IT101- Introduction to Computing

Lect. 5: Networking and the Internet

Spring 2018

Networking and the Internet

1. Network Fundamentals
2. The Internet
3. The World Wide Web
4. Internet protocols
5. Security

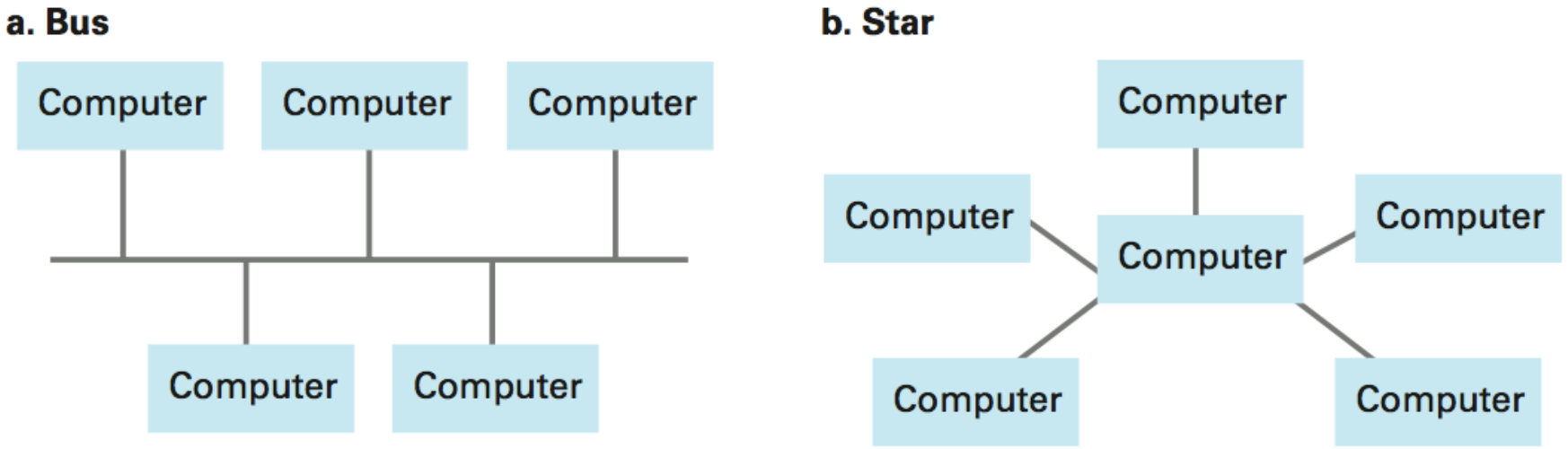
1. Network Fundamentals

Network Classifications

Scope

- Personal area network (PAN)
- Local area network (LAN)
- Metropolitan area (MAN)
- Wide area network (WAN)
- Internet

Network topology: bus vs. star



Protocols

Definition: A set of rules that defines how data is formatted and processed on a network

CSMA/CD

- Used in Ethernet

CSMA/CA

- Used in WiFi

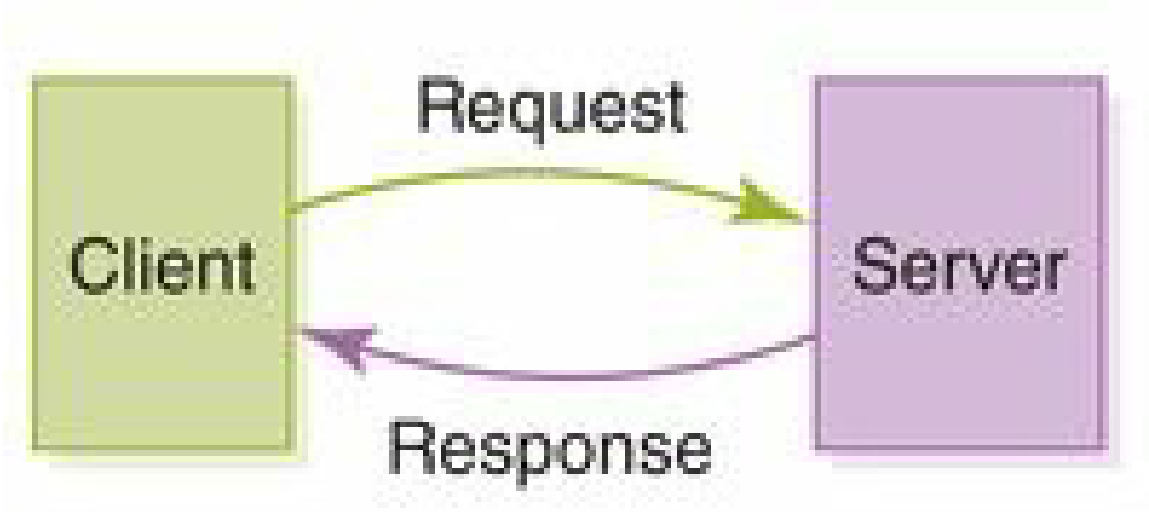
Open vs. close

Open system: A system that is based on a common model of network architecture and an accompanying suite of protocols

Proprietary system: A system that uses technologies kept private by a particular commercial vendor

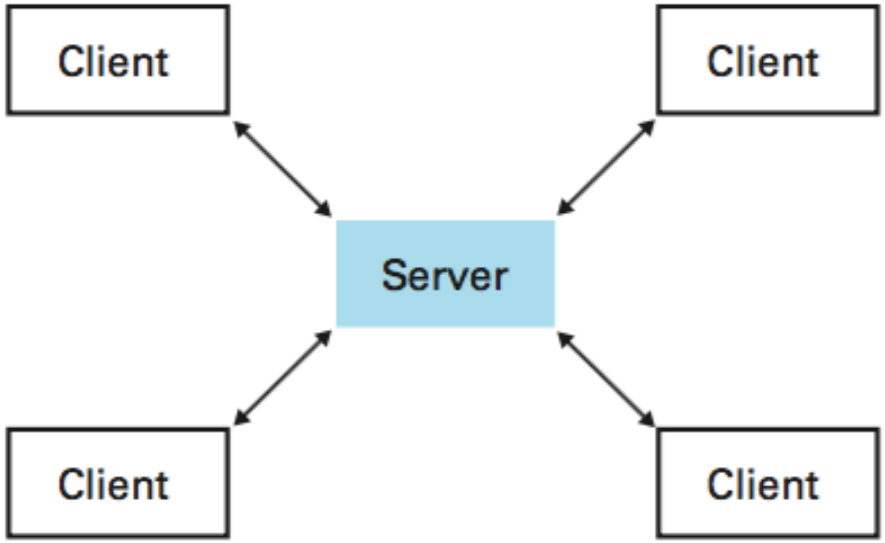
=> Interoperability: The ability of software and hardware on multiple machines and from multiple commercial vendors to communicate

