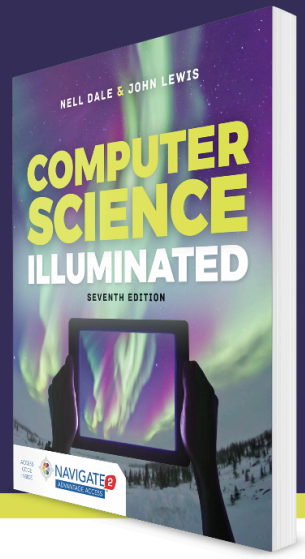


CHAPTER 15
LECTURE OUTLINE

Computer Science Illuminated, Seventh Edition

Nell Dale, PhD; John Lewis, PhD

Networks

15.1 Networking

- Types of Networks
- Internet Connections
- Packet Switching

15.2 Open Systems and Protocols

- Open Systems
- Network Protocols
- TCP/IP
- High-Level Protocols
- MIME Types
- Firewalls

15.3 Network Addresses

- Domain Name System
- Who Controls the Internet?

15.4 Cloud Computing

15.5 Blockchain

Credits

Nell Dell, PhD & John Lewis, PhD
Authors

Jones & Bartlett Learning
Publisher

Eric Pogue
Audio commentary plus slides with the grey backgrounds

Chapter Goals (1 of 2)

- 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
- Compare and contrast various technologies for home Internet connections

Chapter Goals (2 of 2)

- 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
- Describe cloud computing and its benefits

Networking (1 of 4)

Computer Network

A collection of computing devices connected in order to communicate and share resources

Connections between computing devices can be physical, using wires or cables, or wireless, using radio waves or infrared signals

Can you name some of the devices in a computer network?

Networking (2 of 4)

Node (host)

Any device on a network

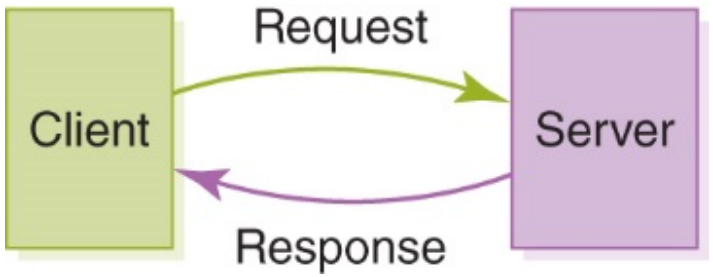
Data Transfer Rate (bandwidth)

The speed with which data is moved from one place to another on a network

Why is bandwidth so key?

Networking (3 of 4)

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



Client/server interaction

Networking (4 of 4)

Protocol

A set of rules that defines how data are formatted and processed on a network

File Server

A computer dedicated to storing and managing files for network users

Web Server

A computer dedicated to responding to requests for web pages

P2P Model

A decentralized approach that shares resources and responsibilities among many “peer” computers

Types of Networks (1 of 5)

Local-Area Network (LAN)

