CSIM 19 User Story

Computer Communication Systems Performance Evaluation: *A Discrete Event Simulation with CSIM 19*

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Introduction

I am a PhD student in Electrical and Computer Engineering at Duke University. I work with Dr. Kishor S. Trivedi, and our research interests focus on reliability and performance assessment of computer and communication systems. Our team, a part of the Center for Advanced Computing and Communication, is studying the effect of web caching on network planning. We study the latency of a browser retrieving files for given traffic characteristics, number of users, bandwidth of access link and cache hit rate, in order to find the fastest and most cost-effective network configuration.

Application Area:
Network Performance

Platform:
Windows

CSIM 19's Challenge:
Assessing the performance of several network configurations:

- *256 kb / no cache*
- *512 kb / no cache*
- *256 kb / cache with 50% hit rate*

The Project

The purpose of our project is to determine whether doubling network bandwidth is a better solution for improved performance, or if adding a web cache is more effective.

Our system model consists of a typical infrastructure interconnecting a subnet with the Internet, as shown in Figure 1. When the user clicks on a hyperlink, several URL requests are sent from the browser to the web proxy, which contains a cache of stored files. If the web proxy contains a copy of the requested file that is consistent with the original copy on the remote server, then a *hit* occurs and the web page is retrieved from the cache; otherwise a *miss* occurs, and the proxy retrieves an original copy of the file from the remote server (a process that takes more time).

We are interested in the response time, or latency, that occurs in delivering the file. We define response time as the time interval from the user clicking on the link to the requested object being displayed on the monitor.

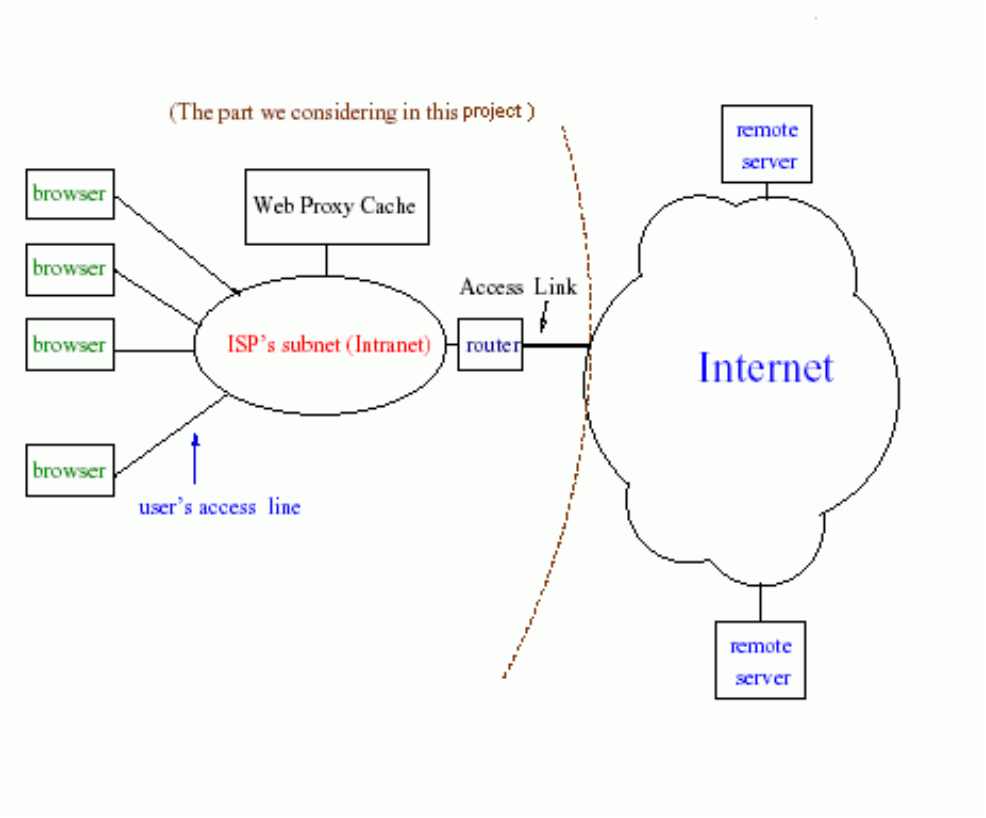

Figure 1: Internet Architecture under Evaluation

We have run simulations for three different system architectures:

- Bandwidth= 256kb/s, with no web cache
- Bandwidth=512 kb/s, with no web cache
- Bandwidth= 256kb/s, with a web cache having a hit ratio of 50% (meaning that 50% of the files requested can be found in the cache)

We also consider two cases of arrival processes. In the first case, we assume the arrival process to be Poisson from a source with 100 users, and the service time is taken to be generally distributed. When a *miss* occurs, the arrivals form an M/G/1 queue. *Note: This assumption is very coarse and not entirely inaccurate, and we relax it in the second case.*

In the second case, we assume the arrival process to be an ON-OFF process. The ON periods follow a Weibull distribution and are initiated by the user's clicks on the hypertext links. During the OFF period, requests are not generated. We assume that the duration of the OFF period follows a Pareto distribution [1]. In this case, we simulate 500 browsers logging onto the Internet simultaneously.

MESQUITE SOFTWARE

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- P.K. Choudhary

Specific Requirements for CSIM

CSIM 19 provided many important features required by our project. First, since CSIM is compiled rather than interpreted, our models execute quickly. This execution speed enabled us to model our desired test case of 500 simultaneous users.

CSIM's provisions for tracing execution of the simulation model and for logging simulated events gave us the detailed information we needed for debugging and understanding model execution. We also found the variety of non-exponential distributions quite useful.

Finally, we liked the fact that we can easily specify a simulation's termination in CSIM, either by defining the number of events to simulate or the total execution time desired. CSIM also provides an option to calculate confidence intervals and control the length of simulation execution through the Run Length Control, a feature we used extensively.

Results with CSIM

In both cases (with the Poisson arrivals and with the On-Off arrivals), we discovered that the configuration with the web cache and half the bandwidth (256kb/s) performed almost as well as, and in some cases better than, the configuration with greater bandwidth (512 kb/s) and no cache.

We also discovered that our analytical calculations of mean response time closely matched the results we found with our CSIM simulation.

Conclusion

With the availability of fast and cheap computing power, simulation has become a viable method to analyze large and complex networks. This project used simulation with CSIM 19 to determine network performance given varying bandwidths and the presence or absence of a web proxy cache.

Cache is generally much less expensive and easier to add to a network than bandwidth. Our finding, that the presence of a cache with a 50% hit rate provides similar performance as a system with double the bandwidth, provides valuable information that can be used to help create more efficient and cost-effective networks.

"Using CSIM 19, we found that a network with bandwidth of 256kb/s and a 50% hit-rate-cache delivered roughly equal performance as one with 512kb/s with no cache."
- P.K. Choudhary

References:

[1] Gunter Bolch, Stefan Greiner, Hermann de Meer and Kishor S. Trivedi, *Queuing Networks and Markov Chains: Modeling and Performance Evaluation with Computer Science Applications*, John Wiley, New York, NY, 1998 (*note: this project will be featured in the second edition, to be published in 2005*).

You can find more information about this project online at
http://www.ee.duke.edu/~pkc4/webcache.pdf
It was also presented at the 2004 World Computer Congress:
http://www.wcc2004.org/congress/tutorials/tut2.htm

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Greatest Challenge:
The initial modeling exercise proved to be one of the greatest challenges of the project.

For more information about CSIM 19, please contact Mesquite Software:

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