A Review Paper on Grid Computing

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***Abstract*-- Grid is a generalized network computing system that is supposed to scale to Internet levels and handle data and computation seamlessly. Grid computing an extension of distributed computing supports computation across multiple administrative domains which enable it to be distributed over a local, metropolitan or wide area network. Grid infrastructure is a large set of nodes geographically distributed and connected by a communication. As, the users can access the resources simply and transparently without knowing where they are physically located, there are many challenges involved for constructing the grid environment. This paper gives a detailed survey on the challenges and characteristics of the grid and how to manage the resources in the grid environment. This paper also deals with the security issues related to grid.**

***Keywords*-- Grid computing, Grid Architecture, Grid Security**

I. INTRODUCTION

Grid computing is a powerful and efficient computational technology which represented as an advanced step for the previous distributing computing. Grid Computing concentrates on fundamental aspects, including three key core technologies: grid security, data management, and scheduling. Grid computing [6] combines computers from multiple administrative domains to reach a common goal, to solve a single task, and may then disappear just as quickly. It is analogous to the power grid [7]. All Grid is a system which coordinates resources that are not subject to centralized control, using standard, open, general purpose protocols and interfaces to deliver nontrivial qualities of service [1].With the increased popularity of internet and availability of high performance computers and high speed networks as low cost commodity, it has become possible to use networks of computers as a single unified computing resource. Grid technology allows organizations to use numerous computers to solve problems by sharing computing resources. The problems to be solved might involve data processing, network bandwidth, or data storage. The systems tied together by a grid might be in the same room, or distributed across the globe; running on multiple hardware platforms; running different operating systems; and owned by different organizations. The idea is to grant users one place where they can go to undertake a particular task; the grid leverages its vast IT capabilities and completes the task. All the grid user experiences, essentially, is a very large virtual computer doing work.

The seamless integration of geographically distributed resources forms what is termed as Computational Grid and it can be described as a distributed network computing system where networked set of heterogeneous resources agree to share their local resources to form a unified virtual computer [7].

Grid computing is enabled by relatively high-performance computers, robust computer networks, grid management software, and the divisibility of difficult scientific problems. Together these allow a job to be subdivided and distributed to thousands or even millions of computers to calculate a solution.

A grid [2] is a distributed platform which is the aggregation of heterogeneous resources. They do an analogy with the electrical power grid. The computing power provided by a grid should be transparently made available from everywhere, and for everyone. Given the fact that an average computer is idle 90% of the time and that 99% of its capabilities are never tapped, as measured by the computational stress on the CPU, there is a huge opportunity to apply this power in a beneficial manner. The grid technologies originally developed for global distributed computing are also being applied in centralized computing centers to create high-performance resources that can be rented to Companies that need such power very infrequently, or who do not wish to manage the computing environment necessary to maintain their own hardware. The ultimate purpose is to provide to scientific communities, governments and industries an unlimited computing power, in a transparent manner. This raised lots of research challenges, due to the complexity of the Infrastructure. One of the main strategies of grid computing is to use middleware to divide and apportion pieces of a program among several computers. Grid computing Involves computation in a distributed fashion, which may also involve the aggregation of large-scale cluster computing based systems. The size of a grid may vary from small a network of computer workstations within a corporation to large collaborations across many companies and networks. Heterogeneity is present at all levels, from the hardware (computing power, available memory, interconnection network), to the software (operating system, available libraries and software), via the administration policies. Grid computing has the potential to reduce computation time on complex problems from a period of months to hours. This presents a significant business opportunity if there are enough customers who need such a capability. The name "grid computing" refers to the goal of providing computer services to users in the same way that water and electricity are provided. Customers need not own the means to produce their own water or electricity; instead, they outsource that capability to a utility and purchase only as much as they need Grid computing will allow dynamic sharing of resources among participants, organizations and businesses in order to be able to pool, and thus run compute-intensive applications or treatment of very large volumes of data. Since the failure probability increases with a rising number of components.

Section II describes the Layered Grid Architecture. In Section III, we talk about Types of Grid. Challenges are presented in Section IV. In section V, we present the Grid Characteristics. Resource management describe in section VI, we present the grid security in section VII.we present the conclusion in section VIII.

