Oracle® Database

2 Day + Performance Tuning Guide

11*g* Release 1 (11.1)

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Oracle Database 2 Day + Performance Tuning Guide, 11*g* Release 1 (11.1)

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Preface

This preface contains the following topics:

Audience

This guide is intended for Oracle database administrators (DBAs) who want to tune and optimize the performance of Oracle Database. Before using this document, you should complete *Oracle Database 2 Day DBA*.

In particular, this guide is targeted toward the following groups of users:

- Oracle DBAs who want to acquire database performance tuning skills
- DBAs who are new to Oracle Database

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Related Documents

For more information about the topics covered in this document, see the following documents:

- *Oracle Database 2 Day DBA*
- *Oracle Database Administrator's Guide*
- *Oracle Database Concepts*
- *Oracle Database Performance Tuning Guide*

Conventions

The following conventions are used in this document:

Convention	Meaning
boldface	Boldface type indicates graphical user interface elements associated with an action, or terms defined in text or the glossary.
italic	Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.
`monospace`	Monospace type indicates commands within a paragraph, URLs, code in examples, text that appears on the screen, or text that you enter.

What's New in Oracle Performance?

This section describes new performance features of Oracle Database 11*g* Release 1 (11.1) and provides pointers to additional information. The features and enhancements described in this section comprise the overall effort to optimize database performance.

For a summary of all new features for Oracle Database 11*g* Release 1 (11.1), see *Oracle Database New Features Guide*.

The new and updated performance features in Oracle Database 11*g* Release 1 (11.1) include:

- Automatic Database Diagnostic Monitor (ADDM) enhancements

  ADDM has been enhanced to perform global analysis on all instances of an Oracle Real Application Clusters (Oracle RAC) cluster.

  For more information, see "ADDM for Oracle Real Application Clusters" on page 3-3.

- Wait activity details

  You can view wait activity details for services, modules, and actions from the Top Activity page.

  For more information, see "Monitoring User Activity" on page 4-2.

- Improved Automatic Workload Repository (AWR) baselines

  You can create a single, fixed-time AWR baseline or a repeating baseline. Additionally, improved manageability of AWR baselines is now available, including the ability to compute threshold statistics.

  For more information, see "Managing Baselines" on page 8-1.

- Improved manageability of SQL Advisor, SQL Access Advisor, and SQL Tuning Sets

  Significant improvements were made to managing SQL Tuning Advisor, SQL Access Advisor, and SQL Tuning Sets.

  For more information, see Chapter 10, "Tuning SQL Statements" and Chapter 11, "Optimizing Data Access Paths".

- SQL Performance Analyzer

  SQL Performance Analyzer enables you to measure the impact of system changes on SQL performance by testing these changes using a SQL workload on a test system.

  For more information, see Chapter 12, "Analyzing SQL Performance Impact".

- Active Session History (ASH) enhancements

  The ASH report has been enhanced to include row-level tracking of top SQL statements, top PL/SQL procedures, top Java workload, top phases of execution, and other session-related information.

  For more information, see Chapter 7, "Resolving Transient Performance Problems".

- Automated Maintenance Tasks

  Key maintenance tasks such as optimizer statistics collection, Automatic SQL Tuning, and Segment Advisor are now managed through the Automatic Maintenance Task framework. This framework enables you to exercise finer control over the scheduling of maintenance tasks and on their CPU consumption.

  For more information, see "Viewing Automatic SQL Tuning Results" on page 10-5.

- Customizable Performance page

  You can customize the Performance page to show only the graphs and charts that you want displayed. You can also choose whether to include AWR baselines in the performance charts.

  For more information, see "Customizing the Database Performance Page" on page 4-27.

- I/O Statistics

  The Performance page now contains charts for Throughput, I/O, Parallel Execution, and Services. You can use the I/O charts to monitor I/O throughput and latency information based on various criteria such as function (for example, Recovery Manager), consumer groups, and file types.

  For more information, see "Monitoring Instance Activity" on page 4-10.

Part I

Getting Started

Part I provides an introduction to this guide and explains the Oracle Database performance method. This part contains the following chapters:

- Chapter 1, "Introduction"
- Chapter 2, "Oracle Database Performance Method"

1 Introduction

As an Oracle database administrator (DBA), you are responsible for the performance of your Oracle database. Tuning a database to reach a desirable performance level may be a daunting task, especially for DBAs who are new to Oracle Database. *Oracle Database 2 Day + Performance Tuning Guide* is a quick start guide that teaches you how to perform day-to-day database performance tuning tasks using features provided by Oracle Diagnostics Pack, Oracle Tuning Pack, and Oracle Enterprise Manager (Enterprise Manager).

This chapter contains the following sections:

About This Guide

Before using this guide, you need to do the following:

- Read *Oracle Database 2 Day DBA* in its entirety.
- Obtain the necessary products and tools described in "Tools for Tuning the Database" on page 1-2.

Oracle Database 2 Day + Performance Tuning Guide is task-oriented. The objective is to describe why and when tuning tasks need to be performed.

This guide is not an exhaustive discussion of all Oracle Database concepts. For this type of information, see *Oracle Database Concepts*.

This guide does not describe basic Oracle Database administrative tasks. For this type of information, see *Oracle Database 2 Day DBA*. For a complete discussion of administrative tasks, see *Oracle Database Administrator's Guide.*

The primary interface used in this guide is the Enterprise Manager Database Control console. This guide is not an exhaustive discussion of all Oracle Database performance tuning features and does not cover available application programming interfaces (APIs) that provide comparable tuning options to those presented in this guide. For this type of information, see *Oracle Database Performance Tuning Guide*.

Common Oracle DBA Tasks

As an Oracle DBA, you can expect to be involved in the following tasks:

- Installing Oracle software

- Creating an Oracle database
- Upgrading the database and software to new releases
- Starting up and shutting down the database
- Managing the storage structures of the database
- Managing user accounts and security
- Managing schema objects, such as tables, indexes, and views
- Making database backups and performing database recovery, when necessary
- Proactively monitoring the condition of the database and taking preventive or corrective actions, as required
- Monitoring and tuning database performance

In a small-to-midsize database environment, you might be the sole person performing these tasks. In large, enterprise environments, the job is often divided among several DBAs—each with his or her own specialty—such as database security or database tuning. *Oracle Database 2 Day + Performance Tuning Guide* describes how to accomplish the last two tasks in this list.

Tools for Tuning the Database

The intent of this guide is to allow you to quickly and efficiently tune and optimize the performance of Oracle Database.

To achieve the goals of this guide, you will need to acquire the following products, tools, features, and utilities:

- **Oracle Database 11*g* Enterprise Edition**

  Oracle Database 11*g* Enterprise Edition offers enterprise-class performance, scalability and reliability on clustered and single-server configurations. It includes many performance features that are used in this guide.

- **Oracle Enterprise Manager**

  The primary tool to manage your database is Enterprise Manager, a Web-based interface. After you install the Oracle software, create or upgrade a database, and configure the network, you can use Oracle Enterprise Manager to manage your database. In addition, Enterprise Manager provides an interface for performance advisors and for database utilities, such as SQL*Loader and Recovery Manager (RMAN).

- **Oracle Diagnostics Pack**

  Oracle Diagnostics Pack offers a complete, cost-effective, and easy-to-use solution to manage the performance of Oracle Database environments by providing unique features, such as automatic identification of performance bottlenecks, guided problem resolution, and comprehensive system monitoring. Key features of Oracle Diagnostics Pack that are used in this guide include Automatic Database Diagnostic Monitor (ADDM) and Automatic Workload Repository (AWR).

- **Oracle Database Tuning Pack**

  Oracle Database Tuning Pack automates the database application tuning process, thereby significantly lowering database management costs while enhancing performance and reliability. Key features of Oracle Database Tuning Pack that are used in this guide include the following:

  - SQL Tuning Advisor

    This feature enables you to submit one or more SQL statements as input and receive output in the form of specific advice or recommendations for how to tune statements, along with a rationale for each recommendation and its expected benefit. A recommendation relates to collection of statistics on objects, creation of new indexes, restructuring of the SQL statements, or creation of SQL Profiles.

  - SQL Access Advisor

    This feature enables you to optimize data access paths of SQL queries by recommending the proper set of materialized views and view logs, indexes, and partitions for a given SQL workload.

- **Oracle Real Application Testing**

  Oracle Real Application Testing consists of two key features: Database Replay and SQL Performance Analyzer. Database Replay enables you to capture the database workload on a production system, and replay it on a test system with the exact same timing and concurrency as the production system on the same or newer release of Oracle Database. SQL Performance Analyzer enables you to assess the effect of system changes on SQL performance by identifying SQL statements that have regressed, improved, or remained unchanged.

Note: Some of the products and tools in the preceding list, including Oracle Diagnostics Pack and Oracle Database Tuning Pack, require separate licenses. For more information, see *Oracle Database Licensing Information*.

2

Oracle Database Performance Method

Performance improvement is an iterative process. Removing the first bottleneck (a point where resource contention is at its highest) might not lead to performance improvement immediately because another bottleneck might be revealed that has an even greater performance impact on the system. For this reason, the Oracle performance method is iterative. Accurately diagnosing the performance problem is the first step toward ensuring that the changes you make to the system will result in improved performance.

Performance problems generally result from a lack of throughput, unacceptable user or job response time, or both. The problem might be localized to specific application modules, or it might span the entire system. Before looking at any database or operating system statistics, it is crucial to get feedback from the most important components of the system: the users of the system and the people ultimately paying for the application. Getting feedback from users makes determining the performance goal easier, and improved performance can be measured in terms of real business goals, rather than system statistics.

The Oracle performance method can be applied until performance goals are met or deemed impractical. Because this process is iterative, it is likely that some investigations will be made that have little impact on the performance of the system. It takes time and experience to accurately pinpoint critical bottlenecks in a timely manner. Automatic Database Diagnostic Monitor (ADDM) implements the Oracle performance method and analyzes statistics to provide automatic diagnosis of major performance problems. Using ADDM can significantly shorten the time required to improve the performance of a system, and it is the method used in this guide.

This chapter discusses the Oracle Database performance method and contains the following sections:

Gathering Database Statistics Using the Automatic Workload Repository

Database statistics provide information about the type of load on the database and the internal and external resources used by the database. To accurately diagnose performance problems with the database using ADDM, statistics must be available.

Oracle Database generates many types of cumulative statistics for the system, sessions, and individual SQL statements. Oracle Database also tracks cumulative statistics about segments and services. Automatic Workload Repository (AWR) automates database

statistics gathering by collecting, processing, and maintaining performance statistics for database problem detection and self-tuning purposes.

By default, the statistics gathering process repeats every hour and results in an AWR snapshot, which is a set of data for a specific time that is used for performance comparisons. The delta values captured by the snapshot represent the changes for each statistic over the time period. Statistics gathered by AWR are queried from memory. The gathered data can be displayed in both reports and views.

Gathering database statistics using AWR is enabled by default and is controlled by the `STATISTICS_LEVEL` initialization parameter. The `STATISTICS_LEVEL` parameter should be set to `TYPICAL` or `ALL` to enable statistics gathering by AWR. The default setting is `TYPICAL`. Setting the `STATISTICS_LEVEL` parameter to `BASIC` disables many Oracle Database features, including AWR, and is not recommended. For information about the `STATISTICS_LEVEL` initialization parameter, see *Oracle Database Reference*.

The `CONTROL_MANAGEMENT_PACK_ACCESS` initialization parameter should be set to `DIAGNOSTIC+TUNING` (default) or `DIAGNOSTIC` to enable automatic database diagnostic monitoring. Setting `CONTROL_MANAGEMENT_PACK_ACCESS` to `NONE` disables many Oracle Database features, including ADDM, and is strongly discouraged. For information about the `CONTROL_MANAGEMENT_PACK_ACCESS` initialization parameter, see *Oracle Database Reference*.

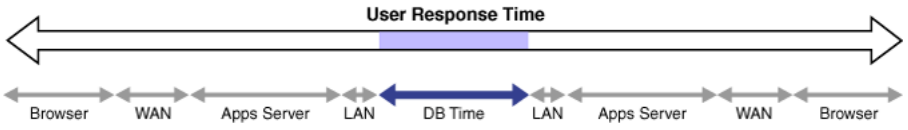
The database statistics collected and processed by AWR include:

- Time Model Statistics
- Wait Event Statistics
- Session and System Statistics
- Active Session History Statistics
- High-Load SQL Statistics

Time Model Statistics

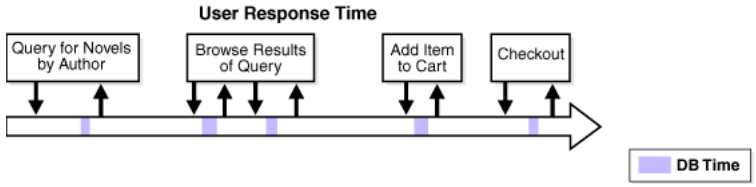
Time model statistics measure the time spent in the database by operation type. The most important time model statistic is database time, or DB time. Database time represents the total time spent in database calls, and is an indicator of the total instance workload. As shown in Figure 2–1, database time makes up a portion of an application's overall user response time.

Figure 2–1 DB Time in Overall User Response Time



A session is a specific connection of a user to an Oracle Database instance through a user process. Database time is calculated by aggregating the CPU time and wait time of all user sessions not waiting for idle wait events (user sessions that are not idle). For example, a user session may involve an online transaction made at a bookseller's Web site consisting of the actions shown in Figure 2–2.

Figure 2–2 DB Time in User Transaction



1. Query for novels by author

   The user performs a search for novels by a particular author. This action causes the application to perform a database query for novels by the author.

2. Browse results of query

   The user browses the returned list of novels by the author and accesses additional details, such as user reviews and inventory status. This action causes the application to perform additional database queries.

3. Add item to cart

   After browsing details about the novels, the user decides to add one of the novels to the shopping cart. This action causes the application to make a database call to update the shopping cart.

4. Checkout

   The user completes the transaction by checking out, using the address and payment information previously saved at the bookseller's Web site from a previous purchase. This action causes the application to perform various database operations to retrieve the user's information, add a new order, update the inventory, and generate an E-mail confirmation.

For each of the preceding actions, the user makes a request to the database, as represented by the down arrow in Figure 2–2 on page 2-3. The CPU time spent by the database processing the request and the wait time spent waiting for the database are considered DB time, as represented by the shaded areas. After the request is completed, the results are returned to the user, as represented by the up arrow. The space between the up and down arrows represents the total user response time for processing the request, which contains other components besides DB time, as illustrated in Figure 2–1 on page 2-2.

The objective of database tuning is to reduce the time that users spend performing actions on the database, or reducing database time. In this way, you can improve the overall response time of user transactions on the application.

Wait Event Statistics

Wait events are incremented by a session to indicate that the session had to wait for an event to complete before being able to continue processing. When a session has to wait while processing a user request, the database records the wait by using one of a set of predefined wait events. The events are then grouped into wait classes, such as User I/O and Network. Wait event data reveals symptoms of problems that might be affecting performance, such as latch, buffer, and I/O contention.

See Also:

- *Oracle Database Performance Tuning Guide*
- *Oracle Database Reference*

Session and System Statistics

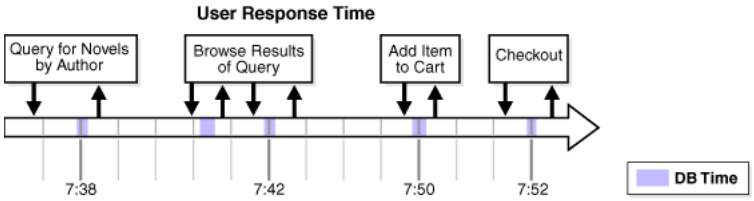
A large number of cumulative database statistics are available on a system and session level. Some of these statistics are collected by AWR.

Active Session History Statistics

The Active Session History (ASH) statistics are samples of session activity in the database. The database samples active sessions every second and stores them in a circular buffer in the System Global Area (SGA). Any session that is connected to the database and using CPU, or is waiting for an event that does not belong to the idle wait class, is considered an active session. By capturing only active sessions, a manageable set of data is represented. The size of the data is directly related to the work being performed, rather than the number of sessions allowed on the system.

Using the DB time example described in "Time Model Statistics" on page 2-2, samples of session activity are collected from the online transaction made at the bookseller's Web site, represented as vertical lines below the horizontal arrow in Figure 2–3.

Figure 2–3 Active Session History



The light vertical lines represent samples of inactive session activity that are not captured in the ASH statistics. The bold vertical lines represent samples of active sessions that are captured at:

- 7:38, while novels by the author are being queried
- 7:42, while the user is browsing the query results
- 7:50, when one of the novels is added to the shopping cart
- 7:52, during the checkout process

Table 2–1 lists the ASH statistics that are collected for the active sessions, along with examples of the session ID (SID), module, SQL ID, session state, and wait events that are sampled.

Table 2–1 Active Session History

Time	SID	Module	SQL ID	State	Event
7:38	213	Book by author	qa324jffritcf	Waiting	db file sequential read
7:42	213	Get review ID	aferv5desfzs5	CPU	
7:50	213	Add item to cart	hk32pekfcbdfr	Waiting	buffer busy wait
7:52	213	Checkout	abngldf95f4de	Waiting	log file sync

High-Load SQL Statistics

SQL statements that are consuming the most resources produce the highest load on the system, based on criteria such as elapsed time and CPU time.

Using the Oracle Performance Method

Performance tuning using the Oracle performance method is driven by identifying and eliminating bottlenecks in the database, and by developing efficient SQL statements. Database tuning is performed in two phases: proactively and reactively.

In the proactive tuning phase, you must perform tuning tasks as part of your daily database maintenance routine, such as reviewing ADDM analysis and findings, monitoring the real-time performance of the database, and responding to alerts.

In the reactive tuning phase, you must respond to issues reported by the users, such as performance problems that may occur for only a short duration of time, or performance degradation to the database over a period of time.

SQL tuning is an iterative process to identify, tune, and improve the efficiency of high-load SQL statements.

Applying the Oracle performance method involves the following:

- Performing pre-tuning preparations, as described in "Preparing the Database for Tuning" on page 2-5
- Tuning the database proactively on a regular basis, as described in "Tuning the Database Proactively" on page 2-6
- Tuning the database reactively when performance problems are reported by the users, as described in "Tuning the Database Reactively" on page 2-6
- Identifying, tuning, and optimizing high-load SQL statements, as described in "Tuning SQL Statements" on page 2-7

To improve the performance of your database, you will need to apply these principles iteratively.

Preparing the Database for Tuning

This section lists and describes the steps that must be performed before the database can be properly tuned.

To prepare the database for tuning:

1. Get feedback from users.

   Determine the scope of the performance project and subsequent performance goals, and determine performance goals for the future. This process is key for future capacity planning.

2. Check the operating systems of all systems involved with user performance.

   Check for hardware or operating system resources that are fully utilized. List any overused resources as possible concerns for later analysis. In addition, ensure that all hardware is functioning properly.

3. Ensure that the `STATISTICS_LEVEL` initialization parameter is set to `TYPICAL` (default) or `ALL` to enable the automatic performance tuning features of Oracle Database, including AWR and ADDM.

4. Ensure that the `CONTROL_MANAGEMENT_PACK_ACCESS` initialization parameter is set to `DIAGNOSTIC+TUNING` (default) or `DIAGNOSTIC` to enable ADDM.

See Also:

- "Gathering Database Statistics Using the Automatic Workload Repository" on page 2-1 for information about configuring AWR
- "Configuring Automatic Database Diagnostic Monitor" on page 3-3

Tuning the Database Proactively

This section lists and describes the steps required to keep the database properly tuned on a regular basis. These tuning procedures are considered proactive and should be performed as part of your daily maintenance of Oracle Database.

To tune the database proactively:

1. Review the ADDM findings, as described in Chapter 3, "Automatic Database Performance Monitoring".

   ADDM automatically detects and reports on performance problems with the database, including most of the "Common Performance Problems Found in Oracle Databases" on page 2-8. The results are displayed as ADDM findings on the Database Home page in Oracle Enterprise Manager (Enterprise Manager). Reviewing these findings enables you to quickly identify the performance problems that require your attention.

2. Implement the ADDM recommendations, as described in Chapter 3, "Automatic Database Performance Monitoring".

   ADDM automatically provides a list of recommendations for reducing the impact of the performance problem with each ADDM finding. Implementing a recommendation applies the suggested changes to improve the database performance.

3. Monitor performance problems with the database in real time, as described in Chapter 4, "Monitoring Real-Time Database Performance".

   The Performance page in Enterprise Manager enables you to identify and respond to real-time performance problems. By drilling down to the appropriate pages, you can identify and resolve performance problems with the database in real time, without having to wait until the next ADDM analysis.

4. Respond to performance-related alerts, as described in Chapter 5, "Monitoring Performance Alerts".

   The Database Home page in Enterprise Manager enables you to view performance-related alerts generated by the system. Typically, these alerts reveal performance problems whose resolutions will improve the performance of your database.

5. Validate that the changes made have produced the desired effect, and verify that the users perceive performance improvements.

6. Repeat these steps until your performance goals are met or become impossible to achieve because of other constraints.

Tuning the Database Reactively

This section lists and describes the steps required to tune the database based on user feedback. This tuning procedure is considered reactive. Perform this procedure periodically when performance problems are reported by the users.

To tune the database reactively:

1. Run ADDM manually to diagnose current and historical database performance when performance problems are reported by the users, as described in Chapter 6, "Manual Database Performance Monitoring".

   This task is useful if you want to analyze current database performance before the next ADDM analysis, or to analyze historical database performance when you were not proactively monitoring the system.

2. Resolve transient performance problems, as described in Chapter 7, "Resolving Transient Performance Problems".

   The Active Session History (ASH) reports enable you to analyze transient performance problems with the database that are short-lived and do not appear in the ADDM analysis.

3. Resolve performance degradation over time, as described in Chapter 8, "Resolving Performance Degradation Over Time".

   The Automatic Workload Repository (AWR) Compare Periods report enables you to compare database performance between two periods of time, and resolve performance degradation that may happen from one time period to another.

4. Validate that the changes made have produced the desired effect, and verify that the users perceive performance improvements.

5. Repeat these steps until your performance goals are met or become impossible to achieve due to other constraints.

Tuning SQL Statements

This section lists and describes the steps required to identify, tune, and optimize high-load SQL statements.

To tune SQL statements:

1. Identify high-load SQL statements, as described in Chapter 9, "Identifying High-Load SQL Statements".

   Use the ADDM findings and the Top SQL section to identify high-load SQL statements that are causing the greatest contention.

2. Tune high-load SQL statements, as described in Chapter 10, "Tuning SQL Statements".

   You can improve the efficiency of high-load SQL statements by tuning them using SQL Tuning Advisor.

3. Optimize data access paths, as described in Chapter 11, "Optimizing Data Access Paths".

   You can optimize the performance of data access paths by creating the proper set of materialized views, materialized view logs, and indexes for a given workload by using SQL Access Advisor.

4. Analyze the SQL performance impact of SQL tuning and other system changes, as described in Chapter 12, "Analyzing SQL Performance Impact".

   You can analyze the performance impact of your SQL tuning activities or other system changes on a given SQL workload by using SQL Performance Analyzer.

5. Repeat these steps until all high-load SQL statements are tuned for greatest efficiency.

Common Performance Problems Found in Oracle Databases

This section lists and describes common performance problems found in Oracle databases. By following the Oracle performance method, you should be able to avoid these problems. If you have these problems, then repeat the steps in the Oracle performance method, as described in "Using the Oracle Performance Method" on page 2-5, or consult the appropriate section that addresses these problems:

- CPU bottlenecks

  Is the application performing poorly because the system is CPU-bound? Performance problems caused by CPU bottlenecks are diagnosed by ADDM, as described in Chapter 3, "Automatic Database Performance Monitoring". You can also identify CPU bottlenecks by using the Performance page in Enterprise Manager, as described in "Monitoring CPU Utilization" on page 4-19.

- Undersized memory structures

  Are the Oracle memory structures—such as the System Global Area (SGA), Program Global Area (PGA), and buffer cache—adequately sized? Performance problems caused by undersized memory structures are diagnosed by ADDM, as described in Chapter 3, "Automatic Database Performance Monitoring". You can also identify memory usage issues by using the Performance page in Enterprise Manager, as described in "Monitoring Memory Utilization" on page 4-22.

- I/O capacity issues

  Is the I/O subsystem performing as expected? Performance problems caused by I/O capacity issues are diagnosed by ADDM, as described in Chapter 3, "Automatic Database Performance Monitoring". You can also identify disk I/O issues by using the Performance page in Oracle Enterprise Manager, as described in "Monitoring Disk I/O Utilization" on page 4-25.

- Suboptimal use of Oracle Database by the application

  Is the application making suboptimal use of Oracle Database? Problems such as establishing new database connections repeatedly, excessive SQL parsing, and high levels of contention for a small amount of data (also known as application-level block contention) can degrade the application performance significantly. Performance problems caused by suboptimal use of Oracle Database by the application are diagnosed by ADDM, as described in Chapter 3, "Automatic Database Performance Monitoring". You can also monitor top activity in various dimensions—including SQL, session, services, modules, and actions—by using the Performance page in Enterprise Manager, as described in "Monitoring User Activity" on page 4-2.

- Concurrency issues

  Is the database performing suboptimally due to a high degree of concurrent activities in the database? A high degree of concurrent activities might result in contention for shared resources that can manifest in the forms of locks or waits for buffer cache. Performance problems caused by concurrency issues are diagnosed by ADDM, as described in Chapter 3, "Automatic Database Performance Monitoring". You can also identify concurrency issues by using Top Sessions in Enterprise Manager, as described in "Monitoring Top Sessions" on page 4-5.

- Database configuration issues

  Is the database configured optimally to provide desired performance levels? For example, is there evidence of incorrect sizing of log files, archiving issues, excessive number of checkpoints, or suboptimal parameter settings? Performance

problems caused by database configuration issues are diagnosed by ADDM, as described in Chapter 3, "Automatic Database Performance Monitoring".

- Short-lived performance problems

  Are users complaining about short-lived or intermittent performance problems? Depending on the interval between snapshots taken by AWR, performance problems that have a short duration may not be captured by ADDM. You can identify short-lived performance problems by using the Active Session History report, as described in Chapter 7, "Resolving Transient Performance Problems".

- Degradation of database performance over time

  Is there evidence that the database performance has degraded over time? For example, are you or your users noticing that the database is not performing as well as it was 6 months ago? You can generate an AWR Compare Periods report to compare the period when the performance was poor to a period when the performance is stable to identify configuration settings, workload profile, and statistics that are different between these two time periods. This technique will help you identify the cause of the performance degradation, as described in Chapter 8, "Resolving Performance Degradation Over Time".

- Inefficient or high-load SQL statements

  Are any SQL statements using excessive system resources that impact the system? Performance problems caused by high-load SQL statements are diagnosed by ADDM, as described in Chapter 3, "Automatic Database Performance Monitoring" and "Identification of High-Load SQL Statements Using ADDM Findings" on page 9-1. You can also identify high-load SQL statements by using Top SQL in Enterprise Manager, as described in "Identifying High-Load SQL Statements Using Top SQL" on page 9-2. After they have been identified, you can tune the high-load SQL statements using SQL Tuning Advisor, as described in Chapter 10, "Tuning SQL Statements".

- Object contention

  Are any database objects the source of bottlenecks because they are continuously accessed? Performance problems caused by object contention are diagnosed by ADDM, as described in Chapter 3, "Automatic Database Performance Monitoring". You can also optimize the data access path to these objects using SQL Access Advisor, as described in Chapter 11, "Optimizing Data Access Paths" on page 4-25.

- Unexpected performance regression after tuning SQL statements

  Is the performance of SQL statements degrading after they have been tuned? Tuning SQL statements may cause changes to execution plans of SQL statements, resulting in a significant impact on SQL performance. In some cases, the changes may result in the improvement of SQL performance. In other cases, the changes may cause SQL statements to regress, resulting in a degradation of SQL performance. Before making changes on a production system, you can analyze the performance impact from tuning SQL statements on a test system by using SQL Performance Analyzer, as described in Chapter 12, "Analyzing SQL Performance Impact".

Part II

Proactive Database Tuning

Part II describes how to tune Oracle Database proactively on a regular basis and contains the following chapters:

3

Automatic Database Performance Monitoring

Automatic Database Diagnostic Monitor (ADDM) automatically detects and reports performance problems with the database. The results are displayed as ADDM findings on the Database Home page in Oracle Enterprise Manager (Enterprise Manager). Reviewing the ADDM findings enables you to quickly identify the performance problems that require your attention.

Each ADDM finding provides a list of recommendations for reducing the impact of the performance problem. Reviewing ADDM findings and implementing the recommendations are tasks that you should perform daily as part of the regular database maintenance. Even when the database is operating at an optimal performance level, you should continue to use ADDM to monitor database performance on an ongoing basis.

This chapter contains the following sections:

See Also:

- *Oracle Database Performance Tuning Guide* for information about using the `DBMS_ADVISOR` package to diagnose and tune the database with the Automatic Database Diagnostic Monitor

Overview of Automatic Database Diagnostic Monitor

ADDM is self-diagnostic software built into Oracle Database. ADDM examines and analyzes data captured in the Automatic Workload Repository (AWR) to determine possible performance problems in Oracle Database. ADDM then locates the root causes of the performance problems, provides recommendations for correcting them, and quantifies the expected benefits. ADDM also identifies areas where no action is necessary.

This section contains the following topics:

- ADDM for Oracle Real Application Clusters

ADDM Analysis

An ADDM analysis is performed after each AWR snapshot (every hour by default), and the results are saved in the database. You can then view the results by means of Oracle Enterprise Manager. Before using another performance tuning method described in this guide, first review the results of the ADDM analysis.

The ADDM analysis is performed from the top down, first identifying symptoms and then refining the analysis to reach the root causes of performance problems. ADDM uses the DB time statistic to identify performance problems. DB time is the cumulative time spent by the database in processing user requests, including both the wait time and CPU time of all user sessions that are not idle.

The goal of database performance tuning is to reduce the DB time of the system for a given workload. By reducing DB time, the database is able to support more user requests by using the same or a smaller amount of resources. ADDM reports system resources that are using a significant portion of DB time as problem areas and sorts them in descending order by the amount of related DB time spent. For more information about the DB time statistic, see "Time Model Statistics" on page 2-2.

ADDM Recommendations

In addition to diagnosing performance problems, ADDM recommends possible solutions. When appropriate, ADDM recommends multiple solutions from which you can choose. ADDM recommendations include the following:

- Hardware changes

  Adding CPUs or changing the I/O subsystem configuration

- Database configuration

  Changing initialization parameter settings

- Schema changes

  Hash partitioning a table or index, or using automatic segment space management (ASSM)

- Application changes

  Using the cache option for sequences or using bind variables

- Using other advisors

  Running SQL Tuning Advisor on high-load SQL statements or running the Segment Advisor on hot objects

ADDM benefits apply beyond production systems. Even on development and test systems, ADDM can provide an early warning of potential performance problems.

Performance tuning is an iterative process. Fixing one problem can cause a bottleneck to shift to another part of the system. Even with the benefit of the ADDM analysis, it can take multiple tuning cycles to reach a desirable level of performance.

See Also:

- *Oracle Database 2 Day DBA* for information the Segment Advisor

ADDM for Oracle Real Application Clusters

In an Oracle Real Application Clusters (Oracle RAC) environment, you can use ADDM to analyze the throughput performance of a database cluster. ADDM for Oracle RAC considers DB time as the sum of database times for all database instances and reports findings that are significant at the cluster level. For example, the I/O levels of each cluster node may be insignificant when considered locally, but the aggregate I/O level may be a significant problem for the cluster as a whole.

See Also:

- *Oracle Database 2 Day + Real Application Clusters Guide* for information about using ADDM for Oracle RAC

Configuring Automatic Database Diagnostic Monitor

This section describes how to configure ADDM and contains the following topics:

Setting Initialization Parameters to Enable ADDM

Automatic database diagnostic monitoring is enabled by default and is controlled by the `CONTROL_MANAGEMENT_PACK_ACCESS` and the `STATISTICS_LEVEL` initialization parameters.

The `CONTROL_MANAGEMENT_PACK_ACCESS` initialization parameter should be set to `DIAGNOSTIC+TUNING` (default) or `DIAGNOSTIC` to enable automatic database diagnostic monitoring. Setting `CONTROL_MANAGEMENT_PACK_ACCESS` to `NONE` disables many Oracle Database features, including ADDM, and is strongly discouraged.

The `STATISTICS_LEVEL` initialization parameter should be set to the `TYPICAL` (default) or `ALL` to enable automatic database diagnostic monitoring. Setting `STATISTICS_LEVEL` to `BASIC` disables many Oracle Database features, including ADDM, and is strongly discouraged.

To determine whether ADDM is enabled:

1. From the Database Home page, click **Server**.

   The Server subpage appears.

2. In the Database Configuration section, click **Initialization Parameters**.

   The Initialization Parameters page appears.

3. In the **Name** field, enter `statistics_level` and then click **Go**.

   The table shows the setting of this initialization parameter.

4. Do one of the following:

   - If the Value column shows **ALL** or **TYPICAL**, then do nothing.
   - If the Value column shows **BASIC**, then select **ALL** or **TYPICAL** and click **Apply**.

5. In the **Name** field, enter `control_management_pack_access` and then click **Go**.

The table shows the setting of this initialization parameter.

6. Do one of the following:
   - If the Value column shows **DIAGNOSTIC** or **DIAGNOSTIC+TUNING**, then do nothing.
   - If the Value column shows **NONE**, then select **DIAGNOSTIC** or **DIAGNOSTIC+TUNING** and click **Apply**.

See Also:

- *Oracle Database Reference* for information about the `STATISTICS_LEVEL` initialization parameter
- *Oracle Database Reference* for information about the `CONTROL_MANAGEMENT_PACK_ACCESS` initialization parameter

Setting the DBIO_EXPECTED Parameter

ADDM analysis of I/O performance partially depends on a single argument, `DBIO_EXPECTED`, that describes the expected performance of the I/O subsystem. The value of `DBIO_EXPECTED` is the average time it takes to read a single database block, in microseconds. Oracle Database uses the default value of 10 milliseconds, which is an appropriate value for most hard drives. If your hardware is significantly different, then consider using a different value.

To determine the correct setting for the `DBIO_EXPECTED` initialization parameter:

1. Measure the average read time of a single database block for your hardware.

   This measurement needs to be taken for random I/O, which includes seek time if you use standard hard drives. Typical values for hard drives are between 5000 and 20000 microseconds.

2. Set the value one time for all subsequent ADDM executions.

   For example, if the measured value is 8000 microseconds, then execute the following PL/SQL code as the `SYS` user:

```
EXECUTE DBMS_ADVISOR.SET_DEFAULT_TASK_PARAMETER(
                     'ADDM', 'DBIO_EXPECTED', 8000);
```

Managing AWR Snapshots

By default, the Automatic Workload Repository (AWR) generates snapshots of performance data once every hour, and retains the statistics in the workload repository for 8 days. You can change the default values for both the snapshot interval and the retention period.

Oracle recommends that you adjust the AWR retention period to at least a month. You can also extend the period to one business cycle so you can compare data across time frames such as the close of the fiscal quarter. You can also create AWR baselines to retain snapshots indefinitely for important time periods.

The data in the snapshot interval is analyzed by ADDM. ADDM compares the difference between snapshots to determine which SQL statements to capture, based on the effect on the system load. The ADDM analysis shows the number of SQL statements that need to be captured over time.

This section contains the following topics:

- Creating Snapshots

Creating Snapshots

Manually creating snapshots is usually not necessary because AWR generates snapshots of the performance data once every hour by default. In some cases, however, it may be necessary to manually create snapshots to capture different durations of activity, such as when you want to compare performance data over a shorter period of time than the snapshot interval.

To create snapshots:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

2. Under Additional Monitoring Links, click **Snapshots**.

   The Snapshots page appears with a list of the most recent snapshots.

3. Click **Create**.

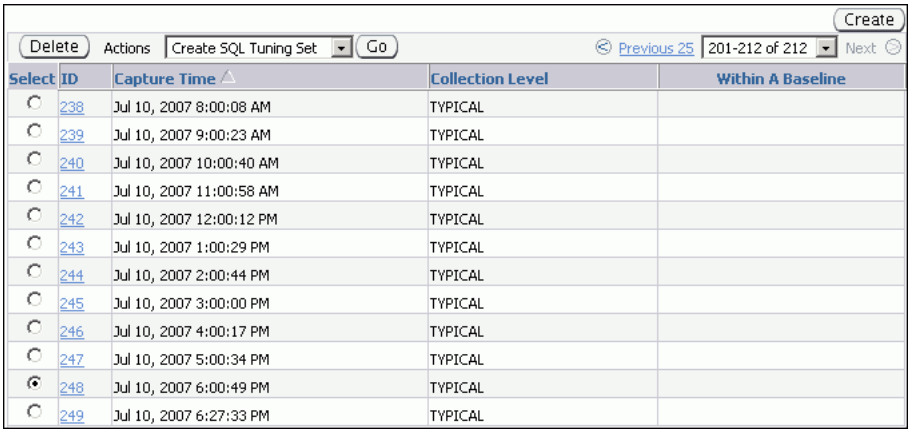
   The Confirmation page appears.

4. Click **Yes**.

   The Processing: Create Snapshot page is displayed while the snapshot is being taken.

   After the snapshot is taken, the Snapshots page reappears with a Confirmation message.

   In this example, the ID of the snapshot that was created is 249.



Select	ID	Capture Time	Collection Level	Within A Baseline
○	238	Jul 10, 2007 8:00:08 AM	TYPICAL	
○	239	Jul 10, 2007 9:00:23 AM	TYPICAL	
○	240	Jul 10, 2007 10:00:40 AM	TYPICAL	
○	241	Jul 10, 2007 11:00:58 AM	TYPICAL	
○	242	Jul 10, 2007 12:00:12 PM	TYPICAL	
○	243	Jul 10, 2007 1:00:29 PM	TYPICAL	
○	244	Jul 10, 2007 2:00:44 PM	TYPICAL	
○	245	Jul 10, 2007 3:00:00 PM	TYPICAL	
○	246	Jul 10, 2007 4:00:17 PM	TYPICAL	
○	247	Jul 10, 2007 5:00:34 PM	TYPICAL	
◉	248	Jul 10, 2007 6:00:49 PM	TYPICAL	
○	249	Jul 10, 2007 6:27:33 PM	TYPICAL	

Modifying Snapshot Settings

By default, AWR generates snapshots of performance data once every hour. Alternatively, you can modify the default values of both the interval between snapshots and their retention period.

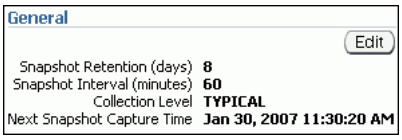
To modify the snapshot settings:

1. From the Database Home page, click **Server**.

   The Server subpage appears.

2. In the Statistics Management section, click **Automatic Workload Repository**.

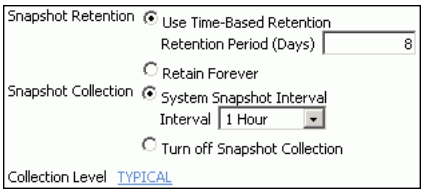
   The Automatic Workload Repository page appears.



In this example, snapshot retention is set to 8 days and snapshot interval is set to 60 minutes.

3. Click **Edit**.

   The Edit Settings page appears.

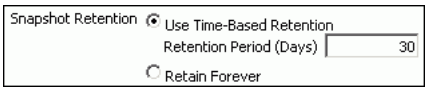


4. For **Snapshot Retention**, do one of the following:

   - Select **Use Time-Based Retention Period (Days)**, and in the associated field enter the number of days to retain the snapshots.
   - Select **Retain Forever** to retain snapshots indefinitely.

   It is recommended that you increase the snapshot retention period whenever possible based on the available disk space.

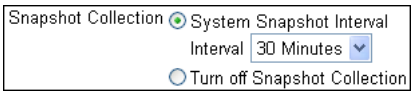
   In this example, the snapshot retention period is changed to 30 days.



5. For **Snapshot Collection**, do one of the following:

   - Select **System Snapshot Interval** and, in the Interval list, select the desired interval to change the interval between snapshots.
   - Select **Turn off Snapshot Collection** to disable snapshot collection.

   In this example, the snapshot collection interval is changed to 30 minutes.

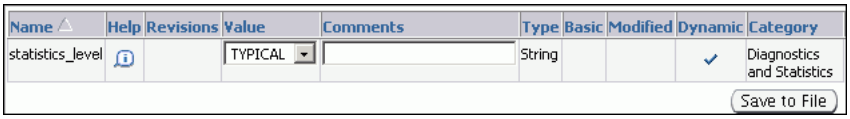


6. Click the link next to **Collection Level**.

   The Initialization Parameter page appears.

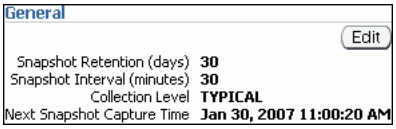
   To change the statistics level, select the desired value in the Value list for the `statistics_level` parameter. Click **Save to File** to set the value in the server parameter file.

   In this example, the default value of Typical is used.



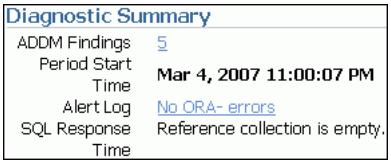
7. Click **OK** to apply the changes.

   The Automatic Workload Repository page appears and displays the new settings.



Reviewing the Automatic Database Diagnostic Monitor Analysis

By default, ADDM runs every hour to analyze snapshots taken by AWR during that period. If the database finds performance problems, then it displays the results of the analysis under Diagnostic Summary on the Database Home page.

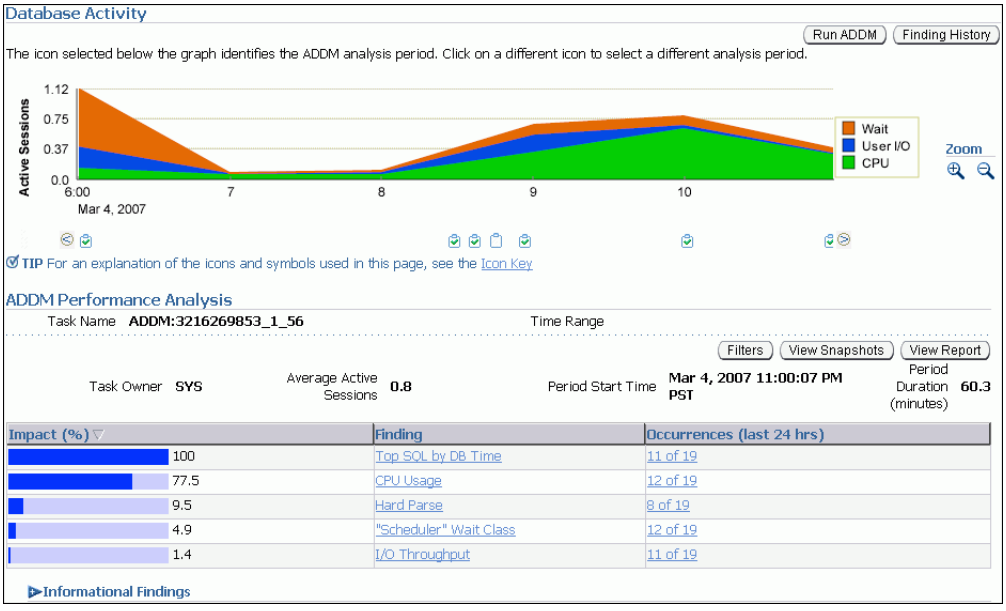


The ADDM Findings link shows how many ADDM findings were found in the most recent ADDM analysis.

To view ADDM findings:

1. On the Database Home page, under Diagnostic Summary, click the link next to **ADDM Findings**.

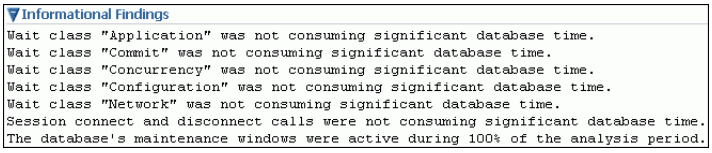
   The Automatic Database Diagnostic Monitor (ADDM) page appears. The results of the ADDM run are displayed.



   On the Automatic Database Diagnostic Monitor (ADDM) page, the Database Activity chart shows the database activity during the ADDM analysis period. Database activity types are defined in the legend based on their corresponding colors in the chart. Each icon below the chart represents a different ADDM task, which in turn corresponds to a pair of individual Oracle Database snapshots saved in the Workload Repository.

In this example, the largest block of activity from 8:00 onwards appears in green and corresponds to CPU usage, as described in the legend. This data suggests that CPU may be a performance bottleneck during the ADDM analysis period.

In the ADDM Performance Analysis section, the ADDM findings are listed in descending order, from highest impact to least impact. The Informational Findings section lists the areas that do not have a performance impact and are for informational purpose only.



