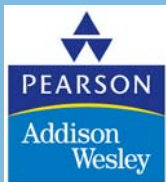# Networking and the Internet

Computer Science: An Overview
Tenth Edition

by
Kai-Lung Hua

Networking and the Internet

- 1 Network Fundamentals
- 2 The Internet
- 3 The World Wide Web
- 4 Internet Protocols
- 5 Security

Network Classifications

- Scope
  - Local area network (LAN)
  - Metropolitan area (MAN)
  - Wide area network (WAN)
- Ownership
  - Closed versus open
- Topology (configuration)
  - Bus (Ethernet)
  - Star (Wireless networks with central Access Point)
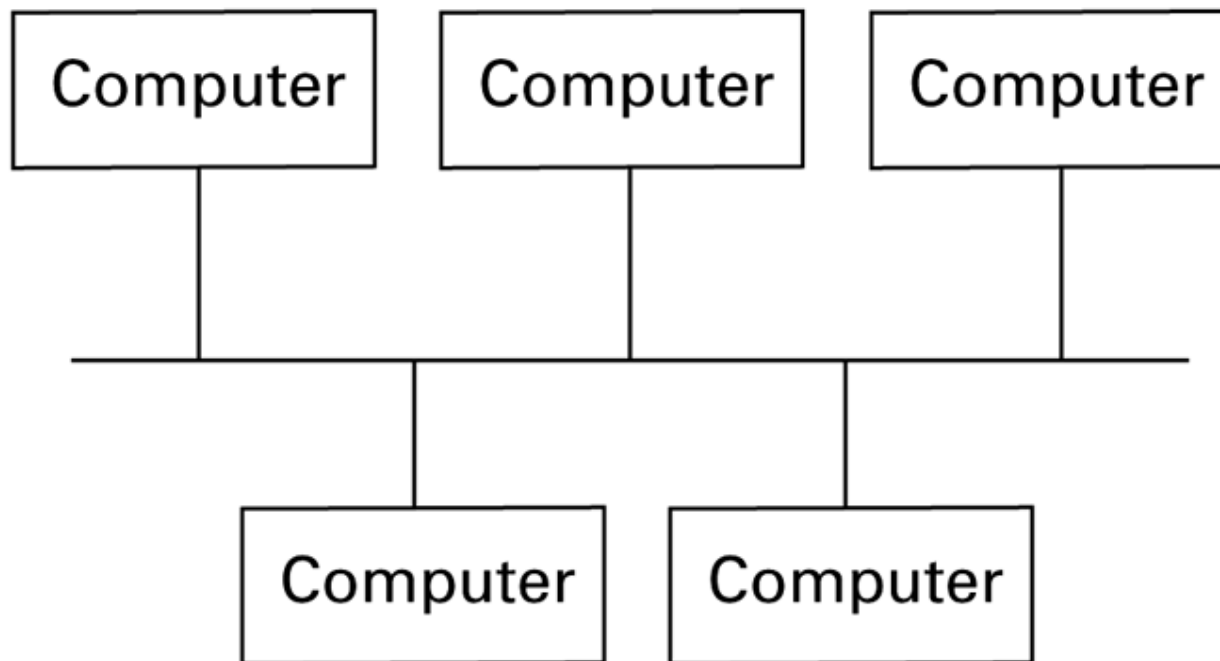
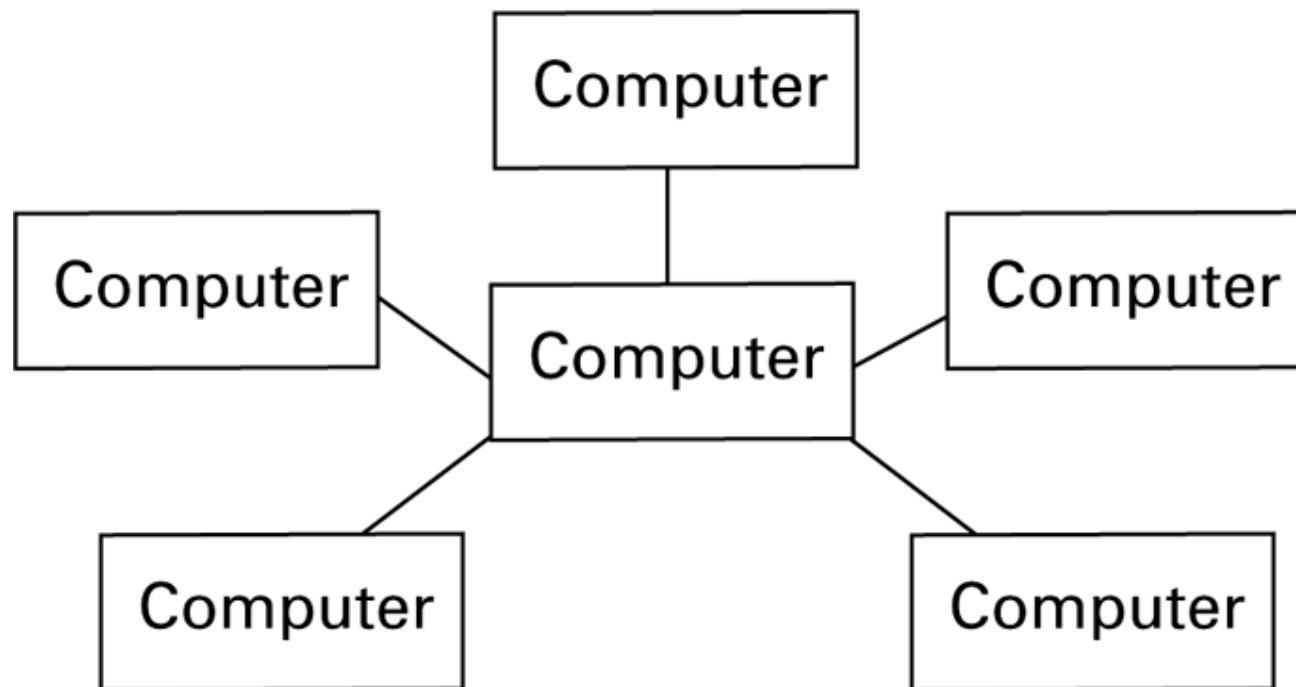# Figure 4.1 Network topologies

