computer science

illuminated

Networks

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(adaptation by Michael Goldwasser)

Chapter Goals

- Describe the core issues related to computer networks
- List various types of networks and their characteristics
- Explain various topologies of local-area networks
- Explain why network technologies are best implemented as open systems

Chapter Goals (cont.)

- Compare and contrast various technologies for home Internet connections
- Explain packet switching
- Describe the basic roles of various network protocols
- Explain the role of a firewall
- Compare and contrast network hostnames and IP addresses
- Explain the domain name system

Networking

- A **computer network** is a collection of computing devices that are connected in various ways in order to communicate and share resources
- Usually, the connections between computers in a network are made using physical wires or cables
  - However, some connections are **wireless**, using radio waves or infrared signals

Networking

- The generic term **node** or **host** to refer to any device on a network

- A key issue related to computer networks is the **data transfer rate**, the speed with which data is moved from one place on a network to another

Networking

- Computer networks have opened up an entire frontier in the world of computing called the **client/server model**

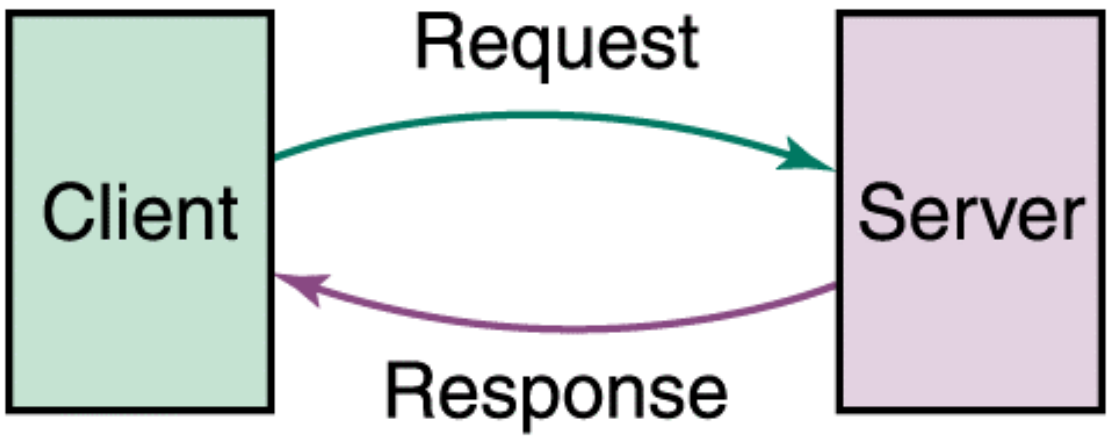

Figure 15.1 Client/Server interaction

Networking

- A **file server** is a computer that stores and manages files for multiple users on a network
- A **Web server** is a computer dedicated to responding to requests (from the browser client) for Web pages

Types of Networks

- A **local-area network (LAN)** connects a relatively small number of machines in a relatively close geographical area

Types of Networks

- Various configurations, called topologies, have been used to administer LANs
  - A **ring topology** connects all nodes in a closed loop on which messages travel in one direction
  - A **star topology** centers around one node to which all others are connected and through which all messages are sent
  - In a **bus topology**, all nodes are connected to a single communication line that carries messages in both directions