2. Optionally, click the Zoom icons to shorten or lengthen the analysis period displayed on the chart.
3. To view the ADDM findings in a report, click **View Report**.

   The View Report page appears.

   You can click **Save to File** to save the report for later access.

Interpretation of Automatic Database Diagnostic Monitor Findings

The ADDM analysis results are represented as a set of findings. Each ADDM finding belongs to one of three types:

- Problem

  Findings that describe the root cause of a database performance issue.

- Symptom

  Findings that contain information that often leads to one or more problem findings.

- Information

  Findings that are used to report areas of the system that do not have a performance impact.

Each problem finding is quantified with an estimate of the portion of DB time that resulted from the performance problem.

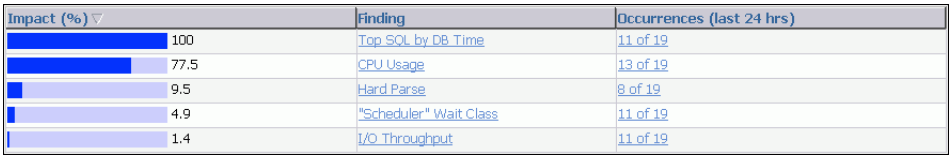
When a specific problem has multiple causes, ADDM may report multiple findings. In this case, the impacts of these multiple findings can contain the same portion of DB time. Because the performance problems can overlap, summing all the impacts of the reported findings can yield a number higher than 100 percent of DB time. For example, if a system performs many read I/O operations, ADDM may report a SQL statement responsible for 50 percent of DB time due to I/O activity as one finding, and an undersized buffer cache responsible for 75 percent of DB time as another finding.

A problem finding can be associated with a list of recommendations for reducing the impact of a performance problem. Each recommendation has a benefit that is an estimate of the portion of DB time that can be saved if the recommendation is implemented. When multiple recommendations are associated with an ADDM finding, the recommendations may contain alternatives for solving the same problem. In this case, the sum of the benefits may be higher than the impact of the finding. You do not need to apply all the recommendations to solve the same problem.

Recommendations are composed of actions and rationales. You must apply all the actions of a recommendation to gain the estimated benefit of that recommendation. The rationales explain why the set of actions was recommended, and provide additional information for implementing the suggested recommendation. An ADDM action may present multiple solutions to you. If this is the case, then choose the easiest solution to implement.

Implementing Automatic Database Diagnostic Monitor Recommendations

This section describes how to implement ADDM recommendations. ADDM findings are displayed in the Automatic Database Diagnostic Monitor (ADDM) page under ADDM Performance Analysis.



Impact (%)	Finding	Occurrences (last 24 hrs)
100	Top SQL by DB Time	11 of 19
77.5	CPU Usage	13 of 19
9.5	Hard Parse	8 of 19
4.9	"Scheduler" Wait Class	11 of 19
1.4	I/O Throughput	11 of 19

To implement ADDM recommendations:

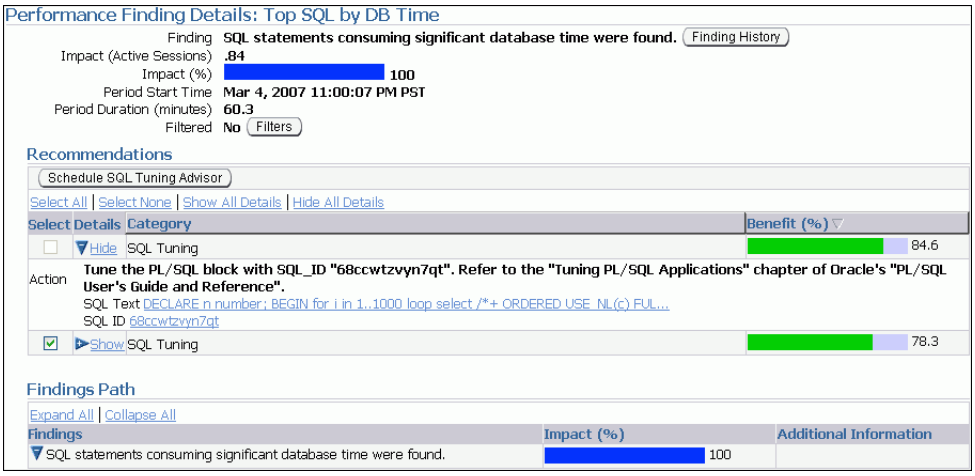
1. On the Database Home page, under Diagnostic Summary, click the link next to **ADDM Findings**.

   The Automatic Database Diagnostic Monitor (ADDM) page appears.

2. In the ADDM Performance Analysis section, click the ADDM finding that has the greatest impact.

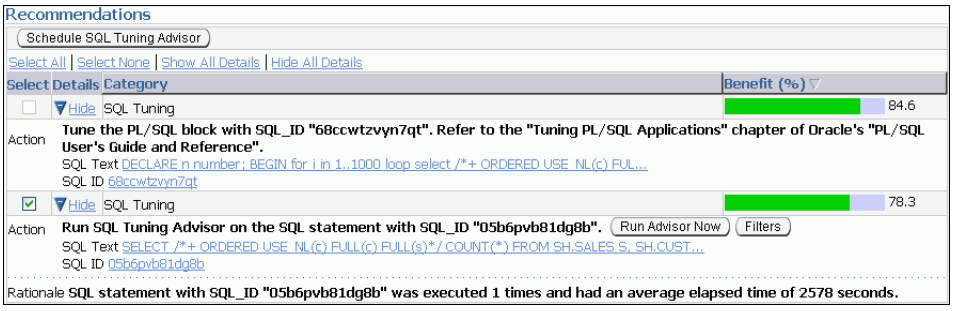
   In this example, the finding with the greatest impact is Top SQL by DB Time.

   The Performance Finding Details page appears.



3. Under Recommendations, review the recommendations and required actions for each recommendation.

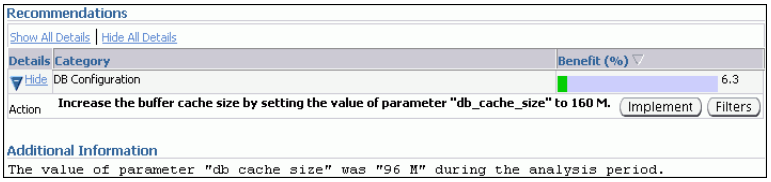
   The Category column displays the category of the recommendation. The Benefit (%) column displays the estimated benefit of implementing the recommendation.



In this example, two recommendations are displayed for this finding. The first recommendation contains one action and is estimated to have a maximum benefit of up to 84.6% of DB time in the analysis period. The second recommendation contains one action and is estimated to have a maximum benefit of up to 78.3% of DB time in the analysis period.

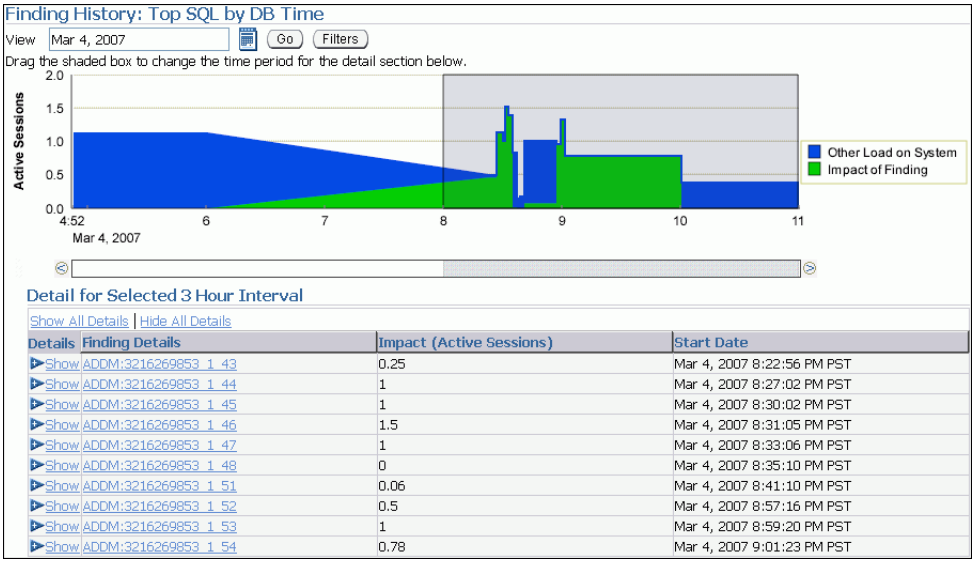
4. If additional information about why the set of actions was recommended is available, then click **Additional Information**, or review the content displayed under Additional Information.

   For example, the Undersized Buffer Cache finding contains additional information to indicate the value of the `DB_CACHE_SIZE` initialization parameter.



5. To view the history of a finding, click **Finding History**.

   The Finding History page appears.



The Finding History page shows how often a particular finding has occurred in a selected 3-hour interval. You can use this information to determine whether the finding was a transient or a persistent problem on the system. Based on this information, you can determine whether the actions associated with the finding should be implemented.

The Active Sessions chart shows the impact of the finding and of the other load on the system. You can change the display as follows:

a. To move the 3-hour interval, click and drag the shaded box in the Active Sessions chart to the time period in which you are interested.

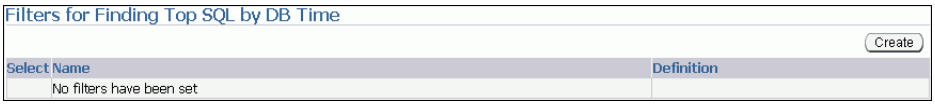
b. To change dates, enter the desired date in the **View** field and click **Go**.

c. To view details about a finding, under Detail for Selected 3 Hour Interval, click the link in the **Finding Details** column to display the Performance Finding Details page for the corresponding ADDM finding.

6. Optionally, create a filter to suppress known findings that have been tuned or cannot be tuned further. To create filters for this ADDM finding:

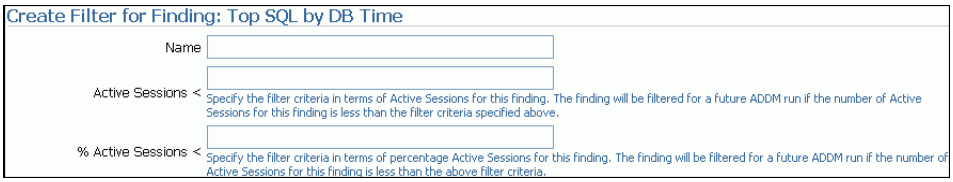
a. Click **Filters**.

The Filters for Finding page appears.



b. Click **Create**.

The Create Filter for Finding page appears.



c. In the **Name** field, enter a name for the ADDM filter.

d. In the **Active Sessions** field, specify the filter criteria, in terms of the number of active sessions, for this finding.

The ADDM finding will be filtered for future ADDM runs if the number of active sessions for this finding is less than the specified filter criteria.

e. In the **% Active Sessions** field, specify the filter criteria, in terms of percentage of active sessions, for this finding.

The ADDM finding will be filtered for future ADDM runs if the number of active sessions for this finding is less than the specified filter criteria.

f. Click **OK**.

7. Perform the required action of a chosen recommendation.

Depending on the type of action you choose to perform, various buttons may be available, such as **Implement** or **Run Advisor Now**. These buttons enable you to implement the recommendation immediately with only a single mouse click.

In this example, the simplest solution is to click **Run Advisor Now** to immediately run a SQL Tuning Advisor task on the SQL statement.

See Also:

- Chapter 10, "Tuning SQL Statements"

Viewing Snapshot Statistics

You can view the data contained in snapshots taken by AWR using Enterprise Manager. Typically, it is not necessary to review snapshot data because it consists primarily of raw statistics. Instead, you should rely on ADDM, which analyzes these statistics to identify performance problems. Snapshot statistics should be used primarily by advanced users, or by DBAs who are accustomed to using Statspack for performance analysis.

To view snapshot statistics:

1. From the Database Home page, click **Performance**.

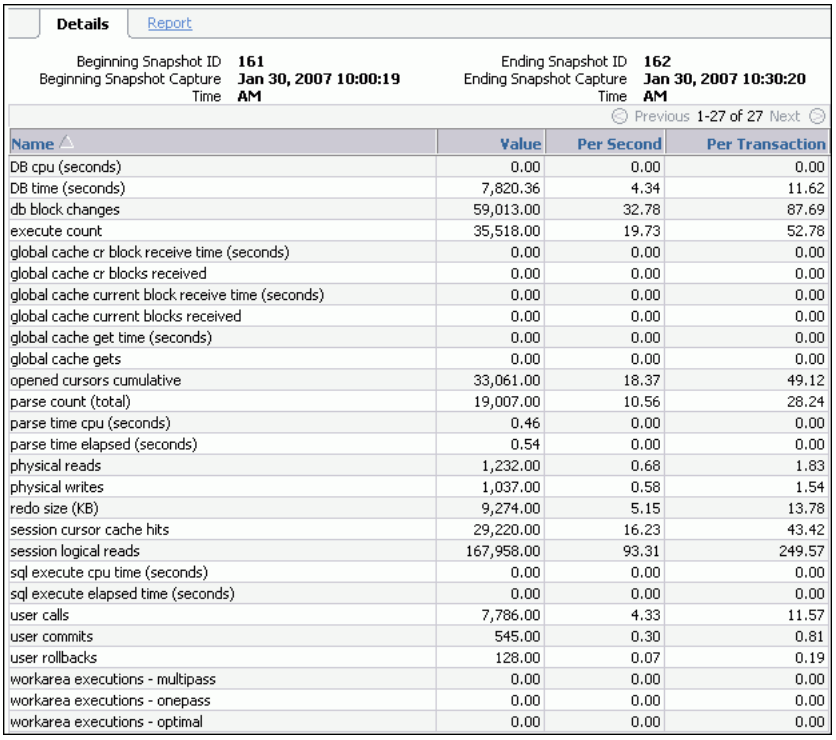
   The Performance page appears.

2. Under Additional Monitoring Links, click **Snapshots**.

   The Snapshots page appears with a list of the most recent snapshots.

3. To view the statistics gathered in a snapshot, click the **ID** link of the snapshot you want to view.

   The Snapshot Details appears, showing the Details subpage.



Details | Report

Beginning Snapshot ID **161**
Beginning Snapshot Capture Time **Jan 30, 2007 10:00:19 AM**

Ending Snapshot ID **162**
Ending Snapshot Capture Time **Jan 30, 2007 10:30:20 AM**

Previous 1-27 of 27 Next

Name	Value	Per Second	Per Transaction
DB cpu (seconds)	0.00	0.00	0.00
DB time (seconds)	7,820.36	4.34	11.62
db block changes	59,013.00	32.78	87.69
execute count	35,518.00	19.73	52.78
global cache cr block receive time (seconds)	0.00	0.00	0.00
global cache cr blocks received	0.00	0.00	0.00
global cache current block receive time (seconds)	0.00	0.00	0.00
global cache current blocks received	0.00	0.00	0.00
global cache get time (seconds)	0.00	0.00	0.00
global cache gets	0.00	0.00	0.00
opened cursors cumulative	33,061.00	18.37	49.12
parse count (total)	19,007.00	10.56	28.24
parse time cpu (seconds)	0.46	0.00	0.00
parse time elapsed (seconds)	0.54	0.00	0.00
physical reads	1,232.00	0.68	1.83
physical writes	1,037.00	0.58	1.54
redo size (KB)	9,274.00	5.15	13.78
session cursor cache hits	29,220.00	16.23	43.42
session logical reads	167,958.00	93.31	249.57
sql execute cpu time (seconds)	0.00	0.00	0.00
sql execute elapsed time (seconds)	0.00	0.00	0.00
user calls	7,786.00	4.33	11.57
user commits	545.00	0.30	0.81
user rollbacks	128.00	0.07	0.19
workarea executions - multipass	0.00	0.00	0.00
workarea executions - onepass	0.00	0.00	0.00
workarea executions - optimal	0.00	0.00	0.00

   In this example, statistics gathered from the previous snapshot (snapshot 161) to the selected snapshot (snapshot 162) are displayed.

4. To view a Workload Repository report of the statistics, click **Report**.

   The Workload Repository report appears.

5. Optionally, click **Save to File** to save the report for later access.

See Also:

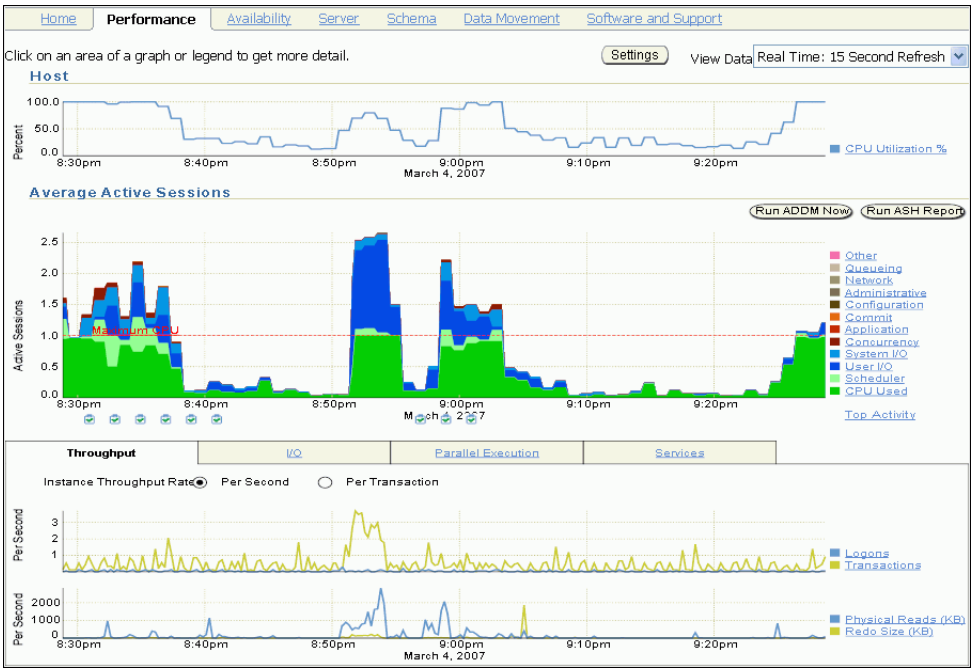
- Chapter 8, "Resolving Performance Degradation Over Time"

4

Monitoring Real-Time Database Performance

The Performance page in Oracle Enterprise Manager (Enterprise Manager) displays information in three sections that you can use to assess the overall performance of the database in real time.

Figure 4–1 Performance Page



Typically, you should use the automatic diagnostic feature of Automatic Database Diagnostic Monitor (ADDM) to identify performance problems with the database, as described in Chapter 3, "Automatic Database Performance Monitoring". In some cases, however, you may want to monitor the database performance in real time to identify performance problems as they happen. For example, ADDM performs its analysis after each Automatic Workload Repository (AWR) snapshot, which by default is once every hour. However, if you notice a sudden spike in database activity on the Performance page, then you may want to investigate the incident before the next ADDM analysis.

By drilling down to appropriate pages from the Performance page, you can identify performance problems with the database in real time. If you find a performance problem, then you can choose to run ADDM manually to analyze it immediately, without having to wait until the next ADDM analysis. To learn how to run ADDM

manually to analyze performance in real time, see "Manually Running ADDM to Analyze Current Database Performance" on page 6-1.

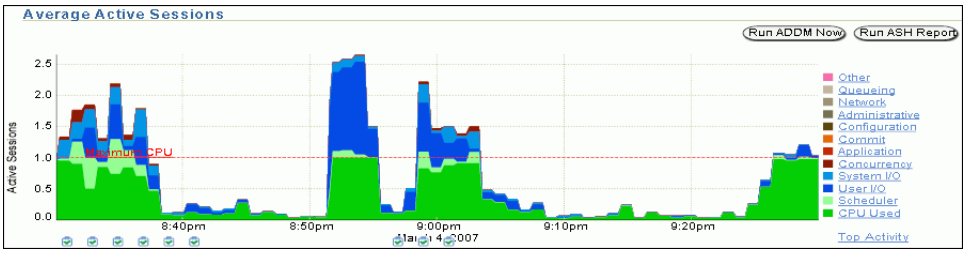
This chapter contains the following sections:

- Monitoring User Activity
- Monitoring Instance Activity
- Monitoring Host Activity
- Customizing the Database Performance Page

Monitoring User Activity

The Average Active Sessions chart of the Performance page shows potential problems inside the database, including how much CPU users are consuming. The wait classes show how much of the database activity is consumed by waiting for a resource such as disk I/O.

Figure 4–2 Monitoring User Activity



By following the performance method explained in Chapter 2, "Oracle Database Performance Method", you can drill down from the charts to identify the cause of instance-related performance issues and resolve them.

To monitor user activity:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

2. Locate the spikes in the Average Active Sessions chart.

   When the CPU Used value reaches the Maximum CPU line (shown as a dotted line), the database instance is running at 100 percent of CPU time on the host system.

   All other values in the chart represent users waiting and contention for resources, which are categorized by wait classes in the legend. Values that use a larger block of active sessions represent bottlenecks caused by a particular wait class, as indicated by the corresponding color in the legend.

   In the chart shown in Figure 4–2 on page 4-2, the largest block of activity appears in green and corresponds to the CPU Used wait class as described in the legend.

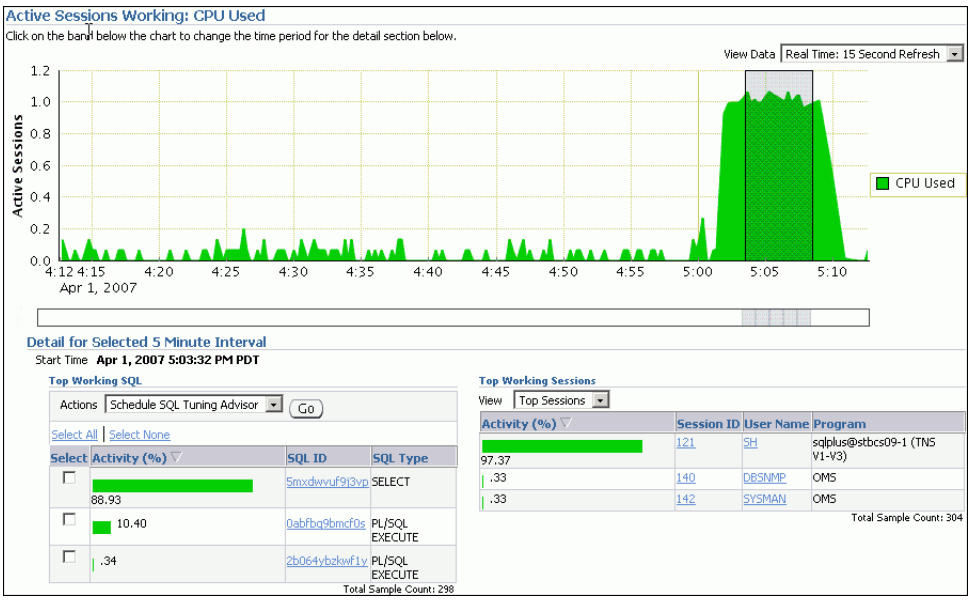
3. To identify each wait class, move your cursor over the block in the Average Active Sessions chart corresponding to the class.

   The corresponding wait class is highlighted in the chart legend.

4. Click the largest block of color on the chart or its corresponding wait class in the legend to drill down to the wait class with the most active sessions.

If you click **CPU Used**, then the Active Sessions Working page for the wait class appears. If you click a different wait class, such as **User I/O**, then the Active Sessions Waiting page appears.

Figure 4–3 Active Sessions Working page



The Active Sessions Working page shows a 1-hour time line. Details for each wait class are shown in 5-minute intervals under Detail for Selected 5 Minute Interval.

You can view the details of wait classes in different dimensions by proceeding to one of the following sections:

- "Monitoring Top SQL" on page 4-4
- "Monitoring Top Sessions" on page 4-5
- "Monitoring Top Services" on page 4-6
- "Monitoring Top Modules" on page 4-7
- "Monitoring Top Actions" on page 4-7
- "Monitoring Top Clients" on page 4-8
- "Monitoring Top PL/SQL" on page 4-9
- "Monitoring Top Files" on page 4-9
- "Monitoring Top Objects" on page 4-10

5. To change the time selected interval, move the slider below the chart to a different interval.

   The information contained in the Detail for Selected 5 Minute Interval section is automatically updated to display the selected time period.

   In the example shown in Figure 4–3, the 5 -minute interval from 5:03 to 5:08 is selected for the CPU Used wait class.

6. If you discover a performance problem, then you can attempt to resolve it in real time. On the Performance page, do one of the following:

- Click a snapshot below the chart that corresponds to the time when the performance problem occurred to run ADDM for that time period.

  For information about ADDM analysis, see "Reviewing the Automatic Database Diagnostic Monitor Analysis" on page 3-7.

- Create a snapshot manually by clicking **Run ADDM Now**.

  For information about creating snapshots manually, see "Creating Snapshots" on page 3-5. For information about running ADDM manually, see "Manually Running ADDM to Analyze Current Database Performance" on page 6-1.

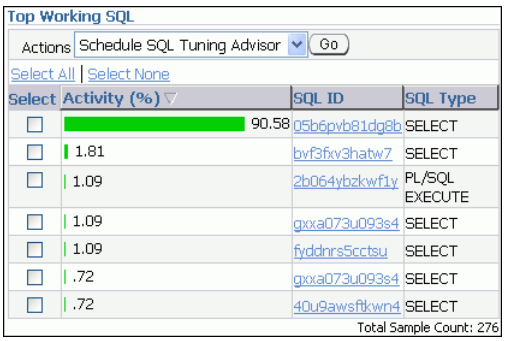
- Click **Run ASH Report** to create an ASH report to analyze transient performance problems that last for only a short period of time.

  For information about ASH reports, see "Active Session History Reports" on page 7-3.

Monitoring Top SQL

On the Active Sessions Working page, the Top Working SQL table shows the database activity for actively running SQL statements that are consuming CPU resources. The Activity (%) column shows the percentage of this activity consumed by each SQL statement. If one or several SQL statements are consuming a majority of the activity, then you should investigate them.

Figure 4–4 Monitoring Top SQL



In the example shown in Figure 4–4, the `SELECT` statement is consuming over 90% of database activity and should be investigated.

To monitor the top working SQL statements:

1. On the Performance page, in the Average Active Sessions chart, click the CPU block on the chart or its corresponding wait class in the legend.

   The Active Sessions Working page appears.

2. Under Detail for Selected 5 Minute Interval, click the **SQL ID** link of the most active SQL statement in the Top Working SQL table.

   The SQL Details page appears.

   For SQL statements that are using the majority of the wait time, use SQL Tuning Advisor or create a SQL Tuning Set to tune the problematic SQL statements.

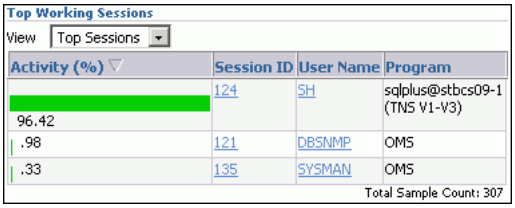
See Also:

- "Viewing Details of SQL Statements" on page 9-4
- "Tuning SQL Statements Using SQL Tuning Advisor" on page 10-2

Monitoring Top Sessions

On the Active Sessions Working page, the Top Working Sessions table displays the top sessions waiting for the corresponding wait class during the selected time period. Sessions represent specific user connections to the database through a user process.

Figure 4–5 Monitoring Top Sessions



A session lasts from the time the user connects to the database until the time the user disconnects or exits the database application. For example, when a user starts SQL*Plus, the user must provide a valid database user name and password to establish a session. If a single session is using the majority of the wait time, then you should investigate it.

To monitor the top working sessions:

1. On the Performance page, in the Average Active Sessions chart, click the CPU Used block on the chart or its corresponding wait class in the legend.

   The Active Sessions Working page appears.

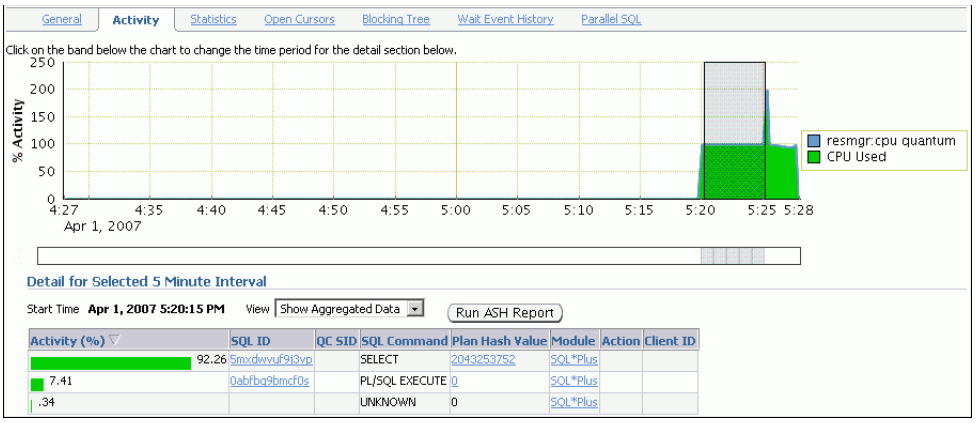
2. Under Detail for Selected 5 Minute Interval, click the **Session ID** link of the session consuming the most database activity.

   The Session Details page appears.

   This page contains information such as session activity, session statistics, open cursors, blocking sessions, wait events, and parallel SQL for the selected session.

   In the example shown in Figure 4–5, the SQL*Plus session for user `sh` is consuming over 96% of database activity and should be investigated.

Figure 4–6 Viewing Session Details



In this example, because the session is consuming 100 percent of database activity, consider ending the session by clicking **Kill Session**, and proceeding to tune the SQL statement that this session is running.

See Also:

- Chapter 10, "Tuning SQL Statements"

Monitoring Top Services

The Top Services table displays the top services waiting for the corresponding wait event during the selected time period.

Services represent groups of applications with common attributes, service-level thresholds, and priorities. For example, the `SYS$USERS` service is the default service name used when a user session is established without explicitly identifying its service name. The `SYS$BACKGROUND` service consists of all Oracle Database background processes. If a single service is using the majority of the wait time, then you should investigate it.

To monitor a service:

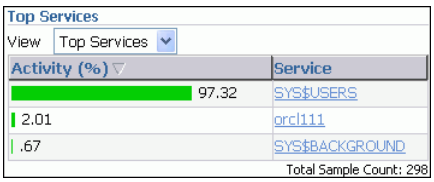
1. On the Performance page, in the Average Active Sessions chart, click a block on the chart or its corresponding wait class in the legend.

   The Active Sessions Working page appears.

2. Under Detail for Selected 5 Minute Interval, select **Top Services** from the View list.

   The Top Services table appears.

Figure 4–7 Monitoring Top Services



In the example shown in Figure 4–7, the `SYS$USERS` service is consuming 97.32% of database activity. This service corresponds to the SQL*Plus session for user `sh` shown in Figure 4–5.

3. Click the **Service** link of the most active service.

   The Service page appears.

   This page contains information about the modules, activity, and statistics for the selected service.

Monitoring Top Modules

The Top Modules table displays the top modules waiting for the corresponding wait event during the selected time period.

Modules represent the applications that set the service name as part of the workload definition. For example, the `DBMS_SCHEDULER` module may assign jobs that run within the `SYS$BACKGROUND` service. If a single module is using the majority of the wait time, then it should be investigated.

To monitor a module:

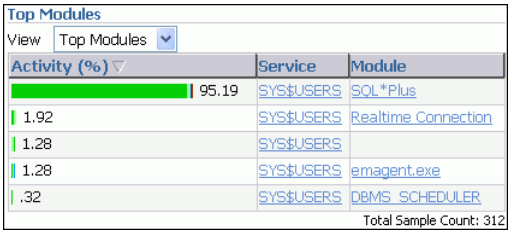
1. On the Performance page, in the Average Active Sessions chart, click a block on the chart or its corresponding wait class in the legend.

   The Active Sessions Working page appears.

2. Under Detail for Selected 5 Minute Interval, select **Top Modules** from the View list.

   The Top Modules table appears.

Figure 4–8 Monitoring Top Modules



3. Click the **Module** link of the module that is showing the highest percentage of activity.

   The Module page appears.

   This page contains information about the actions, activity, and statistics for the selected module.

   In the example shown in Figure 4–8, the SQL*Plus module is consuming over 95% of database activity and should be investigated. As shown in Figure 4–5, the SQL*Plus session for user `sh` is consuming a huge percentage of database activity.

Monitoring Top Actions

The Top Actions table displays the top actions waiting for the corresponding wait event during the selected time period.

Actions represent the jobs that are performed by a module. For example, the `DBMS_SCHEDULER` module can run the `GATHER_STATS_JOB` action to gather statistics on all database objects. If a single action is using the majority of the wait time, then you should investigate it.

To monitor an action:

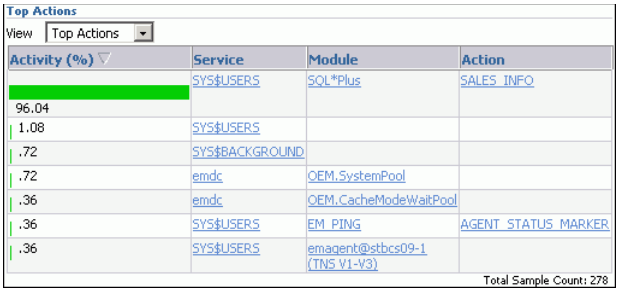
1. On the Performance page, in the Average Active Sessions chart, click a block on the chart or its corresponding wait class in the legend.

   The Active Sessions Working page appears.

2. Under Detail for Selected 5 Minute Interval, select **Top Actions** from the View list.

   The Top Actions table appears.

Figure 4–9 Monitoring Top Actions



3. Click the **Action** link of the most active action.

   The Action page appears.

   This page contains statistics for the selected action.

   In the example shown in Figure 4–9, the action associated with the SQL*Plus module and `SALES_INFO` action is consuming 96% of the database activity. This information is consistent with Figure 4–5, which shows that the SQL*Plus session for user `sh` is consuming over 96% of database activity.

Monitoring Top Clients

The Top Clients table displays the top clients waiting for the corresponding wait event during the selected time period. A client can be a Web browser or any end-user process that initiates requests for an operation to be performed on the database. If a single client is using the majority of the wait time, then you should investigate it.

To monitor a client:

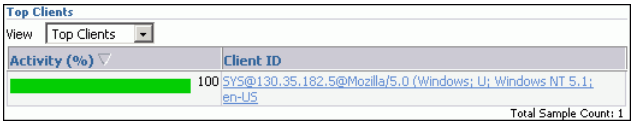
1. On the Performance page, in the Average Active Sessions chart, click a block on the chart or its corresponding wait class in the legend.

   The Active Sessions Working page appears.

2. Under Detail for Selected 5 Minute Interval, select **Top Clients** from the View list.

   The Top Clients table appears.

Figure 4–10 Monitoring Top Clients



3. Click the **Client ID** link of the most active client.

   The Clients page appears.

This page contains statistics for the selected user process.

Monitoring Top PL/SQL

The Top PL/SQL table displays the top PL/SQL subprograms waiting for the corresponding wait event during the selected time period. If a single PL/SQL subprogram is using the majority of the wait time, then you should investigate it.

To monitor a PL/SQL subprogram:

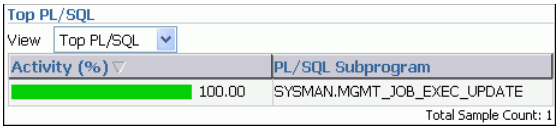
1. On the Performance page, in the Average Active Sessions chart, click a block on the chart or its corresponding wait class in the legend.

   The Active Sessions Working page appears.

2. Under Detail for Selected 5 Minute Interval, select **Top PL/SQL** from the View list.

   The Top PL/SQL table appears.

Figure 4–11 Monitoring Top PL/SQL



3. Click the **PL/SQL Subprogram** link of the most active subprogram.

   The PL/SQL Subprogram page appears.

   This page contains statistics for the selected subprogram.

   In Figure 4–11, the `SYSMAN.MGMT_JOB_EXEC_UPDATE` subprogram is consuming 100% of database activity.

Monitoring Top Files

The Top Files table displays the average wait time for specific files during the selected time period. This data is available from the Active Sessions Waiting: User I/O page.

To monitor a file:

1. On the Performance page, in the Average Active Sessions chart, click the User I/O block on the chart or its corresponding wait class in the legend.

   The Active Sessions Waiting: User I/O page appears.

2. Under Detail for Selected 5 Minute Interval, select **Top Files** from the View list.

   The Top Files table appears.

Figure 4–12 Monitoring Top Files

3. Click the **Tablespace** link of the file with the highest average wait time.

   The View Tablespace page appears.

In the example shown in Figure 4–12, the wait times are all associated with I/O for the file in the SYSTEM tablespace.

Monitoring Top Objects

The Top Objects table displays the top database objects waiting for the corresponding wait event during the selected time period. This data is available from the Active Sessions Waiting: User I/O page.

To monitor an object:

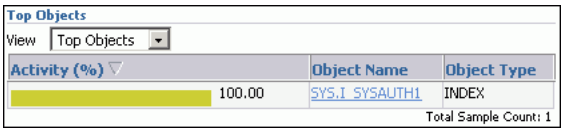
1. On the Performance page, in the Average Active Sessions chart, click the User I/O block on the chart or its corresponding wait class in the legend.

   The Active Sessions Waiting: User I/O page appears.

2. Under Detail for Selected 5 Minute Interval, select **Top Objects** from the View list.

   The Top Objects table appears.

Figure 4–13 Monitoring Top Objects



3. Click the **Object Name** link of the object with the highest average wait time.

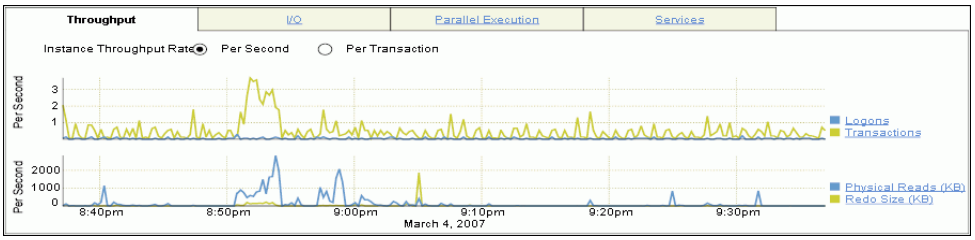
   The View page for the object appears.

   This example in Figure 4–13 shows that all the waits are for the SYS.I_SYSAUTH1 index. Given the information in Figure 4–4 and Figure 4–5, you can conclude that the performance problem is caused by the SELECT statement executed by user sh, which is waiting for access to the SYS.I_SYSAUTH1 index.

Monitoring Instance Activity

In the Average Active Sessions section of the Performance page, you can use the Throughput, I/O, Parallel Execution, and Services charts to monitor database instance activity. As explained in "Customizing the Database Performance Page" on page 4-27, you can also customize the Performance page so that the most useful charts are displayed by default.

Figure 4–14 Monitoring Instance Activity



You can use the instance activity charts to perform the following tasks:

- Monitoring Throughput
- Monitoring I/O

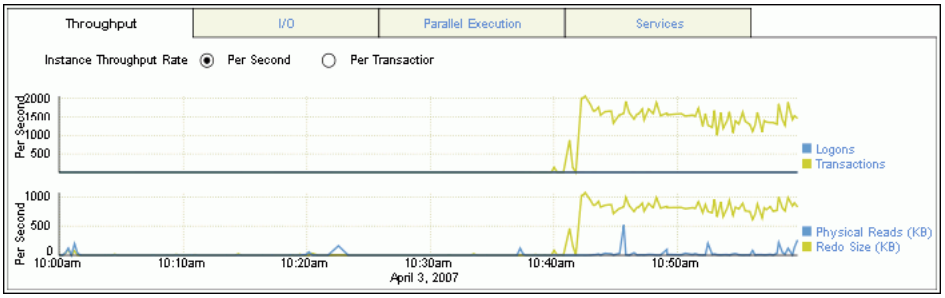
- Monitoring Parallel Execution
- Monitoring Services

Monitoring Throughput

The Throughput charts show any contention that appears in the Average Active Sessions chart. The charts indicate how much work the database is performing for the user. The Throughput charts on the Performance page display:

- Number of physical reads, redo size, logons, and transactions per second
- Number of physical reads and redo size per transaction

Figure 4–15 Monitoring Throughput



Compare the peaks on the Throughput charts with the peaks on the Average Active Sessions chart. If the Average Active Sessions chart displays a large number of sessions waiting, indicating internal contention, but throughput is high, then the situation may be acceptable. The database is probably also performing efficiently if internal contention is low but throughput is high. However, if internal contention is high but throughput is low, then consider tuning the database.

To monitor throughput:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

2. In the instance activity chart, click **Throughput**.

   The Throughput charts are shown with **Instance Throughput Rate** set to the default value of **Per Second**. You can select **Per Transaction** to show the throughput rate per transaction.

   In the example in shown in Figure 4–15, the number of transactions and physical reads per second spiked at around 10:45 a.m. The number of transactions per second has remained between 1000 and 2000 for 25 minutes. The physical reads have remained between 500 and 1000 KB per second.

3. To view the top consumers for each type of activity, click the corresponding link in the legend.

   The Top Consumers page appears. This page shows the top sessions for the selected activity.

Kill Session | View | Disable SQL Trace | Enable SQL Trace

Select	SID	DB User	CPU (1/100 sec)	PGA Memory (bytes)	Physical Reads	Logical Reads	Hard Parses	Total Parses	Disk Sorts	user commits	Status	Program	OS PID	Machine	OS User	SQL Trace
◉	124	SYS	545	5232788	1	70762	0	1803	0	13532	ACTIVE	sqlplus@stbcs09-1 (TNS V1-V3)	26374	stbcs09-1	lashdown	DISABLED
○	157	CJQ0	0	2684008	0	8	0	0	0	0	ACTIVE	oracle@stbcs09-1 (CJQ0)	11056	stbcs09-1	lashdown	DISABLED
○	130	W000	0	5143396	0	0	0	0	0	0	ACTIVE	oracle@stbcs09-1 (W000)	26761	stbcs09-1	lashdown	DISABLED
○	165	PSP0	0	602028	0	0	0	0	0	0	ACTIVE	oracle@stbcs09-1 (PSP0)	11014	stbcs09-1	lashdown	DISABLED
○	160	SMON	0	3010464	0	0	0	0	0	0	ACTIVE	oracle@stbcs09-1 (SMON)	11052	stbcs09-1	lashdown	DISABLED
○	148	DBSNMP	7	2400192	0	3	0	5	0	0	ACTIVE	emagent@stbcs09-1 (TNS V1-V3)	26283	stbcs09-1	lashdown	DISABLED
○	159	CKPT	0	1164332	4	0	0	0	0	0	ACTIVE	oracle@stbcs09-1 (CKPT)	11048	stbcs09-1	lashdown	DISABLED

In this example, a SQL*Plus session created by operating system user `lashdown` is responsible for the increase in database throughput.

4. Select any session and click **View** to obtain more information.

   After you analyze the information, you can choose to end the session by clicking **Kill Session**, or return to the Performance page.

Monitoring I/O

The I/O charts show I/O statistics collected from all database clients. The I/O wait time for a database process represents the amount of time that the process could have been doing useful work if a pending I/O had completed. Oracle Database captures the I/O wait times for all important I/O components in a uniform fashion so that every I/O wait by any Oracle process can be deduced from the I/O statistics.

Figure 4–16 Monitoring I/O

The Latency for Synchronous Single Block Reads chart shows the total perceived I/O latency for a block read, which is the time difference between when an I/O is issued and when it is processed by the database. Most systems are performing satisfactorily if

latency is fewer than 10 milliseconds. This type of I/O request is the best indicator of I/O performance for the following reasons:

- Write operations may exhibit good performance because of write caches in storage.
- Because multiblock I/O requests have varying sizes, they can take different amounts of time.
- The latency of asynchronous I/O requests does not represent the full I/O wait time.

The other charts shown depend on your selection for **I/O Breakdown**, as described in the following sections:

- Monitoring I/O by Function
- Monitoring I/O by Type
- Monitoring I/O by Consumer Group

Monitoring I/O by Function

The I/O Function charts determine I/O usage level by application or job. The component-level statistics give a detailed view of the I/O bandwidth usage, which you can then use in scheduling jobs and I/O provisioning. The component-level statistics fall in the following categories:

- Background type

  This category includes ARCH, LGWR, and DBWR.

- Activity

  This category includes XML DB, Streams AQ, Data Pump, Recovery, and RMAN.

- I/O type

  The category includes Direct Write, which is a write issued by a foreground process that is not from the buffer cache; Direct Read, which is a physical I/O from a datafile that bypasses the buffer cache and reads the data block directly into process-private memory; and Buffer Cache Read.

- Others

  This category includes I/Os such as control file I/Os.

To monitor I/O by function:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

2. In the instance activity chart, click **I/O**.

   The I/O Megabytes per Second and I/O Requests per Second charts appear.

