COMP 535 -- Computer Networks

September 2009

General Information

Instructor:	Muthucumaru Maheswaran
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Office:	Room 754, McConnell Engineering Building

Office hours:	MW 2:00-3:30pm. Appointments can be made for meetings at other times.
Email:	Please use SOCS email for urgent email. For other messages (particularly with large attachments) use WebCT mail.
Class:	MW 16:35-17:55 ENGTR 0070
Tutorial:	TBA
Prerequisites:	CS 310 or ECSE 427 (or any Operating Systems course)
Class web page:	`http://www.cs.mcgill.ca/~cs535`. (used for GINI information only). See WebCT for all other information.
TAs:	Ning Jia, other TA (TBA)
TA office hours:	TBA

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Brief Course Description

This is a senior undergraduate/first-year graduate course in computer networks. We will examine computer networks within the context of the Internet. It will build on prior knowledge in operating systems, basic algorithms, and C programming. We will study the fundamental principles, elements, and protocols of computer networks. We will investigate how the different protocols work, why they work that way, and their performance trade-offs. Using this knowledge, we will try to examine the way applications are deployed on the Internet and their performance trade-offs. In particular, we will try to examine some strategies that are commonly used to accelerate application-level performance in the context of the operation of the Internet.

By the end of the course, you should be able to: (i) explain the operation of a range computer networking applications such as email, web, and peer-to-peer file-sharing; (ii) relate the architecture of the Internet to the underlying design principles; (iii) illustrate the operation of common routing protocols, queuing mechanisms, and congestion control mechanisms; (iv) develop elements of a network such as gateways and routers that conform to IETF standards with acceptable levels of simplification and (v) explain the performance of a given set of routing protocols, queuing mechanisms, and congestion control mechanisms on an example network.

Course Schedule

Week	Topics	Book chapters/ sections	Papers	Other
Sep. 2	Course outline, organization, Networks – the Big Picture (Anatomy of Networks and particularly the Internet)	1		
Sep. 7	Introduction to GINI; Simple internetworking; example scenarios; packet routing within a LAN, connecting LANs	4.1, 4.4		GINI handout Assignment #1 (LAN conf.) given out
Sep. 14	Networking applications: DNS, email, traditional apps, Overlay, multimedia applications	2.1-2.2, 2.4-2.6, 2.6, 7.1-7.2		Assignment #2 (DNS and Email conf.) given out
Sep. 21	Network applications; More on GINI			
Sep. 28	Routing; Internet topology; autonomous systems; network attacks, vulnerabilities, denial of service	4.5		Assignment #3 (denial of service attacks) given out
Oct. 05	Network vulnerabilities, Intra AS routing; RIP and OSPF routing protocols, inter-AS routing; BGP	4.6		
Oct. 12	Network protection; firewalls; network intrusions & detection			Assignment #4 (firewalls and intrusions) given out
Oct. 19	Network security fundamentals; end-to-end security; protocols; SSL	8		Assignment #5 (network hijacking) given out
Oct. 26	Framing, Transport services, reliable data transfer, SR, GBN, UDP, TCP, streaming protocols, congestion control	3.1-3.5		Assignment #6 (UDP design and impl.) given out

Nov. 2	Multicasting algorithm, End system support for multicasting; multicasting in Linux	4.7		
Nov. 9	IPv6 and other "Next generation" protocols			Assignment #7 given out handout
Nov. 16	Wireless links, characteristics, multiple access protocols, wireless LANs	5.3, 6.1-6.3		Optional Assignment #8 given out
Nov 23	Wireless LANs (cont)			

Instructional Method

The course will consist of three hours of instructor led classes per week together with a *maximum* of one hour of tutorial per week taken by the TAs. The class time will be devoted to the presentation and development of new concepts and the application of these concepts to examples and problems, while the tutorials will discuss solutions to the programming projects and other assignments.

Course Materials

Textbooks

Required text: James Kurose and Keith Ross, *Computer Networking: A Top-Down Approach Featuring the Internet, 4th Edition,* Addison-Wesley.

Supplementary or Reference texts:

[1] Douglas Comer and David Stevens, *Internetworking with TCP/IP, Volume II, Design, Implementation, and Internals,* Prentice-Hall, 1999.

[2] Larry Paterson and Bruce Davie, *Computer Networks: A Systems Approach, 2nd Edition,* Morgan Kaufmann, 2003.

[3] Radia Perlmann, *Interconnections, 2nd Edition,* Addison-Wesley, 2000.

[4] Christian Huitema, *Routing in the Internet, 2nd Edition,* Prentice-Hall, 2000.

Paper List:
I have divided the papers into the following groups.

Internet Naming: These papers will cover Internet naming provided by DNS and its issues.

[IN-1] V. Ramasubramanian and E. Gun-Sirer, "Perils of transitive trust in the domain name system," *Internet Measurement Confereence,* 2005.

[IN-2] V. Ramasubramanian and E. G. Sirer. The Design and Implementation of a Next Generation Name Service for the Internet. In Proc. of ACM SIGCOMM, Portland, OR, Aug. 2004.

[IN-3] P. Mockapetris and K. Dunlop. Development of the Domain Name System. In Proc. of ACM SIGCOMM, Stanford, CA, 1988.

Network Applications: These papers will cover networking applications. We have overlay applications from real-time communications and file sharing.

[NA-1] An Analysis of Internet Content Delivery Systems, Stefan Saroiu, Krishna P. Gummadi, Richard J. Dunn, Steven D. Gribble, and Henry M. Levy, Proceedings of the 5th Symposium on Operating Systems Design and Implementation (OSDI), Boston, MA, December 2002.

