Oracle Database 10g: Intelligent Self-Management Infrastructure

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INTRODUCTION

According to a survey conducted by Oracle in 2001, Database Administrators (DBAs) spend about 55% of their time performing on-going system administrative tasks such as database monitoring, performance tuning, space management, and backup & recovery. In order to tackle each of these tasks, DBAs often spend significant amount of time configuring and managing multiple tools that are external to the database, each performing only a specific task. The recommendations provided by such tools are usually based on generalized assumptions and aren't always effective in resolving problems. In addition, the performance overhead imposed on the system by these tools may be significant due to their intrusive nature making them impractical to use for performance sensitive environments.

Fortunately, Oracle Database 10g introduces a sophisticated self-management infrastructure that automates and simplifies on-going management tasks in order to dramatically reduce the time that DBAs have to spend on these activities. Built as a part of the core database kernel, the Oracle Database 10g self-management infrastructure provides database the intelligence to learn about its operational environment, use this intelligence to automatically remedy any potential problems, and adapt to workload variations. This is one of the most crucial differentiating aspects of the manageability advances made by Oracle Database 10g. Unlike other products/tools, Oracle Database 10g's self-management decisions are not based on a set of generalized assumptions. Rather, thanks to its intelligent self-management infrastructure, Oracle Database 10g always tailors its actions for the environment it operates in. Moreover, the integration of the self-management infrastructure with the core database engine allows it to make the self-management decisions at the same time as providing the regular services while incurring negligible performance overhead.

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[1] Some of the features referenced below are part of separately licensed Diagnostic and Tuning packs. Please refer to the appendix at the end of the document for more details.

This paper describes the various components of the Oracle Database 10g self-management infrastructure and the kind of intelligence they provide to the product. It also outlines the various configuration options available to DBAs to tailor Oracle Database 10g's self-management behavior for their unique requirements. The results of an Oracle internal performance benchmark are presented to prove the negligible impact of Oracle Database 10g's self-management actions on normal database performance. Finally, the paper presents a set of real world success stories to illustrate how Oracle Database 10g self-management infrastructure is helping customers realize net gain in performance by simply upgrading to Oracle Database 10g.

INTELLIGENT SELF-MANAGEMENT INFRASTRUCTURE COMPONENTS

Oracle Database 10g self-management infrastructure comprises of four components, namely, Automatic Workload Repository, Automated Maintenance Task infrastructure, Server Generated Alerts, and Advisory Framework. The following sections discuss each of these components in detail.

Automatic Workload Repository (AWR)

Automatic Workload Repository (AWR) is a built-in, self-managing operational data repository within Oracle Database 10g and is installed out-of-the-box. AWR resides in the SYSAUX tablespace and contains a wealth of information about the database it is operating within: performance statistics, configuration settings, feature usage, Active Session History data, workload profile, and other such information. At regular intervals, the database makes a snapshot of all its vital statistics and workload information and stores them in AWR. The data captured in AWR is retained for 7 days by default. AWR snapshot interval and data retention can be customized if needed. AWR automatically manages its space requirements by periodically purging old data or as needed under space pressure.

AWR acts as a source of "site specific information" for various automatic tuning activities being performed as part of the self-management of the database. For example, using Automatic Undo Retention (AUM) feature, undo retention on the database is auto tuned, i.e., if the workload on the system varies between day and night, from OLTP to batch processing, undo retention will automatically adjust downwards during day time to accommodate more undo data from OLTP transactions without putting space pressure on the UNDO tablespace, and vice-versa during night time. Such adaptive self-managing behavior to workload demand significantly minimizes the chances of job failures due to errors (such as ORA-1555, snapshot too old) and requires no manual intervention by the DBAs. This is made possible since AWR intelligently tracks all active queries, allowing the database to automatically keep the undo retention ahead of the maximum current system query length. Another key benefit of AWR is the ability to perform historical performance analysis. DBAs are often asked questions as to why performance was slow sometime in the past. Since all the required performance

data is stored in AWR, DBAs can go back in time and determine the exact cause of the problem.