3. For **I/O Breakdown**, select **I/O Function**.

   The I/O Megabytes per Second by I/O Function and I/O Requests per Second by I/O Function charts appear.

   The example in Figure 4–16 shows that a significant amount of I/O is being performed by the log writer. The log writer activity peaked at around 550 I/O requests per second.

4. Click the largest block of color on the chart or its corresponding function in the legend to drill down to the function with the highest I/O rate.

   The I/O Details page appears.

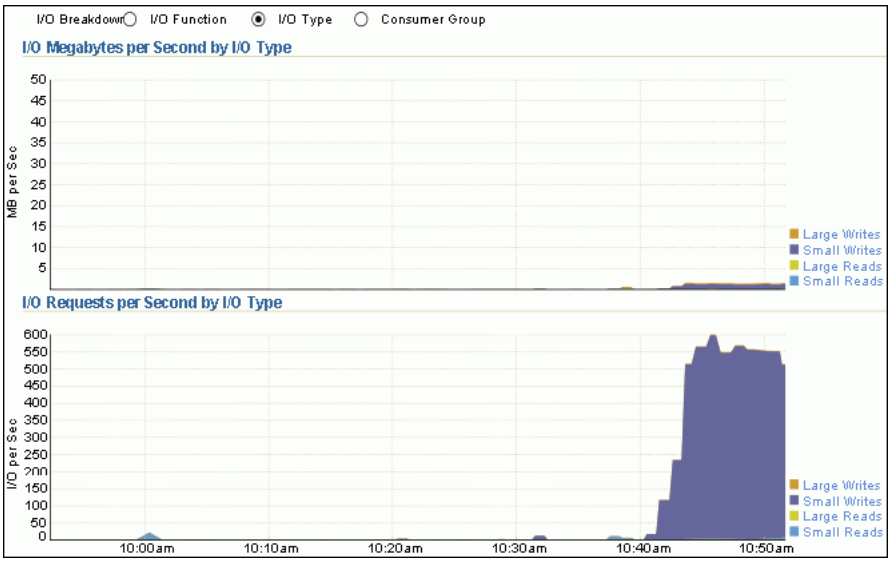
   You can view real-time or historical data for details on I/O megabytes or I/O requests.

   See Also:

   - *Oracle Database Concepts* to learn about database background processes such as ARCH, LGWR, and DBWR

Monitoring I/O by Type

The I/O Type charts enable you to monitor I/O by the types of read and write operations. Small I/Os are requests smaller than 128 KB and are typically single database block I/O operations. Large I/Os are requests greater than or equal to 128 KB. Large reads are generated by database operations such as table/index scans, direct data loads, backups, restores, and archiving.



If you are optimizing for low transaction times, then monitor the rate at which I/O requests are completed. Single-block performance is optimal when there is low I/O latency. High latencies typically indicate that the storage system is a bottleneck. Performance is negatively impacted by large I/O workloads.

If you are optimizing for large queries, such as in a data warehouse, then performance is dependent on the maximum throughput your storage system can achieve rather than the latency of the I/O requests. In this case, monitor the I/O megabytes per second rather than the synchronous single-block read latencies.

To monitor I/O by type:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

2. In the instance activity chart, click **I/O**.

   The I/O Megabytes per Second and I/O Requests per Second charts appear

3. For **I/O Breakdown**, select **I/O Type**.

The I/O Megabytes per Second by I/O Type and I/O Requests per Second by I/O Type charts appear.

In this example, the number of small writes per second increased to 550. These writes correspond to the log writer I/O requests shown in Figure 4–16.

4. Click the largest block of color on the chart or its corresponding function in the legend to drill down to the function with the highest I/O rate.

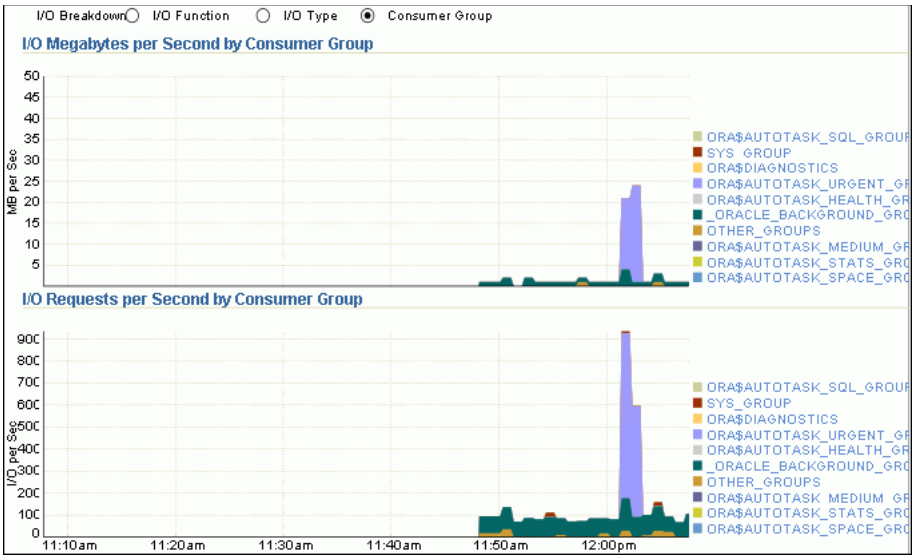
   The I/O Details page appears.

   You can view real-time or historical data for details on I/O megabytes or I/O requests.

Monitoring I/O by Consumer Group

When Oracle Database Resource Manager is enabled, the database collects I/O statistics for all consumer groups that are part of the currently enabled resource plan. The Consumer Group charts enable you to monitor I/O by consumer group.

A resource plan specifies how the resources are to be distributed among various users (resource consumer groups). Resource consumer groups let you group user sessions together by resource requirements. Note that the `_ORACLE_BACKGROUND_GROUP_` consumer group contains I/O requests issued by background processes.



To monitor I/O requests by consumer group:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

2. In the instance activity chart, click **I/O**.

   The I/O Megabytes per Second and I/O Requests per Second charts appear.

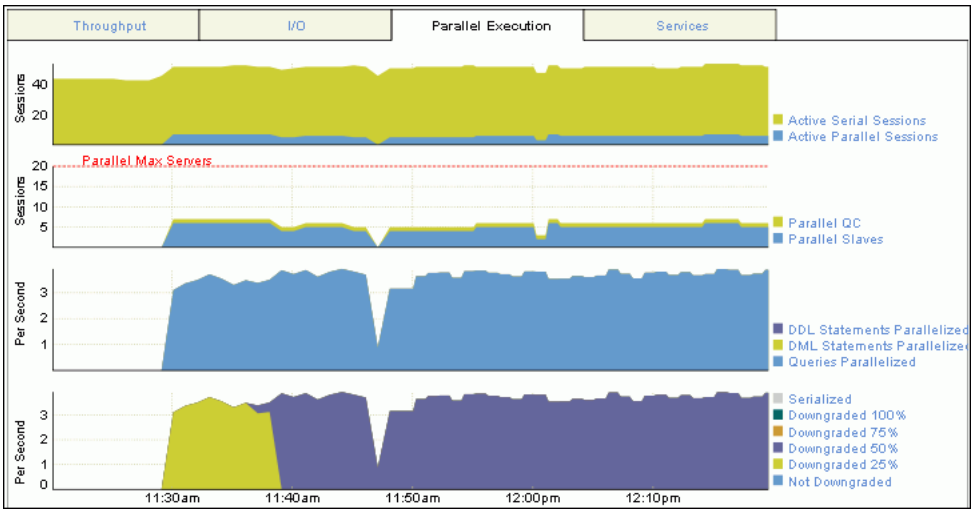
3. For **I/O Breakdown**, select **Consumer Group**.

   The I/O Megabytes per Second by Consumer Group and I/O Requests per Second by Consumer Group charts appear.

Monitoring Parallel Execution

The Parallel Execution charts show system metrics related to parallel queries. A parallel query divides the work of executing a SQL statement across multiple processes. The charts show parallel queries that were waiting for a particular wait event that accounted for the highest percentages of sampled session activity.

Figure 4–17 Monitoring Parallel Execution



To monitor parallel execution:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

2. In the instance activity chart, click **Parallel Execution**.

   The Parallel Execution charts appear.

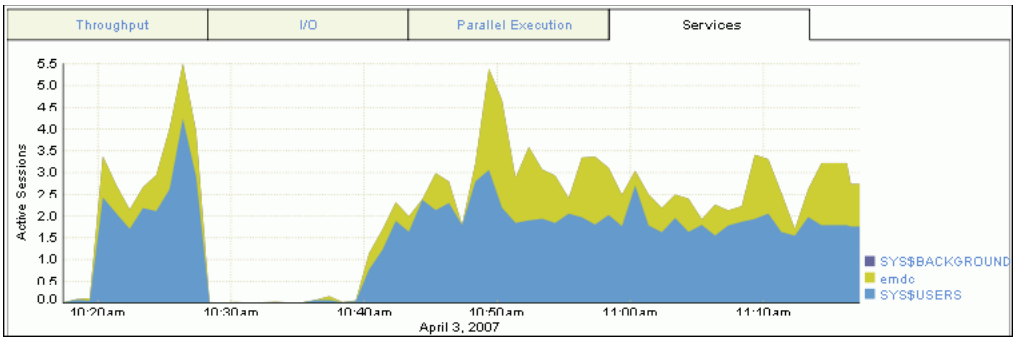
   Two pairs of charts are displayed. The first pair of charts shows the number of sessions on the y-axis, whereas the second pair shows the per second rate on the y-axis.

   In the example shown in Figure 4–17, query parallelization was active between 11:30 a.m. to 12:20 p.m.

Monitoring Services

The Services charts show services waiting for the corresponding wait event during the time period shown. Services represent groups of applications with common attributes, service-level thresholds, and priorities. For example, the `SYS$USERS` service is the default service name used when a user session is established without explicitly identifying its service name. Only active services are shown.

Figure 4–18 Monitoring Services



To monitor services:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

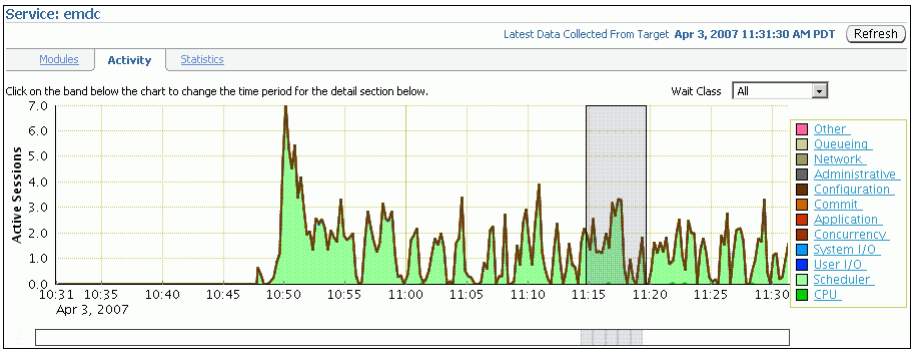
2. In the instance activity chart, click **Services**.

   The Services chart appears.

   In Figure 4–18, the `emdc` and `SYS$USERS` services have the greatest number of active sessions.

3. Click the largest block of color on the chart or its corresponding service in the legend to drill down to the service with the highest number of active sessions.

   The Service page appears, showing the Activity subpage.

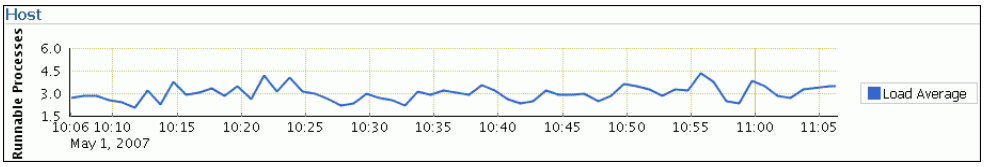


   You can view real-time data showing the session load for all wait classes associated with the service.

Monitoring Host Activity

The Host chart on the Performance page displays utilization information about the system hosting the database.

Figure 4–19 Monitoring Host Activity



To determine if the host system has enough resources available to run the database, establish appropriate expectations for the amount of CPU, memory, and disk resources that your system should be using. You can then verify that the database is not consuming too many of these resources.

To view details about CPU, memory, and disk utilization:

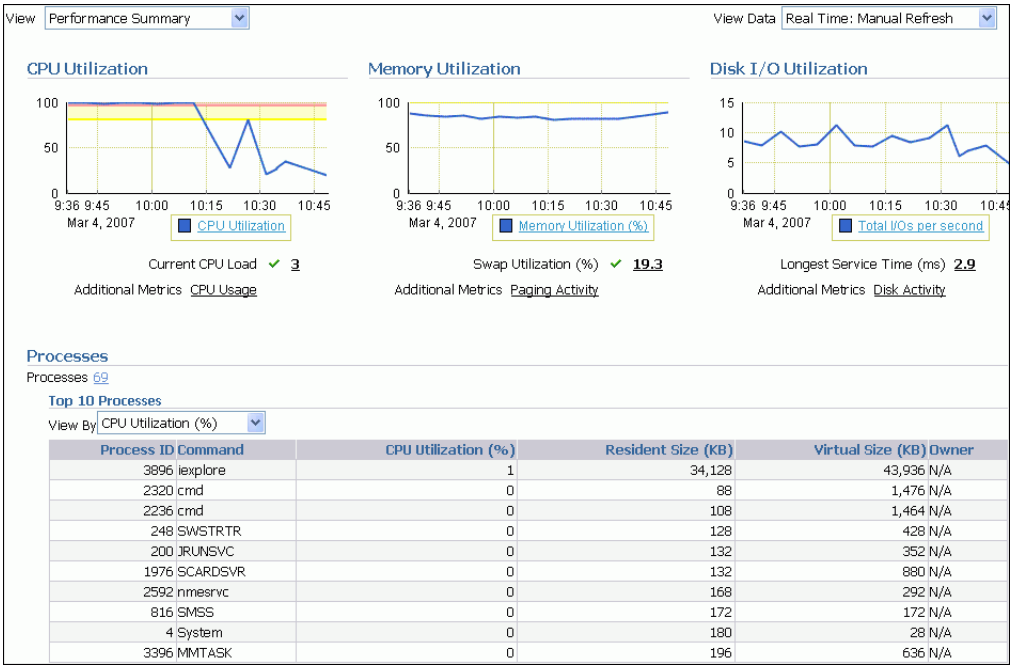
1. From the Database Home page, click **Performance**.

   The Performance page appears.

2. Click **Load Average** in the legend for the Host chart.

   The Host page appears, showing the Performance subpage.

Figure 4–20 Performance Summary



   The Performance Summary view is shown by default. The Performance Summary view displays metric values for CPU utilization, memory utilization, disk I/O utilization, and the top 10 processes ordered by both CPU and memory utilization.

3. Determine whether sufficient resources are available and whether when your system is using too many resources.

   Determine the amount of CPU, memory, and disk resources the database uses in the following scenarios:

   - When your system is idle, or when little database and nondatabase activity exists
   - At average workloads
   - At peak workloads

   Workload is an important factor when evaluating the level of resource utilization for your system. During peak workload hours, 90 percent utilization of a resource, such as a CPU with 10 percent idle and waiting time, can be acceptable. However, if your system shows high utilization at normal workload, then there is no room for additional workload.

Use the procedures in the following sections to monitor the host activity for your database:

- Monitoring CPU Utilization
- Monitoring Memory Utilization
- Monitoring Disk I/O Utilization

4. Set the appropriate threshold values for the performance metrics so the system can automatically generate alerts when these thresholds are exceeded.

   For information about setting metric thresholds, see "Setting Metric Thresholds for Performance Alerts" on page 5-1.

Monitoring CPU Utilization

To address CPU problems, first establish appropriate expectations for the amount of CPU resources your system should be using. You can then determine whether sufficient CPU resources are available and recognize when your system is consuming too many resources. This section describes how to monitor CPU utilization.

To monitor CPU utilization:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

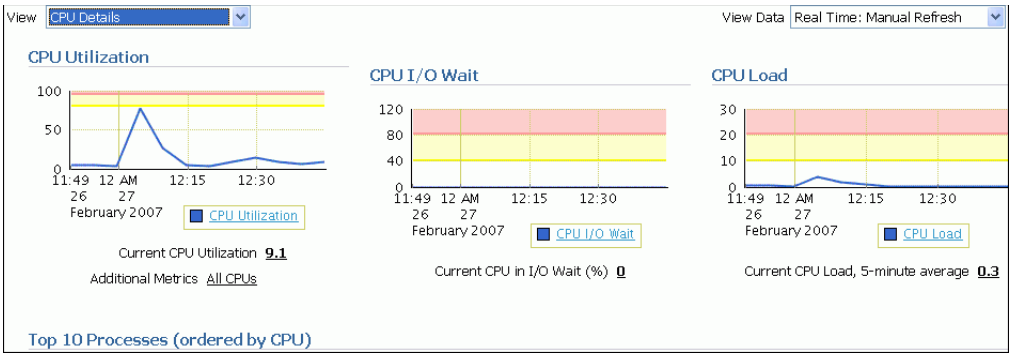
2. In the Host chart, click **Load Average** in the legend.

   The Host page appears, showing the Performance subpage.

3. Select **CPU Details** from the View list.

   The CPU Details view appears.

   This view contains statistics about CPU utilization, I/O wait times, and load gathered over the last hour. The top 10 processes are also listed ordered by CPU utilization.



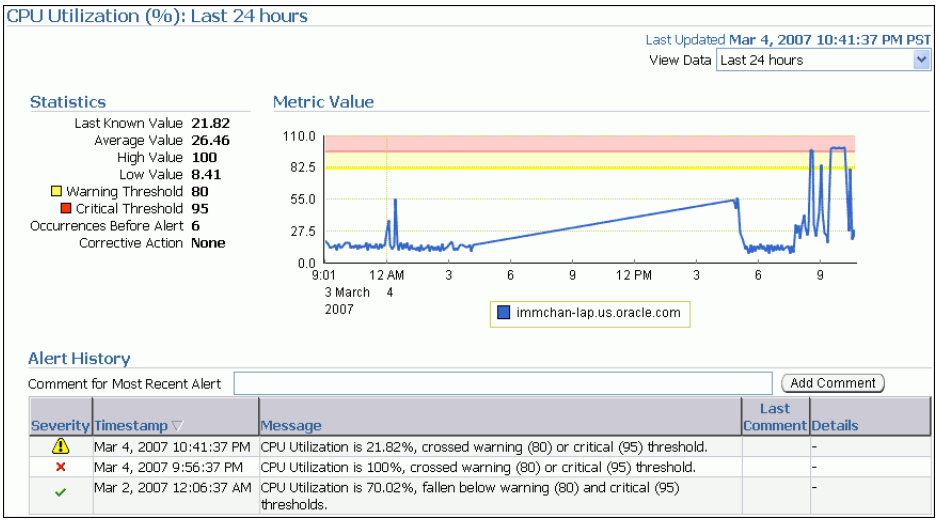
4. Verify the current CPU utilization using the CPU Utilization chart.

   The CPU Utilization chart shows CPU utilization over the last hour. The current value is displayed below the chart. During standard workload hours, the value should not exceed the critical threshold.

5. Click **CPU Utilization**.

   The CPU Utilization page appears.

   This page contains CPU utilization statistics and related alerts generated over the last 24 hours.



In this example, the CPU utilization crossed the critical threshold value at 9:56 p.m., so an alert for CPU utilization is generated to indicate that a CPU performance problem may exist.

If you notice an unexpected spike in this value that is sustained through normal workload hours, then the CPU performance problem should be investigated.

6. Verify the current CPU I/O wait time using the CPU I/O Wait chart.

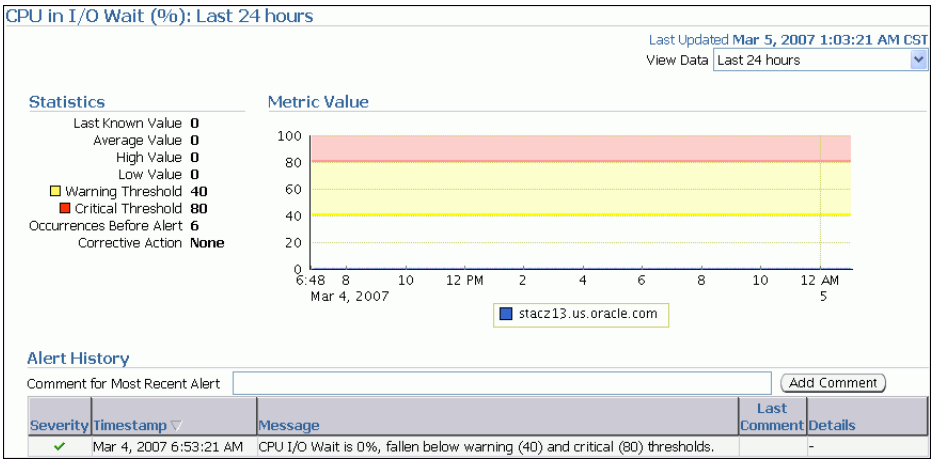
   The CPU I/O Wait chart shows CPU I/O wait time over the last hour. The current value is displayed below the chart. During normal workload hours, the value of CPU I/O wait should not exceed the warning threshold.

   CPU I/O wait represents the average number of jobs waiting for I/O during an interval.

7. Click **CPU I/O Wait**.

   The CPU in I/O Wait page appears.

   This page contains CPU I/O wait statistics and related alerts generated over the last 24 hours.



If you notice an unexpected spike in this value that is sustained through standard workload hours, then a CPU performance problem might exist.

8. Verify the current CPU load using the CPU Load chart.

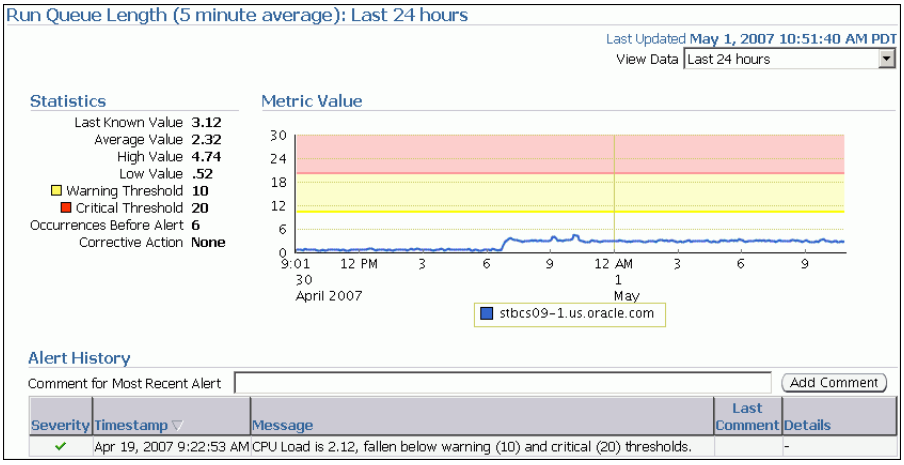
The CPU Load chart shows the CPU load over the last hour. The current value is displayed below the chart. During standard workload hours, the value of CPU load should not exceed the warning threshold.

CPU load represents the average number of processes waiting to be scheduled for CPU resources in the previous minute, or the level of CPU contention time over time.

9. Click **CPU Load**.

   The Run Queue Length page appears.

   This page contains CPU load statistics and related alerts generated over the last 24 hours.



   In this example, the CPU load crossed the warning threshold, but it is still below the critical threshold, so an alert was not generated.

   If you notice an unexpected spike in this value that is sustained through normal workload hours, then a CPU performance problem might exist.

10. Return to the CPU Details view of the Host Performance subpage and review the Top 10 Processes table.

    If a process is consuming too much of the CPU utilization percentage, then this process should be investigated.

Top 10 Processes (ordered by CPU)

Command	CPU Utilization (%)	Resident Size (KB)	Virtual Size (KB)	Owner	Process ID
ORACLE	100	257,060	390,152	N/A	836
emdctl	0.97	22,340	20,836	N/A	5208
SWAGENT	0	84	1,872	N/A	240
cmd	0	88	1,476	N/A	2320
cmd	0	108	1,464	N/A	2236
SWSOC	0	116	2,148	N/A	348
SWSTRTR	0	128	428	N/A	248
SCARDSVR	0	132	880	N/A	1976
JRUNSVC	0	132	352	N/A	200
MMTASK	0	140	636	N/A	3396

   In this example, the database is consuming 100 percent of CPU utilization. Therefore, the database is the likely source of a potential CPU performance problem and should be investigated.

11. If a CPU performance problem is identified, then you can try to resolve the issue by doing the following:

- Using Oracle Database Resource Manager to reduce the impact of peak-load-use patterns by prioritizing CPU resource allocation
- Avoiding running too many processes that use a lot of CPU
- Increasing hardware capacity, including changing the system architecture

See Also:

- *Oracle Database Performance Tuning Guide* for information about resolving CPU issues
- *Oracle Database Administrator's Guide* for information about Oracle Database Resource Manager

Monitoring Memory Utilization

Operating system performance issues commonly involve process management, memory management, and scheduling. This section describes how to monitor memory utilization and identify problems such as paging and swapping.

To monitor memory utilization:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

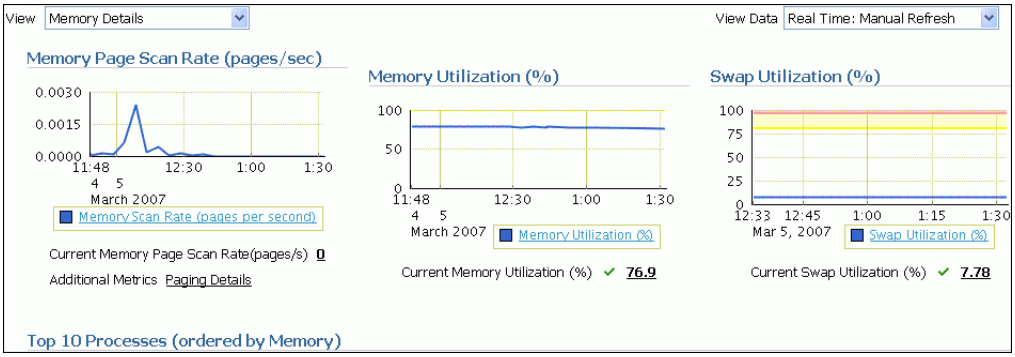
2. In the Host chart, click **Load Average** in the legend.

   The Host page appears, showing the Performance subpage.

3. Select **Memory Details** from the View list.

   The Memory Details view of the Performance subpage appears.

   This view contains statistics about memory utilization, page scan rates, and swap utilization gathered over the last hour. The top 10 processes are also listed ordered by memory utilization.



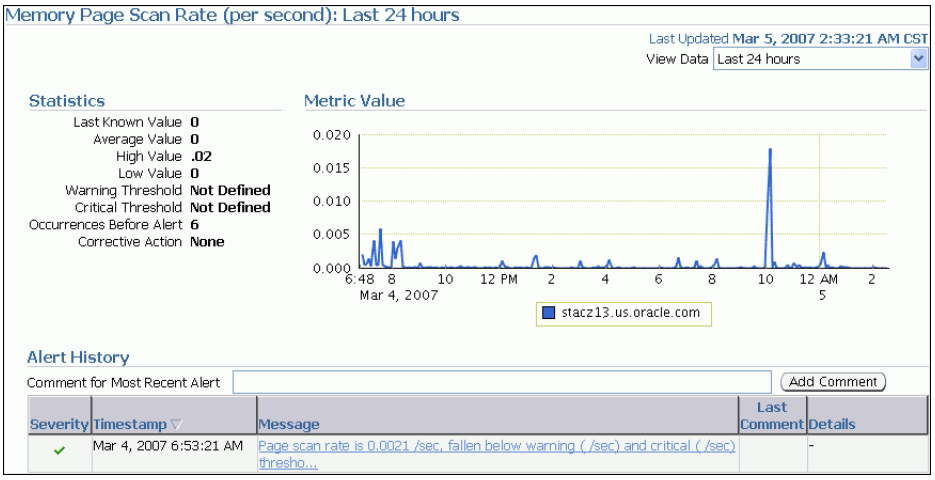
4. Verify the current memory page scan rate using the Memory Page Scan Rate chart.

   The current value of the memory page scan rate is displayed below the chart. On UNIX-based systems, this value represents the number of pages scanned per second. On Microsoft Windows, this value represents the rate at which pages are read from or written to disk to resolve hard page faults. This value is a primary indicator of the kinds of faults that may be causing systemwide delays.

5. Click **Memory Scan Rate**.

   The Memory Page Scan Rate page appears.

This page contains memory page scan rate statistics and related alerts over the last 24 hours.



In this example, an alert is not generated because a threshold is not defined.

If you notice an unexpected spike in this value that is sustained through standard workload hours, then a memory performance problem might exist.

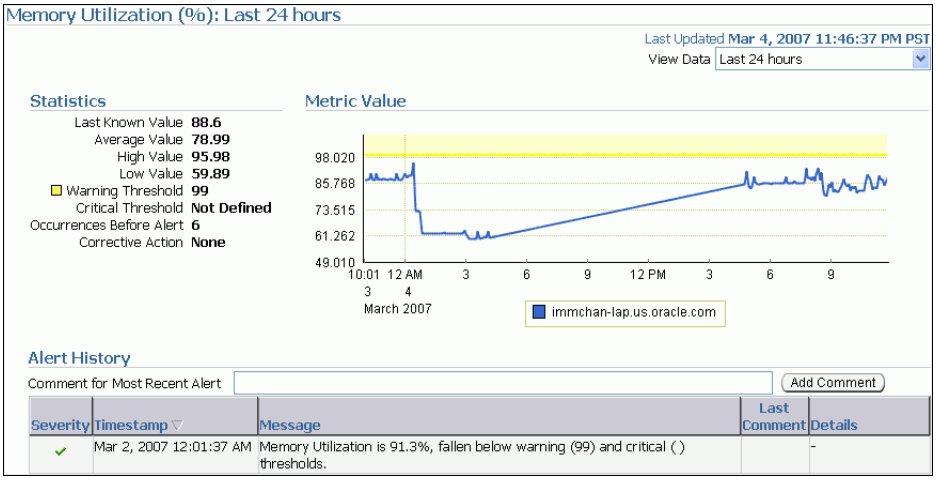
6. Verify the current memory utilization using the Memory Utilization chart.

   The Memory Utilization chart shows how much memory is being used. The current value of memory utilization is displayed below the chart. During standard workload hours, the value should not exceed the warning threshold (shown in yellow).

7. Click **Memory Utilization**.

   The Memory Utilization page appears.

   This page contains memory utilization statistics and related alerts generated over the last 24 hours.



In this example, memory utilization is near, but does not exceed, the warning threshold value (99 percent), so an alert is not generated.

If you notice an unexpected spike in this value that is sustained through normal workload hours, then a memory performance problem might exist.

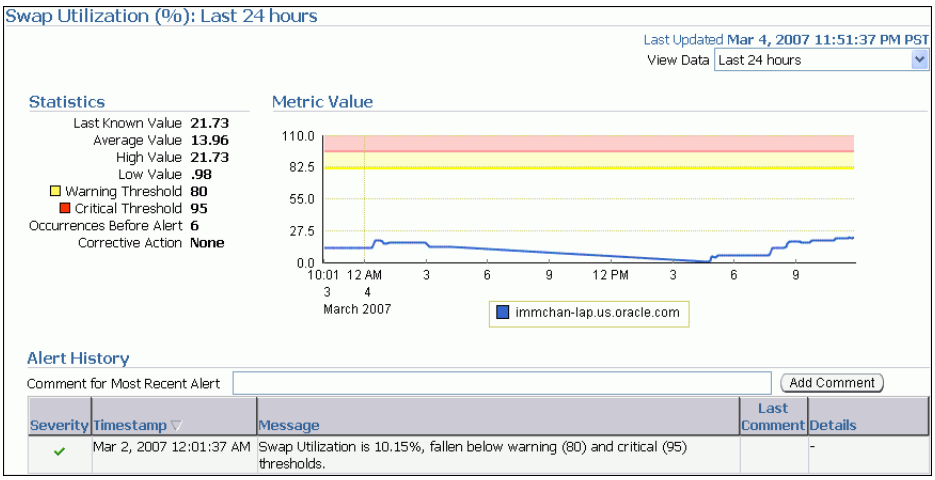
8. Verify current swap utilization using the Swap Utilization chart.

   The Swap Utilization chart shows how much swap space is being used. The current value of swap utilization is displayed below the chart. During normal workload hours, the value should not exceed the warning threshold.

9. Click **Swap Utilization**.

   The Swap Utilization page appears.

   This page contains swap utilization statistics and related alerts generated over the last 24 hours.



   In this example, swap utilization is below the warning threshold, so an alert is not generated.

   If you notice an unexpected spike in this value that is sustained through normal workload hours, then a memory performance problem might exist.

10. On the Memory Details view of the Host Performance subpage, verify the top processes in the Top 10 Processes table.

    If a process is taking up too much memory, then this process should be investigated.

    In this example, the database is consuming 82.86 percent of the CPU. The resident size is 259 MB, while the virtual size is 391 MB. Therefore, the database is the likely source of a potential memory problem and should be investigated.

Top 10 Processes (ordered by Memory)

Command	Resident Size (KB)	Virtual Size (KB)	CPU Utilization (%)	Owner	Process ID
ORACLE	265,704	400,392	82.86	N/A	836
java	169,544	192,704	0	N/A	2440
iexplore	58,552	40,320	0	N/A	6060
OUTLOOK	56,844	35,056	0	N/A	1896
iexplore	34,688	44,020	0	N/A	3896
sqlplus	29,964	26,440	0	N/A	5512
FrameMaker	21,608	53,112	2.86	N/A	3340
JRUN	21,472	40,788	9.52	N/A	292
NOTEPAD	14,912	12,624	0	N/A	5568
emagent	14,456	36,176	0	N/A	2500

11. If a memory performance problem is identified, you can attempt to resolve the issue by doing the following:

    - Using Automatic Memory Management to automatically manage and distribute memory between the System Global Area (SGA) and the aggregate program global area (PGA aggregate)

- Using the Memory Advisor to set SGA and PGA memory target values
- Using Automatic PGA Management to manage SQL memory execution
- Avoiding running too many processes that use a lot of memory
- Reducing paging or swapping
- Reducing the number of open cursors and hard parsing with cursor sharing

See Also:

- *Oracle Database Administrator's Guide* for information about using Automatic Memory Management
- *Oracle Database 2 Day DBA* for information about using the Memory Advisor
- *Oracle Database Performance Tuning Guide* for information about resolving memory issues

Monitoring Disk I/O Utilization

Because the database resides on a set of disks, the performance of the I/O subsystem is very important to the performance of the database. Important disk statistics include the disk I/Os per second and the length of the service times. These statistics show if the disk is performing optimally or if the disk is being overworked. This section describes how to monitor disk I/O utilization.

To monitor disk I/O utilization:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

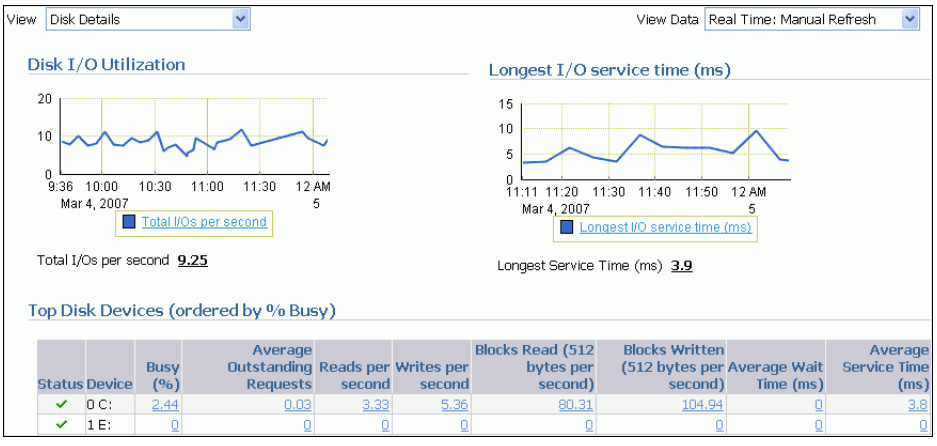
2. In the Host chart, click **Load Average** in the legend.

   The Host page appears, showing the Performance subpage.

3. Select **Disk Details** from the View list.

   The Disk Details view appears.

   This view contains disk I/O utilization and service time statistics gathered over the last hour, and the top disk devices ordered by busy percentage.



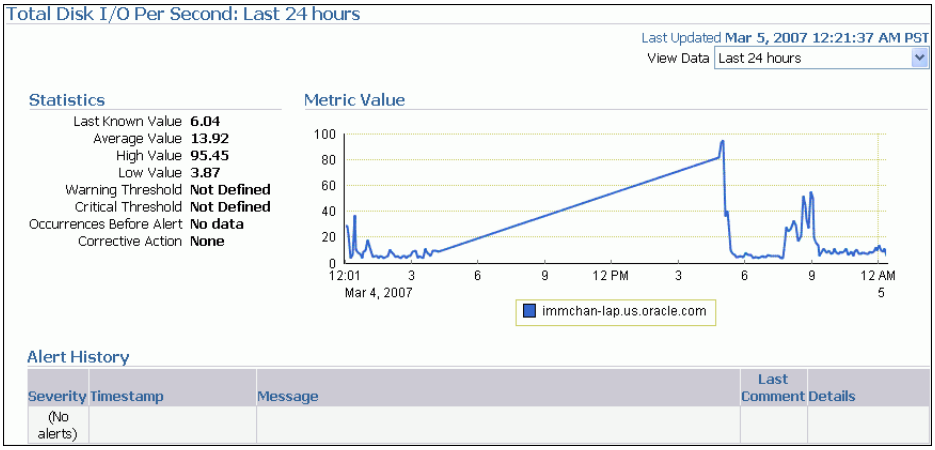
4. Verify the current disk I/O utilization using the Disk I/O Utilization chart.

The Disk I/O Utilization chart shows how many disk I/Os are being performed per second. The current value for total I/Os per second is displayed below the chart.

5. Click **Total I/Os per Second**.

   The Total Disk I/O Per Second page appears.

   This page contains disk utilization statistics and related alerts generated over the last 24 hours.



In this example, an alert is not generated because a threshold is not defined.

If you notice an unexpected spike in this value that is sustained through standard workload hours, then a disk I/O performance problem might exist and should be investigated.

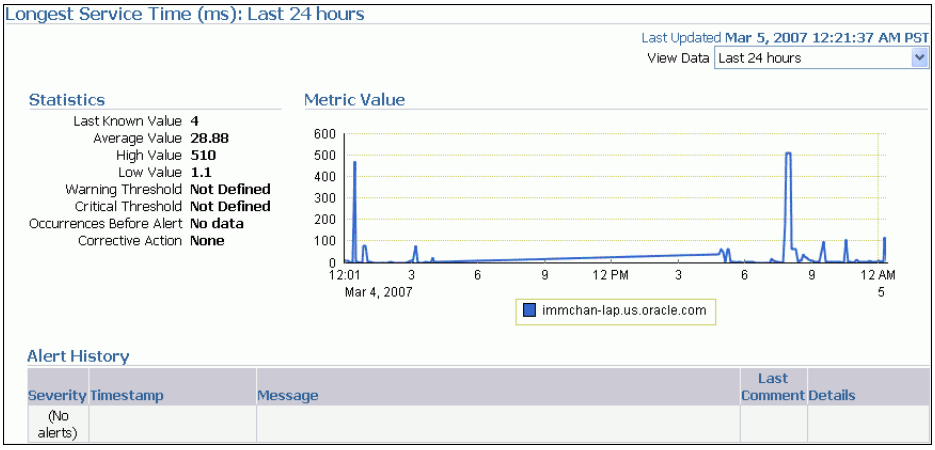
6. Verify the current I/O service time using the Longest I/O Service Time chart.

   The Longest I/O Service Time chart shows the longest service time for disk I/Os in milliseconds. The current value for longest I/O service time is displayed below the chart.

7. Click **Longest I/O Service Time**.

   The Longest Service Time page appears.

   This page contains I/O service time statistics and related alerts generated over the last 24 hours.



In this example, an alert is not generated because a threshold is not defined.

If you notice an unexpected spike in this value that is sustained through normal workload hours, then a disk I/O performance problem might exist and should be investigated.

8. On the Disk Details page, verify the disk devices in the Top Disk Devices table.

   If a particular disk is busy a high percentage of the time, then this disk should be investigated.

   In this example, the drive that hosts Oracle Database (drive C) is only busy about 2.82 percent of the time, and there does not appear to be a disk performance problem.

Top Disk Devices (ordered by % Busy)

Status	Device	Busy (%)	Average Outstanding Requests	Reads per second	Writes per second	Blocks Read (512 bytes per second)	Blocks Written (512 bytes per second)	Average Wait Time (ms)	Average Service Time (ms)
✓	0 C:	2.82	0.06	3.04	5.14	120.85	84.53	0	7.3
✓	1 E:	0	0	0	0	0	0	0	0

9. If a disk I/O performance problem is identified, you can attempt to resolve the problem by doing the following:
   - Using Automatic Storage Management (ASM) to manage database storage
   - Striping everything across every disk to distribute I/O
   - Moving files such as archived redo logs and online redo logs to separate disks
   - Storing required data in memory to reduce the number of physical I/Os

   See Also:

   - *Oracle Database Performance Tuning Guide* for information about resolving disk I/O issues

Customizing the Database Performance Page

You can customize the Performance page so that it specifically addresses your requirements. As explained in "Monitoring Instance Activity" on page 4-10, you can specify which charts you want to appear by default in the Performance page, and how you want them to appear. You can also decide whether to include baseline values in the Throughput and Services charts.

Enterprise Manager stores persistent customization information for each user in the repository. Enterprise Manager retrieves the customization data when you access the Performance page and caches it for the remainder of the browser session until you change the settings.

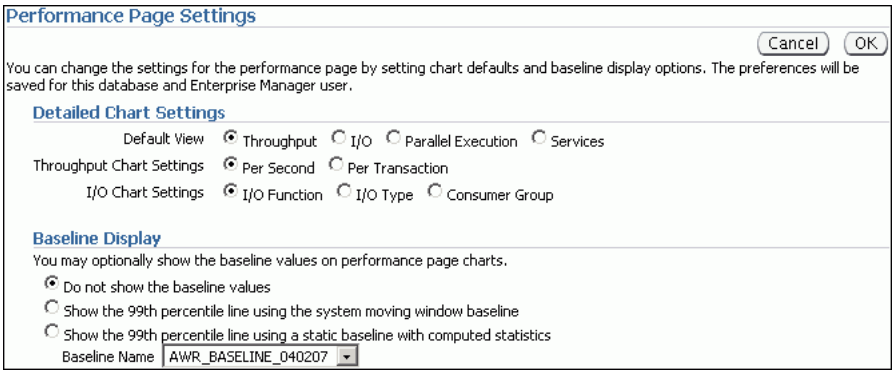
To customize the Performance page:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

2. On the Performance page, click **Settings**.

   The Performance Page Settings page appears.



3. In the Detailed Chart Settings section, choose the defaults for display of the instance activity charts. Complete the following steps:

   a. In **Default View**, select the instance activity chart to appear by default in the Average Active Session section.

      See "Monitoring Instance Activity" on page 4-10 for a description of the Throughput, I/O, Parallel Execution, and Services charts.

   b. In **Throughput Chart Settings**, select **Per Second** or **Per Transaction** as the default instance throughput rate to be displayed in the Throughput chart.

      See "Monitoring Throughput" on page 4-11 to learn how to use the Throughput charts.

   c. In **I/O Chart Settings**, select the default I/O breakdown to be displayed in the I/O chart.

      See "Monitoring I/O" on page 4-12 to learn how to use the I/O charts.

4. In the Baseline Display section, choose how Automatic Workload Repository (AWR) baselines will be displayed in the performance charts. Do one of the following:

   - Select **Do not show the baseline values** to prevent baselines from appearing.
   - Select **Show the 99th percentile line using the system moving window baseline** to specify a percentile to display for the Throughput and Services charts.

     Note that the 99th percentile is a very high significance level.
   - Select **Show the 99th percentile line using a static baseline with computed statistics** and then select a baseline name from the Baseline Name list.

     Note that you can select only baselines that have undergone schedule statistics computation, as described in "Computing Threshold Statistics for Baselines" on page 8-6.

5. Click **OK**.

   The Performance page reappears.

   The charts are now displayed according to your customization settings.

5

Monitoring Performance Alerts

Oracle Database includes a built-in alerts infrastructure to notify you of impending problems with the database. By default, Oracle Database enables the following alerts:

- Tablespace Usage
- Snapshot Too Old
- Recovery Area Low on Free Space
- Resumable Session Suspended

For information about alerts and how to manage them, see *Oracle Database 2 Day DBA*.

In addition to these default alerts, you can use performance alerts to detect any unusual changes in database performance.

