CHAPTER 1
INTRODUCTION

Technologies have seen rapid growth in the field of Distributed Computing within a short span of time. Transition from Peer to Peer Computing to Desktop Computing, and then to the presently prevalent technology called Grid Computing, has taken place in quick succession. All these technologies have a sole aim which is to posses as well as deliver computing power to a large number of end-users in a reliable, efficient and scalable manner. As in Power Grids, where users (or electrical appliances) get access to electricity through wall sockets without bothering-about or considering as to from where the electricity is actually generated and how it is generated, Grid Computing possess the similar vision whereby computing attains the pervasive nature and thereby individual users (or client applications) gain access to computing resources (processors, storage, data, applications, and so on) without bothering about the location of those very resources.

1.1 Grid Computing

A Grid system is a scalable, independent and self-governing infrastructure concerned with the integration, virtualization vis a vis management of services and resources. These services and resources are in a dispersed and diverse environment, which also supports grouping of users and resources (Virtual Organizations – VOs) across traditional administrative and organizational domains. The Grid application defines the requisite features or factors based upon which each and every resource is carefully selected from available resources and this selected resources are then included in the Grid framework for that particular application. Thus, resources within the Grid may vary in nature, including processors, data, scientific instruments and other services. This leads to its Commercial importance and this Commercial importance raises the question of Quality, which can only be answered through Secured Resource Management.
In a Grid environment, band of resources is able to work collectively in an organized manner because of defined protocols that control connectivity, coordination, resource allocation, resource management and security. Generally the protocols are implemented in the middleware. The systems attached together by a computing Grid may be located in the vicinity to each other or may be located far away across the earth; they may have homogenous or heterogeneous hardware platforms while operating; while operating, they may be on similar or diverse operating systems; and they may belong to one or more organizations as their owner. Grid Computing is to provide users with a single view and single method which can be employed to carry out any number of computing tasks in efficient and reliable manner.

The distinctive benefits that can be achieved by means of Grid include performance with scalability, resource utilization, management & reliability and virtualization. The capability of Grid to utilize and share resources across geography makes it strikingly popular. Grid computing in whole, as an environment, offers additional computational potential and assists to increase the efficiency and scalability of the infrastructure. Many projects require flexible and scalable infrastructure, therefore, most of the applications being run on the Grid infrastructure are compute-intensive or batch type applications. Another Grid requirement is the need to use the resources more proficiently. A Grid can control the unused processing power available in computing systems sited in different time zones.

A resilient and robust infrastructure can be formed by the Grid by applying decentralization, fault tolerance and fail-over so as to create the infrastructure which is better matched in order to respond to minor or major adversities. The Grid provides virtualization of assorted resources which is consequential in better management of resources. However, as Grid systems gained popularity, question arose: How to share computing resources between potentially unknown parties? Answer to which is: Dynamic Trust Establishment. It turns out to be crucial factor for qualifying resources for selection, thus ensuring successful business collaborations through Grid Computing.
1.1.1 Global Grid

Global Grid model offers an opportunity for every Virtual Organization to pool its local resources as part of a single, massive scale resource sharing abstraction. Global Grid is the decentralized Grid using brokering approaches with major focus on coordinated resource management. In other words, the brokering system focus towards pooling-in distributed Grid resources as part of a single joint resource sharing system such as a confederation or virtual organization. Broadly speaking, a distributed system arrangement is deemed as decentralized if neither of the constituents in the system is more vital than the others and in case one of the constituents does not succeed, then situation caused is neither more nor less unsafe to the system than the one caused by the failure of any other constituent in the system.

Global Grids based on Peer to Peer network model prevail over the existing restrictions of centralized and hierarchical model in scalability, trustworthiness, independence, autonomy and single point failure. Inter-connecting distributed Virtual Organization through Peer-to-Peer steering is vital in order to evade the tribulations of resource management efficiency log-jam and single point of failure in the centralized or hierarchical resource management approaches.

1.1.2 Grid Resource Management System

In a Grid system, an end user submits to the management system a job that is to be executed along with some checks and riders, like job execution deadline, the maximum cost of execution, etc. These checks and riders are the requisites of the task to be accomplished. Thus, the function of the Grid Resource Management System is to take these checks and riders as the job specifications and from these specifications, it has to estimate the resource requirements like the number of processors required, the execution time, and memory required. Once the estimation of the resource requirements has been done, Grid Resource Management System (GRMS) is responsible for discovering available resources and selecting appropriate resources for job execution. Further, this
management system has to plan and schedule the tasks on the selected resources by interacting with source provider’s Resource Management System. It is also responsible for assigning a name to every the resource in the system, monitoring and reporting the job, resource status and accounting for resource usage.

