RESEARCH ON METHODOLOGIES TO DEVELOP BEOWULF CLASS SUPERCOMPUTERS USING COMMODITY OFF THE SHELF (COTS) BASED HARDWARE AND OPEN SOURCE SOFTWARE (OSS)

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ABSTRACT
This research focuses on developing High Performance Computers or Supercomputers using Commodity off the Shelf (*COTS*) based hardware. This is a new approach in clustering technology to produce three sets of Beowulf Class Supercomputers, namely DOROTHY I, DOROTHY II and DOROTHY III. The performances of these Beowulf Class Supercomputers are benchmarked and compared against each other. This research tries to prove that the quality and the processing speed of the Beowulf class supercomputers (developed using *COTS* with limited resources) are as good as the CRAY Supercomputer. Also, this paper researches on the causes of bottlenecks to the Beowulf Class Supercomputer.

INTRODUCTION

Why do we need supercomputers?

The most significant project of the human race – The Human Genome Project provides the best example of the usage of supercomputers. The class of supercomputer, which drives the computing technology behind the success of this project, is called Beowulf (STERLING, THOMAS 2001). Without super computing powers, it could take 100 years to perform a complete *protein–folding* computation. Using supercomputers, the time for this tedious task is shortened significantly. However, supercomputers are expensive and hard to maintain. This is where the Beowulf Project comes in. Beowulf Project involves using off-shelf, low cost personal computers to combine their processing powers to become a supercomputer. With the success of this project, it revolutionises the relationship between supercomputers and applications that require extensive computing powers, like climate modeling, national defense, bioscience, astronomy and so on.

METHODOLOGIES

The architecture of Beowulf Class Supercomputers can be described as multiple Personal Computers (PCs) linked through networks to share computing power and run applications in the form of parallel processing. This generally meets 2 simple conditions.

I. All the hardware used are commodity hardware and have a good price over performance ratio
II. Software used for Beowulf are mostly free and open source

Network Architecture

Beowulf Class Supercomputers are developed in the parallel processing environment. According to George Desrocher (1988), parallel computers can be grouped into 2 categories.

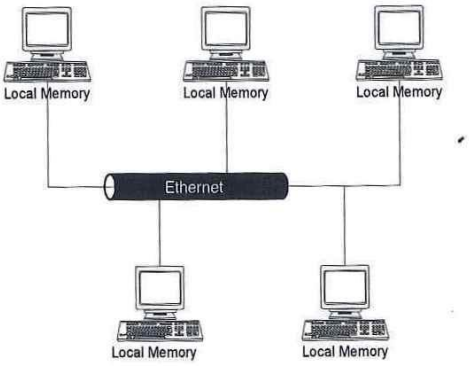

Figure 1. Local Memory Parallel System.

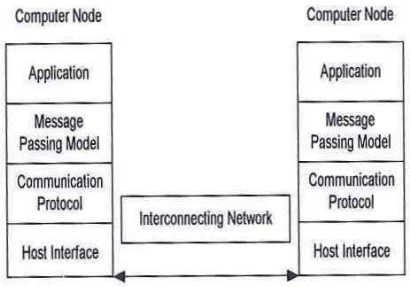

Figure 2. Overview of Beowulf Architecture.

First, parallel computers that have local memory for each node and secondly, parallel computers that share memory for all nodes. Beowulf belongs to the first category. Its nodes communicate with each other via the network. Figure 1 shows the local memory parallel system used in Beowulf Class Supercomputer.

Hardware Architecture

A Beowulf Class Supercomputer consists of several nodes[1] linked via a fast Ethernet network (similar to figure 1). In Beowulf clustering environment, every node is responsible for executing its own copy of kernel even for some diskless nodes. Since Beowulf executes its applications using parallel mode, normal *programming model* is not suitable for use. Therefore, it uses Parallel Virtual Machine (PVM) and Bull Synchronous Parallel (BSP) programming models.

Software Architecture

Beowulf operates under Linux Operating Systems and other Open Source Software (OSS) available. Linux is used to construct Beowulf because of its portability in running on multiple hardware architecture. The Linux kernel features POSIX compliance, a TCP/IP (Transmission Control Protocol/Internet Protocol) protocol stack with a socket interface, inter-process communication, and an efficient virtual memory sub-system with unified buffer. Due to the flexibility of Linux, a set of Beowulf Class Supercomputers can be constructed using multiple types of processors. Overall, the Beowulf architecture is shown in Figure 2.

HARDWARE AND SOFTWARE SPECIFICATION

In order to compare the performance of the Beowulf Class Supercomputers constructed on different hardware platforms, three sets of supercomputers are built. The three sets of Beowulf Class Supercomputers are named DOROTHY I, DOROTHY II and DOROTHY III.

DOROTHY I

DOROTHY I is the first set of Beowulf Class

[1] A node is defined as an individual computer that has complete operating system and hardware that has the ability to execute any user programs with the ability to communicate with other nodes in the cluster. A node in Beowulf can be constructed by using desktop PC, high-end workstation or Symmetric Multi-Processors (SMP); however, cost effective PCs are used in this research.