This chapter contains the following sections:

Setting Metric Thresholds for Performance Alerts

A metric is defined as the rate of change in some cumulative statistic. This rate can be measured against a variety of units, including time, transactions, or database calls. For example, the number database calls per second is a metric.

Performance alerts are based on metrics that are performance-related. These alerts are either environment-dependent or application-dependent.

Environment-dependent performance alerts may not be relevant on all systems. For example, the `AVERAGE_FILE_READ_TIME` metric generates an alert when the average time to read a file exceeds the metric threshold. This alert may be useful on a system with only one disk. On a system with multiple disks, however, the alert may not be relevant because I/O processing is spread across the entire subsystem.

Application-dependent performance alerts are typically relevant on all systems. For example, the `BLOCKED_USERS` metric generates a performance alert when the number of users blocked by a particular session exceeds the metric threshold. This alert is relevant regardless of how the environment is configured.

To obtain the most relevant information from performance alerts, set the threshold values of performance metrics to values that represent desirable boundaries for your system. You can then fine-tune these values over time until an equilibrium is reached.

To set thresholds for performance metrics:

1. On the Database Home page, under Related Links, click **Metric and Policy Settings**.

   The Metric and Policy Settings page appears, showing the Metric Thresholds subpage.

2. For each performance metric relevant for your system, click the **Edit** icon.

   The Edit Advanced Settings page appears.

3. Follow the steps of the wizard to set the threshold value.

See Also:

- "Setting Metric Thresholds for Baselines" on page 8-7
- *Oracle Database 2 Day DBA* to learn how to set metric thresholds

Responding to Alerts

When an alert is generated by Oracle Database, it appears under Alerts on the Database Home page.

Oracle Enterprise Manager enables you to configure alerts to be sent by means of e-mail, pager, or cellular phone text messaging.

To respond to an alert:

1. On the Database Home page, under Alerts, locate the alert that you want to investigate and click the **Message** link.

   A page that contains further information about the alert appears.

2. Do one of the following:

   - Follow the recommendations.
   - Run Automatic Database Diagnostic Monitor (ADDM) or another advisor to get more detailed diagnostics of the system or object behavior.

See Also:

- *Oracle Database 2 Day DBA* for information about how to configure the alert notification method

Clearing Alerts

Most alerts, such as the CPU Utilization alert, are cleared automatically when the cause of the problem disappears. However, other alerts, such as the Generic Alert Log Error alert, must be acknowledged.

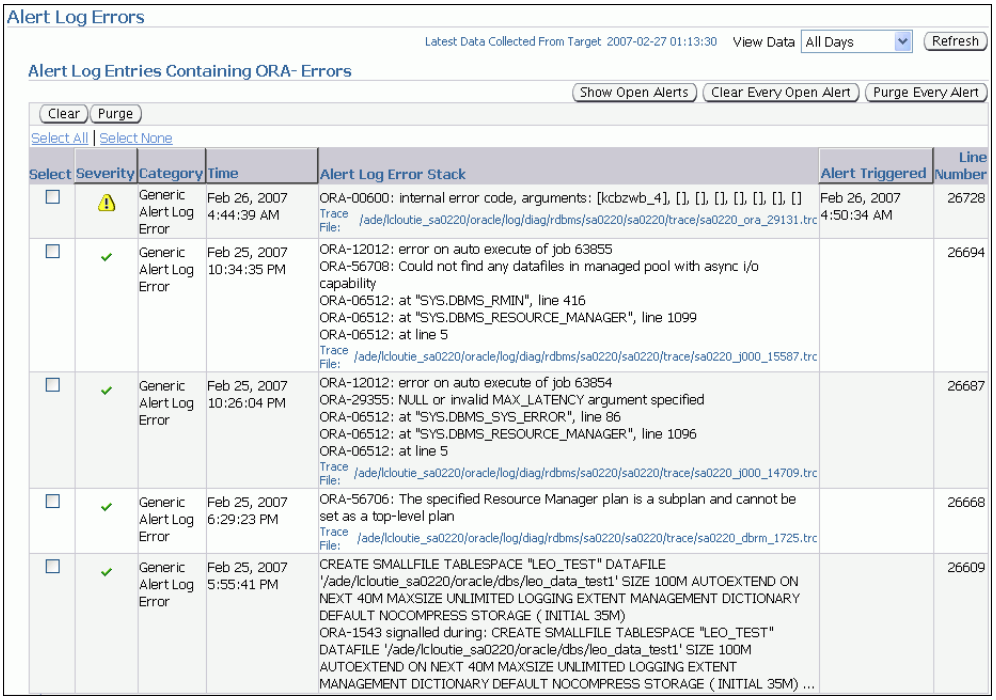
After taking the necessary corrective measures, you can acknowledge an alert by clearing or purging it. Clearing an alert sends the alert to the Alert History, which can

be viewed from the Database Home page under Related Links. Purging an alert removes it from the Alert History.

To clear alerts:

1. On the Database Home page, under Diagnostic Summary, click the **Alert Log** link.

   The Alert Log Errors page appears.



2. Do one of the following:
   - Select the alerts that you want to clear and click **Clear**.
   - To clear all open alerts, click **Clear Every Open Alert**.
3. Do one of the following:
   - Select the alerts that you want to purge and click **Purge**.
   - To purge all alerts, click **Purge Every Alert**.

See Also:

- *Oracle Database 2 Day DBA* to learn how to manage alerts

Part III

Reactive Database Tuning

Part III describes how to tune Oracle Database in response to a reported problem, such as when the user reports a performance problem with the database that needs to be tuned immediately.

This part contains the following chapters:

6

Manual Database Performance Monitoring

You can run the Automatic Database Diagnostic Monitor (ADDM) manually to monitor current and historical database performance. Typically, you use the automatic diagnostic feature of ADDM to identify performance problems with the database. As described in Chapter 3, "Automatic Database Performance Monitoring", ADDM runs once every hour by default. It is possible to configure ADDM to run more or less frequently. However, in some cases you may want to run ADDM manually.

One reason for running ADDM manually is to analyze a time period longer than one ADDM analysis period. For example, you may want to analyze database performance in a full workday by analyzing 8 consecutive hours of activity. One technique is to analyze each of the individual ADDM analyses within this 8-hour period. However, this approach may become complicated if performance problems exist for only part of the 8-hour period, because they may appear in only some of the individual ADDM analyses. Alternatively, you can run ADDM manually with a pair of Automatic Workload Repository (AWR) snapshots that encompass the 8-hour period. In this case, ADDM will identify the most critical performance problems in the entire time period.

This chapter contains the following sections:

Manually Running ADDM to Analyze Current Database Performance

By default, ADDM runs every hour to analyze snapshots taken by AWR during this period. In some cases you may notice performance degradation that did not exist in the previous ADDM analysis period, or a sudden spike in database activity on the Performance page, as described in Chapter 4, "Monitoring Real-Time Database Performance". If the next ADDM analysis is not scheduled to run for 30 minutes, then you may want to run ADDM manually to identify and resolve the performance problem.

When you run ADDM manually, a manual AWR snapshot is created automatically. This manual run may affect the ADDM run cycle. For example, if you scheduled ADDM to run hourly at the start of each hour and the last ADDM run was at 8:00 p.m., running ADDM manually at 8:30 p.m. will cause the next scheduled ADDM run to start at 9:30 p.m., not 9:00 p.m. All subsequent ADDM runs will continue on the new run cycle, occurring hourly at the half-hour instead of the start of each hour.

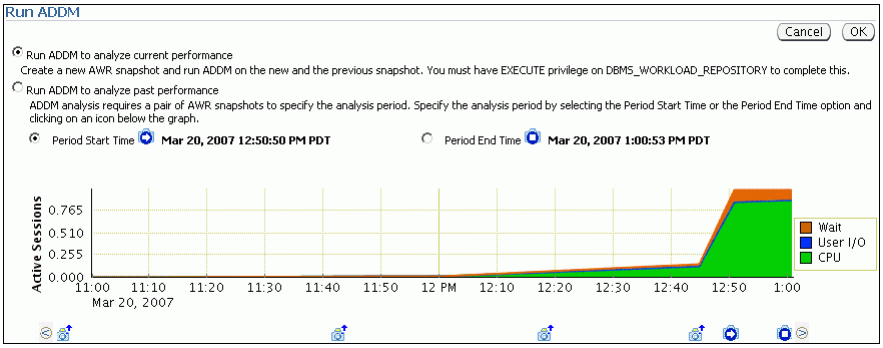
To analyze current database performance by manually running ADDM:

1. On the Database Home page, under Related Links, click **Advisor Central**.

The Advisor Central page appears.

2. Under Advisors, click **ADDM**.

   The Run ADDM page appears.



   In this example, CPU usage spiked in the last 10 minutes.

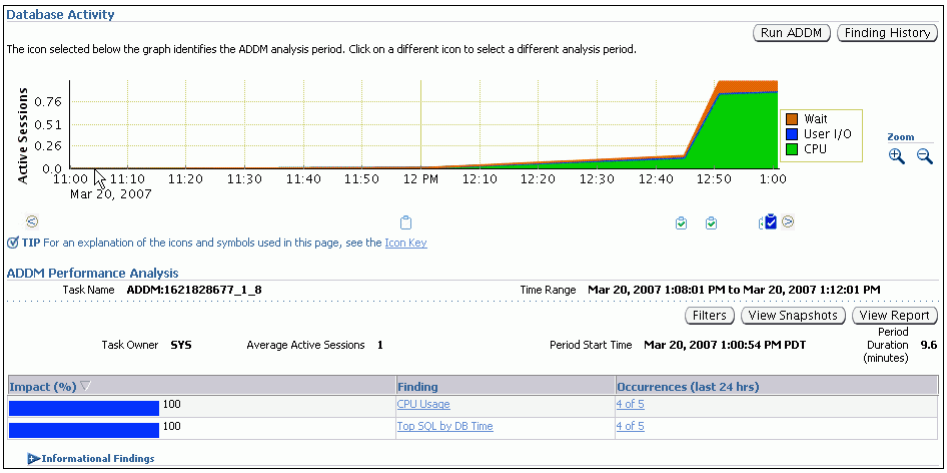
3. Select **Run ADDM to analyze current instance performance** and click **OK**.

   The Confirmation page appears.

4. Click **Yes**.

   The Processing: Run ADDM Now page appears while the database takes a new AWR snapshot.

   An ADDM run occurs for the time period between the new and the previous snapshot. After ADDM completes the analysis, the Automatic Database Diagnostic Monitor (ADDM) page appears with the results.



5. Click **View Report**.

   The View Report page appears.

6. Optionally, click **Save to File** to save the results of the ADDM task in a report for later access.

See Also:

- "Reviewing the Automatic Database Diagnostic Monitor Analysis" on page 3-7

Manually Running ADDM to Analyze Historical Database Performance

You can run ADDM manually to analyze historical database performance by selecting a pair or range of AWR snapshots as the analysis period. This technique is useful when you have identified a time period in the past when database performance was poor.

In the Performance page, you can monitor historical performance by selecting **Historical** from the View Data list. In Historical view, you can monitor database performance in the past, up to the duration defined by the AWR retention period. If you notice performance degradation, then you can drill down to appropriate pages from the Performance page to identify historical performance problems with the database, as described in Chapter 4, "Monitoring Real-Time Database Performance". If you identify a problem, then you can run ADDM manually to analyze a particular time period.

To analyze historical database performance by manually running ADDM:

1. On the Database Home page, under Related Links, click **Advisor Central**.

   The Advisor Central page appears.

2. Under Advisors, click **ADDM**.

   The Run ADDM page appears.

3. Select **Run ADDM to analyze past instance performance**.

4. Specify a time period for analysis by selecting a pair of AWR snapshots. Complete the following steps:

   a. Select **Period Start Time**.

   b. Below the chart for the starting snapshot, click the snapshot you want to use for the start time.

      A play icon (displayed as an arrow) appears over the snapshot icon.

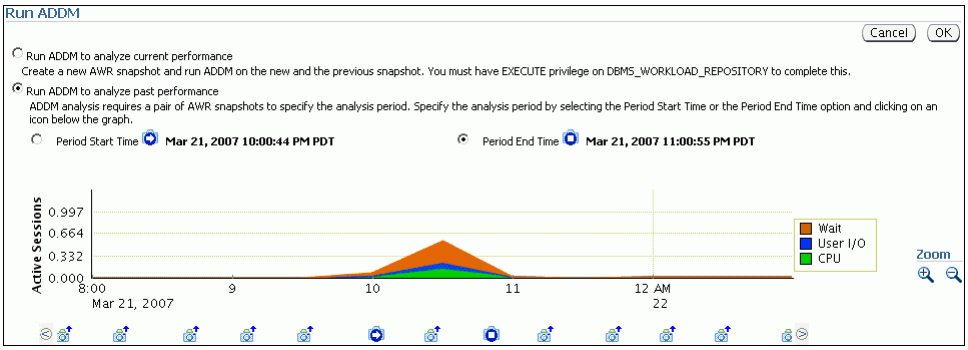
      In this example, database activity peaked from 10 p.m. to 11 p.m., so the snapshot taken at 10:00 p.m. is selected for the start time.

   c. Select **Period End Time**.

   d. Below the chart for the ending snapshot, click the snapshot you want to use for the end time.

      A stop icon (displayed as a square) appears over the snapshot icon.

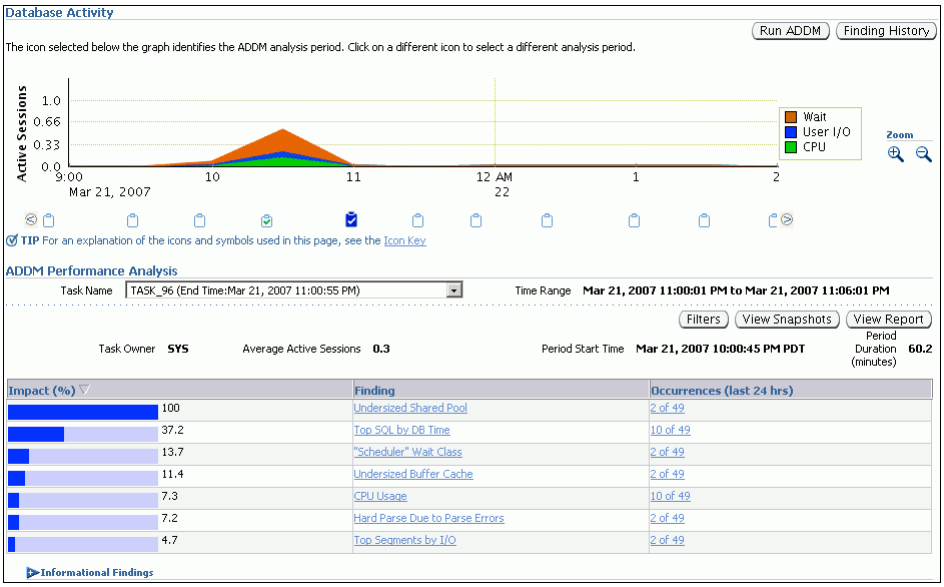
      In this example, the snapshot taken at 10:00 p.m. is selected.



5. Click **OK**.

After ADDM completes the analysis, the Automatic Database Diagnostic Monitor (ADDM) page appears with the results of the ADDM run.

Figure 6–1 Analyzing Historical Database Performance



6. Click **View Report**.

   The View Report page appears.

7. Optionally, click **Save to File**.

See Also:

- "Reviewing the Automatic Database Diagnostic Monitor Analysis" on page 3-7

Accessing Previous ADDM Results

If you ran ADDM manually to analyze current or historical database performance, the results are displayed on the Automatic Database Diagnostic Monitor (ADDM) page after the ADDM run has completed.

You can access the ADDM results at a later time, or access the ADDM results from previous executions.

To access the ADDM results:

1. On the Database Home page, under Related Links, click **Advisor Central**.

   The Advisor Central page appears.

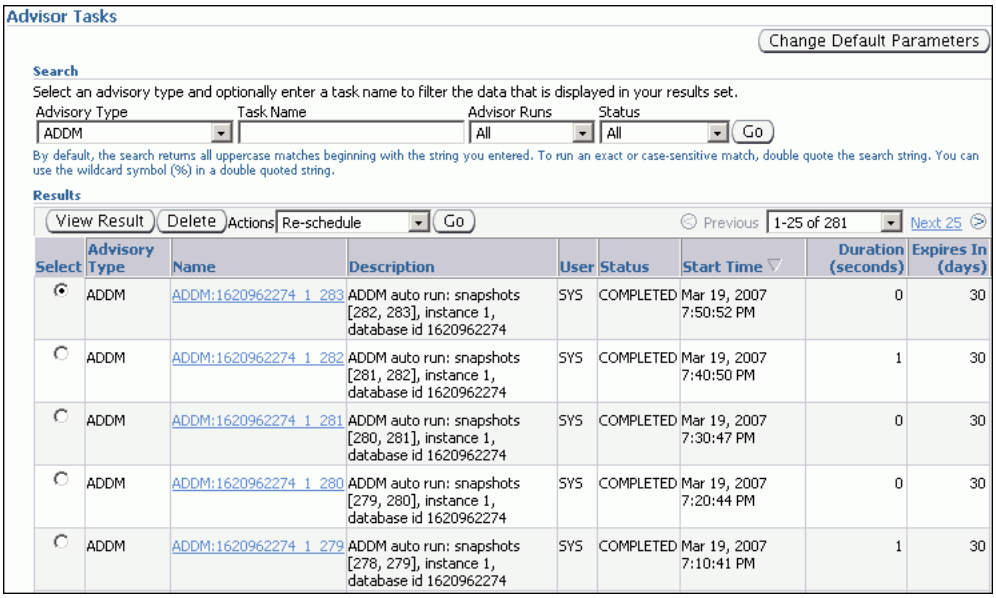
2. Complete the following steps:

   a. Under Advisor Tasks, select **ADDM** from the Advisory Type list.

   b. Select the appropriate search criteria.

      For example, you can select **All** in the Advisor Runs list to view all ADDM tasks.

   c. Click **Go**.



The ADDM tasks are displayed under Results.

3. To view an ADDM result, select the desired ADDM task and click **View Result**.

   The results from the selected ADDM task are shown in the Automatic Database Diagnostic Monitor (ADDM) page.

See Also:

- "Reviewing the Automatic Database Diagnostic Monitor Analysis" on page 3-7

7

Resolving Transient Performance Problems

Transient performance problems are short-lived and do not appear in the Automatic Database Diagnostic Monitor (ADDM) analysis. ADDM tries to report the most significant performance problems during an analysis period in terms of their effect on DB time. If a problem lasts for a brief time, then its severity might be averaged out or minimized by other performance problems in the entire analysis period. Therefore, the problem may not appear in the ADDM findings. Whether or not a performance problem is captured by ADDM depends on its duration compared to the interval between the Automatic Workload Repository (AWR) snapshots.

If a performance problem lasts for a significant portion of the time between snapshots, then it will be captured by ADDM. For example, if the snapshot interval is one hour, a performance problem that lasts 30 minutes should not be considered a transient performance problem because its duration represents a significant portion of the snapshot interval and will likely be captured by ADDM.

On the other hand, a performance problem that lasts 2 minutes could be a transient performance problem because its duration represents a small portion of the snapshot interval and will likely not show up in the ADDM findings. For example, if the system was slow between 10:00 p.m. and 10:10 p.m., but the ADDM analysis for the time period between 10:00 p.m. and 11:00 p.m. does not show a performance problem, a transient performance problem may have occurred for only a few minutes of the 10-minute interval reported by the user.

This chapter contains the following sections:

Overview of Active Session History

To capture a detailed history of database activity, Oracle Database samples active sessions each second with the Active Session History (ASH) sampler. The Automatic Workload Repository (AWR) snapshot processing collects the sampled data into memory and writes it to persistent storage. ASH is an integral part of the Oracle Database self-management framework and is extremely useful for diagnosing performance problems.

Unlike instance-level statistics gathered by AWR, sampled data is gathered at the session level by ASH. By capturing statistics for only active sessions, a manageable set of data is represented. The size of this data is directly related to the work being performed, rather than to the entire database instance.

Sampled data captured by ASH can be aggregated based on the various dimensions that it captures, including the following:

- SQL identifier of a SQL statement
- Object number, file number, and block number
- Wait event identifier and parameters
- Session identifier and session serial number
- Module and action name
- Client identifier of the session
- Service hash identifier

You can run ASH reports to analyze transient performance problems with the database that only occur during specific times. This technique is especially useful when you are trying to do either of the following:

- Resolve transient performance problems that may last for only a short period of time, such as why a particular job or session is not responding when the rest of the instance is performing as usual
- Perform scoped or targeted performance analysis by various dimensions or their combinations, such as time, session, module, action, or SQL identifier

See Also:

- "Active Session History Statistics" on page 2-4

Running Active Session History Reports

This section describes how to generate ASH reports using Oracle Enterprise Manager (Enterprise Manager).

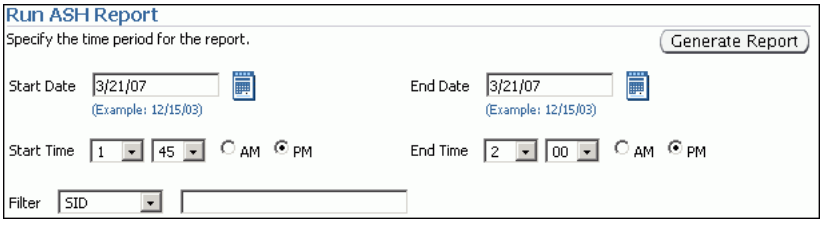
To run ASH reports:

1. On the Performance page, under Average Active Sessions, click **Run ASH Report**.

   The Run ASH Report page appears.

2. Enter the date and time for the start and end of the time period when the transient performance problem occurred.

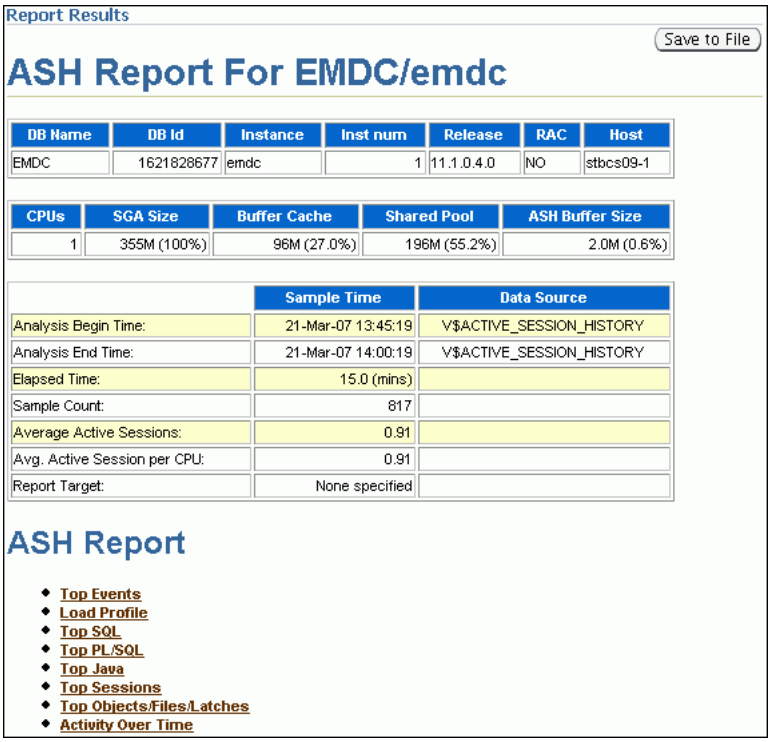
   In this example, database activity increased between 1:45 p.m. and 2:00 p.m., so an ASH report needs to be created for that time period.



3. Click **Generate Report**.

   The Processing: View Report page appears while the report is being generated.

   After the report is generated, the ASH report appears under Report Results on the Run ASH Report page.


Report Results

Save to File

ASH Report For EMDC/emdc

DB Name	DB Id	Instance	Inst num	Release	RAC	Host
EMDC	1621828677	emdc	1	11.1.0.4.0	NO	stbcs09-1

CPUs	SGA Size	Buffer Cache	Shared Pool	ASH Buffer Size
1	355M (100%)	96M (27.0%)	196M (55.2%)	2.0M (0.6%)

	Sample Time	Data Source
Analysis Begin Time:	21-Mar-07 13:45:19	V$ACTIVE_SESSION_HISTORY
Analysis End Time:	21-Mar-07 14:00:19	V$ACTIVE_SESSION_HISTORY
Elapsed Time:	15.0 (mins)	
Sample Count:	817	
Average Active Sessions:	0.91	
Avg. Active Session per CPU:	0.91	
Report Target:	None specified	

ASH Report

- Top Events
- Load Profile
- Top SQL
- Top PL/SQL
- Top Java
- Top Sessions
- Top Objects/Files/Latches
- Activity Over Time

4. Optionally, click **Save to File** to save the report in HTML for future analysis.

Active Session History Reports

You can use an ASH report to identify the source of transient performance problems. The report is divided into titled sections. The following sections of the ASH report are a useful place to begin the investigation:

- Top Events
- Load Profile
- Top SQL
- Top Sessions
- Top DB Objects
- Top DB Files
- Activity Over Time

See Also:

- *Oracle Database Performance Tuning Guide* for more detailed information about the ASH report

Top Events

The Top Events section of the report describes the top wait events of the sampled session activity categorized by user, background, and priority. Use this information to identify the wait events that may be the cause of the transient performance problem.

The Top Events section of the report contains the following subsections:

- Top User Events

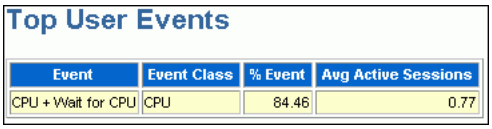
- Top Background Events

Top User Events

The Top User Events subsection of the report lists the top wait events from user processes that accounted for the highest percentages of sampled session activity.

The example in Figure 7–1 shows that 84 percent of database activity is consumed by the `CPU + Wait for CPU` event. In this example, the Load Profile section should be examined next to determine the type of activity that is causing this wait event.

Figure 7–1 Top User Events



Top User Events

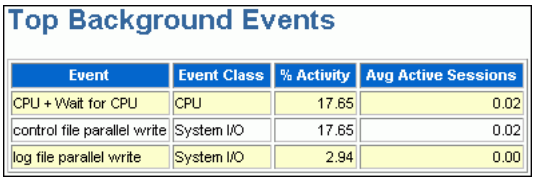
Event	Event Class	% Event	Avg Active Sessions
CPU + Wait for CPU	CPU	84.46	0.77

Top Background Events

The Top Background Events subsection of the report lists the top wait events from the background events that accounted for the highest percentages of sampled session activity.

The example in Figure 7–2 shows that 17.65 percent of sampled session activity is consumed by the `CPU + Wait for CPU` event.

Figure 7–2 Top Background Events



Top Background Events

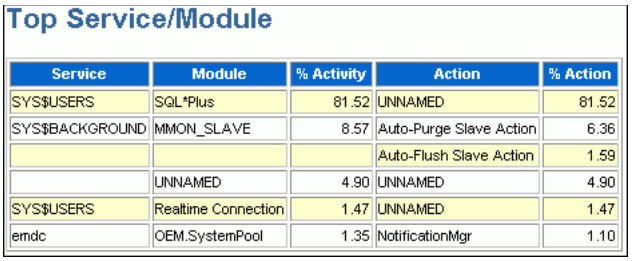
Event	Event Class	% Activity	Avg Active Sessions
CPU + Wait for CPU	CPU	17.65	0.02
control file parallel write	System I/O	17.65	0.02
log file parallel write	System I/O	2.94	0.00

Load Profile

The Load Profile section of the report describes the load analyzed in the sampled session activity. Use the information in this section to identify the service, client, or SQL command type that may be the cause of the transient performance problem. The Top Service/Module subsection lists the services and modules that accounted for the highest percentages of sampled session activity.

The example in Figure 7–3 shows that 81 percent of database activity is consumed by the `SYS$USERS` service running the SQL*Plus module. In this example, it appears that the user is running a high-load SQL statement that is causing the performance problem indicated in Figure 7–1. The Top SQL section of the report should be analyzed next to determine whether a particular type of SQL statement makes up the load.

Figure 7–3 Top Service/Module



Top Service/Module

Service	Module	% Activity	Action	% Action
SYS$USERS	SQL*Plus	81.52	UNNAMED	81.52
SYS$BACKGROUND	MMON_SLAVE	8.57	Auto-Purge Slave Action	6.36
			Auto-Flush Slave Action	1.59
	UNNAMED	4.90	UNNAMED	4.90
SYS$USERS	Realtime Connection	1.47	UNNAMED	1.47
emdc	OEM.SystemPool	1.35	NotificationMgr	1.10

See Also:

- "Monitoring Top Services" on page 4-6
- "Monitoring Top Modules" on page 4-7

Top SQL

The Top SQL section of the report describes the top SQL statements of the sampled session activity. Use this information to identify high-load SQL statements that may be the cause of the transient performance problem. One useful subsection is Top SQL with Top Events, which lists the SQL statements that accounted for the highest percentages of sampled session activity. The Sampled # of Executions column shows how many distinct executions of a particular SQL statement were sampled. To view the text of the SQL statements, click the **SQL ID** link.

The example in Figure 7–4 shows that 75 percent of database activity is consumed by a particular `SELECT` statement. This statement was executed in the SQL*Plus module shown in Figure 7–3. It appears that this high-load SQL statement is causing the performance problem. The Top Sessions section should be analyzed to identify the session running this SQL statement.

Figure 7–4 Top SQL with Top Events

SQL ID	Planhash	Sampled # of Executions	% Activity	Event	% Event	Top Row Source	% RwSrc	SQL Text
5mxdwvuf9j3wp	3219640484	583	75.64	CPU + Wait for CPU	75.64	SELECT STATEMENT	42.96	SELECT /*+ ORDERED USE_NL(c) F...
0abfbq9bmcf0s		1	5.63	CPU + Wait for CPU	5.63	** Row Source Not Available **	5.63	DECLARE n number; BEGIN for i...

See Also:

- "Monitoring Top SQL" on page 4-4

Top Sessions

The Top Sessions section lists the sessions that were waiting for the wait event that accounted for the highest percentages of sampled session activity. Use this information to identify the sessions that accounted for the highest percentages of sampled session activity, which may be the cause of the performance problem.

The example in Figure 7–5 shows that 81 percent of database activity is used by the user `SH` with the session ID of 147. Thus, it appears that this user was running the high-load SQL statement identified in Figure 7–4. You should investigate this session to determine whether it is performing a legitimate operation and tune the SQL statement if possible. If tuning the SQL is not possible and the session is causing an unacceptable performance impact on the system, consider terminating the session.

Figure 7–5 Top Sessions

Sid, Serial#	% Activity	Event	% Event	User	Program	# Samples Active	XIDs
147, 9322	81.40	CPU + Wait for CPU	81.40	SH	sqlplus@stbcs09-1 (TNS V1-V3)	665/900 [74%]	0
125,15415	6.36	CPU + Wait for CPU	3.55	SYS	oracle@stbcs09-1 (m000)	29/900 [3%]	2
		db file sequential read	1.96			16/900 [2%]	4
131, 45	1.10	SQL*Net break/reset to client	0.98	SYSMAN	OMS	8/900 [1%]	0
161, 1	1.10	log file parallel write	1.10	SYS	oracle@stbcs09-1 (LGWR)	9/900 [1%]	0
164, 3	1.10	CPU + Wait for CPU	1.10	SYS	oracle@stbcs09-1 (DIA0)	9/900 [1%]	0

See Also:

- "Monitoring Top Sessions" on page 4-5
- Chapter 10, "Tuning SQL Statements"

Top DB Objects

The Top DB Objects subsection lists the database objects (such as tables and indexes) that accounted for the highest percentages of sampled session activity.

The example in Figure 7–6 shows that the objects accounting for the most session activity are in the `SYSTEM` and `SYSAUX` tablespaces. In each row of the table, the event is `db file sequential read`, which signifies that a user process is reading a buffer into the system global area (SGA) buffer cache and is waiting for a physical I/O call to return.

Figure 7–6 Top DB Objects

Top DB Objects

- With respect to Application, Cluster, User I/O and buffer busy waits only.

Object ID	% Activity	Event	% Event	Object Name (Type)	Tablespace
512	2.94	db file sequential read	2.94	SYS.KOTTD$ (TABLE)	SYSTEM
523	2.94	db file sequential read	2.94	SYS.SYS_C00648 (INDEX)	SYSTEM
60507	2.94	db file sequential read	2.94	SYSMAN.MGMT_TARGET_TYPES (TABLE)	SYSAUX
60684	2.94	db file sequential read	2.94	SYSMAN.PK_MGMT_CREDENTIALS (INDEX)	SYSAUX
60789	2.94	db file sequential read	2.94	SYSMAN.MGMT_BUG_ADVISORY (TABLE)	SYSAUX

Top DB Files

The Top DB Files subsection lists the database files that accounted for the highest percentages of sampled session activity.

The example in Figure 7–7 shows that most of the session activity involves the datafile in the `SYSTEM` tablespace. This information is consistent with Figure 7–6, which shows that the objects accounting for the most session activity are located in the `SYSTEM` and `SYSAUX` tablespaces.

Figure 7–7 Top DB Files

Top Files

View: Top Files

Activity (%)	Name	Tablespace	Average Wait Time (ms)
100.00	/ade/las...acle/dbs/t_db1.f	SYSTEM	322

Total Sample Count: 3

Activity Over Time

The Activity Over Time section of the ASH report is particularly useful for longer time periods because it provides in-depth details about activities and workload profiles during the analysis period. The Activity Over Time section is divided into multiple time slots.

Figure 7–8 Activity Over Time

Slot Time (Duration)	Slot Count	Event	Event Count	% Event
13:45:19 (41 secs)	2	CPU + Wait for CPU	1	0.12
		SQL*Net break/reset to client	1	0.12
13:46:00 (2.0 min)	19	CPU + Wait for CPU	17	2.08
		SQL*Net break/reset to client	2	0.24
13:48:00 (2.0 min)	130	CPU + Wait for CPU	122	14.93
		SQL*Net break/reset to client	3	0.37
		control file parallel write	2	0.24
13:50:00 (2.0 min)	133	CPU + Wait for CPU	129	15.79
		control file parallel write	2	0.24
		db file sequential read	1	0.12
13:52:00 (2.0 min)	153	CPU + Wait for CPU	141	17.26
		db file sequential read	5	0.61
		control file parallel write	2	0.24
13:54:00 (2.0 min)	175	CPU + Wait for CPU	143	17.50
		db file sequential read	15	1.84
		enq: WF - contention	5	0.61
13:56:00 (2.0 min)	130	CPU + Wait for CPU	124	15.18
		db file sequential read	4	0.49
		Data file init write	1	0.12
13:58:00 (2.0 min)	74	CPU + Wait for CPU	65	7.96
		log file parallel write	3	0.37
		log file sync	3	0.37
14:00:00 (19 secs)	1	CPU + Wait for CPU	1	0.12

Each of the time slots contains information regarding that particular time slot, as described in Table 7–1.

Table 7–1 Activity Over Time

Column	Description
Slot Time (Duration)	Duration of the slot
Slot Count	Number of sampled sessions in the slot
Event	Top three wait events in the slot
Event Count	Number of ASH samples waiting for the wait event
% Event	Percentage of ASH samples waiting for wait events in the entire analysis period

All inner slots are 2 minutes each and can be compared to each other. The first and last slots, which are also called the outer slots, are odd-sized because they are the only slots that do not have a fixed slot time.

When comparing the inner slots, perform a skew analysis by identifying spikes in the Event Count and Slot Count columns. A spike in the Event Count column indicates an increase in the number of sampled sessions waiting for a particular event. A spike in the Slot Count column indicates an increase in active sessions, because ASH data is sampled from active sessions only and a relative increase in database workload. Typically, when the number of active session samples and the number of sessions

associated with a wait event increase, the slot may be the cause of the transient performance problem.

The example in Figure 7–8 indicates that the number of sampled sessions rose sharply in the first inner slot and fell sharply in the last inner slot. The slot count and event count peaked in the 13:54 p.m. time slot.

8

Resolving Performance Degradation Over Time

Performance degradation of the database over time happens when your database was performing optimally in the past, such as 6 months ago, but has gradually degraded to a point where it becomes noticeable to the users. The Automatic Workload Repository (AWR) Compare Periods report enables you to compare database performance between two periods of time.

While an AWR report shows AWR data between two snapshots (or two points in time), the AWR Compare Periods report shows the difference between two periods (or two AWR reports, which equates to four snapshots). Using the AWR Compare Periods report helps you to identify detailed performance attributes and configuration settings that differ between two time periods. The two time periods selected for the AWR Compare Periods report can be of different durations. The report normalizes the statistics by the amount of time spent on the database for each time period and presents statistical data ordered by the largest difference between the periods.

For example, a batch workload that historically completed in the maintenance window between 10:00 p.m. and midnight is currently showing poor performance and completing at 2 a.m. You can generate an AWR Compare Periods report from 10:00 p.m. to midnight on a day when performance was good and from 10:00 a.m. to 2 a.m. on a day when performance was poor. The comparison of these reports should identify configuration settings, workload profile, and statistics that were different in these two time periods. Based on the differences identified, you can more easily diagnose the cause of the performance degradation.

This chapter contains the following sections:

See Also:

- "Gathering Database Statistics Using the Automatic Workload Repository" on page 2-1

Managing Baselines

Baselines are an effective way to diagnose performance problems. AWR supports the capture of baseline data by enabling you to specify and preserve a pair or a range of snapshots as a baseline. The snapshots contained in a baseline are excluded from the automatic AWR purging process and are retained indefinitely.

A moving window baseline corresponds to all AWR data that exists within the AWR retention period. Oracle Database automatically maintains a system-defined moving window baseline. The default size of the window is the current AWR retention period, which by default is 8 days.

This section contains the following topics:

Creating a Baseline

Before creating a baseline, carefully consider the time period you choose as a baseline because it should represent the database operating at an optimal level. In the future, you can compare these baselines with other baselines or snapshots captured during periods of poor performance to analyze performance degradation over time.

You can create the following types of baseline:

Creating a Single Baseline

A single baseline is captured at a single, fixed time interval. For example, a single baseline may be captured on March 5, 2007 from 5:00 p.m. to 8:00 p.m.

You can choose a start time and an end time that are in the future to create a baseline that captures future database activity. If both the start time and the end time are in the future, a baseline template with the same name as the baseline will also be created. A baseline template is a specification that enables Oracle Database to automatically generate a baseline for a future time period.

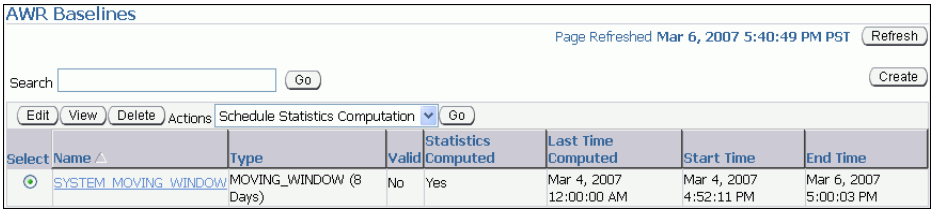
To create a single baseline:

1. From the Database Home page, click **Server**.

   The Server subpage appears.

2. Under Statistics Management, click **AWR Baselines**.

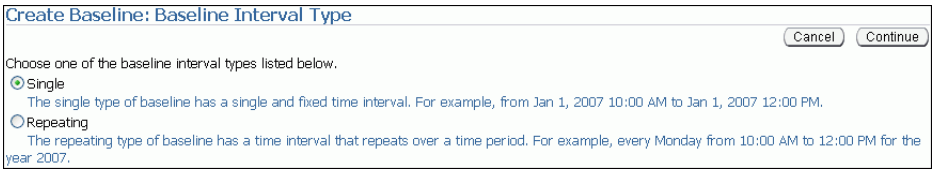
   The AWR Baselines page appears with a list of existing baselines displayed.



3. Click **Create**.

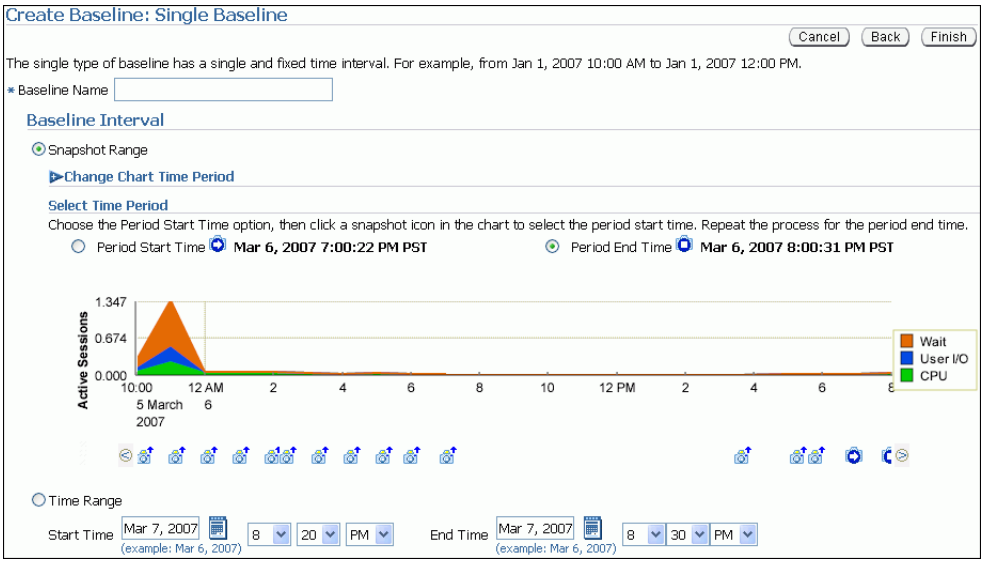
   The Create Baseline: Baseline Interval Type page appears.

4. Select **Single**.



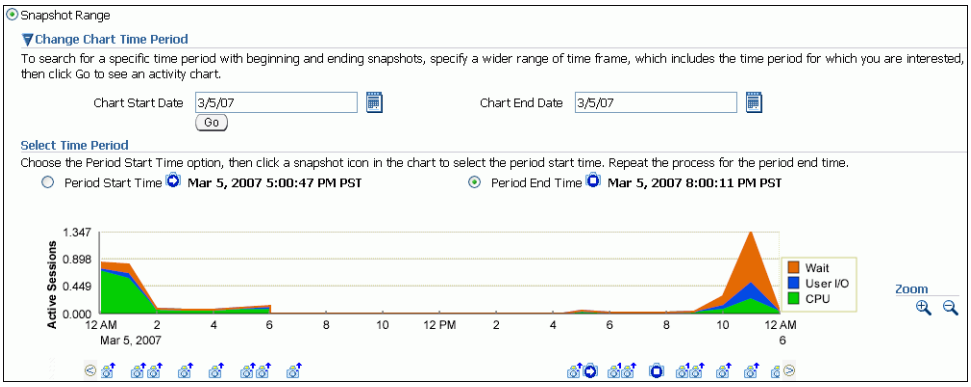
5. Click **Continue**.

   The Create Baseline: Single Baseline page appears.



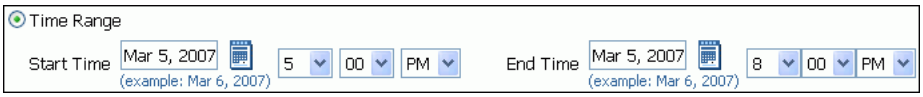
6. In the **Baseline Name** field, enter a name for the baseline.
7. Under Baseline Interval, select whether to use a snapshot range or a time range for the baseline. Do one of the following:
   - To use a snapshot range, select **Snapshot Range**. Complete the following steps:
     - Optionally, to view older snapshots that are not displayed below the Active Sessions chart, expand **Change Chart Time Period**. Enter the desired start date in the **Chart Start Date** field and the desired end date in the **Chart End Date** field, and click **Go**.
     - Under Select Time Period, select a start time for the baseline by selecting **Period Start Time** and the snapshot icon below the Active Sessions chart that corresponds to the desired start time.
     - Select an end time for the baseline by selecting **Period End Time** and the snapshot icon below the Active Sessions chart that corresponds to the desired end time.

     In this example, a snapshot range on March 5, 2007 from 5:00 p.m. to 8:00 p.m. is selected.



- To use a time range, select **Time Range**. Complete the following steps:
  - In the **Start Time** fields, select a start time for the baseline.
  - In the **End Time** fields, select an end time for the baseline.

  In this example, a time range from 5:00 p.m. to 8:00 p.m. on March 5, 2007 is selected.



8. Click **Finish**.

   The AWR Baselines page reappears with the newly created baseline displayed.

Creating a Repeating Baseline

A repeating baseline is a baseline that repeats during a time interval over a specific period. For example, a repeating baseline may repeat every Monday from 5:00 p.m. to 8:00 p.m. for the year 2007.

