15-740/18740 Computer Architecture Fall 2010
Project Statement

1   Important Dates

Proposal Due	September 27th
Milestone 1 Report Due	October 13th
Milestone 2 Report Due	November 1st
Milestone 3 Report Due	November 19th
Final Presentations	November 29th - December 3rd
Poster Session	December 8th - December 10th (tentative)
Final Report Due	December 12th (Hard deadline)

All reports should be submitted via blackboard as pdf files.

2   Introduction

In this project, you will improve the state-of-the-art and understanding in computer architecture by developing new architecture techniques or designing extensions to techniques presented in class or a recent architecture conference. The purpose of this project is to propose, conduct, and generate publication-quality research and to improve the state of the art. The project report will be in the form of a research article similar to those we have been reading and discussing in class. High-quality projects and reports will likely have a chance to be submitted to a top computer architecture conference (ISCA, MICRO, ASPLOS, HPCA) or systems (OSDI, SOSP, USENIX, USENIX Security, DSN) conference.

The project will account for 35% of your final course grade. It will be graded out of 100 points. The tentative breakdown is as follows:

Proposal	10 Points
Milestone	10 Points
Final Presentations & Poster	40 Points
Final Report	40 Points

All members of the team are expected to contribute equally to the project. At each milestone, we will ask each member to evaluate every other member's contribution to the project.

3   Advice

Get started early. Choose a topic that is exciting and important. Plan well. Do not procrastinate. Work hard. This is not a project in which you can leave all the work to the last week, last month, or even the last 1.5 months. Make sure you make steady progress *every* week.

When in doubt, meet with us during appointment or office hours. Conducting research is a time-consuming experience and choosing a topic you are excited about is an important part of it. Carefully choose your topic and write up your proposal after doing extensive literature search and consulting with the TAs and me.

4 Proposal

The proposal is a written two-page document including the following:

- **Problem definition and motivation**: What problem is the intended project trying to solve? Why is it important and/or interesting?

- **A brief survey of related work**: What is the most relevant previous research that was published on the problem? Why previous research did not solve this problem (fully) or why could previous research be (possibly) wrong or incomplete? Please explain in detail how this prior work relates to your proposed work. The CALCM web page (www.ece.cmu.edu/CALCM) has links to online IEEE and ACM proceedings. Conferences that primarily focus on architecture research are ISCA, ASPLOS, MICRO, HPCA, SIGMETRICS, ISLPED, and DSN. Other relevant systems conferences are OSDI, SOSP, USENIX (all variants). You can search the online pages and/or contact us for pointers. The World Wide Computer Architecture web page www.cs.wisc.edu/ arch/www is a good source of information.

- **A brief description of how you plan to solve the problem** (This does not have to be complete, but you are encouraged to provide initial ideas which can later change during the course of your discovery and experimentation)

- **A description of your experimental methodology/setup** including modifications you plan to make to the simulation/evaluation environment of your choice.

- **A brief research plan**: What is your goal? What are the steps you will take to achieve your goal? What do you expect to see in each Milestone (1 and 2)? How would you change your plan if your hypotheses are not supported as you gather intuition and experimental data on the problem?

5 Milestone 1

You shall have successfully brought up your research infrastructure and tested the potential/initial benefits of your ideas by this milestone. This milestone will ensure that you have successfully brought up the infrastructure you will need for your project and conducted initial studies and experiments. Furthermore, you must demonstrate the problem your project attacks using this experimental infrastructure. For example, you might need to bring up a simulation framework and reproduce some baseline case or prior results as a starting point for your own work. This milestone consists of two parts:

1. You will hand in a two-page (double-column, single-spaced) writeup describing:

   - The current status of the project (what have you done so far)
   - The infrastructure you are using for the project
   - The demonstration of the research problem you are planning to solve using the infrastructure
   - Any changes to your research/evaluation plans you outlined in the proposal (must be justified with data and analyses)

2. You will make an appointment to meet with one of us (faculty or TA team) to present your own results motivating your project and explain how your infrastructure is suitable for your project. The appointments are made by filling out an appointment sheet in class the week prior to the meetings.

6 Milestone 2

You should be well ahead in your research project by now, generating results, trying out new ideas that you did not think of before, and coming up with new insights. The purpose of this milestone is to ensure that you are well ahead in executing your research plan. The milestone consists of two parts:

1. You will hand in a two-page (double-column, single-spaced) write-up describing:

   - The results you have obtained
   - Your understanding of the reliability and validity of these preliminary results

   Based on the results, what are your plans for the rest of the project? What kind of analyses will you conduct? What kind of techniques you will develop and evaluate? How and why did your original research plan change (if it did)? (Again, changes must be backed up with data and analyses)

2. You will make an appointment to meet with one of us (faculty or TA team) to go over the project status. The appointments are made by filling out an appointment sheet in class the week prior to the meetings.

7 Milestone 3

By this milestone, you should have most of your project complete and running smoothly. The purpose is to provide feedback so that you can improve your work. You will hand in a two-page report and arrange a meeting with one of us to discuss your progress, similarly to other milestones.

8 Final Report

You will hand in a report in the conference submission style. **Your final report should be formatted and written as if you are submitting the report to a top computer architecture conference (ISCA, MICRO, ASPLOS, HPCA)**. The report should include the following:

- A descriptive title and author names
- Abstract
- Introduction (Problem and Motivation)
- Related Work and its Shortcomings
- Description of the Techniques (designed and evaluated)
- Evaluation Methodology
- Results and Analyses
- Conclusion/Summary
- Lessons Learned, Shortcomings, and Future Work
- Acknowledgements (if any)
- References (cited throughout the paper)

The page limit is 10 double-column, single-spaced pages. Make sure your document is spell-checked and grammatically sound.

9 Final Presentation/Poster

In the last week of classes and during the final exam time we will hold presentation session(s) and a poster session in which teams get to present their projects and findings orally. More information on this will follow.

10   Best Projects

The top projects in class will be selected for submission to a computer systems conference for publication. In the past a number of papers from 740/741/742 have become full-blown research projects. For example, Yoongu Kim and Dongsu Han's ATLAS paper on "multiple memory controller scheduling" that appeared in HPCA 2010 was a 741 (now renumbered 740) project in Spring'09. Similarly, another Spring 2009 project, "Congestion Control on Bufferless Ingterconnects," will appear as a HotNets 2010 paper very soon. Other projects that appeared in top conferences include the "SMARTS" paper on simulation sampling that appeared in ISCA 2003, and the "Spatial Pattern Prediction" paper that appeared in HPCA 2004, and subsequently in ISCA 2006.

11   Evaluation Techniques and Inrastructure

You are welcome to use any infrastructure, tools, and benchmarks/applications that satisfy the needs of your project. However, you will need to justify why you use the infrastructure you choose. There are many simulation infrastructures available to perform experimental computer architecture research. Some of the tools you might find useful are:

- Internal CMU simulators (ask us)

- Simplescalar (contains timing models)

- PTLSim (contains timing models)

- GEMS (contains timing models)

- Pin dynamic binary instrumentation tool (no timing models)

- Simics (very crude timing models)

- Garnet (interconnection network simulator)

- Flexus (contains timing models)

These and other simulators can be found at `http://www.cs.wisc.edu/arch/www/tools.html`

Note that your proposed project does not have to use a simulator for evaluation. You can design real hardware, FPGA implementations, or even provide theoretical analyses. You only need to convincingly justify that your methodology is valid and satisfactory for the purposes of the project you propose.