

Chapter 4: Networking and the Internet

Computer Science: An Overview
Twelfth Edition

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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

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Network Classifications

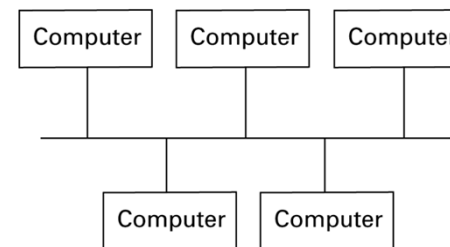
- Scope
 - Personal area network (PAN)
 - Local area network (LAN)
 - Metropolitan area (MAN)
 - Wide area network (WAN)
- Ownership
 - Closed versus open
- Topology (configuration)
 - Bus (Ethernet)
 - Star (Wireless networks with central Access Point)

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Figure 4.1 Network topologies

a. Bus

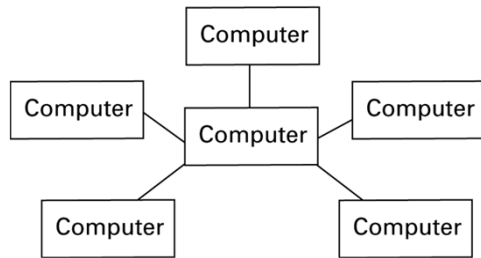


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Figure 4.1 Network topologies (continued)

b. Star



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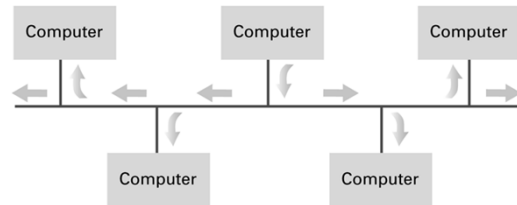
Protocols

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

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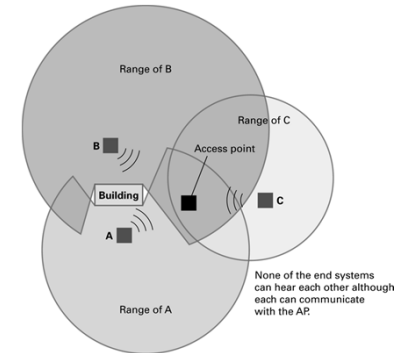
Figure 4.2 Communication over a bus network



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Figure 4.3 The hidden terminal problem



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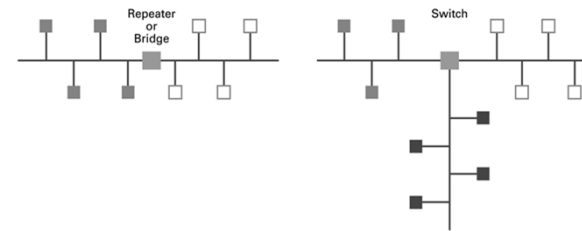
Connecting Networks

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

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Figure 4.4 Building a large bus network from smaller ones



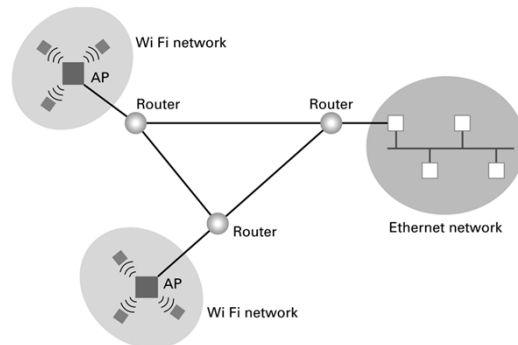
a. A repeater or bridge connecting two buses

b. A switch connecting multiple buses

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



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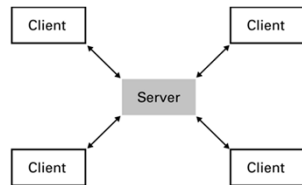
Inter-process Communication

- **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

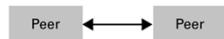
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Figure 4.6 The client/server model compared to the peer-to-peer model



a. Server must be prepared to serve multiple clients at any time.



b. Peers communicate as equals on a one-to-one basis.

