CSci551 Syllabus—FA2013, Friday Section

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August 22, 2013

Class meets Fridays, 9am to 11:50am, beginning August 30 and ending December 6. Thanksgiving break (for my class) is November 29 and the the stop period does not intersect classroom days. The date and time of the final is Monday, Dec. 16, 11am–1pm.

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

2013-06-15: 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 `http://www.isi.edu/~johnh/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 (I 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 previously used iAnnotate). I have 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 my 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 day, 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 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.

Other class activities: This syllabus lists exams and papers. You should also expect a class project, typically in three parts (A, B and C), and several homework assignments (often 4, but at least 3 and no more than 6). Dates for these will be given as the semester progresses.

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

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]

S1. **[Peterson00a]** Larry L. Peterson and Bruce S. Davie. *Computer Networks: A Systems Approach*. Morgan Kaufmann Publishers, 2000.

Sockets programming (useful for the project): [Stevens03a]

S2. **[Stevens03a]** W. Richard Stevens, Bill Fenner, and Andrew M. Rudoff. *Unix Network Programming: Volume 1: Networking APIs, Sockets*. Prentice-Hall, third eedition edition, 2003.

(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 (Aug. 30):

Primary: Tips for reading papers: [Hanson99a]

P1. **[Hanson99a]** Michael J. Hanson. Efficient reading of papers in science. Brochure of unknown origin, revised 1999 by Dylan J. McNamee, 1989.

Another viewpoint of paper reading [Jamin03a]

P2. **[Jamin03a]** Sugih Jamin. Paper reading and writing check lists. web page `http://irl.eecs.umich.edu/jamin/courses/eecs589/papers/checklist.html`, November 2003.

What to look for in systems papers: [Levin83a]

P3. **[Levin83a]** Roy Levin and David D. Redell. An evaluation of the ninth SOSP submissions, or how (and how not) to write a good systems paper. *ACM Operating Systems Review*, 17(3):35–40, July 1983.

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

2 Design principles

Class 2 (Sept. 6):

No paper, but will discuss: BGP routing.

Primary: The Internet architecture: [Clark88a]

P4. [Clark88a] David D. Clark. The design philosophy of the DARPA internet protocols. In *Proceedings of the 1988 Symposium on Communications Architectures and Protocols*, pages 106–114. ACM, August 1988.

Naming: [Saltzer82a]

P5. [Saltzer82a] Jermome H. Saltzer. On the naming and binding of network destinations. In *International Symposium on Local Computer Networks*, pages 311–317, April 1982.

The end-to-end argument: [Saltzer81a]

P6. [Saltzer81a] J. H. Saltzer, D. P. Reed, and D. D. Clark. End-to-end arguments in system design. *Proceedings of the 2nd International Conference on Distributed Computing Systems*, pages 509–512, April 1981.

No paper, but we will review and discuss: data marshaling, packet formats and encoding, SOAP and REST.

Supplementary:
How "tussles" affect network architecture: [Clark02a]

S3. [Clark02a] David D. Clark, John Wroclawski, Karen Sollins, and Robert Braden. Tussle in cyberspace: Defining tomorrow's internet. In *Proceedings of the ACM SIGCOMM Conference*, pages 347–356, Pittsburgh, PA, USA, August 2002. ACM.

Ways to design the next Internet? [Anderson05a]

S4. [Anderson05a] Thomas Anderson, Larry Peterson, Scott Shenker, and Jonathan Turner. Overcoming the Internet impasse through virtualization. *IEEE Computer*, 38(4):34–41, April 2005.

3 Unicast Routing

Class 3 (Sept. 13):

Primary:

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

Routing stability and oscillation: [Shaikh00a]

P7. [Shaikh00a] Aman Shaikh, Lampros Kalampoukas, Rohit Dube, and Anujan Varma. Routing stability in congested networks: Experimentation and analysis. In *Proceedings of the ACM SIGCOMM Conference*, pages 163–174, Stockholm, Sweeden, August 2000. ACM.

