STUDY ON CLUSTER COMPUTING

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ABSTRACT

A computer cluster is a group of linked computers, working together closely so that in many respects they form a single computer. The Components of a cluster are commonly, but not always, connected to each other through fast local area networks. Clusters are usually deployed to improve performance and/or availability over that provided by a single computer, while typically being much more cost-effective than single computers of comparable speed or availability. The major objective in the cluster is utilizing a group of processing nodes so as to complete the assigned job in a minimum amount of time by working cooperatively. The main and important strategy to achieve such objective is by transferring the extra loads from busy nodes to idle nodes. The seminar will contain the concepts of cluster computing and the principles involved in it.

***Keywords:* nodes, middleware, os, Oscar, scyld**

1. INTRODUCTION

Parallel computing has seen many changes since the days of the highly expensive and proprietary super computers. Changes and improvements in performance have also been seen in the area of mainframe computing for many environments. But these compute environments may not be the most cost effective and flexible solution for a problem. Over the past decade, cluster technologies have been developed that allow multiple low cost computers to work in a coordinated fashion to process applications. The economics, performance and flexibility of compute clusters makes cluster computing an attractive alternative to centralized computing models and the attendant to cost, inflexibility, and scalability issues inherent to these models.

Many enterprises are now looking at clusters of high-performance, low cost computers to provide increased application performance, high availability, and ease of scaling within the data center. Interest in and deployment of computer clusters has largely been driven by the increase in the performance of off-the-shelf commodity computers, high-speed, low-latency network switches and the maturity of the software components. Application performance continues to be of significant concern for various entities including governments, military, education, scientific and now enterprise organizations. This document provides a review of cluster computing, the various types of clusters and their associated applications. This document is a high level informational document; it does not provide details about various cluster implementations and applications.

Cluster computing is best characterized as the integration of a number of off-the-shelf commodity computers and resources integrated through hardware, networks, and software to behave as a single computer. Initially, the terms cluster computing and high performance computing were viewed as one and the same. However, the technologies available today have redefined the term cluster computing to extend beyond parallel computing to incorporate load-balancing clusters (for example, web clusters) and high availability clusters. Clusters may also be deployed to address load balancing, parallel processing, systems management, and scalability. Today, clusters are made up of commodity computers usually restricted to a single switch or group of interconnected switches operating at Layer 2 and within a single virtual local-area network (VLAN). Each compute node (computer) may have different characteristics such as single processor or symmetric multiprocessor design, and access to various types of storage devices. The underlying network is a dedicated network made up of high-speed, low-latency switches that may be of a single switch or a hierarchy of multiple switches.

A growing range of possibilities exists for a cluster interconnection technology. Different variables will determine the network hardware for the cluster. Price-perport bandwidth, latency, and throughput are key variables. The choice of network technology depends on a number of factors, including price, performance, and compatibility with other cluster hardware and system software as well as communication characteristics of the applications that will use the cluster. Clusters are not commodities in themselves, although they may be based on commodity hardware. A number of decisions need to be made (for example, what type of hardware the nodes run on, which interconnect to use, and which type of switching architecture to build on) before assembling a cluster range. Each decision will affect the others, and some will probably be dictated by the intended use of the cluster. Selecting the right cluster elements involves an understanding of the application and the necessary resources that include, but are not limited to, storage, throughput, latency, and number of nodes.

II. DETAILS EXPERIMENTAL

2.1. Components and Procedures

The basic building blocks of clusters are broken down into multiple categories: the cluster nodes, cluster operating system, network switching hardware and the node/switch interconnect (see Figure 3). Significant advances have been accomplished over the past five years to improve the performance of both the compute nodes as well as the underlying switching infrastructure.

Application: It includes all the various applications that are going on for a particular group. These applications run in parallel. These includes various query running on different nodes of the cluster. This can be said as the input part of the cluster component.

