Improvment on the Lazy Replication Method for Distributed Databases by Migrating the Master Site

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February 13, 1998

Keywords: Distributed Databases, Replication, Master Site Migration.

1 Introduction

The replication technique is paid to attention as realistic and powerful method for constructing distributed database systems in recent years. The replication technique is a technique that copies of an original database are placed on other sites according to the access demand to reduce communication costs, to increase the reliability, and so on. Now, a site where the original data is maintained is called master site, and the replicated data are maintained replica sites.

The replication technique is roughly divided into the following three kinds.

- Eager-Replication: updates tables by taking synchronization among all sites.
- Lazy-Group-Replication: The update is permitted on any sites in a group. The update is asynchronously propagated.
- Laze-Master-Replication: The update is permitted on the master site. The update is asynchronously propagated.

Jim Gray's group showed that the rate of transaction failure and deadlock was extremely surppressed when the Laze-Master-Replication technique was used[1]. Moreover, San-Yih Hwang's group showed that the average response time of the system was more shortened by Lazy-Replication than Eager-Replication[2]. If the update need not always to be synchronize among the replica sites,

it can be said that it is the best selection to use the Lazy-Master-Replication technique from the viewpoint of the transaction processing efficiency and the cost for constructing a distributed database system.

However, when an update demand is occured on the replica site accesses to the master site via the network are required in the Lazy-Master-Replication technique.

Therefore, if the master site is migrated to the site which most frequently accepts access demands to original data, the communication costs can be suppressed further. Thus, it is expected that the average transaction processing cost can be reduced. This is, the transaction throughput of whole the system can be improved.

In this research, we assume the case where there are skews in the access demand frequency. We consider the master-site-migration method capable of improving the trasaction processing efficiency in the Lazy-Master-Replication technique.

In addition, we analyze the throughput improvement rate by migrating. the master site, and consider condtions for improving througput as possible.

2 Master-Site-Migration Method

The master-site-migration method makes a site which most frequently accessed the master data in the recent past become the next master site. When the master site moves, the synchronization of the update is taken among sites. A rough procedure becomes as follows.

The master site observes the access number to master tables while being accepting transactions with a transaction-watching mechanism. For each update demand, its content is preserved as an update log of access. When the number of accessing the master table exceeds some threshold, the acceptance of theaccess demand is temporaily discontinued because it moves it moves to processing phase where the next master site is selected. All other sites are notified to start to the next-master-site selection at the same time. The next master site is selected at the current master site by referring to the access log the highest access demand frequency. The system moves to processing of migrating the master site when the current master site is not is not chosen as the next master site. When the master site is migrated ,the update log till then and information on the next master site are forwarded to all other sites, and synchronization is taken by two-phases commit protcol.

3 Estimate the Effect of Migrating Master Site

After considering concerning the master site migration method, we evaluate its effect by modeling the method. In the evaluation, the average throughput in a synchronous interval of the update by fixing the master site is calculated. Here, to assume a geographic, and temporal skews to the access demand frequency, we use two parameters of "Site skew ratio" and "interval of master site migration" as criteria for evaluation. The former is a ratio of the average transaction number in between a site accepting the most transaction

and other site. The latter is the average transaction numbers accepted during the interval of the master site migration. Some other assumption conditions also adopted to the system model for making the calculation, simple.

From the above mentioned calculation results it was confirmed that the improvment of throghput can be expected under the situation where geographical and temporal skews are assumed in the access demand frequency. In addition, we find some observations concerning on the condition for deriving the effect of the master-site-migration method. The folloing items are noteworthy observations:

- To draw out the throughput improvement by the master-site- migration method, the intervals of the migration of the master site should be much longer than that of the fluctuation of the site skew.
- If it is possible, less than five is preferable for the number of sites in the system. The throughput improvement rate exponentially decreases as the number of sites increases. The effect cannot be expected withouot site skew ratio considerably high when the number of sites exceeds ten.
- The degree of the throughput improvement rate decreased because by the network throughput and the degree of the throughput improvement rate increased by the site skew ratio are almost equal. Therefore, an increase at the throughput improvement rate can be expected in the case of the latter degree exceeding the former degree.

4 Summary and Future Works

In this research,we tried to consider and verify the possibility of the master-site-migration method. As a result, a very high throughput improvement can be obtained under specific conditions. The replication form analzed in this research is one of the simplest types, one-by-one. Analyses of the models of the more complex replication form, like the horizontal division type which has more reality are in future works.

References

[1] Jim Gray,Pat Helland,Patrick O'Neil and Dennis Shasha "*The Dangers of Replication and a Solution*", SIGMOD'96, 173-182pp,1996.

[2] San-Yih Hwang and Keith K.S.Lee and Y.H.Chin "*Data Replication in a Distributed System: A Performance Study.*", DEXA, 708-717pp,1996.