

# Three short case studies

- **peer to peer networking**
- **wireless systems**
- **search engines**
- **each includes issues of**
  - hardware  
processors, storage, peripherals, networks, ...  
representation of information, analog vs. digital, bits & bytes
  - software  
applications, operating system, client-server and peer to peer  
organization of information, file systems, ...  
algorithms: searching, sorting, compression
  - communications,  
Internet, Web, TCP/IP, protocols  
bandwidth, speed, caching  
compression, error detection and correction
  - security and privacy; cryptography
  - intellectual property and ownership
  - social & legal & policy concerns

# Peer to peer networking

- **direct connections between peers**
  - distributed instead of clients talking to single server
  - all clients provide bandwidth, storage, processing
- **"peer-to-peer" file-sharing**
  - centralized directories (original Napster in 1999)
  - decentralized directories (Gnutella, Kazaa, Limewire, Morpheus, etc.)
- **once a file is found somewhere**
  - set up direct connection between supplier and consumer ("peers")
  - applications typically use TCP/IP (analogous to HTTP, SSH, SMTP, etc.)
- **other examples**
  - BitTorrent file distribution system (2001)
  - Skype Internet telephony (2003) [hybrid]
  - Bitcoin digital money (2009)

# BitTorrent

- **file-sharing for big files in high demand**
- **original file exists on at least one "seed" site**
- **"tracker" server knows who has what pieces**
  - coordinates all transfers but does not have any of the file contents
- **clients download blocks of file from multiple sources in parallel**
  - blocks have cryptographic checksum to verify correct content
- **downloaded blocks also then uploaded to others**
  - download rate limited by upload rate: have to contribute
  - tracker knows download and upload statuses
    - balances traffic, favors sites that are cooperating
- **blocks reassembled by client**
  - when client has the whole file, it can be a seed for further transfers
- **much faster than single server for right kind of use**
  - less vulnerable to flash crowds
  - but takes time to get started, can't do streaming, etc.

# Internet telephony

- **Voice over IP**
  - package speech in IP packets
  - may connect to public telephone network on each end
  - strict requirements on delay (latency), jitter (variable delay), error handling, etc.
- **lots of commercial providers (AT&T, Comcast, Verizon, Vonage,...)**
  - alternative to conventional telephone service
- **Skype: peer to peer VoIP**
  - 256-bit AES to encrypt each call, RSA to establish AES session key
  - proprietary protocol, uses both TCP and UDP
  - it can use your computer as a supernode (like Kazaa)
  - Skype bought by eBay 10/05 for \$2.5B, sold again 11/09 for \$2B
  - bought by Microsoft 10/11 for \$8.5B

# Technology meets law/policy/economics/politics

- should there be laws controlling peer to peer technology?
- should content providers like RIAA be permitted to install search (& destroy) software on home computers?
- should universities be required to enforce file-sharing laws?
- should VoIP be regulated by the FCC?
  - should VoIP suppliers have to provide services like 911?
  - should VoIP suppliers pay taxes and fees, and for connectivity to public telephone network?
  - should VoIP calls be subject to wire-tapping laws like regular phones?
- should common carriers like Verizon be permitted to discriminate against traffic from competitors like other VoIP suppliers?
  - should there be different prices and policies for different kinds of traffic?

# Copyright

- protects expression, not idea
- duration used to be 17 years + one renewal
- now life + 70 years, or 95 years for commercial works
  - (the "Mickey Mouse Protection Act", 1998)
- "fair use" permits limited copying under some circumstances
  - criticism, comment, scholarship, research, news reporting, teaching
- uncertain what fair use really is -- case by case decisions
- considerations:
  - purpose and character of the use
  - nature of the copyrighted work
  - amount and substantiality of the portion used
  - effect of the use on potential market or value of the copyrighted work
- recent copyright laws may prevent some fair uses
  - can't decrypt to make excerpt for teaching or criticism
  - can't reverse engineer to make copies in different media

# DMCA: Digital Millennium Copyright Act (1998)

- US copyright law: [www.copyright.gov/title17](http://www.copyright.gov/title17), Chapter 12
- anticircumvention: illegal to circumvent a technological measure protecting access to or copying of a copyrighted work
  - limited exceptions for reverse engineering for interoperability, encryption research, security testing
- illegal to remove or alter copyright notices and management information
- "safe harbor": protects ISPs from copyright infringement claims if they follow notice and takedown procedures

# DMCA test cases

- **Grokster**
  - peer to peer software makes copyright infringement easy; are its distributors violating the DMCA?
- **Diebold**
  - internal emails reveal flaws in voting machine software; is posting of the emails a violation of DMCA?
- **SDMI**
  - does demonstration of how to remove digital watermarking on audio files violate DMCA?
- **Lexmark**
  - cryptography used to prevent 3rd parties from supplying replacement ink cartridges; is reverse engineering a violation of DMCA?
- **Viacom v Google**
  - YouTube shows numerous copyrighted clips; is it sufficient that Google responds to individual takedown notices?
- **DeCSS**
  - Content Scrambling System protects DVDs from copying; does publication of code to defeat it violate DMCA?