Routing outages, results, and causes: [Wang06b]

P8. **[Wang06b]** Feng Wang, Zhuoqing Morley Mao, Jia Wang, Lixin Gao, and Randy Bush. A measurement study on the impact of routing events on end-to-end Internet path performance. In *Proceedings of the ACM SIGCOMM Conference*, pages 375–386, Pisa, Italy, August 2006. ACM.

Path inflation (NEW FA2013): [Spring03a]

P9. **[Spring03a]** Neil Spring, Ratul Mahajan, and Thomas Anderson. Quantifying the causes of path inflation. In *Proceedings of the ACM SIGCOMM Conference*, pages 113–124, Karlsruhe, Germany, August 2003. ACM.

Supplementary:
BGP route convergence time: [Labovitz00a]

S5. **[Labovitz00a]** Craig Labovitz, Abha Ahuja, Abhijit Abose, and Farnam Jahanian. Delayed Internet routing convergence. In *Proceedings of the ACM SIGCOMM Conference*, pages 175–187, Stockholm, Sweeden, August 2000. ACM.

Supplement with detailed BGP information: [Stewart99a]

S6. **[Stewart99a]** John W. Stewart. *BGP4 Inter-Domain Routing in the Internet.* Addison-Wesley, 1999.

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

S7. **[Floyd94b]** S. Floyd and V. Jacobson. The synchronization of periodic routing messages. *ACM/IEEE Transactions on Networking*, 2(2):122–136, April 1994.

Effects of of network outages, and detecting them in odd data sources: [Turner10a]

S8. **[Turner10a]** Daniel Turner, Kirill Levchenko, Alex C. Snoeren, and Stefan Savage. California fault lines: Understanding the causes and impact of network failures. In *Proceedings of the ACM SIGCOMM Conference*, pages 315–326, New Delhi, India, August 2010. ACM.

Other BGP background references: `http://www.academ.com/nanog/feb1997/BGPTutorial/` and `http://www.ittc.ku.edu/EECS/EECS_800.ira/bgp_tutorial/`

Class 4 (Sept. 20):

Primary:

Network topology (NEW FA2013): [Oliveira08a]

P10. **[Oliveira08a]** Ricardo V. Oliveira, Dan Pei, Walter Willinger, Beichuan Zhang, and Lixia Zhang. In search of the elusive ground truth: the Internet's AS-level connectivity structure. In *Proceedings of the ACM SIGMETRICS*, pages 217–228. ACM, June 2008.

(The following paper is out of order, but it's pulled forward to support the class project.)

Project background: [Stoica00a]

P11. **[Stoica00a]** Ion Stoica, Robert Morris, David Karger, M. Frans Kaashoek, and Hari Balakrishnan. Chord: A scalable peer-to-peer lookup service for Internet applications. In *Proceedings of the ACM SIGCOMM Conference*, pages 149–160, Stockholm, Sweden, September 2000. ACM.

Supplementary:
Routing hierarchy and policy: [Gao01b]

S9. [**Gao01b**] Lixin Gao. On inferring autonomous system relationships in the Internet. *ACM/IEEE Transactions on Networking*, 9(6):733–745, December 2001.

Delay-tolerant networking: [Fall08a]

S10. [**Fall08a**] Kevin Fall and Stephen Farrell. DTN: An architectural retrospective. *IEEE Journal of Selected Areas in Communication*, 26(5):828–837, June 2008.

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

S11. [**Griffin99a**] Timothy G. Griffin and Gordon Wilfong. An analysis of BGP convergence properties. In *Proceedings of the ACM SIGCOMM Conference*, pages 277–288, Cambridge, MA, USA, September 1999. ACM.

4 Transport protocols, Congestion Control, and Queue Management

Class 5 (Sept. 27):

Primary: TCP and congestion control: [Jacobson88a]

P12. [**Jacobson88a**] Van Jacobson. Congestion avoidance and control. In *Proceedings of the ACM SIGCOMM Conference*, pages 314–329, Stanford, California, USA, August 1988. ACM.