Client – server architecture

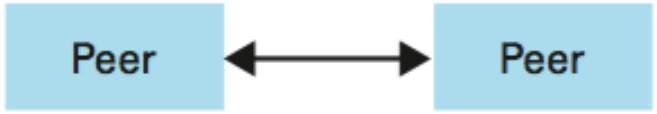


File server
Web server

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

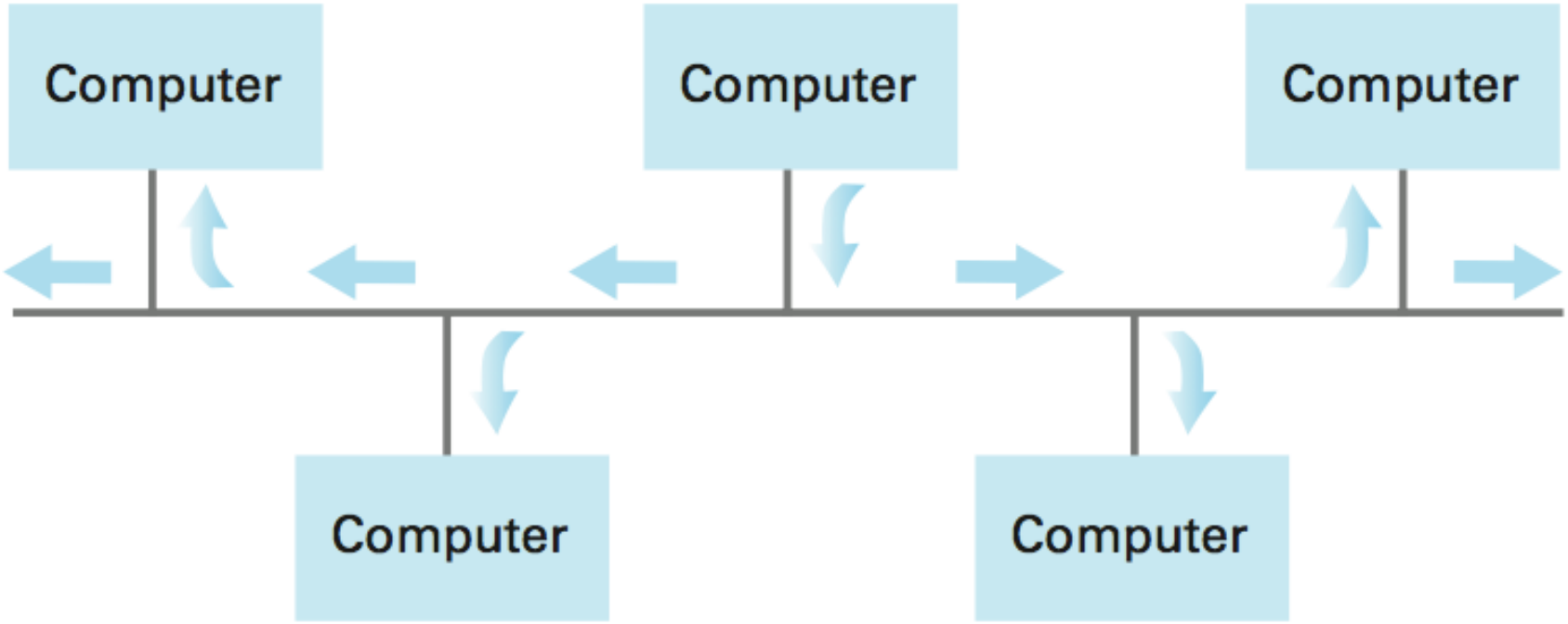


a. Server must be prepared to serve multiple clients at any time.



