Exploration and Application of Oracle Database Service Pool in University

Lixin Wang

Southwest Petroleum University Network and information center of Southwest Petroleum University, Chengdu, Sichuan China, 610500, China.

Abstract

As the core database of most universities, Oracle database plays an important role in the infrastructure construction of smart campus. Based on the principle of Oracle RAC, this article deeply analyzes the key factors in the cluster, such as computing, network and storage, and proposes a database pool solution which is based on InfiniBand network and distributed storage technology. At the same time, this article takes the core database construction of Southwest Petroleum University as an example for practical application, realizing the centralized, unified management and sharing of database resources, and achieving the purpose of unified integration of database services. The database service pool scheme has the typical characteristics of high availability, high performance and high expansibility, and obtains good application effect.

Keywords

Oracle RAC; Distributed Storage; Database Service Pool.

1. Introduction

With the rapid rise of big data, artificial intelligence and other new technologies, the value of data has been paid more and more attention in information construction. Oracle database is selected as the core database software by most universities due to its stability and high availability. After decades of development and progress of technology, the database schema has changed from single database to shared database, to the schema of large shared database service pool. On the one hand, database is faced with the challenge of concurrent requirements of multi-service systems; on the other hand, the construction of large-scale service system based on service domain has put forward higher requirements for database support capacity. The future database schema design must meet the characteristics of high security, high availability, high performance, high scalability and so on [1][2]. Third, under the current situation of information input, universities cannot support large-scale procurement of expensive database software authorization, the database schema of universities is bound to scale and centralization. Correspondingly, this kind of large-scale database cluster also puts forward higher requirements to the management personnel's large technical level.

2. Current situation of Oracle database deployment schema in university

At present, there are four common modes of Oracle database deployment schema in universities, which are hardware sharing mode, exclusive instance mode, shared instance mode and cluster domain mode. As shown in Figure 1, the hardware sharing mode typically deplores business system applications and Oracle database software on one server. It is well known that database software itself consumes large server resources, which undoubtedly wastes huge computing and storage resources. In contrast, the exclusive instance mode consumes less resources. An exclusive instance is an application that monopolizes a database instance, and it is mainly used in the application scenarios of important service systems. Shared instance mode is a compromise scheme selected by some universities. Before the Oracle 11 g,Because instances are logically isolated from each other, resource sharing between instances cannot be realized under a node schema. However, in order to solve the database requirements of multiple applications, adopt the method of multiple applications share one instance. In principle, this method is realized through the logical isolation of database objects by users

in Oracle instances, the model for multiple business share one instance, they will be affected by competition for database resources. Meanwhile, this sharing mode also increases the difficulty and complexity of operation and maintenance management. Finally, the cluster domain mode, mainly relying on the multi-tenant feature supported by Oracle 12C, the container instance CDB is used to realize the effective unification and dynamic allocation of computing resources between instances, and logically realizes the isolation between tenant instance PDB [2], which solves the problem of business isolation between services under the shared instance mode. In addition, considering the security of services, the establishment of different database cluster domains to provide database services with different characteristics can realize the implementation of different security policies for different container instances, which not only ensures the security isolation between domains, but also takes into account the centralized management of resources for the whole cluster.