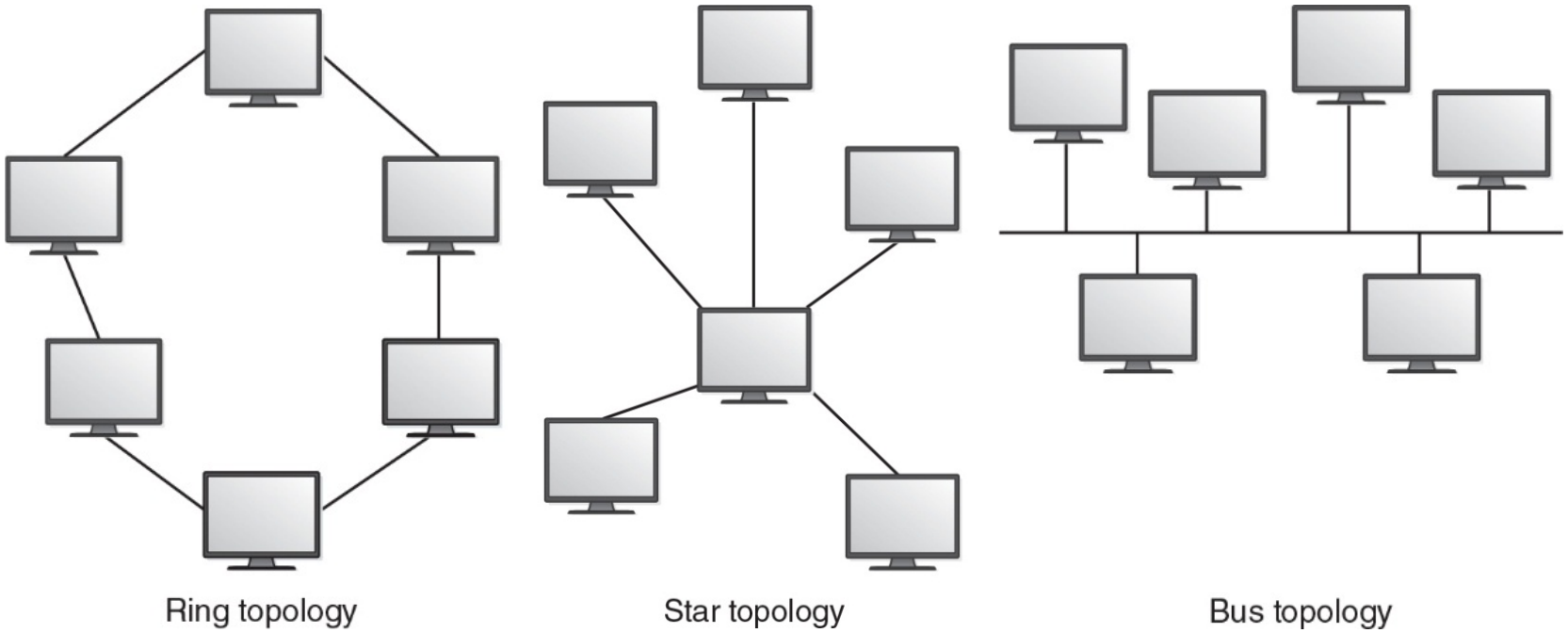
A network that connects a relatively small number of machines in a relatively close geographical area

Ring Topology Connects all nodes in a closed loop on which messages travel in one direction

Star Topology Centers around one node to which all others are connected and through which all messages are sent

Bus Topology Nodes are connected to a single communication line that carries messages in both directions

Types of Networks (2 of 5)



Network topologies

Types of Networks (3 of 5)

Wide-Area Network (WAN)

A network that connects local-area networks over a potentially large geographic distance

