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Grid Computing: Review and S.W.O.T Analysis

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Abstract: In this paper, review of Grid computing has been done.The paper also presents the S.W.O.T. analysis of Grid Computing.
Keywords: Big Data Analysis, Grid Computing, Virtualization, Parallel Computing, Distributed Computing.

I. Introduction

Today's organizations are capturing extremely large amount of data and this will continue to increase. The exponential growth in volumes of data is surprising and has affected business. In order to know their customers and citizens better, Government, companies and many organizations acquire and store data about them. Social networking sites produce new data every second and handling such data is a challenge that the companies are facing. According to IBM estimates 90% of the data in the world today has been created in the last two years [1]. This data is called Big Data. Big Data is associated mainly with three dimensions: Volume which is in terabytes and petabytes, Velocity with which it is processed and Variety of sources. It extends beyond the structured data and also includes unstructured data of all varieties. Because of its size and heterogeneity, Big data can't be captured, stored or managed by typical database software tools. As a result, the paradigm of analyzing large data sets has been shifted from centralized to distributed architecture in the past few years.
Scientists and Engineers are changing the way they do computing because of availability of high speed networks and powerful computers along with the growth of the internet. New technologies support the clustering of wide variety of resources and also seamless access and interaction among these resources which are geographically distributed.

However, this paper mainly focuses on Grid Computing among those new technologies.
The basic notion of Grid came into existence in 1990's but still Grid means different to different people. Grid is analogous to the electric power grid which is supposed to provide astonishingly consistent, steady going, transparent access to electricity irrespective of its source. The consumer just utilizes the electricity plugged through wall sockets.
The paper is divided into several sections for the ease of understanding. Section 2, introduces Grid Computing. Section 3 provides the architecture, types and topologies of Grid Computing. Section 4, presents the S.W.O.T analysis of Grid Computing. Section 5, states the conclusion drawn from the paper.

II. Grid Computing

The term Grid Computing was firmly established by Fostera and Kesselman in 1998 with the publication of "The Grid: Blueprint for the New Computing Infrastructure." He defined Grid as "a system that coordinates resources which are not subject to centralized control, using standard, open, general purpose of protocols and interfaces to deliver nontrivial qualities of services."[6].Various other definitions for the Grid are provided by various network technology gurus. The Globus Project defines Grid as "as infrastructure that enables the integrated, collaborative use of high end computers, networks, databases and scientific instruments owned and managed by multiple organizations"[5]. Another definition put by GridBus Project is "Grid is a type of parallel and distributed system that enables the sharing, selection and aggregation of geographically distributed "autonomous" resources dynamically at runtime depending on their availability, capability, performance, cost and user's quality of service requirements" [9]. Before any system could be called a Grid, four important procedures need to be carried out. These are: Resource Discover, Authentication, Authorization and Resource Access [4]. The main reasons for Grid to become popular are [3][4][8]: Firstly, The vision of grid computing was to allow access to computer based resources in the same manner as the real world utilities. Secondly, the capabilities of modern computer systems and networks have increased drastically with time as compared to the traditional computer systems. This improvement in the performance, leads to CPU being idle most of the time. As a result, computational resources are wasted. These idle CPU cycles are utilized by the Grid to perform computation when needed by the Grid users. Hence, it enables the user to perform complex computations that in traditional cases would have demanded large scale resources. Another reason for the growth of Grid Computing is that the organization can reduce the operating and capital cost of its computing resources while it maintains the computing capabilities of the organization. This is because certain computational resources are necessary for certain operations but at the same time vastly underutilized. Thus, there is ROI on computing investment if the resources are participated in the Grid Computing.

III. Architecture, Topologies and Types of Grid Computing

Layered architecture of Grid Computing include the following layers [2][4][13]:

a) Fabric Layer- It consists of all the shared resources of the Grid owned by different individuals and organizations.
b) Resource and Connectivity protocols layer- It contains the core communication and authentication protocols that provide security mechanisms to verify the identity of users and resources and allow the data to be shared.

c) Collective Services layer- It contains Application Programming Interfaces and services to implement interactions between the shared resources.

d) User Applications layer

The topologies which are possible within a Grid are [10]:

a) Intra-Grid: It is the simplest of the three technologies and is composed of services within a single organization.

b) Extra-Grid: It is composed of services between different Intra Grids which span across multiple organizations and wide area network. The security is dispersed as compared to single security provider in Intra Grids.

c) Inter-Grid: It is the most complicated topology. It shares the same characteristics as Extra Grid, except the fact that the data and resources within the environment are global and available to public. Whereas in Extra Grid they are restricted to the respective organization and the partners it wishes to share with.

