Evolution towards Grid Computing: A Survey

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***Abstract*— Grid computing is the form of parallel and distributed computing where the different resources are shared to solve a particular type of problem. It consists of coordinating and sharing computational power, storage and network resources across geographically dispersed locations. We can see Grid computing has emerged as the next-generation computing that is capable of solving a range of large-scale parallel applications in various domains**

***Keywords*— Super Computer, Cloud Computing, Distributed Computing, Grid Computing Model, Job Scheduling.**

I. INTRODUCTION

Grid Computing is a form of distributed computing. We can treat it as a "super virtual computer" composed of many networked loosely coupled resources acting together to perform large designated tasks [1]. For certain applications, "Distributed" or "Grid" computing [2] can be seen as a special type of parallel computing. According to John Patrick, IBM's vice president for Internet strategies, has stated that "The next big thing will be Grid computing". In recent era processing speed is increasing. Even then it is not enough to fulfil the requirements of researchers, scientist, and academies for high computation projects. Alternative approach is one that will provide the same capability within the range and on the same note should be cost effective, that is nothing but is Grid computing which provides enough processing power in a distributed environment with variety of heterogeneous and geographically dispersed resources managed by different organizations. One of crucial phase of grid system is Grid Scheduling which is the process of mapping submitted tasks to the available resources [10]. Many algorithms have been used to obtain the near optimal solution. The performance of grid should be improved by reducing the job processing time with resource utilization as a prime consideration.

II. GENERAL GRID COMPUTING MODEL:

Grid model generally composed of a number of users, each composed of several computational resources [3, 4]. The four basic building blocks of grid model are user(s), resource broker, Grid Information Service (GIS) and resources.

1. When user want to execute a job within required time unit, then user submit the job to the broker in grid.
2. Resource Broker splits the job into various tasks and distributes to several resources according to user's requirements and availability of resources.
3. GIS keeps the status information of all resources which helps the broker for scheduling and further actions to be taken into account in case of rescheduling or load balancing etc.

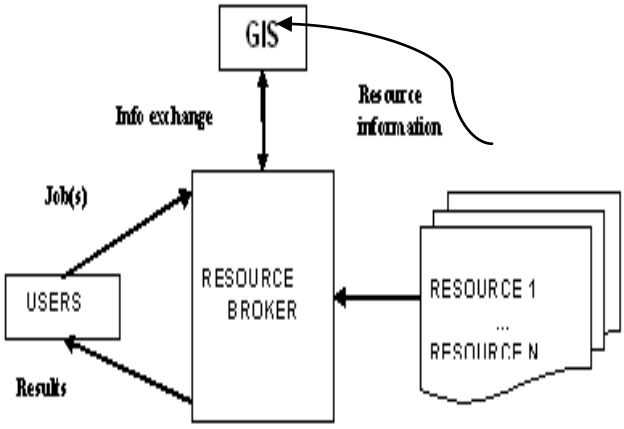

Figure 1: General Grid Computing Model

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III. EVOLUTION IN COMPUTING:

1.1 SUPER COM PUTING:

A computer that is capable of executing jobs that require huge processing power. Supercomputer was devised with one thing in mind that was nothing but huge processing power. The term "Super Computing" was first used by New York City world newspaper in 1929. Supercomputers were introduced in the 1960s and were designed primarily by Seymour Cray at Control Data Corporation (CDC), and later at Cray Research [5]. Now researchers are improving gradually towards their processing power measured in petaFLOPS, as Supercomputer

2013 "Titan" built by Cray at Oak Ridge National Lab for use in different projects. It has processing speed 17.50 petaFLOPS with cost 97 million US $. So their cost is still a major bottleneck towards deployment for different projects.

1.2 PARALLEL COMPUTING:

In parallel computing several task are carried out simultaneously operating on the principle that large problems can often be divided into smaller ones, which are then solved concurrently. There are several different forms of parallel computing: bit-level, instruction level, data, and task parallelism. The concept of Instruction pipelining was inspired by parallel computing. Traditionally, computer programs have been written for serial computation. But with the advent of Parallel computing multiple processing tasks can be executed simultaneously. This is accomplished by breaking the problem into independent parts so that each processing element can execute its part of the simultaneously with the others.

1.3 CLUSTER COMPUTING:

A new form of parallel computing which consists of similar type of machines connected together to solve a particular type of problem. In such architecture machines are tightly-coupled using dedicated network connections where ultimate motive is to share resources. The advantage of computer clusters over single computers, are that they usually improves the performance while still being cheaper than single computers of comparable speed and size. But due to high degree of coupling the changes require in one node led to overhead in the whole cluster.

1.4 DISTRIBUTED COMPUTING:

A Distributed system consists of multiple machines that communicate through a computer network. The idea behind distributed computing is to achieve a common goal. The computers that are in a distributed system can be physically close together and connected by a local network, or they can be geographically distant and connected by a wide area network. A distributed system can consist of any number of possible configurations [2]. The goal of distributed computing is to make such a network work as a single computer. The main thing behind such a computing is that they offer scalability and redundancy actually reliability which often lacks in centralized systems.

1.5 VOLUNTEER COMPUTING

Volunteer computing is a type of distributed computing in which computer owners in different administrative domain donate their computing resources such as processing power and storage. We can relate with Direct Memory Access (DMA) in which processor perform Cycle stealing or scavenging process to make one CPU cycle worthy. Volunteer computing was introduced with mainly two objectives:

1.4.1 Increased power consumption:

A CPU that is in idle state generally has lower power consumption than when it is active. The desire to participate may also cause the volunteer to leave the PC on overnight, or to disable power-saving features like suspend.

