

Changing Trends in Replicated Database Systems

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Abstract— Today, we are facing the problem of easily, effectively and efficiently handling very huge amount of sensitive data in order to do our daily routine work without any interruption or failure. Simply, we want that data should be available to the user whenever it is required at any cost. The concept of replication came into existence just because of two facts that are availability and performance. Replication is used in both the fields, centralized databases and distributed databases. Replication (Database Replication) basically improves the availability of data by storing multiple copies of data at some other locations. These multiple copies of data are called replicas. It also improves performance by increasing throughput, by providing access to the data simultaneously to multiple computers (users) with the help of replicas and by facilitating the users to access nearby replicas unless and until there is some issue with it.

Key words: Database Replication, Recovery, distributed Database, Availability, Concurrency Control, Performance

I. INTRODUCTION

In this survey paper, we are going to underline the changing trends in the replicated database systems. A lot of research work has been done since 1980 on the topic of replicated databases just because of the one most important reason that we can't compromise with our scarce and dynamic or active data resources. And, no one can remain existent in today's competitive environment without having a solid and well organised database. In starting period of growth of this concept, a research works were going on the concept of data replication in centralised databases and distributed databases separately.

Here, we will first discuss the basic concepts of replication, fault tolerance and some other topics required to understand what we are actually going to deal with. And, then we will discuss about the technologies available today for providing data replication.

The basic focus of this survey paper is basically understanding that how the concept of replication is implemented in both (Distributed and Centralised Databases) the databases. And, is there any way that may work as a bridge between these two different strategies because it may give birth to the very useful concept that with no any clear cut distinction and that can make it somewhat easier.

This survey paper is organised as follows. In section 2, we discuss about the related areas that are going to be submerged in order to come to any final conclusion. In section 3, we will focus on the basics of replication. Section 4 will basically focuses on the different replication tools (open source and commercial) and their relative performance comparison with each other. Section 5 will discuss the differences and similarities in replication strategies of distributed and centralised database systems. In our point of view, such well organised distinction and

similarities between these two different technologies will help us in formulating some new protocol for handling such kind of issues in a much more efficient way. Finally, section 6 will concludes the paper.

II. RELATED WORK

The work done in this paper is the result of survey in a number of different fields that are virtually connected with each other. Today, so many open source and commercial tools are available in the market. These tools are somewhat show the resemblance in their working up to some extent. We have conducted a detailed study of these tools and come to the conclusion that they all are focusing on some basic parameters (in general) and can be updated by inheriting the good features of others.

In this survey paper, we also compared the replication strategies used in databases as well as distributed systems and came up to the conclusion that these two research fields have a lot of things which are of common interest for the researchers of both the fields.

III. REPLICATION

Data Replication may be understood as a process of creating a duplicate copy of data for increasing the availability of the data and improving the performance of the system.

The basic constraint which must be fulfilled while using replication is that an update should be propagated to each and every replica of original data before its update process being finalised. It means, all the servers having replica of the original data should be active while updating the original data. If any one of the servers having the replica is not available then you have to wait for it and you can't make changes until will become available.

A. Types Of Replication

In general, there are following types of replication that are currently in practice:

1) Snapshot based Replication

In snapshot based replication, basically a snapshot of the database is taken and stored at other location. Snapshot replication is simplest type of replication but it is very costly in terms of storage requirements.

2) Merge Replication

As the name suggests, in merge replications, two or more than two replicas may perform their operations independently and without being in contact with each other. Now, when these replicas will communicate with each other then the replication controller will check that modifications made on these replicas are not conflicting with each other. In case of any conflict, it is resolved to make the database in consistent state. This type of replication is generally used in case of wireless environments.

3) Statement based replication

The statement based replication intercepts every SQL query and sends it to different replicas [3]. In this type of

replication, each replica functions in an independent way. Here, for avoiding the situation of conflict, Read-Write queries are sent to all replica managers while read only queries can be sent to only one replica manager. It leads to the distribution of load due to read only queries which results into the increase in performance.

4) *Transaction Replication*

In transaction replication, the replication agent monitors the server for changes to the database and transmit those changes to other backup servers [2]. Here, transmission can occur immediately or periodically.

B. *Fault Tolerance*

Every system is prone to the failure, and we have to keep our system in consistent state despite of the fact that we can't stop the failures in the systems with 100% guarantee. Fault tolerance is the process of keeping the database in consistent even if when failure occurs. Suppose one of the replica which containing the data gets failed. In this case, the data may be accessed from other replicas that contains the copy of data.