Types of Networks

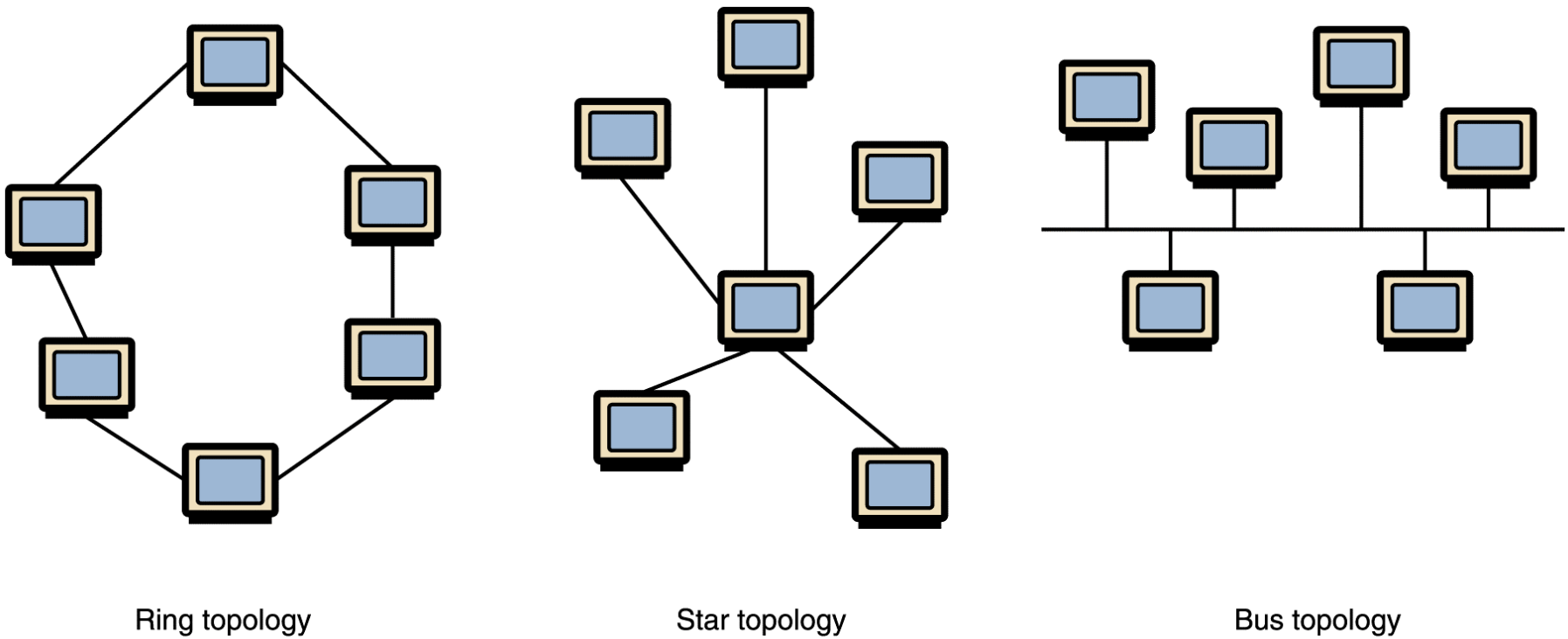

Figure 15.2 **Various network topologies**

- A bus technology called **Ethernet** has become the industry standard for local-area networks

Types of Networks

- A **wide-area network (WAN)** connects two or more local-area networks over a potentially large geographic distance
  - Often one particular node on a LAN is set up to serve as a **gateway** to handle all communication going between that LAN and other networks
- Communication between networks is called internetworking
  - The **Internet,** as we know it today, is essentially the ultimate wide-area network, spanning the entire globe

Types of Networks

- Recently, the term **metropolitan-area network (MAN)** has been adopted to refer to the communication infrastructures that have been developed in and around large cities

