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# 5. Networked computing and the Internet

1. Networked computing
2. Supporting technology
3. Network security and legal issues
4. The Internet and the World Wide Web
5. The Internet and business

Reading: Evans et al,  
Chs. 7, 8, 12

## Inquiry

- Why is the network often down?
- How can I connect better online with my friends?
- What principles enable communication worldwide?

### Overview

- *Distributed computing* uses physically separated processors
- Networks implement distributed computing
- Much of the benefit of computing is in being connected with other users and with shared resources
- The speed and connectivity enabled by networking have major social implications
- *Hypothesis: The networked character of computing today accelerates the rate of change in computing and in society*

### Objectives

- 5a. Recognize or use basic terminology of computer networking\*
- 5b. Distinguish locally stored data from data stored on a server
- 5c. Discuss network security issues\*
- 5d. Use technology that supports collaboration
- 5e. Evaluate online information\*
- 5f. Explain or use hyperlinks
- 5g. Recognize or use basic terminology of the Internet

### 1. Networked computing

- A *network* is a set of computers *configured* to share data and other resources
- Special system software and communication hardware enable networking
- *Standards* are required for computers to communicate and work together
- A *server* is a computer on a network that responds to user (*client*) requests for data, in *client/server computing*
- The *Internet* is a worldwide network of networks

### Kinds of network

- *LAN*: Local area network, as at FSU
- *Wide area network* (WAN): a set of LANs connected together over a sizable geographic area
- *Metropolitan area network* (MAN): network with a wide but limited area near a city
- *Peer to peer* (P2P): two computers each connected to the other
- *Virtual private network* (VPN): infrastructure for intranets with encrypted packets

### Eras of computer connectivity

- *Centralized:*  
mainframes, connected to processorless terminals
- *Distributed:*  
networked PCs, 1980s-90s
- *Networked:*  
communication via HTML using Internet, 1990s to present

### Distributed computing

- Networking makes possible systems whose nodes are different platforms running different software
- *Middleware* helps coordinate computational and data resources on distributed systems
- Examples of distributed systems: Internet-based business systems, bank ATMs and retailer transaction handlers, enterprise databases
- *Software agents* may visit web sites

### Distributed systems

- *Tiered (layered) architectures*
  - single data storage tier
  - business logic tier to process transactions
  - many-noded user tier enabling data entry and showing query results
- *Grid computing*: coordination of computers as equals to achieve high processing speed, often in background
- *Cluster computing*: Fault-tolerant use of multiple dedicated servers, with load balancing

### Client/server computing

- Client initiates all actions, server responds
- *Examples*: browser is client, web-site host is server serving HTML files; email uses server
- No continuous connection, just requests/responses
- Some web pages are generated specifically for one transaction, e.g., flight reservations
- *Middleware*: software, e.g., DBMS, that handles added layers (other than client and server) in *n*-tiered C/S relationship
- Server becomes client of middleware server:  
(C → S → M → S → C)

### Communication of data

- *Synchronous* (waiting turn) vs. *asynchronous* (not waiting turn) communications
- *Bandwidth*: Data capacity of a communication channel, in Hz (bits/sec.)
- *Circuit switching* reserves a channel; *packet switching* enables concurrent use of a channel for many messages
- Networking requires *standards*, *access media*, and *supporting systems software*

### Local vs. remote storage

- *Local data* is stored in secondary storage on a user's device (mobile, desktop, or laptop)
- *Remote data* is stored on a *server* and user accesses it via a network
- The difference between local and remotely stored data may be transparent to the user while online
- *Examples*: Your *C:* drive is local; your *Y:* drive, web email, and Blackboard data are remote

### Quality of service

- QoS is level of performance seen from user point of view, e.g., response time
- Mission of a multi-client system includes good QoS for *all* clients
- Metrics
  - *Response time*: delay before request fulfillment
  - *Throughput*: quantity of data processed per unit of time
  - *Accuracy*
  - *Downtime*
  - *Capacity*: in storage, number of users, connections, packets

### Internet phones

- *IPhone* (for Apple software) and *Droid* (open-source software) are mobile devices, or specs for them, that communicate and run downloaded programs (apps)
- Internet access is becoming generally available now via cell-phone technology
- Packets travel via radio waves from cell towers in this technology; computers use cables and wireless routers

### Twitter

- A Twitter user may send a broadcast (tweet) to all the user's followers
- Followers choose who they follow
- Followers are known to senders
- Tweets may be forwarded
- Is follower relationship public information?