1.4.2 Decreased performance of the PC:

If the volunteer computing application attempts to run while the computer is in use, it may impact performance of the PC. This is due to increased CPU contention, Cache contention, disk I/O contention and network.

1.6 CLOUD COMPUTING:

A large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted virtualized [5], dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet. A cloud is similar to concept of abstraction by hiding the true processes from a user. In a cloud computing environment, data can exist on multiple servers, details of network connections are hidden and the user is none the wiser. In fact, cloud computing is so named because a cloud is often used to depict inexact knowledge of inner workings

IV. COMPARISON WITH GRID COMPUTING ENVIRONMENT

This section aims to compare Grid Computing with various other sort of computing across a wide variety of perspectives, from coupling, architecture, ownership, user management, scalability, resource trust, resource management, throughput, it services, scheduling [5]. Comparison of different computing schemes is shown in table 1.

Table 1: Comparison among different Computing

Parameter	Cluster	Parallel	Distributed	Volunteer	Grid	Cloud
Coupling	Tightly	Tightly	Loosely	Moderate	Loosely	Both
Ownership	Single	Single	Autonomous	Multiple	Multiple	Multiple
User Management	Centralized	Centralized	Decentralized	Decentralized	Decentralized	Both
Resource Management	Centralized	Centralized	Distributed	Distributed	Distributed	Distributed
Allocation or Scheduling	Centralized	Centralized	Decentralized	Decentralized	Decentralized	Decentralized
Operatability	Proprietary	Proprietary	Through protocols	Through protocols	Through protocols	Through protocols
Scalability	100's	100's plus	10,000's	1000's	10,000's	1,0000's
Throughput	Medium	Medium	High	High	High,	High
Resource Trust	High	High	Medium	Low	Medium	Medium
Services	IaaS	IaaS	IaaS , SaaS	IaaS	IaaS	IaaS, SaaS, PaaS
Scheduling	Local	Local	Global + Local	Local	Global + Local	Global + Local

V. WHAT MAKES GRID COMPUTING DIFFERENT FROM OTHERS?

In essence a Grid is expected to encompass three points [1]:

1. The resources co-ordinated are not subject to centralized control, i.e. they run under the do- main of a virtual organization.
2. The standards, protocols & interfaces used are standardized, open and general purpose, i.e. the interoperability of the resources allows seamless integration with anything.
3. The quality of service delivered is not trivial i.e. to an agreement, to different types of agreements, etc.

So we can summarize Foster (2002) points in context with Grid Challenges as:

- Multiple administrative domains.
- Distributed resource with uncertainty.
- Heterogeneous environment.
- Lack of central node facility.
- Dynamic nature of resources etc.

VI. GRID COMPUTING PHASES:

6.1 RESOURCE DISCOVERY:

One of the key areas in a grid environment is how to manage all the types of heterogeneous resources for job executions, a mechanism should thus be provided by the grid infrastructure to discover the relevant resource for its corresponding requests [8, 9]. The process of resource discovery involves number of things that need to be taken into consideration. Resource discovery consist of searching resources in a grid. Some times resource discovery and selection both treated as single task. So this is the initial step which actually fetch out different resources in a system.

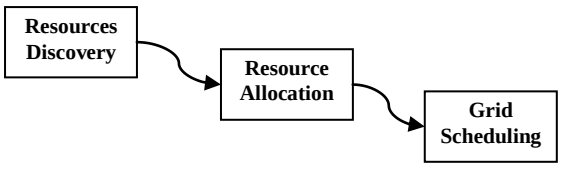

Figure 2: Grid Computing Phases

6.2 RESOURCE ALLOCATION:

Next phase is Resource Allocation as grid resources are distributed heterogeneously over a large geographical area. To manage the use of these resources and users properly, user task(s) need to be scheduled properly and allocated the corresponding requested resources accordingly. As Grid is a dynamic system, which changes with time as a result of a number of factors such as availability of new resources, resource failure, new requests, completion of an executing task etc. are areas of concerns. When any of these occurs, there is need for jobs to be rescheduled or re-allocation of resources for execution [8]. Unlike the conventional problems faced in scheduling and resource allocation in dynamic systems and other distributed systems, problem of dynamics is much more complex and challenging and thus the conventional schemes cannot be applied directly or used efficiently in this case.

6.3 GRID SCHEDULING:

Grid computing contains resource management, job scheduling, security problems, information management and so on [10]. Job scheduling is a fundamental and important issue in achieving high performance in grid computing systems.

In simple terms: Scheduling is the process of mapping submitted tasks to the available resources, means assigning job(s) to intended or selected resource(s). The performance of grid should be improved by reducing the job processing time and by making sure that all the grid resources are used without being idle. Another term is Meta-scheduling a process for deciding the best site locations for job execution within a distributed environment [11].

Different categories of Job Scheduling are:

1. Local vs. Global scheduling
2. Static vs. Dynamic
3. Preemptive vs. Non Preemptive
4. Centralized vs. Self dependent
5. Cooperative vs. Non Cooperative
6. Optimal vs. Non Optimal etc.

VII .CONCLUSIONS

Grid computing environment is still a growing field and many researchers are working on different projects underway. Grid can be seen as a powerful system which uses the resources within different domains distributed among geographical areas. So to make the whole system work efficiently, we have to consider best resources, efficient job scheduling and for that we need suitable resources which can be obtained during resource discovery phase. Our survey represent the evolution in parallel and distributed computing with current state of Grid computing which tells us its unique characteristics like heterogeneous resources, dynamic state, lack of central node facility, different administrative domains etc. are actually its primary challenges.

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