Types of Networks

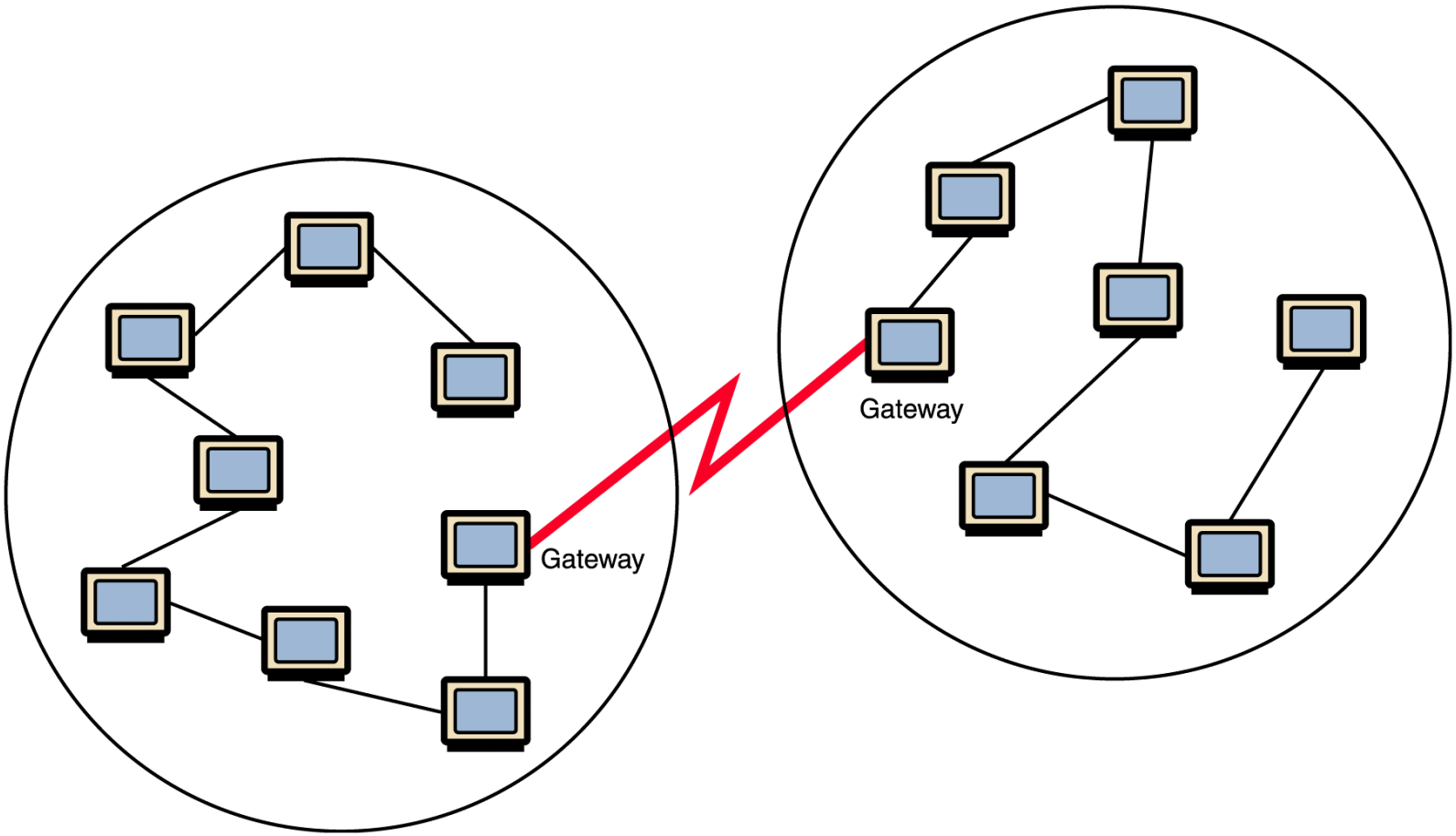

Figure 15.1 **Local-area networks connected across a distance to create a wide-area network**

Internet Connections

- The **Internet backbone** is a term used to refer to a set of high-speed networks that carry Internet traffic
- These networks are provided by companies such as AT&T, GTE, and IBM
- An **Internet service provider (ISP)** is a company that provides other companies or individuals with access to the Internet

Internet Connections

- There are various technologies available that you can use to connect a home computer to the Internet
  - A **phone modem** converts computer data into an analog audio signal for transfer over a telephone line, and then a modem at the destination converts it back again into data
  - A **digital subscriber line (DSL)** uses regular copper phone lines to transfer digital data to and from the phone company's central office
  - **Cable modem**—in this approach, the data is transferred on the same line that your cable TV signals come in on

Internet Connections

- Both DSL connections and cable modems fall under the category of **broadband** connections, which generally mean speeds faster than 128 kilobytes per second
- For both DSL and cable modems, the speed for **downloads** (getting data from the Internet to your home computer) may not be the same as **uploads** (sending data from your home computer to the Internet)

Packet Switching

- To improve the efficiency of transferring information over a shared communication line, messages are divided into fixed-sized, numbered **packets**
- Network devices called routers are used to direct packets between networks

