MPhil in Advanced Computer Science
Advanced Topics in Computer Systems

Leader:	Steven Hand
Timing:	Michaelmas
Prerequisites:	None
Structure:	8× 2-hour seminar sessions (weekly)

AIMS

This module will attempt to provide an overview of "systems research". This is a broad field which has existed for over 40 years and which has historically included areas such as operating systems, database systems, file systems, distributed systems and networking, to name but a few. The course will thus necessarily cover only a tiny subset of the field.

Many good ideas in systems research are the result of discussing and debating previous work. A primary aim of this course therefore will be to educate students in the art of *critical thinking*: the ability to argue for and/or against a particular approach or idea. This will be done by having students read and critique a set of papers each week. In addition, each week will include presentations from two or more participants which aim respectively to advocate or criticise each piece of work.

SYLLABUS

The syllabus for this course will vary from year to year so as to cover a mixture of older and more contemporary systems papers. Contemporary papers will be generally selected from the past 5 years, primarily drawn from high quality conferences such as SOSP, OSDI, ASPLOS, FAST, NSDI and EuroSys.

The schedule for the current year is:

1. Intro: Systems Research & System Design (Lampson, Salzer & Schroeder)

2. OS Structure & Virtual Memory (VMS, Mach, L4)

3. Systems Virtualization (Disco, Xen, VMware)

4. Security Architectures (Capability Systems, DIFC, Asbestos)

5. Weakly Consistent Distributed Storage (Ficus, Bayou, S3)

6. Approaches to Byzantine Fault Tolerance (PBFT, Q/U, Zyzzva, HQ)

7. DataCenter Systems (MapReduce, GFS/Bigtable, Dryad/DryadLINQ)

8. Multicore Operating Systems (K42, Corey, Barrelfish)

Papers references (in parentheses) are indicative, and the full and final list will appear on the course web page before the start of the module.

The reading each week will generally involve a load equivalent to 2–3 full length papers. Students will be expected to read these in detail and prepare a written summary and critique according to the following criteria:

- Summarize the paper (no more than 250 words)

- Answer the following (no more than 750 words in total)

  1. What problem are they trying to solve?

     (a) Why is it important?

     (b) How is it not solved by earlier work?

  2. What is their approach?

     (a) How does it solve the problem?

     (b) How is solution unique and innovative?

     (c) What are the details?

  3. How do they evaluate their solution?

     (a) What is the methodology?

     (b) What questions do they answer?

     (c) What are the strengths and weaknesses?

  4. What do you think?

  5. What future work does this suggest?

In addition, each week will contain one or more short presentations by students for each paper. The types of presentation will include:

- Overview: a balanced presentation of the paper, covering both +ve and -ve aspects.

- Advocacy: a positive spin on the paper, aiming to convince others of its value.

- Criticism: a negative take on the paper, focusing on its weak spots and omissions.

These presentation roles will be assigned in advance, regardless of the *soi disant* absolute merit of the paper or the preference of the student.

All students, regardless of any assigned presentation rôle in a given week, will be expected to participate in the class by asking questions and generally entering the debate.

OBJECTIVES

On completion of this module students should have a broad understanding of some key papers and concepts in computer systems research, as well as an appreciation of how to argue for or against any particular idea.

COURSEWORK & PRACTICAL WORK

Coursework will be the production of the weekly paper reviews. Practical work will be presenting papers as appropriate, as well as ongoing participation in the class.

ASSESSMENT

Participants on this course will be awarded a percentage score which will be made up from the following two components:

1. 75% : for paper reviews submitted on-time each week; grades here will be fed back on a week-by-week basis.

2. 25% : for presentation, attendance and participation; this will be awarded by the course assessor at the end of the course.

RECOMMENDED READING

Most of the reading for this course will be in the form of the selected papers each week. However the following may be useful background reading to refresh your knowledge from undergraduate courses:

- *Operating Systems Concepts (5th Ed.)*
  Silberschatz, Peterson and Galvin, Addison Wesley 1998.

- *Modern Operating Systems (3rd Ed.)*
  Tanenbaum, Prentice-Hall 2008

- *Operating Systems*
  Bacon and Harris, Addison Wesley, 2003

- *The Design and Implementation of the 4.3BSD UNIX Operating System*
  Leffler, Addison Wesley 1989

- *Inside Windows 2000 (3rd Ed)* or *Windows Internals (4th Ed)*
  Solomon and Russinovich, Microsoft Press 2000 [2005]

- *Computer Architecture: a Quantitative Approach* (3rd edition)
  Hennessy and Patterson, Morgan Kaufmann 2003

- *Advanced Concepts in Operating Systems*
  Singhal and Shivaratris, McGraw-Hill, 1994

- *Capability-Based Computer Systems*
  Levy, Digital Press, 1984

Last updated: May 2009