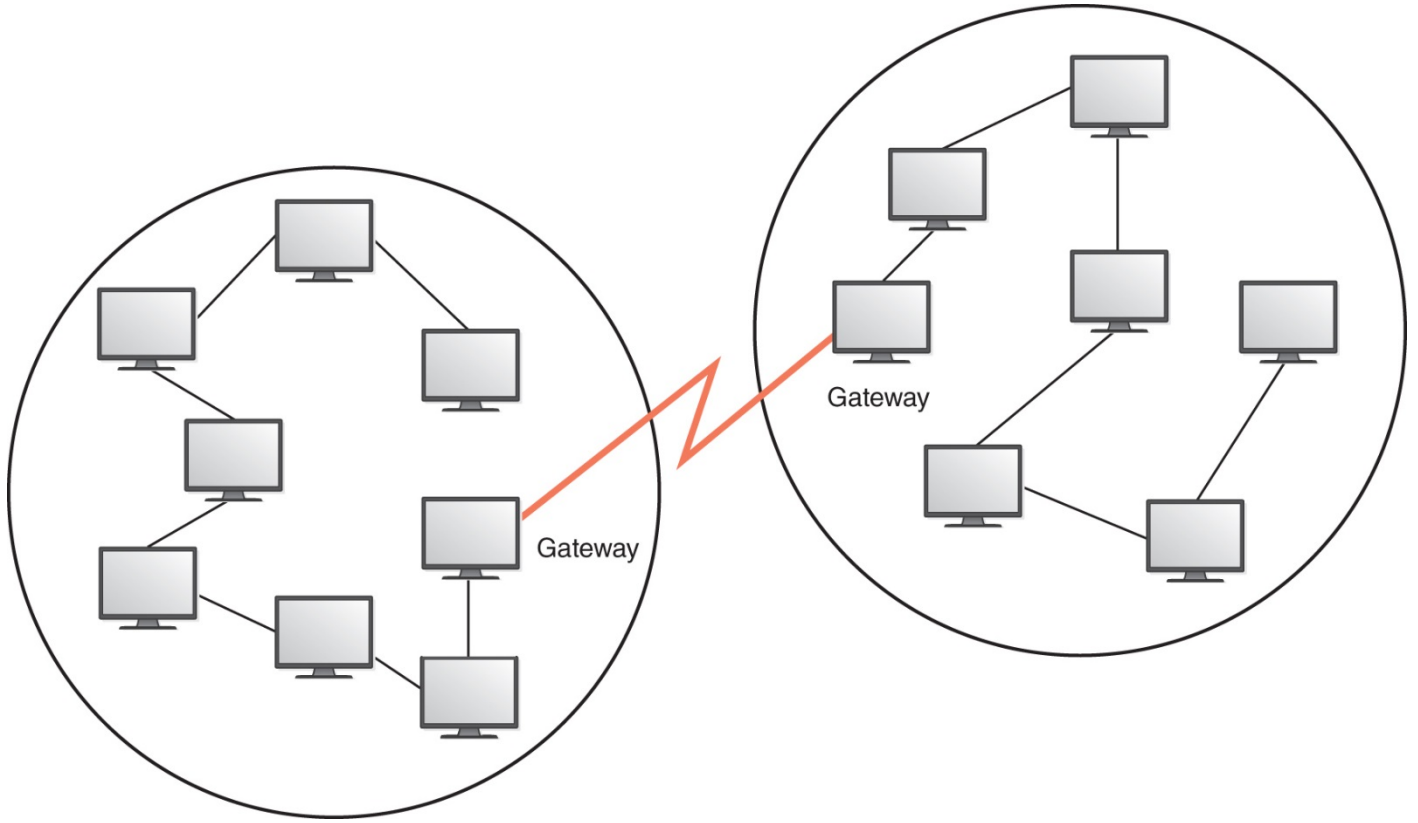
Metropolitan-Area Network (MAN)

The communication infrastructures that have been developed in and around large cities

Gateway

One particular set up to handle all communication going between that LAN and other networks

Types of Networks (4 of 5)



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

Types of Networks (5 of 5)

Internet

A wide-area network that spans the planet

Internet Connections (1 of 4)

Wireless Network

A network in which devices communicate with other nodes through a wireless access point

Bluetooth

A technology used for wireless communication over short distances

Internet Connections (2 of 4)

Latency

The time between the transmission and its receipt

Internet Backbone

A set of high-speed networks that carry Internet traffic, provided by companies such as AT&T, Verizon, GTE, British Telecom, and IBM

Internet Service Provider (ISP)

An organization providing access to the Internet

Internet Connections (3 of 4)

Phone modem (historical) 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

Digital subscriber line (DSL) uses regular copper phone lines to transfer digital data to and from the phone company's central office

Cable modem uses the same line that your cable TV signals come in on to transfer the data

Internet Connections (4 of 4)

Broadband

A connection in which transfer speeds are at least 25 megabits per second (Mbps)

- DSL connections and cable modems are broadband connections
- The speed for **downloads** (getting data from the Internet to your home computer) are usually not the same as **uploads** (sending data from your home computer to the Internet)

Packet Switching (1 of 2)