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Distributed Systems

- Systems with parts that run on different computers
 - Cluster computing
 - Grid computing
 - Cloud computing
 - Amazon's Elastic Compute Cloud
 - Google Drive

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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 a commercial undertaking that links a worldwide combination of PANs, LANs, MANs, and WANs involving millions of computers

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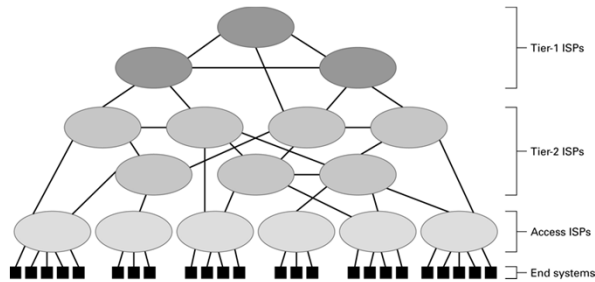
Internet Architecture

- Internet Service Provider (ISP)
 - Tier-1
 - Tier-2
- Access or tier-3 ISP: Provides connectivity to the Internet
 - Hot spot (wireless)
 - Telephone lines
 - Cable/Satellite systems DSL
 - Fiber optics

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Figure 4.7 Internet Composition



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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

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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.

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Early Internet Applications

- Network News Transfer Protocol (NNTP)
- File Transfer Protocol (FTP)
- Telnet and SSH
- Hypertext Transfer Protocol (HTTP)
- Electronic Mail (email)
 - Domain mail server collects incoming mail and transmits outgoing mail
 - Mail server delivers collected incoming mail to clients via POP3 or IMAP

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SMTP Simple Mail Transfer Protocol

```
220 mail.tardis.edu SMTP Sendmail Gallifrey-1.0; Fri, 23 Aug 2413 14:34:10
HELO mail.skaro.gov
250 mail.tardis.edu Hello mail.skaro.gov, pleased to meet you
MAIL From: dalek@skaro.gov
250 2.1.0 dalek@skaro.gov... Sender ok
RCPT To: doctor@tardis.edu
250 2.1.5 doctor@tardis.edu... Recipient ok
DATA
354 Enter mail, end with "." on a line by itself
Subject: Extermination.
EXTERMINATE!
Regards, Dalek
.
250 2.0.0 r7NJYAEI028071 Message accepted for delivery
QUIT
221 2.0.0 mail.tardis.edu closing connection
```

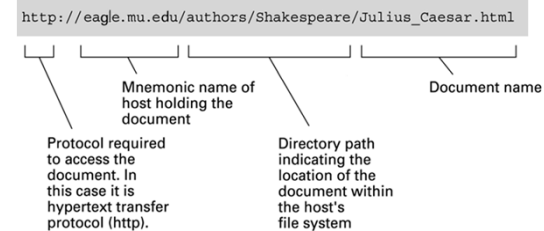
More Recent Applications

- Voice Over IP (VoIP)
- Internet Multimedia Streaming
 - N-unicast
 - Multicast
 - On-demand streaming
 - Content delivery networks (CDNs)

World Wide Web

- **Hypertext** combines internet technology with concept of linked-documents
 - Embeds **hyperlinks** to other documents
- **Browsers** present materials to the user
- **Webservers** provide access to documents
- Documents are identified by **URLs** and transferred using **HTTP**

Figure 4.8 A typical URL



Hypertext Markup Language (HTML)

- 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
 -
 - Insert images
 -

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Figure 4.9 A simple webpage

a. The page encoded using HTML.

| | | |
|--|---|-------------------------------------|
| Tag indicating beginning of document | { | <html> |
| | | <head> |
| Preliminaries | { | <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> |

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Figure 4.9 A simple webpage (continued)

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



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Figure 4.10 An enhanced simple webpage

a. The page encoded using HTML.