Congestion control from first principles: [Ramakrishnan90a]

P13. [**Ramakrishnan90a**] K. K. Ramakrishnan and Raj Jain. A binary feedback scheme for congestion avoidance in computer networks. *ACM Transactions on Computer Systems*, 8(2):158–181, May 1990.

Modeling TCP: [Padhye98a]

P14. [**Padhye98a**] J. Padhye, V. Firoiu, D. Towsley, and J. Kurose. Modelling TCP throughput: A simple model and its empirical validation. In *Proceedings of the ACM SIGCOMM Conference*, pages 303–314, Vancouver, Canada, September 1998. ACM.

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

S12. [**Cerf74a**] Vint Cerf and Robert Kahn. A protocol for packet network interconnection. *IEEE Transactions on Communications*, COM-22(5):637–648, May 1974.

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

S13. [**Brakmo94a**] L. S. Brakmo, S. W. O'Malley, and L. L. Peterson. TCP Vegas: New techniques for congestion detection and avoidance. In *Proceedings of the ACM SIGCOMM Conference*, pages 24–35. ACM, September 1994.

TCP extensions for a datacenter (NEW FA2013): [Alizadeh10a]

S14. [**Alizadeh10a**] Mohammad Alizadeh, Albert Greenberg, David A. Maltz, Jitendra Padhye, Parveen Patel, Balaji Prabhakar, Sudipta Sengupta, and Murari Sridharan. Data center TCP (DCTCP). In *Proceedings of the ACM SIGCOMM Conference*, New Delhi, India, August 2010. ACM.

Class 6 (Oct. 4): TCP follow-up. XCP and other transport protocols. Queue management. Fair queueing.

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

P15. **[Demers89a]** Alan Demers, Srinivasan Keshav, and Scott Shenker. Analysis and simulation of a fair queueing algorithm. In *Proceedings of the ACM SIGCOMM Conference*, pages 1–12, Austin, Texas, September 1989. ACM.

Early drop with CoDel: [Nichols12a]

P16. **[Nichols12a]** Kathleen Nichols and Van Jacobson. Controlling queue delay. *Communications of the ACM*, 55(7):42–50, July 2012.

XCP and non-TCP congestion control: [Katabi02a]

P17. **[Katabi02a]** Dina Katabi, Mark Handley, and Charlie Rohrs. Congestion control for high bandwidth-delay product networks. In *Proceedings of the ACM SIGCOMM Conference*, pages 89–102, Pittsburgh, PA, USA, August 2002. ACM.

Supplementary:
Random early detection: [Floyd93a]

S15. **[Floyd93a]** Sally Floyd and Van Jacobson. Random early detection gateways for congestion avoidance. *ACM/IEEE Transactions on Networking*, 1(4):397–413, August 1993.

Router buffer sizing: [Beheshti08a]

S16. **[Beheshti08a]** Neda Beheshti, Yashar Ganjali, Monia Ghobadi, Nick McKeown, and Geoff Salmon. Experimental study of router buffer sizing. In *Proceedings of the 8th ACM Internet Measurement Conference*, pages 197–210, Vouliagmeni, Greece, October 2008. ACM.

5 Wireless and Mobile Networking

Class 7 (Oct. 11):

Primary:

MAC protocols: [Bharghavan94a]

P18. **[Bharghavan94a]** Vaduvur Bharghavan, Alan Demers, Scott Shenker, and Lixia Zhang. MACAW: A media access protocol for wireless LANs. In *Proceedings of the ACM SIGCOMM Conference*, pages 212–225, London, UK, September 1994. ACM.

Non-IP routing in sensor networks: [Intanagonwiwat00a]

P19. **[Intanagonwiwat00a]** Chalermek Intanagonwiwat, Ramesh Govindan, and Deborah Estrin. Directed diffusion: A scalable and robust communication paradigm for sensor networks. In *Proceedings of the ACM International Conference on Mobile Computing and Networking*, pages 56–67, Boston, MA, USA, August 2000. ACM.

