

CPS 512: Distributed * Systems

Fall 2015

Class Meetings

TTh 3:05 - 4:20 in D106 LSRC

Instructor

[Jeff Chase](#)

Office hours: W 2:00 - 3:00 in D306 LSRC, or by appointment, or try a drop-in.

Teaching Assistant

Max Demoulin

[CPS 512](#) is an advanced course in distributed and networked systems. This offering of CPS 512 will focus on core concepts in distributed systems, using geo-distributed mega-services in the cloud as a motivation and driving example. Well-designed cloud applications are layered above common service platforms that handle the hard problems: tracking groups of participating servers (views), distributing state and functions across a group, coordinating control and ownership of data, managing consensus, and recovering from server and network failures. The course focuses on the design of these service platforms and their abstractions.

Although the course covers the fundamentals, the emphasis is on practical technologies and their limitations. This course includes an important software technology component. We will do some projects using the [Scala](#) language and the [Akka](#) actor system for scalable ``reactive'' applications. Programming labs include a key-value application, a leased lock service, atomic transactions, and a consensus service. There will also be a course project of your choosing.

The course divides loosely into three parts. The first part covers basic problems and abstractions, focusing on elastic key-value stores as an example. In the second part, we dive deeper into foundational distributed systems topics that underlie these systems: quorum replication, logical time and causality, eventual consistency with vector clocks, views and leader election, and consensus. The third part shifts focus to secure Internet-scale systems with multiple identities and federation, showing how cryptosystems are used to manage naming, identity, and authorization. We introduce *trust logic* as a formalism for building secure networked systems, and use it to represent the Internet security architecture and cloud access control. A detailed plan of topics is available on the course web [\[PDF\]](#).

Preparation. You should be familiar with undergraduate-level computer architecture and operating systems, and consider yourself a strong student and a good programmer. We will ask you to program in C and perhaps other languages. You should be comfortable with Unix concepts and the Unix command interface: see the [CSL tutorials](#).

Readings. There is no required textbook. Readings for this course consist of tutorials, surveys, and research papers written by researchers in networked systems. The readings are available through the course website. This course does not emphasize reading of research papers: the purpose of the readings is to support the concepts presented in lectures. Exams cover only the material discussed in class and represented on the lecture slides.

Base workload. In addition to the readings, there are four assigned programming labs, two midterm exams, and a final exam. An important element of the course is a semester project on a related topic of your choosing, with a short presentation. The labs may be done individually or in pairs, and the project may be a group effort. Here are the dates for Fall 2015:

- Sep 17 (Th) Scala/Akka warmup: publish-subscribe service using a key-value store
- Oct 1 (Th) Lab #2: lease/lock service
- Oct 5 (M) Project proposal (a few paragraphs)

- Oct 6 (T) Midterm exam
- Oct 20 (T) Lab #3: atomic transactions
- Nov 3 (T) Midterm exam
- Nov 10 (T) Lab #4: consensus
- Dec XX Project demo/presentation, reports due
- Dec 8 (T) Final exam (7:00 PM - 10:00 PM)

Late work. Late work receives a penalty of 5% per day, depending on circumstances. It is much better to do the work and hand it in late than to receive a zero on an assignment.

Assistance. We will provide online assistance through Piazza: see the course web. Please post your questions there. Anonymous posting is allowed: please maintain a high standard of civility. The instructor holds regular office hours (posted on the course web) and is available at other times by arrangement. Drop-bys are welcome as time allows. If you are having trouble or just want to talk, please visit!

Attendance and participation. Attendance or lack of attendance in class/recitation is not recorded. However, the class is small enough that I will know each of you, and it is expected that you will attend and participate actively. In particular, you should prepare questions or opinions about the reading, and I may call upon you to speak in class. We may also have occasional short written quizzes during class.

Grading. The semester grade is determined from your exam grades (50%) and lab/project work (50%). I will make adjustments of up to half a letter grade for participation, engagement, and quiz results. Additional information about grading policies, project, and exams is available on the course web.

Policy on collaboration for CPS 512. The Duke Community Standard applies in all aspects of this course: we value your honor and your honesty. Collaboration on lab work and project work is encouraged. Help each other. However, any work you turn in must be your own, and you may be called upon to explain (alone) your choices and approaches in more detail. You may incorporate public software into your assigned lab work and course project to a reasonable extent, but not so much as to undermine the educational purpose and spirit of the project. You must acknowledge any sources of your words, ideas, and software when they are not your own, and *you must disclose in advance, without any specific request, any sources you used.* Sharing code among students taking the course *in the same semester* is allowable by *mutual consent*, however it is strongly discouraged and it will not improve your grade. Do not use code from a student who took the course in a previous semester. All students should understand that we have software that flags copied code with a high degree of certainty and precision. (The tools do not differentiate the makers from the takers.) No assistance of any kind is acceptable during exams.