Most importantly, AWR provides the raw information needed by the Oracle Database 10g's self-diagnostic engine, Automatic Database Diagnostic Monitor (ADDM), and other such advisors to help them generate recommendations that would be most effective for a given environment.

Active Session History

One of the key requirements for accurately diagnosing performance problems is the availability of fine grain historical information regarding database activity. But capturing extensive fine-grain data may impose significant performance overhead and adversely impact the system being monitored. Oracle Database 10g provides an elegant solution to this problem by using intelligent sampling. It samples the database activities every second into a circular buffer in memory, and saves only the selected samples to the AWR in order to limit performance overhead. Since only the "active" sessions information is captured, the data collected is not voluminous and the size of data collected depends on the work being done in the database rather than the number of sessions. The ASH information enables quick identification of the root cause of a performance problem, even if the problem was encountered in the past and the user or application that experienced the problem is no longer logged in. The presence of such fine grained historical information in Oracle Database 10g obviates need of "Workload Replay" for diagnosing performance problems, which can be very expensive in terms of time and effort, and often impractical.

Thus, AWR forms the foundation for all intelligent self-management functionality of Oracle Database 10g. It is the source of information that gives Oracle Database 10g an historical perspective on how it is being used and enables it to make decisions that are accurate and specifically tailored for the environment the system is operating in.

Automatic Maintenance Tasks

AWR provides a historical information of how the database being used. By analyzing the information stored in AWR, the database can identify the need to perform routine maintenance tasks. The Automated Maintenance Tasks infrastructure enables the Oracle Database to automatically perform those operations. It uses the rich scheduling functionality introduced in the Oracle Database 10g (through a new feature called Unified Scheduler) to run such tasks in a pre-defined "Maintenance Window". By default, the maintenance window starts at 10 PM every night and lasts until 6 AM next morning, and during the weekend it starts at Saturday 12.00 AM and lasts for 48 hours. All attributes of the "Maintenance Window" are customizable; including start/end time, frequency, days of the week, etc. This allows it to be tailored to environment specific needs. Also,

the impact of automated maintenance tasks on normal database operations can be limited, if desired, by associating a Database Resource Manager resource plan with the maintenance window.

Automated Optimizer Statistics Gathering

The optimizer statistics are automatically refreshed using the Automatic Maintenance Task infrastructure. By intelligently tracking the workload profile including nature of the DML operations on various objects over time, and the previous versions of the object statistics, the optimizer provides solutions to the following issues faced by DBAs on a routine basis:

- Which objects are stale and require statistics refresh?
- Which columns have skewed data and are potential candidates for histogram data? What are the correct bucket sizes for histogram data to be collected?
- What is the optimal sampling percentage for each object?
- What statistics need to be gathered for various segments (for e.g., Global, Partition, Sub-partition statistics, tables, indexes etc.)?
- What is the best degree of parallelism to be used for statistics gathering?
- How to quickly restore old statistics if manually gathered statistics were not adequate for achieving optimal plans?[Ψ]

Thus, the Automated Optimizer Statistics feature in Oracle Database 10g relieves the DBAs from the arduous task of keeping the optimizer statistics up-to-date. In the current economy, as businesses conduct global operations and become highly available, maintenance windows constantly shrink making it hard to schedule downtime for statistics gathering. But efficiently gathering the statistics depending on the workload profile, and only when required, reduces the maintenance window requirements and makes it feasible to keep the optimizer object statistics current. Accurate and up to date statistics help optimizer improve the query performance by picking optimal execution plans.

In the future, more such maintenance tasks will be automated in the intelligent infrastructure framework as required.