Wireless propagation characteristics: [Aguayo04a]

P20. **[Aguayo04a]** Daniel Aguayo, John Bicket, Sanjit Biswas, Glenn Judd, and Robert Morris. Link-level measurements from an 802.11b mesh network. In *Proceedings of the ACM SIGCOMM Conference*, pages 121–132, Portland, Oregon, USA, August 2004. ACM.

Supplementary:

DSR, an ad hoc routing protocol: [Johnson96c]

S17. [Johnson96c] David B. Johnson and David A. Maltz. *Dynamic Source Routing in Ad Hoc Wireless Networks*, chapter 5, pages 153–181. Kluwer Academic Publishers, 1996. in Mobile Computing, edited by Tomasz Imielinski and Hank Korth.

TCP interactions with wireless: [Balakrishnan97c]

S18. [Balakrishnan97c] Hari Balakrishnan, Venkata N. Padmanabhan, and Randy H. Katz. The effects of asymmetry on TCP performance. In *Proceedings of the ACM/IEEE International Conference on Mobile Computing and Networking*, pages 77–89, Budapest, Hungary, September 1997. ACM.

Wireless security (NEW FA2013): [Borisov01a]

S19. [Borisov01a] Nikita Borisov, Ian Goldberg, and David Wagner. Intercepting mobile communications: The insecurity of 802.11. In *Proceedings of the ACM International Conference on Mobile Computing and Networking*, pages 180–189, Rome, Italy, July 2001. ACM.

Wireless software radios: [Bahl09a]

S20. [Bahl09a] Paramvir Bahl, Ranveer Chandra, Thomas Moscibroda, Rohan Murty, and Matt Welsh. White space networking with Wi-Fi like connectivity. In *Proceedings of the ACM SIGCOMM Conference*, pages 27–39, Barcelona, Spain, August 2009. ACM.

6 Midterm

Class 8 (Oct. 18): **midterm exam** The midterm exam will be half of the class period, with lecture the other half.

7 Modeling Network Traffic

Class 9 (Oct. 25):

Primary:

Self-similarity in LAN traffic: [Leland94a]

P21. [Leland94a] W.E. Leland, M.S. Taqqu, W. Willinger, and D.V. Wilson. On the self-similar nature of Ethernet traffic (extended version). *ACM/IEEE Transactions on Networking*, 2(1):1–15, February 1994.

And in WAN and web traffic: [Crovella97a]

P22. [Crovella97a] Mark E. Crovella and Azer Bestavros. Self-similarity in world wide web traffic: evidence and possible causes. *ACM/IEEE Transactions on Networking*, 5(6):835–846, December 1997.

Datacenter traffic (NEW FA2013): [Benson10a]

P23. [Benson10a] Theophilus Benson, Aditya Akella, and David A. Maltz. Network traffic characteristics of data centers in the wild. In *Proceedings of the ACM Internet Measurement Conference*, pages 267–280, Melbourne, Victoria, Australia, November 2010. ACM.

Supplementary:
Interactions between network traffic and topology: [Labovitz10c]

S21. **[Labovitz10c]** Craig Labovitz, Scott Iekel-Johnson, Danny McPherson, Jon Oberheide, and Farnam Jahanian. Internet inter-domain traffic. In *Proceedings of the ACM SIGCOMM Conference*, pages 75–86, New Delhi, India, August 2010. ACM.

Packet-level network dynamics: [Paxson99b]

S22. **[Paxson99b]** Vern Paxson. End-to-end Internet packet dynamics. *ACM/IEEE Transactions on Networking*, 7(3):277–292, June 1999.

8 Cloud Computing

Class 10 (Nov. 1):

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]

P24. **[Fox97a]** Armando Fox, Steven D. Gribble, Yatin Chawathe, Eric A. Brewer, and Paul Gauthier. Cluster-based scalable network services. In *Proceedings of the 16th Symposium on Operating Systems Principles*, pages 78–91, St. Malo, France, October 1997. ACM.

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

P25. **[Dean04a]** Jeffrey Dean and Sanjay Ghemawat. MapReduce: Simplified data processing on large clusters. In *Proceedings of the USENIX Symposium on Operating Systems Design and Implementation*, pages 137–150, San Francisco, California, USA, December 2004. USENIX.