### Cloud computing

- *Definition:* use of remote applications, services, and storage hosted by specialized data centers
- *Basis:* availability of mass storage in data centers, accessed via high-speed Internet
- *Advantages:* businesses are freed of the need to manage their own data centers
- *Data center:* a location for mass storage on servers
- Annual projected 2014 usage of cloud: \$55B

### Cookies

- A *cookie* is a file that a browser allows a web site to leave on the computer of a visitor to the web site
- Browsers also allow web sites to request and receive cookies previously left on visitor's computers
- *Example:* an E business site may leave a cookie at a user's site that enables the site to give better informed service to the user on a later visit

## 2. Supporting technologies

### Components of a network

- Workstations (desktops, laptops, mobile devices)
- Servers
- Transmission medium
- Navigation devices such as switches, routers
- Networking software

### Packet switching

- An alternative to *circuit switching*, which required uninterrupted direct connection between two nodes
- Packets contain at minimum: recipient IP address; reassembly information (if message was split); data to transmit
- *Internet Protocol* (IP) transmits packets
- *Transmission Control Protocol* (TCP) supports error detection and resending of lost packets
- *3-way handshake* of TCP enables request to send, granting of request, and sending of data

### The Ethernet and Wi-Fi standards

- *Ethernet* provides common access to LAN cable
- Packets are broadcast to all devices using a *bus*
- By convention, they are accepted only by devices to which the packets are addressed
- A communications *protocol* (rule) such as Ethernet detects colliding sends, triggers resend
- *Wi-Fi*: a related standard for wireless networks
  - Reduced security
  - Slow transmission
  - Interference

### Network access media

Ordered fast to slow:

- Fiber optic (speed of light)
- Coaxial cable
- Air card or other wireless
- Satellite (dish must point toward Equator)
- DSL via phone line
- Dial-up (ties up phone line)

### Network-related hardware

- *Transmission media*: coax cable; fiber-optic cable; Ethernet cable; phone line; radio waves (wireless)
- *Routers*: transfer data between networks or between external line and networked computers
- *Switches*: transfer data within a network
- *Wireless access points*: relay data between wireless workstations and routers

### Network adapters

- Each workstation on network must have network adapter hardware
- *Adapter*
  - Translates internal digital signals to stronger signals for transmission
  - Assembles data into packets, receives packets and converts to internal data
  - Permits or denies access to outsiders
  - Has a physical address (different from IP address) internal to local network

### Network topologies

Topology is shape or layout of a network

- *Linear bus*: all nodes share access to common bus, use it to transmit and receive. Nodes wait turn
- *Ring*: only one node has “token” (right to transmit); token is passed around ring
- *Star*: all nodes are connected to the server via a single switch

### The OSI 7-layer standard

- Open System Interconnection, a standard adopted by IEEE, Institute of Electrical and Electronics Engineers
- Network operating systems follow OSI standard because it defines guidelines for network protocols
- *Layers:*
  - Application (close to user)
  - Presentation (reformats, compresses, encrypts data)
  - Session (sets up virtual connection between devices)
  - Transport (creates and handles packets)
  - Network (addresses packets)
  - Data link (sends data to physical layer)
  - Physical (close to hardware, transmits data)

### RFID tags

- Often are attached to merchandise at a store
- Contain antenna that broadcasts information either with battery (active) or with energy from card reader (passive)
- Enable inventory tracking

