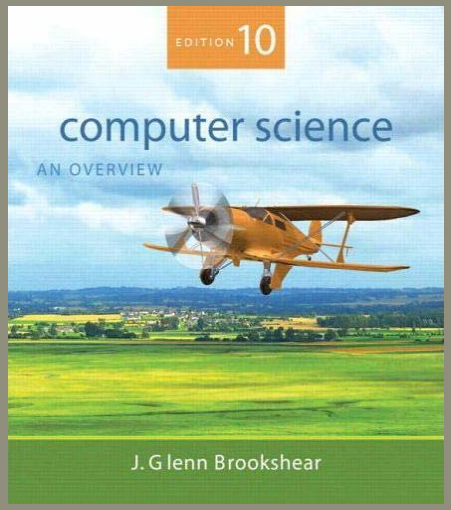
Chapter 4

Networking and the Internet



Chapter 4: Networking and the Internet

- 4.1 Network Fundamentals
- 4.2 The Internet
- 4.3 The World Wide Web
- 4.4 Internet Protocols
- 4.5 Security

Network Classifications

- Scope
  - Local area network (LAN)
  - Metropolitan area (MAN)
  - Wide area network (WAN)
- Ownership
  - Closed versus open
- Topology (configuration)
  - Ring
  - Bus (Ethernet)
  - Star (Wireless networks with central Access Point)

Figure 4.1 Network topologies

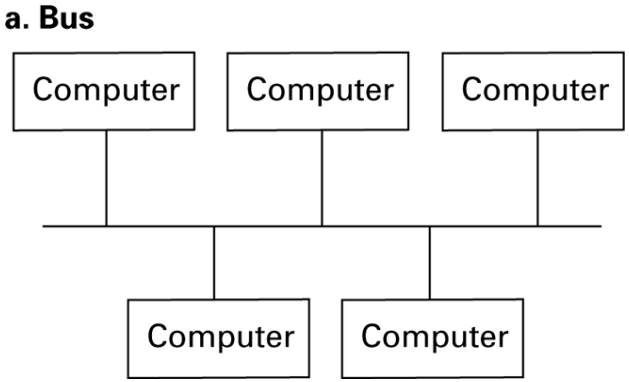
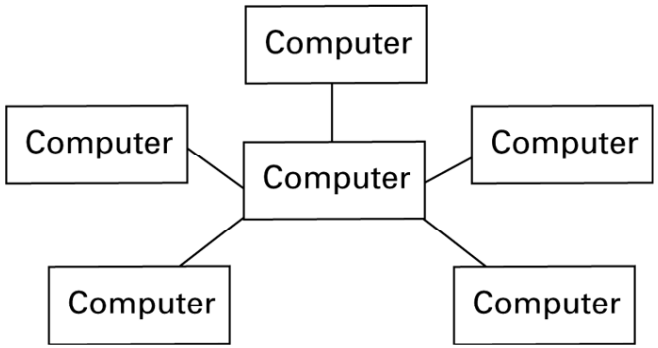


Figure 4.1 Network topologies (continued)

b. Star



Protocols

- CSMA/CD
  - Used in Ethernet
  - Silent bus provides right to introduce new message
- CSMA/CA
  - Used in WiFi
  - Hidden terminal problem