To create a repeating baseline:

1. From the Database Home page, click **Server**.

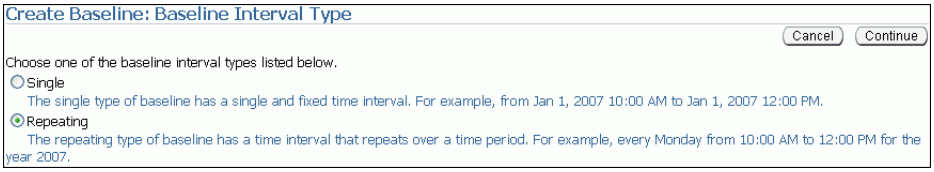
   The Server subpage appears.

2. Under Statistics Management, click **AWR Baselines**.

   The AWR Baselines page appears with a list of existing baselines displayed.

3. Click **Create**.

   The Create Baseline: Baseline Interval Type page appears.



4. Select **Repeating** and then click **Continue**.

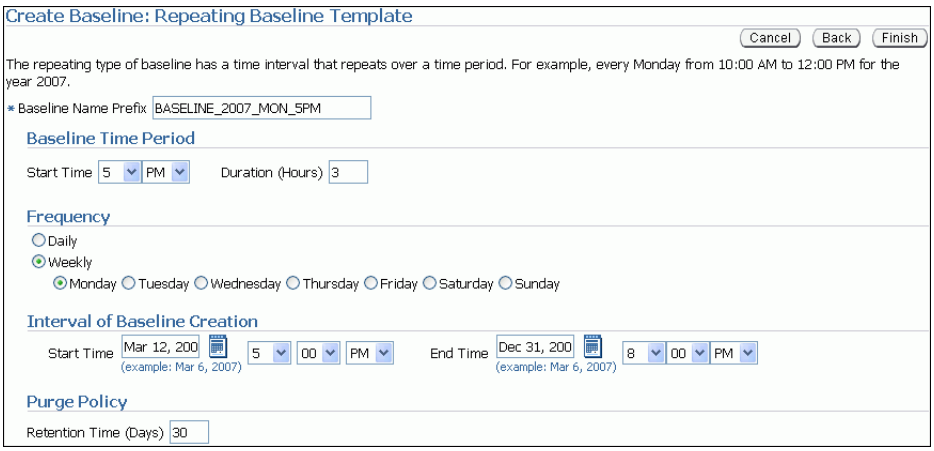
   The Create Baseline: Repeating Baseline Template page appears.

5. In the **Baseline Name Prefix** field, enter a name prefix for the baseline.

6. Under Baseline Time Period, specify the time of the day that you want the baseline to begin collecting AWR data and the duration of the baseline collection.
7. Under Frequency, do one of the following:
   - Select **Daily** if you want the baseline to repeat on a daily basis.
   - Select **Weekly** if you want the baseline to repeat on a weekly basis and select the day of the week on which the baseline will repeat.
8. Under Interval of Baseline Creation, complete the following steps:
   a. In the **Start Time** fields, select a date and time in the future when the data collection should begin.
   b. In the **End Time** fields, select a date and time in the future when the data collection should end.
9. Under Purge Policy, enter the number of days to retain baselines that have been captured.
10. Click **Finish**.

    A baseline template with the same name as the baseline name prefix will also be created. A baseline template is a specification that enables Oracle Database to automatically generate a baseline for a future time period.

    In this example, a repeating baseline that repeats weekly on Mondays from 5:00 p.m. to 8:00 p.m. for the year 2007 will be created.



Deleting a Baseline

To conserve storage space, you may want to periodically delete unused baselines stored in the database.

To delete a baseline:

1. From the Database Home page, click **Server**.

   The Server subpage appears.
2. Under Statistics Management, click **AWR Baselines**.

   The AWR Baselines page appears with a list of existing baselines displayed.
3. Select a baseline and click **Delete**.

   The Confirmation page appears.

4. Select whether to purge the underlying data associated with the baseline.

   The underlying data includes the individual snapshots preserved in the baseline and any statistics that are computed for the baseline. Do one of the following:

   - To delete the underlying data, select **Purge the underlying data associated with the baseline**.
   - To preserve the underlying data, select **Do not purge the underlying data associated with the baseline**.

5. Click **Yes**.

   The AWR Baselines page reappears. A message informs you that the baseline was deleted successfully.

Computing Threshold Statistics for Baselines

Computing threshold statistics for baselines enables you to graphically display the computed statistics in the charts on the Performance page.

To compute threshold statistics for baselines:

1. From the Database Home page, click **Server**.

   The Server subpage appears.

2. Under Statistics Management, click **AWR Baselines**.

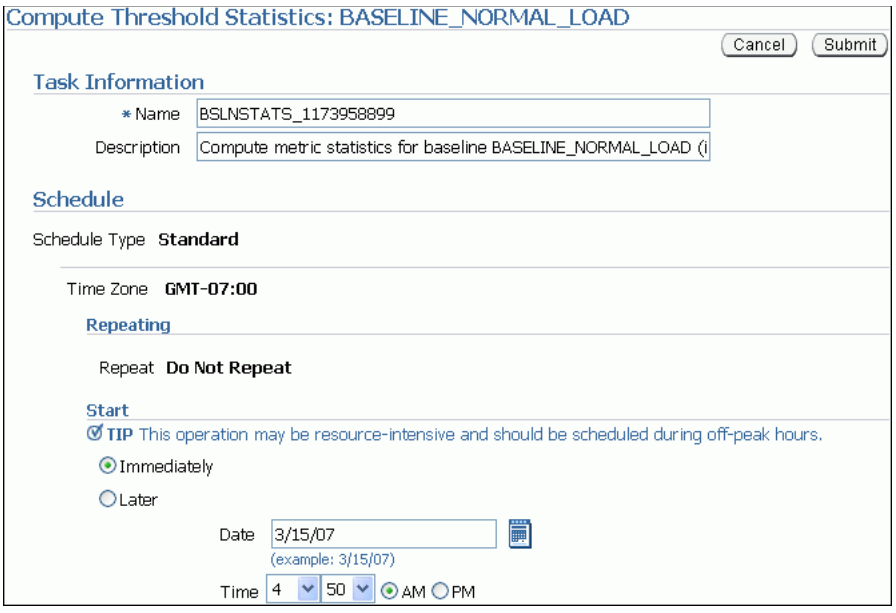
   The AWR Baselines page appears with a list of existing baselines displayed.

3. Select the baseline for which you want to compute statistics.

   Select a baseline that does not already have computed statistics. These baselines are identified by No in the Statistics Computed column.

4. From the Actions list, select **Schedule Statistics Computation**, and then click **Go**.

   The Compute Threshold Statistics page appears.



5. In the **Name** field, enter a name for the task.

   Alternatively, you can choose to use the system-generated name.

6. In the **Description** field, enter a description for the task.

   Alternatively, you can choose to use the system-generated description.

7. Under Start, do one of the following:
   - Select **Immediately** to run the task immediately after it has been submitted.
   - Select **Later** to run the task at a later time as specified using the Date and Time fields.

8. Click **Submit**.

   The AWR Baselines page appears. A message informs you that statistics computation has been scheduled for the selected baseline.

   See Also:

   - "Customizing the Database Performance Page" on page 4-27 for information about displaying computed statistics on the Performance page
   - *Oracle Database 2 Day DBA* for information about thresholds and how to manage them

Setting Metric Thresholds for Baselines

As explained in "Setting Metric Thresholds for Performance Alerts" on page 5-1, a metric is the rate of change in a cumulative statistic. Alerts notify you when particular metric thresholds are crossed. When the metric thresholds are crossed, the system is in an undesirable state. You can edit the threshold settings for baseline metrics.

You can create the following types of baseline:

- Setting Metric Thresholds for the Default Moving Baseline
- Setting Metric Thresholds for Selected Baselines

Setting Metric Thresholds for the Default Moving Baseline

This section describes the easiest technique for setting the metric thresholds for the default moving baseline. You can choose a group of basic metric threshold settings based on common database workload profiles: OLTP, data warehousing, and OLTP with nighttime batch jobs. After choosing a workload profile, you can expand or change the threshold values as needed.

To set metric thresholds for the default moving baseline:

1. On the Database Home page, under Related Links, click **Baseline Metric Thresholds**.

   The Threshold Configuration tab of the Baseline Metric Thresholds page appears.

2. Click **Quick Configuration**.

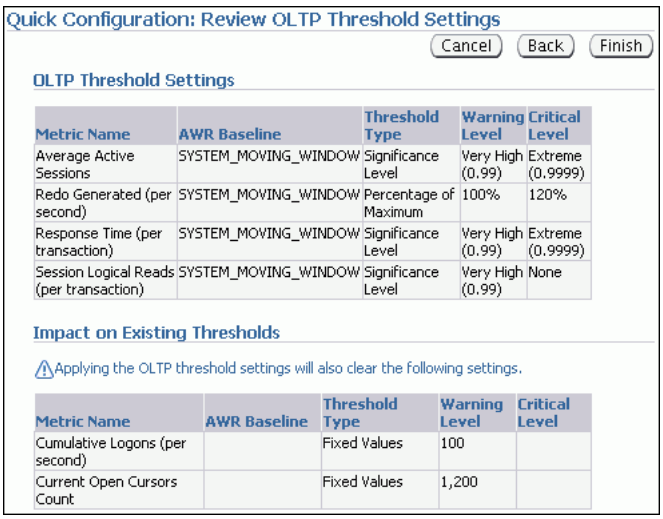
   The Quick Configuration: Baseline Metric Thresholds page appears.

3. In **Workload Profile**, select one of the following options, depending on how you are using the database:
   - **Primarily OLTP (pure transaction processing 24 hours a day)**
   - **Primarily Data Warehousing (query and load intensive)**
   - **Alternating (OLTP during the daytime and batch during the nighttime)**

In this example, select **Primarily OLTP**.

4. Click **Continue**.

   The Quick Configuration: Review OLTP Threshold Settings page appears.



5. Review the metric threshold settings and click **Finish**.

   You are returned to the Baseline Metric Thresholds page, with the Threshold Configuration tab selected. The metric threshold settings are displayed.

Setting Metric Thresholds for Selected Baselines

This section explains how to select a baseline and edit its thresholds. You can configure the type of threshold, for example, whether it is based on significance levels, percentage of maximum values, or fixed values. You can also configure the threshold levels that determine when the system generates critical alerts and warnings.

You can edit thresholds for the default moving baseline or a baseline that you created in the AWR Baselines page. You can select a baseline in the Edit Thresholds page after you have scheduled statistics computation from the AWR Baselines page and the statistics have finished computing on the static baseline.

To set a metric threshold for the default moving baseline:

1. On the Database Home page, under Related Links, click **Baseline Metric Thresholds**.

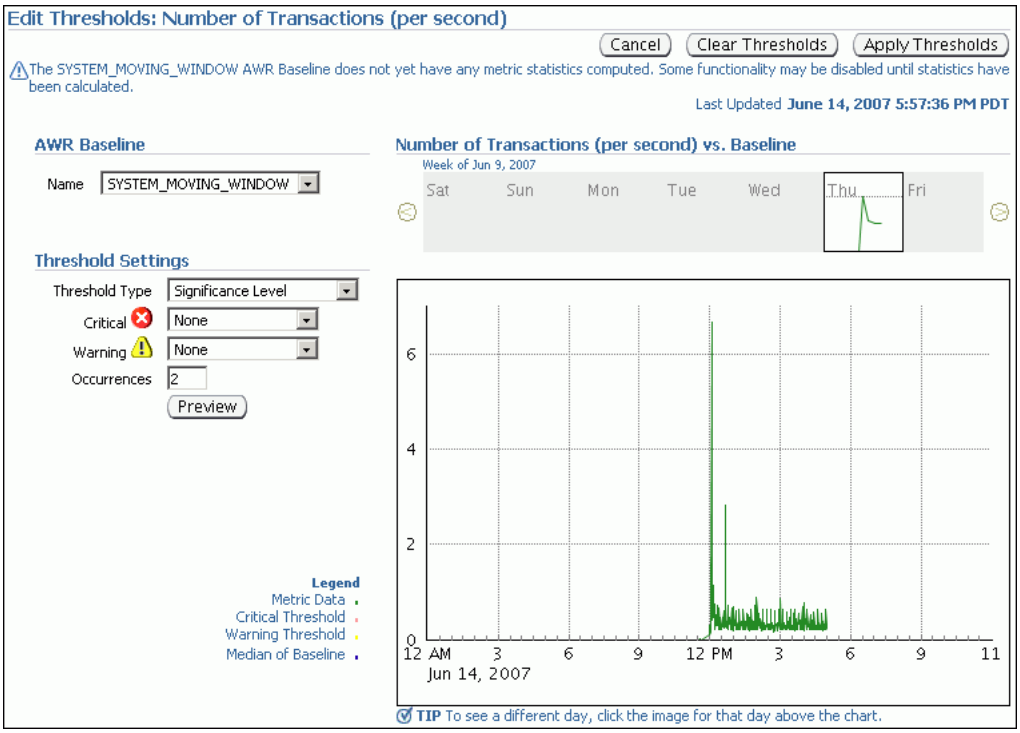
   The Threshold Configuration tab of the Baseline Metric Thresholds page appears.

2. In the View list, select **Basic Metrics**.

   The Baseline Metric Thresholds page appears.

3. In the **Category/Name** column, click the link for the metric whose threshold you want to set or change. For example, click **Number of Transactions (per second)**.

   The Edit Thresholds: Number of Transactions (per second) appears.



The charts on this page provide thumbnail and detailed views of metric activity for a 24-hour period. In the top thumbnail chart, click a day to view the value of the metric plotted against a 24-hour period.

4. Under **AWR Baseline**, in the Name list, select either the default **SYSTEM_MOVING_WINDOW** or the name of a baseline created in the AWR Baselines page.

   A baseline appears in the AWR Baseline list after you have scheduled statistics computation from the AWR Baselines page and the statistics have finished computing on the static baseline.

   In this example, select **AWR_BASELINES_2007**.

   The page refreshes to show the charts for the baseline that you selected.

5. In the Threshold Settings section, complete the following steps:

   a. In **Threshold Type**, leave **Significance Level** selected.

   b. In **Critical**, select **Extreme**.

   c. In **Warning**, select **Very High**.

   d. In **Occurrences**, leave the current value.

6. Click **Apply Thresholds**.

   You are returned to the Baseline Metric Thresholds page. This page shows the altered metric threshold settings.

Running the AWR Compare Periods Reports

This section describes how to run the Automatic Workload Repository (AWR) Compare Periods reports using Oracle Enterprise Manager.

You can use AWR Compare Periods reports to compare the database performance between two time periods by:

- Comparing a Baseline to Another Baseline or Pair of Snapshots
- Comparing Two Pairs of Snapshots

Comparing a Baseline to Another Baseline or Pair of Snapshots

When performance degradation happens to a database over time, you should run the AWR Compare Periods report to compare the degraded performance, captured as a new baseline or a pair of snapshots, to an existing baseline. You will need a baseline that represents the system operating at an optimal level. If an existing baseline is not available, then you can compare database performance between two periods of time by using two arbitrary pairs of snapshots, as described in "Comparing Two Pairs of Snapshots" on page 8-12.

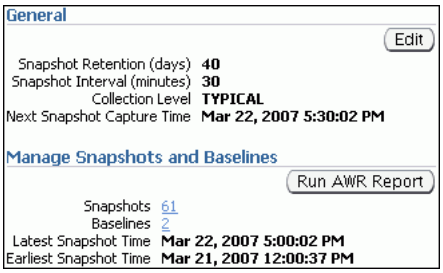
To compare a baseline to another baseline:

1. From the Database Home page, click **Server**.

   The Server subpage appears.

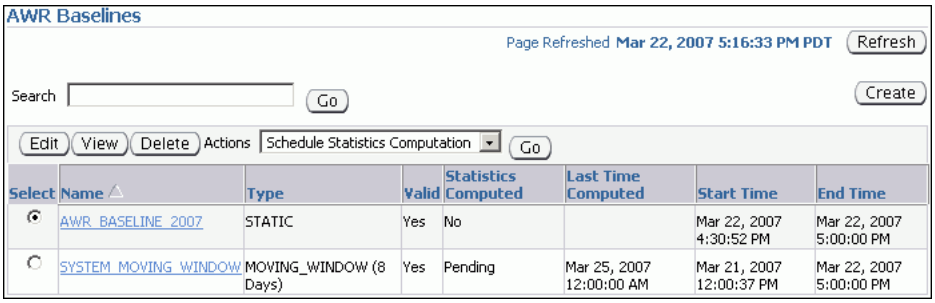
2. Under Statistics Management, click **Automatic Workload Repository**.

   The Automatic Workload Repository page appears.



3. Under Manage Snapshots and Baselines, click the link next to **Baselines**.

   The AWR Baselines page appears.



4. Complete the following steps:

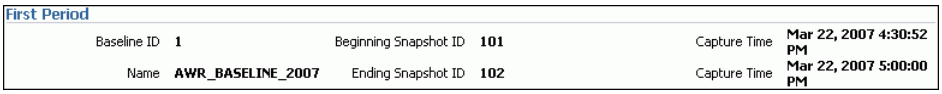
   a. Select the baseline to use for the report.

      At least one existing baseline must be available.

   b. From the Actions list, select **Compare Periods** and click **Go**.

   The Compare Periods: Second Period Start page appears. Under First Period, the selected baseline is displayed.

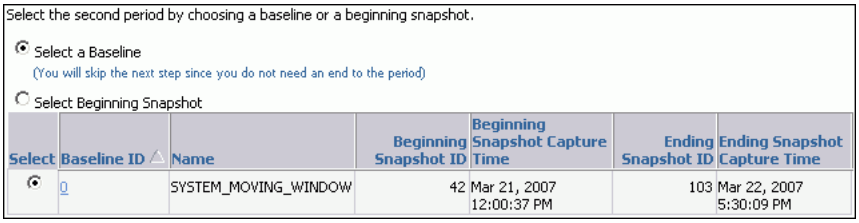
In this example, the baseline named AWR_BASELINE_2007 is selected.



5. Compare the baseline selected in the first period to another baseline or a pair of snapshots. Do one of the following:

   - To compare to another baseline, select **Select a Baseline** and the baseline you want to use in the second period, and then click **Next**.

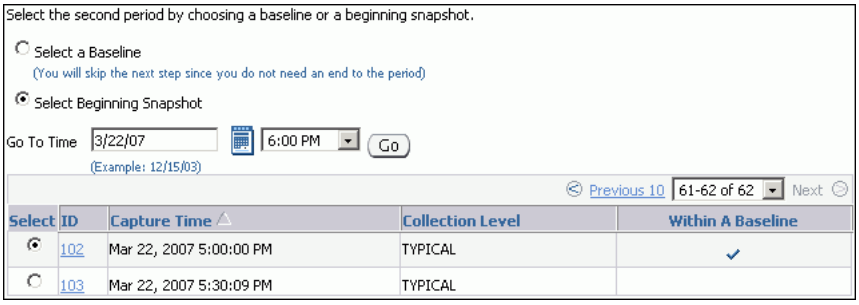
     In this example, the baseline named SYSTEM_MOVING_WINDOW is selected.



     The Compare Periods: Review page appears. Go to Step 7.

   - To compare to a pair of snapshots, select **Select Beginning Snapshot** and the beginning snapshot to use in the second period, and then click **Next**.

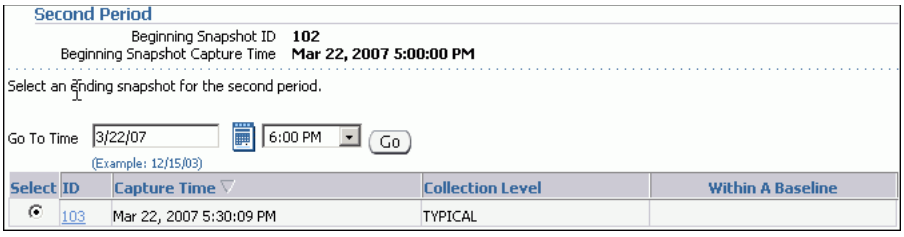
     In this example, snapshot 102, taken on March 22, 2007 at 5:00 p.m., is selected.



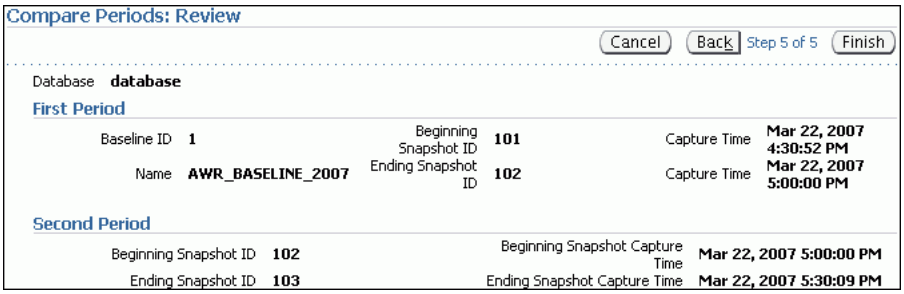
     The Compare Periods: Second Period End appears. Proceed to the next step.

6. Select the ending snapshot for the snapshot period that will be included in the report and click **Next**.

   In this example, snapshot 103, taken on March 22, 2007 at 5:30 p.m., is selected.



   The Compare Periods: Review page appears.



7. Review the periods to be included in the report and click **Finish**.

   The Compare Periods: Results page appears.

   Data from the selected periods appears under the General subpage. You can view data per second or per transaction by selecting an option from the View Data list.

Name	First Period Metric Ratio	Second Period Metric Ratio	First Period Value	Second Period Value	First Period Rate Per Second	Second Period Rate Per Second
DB cpu (seconds)			0.00	0.00	0.00	0.00
DB time (seconds)			5,887.68	5,963.94	3.37	3.30
db block changes			19,944.00	26,344.00	11.42	14.56
execute count			20,285.00	20,770.00	11.61	11.48
global cache cr block receive time (seconds)			0.00	0.00	0.00	0.00
global cache cr blocks received			0.00	0.00	0.00	0.00
global cache current block receive time (seconds)			0.00	0.00	0.00	0.00
global cache current blocks received			0.00	0.00	0.00	0.00
global cache get time (seconds)			0.00	0.00	0.00	0.00
global cache gets			0.00	0.00	0.00	0.00
opened cursors cumulative			18,051.00	18,514.00	10.33	10.23
parse count (total)			5,918.00	5,881.00	3.39	3.25
parse time cpu (seconds)			0.23	0.32	0.00	0.00
parse time elapsed (seconds)			0.26	1.13	0.00	0.00
physical reads			371.00	372.00	0.21	0.21
physical writes			1,202.00	923.00	0.69	0.51
redo size (KB)			3,680.53	4,473.99	2.11	2.47

   In this example, parse time in the second period is much higher than the first.

8. Click **Report** to view the report.

   The Processing: View Report page appears while the report is being generated. After it completes, the report will appear. To change periods, click **Change Periods**. To save the report as an HTML file, click **Save to File**.

   See Also:

   - "Creating a Baseline" on page 8-2
   - "Using the AWR Compare Periods Reports" on page 8-15

Comparing Two Pairs of Snapshots

If an existing baseline is not available, then you can compare the database performance by using two arbitrary pairs of snapshots, one pair taken when the database is

performing optimally, and another pair when the database is performing poorly. At least four existing snapshots must be available.

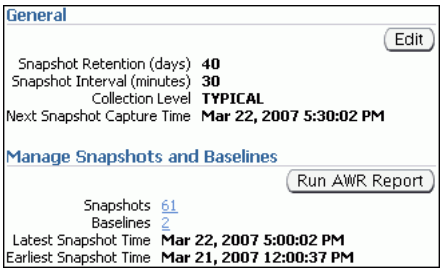
To compare performance using two pairs of snapshots:

1. From the Database Home page, click **Server**.

   The Server subpage appears.

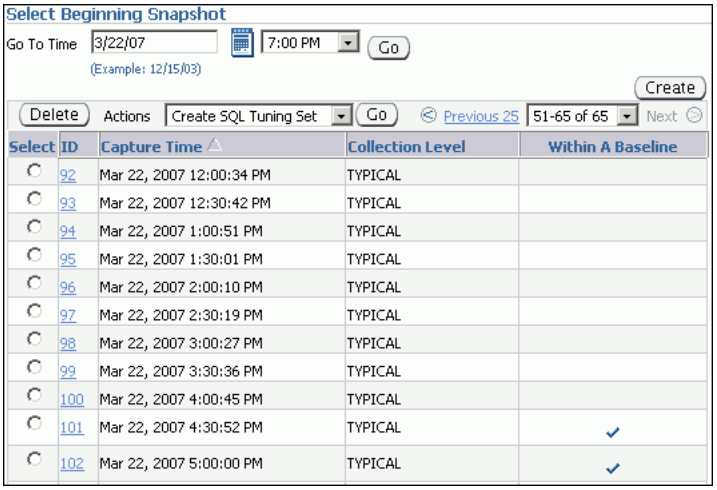
2. Under Statistics Management, click **Automatic Workload Repository**.

   The Automatic Workload Repository page appears.



3. Under Manage Snapshots and Baselines, click the link next to **Snapshots**.

   The Snapshots page appears.



4. From the Go To Time list, select the time for the starting snapshot and click **Go**.

   This action filters the snapshots and displays only the snapshot taken at the start of the comparison period. The time in this example is 5:00 p.m. on March 21, 2007.

5. Under Select Beginning Snapshot, select the starting point for the first snapshot period to be included in the report.

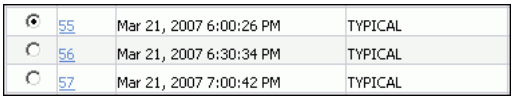
   In this example, snapshot 53, taken on Mar 21, 2007 5:00 p.m., is selected.

6. From the Actions list, select **Compare Periods** and click **Go**.

The Compare Periods: First Period End page appears.

7. Select the ending point for the first snapshot period to be included in the report and click **Next**.

   In this example, snapshot 55, taken on Mar 21, 2007 6:00 p.m., is selected.

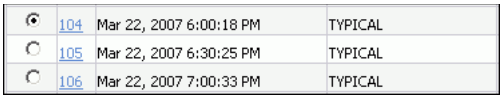


◉	55	Mar 21, 2007 6:00:26 PM	TYPICAL
○	56	Mar 21, 2007 6:30:34 PM	TYPICAL
○	57	Mar 21, 2007 7:00:42 PM	TYPICAL

   The Compare Periods: Second Period Start page appears.

8. Select the starting point for the second snapshot period to be included in the report and click **Next**.

   In this example, snapshot 104, taken on March 22, 2007 at 6:00 p.m., is selected.



◉	104	Mar 22, 2007 6:00:18 PM	TYPICAL
○	105	Mar 22, 2007 6:30:25 PM	TYPICAL
○	106	Mar 22, 2007 7:00:33 PM	TYPICAL

   The Compare Periods: Second Period End page appears.

9. Select the end point for the second period that will be included in the report and click **Next**.

   In this example, snapshot 106, taken on March 22, 2007 at 7:00 p.m., is selected.

◉	106	Mar 22, 2007 7:00:33 PM	TYPICAL
○	107	Mar 22, 2007 7:30:41 PM	TYPICAL
○	108	Mar 22, 2007 8:00:50 PM	TYPICAL

   The Compare Periods: Review page appears.

First Period

Beginning Snapshot ID	**53**	Beginning Snapshot Capture Time	**Mar 21, 2007 5:00:09 PM**
Ending Snapshot ID	**55**	Ending Snapshot Capture Time	**Mar 21, 2007 6:00:26 PM**

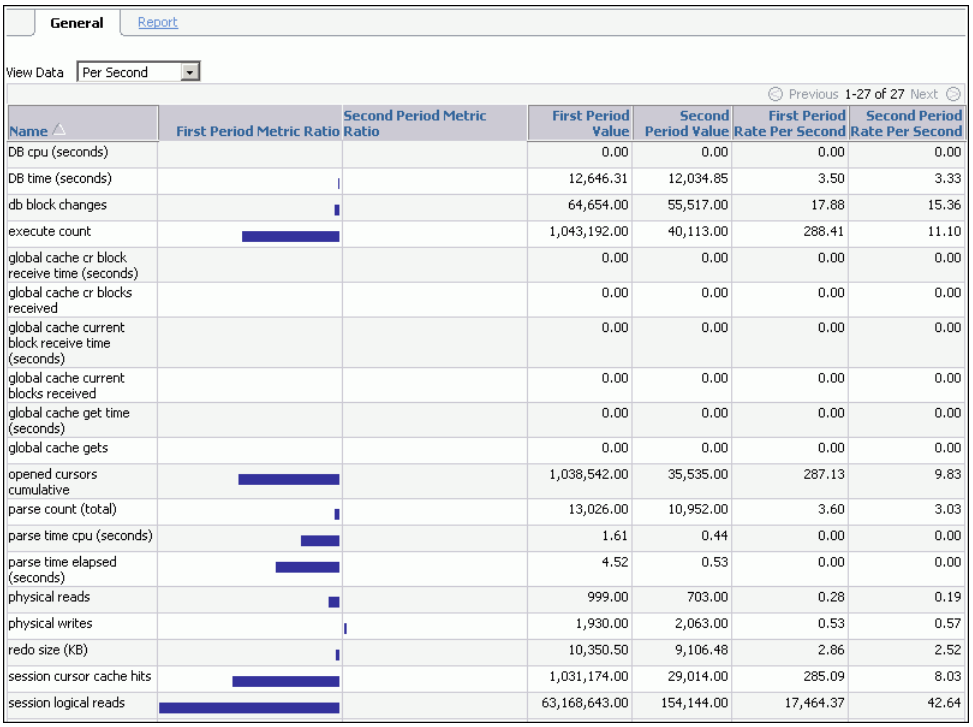
Second Period

Beginning Snapshot ID	**104**	Beginning Snapshot Capture Time	**Mar 22, 2007 6:00:18 PM**
Ending Snapshot ID	**106**	Ending Snapshot Capture Time	**Mar 22, 2007 7:00:33 PM**

10. Review the selected periods that will be included in the report and click **Finish**.

    The Compare Periods: Results page appears.

    Data from the selected periods appears under the General subpage. You can view data per second or per transaction by selecting an option from the View Data list.



General | Report

View Data: Per Second

Previous 1-27 of 27 Next

Name	First Period Metric Ratio	Second Period Metric Ratio	First Period Value	Second Period Value	First Period Rate Per Second	Second Period Rate Per Second
DB cpu (seconds)			0.00	0.00	0.00	0.00
DB time (seconds)			12,646.31	12,034.85	3.50	3.33
db block changes			64,654.00	55,517.00	17.88	15.36
execute count			1,043,192.00	40,113.00	288.41	11.10
global cache cr block receive time (seconds)			0.00	0.00	0.00	0.00
global cache cr blocks received			0.00	0.00	0.00	0.00
global cache current block receive time (seconds)			0.00	0.00	0.00	0.00
global cache current blocks received			0.00	0.00	0.00	0.00
global cache get time (seconds)			0.00	0.00	0.00	0.00
global cache gets			0.00	0.00	0.00	0.00
opened cursors cumulative			1,038,542.00	35,535.00	287.13	9.83
parse count (total)			13,026.00	10,952.00	3.60	3.03
parse time cpu (seconds)			1.61	0.44	0.00	0.00
parse time elapsed (seconds)			4.52	0.53	0.00	0.00
physical reads			999.00	703.00	0.28	0.19
physical writes			1,930.00	2,063.00	0.53	0.57
redo size (KB)			10,350.50	9,106.48	2.86	2.52
session cursor cache hits			1,031,174.00	29,014.00	285.09	8.03
session logical reads			63,168,643.00	154,144.00	17,464.37	42.64

In this example, the first period shows significantly more activity, especially in session reads, than the second period.

11. To view the report, click the **Report** tab.

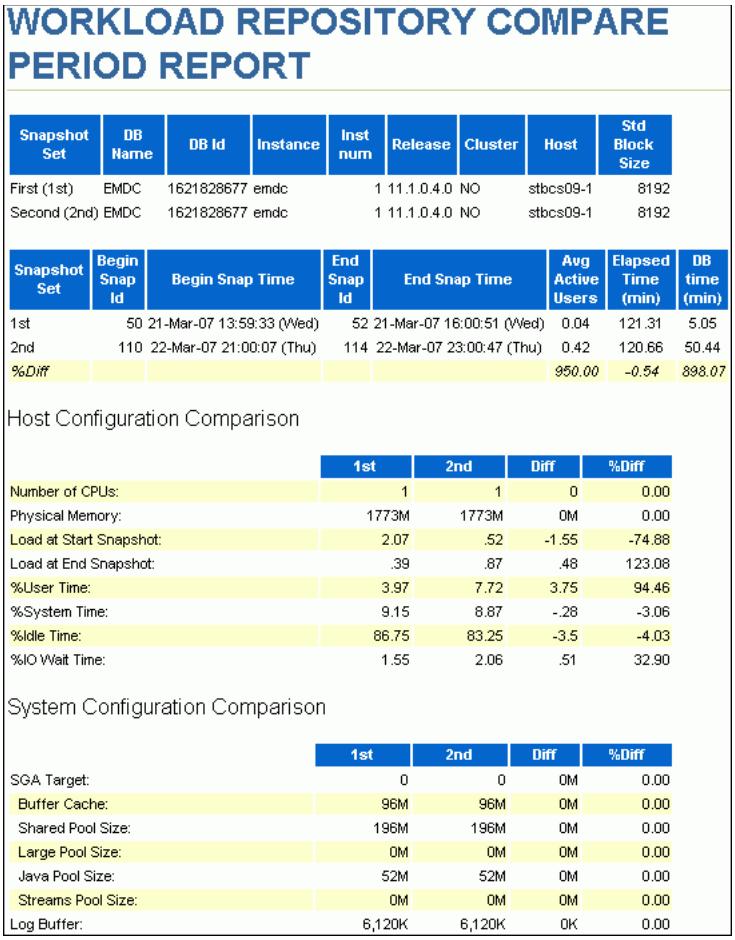
    The Processing: View Report page appears while the report is being generated. After it completes, the report will appear. To change periods, click **Change Periods**. To save the report as an HTML file, click **Save to File**.

Using the AWR Compare Periods Reports

After an AWR Compare Periods report is generated for the time periods you want to compare, you can use it to perform an analysis of performance degradation with Oracle Database that may have happened over time. To learn how to generate AWR Compare Periods reports, see "Running the AWR Compare Periods Reports" on page 8-9.

Figure 8–1 shows an example of an AWR Compare Periods report.

Figure 8–1 AWR Compare Periods Report



WORKLOAD REPOSITORY COMPARE PERIOD REPORT

Snapshot Set	DB Name	DB Id	Instance	Inst num	Release	Cluster	Host	Std Block Size
First (1st)	EMDC	1621828677	emdc	1	11.1.0.4.0	NO	stbcs09-1	8192
Second (2nd)	EMDC	1621828677	emdc	1	11.1.0.4.0	NO	stbcs09-1	8192

Snapshot Set	Begin Snap Id	Begin Snap Time	End Snap Id	End Snap Time	Avg Active Users	Elapsed Time (min)	DB time (min)
1st	50	21-Mar-07 13:59:33 (Wed)	52	21-Mar-07 16:00:51 (Wed)	0.04	121.31	5.05
2nd	110	22-Mar-07 21:00:07 (Thu)	114	22-Mar-07 23:00:47 (Thu)	0.42	120.66	50.44
%Diff					*950.00*	*-0.54*	*898.07*

Host Configuration Comparison

	1st	2nd	Diff	%Diff
Number of CPUs:	1	1	0	0.00
Physical Memory:	1773M	1773M	0M	0.00
Load at Start Snapshot:	2.07	.52	-1.55	-74.88
Load at End Snapshot:	.39	.87	.48	123.08
%User Time:	3.97	7.72	3.75	94.46
%System Time:	9.15	8.87	-.28	-3.06
%Idle Time:	86.75	83.25	-3.5	-4.03
%IO Wait Time:	1.55	2.06	.51	32.90

System Configuration Comparison

	1st	2nd	Diff	%Diff
SGA Target:	0	0	0M	0.00
Buffer Cache:	96M	96M	0M	0.00
Shared Pool Size:	196M	196M	0M	0.00
Large Pool Size:	0M	0M	0M	0.00
Java Pool Size:	52M	52M	0M	0.00
Streams Pool Size:	0M	0M	0M	0.00
Log Buffer:	6,120K	6,120K	0K	0.00

The AWR Compare Periods report is divided into the following sections:

- Summary of the AWR Compare Periods Report
- Details of the AWR Compare Periods Report
- Supplemental Information in the AWR Compare Periods Report

Summary of the AWR Compare Periods Report

The report summary is at the beginning of the AWR Compare Periods report, and summarizes information about the snapshot sets and loads used in the report. The report summary contains the following sections:

- Snapshot Sets
- Host Configuration Comparison
- System Configuration Comparison
- Load Profile
- Top Timed Events

Snapshot Sets

The Snapshot Sets section displays information about the snapshot sets used for this report, such as instance, host, and snapshot information.

In the example shown in Figure 8–1 on page 8-16, the first snapshot period corresponds to the time when performance was stable on March 21, 2007 from 1:59 p.m. to 4:00 p.m. The second snapshot period corresponds to the time when performance degradation occurred on March 22, 2007 from 9:00 p.m. to 11:00 p.m.

Host Configuration Comparison

The Host Configuration Comparison section compares the host configurations used in the two snapshot sets. For example, the report compares physical memory and number of CPUs. Any differences in the configurations are quantified as percentages in the %Diff column.

System Configuration Comparison

The System Configuration Comparison section compares the database configurations used in the two snapshot sets. For example, the report compares the SGA and log buffer size. Any differences in the configurations are quantified as percentages in the %Diff column.

Load Profile

The Load Profile section compares the loads used in the two snapshot sets. Any differences in the loads are quantified as percentages in the %Diff column.

Load Profile

	1st per sec	2nd per sec	%Diff	1st per txn	2nd per txn	%Diff
DB time:	0.01	0.25	2,400.00	0.04	0.70	1,650.00
CPU time:	0.01	0.04	300.00	0.02	0.12	500.00
Redo size:	2,676.70	8,280.03	209.34	7,945.55	23,502.95	195.80
Logical reads:	43.25	754.87	1,645.36	128.39	2,142.71	1,568.91
Block changes:	16.59	202.59	1,121.16	49.24	575.05	1,067.85
Physical reads:	0.10	8.19	8,090.00	0.29	23.23	7,910.34
Physical writes:	0.61	1.76	188.52	1.81	5.01	176.80
User calls:	3.37	3.17	-5.93	9.99	9.00	-9.91
Parses:	2.97	6.99	135.35	8.83	19.84	124.69
Hard parses:	0.01	0.38	3,700.00	0.02	1.07	5,250.00
Sorts:	2.18	3.88	77.98	6.48	11.03	70.22
Logons:	0.03	0.03	0.00	0.09	0.09	0.00
Executes:	11.04	23.38	111.78	32.78	66.38	102.50
Transactions:	0.34	0.35	2.94			

	1st	2nd	Diff
% Blocks changed per Read:	38.35	26.84	-11.51
Recursive Call %:	88.68	97.50	8.82
Rollback per transaction %:	20.14	0.63	-19.51
Rows per Sort:	3.18	101.17	97.98
Avg DB time per Call (sec):	0.00	0.08	0.07

Top Timed Events

The Top 5 Timed Events section displays the five timed events or operations that consumed the highest percentage of total DB time in each of the snapshot sets.

1st						2nd					
Event	Wait Class	Waits	Time(s)	Avg Time(ms)	%DB time	Event	Wait Class	Waits	Time(s)	Avg Time(ms)	%DB time
CPU time			111.72		36.84	CPU time			912.19		30.14
db file sequential read	User I/O	7,132	99.95	14.01	32.96	resmgr:cpu quantum	Scheduler	1,622	333.99	205.91	11.04
control file parallel write	System I/O	2,635	36.66	13.91	12.09	library cache lock	Concurrency	3	265.85	88,617.53	8.78
log file parallel write	System I/O	2,652	30.51	11.50	10.06	db file sequential read	User I/O	17,442	247.98	14.22	8.19
log file sync	Commit	622	19.33	31.07	6.37	db file scattered read	User I/O	3,229	84.87	26.28	2.80
-db file scattered read	User I/O	932	17.09	18.33	5.63	-log file parallel write	System I/O	3,373	63.08	18.70	2.08
-						-control file parallel write	System I/O	2,774	27.83	10.03	0.92
-						-log file sync	Commit	607	25.54	42.08	0.84

In this example, CPU time is over eight times higher in the second period than in the first. The number of waits for the `db file sequential read` event in the second period is over double the number in the first.

Details of the AWR Compare Periods Report

The details section follows the summary of the AWR Compare Periods report, and provides statistics about the snapshot sets and loads used in the report. For example, the section includes statistics for database time, wait events, SQL execution time, and instance activity.

Supplemental Information in the AWR Compare Periods Report

The supplemental information is at the end of the AWR Compare Periods report, and provides additional information about initialization parameters and SQL statements. The init.ora Parameters section lists all the initialization parameter values for the first snapshot set. The Complete List of SQL Text section lists each statement by SQL ID and shows the text of the SQL statement.

Part IV

SQL Tuning

Part IV describes how to effectively tune SQL statements and contains the following chapters:

9

Identifying High-Load SQL Statements

High-load SQL statements may consume a disproportionate amount of system resources. These SQL statements often cause a large impact on database performance and must be tuned to optimize their performance and resource consumption. Even when a database itself is properly tuned, inefficient SQL statements can significantly degrade database performance.

Identifying high-load SQL statements is an important SQL tuning activity that you must perform regularly. Automatic Database Diagnostic Monitor (ADDM) automates this task by proactively identifying potential high-load SQL statements. Additionally, you can use Oracle Enterprise Manager (Enterprise Manager) to identify high-load SQL statements that require further investigation. After you have identified the high-load SQL statements, you can tune them with SQL Tuning Advisor and SQL Access Advisor.

This chapter describes how to identify high-load SQL statements and contains the following sections:

Identification of High-Load SQL Statements Using ADDM Findings

By default, ADDM runs proactively once every hour. It analyzes key statistics gathered by the Automatic Workload Repository (AWR) over the last hour to identify any performance problems, including high-load SQL statements. When the system finds performance problems, it displays them as ADDM findings in the Automatic Database Diagnostic Monitor (ADDM) page.

ADDM provides recommendations with each ADDM finding. When a high-load SQL statement is identified, ADDM gives appropriate recommendations, such as running SQL Tuning Advisor on the SQL statement. You can begin tuning as described in Chapter 10, "Tuning SQL Statements".

See Also:

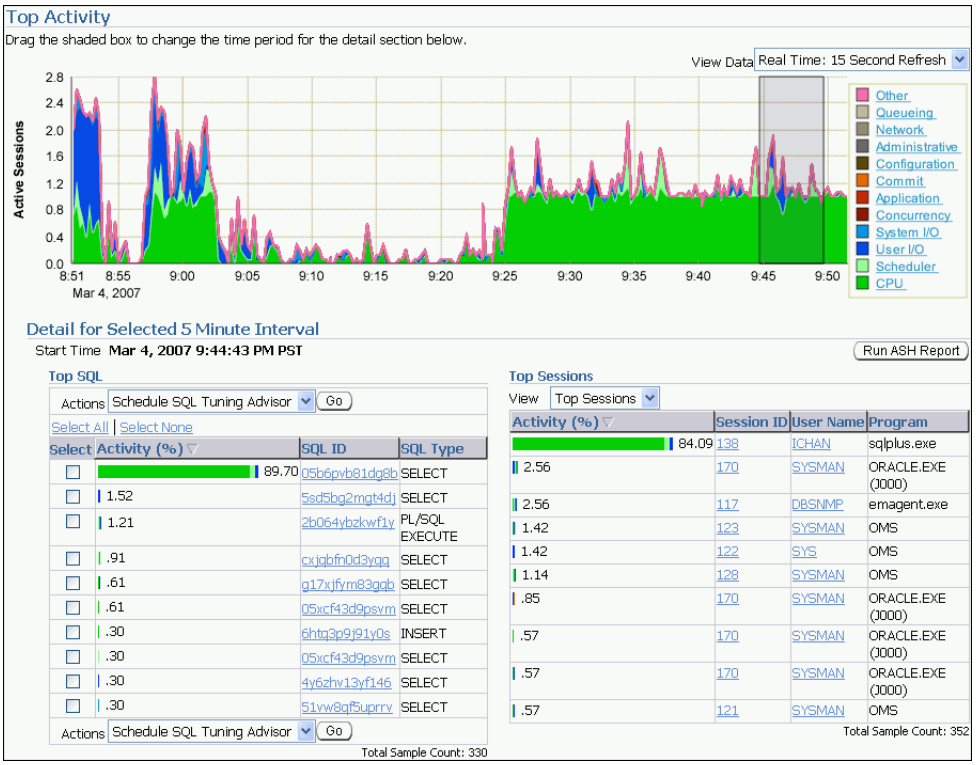
- "Overview of Automatic Database Diagnostic Monitor" on page 3-1
- "Interpretation of Automatic Database Diagnostic Monitor Findings" on page 3-8
- "Implementing Automatic Database Diagnostic Monitor Recommendations" on page 3-9

Identifying High-Load SQL Statements Using Top SQL

ADDM automatically identifies high-load SQL statements that may be causing systemwide performance degradation. Under normal circumstances, manual identification of high-load SQL statements is not necessary. In some cases, however, you may want to monitor SQL statements at a more granular level. The Top SQL section of the Top Activity page in Enterprise Manager enables you to identify high-load SQL statements for any 5-minute interval.