a. Bus

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
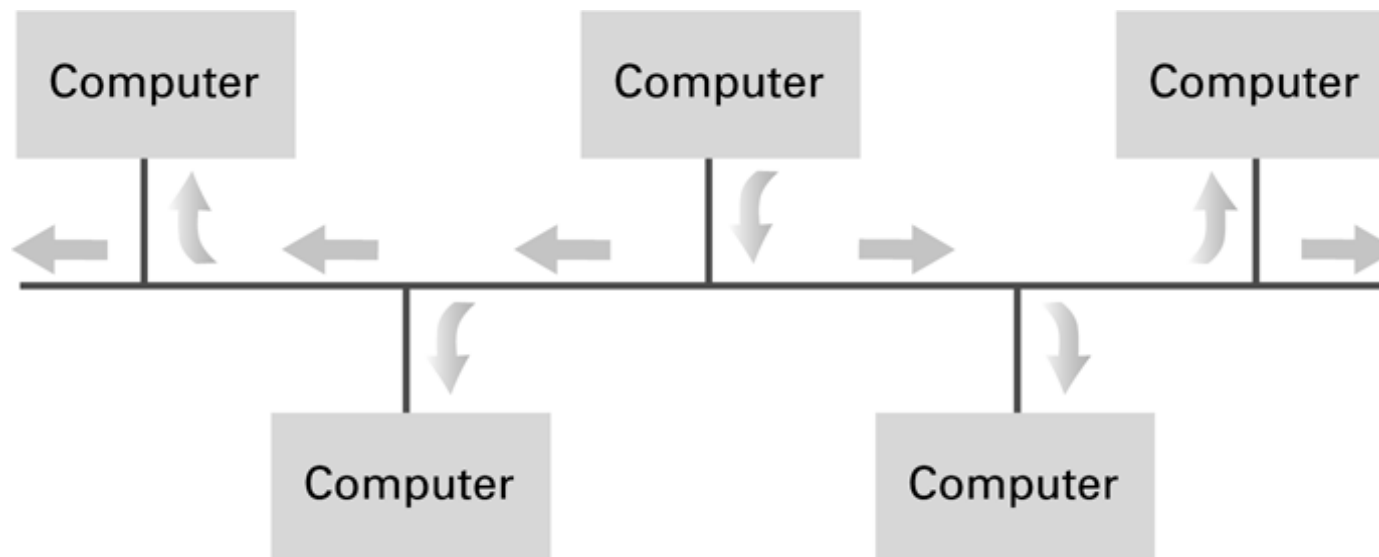
Figure 4.2 Communication over a bus network

Figure 4.3 The hidden terminal problem

Range of B

Range of C

B

Access point

Building

A

C

None of the end systems can hear each other although each can communicate with the AP.