Figure 4.2 Communication over a bus network

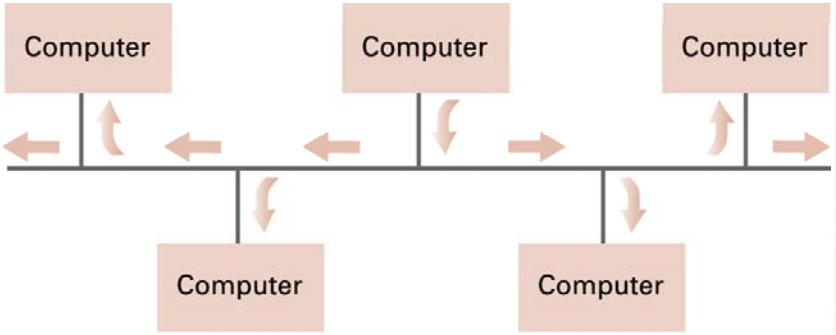
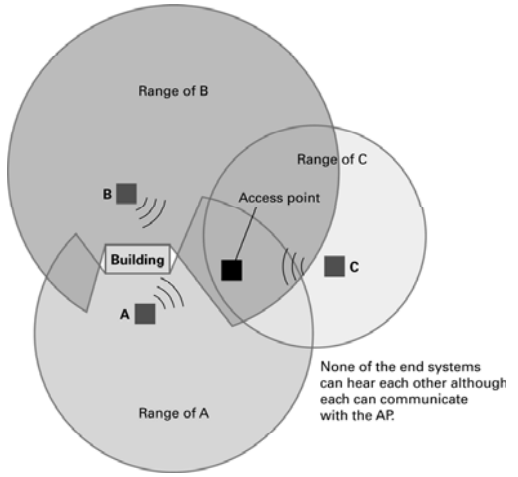


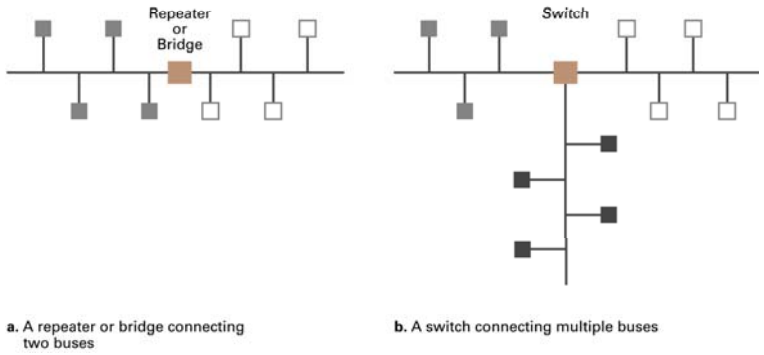
Figure 4.3 The hidden terminal problem



Connecting Networks

- **Repeater:** Extends a network
- **Bridge:** Connects two compatible networks
- **Switch:** Connect several compatible networks
- **Router:** Connects two incompatible networks resulting in a network of networks called an **internet**

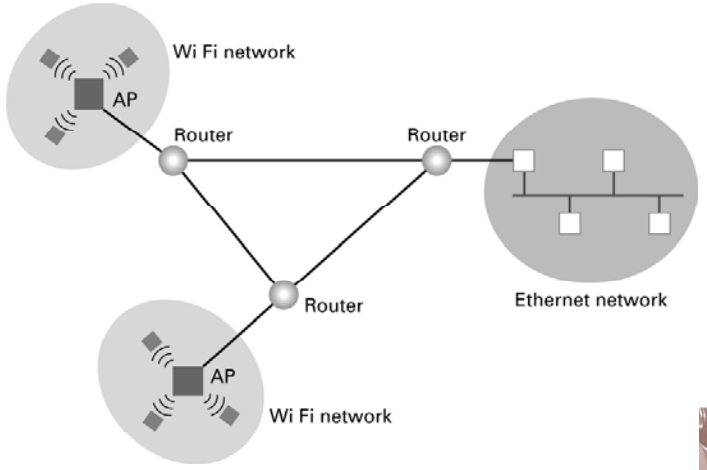
Figure 4.4 Building a large bus network from smaller ones



a. A repeater or bridge connecting two buses

b. A switch connecting multiple buses

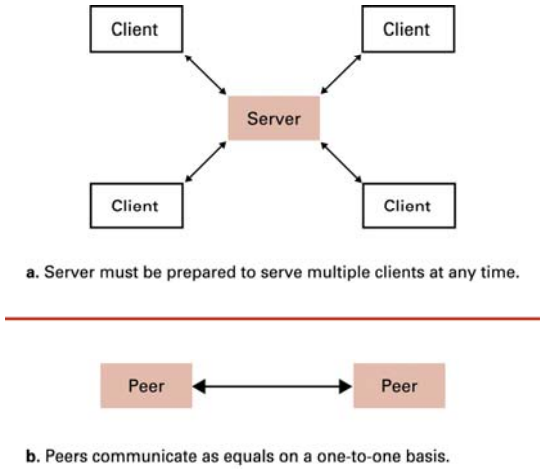
Figure 4.5 Routers connecting two WiFi networks and an Ethernet network to form an internet