II. LAYERED GRID ARCHITECTURE

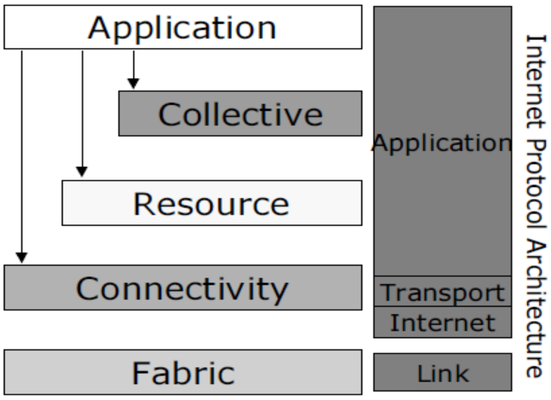

Figure 1 Grid Layers Architecture

Fabric Layer- A diverse mix of resources that may be shared Individual computers, Condor pools, file systems, archives, metadata catalogs, networks, sensors, etc.Few constraints on low-level technology: connectivity and resource level protocols form the "neck in the hourglass" Defined by interfaces not physical characteristics

Connectivity Layer - Communication. Internet protocols: IP, DNS, routing, etc.Security: Grid Security Infrastructure (GSI) Uniform authentication & authorization mechanisms in multi-institutional setting Single sign-on, delegation, identity mapping Public key technology, SSL, X.509, GSS-API Supporting infrastructure: Certificate Authorities, key management, etc.

Resource Layer - Grid Resource Allocation Mgmt (GRAM) Remote allocation, reservation, monitoring, control of compute resources. GridFTP protocol (FTP extensions) High-performance data access & transport Grid Resource Information Service (GRIS) Access to structure & state information Network reservation, monitoring, control All integrated with GSI: authentication, Authorization, policy, delegation.

Collective Layer - Index servers aka Meta directory services Custom views on dynamic resource collections assembled by a community Resource brokers (e.g., Condor Matchmaker) Resource discovery and allocation Replica catalogs Co-reservation and co-allocation services.

III. TYPES OF GRID

Grid systems can be classified depending on their usage. There are different types [6] of grid which can occur in Real-Time Grid System. These grids can be classified on several factors such as:

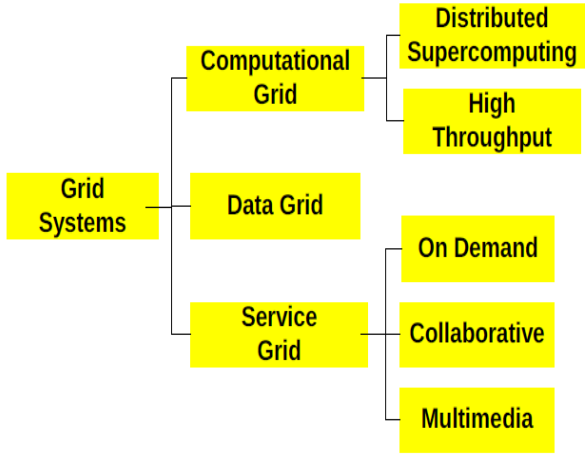

Figure 2 Grid Types

Computational Grid: – denotes a system that has a higher aggregate capacity than any of its Constituent machine. It can be further categorized based on how the overall capacity is used.

Distributed Supercomputing Grid:–executes the application in parallel on multiple machines to reduce the completion time of a job Grand challenge problems typically require a distributed supercomputing Grid one of the motivating factors of early Grid research still driving in some quarters

High throughput Grid:– increases the completion rate of a stream of jobs arriving in real time ASIC or processor design verifications tests would be run on a high throughput Grid.

Data Grid: – systems that provide an infrastructure for synthesizing new information from data repositories such as digital libraries or data warehouses applications for these systems would be special purpose data mining that correlates information from multiple different high volume data sources.

Service Grid: systems that provide services that are not provided by any single machine subdivided based on the type of service they provide

Collaborative Grid: connects users and applications into collaborative workgroups enable real time interaction between humans and applications via a virtual workspace.

Multimedia Grid: – provides an infrastructure for real time multimedia applications requires the support quality of service across multiple different machines whereas a multimedia application on a single dedicated machine can be deployed without QoS.synchronization between network and end-point QoS.

Demand Grid: – category dynamically aggregates Different resources to provide new services data visualization workbench that allows a scientist to dynamically increase the fidelity of a simulation by allocating more machines to a Simulation would be an example.