### 3. Network security and legal issues

- *Availability*: ability to receive and process data
- *Integrity*: assurance of accuracy and against unauthorized changes
- *Authentication*: protection against fraudulent transmission through assurance of identity of sender
- *Confidentiality*: assurance of nondisclosure of info to entities not authorized to receive
- *Nonrepudiation*: a way of certifying that sender and receiver have participated in a transaction

### Forms of network attack

- Theft of information
- Destruction of data
- Seizing control of computer for use in attacks on other computers (zombies, botnets, distributed denial of service)

### Malware

- *Virus* replicates self from file to file
- *Trojan horse* disguises self as a useful application
- *Worm* replicates from computer to computer
- *Botnets* are sets of computers (zombies) controlled remotely in background
- *Email address spoofing*: Email return addresses are not necessarily genuine, can deceive users into infecting their computers

### Spyware and popup hosts

- *Spyware*: Communicates via Internet without user permission
- Some undesired apps host popup messages
- This malware is installed either by tricking the user to click “Install,” or via security weaknesses in Windows associated with ActiveX controls
- Even opening an email attachment or visiting a web site can install malware

### Network security measures

- *Authentication* (password, biometrics, passcard) requires users to prove they have permission to access network
- *Levels of access privileges* segment users according to need to know
- *Firewalls* may be layered:
  - External screening router to examine packets
  - Bastion host and proxy server screens Internet traffic
  - Internal screening router limits acceptable Internet requests

### Firewalls

- Most users wish to be clients (obtaining data from Internet servers) but not servers (providing information on request)
- Purpose of firewalls is to block outside access to computers via the Internet
- Firewall *packet filtering* may block outside access to logical Port 21 (FTP port), for example
- *Network address translation* (NAT) by firewalls assigns workstations IP addresses known only within the network

### Passwords and encryption

- *Secure web sites* are password-protected
- *Strong* passwords are ones considered difficult to guess
- *Secure connections* are those that encrypt the data communicated; protocol is *https*
- *Encryption* transforms a message into a difficult-to-read text; *decryption* transforms encrypted text to readable form
- *Strong encryption* is hard to “break”

### File-sharing software and copyright

- *Songs and videos* available in MP3 and other compressed formats for MP3 players, iPods, etc.
- Software is generally free, enables users' PCs to act as clients of other users' PCs and to turn their computers into servers for other users
- One problem: This swapping occurs without asking permission of songs' copyright owners
- Government and industry challenged Napster software developer
- Recent example of file-sharing software: Limewire
- Some users report software is ill-behaved

### Email privacy

- PATRIOT Act relaxes search-warrant rules
- Sniffing software may scan all messages entering or leaving an ISP to find email associated with a person under investigation
- Email intercepts by law enforcement require court order
- Employers are not legally restricted in looking at employees' emails
- Suggestion: treat emails like postcards accessible to whoever delivers them

## 4. The Internet and the World Wide Web

- The Internet is a worldwide network of networks that links almost all computing devices worldwide
- *Agreed standards* enable exchange of data
- The Internet has a physical infrastructure and has governing bodies to make decisions
- Users connect to Internet via Internet Service Providers (ISPs)

### Internet history

- Developed by Defense Advanced Research Projects Agency, DARPA, as a decentralized solution to danger of a disruption of military communication in case of nuclear war
- Mosaic (later, Netscape) browser, mid-1990s, enabled millions to use the Internet easily

### Protocols of the Internet

- *Protocol*: A set of rules for communicating, e.g., to encode; decode; or correct transmission errors
- *Internet Protocol* addresses: four 8-bit numbers separated by dots
- *TCP/IP* (Transmission Control Protocol / Internet Protocol) converts messages into *packets* that are independently routed using multiple hops, in point-to-point communication
- *Domain names*: DNS servers convert names to IP addresses