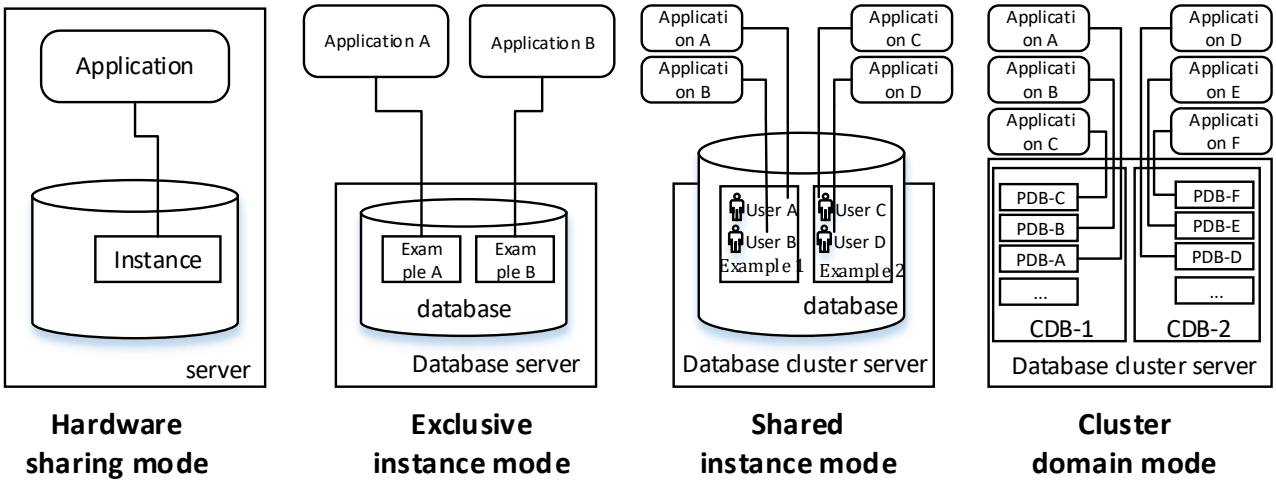

Figure 1. Common deployment mode of university core database

3. Oracle database service pool

Oracle Real Application Cluster (RAC) [3] software was originally designed to provide a stable and highly available solution for applications. Since the launch of Oracle10g RAC solution, through 11g, 12C and mature 19C version, RAC focuses on building a shared resource pool from three levels of computing, storage and network [4] to form an integrated database service pool solution. The following will be elaborated from these three aspects.

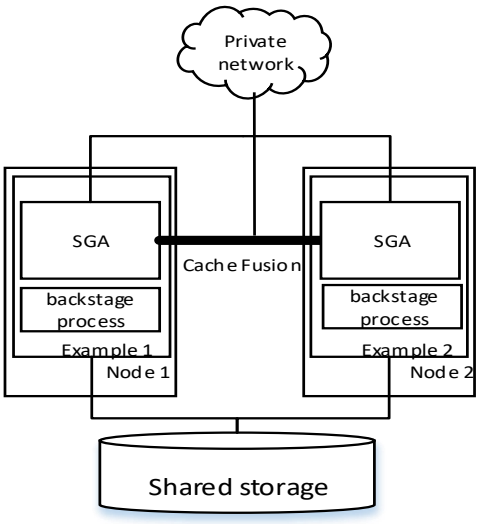

Figure 2. Oracle RAC schema

Computing resource pool. As shown in Figure 2, after Oracle 10G version, through the Cache Fusion [5] Cache sharing mechanism, the problem of data block access consistency between SGA (system global area) of instances is solved, and the memory-level resource sharing pool is constructed. It realizes data block transmission and data consistency point control between SGA through GES and GCS. The advantages of high-speed network transmission replace the performance problems caused by low-speed DISK I/O. Once data is read from an instance, the next data read only needs to be transmitted to the local instance over the high-speed network, greatly improving the data access efficiency. Oracle SGA uses the Database Buffer Cache to Cache previously accessed data blocks, and directly reads the data blocks in the Buffer for the next read. Thus, avoiding IO performance problems caused by inefficient reading of data blocks [6].

Network resource pool. The Oracle cluster has two networks. One is for external database services. The Scan IP address and Public IP address are used to encapsulate external networks. The other is private network, which is designed solely for Cache Fusion. As mentioned above, data block sharing and node communication between instances are transmitted through this network. Therefore, this part of the network is generally a high-speed and redundant network to ensure the high efficiency and stability of transmission.[7,8]

Storage resource pool. Since Oracle 10G, ASM has taken over storage resource management, providing Oracle with a proprietary file system and volume management solution, as shown in Figure 3. In principle, ASM uses a set of independent instances to manage storage resources. This storage management instance provides standard unified storage resource services for Oracle single instance or cluster instance.

