CSci551 Syllabus—FA2014, Tuesday-Thursday 5-6:20pm Section

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August 26, 2014

Class meets Tuesday-Thursday, 5-6:20pm, beginning August 26 and ending December 4. Thanksgiving break (for my class) is November 27 (also my birthday!). The date and time of the final is Thursday, December 11 4:30-6:30pm.

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

2014-08-26: no changes yet.

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 www-bcf.usc.edu/~katzbass/cs551.html and follow the instructions, or contact the professor or TA.

The primary source of content for the class is these papers, so you will want to download and read them. Downloaded they take up about 95MB storage.

A good option for handling the paper is to get some kind of an e-reader. Several class members and the professor did that last year. You need something that can display 8.5x11 inch PDF files comfortably. Android tables work well and several PDF annotators are available (John Heidemann use RepliGo PDF Reader, which is a nice annotator as well). An iPad works well, and several PDF readers and note-taking programs are available. I use an iPad Mini Retina with iAnnotate. John has used a small Kindle, which worked adequately if you can tolerate only seeing half a page at a time. The large Kindle (DX) is good for reading, but John’s experience was that its software doesn’t support note taking over PDF at all. Please let me know if you have any other suggestions.

Printing out the papers is also tried and true, and note taking with pencils works well. If you print the papers out, I strongly encouraged you 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 (2–5MB) 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.)

Class Pace: We will usually go over two or three papers per week, although sometimes more. The syllabus is designed to be slightly front-loaded, with the intent that we will run a paper or two (or sometimes a full
class) behind for part of the semester.

**Primary and Supplemental Papers:** There are two groups of papers. We will discuss *primary* papers in class. The concepts and details from primary papers are fair game in exams. You are encouraged to read the supplemental papers if you’re interested in an area. Additionally, each of you will be required to read and present a few supplemental papers each as part of your coursework. Outside of these student presentations (and any questions you may ask), we will not discuss *supplemental* papers in class, and you are only required to know the details of supplemental papers that you yourself presented in class.

I am happy to take questions about either primary or supplemental papers in class or office hours.

**Other class activities:** This syllabus lists exams and papers. You should also expect a class project, typically in three parts (A, B and C). For homework, you will have to write about some of the papers we read. You will also have to read some of the responses of your classmates and participate in class discussions about the papers. Please note that the class dates are when you are expected to have read the papers. At times during the semester we will probably be behind a couple of papers, but you are encouraged to stay with this syllabus for reading.

1 **Reference and background**

*Supplemental:*

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): [Stevens03a]


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

**Week 1** (Aug. 26 and 28):

Primary: Tips for reading papers: [Hanson99a]


Another viewpoint of paper reading [Jamin03a]


What to look for in systems papers: [Levin83a]

Finding and judging new ideas: (NEW-FA2014) [Heilmeier92a]


No paper, but we will review and discuss: General networking, network addressing.

2 Design principles

Week 2 (Sept. 02 and 04):

Primary: The Internet architecture: [Clark88a]


Naming: [Saltzer82a]


The end-to-end argument: [Saltzer81a]


No paper, but we will review and discuss: data marshaling, packet formats and encoding, SOAP and REST at some point in the first several classes.

Supplemental:

How “tussles” affect network architecture: [Clark02a]


3 Unicast Routing

Week 3 (Sept. 09 and 11):

Primary:

Review of unicast and distance vector routing. (Will use class notes, plus please review your EE450 work.)

BGP introduction: (NEW-FA2014) [Caesar05a]

Routing stability and oscillation (plus a taste of queuing theory): [Shaikh00a]


Routing outages, results, and causes: [Wang06b]


Path inflation: [Spring03a]


*Supplemental:*

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


**Week 4 (Sept. 16 and 18):**

Primary:

(The following paper is out of order, but it’s pulled forward to support the class project.) Onion routing (TOR): [Dingledine04a]


We’ll come back to routing security in the security section of class.

Network topology: (NEW-FA2014) [Oliveira08a]


*Supplemental:*

Routing hierarchy and policy: [Gao01b]


Delay-tolerant networking: [Fall08a]


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

4 Transport protocols, Congestion Control, and Queue Management

Week 5 (Sept. 23 and 25):
Primary: TCP and congestion control: [Jacobson88a]


Congestion control from first principles: [Ramakrishnan90a]


Modeling TCP: [Padhye98a]


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


TCP extensions for a datacenter: [Alizadeh10a]


Modern TCP variations to do better: (NEW-FA2014) [Flach13a]


Congestion control by exhaustive computer search: (NEW-FA2014) [Winston13a]


Week 6 (Sept. 30 and Oct. 2): TCP follow-up. XCP and other transport protocols. Queue management.