Packet

A unit of data sent across a network

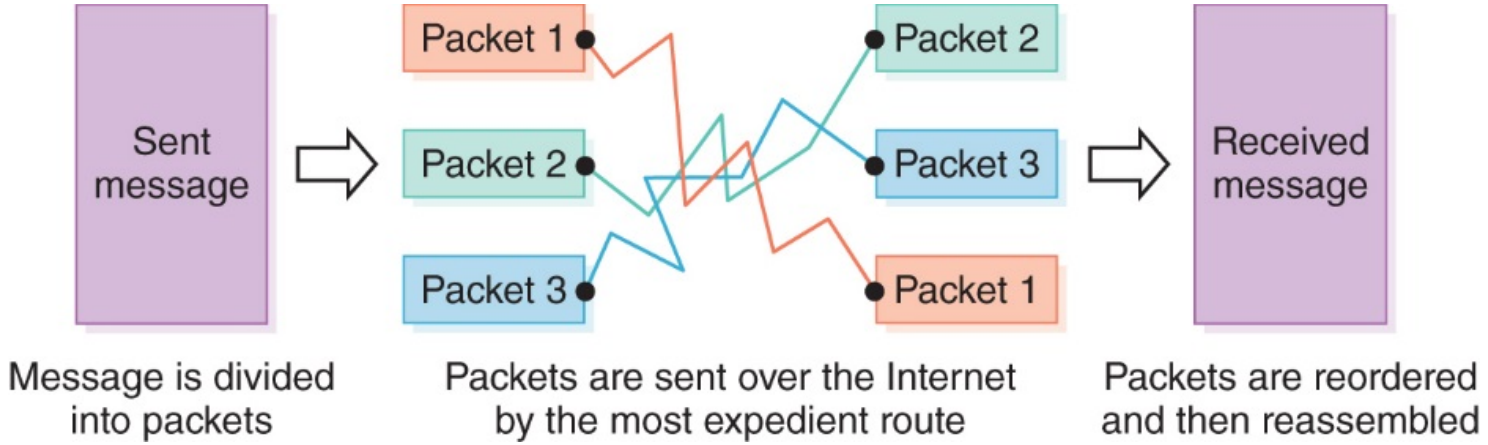
Router

A network device that directs a packet between networks toward its final destination

Packet Switching

Messages are divided into fixed-sized, numbered packets; packets are individually routed to their destination, then reassembled

Packet Switching (2 of 2)



Messages sent by packet switching

Take a message, break it into three packets, and simulate this process

Open Systems (1 of 2)

A logical progression...

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

Open Systems

Systems based on a common model of network architecture and a suite of protocols used in its implementation

Open Systems (2 of 2)

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

The layers of the OSI Reference Model

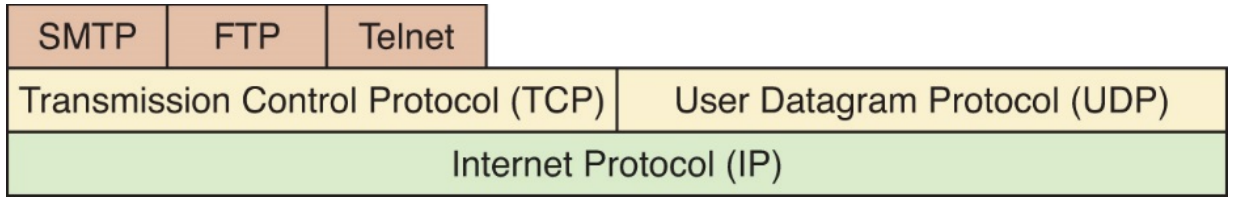
Open Systems Interconnection Reference Model

A seven-layer logical break down of network interaction to facilitate communication standards

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**



Layering of key network protocols

TCP/IP (1 of 2)

Transmission Control Protocol (TCP)

Software that breaks messages into packets, hands them off to the IP software for delivery, and then orders and reassembles the packets at their destination

Internet Protocol (IP)

Software that deals with the routing of packets through the maze of interconnected networks to their final destination

TCP/IP (2 of 2)

User Datagram Protocol (UDP)