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

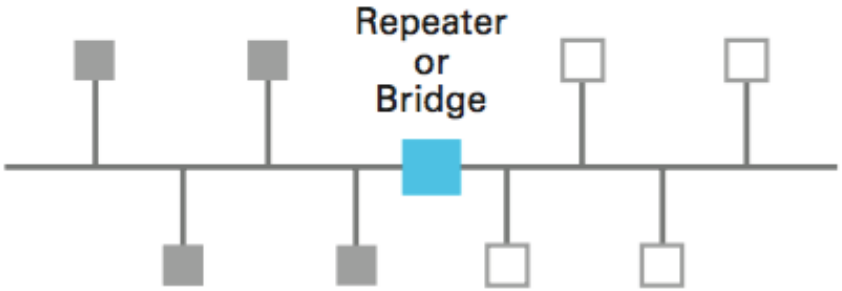
Communication over a bus network



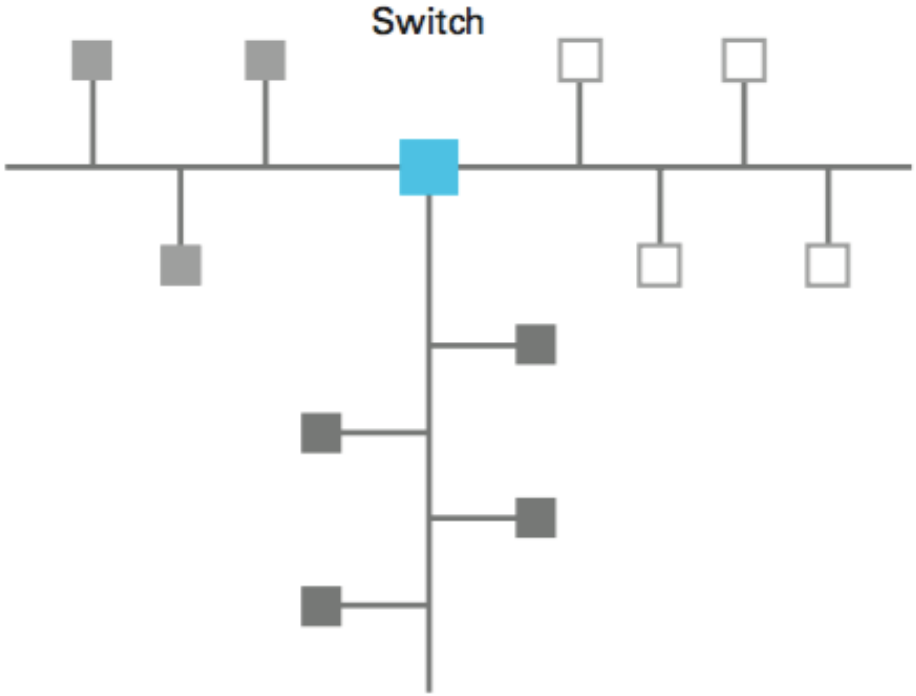
Connecting Networks

- **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**

Building a large bus network from smaller ones

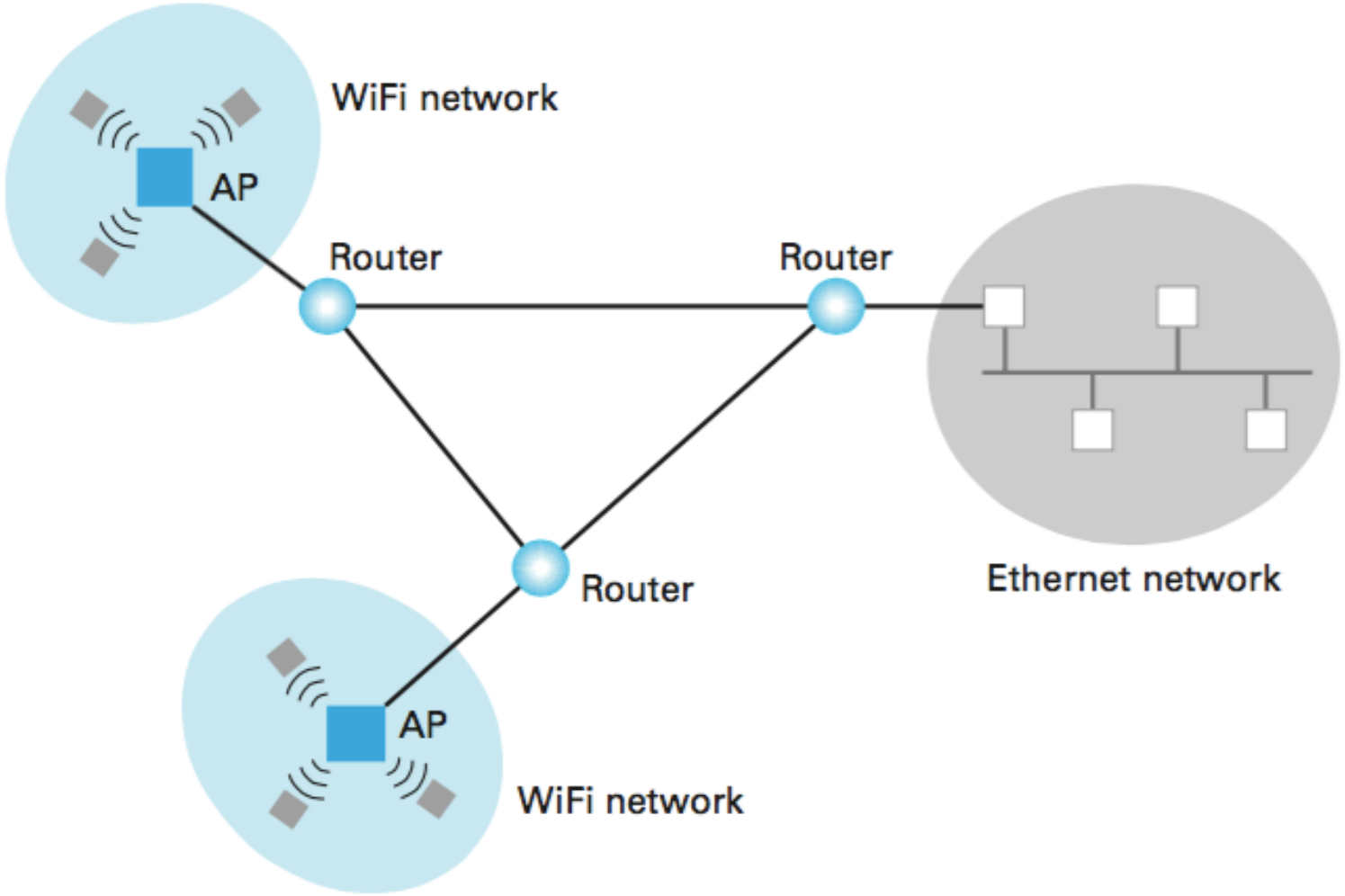


a. A repeater or bridge connecting two buses



b. A switch connecting multiple buses

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



Wireless / mobile connections

- Bluetooth
- Zigbee
- RFID
- Wifi IEEE 802.11 g, n, ac
- 3G / 4G / 5G mobile conncetions

Client / server vs. peer-to-peer (P2P)

Client-server

- One server, many clients
- Server must execute continuously
- Client initiates communication

Peer-to-peer (P2P)