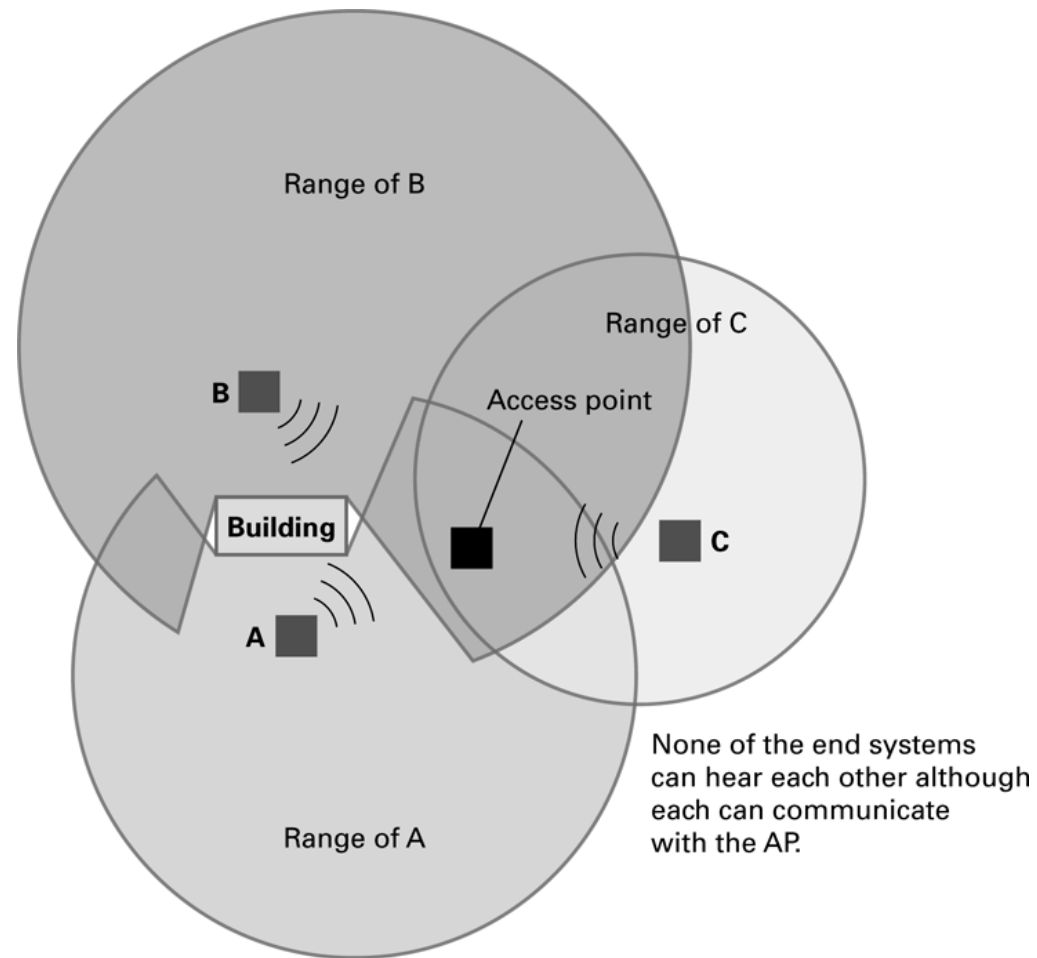Range of A

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
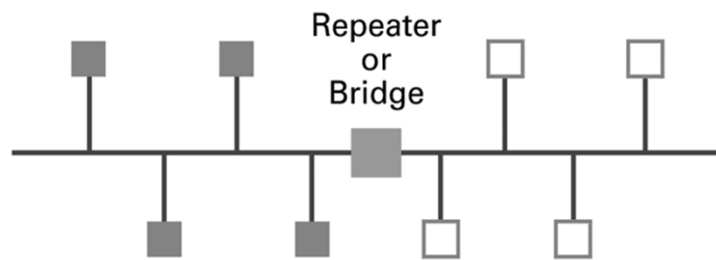
a. A repeater or bridge connecting two buses
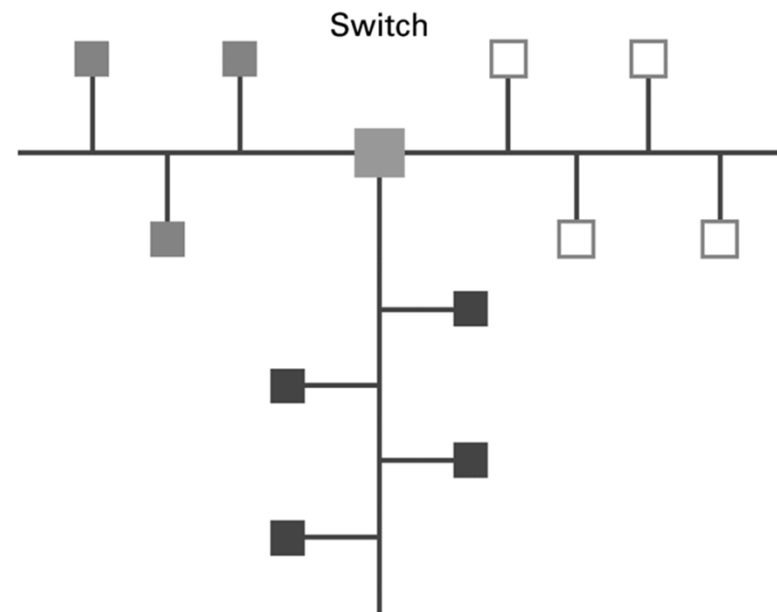
b. A switch connecting multiple buses