| | | |
|---------------------------------|---|--|
| | { | <html> |
| | | <head> |
| | | <title>demonstration page</title> |
| | | </head> |
| | | <body> |
| | | <h1>My Web Page</h1> |
| | | <p>Click |
| Anchor tag containing parameter | { | |
| | | here |
| Closing anchor tag | { | |
| | | for another page.</p> |
| | | </body> |
| | | </html> |

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Figure 4.10 An enhanced simple Web page (continued)

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



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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

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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>
```

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



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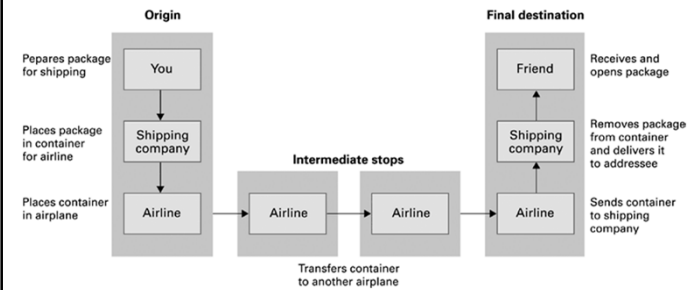
Client Side Versus Server Side

- Client-side activities
 - Javascript
 - Macromedia Flash
- Server-side activities
 - Common Gateway Interface (CGI)
 - Servlets
 - JavaServer Pages (JSP) / Active Server Pages (ASP)
 - PHP

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Figure 4.12 Package-shipping example



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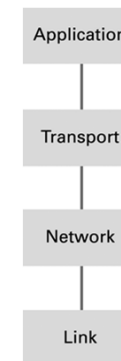
Internet Software Layers

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

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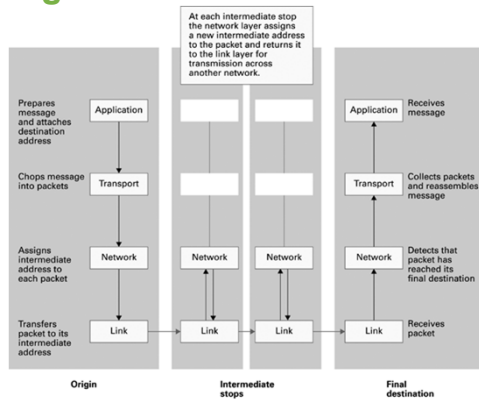
Figure 4.13 The Internet software layers



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Figure 4.14 Following a message through the Internet



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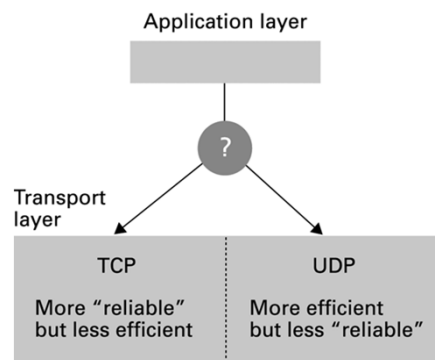
TCP/IP Protocol Suite

- Transport Layer
 - Transmission Control Protocol (TCP)
 - User Datagram Protocol (UDP)
- Network Layer
 - Internet Protocol (IP)
 - IPv4
 - IPv6

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Figure 4.15 Choosing between TCP and UDP



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Security

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

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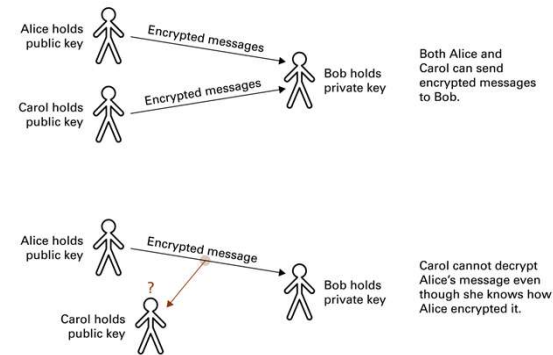
Encryption

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

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Figure 4.16 Public-key encryption



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