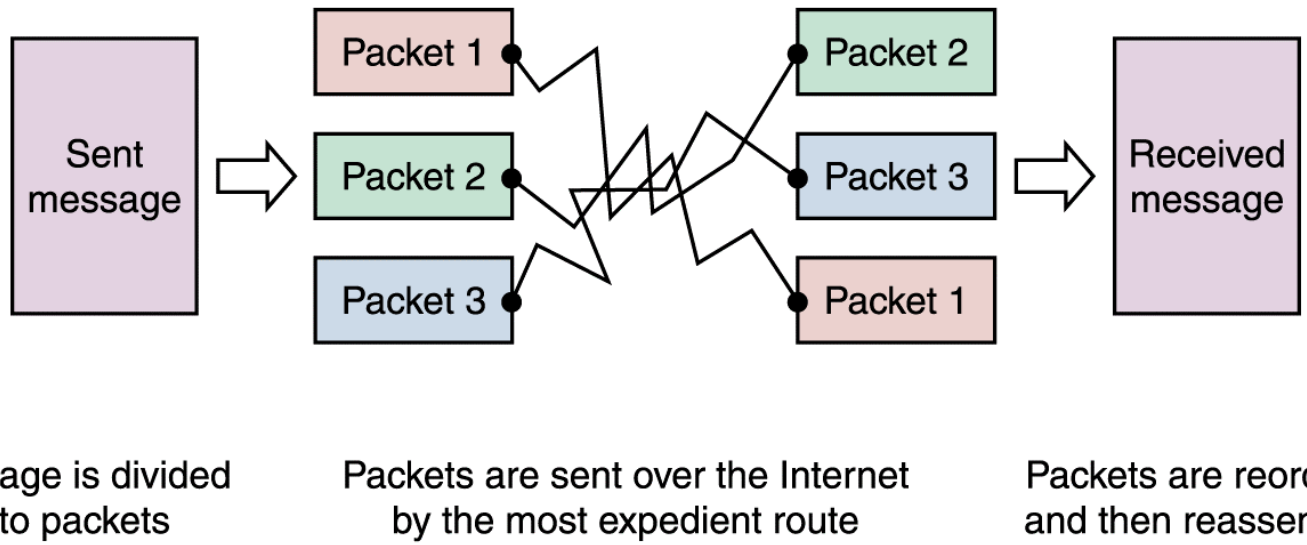

Figure 15.4 Messages sent by packet switching

Open Systems

- As network technologies grew, the need for **interoperability** became clear
- We needed a way for computing systems made by different vendors to communicate
- An **open system** is one based on a common model of network architecture and a suite of protocols used in its implementation

Open Systems

7	Application layer
6	Presentation layer
5	Session layer
4	Transport layer
3	Network layer
2	Data Link layer
1	Physical layer

Figure 15.5 **The layers of the OSI Reference Model**

- The International Organization for Standardization (ISO) established the **Open Systems Interconnection (OSI) Reference Model**
- Each layer deals with a particular aspect of network communication

Network Protocols

- Network protocols are layered such that each one relies on the protocols that underlie it
- Sometimes referred to as a **protocol stack**

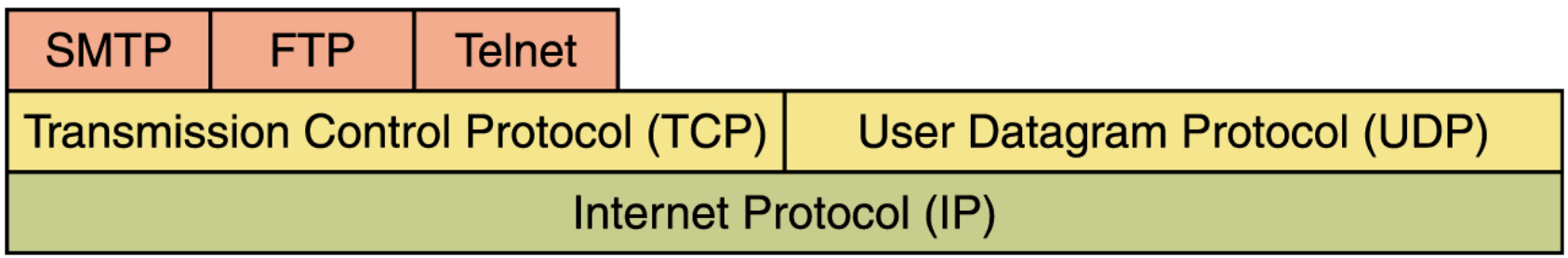

Figure 15.6 **Layering of key network protocols**

TCP/IP

- IP stands for **Internet Protocol**
  - IP software deals with the routing of packets through the maze of interconnected networks to their final destination
- TCP stands for **Transmission Control Protocol**
  - TCP software breaks messages into packets, hands them off to the IP software for delivery, and then orders and reassembles the packets at their destination

TCP/IP (cont.)

- UDP stands for **User Datagram Protocol**
  - It is an alternative to TCP
  - The main difference is that TCP is highly reliable, at the cost of decreased performance, while UDP is less reliable, but generally faster

High-Level Protocols

- Other protocols build on the foundation established by the TCP/IP protocol suite
  - Simple Mail Transfer Protocol (SMTP)
  - File Transfer Protocol (FTP)
  - Telnet
  - Hyper Text Transfer Protocol (http)

Protocols & Ports

Protocol	Port
Echo	7
File Transfer Protocol (FTP)	21
Telnet	23
Simple Mail Transfer Protocol (SMTP)	25
Domain Name Service (DNS)	53
Gopher	70
Finger	79
Hyper Text Transfer Protocol (HTTP)	80
Post Office Protocol (POP3)	110
Network News Transfer Protocol (NNTP)	119
Internet Relay Chat (IRC)	6667

