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MANAGEMENT AND HIGH AVAILABILITY IN DATABASE STORAGE

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ABSTRACT: This article presents concepts and tools, which are able to provide solutions in order to improve database storage management, focusing on high availability and performance. The concepts which were covered can be applied to stand-alone or clustered servers. Having defined the concepts, the current work approaches a proprietary tool which provides high availability and performance in database storage.
Keywords: Servers. Cluster. Stand-alone. Tools.

1 INTRODUCTION

A big challenge for any database administrator is to manage and promote high performance and availability in the technological infrastructure. According to Shrivastava and Somasundaram (2009, p. 25) the need for information storage in the corporate world grows a lot. For companies to be successful in their business it is essential to use tools that provide data storage management, and allow high availability and business continuity.

In a high availability environment, stopping the database for performance maintenance (tuning), making new configurations or change of hard disks in the technological environment could bring grave financial consequences for the company.

In this article, the abbreviation for Database Administrator (DBA) is used to designate a professional who is responsible for the administration, confidentiality, integrity and availability of a Database Management System (DBMS). With the growth of the database, the DBA needs more tools to increase productivity and assist him in automating the daily tasks.

Storage and high availability in database systems is a big focus for any DBA. When data access performance and high availability is sought, technologies and resources available in the market should be used adequately, ensuring numerous improvements in the environment's management and availability.

2 RELATIONAL DATABASE

A Database could be defined as a logically coherent collection of data with some inherent meaning. Such data is managed, interpreted and manipulated according to some specific need. According to Elmasri and Navathe (2011), databases are one of the essential components of life in society and most persons find several activities every day in which they interact with a database.

According to Date (2004, p. 6): "[...] a database system is basically a computerized register maintenance system". These registers are stored in a database that is controlled by a DBMS.

According to Elmasri and Navathe (2011, p. 3) the DBMS has characteristics of data sharing, access control, redundancy control, interfacing, schematization, backup and integrity control; these options ensure the data to be safe, complete and available when requested by any system user. The most popular data model is the Entity-Relationship (ER). In the ER model we have entities, attributes and relationships. The standard data access language of Relational DBMSs is the Structured Query Language (SQL) which was based on relational algebra, it is easy to understand and, for this reason, became a standard adopted by the market.

Data storage technology is a broad concept, which involves equipment, types of disks, control boards, disk usage techniques, among several other concepts that could be correlated. According to Pichiliani (2013), Information Technology professionals, especially a DBA, have to be able to justify certain attitude changes or even technological resources based on more than intuition and ideas without quantification. According to the same author, the DBA needs to be able to justify an improvement when using a functionality or a change of equipment; besides, he needs to quantitatively demonstrate database performance improvements.

Following general recommendations or good practices could even point out the best way, but such practice makes measuring results unpredictable. The best performance of a database system could be obtained with various considerations, among which: the definition of the type of storage to be used and the performance when recording and/or recovering information in a database that could be related to several factors, among which: the operating system, the hardware used, the network infrastructure, the programming and, also, the storage media and technologies used.

The performance of a database is a factor to be considered when thinking on its availability. For Hatamura (2012), optimizing the performance of a database is reducing the response time, improving the database server performance, reducing the network traffic and reducing the I/O time. All of this involves changing applications, database structure and parameters of a DBMS, adequately configuring an operating system and/or the hardware, adequately dimensioning the storage media used, i.e., it requires broad knowledge of applications, operating systems and computer hardware.

3 FILE SYSTEM

For Flynn and McHoes (2002, p. 193) a file system "[...] controls all files in a system and processes the commands of users that wish to interact (read, record, modify, create, erase, among others.)". Any file system should be capable of storing, organizing, decoding and handling the data independently from the storage form used.

Another point approached by Flynn and McHoes (2002) is that a file system must manage and maintain the integrity and safety of the files allowing the identification, organization, sharing, access, protection and Input/Output (I/O) operations on the stored data, besides ensuring a quick access to the data requested by the operating system.

The most common file systems are:

- Apple: HFS+;
- Unix: UFS, Ext2, Ext3 and Ext4;
- IBM: HPFS;
- Microsoft: FAT 32 and NTFS.

In summary, a file system must be extremely safe, quick and easy to maintain.

An important concept in storage is the raw devices (raw data storage device). In a critical environment, databases need the best data recording and recovery performance in disk. The reading and recording performance in the database is one of the objectives most desired by any DBA. Raw devices are partitions in raw form, i.e., without formatting. In this case, a specific application is necessary for its management, since as the partition is not formatted, it does not have a file system.

4 CRITICAL SYSTEMS AND HIGH AVAILABILITY

Pitanga (2008, p. 33) justifies the use of cluster with the following argument "[...] a great computational problem in which the parallel processing if considered an advantage, could be indicated for use in a cluster".

A cluster is a grouping of two or more computers or systems, which basically share memory, storage, processing and network. In a cluster system, the computers are called nodes and are connected between themselves through a Local Area Network (LAN).

The main characteristics of a cluster are:

- Performance;
- Load balancing;
- Data redundancy.