Inter-process Communication

- Client-server
  - One server, many clients
  - Server must execute continuously
  - Client initiates communication
- Peer-to-peer (P2P)
  - Two processes communicating as equals
  - Peer processes can be short-lived

Figure 4.6 The client/server model compared to the peer-to-peer model



Distributed Systems

- Systems with parts that run on different computers
  - Infrastructure can be provided by standardized toolkits
    - Example: Enterprise Java Beans from Sun Microsystems
    - Example: .NET framework from Microsoft

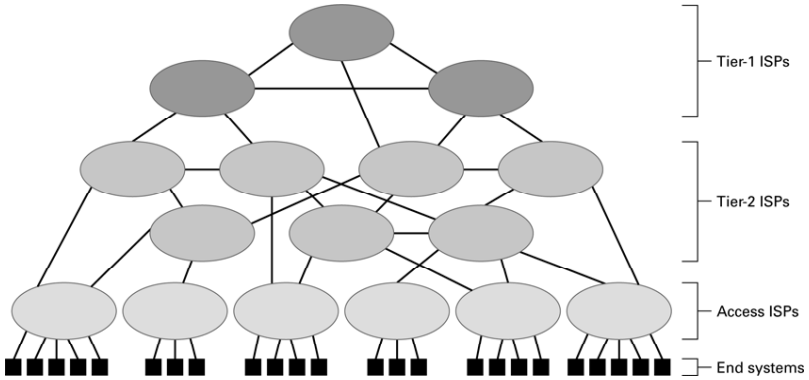
The Internet

- The Internet: An internet that spans the world
  - Original goal was to develop a means of connecting networks that would not be disrupted by local disasters.
  - Today it has shifted from an academic research project to a commercial undertaking.

Internet Architecture

- Internet Service Provider (ISP)
  - Tier-1
  - Tier-2
- Access ISP: Provides connectivity to the Internet
  - Traditional telephone (dial up connection)
  - Cable connections
  - DSL
  - Wireless

Figure 4.7 Internet Composition



Internet Corporation for Assigned Names & Numbers (ICANN)

- Allocates IP addresses to ISPs who then assign those addresses within their regions.
- Oversees the registration of domains and domain names.

Internet Addressing

- IP address: pattern of 32 or 128 bits often represented in dotted decimal notation
- Mnemonic address:
  - Domain names
  - Top-Level Domains
- Domain name system (DNS)
  - Name servers
  - DNS lookup

Traditional Internet Applications

- Electronic Mail (email)
  - Domain mail server collects incoming mail and transmits outing mail
  - Mail server delivers collected incoming mail to clients via POP3 or IMAP
- File Transfer Protocol (FTP)
- Telnet and SSH

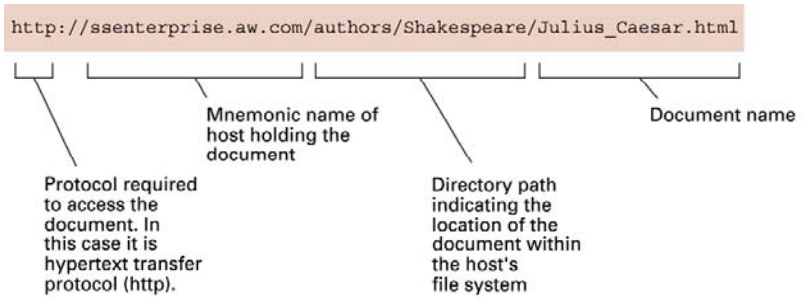
More Recent Applications

- Voice Over IP (VoIP)
- Internet Radio
  - N-unicast
  - Multicast

World Wide Web

- Hypertext and HTTP
- Browser gets documents from Web server
- Documents identified by URLs

Figure 4.8 A typical URL



Hypertext Document Format

- Entire document is printable characters
- Contains tags to communicate with browser
  - Appearance
    - <h1> to start a level one heading
    - <p> to start a new paragraph
  - Links to other documents and content
    - <a href = . . . >
  - Insert images
    - <img src = . . . >

Figure 4.9 A simple Web page

a. The page encoded using HTML.

