Exam Policies and Format

Prior to the Exam

1. Students taking the Systems & Networking Ph.D. qualifying exam are strongly encouraged to take two 500-level courses from different professors prior to taking the exam (that is, in semesters before the semester in which the exam is taken), selected from the Course Requirements list below.
2. When registering to take the exam with the Academic Office, each student must provide a qual statement. This statement should be 200 words long, should be written by the student taking the exam, and should consist of the following parts:
    a. Description of student's general core research area (100 words)
    b. Description of research that the student works on or has worked on and is in their research interest area (100 words)
    c. List of two papers that the student found interesting in their research area, and which are not on the basic reading list
    d. Ranking (from 1-4) of the subareas relevant to the student's research, among the list of subareas in the Reading List below. The student's primary area should be ranked 1. Two of the six subareas may be unranked, indicating that the exam will skip these areas: the student is not expected to read papers in these areas, and will not be tested on these papers during oral questions.
3. The qual statement is an important document as it is used (1) by the system-and-networking chair to select two appropriate presentation papers that are relevant to student's core research area, (2) by the qualifying committee to understand what the student's research area is and where the student should have strong background knowledge, (3) by the qualifying committee to provide some evaluation of the student's writing skills.
4. Each student will be assigned two (2) research papers by the area chair at least 2 weeks prior to the qual exam. Students will be informed by the chair's secretary of the date, time, location and papers list.
5. Prior to the exam, each student is expected to read the two assigned research papers, related work to the two assigned research papers, and all papers from the reading list other than those in the subarea they have chosen to skip.
6. Each student is expected to prepare one presentation per research paper. As a guideline, we recommend preparing no more than 10 slides and no more than a 20 minute long presentation per paper.

During the Exam

1. The student will present the two assigned research papers. The student will be examined on these papers in substantial depth. Students should be prepared to be interrupted during the presentations and take any questions related to the assigned papers and/or to the related work of the presented papers and/or reading list papers that are related to the assigned two research papers. The student should be prepared to answer all kinds of questions around the two research papers, including questions about principal ideas, theoretical analysis (e.g., prove the correctness of the algorithm X), systems design decisions, experiments, limitations of the paper, and other related questions. Be aware that students may be asked to not present all prepared slides, due to questions and time constraints.

2. The student will be examined on the papers in the reading list posted on the web site. For the papers on the reading list that are in the student's declared area(s) of research, the qualifying exam committee will ask any types of questions in substantial detail, as on the two assigned presentation papers. For the papers on the reading list that are outside of the declared research area(s), the student must know the answers to questions related to main ideas of the papers, basic questions, and conceptual questions. For papers in the area identified to be skipped, the student will not be asked questions.

Course Requirements

Students taking the Systems & Networking qualifying exam are strongly encouraged to take two 500-level courses from different professors prior to taking the exam (that is, in semesters before the semester in which the exam is taken), selected from the following list of courses:

1. CS 523 - Advanced Operating Systems
2. CS 525 - Advanced Distributed Systems
3. CS 537 - Advanced Topics in Internet of Things
4. CS 538 - Advanced Computer Networking
5. CS 541 - Computer Systems Analysis
6. CS 563 - Advanced Computer Security
7. CS 598 HPN - High-Speed/Programmable Networks
8. CS 598 RAP - Storage Systems
9. CS 598 WSI - Advanced Wireless Networks and IoT
10. CS 598 MS - ML + Data Systems
11. CS 598 AIE - AI Efficiency: Systems And Algorithms
12. CS and ECE 500 level courses with a regular number that are approved by the student's advisor or the area chair

Reading List

Cyber-Physical Systems

- Scheduling Algorithms for Multiprogramming in a Hard-Real-Time Environment. C. L. Liu, J. W. Layland, Journal of the ACM, Volume 20, Issue 1, Jan. 1973.
- Cyber Physical Systems: Design Challenges. E. A. Lee. 11th IEEE International Symposium on Object and Component-Oriented Real-Time Distributed Computing (ISORC), 2008.
- Sparsification and Separation of Deep Learning Layers for Constrained Resource Inference on Wearables. S. Bhattacharya, Proceedings of the 14th ACM Conference on Embedded Network Sensor Systems, 2016.
- Reactive Control of Autonomous Drones. E. Bregu, N. Casamassima, D. Cantoni, L. Mottola, K. Whitehouse, Proceedings of the 14th Annual International Conference on Mobile Systems, Applications, and Services, 2016.
- Limiting the Impact of Stealthy Attacks on Industrial Control Systems. D. I. Urbina, J. Giraldo, A. A. Cardenas, N. O. Tippenhauer, J. Valente, M. Faisal, J. Ruths, R. Candell, H. Sandberg, Proceedings of the 2016 ACM SIGSAC Conference on Computer and Communications Security, Oct. 2016.

