Exploiting Automated Database Diagnostics in Oracle Database 10g

The task of monitoring and managing database system performance has become increasingly important as enterprise applications grow in complexity. This article presents a Dell study that demonstrates how administrators can use Automatic Database Diagnostic Monitor, a feature of Oracle® Database 10g, to monitor and manage the performance of Oracle Real Application Clusters 10g.

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A key management feature in Oracle Database 10g is Automatic Database Diagnostic Monitor (ADDM). ADDM proactively monitors the state of the production database environment, reporting on performance issues and recommending potential solutions to those issues. ADDM is designed to perform a top-down analysis of the discovered problem, resulting in a set of findings that includes the root cause of the problem and suggestions for resolution.

This article provides an overview of a common scenario for automating management processes using ADDM. In August and September 2004, through a controlled laboratory simulation of a midsized workload on Oracle Database 10g that used out-of-the-box settings, Dell engineers demonstrated how the self-diagnostic features of the database engine could help identify performance issues. This article analyzes some of the recommendations that ADDM provided in response to the performance issues discovered during the test.

Configuration of the test environment

The test environment comprised the Oracle Database 10g Enterprise Edition 10.0.2.0 database server running on two Dell™ PowerEdge™ 6600 servers, each with dual Intel® Xeon™ processors at 1.9 GHz, 1 MB level 2 (L2) cache, and 4 GB physical memory. The servers ran the Red Hat® Enterprise Linux® 3 Update 2 operating system (OS). For storage, the test team configured a Dell PowerVault™ 22xS SCSI enclosure with ten 36 GB 15,000 rpm disks.

Order-entry processing workload simulation

The study used an order-entry processing workload. The database was about 5 GB, and the largest table in the database had 15 million rows. The second largest table had 1.5 million rows. The test team used a driver program to simulate 25 concurrent users who executed five different transactions against the database such as select, insert, delete, and update operations. The workload exhibited online transaction processing (OLTP) characteristics—that is, short-duration transactions involving random and small-block reads and writes. Dell engineers executed the workload for one hour, which allowed two to three snapshots to be gathered for analysis during a steady state.

Automatic Workload Repository functionality

The Oracle database engine is designed to accumulate statistics such as Wait Events and Time Model Statistics in internal database tables—a capability known as dynamic performance views. However, the values in dynamic performance views are reset on instance startup and, therefore, performance data that could be used for comparisons is lost on startup. Automatic Workload Repository (AWR) is a feature of Oracle Database 10*g* that automatically stores the cumulative and delta values for a majority of the statistics in persistent storage to aid in proactive analysis of performance issues. The collection of a single data set is called an AWR snapshot. A pair or a sequence of snapshots serves as a baseline, which can be compared with snapshots captured during the occurrences of a performance issue to help isolate the issue.

ADDM proactively monitors the state of the production database environment, reporting on performance issues and recommending potential solutions to those issues.

In studying the overall test environment, time was chosen as the common unit of measurement. The parameter `db_time` was the most important statistic. The `db_time` parameter represented the total time spent by an application in the database as it executed transactions. This parameter was the sum of CPU and wait times of all sessions, excluding idle user sessions. A major goal of tuning an Oracle system is to minimize bottlenecks such as inefficient SQL statements, which can potentially decrease performance and throughput.

AWR captures database statistics as well as system statistics. By default, it automatically generates snapshots of the database performance statistics once every hour (this is the snapshot interval) and retains the data for seven days (this is the snapshot retention). The degree of statistics collection is controlled by the initialization parameter `statistics_level`. By default, it is set to `typical`, which is sufficient for most cases.

To access AWR from Oracle Enterprise Manager 10*g* management software, administrators should perform the following steps:

1. From the Enterprise Manager startup screen, select the Targets tab.
2. Choose the Databases tab, and select the desired database.
3. Click "Administration."
4. Click "Automatic Workload Repository" to open the Automatic Workload Repository page.