IV. CHALLENGES IN GRID

Grid Computing has made significant landmarks in field of high-performance computing, there are still a number of challenges that need to be addressed to provide seamless computing environment. One of the main challenges is the heterogeneity that results from the vast range of technologies, both software and hardware, encompassed by the Grid.

In short, we can collect some of the expectations in the following list:

- Enabling efficient and optimal resource usage.
- Share inter-organization resources efficiently.
- Secure user authentication and authorization.
- Security of stored data and programs.
- Secure Communication.
- Centralized or semi-centralized control.
- Auditing.
- Enforcement of Quality of Service (QoS) and Service Level Agreements (SLA)
- Interoperability of different grids.
- Support for transactional processes.

This is not an exhaustive list of challenges that the grids are expected to meet. There are a number of other concerns that daunt the grids but have not been included in this paper some of the Challenges are given below,

- Security
- Uniform access
- Computational economy
- Resource discovery
- Resource allocation and scheduling
- Data locality
- Application construction
- Network management
- System management

There is no clear standard to follow Still lots of debate on what grid computing is, and what is not Grid application development is still difficult Application area is limited and significant applications are lacked Lots of efforts should be done to make a software package or a service useable over grid

Centralized management of grid computing Business model of grid is ambiguous Management and administration of grid is the most challenged one secure access to resources and computations (identification, authentication, and computational delegation) is provided by low level middleware systems like Globus. Resource discovery involves discovering appropriate resources and their properties that match with users t We maintain resource listings for Globus, Legion, and Condor and their static and dynamic properties are discovered using grid information services. For example, in case of Globus resources, we query Globus LDAP-based GRIS server for resource information.

V. GRID CHARACTERISTICS

A grid is a large-scale geographically distributed hardware and software infrastructure composed of heterogeneous networked resources owned and shared by multiple administrative organizations which are coordinated to provide transparent, dependable, pervasive and consistent computing support to a wide range of applications. These applications can perform their distributed computing, high throughput computing, on-demand computing, data-intensive computing, collaborative computing or multimedia computing. The most incredible characteristics that make Grid a more usable system that all its predecessors are listed below:

A. *Heterogeneity:*

Grids involve heterogeneity. It allows incorporating varying software and hardware resources spread across different administrative domains.

B. *A wide spectrum of Resources:*

The grid is an all-compassing in context of the resources that constitute it. Broadly speaking, the grid resources incorporate computational resources, data storage, communication links, software, licenses, special equipment, supercomputers, and clusters. The Grids promise to provide consistent, dependable, transparent access to these resources despite their source.

C. *User-Centric:*

Grids lay the entire focus on the end-user. This means that the specific machines are that are used to execute an application are chosen from user's point of view, maximizing the performance of that application, regardless of the effect on the system as a whole. Since one of the major drives behind grid computing has been the collaborative research, so grid computing has played a marvelous role in:

A. Improving distributed management while retaining full control over locally managed resources.
B. Improving the availability of data and identifying problems and solutions to data access patterns.
C. Providing researchers with a uniform user-friendly environment that enables access to a wider range of physically distributed facilities improving quality.

A high-performance system capable of performing the necessary responses to load and generation trends and perturbations will normally have the following characteristics:

1. Adequate grid interconnection, involving multiple parallel lines Adequate reserve margins, especially spinning reserves Modern load dispatching centers in operation.
2. A reliable high-speed protective system continually in operation.With the above capabilities, the grid maintains narrow limits of frequency and voltage fluctuations does not permit prolonged off-nominal frequency and voltage operation Keeps disturbances and transients to short duration, and prevents their propagation throughout the system.

VI. GRID RESOURCE MANAGEMENT

A grid must optimize the resources under its disposal to achieve maximum possible throughput. Resource management includes submission of a job remotely, checking its status while it is in progress and obtaining the output when it has finished execution. When a job is submitted, the available resources are discovered through a directory service. Then, the resources are selected to run the individual job. This decision is made by another resource management component of the grid, namely, the grid scheduler. The scheduling decision can be based on a number of factors. For example, if an application consists of some jobs that need sequential execution because the result of one job is needed by another job, then the scheduler can schedule these jobs sequentially.

The grid resource broker is responsible for resource discovery, deciding allocation of a job to a particular grid node, binding of user applications (files), hardware resources, initiate computations, adapt to the changes in grid resources and present the grid to the user as a single, unified resource.