Distributed Systems

- Time, clocks, and the ordering of events in a distributed system. L. Lamport, CACM, vol. 21, no. 7, Jul. 1978.
- Chord: a scalable peer-to-peer lookup service for Internet applications. I. Stoica, R. Morris, D. Karger, M. F. Kaashoek, H. Balakrishnan, Proc. ACM SIGCOMM, 2001.
- Dynamo: Amazon's highly available key-value store. G. DeCandia, D. Hastorun, M. Jampani, G. Kakulapati, A. Lakshman, A. Pilchin, S. Sivasubramanian, P. Vosshall, W. Vogels, Proc. ACM SOSP, 2007.
- In Search of an Understandable Consensus Algorithm. D. Ongaro, J. Ousterhout, USENIX ATC, 2014.
- Practical Byzantine Fault Tolerance. M. Castro, B. Liskov, OSDI, 1999.

Machine Learning Systems

- Efficient Large-Scale Language Model Training on GPU Clusters Using Megatron-LM. Deepak Narayanan, Mohammad Shoeyb, Jared Casper, Patrick LeGresley, Mostofa Patwary, Vijay Korthikanti, Dmitri Vainbrand, Prethvi Kashinkunti, Julie Bernauer, Bryan Catanzaro, Amar Phanishayee, Matei Zaharia, 2021.
- TVM: An Automated End-to-End Optimizing Compiler for Deep Learning. Tianqi Chen, Thierry Moreau, Ziheng Jiang, Lianmin Zheng, Eddie Yan, Meghan Cowan, Haichen Shen, Leyuan Wang, Yuwei Hu, Luis Ceze, Carlos Guestrin, Arvind Krishnamurthy, USENIX OSDI, 2018.
- Towards Federated Learning at Scale: System Design. Keith Bonawitz, Hubert Eichner, Wolfgang Grieskamp, Dzmitry Huba, Alex Ingerman, Vladimir Ivanov, Chloe Kiddon, Jakub Konečný, Stefano Mazzocchi, H. Brendan McMahan, Timon Van Overveldt, David Petrou, Daniel Ramage, Jason Roselander. 2nd SysML Conference, 2019.
- The Case for Learned Index Structures. Tim Kraska, Alex Beutel, Ed H. Chi, Jeffrey Dean, Neoklis Polyzotis, ACM SIGMOD, 2018.
- Ray: A Distributed Framework for Emerging AI Applications. Philipp Moritz, Robert Nishihara, Stephanie Wang, Alexey Tumanov, Richard Liaw, Eric Liang, Melih Elibol, Zongheng Yang, William Paul, Michael I. Jordan, Ion Stoica, USENIX OSDI, 2018.

Networking

- The Design Philosophy of the DARPA Internet Protocols. D. Clark, ACM SIGCOMM, 1988.
- Congestion avoidance and control. V. Jacobson, M. Karels, Proc. ACM SIGCOMM, 1988.
- Ethane: Taking Control of the Enterprise. M. Casado, M. Freedman, J. Pettit, J. Luo, N. McKeown, S. Shenker, ACM SIGCOMM, 2007.
- Achieving High Utilization with Software-Driven WAN. C. Hong, S. Kandula, R. Mahajan, M. Zhang, V. Gill, M. Nanduri, R. Wattenhofer, ACM SIGCOMM, 2013.
- How Secure are Secure Interdomain Routing Protocols? S. Goldberg, M. Schapira, P. Hummon, and J. Rexford. ACM SIGCOMM, 2010.

Operating Systems

- The Performance of Microkernel-Based Systems. H. Härtig, M. Hohmuth J. Liedtke, S. Schönberg, J. Wolter, SOSP, 1997.
- Machine-Independent Virtual Memory Management for Paged Uniprocessor and Multiprocessor Architectures. R. Rashid, A. Tevanian, M. Young, D. Golub, R. Baronn, D. Black, W. Bolosky, and J. Chew, ASPLOS-II, October 1987.

- The Design and Implementation of a Log-Structured File System. M. Rosenblum and J. K. Ousterhout, SOSP '91, December 1991.
- Xen and the Art of Virtualization. P. Barham, B. Dragovic, K. Fraser, S. Hand, T. Harris, A. Ho, R. Neugebauery, I. Pratt, A. Warfield, SOSP, 2003.
- Can We Make Operating Systems Reliable and Secure? A. S. Tanenbaum, J. N. Herder, H. Bos, IEEE Computer, vol. 39, no. 5, May, 2006.

Wireless and Mobile Systems

- Cross-layer wireless bit rate adaptation. M. Vutukuru, H. Balakrishnan, K. Jamieson, ACM SIGCOMM, 2009.
- Fine-grained Channel Access in Wireless LAN. K. Tan, J. Fang, Y. Zhang, S. Chen, L. Shi, J. Zhang, Y. Zhang, ACM SIGCOMM, 2010.
- RADAR: an in-building RF-based user location and tracking system. P. Bahl, V. N. Padmanabhan, Proc. IEEE INFOCOM, 2000.
- Odessa: enabling interactive perception applications on mobile devices. M. Ra, A. Sheth, L. Mummert, P. Pillai, D. Wetherall, R. Govindan, MobiSys, 2011.
- DolphinAttack: Inaudible Voice Commands. G. Zhang, C. Yan, X. Ji, T. Zhang, T. Zhang, W. Xu, ACM CCS 2017.