For a cluster user, it is summarized as a much more powerful computer.

Some type of clusters:

- High Availability: used in critical mission database;
- Load Balancing: distributes the input data and resources of the nodes, used in web farms and also in distributed processing cluster.

This model increases the performance and availability of applications especially of large computational tasks, and is also used in financial and scientific applications. The Business Continuity (BC) implies in preparation, response and recovery of a systemic failure, involves proactive measures, risk analyses and assessments, data protection, security and also reactive measures in case of failures.

According to Shrivastava and Somasundaram (2009, p. 251) "Business Continuity" has to ensure the "availability of information" ensuring the operations of the company. Unavailability of data, inactive time or unplanned stoppages result in loss of productivity and income, weak financial performance and damages to reputation. The impact of inactivity time on the business is the sum of all these losses generated as a result of a given interruption. The average cost per hour of inactive time provides a key estimate to establish BC solutions.

According to Shrivastava and Somasundaram (2009, p. 260) "To attenuate a single point of failure, systems are designed with redundancy, such that they only fail if all components of the redundancy group fail". This structure ensures that a failure of a single component does not affect the availability of data.

Strict guidelines are applied to implement the failure tolerance structure in Data Centers, among which we can mention:

- Storage Array configuration;
- RAID configuration ensures a continuous operation in case of failure of the Hard Disk (HD);
- Clusters configuration.

New technologies lead to a varied set of options in terms of storage devices and solutions that meet the requirements of high availability and business continuity. Analyzing hardware and software configuration and its impact in the company operations are essential, since in a business environment under constant change, the BC becomes a demanding task.

The use of specific tools that ensure integrity, high availability, security and high performance in data storage in a critical environment must be carefully chosen by the DBA, as a planning that does not correctly approach the company's growth will affect its storage need, and full and safe access along time.

An incorrect management of information made available in its database drastically affects the business continuity. Normally, the database administrators seek tools where they can obtain a better performance allied with greater security. The above concepts will help understand a technology developed by Oracle that was implemented in the Oracle 10g release 1 version called Oracle Automatic Storage Management (ASM).

Oracle Corporation better known as Oracle is an American company with headquarters in Redwood City in the state of California. Its main product is Oracle Database, which is found in Express Edition, Standard Edition, Standard Edition One versions and Enterprise Edition, currently in 11G release 2 version. Following the relational model is the main characteristic of the Oracle database, besides evolving with each new release offering tools for a better management, providing scalability, security and high performance for data storage.

The ASM technology has its own file system, called Oracle ACFS, (Automatic Storage Management Cluster File System), which is a scalable and multiplatform file system, capable of managing the storage in

stand-alone servers or clustered servers, and disposes of integrated functions that allow the DBA the full analysis of his storage environment, ensuring the integrity of the information made available.

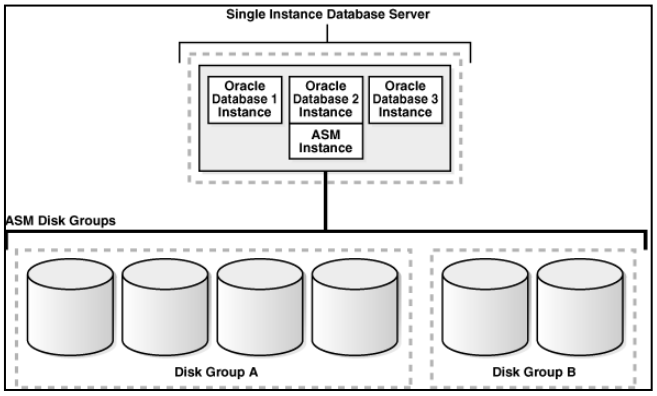
It is possible to visualize the information I/O load in use in the group of disks, and this visualization allows the DBA planning more efficiently the technical maintenance, besides adequately planning the expansion of the storage environment. It is made up of a volumes manager and a file system that uses the automated multiplexing resource that distributes, among the disks available, data files, redo log files and control files, it supports plain instances and multiple instance configurations through the Oracle Real Application Cluster (RAC), which is the cluster solution with high availability resources and load balancing for Oracle Database. This management and storage solution uses Raw devices separated by groups of disks, used to store the data files, with the disks groups being a collection of disks managed as a single unit.

The Oracle ASM technology allows the management, addition and removal of new disks to the group of disks while the database is not interrupted, this way, unplanned stoppages are eliminated, coexisting with other types of file systems and disk storage management technologies, thus facilitating its implementation. According to Bryla and Loney (2007, p. 102) an Oracle ASM instance is similar to a database instance concept, having an area called System Global Area (SGA) and background processes, but because it performs a lower quantity of tasks, the Oracle ASM's SGA has lower server performance impact. Oracle ASM instances make the files available and assemble the groups of disks for the database instance.

In Oracle RAC environments, an ASM instance is created for each cluster node, no matter how many database instances are in the node.

Figure 1 shows multiple database instances accessing a single Oracle ASM instance.

