REPLICA SELECTION USING RANDOM AND AHP ALGORITHMS IN DATA GRID

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Abstract –

In the current scenario, there is a need to store large amount of data for an application. All these data are stored in a single computer and they have to be shared by many users with accuracy, fairness and security. If any crash occurs in the system, then the whole data will be lost. In large-scale Grid, data replication provides a suitable solution for managing data files where data reliability and data availability are enhanced. Replica selection is one of the major functions of data replication that decides which replica location is the best for Grid users. In order to provide minimum response time, the replicas as a resource must be allocated among the users fairly. Replication systems create multiple copies of the same data file, and distribute these copies (replicas) into different site locations. Thus, there is a significant difference in selecting one replica among many replicas widely distributed. Hence, it is feasible to focus on the replica selection strategies in order to select the best replica location according to some criteria. The criteria set such as reliability, security and response time are considered to provide the best replica of high quality in minimum response time.

Replicas are selected using Random and Analytical Hierarchy Process (AHP) algorithms. The best replica is selected based on the reliability and security values. The performance of these two algorithms is evaluated in this paper.

Index Terms - Data grid, fairness, analytic hierarchy process, fairness.

I. INTRODUCTION

Grid Computing is the combination of computer resources from multiple administrative domains applied to a common task, usually to a scientific, technical or business problem that requires a great number of computers processing cycles or the need to process large amounts of data. The thing that distinguishes grid computing from conventional high performance computing systems such as cluster computing is that Grids tend to be more loosely coupled, heterogeneous, and geographically dispersed. Grids are often constructed with the aid of general-purpose grid software libraries known as middleware.

The goal of grid computing is to allow the sharing of computing and data resources for a number of workloads and to enable collaboration both within and across organizations. Replica is a copy that is relatively indistinguishable from the original. It is a copy of an original object that can only be made by the original company of the firm that made the original object. Replicas are geographically distributed in different sites.

Replication of data helps a lot to enable high throughput file transfer and scalable resource storage in distributed Data Grid environment. The selection of a data replica is critical for users to effectively access a data file. Data replication is adopted to improve data access performance in Data grid. When different sites hold replicas, there are significant benefits while selecting the best replica. Data replication can reduce access time and improve fault tolerance and load balancing. Replication is an effective mechanism to reduce file transfer time and bandwidth consumption in Data Grids.

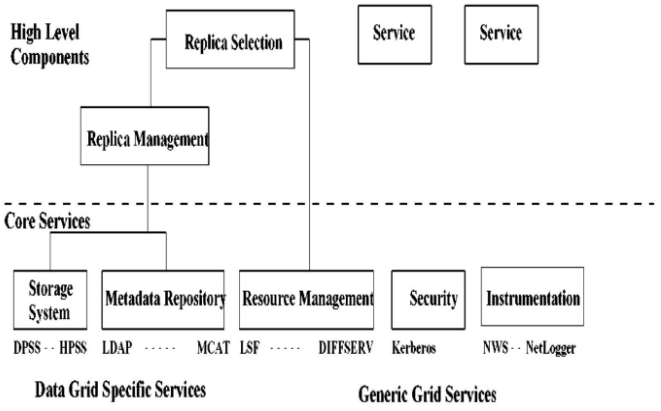

Fig.1 Data Grid Architecture

Replica selection is a high-level service in data Grid that can use low-level services as illustrated in Figure 1. Replica selection in turn depends on replica management which provides some core data grid services like system

storage and metadata repository. Generic Grid Services are resource management, security and instrumentation. Response time is the elapsed time between the end of an inquiry or demand on a computer system and the beginning of a response. It is the time a user senses as the beginning of input and the end of the response. It is actually possible for perceived response time to be too fast. However, this is not the usual complaint.

Data is stored in many sites and the files are stored as replicas in all sites. When the user requests for replica, the user will be provided with the requested file in minimum response time. Many users will request for some replicas at a time and they can be served immediately. All users should be treated equally and they should be satisfied. To achieve this, the system should provide fairness.

