The University of Arizona
Department of Electrical and Computer Engineering

Term Paper for ECE 568 Fall 2005

The term project for this semester is an independent study on a selected area of computer architecture design. It requires reading of research literature, analysis of existing or proposed techniques, and some synthesis of new ideas. Your investigation should be based on up-to-date information through scientific journals, conference proceedings, high-tech and trade magazines, technical manuals supplied by manufacturers, etc. Do not just make a list or summary of existing references on a particular area.

A professionally documented report is required. The report should be technically informative and highly written (it must be typed). There is no page limit on the report (anywhere from 15 printed single-space pages to 30 is fine). Each person is expected to turn in his own report. Your work should be done individually and independently; no collaboration is allowed except for sharing references. Turn in your final complete typed report no later than December 11, 2005. It should have an abstract describing the nature of the work and major results obtained, an introduction, a detailed analysis of the subject area, conclusions, references, and possibly, although not required, future work to be done in that area (just some suggestions, in case someone else wants to expand your work). References should be written according to the IEEE format (see any IEEE published paper for an example).

The grade for the report is as follows: Written report: depth (25 %), significance (20 %), originality (20 %), organization and quality of the writing (20 %), technical accuracy of the results and references (15 %).

Milestone Dates:

1. By December 11, 2005, please provide the final report.
   Submit by e-mail to avinashk@ece.arizona.edu

Sources of Information

Let me first tell you how to go by getting the appropriate reference to start your project. Good places to look in are:

2. IEEE Transactions on Computers,
4. IEEE Parallel and Distributed Technology
5. Proceedings of the IEEE
6. Journal of Parallel and Distributed Computing
7. IEEE Network
10. IEEE Journal on Selected Areas in Communications
11. Journal of Lightwave Technology
12. Applied Optics
13. Optics Letters
14. Proceedings of

- International Conference on Parallel Processing (ICPP)
- International Conference on Supercomputing (ICS)
- International Symposium on Computer Architecture (ISCA)
- High Performance Computer Architecture (HPCA)
- International Parallel and Distributed Processing Symposium (IPDPS)
- and several other conferences and symposia.

15. There are also several books on the subjects. You may see me if you need more sources.

- Interconnection Networks, an Engineering Approach By Jose Duato, Sudhakar Yalamanchilli and Lionel Ni
- Interconnection Networks for Large-Scale Parallel Processing By Howard Jay Siegel
- Interconnection Networks for Multiprocessors and Multicomputers: Theory and Practice By Anujan Verma and C.S.Raghavendra
- Introduction to Parallel Algorithms and Architectures : Arrays, Trees, Hypercubes By F. Thomson Leighton
- Parallel Computer Architecture, A Hardware/Software Approach By David E. Culler Jaswinder Pal Singh with Anoop Gupta
- Optical Networks, A Practical Perspective By Rajiv Ramaswami and Kumar N. Sivarajan
- Principles of Interconnection Networks By William Dally and Brian Towles

16. There is also the web.

- http://www.hoti.org/

Usually, Every journal has a yearly index (by author and subject): most of the journals include it in the last issue of the year (which is December issue of that journal). Once you choose your topic, you should immediately go to the library and look at the index of the last five to seven years of the appropriate journals and see what has been done in that particular area. For example if your subject is interconnection networks then check the subject index of appropriate journals for the last five or seven years, and the relevant conference proceedings for the last five years or so.
List of Topics

1. **Multi-core Architectures with Chip Multiprocessing:** Currently, multi-core architectures are being developed by several vendors for improving the performance of desktops and servers. Can you examine the area, power, performance and design issues for the on-chip interconnect on a chip multiprocessor? Can you come up with some new solution to design on-chip interconnect architectures?

2. **Design of Network Interface Cards (NICs):** Network interface processing requires support for the following characteristics: a large volume of frame data, frequently accessed frame metadata, and high frame rate processing. With current line rates of 10 Gbps and future line rates increasing to almost 40 Gbps data rate, can you evaluate the performance of NICs that can perform the desired functions?

3. **Performance Modelling - Router Architectures:** Internet routers/switches are the fundamental equipments for the overall network infrastructure. These devices provide the functionality to receive, decode, repack, and switch packets of data within the network. Can you come up with new router interconnect architectures based on electronics/optics that can improve the performance of such architectures?

4. **Power-aware Modelling of Interconnection Networks:** With increased demands for link bandwidth, optical links are replacing electrical links in inter-chassis and inter-board environments. As a result, the power dissipation of optical links is becoming as critical as their speed. Can you model electrical/optical links and study the performance of these networks?

5. **Modelling Interconnects for Clusters:** What are the state-of-the-art existing interconnects for both on-board/off-board communication? Can you model these interconnects for various optical/electrical interconnect architectures? Study the performance and various metrics such as throughput, average latency for due to various interconnects for clustering.

6. **Profiling MPI Semantics for Cluster Computing:** MPI programming is commonly used for parallel computing systems. In order to efficiently program these models for interconnection networks, understanding MPI semantics such as Blocking Send/Receive, Non-Blocking Send/Receive, MPI Broadcast, etc is critical. Can you develop models that can effectively capture MPI semantics? In the literature, there are models used such as LogP and LogGP models.

7. **Cluster of SMPs:** The goal of this work is to understand the fundamental performance, system design, and implementation tradeoffs in cluster-based computing systems based on tightly integrated symmetric multiprocessor nodes (i.e., servers), interconnected by a high performance, scalable system area network. Can you evaluate the performance of such networks, where nodes broadcast on the bus for intra-board communication and message passing is used for inter-board communication. Clumps, Clint, these are some starting examples of cluster of SMPs models.

8. **Performance Modelling of Hybrid Architectures using MPI:** It is commonly seen in literature, many system architectures differentiate between the use of optical and electrical technologies based on packet sizes, long packets use optical interconnect (data/payload) and short packets use electrical (control). Can you evaluate the performance of such hybrid architectures using MPI or discrete-event simulators?