TELKOMNIKA Indonesian Journal of Electrical Engineering
Vol. 13, No. 3, March 2015, pp. 529 ~ 536
DOI: 10.11591/telkomnika.v13i3.7114

Distributed System and Multimaster Replication Model on Reliability Optimation Database

Ravie Kurnia Laday*[1], Heru Sukoco[2], Yani Nurhadryani[3]
[1,2,3]Department of Computer Science, Faculty of Mathematics and Natural Sciences,
Bogor Agricultural University, Bogor 16680, Indonesia
*Corresponding author, e-mail: raviekurnial11p@apps.ipb.ac.id[1], ravie.4n2sc@gmail.com[2]

Abstract

Over the last two decades, significant advances have been made in the development of techniques for evaluating the performance, availability, and reliability of computer and communication systems in integration [11]. The reliability of the network is an important parameter in network [4]. Reliability is the performance, availability and security is a factors most important in a network. A distributed system is a system architecture in which computers can communicate and share resources [8]. This research applies a distributed system with load balancing and multimaster replication techniques in database. The results of this study found that the design of a system built to keep the data for connections between servers is in good condition and occurs down on one of the database server.

Keywords*: distributed system, multi-master replication, reliability.*

1. Introduction

The ease of access to services and or information is one of the factors important in this day and age, especially inforrmation and or services towards costumers--university included [10]. The development of information technology today is conncected to the use of network and database management in business process whether within companies or educational institutions. The last two decades significant improvement has occured in terms of performance evaluation technique, computer availability and reliability, and communication system [11]. Network reliability is an important parameter in quantitative understanding of the network [4]. To reach high reliability value, other determining factors are needed. Factors that affect reliability are performance, availability, and security [7]. Previous research with the title of *LOCUS A Network Transparent, High Reliability Distributed System* has the purpose of searching, understanding, and studying determining standard structure for implementing distributed system. The research stated that concerning transparance, local network has high performaance, and it has loads of advantages [5]. Distributed system is a form of system architecture where computers working autonomously able to communicate dan share resources without having to concern the computer's locaton and the platform used [8].

Alkamal Institute of Science and Technology is one of private universites running under KOPERTIS III. In order to function as a university, this university is highly depending on the activity of accessing server filled with students' data basis that network usage, whether it is in terms of availability, speed, or even security, is really needed. Problem arise when saved data undergo changes or even data loss that several cases such as student data not properly saved, can be a problem of its own. Another problem happens when computer connection in accessing the server ran itu trouble and also lack of availability because data basis has no good backup.

The alternative of these problems can be solved through building availability optimalization on data basis by implementing replication technique, which is a technique of copying and distributing data and database objects to another database and enacting synchronization between database so that data consistency can be guaranteed [2]. Other research itled "The Comparison of MySL Backup Database Method between Replication and MySQLDump" sated that replication technique is a better and more efficient technique than MySQLDump technique in terms of memory usage, CPU usage, and processing time at the time the server did the backup process [9]. This research tried to implement distributed system

Received October 2, 2014; Revised December 1, 2014; Accepted December 30, 2014

and multimaster replicaton technique on database and test with offered experimental method to imspect the possibility of causal connection by controlling [1] the said suggested connection and system performance.

2. Research Method

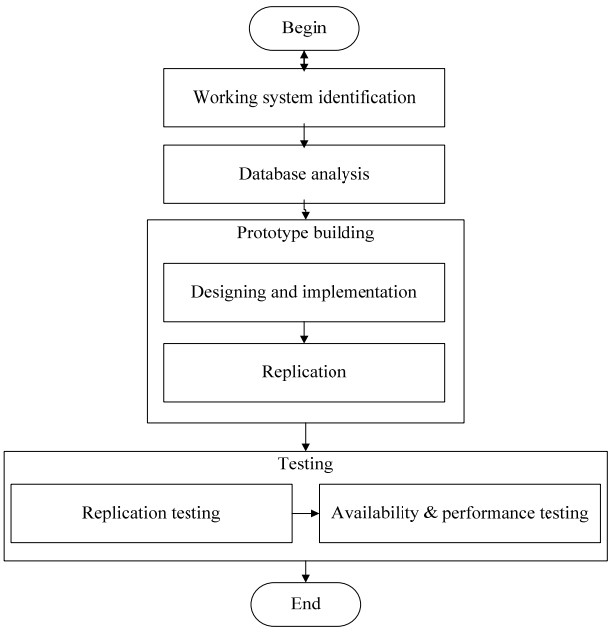

Figure 1. Research Method Pathway

2.1. Working System Identificaton

This step would do the process of searching, observing, and analyzing the working system beginning from picturing the working database, client/server architecture, and network architecture. These are done so that early identification and development can be adjusted with the need of the working system and the need on replication. The following system planning would be done after analyzing the working system so that if it happen to still have faults network architecture can be designed in accordance.

