Class meets Fridays, 9am to 11:50am, beginning January 15 and ending April 30. Spring break (for my class) is March 19 and the the stop period does not intersect classroom days. The date and time of the final is Friday, May 7, 8–10am.

Changes: This syllabus may be updated over the semester. The most recent version can always be found at the class Moodle site.

18-Nov-09: no changes yet
7-Dec-09: final and spring break date corrected

Obtaining these papers: All of these papers are available from the CSci551 Moodle site (see URL above) in PDF format. Because they are copyrighted they are available only for classroom use. The Moodle site is only available to students with class-specific accounts to enforce this; to get an account, go to [http://www.isi.edu/~johnh/cs551.html](http://www.isi.edu/~johnh/cs551.html) and follow the instructions, or contact the professor or TA.

You are encouraged to download and print the papers. Downloaded they take up about 95MB storage. You’re encouraged to print them out and make notes on them as you go. Because there are many papers and many, many pages, you are strongly encouraged to use a double-sided printer. You will need a 3-inch binder if you keep them that way. (If you have to pay for printing, you may find it cheaper to get together with other students to print one copy and photocopy additional ones.)

Some of the papers were scanned. These tend to have large (2–5 MB) PDF files, and may look slightly fuzzy when printed. Some of the papers may not display well in Acrobat on the screen, but they all should look reasonable when printed.

In SP2005 we tried making hardcopies of the papers available to students. Unfortunately, USC requires that we charge for these (to recover the duplication costs), and the copyright owners (ACM, IEEE, etc.) insist that if there is any charge, then they must get a copyright fee. The total fee for the entire paper set was well over $250, and it was still more than $100 even if the optional papers were eliminated. For this reason I do not plan to make hardcopies available.

In this syllabus, I indicate “new” by papers relative to my section of CSci551 from last year. (There will be other variations between my section and sections taught by other professors.)

Primary and Supplementary Papers: There are two groups of papers. We will discuss primary papers in class. The concepts and details from primary papers is fair game in exams. On the other hand, supplementary will not be discussed in class, and you are not required to know details from those papers for exams (although the concepts might, since they are networking papers). You are encouraged to read the supplementary papers if you’re interested in an area. (Supplementary papers will also appear on homework 1.)

I am happy to take questions about either primary or supplementary papers in class or office hours.
1 Reference and background

Supplementary:
All of the textbooks are optional. Peterson and Davies and Keshav provide an overview of some of the topics we talk about. They provide helpful background and are generally broader and more consistent in their coverage of networking, but less deep on the subjects we cover in class. General background about networking: [Peterson00a]


Sockets programming (useful for the project): [Stevens97b]


(The Stevens TCP/IP Illustrated books are also excellent references relating the RFCs to the BSD code, but are less useful for class.)

Class 1 (Jan. 15):
Primary: Tips for reading papers: [Hanson99a]


(UPDATED SP2010) Another viewpoint of paper reading [Jamin03a]


What to look for in a paper: [Levin83a]


2 Design principles

Class 2 (Jan. 22):
Primary: The Internet architecture: [Clark88a]


Naming: [Saltzer82a]


The end-to-end argument: [Saltzer81a]
Class project: The class project this semester will be related to map/reduce. I don’t plan to review this paper on the first day of class, but I will go over it sometime before mid-February when the class project is released, so please read this paper before January 31. I will post when I’ll talk about it on the class Moodle.

Data-parallel processing with map/reduce: [Dean04a]

No paper, but review: data marshalling, packet formats and encoding, SOAP and REST. (No paper, but we will cover the material with class notes.)

Supplementary:
How “tussles” affect network architecture: [Clark02a]


Ways to design the next Internet? [Anderson05a]


3 Unicast Routing

Class 3 (Jan. 29):
Primary:
Review of unicast and distance vector routing: [Narten89a]


Potential routing problems: [Labovitz00a]


Routing stability and oscillation: [Shaikh00a]


Supplementary:
Supplement with detailed BGP information: [Stewart99a]

Synchronization problems in routing (but also applies much wider): [Floyd94b]


**Class 4** (Feb. 5):

Primary:

(UPDATED SP2010) Delay-tolerant networking: [Fall08a]


Routing hierarchy and policy: [Gao02a]


**Supplementary:**

Classic cases where policy choices in peerings result in oscillations: [Griffin99a]


**4 Transport protocols, Congestion Control, and Queue Management**

**Class 5** (Feb. 12):

Primary: Congestion control from first principles: [Ramakrishnan90a]


TCP and congestion control: [Jacobson88a]


Modeling TCP: [Padhye98a]


**Supplementary:**

An early academic paper on TCP, prompting the 2004 Turning Award to its authors: [Cerf74a]