An alternative to TCP that is faster but less reliable

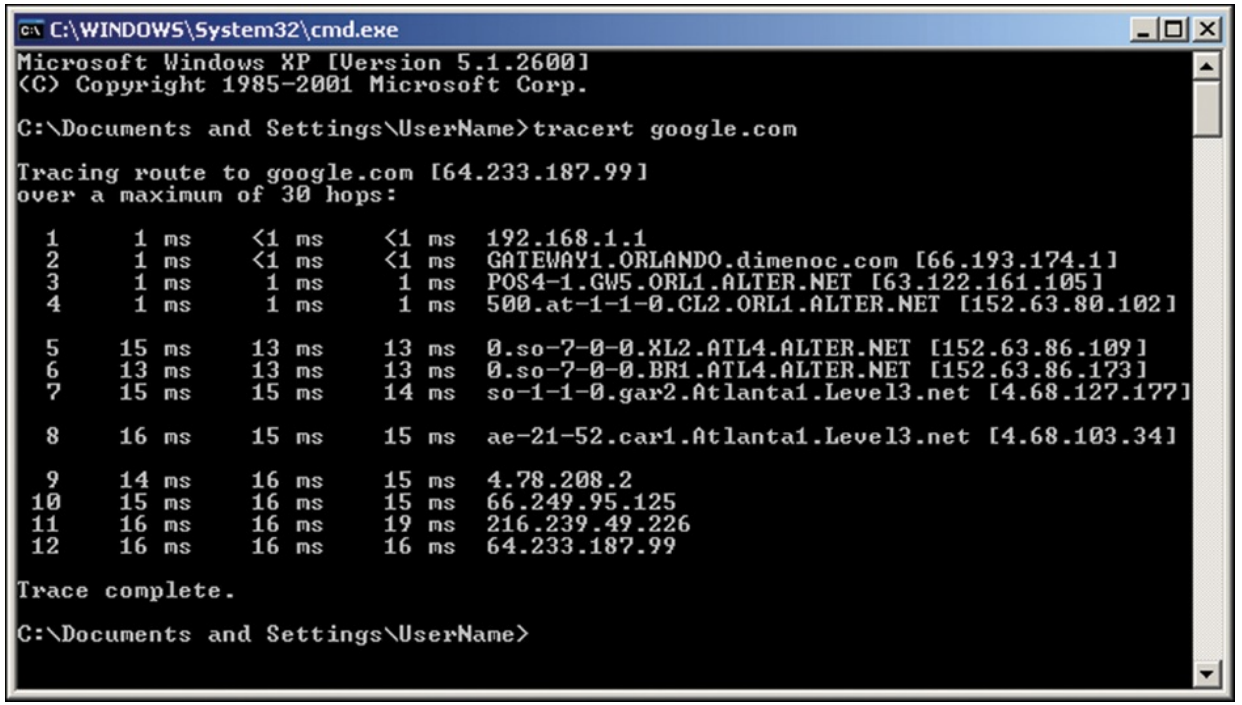
Ping

A program used to test whether a particular network computer is active and reachable

Traceroute

A program that shows the route a packet takes across the Internet

Traceroute in Action



The traceroute utility

High-Level Protocols (1 of 2)

Other protocols build on TCP/IP protocol suite

Simple Mail Transfer Protocol (SMTP) is used to specify transfer of electronic mail

File Transfer Protocol (FTP) allows a user to transfer files to and from another computer

Telnet is used to log onto one computer from another

Hypertext Transfer Protocol (http) allows exchange of Web documents

Which of these have you used?

High-Level Protocols (2 of 2)

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
Hypertext Transfer Protocol (HTTP)	80
Post Office Protocol (POP3)	110
Network News Transfer Protocol (NNTP)	119
Internet Relay Chat (IRC)	6667

Some protocols and the ports they use

Port
A numeric designation that corresponds to a particular high-level protocol

MIME Types

MIME Type

A standard for defining the format of files that are included as email attachments or on websites

What does MIME stand for?

Multipurpose Internet Mail Extension

Firewalls (1 of 2)