2.2. Database Analysis

Academic information system data analysis was done by defining table and field of respective table against the working database to search for faults or defects and after that redesigning were done by research and development approach. After analyzing the database, adjustment was done on the working application by implementing distributed system.

2.3. System Prototype

This step included the designing of distributed system replication and architecture beginning from client server model up until system planning which would be suggested as the improvement of the already working system. Replication would be done to replicate all changes happen to a server, called master server or master, to another server, called slave server or slave [3]. This reserch would improve the working system using multi master replication where one computer act as the master server while another function as master server as well after replication setting towards the two server database. After that, distributed system model was designed. The distributed system model developed would use load balancer as service balancer by distributing traffic between the two server [6] of pre-built database. This system was needed to serve the user demands in accessing database server. Method that would be used in implementing load balancer is round robin method which was one of most used methods and even categorized as the better method compared to others, like least connection method [6].

2.4. Testing

Testing as done to see which database server, that was serving request in realtime and analyze the service changing, from one database server to another by making the php script which recorded IP address and time. The testing figure could be seen on Figure 2.

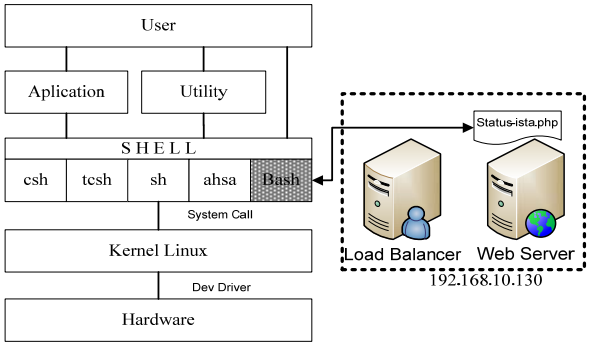

Figure 2. Testing Structure

This step created php script that recorded IP address and time (represented by minute and second) which was run by command shell. It would then be integrated to the same server machine with the load balancer server machine in order to make the recording accuracy as close to the real time as possible.

The testing was done by beta testing from user side where every possible action was done in order to get a relevant result towards the initial assumption. This was done by accessing status-ista.php file. Below was the testing scenario table done to the built system planning.

Table 1. Connection Testing Scheme

Parameter	Scheme			
	1	2	3	4
Server 1	Standby	Reboot	Standby	Standby
Server 2	Standby	Standby	Reboot	Standby
request	telnet 192.168.10.130 3306			
Numbers of connections	4			

Performance test was done by using httperf application installed on client computer by calling the script:

--server=192.168.10.130	The tested server address
--uri=/tabel_record.php	Accessed target file
--num-conns=1000	Determining the number of connection
--rate=1000	Determining the number of request per second

Testing was conducted to 192.168.10.130/index.php address and 192.168.10.130/tabel_record.php page in which the page was filled by the recording of the previous attempt. The number of connection that would be tested on the server was 100-100 connection while the number of request per second that would be delivered was 1000 req/s. The scheme of the testing could be seen on Table 2 below:

Table 2. Respon Time Testing Scheme

Parameter	Scheme									
	1	2	3	4	5	6	7	8	9	10
Number of connection	100	200	300	400	500	600	700	800	900	1000
Number of *request*	1000									
Target 1 address	192.168.10.130									
Target 2 address	192.168.10.130/tabel_record.php									

3. Results and Analysis

3.1. Working System Identification

Working information system consist of a server and two client unit by using 2-tier architecture as topology basis while the academic information system architecture analyses step as drawn in Figure 3, still used the 2-tier (client-server) in updating student data or grades.

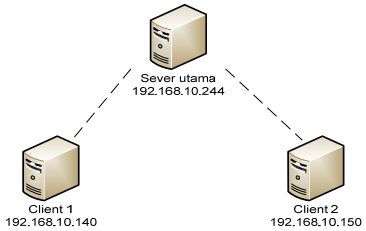

Figure 3. Architecture academic information system

Network architecture in ISTA used hybrid typology where two routers split into two network: 1. Internal network that can be connected to PCs in every staff room, 2. External network connected to all WiFi accessable by both student and staff.