From the Automatic Workload Repository page, administrators can manage snapshots or modify AWR settings. Configurable parameters for AWR are snapshot retention, snapshot interval, and collection level.

Figure 1 displays the current settings for these three configurable parameters. Administrators can change the settings by pressing the Edit button. The Automatic Workload Repository page also displays information about the number of snapshots available and the time of the earliest and most recent snapshots since the database instance was started. For the study discussed in this article, Dell engineers set the snapshot interval to 15 minutes and used the default settings for the other two parameters.

Automatic Database Diagnostic Monitor functionality

ADDM periodically analyzes the AWR data, locates the root causes of performance problems, and provides recommendations for resolving the problems. It also identifies non-problem areas of the systems running Oracle Database 10*g* to help administrators avoid misdiagnoses. Oracle Database 10*g* performs an ADDM analysis every time AWR takes a snapshot.

Even with ADDM, tuning is an iterative process; fixing one problem can cause another to arise. Administrators may find they require multiple cycles to achieve acceptable performance levels. ADDM enables proactive system monitoring, however, which enables administrators to take corrective action on problems efficiently and accurately. The types of issues that ADDM helps diagnose include the following:

- CPU bottlenecks
- Size of Oracle Database 10*g* memory structures
- Lack of I/O capacity
- Oracle Real Application Clusters (RAC)–related considerations such as hot global cache blocks and interconnect latency
- Lack of concurrency
- Application performance
- Lack of optimal configuration
- High PL/SQL execution time

Figure 1. Automatic Workload Repository page

Figure 2. Performance Analysis page

ADDM analysis reports include the following components:

- Problem (quantified by `db_time`)
- Symptom
- Recommendation (action and rationale)
- Informational findings (symptoms that do not particularly affect performance)

ADDM is enabled by default, and depends on the performance data gathered by AWR. ADDM I/O performance analysis is driven by the initialization parameter `dbio_expected`, which specifies the average time in microseconds required to perform a physical database read.

To access ADDM from Oracle Enterprise Manager 10*g*, administrators should perform the following steps:

1. From the Enterprise Manager startup screen, select the Targets tab.
2. Choose the Databases tab, and select the desired database.
3. Click "Advisor Central."
4. Click "ADDM" to open the Create ADDM Task page.

The Create ADDM Task page lets administrators create an ADDM task by specifying an appropriate start time and end time and clicking the OK button. Doing so displays a Performance Analysis page, which shows the performance analysis and informational findings.

Figure 2 shows the findings detected by ADDM when Dell engineers executed the workload. Several of these findings addressed performance. The informational findings, also shown in Figure 2, provided data regarding non-problems.

For performance issues, ADDM provides an estimated impact and summary of recommendations, which are classified into categories such as SQL Tuning, DB Configuration, Host Configuration, and so on.

Figure 3 shows details and recommendations for one of the performance findings for the multiuser workload: "Database writers (DBWR) were unable to keep up with the demand for free buffers."

Because the OLTP workload incurred a mix of read and write transactions, the test team expected the database buffer cache to become full rapidly. The `database_cache` parameter was set to 1.2 GB and the size of the database was about 5 GB. The finding "Database writers (DBWR) were unable to keep up with the demand for free buffers" addressed the insufficient buffer cache issue. Because the test workload was write intensive, the number of dirty buffers in the cache increased rapidly as the test team executed the workload.

The first recommendation provided by ADDM suggested increasing the number of `db_writer_processes` so that the dirty buffers could be flushed and freed up for reuse. The second recommendation pointed out potential limitations of the I/O subsystem. Following the second recommendation, administrators could check the Memory Adviser for buffer cache usage or review the Automatic Storage Management (ASM) performance monitor to quickly determine which component was the bottleneck, and then take corrective action. Both the Memory Adviser and ASM are features of Oracle Enterprise Manager 10*g*. The third recommendation indicated that administrators should examine the application logic to optimize the way the records are inserted.