The resource broker acts as a mediator between the user and grid resources using middleware services. It is responsible for resource discovery, resource selection, binding of software (application), data, and hardware resources, initiating computations, adapting to the changes in grid resources and presenting the grid to the user as a single, unified resource. The components of resource broker are the following:

JOB CONTROL AGENT (JCA): This component is a persistent central component responsible for shepherding a job through the system. It takes care of schedule generation, the actual creation of jobs, and maintenance of job status, interacting with clients/users, schedule advisor, and dispatcher.

SCHEDULE ADVISOR (SCHEDULER): This component is responsible for resource discovery (using grid explorer), resource selection, and job assignment (schedule generation). Its key function is to select those resources that meet user requirements such as meet the deadline and minimize the cost of computation while assigning jobs to resources.

VII.SECURITY IN GRID

Security forms the vital aspect of grid computing. We look at the three most desirable security features a grid should provide. These are single sign-on, authentication and authorization. Single sign-on means that the user is able to login once using his security credentials and can then access the service of the grid for certain duration. Authentication refers to providing the necessary proof to establish one's identity. So, when you login to your email account, you authenticate to the server by providing your username and password. Authorization is the process that checks the privileges assigned to a user.

Security in grids differs from the Internet security due to the challenges that arise when we seek to build scalable virtual organizations (VOs). Security requirements within the Grid environment are driven by the need to support scalable, dynamic, distributed virtual organizations (VOs) collections of diverse and distributed individuals that seek to share and use diverse resources in a coordinated fashion. From a security perspective, a key attribute of VOs is that participants and resources are governed by the rules and policies of the classical organizations of which they are members.

Furthermore, while some VOs, such as multiyear scientific collaborations, may be large and long-lived (in which case explicit negotiations with resource providers are acceptable), others will be short-lived created, perhaps, to support a single task, for example, two individuals sharing documents and data as they write a proposal in which case overheads associated with VO creation and operation have to be small. A fundamental requirement is thus to enable VO access to resources that exist within classical organizations and that, from the perspective of those classical organizations, have policies in place that speak only about local users.

This VO access must be established and coordinated only through binary trust relationships that exist between (a) the local user and their organization and (b) the VO and the user. We cannot, in general, assume trust relationships between the classical organization and the VO or its external members.

A. *Existing Security Technologies*

In this section we cover those security technologies that have been successfully deployed in various existing security systems. All of these technologies are based on open standards and form an integral part of grid security. Of these technologies, Kerberos is not explicitly the part of existing grid security architecture, but can be used as an authentication mechanism to provide security in client/server architecture. As we shall see, Kerberos also provides some of the functionalities desirable in grids like single sign-on and delegation of privileges using Ticket Granting Ticket (TGT). The same functionality is provided by X.509 proxy certificate, which is a part of the Grid Security Infrastructure (GSI). However, the creation and delegation of Kerberos TGTs require involvement of a trusted third party (KDC). On the other hand an X.509 proxy certificate can be created without the involvement of a third party. We start our discussion with Public Key Infrastructure (PKI), which forms an integral part of GSI. In PKI we talk about the X.509 digital certificates, which form an integral part of PKI. Next in this section, we cover the Kerberos network authentication protocol explaining the key components of Kerberos and the steps involved in the authentication mechanism. In the end we discuss GSI, the existing security infrastructure used in the grids today.

PUBLIC KEY INFRASTRUCTURE - Public Key Infrastructure (PKI) provides users a way to do secure communication in insecure public network using public/private key pair.

KERBEROS - Kerberos is a network authentication protocol developed by MIT. It is a distributed authentication protocol that provides mutual authentication to client and server using symmetric-key cryptography. Symmetric-key cryptography means that the same key is used for both encryption and decryption of the message.

GRID SECURITY INFRASTRUCTURE - Grid Security Infrastructure (GSI) is part of the Globus Toolkit. As the name suggests it defines the complete architecture that provides the necessary functionalities for the implementation of security in grids.

VIII. CONCLUSION

We are in the world of complex computational power and very high speed machine processing capabilities with complex data storage methods. But these advancements are not enough for the complex and challenging demands placed by home users, businesses and industries. In this perspective, this paper has given a survey on grid computing which is the solution for the above said problem. This paper has detailed on the architecture of grid, types of grid, characteristics, challenges, Resource Management and security issue of the grid that has to be considered while creating a grid environment. Also, it has given a brief account on how to manage the resources and the security issues.

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