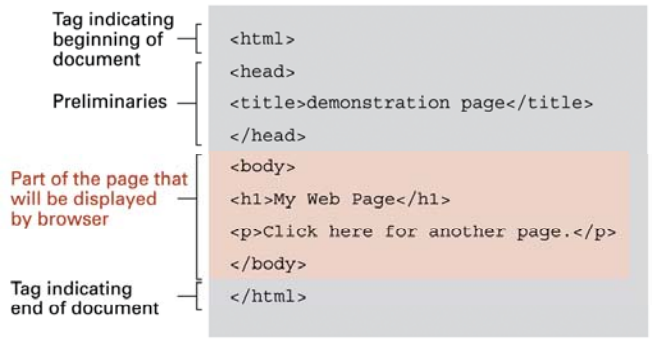


Figure 4.10 An enhanced simple Web page

a. The page encoded using HTML.

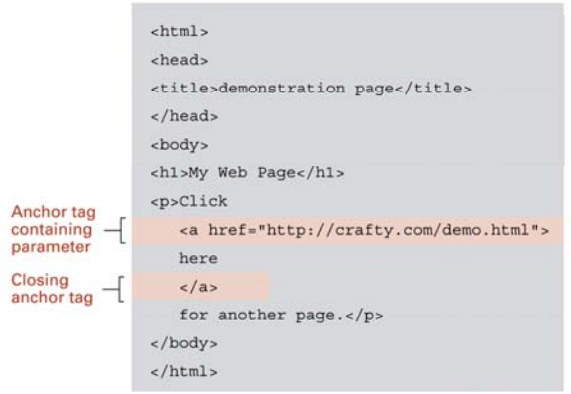


Figure 4.9 A simple Web page (continued)

b. The page as it would appear on a computer screen.

Figure 4.10 An enhanced simple Web page (continued)

b. The page as it would appear on a computer screen.

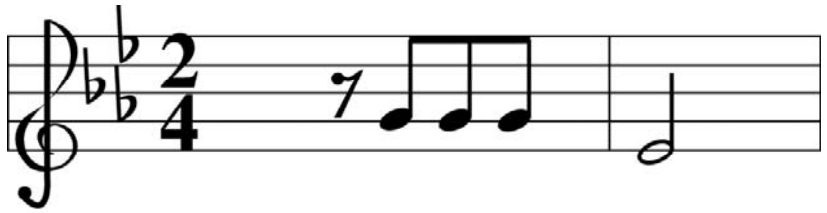
Extensible Markup Language (XML)

- XML: A language for constructing markup languages similar to HTML
  - A descendant of SGML
  - Opens door to a World Wide *Semantic* Web

Using XML

<staff clef = “treble”> <key>C minor</key>
<time> 2/4 </time>
<measure> < rest> egth </rest> <notes> egth G,
egth G, egth G </notes></measure>
<measure> <notes> hlf E </notes></measure>
</staff>

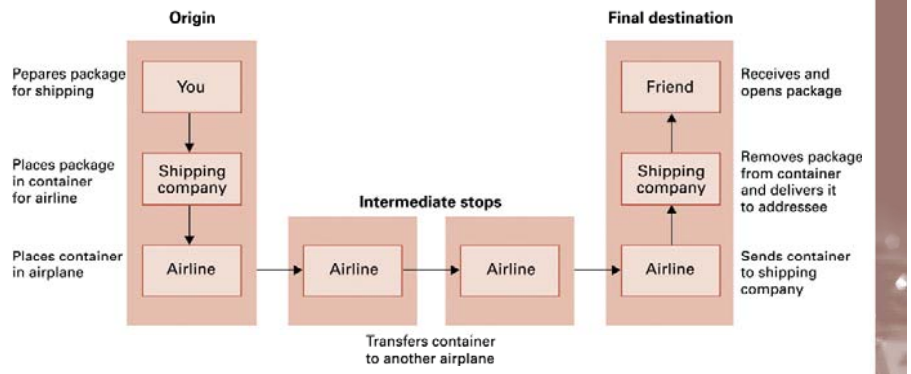
Figure 4.11 The first two bars of Beethoven’s Fifth Symphony