Figure 9–1 shows an example of the Top Activity page.

Figure 9–1 Top Activity Page



To access the Top Activity page:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

2. Under Additional Monitoring Links, click **Top Activity**.

   The Top Activity page appears.

   This page shows a 1-hour time line of the top activity running on the database. SQL statements that are using the highest percentage of database activity are listed under the Top SQL section, and are displayed in 5-minute intervals.

3. To move the 5-minute interval, drag and drop the shaded box to the time of interest.

   The information contained in the Top SQL section will be automatically updated to reflect the selected time period. Use this page to identify high-load SQL statements that may be causing performance problems.

4. To monitor SQL statements for a longer duration than one hour, select **Historical** from the View Data list.

   In Historical view, you can view the top SQL statements for the duration defined by the AWR retention period.

This section contains the following topics:

- Viewing SQL Statements by Wait Class
- Viewing Details of SQL Statements

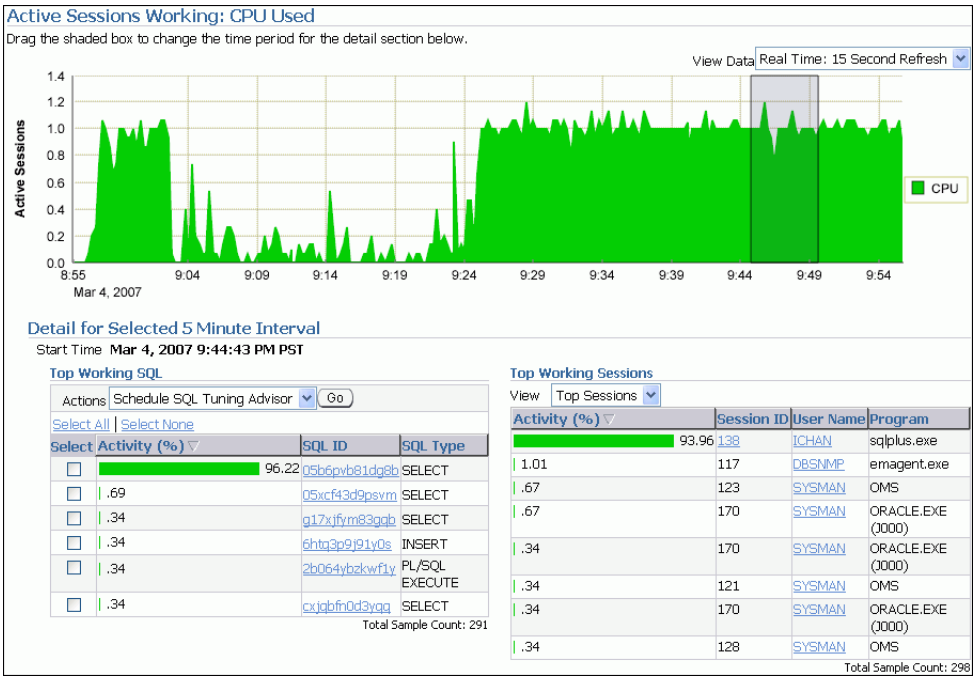
Viewing SQL Statements by Wait Class

The SQL statements that appear in the Top SQL section of the Top Activity page are categorized into various wait classes, based on their corresponding color as described in the legend on the Top Activity chart.

To view the SQL statements for a particular wait class, click the block of color on the chart for the wait class, or its corresponding wait class in the legend. The Active Sessions Working page for the selected wait class appears, and the Top SQL section will be automatically updated to show only the SQL statements for that wait class.

The example in Figure 9–2 shows the Active Sessions Working page for the CPU Used wait class. Only SQL statements that are consuming the most CPU time are displayed in the Top Working SQL section.

Figure 9–2 Viewing SQL Statement by Wait Class



See Also:

- "Monitoring User Activity" on page 4-2 for information about using the Active Sessions Working page

Viewing Details of SQL Statements

The Top SQL section of the Top Activity page displays the SQL statements executed within the selected 5-minute interval in descending order based on their resource consumption. The SQL statement at the top of this table represents the most resource-intensive SQL statement during that time period, followed by the second most resource-intensive SQL statement, and so on.

In the example shown in Figure 9–1 on page 9-2, the SQL statement with `SQL_ID` 05b6pvb81dg8b is consuming 89.7 percent of database activity and should be investigated.

To view details of SQL statements:

1. From the Database Home page, click **Performance**.

   The Performance page appears.

2. Under Additional Monitoring Links, click **Top Activity**.

   The Top Activity page appears.

3. In the Top SQL section, click the **SQL ID** link of the SQL statement.

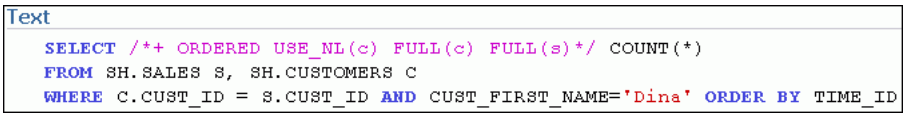
   The SQL Details page for the selected SQL statement appears.

4. To view SQL details for a longer time period, select **Historical** from the View Data list.

   You can now view SQL details in the past, up to the duration defined by the AWR retention period.

5. Review the SQL text for the SQL statement.

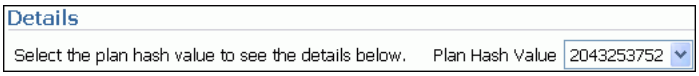
   The Text section contains the SQL text for the selected SQL statement.



   If only part of the SQL statement is displayed, then a plus sign (+) icon will appear next to the Text heading. To view the SQL text for the entire SQL statement, click the plus sign (+) icon.

6. If the SQL statement has multiple plans, then select **All** from the Plan Hash Value list to show SQL details for all plans.

   Alternatively, you can select a particular plan to display SQL details for that plan only.



7. Access the subpages from the SQL Details page to gather more information about the SQL statement, as described in the following sections:

   - Viewing SQL Statistics
   - Viewing Session Activity
   - Viewing the SQL Execution Plan
   - Viewing the SQL Tuning Information

8. If the SQL statement is a high-load SQL statement, then tune it as described in Chapter 10, "Tuning SQL Statements".

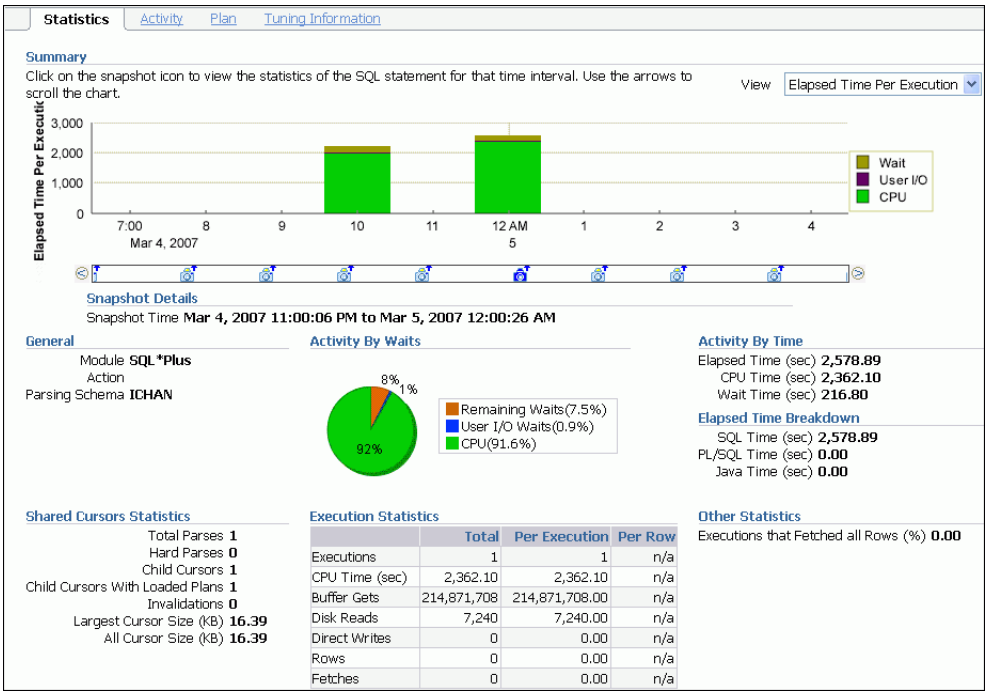
Viewing SQL Statistics

The Statistics subpage of the SQL Details page displays statistical information about the SQL statement.

To view statistics for the SQL statement:

1. On the SQL Details page, under Details, click **Statistics**.

   The Statistics subpage appears.



2. View the statistics for the SQL statement, as described in the following sections:
   - SQL Statistics Summary
   - General SQL Statistics
   - Activity by Wait Statistics and Activity by Time Statistics
   - Elapsed Time Breakdown Statistics
   - Shared Cursors Statistics and Execution Statistics
   - Other SQL Statistics

SQL Statistics Summary The Summary section displays SQL statistics and activity on a chart.

In the Real Time view, the Active Sessions chart shows the average number of active sessions executing the SQL statement in the last hour. If the SQL statement has multiple plans and **All** is selected in the Plan Hash Value list, then the chart will display each plan in different colors, enabling you to easily spot if the plan changed and whether this may be the cause of the performance degradation. Alternatively, you can select a particular plan to display that plan only.

In the Historical view, the chart shows execution statistics in different dimensions. To view execution statistics, select the desired dimension from the View list:

- Elapsed time per execution
- Executions per hour
- Disk reads per execution
- Buffer gets per execution

This enables you to track the response time of the SQL statement using different dimensions and determine if the performance of the SQL statement has degraded based on the dimension selected.

To view statistics of the SQL statement for a particular time interval, click the snapshot icon below the chart. You can also use the arrows to scroll the chart to locate a desired snapshot.

General SQL Statistics The General section enables you to identify the origin of the SQL statement by listing the following information:

- Module, if specified using the `DBMS_APPLICATION_INFO` package
- Action, if specified using the `DBMS_APPLICATION_INFO` package
- Parsing schema, or the database users account that is used to execute the SQL statement
- PL/SQL source, or the code line if the SQL statement is part of a PL/SQL program unit

Activity by Wait Statistics and Activity by Time Statistics The Activity by Wait and Activity by Time sections enable you to identify where the SQL statement spent most of its time. The Activity by Wait section contains a graphical representation of how much elapsed time is consumed by CPU and by remaining waits. The Activity by Time section breaks out the total elapsed time into CPU time and wait time by seconds.

Elapsed Time Breakdown Statistics The Elapsed Time Breakdown section enables you to identify if the SQL statement itself is consuming a lot of time, or if the total elapsed time is inflated due to the amount of time the originating program or application is spending with the PL/SQL or Java engine. If the PL/SQL time or Java time makes up a significant portion of the elapsed time, then there may be minimal benefit gained by tuning the SQL statement. Instead, you should examine the application to determine how the PL/SQL time or Java time can be reduced.

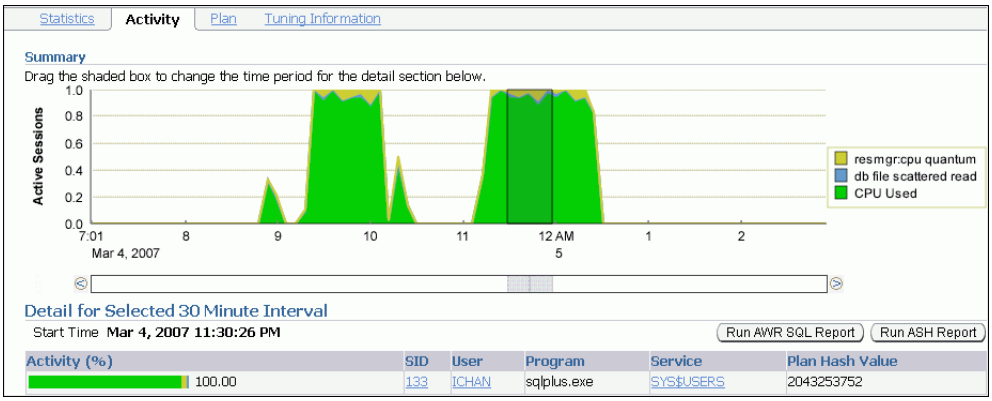
Shared Cursors Statistics and Execution Statistics The Shared Cursors Statistics and Execution Statistics sections provide information about the efficiency of various stages of the SQL execution process.

Other SQL Statistics The Other Statistics section provides additional information about the SQL statement, such as average persistent and run-time memory.

Viewing Session Activity

To view session activity for the SQL statement, in the Details section, click **Activity**.

The Activity subpage contains a graphical representation of the session activity.



The Activity subpage displays details of various sessions executing the SQL statement. The Active Sessions chart profiles the average number of active sessions over time. You can drag the shaded box to select a 5-minute interval. The Detail for Selected 5 Minute Interval section lists the sessions that executed the SQL statement during the selected 5-minute interval. The multicolored bar in the Activity % column depicts how the database time is divided for each session while executing the SQL statement. To view more details for a particular session, click the link in the **SID** column of the session you want to view to display the Session Details page.

See Also:

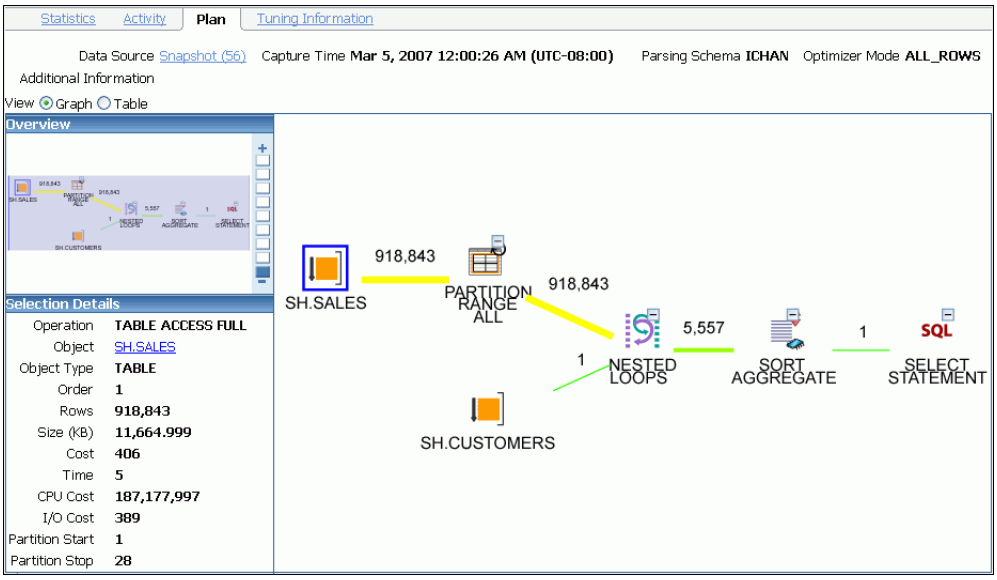
- "Monitoring Top Sessions" on page 4-5 for information about monitoring session activity and details

Viewing the SQL Execution Plan

To view the execution plan for the SQL statement, in the Details section, click **Plan**. The execution plan for a SQL statement is the sequence of operations Oracle performs to run the statement.

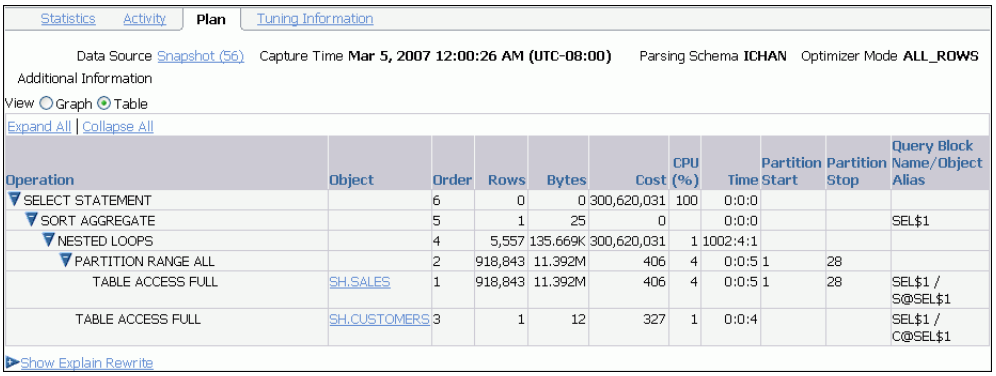
The Plan subpage displays the execution plan for the SQL statement in a graph view and a table view.

To view the SQL execution in a graph view, click **Graph**.



In the graph view, you can display details about the operations shown in the execution plan by selecting the operation in the graph. Details about the selected operations are displayed under Selection Details. If the selected operation is on a particular database object (such as a table), then you can view further details about the database object by clicking the **Object** link.

To view the SQL execution in a table view, click **Table**.


Statistics | Activity | Plan | Tuning Information

Data Source Snapshot (56) Capture Time **Mar 5, 2007 12:00:26 AM (UTC-08:00)** Parsing Schema **ICHAN** Optimizer Mode **ALL_ROWS**

Additional Information

View ○ Graph ◉ Table

Expand All | Collapse All

Operation	Object	Order	Rows	Bytes	Cost	CPU (%)	Time	Partition Start	Partition Stop	Query Block Name/Object Alias
SELECT STATEMENT		6	0	0	300,620,031	100	0:0:0			
SORT AGGREGATE		5	1	25	0		0:0:0			SEL$1
NESTED LOOPS		4	5,557	135.669K	300,620,031	1	1002:4:1			
PARTITION RANGE ALL		2	918,843	11.392M	406	4	0:0:5	1	28	
TABLE ACCESS FULL	SH.SALES	1	918,843	11.392M	406	4	0:0:5	1	28	SEL$1 / S@SEL$1
TABLE ACCESS FULL	SH.CUSTOMERS	3	1	12	327	1	0:0:4			SEL$1 / C@SEL$1

Show Explain Rewrite

Oracle Database compares the cost for the query, with and without query rewrite, and selects the least costly alternative. If a rewrite is necessary, then the query rewrite and its cost benefit are displayed in the Explain Rewrite section.

See Also:

- Chapter 10, "Tuning SQL Statements" for information about execution plan and the query optimizer

Viewing the SQL Tuning Information

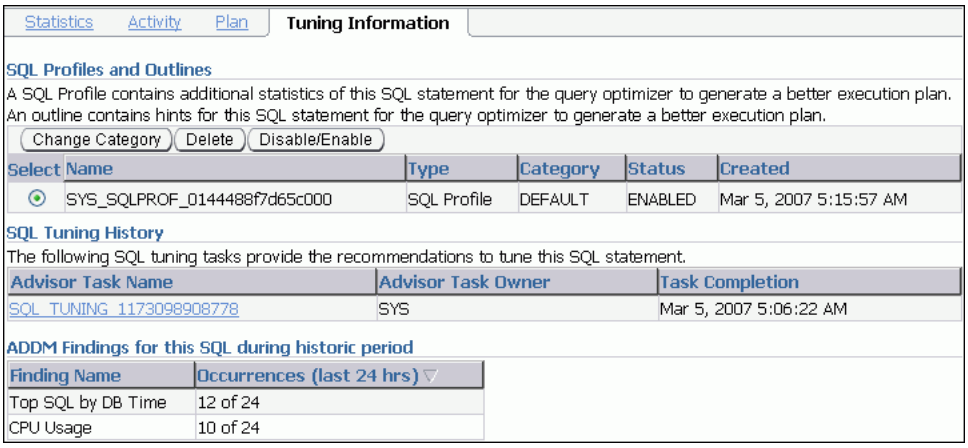
To view the tuning information for the SQL statement, in the Details section, click **Tuning Information**.

The Tuning Information subpage contains information about the SQL tuning tasks and the SQL profiles recommended by SQL Tuning Advisor for the SQL statement.

The SQL Profiles and Outlines section displays SQL profiles and outlines associated with the SQL statement. A SQL profile contains additional statistics of the SQL statement. An outline contains hints for the SQL statement for the query optimizer. Both are used by the query optimizer to generate a better execution plan for the SQL statement.

The SQL Tuning History section displays a history of SQL Tuning Advisor or SQL Access Advisor tasks.

The ADDM Findings for this SQL During Historic Period section displays the number of occurrences of ADDM findings that are associated with the SQL statement.



See Also:

- Chapter 10, "Tuning SQL Statements" for information about SQL Tuning Advisor and SQL profiles
- "Managing SQL Profiles" on page 10-19
- Chapter 11, "Optimizing Data Access Paths" for information about SQL Access Advisor

10

Tuning SQL Statements

A SQL statement expresses the data you want Oracle Database to retrieve. For example, you can use a SQL statement to retrieve the names of all employees in a department. When Oracle Database executes the SQL statement, the query optimizer (also called simply the optimizer) first determines the best and most efficient way to retrieve the results.

The optimizer determines whether it is more efficient to read all data in the table, called a full table scan, or use an index. It compares the cost of all possible approaches and chooses the approach with the least cost. The access method for physically executing a SQL statement is called an execution plan, which the optimizer is responsible for generating. The determination of an execution plan is an important step in the processing of any SQL statement, and can greatly affect execution time.

The query optimizer can also help you tune SQL statements. By using SQL Tuning Advisor and SQL Access Advisor, you can invoke the query optimizer in advisory mode to examine a SQL statement or set of statements and determine how to improve their efficiency. SQL Tuning Advisor and SQL Access Advisor can make various recommendations, such as creating SQL profiles, restructuring SQL statements, creating additional indexes or materialized views, and refreshing optimizer statistics. Additionally, Oracle Enterprise Manager (Enterprise Manager) enables you to accept and implement many of these recommendations with just a few mouse clicks.

SQL Access Advisor is primarily responsible for making schema modification recommendations, such as adding or dropping indexes and materialized views. SQL Tuning Advisor makes other types of recommendations, such as creating SQL profiles and restructuring SQL statements. If significant performance improvements can be gained by creating a new index, then SQL Tuning Advisor may recommend it. However, such recommendations should be verified by running SQL Access Advisor using a SQL workload that contains a set of representative SQL statements.

This chapter describes how to tune SQL statements using the SQL Tuning Advisor and contains the following sections:

- Tuning SQL Statements Using SQL Tuning Advisor
- Managing SQL Tuning Sets
- Managing SQL Profiles
- Managing SQL Execution Plans

See Also:

- Chapter 9, "Identifying High-Load SQL Statements"
- Chapter 11, "Optimizing Data Access Paths" for information about SQL Access Advisor

Tuning SQL Statements Using SQL Tuning Advisor

You can use SQL Tuning Advisor to tune one or more SQL statements. When tuning multiple statements, keep in the mind that SQL Tuning Advisor does not recognize interdependencies between the SQL statements. Instead, it is intended as a convenient way to run SQL Tuning Advisor for a large number of SQL statements.

Besides enabling you to tune SQL statements manually, Oracle Database generates SQL tuning reports automatically. Automatic SQL Tuning runs during system maintenance windows as an automated maintenance task, searching for ways to improve the execution plans of high-load SQL statements.

Tuning SQL Manually Using SQL Tuning Advisor

As described in Chapter 9, "Identifying High-Load SQL Statements", ADDM automatically identifies high-load SQL statements. In such cases, simply click **Schedule/Run SQL Tuning Advisor** on the Recommendation Detail page to invoke SQL Tuning Advisor.

To tune SQL statements manually using SQL Tuning Advisor:

1. On the Database Home page, under Related Links, click **Advisor Central**.

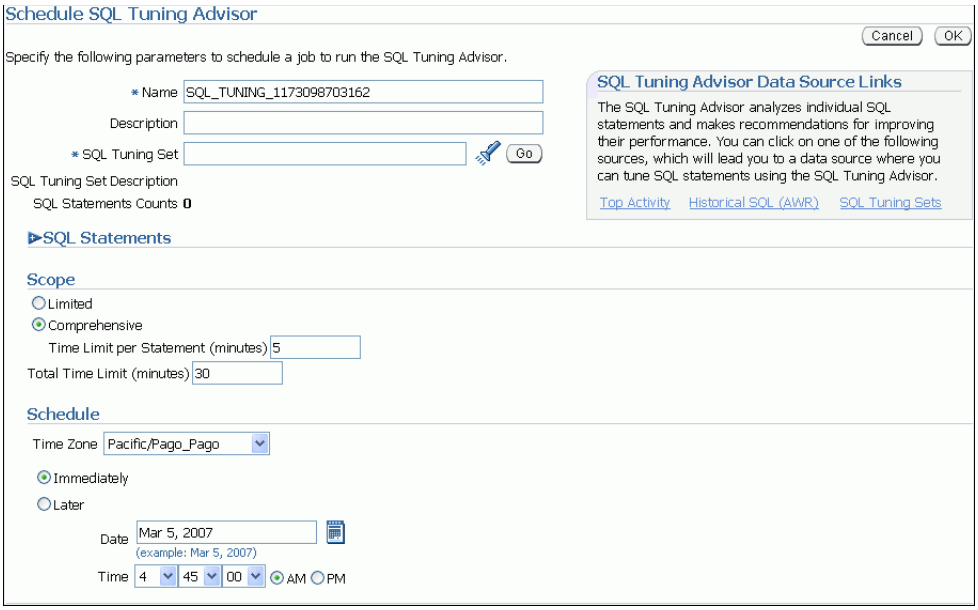
   The Advisor Central page appears.

2. Under Advisors, click **SQL Advisors**.

   The SQL Advisors page appears.

3. Under SQL Tuning Advisor, click **SQL Tuning Advisor**.

   The Schedule SQL Tuning Advisor page appears.



4. In the **Name** field, enter a name for the SQL tuning task.

   If unspecified, a system-generated name is used.

5. Do one of the following:

   - To run a SQL tuning task for one or more high-load SQL statements, under SQL Tuning Advisor Data Source Links, click **Top Activity**.

The Top Activity page appears.

Under Top SQL, select the SQL statement you want to tune and click **Schedule SQL Tuning Advisor**. For information about identifying high-load SQL statements using the Top Activity page, see "Identifying High-Load SQL Statements Using Top SQL" on page 9-2.

- To run a SQL tuning task for historical SQL statements from the Automatic Workload Repository (AWR), under SQL Tuning Advisor Data Source Links, click **Historical SQL (AWR)**.

  The Historical SQL (AWR) page appears.

  Under Historical SQL (AWR), click the band below the chart, and select the 24-hour interval for which you want to view SQL statements that ran on the database. Under Detail for Selected 24 Hour Interval, select the SQL statement you want to tune, and click **Schedule SQL Tuning Advisor**.

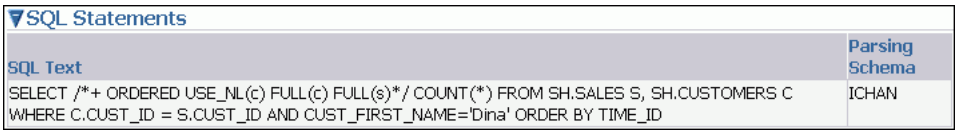
- To run a SQL tuning task for a SQL Tuning Set, click **SQL Tuning Sets**.

  The SQL Tuning Sets page appears.

  Select the SQL Tuning Set that contains the SQL statements you want to tune and click **Schedule SQL Tuning Advisor**. For information about creating SQL Tuning Sets, see "Creating a SQL Tuning Set" on page 10-8.

The Schedule SQL Tuning Advisor page reappears.

6. To display the SQL text of the selected statement, expand **SQL Statements**.



7. Under Scope, select the scope of tuning to perform. Do one of the following:

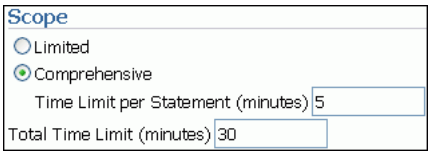
   - Select **Limited**.

     A limited scope takes approximately 1 second to tune each SQL statement but does not recommend a SQL profile.

   - Select **Comprehensive**, and then set a time limit (in minutes) for each SQL statement in the **Time Limit per Statement** field, and a total time limit (in minutes) in the **Total Time Limit** field.

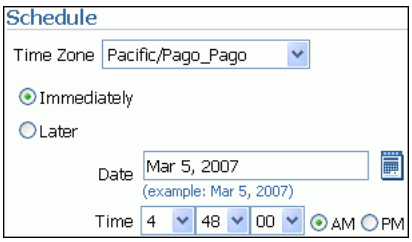
     A comprehensive scope performs a complete analysis and recommends a SQL profile, when appropriate, but may take much longer. Note that setting the time limit too small may affect the quality of the recommendations.

     Running a SQL Tuning Advisor task in comprehensive mode may take several minutes to tune a single SQL statement. This mode is both time and resource intensive because each time a query must be hard-parsed. Thus, you should only use comprehensive scope for high-load SQL statements that have a significant impact on the entire system.



For information about SQL profiles, see "Managing SQL Profiles" on page 10-19.

8. Under Schedule, do one of the following:
   - Select **Immediately** to run the SQL tuning task immediately, and then proceed to Step 10 after the SQL Tuning Results page appears.
   - Select **Later** to schedule a specific time in the future, and click **OK**.

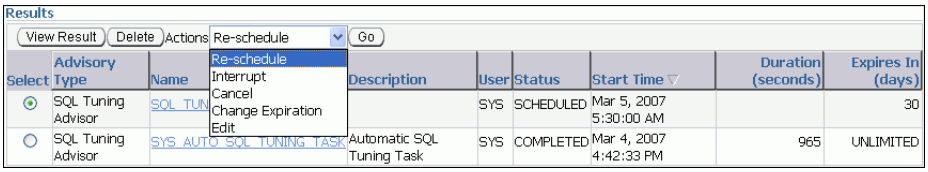


9. Optionally, on the Advisor Central page, do one of the following:
   - To view results for the SQL tuning task after it completes, select the SQL Tuning Advisor task and click **View Result**.

     The SQL Tuning Results page appears. Select the recommendation you want to implement and click **View**.

     Proceed to the next step.
   - To delete a SQL tuning task, select the SQL Tuning Advisor task and click **Delete**.
   - To reschedule a SQL tuning task, select the SQL Tuning Advisor task. From the Actions list, select **Re-schedule** and click **Go**.
   - To interrupt a SQL tuning task that is running, select the SQL Tuning Advisor task. From the Actions list, select **Interrupt** and click **Go**.
   - To cancel a scheduled SQL tuning task, select the SQL Tuning Advisor task. From the Actions list, select **Cancel** and click **Go**.
   - To change the expiration of a SQL tuning task, select the SQL Tuning Advisor task. From the Actions list, select **Change Expiration** and click **Go**.

     Results of each advisor run are stored in the database so that they can be referenced later. This data is stored until it expires, at which point it will be deleted by the AWR purging process.
   - To edit a scheduled SQL tuning task, select the SQL Tuning Advisor task. From the Actions list, select **Edit** and click **Go**.



10. On the SQL Tuning Results page, click **View**.

    The Recommendations for SQL ID page appears.

    If you used a SQL Tuning Set, then multiple recommendations may be displayed. To help you decide whether or not to implement a recommendation, an estimated benefit of implementing the recommendation is displayed in the Benefit (%) column. The Rationale column displays an explanation of why the recommendation is made.

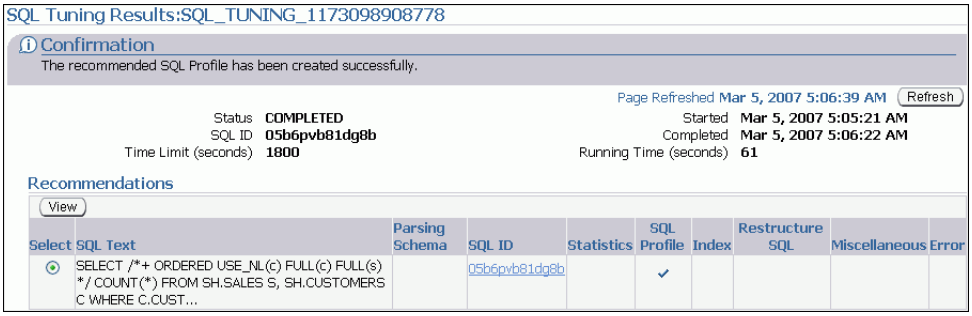
11. Optionally, if multiple recommendations are displayed, then do one of the following:

    - To view the original execution plan for the SQL statement, click **Original Explain Plan**.
    - To compare the new and original execution plans, click the icon in the **Compare Explain Plans** column.
    - To view the new execution plan for the SQL statement, click the icon in the **New Explain Plan** column.

    For information about viewing execution plans, see "Viewing the SQL Execution Plan" on page 9-7.

12. To implement the recommendation, click **Implement**.

The SQL Tuning Results page appears with a confirmation that the recommended action was completed.



Viewing Automatic SQL Tuning Results

By analyzing information stored in the Automatic Workload Repository (AWR), the database can identify routine maintenance tasks that need to be run. The automated maintenance tasks infrastructure (known as AutoTask) schedules these tasks to run in Oracle Scheduler time periods known as maintenance windows. By default, one window is scheduled for each day of the week. You can customize attributes of these maintenance windows, including start and end time, frequency, and days of the week.

AutoTask automatically schedules SQL Tuning Advisor to run during the maintenance windows. You can view the results of automated execution of SQL Tuning Advisor on observed high-load SQL statements.

To view automatic SQL tuning results:

1. On the Database Home page, under Related Links, click **Advisor Central**.

   The Advisor Central page appears.

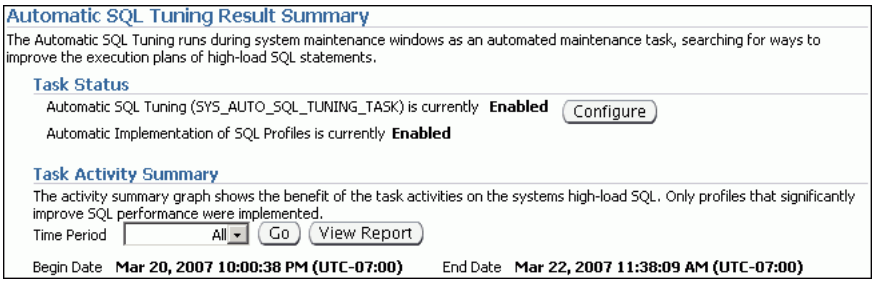
2. Under Advisors, click **SQL Advisors**.

The SQL Advisors page appears.

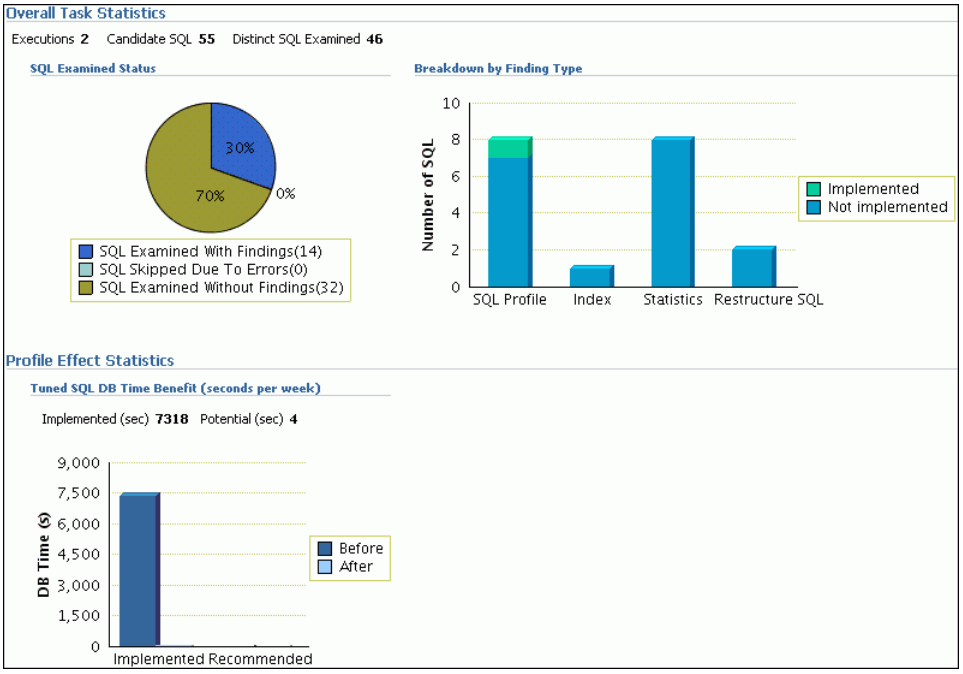
3. Under SQL Tuning Advisor, click **Automatic SQL Tuning Results**.

   The Automatic SQL Tuning Result Summary page appears.

   The top half of the page includes sections for the status and activity summary of the SQL Tuning task.



   The bottom half of the Automatic SQL Tuning Result Summary page shows statistics for the overall task and the profile effect.



   The Tuned SQL DB Time Benefit chart estimates the weekly DB time saved by SQL profiles that were automatically implemented. The chart also shows time that could be saved if other recommended SQL profiles were implemented. For example, the **Before** bar in the **Implemented** set aggregates the DB times during the week before tuning for all SQL statements with profiles implemented. The **After** bar projects the new weekly cumulative DB time, calculated by lowering the time of each SQL statement according to the benefit found by test execution. Thus, the **Implemented** set shows DB time benefit that has already been realized, whereas the **Recommended** set shows the potential benefit of profiles that were not automatically accepted by the SQL Tuning Advisor.

4. Optionally, in the Task Status section, click **Configure** to change the attributes of the Automatic SQL Tuning task.

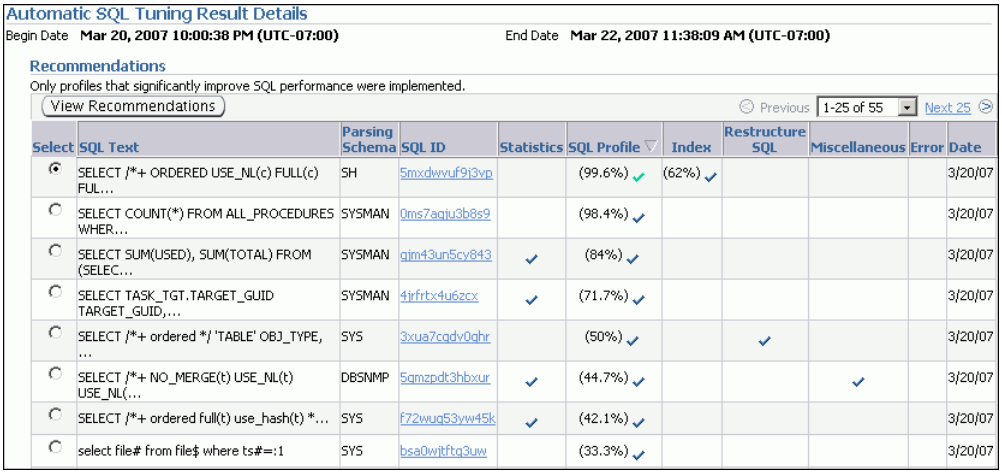
   The Automated Maintenance Tasks Configuration page appears.

In this page, you can enable or disable the Automatic SQL Tuning task and specify which days it should run. Click **Apply** or **Revert** to return to the previous page.

5. In the Task Activity Summary section, leave **All** selected for the **Time Period** and then click **View Report**.

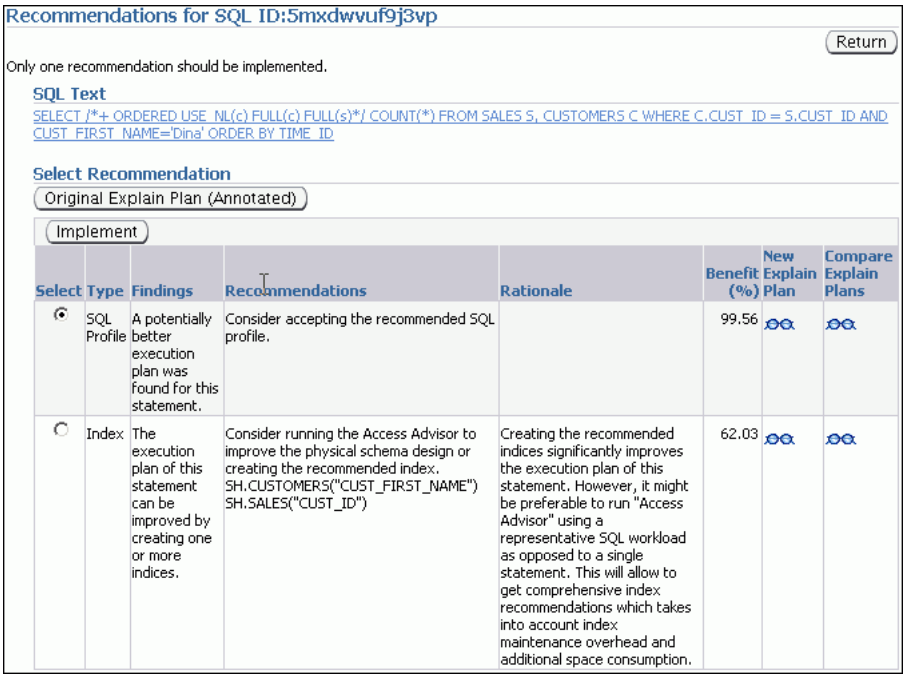
   The Automatic SQL Tuning Result Details page appears.

   The page lists SQL statements that have been automatically selected by the database as candidates for SQL tuning.



6. Under Recommendations, select a SQL statement and then click **View Recommendations**.

   The Recommendations for SQL ID page appears.



This page can include recommendations for SQL profiles and indexes. See "Tuning SQL Manually Using SQL Tuning Advisor" on page 10-2 to learn how to implement recommendations made by SQL Tuning Advisor.

Managing SQL Tuning Sets

A SQL Tuning Set is a database object that includes one or more SQL statements and their execution statistics and execution context. You can use the set as an input source for various advisors, such as SQL Tuning Advisor, SQL Access Advisor, and SQL Performance Analyzer. You can load SQL statements into a SQL Tuning Set from different SQL sources, such as AWR, the cursor cache, or high-load SQL statements that you identified.

A SQL Tuning Set includes the following:

- A set of SQL statements
- Associated execution context, such as user schema, application module name and action, list of bind values, and the cursor compilation environment
- Associated basic execution statistics, such as elapsed time, CPU time, buffer gets, disk reads, rows processed, cursor fetches, the number of executions, the number of complete executions, optimizer cost, and the command type
- Associated execution plans and row source statistics for each SQL statement (optional)

SQL statements can be filtered using the application module name and action, or any of the execution statistics. In addition, SQL statements can be ranked based on any combination of execution statistics.

SQL Tuning Sets are transportable across databases and can be exported from one system to another, allowing SQL workloads to be transferred between databases for remote performance diagnostics and tuning. When high-load SQL statements are identified on a production system, it may not be desirable to perform investigation and tuning activities on the production system directly. This feature enables you to transport the high-load SQL statements to a test system, where they can be safely analyzed and tuned. For information about transporting SQL Tuning Sets, see *Oracle Database Performance Tuning Guide*.

Using Oracle Enterprise Manager, you can manage SQL Tuning Sets by doing the following:

- Creating a SQL Tuning Set
- Dropping a SQL Tuning Set
- Transporting SQL Tuning Sets

Creating a SQL Tuning Set

This section describes how to create a SQL Tuning Set by using Oracle Enterprise Manager.

To create a SQL Tuning Set:

1. Specify the initial options for the SQL Tuning Set, as described in "Creating a SQL Tuning Set: Options" on page 10-9.
2. Select the load method to use for collecting and loading SQL statements into the SQL Tuning Set, as described in "Creating a SQL Tuning Set: Load Method" on page 10-10.
3. Specify the filter options for the SQL Tuning Set, as described in "Creating a SQL Tuning Set: Filter Options" on page 10-13.

4. Schedule and submit a job to collect the SQL statements and load them into the SQL Tuning Set, as described in "Creating a SQL Tuning Set: Schedule" on page 10-15.

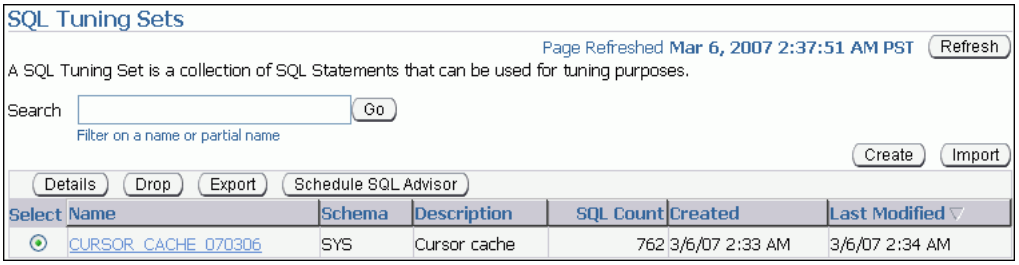
Creating a SQL Tuning Set: Options

The first step in creating a SQL Tuning Set is to specify initial options for the set such as name, owner, and description.