Server Generated Alerts

For problems that cannot be resolved automatically and require administrators to be notified, such as running out of space, the Oracle Database 10g contains a new self-management infrastructure component called Server Generated Alerts. As may be obvious from its name, the Oracle Database 10g has the ability to monitor itself

[Ψ] Oracle recommends using Automatic Optimizer Statistics Gathering feature. However, for legacy applications that have not yet been enabled to use Automatic Optimizer Statistics Gathering, statistics versioning and lock statistics features are very useful.

and send out alerts to notify DBAs of any impending problem in an efficient and timely manner. Since the monitoring activities take place efficiently at the same time the database performs its regular operations, it incurs negligible performance overhead. For example, Oracle Database 10g supports complete lifecycle around Space Alerts. Each tablespace in Oracle Database 10g comes with a set of pre-defined alert thresholds, 97% full for critical and 85 % full for warning. The pre-defined thresholds can be customized appropriately through EM interface or command line if needed. Alert condition checks are efficiently done at the time space is allocated or freed up in the database server. It ensures that the database is aware of the problem the moment they arise, enabling it to notify administrators just in time. Once the underlying problem for the alert is fixed, the alert is automatically cleared and moved to alert history for tracking purposes.

The Oracle Database 10g Server Generated Alert implementation is in sharp contrast to the mechanism employed by other monitoring tools available today, all of which regularly poll the database (pull model) to evaluate alert condition consuming a significant amount of system resources. To add to that, since the polling is done at a pre-set interval, it may cause the delay in problem detection and eventually in alert generation. The alerts produced by the Oracle Database 10g not only notify administrators of the problem, they also provide recommendation on how the problem being reported can be resolved. This ensures quicker problem resolution and helps prevent potential failures.

Advisory Task Infrastructure

Oracle Database 10g includes a number of advisors for different subsystems in the database to advise on how the operation of the corresponding sub-components could be further optimized. In order to ensure the consistency and uniformity in the way various advisors function and allow them to interact with each other seamlessly, the Oracle Database 10g include an Advisory Framework. The advisor framework provides a consistent manner in which advisors are invoked and how the results are reported. Even though these advisors are primarily used by the database itself to optimize its own performance, administrators can also invoke them to get more insight into the functioning of a particular sub-component. Having a uniform and consistent interface makes easier for administrators to use these advisors and use the generated information to get a better understanding of their system.

Some of the prominent advisors in Oracle Database 10g are: ADDM, SQL Tuning and Access Advisors, Memory Advisor, Segment Advisor and Undo Advisor. The Automatic Database Diagnostic Monitor (ADDM) is Oracle Database 10g's self-diagnostic engine that completely automates the task of diagnosing performance problems. SQL Tuning and Access Advisors provide recommendations for tuning SQL statements and optimizing schema design, while Memory Advisor helps in sizing the various memory pools without resorting to trial-and-error techniques. Segment advisor helps administrators identify tables/index that are good candidates

for shrinking and the Undo Advisor provides recommendations to optimally configure the undo tablespace.

All the components of the intelligent self-management, namely, AWR, Server Generated Alerts, Automated Maintenance Tasks, and Advisor Task Infrastructure are enabled by default and configured to run out-of-the-box. Additionally, advisors like ADDM and Memory Advisors while not part of the self-management infrastructure, are also enabled by default. These advisors are discussed in the following sections. Some other advisors like SQL Tuning Advisor, and Segment Advisor can be invoked manually if required by the DBAs.

Automatic Database Diagnostic Monitor (ADDM)

As stated above, ADDM is a specialized advisor that automates the process of performance diagnosis. ADDM pro-actively examines the state of the database periodically, automatically identifies potential database performance bottlenecks, and recommends corrective actions. It also provides impact-benefit analysis for the findings and recommendations in the context of the workload running on the system. While the competing Database Management System (DBMS) products lack even basic infrastructure (like V$ performance tables querying mechanism and snapshots) to efficiently monitor databases, ADDM takes performance diagnosis to its next level using the concept of Database (DB) Time. DB Time is the total time spent by the database processing user requests, it includes the time spent waiting on resources and running on CPU. Oracle Database 10g features extensive code instrumentation to accurately measure the time spent in performing various internal operations in response to a user request. These measurements are then rolled up to quantify the total work done by the database in terms of the DB Time. While analyzing the database performance, ADDM identifies the operations/tasks that account for the bulk of the DB Time as well as the resources that are causing significant performance bottleneck, and recommends remedial measures. Using DB time, Oracle Database 10g scientifically attributes weights to the performance findings and recommendations thereby prioritizing them for the DBAs. ADDM also provides inference path analysis, rationale behind the findings, and non-problem areas to aid DBAs in performance diagnosis. This is in sharp contrast to the solutions provided by other vendors of either providing just the raw information or a checklist of recommendations, both of which hardly help DBAs in resolving problems. Also, since ADDM runs pro-actively to determine the performance bottlenecks on the system and stores the results in the advisory framework (AWR), it allows DBAs to easily perform historical performance analysis.