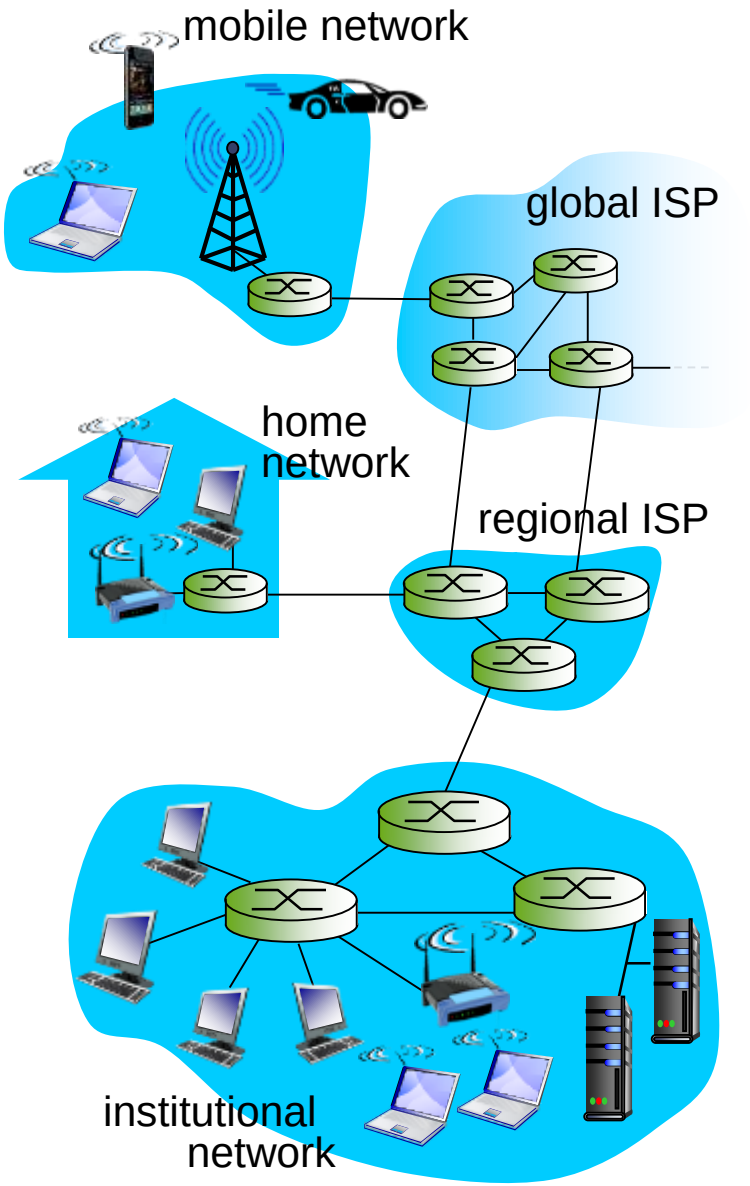
- Two processes communicating as equals
- Peer processes can be short-lived

2. The Internet

Home-works

1. Bluetooth version 4 and RFID technologies: application, features, network architecture, ...

2. Compare and contrast 3G, 4G and 5G mobile networks.


mobile network
global ISP
home
network
regional ISP
institutional
network

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
- Test with tracert, ping commands

Internet Architecture

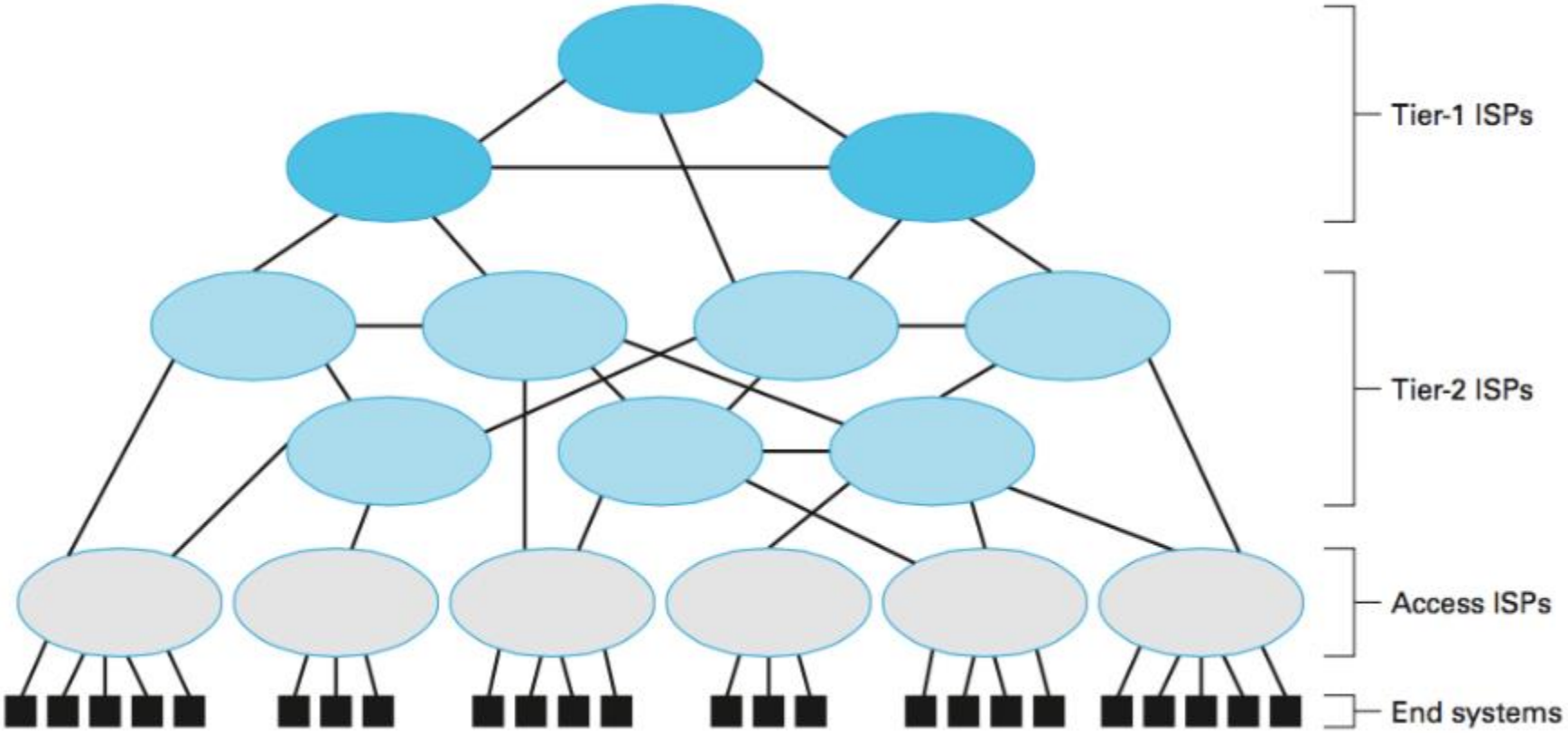
Internet Service Provider (ISP)

- 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

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.