Figure 4.5 Routers connecting two WiFi networks and an Ethernet network to form an internet
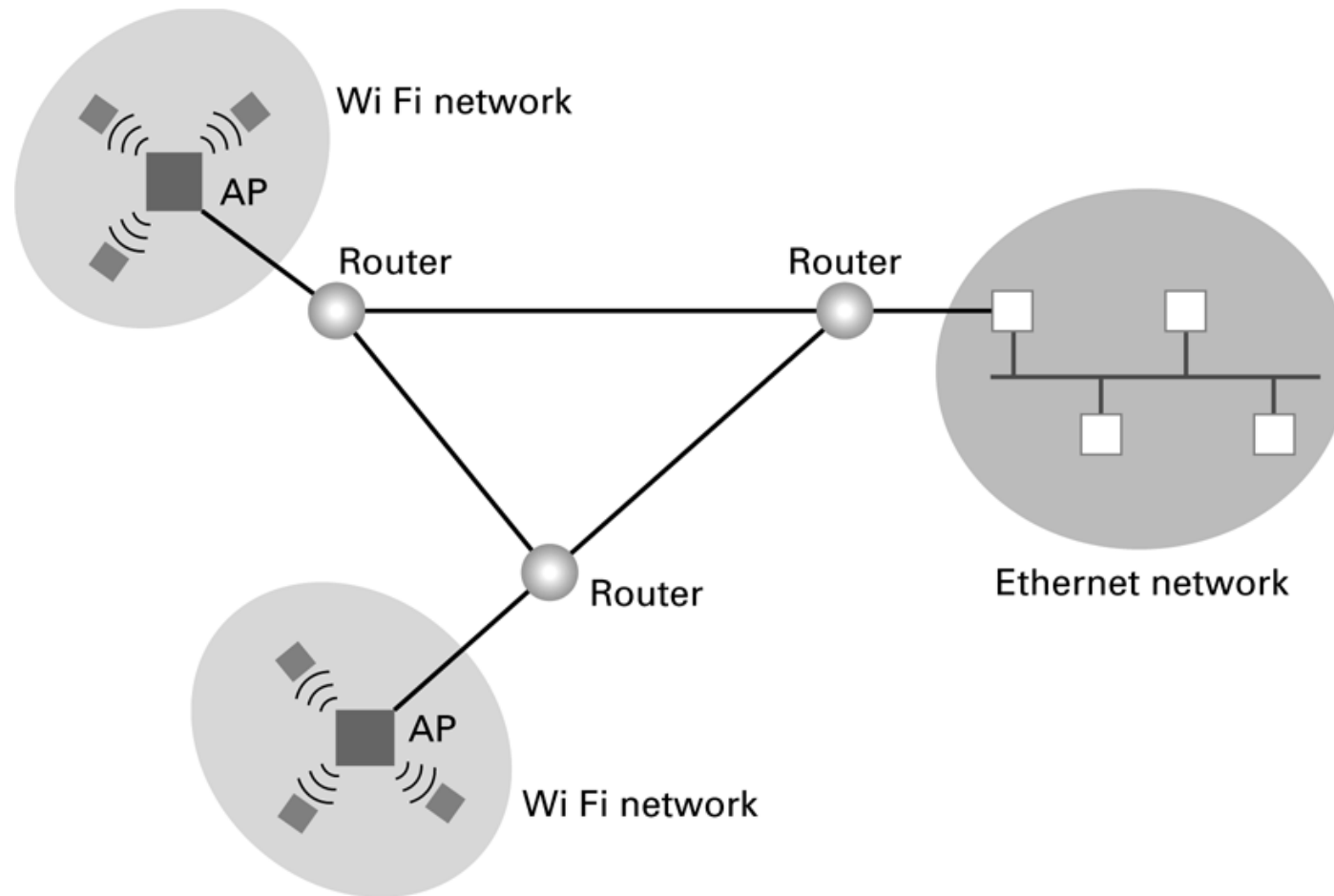
Inter-process Communication

- 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**
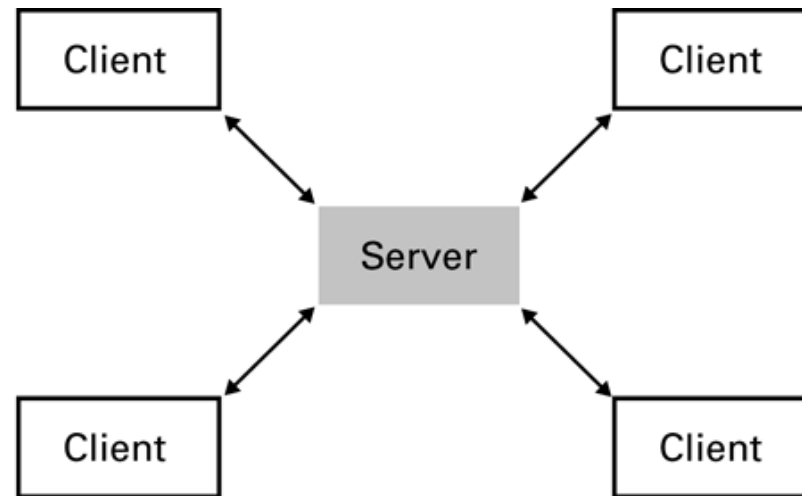
a. Server must be prepared to serve multiple clients at any time.
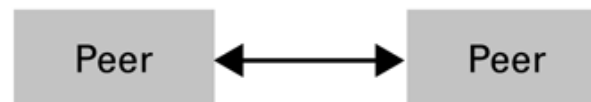
b. Peers communicate as equals on a one-to-one basis.

