Class announcements

- Speaker Today
  - Dzintars Grinfelds

- For Monday 06/01
  - ***Database Project due***
  - Folio Article 3 Due
  - Read: Akamai Case
  - Speaker: Tracie Kemmerle

- For Wednesday 06/03
  - ***Business Paper due***
  - Two speaker slots still open...

Today's Schedule

- Announcements
- Database project help
- Business paper help
- Dzintars' presentation
- Lecture topic 1: complete Chapter 18, Networking
- Lecture topic 2: Chapter 8, Economics and Policy

Database Project Help

- Turn in on WebCT
- Paste in screen shots of your queries
- [http://www.soe.ucsc.edu/classes/ism050/ch09/spring09/moreDBHints.htm](http://www.soe.ucsc.edu/classes/ism050/ch09/spring09/moreDBHints.htm)

Business paper theme: “How IT gives your company a competitive advantage.” You need to interpret what that means for your company.

- For most companies that sell non-IT products, you’ll talk about ERP system deployments (Frito-Lay, Mary Kay, McDonald’s, …)

- from the Oracle team: Oracle is an IT supplier. So Oracle is competing to supply IT solutions that give their customers an edge. Discuss IT product development/marketing decisions that give Oracle a competitive edge in the markets they serve

- Frito Lay, McDonalds Trajectory: If the company successfully used information systems in its past, has it continued to innovate and improve up until today? Is the company effectively postured for the future?

- Oracle Trajectory: How is Oracle’s business and industry changing? What are they doing to stay ahead in the industry?
Chapter 18: Collective Issues in Networking

**Concepts from our study of networking and Chapter 18**
- Layering of Network Architecture
- Statistical multiplexing
- Physical Layer
- Link Layer
- Ethernet
- Hubs and Switches
- MAC Addresses
- Network Layer
- Routing Table
- IP Addresses
- Encapsulation of IP packets within an Ethernet Frame
- Order of 5 OSI Layers
- Transport Protocols – TCP and UDP
- ISP, NSP, Local Loop, Telephone Company Local Office
- Web Caching

**Big picture analysis of the architecture of the Internet, using 1-decomposition, 2-Metcalfe’s Law, 3-hierarchy, and 4-statistical multiplexing**

1. **Decomposition**: into hosts and links
2. **Value according to Metcalfe’s Law**
   (text, page 232)
3. **Hierarchy**
4. **Statistical multiplexing**

Internet hosts: $n = 10^9$ (~1 billion)

Internet links: $n^2 = 10^{18}/2$, or 0.5 quintillion (too many!)

Nobody knows $k$, but a very low estimate might be $k=6$? (Zhou and Mondragon, 2004)

**3. Hierarchy**: Network Service Provider (NSP)

**ISP, NSP, Local Loop, Telephone Company Local Office**


**Backbone or NSP**: (MCI, ATT)

**Autonomous System (AS)**

**ISP or IAP**: (CRUZIO, AOL)

**Customer AS**

**Host A**

**Host B**
3. **Hierarchy**: National Research Networks (NRN)

Abilene, NLR & NTNC

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**Sharing of Limited Resources**

- How should \( A \) and \( B \) share a link with limited bit rate?

Source A → C bits per second → Destination A

Source B → Destination B

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4. **Statistical multiplexing**

- Link shared in such a way that connections are not assigned a fixed fraction of the link (unlike TDM).
- \( A \) and \( B \) unlikely to offer peak rate at the same time.
  - \( \max(A + B) = \max(A) + \max(B) \)

Source A → \( A+B \) → Destination A

Source B → Destination B

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**Time Division Multiplexing**

- Gives each connection the use of the link a fixed fraction of time.
- Fixed fraction of resources reserved for each connection.
- Technology called *circuit switching*.

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**Problem**

- When \( A \) is silent, \( A \)'s fraction of link goes unused.

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4. **Statistical multiplexing**

- Because resources aren't reserved. It's possible offered load too high.
- Packets are put into a queue.
- **PROBLEM**: if offered load remains too high, queue will fill up and overflow.

