

Computer Networks

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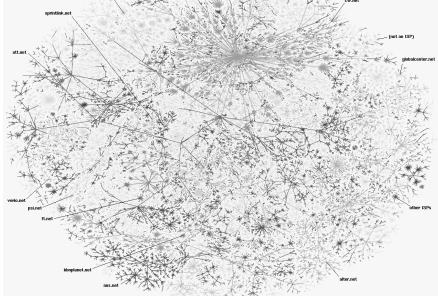
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Computer networks (10 minute course overview)

- Goal: Connect all these nodes



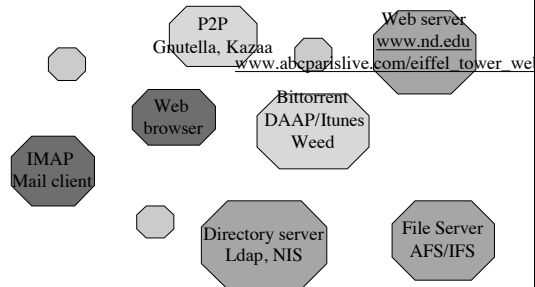
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Computer networks (10 minute course overview)

- Network applications view



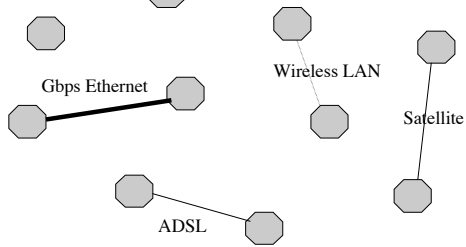
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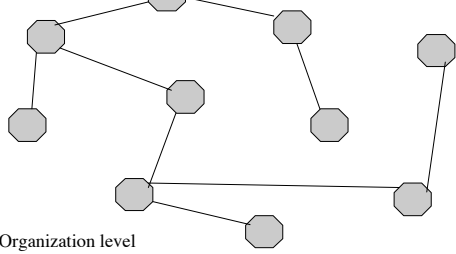
Computer networks (10 minute course overview)

- Problem 1: Direct link networks - physically connecting networks



Computer networks (10 minute course overview)

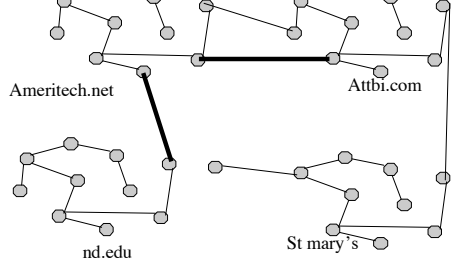
- Problem 2: Direct link networks - not all nodes are directly connected



Organization level

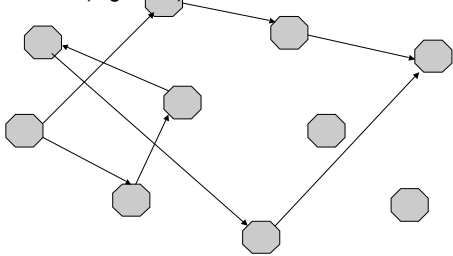
Computer networks (10 minute course overview)

- Problem 3: Internetwork - there is more than one network



Computer networks (10 minute course overview)

- Goal: Congestion control, Reliable. End-to-end protocols (e.g. TCP) etc.



Computer networks (10 minute course overview)

- Rest:
 - Wireless and ad-hoc networks
 - TCP
 - Internet Performance
 - P2P (Napster, Gnutella etc) and CDN's (Akamai etc)
 - Network performance and modeling
 - Future directions

Course Goals

- Cover core as well as newer networking technologies
- Goal is to cover as much breadth rather than depth
- Lots of interesting topics to cover
 - Feedback if you would like us to discuss some other technology
- As much hands on experience as possible
- Home work projects should help
- Probably wouldn't cover specific acronyms (e.g. ADSL, GSM, CDMA, TDMA, 2G, 2.5G, 3G, ATM, 802.3, 802.11a/b/e/g/i,)

Outline for today

- Course policies:
 - Course organization and expectation
 - Grading policy, late policy, reevaluation policy
 - Academic honesty
- Project Assignment 1:
 - P2P Systems overlay (bittorrent)
- Project Assignment 2:
 - P2p search (query routing)
- Project Assignment 3:
 - TCP over UDP (reliable delivery)
- Project Assignment 4:
 - Individually defined project



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Course Organization

We will follow the course text for the most part with research papers at the end of the second half.

I will augment the discussions with topical research papers

I encourage open discussion about the technologies



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Grade distribution

- Class participation – 4 %
- Paper evaluation – 2 %
- Cool technology of the day - 2%
 - Before each class, I would like each student to report on one networking technology that they found interesting, do a little background research and report why you find this topic interesting. This is a good way to look broadly at what is happening in the Networking areas that affect our lives. We can briefly discuss the implications of this technology in the class
- Midterm – 10%
- Final – 10%
- Homework projects – 48% (4 x 12%)
- Take home assignments – 24% (2 x 12%)



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Class participation and paper evaluation

- Class participation is very important. You will be graded on your involvement in class discussions. There are no “dumb” questions. You will only be penalized for “no” questions/comments.
- To foster interaction I will randomly pick name – more than two unexcused absences is grounds for administrative withdrawal.
- Over the course of the semester, you will read and critique research papers. You will discuss your criticisms during the class discussion. Critiquing other work is a good way to start thinking of a better solution



Midterm and Final

- One open book, open notes, in class exam



Homework projects

- **Projects are group (ideally two) efforts.**
- Each project should be electronically turned in with a succinct report on your implementation strategy and what you learned.
- Projects should compile without any modifications. You are free to choose your own programming language - no GUIs please (hard to grade). C is preferred. Use the FreeBSD cluster in Cushing 208 for the projects. If you need a specific OS, you should make arrangements beforehand
- I will randomly select submissions for an one-on-one oral interview



Reevaluation policy

- Arithmetic errors, missed grading will be reevaluated.
- I encourage you to discuss concerns with your solution with me
- I discourage re-evaluation of partial credits:
 - Football penalty policy:
If you think you deserve a better partial grade, write down the reason why you think that you deserve a better grade and how many extra points you think you deserve. If I agree, you could get up to this many extra points. If I disagree, you will lose this much points.