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
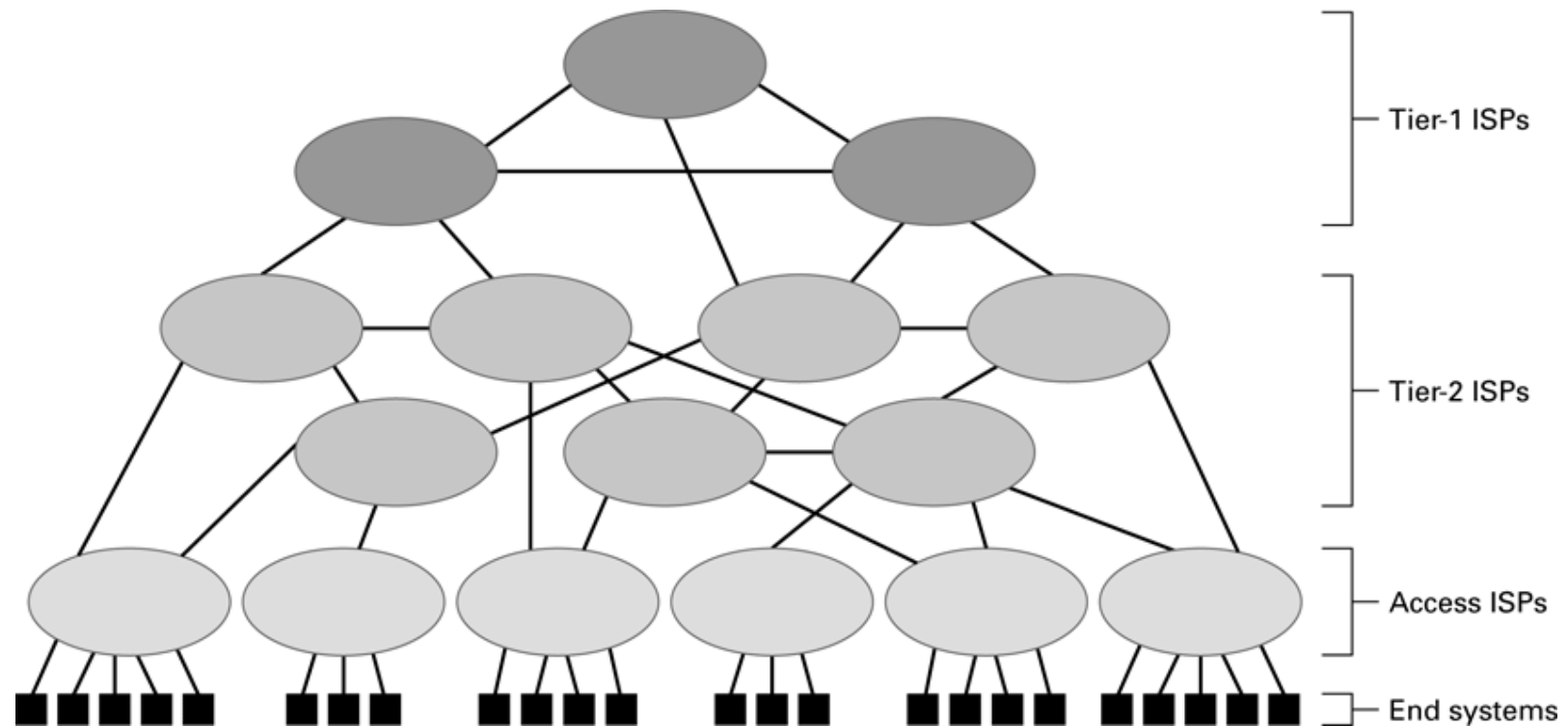
Internet Addressing

- 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

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.

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

`http://ssenterprise.aw.com/authors/Shakespeare/Julius_Caesar.html`

Mnemonic name of host holding the document

Document name

Protocol required to access the document. In this case it is hypertext transfer protocol (http).

Directory path indicating the location of the document within the host's file system
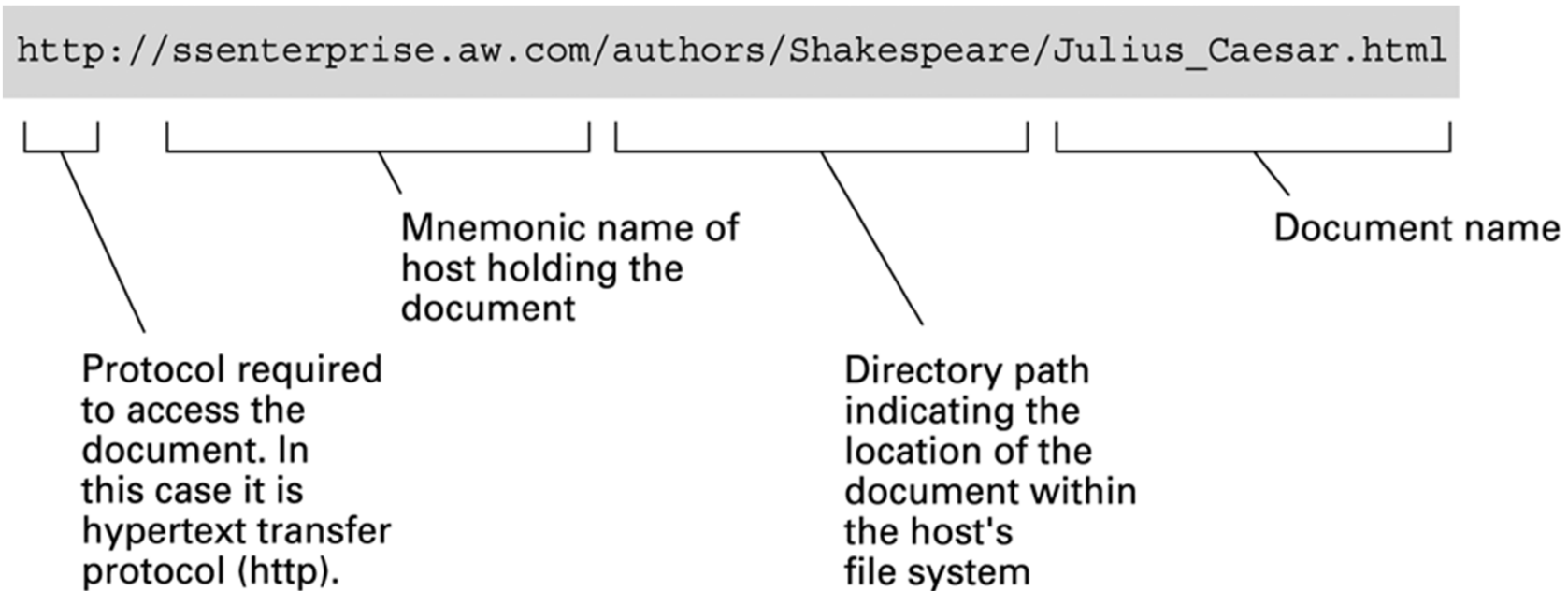
Hypertext Document Format

- Encoded as text file

- 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.