Source A → \( A \) → Destination A

Source B → \( B \) → Destination B

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**Problem**

- System designer assumes this event is statistically unlikely.
  - What if she's wrong? Or what if user demand increases?
4. Statistical multiplexing

Congestion instability
(text, p. 502)

- Carried traffic
- Congestion instability
- Offered traffic
- Network “capacity”
- Increasing portion of network traffic is resent packets
- Social optimum

4. Statistical multiplexing

Congestion Control

- When networks are congested, certain sessions (Source-destination pairs) should reduce offered rates.
  - Today all TCP sessions slow down when they detect packet losses.
  - UDP sessions do not slow down.

- What are some alternative strategies?
  - Have those whose applications aren’t as sensitive slow down more?
  - How would we know which are less sensitive?

Transmission Control Protocol (TCP)

Retransmit mechanism for reliability
- Receiver sends acknowledgements to sender
- If a packet is lost, source fails to get ACK, and then retransmits.

- Congestion control
  - If congestion perceived (by lost packets)
  - Source reduces its send rate
    - When lost, sender reduces send rate by half
    - Otherwise slowly increases

Transmission Control Protocol (TCP)

TCP port numbers
- TCP Header has a “port” number field
- Helps host sort out how to route packets to applications

Transmission Control Protocol (TCP)

For some applications packet retransmissions are not worthwhile
- Why?

- For those applications, we use UDP
- UDP is a transport protocol that
  - Does not do retransmissions
  - Does not do congestion control

Big picture architecture: statistical multiplexing (Internet) vs. time domain multiplexing (old telephone network)

- ARPANET (packet switching, St. Mux.)
  - + high throughput, flexible, easy to grow
  - NETWORK EFFECT, LOCK IN!
  - - mediocre QoS

- Telephone network (Circuit switching, TDM)
  - + good quality of service (QoS) guaranteed
  - - lower throughput, inefficient, inflexible

UDP

- Audio coder
- Stream of packets
- Audio decoder

- For some applications packet retransmissions are not worthwhile
  - Why?

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Big picture architecture: statistical multiplexing (Internet) vs. time domain multiplexing (old telephone network)

- Asynchronous Transfer mode (packet switching with strict resource allocation, p. 507)

- Contemporary QoS: reintroduce TDM-like, sophisticated resource reservation schemes into Internet packet switching (Cisco’s new routers)
IP Addresses vs Mac Addresses

- Hierarchical
  - The beginning bits tell you which network the host is on
  - Ex: UCSC addresses start with 128.114.X.X
  - The last bits tell you which host of the network
- Changeable
  - Changes with location of Host
  - 4 bytes
  - Only 4.2 billion (IPv4)
- Not Hierarchical
  - Beginning bits tell nothing useful
- Not Changeable
  - 6 bytes
  - 281 Trillion

OSI Layers - Important

Internet Explorer, UCSC Email, Firefox, iTunes, Real Player, ...

- Application
- Presentation
- Transmission
- Network
- Link
- Physical

Modulation Schemes: QAM, OFDM, etc...
Internet Protocol (IP), ...
TCP, UDP
Ethernet, Wi-Fi, SONNET, ...

Link and Network Layer Interaction

Routing Table has Wild Cards

Web Caching

- Speed up web page loading by storing previously seen components locally
**Web Caching at a proxy server at an ISP**

**UCSC Campus Policy: Packet Shaping**

TCP/IP offers only best-effort

- Every connection gets "best-effort" service

Achieving maximum latency guarantees

- Reserve resources
- Or attach priorities to packets
  - Contract may allow network to delay or discard low-priority packets when necessary
  - Application may guarantee traffic "shape"
    - e.g., steady flow rather than bursts

**Pricing within the Internet**

- Customer pays an ISP
  - Often Flat Rate per month
  - ISP pays a backbone AS
  - Often just flat rate, dependent on access link speed.
  - Sometimes based on total usage
  - Backbone NSPs peer with each other
  - Often for free if they exchange comparable amounts of traffic.
- Overall...
  - Internet billing today is much more course grained than telephone billing. Should customers be

**How did Amazon design the Kindle’s networking features???</p>

- Does each Kindle have a:
  - MAC address?
  - IPv4 address?
  - What networks does it use?
  - What bandwidth is required, and how does Amazon pay for it?