9 Data Center Networks and Software Defined Networking

Optimizing a datacenter network: [Greenberg09a]

P26. **[Greenberg09a]** Albert Greenberg, James R. Hamilton, Navendu Jain, Srikanth Kandula, Changhoon Kim, Parantap Lahiri, David A. Maltz, and Parveen Pat. VL2: A scalable and flexible data center network. In *Proceedings of the ACM SIGCOMM Conference*, pages 51–62, Barcelona, Spain, August 2009. ACM.

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

P27. **[Casado09a]** Martin Casado, Michael J. Freedman, Justin Pettit, Jianying Luo, Natasha Gude, Nick McKeown, and Scott Shenker. Rethinking enterprise network control. *ACM/IEEE Transactions on Networking*, 17(4):1270–1283, August 2009.

Supplementary:
Middle boxes and cloud computing: [Sherry12a]

S23. **[Sherry12a]** Justine Sherry, Shaddi Hasan, Colin Scott, Arvind Krishnamurthy, Sylvia Ratnasamy, and Vyas Sekar. Making middleboxes someone else's problem: Network processing as a cloud service. In *Proceedings of the ACM SIGCOMM Conference*, pages 13–24, Helsinki, Finland, August 2012. ACM.

OpenFlow, a descendant of Ethane: [McKeown08a]

S24. **[McKeown08a]** Nick McKeown, Tom Anderson, Hari Balakrishnan, Guru Parulkar, Larry Peterson, Jennifer Rexford, Scott Shenker, and Jonathan Turner. OpenFlow: enabling innovation in campus networks. *ACM Computer Communication Review*, 38(2):69–74, March 2008.

Data-center electrical usage: [Qureshi09a]

S25. **[Qureshi09a]** Asfandyar Qureshi, Rick Weber, Hari Balakrishnan, John Guttag, and Bruce Maggs. Cutting the electric bill for Internet-scale systems. In *Proceedings of the ACM SIGCOMM Conference*, pages 123–135, Barcelona, Spain, August 2009. ACM.

Evaluation of Cloud computing: [Li10a]

S26. **[Li10a]** Ang Li, Xiaowei Yang, Srikanth Kandula, and Ming Zhang. CloudCmp: Comparing public cloud providers. In *Proceedings of the ACM Internet Measurement Conference*, pages 1–14, Melbourne, Victoria, Australia, November 2010. ACM.

Data center topology/routing co-design: [Liu13b]

S27. **[Liu13b]** Vincent Liu, Daniel Halperin, Arvind Krishnamurthy, and Thomas Anderson. F10: A fault-tolerant engineered network. In *Proceedings of the USENIX Symposium on Network Systems Design and Implementation*, pages 399–412, 2013.

10 Network Architecture Past and Future: Quality of Service, Differentiated/Integrated Services, and Information-Centric Networking

Class 11 (Nov. 8):

Primary: Quality of service and admission control: [Shenker95a]

P28. **[Shenker95a]** Scott Shenker. Fundamental design issues for the future Internet. *IEEE Journal of Selected Areas in Communication*, 13(7):1176–1188, September 1995.

Google's use of Software Defined Networking for traffic engineering (NEW FA2013): [Jain13a]

P29. **[Jain13a]** Sushant Jain, Alok Kumar, Joon Ong Subhasree Mandal, Leon Poutievski, Arjun Singh, Subbaiah Venkata, Jim Wanderer, Junlan Zhou, Jonathan Zolla Min Zhu, Urs Hölzle, Stephen Stuart, and Amin Vahdat. B4: Experience with a globally-deployed software defined WAN. In *Proceedings of the ACM SIGCOMM Conference*, page to appear, Hong Kong, China, August 2013. ACM.

Information-centric networking: [Jacobson09a]

P30. **[Jacobson09a]** Van Jacobson, Diana K. Smetters, James D. Thornton, Michael F. Plass, Nicholas H. Briggs, and Rebecca L. Braynard. Networking named content. In *Proceedings of the 5th ACM Conference on Emerging Networking Experiments and Technologies*, pages 1–12, Rome, Italy, December 2009. ACM.