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 outing mail
  - Mail server delivers collected incoming mail to clients via POP3 or IMAP

SMTP Simple Mail Transfer Protocol

```
1  220 mail.tardis.edu SMTP Sendmail Gallifrey-1.0; Fri, 23
     Aug 2413 14:34:10
2  HELO mail.skaro.gov
3  250 mail.tardis.edu Hello mail.skaro.gov, pleased to meet you
4  MAIL From: dalek@skaro.gov
5  250 2.1.0 dalek@skaro.gov... Sender ok
6  RCPT To: doctor@tardis.edu
7  250 2.1.5 doctor@tardis.edu... Recipient ok
8  DATA
9  354 Enter mail, end with "." on a line by itself
10 Subject: Extermination.
11
12 EXTERMINATE!
13 Regards, Dalek
14 .
15 250 2.0.0 r7NJYAEl028071 Message accepted for delivery
16 QUIT
17 221 2.0.0 mail.tardis.edu closing connection
```

More Recent Applications

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

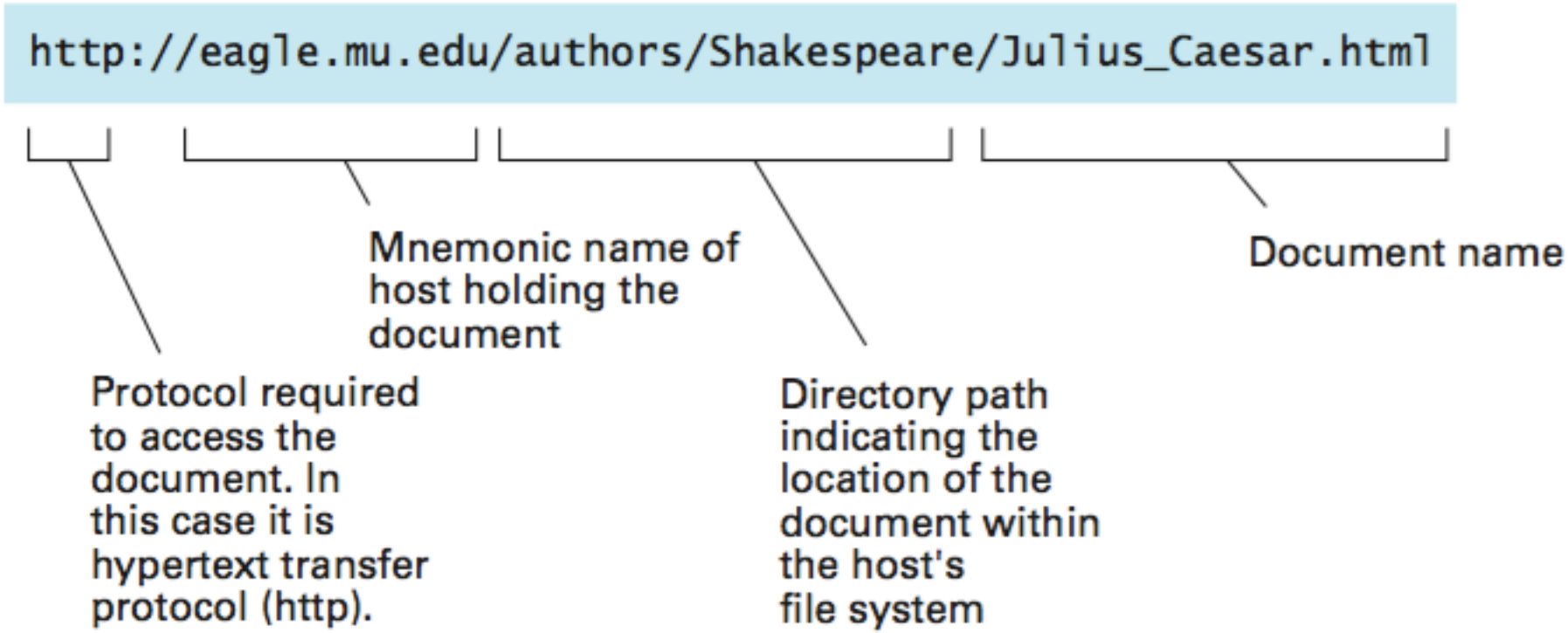
3 The World Wide Web

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 **URL**s and transferred using **HTTP**

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
    - <a href = . . . >
  - Insert images
    - <img src = . . . >

A simple webpage

a. The page encoded using HTML.

A simple webpage (continued)