Memory Advisors

Oracle Database 10g includes a number of advisors to help administrators configure memory settings optimally. These advisors use ongoing simulation to predict the database behavior for different sizes of a given memory sub-component, such as buffer cache and shared pool. As the advisor output is based

on workload simulation, they are always tailored specifically for the environment database is operating in. Using these advisors allows administrators to easily determine whether the database instance memory settings are over or under configured, liberating them from any trial and error based techniques.

INTELLIGENT SELF-MANAGEMENT INFRASTRUCTURE: CONFIGURATION

The initialization parameter, STATISTICS_LEVEL, governs whether the self-management infrastructure is enabled or disabled. It may be important to repeat here that the self-management infrastructure includes all the features that are enabled by default and described in the preceding sections of this paper. The parameter can accept three values, namely, BASIC, TYPICAL, and ALL. The default setting of `TYPICAL` ensures collection of all major statistics required for making intelligent self-management decisions and, therefore, enables the self-management features and functionality. This setting also ensures the most reasonable performance overhead on the system. This default value should be adequate for most environments. Here is the list of various features and associated statistics that is governed by TYPICAL setting:

- Automatic Workload Repository (AWR): Includes ASH, Enhanced Time/Wait Model, Client Tracing, Service Level and other Snapshot related Statistics
- Server Generated Alerts
- Automated Task Infrastructure
- Automatic Optimizer Statistics Collection
- Automatic Database Diagnostic Monitory (ADDM)
- Advisories: MTTR, Buffer Cache, PGA_TARGET, Shared Pool,Undo, Redo
- Object and Segment Level Statistics
- Automatic SGA Memory Management
- Timed Statistics

For further information regarding the functionality and their associated statistics governed by STATISTICS_LEVEL, please refer the Oracle® Database Reference 10g Release 1 (10.1)

When the STATISTICS_LEVEL parameter is set to ALL, additional statistics, such as timed OS statistics and plan execution statistics are gathered. These additional statistics are not required for the functioning of the self-management infrastructure but may help in certain diagnostic activities. Collection of these additional statistics may be expensive on some platforms causing adverse impact on database performance. For this reason, "ALL" setting should only be used when advised so by Oracle Support. Setting the value of the STATISTICS_LEVEL parameter to

BASIC disables collection of most of the statistics required by the database to make self-management decisions and turns off the self-management infrastructure. For this reason, Oracle Corporation does not recommend this setting, barring exceptional circumstances. The STATISTICS_LEVEL parameter can be altered dynamically at the system and session level.

INTELLIGENT SELF-MANAGEMENT INFRASTRUCTURE: PERFORMANCE OVERHEAD

One of the biggest design considerations when implementing the self-management infrastructure in Oracle Database 10g has been to ensure that it is extremely lightweight and its performance overhead is negligible. Before the production release of Oracle Database 10g, numerous tests were done in-house on extremely well tuned systems to ensure that the performance overhead never exceeded the internal imposed limit of 5%[∝]. It should be noted that the environments used were already well tuned to squeeze utmost performance gain and represent the worst-case scenario for assessing the performance of self-management infrastructure. However, most real world customer systems are not fully tuned and provide scope for improvement. As such, most customer deployments of Oracle Database 10g have reported net performance gain, a few of them are discussed in the following section. With Oracle Database 10g, the performance improvement provided by the self-management infrastructure is due to the following two main reasons:

a) Identifying issues that were previously unknown and providing solutions for those issues; and

b) Adapting to the workload on the system obviates the need to manually tune the system, and puts the invaluable system resources to use where they are needed the most.

