Research and Practice of university database Migration

Qian Wang, Naijia Liu, Chun Yu
Computer and Information Management Center
Tsinghua University
Beijing, 100084, China

Abstract—This paper presents an investigation into approaches and techniques used for database Migration. Different database migration is discussed such as Oracle, SqlServer. As an example, we design and implement a migration project for Tsinghua University. This project migrated Oracle RAC into a different platform completely and successfully. At the same time, it shortened switching time and minimized the effect.

Keywords-database migration; oracle; transportable tablespace; conversion; character set

I. INTRODUCTION

With the scale enlargement of the university information system, the resulting data quantity becomes bigger and bigger, so the database server load gets heavier increasingly. To cope with the changes and to improve the overall performance of the application system, we should overall upgrade the software and hardware of the existing database server generally. During this period, the database will be often switched, and business interruption appears. In the database switching process, with the guarantee of data reliability, how to shorten the down time as far as possible and to reduce the influence of the business of engineering project switch is the key and difficult point[1~3]. Tsinghua university data center has made a lot of research and practice in different architecture database switch[4~7]. And they have achieved good result in the process of core database upgrade and migration relatively in the data center.

II. KEY TECHNIQUES

Database switching tends to appear in the process of database upgrade, database migration and database failure transferring. According to the different application environment of database switch, the database switching technology is divided in two types: the database switch under the same environment and under the different environment.

A. The Same Database Environment

The same environment refers to the same version of database and operating system before and after database switching. It commonly occurs in the migration of server hardware environment damage or the opening use of backup environment. In this kind of circumstance, the construction of the new data environment used to switch can be recovered by logic and by physical tool. For example: Oracle database can be imported and exported logically using exp/imp or expdp/impdp. And it can also be totally restored by using rman [8] physical backup. Sqlserver can import and export tools, and also can restore tools through backup. And even it can restore by copying all database files directly after shutting down database. Generally, the physical recovery is faster than logic, and down time of switching process is relatively short.

In the face of large volumes of database, backup recovery time is still relatively long, and directly it extends down time of the transition process. For this reason, all the database manufacturers provide with corresponding available framework such as HA, AA and etc. to prevent interruption of the single point database response. For example, Oracle provides the RAC structure, and Sqlserver provides failover cluster. In addition, the disaster tolerant tools DataGuard provided by Oracle and mirror image database provided by Sqlserver can also achieve quickly switch in the same condition. The advantages and characteristics of these methods will be analyzed briefly as below.

- RAC is the abbreviation of Real Application Clusters. Oracle RAC run above Oracle cluster and belong to the AA (double live) framework. If any node within the cluster goes wrong, Oracle will request to switch to other nodes and continue operation. The business is not affected, and the user will have no aware of switch of database node.
- Sqlserver fault transferring cluster can achieve HA high available framework through the Windows cluster. When any node is down, it will automatically start another node. The Switching time is influenced by server startup time, and it will take a few minutes generally.
- DataGuard is originally integrated disaster recovery solutions of Oracle which can be backedup synchronously through the synchronous log maintain production database. It is composed of production database primary and backup database standby. And it can quickly switch to use standby database by hand.
- Sqlserver mirror image database is similar to Oracle DataGuard which can quickly switch to use standby database through synchronizing database state by the log transmission when the mainframe is at fault.
Because the host database and the standby database are in different operation environment, switching is faster than fault transfer cluster.

B. Different Database Environments

Different conditions refer to the different database version or different operation system platform. For example, with database version upgrade, the operation system changes to Unix or Linux from Windows, and the database to 64 bits from 32 bit, and etc. Database migration under different environments cannot directly use recovery mode by physical backup, while it generally can recover database by using the logical import and export, and thus complete database switch. Logical recovery will take more time generally. In this kind of situation, we can work by using special technology. Due to the big difference existing in database migration under different environments, this paper focuses on analyzing two kinds of common technologies: ROLLING UPDATE [9] and transportable tablespace[10] used in the process of Oracle database upgrade and cross-platform migration.

- **ROLLING UPDATE.** Cluster upgrade method provided by Oracle refers to that a node installs the patch or upgrade version, while other nodes provide the same service. And then other nodes install patch or upgrade while the completely upgraded and installed patch node initiates to provide service. The external service does not stop in the whole process of installation patch or upgrade. DATA GUARD, STREAM and RAC environment of Oracle all support high available ROLLING UPDATE, but RAC environment only supports ROLLING UPDATE of small patch, and it does not support the installation of large patch sets and upgrade of large version.

- **Transportable table space** is mainly used to implement the Oracle cross-platform data transplantation. It only exports metadata in this way by using a group of self-contained and read-only watch space, and it will copy data file of table space to the target platform in the operating system level, and then it will import metadata to data dictionary. This method applies to the situation of different platform. It runs faster and more reliable than logic import and export.

