CPSC 3620 Assignment One

Due: 1/20/2017

Partners: Nicole Michaud, Parth Patel, Stuart Jackson

"I worked on this assignment with **Parth Patel and Nicole Michaud**. My role in completing the assignment was to **provide the second half of part 2**, while provide **Nicole and Parth's** role in completing the assignment was **to answer the part 1 and the first half of part 2, respectively**. We consulted related material that can be found at http://www.compete.org/storage/images/uploads/File/PDF%20Files/HPC_Brain%20Research_052308.pdf and *SDSC.org*.

1. (5 points) What are the factors that limit the availability of high-end computing?

The factors that mainly limit the availability of high end computing are high cost, decreasing number of vendors, variability of architecture types across vendors and inadequate software environments.

2. (1 points) Provide the definition of a Beowulf-class system.

The Beowulf-class system is a combination of hardware, software, and usage. This results in a scalable, sophisticated, robust environment with very good price-performance. The Beowulf-class system also has broad applications. It is comprised of clusters of PCs that use COTS technology and a Unix-like operating system.

3. (4 points) Describe two approaches to help solve the bottleneck problem of system-wide random communications in a Beowulf-class system.

The first solution to this issue would be to create a varied and sophisticated topology so that each processor node can add some delay to the message packet transmission time. However, this is limited by scalability. To fix this, switches and through processor communication can be used to fix the bottleneck issue in a larger system.

The other approach to this problem is to use a hierarchy of communication technologies for moderate bandwidth channels into each node and high bandwidth backplanes for global communication.

4. (6 points) What are the three distinguishing characteristics of application algorithms that scale?

One characteristic of a scaling application algorithm is that applications that are "parallel out-of-core" style tend to run well on Beowulf-class systems because the granularity of the parallelization is large and explicit. Another characteristic is that applications that are written without global synchronizations tend to do well on Beowulf-class systems as well. The last characteristic of scaling algorithms is that they can combine all of their communications into a single, large communication.

5. (4 points) What are the four determining factors to support scalability of a Beowulf-class system?

One determining factor on scalability in Beowulf-class systems is hardware. Network hardware and switches may claim to scale but have not been tested enough to determine if they would function in a real life application. The second factor is the number of disks on EIDE or SCSI channels. A third factor would be the ability of memory bandwidth to support multiple processors per motherboard. The last factor is software. System software scalability must be able to support the hardware scalability.

Researchers at the Salk Institute are investigating how brain synapses work through supercomputing in hopes of reducing the cost of treatment and long-term care of brain related disorders. The key researchers are Terry Sejnowski and Tom Bartol, who have a small group of graduate students helping them. (1) Their research focuses on modeling what happens when a neuron sends a message to another neuron across a synapse. Supercomputing has many benefits to their research. Supercomputers let them create computational models and "perform parameter sweeps - adjustments of the numerical parameters making up the simulation to provide the closest approximation to reality possible." (1) It lets them "run simulation programs at a level of complexity previously not obtainable by in-house workstations." (1) And it "provides research results that will help pharmaceutical companies design more effective drugs to treat mental disorders." (1)

The use of high powered computing, specifically those such as Comet and Gordon from the San Diego Supercomputer Center, allowed the Salk institute to visualise human synapses in a way never before possible. (2) This allows the team to focus not on simplifying their model in order to find a way to run it, but instead on gathering the information from whatever model they want in order to advance our understanding of biological systems. According to some at the Salik institute, with the use of high powered computing biology will move from a primarily observational, qualitative science to a much more quantitative study. (1) This has the potential to harken in new leaps and bounds for the field, allowing researchers to study the most intricate and complex parts of the body, opening new doors in the study of the human body, and ways in which to benefit it.

Sources

1. "Breakthroughs in Brain Research with High Performance Computing." *Compete.org*. The National Science Foundation, 2008. Web. 19 Jan. 2017. <http://www.compete.org/storage/images/uploads/File/PDF%20Files/HPC_Brain%20Research_052308.pdf>.

2. *SDSC.org.* San Diego Supercomputer Center. Web. 19 Jan. 2017.

"I worked on this assignment with **names of the people you worked with**. My role in completing the assignment was **provide description of all your contributions**, while provide **names of other collaborators** role in completing the assignment was **provide a description of their contributions**. We consulted related material that can be found at **cite any other materials not provided as course materials**."