This section discusses the various tests done internally at Oracle to assess the performance overhead of the self-management infrastructure using real customer workload.

Test Bed - Workload Description

As a part of its stringent Quality Assurance (QA) process, Oracle has been working with one of the leading insurance company in Europe for the last several years to stress test new database software releases. The workload provided by the customer represents their key business process of providing various insurance services to customers through their agents. The business process includes checking eligibility requirements for insurance, storing customer profiles, and generating most competitive insurance quotes. The workload imposes stringent service level requirements on performance and throughput -- the system should service the 90% of user requests in less than 30 seconds and support a given number of users at any

[∝] The performance overhead of 5% was based on the feedback given by customers in a survey conducted by Oracle at IOUG 2001 as the maximum tolerable performance overhead limit for database self-management and monitoring infrastructure.

time. Each business transaction involves navigating through multiple screens with a 1 second sleep/think time between screen changes. Any degradation in performance impacts the customer's ability to do core business, and results in potential loss of revenue and customer satisfaction.

The workload was already well tuned by the customer, so this represents the worst-case scenario for assessing the performance of self-management infrastructure. The workload profile is OLTP, with database read to write ratio of 70 to 30 percent.

Test Bed - Environment

The tests were run on a Linux machine with 2 x 2.8GHz Xeon CPUs (4 Hyper-Threaded) running Red Hat Enterprise AS Release 3 Update 2. The system was configured with 8 GB RAM and attached to EMC Clarion CX300 storage. The disk-subsystem consisted of 15 x 32GB disks and used Oracle's Automatic Storage Manager (ASM) striping. The hardware was configured to run Oracle Database 10g Release 10.1.0.3.

The database that was used for testing had default out-of-the-box settings for the configuration parameters.

Test Bed - Methodology

Using the workload provided by the customer, we tested the performance overhead of Oracle Database 10g intelligent self-management infrastructure. The testing methodology that was followed is described below.

The performance overhead for each of the tests was characterized by three key attributes:

a) User Throughput on the System (user commits/second)

b) User Response Time (seconds)

c) Total CPU Utilization Percent

Each test consisted of running 420 users concurrently for at least 2 hours and monitoring the performance in terms of the above three attributes. The tests were repeated multiple times, and results averaged out. The performance overhead in terms of key attributes was noted when STATISTICS_LEVEL was set to BASIC and TYPICAL, i.e., with self-management infrastructure disabled and enabled.

Test Results

Table 1 below depicts that the performance overhead of enabling self-management infrastructure (i.e. STATISTICS_LEVEL setting TYPICAL) is negligible. With the self-management infrastructure turned on, Response Time and Throughput degraded by mere 2.6 % and 2.4% respectively, while the Total CPU Utilization almost remained unchanged in steady state compared to the measurements made when the infrastructure was turned off. It is important to note that these numbers represent the worst-case scenario for the performance overhead since the workload

was already well tuned with little scope of performance improvement. In reality, the benefit any customer sees due to self-management infrastructure should far outweigh the negligible overhead incurred.

STATISTICS_LEVEL	User Response Time (secs)	User Throughput (user commits/sec)	Total CPU Utilization %
BASIC	30.04	263.51	84.83
TYPICAL	30.83	257.31	85.79
Performance Overhead of Self-Management Infrastructure (%)	**2.6%&**	**-2.4%#**	**1.1% ***

&: Increase in User Response time, #: Decrease in User Throughput, *: No significant change observed, within margin of error

Table 1: Performance Overhead of Oracle Database 10g Self-Management Infrastructure

It is also important to point out here that the performance overhead on an idle system will be significantly less than when the system has full workload running. On an idle system, a common mistake made by most users is to look at top consumers on the system, which could be the self-management infrastructure as it may be the only active component in the database, and assume it incurred significant overhead.