Fair queueing.

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

Early drop with CoDel: [Nichols12a]


XCP and non-TCP congestion control: [Katabi02a]


*Supplemental:*

Random early detection: [Floyd93a]


5 Wireless and Mobile Networking

Week 7 (Oct. 07 and 09):

Primary:

MAC protocols: [Bharghavan94a]


Non-IP routing in sensor networks: [Intanagonwiwat00a]


Mobile (cellular) networks: (NEW-FA2014) [Huang13a]


*Supplemental:*

Wireless propagation characteristics: [Aguayo04a]


Wireless security: [Borisov01a]

Wireless software radios: [Bahl09a]


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6 Catchup

**Week 8** (Oct. 14 and 16): We will spend this week catching up on earlier topics.

7 Characterizing Network Traffic

**Week 9** (Oct. 21 and 23):

Primary:

Self-similarity in LAN traffic: [Leland94a]


And in WAN and web traffic: [Crovella97a]


Changes to the network traffic mix: (NEW-FA2014) [Labovitz10c]


*Supplemental:*

Packet-level network dynamics: [Paxson99b]


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8 Cloud Computing and In the Cloud

**Week 10** (Oct. 28 and 30):

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, often the “inside” of the cloud. For more work in this direction, see CSci555 (graduate operating systems) and distributed computing.

Building large-scale services [Fox97a]

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


9 Data Center Networks and Software Defined Networking

What’s the right network to run the apps from the last class?

Week 11 (Nov. 4 and 6):

Optimizing a datacenter network: [Greenberg09a]


Running an enterprise network (Ethane, a parent of OpenFlow): [Casado09a]


Supplemental:

Data-center electrical usage: [Qureshi09a]


An alternative datacenter topology, randomness (NEW-FA2014): [Singla12a]


Programming SDNs: (NEW-FA2014) [Foster13a]


10 Network Architecture Pasts and Future

Week 12 (Nov. 11 and 13):

Primary:

Google’s use of Software Defined Networking for traffic engineering: [Jain13a]
Quality of service and admission control: [Shenker95a]

Information-centric networking: (NEW-FA2014) [Jacobson12a]

Lighter-weight QoS: [Stoica03a]

Use of QoS and differentiated services: [Davie03a]

Routing security: (NEW-FA2014) [Heilman14a]

11 Network Security

Week 13 (Nov. 18 and 20):

Primary:

Spam and anti-spam: [Levchenko11a]

Onion routing (TOR): [Dingledine04a]

[Dingledine04a] see above.

Routing security: (NEW-FA2014) [Heilman14a]

Supplemental:

Denial of service attacks: [Hussain03b]


Worm propagation: [Staniford02a]


End-to-end encryption: (NEW-FA2014) [Popa14a]


(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 Voydock and Kent and Needham and Schroder there.

12 Catchup and Thanksgiving Break

Week 14 (Nov. 25):
We will spend Tuesday catching up on earlier topics. Thursday is Thanksgiving break, so no class.

13 Data: Peer-to-peer, Content Delivery Networks, Distributed Hash Tables

Week 15 (Dec. 5):
Primary:
Efficient peer-to-peer storage: [Stoica00a]


Growth of content-delivery networks: (NEW-FA2014) [Calder13a]

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


Privacy built over BitTorrent in OneSwarm: (NEW-FA2014) [Isdal10a]


14 Network Diagnosis

Detecting problems centrally (header-space analysis, SDNs): (NEW-FA2014) [Kazemian12a]


15 Multicast Routing, Transport, and Applications

Multicast was a major push in networking in the 1990s, and it is standardized, deployed, and used in some niches. However a glut of bandwidth and technical challenges dealing with state (most protocols required per-multicast-group state in routers) means that wide-area IP multicast does not seem to have prospered. The techniques developed in multicast are interesting, worth understanding, and used by some. But as of FA2014, they are all supplemental.

Supplemental:
Multicast routing (flood-and-prune, rendezvous): (for [Deering88b], please read only sections 1–4, pages 85–103): [Deering88b]


Reliable multicast and SRM: (for [Floyd97c], please read only through section 7.1, page 15)) [Floyd97c]


File distribution and coding: [Byers98a]


Multimedia: [Bolot94a]

16 Privacy and Ethics

Supplemental:
Network data collection and differential privacy: [McSherry10a]


17 Other Topics: Hardware and Software in Routers and Devices

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

Supplemental:
Router design: [Partridge98a]


Router software (Click): (NEW-FA2014) [Kohler00a]


Optical networking: [Mukherjee00a]


RFID-inspired energy harvesting networks: (NEW-FA2014) [Liu13a]


18 Final Exam

The final exam is Thursday, December 11 4:30-6:30pm.