The replica has to be selected from the best site using some algorithms. The proposed system focuses on replica selection decision and on estimating fairness among users. The proposed system uses AHP, Random algorithms to provide fairness among the users. The random algorithm will select a replica from a site randomly. Efficiency becomes less in random algorithm when the number of users and sites get increased. The AHP algorithm will provide the best site to select the replica. The objective of the project is to process the user's request and provide the best replica from the best site with fairness in minimum response time.

The objectives of the proposed system are provides the Grid users with the required replica in minimum response time and establishes fairness among the users by providing a new method for resources allocation.

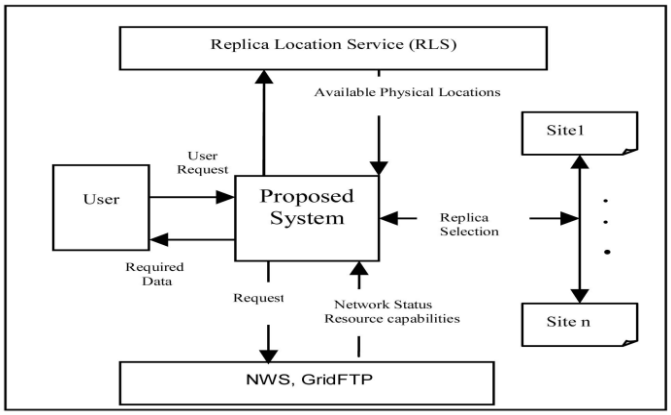

Fig.2 Proposed System and other grid services

II. PROBLEM SPECIFICATOIN

Grid users aim to select the best required replica location (Grid site) from among many replicas distributed across grid sites for their jobs. Typically, grid users would want their replicas in minimum response time and high level of Quality of Service (QoS). In order to do so, the replicas as a resource must be allocated among the users fairly.

Dynamic replica selection strategies [2], [7], [8], [10], [14] have emerged to improve the estimation of the expected user response time based on measurements of network parameters such as Round-Trip Time (RTT), bottleneck bandwidth, available bandwidth, and server request latency. An intelligent prediction based on historical log files was used to decide which replica is the best. In grids, huge amount of data have to be handled. If the user requests a file and if it is present in only one server, it is very hard to retrieve the file soon with more accuracy. So the text files are divided into many replicas and are made available in many servers. Whenever the file is requested, it may be selected and retrieved from any of the servers using some algorithms in a small amount of time. Some algorithms like random, AHP are now in use to retrieve the files efficiently.

The replica selection is proposed with the required replica in high level of QoS and minimum response time. Since the multicriteria considered in the selection decision in the proposed system— response time, security, and reliability—are in conflict with each other and heterogeneous, the Analytical Hierarchy Process (AHP) model was used to solve the problem. The levels of security [16], [20] are considered.

Intelligent replica selection requires information about the capabilities and performance characteristics of storage systems and underlying transport network, thus it is highly dependent on other Grid services, such as monitoring/forecasting services like the Network Weather Service (NWS), Grid resource information services. The Replica Location Service (RLS) maintains and provides access to information about the physical location of the copies. NWS measures and forecasts network throughput and latency for a collection of Grid nodes.

Replication Service [6] among the nodes improves failure resistance and increase system availability. By the

grid replica cataloguing service, one can attain the replication information of all the nodes and define various higher level replica selection optimization based on different services. It often comprises of replica location service (RLS) and a replica selection service (RSS). The effective RLS system is the system Giggle, a framework with which one can tune the behavior of the RLS system based on the scale, performance, reliability and cost requirements of particular classes of application. Replica Selection Service involves choosing a replica from among those spread across the grid, based on some application specified characteristics.

III. SYSTEM MODEL

The proposed system focuses on replica selection decision and on estimating fairness among users. Most important reason considered here is data files which are required for job execution. Since data files have many replica distributions on different grid sites, each site has its own characteristic which we have termed as criterion set namely reliability, security and response time. The proposed system uses AHP, Random and PSO algorithms to provide these services effectively.

