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Cluster Computing

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Abstract: **A group of linked computers is called Computer cluster which works closely to form a single computer. Mostly components of clusters are connected through LAN. Clusters are mostly deployed to Improve availability and/or performance over that provided by a single Computer. It is more cost-effective than others. The main objective of the cluster computer is using a processing node groups so as to complete the job in a less amount of time. It is achieved by transferring loads from busy to idle nodes. The strategy to achieve such objective is by transferring the extra loads from busy nodes to idle nodes.**

I. INTRODUCTION

Cluster Computing addresses the latest results in the field that support High Performance Distributed Computing (HPDC). In HPDC environments, parallel and distributed computing are applied to the problem of intensive applications across networks of computers. The journal represents an important source of information for the growing number of researchers, developers and users of HPDC environments. Clusters Computing: the Journal of Networks, Software Tools and Application gives a forum for presenting the latest search in the fields of parallel processing,computer cluster distributed computing systems and computer networks.

Attributes of clusters

Computer cluster may be configured for different purposes ranging from general purpose business needs web-service support, to computation-intensive scientific protocol calculations. In either case, the cluster system may use a large-availability approach. Note that the attributes are not exclusive and a "compute cluster" may also use a large availability cluster approach.

A load balancing cluster with two servers and cluster stations."Load-balancing" clusters are specifications in cluster-nodes share computational work load to give better all performance. For eg, a web server cluster system may assign different queries to nodes, so the overall response time will be optimized. However, approaches can be load-balancing may change among applications, example a high-performance cluster used balance load with different algorithms from a web-server cluster may just use a simple round-robin method by assigning request to a different node "Computer clusters" are used for intensive purposes, rather than IO-oriented operations such as web service or databases. For instance, a computer cluster might support computational of vehicle loses or weather. Very tightly coupled clusters are designed for work that may approach "super computing clusters”,” High availability clusters system improve the availability of the cluster . They operate by having redundant nodes cluster, which are then used to service when system components fail. Cluster implementations attempt to use redundancy of cluster components to eliminate single points of failure. There are commercial High-Availability clusters for several Oss.

Cluster Computer Architecture

A cluster is a kind of processing system, which consists of a collection of interconnected simple computers joined working as a single, integrated computing resource. A node a single or double processor system with cache, I/O facilities, & OS commonly 2 or more computer joined together in a single cabinet, or physically separated & process via a local are network appear as a cluster system to users and applications gives a cost success way to benefits.

Design and specification

One of the issues in designing a cluster is how tightly coupled the individual nodes. For instance, a single computer job may need continues communication among nodes: this implies that the cluster gives a dedicated network, is densely placed, and small has homogeneous nodes. The another extreme is where a computer job uses one or few nodes, and little or no inter-node communication.

A Beowulf specification

In a Beowulf system, the application programs see the computational nodes but only interact with the "Master" which is a simple computer handling the making and management of the slaves. In a typical start to the Master has single network interfaces, communicates with the private sector Beowulf network for the slaves, the other for the common need network of the organization..The slave computers typically have their own version of the same OS, and memory and disk space. However, the slave network may also have a big and shared file server that stores universal persistent data, accessed to the slaves as important.

By dim, the special purpose 144 node DEGIMA cluster is taken to running astrophysical N-body simulations using the Double-Walk simultaneous tree code, rather than common purpose scientific computations.

Because of the computing power of every generation of game consoles, a book use has emerged where they are repurposed into High-performance computing clusters. Some eg of game console clusters are Sony PlayStation clusters and Microsoft Xbox clusters. Other example of consumer game product is the Nvidia Tesla Personal Supercomputer workstation, which can be used multiple graphics accelerator processor chips.

Computer clusters have historically run on separate physical computers with the same OS. With the advent of virtualization, the cluster nodes may run on single physical computers with other OS which are painted above with a virtual layer to be similar. The cluster can also be virtualized on various configurations as maintain makes place.