Real-World Deployment Case Studies

The true test of any product is how well it performs in real world deployments. Over the last year, numerous customers have used Oracle Database 10g with its intelligent self-management infrastructure to successfully administer and monitor their systems. The self-management infrastructure has automatically diagnosed numerous performance problems and helped eliminate the bottlenecks with minimal manual effort and performance overhead. Also, by intelligently adapting to the specific workload on the system, and only executing those tasks maintenance that are required, the self-management infrastructure has improved the performance of the database without additional tuning.

Dell Inc.

Dell has deployed Oracle Database 10g in production for their critical DW/DSS system called "Eurostar". The database supporting the Eurostar system is 1 TB in size, runs on a 3-Node RedHat 3.0 Linux RAC Cluster, and supports a total of 1200 database users. Each node has 4 CPUs and 8 GB RAM. Eurostar's workload profile is Hybrid OLTP/DSS, consisting of daily batch loads and daily online processing.

When Dell consolidated their Eurostar system to Oracle Database 10g, they experienced performance problems during their peak processing period. ADDM automatically identified that the optimizer statistics were being collected during their peak load time, competing for resources with the normal business processing. Eurostar is designed to do ETL type of operations after the processing of daily online work. Therefore, the heaviest load time of the day overlapped in this case with the Oracle default management window. In addition, global nature of operations at Dell further compounded the problem. Modifying the management window times and moving it outside of their busy period helped both load times and the automatic management operations. Dell has also used SQL Tuning Advisor numerous times to tune complex queries with no manual effort.

Dell has successfully diagnosed performance problems in at least 40 known cases by leveraging the Oracle Database 10g self-management infrastructure. Accurately resolving these performance problems, with minimal manual effort, has resulted in net performance improvement of 30% on Eurostar system. Dell has seen similar performance improvement for the OLTP Order Management System that has been migrated to Oracle Database 10g.

Oklahoma State University

Oklahoma State University (OSU) uses Oracle Database 10g for their critical mail-provisioning system. The system manages e-mail user account creation/deletion, forwarding email between accounts, maintaining contact information, and load balancing mailbox storage across servers. The mail-provisioning system supports about 30,000 users, and is expected to grow significantly as OSU expands to more campuses and adds additional applications to this database. The system is hosted on a two-node RedHat 3.0 RAC Cluster, Oracle Database 10g Release 10.1.0.3. Each node has 4 CPUs and 16 GB RAM. The workload profile is mostly OLTP with batch processing during off hours.

There are at least 8 known cases at OSU where ADDM and SQL tuning advisor recommendations significantly improved the performance of the database. In one such case, the DBA was faced with the challenging task of shortening the existing batch processing window on the mail-provisioning system. The DBA looked at the ADDM recommendations for the relevant time period and followed its recommendations to run SQL Tuning Advisor for identified high load SQL statements. On implementing the SQL Tuning Advisor's recommendation of creating a SQL Profile, the queries ran significantly faster than in Oracle 9i. The DBA was amazed how easily he could tune these complex queries – with a single click of a button from EM; and without recompiling application code or changing the SQL!

Qualcomm Inc.

Qualcomm has deployed Oracle Database 10g for their crucial enterprise system monitoring system called "Centauri". The Oracle Database 10g database

supporting Centauri system is hosted on a two-node Red Hat 3.0 cluster, each with 4 CPUs and 16 GB RAM.

After the upgrade of Centauri system to Oracle Database 10g, the DBA noticed that certain operations were not running as well as expected. Typically, a problem of this kind can require a long amount of time to diagnose. Thanks to ADDM, this problem was immediately detected! ADDM automatically identified that certain SQL statements were consuming disproportionate amount of system resources. Drilling down into this finding revealed the precise SQL statements that were consuming high amount of database time along with possible benefit. As advised by ADDM, they ran the SQL Tuning Advisor and it recommended that performance could be improved by creating a new index. Since the query was business critical and reported as high load SQL by ADDM, they implemented the index and query performance improved substantially.

Based on the success and the overall performance improvement gained on the Centauri system, Qualcomm plans to deploy Oracle Database 10g enterprise-wide in the next few years.