For another test finding, "Log file switch operations were consuming significant database time while waiting for checkpoint completion," ADDM provided a specific recommendation: increase the size of the log files to 1221 MB to hold at least 20 minutes of redo information. Using this recommendation, administrators could tune the log files accordingly without having to go through

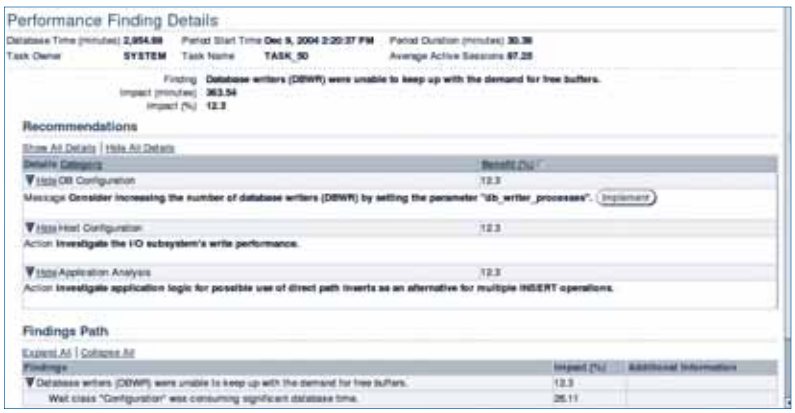

Figure 3. Performance Finding Details page

USING SQL TO CREATE AN AWR OR ADDM REPORT

The AWR report provides a summary of database events and statistics for a given snapshot interval. AWR reports can be obtained by running `awrrpt.sql` as a user with database administrator privileges:

```
SQL> @$ORACLE_HOME/rdbms/admin/awrrpt
```

The preceding command prompts the administrator with options for generating the report in either HTML or plain text. The command also prompts the administrator with the list of snapshot IDs. The administrator should enter the beginning and ending snapshot IDs, and either accept the default file name for the report or specify an alternate name.

SQL can also generate an ADDM report through the following command:

```
SQL> @$ORACLE_HOME/rdbms/admin/addmrpt
```

an iterative process to determine the optimal value for the size of the log files.

For the finding, "Waits on event 'log file sync' while performing COMMIT and ROLLBACK operations were consuming significant database time," ADDM recommended that administrators investigate application logic for possible reduction in the number of COMMIT operations by increasing the size of transactions, and also investigate the possibility of improving the I/O performance to the online redo log files.

ADDM also points administrators to the application-level SQL statement corresponding to a given finding.

ADDM also provides information to point administrators to the application-level SQL statement corresponding to a given finding. For example, clicking on the findings for which the recommendation category is "SQL Tuning" provides the details of the statements that need to be tuned. The projected impact and benefit of tuning the statement are provided as percentage values. ADDM also displays the Explain Plan for the SQL statement. The Explain Plan is the data access path chosen by the database server for executing a SQL query. These details can help database administrators and application developers to optimize the SQL code. Administrators can obtain similar details using SQL (see the "Using SQL to create an AWR or ADDM report" sidebar in this article).

Proactive monitoring of database servers

Using a midsized, multiuser workload on Dell PowerEdge servers running Oracle Database 10*g*, Dell engineers demonstrated how the AWR and ADDM features of Oracle Database 10*g* are designed to work together to proactively monitor the health of the database server and provide recommendations and information to help administrators address performance issues. The self-diagnostic features of Oracle Database 10*g* can help reduce total cost of ownership by proactively monitoring the performance of the database server and significantly lightening the burden on database administrators who manage increasingly complex and global database environments.

Acknowledgments

The authors would like to thank their colleagues Paul Rad and Anthony Fernandez for their valuable comments and help.

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FOR MORE INFORMATION

Oracle Database 10*g* documentation:
www.oracle.com/technology/documentation/database10g.html

Dell and Oracle supported configurations:
www.dell.com/oracle