Interconnection Technologies

Clusters have to incorporate slow interconnection technologies in order to support more-bandwidth and less latency inter-processor communication through cluster nodes. Slow interconnection technique had always been a performance bottleneck for cluster computing. Now, improved network technologies gives realize the construction of more efficient clusters. Selecting a cluster interconnection network technique depends on more factors, such as compatibility with the help of cluster hardware and OS, price, and performance. There are two metrics to measure performance for interconnects: bandwidth and latency. It is the Product of data that can be translated over the interconnect hardware in a some period of time, while cluster is the time to ready and transmit information from a console node to an end node.

Single System Image (SSI)

The Single System Image (SSI) shows that the seen of a distributed computer as a simple unified computing output. This provides best usage for the users as it hides the complexities of the below lying distributed and heterogeneous nature of clusters from them. SSI can be established through one or several mechanisms implemented at different levels of abstraction in the cluster architecture: hardware, OS, high ware, and applications. The design for SSI cluster-based systems held on complete transparent of reference management, scalable performance, and system availability in supporting user applications. Key SSI attributes that are commonly considered desirable add point of entry, UI, process space, memory space, I/O space, file hierarchy, virtual networking, job management system, and control point and management.

The following section explains the cluster resource management systems.

SSI at OS Level

The OS in each of the cluster nodes gives the fundamental system support for the combined operation of the cluster. The OS provides services such as protection boundaries, process thread coordination, inter-process communication, and device handling, thus creating a high-level software interface for applications.

A computer cluster OS is desired to have the following features:

Manageability: rightd to manage and administrate local and remote resources.

Stability: Support for robustness against computer failures with system recovery.

Performance: every types of operations should be optimized and efficient.

Extensibility: Gives easy integration of cluster-specific extensions.

Scalability: ability to scale without impact on performance.

Support: system administrator support is essential.

Heterogeneity: Portability above several architectures to support a cluster contains of heterogeneous hardware components.

May be achieved through the use of middleware. Single System Image Benefits Gives a simple, forward view of all system resources and activities, to any node of the cluster computer Free the end user from having to know where an application will run Free the operator from having to know where are source is located. Let the system work with familiar interface and commands and allows the administrators to manage the entire clusters as a single entity Reduce the risk of compile errors, with the conclusion that end users see improved reliability and higher availability of the system Allowing centralize system management and control to remove the needed of skilled administrators to system administration now multiple, cooperating system of an application to the administrator as a single system Greatly simplify system management Provide GPS-independent message communication Help track the locations by GPS of all resource because that there is no longer any need to system operators by concerned with their physical/logical location Provide transparent migration and load balancing among nodes. Improved cluster system response time and performance Resource Management System (RMS) Middleware.

A cluster resource management system (RMS) acts as a cluster middleware that implements the SSI [24] for a cluster of machines. It enables users to execute jobs on the cluster without the need to understand the complexities of the underlying cluster architecture. A RMS manages the cluster through four major branches, namely: cluster *resource management*, cluster *job queuing*, cluster *job scheduling*, and cluster *job management.*

A RMS manages the collection of resources such as processors and disk storage in the cluster. It maintains status information of resources so as to know what resources are available and can thus assign jobs to available machines. The RMS uses job queues that hold submitted jobs until there are available resources to execute the jobs. When resources are available, the RMS invokes a job scheduler to select from the queues what jobs to execute. The RMS then manages the job execution processes and returns the results to the users upon job completion.

The advent of Grid computing [48] further enhances the significance of the RMS in clusters. Grid brokers can discover Grid resources such as clusters and submit the jobs to via a RMS. The RMS then manages and executes the jobs before returning the results back to the Grid brokers. To enable effective resource management to clusters, many number of cluster management systems and schedulers have been designed.

II. CLUSTER PROGRAMMING MODELS

All of a cluster's subsystems, from I/O to job scheduling to the choice of node OS, must support the applications the cluster is designed to run. While small clusters are often constructed to support a single class of applications, such as serving Web ages or database applications, larger clusters are often called on to dedicate parts of their resources to different kinds of applications simultaneously [50][51].

These applications often differ not only in their workload characteristics, but also in the programming models they employ. The programming models employed by an application, in turn, determine the key performance characteristics of a cluster application. This section details the most important programming models used to construct cluster-aware applications; the next section provides examples of cluster applications constructed with one or more of these models.