3.2. Database Analysis

Database used to support Finance and Academic Information System consists of 44 table where each table has its own function. However, this research only analyzed database that concerns Academic Informatin System which consists of 28 table. After acquiring the list of table, detailed analysis was done to each field in each table. Upon inspection, inconsistency was found on data type and data length between tables. To solve the problem, table standarization must be done on the aspect of data renaming to data type and size so that consistency can be reached. The following are tables actively used in Academic Information System:

Table 3. Table names active in Academic Information System

daftarnilai	**Mstjurusan**	**programGroup**
mstdosen	**Mstkelompokmk**	**programDetail**
mstfakultas	**Mstmahasiswa**	**transJadwalujian**
mstjenisklh	**Mstmatakuliah**	**trsFRS**
Mstjadwal	**Mststsdosen**	**userProgram**

The relationship between information system entity used can be drawn as of Figure 4 below:

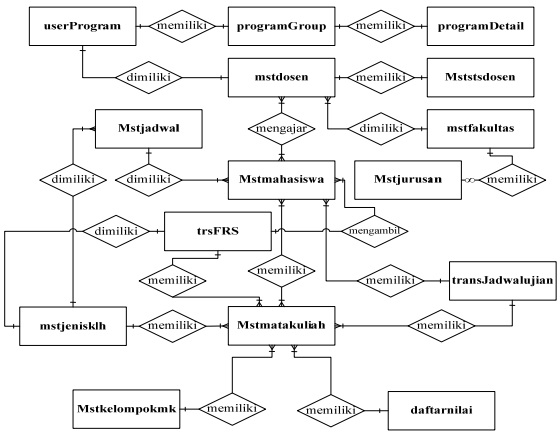

Figure 4. Entity relationships

The tables would then be analyzed by looking at the content of respective table and the relationship between tables. From the result of the analysis, several problems where found and explained on the table below:

Table 4. Relationship Analysis between Tables

No	Table Name	Status	descriptions
1	Table mstdosen and table mststsdosen	Working	No connection was established between mstdosen table and mststsdosen table, while it supposed to exist
		Suggested	Adding field no_dosen into mststsdosen table to reach a connection with table mstdosen.
2	Table mstjurusan and table mstdosen	Working	Naming inconsistecy in mstjurusan and mst dosen table
		Suggested	Field **ps** on mstdosen table changed into **kd_jurusan**
3	Table mstjurusan and table trsFRS	Working	There was no field kd_jurusan on trsFRS table
		Suggested	Adding field kd_jurusan on trfFRS table

Query analysis observed the level of query complexity on the working system. Based on the observation result of the working system query, it is known that there were two queries consist of one or more of other query. The queries are **Mstmhjenisklh(masaStudi)** query and **CetakJadwal** query. Because of that, the two queries could be categorized as query level 2 while other queries could be seen on the following table:

Table 5. Query

CariMatakuliah	QryTransaksiFRS	Qrymatakuliah
CetakTrankrip	Dtlmahasiswa	qryJadwal
BukaUser	Laporan(khs)	sumSKS

3.3. Replication Model Designing

In this step, multi master replication would be designed on server database which would then be integrated to suggested system. On designing multi master replication model, the first thing to do was ensuring the connection between database server recognized each other and connected while adding domain to /etc/hosts file to each other (Figure 5 and 6) and doing connection test between server via ping-ing to and from other server.

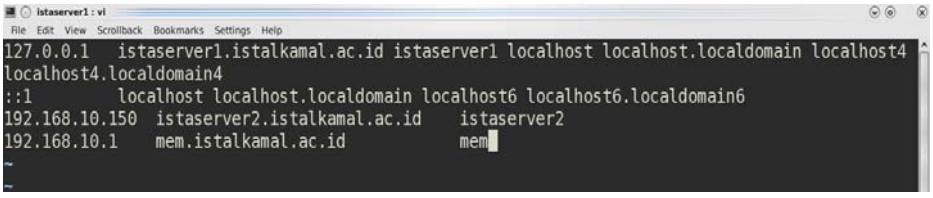

Figure 5. Adding Domain

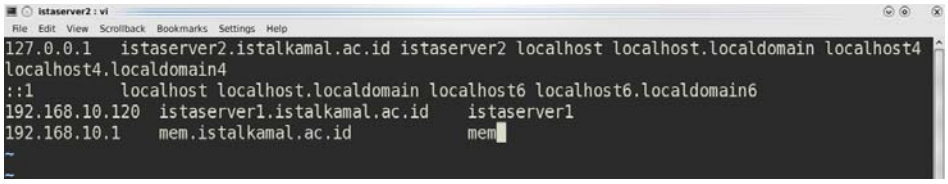

Figure 6. adding domain

Ensuring port 25, 110, and port 3306 registered in iptables firewall of respective server in file /etc/sysconfig/iptables. The next stage of adding user to the database are inputted by other servers (for example server 2 to server 1) can be recognized by other servers, required the addition of a user for each database with SQL commands:

grant replication slave on *.* to rad_slave@'%' identified by 'istaslave';