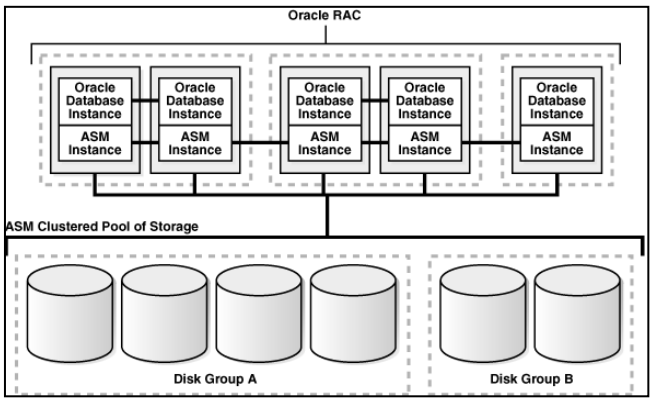
Figure 1 - Oracle ASM for Single-Instance Oracle Databases



Source: Oracle (2010a).

Figure 2 shows Oracle RAC accessing a set of storage, with one Oracle ASM instance for each node, serving multiple or single database instances. All databases could access and share the same two groups of disks.

Figure 2- Configuration of the Oracle ASM Cluster with Oracle RAC



Source: Oracle (2010a).

A group of disks is a set of several disks, this being the fundamental object managed by the Oracle ASM, including disks, files and the allocation units.

A database could make use of files scattered in several groups of disks due to the fact that the files could be part of several databases.

Oracle ASM Disks are storage devices made available to a group of disks of the Oracle ASM, which could contain:

- A disk or a partition of a disk array;
- A full disk or a partition of a disk;
- Logical Volumes;
- NFS - Network File System.

Within this structure, the files could be proportionally scattered within the group of disks. This storage pattern maintains each disk with the same capacity and ensures that each disk has the same I/O load. This load balancing discourages the configuration of different ASM Disks in the same physical disk.

Oracle ASM Files are Oracle database files, which could be data files, control files, parameter files, among others, stored in the groups of disks existing in the environment, where the database instance communicates with these files. When a new file is created, it is divided and distributed (striped) through the group of disks. For example, a group of six disks with Oracle ASM disks has its allocation space equally distributed in the six disks and, when accessed, it will be read in the six disks in parallel, thus increasing its performance.

5 IMPLEMENTATION OF ORACLE ASM

To better demonstrate the Oracle ASM tool, an empirical test was made for the installation of the Oracle Database 11G release 1 in the Linux CentOS 5.4 32 bits operating system and Oracle Database 11G release 2 in Microsoft Windows Server 2012 Standard 64 bits, using the Virtual Box release 4.2 software,

with creation of 2 virtual machines. In both systems, it was necessary the preparation of the group of disks in RAW device mode before installation of the database.

In the installation made in Linux CentOS, it was necessary to configure and enable the raw device service, which are raw character devices and that do not perform buffer. The installation and configuration of three packages, mentioned below, was performed for preparation of the environment, besides the creation of three more groups of specific users for installation of Oracle ASM. During the installation of Oracle Database 11G release 1, it was possible to see the moment when the ASM instance was created.

In Microsoft Windows Server 2012, there is a tool incorporated in the operating system that helps in the disk management process, with possibility of creating the primary partition in RAW mode. It was necessary the installation of the Oracle Grid Infrastructure for creation of the group of disks; after this, the installation of the Oracle Database 11G release 2 was performed.

In both cases, we used the Enterprise Manager and SQL Plus tools to check the status of the database and ASM instance. Despite the release version of the systems mentioned above not being accredited by Oracle, the installation occurred satisfactorily.

It is important to stress that Oracle ASM does not have versions to be installed in the 32 bits version of the Microsoft Windows Server 2008 operating system, fact which was proven during the tests by means of error INS-35210 during installation.

To implement Oracle ASM in an environment with Linux Operating System, the preparation of the environment (creation of areas, users, installation of libraries, among others) requires greater attention and steps than those involved in the Microsoft Windows Server 2008 Operating System. The Oracle ASM tool disposes of resources that facilitate the management of groups of disks; when needed to expand the group of disks, the stoppage of the database is not necessary. This technology has a flexible structure; it is possible to manage ASM instances and groups of disks by means of the Enterprise Manager or SQL Plus applications. Oracle ASM provides I/O load balancing in the groups of disks and LUNs (Logical Unit Number).

Using the Enterprise Manager application we visualize the group of disks, the status of each disk, disk usage history, having also a graph of I/O response time. These resources provide management besides high availability and disk redundancy resources.

6 CONCLUSION

The need for storage management and high availability must gather various techniques and tools. Faulty points like single disks and environments without redundancy directly affect the business continuity.

A file system in conjunction with a volumes manager must use high availability and management in an efficient and safe manner. The tools available in the market ensure the DBA highly efficient solutions for database management, which when implemented, ensure performance, scalability, security and high availability of the stored information.

During installation, configuration and use of Oracle ASM it was possible to check that the tool brings options for the management and high availability in database storage in a practical manner, assisting in the DBA's work.

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