Middleware: These are software packages which interacts the user with the operating system for the cluster computing. In other words we can say that these are the layers of software between applications and operating system. Middleware provides various services required by an application to function correctly. The software that are used as middleware are:

OSCAR Features:

Image based Installation. Supported by Red Hat 9.0 and Mandrake 9.0. Processors supported: x86, Itanium (in beta). Interconnects: Ethernet, Myrinet. Diskless support in development. Opteron support in development. High-availability support in alpha testing.

SCYLD Features:

Commercial distribution. Single system image design. Processors: x86 and Opteron. Interconnects: Ethernet and Infiniband. MPI and PVM. Diskful and diskless support.

Rocks Features:

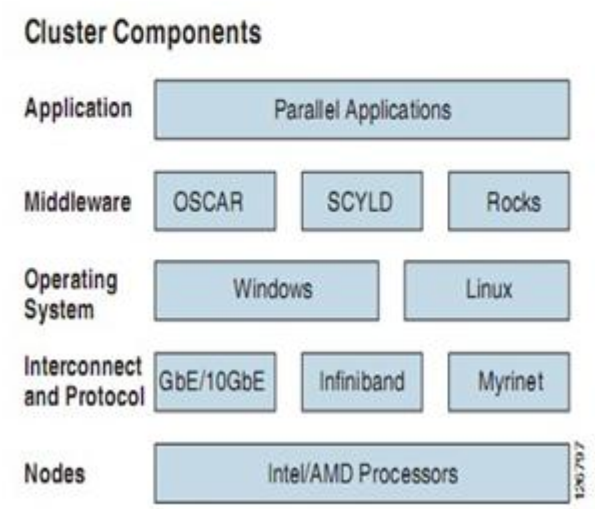
Processors: x86, Opteron, Itanium. Interconnects: Ethernet and Myrinet. Compute node management via Red Hat's kickstart mechanism. Diskfull only.Cluster on CD.

Operating System: Clusters can be supported by various operating systems which includes Windows, Linux.etc.

Interconnect: Interconnection between the various nodes of the cluster system can be done using 10GbE, Myrinet etc. In case of small cluster system these and be connected with the help of simple switches.

Nodes: Nodes of the cluster system implies about the different computers that are connected. All of these processors can be of intels or AMD 64 bit.

Figure 3 Cluster Components



Working of cluster: There are several types of clusters, each with specific design goals and functionality. These clusters range from distributed or parallel clusters for computation intensive or data intensive applications that are used for protein, seismic, or nuclear modeling to simple load-balanced clusters.

1. High Availability or Failover Clusters:

These clusters are designed to provide uninterrupted availability of data or services (typically web services) to the end-user community. The purpose of these clusters is to ensure that a single instance of an application is only ever running on one cluster member at a time but if and when that cluster member is no longer available, the application will failover to another cluster member. With a high-availability cluster, nodes can be taken out-of-service for maintenance or repairs. Additionally, if a node fails, the service can be restored without affecting the availability of the services provided by the cluster (see Figure 2.1). While the application will still be available, there will be a performance drop due to the missing node. High-availability clusters implementations are best for mission-critical applications or databases, mail, file and print, web, or application servers.

