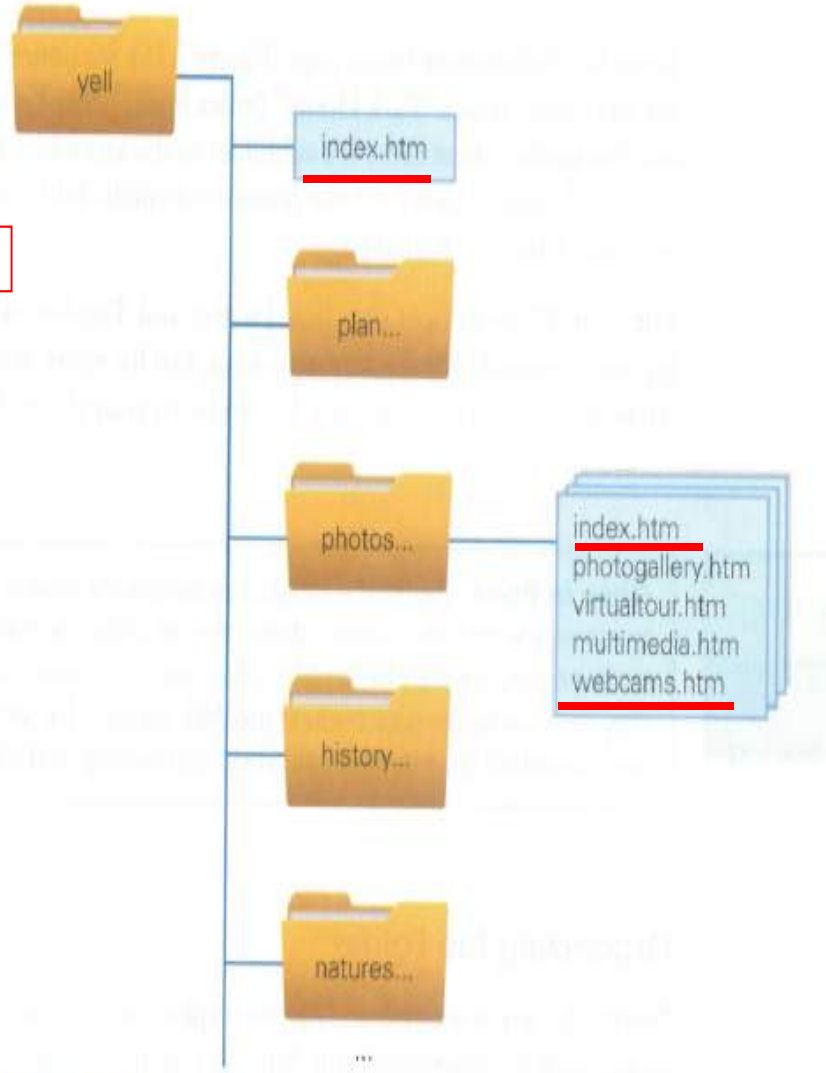



Figure 3.14 Top-level structure of the Yellowstone folder for the NPS Web server.

http://www.nps.gov/yell/

http://www.nps.gov/yell/index.htm

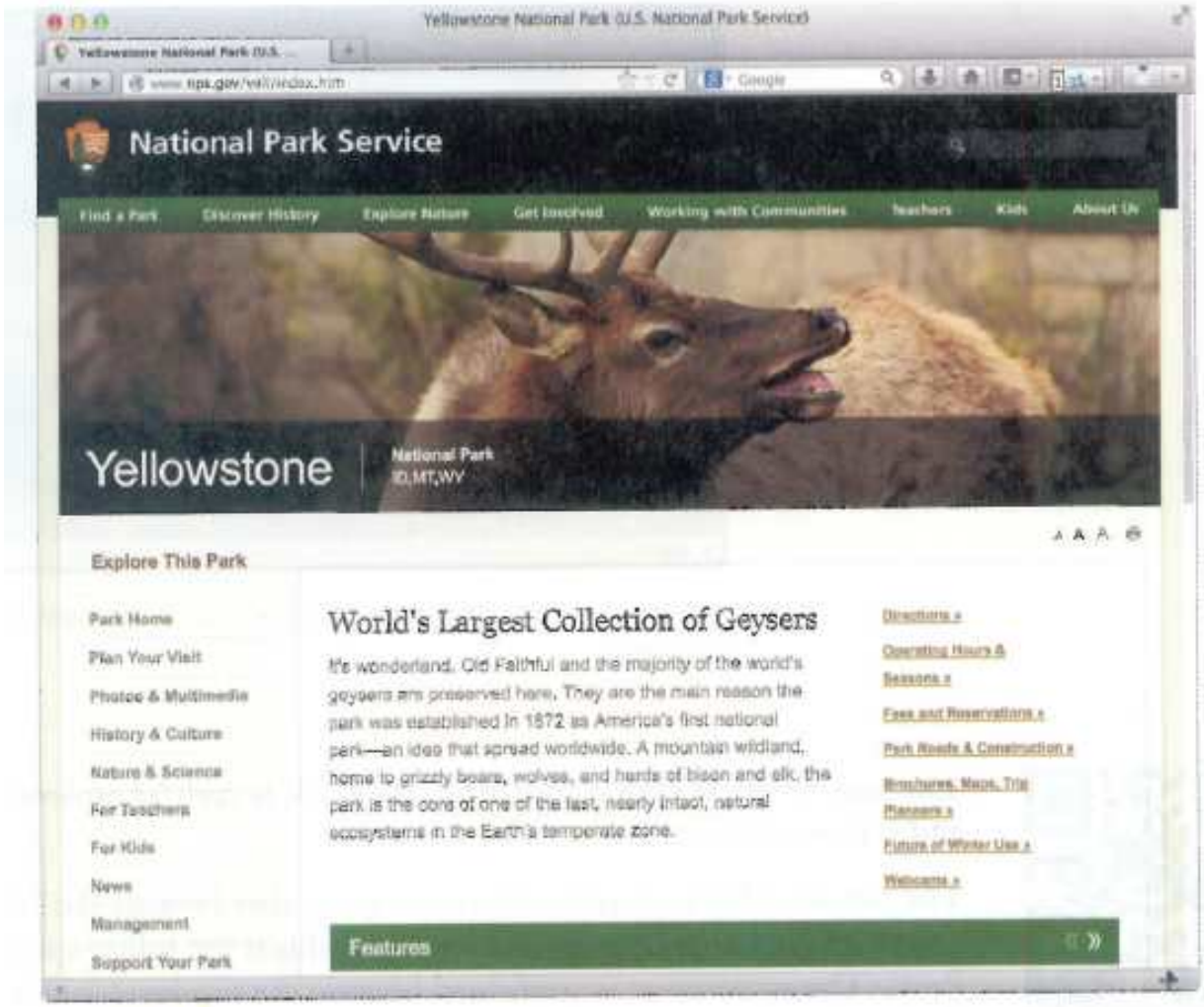



Figure 3.15 Yellowstone National Park home page (www.nps.gov/yell/index.htm).

# Summary

– Basic types of communication: point-to-point, multicast, broadcast, synchronous, and asynchronous

– Networking Technologies, including IP addresses, domains, IP packets, IP protocol, WANS and LANS, Ethernet protocol, ISPs, enterprise networks, and wireless networks

– The difference between the Internet and the World Wide Web

– File hierarchies in preparation for our further study of HTML