

Discussion of the Automatic Migration Scheme of Oracle Database

Mingli Wu, Xueya Jiao, Yebai Li

College of Computer Science, North China University of Technology, Beijing, China

wuml@ncut.edu.cn

Keywords: augmented reality; database migration; automatic migration; table structure synchronization

Abstract. As migration technique for table spaces of enterprise database is required in multi-user inventory management systems, in this paper we investigate automatic migration technique when database performance is found declined by our monitoring system. Two methods are discussed, timing automatic migration and semi-automatic migration. Table structure of several databases is modified by DBlink, to keep databases synchronized. In addition, we analyze various factors that must be taken into consideration when do migration. We also verify the methods in practical application, and introduced the technical details. Experiments show that this method is effective.

Introduction

With the rapid development of computer network and database systems, enterprise information technologies update fast. More and more attention has been paid to the safe operation of the application system. Automated processing has become the future development trend, and then automatically migrating database to servers with better performance becomes an interesting problem.

In a real multi-enterprise inventory management system, multiple oracle databases exist. Data of multiple enterprises are stored in one database, but each enterprise has its own independent table space. In addition, each database has same structure. Given this special multi-database environment, the volume of data is increased as the database running. When adding new enterprise, we should add extra table space. These operations may decrease the efficiency of the database server. Then we need more database servers or we can migrate our table space to another server with better efficiency.

We propose a scheme that can migrate data automatically in this multi-database environment. First a monitoring procedure may give alarm and then data will be migrated to other servers automatically. The server will restart automatically, so that, the applications will be connected to the new servers. Although database migration includes isomorphic database migration and heterogeneous database migration, we focus on isomorphic database migration at oracle table space level, which is suitable for our special application environment.

We analyze the data structure of our application system, and discuss table structure consistency of the multi-database system. Then we set up four kinds of automatic migration schemes, and study them for our real application. Automatic migration is completed successfully in multi-enterprise inventory management system, and makes business application stable and efficient.

Application Environment

The Oracle database management system is developed by Oracle company. It is so far the leader of the database management system. It achieves excellent portability and compatibility, security. Due to the strong performance, complicated structure, it is relatively difficult to grasp comparing to other database management systems. The multi-enterprise inventory management system is a across multiple server database management system. The relation of each database is as illustrated in “Fig. 1”.

The application makes data connection via the routing database servers to application database

servers. Each application database server has the same structure. To achieve automatic migration of table space among application database servers, we store application database servers, connection information in the routing database server. After the automatic migration, we should ensure that the routing information can be modified automatically. The applications can re-connect to the corresponding table space of new database servers.

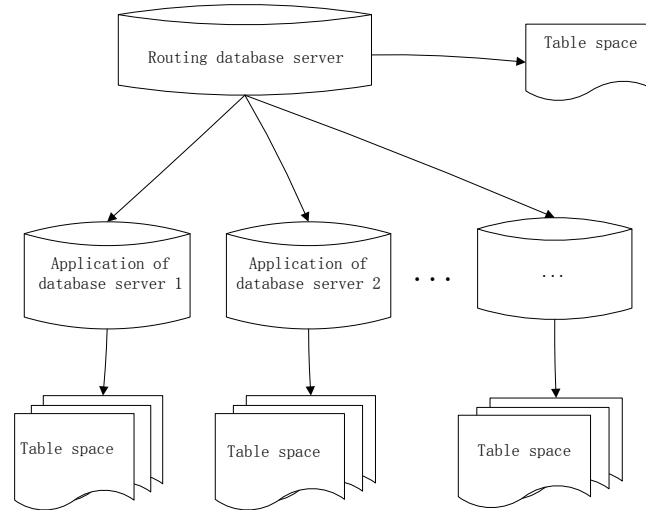


Figure 1. Database System Architecture

Oracle database migration technology

A. Oracle Migration Tools

- Expdp/Impdp: It can save the database as a binary format file under OS. It is irrelevant to the platform.
- Dblink: It establishes a remote database link through the network to transfer data within different database server quickly.
- RMAN: It is mainly used as a tool to backup, restore and recovery database, migrate the database and several of database files, and allow the backup in incremental block level.

