Project Ideas

Due: on end of term

Directions: You can work in groups of 2 or 3. The following are suggestions. The goal is to apply some of our principles, do some experiments to demonstrate improvement in performance, and above all to show insight. The projects should show ideas that can improve performance not add functionality.

1. **QOS, Lottery Scheduling for routers:** There is a paper called "Lottery Scheduling: Flexible Proportional Share Resource Management" by Waldsburger and Weihl. It is a way of dividing resources among users. It has been used for OS schedulers. On the other hand, routers use fair queuing mechanisms like Deficit Round Robin (DRR) or weighted fair queuing. Can you propose a way of doing Lottery Scheduling to schedule packets in an outbound queue in a router. Compare it to DRR and do some simple analytical comparison and some simulations in NS2. NS2 already has a Deficit Round Robin module. This may be a paper or an MS thesis if you discover something new.

2. **Measurement, LDA:** The references below has a link to a paper we just wrote called "Lossy Difference Aggregation: Enabling Fine Granularity Measurement". This shows a way to obtain loss measurements up to 1 in a million and latency measurements down to 1 usec. The project is to implement it in hardware using NetFPGA boards. We have NetFPGA boards and one student who can help but we do need you to know about hardware. Only 1 hardware project possible so check with me.

3. **Lookups, Tree Bitmap Prefix Lookups:** Below is a link for a paper called Tree BitMap that we will study in class. Your goal is to implement this algorithm and try it out (measure speed) on publicly available IP lookup databases. Examine the storage-time tradeoff. We can make your code publicly available so it will likely be picked up by others and will help get you a job.

4. **Lookups, Exact Matching, d-left:** The web site for the course has a paper on the d-left hashing algorithm. Your goal is to write some code for d-left (which really is best done in hardware) and try to give a hardware designer some guidance on the best values for the width of memories d and the amount of parallelism. Investigate the load factor and invent a benchmark (e.g., for an ARP table, a list of IP addresses) and see how it scales. Your report will likely be valuable for hardware designers of exact match and will be picked up if good.

5. **Diff Serv and TCP:** Today many routers use token buckets at the edge to limit the traffic of a flow. If the traffic is more than some rate, the traffic is market with some QoS bits. The idea in some versions of DiffServ (Clark's Assured Service model, RIO etc see referernce below, PHBs in DiffServ, do Google lookups to find these papers) is to drop marked packets preferably over non-marked packets. Consider a single TCP stream end-to-end that is sending over its limit. Some fraction of its packets are marked at the edge. Some downstream router must drop the marked packets. But it must also preserve ordering. The idea is to drop packets at the entrance to queues with a higher probability. Examine implementations of this and the potential problems. This could be a paper.

6. **iSLIP simulations:** iSLIP is a very influential switching algorithm used in routers. We will study it and it is described in my book. It would be nice to have a simulator to study its dynamics and see how performance varies with the parameters (e.g., number of rounds). I would be interested in understanding the tradeoff between fairness and throughput. Jon Kleinberg and I have a theoretical result that states that given fairness requirements, the max throughput of a switch is 75to that bound. Any other insight would also be fine.

6. **Interesting connections with other fields:** There are several fields in computer science that can impinge on Network Algorithmics. One example is cryptography. A group has already suggested investigating what it takes to do high speed encryption in routers for say VPNs and IPsec. Another field is database. The database folks have a number of practical streaming algorithms that may be adapted to networking. You should discuss specific proposals with me but they all must somehow end up influencing network performance.

Useful web links

```
d-left paper by Broder and Mitzenmacher
http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=916641&isnumber=19795
(thanks Kristen)

Lookup paper on Tree Bitmap
www-cse.ucsd.edu/~varghese/PAPERS/willpaper.pdf

Our measurement paper for latency measurement in hardware
http://www-cse.ucsd.edu/users/varghese/lda.pdf

The Rio paper for DiffServ
http://nms.lcs.mit.edu/6829-papers/p362-clark.pdf
(See also papers and IETF drafts by Shiv Kalyanaraman)
```