Firewall

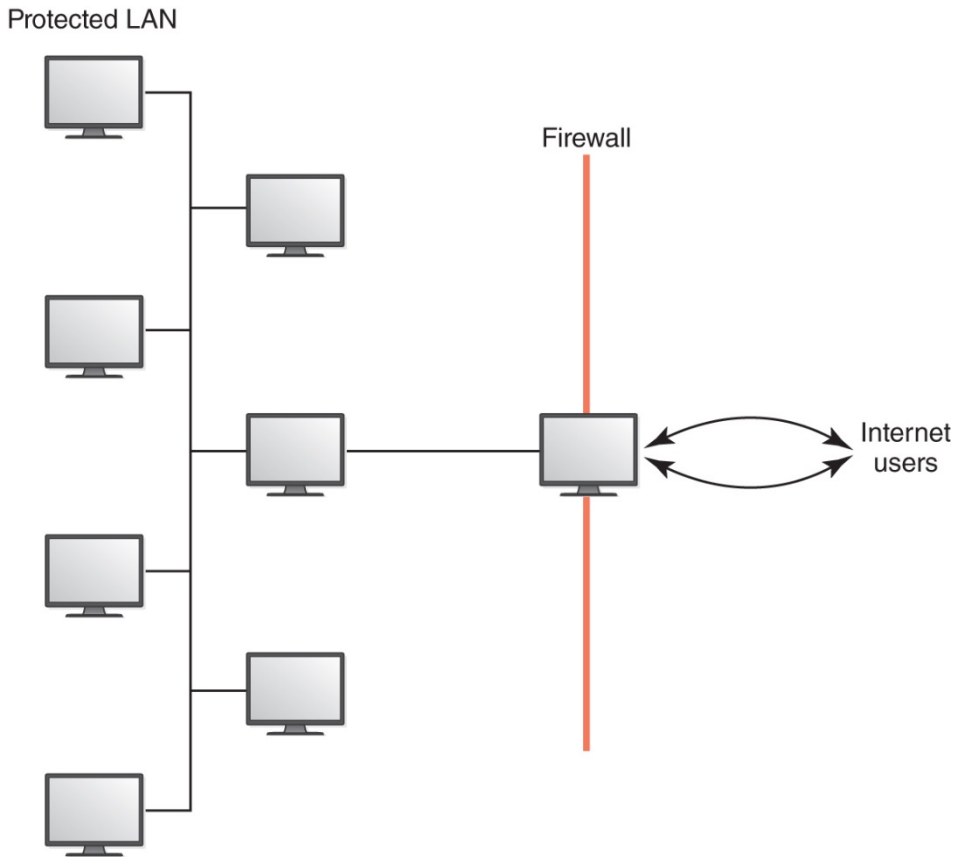
A gateway machine and its software that protects a network by filtering the traffic it allows

Access Control Policy

A set of rules established by an organization that specifies what types of network communication are permitted and denied

Have your messages ever been returned undelivered, blocked by a firewall?

Firewalls (2 of 2)



A firewall protecting a LAN

Network Addresses (1 of 3)

Hostname

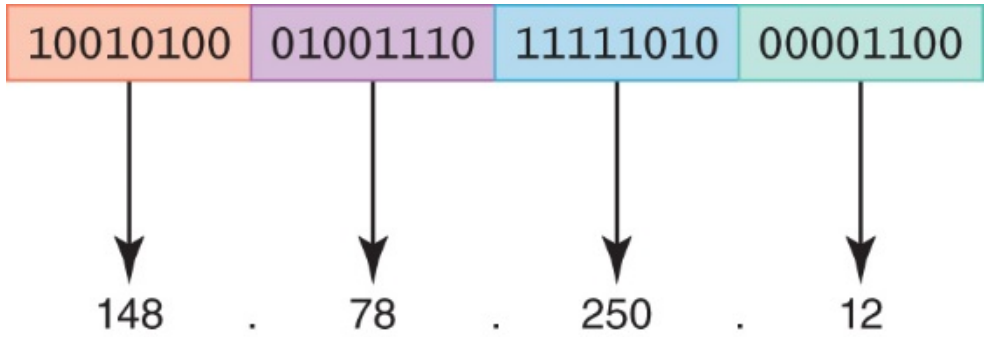
A name made up of words separated by dots that uniquely identifies a computer on the Internet

IP Address

An address made up of four one-byte numeric values separated by dots that uniquely identifies a computer on the Internet

Is there a correspondence between the parts of a hostname and an IP address?

Network Addresses (2 of 3)



An IP address stored in 4 bytes

What is wrong with the IP4 strategy?

How did smartphones contribute to the problem?

Network Addresses (3 of 3)

IPv4

The last block was assigned in 2011

IPv6

32 bits organized into four groups of 8

`FE80:0000:0000:0000:0202:B3FF:FE1E:8329`

They work in parallel

Domain Name System (1 of 5)

Host Number

The part of the IP address that specifies a particular host (machine) on the network

Yes, but what is it?