Tag indicating beginning of document
```
<html>
```

Preliminaries
```
<head>
<title>demonstration page</title>
</head>
```

The part of the document that will be displayed by a browser
```
<body>
<h1>My Web Page</h1>
<p>Click here for another page.</p>
</body>
```

Tag indicating end of document
```
</html>
```
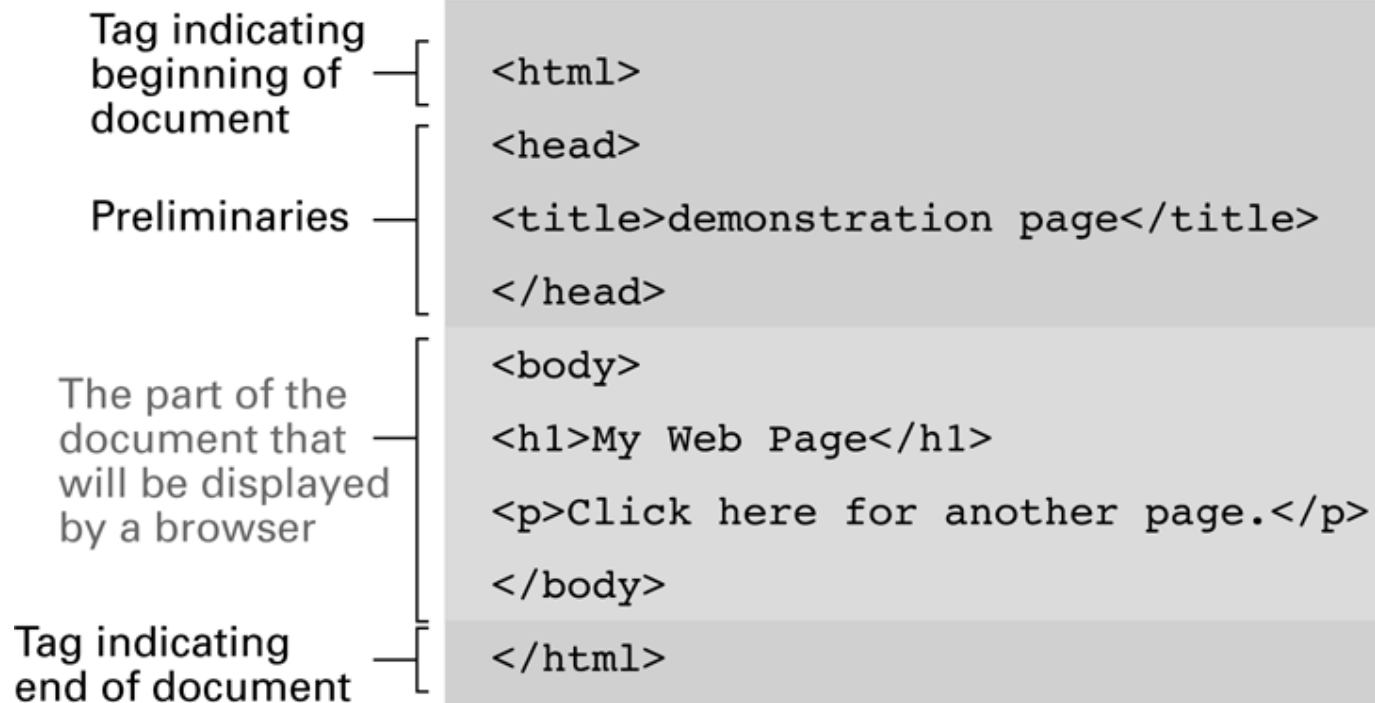
Figure 4.9 A simple Web page (continued)

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

My Web Page

Click here for another page.

Figure 4.10 An enhanced simple Web page

a. The page encoded using HTML.

```
<html>
<head>
<title>demonstration page</title>
</head>
<body>
<h1>My Web Page</h1>
<p>Click
    <a href="http://crafty.com/demo.html">
    here
    </a>
    for another page.</p>
</body>
</html>
```

Anchor tag containing parameter — `<a href="http://crafty.com/demo.html">`

Closing anchor tag — `</a>`

Figure 4.10 An enhanced simple Web page (continued)

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

My Web Page

Click here for another page.