Bug DB

Bug DB is an internal system within Oracle used for creating and tracking software defects. It is accessed by support analysts, developers and QA engineers across the world. Bug DB is a business critical system - if the system is slow or unavailable, Oracle's ability to support customers is seriously impacted. The Bug DB supports 33000 database users on a HP–UX 64-bit, 2 Node, RAC cluster. Each node has 8 CPUs and the size of the database is 98GB.

The Oracle Database 10g self-management infrastructure has been used in numerous cases with Bug DB. In one case, ADDM highlighted a high load SQL statement was consuming large amount of system resources. Incidentally, this problem was being detected on a regular interval (4 hour cycle) indicating that the problem SQL statement may have been coming from some automated job. Using Enterprise Manager, Oracle DBAs monitored the users that were executing this SQL. It was then determined that the SQL was coming from a generic account and there were 5 copies of the program running concurrently accounting for 27% of the total database workload. After performing detailed investigation, DBA figured out that these jobs were not supposed to be run at that time and appropriate action was taken to disable them.

Thanks to several others ADDM recommendations like the one mentioned above, the Bug Database today is running much more efficiently with significantly lower CPU usage. A machine, that had been CPU bound for the last 18 months, now runs consistently at around 70% utilization despite supporting an increased workload.

CONCLUSION

Oracle Database 10g introduces industry's first truly self-managing database featuring an intelligent self-management framework. Oracle Database 10g's self-management infrastructure takes the database management automation to an unprecedented level by automating complex tasks such as performance diagnostic and tuning. Our tests with the customer workloads revealed that even in the worst-case scenario, the overall performance overhead associated with the self-management infrastructure is negligible. As most real-world systems usually provide some scope of performance tuning, Oracle Database 10g's self-management features will actually improve overall performance by identifying and fixing the issues previously unknown. Also, Oracle Database 10g's ability to intelligently adapt to the workload variations significantly reduces the need of manual adjustments and ensures most efficient utilization of available resources.

APPENDIX: ORACLE DIAGNOSTIC AND TUNING PACKS

The sections below describe the Oracle Diagnostic and Tuning packs. These packs can be purchased only with Enterprise Edition. The features in these packs are accessible through Oracle Enterprise Manager Database Control, Oracle Enterprise Manager Grid Control, and APIs provided with Oracle Database software.

Oracle Diagnostic Pack

The Oracle Diagnostic Pack provides automatic performance diagnostic and advanced system monitoring functionality. The Diagnostic Pack includes the following features:

- Automatic Workload Repository
- Automatic Database Diagnostic Monitor (ADDM)
- Performance monitoring (database and host)
- Event notifications: notification methods, rules, and schedules
- Event history and metric history (database and host)
- Blackouts
- Dynamic metric baselines
- Monitoring templates

In order to use the features listed above, you must purchase licenses for the Diagnostic Pack. The Diagnostics Pack functionality can be accessed by Enterprise Manager links as well as through the database server command-line APIs. The use of either interface requires a Diagnostic Pack license.

Enterprise Manager

To determine which links in Enterprise Manager Grid Control and Database Control are part of the Diagnostics Packs, click the Setup link on the top right-hand part of the Enterprise Manager Home page.

- When you click the Setup link, the navigation bar contains the Management Pack Access link. Click this link.
- This will take you to the Management Pack Access page, which allows you to grant and remove access from all the management packs.
    - For Enterprise Manager Database Control, click the Remove Access radio button for the Diagnostic Pack and click Apply.
    - For Enterprise Manager Grid Control, click the appropriate check box for the Diagnostic Pack and click Apply.

This will disable all the links and tabs associated with the Diagnostics Pack in Enterprise Manager. All the disabled links and tabs are part of the Diagnostics Pack and therefore require pack license.