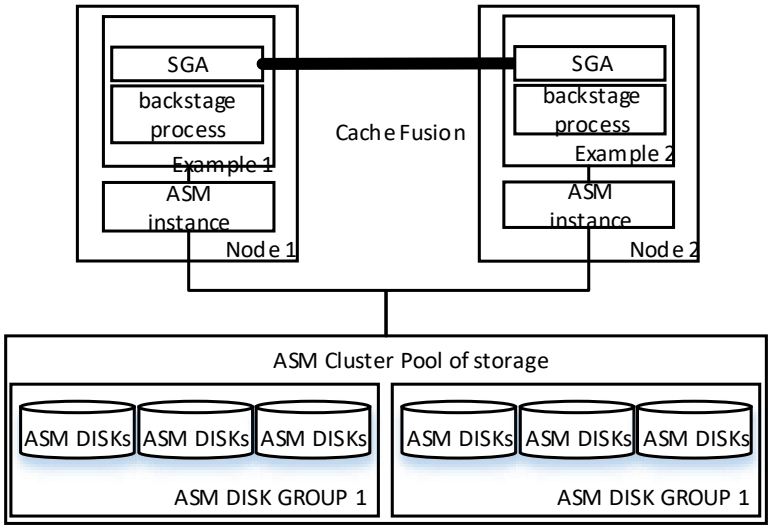

Figure 3. Oracle ASM schema

As described above, storage resource pool is the most important factor affecting Oracle RAC performance. Currently, there are various solutions for shared storage, including NFS, FC SAN disk array, and X86 distributed storage. NFS provides disk sharing based on disk mapping between operating systems. This storage sharing solution in the form of exclusive files is outdated. The FC SAN mode provides raw device storage resources to ASM by using external disk arrays. This schema was very popular in the past few years. The advantage of this schema is that it uses external high-performance storage to solve the disk sharing requirements, but the disadvantage is that it is very expensive, easy to form performance bottlenecks, and inconvenient to upgrade and expand later, because the performance of this schema is affected by the storage controller, optical switching performance and bandwidth, the cost of replacement is high. With the advent of X86 distributed storage, this inexpensive, large-capacity, high-speed and high-performance disk solution provides Oracle RAC with a more ideal solution, which truly realizes centralized management and linear expansion of storage resources.

4. Deployment Implementation

This part takes Southwest Petroleum University (SPU) as an example, the construction of Oracle RAC cluster based on X86 distributed storage schema is described to replace the original Oracle 11G RAC schema based on virtualization environment.

4.1 Software and hardware resources planning

4.1.1 Hardware planning

As illustrated in the Figure 4, SPU plans to use two H3C R4900 servers as RAC nodes. Each node is configured with two 20-core CPU, 256G internal storage, and three NVME 4TB disks. Two InfiniBand switches provide a high-speed network of up to 40Gb. In addition, one H3C R4900 server implements virtual integration and centralized management of disks in RAC nodes to form a large storage resource pool to provide shared storage for two nodes. The two nodes plan to use 2.1 TB available Flash storage resource pool and 1TB available HDD storage resource space.

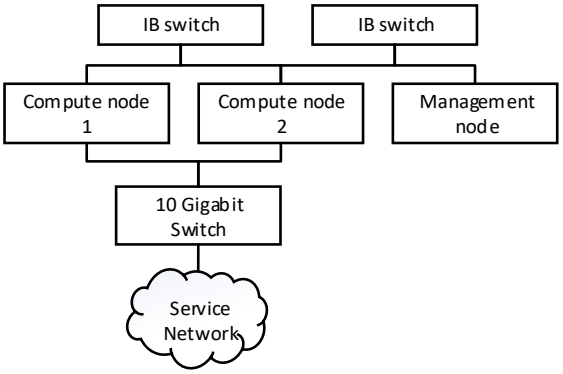

Figure 4. Oracle database service pool schema

4.1.2 Software planning

RedHat 7.6 is selected as the operating system to ensure compatibility with Oracle. Select Oracle 19.12 and install Oracle Cluster Ware and Grid Infrastructure software. In terms of storage, Zdata distributed storage management software is installed to centrally manage the storage of nodes and build storage sharing pool.