Best replica is selected using random algorithm using a replica catalogue. Replicas are selected randomly from the site based on the user's request for replicas. The replica may be selected because it may be nearer to the user or it may be of high quality or small in size. The site ids and full description of the sites in the grid are maintained in a replica catalogue.

The user's requests for sites are compared with the catalogue and the requested replicas are chosen randomly from a site. Fairness is not achieved in random selection of replicas. The user will be given minimum response time to get the requested replica.

The following are the steps to select the user requested replica using random algorithm.

- **Step 1**: Get the request for the replica from the user. All the site Ids and replica are updated in replica catalogue.
- **Step 2**: The proposed system will process the user request by searching the replica catalogue and it will provide a replica to the user randomly without thinking about quality and fairness.

AHP uses the weighted sum approach and is widely used in many selection problems. The reliability, security and response time values for all sites are updated in the replica catalogue. Then the reliability, security, response time and fairness matrix are calculated using the values in the catalogue. The Eigen value and Eigen vector are calculated using the four matrices.

As a result the ranked site matrix will be generated from which the best site for the requested replica will be selected. The following steps explain the process of AHP algorithm [13][21].

Step 1: Calculate the User Criteria Average (UCA) from the historical data file for each criterion as follows:

$$UCA = \frac{\sum_{i=1}^{n} Criterion}{n}$$

where n is the number of times the specified user requests a replica. We can derive sub equations for each criterion namely, Reliability Criterion Average (RCA), Security Criterion Average (SCA), and Response Time Criterion Average (RTCA) as follows:

$$RCAuser = \frac{\sum_{i=1}^{n} \mathrm{Re}liability}{n}$$

$$SCAuser = \frac{\sum_{i=1}^{n} Security}{n}$$

$$RTCAuser = \frac{\sum_{i=1}^{n} \mathrm{Re}sponseTime}{n}$$

Step 2: Calculate the System Criteria Average (SCA) for all users in the Grid system which exist in the historical data file. Here the value of m is the total number of all users' requests rather than one user.

$$SCA = \frac{\sum_{i=1}^{n} Criterion}{m}$$

We can derive sub equations for each criterion as follows:

$$RCAsystem = \frac{\sum_{i=1}^{n} \mathrm{Re}liability}{m}$$

$$SCAsystem = \frac{\sum_{i=1}^{n} Security}{m}$$

$$RTCAsystem = \frac{\sum_{i=1}^{n} \mathrm{Re}\,sponseTime}{m}$$

Step 3: User Fairness (UF) is calculated for each criterion.

$$UF = \frac{CriterionAvgsystem}{CriterionAvguser}$$

We can derive sub equations for each criterion, as follows:

$$\mathrm{Re}\,liabilityF\,airness = \frac{RCAsystem}{RCAuser}$$

$$SecurityFa\,irness = \frac{SCAsystem}{SCAuser}$$

$$\mathrm{Re}\,sponseTimeFairness = \frac{RTCAsystem}{RTCAuser}$$

Step 4: Calculate the correlated criteria weights, which is the criteria relatively important to provide a suitable method for generating criteria weights which reflect users' preferences.

$$Weights = Wij\,\frac{CriterionFairnessi}{CriterionFairnessj}$$

Step 5: Security, reliability, and response time are evaluated for each alternative (site). Accordingly, the Security Matrix is generated by dividing each security value. The reliability and response time matrices are also calculated in the same way as the security matrix. So far we have four matrices, namely, Fairness Matrix, Security Matrix, Reliability Matrix, and Response Time Matrix.

Step 6: For each matrix from the four matrices, the AHP_Eigenvector is calculated by computing the sum of each row in the matrix and dividing each result by the total sum. The Eigenvectors for reliability, response time, and fairness matrices are computed is the same manner as the AHP_Eigenvector of the security matrix.

Step 7: Aggregate the AHP_Eigenvector for reliability, security, and response time in one matrix against the related alternatives (Sites), and then multiply this matrix by the

AHP_Eigenvector of the fairness matrix, thus resulting in a one-dimensional array called the rank array; The highest value in the rank array will be the best selection of the available alternatives.