B. Database Migration System

Since different enterprise originally used different databases, when we upgrade the system, we maybe need in order to migrate the database. In order to solve this problem, we need to design a database migration system, to realize the transfer between different databases. The system connects different database systems; it can choose a different table and different fields in tables and achieve the conversion in table data type during migration. This migration mode is slow because of transferring API to object and then to focus on the database format, so it is not suitable for large data transmission. The model of migration system's data conversion is as illustrated in "Fig. 2".

C. Import SQL Scripts

This scheme realizes the database replication by execution of the SQL script. The features of this migration are those: poor database integrity, poor expansibility, not very flexible, but quickly the timeliness, and of better isomorphic database applications.

Considering the characteristics of database migration methods above, in order to realize the automatic migration we combine the application software system and SQL scripts threaded to complete the migration. We realise the links within different databases with Dblink, then completion of the database migration within different servers fast and efficiently. In order to make up for the questions as poor expansibility, not very flexible, caused of database script transfer, we judge the dynamic call SQL scripts to perform automatic migration according to the application software monitoring results; at the same time in order to make up for the questions as poor integrity, caused of the database script migration, after migrating, to ensure the integrity of the database migration, we use the application of software to verify the consistency of the database.

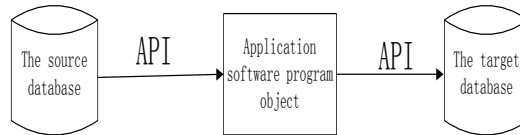


Figure 2. The conversion model of data

Automatic Migration related Technology

A. Timer Method

Automatic migration means that there is no manual intervention. When the conditions are met, the database system can automatically perform database migration. So in order to achieve automatic migration, you must have an event which can automatically trigger an automatic migration method. The current can trigger the automatic migration method has two ways:

1) Windows-based Automatic Timing Method

Windows timer prototype is that:

WINSERAPI UINT WINAPI SetTimer(HWND hwnd, UINT nIDFlag, UINT uTime, TIMERPROC timerFunc);

- *hwnd*: A desire to set the timer window handles. Regular time, the system will send a WM_TIMER message to the form.
- *nIDFlag*: Timer identifier. You can use multiple timers in a window of the body, according to nIDFlag to distinguish different timers.
- *uTime*: Regular time, in milliseconds.
- *timerFunc*: Timer callback function. If the value is NULL, regular time to time, the message WM_TIMER sent by timer the default function will process the message; otherwise processed by the callback function.

2) Oracle Timer Method

Oracle Timer general for operating various tables, views, and stored procedures, we usually create a stored procedure. To the timing of the implementation of the stored procedure through the timer, the stored procedure is usually some operations on the table or view. Its structure is as follows:

- a) *declare*
- b) *job number;*
- c) *begin dbms_job.submit(*
- d) *jobnum,*
- e) *'PRC_INSERT';*
- f) *sysTime,*
- g) *'sysdate + a/b'*
- h) *);*
- i) *commit;*
- j) *end;*

The a-c line: Express the statement of the timer job;

The d line: Timer ID, the system can get automatically;

The e line: The name of the stored procedure execution;

The f line: The timer starts execution time, sysTime means immediate execution;

The g line: Interval, set the frequency of the timer execution;

The h-j line: Express the ending of the timer job.

Windows timer which was used in VC frequently, and is in a large number of table-level operations. It is recommended to use the database itself timer job, which is more convenient, high

efficiency; another if a system-level timer, which is too dependent on the system, in addition to a lot of programming work will increase, and cost increased, is very easy to make mistakes; things more simple the less chance of error. Therefore, the system triggers automatic migration is to use the Oracle database itself timer to trigger automatic migration.

B. Hot Backup and Incremental Backup

Hot backup is under the condition of the database operation, adopt the Archivelog mode method to back up the database. That hot backup is that system is in normal operation state and backup the database. So, if you had last night a cold backup and today's hot backup files, in the event of a problem, you can use these data in recovery for more information. Hot backup requires the database in Archivelog mode, and requires a lot of file space. Once the database is running in Archivelog mode, you can make a backup. Sometimes, we will be online data backup is called hot backup, and the off-line data backup is called a cold backup, to distinguish two different backup concepts. They will do more data compression to the existing memory, by reducing access to the hard disk (called virtual memory) method to solve the problem.

1) The advantages of hot backup

- a) In the table space or the database file backup, backup time is short;
- b) During the backup time the database can still use;
- c) Level recovery can reach second level(restored to a certain time point);
- d) It can do recovery for almost all database entity;
- e) Recovery is fast, in most cases when the database is still work to recover.