4.1.3 Network planning

Planning private and service networks, use 192.*.*.* as the DATABASE service IP address segment, use 10.* *.* and 11.*.*.* as the private high-speed network segment, and design 11.*.*. as an alternate private network segment. As shown in the table 1.

Table 1. IP planning

Node Host	IP Address	Type
EMDB01	192. *. *. 101	Public
EMDB01	10.*. *.201	Private
EMDB01	11.*. *.201	Private
EMDB02	192. *. *. 102	Public
EMDB02	192.*. *.104	Private
EMDB01	10.*. *.202	Private
EMDB01	11.*. *.202	Private
SCANIP	192.*. *.105	Public

4.2 Deployment and implement

The deployment and implementation include two parts: One is the construction of new database environment, the other is the migration of the original database and business system reconfiguration.

Since cross-release upgrade, considering the compatibility between the service system and the new environment, the old environment is used to run in parallel to ensure that services are not affected by test failures. The main steps are as follows:

(1) Set up a distributed storage management environment. First, connect and configure the InfiniBand network, install the operating system (OS) and distributed storage management software on three X86 servers, virtualize disks on the two nodes into storage pools, and mount them to all database node servers.

(2) Install the database cluster software. Install system patches for two database nodes, configure network resources, and deploy Oracle Cluster and Grid Infrastructure software.

(3) Allocate and configure storage resources. Create ASM Data groups as required and set the disk group mirroring protection mode to NOMAL, that is, the three-copy protection mode.

(4) Deploy data instances as required. Create container instance CDB and multi-tenant instance PDB as required.

(5) Test the tuning. Set up the business system test environment, test the new data environment, and make the new environment meet the needs of the business system through tuning.

(6) Online. Switch the database of the service system to the database pool.

5. Conclusion

Through the construction of Oracle database service pool, the X86 distributed storage schema is used to meet the requirements of high reliability and high scalability of storage resources. After adding disks through tests, the cluster storage performance is stable and I/O load can be automatically balanced. The test disk is hot swapped offline. The performance of the storage cluster is not significantly degraded and the storage cluster runs smoothly. Meanwhile, the high-speed InfiniBand private network ensures efficient data transmission between nodes. The construction of Oracle data pool has achieved the centralized and unified management of t he Oracle database of SPU, as well as the design purpose of isolating instances from each other, sharing resources with each other and linear expansion performance linear growth.

References

[1] Y.H. Lv, J.H. Sun, L. Ma. Design and Implementation of campus Network database cluster System based on Oracle RAC [J]. Modern Electronic Technique,2016, (4): 72-75.

[2] B.H. Wu, S.M. Zhu, X.Z. Wu. Application of Oracle RAC Cluster technology in smart campus card system [J]. Journal of Central China Normal University (Natural Science Edition), 2017: 17-20.

[3] Oracle company. Oracle Database Documentation. https://docs.oracle.com/en/database/oracle/ oracle-database/index.html

[4] Oracle company. Real Application Clusters Administration And Deployment Guide. https://docs. oracle.com/en/database/oracle /oracle-database/19/racad/index.html

[5] C.W. Hu, Y. Li, W.A. He, D.D. Nong, W.M. Xie. Research on the Application of RAC Cluster Technology based on Oracle Database in Key Business of University Library [J]. Library theory and practice, 2014, (6): 102-105.

[6] Q.B. Wu, L. Li, X.F. Zhao. Research and implementation of Cluster system based on Oracle RAC database[J]. Journal of suzhou university, 2020,35(11): 12-15, 38.

[7] L.Z. Su. Research on construction scheme of university data center based on Oracle [J]. Journal of Henan Normal University (Natural Science), 2011, (4): 138-141.

[8] N.J. Liu, G.Z. Gao, L.Q. Shen, L.Qi. Research and Practice on Oracle Database Architecture of University Information System [J]. Journal of Sun Yat-sen University (Natural Science), 2009: 274-276.