Cluster computing programming models have traditionally been divided into categories based on the relationship of programs to the data the programs operate on [52]. The Single-Instruction, Single-Data (SISD) model defines the traditional von Neumann computer. Multiple-Instruction, Multiple-Data (MIMD) machines include most of today's clusters as well as parallel computers. In the Single-Instruction, Multiple-Data (SIMD) model each system executes the same program denotes cluster systems where more than two programs operate on the similar data. MIMD emerged as the most revalent programming model on clusters.

In addition to dividing cluster programming models on how programs relate to data, programming models can also be categorized on how they exploit a cluster system inherent parallelism. On that system,cluster computing programming methods can roughly be classifed in two categories: The first category of models allows a serial (non-parallel) applications to take advantage of a cluster's parallelism. The second category of programming models aid in the explicit parallelization of a program. Since cluster users are much more familiar with creating a serial program than developing explicit parallel system, the one category of programming models has become dominant in cluster system computing applications.

Linux based Software programming and Hardware process for Clustering Linux [20] is a free available UNIX-like open OS that is classified by its users and developers., initially developed Linux. Now, Linux has become a robust and reliable POSIX compliant OS. Several companies have build businesses by packaging Linux software into organized distributions, RedHat[21] is an example of such a computer system.

Linux provides the features typically found in standard UNIX such as multi-user access, pre-emptive and multi-tasking, demand-paged into virtual memory and to SMP support [22]. In order to the Linux kernel, a large amount of application and cluster system software And system tools are is also available. This makes Linux the preferred OS for cluster system.

The most popular system compilers used in Linux cluster based on GNU C and Fortran compilers [23]. For most applications, gcc and g77 are adequate. However, if an application used the Fortran program paradigm and tools, then GNU Fortran is not as robot, or is there sufficient support for the parallel program libraries as there is in the commercial Fortran compilers.

Absoft [24] produces Fortran compilers (F77/F90) for Intel-based Linux systems, Apple Mac and Microsoft Windows. Absoft also market various mathematical libraries for use with their compilers. The Numerical Algorithms Group (NAG) [25] produce or markets various Fortran solutions. NAG has been providing compilers and libraries for performance computers since 1975. Their compilers run on various platforms, including Linux. The Portland Group [26] is a vendor of Fortran compilers.

Portland also produces C and C++ compilers. Portland tailors their systems for used in clustered environments. Clustering is use in Many Applications Clustered computing in its simple form consists of a number of workstations linked via control software and a high-speed LAN. Computation requests are given to a resource managers and are executed within the clusters. Users are isolated to the workstation that process to request: speed and throughput so increased beyond what a single workstation could achieve. Distributed applications are running across multiple hosts within a cluster is increasingly common. Clustering is used by support many classes of resource-intensive applications, from database server from numerical analysis programming.

Clusters are an attractive alternative for certain classes of applications. While a clustering system cannot achieve the inter-process ring communication speeds of a parallel super computer, some applications do not need some communication performance. The sum of memory consumed by the applications and the processing speeds available across supercomputers and workstations should also have considered. To date, the processor speeds and addressable memory to achieve within the highly competitive workstation market quickly outstrip the processor speeds and memory per processor used in a supercomputers implementation soon after the supercomputer reached the market.

Distributed Simulation via Clustered Computing Clustering worked well for more than two application areas, but how does it apply to distributed simulation? This question forces a closer examination of what distributed really means. Does it imply that all model must be capable of execution anywhere in the distributed systems, or may we assume that models can be bound to a simple site? What of the simulation users? Must of the co-located with the models, or may the users and models be located anywhere in the distributed system?

In fact, many current simulation systems may be considered cluster-based to one extent or another model. A paper by Fred Wieland, titled "Parallel Simulation for Aviation Applications," describes a model constructed and support by the Mitre Corporation for the Federal Aviation Administration's aircraft traffics modeling. All model execution is done at a central site via parallel processors. Users configure the models and access via the web. The Joint Precision Strike Demo infrastructure supports large-scale training exercises by used a group of co-located workstations linked together via an ATM-based LAN. Ed Powell's paper "The Joint Precision Strike Demo Simulation Architecture describe the configuration technique and gateways used to minimize communication loads within the systems and the connections out to remote trainees. From these and similar systems, distributed simulation clearly encompasses a wide range of simulation use cases.