2) The disadvantages of hot backup

- a) It can't go wrong, otherwise the consequence is serious;
- b) If the hot backup is not successful, the results cannot be used for recovery to the point in time;
- c) Because of difficult to maintain, it should be especially careful, do not allow the "failed".

(2)Incremental backup means that after the first full backup or incremental backup, then each backup only once or increase compared with the previous file is modified. After each backup only back up the files that simply compared with the previous increase or modified; the second incremental backup objects are the incremental backup increase and modified files after the first time, and so on. The most significant advantage of this backup method is that there is no duplication of backup data, the backup data volume is not big, and the backup time is short.

Analyzing the characteristic of hot backup and incremental backup, concluded that can combine hot backup and incremental backups to implement backup database. First, we can back up the whole online database; then we will increase the content of the database backup to another database at regular intervals. So that a backup of the online database can be timely backup; its technical implementation can use DML trigger. When the database is detected at risk, you can dynamically link to the backup of the database, realize the goal of automatic migration database.

Automatic Migration Monitoring Indicators

A. Monitoring Indicators

Database migration, from the source and target databases composed, when the system achieves to migrate the source database monitoring indicators, choose a better performance of the target database migration. The following analysis is to monitor indicators of the source and target databases.

Source database:

- Table space counts, found through experiments, which a database can accommodate up to 65,535 table spaces;
- A larger share of physical disks;
- CPU share of long-term 70% - 90%;
- Database monitoring alarm counts.

Target database:

- Query each server database table space number;
- Smaller share of physical disks;
- CPU share is relatively low;
- Database monitoring alarm counts.

Analysis of the above indicators, find the database cache hit rate and CPU time share is the result of the analysis is not to do as an indicator of instantaneous data transfer, so to use the results of the analysis period as an indicator of the migration of the database.

B. Parametric Analysis

1) CPU's occupancy rate is in seconds and Data recorded at every 5s.As shown in "fig. 3".

CPU's average value formula:

$$P = \frac{\sum_{i=1}^N k_i}{N}$$

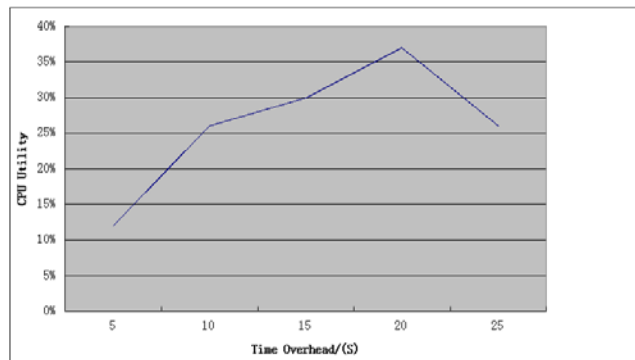


Figure 3. CPU' s occupancy

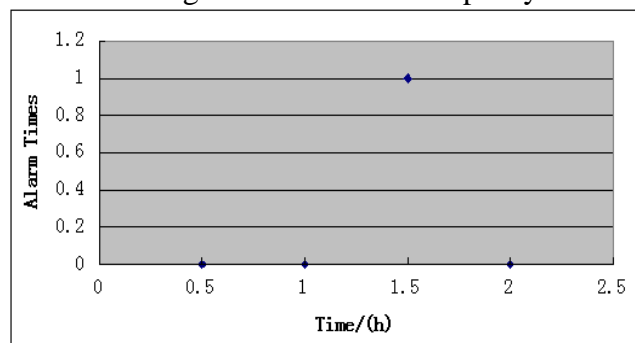


Figure 4. Alarm times

2) Record number of database monitoring alarm and data recorded at every half an hour.As shown in "fig. 4":

3) Monitoring these indicators, the average number of CPU' s occupancy and database cache hit rate recorded at every 2 hours. Database performance is calculated by the weighted average, monitoring indicators' s formula:

$$M = k_1 \frac{a}{65535} + k_2 \frac{b}{3} + k_4 \frac{0.8}{c} + k_5 \bullet d$$

Meaning of the parameters:

a: The number of tablespaces, range oracle database tablespaces for (0-65535)

b: Disk usage rate

c: CPU's occupancy rate.Under normal circumstances ,CPU occupancy rate should be less than (70%-90%)

d : The number of database' s alarm times, statistics is that this two-hour alarm times

k_i : Monitoring weight.Set different parameter values according to system specific circumstances.