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
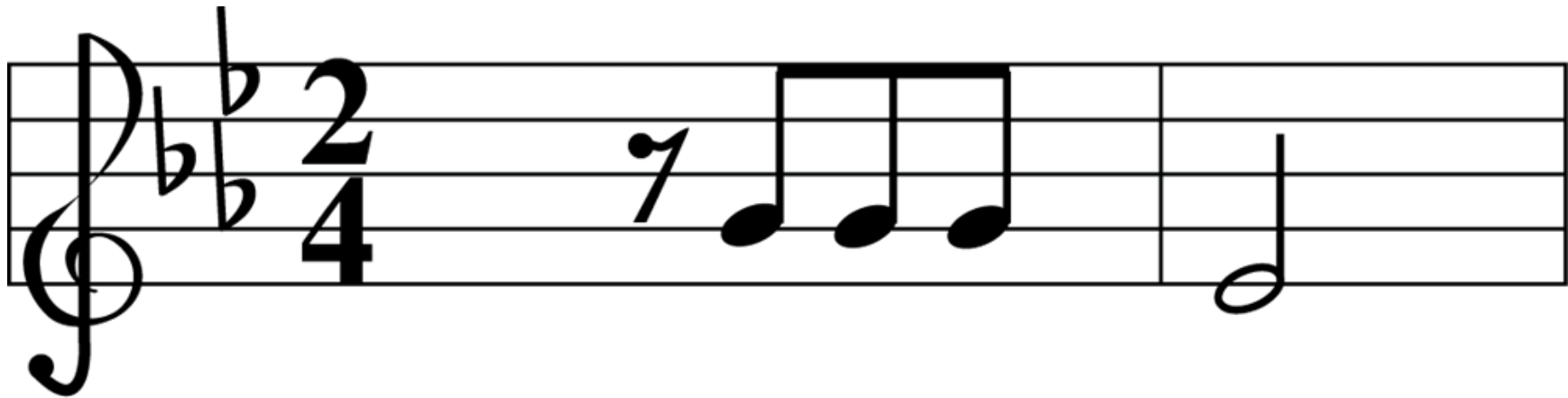
Client Side Versus Server Side

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

Figure 4.12 Package-shipping example
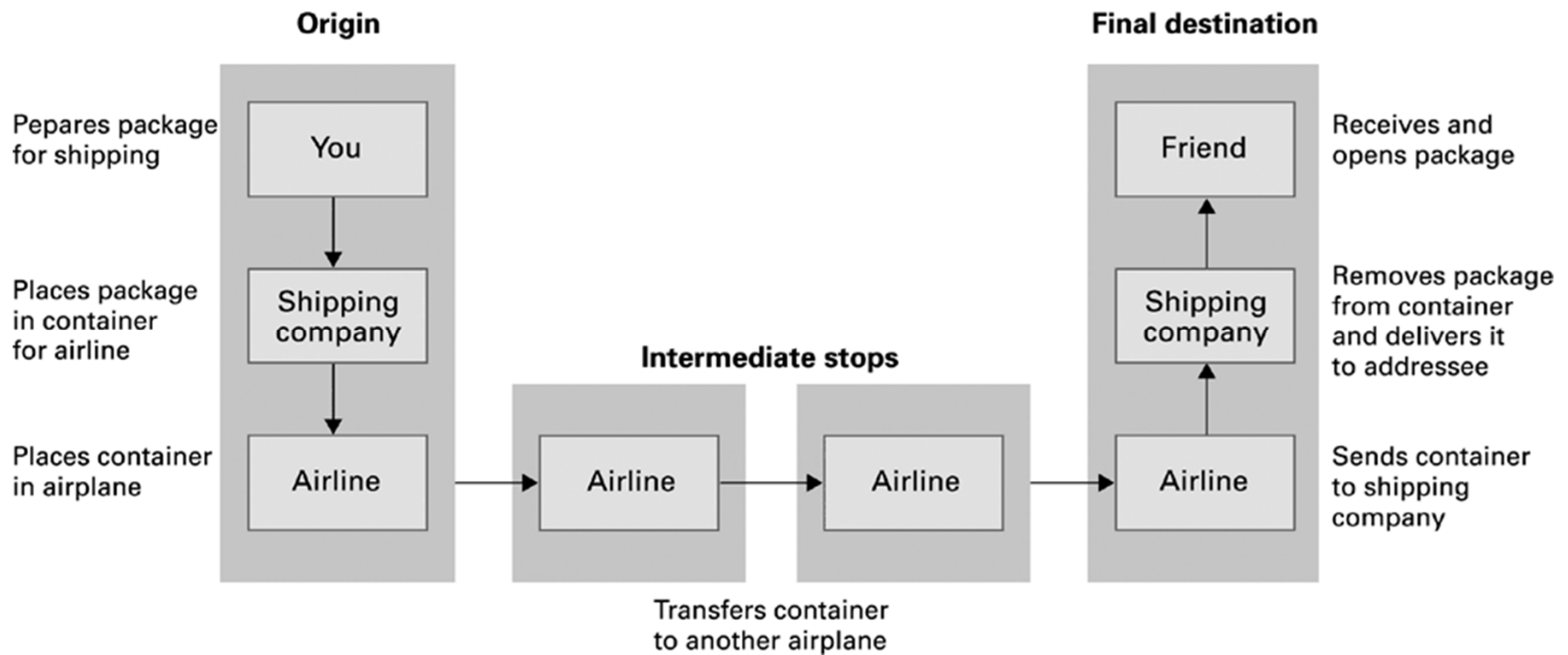
Internet Software Layers

- **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
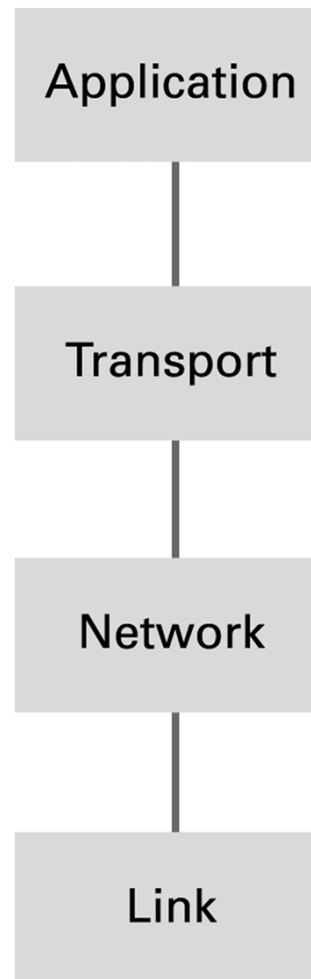
Figure 4.14 Following a message through the Internet

At each intermediate stop the network layer assigns a new intermediate address to the packet and returns it to the link layer for transmission across another network.