But what of the popular DIS-style training exercises, where models are located with model controllers or trainees at physically separate response sites? Moving key personnel from response sites to a central location for a single exercise is generally not feasible. The use of clustering in such cases will require a shift in how all components of the system users, models, computers, and networks are linked together.

Under an ideals clustered computing scenario, the simulations used would remain fully distributed and connect into the cluster via standard WAN. The bulk of the models will be executed within the cluster environment, communicate via a low latency, high bandwidth LAN.

What Does the Hold for Clustering?

Cluster compute appears to hold great promise in supporting large scale distributed simulation. Advantage over fully (WAN) distributed execution exist from both hardware cost and performance viewpoints, while support is maintain for distributed users interacting with cluster models. Increased industry support from low latency clusters will be help in availability and performance, but restrictions within the API (and the supporting hardware) may require a departure from the current multicast-oriented data distribution strategies. However, latency and bandwidth performance continue to improve in the Ethernet and ATM worlds, providing the basis for very low cost clusters with multicast support. To ease the transition of clustering into the distributed simulation community, implementations of the HLA RTI standard should be optimized to transparently provide cluster-based performance to federation designers.

Some implementations

The GNU/Linux world supports various cluster software; for application clustering, there is distcc, and MPICH. Linux Virtual_Server, Linux-HA - director-based clusters that allow incoming requests for services to be distributed across multiple cluster nodes. MOSIX, openMosix, Kerrighed, OpenSSI are full-blown clusters integrated into the kernel that provide for automatic process migration among homogeneous nodes. OpenSSI, openMosix and Kerrighed are single-system image implementations.

Microsoft Windows Compute Cluster Server 2003 based on the Windows Server platform provides pieces for High performance Computing like the Job Scheduler, MSMPI library and management tools.

g Lite is a set of middleware technologies created by the Enabling Grids for E-sciencE (EGEE) project.

slurm is also used to schedule and manage some of the largest supercomputer clusters

Benefits of Clustering

If one server in a cluster stops working, a process called *failover* automatically shifts the workload of the failed server to another server in the cluster. Failover ensures continuous availability of applications and data.

This ability to handle failure allows clusters to meet two requirements that are typical in most data center environments:

High availability: The ability to provide end users with access to a service for a high percentage of time while reducing unscheduled outages.

High reliability: The ability to reduce the frequency of system failure.

Additionally, Network Load Balancing clusters address the need for high scalability, which is the ability to add resources and computers to improve performance.

Limitations of Clustering

Server clusters are designed to keep applications available, rather than keeping data available. To protect against viruses, corruption, and other threats to data, organizations need solid data protection and recovery plans. Cluster tech cannot protect against failures caused by viruses, software corruption, or human error.

The Cluster service, the service behind server clusters, depends on compatible applications and services to operate properly. The software must respond appropriately when a failure occurs. Administrators must be able to configure where an application stores its data on the server cluster. Also, clients that are accessing a clustered application or service must be able to reconnect to the cluster virtual server after a failure has occurred and a new cluster node has taken over the application. Only services and applications that use TCP/IP for client-server communication are supported on Network Load Balancing clusters and server clusters.

You cannot use Windows Server 2003 File Replication service (FRS) on shared cluster storage. You also cannot create domain-based Distributed File System (DFS) roots on shared cluster storage. Finally, without the proper management tools, you also cannot use dynamic disks on shared cluster storage.

III. CONCLUSION

Cluster computing is becoming popular and the latest technological developments and research innovations are pushing clusters into mainstream computing. This poses a number of new research challenges that need to be addressed, particularly in the areas of resource management, scalability, expandability, efficient communication, system administration, and single system image. Some of the work described here contributes towards addressing these challenges, and a number of them have commercial potential.

Cluster computing is primary and can continue to a major field of research interest for more-performance and big-end computing community.

In Australia, special events such as wide area computer clusters and sharing of scarc resources Are very important and are therefore drivers for software research.

Applications areas including e-commerce and business systems are likely to be major drivers for computer cluster computing in addition to the more areas such as scientific and engineering applications.

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