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

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
   <a href="http://crafty.com/demo.html">
   here
   </a>
   for another page.</p>
</body>
</html>
```

Anchor tag containing parameter

Closing anchor tag

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>

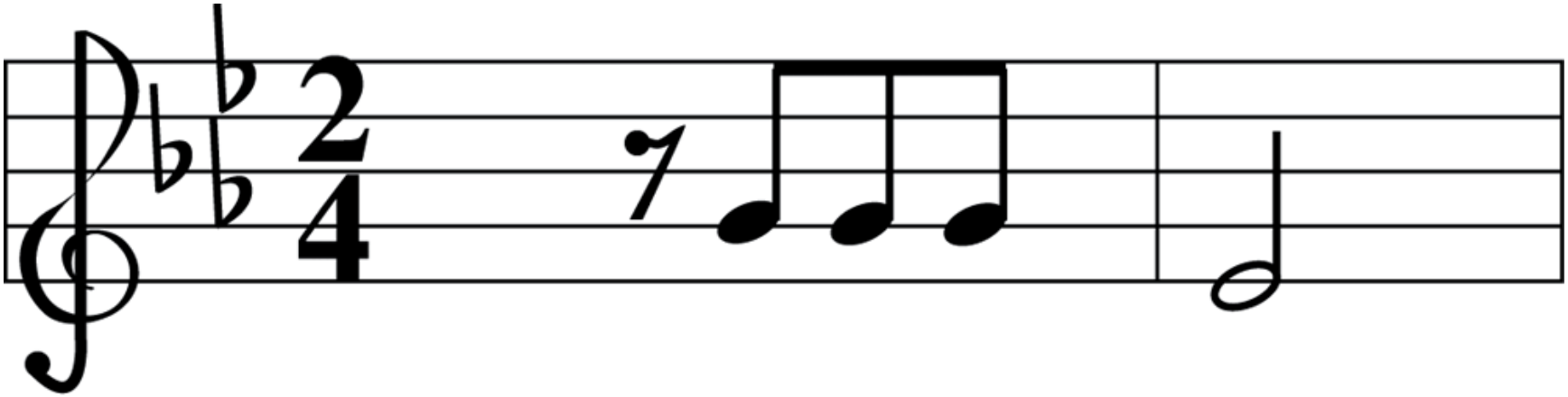
<time> 2/4 </time>

<measure> < rest> egth </rest> <notes> egth G, egth G, egth G
</notes></measure>

<measure> <notes> hlf E </notes></measure>