Supplementary:
Lighter-weight QoS: [Stoica03a]

S28. [Stoica03a] Ion Stoica, Scott Shenker, and Hui Zhang. Core-stateless fair queueing: a scalable architecture to approximate fair bandwidth allocations in high-speed networks. *ACM/IEEE Transactions on Networking*, 11(1):33–46, February 2003.

Use of QoS and differentiated services: [Davie03a]

S29. [Davie03a] Bruce Davie. Deployment experience with differentiated services. In *Proceedings of the ACM Workshop on Revisiting IP QoS*, pages 131–136, Karlsruhe, Germany, August 2003. ACM.

11 Network Security

Class 12 (Nov. 15):

Primary:

Spam and anti-spam: [Levchenko11a]

P31. [Levchenko11a] Kirill Levchenko, Andreas Pitsillidis, Neha Chachra, Brandon Enright, Márk Félgyházi, Chris Grier, Tristan Halvorson, Chris Kanich, Christian Kreibich, He Liu, Damon McCoy, Nicholas Weaver, Vern Paxson, Geoffrey M. Voelker, and Stefan Savage. Click trajectories: End-to-end analysis of the spam value chain. In *Proceedings of the IEEE Symposium on Security and Privacy*, pages 431–446, Oakland, CA, USA, May 2011. IEEE.

Onion routing (TOR): [Dingledine04a]

P32. [Dingledine04a] Roger Dingledine, Nick Mathewson, and Paul Syverson. Tor: The second-generation onion router. In *Proceedings of the 13th USENIX Security Symposium*, pages 303–320, San Diego, CA, USA, August 2004. USENIX.

Supplementary:
Also possible BGP and spam (NEW FA2013): [Ramachandran06a]

S30. [Ramachandran06a] Anirudh Ramachandran and Nick Feamster. Understanding the network-level behavior of spammers. In *Proceedings of the ACM SIGCOMM Conference*, pages 291–302, Pisa, Italy, September 2006. ACM.

Denial of service attacks: [Hussain03b]

S31. [Hussain03b] Alefiya Hussain, John Heidemann, and Christos Papadopoulos. A framework for classifying denial of service attacks. In *Proceedings of the ACM SIGCOMM Conference*, pages 99–110, Karlsruhe, Germany, August 2003. ACM.

Spam in Twitter: [Thomas11a]

S32. [Thomas11a] Kurt Thomas, Chris Grier, Vern Paxson, and Dawn Song. Suspended accounts in retrospect: An analysis of Twitter spam. In *Proceedings of the ACM Internet Measurement Conference*, pages 243–258, Berlin, Germany, November 2011. ACM.

Worm propagation: [Staniford02a]

S33. [Staniford02a] Stuart Staniford, Vern Paxson, and Nicholas Weaver. How to 0wn the Internet in your spare time. *Proceedings of the 11th USENIX Security Symposium*, pages 149–167, August 2002.

(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 Peer-to-peer and Content Delivery Networks

Class 13 (Nov. 22):

Primary:

(Here is the correct location for [Stoica00a].)

Efficient peer-to-peer storage: [Stoica00a]

[Stoica00a] see above.

BitTorrent (NEW FA2013): [Piatek07a]

P33. [Piatek07a] Michael Piatek, Tomas Isdal, Thomas Anderson, Arvind Krishnamurthy, and Arun Venkataramani. Do incentives build robustness in BitTorrent? In *Proceedings of the 4th USENIX Symposium on Network Systems Design and Implementation*, pages 1–14. USENIX, April 2007.

Content-delivery systems (NEW FA2013): [Saroiu02b]

P34. [Saroiu02b] Stefan Saroiu, Krishna P. Gummadi, Richard J. Dunn, Steven D. Gribble, and Henry M. Levy. An analysis of internet content delivery systems. In *Proceedings of the Fifth USENIX Symposium on Operating Systems Design and Implementation*, pages 315–327, Boston, Mass., USA, December 2002. USENIX.

