Chapter 15

Networks

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

Networking

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

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

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

Protocol
A set of rules that defines how data is formatted and processed on a network; i.e., rules that allow client/server interaction

File server
A computer that stores and manages files for multiple users on a network

Web server
A computer dedicated to responding to requests (from the browser client) for web pages

Types of Networks

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

**Ethernet**
The industry standard bus technology for local-area networks

**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

**Internet**
A wide area network that spans the planet

*So, who owns the Internet?*
Internet Connections

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

Internet service provider (ISP)
A company that provides other companies or individuals with access to the Internet

Internet Connections

Various technologies available to connect a home computer to the Internet

- **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
- **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 back and forth

Internet Connections

Broadband
A connection in which transfer speeds are faster than 128 bps (bits per second)
- DSL connections and cable modems are broadband connections
- 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

**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

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

Open Systems

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

<table>
<thead>
<tr>
<th>Number</th>
<th>Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Application layer</td>
</tr>
<tr>
<td>6</td>
<td>Presentation layer</td>
</tr>
<tr>
<td>5</td>
<td>Session layer</td>
</tr>
<tr>
<td>4</td>
<td>Transport layer</td>
</tr>
<tr>
<td>3</td>
<td>Network layer</td>
</tr>
<tr>
<td>2</td>
<td>Data Link layer</td>
</tr>
<tr>
<td>1</td>
<td>Physical layer</td>
</tr>
</tbody>
</table>

Open Systems Interconnection Reference Model
A seven-layer logical breakdown 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

<table>
<thead>
<tr>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMTP</td>
</tr>
<tr>
<td>FTP</td>
</tr>
<tr>
<td>Telnet</td>
</tr>
<tr>
<td>Transmission Control Protocol (TCP)</td>
</tr>
<tr>
<td>User Datagram Protocol (UDP)</td>
</tr>
<tr>
<td>Internet Protocol (IP)</td>
</tr>
</tbody>
</table>
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.

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.

High-Level Protocols
Other protocols build on TCP/IP protocol suite.

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

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

Telnet used to log onto one computer from another.

Hyper Text Transfer Protocol (HTTP) allows exchange of Web documents.

Which of these have you used?

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>7</td>
</tr>
<tr>
<td>File Transfer Protocol (FTP)</td>
<td>21</td>
</tr>
<tr>
<td>Telnet</td>
<td>23</td>
</tr>
<tr>
<td>Simple Mail Transfer Protocol (SMTP)</td>
<td>25</td>
</tr>
<tr>
<td>Domain Name Service (DNS)</td>
<td>53</td>
</tr>
<tr>
<td>Gopher</td>
<td>70</td>
</tr>
<tr>
<td>Finger</td>
<td>79</td>
</tr>
<tr>
<td>Hypertext Transfer Protocol (HTTP)</td>
<td>80</td>
</tr>
<tr>
<td>Post Office Protocol (POP3)</td>
<td>110</td>
</tr>
<tr>
<td>Network News Transfer Protocol (NNTP)</td>
<td>119</td>
</tr>
<tr>
<td>Internet Relay Chat (IRC)</td>
<td>6667</td>
</tr>
</tbody>
</table>
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?*

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Firewalls

**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 specify what types of network communication are permitted and denied

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

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Network Addresses

**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

Class A: first byte network address and three bytes for host number
Class B: first two bytes for network address and two bytes for host number
Class C: first three bytes for network address and one byte for host number

Where does the host number come from?

Domain Name System

Host number
The part of the IP address that specifies a particular host 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

Where does the host number come from?

Domain Name System

matisse.csc.villanova.edu

Compute name
Domain name
TLD

Domain Name System

<table>
<thead>
<tr>
<th>Top-Level Domain</th>
<th>General Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>com</td>
<td>U.S. Commercial (unrestricted)</td>
</tr>
<tr>
<td>biz</td>
<td>Business</td>
</tr>
<tr>
<td>info</td>
<td>Information (unrestricted)</td>
</tr>
<tr>
<td>int</td>
<td>International organizations</td>
</tr>
<tr>
<td>edu</td>
<td>U.S. Educational</td>
</tr>
<tr>
<td>gov</td>
<td>U.S. Government</td>
</tr>
<tr>
<td>pro</td>
<td>Certain professions</td>
</tr>
<tr>
<td>name</td>
<td>Aerospace Industry</td>
</tr>
<tr>
<td>.mil</td>
<td>U.S. Military</td>
</tr>
<tr>
<td>.museum</td>
<td>Museums</td>
</tr>
<tr>
<td>.name</td>
<td>Individuals and families</td>
</tr>
<tr>
<td>.net</td>
<td>Network (restricted)</td>
</tr>
<tr>
<td>.org</td>
<td>Nonprofit organization (unrestricted)</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Country Code TLD</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>.au</td>
<td>Australia</td>
</tr>
<tr>
<td>.br</td>
<td>Brazil</td>
</tr>
<tr>
<td>.ca</td>
<td>Canada</td>
</tr>
<tr>
<td>.gr</td>
<td>Greece</td>
</tr>
<tr>
<td>.in</td>
<td>India</td>
</tr>
<tr>
<td>.ru</td>
<td>Russian Federation</td>
</tr>
<tr>
<td>.uk</td>
<td>United Kingdom</td>
</tr>
</tbody>
</table>

Do you email someone in another country?

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

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

Ethical Issues

Ubiquitous Computing

What does “ubiquitous computing” mean?

Name three ways that an employer can monitor an employees computer interaction

Should an employee have any right to privacy in the workplace?

Who am I?

What two major awards did I win?

For what were they given?
Do you know?

What is SETI? What does it have to do with extraterrestrials?
For what did Bill Gates receive a Knighthood from Queen Elizabeth?
What are “Captcha” codes? For what are they used?