To specify options for creating a SQL Tuning Set:

1. On the Database Performance page, under Additional Monitoring Links, click **SQL Tuning Sets**.

   The SQL Tuning Sets page appears. Existing SQL Tuning Sets are displayed on this page.



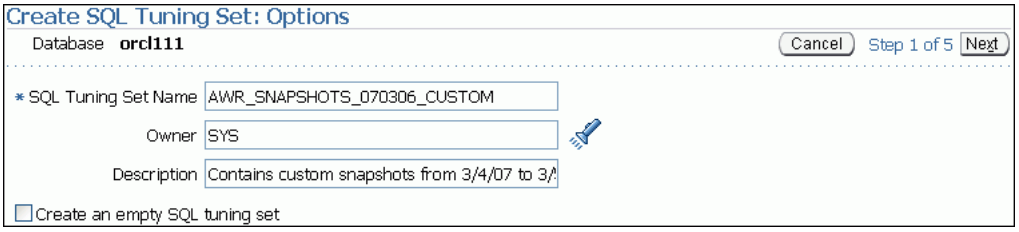
2. Click **Create**.

   The Create SQL Tuning Set: Options page appears.

3. In the **SQL Tuning Set Name** field, enter a name for the SQL Tuning Set.

4. In the **Owner** field, enter the owner of the SQL Tuning Set.

5. In the **Description** field, enter a description of the SQL Tuning Set.



6. Optionally, if you want to create an empty SQL Tuning Set and add SQL statements to it at a later time, then complete the following steps:

   a. Enable **Create an empty SQL tuning set**.

   b. Click **Next**.

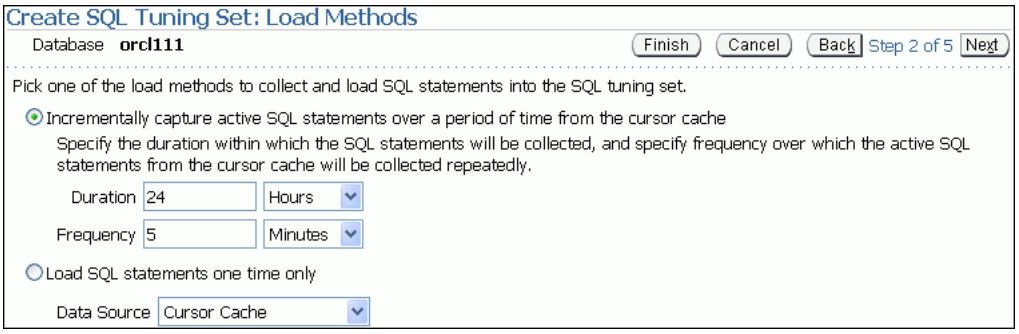
      The Create SQL Tuning Set: Review page appears.

   c. Review the SQL Tuning Set options that you have selected and click **Submit**.

      The empty SQL Tuning Set is created. You can add SQL statements to it at a later time.

7. Click **Next**.

   The Create SQL Tuning Set: Load Methods page appears.



8. Proceed to the next step, as described in "Creating a SQL Tuning Set: Load Method" on page 10-10.

Creating a SQL Tuning Set: Load Method

After options are specified for the SQL Tuning Set, select the load method to use for collecting and loading SQL statements into the SQL Tuning Set, as described in the following sections:

- Loading Active SQL Statements Incrementally from the Cursor Cache
- Loading SQL Statements from the Cursor Cache
- Loading SQL Statements from AWR Snapshots
- Loading SQL Statements from AWR Baselines
- Loading SQL Statements from a User-Defined Workload

> **Tip:** Before selecting the load method for the SQL Tuning Set, create a SQL Tuning Set and specify the initial options, as described in "Creating a SQL Tuning Set: Options" on page 10-9

Loading Active SQL Statements Incrementally from the Cursor Cache You can load active SQL statements from the cursor cache into the SQL Tuning Set incrementally over a specified period of time. This enables you to not only collect current and recent SQL statements stored in the SQL cache, but also SQL statements that will run during the specified time period in the future.

To load active SQL statements incrementally from the cursor cache:

1. On the Create SQL Tuning Set: Load Methods page, select **Incrementally capture active SQL statements over a period of time from the cursor cache**.
2. In the **Duration** field, specify how long active SQL statements will be captured.
3. In the **Frequency** field, specify how often active SQL statements will be captured during the specified duration.
4. Click **Next**.

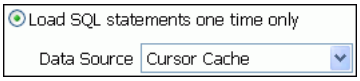
   The Create SQL Tuning Set: Filter Options page appears.
5. Proceed to the next step, as described in "Creating a SQL Tuning Set: Filter Options" on page 10-13.

Loading SQL Statements from the Cursor Cache You can load SQL statements from the cursor cache into the SQL Tuning Set. However, because only current and recent SQL statements are stored in the SQL cache, collecting these SQL statements only once may

result in a SQL Tuning Set this is not representative of the entire workload on your database.

To load SQL statements from the cursor cache:

1. On the Create SQL Tuning Set: Load Methods page, select **Load SQL statements one time only**.
2. In the Data Source field, select **Cursor Cache**.



3. Click **Next**.

   The Create SQL Tuning Set: Filter Options page is shown.

4. Proceed to the next step, as described in "Creating a SQL Tuning Set: Filter Options" on page 10-13.

Loading SQL Statements from AWR Snapshots You can load SQL statements captured in AWR snapshots. This is useful when you want to collect SQL statements for specific snapshot periods of interest that can be used for later comparison or tuning purposes.

To load SQL statements from AWR snapshots:

1. On the Create SQL Tuning Set: Load Methods page, select **Load statements one time only**.
2. In the **Data Source** field, select **AWR Snapshots**.
3. In the **AWR Snapshots** field, select the snapshots to include. Do one of the following:
   - Select **Last 24 hours** and then go to Step 5.

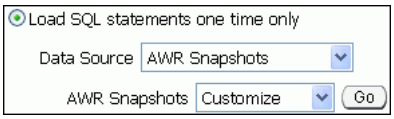
     Only snapshots that are captured and stored in AWR in the last 24 hours will be included.
   - Select **Last 7 days** and then go to Step 5.

     Only snapshots that are captured and stored in AWR in the last 7 days will be included.
   - Select **Last 31 days** and then go to Step 5.

     Only snapshots that are captured and stored in AWR in the last 31 days will be included.
   - Select **ALL** and then go to Step 5.

     All snapshots that are captured and stored in AWR will be included.
   - Select **Customize** and then proceed to Step 4.

     Only snapshots that are captured and stored in AWR during a customized time period that you specify will be included.
4. To select a customized time period of snapshots to include, complete the following steps:
   a. Select **Customize** and click **Go**.



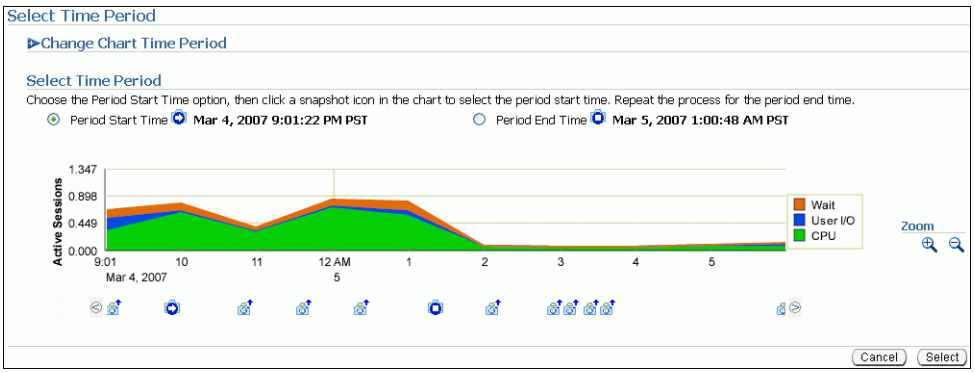
The Select Time Period window opens.

b. For the starting snapshot, select **Period Start Time** and click the snapshot icon below the Active Session graph that corresponds to the desired start time.

c. For the ending snapshot, select **Period End Time** and click the snapshot icon below the Active Session graph that corresponds to the desired end time.

d. Click **Select**.

In this example, the snapshot taken on March 4, 2007 at 9:01 p.m. is selected as the start time, and the snapshot taken on March 5, 2007 at 1:00 a.m. is selected as the end time.



5. Click **Next**.

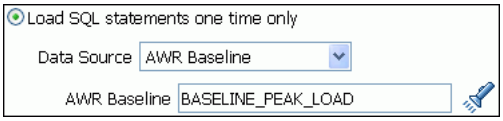
   The Create SQL Tuning Set: Filter Options page is shown.

6. Proceed to the next step, as described in "Creating a SQL Tuning Set: Filter Options" on page 10-13.

Loading SQL Statements from AWR Baselines You can load SQL statements captured in AWR baselines. This is useful when you want to collect SQL statements that are representative of a time period during known performance levels that can be used for later comparison or tuning purposes.

To load SQL statements from AWR baselines:

1. On the Create SQL Tuning Set: Load Methods page, select **Load SQL statements one time only**.
2. In the **Data Source** field, select **AWR Baseline**.
3. In the **AWR Baseline** field, select the baseline to include.



4. Click **Next**.

   The Create SQL Tuning Set: Filter Options page is shown.

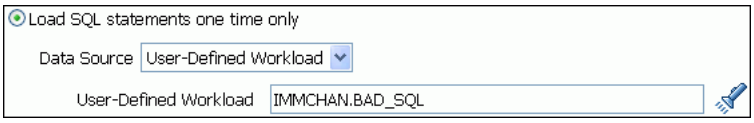
5. Proceed to the next step, as described in "Creating a SQL Tuning Set: Filter Options" on page 10-13.

Loading SQL Statements from a User-Defined Workload You can load SQL statements by importing from a table or view. This is useful if the workload you want to analyze is not currently running on the database or captured in an existing AWR snapshot or AWR baseline.

There are no restrictions on which schema the workload resides in, the name of the table, or the number of tables that you can define. The only requirement is that the format of the table must match format of the `USER_WORKLOAD` table.

To load SQL statements from a user-defined workload:

1. On the Create SQL Tuning Set: Load Methods page, select **Load statements one time only**.
2. In the **Data Source** field, select **User-Defined Workload**.
3. In the **User-Defined Workload** field, select the table or view to include.



4. Click **Next**.

   The Create SQL Tuning Set: Filter Options page is shown.

5. Proceed to the next step, as described in "Creating a SQL Tuning Set: Filter Options" on page 10-13.

Creating a SQL Tuning Set: Filter Options

After the load method is selected, you can apply filters to reduce the scope of the SQL statements found in the SQL Tuning Set. While using filters is optional, it can be very beneficial due to the following:

- Using filters directs the various advisors that use the SQL Tuning Set as a workload source—such as SQL Tuning Advisor, SQL Access Advisor, and SQL Performance Analyzer—to make recommendations based on a specific subset of SQL statements, which may lead to better recommendations.
- Using filters removes extraneous SQL statements from the SQL Tuning Set, which may greatly reduce processing time when it is used as a workload source for the various advisors.

> **Tip:** Before you can specify the filter options for the SQL Tuning Set, do the following:
>
> - Create a SQL Tuning Set and specify the initial options, as described in "Creating a SQL Tuning Set: Options" on page 10-9
> - Select the load method, as described in "Creating a SQL Tuning Set: Load Method" on page 10-10

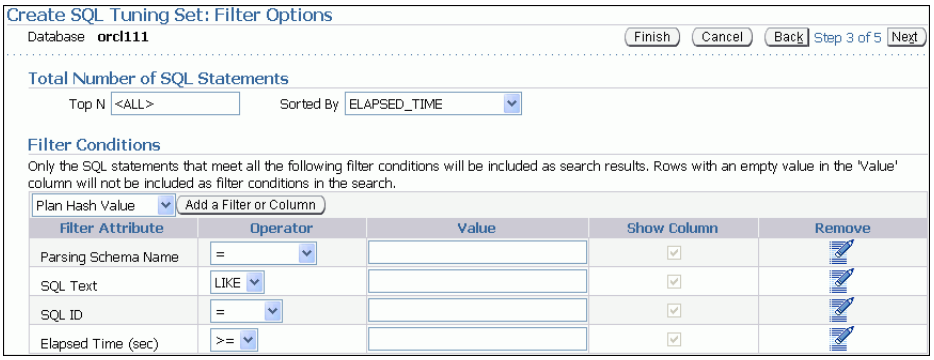
To specify filter options for a SQL Tuning Set:

1. On the Create SQL Tuning Set: Filter Options page, specify the values of filter conditions that you want use in the search in the **Value** column, and an operator or a condition in the **Operator** column.

Only the SQL statements that meet all of the specified filter conditions will be added to the SQL Tuning Set. Unspecified filter values will not be included as filter conditions in the search.

By default, the following filter conditions are displayed:

- Parsing Schema Name
- SQL Text
- SQL ID
- Elapsed Time (sec)



2. To add filter conditions, under Filter Conditions, select the filter condition you want to add and click **Add a Filter or Column**.

   The available filter conditions include the following:

   - Plan hash value
   - Module
   - Action
   - Buffer gets
   - Disk reads
   - Disk writes
   - Rows processed
   - Fetches
   - Executions
   - End of fetch count
   - Command type

   After the desired filter conditions have been added, specify their values in the **Value** column, and an operator or a condition in the **Operator** column.

3. To remove any unused filter conditions, click the icon in the **Remove** column for the corresponding filter condition you want to remove.

4. Click **Next**.

   The Create SQL Tuning Set: Schedule page appears.

5. Proceed to the next step, as described in "Creating a SQL Tuning Set: Schedule" on page 10-15.

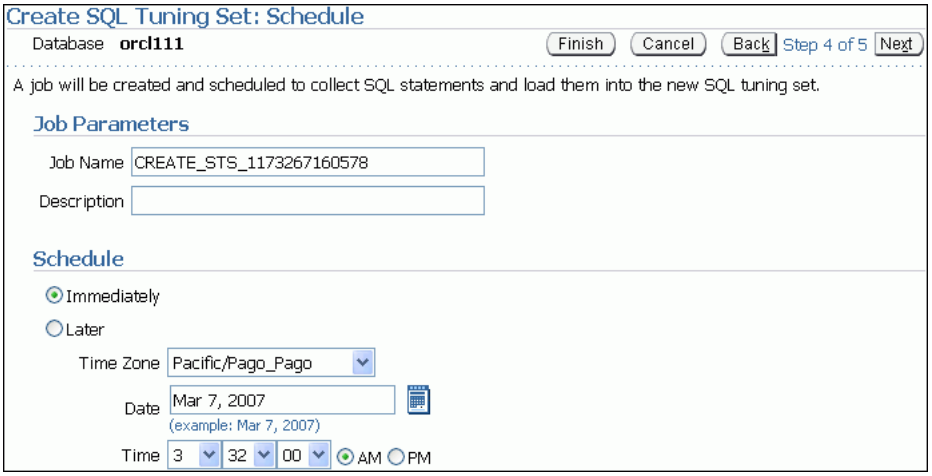
Creating a SQL Tuning Set: Schedule

After the filter options are specified for the SQL Tuning Set, you can schedule and submit a job to collect the SQL statements and load them into the SQL Tuning Set.

> **Tip:** Before you can schedule a job to create the SQL Tuning Set, do the following:
>
> - Create a SQL Tuning Set and specify the initial options, as described in "Creating a SQL Tuning Set: Options" on page 10-9.
> - Select the load method, as described in "Creating a SQL Tuning Set: Load Method" on page 10-10.
> - Specify the filter options, as described in "Creating a SQL Tuning Set: Filter Options" on page 10-13.

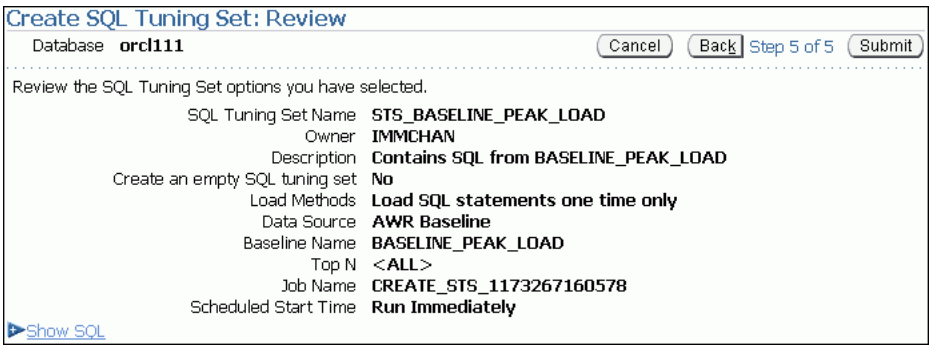
To schedule and submit a job to create a SQL Tuning Set:

1. On the Create SQL Tuning Set: Schedule page, under Job Parameters, enter a name in the **Job Name** field if you do not want to use the system-generated job name.
2. In the **Description** field, enter a description of the job.
3. Under Schedule, do one of the following:
   - **Immediately** to run the job immediately after it has been submitted
   - **Later** to run the job at a later time as specified using the Time Zone, Date, and Time fields



4. Click **Next**.

   The Create SQL Tuning Set: Review page appears.



5. Review the SQL Tuning Set options that you have selected.

   To view the SQL statements used by the job, expand **Show SQL**.

6. Click **Submit**.

   The SQL Tuning Sets page appears.

   If the job was scheduled to run immediately, then a message is displayed to inform you that the job and the SQL Tuning Set were created successfully. If the job was scheduled to run at a later time, a message is displayed to inform you that the job was created successfully.

7. To view details about the job, such as operation status, click **View Job Details**.

   The View Job page appears to display details about the job.

Dropping a SQL Tuning Set

This section describes how to drop a SQL Tuning Set. To conserve storage space, you may want to periodically drop unused SQL Tuning Sets stored in the database.

To drop a SQL Tuning Set:

1. On the Database Performance page, under Additional Monitoring Links, click **SQL Tuning Sets**.

   The SQL Tuning Sets page appears.

   Existing SQL Tuning Sets are displayed on this page.

2. Select the SQL Tuning Set you want to drop and click **Drop**.

   The Confirmation page appears to verify if you want to delete the selected SQL Tuning Set.

3. Click **Yes**.

   The SQL Tuning Sets page appears.

   A confirmation message is displayed to indicate that the SQL Tuning Set was successfully deleted.

Transporting SQL Tuning Sets

You can transport SQL Tuning Sets from one system to another by first exporting a SQL Tuning Set from one system, then importing it into another system.

This section contains the following topics:

- Exporting a SQL Tuning Set
- Importing a SQL Tuning Set

Exporting a SQL Tuning Set

This section describes how to export a SQL Tuning Set, thereby enabling it to be transported to another system.

To export a SQL Tuning Set:

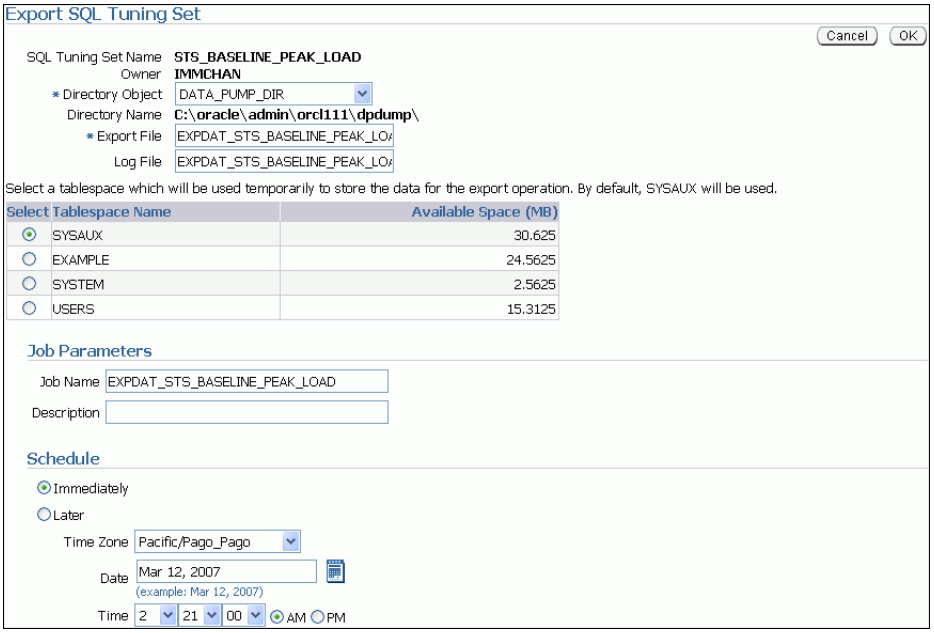
1. On the Database Performance page, under Additional Monitoring Links, click **SQL Tuning Sets**.

   The SQL Tuning Sets page appears.

Existing SQL Tuning Sets are displayed on this page.

2. Select the SQL Tuning Set you want to export and click **Export**.

   The Export SQL Tuning Set page appears.



3. In the **Directory Object** field, select a directory where the export file will be created.

   For example, to use the Oracle Data Pump directory, select `DATA_PUMP_DIR`. The Directory Name field refreshes automatically to indicate the selected directory.

4. In the **Export File** field, enter a name for the dump file that will be exported.

   Alternatively, you can accept the name generated by the system.

5. In the **Log File** field, enter a name for the log file for the export operation.

   Alternatively, you can accept the name generated by the system.

6. Select a tablespace to temporarily store the data for the export operation.

   By default, `SYSAUX` is used.

7. Under Job Parameters, in the **Job Name** field, enter a name for the job.

   Alternatively, you can accept the name generated by the system.

8. Under Schedule, do one of the following:

   - Select **Immediately** to run the job immediately after it has been submitted.
   - Select **Later** to run the job at a later time as specified by selecting or entering values in the **Time Zone**, **Date**, and **Time** fields.

9. Click **OK**.

   The SQL Tuning Sets page appears.

   A confirmation message is displayed to indicate that the job was successfully created.

10. Optionally, transport the export file to another system using the mechanism of choice (such as Oracle Data Pump or a database link).

Importing a SQL Tuning Set

Before a SQL Tuning Set can be imported, you must first export a SQL Tuning Set from another system and transport it to your current system. For more information, see "Exporting a SQL Tuning Set" on page 10-16.

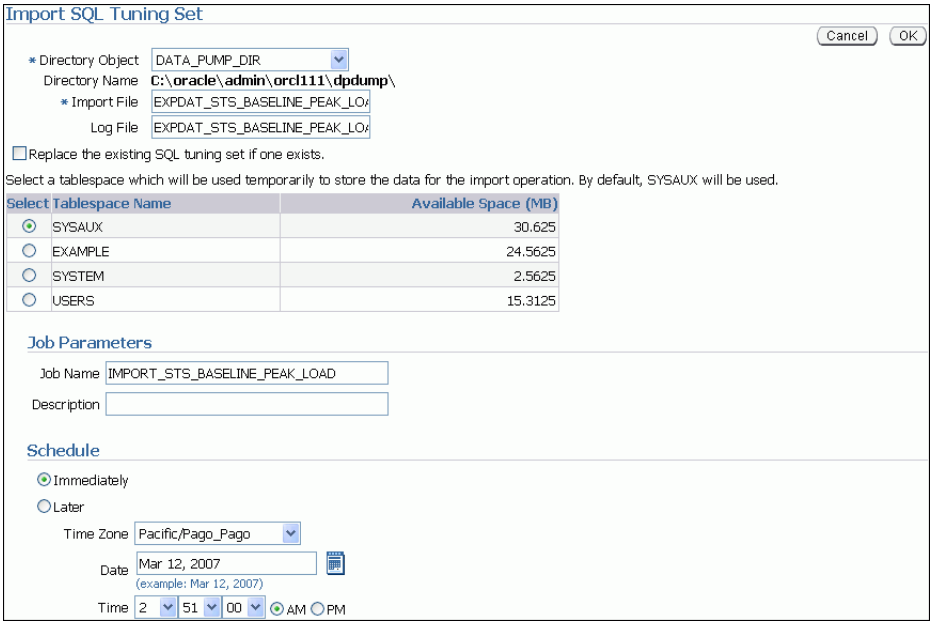
To import a SQL Tuning Set:

1. On the Database Performance page, under Additional Monitoring Links, click **SQL Tuning Sets**.

   The SQL Tuning Sets page appears.

2. Click **Import**.

   The Import SQL Tuning Set page appears.



3. In **Directory Object**, select a directory where the import file is stored.

   The directory should contain the export file that was transported to your current system. For example, if the file resides in the Data Pump directory, then select `DATA_PUMP_DIR`. The Directory Name field refreshes automatically to indicate the selected directory.

4. In the **Import File** field, enter the name of the dump file that will be imported.

5. In the **Log File** field, enter a name for the log file for the import operation.

6. To replace an existing SQL Tuning Set with the one that you are importing, select **Replace the existing SQL tuning set if one exists**.

7. Select a tablespace to temporarily store the data for the import operation.

   By default, `SYSAUX` is used.

8. Under Job Parameters, in the **Job Name** field, enter a name for the job.

   Alternatively, you can accept the name generated by the system.

9. Under Schedule, do one of the following:

   - Select **Immediately** to run the job immediately after it has been submitted.

- Select **Later** to run the job at a later time as specified by selecting or entering values in the **Time Zone**, **Date**, and **Time** fields.

10. Click **OK**.

    The SQL Tuning Sets page appears.

    A confirmation message is displayed to indicate that the job was successfully created. If the job is scheduled to run immediately, then the imported SQL Tuning Set will be displayed on this page. You may need to refresh the page.

Managing SQL Profiles

When running a SQL Tuning Advisor task with a limited scope, the query optimizer makes estimates about cardinality, selectivity, and cost. These estimates can sometimes be off by a significant amount, resulting in poor execution plans.

To address this problem, consider running a SQL Tuning Advisor task with a comprehensive scope to collect additional information using sampling and partial execution techniques to verify and, if necessary, adjust these estimates. These auxiliary statistics about the SQL statement are collected into a SQL profile.

During SQL profiling, the query optimizer uses the execution history information about the SQL statement to create appropriate settings for optimizer parameters. After the SQL profiling completes, the query optimizer uses the information stored in the SQL profile, in conjunction with regular database statistics, to generate execution plans. The availability of the additional information makes it possible to produce well-tuned plans for corresponding SQL statements.

After running a SQL Tuning Advisor task with a comprehensive scope, a SQL profile may be recommended. If you accept the recommendation, then the SQL profile will be created and enabled for the SQL statement.

In some cases, you may want to disable a SQL profile. For example, you may want to test the performance of a SQL statement without using a SQL profile to determine if the SQL profile is actually beneficial. If the SQL statement is performing poorly after the SQL profile is disabled, then you should enable it again to avoid performance degradation. If the SQL statement is performing optimally after you have disabled the SQL profile, you may want to remove the SQL profile from your database.

To enable, disable, or delete a SQL profile:

1. On the Performance page, click **Top Activity**.

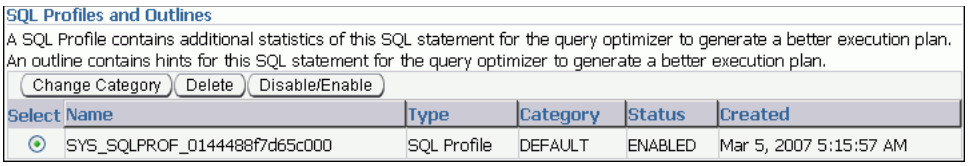
   The Top Activity page appears.

2. Under Top SQL, click the **SQL ID** link of the SQL statement that is using a SQL profile.

   The SQL Details page appears.

3. Click the **Tuning Information** tab.

   A list of SQL profiles is displayed under SQL Profiles and Outlines.



4. Select the SQL profile you want to manage. Do one of the following:

- To enable a SQL profile that is disabled, click **Disable/Enable**.
- To disable a SQL profile that is enabled, **Disable/Enable**.
- To remove a SQL profile, click **Delete**.

A confirmation page appears.

5. Click **Yes** to continue, or **No** to cancel the action.

Managing SQL Execution Plans

SQL plan management records and evaluates the execution plans of SQL statements over time. This mechanism builds SQL plan baselines composed of a set of existing plans known to be efficient. If the same SQL statement is run repeatedly, and if the optimizer generates a new plan that differs from the baseline, then the database compares the new plan with the baseline and chooses the best one.

Some events can cause changes to SQL execution plans, such as new optimizer statistics, changes to initialization parameter values, a database upgrade that causes a change to the optimizer, and so on. These changes can cause regressions in SQL performance, which can be difficult and time-consuming to fix manually. As a preventative measure, you can fix SQL plan baselines to preserve performance of corresponding SQL statements, regardless of changes occurring in the system.

To load SQL execution plans:

1. From the Database Home page, click **Server**.

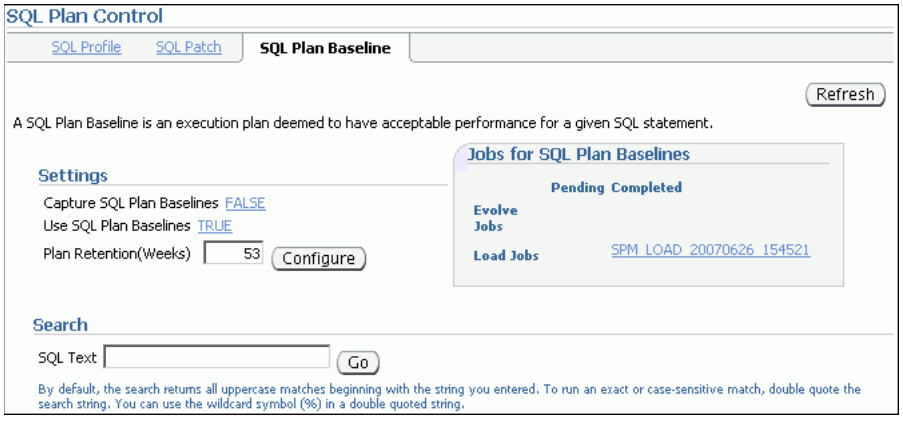
   The Server subpage appears.

2. Under Query Optimizer, click **SQL Plan Control**.

   The SQL Profile subpage of the SQL Plan Control page appears.

3. Click **SQL Plan Baseline**.

   The SQL Plan Baseline subpage appears.



4. Under Settings, click the link next to **Capture SQL Plan Baselines**.

   The Initialization Parameters page appears.

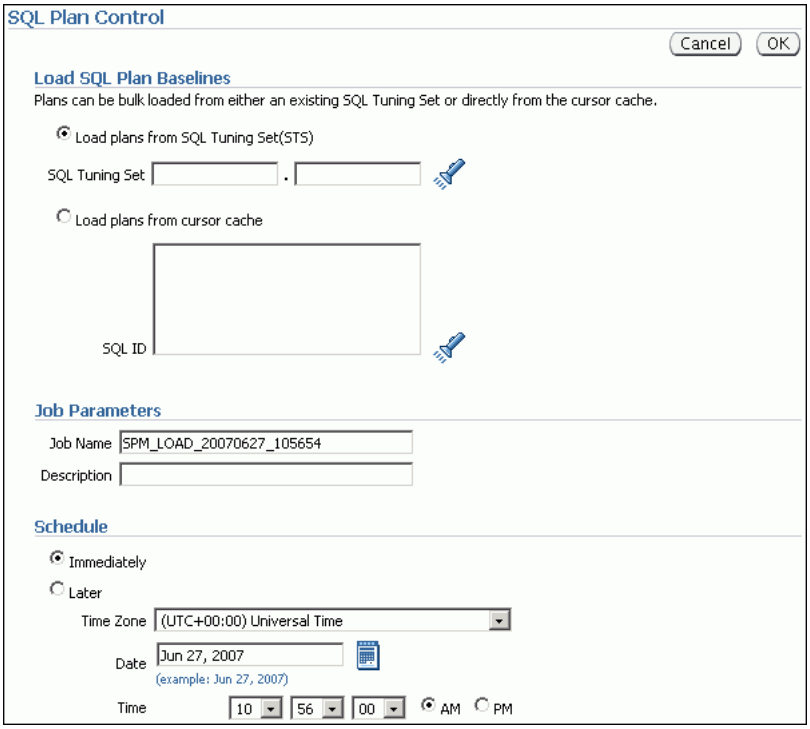
5. In the **Value** column of the table, select **TRUE** and then click **OK**.

   You are returned to the SQL Plan Baseline subpage, which now shows **Capture SQL Baselines** set to **TRUE**.

Because you configured baselines to be captured, the database automatically keeps a history of execution plans for all SQL statements executed more than once.

6. Click **Load**.

   The SQL Plan Control page appears.



7. Select the SQL plan baselines to be loaded. Complete the following steps:

   a. Under Load SQL Plan Baselines, select **Load plans from SQL Tuning Set (STS)**.

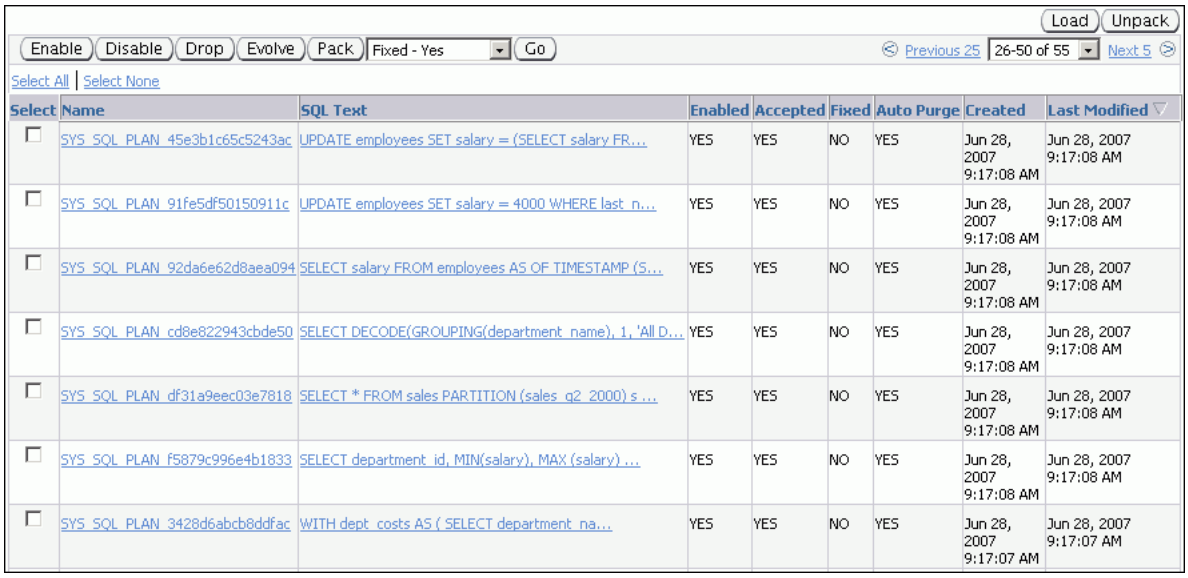
      In this example, load plans from the SQL Tuning Set that you created in "Creating a SQL Tuning Set" on page 10-8.

   b. In **Job Name**, enter a name for the job. In this example, enter `SPM_LOAD_TEST`.

   c. Under Schedule, select **Immediately**.

   d. Click **OK**.

   The SQL Profile subpage of the SQL Plan Control page appears. The table displays a list of SQL plans that are stored as SQL plan baselines.



8. Optionally, fix the execution plan of a baseline so that the database will not use any alternative SQL plan baseline. Complete the following steps:

   a. Select a SQL plan baseline that is not fixed.

   b. Select **Fixed - Yes** from the list preceding the baseline table.

   c. Click **Go**.

   The table is refreshed to show the SQL execution plan with the value `YES` in the Fixed column of the table.

   See Also:

   - *Oracle Database Performance Tuning Guide* to learn how to use SQL plan management

11

Optimizing Data Access Paths

To achieve optimum performance for data-intensive queries, materialized views and indexes are essential when tuning SQL statements. Implementing these objects, however, does not come without a cost. Creation and maintenance of these objects can be time-consuming, and space requirements can be significant. SQL Access Advisor enables you to optimize data access paths of SQL queries by recommending the proper set of materialized views and view logs, indexes, SQL profiles, and partitions for a given workload.

A materialized view provides access to table data by storing query results in a separate schema object. Unlike an ordinary view, which does not take up storage space or contain data, a materialized view contains the rows resulting from a query against one or more base tables or views. A materialized view log is a schema object that records changes to a master table's data, so that a materialized view defined on the master table can be refreshed incrementally. SQL Access Advisor recommends how to optimize materialized views so that they can be rapidly refreshed and take advantage of the general query rewrite feature. For more information about materialized views and view logs, see *Oracle Database Concepts*.

SQL Access Advisor also recommends bitmap, function-based, and B-tree indexes. A bitmap index provides a reduced response time for many types of ad hoc queries and reduced storage requirements compared to other indexing techniques. A function-based index derives the indexed value from the table data. For example, to find character data in mixed cases, a function-based index can be used to look for the values as if they were all in uppercase characters. B-tree indexes are most commonly used to index unique or near-unique keys.

Using SQL Access Advisor involves the following tasks:

- Running SQL Access Advisor
- Reviewing the SQL Access Advisor Recommendations
- Implementing the SQL Access Advisor Recommendations

See Also:

- Chapter 9, "Identifying High-Load SQL Statements"
- Chapter 10, "Tuning SQL Statements" for information about SQL Tuning Advisor

Running SQL Access Advisor

This section describes how to run SQL Access Advisor to make recommendations on a SQL workload.

To run SQL Access Advisor:

1. Select the initial options, as described in "Running SQL Access Advisor: Initial Options" on page 11-2.
2. Select the workload source you want to use for the analysis, as described in "Running SQL Access Advisor: Workload Source" on page 11-3.
3. Define the filters options, as described in "Running SQL Access Advisor: Filter Options" on page 11-5.
4. Choose the types of recommendations, as described in "Running SQL Access Advisor: Recommendation Options" on page 11-7.
5. Schedule the SQL Access Advisor task, as described in "Running SQL Access Advisor: Schedule" on page 11-9.

Running SQL Access Advisor: Initial Options

The first step in running SQL Access Advisor is to select the initial options on the SQL Access Advisor: Initial Options page.

To select initial options:

1. On the Database Home page, under Related Links, click **Advisor Central**.

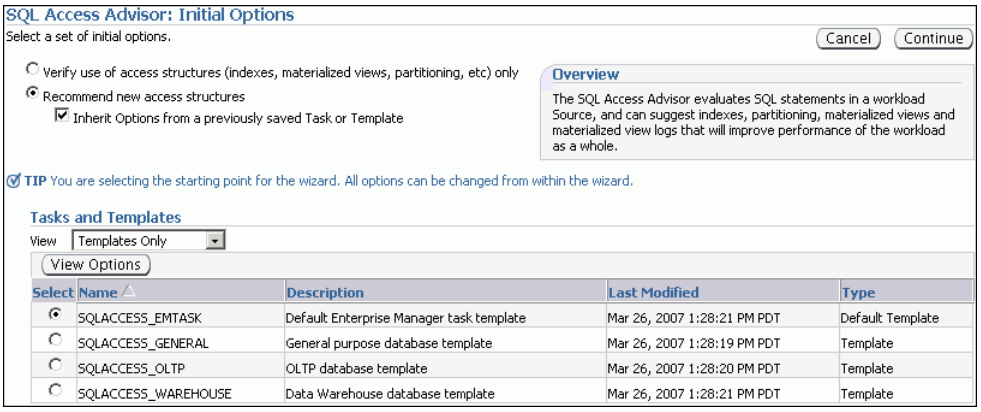
   The Advisor Central page appears.
2. Under Advisors, click **SQL Advisors**.

   The SQL Advisors page appears.
3. Click **SQL Access Advisor**.

   The SQL Access Advisor: Initial Options page appears.
4. Select the initial options. Do one of the following:
   - Select **Verify use of access structures (indexes, materialized views, partitioning, and so on) only** to verify existing structures.
   - Select **Recommend new access structures** to use the recommended options defined in the Oracle Enterprise Manager default template.

     If you select this option, then you can optionally complete the following additional steps:
     - Select **Inherit Options from a previously saved Task or Template** to use the options defined in an existing SQL Access Advisor task or another template.
     - In Tasks and Templates, select the task or template that you want to use.

   In this example, **Recommend new access structures** is selected.



5. Click **Continue**.

   The SQL Access Advisor: Workload Source page appears.

6. Proceed to the next step, as described in "Running SQL Access Advisor: Workload Source" on page 11-3.

Running SQL Access Advisor: Workload Source

After initial options are specified for SQL Access Advisor, select the workload source that you want to use for the analysis, as described in the following sections:

- Using SQL Statements from the Cache
- Using an Existing SQL Tuning Set
- Using a Hypothetical Workload

> **Tip:** Before you can select the workload source for SQL Access Advisor, select the initial options, as described in "Running SQL Access Advisor: Initial Options" on page 11-2.

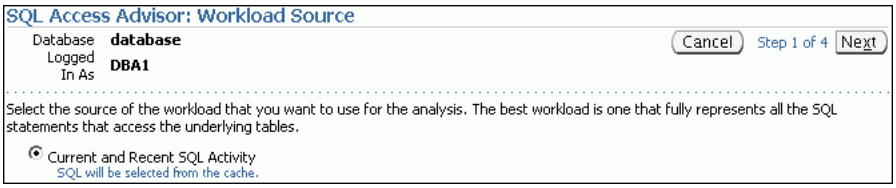
Using SQL Statements from the Cache

You can use SQL statements from the cache as the workload source. However, because only current and recent SQL statements are stored in the SQL cache, this workload source may not be representative of the entire workload on your database.

To use SQL statements from the cache as the workload source:

1. On the SQL Access Advisor: Workload Source page, select **Current and Recent SQL Activity**.

   In this example, **Use Default Options** is selected.



2. Proceed to the next step, as described in "Running SQL Access Advisor: Filter Options" on page 11-5.

Using an Existing SQL Tuning Set

You can use an existing SQL Tuning Set as the workload source. This option is useful because SQL Tuning Sets can be used repeatedly as the workload source for not only SQL Access Advisor, but also SQL Tuning Advisor.

To use a SQL Tuning Set as the workload source:

1. On the SQL Access Advisor: Workload Source page, select **Use an existing SQL Tuning Set**.
2. Click the **SQL Tuning Set** search icon to use an existing SQL Tuning Set.

   The Search and Select: SQL Tuning Set dialog box appears.
3. In the **Schema** field, enter the name of the schema containing the SQL Tuning Set you want to use and click **Go**.

   A list of SQL Tuning Sets contained in the selected schema appears.
4. Select the SQL Tuning Set to be used for the workload source and click **Select**.

   The Search and Select: SQL Tuning Set dialog box closes and the selected SQL Tuning Set now appears in the **SQL Tuning Set** field.
5. Proceed to the next step, as described in "Running SQL Access Advisor: Filter Options" on page 11-5.

See Also:

- "Managing SQL Tuning Sets" on page 10-8

Using a Hypothetical Workload

A dimension table stores all or part of the values for a logical dimension in a star or snowflake schema. You can create a hypothetical workload from dimension tables containing primary or foreign key constraints. This option is useful if the workload to be analyzed does not exist. In this case, SQL Access Advisor examines the current logical schema design, and provides recommendations based on the defined relationships between tables.

To use a hypothetical workload as the workload source:

1. On the SQL Access Advisor: Workload Source page, select **Create a Hypothetical Workload from the Following Schemas and Tables**.
2. Leave **Schemas and Tables** empty and click **Add** to search for tables.

   The Workload Source: Search and Select Schemas and Tables page appears.
3. In the Tables section, enter a schema name in the **Schema** field and click **Search**.

   A list of tables in the selected schema is displayed.
4. Select the tables to be used in creating the hypothetical workload and click **Add Tables**.

   The selected tables now appear in the **Schemas and Tables** field.
5. Click **OK**.

   The SQL Access Advisor: Workload Source page appears with the selected tables now added.
6. Proceed to the next step, as described in "Running SQL Access Advisor: Filter Options" on page 11-5.

Running SQL Access Advisor: Filter Options

After the workload source is selected, you can apply filters to reduce the scope of the SQL statements found in the workload. While using filters is optional, it can be very beneficial due to the following:

- Using filters directs SQL Access Advisor to make recommendations based on a specific subset of SQL statements from the workload, which may lead to better recommendations.
- Using filters removes extraneous SQL statements from the workload, which may greatly reduce processing time.

> **Tip:** Before you can select the filter options for the workload, do the following:
>
> - Select initial options, as described in "Running SQL Access Advisor: Initial Options" on page 11-2.
> - Select the workload source, as described in "Running SQL Access Advisor: Workload Source" on page 11-3.