Grid Resource Management System’s architecture and the services offered by it are affected by the type of Grid system it is set-up in. In a Grid System, resources could be hardware (computation cycle, network bandwidth and data stores) or software resources (applications and databases). Majorly, the GRMS interacts with:

a) the security system to authenticate user needs and specifications;
b) the information service to attain information about resource accessibility; and
c) the local system to plan and schedule tasks on the local resource management system;

In a general state of affairs and circumstances, the resources belong to diverse and self-governing resource providers, who assert executive independence and usually have different usage policies. Characteristically, the respective policies are made obligatory by the Local Resource Management Systems. Consequently, the Local RMSs with a high degree of heterogeneity in the technological features as well as obligatory policies are witnessed in these Grid designs and configurations. This, thus, reflects following major difference between the Local Resource Management Systems and The Grid Resource Management Systems:

‘The Grid RMS has a highly dynamic environment and in this dynamic environment, it has to deal with many heterogeneous resources whilst it has no special control over any of the resources it is configured of. Contrarily, only one or a few resource types are managed by the Local RMS and that too in a static configuration. A single administrative domain houses these resources, wherein the RMS has exclusive control over them.’
1.2 Problem Statement

With the fast expansion of Grid environment and its dynamic nature, as well as with emergence of new generation distributed systems, the researchers are looking for an answer to the question: How to share computing resources between potentially unknown parties? Which implies that ‘Trust and past Reputation’ of the computing resource has to be ascertained before the resource is used by a Grid System for performing the Grid User’s job. This shall not only assist in effective Grid Resource Management but shall also lead to Grid User’s satisfaction with successful completion of job. With the Grid technologies entering the commercial arena, it has become critically important to handle trust and reputation of various Grid resources as a part of Grid Resource Management.

This thesis addresses the problem of dynamic Trust Establishment for qualifying resources for Resource Management, thus ensuring successful commercial collaborations. Despite the acknowledgement of the importance of Trust Management in Grid computing, Reputation-based Trust Models are still barely considered for classical Grid systems. Since the long term future of the Grid is to provide dynamic aggregation of resources, provided as services between businesses, need for new architectures and detailed mechanisms for bringing together arbitrary resources arises. The deployment of a Reputation-based Trust Management System is a saluting addition to the Grid computing community as it would allow high degree of fine-grained Resource Management in order to exoterically match specific job requirements. As a result, this makes the Reputation-based Trust research topic an important milestone toward the evolution from failure tolerant research-oriented Grid systems into mission critical commercial ones.

In the context of Grid computing, Reputation-based Trust Management Systems play an imperative and critical role in supporting coordinated resource sharing, as they can manage job execution risk by preemptively selecting computing resources based on aggregated past recommendations. No doubt Grid computing has gained amazing popularity in commercial sector, foremost concern which still remains is Reputation, as it is a necessity for establishing Trust dynamically among untrusted participants of the Grid.
With a secured Grid Resource Management System, Grid’s entry to the commercial arena is successful and without this guarantee of a strong Trust bond between consumer and provider, this success cannot be achieved. This research explores the implementation of security in Grid Resource Management as to how much Trust can be put-on or be assured-of a Grid Resource depending on various factors like nature of job, performance, availability etc.

Specifically, the main problems considered in this thesis are stated as follows:

Problem 1: *How Reputation-based Trust Models are applicable in Grid?*

Problem 2: *How to frame a standard for reputation models when applied in Grid environment?*

Problem 3: *How to improve the existing Grid architecture in order to make it more secure and reliable?*

Problem 4: *How to implement the new/modified architecture in a simulated environment?*

Problem 5: *How to check the applicability of new/modified architecture in global grid in comparison with existing possibilities?*

The effort in adapting to the above requirements resulted in the development of the following contributions:

- Pre-standardization of Reputation models for Grid Environment
- Proposed Trust-based Architecture for Global Grids
- Reputation-based Trust Model
- Grid Resource Reputation Trust Manager
- Countering Feedback Security Threats
1.3 Thesis Organization

In this research, the issues and tradeoffs for the reputation-based trust framework are investigated. Following research methodology has been adopted: A comprehensive literature survey has been conducted to understand the strengths and weaknesses of the existing reputation-based management system in multiple disciplines. Inspirations of the insight led to the development of reputation-based trust framework deployed in grid resource management system.

Chapter 2 reviews prior work. The presentation covers a survey of different reputation-based trust management systems that guide the devise of new reputation-based trust framework. In this context, various tradeoffs made to improve performance, consistency, robustness and non-vulnerability are identified which help a researcher will build new reputation-based trust framework. In addition, the standardization efforts for trust model from Grid Computing perspective are explored.

A reputation-based trust framework deployed in grid resource management system, is proposed and analyzed in Chapter 3. The fault-tolerance and performance of this trust framework has been enhanced by adding parameters to be used in the evaluation of entity trust. The reputation-based trust framework is used as part of Grid Resource Management System in preference to security module that has been more popular with the researchers in the past. This novelty reduces the problem of dynamic trust establishment for qualifying resources for resource management, thus ensuring successful commercial collaborations.

A Secured Grid Resource Management for Global Grids by addition of a trust-based layer is presented in Chapter 4. This allow Grid resource to enter the commercial area, wherein it shall help the Grid consumer in Decision Making, as the system will offer only those Gird resources which assure of a high degree of trust relationship of Grid resource provider.
Chapter 5 presents the GridPeerTrust testbed architecture by discussing the design requirements for allowing side-by-side comparison of GridPeerTrust reputation model with the other reputation model along present a case study which is highly applicable to the commercial taxes and utilizes the GridPeerTrust testbed. The testbed environment including system constraints and resolutions as well as the mandatory steps required executing GridPeerTrust model.

Experiment Evaluations are evaluated in Chapter 6 which evaluates experimental results produced by the GridPeerTrust testbed architecture and a post analysis based on these results. A comparative analysis of GridPeer Trust with other reputation models based on the security threats reveals the tremendous performance of GridPeerTrust.

Finally, Chapter 7 summarizes this thesis by discussing the contributions of the proposals and drawing the conclusions. The directions in which this work can be further extended are also outlined.