### IP addresses

- Internet Protocol (IP) handles addressing of packets
- Each device on the Internet has an IP address
- IP address is a 32-bit number, shown as four 8-bit values in {0..255}, and expressed in decimal notation, e.g., 204.109.1.127
- Servers usually have permanent (static) IP addresses, workstation IPs are usually assigned at time of Internet connection (dynamically)

### The Internet's infrastructure

- *Backbone*: main paths, a set of networks owned by large commercial or governmental organizations, e.g., Verizon, AT&T, Sprint Nextel, Qwest
- *Physical medium*: optical carrier lines, carrying up to 40 Gb/sec on OC-768 lines
- *Major governing organizations*: Internet Society, Internet Engineering Task Force, Internet Architecture Board, Internet Corporation for Assigned Names and Numbers, World Wide Web Consortium
- *Internet exchange points (IXPs)* enable networks to connect directly to each other using switches

### The World Wide Web

- *World Wide Web*: An abstract information space within the Internet in which servers host web pages, clients access Web servers via browsers
- *HTTP*: Hypertext Transfer Protocol, governs retrieval of web sites by users
- *URL* (Uniform Resource Locator)
  - the address of a web page
  - components: **protocol**, **server**, **pathname**  
(<http://www.framingham.edu/~dkeil>)
- *HTML* (Hypertext Markup Language) enables nonlinear, formatted documents

### Steps in display of a web page

1. User clicks a hyperlink or enters a URL
2. User system (as client) sends URL and request to domain-name server for IP address of URL's server
3. Client sends request for page to URL's server via IP address
4. Server sends HTML file to client
5. User's browser formats HTML file to screen

### Interoperability requires standards

- All protocols support interoperability
- HTML enables web-based data to be self-formatting (appearance)
- CGI (Common Gateway Interface), an extension of HTML that supports *scripts*, e.g., for *forms*
- *Java virtual machine* supports *applets* downloaded from Internet to different platforms
- XML (Extensible Markup Language) enables data to be self describing (meaning)
- W3C (World Wide Web Consortium) sets standards

### Support for Web-page interaction

- *Common Gateway Interface* (CGI) provides for running *scripts* in languages such as Perl, C, C++, on web browsers
- Some scripts support user interaction, such as form filling
- Scripts are run on server side
- Dynamic HTML (DHTML) allows modification of HTML after client loads it

### Java applets

- Java is an object-oriented language designed especially for Internet use
- Programs in the Java language compiled to run on a browser's Java Virtual Machine are *applets*
- Browsers for many platforms have JVMs that run the same compiled code
- The JVM cannot access files, make network connections, or allow programs to start other programs

### Search engines and research

- A *web crawler* at Google, Yahoo, etc., reads billions of web pages and creates an index (CiteSeer reads online academic research)
- The *search engine* responds to queries by performing lookup in the index
- Services such as CiteSeer provide info on what papers have cited the paper in question
- Many papers are available in Acrobat form (.PDF); others in Postscript (.PS)
- With more information available, more critical tools need to be used to *select* info

### Online data and search

- Libraries are still the best source of pre-1985 information; catalogs are online
- Data hierarchies narrow search, step by step: root, branch, leaf
- Evaluate sources for credibility
- Primary vs. secondary/tertiary sources
- Search techniques: Use of quotes, AND, NOT, refined search
- Question: Is Wikipedia a reliable research source?

### Boolean operators in Web searches

- AND, OR, NOT
- AND is presupposed; e.g., a search for **internet protocol** implies a search for web pages that contain both the words “internet” and “protocol”
- To search for a phrase, use quotes, so that searching for pages containing the phrase “Internet Protocol” requires keyword **“internet protocol”** with the quotes
- \* is a string wild card, % a character wild card

### Online research

- Preferred sources are those that have been *peer reviewed* by other experts
- Consider using Google Scholar
- To narrow your search, use two or more keywords you want to relate
- Proper bibliographic entries begin with *author names* and include *publication information*; bibliographic references may be checked at [www.easybib.com](http://www.easybib.com)
- Researchers must properly acknowledge all work used, including by quoting if text is used verbatim