Late policy

- None – Projects/homework/critiques are due at 12:30 pm (right before the beginning of class). **I do not accept late submissions** (not even a second)
- Please contact me regarding unforeseen emergencies



Academic Honesty

- Freedom of information rule:
 - Collaboration is acceptable
 - To assure that all collaboration is on the level, **you must always write the name(s) of your collaborators on your assignment.** Failure to adequately acknowledge your contributors is at best a lapse of professional etiquette, and at worst it is plagiarism. Plagiarism is a form of cheating.



Academic Honesty – Gilligans Island Rule

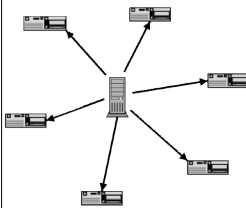
- This rule says that you are free to meet with fellow students(s) and discuss assignments with them. Writing on a board or shared piece of paper is acceptable during the meeting; however, you may **not take any written (electronic or otherwise) record away from the meeting**. This applies when the assignment is supposed to be an individual effort. After the meeting, engage in half hour of mind-numbing activity (like watching an episode of Gilligan's Island), before starting to work on the assignment. This will assure that you are able to reconstruct what you learned from the meeting, by yourself, using your own brain.



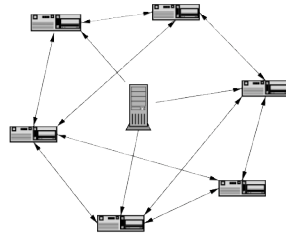
Assignment I – Due 02/10/2004

- Peer to Peer system similar to Bittorrent

Problem: more customers require more bandwidth



BitTorrent Solution: customers help distribute content



Courtesy - <http://bitconjurer.org/BitTorrent/>



Assignment I – Due 02/10/2004

- Problem 1: Locating and creating overlay of other peers
 - Locating what is “around” you is an important problem
 - Need this functionality to access “services”
 - need to know who has a laptop/palm top in this room so that you can communicate with them
 - need to know the location and security key for the wireless access point to use it
 - need to know who has my favorite mp3 song



P2P identity exchange scheme

- Peers use broadcast/multicast to find other peers
 - When you broadcast a packet, every other computer in your network receives your query
 - When you multicast your query, only interested beacons that are a member of a multicast group receive the query
 - E.g. gnutella
- Peer maintain list of peers (only two for this project)



Problem 2: Service

- Peers will provide the following service in their service port (chosen by you):
 - **get(key)** This service will send the *value* associated with a given *key*. The key should be among the keys listed in the *list* service. Requests for a key that is not available should be denied
 - **list()** This service will list all the keys that are available at the beacon using earlier *set* operations



Assignment 1

- You are free to choose any implementation language/mechanism. For ease of grading, please do not use Java GUI's for your program. C would be *REALLY* helpful for future programming assignments/projects.
- Sample code from Richard Stevens book (url in handout)
- Submit code and a report detailing your approach, compilation instructions and how it solves:
 - Interoperability
 - Scalability
 - Consistency
- Remember: I will not accept late home works



Network programming in C

- Client and Server end of a network connection
 - Server end waits for connection requests
 - Client end connects to server end
 - Network server can in fact be a client to other services
 - Each network connection end point is identified by a IP and port number



Sockets

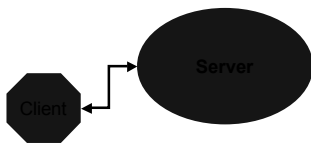
- Communications mechanism
- Behaves like a pipe – data sent on one end is received on the other end



- On a server, you can bind the socket to a port so that it listens for connection requests on that port
- On the client, you can connect to a server socket



Central server based location management



- Simple central server based approach
 - Server bind and waits on a well known port for requests
 - Clients connect to server using well known port



Connectionless

```
soc = socket(AF_INET, SOCK_STREAM, IP)

sendto(soc, messageBuffer, messageLen, flags,
        destinationSockaddr, len)

recvfrom (soc, messageBuffer, messageLen, flags,
          sourceAddr, len)
```



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Client

```
soc = socket(AF_INET, SOCK_STREAM, IP);
bzero((void *) &sAddr, sizeof(sAddr));
sAddr.sin_family = AF_INET;
sAddr.sin_addr = SERVER_ADDRESS;
sAddr.sin_port = SERVER_PORT;
connect(soc, &sAddr, sizeof(sAddr))
<-----END----->
write(soc, .., ..)
read(soc, .., ..)
close(soc)
```



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Server

```
soc = socket(AF_INET, SOCK_STREAM, IP);
bzero((void *) &sAddr, sizeof(sAddr));
sAddr.sin_family = AF_INET;
sAddr.sin_addr = INADDR_ANY;
sAddr.sin_port = SERVER_PORT;
bind(soc, &sAddr, sizeof(sAddr))
socNew = accept(soc, .., ..)
<-----END----->
write(socNew, .., ..)
read(socNew, .., ..)
close(socNew)
```



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Useful tools

- **Tcpdump**
 - Dumps network packets
- **Netstat**
 - Shows active connections
- **Ping and traceroute**
 - Verifies that “packets” can get to a machine
- **Host/dig/nslookup**
 - Hostname->IP mapping



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