Figure 15.7
Some protocols and the ports they use

MIME Types

- Related to the idea of network protocols and standardization is the concept of a file's MIME type
  - MIME stands for **Multipurpose Internet Mail Extension**
  - Based on a document's MIME type, an application program can decide how to deal with the data it is given

Firewalls

- A **firewall** is a machine and its software that serve as a special gateway to a network, protecting it from inappropriate access
  - Filters the network traffic that comes in, checking the validity of the messages as much as possible and perhaps denying some messages altogether
  - Enforces an organization's **access control policy**

Firewalls

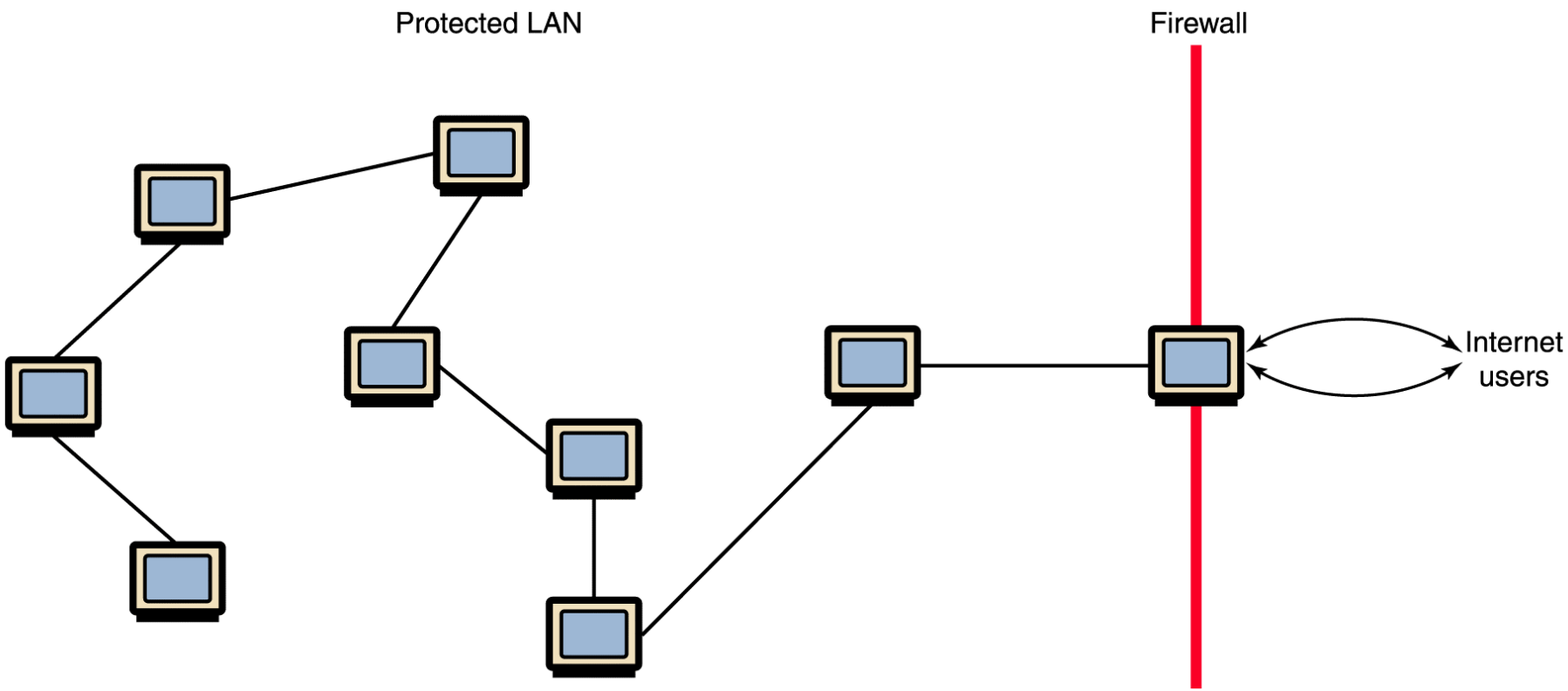

Figure 15.8 **A firewall protecting a LAN**

Network Addresses

- A **hostname** is a unique identification that specifies a particular computer on the Internet
- For example

  matisse.csc.villanova.edu

  condor.develocorp.com

Network Addresses

- Network software translates a hostname into its corresponding IP address
- For example