Automatic Migration Scenario Selection

- 1. Instant - Automatic

When the migration conditions are met, immediately migration.

- 2. Instant - Semi-automatic

When the migration conditions are met, the pop-prompt window will be existing. It will show whether the migration immediately. Selecting “Yes” mean to migrate immediately; or selecting “No” mean jumps to “C”.

- 3. Timing - Automatic

When the migration conditions are met, migration timing open to 0:00 pm beginning the migration.

- 4. Timing - Semi-automatic

When the migration conditions are met, then the pop-prompt window will show whether to open the regular automatic migration. Clicking “Yes” means to jump “3”; clicking “No” means that it will not migrate.

Migration scenario analysis above can be drawn, “1” scheme is not practical, since “A” plan too risky, it may lead to daytime running application software cannot be used temporarily and loss of customer data running on the system too much influence. So the use of “2”, “3”, “4” program to automatically migrate more appropriate.

Automatic Database MigratIION

Definition of automatic is the ability to automatically migrate database timed, and delete the existing database. Now design an automated migration scenarios, you can manually configure the automatic migration scenarios. When the migration conditions are met, the program can automatically perform the migration, migrate the database and can automatically restart the server to achieve application software to connect to the new database server. At the same time in order to ensure the consistency of each database system architecture, through DBlink links are linked to each database, so that when you modify the table structure, and modify the other database table structure corresponding functional background management system. Its automated migration process is as illustrated in “fig. 5”.

Data Consistency For Migration

We need to verify the data when the data migration has been completed. The verification can check the quality of the data migration, while the results of data validation are an important basis to judge whether the new system was officially used.

We can verify the migrated data by the two ways. Comparing the old and new systems to check the data, to query the data of same indicators and compare the final query results with the query tools of old system and new system. The data of new system is recovered to the state of the old system has not been migrated, and add the business data what happened on the last day on the old system to the new system, then check for abnormalities and compare the final results with the old system.

By the data quality check tools or the specific inspection program, we can analyze the quality of migration data. It’s different from the quality analysis hasn’t migrated. The validation of migration data is mainly to check the different indicators. The indicator for the validation of migration data includes four areas. Integrity Check is to test whether the foreign key of references exists; consistency Check is to test whether the data values of the same meaning but at different locations are same; record Check is to test whether the number of corresponding new system and old system is same. Special Sample Data Check is to test whether the new database and the old database is same, which is achieved by randomly comparing record of one day.