Some general terms which are used frequently with their meaning are:

1) *Failover*

Failover is the method of transferring the control from failed primary site to the secondary site in order to maintain the availability of data.

2) *Failback*

A process of failback generally occurs after a failover. When the primary site gets recovered, we resume all the controls from the secondary site to the primary site while keeping the database in a consistent state.

3) *Active-Active*

In Active-Active mode, both the servers, (primary and secondary) remain active or in running state. In case of primary server failure, secondary server will be responsible for all the operations until primary server failbacks.

4) *Active-Passive*

In Active-Passive mode, only primary server remains in active state and the operations are performed with the help of primary server. But, when a failover occurs at primary server, secondary server will resumes operations until primary server failbacks.

IV. COMPARATIVE STUDY OF OPEN SOURCE AND COMMERCIAL REPLICATION TOOLS

Today, so many open source as well as commercial tools are available in the market which are being used depending upon user's specific requirements.

A. *open source replication tools*

Open source replication tools are freely available for the public use. It means, these tools are not paid and any one can easily use them and as well as suggest positive changes if they think that it will increase the performance or anyhow the changes will lead to beneficiaries to the end user.

Some of the open source replication tools are listed below in tabular format. We have considered some general parameters for making it easy to compare them with each other.

Table 1 describes the differences and similarities between given open source replication tools with the help of certain parameters.

Parameters For comparison of these tools	A list of open source replication tools			
	Postgres - R	Slony-I	DB Replicator	Pgpool II
Sync/Async	Async	Async	Async	Sync
Master Slave Concept	YES	YES	YES	YES
WAN Technology Support	YES	YES	YES	YES
Distribution of workload	YES	NO	NO	YES
UPDATE ANY WHERE	YES	NO	YES	YES
Conflict Resolution Technique	YES	NO	YES	YES
Automatic Component Failure Detection	YES	NO	NO	YES

Table 1: comparison between open source replication tools on different parameters

B. *Commercial Replication Tools*

Commercial replication tools are not freely available for the public use. It means, if you want to avail the services of these tools then you have to pay for it. The solutions provided by commercial replication tools are very costly in comparison to that of open source replication tools.

Some of the commercial replication tools are listed below in tabular format. We have considered some general parameters for making it easy to compare them with each other.

Table 2 describes the differences and similarities between given commercial tools with the help of certain parameters.

Replication Tools	Replication Strategy	Recovery Process
IBM Informix Replication	Supports both "active- passive" and "active- active " replication	Continuous Log restore[CLS] Remote Standalone Secondary Servers[RSS]
DB 2 Data Propagator	DB2 data propagator uses a change-capture mechanism and a log to replicate data between a source system and target system	Replicate all or subset of data to one or more locations
Q- Replication Tools	Allow the concept of multidirectional	Emergency Restart(ERE) Failure Recovery

	replication	
Sybase Replication Server	Publish and Subscribe Model Heterogeneous data server support	Replication Server and Replication Agents are responsible for synchronization and recovery of data between similar or heterogeneous databases
Oracle Stream	Oracle stream replication capture changes from a source database stages and propagates those changes to one or more remote databases.	Recovery of primary or secondary database is achieved with the help of redo logs.

Table 2: Comparison between Commercial Replication Tools Using Different Parameters

V. REPLICATION STRATEGIES USED IN DISTRIBUTED SYSTEMS AND DATABASES

Replication is a concept on which research is going on in both distributed systems and databases. The protocols developed in these two fields for replication are similar in some aspects but they differ with each other with respect to assumptions taken, mechanism used, guiding model and guarantee of service.

In distributed systems replication strategies are implemented using synchronous (eager) and asynchronous (lazy) system models. The basic difference between synchronous and asynchronous model for data replication is that synchronous model allow the system to detect the error correctly while in asynchronous model, the error may be falsely detected which is not actually exist.

On the other hand, databases are not based on synchronous and asynchronous system models. Databases are dependent on a wide range of locking protocols for their functioning.

These are the basic differences between the replication strategies of both (distributed systems and databases).

VI. CONCLUSION

The replication algorithms used in distributed systems and databases are generally using different procedures and prototyping concepts, but still they have so many similarities in their operations. These similarities give us the indication that there is a very strong relationship between these two fields and much more quality work may be done if both the communities will cooperate with each other and share their views and try to model a new protocol that may efficiently handle the replication activities taking place in both the fields. Presently, we are trying to develop some new protocol that may be the hybrid of the technologies available in both the fields in order to make the proposal of this survey paper in reality.

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