Prepares message and attaches destination address — Application

Chops message into packets — Transport

Assigns intermediate address to each packet — Network

Transfers packet to its intermediate address — Link

Network

Link

Network

Link

Application — Receives message

Transport — Collects packets and reassembles message

Network — Detects that packet has reached its final destination

Link — Receives packet

Origin

Intermediate stops

Final destination

TCP/IP Protocol Suite

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

Figure 4.15 Choosing between TCP and UDP

Application layer

?

Transport layer

TCP	UDP
More "reliable" but less efficient	More efficient but less "reliable"
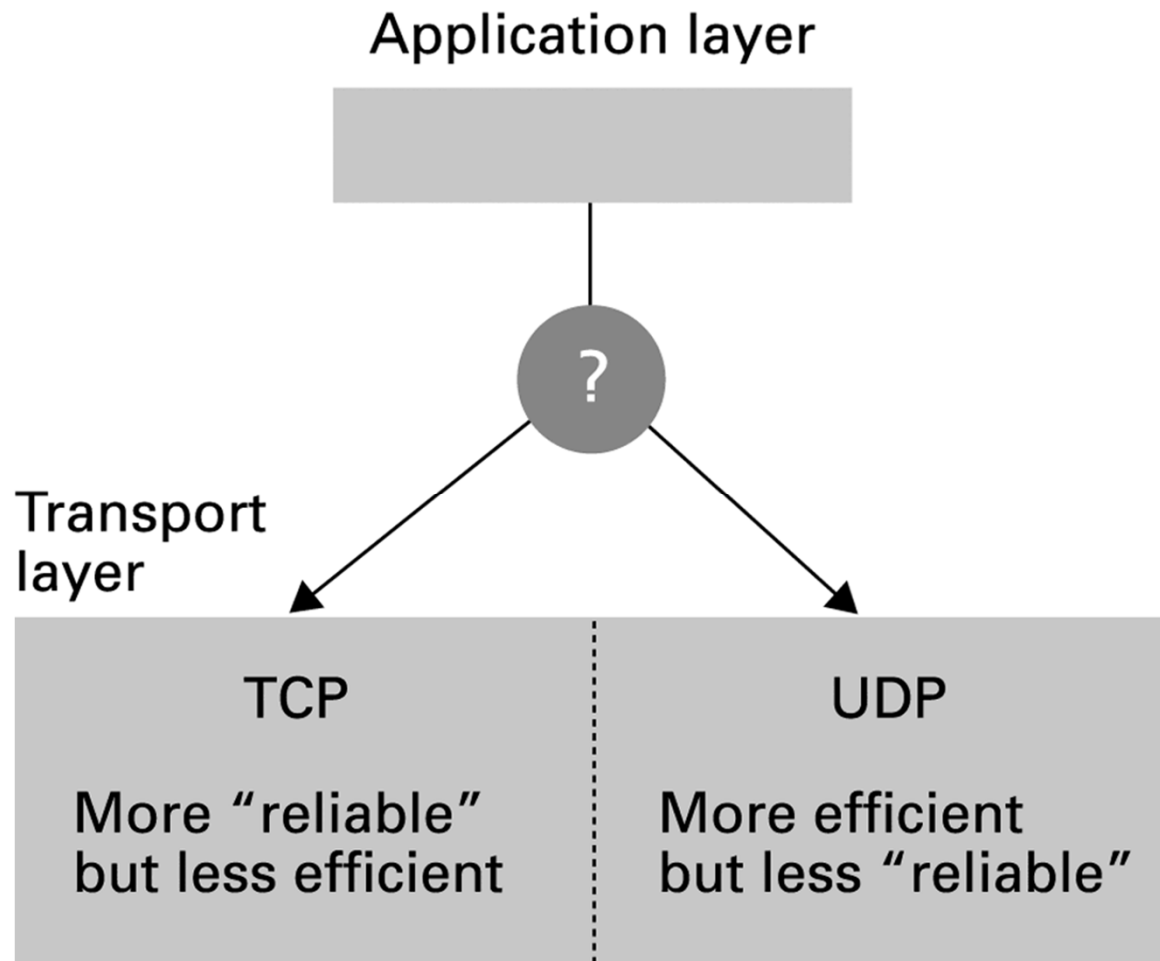
Security

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

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**

Alice holds public key → Encrypted messages → Bob holds private key

Carol holds public key → Encrypted messages →

Both Alice and Carol can send encrypted messages to Bob.

Alice holds public key → Encrypted message → Bob holds private key

Carol holds public key — ?

Carol cannot decrypt Alice's message even though she knows how Alice encrypted it.