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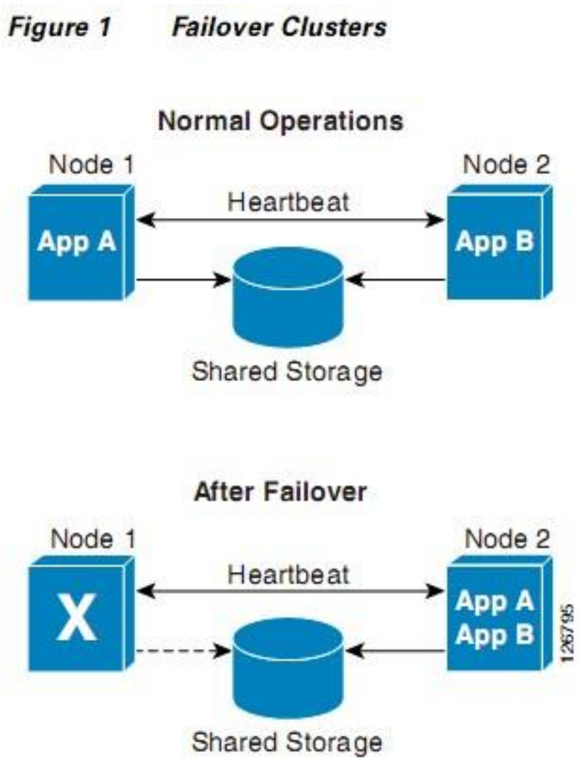
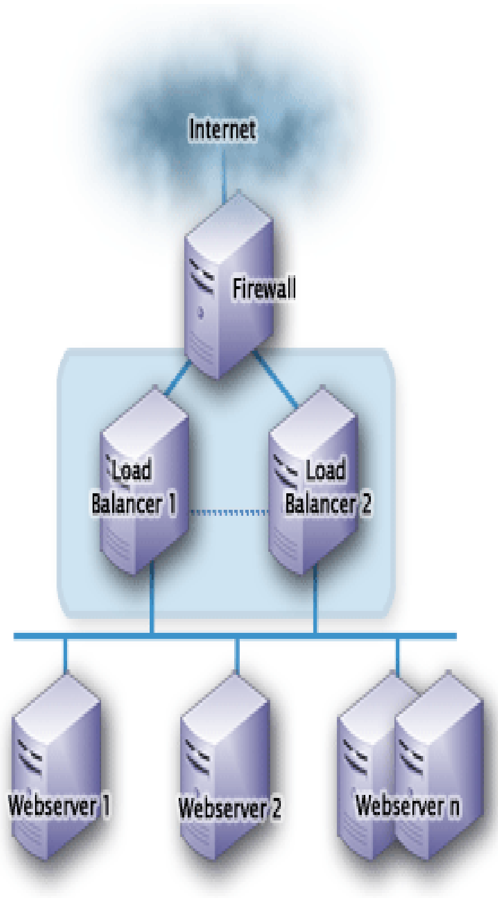


(Failover Clusters) (Figure- 2.1)

Unlike distributed or parallel processing clusters, high-availability clusters seamlessly and transparently integrate existing standalone, non-cluster aware applications together into a single virtual machine necessary to allow the network to effortlessly grow to meet increased business demands.

II. LOAD BALANCING CLUSTER:

This type of cluster distributes incoming requests for resources or content among multiple nodes running the same programs or having the same content (see Figure 2). Every node in the cluster is able to handle requests for the same content or application. If a node fails, requests are redistributed between the remaining available nodes. This type of distribution is typically seen in a web-hosting environment.

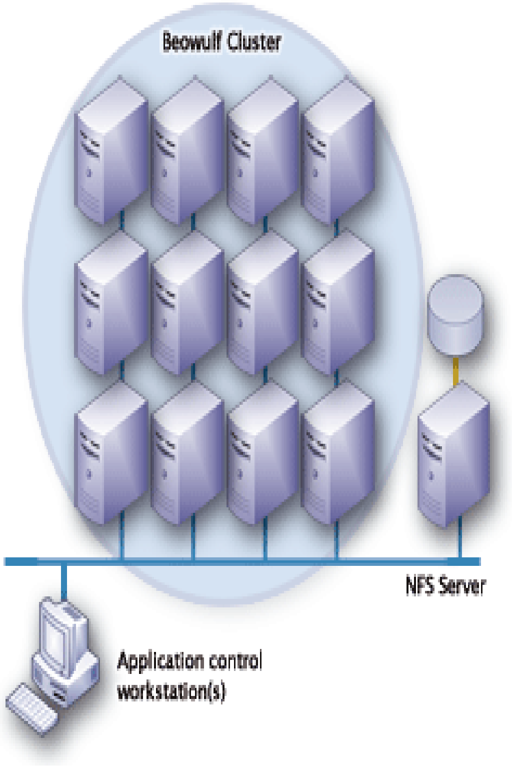


(Figure:2) Load balancing cluster

Both the high availability and load-balancing cluster technologies can be combined to increase the reliability, availability, and scalability of application and data resources that are widely deployed for web, mail, news, or FTP services.