[NA-2] An Analysis of the Skype Peer-to-Peer Internet Telephony, SA Baset, H Schulzrinne - Arxiv preprint cs.NI/0412017, 2004 - arxiv.org.

[NA-3] A Measurement Study of a Large-Scale P2P IPTV System, X Hei, C Liang, J Liang, Y Liu, KW Ross, IPTV Workshop, International World Wide Web Conference, 2006.

Denial of Service and Traffic Shaping: These papers discuss network denial of service attacks and how traffic shaping/filtering can counter those threats. *** TBD ***

Network Security: Session Hijacking and Remedial Measures: These papers discuss how we can prevent network level vulnerabilities that allow attackers to hijack network sessions. We will look into papers that discuss implementable techniques to remedy this situation.

Network Intrusions: Scanning, Firewalling, Intrusion prevention and detection: These papers discuss how we can prevent network level scanning. In particular various advancements in firewalling will be examined.

Network Attacks: Phishing, Spoofing, and other forms of attacks and remedial measures

Network Resource Allocation: Packet Queuing, Congestion Control, and Fairness

Networking and Multicasting Protocols: We will investigate network-layer versus end-system multicasting using papers.

[MP-1] S. Ratnasamy, A. Ermolinskiy, and S. Shenker, "Revisiting IP Multicast," ACM SIGCOMM, 2006.

[NP-2] J. Saltzer, D. P. Reed, and D. D. Clark, "End-to-End Arguments in System Design," ACM Transactions on Computer Systems, Nov. 1984.

[NP-3] D. Clark and D. Tennenhouse, "Architectural Considerations for a New Generation of Protocols," ACM SIGCOMM, 1990.

IPv6 and Next Generation Protocols: We will look at one paper on IPv6 and another on alternative approaches for next generation network protocols. IPv6 is not a true next generation protocol. It is a protocol for extending current generation into next!
*** TBD ***

Wireless Networks: Fundamental issues in wireless networking.

[W-1] A survey on wireless mesh networks, Akyildiz, I.F., Xudong Wang, IEEE Communications Magazine, Sep. 2005.

Assignments and Evaluation

Activity	Percentage
Quizzes (**best 8 out of 10**)	24%
Paper summaries (**best 8 out of 10**)	24%
Assignment #1 (setup and test LANs)	5%
Assignment #2 (DNS and Email setup and test)	5%
Assignment #3 (network denial of service and counter measures)	5%
Assignment #4 (network firewalls and intrusion testing)	5%
Assignment #5 (network hijacking and security)	5%
Assignment #6 (implement datagram protocol)	10%
Assignment #7 (implement multicasting)	17%
Assignment #8 (your idea in networks)**	10%
Total	**100% (110% with A#8)**

Undergraduate students: letter grades will be out of 100%. Assignment 8 is not available for undergraduates. You are welcome to propose your idea for a COMP 400 or ECSE 474 project!

Graduate students: letter grades will be out of 110%. You need to complete Assignment #8 to score 110%. Propose your idea for Assignment #8. It should have a component for

design and implementation. Ideas that only involve reading papers and writing a report are not suitable unless you can make a valid case for an exception. Suppose you have X points after doing all your assignments, quizzes, and papers. I will compute an effective marks (X/110)*100. This will be used in assigning the letter grade.

ALL activities except Quizzes are done in groups (at most three).
GROUP work – all members of a group should be involved in doing all aspects of the course. DO NOT split the workload such that one member does the programming assignments and another person does the reading assignments. This is prohibited.

Quizzes: These are in class quizzes. We will use 10-15 minutes of class time to do the quiz. Each quiz will cover preceding reading, lecture, assignment (reading) material. Given the short duration, quizzes are going to include simple questions that are going to ascertain familiarity with the overall concepts.

Paper summaries: I will be assigning papers on a topic that should be read before certain classes. For some reading assignments you might have to read more than 1 paper. With more than 1 paper, you can divide the papers among the group members. After reading the papers individually discuss the papers and then write a summary based on your collective finding. With certain paper assignments, I will post questions for which you need to find answers. Some of the questions will be discussion oriented. That is, the paper would not directly answer the question. Read the paper and reflect on the question and paper before you answer the question. You could read additional papers if you are interested to find more information. If you happen to read additional papers (not Wikipedia entries), please cite them in your summaries/answers. This will definitely influence the marks you get for the summaries. You submit one summary per group will all the group members listed there.

The summary you turnin should describe the main ideas of the papers in your own words. Please do not copy the abstract of the papers or just reword them. The suggested approach is to read the paper one or more times and then write the summary. Your summary should be greater than 1 page and less than 2 pages. No summaries longer than 2 pages.

Programming assignments: The programming assignments will be based on GINI – a toolkit we developed at McGill for teaching and learning computer networks. The programming assignments get harder towards the end. First ***five*** assignments don't need programming. They require configuring, observing networks in action, and explaining the behavior. Last ***two*** assignments require C programming. You will add new features into the gRouter (the virtual router provided as part of the GINI toolkit).

Late assignment/project policy: There will be two deadlines for each assignment: proper deadline and cut-off date. After the proper deadline, there will be a penalty of 10%

for each day the assignment is late until the cut-off date. After the cut-off date, the assignment cannot be handed in. No individual requests for extensions will be granted unless they are for medical reasons.

The deadlines will be set for 11:55 pm or 11:59pm. Please observe the time and date very carefully. It is your responsibility to make sure that the assignment is properly submitted via the WebCT.

Grading/Regrading Policy: For certain assignments, we will schedule meetings with you for a demonstration of your assignment. This is the quickest way of grading your assignment. The demos are usually done in groups. It is the responsibility of the group members to demonstrate equal proficiency in the assignment material. If it is established that one group member has done more work and other member is not engaged in the process, different assignment grades will be given.