Domain Name

The part of a hostname that specifies a specific organization or group

Top-Level Domain (TLD)

The last section of a domain name that specifies the type of organization or its country of origin

Domain Name System (2 of 5)

Domain Name System (DNS)

A distributed system for managing hostname resolution

Domain Name Server

A computer that attempts to translate a hostname into an IP address

Domain Squatting

Ransoming domain names

Should the tables containing hostname/IP mappings be sorted or unsorted? Why?

Domain Name System (3 of 5)

Top-Level Domain	General Purpose
.aero	Aerospace industry
.biz	Business
.com*	U.S. commercial (unrestricted)
.coop	Cooperative
.edu*	U.S. educational
.gov*	U.S. government
.info	Information (unrestricted)
.int*	International organizations
.jobs	Employment
.mil*	U.S. military
.museum	Museums
.name	Individuals and families
.net*	Network (unrestricted)
.org*	Nonprofit organization (unrestricted)
.pro	Certain professions

Some top-level domains and their general purpose (* indicates an original TLD)

Domain Name System (4 of 5)

Organizations based in countries other than the United States may 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

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

Domain Name System (5 of 5)

Here are a few of the many TLDs that are available:

social	furniture	dental	paris	media
career	town	rocks	cooking	rodeo
nyc	trade	webcam	vote	actor
vacations	industries	wiki	productions	flights
rentals	catering	dating	bargains	cool
pics	guitars	tax	dance	email
farm	education	ninja	coffee	shoes
menu	kitchen	land	support	associates
institute	camp	center	directory	florist

Who Controls the Internet?

Control of IP Addresses and Domain Names

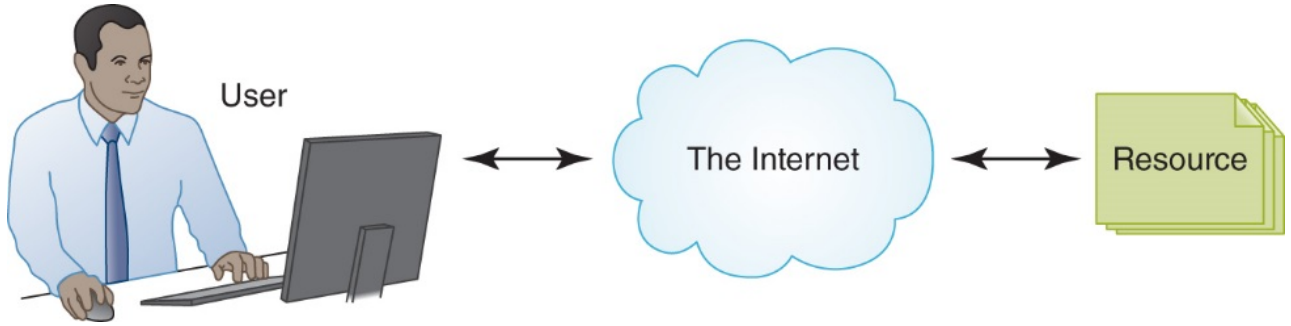
- Internet began as ARPANET, a project of the U.S. Department of Defense
- Control subcontracted to ICANN in 1998
- U.S. government to further reduce role as early as 2015

FCC Proposal

- Would allow ISPs to provide “premium” access to certain customers, perhaps by deliberately slowing down data transfer for others
- Net neutrality The principle that ISPs should deliver data to everyone equally, as fast as the technology allows

Cloud Computing

- A paradigm in which resources (computers, storage, etc.) are provided by a third party and managed through Internet communication
- Example: Google's Gmail
- Popular providers of cloud computing: Amazon Web Services, Google Cloud, and Microsoft Azure



Internet communication depicted using a cloud

Types of Cloud Services

- **Public clouds** are accessible by any subscriber
- **Private clouds** are established for a specific group or organization
- **Community clouds** are shared among two or more organizations with the same needs
- **Hybrid clouds** are some combination of the others

Blockchain

- A network-based technology that acts like a public ledger, recording important economic transactions
- Once verified, a transaction is added to a **block** of transactions, which is added to the **chain** of ongoing sequential transactions
- Blockchain is considered incorruptible—it is decentralized and self-auditing
- There is no single point of failure and it cannot be controlled by any single entity

Chapter 15 Lecture