Before configuring, *master_log_file* location (as the file log referred in replication technique) need to be known before hand. This could be done by typing *master_log_file* name and the file position by typing syntac show master status;

After that, configuration was done by adding host, use, password, file, and master position by this command:

change master to master_host='istajakartasatu.ista.ac.id', master_user='rad_slave',
master_password='istaslave',
master_log_file='distalkamalradjtg-01-bin.000005',
master_log_pos=345;

After slave configuration was finished, the next step was running slave by the command slave start; The next step was doing the same process to the other server. This type of configuration is called multi-master replication because in a way a server functioned as server but in other way as a slave and so on. As such, the replication structure formed can be Figured as of Figure 7.

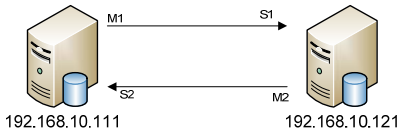

Figure 7. Multimaster Replication Model

3.4. Load Balancing Model Designing

Database servers that had replicated one another were integrated with load balancer so that the need of access to database server could be fulfilled. The topology of load balancer could be seen on Figure 8.

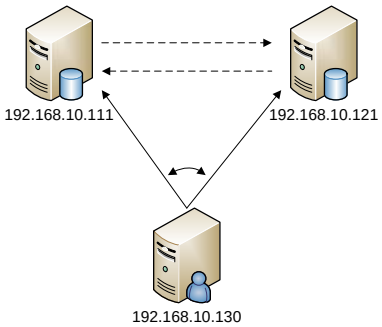

Figure 8 Load Balancer

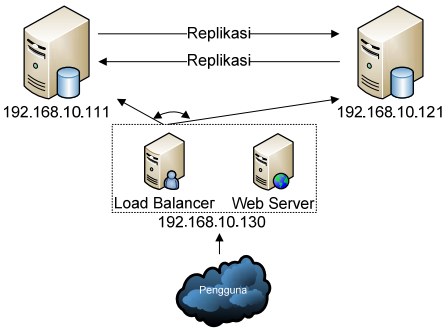

Figure 9 Client-Server Topology

Load balancer configuration process used PEN application with round robin method. There was a small adjustment in order for the application to work as needed. The adjustment was done by putting in first database server IP and second database server IP followed by adding port 3306 (MySL) within these lines:

```
LOGFILE=/var/log/pen.log
CONTROL=127.0.0.1:10080
MAX_CONNECTIONS=500
PORT=3306
BACKEND=2
SERVER1=192.168.10.111:3306
SERVER2=192.168.10.121:3306
```

3.5. Client-Server Model Designing

System designing was done to ease the picturing. Considering the needs, client server topology could be seen on Pictue 9. The creation of web service in load balancer server was done to optimize the recording of access changing test from database server one to basis dara server to and vice versa.

3.6. Testing

Testing on the first scheme was done by turning on all sever and checking if all server has been connected to each other, marked by the existence of reply when pinging was done to every server addres then followed by recording each server location through reading the IP recorded by the testing script which was planted on the web server machine. The result by default load balancer will show server 1 as the main server.

The second scheme did reboot on the first server machine and watched the data changes in the form of recorded IP and time. Load balancer automatically chose server 2, indicated by the recording of IP server 2 on the record table with the shift time between 30-69 second. The connection is still connected to the server 2 even though the server 1 on standby.

The third scheme did reboot to server two, then load balancer connection change was received, which redirected to server 1 in 41-64 seconds. The last scheme ensure the availability of server 2 and observe the IP changing, however IP changing didn't happen and instead load balancer would still choose server 1 even if server 2 was back to normal.