IV. EXPERIMENTAL STUDY

The experiments are conducted to evaluate the performance of the system. Both the performance of Random algorithm and AHP algorithm are evaluated. The algorithm which is more efficient to find the best site is found out based on response time, reliability and security values. A performance evaluation graph is plotted to find best efficient site.

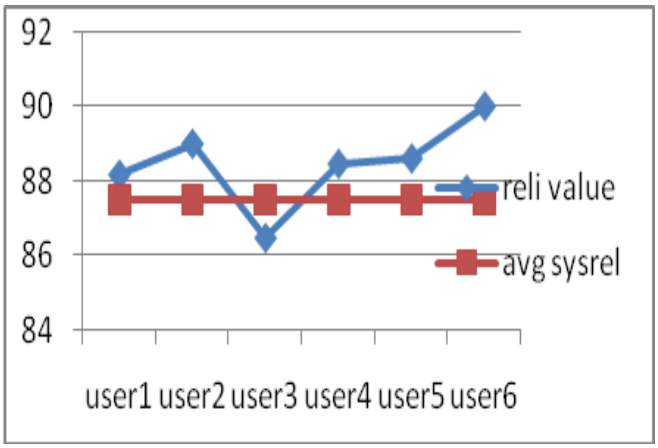

Figure 3 Reliability vs Users

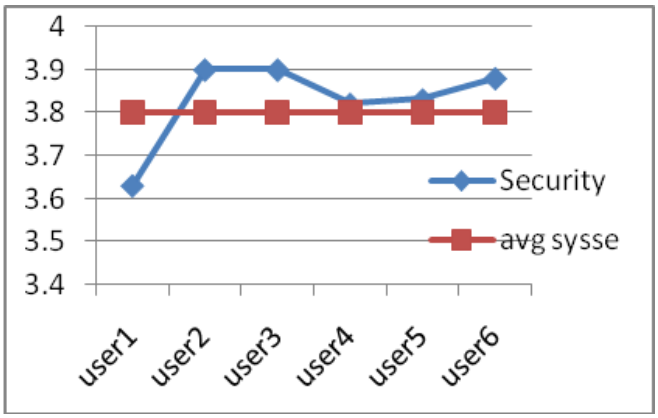

Figure 4 Security vs Users

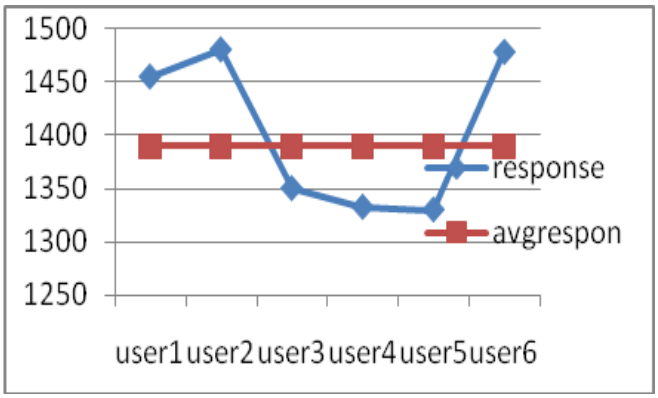

Figure 6 Response Time vs Users

V. RELATED WORK

In typical grid environment, replication systems create multiple copies of the same data file, and distribute these copies (replicas) into different site locations. These site locations vary in their capabilities, resources, and network bandwidths. Thus, there is a significant difference in selecting one replica among many replicas widely distributed [15]. Hence, it is feasible to focus on the replica selection strategies in order to select the best replica location according to some criteria. The big challenge of any replica selection strategy consists of defining appropriate criteria to determine the best replica location to which the requesting user should be bound, and the selection algorithm used for replica selection strategy.

The first replica selection approaches were aimed at selecting the closest server to the user that houses the required replica, according to some static metric criteria such as the geographical distance in miles and the topological distance in number of hops [14]. However, the static metrics are not sufficient as predictors for the expected response time of user requests; moreover, the network dynamic conditions are neglected.