  205.39.145.18

Network Addresses

- An **IP address** can be split into
  - **network address**, which specifies a specific network
  - **host number**, which specifies a particular machine in that network

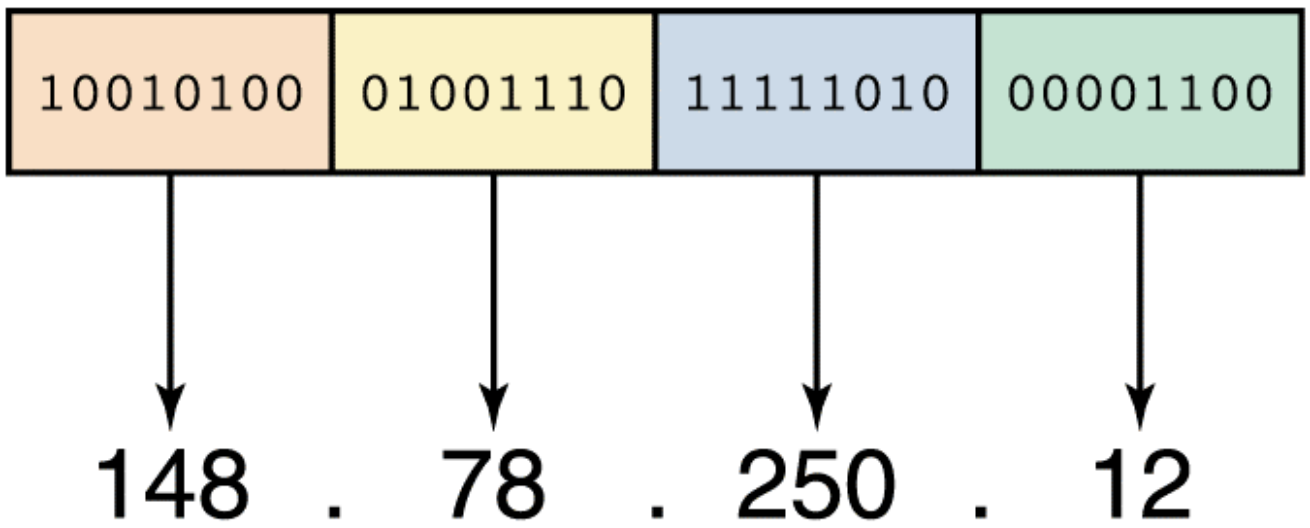

Figure 15.9
An IP address is stored in four bytes

Domain Name System

- A hostname consists of the computer name followed by **the domain name**
- csc.villanova.edu is the domain name
  - A domain name is separated into two or more sections that specify the organization, and possibly a subset of an organization, of which the computer is a part
  - Two organizations can have a computer named the same thing because the domain name makes it clear which one is being referred to

Domain Name System

- The very last section of the domain is called its **top-level domain (TLD)** name

Top-Level Domain	General Purpose	New TLDs	General Purpose
.com	U.S. Commercial	.biz	Business
.net	Network	.info	Information
.org	Nonprofit organization	.pro	Professional
.edu	U.S. Educational	.museum	Museums
.int	International	.aero	Aerospace industry
.mil	U.S. Military	.coop	Cooperative
.gov	U.S. Government		

Figure 15.10 **Top-level domains, including some relatively new ones**

Domain Name System

- Organizations based in countries other than the United States use a top-level domain that corresponds to their two-letter country codes

Country Code TLD	Country
.au	Australia
.br	Brazil
.ca	Canada
.gr	Greece
.in	India
.ru	Russian Federation
.uk	United Kingdom

Figure 15.11
Some of the top-level domain names based on country codes

Domain Name System

- The **domain name system** (DNS) is chiefly used to translate hostnames into numeric IP addresses
  - DNS is an example of a distributed database
  - If that server can resolve the hostname, it does so
  - If not, that server asks another domain name server

Ethical Issues: Cybersquatting

- Cybersquatting refers to registering an Internet domain name for the purpose of selling it later
- The Anti-cyber Piracy Act establishes that someone registering a domain name may be liable to the owner of a trademark or to others that may be affected by the “bad faith” of the domain name registrant

Ethical Issues: Cybersquatting

- In 1998 the Internet Corporation for Assigned Names and Numbers (ICANN), a technical coordination body for the Internet, issued the Uniform Domain-Name Dispute-Resolution Policy

  "Under the policy, most types of trademark-based domain-name disputes must be resolved by agreement, court action, or arbitration before a registrar will cancel, suspend, or transfer a domain name…"