**Chapter 8: Economics and Policy**

**Externality**

- The impact of one consumer’s behavior on another without compensation
  - Examples:
    - Automobiles
    - Clothing
    - Hair styles
    - eBay
    - Face book
    - YouTube
**Network Effects**
- **Direct**
  - Value of product or service depends on number of users
  - What determines the value of the internet?
  - Value of product or service depends on number of complementary products
  - What determines the value of a word processor?
- **Indirect**
  - Value of product or service depends on availability of software or content
  - What determines the value of a Web browser?

**Other important concepts**
- **Critical mass**
  - Demand for a product or service that exceeds the suppliers cost
- **Positive feedback (success breeds success)**
  - Once critical mass is achieved, new adopters further increase the value of the product or service

**Standardization**
- How do strong network effects relate to standards?
- What is today’s de facto personal computer standard - or does one exist?

**Network effects**
Fundamental identity:

\[ \text{Revenues} = \text{market share} \times \text{market size} \]

**Lock-in**
- Since systems are comprised of interoperable components, changing a component means that the replacement must be a direct substitute.
- The value of the system is found in both tangible and intangible costs
  - Tangible costs are those associated with the acquisition of hardware, software, etc.
  - Intangible costs are those associated with training and management of the system
Lock-in and Switching Costs

- Suppliers can charge premium costs to locked-in customers, but not beyond the point where the premium costs reach the cost of switching.

Lock-in and Open System Standards

- How does lock-in drive open system standards?
  - Allows for independent product upgrades
  - Allows customers to mix and match products from different suppliers
  - Increases competition (more choice for buyers)
  - Reduces switching costs
  - Also may place burden on the buyers to function as the system integrator

Economic Properties of Information

- Phases in supply of content
  - Creation
    - Author (book, song, music)
    - Produce (movie, performance)
    - Collect (almanac, weather)
    - Some combination (news reporting)
  - Replication (for each user)
  - Distribution (network? Physical means?)

Software economies

- Creation is expensive
  - Sunk costs
  - Development is risky
- Replication is inexpensive
- Costs of maintenance and upgrade are SIGNIFICANT!
  - Related to lock-in

Intellectual Property

- "Information or ideas with commercial value for which the government has granted exclusive property rights, including, copyright, patent, trademark, and trade secret"
- We'll discuss:
  - Copyrights and Patents
  - Privacy Policy
  - Regulations

Copyrights and Patents

- Copyright grants an author exclusive control over original works of information content or software
- A patent is granted by the federal government for the right to make, use or sell an invention for a fixed period of time.
- More on each of these....
Copyrights

- Prevents others from appropriating, replicating or displaying a work without permission of the copyright holder.
- Limitations: fair use - we can copy materials for use in our class.
- Major implications for digital materials:
  - What is digital fair use?
  - Digital Millennium Copyright Act (DMCA) used by RIAA and others to make charges of copyright violation called infringement.

Copyrighting Software

- Software license stipulates the terms and conditions under which copyrighted software is used.
  - Freeware - copyright, but is given away.
  - Shareware - copyright, but seeks voluntary payment.
  - Copyleft - limits derivative works to those distributed free of charge.
- Infringement - violation of copyright.
- Piracy - selling large volumes of copyrighted material.

Patents

- Encourage research and development due to exclusive rights (for a limited time).
- Patents in computing and communications may be cross-licensed for mutual benefit (examples include Microsoft and Lexmark, Microsoft and HP).
- Software patent controversy - when is software an innovation? When not?

Privacy Policy

- The issue of personally identifiable information (PII):
  - What is PII? Name, data of birth, SSN, credit card info.
  - Issues:
    - Identity theft
    - Fraud
    - Secure transmission
  - Concerns when dealing with 3rd party outsourcing:
    - Security of data
    - Persistence of data.

Regulations

- A selection of privacy laws:
  - Federal Wiretap Statute - 1968
  - FERPA - 1974 (updated many times through 2009)
  - Electronic Communication Privacy Act - 1986
  - HIPAA - Health - 1996
  - Fair Credit Reporting Act (FCRA) - 1997
  - Gramm-Leach-Bliley Act - 1999
- More when we discuss security on 6/3/09.

GPL vs. BSD Software Licensing (Part One)
### GPL vs. BSD Software Licensing (Part 2)

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<th>Geoff's Repository (w/o Geoff's Code)</th>
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