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

S34. [Clarke02a] Ian Clarke, Theodore W. Hong, Scott G. Miller, Oskar Sandberg, and Brandon Wiley. Protecting free expression online with Freenet. *IEEE Internet Computing*, 6(1):40–49, February 2002.

Novel routing with DHTs: [Caesar06a]

S35. [Caesar06a] Matthew Caesar, Tyson Condie, Jayanthkumar Kannan, Karthik Lakshminarayanan, Ion Stoica, and Scott Shenker. ROFL: Routing on flat labels. In *Proceedings of the ACM SIGCOMM Conference*, pages 363–374, Pisa, Italy, September 2006. ACM.

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

13 Thanksgiving Break

Thanksgiving break and no class on Nov. 26.

14 Multicast Routing, Transport, and Applications

Class 14 (Dec. 6):

Primary:

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

P35. **[Deering88b]** Stephen E. Deering. Multicast routing in internetworks and extended LANs. In *Proceedings of the ACM SIGCOMM Conference*, pages 55–64, Stanford, CA, August 1988. ACM.

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

P36. **[Floyd97c]** Sally Floyd, Van Jacobson, Ching-Gung Liu, Steven McCanne, and Lixia Zhang. A reliable multicast framework for light-weight sessions and application level framing. *ACM/IEEE Transactions on Networking*, 5(6):784–803, December 1997.

Supplementary:
File distribution and coding: [Byers98a]

S36. **[Byers98a]** John W. Byers, Michael Luby, Michael Mitzenmacher, and Ashutosh Rege. A digital fountain approach to reliable distribution of bulk data. In *Proceedings of the ACM SIGCOMM Conference*, pages 56–67, Vancouver, Canada, September 1998. ACM.

Multicast at the application layer: [Chu02b]

S37. **[Chu02b]** Yang hua Chu, Sanjay G. Rao, Srinivasan Seshan, and Hui Zhang. A case for end system multicast. *IEEE Journal of Selected Areas in Communication*, 20(8):1456–1471, October 2002.

Multimedia: [Bolot94a]

S38. **[Bolot94a]** Jean-Chrysostome Bolot, Thierry Turlettil, and Ian Wakeman. Scalable feedback control for multicast video distribution in the Internet. In *Proceedings of the ACM SIGCOMM Conference*, pages 58–67, London, United Kingdom, September 1994. ACM.

15 Privacy and Ethics

Primary:

Ethics of data collection (NEW FA2013): [Bailey12a]

P37. **[Bailey12a]** Michael Bailey, David Dittrich, Erin Kenneally, and Doug Maughan. The Menlo report. *IEEE Symposium on Security and Privacy*, 10(2):71–75, March 2012.

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

S39. **[McSherry10a]** Frank McSherry and Ratul Mahajan. Differentially-private network trace analysis. In *Proceedings of the ACM SIGCOMM Conference*, pages 123–134, New Delhi, India, August 2010. ACM.

16 Other Topics: Router and Hardware Design

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

Supplementary:
Router design: [Partridge98a]

S40. [Partridge98a] Craig Partridge, Steve Kohalmi, Tracy Ma, John Mcallen, Trevor Mendez, Walter C. Milliken, Ronald Pettyjohn, John Rokosz, Joshua Seeger, Michael Sollins, Steve Storch, Philip P. Carvey, Benjamin Tober, Gregory D. Troxel, Ed Burgess, Isidro Castineyra, Tom Clarke, Lise Graham, Michael Hathaway, Phil Herman, and Allen King. A fifty gagabit per second IP router. *ACM/IEEE Transactions on Networking*, 6(3):237–248, June 1998.

Optical networking: [Mukherjee00a]

S41. [Mukherjee00a] Biswanath Mukherjee. WDM optical communication networks: Progress and challenges. *IEEE Journal of Selected Areas in Communication*, 18(10):1810–1824, October 2000.

17 Final Exam

The final exam is **Monday, December 16, 11am–1pm**.