An intelligent prediction based on historical log files was used to decide which replica is the best. Among those approaches is the Replica Optimization Service (ROS) [8], which is responsible for selecting the best replica in order to minimize data transfer time based on two main criteria, namely, network status and storage access latency. Other approaches [17], [18], [19] have used parallel download from different locations concurrently to minimize transfer time. These approaches use algorithms that select all or a number of servers which have the requested file. Thus, the required file is partitioned into segments.

Each segment will be downloaded from each available server. Feng et al. [18] have proposed a new data transportation mechanism termed rFTP that retrieved partial segments of data concurrently. Some portions of data files are transferred from several replicas together, and aggregate the sum of the best transfer rates of each replica. rFTP make uses of other grid services such as GridFTP, NWS, and RLS.

Zhou et al. [17] have proposed three algorithms for retrieving the required replica, namely, uniform, greedy, and assigning with prediction. Uniform algorithm divides the required replica into equally fixed sized segments according to the available number of replicas. For example, if a replica available in three servers, then the replica sized S is divided by the number 3. Thus, each segment equals S/3. The main disadvantage to the uniform technique is that when faster servers finish their transfer, the entire file cannot be aggregated until slower servers finish their transfer.

VI. CONCLUSION AND FUTURE RESEARCH

The proposed system mainly focuses on the effectiveness in selecting the replicas and comparing the performance of algorithms. The developed system has implemented the replica selection using random and AHP algorithms. It also featured the performance comparison of the two algorithms to provide the best replica. Our system as a whole entitled the selection of replicas in a data grid. In future, more number of sites and requests from users can be included. A browser can be connected and files can be downloaded from that. The Quality of Service can be improved by using some other algorithms and their performance can be compared. This concept can be extended to a bigger network wherein we can have n number of sites.

REFERENCES

[1]. Husni Hamad E.AL- Mistarihi and Chan Huah Young, “On Fairness, Optimizing Replica Selection in Data Grids”, IEEE transactions on Parallel and distributed systems, August 2009.

[2]. T.Ho and D.Abramson, “The GridLeS Data Replication service”, Proc.First international Conference e-science Grid Computing, 2005.

[3]. S.Vazhkudai, S.Tuecke and I. Foster, “Replica Selection in Globus Data Grid”, Proc.First international Symp. cluster computing grid, 2001

[4]. Jun Feng, Marty Humphery “Eliminating Replica selection Using Multiple Replicas to accelerate Data Transfer on Grids”, Proc. 10th Int'l Conf. Parallel Distributed Systems (ICPADS), 2004.

[5]. Bingxiang, YI Kui., “A Global Dynamic Scheduling with Replica Selection Algorithm using GridFTP”, 2010.

[6]. Dafei Yin, Bin Chen and yu Fang “A Fast Replica Selection Algorithm for Data Grid” Proc. of 31st Annual International Computer Software and Applications Conference, 2007 (COMPSAC 2007) , pp. 383 - 387

[7]. C. Ferdean and M. Makpangou, “A Scalable Replica Selection Strategy Based on Flexible Contracts,” Proc. Third IEEE Workshop Internet Applications (WIAPP), 2003.

[8]. Replica Optimization Service (ROS) and EuropeanDataGrid,http://edg-wp2.web.cern.ch/edg-wp2/index.html.

[9]. A. Sulistio, C.S. Yeo, and R. Buyya, “A Taxonomy of Computer-Based Simulations and Its Mapping to Parallel and Distributed Systems Simulation Tools,” Software Practice and Experience,vol. 34, pp. 653-673, 2004.

[10]. S. Vazhkudai, S. Tuecke, and I. Foster, “Replica Selection in the Globus Data Grid,” Proc. First Int’l Symp. Cluster Computing Grid, 2001.

[11]. Globus Toolkit Web Site, http://www.globus.org, 2009.

[12]. B. Boe¨hm, Characteristics of Software Quality, TRW Series on Software Technology, vol. 1. North Holland, 1978.

[13]. Th.L. Saaty, The Analytic Hierarch Process, Planning, Priority, Setting, Resource Allocation. McGraw-Hill, 1980.