An alternative, delay-based approach to detect congestion (more recent “FAST TCP” builds on this much earlier work): [Brakmo94a]


   Primary: Active queue management, such as fair queueing: [Demers89a]


Random early detection: [Floyd93a]


XCP and non-TCP congestion control: [Katabi02a]


Supplementary:
Router buffer sizing: [Beheshti08a]


A recent look at a two-bit feedback from routers: [Xia05a]


5 Differentiated and Integrated Services

Class 7 (Feb. 26):
   Primary: Quality of service and admission control: [Shenker95a]


Lighter-weight QoS: [Stoica03a]

Supplementary:
Resource reservation and RSVP: [Zhang93a]


Use of QoS and differentiated services: [Davie03a]


6 Wireless and Mobile Networking

Class 8 (Mar. 5):

Primary:
MAC protocols: [Bharghavan94a]


DSR, an ad hoc routing protocol: [Johnson96c]


Non-IP routing in sensor networks: [Intanagonwiwat00a]


Wireless propagation characteristics: [Aguayo04a]


Supplementary:
TCP interactions with wireless: [Balakrishnan97c]


City-wide WiFi evaluation [Afanasyev08a]


A survey of sensor net research: [Heidemann04a]

7  Midterm and Spring Break

Class 9 (Mar. 12): midterm exam The midterm exam will be half of the class period, with lecture the other half.

Spring break: March 19, no class.

8  Modeling Network Traffic

Class 10 (Mar. 26):

Primary:
Self-similarity in LAN traffic: [Leland94a]


And in WAN and web traffic: [Crovella97a]


Supplementary:
More information about potential causes of self-similarity: [Feldmann99a]


Packet-level network dynamics: [Paxson99b]


9  Web, Content Delivery, and Large Scale Services

Class 11 (Apr. 2):

Primary:
While most of the class focuses on protocols that connect things, this class focuses on how one builds data services that can sit at one end of the connection. For more in this direction, see CSci555 (graduate operating systems).

Building large-scale services [Fox97a]

(The [Dean04a] paper about map/reduce belongs here.)

**Supplementary:**

Web caching and cache consistency: [Wolman99a]


NEW SP2010: Content distribution: [Freedman04a]


Supplemental to map/reduce:
The Google file system, useful to support fault-tolerant and local data access: [Ghemawat03a]


## 10 Multicast Routing, Transport, and Applications

### Class 12 (Apr. 9):

**Primary:**

Multicast routing (flood-and-prune, rendezvous): [Deering88b]


Reliable multicast and SRM: [Floyd97c]


File distribution and coding: [Byers98a]


**Supplementary:**

An alternate take at multicast: [Holbrook99a]


Multicast at the application layer: [Chu02b]

Layered multicast, congestion control, and multimedia/video: [McCanne96a]


Multimedia: [Bolot98a]


### 11 Network Security

**Class 13** (Apr. 16):

Primary: Denial of service attacks: [Hussain03b]


(NEW SP2010) Spam countermeasures: [Xie08a]


*Supplementary:*

Worms and viruses: [Moore03a]


Subverting routing with prefix hijacking: [Ballani07a]


Worm propagation: [Staniford02a]


(Note that, in this class, we intentionally do not do the cryptographic side of network security. There is coverage of that material in CSci555, Graduate Operating Systems, and most of CSci530, Security Systems, is about that.)

Unfortunately there is not time to talk about security and network protocols in CSci551. CSci555 provides a good coverage of security from an operating systems perspective; see the papers by Vojdack and Kent and Needham and Schroder there.)
12 Peer-to-peer storage

Class 14 (Apr. 23):

Primary:

Freenet and anonymous peer-to-peer file sharing: [Clarke02a]


Efficient peer-to-peer storage: [Stoica00a]


(NEW SP2010) BitTorrent: [Bharambe06a]


Supplementary:

Novel routing with DHTs: [Caesar06a]


(This paper should be with routing, but we’ll talk about it here because it assumes background about Chord.)

Geographical peer-to-peer storage: [Ratnasamy02b]


13 Current topics

Class 15 (Apr. 30):

Primary:

Running an enterprise network: [Casado07b]


(NEW SP2010) Enterprise network fault diagnosis: [Kandula09a]
14 Other Topics

These are topics we cannot cover but that are considered in some similar network courses. All these materials are supplementary.

Supplementary:
Router design: [Partridge98a]


Fast IP lookup in routers: [Degermark97a]


(NEW SP2010) optimizing a datacenter network: [Greenberg09a]


(NEW SP2010) Data-center electrical usage: [Qureshi09a]


Optical networking: [Mukherjee00a]

15 Final Exam

The final exam is Friday, May 7, 8–10 am.