III. DATABASE MIGRATION IN TSINGHUA UNIVERSITY

A. Current Environment Analysis

Tsinghua university data center uses different database such as Oracle, SQL Server, MySql and so on. And among them, Oracle occupies the largest proportion which is the most importantly used business database. The framework is shown in figure 1:

Tsinghua university database framework is designed as figure 1. Each link as RAC cluster, network, host disk, storage and so on used by Oracle in four nodes has realized fully redundant design and eliminated single point failure. It realizes unified backup automatically to the database cluster of different segments by using centralized management. And the standby database synchronizes automatically with production database daily so that it can quickly switch when the failure occurs. It sets up disaster tolerant environment in university library and realizes effective disaster recovery by using Oracle DataGuard [11].

The current database structure meets the requirements of database high availability. Therefore, the database environment faces the following questions:

- The core production database uses SUN v490. With the increase of business system and the growth of data quantity, the whole performance of current database has not completely met the needs of the business system, so the hardware requires upgrade urgently. Comprehensive all aspects of factors, database platform needs to adjust to Linux from Solaris.

- The current core database character set coding uses ZHS16GBK uniformly. Obviously, it is not suitable to support multi-language environment. The database character set need convert from ZHS16GBK to AL32UTF8.

- All kinds of disaster tolerant and database management environment need to keep consistent to production database, so other database environment should adjust synchronously with production database.
B. Migration Design

To solve the above problems, Tsinghua University Data Center has started program of database upgrade. Core database cluster adopts new purchased server which will construct database cluster in Linux environment. Database character set uses UTF8 encoding, and then it will completely move the source database to a new platform uniformly. Database migration process is shown in figure 2:

![Flowchart of Database Migration](image)

Figure2. The Flowchart of Database Migration

Needed operation in the source database end is shown in above figure. It will run self-contained check whether migration can be done by using transportable table space. If the check is successful, the database should be firstly set to read-only mode. And on one hand, running application procedure will continue using the database in read-only mode; on the other hand, it can ensure the data consistency in the process of database migration. The next stage is to export transport tablespaces from the source database end expdp and database metadata from expdp. And at the same time, it will convert data file which will be stored together in shared storage which the target database can also have access.

In the target database end, to guarantee of the integrity of the database object, it is demanded that data files be converted to the database firstly, and then the information of transportable table space be imported into, and finally the whole database metadata be imported into again. In order to ensure the consistency and integrity of the database after migration, this scheme should recompile uniformly all invalid object and restore table space to reading and writing condition after checking. And thus, database migration work will be completed.

C. Implement

Database needs to be migrated from Solaris to Linux. During this period, the main problems faced are as following:

- The core database carries business data of hundreds of application processes, so we should shorten the migration time as possible.
- Because the Chinese characters storage of ZHS16GBK has 2 bytes, and the Chinese characters storage of AL32UTF8 has three bytes, it will inevitably cause space changes after database migration, some data lost or not in use, and even the reform of application process.

Based on the above two aspects, we finally complete database migration through carefully test before the implementation. The problems and experience in the course of specific implementation are as follows:

- To try to shorten the migration time, we directly migrate data files by using the transportable table space plan. And it can shorten the time to one half and less.
- The character data default length of newly built UTF8 database is set as char, so that we can expand space of character data automatically in the migration process, and then avoid the data overflow error.
- To ensure object integrity of database after migration, writing scripts will check all the database objects including all kinds of roles and authorization.

IV. CONCLUSION

The migration of database operating platform is relatively easy to implement under the condition of invariable Character set. Therefore, due to different operation platform, we cannot migrate database through physical restore, and can only import and export through logic. Logical import and export is relatively slow, so the migration becomes the biggest problem under the condition of a large quantity of data.

At the same time of database migration, we should realize the transformation of the character set. Due to the change of storage space, it is possible to cause space changes after database migration, some data lost or not in use, and even the reform of application process. For example: char (6) type can store 3 Chinese characters in gbk database, while only two Chinese characters in utf8 database. If the original database is more than two Chinese records it will be unable to import into utf8 database. The method to solve this problem is to enlarge
the space of character types uniformly. In fact, the maximum storage space of Char type data is 2000 bytes, while varchar2 types 4000 bytes. Even if we enlarge char (2000 byte) to char (2000 char) and varchar2 (4000 byte) to varchar2 (4000 char), the maximum storage space can't be expanded yet. It means that the char type records more than 1334 Chinese characters in original gbk database, or varchar2 data more than 2667 Chinese characters can only change data types in utf8 database. And thus it will inevitably lead to the application change.

Because the core database provides service for hundreds of applications, it is demanded to test and even amend the applications whether they can be in normal use after database migration, especially the change of character set encoding. Therefore, it is relatively difficult to test hundreds of applications. And the reform of the applications code without normal operation is to need to pay a big cost.

In conclusion, database cross-platform migration is relatively easy to implement without any change of database character set, while it is very difficult to realize perfect migration with change of database character set. Especially related to the problems of Chinese coding, it is possible to lose data. And only through artificially reform can the problem of data loss be solved.

REFERENCES