Table 6. Respon time testing (192.168.10.130/index.php)

Number of connection	Number of request	test-duration		connection rate		request rate		reply time	
100	1000	4.987	s	40.2	conn/s	40.2	req/s	1374.4	ms
200	1000	1.774	s	112.8	conn/s	112.8	req/s	726	ms
300	1000	3.092	s	97	conn/s	97	req/s	1213.6	ms
400	1000	5.289	s	75.6	conn/s	75.6	req/s	2546.4	ms
500	1000	6.366	s	78.5	conn/s	78.5	req/s	1599.1	ms
600	1000	4.688	s	128	conn/s	128	req/s	1235.1	ms
700	1000	33.587	s	20.8	conn/s	13.5	req/s	13808.4	ms
800	1000	70.928	s	11.3	conn/s	10.9	req/s	4773.6	ms
900	1000	20.953	s	43	conn/s	43	req/s	2887.8	ms
1000	1000	38.564	s	25.9	conn/s	24.3	req/s	8714.8	ms

Table 7. Respon time testing (192.168.10.130/tabel_record.php)

Number of connection	Number of request	test-duration		connection rate		request rate		reply time	
100	1000	15.91	s	6.3	conn/s	6.3	req/s	7340	ms
200	1000	30.577	s	6.5	conn/s	6.5	req/s	16278.3	ms
300	1000	41.614	s	7.2	conn/s	7.2	req/s	21101	ms
400	1000	114.346	s	3.5	conn/s	3.5	req/s	37915.1	ms
500	1000	59.332	s	8.4	conn/s	7	req/s	29701.2	ms
600	1000	53.798	s	11.2	conn/s	10.5	req/s	24341.1	ms
700	1000	63.421	s	11	conn/s	7.4	req/s	33872.2	ms
800	1000	66.038	s	12.1	conn/s	7.5	req/s	31955.5	ms
900	1000	87.108	s	10.3	conn/s	7	req/s	39233.2	ms
1000	1000	76.002	s	13.2	conn/s	9.3	req/s	37761.2	ms

According to the two table above, it is known that respon time was not affected by the number of connection arise. It is shown by the 7th scheme where the number of connection was increased as manhy as 700 connection but what was acquired in this research, the request time showed a higher number than the others (Table 6) while on Table 7 the highest request was

acquired from the 9th scheme. The many factors such as the amount of load on the page accessed or even error caused by network connection from the user to server are among the factors that must be taken into account.

4. Conclusion

Multi Master Replication Method can be the solution for data loss problem,the multi master nature to back up each other and the system generated able to keep the data availability as long as the connection between server is in good condition, or even when a system failure happened to one of the basis data server. There more than two servers system and other replication method need to be developed.

References

[1] Dharma S. Pendekatan, Jenis, dan Metode Penelitian Pendidikan. Departemen Pendidikan Nasional. 2008.
[2] George C, Jean D, Tim K. Distributed Systems Concept and Design. Addison Wesley. 3rd Edition. 2001.
[3] Howard G, Irving, SM, Sceales AM, Sauvage AMF. *Error prevention for data replication*. GB2468742A (Patent). 2010.
[4] Morgan DE, DJ Taylor, G Custeau. A Survey of Methods for Improving Computer Network Reliability and Availability. *Computer.* 1977; (11): 42~50
[5] Popek G, Walker B, Chow J, Edwards D, Kline C, Rudisin G, Thiel G. LOCUS A Network Transparent, High Reliability Distributed System. *ACM SIGOPS Operating Systems Review*. 1981; 15(5): 169
[6] Rabu JA, Purwadi J, Raharjo WS. 2012. *Jurnal Informatika*. Yogyakarta. 2012; 8(2): 169-180.
[7] Stiawan D, Abdul H, Mohd YI. *Reliability Measurement of Internet Services*. International Conference on Green Computing. ICGC-RCICT. 2010.
[8] Sutanto FA, Jeffry AR. *Jurnal Teknologi Informasi DINAMIK.* 2010; XV(2): 83-89.
[9] Tawar, Safitri W. Pembandingan Metode Backup Database MySQL antara Replikasi dan MySQLDump. *Jurnal Sistem Informasi Indonesia*. ISSN 2087-8737. 2011; 1(1).
[10] Triyono, Joko. Replikasi untuk Meningkatkan Kinerja dan Ketersediaan Data (Study Kasus Sistem Informasi Akademik). *Jurnal Teknologi Technoscientia*. 2012; 5(1).
[11] Yue Ma, James J Han, Kishor ST. Composite Performance and Availability Analysis of Wireless Communication Networks. IEEE Transactions on Verhicular Technology. 2001; 50(5).