Grid is divided into the following types based on their use [4]:

a) Computational Grid: Provide access to Computational resources to process computational problems which otherwise would have required high computing power machines.

b) Collaboration Grid: Desired collaborations of organizations are best possible with these kinds of Grids.

c) Utility Grid: Apart from CPU cycles, other special peripherals and software are also shared.

d) Network Grid: Provides high performance communication between nodes using data caching with each cache node acting as a router.

e) Data Grid: Provides support for data storage and other services like discovery of data, handling of data, publication etc.

IV. S.W.O.T analysis of Grid Computing

Grid makes an optimized use of resources, utilizing the CPU cycles which otherwise would have been wasted. With this the users can get extra computation resource and thus can process large scale computational problems [4].The major benefits of application of Grid are [4]: Improved efficiency/ Reduced costs, Optimized utilization of underutilized resources, Exploiting underutilized resources, Virtual resources and virtual organization, Increased capacity and productivity, Parallel processing capacity, Resource balancing, Heterogeneous system support and Reduced time of result. Although tremendous benefits can be achieved from Grid Computing but road to Grid is not free of Difficulties. Inherent nature of Grid i.e. heterogeneity of software and hardware, handling widespread resources, control of different organizations pose serious challenges before the researchers. Many scientific problems which cannot be tested practically are simulated over the Grid. But this simulation itself is a challenge for Grid [4]. Various challenges in developing, deploying, promoting and use of Grid Computing are as follow[4]: Grid reliability, Scheduling of tasks, Load balancing, Resource monitoring, Service availability, Distributed management, Availability of data, Uniform user friendly environment, Grid application development, Standard protocols, Efficient algorithms and problem solving methods, Programming models and tools, Management and administration of grid, Performance analysis and resource monitoring, Centralized management, No widely accepted definition and scope of Grid computing, Hidden costs.

Moreover, the corporate culture of many organizations may be fundamentally opposed to resource sharing. Some organizations due to perceived economic or security threat may guard their machines and data. Grid Computing may require redefining of ownership, copyrights and licensing [11].

Other than this the two main security concerns when data and resources are shared in huge amount within the organizations are [3]: The first concern is mainly because it is possible for someone to tap your data and possibly modify it on its path and the second concern is that when you use other's computers in the grid, it is possible that the owners of those computers may read your data.

However, the following are the current security technologies that have been successfully deployed [12]:

Public Key Infrastructure – It provides users a way to do secure communication in insecure public network using public/private key pair.

KERBEROS – It is a distributed authentication protocol that provides mutual authentication to client and server using symmetric cryptography.

Grid Security Infrastructure – It is a part of Globus Toolkit and provides complete architecture for the implementation of security in Grids.

The various domains in which Grid Computing is utilized are [4]:

1. Engineering Design and Automation- Computational aerodynamics, artificial intelligence and automation, finite element analysis, remote sensing applications, pattern recognition, computer vision, image processing etc.
2. Medical, military and basic research- Polymer chemistry, medical imaging, nuclear weapon design, problem of quantum mechanics etc.
3. Predictive modeling and simulation- Flood warning, socio economic and government use, numerical weather forecasting, astrophysics, semiconductor simulation, Oceanography, human genome sequencing.
4. Energy resource exploration-Plasma Fusion power, seismic exploration, nuclear reactor safety, reservoir modeling etc.
5. Visualization- Computer generated graphics, films and animations, data visualizations etc.

E-libraries and E-learning centers are already doing benefits by using grid based tools for accessing distributed students, resources and tutors [3].

Figure 1 shows the summary of S.W.O.T analysis of Grid Computing:

Figure 1: S.W.O.T Table of Grid Computing

Strengths	Weaknesses
Improved Efficiency. Reduced Cost. Underutilized resources are utilized. Virtual Resources and organization. Increased productivity and	Interoperability issues. Resource discovery and management is difficult. Policy issues of cross organizations. Underlying security issues. Skill gap.

performance capacity. Resource Balancing and sharing. Heterogeneous system support. Transparent, dependable and consistent access. Improved mining of data and pattern finding. Increased Knowledge sharing.	Lack of standard protocols. Accounting issues. Network Latency and issues related to performance. Lack of Grid Applications. US driven protocols and tools.
Opportunities Engineering Design and Automation. Medical & military research. Predictive modeling and simulation. Energy resource exploration. E-libraries and E-learning centers for accessing distributed students, resources and tutors. Grid as the next internet/web. Better distribution of resources where needed. Potential for improved application integration.	Threats Awareness is limited. Technical and cultural challenges. Hidden Cost issues. Heterogeneity of systems. Different security protocols by different participating organizations. Potential presence of un trusted resources. Underlying complexity.

V. Conclusion

On one hand Grid has high computational power and does optimized use of resources but on the other hand ability to manage distributed and heterogeneous systems is difficult. No doubt Grid Computing is still evolving and in near future better protocols and standards will be implemented.

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