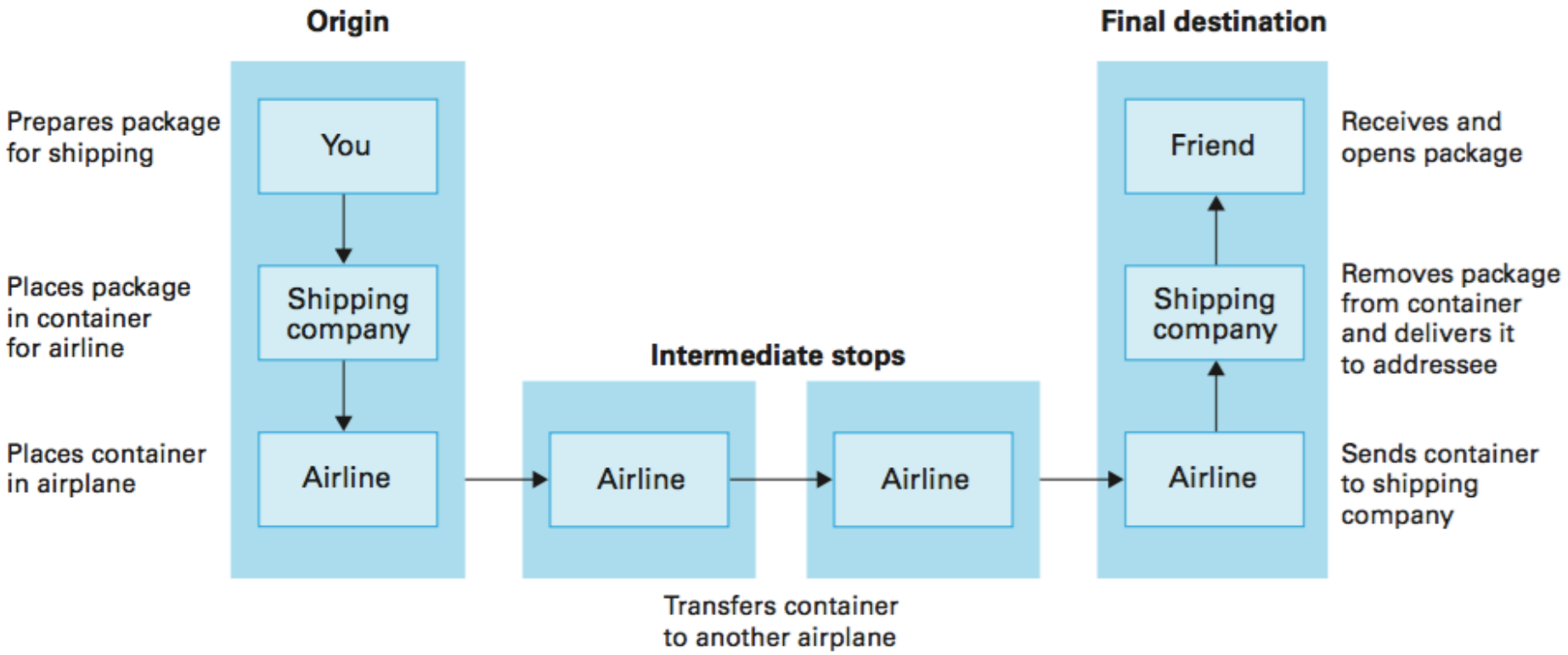
</staff>

The first two bars of Beethoven's Fifth Symphony



4 Internet Protocols

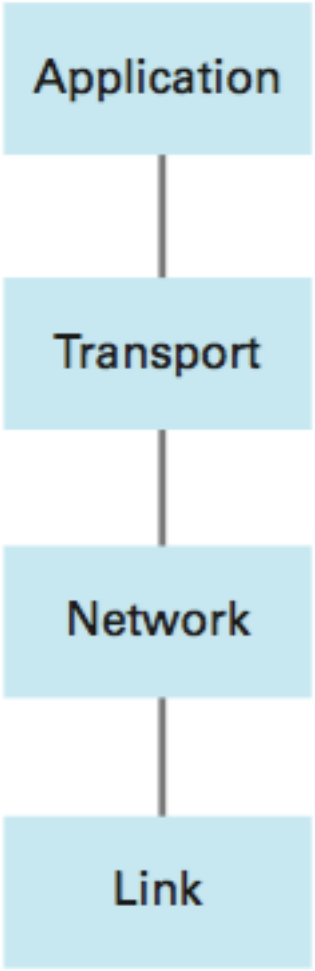
Package-shipping example



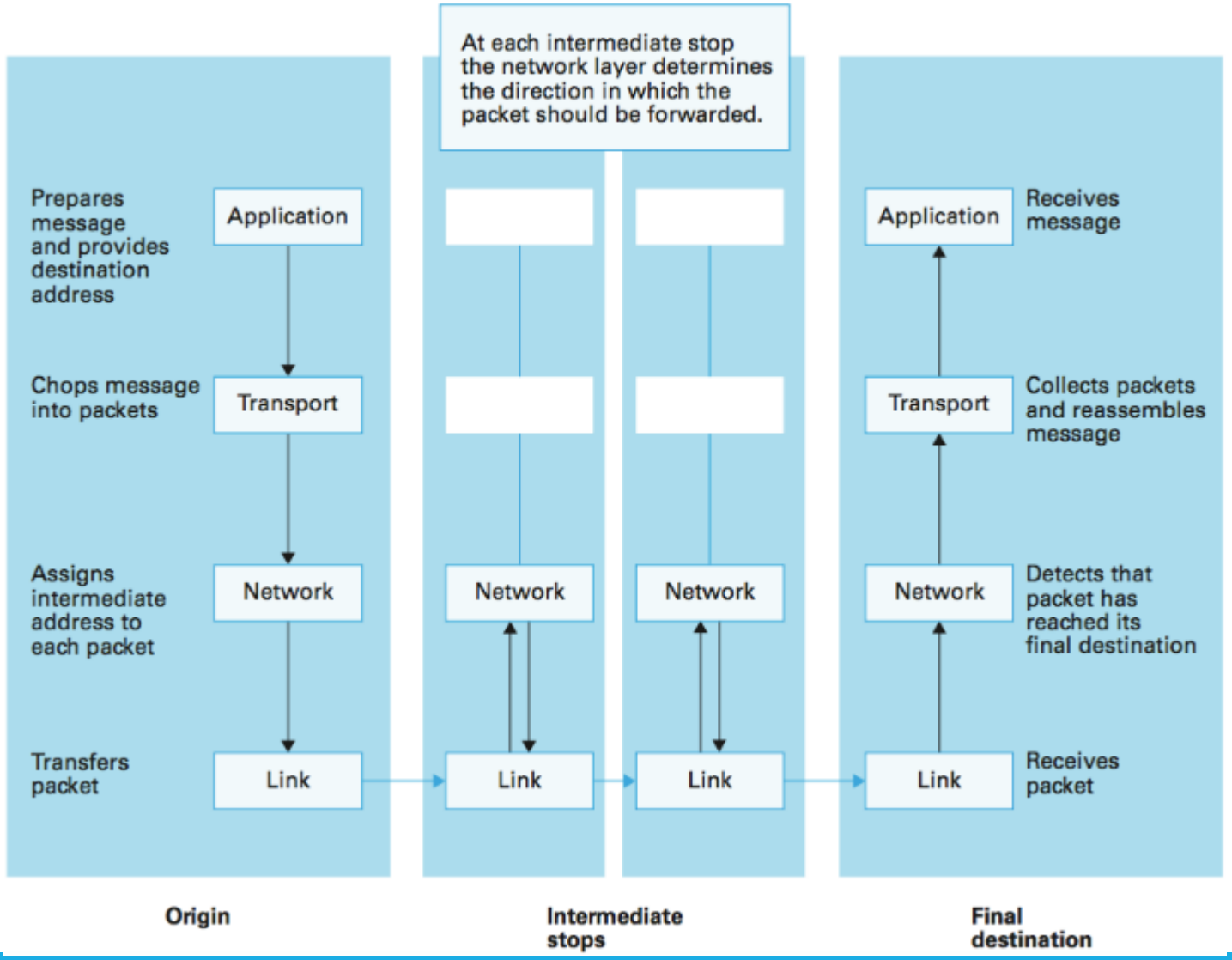
Internet Software Layers

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

The Internet software layers



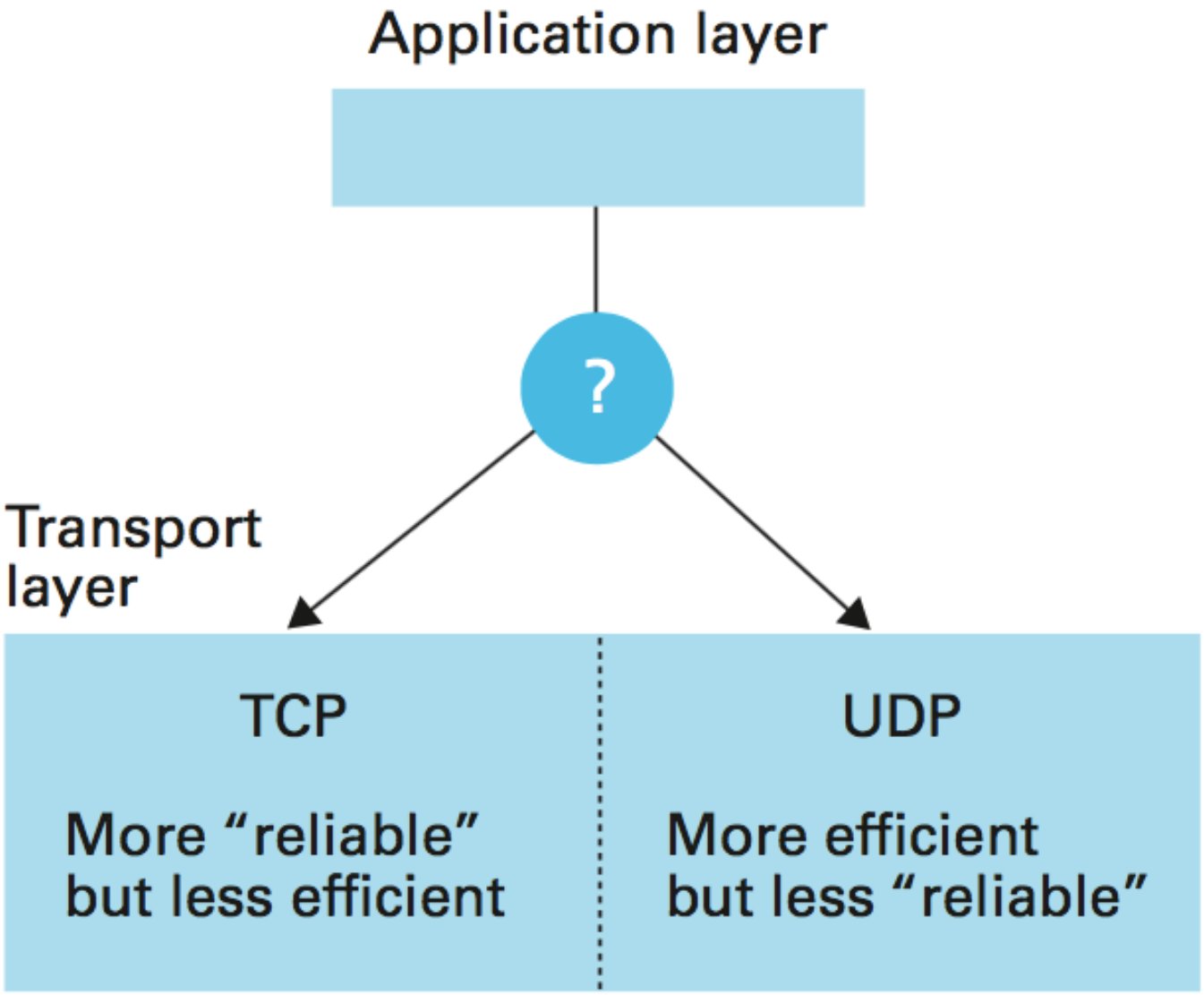
Following a message through the Internet



TCP/IP Protocol Suite

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