Command-Line APIs

Diagnostics Pack features can also be accessed by way of database server APIs and command-line interfaces:

- The `DBMS_WORKLOAD_REPOSITORY` package is part of this pack.
- The `DBMS_ADVISOR` package is part of this pack if you specify `ADDM` as the value of the advisor_name parameter, or if you specify for the value of the task_name parameter any value starting with the `ADDM` prefix.
- The `V$ACTIVE_SESSION_HISTORY` dynamic performance view is part of this pack.
- All data dictionary views beginning with the prefix `DBA_HIST_` are part of this pack, along with their underlying tables.
- All data dictionary views with the prefix `DBA_ADVISOR_` are part of this pack if queries to these views return rows with the value `ADDM` in the `ADVISOR_NAME` column or a value of `ADDM*` in the `TASK_NAME` column or the corresponding `TASK_ID`.
- The following reports found in the /rdbms/admin/ directory of the Oracle home directory are part of this pack: awrrpt.sql, awrrpti.sql, addmrtp.sql, addmrpti.sql, awrrpt.sql, awrrpti.sql, addmrpt.sql, addmrpti.sql, ashrpt.sql, ashrpti.sql, awrddrpt.sql, awrddrpi.sql, awrsqrpi.sql, awrsqrpt.sql.

Oracle Diagnostics Pack Enterprise Manager Repository Views

- Monitoring Views
  - MGMT$BLACKOUT_HISTORY
  - MGMT$BLACKOUTS
  - MGMT$ALERT_ANNOTATIONS
  - MGMT$ALERT_NOTIF_LOG
  - MGMT$TARGET_METRIC_COLLECTIONS
  - MGMT$METRIC_COLLECTIONS
  - MGMT$TARGET_METRIC_SETTINGS
  - MGMT$AVAILABILITY_CURRENT
  - MGMT$AVAILABILITY_HISTORY

    - MGMT$ALERT_CURRENT
    - MGMT$ALERT_HISTORY
    - MGMT$METRIC_DETAILS
    - MGMT$METRIC_CURRENT
    - MGMT$METRIC_HOURLY
    - MGMT$METRIC_DAILY
- Template Views
    - MGMT$METRIC_DAILY
    - MGMT$TEMPLATES
    - MGMT$TEMPLATE_POLICY_SETTINGS
    - MGMT$TEMPLATE_METRIC_COLLECTION
    - MGMT$TEMPLATE_METRIC_SETTINGS

Oracle Tuning Pack

The Oracle Tuning Pack provides database administrators with expert performance management for the Oracle environment, including SQL tuning and storage optimizations. The Oracle Diagnostic Pack is a prerequisite product to the Oracle Tuning Pack. Therefore, to use the Tuning Pack, you must also have a Diagnostic Pack. The Tuning Pack includes the following features:

- SQL Access Advisor
- SQL Tuning Advisor
- SQL Tuning Sets
- Reorganize objects

In order to use the features listed above, you must purchase licenses for the Tuning Pack. The Tuning Pack functionality can be accessed by the Enterprise Manager links as well as through the database server command-line APIs. The use of either interface requires licensing of the Tuning Pack.

Enterprise Manager

To determine which links in Enterprise Manager Grid Control and Database Control are part of the Diagnostics Packs, click the Setup link on the top right-hand part of the Enterprise Manager Home page.

- When you click the Setup link, the navigation bar contains the Management Pack Access link. Click this link.
- This will take you to the Management Pack Access page, which allows you to grant and remove access from all the management packs.

- For Enterprise Manager Database Control, click the Remove Access radio button for the Tuning Pack and click Apply.
- For Enterprise Manager Grid Control, click the appropriate check box for the Tuning Pack and click Apply.

This will disable all the links and tabs associated with the Tuning Pack in Enterprise Manager. All the disabled links and tabs are part of the Tuning Pack and therefore require pack license.

Command-Line APIs

Tuning Pack features can also be accessed by way of database server APIs. Use of the following PL/SQL packages requires a license for the Oracle Tuning Pack:

- `DBMS_SQLTUNE`
- `DBMS_ADVISOR`, when the value of the advisor_name parameter is either `SQL Tuning Advisor` or `SQL Access Advisor`.

The following report found in the /rdbms/admin/ directory of the Oracle home directory is part of this pack: sqltrpt.sql.

White Paper Title: Oracle Database 10g: Intelligent Self-Management Infrastructure
February 2005
Author: Prabhaker Gongloor
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