### Web 2.0 (interactive Web)

- *Social networks* (Facebook, MySpace): Web sites that enable users to post “profile” info about themselves and to connect to “friends”
- *Instant Messaging*: Real-time text conversations
- *Podcasts*: Subscribers receive text, audio, or video files from providers as they are produced
- *Blogs*: public personal journals with support for user response
- *Wikis*: Web documents editable by multiple users as a collaboration tool

### 5. The Internet and business

- *E commerce*: “Conducting business using electronic data communication” (L. Snyder, Ch. 16)
- *Variations*: web shopping, electronic funds transfer, point-of-sale transactions, business to business commerce, networked meetings
- *Features*: diverse audience, client/server environment, transaction based, need for interoperability standards, unreliability of systems
- *Intranet*: Private network accessible only to employees but using Internet’s infrastructure

### Models of E commerce

- B2B: Business to business
- B2C: Business to consumer (e.g., *Amazon.com*)
- C2C: Consumer to consumer (e.g., *Ebay*)
- B2G: Business to government
- Use of online transaction processing greatly reduces costs of commerce
- E commerce has disadvantages, e.g., lack of human interaction that may provide useful information to customer

### Transaction processing and data integrity

- A transaction is an *atomic* (indivisible) series of steps
- Simultaneous requests require database *lock* to preserve atomicity
- Another term for this is *serialized behavior*
- *Example*: edits of a document by multiple authors should be serialized so that conflicting versions never coexist

### Enterprise computing

- *Enterprise computing systems* serve organizations of hundreds or thousands of users
- May comprise many information systems (transaction processing, management information, decision support)
- *Scaling up* adds processors or storage to a machine; *scaling out* adds computers to a system
- Enterprise systems may share a database, distribute a database, or synchronize databases
- *System integration* connects hardware, software systems for data sharing

### Technologies in enterprise computing

- *Blade servers*: slim rack-mounted server computers that occupy little space
- *RAID*: Redundant array of independent disks for fast fault-tolerant storage
- *Storage area networks*: Sets of devices acting as a node in a larger network
- *Mirroring*: Real-time maintenance of a duplicate of a data set
- *Network attached storage*: Serverless storage used in a network

### Email and email attachments

- Most email today is *web based*, accessible from any Internet computer
- It is considered preferable to send PDF files rather than MS Word files
  - Some recipients may not be able to open an MS Word file
- When any attached file is edited and saved, note that it is saved to a temporary folder; files to edit should be saved before editing

### Information systems jobs

- *Network administrators* (engineers) plan, install, and test networks
- *Database administrators* assure DB integrity and the performance of DB servers
- *Web server administrators* install and maintain and assure access
- *Telcom technicians* manage telecommunications infrastructure and assure access
- *Software and web development*

### Training for IT careers

- Two and four year degrees in
  - Computer science
  - Management information systems
  - Computer engineering
- Certifications, e.g.,
  - Cisco Systems
  - Microsoft's MSCE

### Networking concepts

asynchrony	integrity	router
authentication	LAN	script
bandwidth	middleware	security
broadcast	network	server
client	network administrator	synchrony
client/server	network adapter	TCP
computing	network medium	topology
data compression	OSI standard	transaction
data hierarchy	packet	processing
distributed	point-to-point	upload
computing	protocol	workstation
download	RFID	
firewall		

### Internet concepts

atomic transaction	Internet	server
blog	Internet security	social network
browser	interoperability	spyware
client	intranet	TCP/IP
client/server computing	IP	URL
crawler	IP address	web page
data integrity	ISP	web service
domain name	packet	web site
e-business	pathname	Web 2.0
enterprise computing	protocol	Wi-Fi
HTML	query processor	wiki
HTTP	script	World Wide Web
hyperlink	search engine	XML

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