Neighbour Replica Transaction Failure Framework in Data Grid

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Abstract. Significant and urgent requirement to obtain solutions to manage, distribute and access large sets of raw and processed data efficiently and effectively in the emerging distributed systems such as the data grid. Data grid deals with the efficient management, placement and replication of large amounts of data. Nowadays, replication in distributed environment receives particular attention for providing efficient access to data, fault tolerance and enhance the performance of the system. This paper presents the new Neighbour Replica Transaction Failure Framework (NRTFF) in data grid. We address how to build reliable system for managing transaction on Neighbour Replication Data Grid (NRDG) to maintain data availability, fault tolerance and at the same time avoid the deadlock. The result shows that managing transactions on NRDG through the proposed NRTFF provides fault tolerance capabilities that allow to withstand failure both in handling quorum locking and the transaction execution.

Keywords: Transaction, NRDG, NRTFF, replication, data grid.

1 Introduction

Ensuring efficient access to such a huge network and widely distributed data is quite complex and challenging process. Significant and urgent requirement to obtain solutions to manage, distribute and access large sets of raw and processed data efficiently and effectively in the emerging distributed systems such as the data grid. The required for data grids because of the data is being produced at a tremendous rate and volume especially from scientific experiments in the fields of high-energy physics, molecular docking, computer micro-tomography and many others. For example, Grid Workloads Archive (GWA) is to provide a virtual meeting place where practitioners and researchers can exchange grid workload traces [1]. Another example, experiments in the Large Hadron Collider (LHC) are forecasted to generate massive quantities of data [2]. ATLAS [3], currently the largest of the experiments to be conducted on the LHC, is projected to generate several petabytes of data per year alone. Laser Interferometer Gravitational Wave Observatory (LIGO) is a multi-site national research facility whose objective is the detection of gravitational waves. The data management challenge faced by LIGO [4] is therefore to replicate approximately 1 TB/day of data

F. Zavoral et al. (Eds.): NDT 2010, Part II, CCIS 88, pp. 488–495, 2010.

to multiple sites securely, efficiently, robustly, and automatically; to keep track of where replicas have been made for each piece of the data; and to use the data in a multitude of independent analysis runs.

Data replication is one of the key components in data grid architecture as it enhances data access and reliability. Data grid deals with the efficient management, placement and replication of large amounts of data [2]. However, once data are in place, computational tasks can be run on the grid using the provided data. In this data grid system, several characteristics are considered such as: (1) provides an interface to user which is transparent to where the data actually resides; (2) ability to locate the data; (3) network-wide concurrency control and recovery procedures; (4) mediators to provide translation of queries and data between heterogeneous systems [5]. Replication in distributed environment receives particular attention for providing efficient access to data, fault tolerance and enhance the performance of the system [5-7]. In distributed environment, it is necessary to consider the breakdown possibility of a site [8]. A halt in an operation of computer or other systems can cause the transaction failure during its execution. In the event of disaster, some changes may have been made and others are not. This will jeopardize the data consistency and may produce incorrect results. Another challenging question might arise like this one: given that all jobs of the works are supposed to satisfy some constraint such as the overall atomicity, how can we best schedule the work onto different resources, so that we can cater for the constraints whilst try to maintain the fault tolerance during system failure? This likely failing must not affect the working of the whole system. Consequently the fault tolerance must be studied to ensure consistent and a very strong safety of working in distributed environment [9-10]. Tolerance to faults can be assured without redundancy and the distributed concept of processing data is an interesting solution to solve this aspect. The faults may result in unsatisfactory performance or instability [11]. In addition, tolerance to faults is a motivating factor to extend work to design the Neighbour Replica Transaction Failure Framework (NRTFF) from previous working model [7]. NRTFF considers two failure cases include (1) less neighbour replica has failure than a majority quorum; and (2) more neighbour replicas have failures than a majority quorum; which not has not been discussed in our previous work.

This paper presents the proposed NRTFF in data grid environment. In Section 2, recall the theoretical background Neighbour Replication on Data Grid (NRDG) Transaction Model. In Section 3, we present the proposed framework. The implementation of the systems and the conclusion are then presented in Section 4 and Section 5 respectively.

2 Theoretical Background

In this section, we recall the NRDG Transaction Model [7] that has been defined as follows:

a) T is a transaction.
b) α and β are groups for the transaction T.