Client Side Versus Server Side

- Client-side activities
  - Examples: java applets, javascript, Macromedia Flash
- Server-side activities
  - Common Gateway Interface (CGI)
  - Servlets
  - PHP

Figure 4.12 Package-shipping example



Internet Software Layers

- **Application:** Constructs message with address
- **Transport:** Chops message into packets
- **Network:** Handles routing through the Internet
- **Link:** Handles actual transmission of packets

Figure 4.13 The Internet software layers

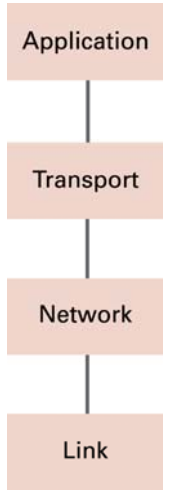
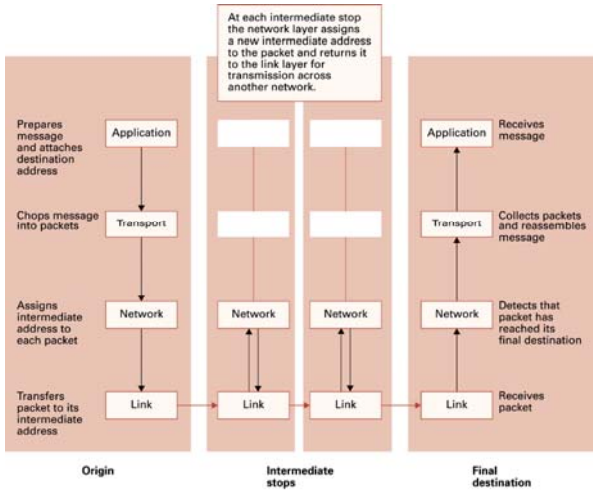


Figure 4.14 Following a message through the Internet



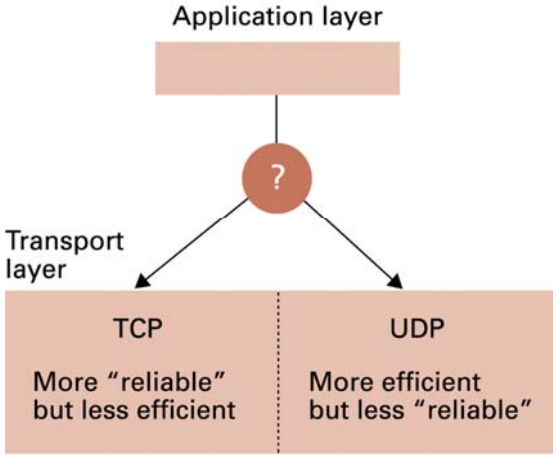
TCP/IP Protocol Suite

- Transport Layer
  - TCP
  - UDP
- Network Layer
  - IP (IPv4 and IPv6)

Security

- Attacks
  - Malware (viruses, worms, Trojan horses, spyware, phishing software)
  - Denial of service
  - Spam
- Protection
  - Firewalls
  - Spam filters
  - Proxy Servers
  - Antivirus software

Figure 4.15 Choosing between TCP and UDP



Encryption

- FTPS, HTTPS, SSL
- Public-key Encryption
  - Public key: Used to encrypt messages
  - Private key: Used to decrypt messages
- Certificates and Digital Signatures

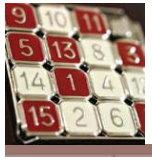


Figure 4.16 Public-key encryption