2. **High Performance Cluster:**

Traditionally, parallel processing was performed by multiple processors in a specially designed parallel computer. These are systems in which multiple processors share a single memory and bus interface within a single computer. With the advent of high speed, low-latency switching technology, computers can be interconnected to form a parallel-processing cluster. These types of cluster increase availability, performance, and scalability for applications, particularly computationally or data intensive tasks. A parallel cluster is a system that uses a number of nodes to simultaneously solve a specific computational or data-mining task. Unlike the load balancing or high availability clusters that distributes requests/tasks to nodes where a node processes the entire request, a parallel environment will divide the request into multiple sub-tasks that are distributed to multiple nodes within the cluster for processing. Parallel clusters are typically used for CPU-intensive analytical applications, such as mathematical computation, scientific analysis (weather forecasting, seismic analysis, etc.), and financial data analysis. One of the more common cluster operating systems is the Beowulf class of clusters. A Beowulf cluster can be defined as a number of systems whose collective processing capabilities are simultaneously applied to a specific technical, scientific, or business application. Each individual computer is referred to as a “node” and each node communicates with other nodes within a cluster across standard Ethernet technologies (10/100 Mbps, GbE, or 10GbE). Other highspeed interconnects such as Myrinet, Infiniband, or Quadrics may also be used.



II. RESULTS AND DISCUSSION

2.1. Issue and discussion:

Cluster networking: If you are mixing hardware that has different networking technologies, there will be large differences in the speed with which data will be accessed and how individual nodes can communicate. If it is in your budget make sure that all of the machines you want to include in your cluster have similar networking capabilities, and if at all possible, have network adapters from the same manufacturer.

Cluster Software

You will have to build versions of clustering software for each kind of system you include in your cluster.

Timing:

This is the most problematic aspect of cluster. Since these machines have different performance profile our code will execute at different rates on the different kinds of nodes. This can cause serious bottlenecks if a process on one node is waiting for results of a calculation on a slower node.

2.2. Behaviour of programming system:

Programming:

Our code will have to be written to support the lowest common denominator for data types supported by the least powerful node in our cluster. With mixed machines, the more powerful machines will have attributes that cannot be attained in the powerful machine.

Network Selection

There are a number of different kinds of network topologies, including buses, cubes of various degrees, and grids/meshes. These network topologies will be implemented by use of one or more network interface cards, or NICs, installed into the head-node and compute nodes of our cluster.

Speed Selection

No matter what topology you choose for your cluster, you will want to get fastest network that your budget allows. Fortunately, the availability of high speed computers has also forced the development of high speed networking systems.

III. CONCLUSION

High-performance cluster computing is enabling a new class of computationally intensive applications that are solving problems that were previously cost prohibitive for many enterprises. The use of commodity computers collaborating to resolve highly complex, computationally intensive tasks has broad application across several industry verticals such as chemistry or biology, quantum physics, petroleum exploration, crash test simulation, CG rendering, and financial risk analysis. However, cluster computing pushes the limits of server architectures, computing, and network performance.

Due to the economics of cluster computing and the flexibility and high performance offered, cluster computing has made its way into the mainstream enterprise data centers using clusters of various sizes. As clusters become more popular and more pervasive, careful consideration of the application requirements and what that translates to in terms of network characteristics becomes critical to the design and delivery of an optimal and reliable performing solution.

Knowledge of how the application uses the cluster nodes and how the characteristics of the application impact and are impacted by the underlying network is critically important. As critical as the selection of the cluster nodes and operating system, so too are the selection of the node interconnects and underlying cluster network switching technologies. A scalable and modular networking solution is critical, not only to provide incremental connectivity but also to provide incremental bandwidth options as the cluster grows. The ability to use advanced technologies within the same networking platform, such as 10 Gigabit Ethernet, provides new connectivity options, increases bandwidth, whilst providing investment protection.

The technologies associated with cluster computing, including host protocol stack processing and interconnect technologies, are rapidly evolving to meet the demands of current, new, and emerging applications. Much progress has been made in the development of low-latency switches, protocols, and standards that efficiently and effectively use network hardware components.

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