Choosing between TCP and UDP



5. Security

Security

Attacks

- Malware (viruses, worms, Trojan horses, spyware, phishing software)
- Denial of service (DoS)
- Spam

Protection

- Firewalls
- Spam filters
- Proxy Servers
- Antivirus software

Encryption

HTTPS and SSL

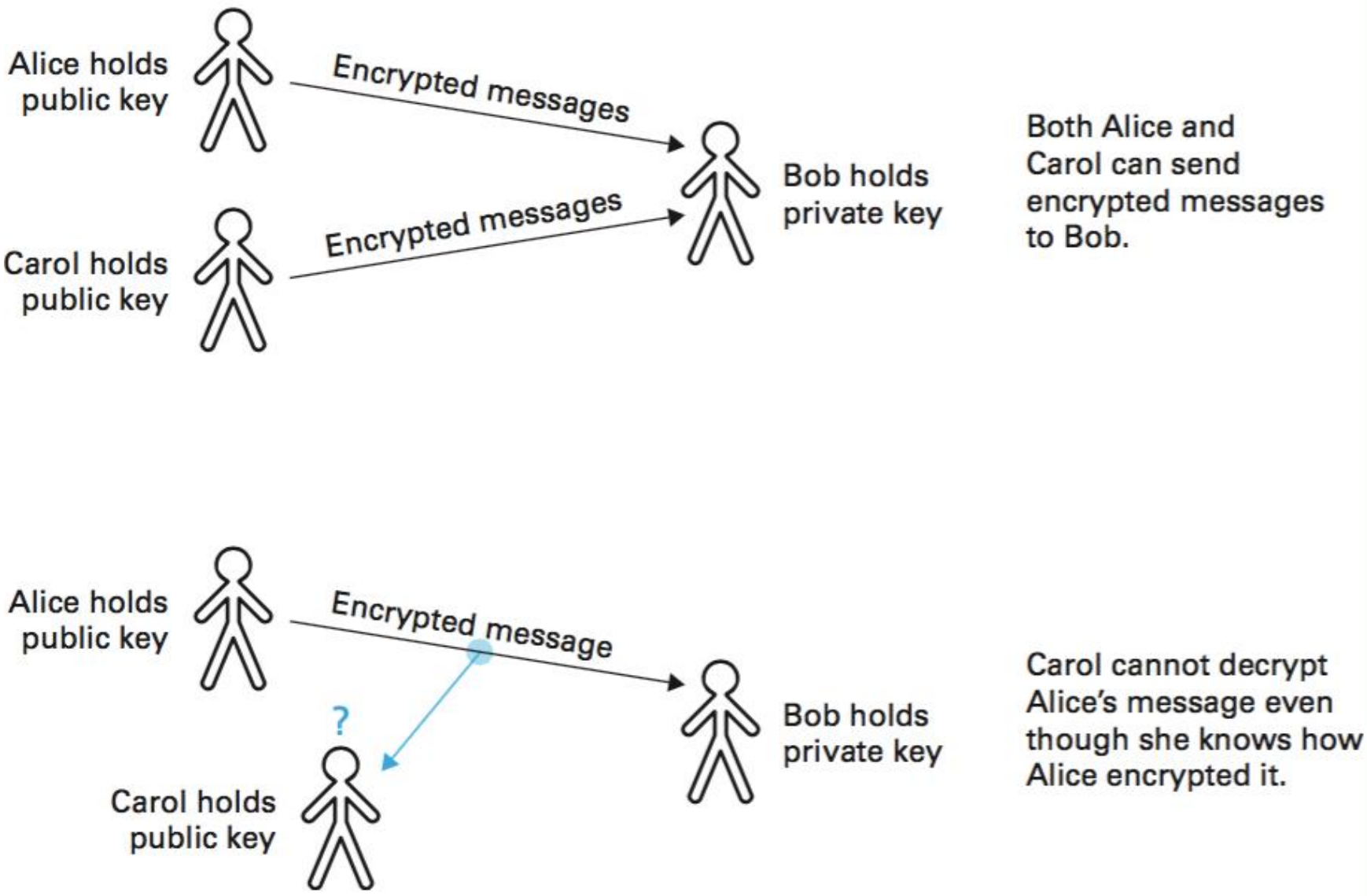
Public-key Encryption

- Public key: Used to encrypt messages
- Private key: Used to decrypt messages

Certificates and Digital Signatures

- Certificate authorities

Public-key encryption



Thank you!