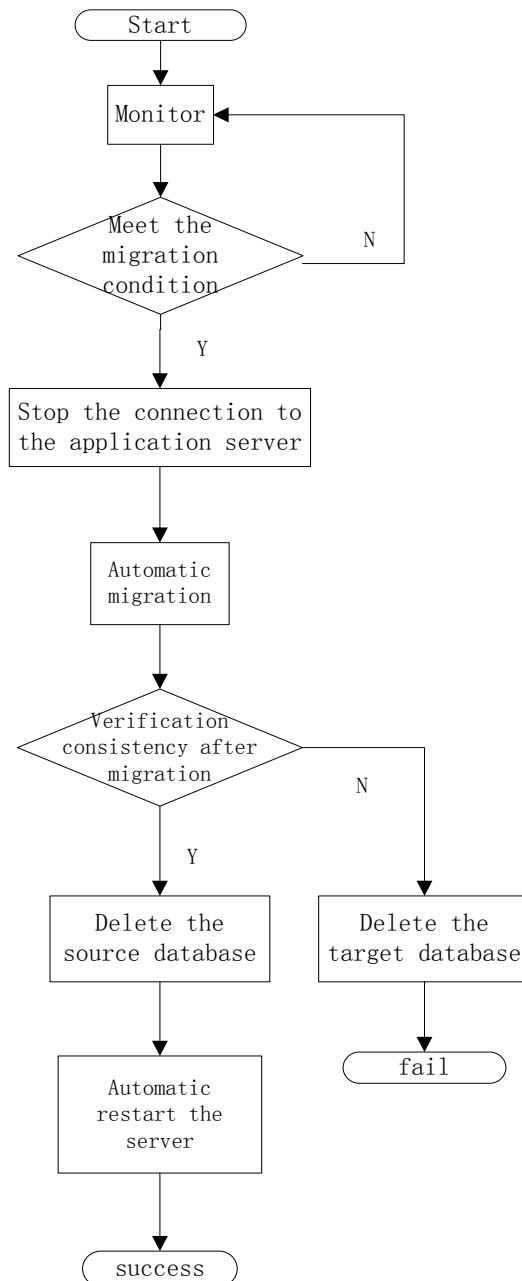


Figure 5. The process of automated migration

Automatic Migration Report

In the migration process, resulting in migration failure due to a hardware problem. network transmission problems, or the script is not executed problem. In order to ensure data security, every step of the automatic migration need to be monitored and recorded, so we require to record the migration process and the results of the migration. We

TABLE I. DATA REPORT

Attrib ute	Type	Description
id	NUMBER	the primary key
starttime	TIME	start time
endtime	TIME	end time
Yip	String	source database ip
Mip	String	Target database ip

YSL	String	instance name of source database
MSL	String	instance name of target database
Result	Boolean	the results of migration

design a report form(TABLE 1) for recording the migration operation.

Multi-database structure synchronization

We find in the process of data migration, because of the multi-database structure we need to modify the structure of table of all the database if we need to modify some structure of a table. It needs manual operation and it's easy to cause error. Based on this, we design an interface and take advantage of triggers principle and link the data of table with DBlink. It can trigger all the table structure when we modify some table structure. Then we can modify the less table and we can achieve it in the background. Now there are two ways which can achieve this goal.

1)Modify the structure of table

We can modify fields to change the structure of table and the field attributes in the database.

2)Modify the SQL

We can use SQL to modify the structure of table. We use DBlink to link all the database, it can keep all the structure of table consistent in the database.

Conclusion

With the quickly development of database technology, data information becomes valuable for most enterprises and database migration has been an important task. Based on all the migration method, our paper take advantage of them synthetically and combine the structure of oracle database. It's the future trend of database migration that achieve the automatic migration by combine the application system migration and scripts migration. In this paper we only discuss the automatic migration of isomorphic database, and we plan to study automatic migration for heterogeneous database in future.

Acknowledgement

This paper funded by: Scientific Research Project of Beijing Municipal Commission of Education (Project No: KM201410009008); Project of Construction of Innovative Teams and Teacher Career Development for Universities and Colleges Under Beijing Municipality(Project No. : IDHT20130502); Project of Construction of the central financial support for Universities and Colleges (Project No.: P X M2014_014212_000097)

Reference

- [1] LUO Linqiu,MENG Qi,LI Xiao and etc. Design and implementation of heterogeneous database migration[J]. Application Research of Computers, 2006, 23(12):233-235.
- [2] XIONG Hui,LIU Yanfeng,GUO Daoqing. Design and implementation of distributed heterogeneous database migration system[J]. Computer Engineering, 2008, 34(4):57-59.
- [3] GAO Cuifen,HUANG Wei. oracle database migration solutions[J]. Electronic Technology & Software , 2013, (24):196-196.
- [4] HE Hui,SUN Fu,LI Sui. Data conversion model of heterogeneous database[J]. Computer Engineering and Design, 2005, 26(9):2461-2463.

- [5] WANG Yutao. Oracle massive heterogeneous data platform (Windows platform migration will be migrated to SolarisX64 Oracle database platform)[J]. Telecom World, 2013, (7):66-67.
- [6] YANG Hanbing, ZHAO Long, JIA Jinyuan. Design and realization of HBase migration tool[J].Computer Science and Technology, 2013, 7(3): 236-246.
- [7] FANG Yinglan,CHENG Binghui,TANG Miao.Design and implementation of heterogeneous database migration system based on JDBC[J]. Journal of North China University of Technology, 2013, 25(1):5-10.
- [8] ZHANG Xiao,ZHANG Yu. Research on remote database migration[J]. Application Research of Computers, 2005, 22(4):106-108.
- [9] TANG Liuhua,MA Yonqiang,LI Chunfu. Dual hot backup system based on TCP protocol[J]. Information Security and Communications Privacy, 2006, (8):173-175.
- [10] ZHENG Xiangyun,ZHANG Juan,GE Wengeng. Design and implementation of database synchronization in data capture differences[J].Computer Knowledge and Technology, 2009, 5(7):1544-1545.