CSE 490h/CSE M552: Distributed Systems

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Class meetings: MWF 9:30 – 10:20, EEB 003
Sections: Thursdays 8:30-9:20, 9:30 – 10:20, MOR 225
      Instructor Office Hours: Mondays, 2:30 – 3:30
      http://www.cs.washington.edu/490h/

Motivation: Distributed systems have become central to many aspects of how computers are used, from web applications to e-commerce to content distribution. This senior-level course will cover abstractions and implementation techniques for the construction of distributed systems, including client server computing, the web, cloud computing, peer-to-peer systems, and distributed storage systems. Topics will include remote procedure call, preventing and finding errors in distributed programs, maintaining consistency of distributed state, fault tolerance, high availability, and distributed security. As we believe the best way to learn the material is to build it, there will be a substantial programming project. Two versions of the course will be offered simultaneously: CSE 490h to undergraduates, and CSE M552 to students in the fifth year masters program.

Student Deliverables:

- Course project to be done in teams of 2-3
- An optional (490h) or required (M552) add-on to the project
- Foundational readings in distributed systems
- Blog entry answering one thought question per paper (M552 only)
- Two problem sets
- Final exam

Textbook, Papers and Blogs: There is no textbook for this course. Instead, we will assign research papers for specific lectures; the readings are to be done before class, as we will take the papers as a starting point, not the end point of the class discussion.

For each assigned paper except the first, we will post a discussion question, linked off the course web page. M552 students are required to post a short, unique comment or observation to the discussion by 8am on the day of the class. Valid posts can be to take a position on a design choice in the paper, to discuss the applicability of the paper to an important problem, to point out a problem in some other student’s argument, etc. CSE 490h students are invited to add comments for extra credit but are not required to do so. Everyone should read the posted comments before class.
**Project:** The core of the course is the project: to design and build a fault tolerant peer-to-peer Facebook application by the end of the quarter. The project is to be done in groups of 2-3 people. The project has five pieces, each building on the previous ones, due roughly every two weeks. This is a very aggressive schedule and so we need every group to get an early start on the assignments. We will provide you some basic message passing code as well as a framework for simulating and emulating a distributed system to aid in debugging.

The first project assignment is to build a simple client-server storage system. We then add cache coherence, crash recovery and high availability to this basic system. The final assignment is to use these pieces to construct a fault tolerant Facebook application that can run without a central server, on a cluster of nodes in the undergraduate PC lab. M552 students will be required to extend the basic design in some interesting way, e.g., to add support for disconnected operation. CSE 490h students may do so for extra credit.

To help provide you time to complete the project, we set aside weeks 8 and 10 as “hack weeks” with no lectures or sections. We will also automatically grant each group three slip days for the project assignments, for you to use at your discretion. Regardless, the final assignment must be turned by March 15.

Details about the project assignments will be provided in a separate handout.

**Problem Sets:** There will be two problem sets handed out during the quarter. The problem sets are to be done individually and are intended to reinforce the basic material covered in the class, and to help prepare students for the final exam. Problem sets are due in section.

**Collaboration/Cheating:** In our experience, students often learn more from each other than they do from the instructor. Thus, we encourage you to collaborate with your classmates, in all aspects of the course. The grading in the class is emphatically not curved; we would like nothing better than for all of you to get a 4.0.

To draw a very clear line, you may use any idea from any other person or group in the class or out, provided you clearly state what you have borrowed and from whom. If you do not provide a citation -- that is, you turn other people’s work in as your own -- that’s cheating. Anything else is fair game. Of course, we’ll be grading you on the ideas you’ve added, but you should always borrow as much as you can as a starting point – there’s no point in reinventing the wheel.

**Final:** The final for this class will be held Wednesday, March 16 at 8:30am. Project demonstrations will be held at various times on Tuesday, March 15.

**Grading (490h):** Project: 50%; problem sets 15%; final: 35%

**Grading (M552):** Project: 50%; problem sets 15%; blogs: 5%; final: 30%
**Tentative Syllabus:** Readings to be done *before* class

1/3: Introduction

Read: Google. Introduction to Distributed System Design. 
http://code.google.com/edu/parallel/dsd-tutorial.html

**Part 1: Client/Server**

1/5: Remote procedure call


Read: Google, Protocol Buffers Developer Guide. 
http://code.google.com/apis/protocolbuffers/docs/overview.html

1/7: Remote method invocation


1/10: Distributed debugging (guest lecture: TBD)

Read: Lamport, Time, Clocks and the Ordering of Events in a Distributed System, CACM 1978. (up to, not including, the section on physical clocks)

**Part 2: Memory consistency and cache coherence**

1/12: Cache coherence, part 1


1/14: Cache coherence, part 2

1/14: **Project part 1 due: client-server**

1/17: **MLK**

1/19: Eventual consistency

Part 3: Failure recovery and Fault Tolerance

1/21: Transactions


1/24: Distributed Transactions, part 1

Read: Bernstein, Hadzilacos, and Goodman. Distributed Recovery. Chapter 7 in Concurrency Control and Recovery in Database Systems. (up to, and not including, three phase commit)

1/26: Distributed Transactions, part 2

1/28: Project part 2 due: cache coherence

1/31: Paxos, part 1


2/2: Paxos, part 2

2/4: GFS


Part 4: Cloud Programming

2/7: MapReduce


2/8: Problem set #1 due

2/9: Dryad

2/11: BigTable

Read: Chang et al. BigTable: Distributed Storage System for Structured Data. OSDI 2006.

2/11: Project part 3 due: distributed transactions

2/14: Dynamo


Part 5: Beyond the Cloud

2/16: PNUTS

Read: Cooper et al. PNUTS: Yahoo’s Hosted Data Serving Platform, VLDB 2008

2/18: DNS


Presidents Day/Hack Week: 2/21 – 2/25

2/25: Project part 4 due: paxos

2/28: BitTorrent


3/2: Distributed Security


3/4: Wrapup


Hack Week: 3/7 – 3/11

3/8: Problem set #2 due
3/14: Project part 5 due: peer to peer Facebook
3/14: M552 project add-on due
3/15: Project demonstrations
3/16: Final Exam, 8:30am – 10:20