To apply filters to the workload source:

1. On the SQL Access Advisor: Workload Source page, click **Filter Options**.

   The Filter Options section expands.

2. Select **Filter Workload Based on these Options**.

   The Filter Options section is enabled.

3. Define the filters you want to apply, as described in the following sections:
   - Defining Filters for Resource Consumption
   - Defining Filters for Users
   - Defining Filters for Tables
   - Defining Filters for SQL Text
   - Defining Filters for Modules
   - Defining Filters for Actions
4. Click **Next**.

   The Recommendation Options page appears.

5. Proceed to the next step, as described in "Running SQL Access Advisor: Recommendation Options" on page 11-7.

Defining Filters for Resource Consumption

The resource consumption filter restricts the workload to include only the number of high-load SQL statements that you specify.

To define a filter for resource consumption:

1. On the SQL Access Advisor: Workload Source page, under User Resource Consumption, enter the number of high-load SQL statements in the **Number of Statements** field.
2. From the Order by list, select one of the methods by which the SQL statements are to be ordered.

Defining Filters for Users

The users filter restricts the workload to include or exclude SQL statements executed by users that you specify.

To define a filter for users:

1. On the SQL Access Advisor: Workload Source page, under Users, select **Include only SQL statements executed by these users** or **Exclude all SQL statements executed by these users**.
2. To search for available users, click the Users search icon.

   The Search and Select: Users dialog box appears.
3. Select the users for which you want to include or exclude SQL statements and click **Select**.

   The Search and Select: Users dialog box closes and the selected tables now appear in the **Users** field.

   In this example, a filter is defined to include only SQL statements executed by the user SH.

Defining Filters for Tables

The tables filter restricts the workload to include or exclude SQL statements that access a list of tables that you specify. Table filters are not permitted if you selected the **Create a Hypothetical Workload from the Following Schemas and Tables** option, as described in "Using a Hypothetical Workload" on page 11-4.

To define a filter for tables:

1. To include only SQL statements that access a specific list of tables, enter the table names in the **Include only SQL statements that access any of these tables** field.
2. To exclude all SQL statements that access a specific list of tables, enter the table names in the **Exclude all SQL statements that access any of these tables** field.
3. To search for available tables, click the Tables search icon.

   The Search and Select: Schema and Table dialog box appears.
4. Select the tables for which you want to include or exclude SQL statements and click **Select**.

   The Search and Select: Schema and Table dialog box closes and the selected tables now appear in the corresponding Tables field.

Defining Filters for SQL Text

The SQL text filter restricts the workload to include or exclude SQL statements that contains SQL text substrings that you specify.

To define a filter for SQL text:

1. To include only SQL statements that contains specific SQL text, enter the SQL text to be included in the **Include only SQL statements containing these SQL text substrings** field.

2. To exclude all SQL statements that contain specific SQL text, enter the SQL text to be excluded in the **Exclude all SQL statements containing these SQL text substrings** field.

Defining Filters for Modules

The module filter restricts the workload to include or exclude SQL statements that are associated with modules that you specify.

To define a filter for module ID:

1. To include only SQL statements associated with a specific module ID in the workload, select **Include only SQL statements associated with these modules**.
2. To exclude all SQL statements associated to a specific module ID from the workload, select **Exclude all SQL statements associated with these modules**.
3. In the Modules field, enter the names of the modules for which associated SQL statements will be included or excluded.

Defining Filters for Actions

The actions filter restricts the workload to include or exclude SQL statements that are associated with actions that you specify.

To define a filter for actions:

1. To include only SQL statements associated with a specific action in the workload, select **Include only SQL statements associated with these actions**.
2. To exclude all SQL statements associated with a specific action from the workload, select **Exclude all SQL statements associated with these actions**.
3. In the **Actions** field, enter the actions for which associated SQL statements will be included or excluded.

Running SQL Access Advisor: Recommendation Options

To improve the underlying data access methods chosen by the optimizer for the workload, SQL Access Advisor provides recommendation for indexes, materialized views, and partitioning. Using these access structures can significantly improve the performance of the workload by reducing the time required to read data from the database. However, you must balance the benefits of using these access structures against the cost to maintain them.

> **Tip:** Before you can select the recommendation options for SQL Access Advisor, do the following:
>
> - Select initial options, as described in "Running SQL Access Advisor: Initial Options" on page 11-2.
> - Select the workload source, as described in "Running SQL Access Advisor: Workload Source" on page 11-3.
> - Define the filter options, as described in "Running SQL Access Advisor: Filter Options" on page 11-5.

To specify recommendation options:

1. On the SQL Access Advisor: Recommendation Options page, under Access Structures to Recommend, select the type of access structures to be recommended by SQL Access Advisor:

- Indexes
- Materialized Views
- Partitioning

In this example, all of the preceding access types are selected.

2. Under Scope, select the mode in which SQL Access Advisor will run. Do one of the following:

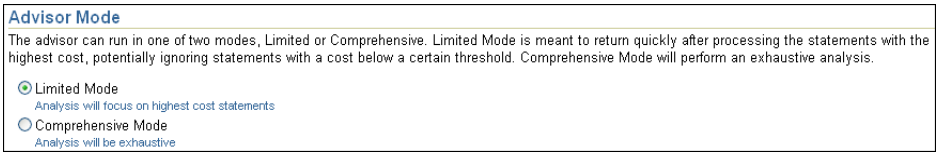
   - Select **Limited Mode**.

     In limited mode, SQL Access Advisor focuses on SQL statements with the highest cost in the workload. The analysis is quicker, but the recommendations may be limited.

   - Select **Comprehensive Mode**.

     In comprehensive mode, SQL Access Advisor analyzes all SQL statements in the workload. The analysis can take much longer, but the recommendations will be exhaustive.

   In this example, **Limited Mode** is selected.



3. Optionally, click **Advanced Options**.

   The Advanced Options section expands. This section contains the following subsections:

   - Workload Categorization

     In this section, you can specify the type of workload for which you want a recommendation. The following categories are available:

     – Workload Volatility

       Select **Consider only queries** if the workload contains primarily read-only operations, as in data warehouses. Volatility data is useful for online transaction processing (OLTP) systems, where the performance of `INSERT`, `UPDATE`, and `DELETE` operations is critical.

     – Workload Scope

       Select **Recommend dropping unused access structures** if the workload represents all access structure use cases.

   - Space Restrictions

     Indexes and materialized views increase performance at the cost of space. Do one of the following:

  - Select **No, show me all recommendations (unlimited space)** to specify no space limits. When SQL Access Advisor is invoked with no space limits, it makes the best possible performance recommendations.
  - Select **Yes, limit additional space to** and then enter the space limit in megabytes, gigabytes, or terabytes. When SQL Access Advisor is invoked with a space limit, it produces only recommendations with space requirements that do not exceed the specified limit.

- Tuning Prioritization

  This section enables you to specify how SQL statements will be tuned. Complete the following steps:

  - From the Prioritize tuning of SQL statements by list, select a method by which SQL statements are to be tuned and then click **Add**.
  - Optionally, select **Allow Advisor to consider creation costs when forming recommendations** to weigh the cost of creating access structures against the frequency and potential improvement of SQL statement execution time. Otherwise, creation cost will be ignored. You should select this option if you want specific recommendations generated for SQL statements that are executed frequently.

- Default Storage Locations

  Use this section to override the defaults defined for schema and tablespace locations. By default, indexes are in the schema and tablespace of the table they reference. Materialized views are in the schema and tablespace of the first table referenced in the query. Materialized view logs are in the default tablespace of the schema of the table that they reference.

4. Click **Next**.

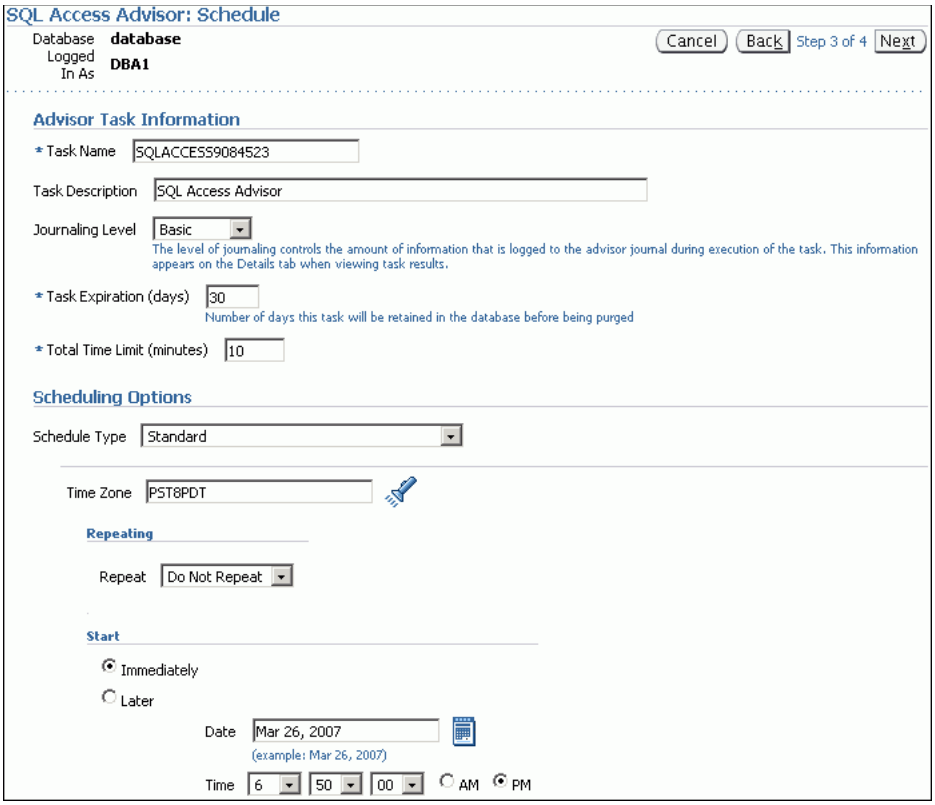
   The SQL Access Advisor: Schedule page appears.

5. Proceed to the next step, as described in "Running SQL Access Advisor: Schedule" on page 11-9.

Running SQL Access Advisor: Schedule

Use the SQL Access Advisor Schedule page to set or modify the schedule parameters for the SQL Access Advisor task.

Figure 11–1 Scheduling a SQL Access Advisor Task



Tip: Before you can schedule a SQL Access Advisor task, do the following:

- Select initial options, as described in "Running SQL Access Advisor: Initial Options" on page 11-2.
- Select the workload source, as described in "Running SQL Access Advisor: Workload Source" on page 11-3.
- Define the filter options, as described in "Running SQL Access Advisor: Filter Options" on page 11-5.
- Specify the recommendation options, as described in "Running SQL Access Advisor: Recommendation Options" on page 11-7.

To schedule a SQL Access Advisor task:

1. On the SQL Access Advisor: Schedule page, under Advisor Task Information, enter a name in the **Task Name** field if you do not want to use the system-generated task name.

   In the example shown in Figure 11–1, `SQLACCESS9084523` is entered.

2. In the **Task Description** field, enter a description of the task.

   In the example shown in Figure 11–1, `SQL Access Advisor` is entered.

3. From the Journaling Level list, select the level of journaling for the task.

   Journaling level controls the amount of information that is logged to the SQL Access Advisor journal during task execution. This information appears on the Details subpage when viewing task results.

In the example shown in Figure 11–1 on page 11-10, **Basic** is selected.

4. In the **Task Expiration (Days)** field, enter the number of days the task will be retained in the database before it is purged.

   In the example shown in Figure 11–1 on page 11-10, `30` is entered.

5. In the **Total Time Limit (minutes)** field, enter the maximum number of minutes that the job is permitted to run.

   You must enter a time in this field rather than use the default of `UNLIMITED`. In the example shown in Figure 11–1 on page 11-10, `10` is entered.

6. Under Scheduling Options, in the Schedule Type list, select a schedule type for the task and a maintenance window in which the task should run. Do one of the following:

   - Click **Standard**.

     This schedule type enables you to select a repeating interval and start time for the task. Complete the following steps:

     – Enter your time zone code in the **Time Zone** field or click the search icon to locate the code for your area.

     – In the Repeat list, select **Do Not Repeat** to perform the task only once, or select a unit of time and enter the number of units in the **Interval** field.

     – Under Start, select **Immediately** to start the task now, or **Later** to schedule the task to start at a time specified using the **Date** and **Time** fields.

   - Click **Use predefined schedule**.

     This schedule type enables you to select an existing schedule. Do one of the following:

     – In the **Schedule** field, enter the name of the schedule to be used for the task.

     – To search for a schedule, click the search icon.

       The Search and Select: Schedule dialog box appears.

       Select the desired schedule and click **Select**. The selected schedule now appears in the **Schedule** field.

   - Click **Standard using PL/SQL for repeated interval**.

     This schedule types enables you to select a repeating interval and an execution time period (window) for the task. Complete the following steps:

     – Enter your time zone code in the **Time Zone** field or click the search icon to locate the code for your area.

     – Under Available to Start, select **Immediately** to start the task now, or **Later** to schedule the task to start at a time specified using the **Date** and **Time** fields.

     – In the Repeat list, select **Do Not Repeat** to perform the task only once, or select a unit of time and enter the number of units in the **Interval** field.

     – In the **Repeated Interval** field, enter a PL/SQL schedule expression, such as `SYSDATE+1`.

     – Under Not Available After, select **No End Date** to indicate that there is no end date for the execution window, or **Specified End Date** to specify an end date using the **Date** and **Time** fields.

- Click **Use predefined window**.

  This schedule type enables you to select an existing window. Select **Stop on Window Close** to stop the job when the window closes. Do one of the following:

  – In the **Window** field, enter the name of the window to be used for the task.

  – To search for a window, click the search icon.

    The Search and Select: Window and Window Groups dialog box appears.

    Select the desired window and click **Select**. The selected window now appears in the **Schedule** field.

- Click **Event**.

  Complete the following steps:

  – Enter your time zone code in the **Time Zone** field or click the search icon to locate the code for your area.

  – Under Event Parameters, enter values in the **Queue Name** and **Condition** fields.

  – Under Start, select **Immediately** to start the task now, or **Later** to schedule the task to start at a time specified using the **Date** and **Time** fields.

  – Under Not Available After, select **No End Date** to indicate that there is no end date for the execution window, or **Specified End Date** to specify an end date using the **Date** and **Time** fields.

- Click **Calendar**.

  Complete the following steps:

  – Enter your time zone code in the **Time Zone** field or click the search icon to locate the code for your area.

  – Under Calendar Expression, enter a calendar expression.

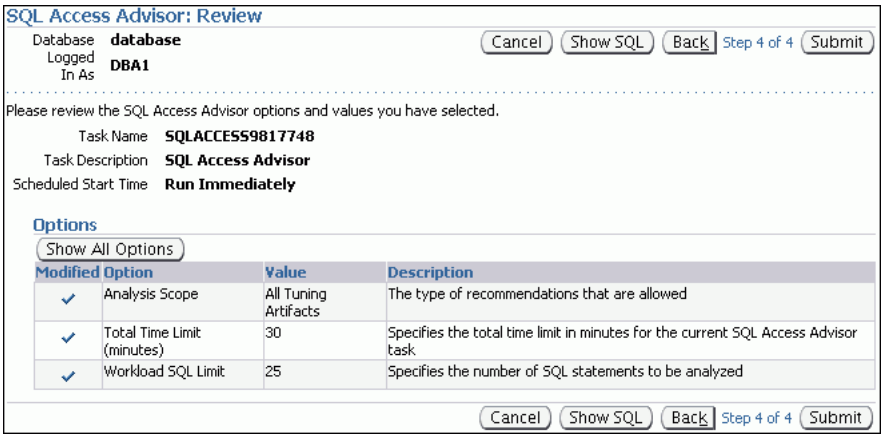
  – Under Start, select **Immediately** to start the task now, or **Later** to schedule the task to start at a time specified using the **Date** and **Time** fields.

  – Under Not Available After, select **No End Date** to indicate that there is no end date for the execution window, or **Specified End Date** to specify an end date using the **Date** and **Time** fields.

In the example shown in Figure 11–1 on page 11-10, **Standard** is selected for schedule type. The task will not repeat and is scheduled to start immediately.

7. Click **Next**.

   The SQL Access Advisor: Review page appears.



Under Options, a list of modified options for the SQL Access Advisor task is shown. To display both modified and unmodified options, click **Show All Options**. To view the SQL text for the task, click **Show SQL**.

8. Click **Submit**.

   The Advisor Central page appears. A message informs you that the task was created successfully.

Reviewing the SQL Access Advisor Recommendations

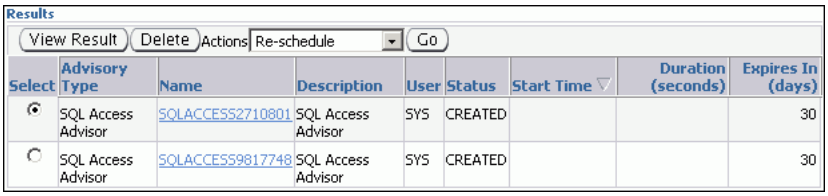
SQL Access Advisor graphically displays the recommendations and provides hyperlinks so that you can quickly see which SQL statements benefit from a recommendation. Each recommendation produced by the SQL Access Advisor is linked to the SQL statement it benefits.

> **Tip:** Before reviewing the SQL Access Advisor recommendations, run SQL Access Advisor to make the recommendations, as described in "Running SQL Access Advisor" on page 11-1.

To review the SQL Access Advisor recommendations:

1. On the Advisor Central page, select the SQL Access Advisor task for review and click **View Result**.

   In this example, **Limited Mode** is selected.



   If the task is not displayed, then you may need to refresh the screen. The Results for Task page appears.

2. Review the Summary subpage, which provides an overview of the SQL Access Advisor analysis, as described in "Reviewing the SQL Access Advisor Recommendations: Summary" on page 11-14.

3. Review the Recommendations subpage, which enables you to view the recommendations ranked by cost improvement, as described in "Reviewing the SQL Access Advisor Recommendations: Recommendations" on page 11-15.

4. Review the SQL statements analyzed in the workload, as described in "Reviewing the SQL Access Advisor Recommendations: SQL Statements" on page 11-18.
5. Review the details of the workload, task options, and the SQL Access Advisor task, as described in "Reviewing the SQL Access Advisor Recommendations: Details" on page 11-19.

Reviewing the SQL Access Advisor Recommendations: Summary

The Summary subpage displays an overview of the SQL Access Advisor analysis.

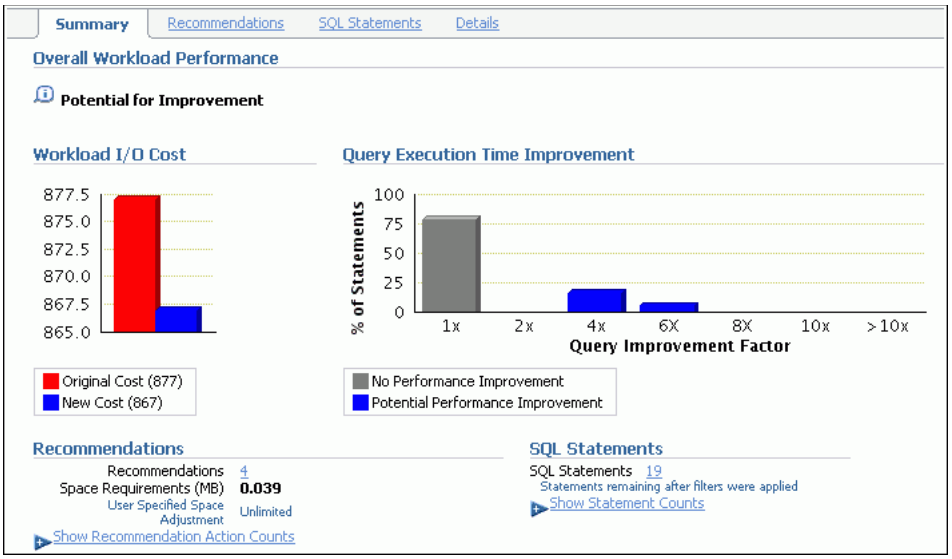
In this example, **Limited Mode** is selected.

To review the recommendations summary:

1. On the Results for Tasks page, click **Summary**.

   The Summary subpage appears.

   In this example, **Limited Mode** is selected.



2. Under Overall Workload Performance, assess the potential for improvement in implementing the recommendations.
3. Use the Workload I/O Cost chart to compare the original workload I/O cost (in red) with the new cost (in blue).

   In this example, the workload I/O cost will decrease from 877 to 867 by implementing the recommendations.
4. Use the Query Execution Time Improvement chart to compare the improvement in query execution time.

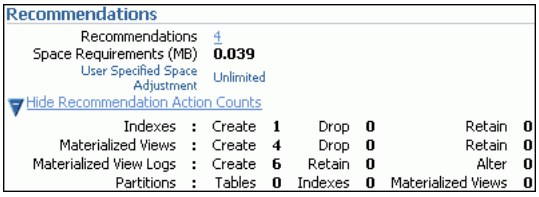
   This chart shows the percentage of SQL statements in the workload whose execution time will improve by accepting the recommendations. The SQL statements are grouped by the projected improvement factor along the horizontal axis on the chart (1x to >10x). The percentage of SQL statements that will improve by the projected improvement factor are along the vertical axis (0% to 100%).

   In this example, approximately 75 percent of SQL statements in the workload will gain no performance improvement in execution time, but about 25 percent will have the potential for improvement of over 4x or more.

5. Under Recommendations, click **Show Recommendation Action Counts**.

   In this example, creating 1 index, 4 materialized views, and 6 materialized view logs is recommended.

   In this example, **Limited Mode** is selected.



6. Under SQL Statements, click **Show Statement Counts** to display the type of SQL statement.

   In this example, 19 `SELECT` statements are analyzed.

   In this example, **Limited Mode** is selected.

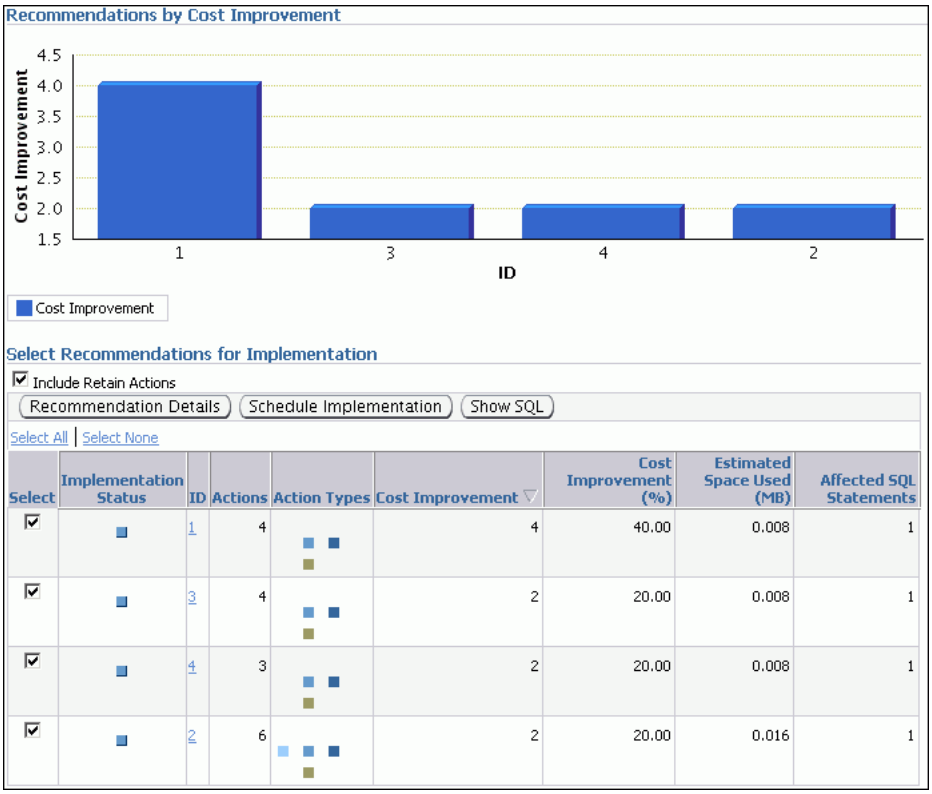
Reviewing the SQL Access Advisor Recommendations: Recommendations

The Recommendations subpage ranks the SQL Access Advisor recommendations by cost improvement. You can also view details about each recommendation.

To review recommendation details:

1. On the Results for Tasks page, click **Recommendations**.

   The Recommendations subpage appears.

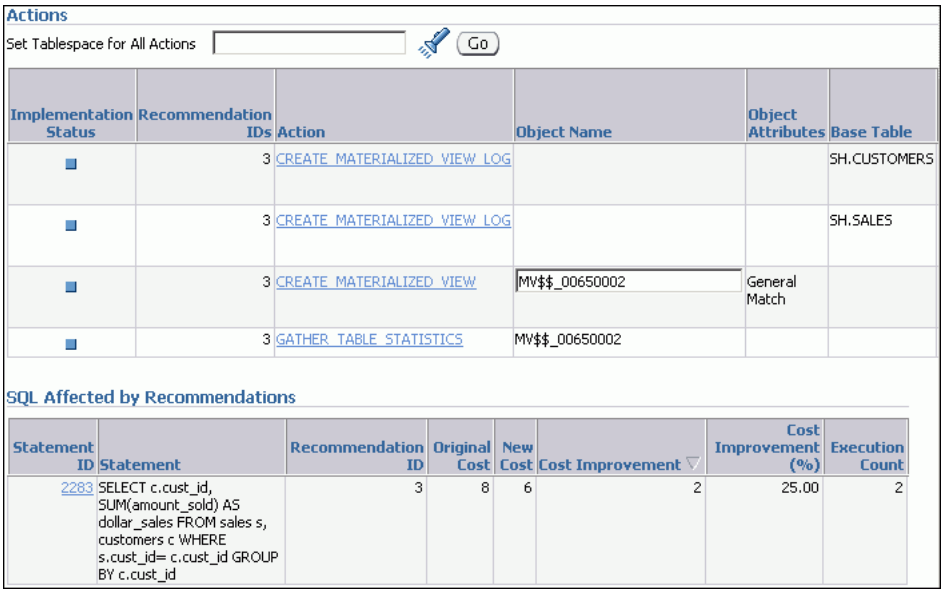


2. Use the Recommendations by Cost Improvement chart to view recommendations ordered by the cost improvement.

   Under Select Recommendations for Implementation, each recommendation is listed with its implementation status, recommendation ID, cost improvement, space consumption, and the number of affected SQL statements for each recommendation. Implementing the top recommendation will have the biggest benefit to the total performance of the workload.

3. To view details for a particular recommendation, select the recommendation and click **Recommendation Details**.

   The Recommendation Details page appears.



The Recommendation Details page displays all actions for the specified recommendation.

Under Actions, you can choose to modify the schema name, tablespace name, and storage clause for each action. To view the SQL text of an action, click the link in the Action column for the specified action.

Under SQL Affected by Recommendation, the SQL text of the SQL statement and cost improvement information are displayed.

4. Click **OK**.

   The Recommendations subpage appears.

5. To view the SQL text of a recommendation, select the recommendation and click **Show SQL**.

   The Show SQL page for the selected recommendation appears.

Show SQL

Done

```
Rem SQL Access Advisor: Version 11.1.0.4.0 - Production
Rem
Rem Username: SYS
Rem Task: SQLACCESS6607720
Rem Execution date:
Rem

CREATE MATERIALIZED VIEW LOG ON
"SH"."CUSTOMERS"
WITH ROWID, SEQUENCE("CUST_ID","CUST_LAST_NAME","CUST_STATE_PROVINCE")
INCLUDING NEW VALUES;

CREATE MATERIALIZED VIEW LOG ON
"SH"."SALES"
WITH ROWID, SEQUENCE("PROD_ID","CUST_ID","QUANTITY_SOLD","AMOUNT_SOLD")
INCLUDING NEW VALUES;

CREATE MATERIALIZED VIEW "SYS"."MV$$_00650002"
REFRESH FAST WITH ROWID
ENABLE QUERY REWRITE
AS SELECT SH.SALES.CUST_ID C1, SUM("SH"."SALES"."AMOUNT_SOLD") M1,
COUNT("SH"."SALES"."AMOUNT_SOLD")
M2, COUNT(*) M3 FROM SH.CUSTOMERS, SH.SALES WHERE SH.SALES.CUST_ID = SH.CUSTOMERS.CUST_ID
GROUP BY SH.SALES.CUST_ID;

begin
dbms_stats.gather_table_stats('"SYS"','"MV$$_00650002"',NULL,dbms_stats.auto_sample_size);
end;
/
```

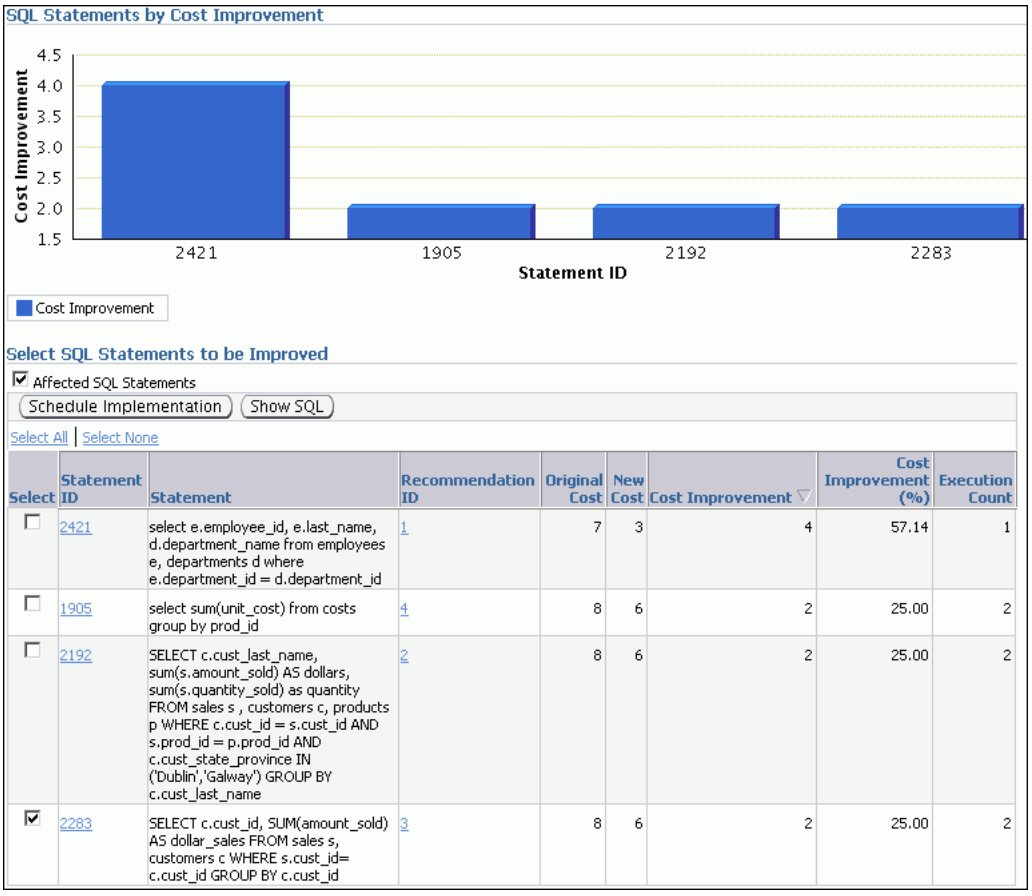
Reviewing the SQL Access Advisor Recommendations: SQL Statements

The SQL Statements subpage ranks SQL statements in the workload by cost improvement. You can use this page to view details about the SQL statements analyzed in the workload.

To review SQL statements:

1. On the Results for Tasks page, click **SQL Statements**.

   The SQL Statements subpage appears.



Select	Statement ID	Statement	Recommendation ID	Original Cost	New Cost	Cost Improvement	Cost Improvement (%)	Execution Count
☐	2421	select e.employee_id, e.last_name, d.department_name from employees e, departments d where e.department_id = d.department_id	1	7	3	4	57.14	1
☐	1905	select sum(unit_cost) from costs group by prod_id	4	8	6	2	25.00	2
☐	2192	SELECT c.cust_last_name, sum(s.amount_sold) AS dollars, sum(s.quantity_sold) as quantity FROM sales s , customers c, products p WHERE c.cust_id = s.cust_id AND s.prod_id = p.prod_id AND c.cust_state_province IN ('Dublin','Galway') GROUP BY c.cust_last_name	2	8	6	2	25.00	2
☑	2283	SELECT c.cust_id, SUM(amount_sold) AS dollar_sales FROM sales s, customers c WHERE s.cust_id= c.cust_id GROUP BY c.cust_id	3	8	6	2	25.00	2

2. Use the SQL Statements by Cost Improvement chart to view SQL statements in the workload ordered by the cost improvement.

   Under Select SQL Statements to be Improved, each SQL statement is listed with its statement ID, SQL text, associated recommendation, cost improvement, and execution count.

   Implementing the recommendation associated with the top SQL statement will have the biggest benefit to the total performance of the workload. In this example, implementing the recommendation with ID 1 will produce the biggest benefit, a cost improvement of 57.14 percent, for the SQL statement with ID `2421`.

3. To view the SQL text of a recommendation, select the recommendation and click **Show SQL**.

   The Show SQL page for the selected recommendation appears.

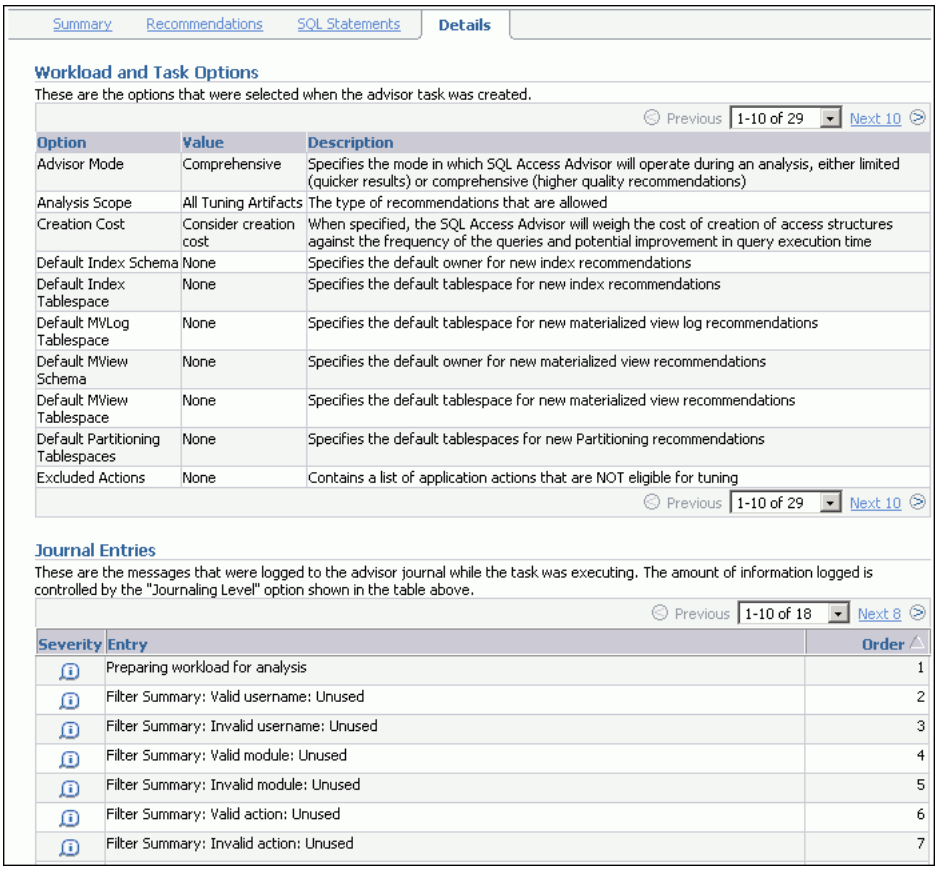
Reviewing the SQL Access Advisor Recommendations: Details

The Details subpage displays a list of all the workload and task options used in the analysis. You can also use this subpage to view a list of journal entries for the task, based on the journaling level used when the task was created.

To review workload and task details:

- On the Results for Tasks page, click **Details**.

  The Details subpage appears.



Under Workload and Task Options, a list of options that were selected when the advisor task was created is displayed.

Under Journal Entries, a list of messages that were logged to the SQL Access Advisor journal while the task was executing is displayed.

Implementing the SQL Access Advisor Recommendations

A SQL Access Advisor recommendation can range from a simple suggestion to a complex solution that requires partitioning a set of existing base tables and implementing a set of database objects such as indexes, materialized views, and materialized view logs. You can select the recommendations for implementation and schedule when the job should be executed.

> **Tip:** Before implementing the SQL Access Advisor recommendations, review them for cost benefits to determine which ones, if any, should be implemented. For more information, see "Reviewing the SQL Access Advisor Recommendations" on page 11-13.

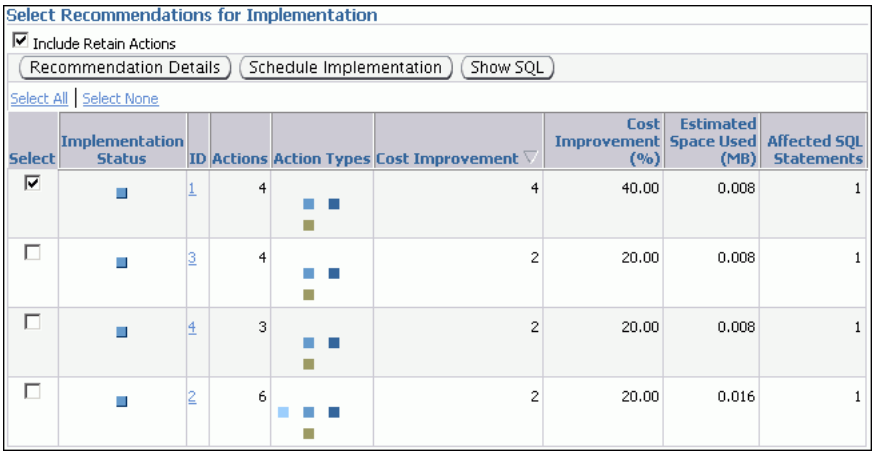
To implement the SQL Access Advisor recommendations:

1. On the Results for Tasks page, click **Recommendations**.

   The Recommendations subpage appears.

2. Under Select Recommendations for Implementation, select the recommendation you want to implement and click **Schedule Implementation**.

In this example, the recommendation with ID value `1` is selected.



Select	Implementation Status	ID	Actions	Action Types	Cost Improvement	Cost Improvement (%)	Estimated Space Used (MB)	Affected SQL Statements
☑		1	4		4	40.00	0.008	1
☐		3	4		2	20.00	0.008	1
☐		4	3		2	20.00	0.008	1
☐		2	6		2	20.00	0.016	1

The Schedule Implementation page appears.

3. In the **Job Name** field, enter a name for the job if you do not want to use the system-generated job name.
4. Determine whether or not the implementation job should stop if an error is encountered. Do one of the following:
   - To stop processing if an error occurs, select **Stop on Error**.
   - To continue processing even if an error occurs, deselect **Stop on Error**.
5. Under Scheduling Options, in the Schedule Type list, select a schedule type for the task and a maintenance window in which the task should run. Do one of the following:
   - Click **Standard**.

     This schedule type enables you to select a repeating interval and start time for the task. Complete the following steps:

     – Enter your time zone code in the **Time Zone** field or click the search icon to locate the code for your area.

     – In the Repeat list, select **Do Not Repeat** to perform the task only once, or select a unit of time and enter the number of units in the **Interval** field.

     – Under Start, select **Immediately** to start the task now, or **Later** to schedule the task to start at a time specified using the **Date** and **Time** fields.
   - Click **Use predefined schedule**.

     This schedule type enables you to select an existing schedule. Do one of the following:

     – In the **Schedule** field, enter the name of the schedule to be used for the task.

     – To search for a schedule, click the search icon.

       The Search and Select: Schedule dialog box appears.

       Select the desired schedule and click **Select**. The selected schedule now appears in the **Schedule** field.
   - Click **Standard using PL/SQL for repeated interval**.

This schedule type enables you to select a repeating interval and an execution window for the task. Complete the following steps:

- Enter your time zone code in the **Time Zone** field or click the search icon to locate the code for your area.
- Under Available to Start, select **Immediately** to start the task now, or **Later** to schedule the task to start at a time specified using the **Date** and **Time** fields.
- In the Repeat list, select **Do Not Repeat** to perform the task only once, or select a unit of time and enter the number of units in the **Interval** field.
- In the **Repeated Interval** field, enter a PL/SQL schedule expression, such as `SYSDATE+1`.
- Under Not Available After, select **No End Date** to indicate that there is no end date for the execution window, or **Specified End Date** to specify an end date using the **Date** and **Time** fields.

■ Click **Use predefined window**.

This schedule type enables you to select an existing window. Select **Stop on Window Close** to stop the job when the window closes. Do one of the following:

- In the **Window** field, enter the name of the window to be used for the task.
- To search for a window, click the search icon.

  The Search and Select: Window and Window Groups dialog box appears.

  Select the desired window and click **Select**. The selected window now appears in the **Schedule** field.

■ Click **Event**.

Complete the following steps:

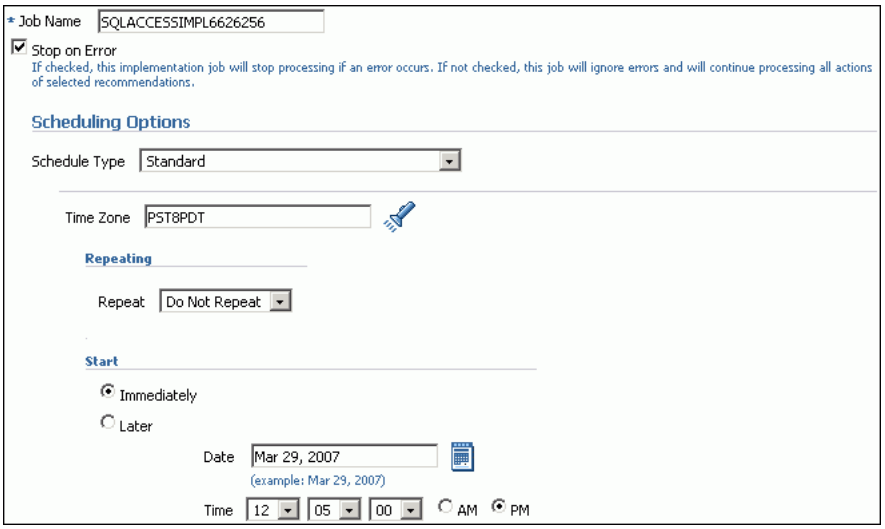
- Enter your time zone code in the **Time Zone** field or click the search icon to locate the code for your area.
- Under Event Parameters, enter values in the **Queue Name** and **Condition** fields.
- Under Start, select **Immediately** to start the task now, or **Later** to schedule the task to start at a time specified using the **Date** and **Time** fields.
- Under Not Available After, select **No End Date** to indicate that there is no end date for the execution window, or **Specified End Date** to specify an end date using the **Date** and **Time** fields.

■ Click **Calendar**.

Complete the following steps:

- Enter your time zone code in the **Time Zone** field or click the search icon to locate the code for your area.
- Under Calendar Expression, enter a calendar expression.
- Under Start, select **Immediately** to start the task now, or **Later** to schedule the task to start at a time specified using the **Date** and **Time** fields.
- Under Not Available After, select **No End Date** to indicate that there is no end date for the execution window, or **Specified End Date** to specify an end date using the **Date** and **Time** fields.

In this example, **Standard** is selected for schedule type. The job will not repeat and is scheduled to start immediately.



6. Optionally, click **Show SQL** to view the SQL text for the job.
7. To submit the job, click **Submit**.

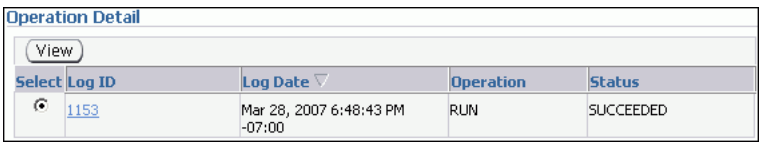
   If the job is scheduled to start immediately, then the Results for Tasks page for the SQL Access Advisor task appears with a confirmation that the job was successfully created.

8. Do one of the following, depending on whether the job is scheduled to start immediately or later:
   - If you submitted the job immediately, and if the Results for Task page is shown, then click the link in the **Scheduler Job** field to display the View Job page. Go to Step 10.
   - If the job is scheduled to start at a later time, then proceed to Step 9.
9. Complete the following steps:
   a. On the Server page, under Oracle Scheduler, click **Jobs**.

      The Scheduler Jobs page appears.

   b. Select the implementation job and click **View Job Definition**.

      The View Job page for the selected job appears.
10. On the View Job page, under Operation Detail, check the status of the operation.



11. Optionally, select the operation and click **View**.

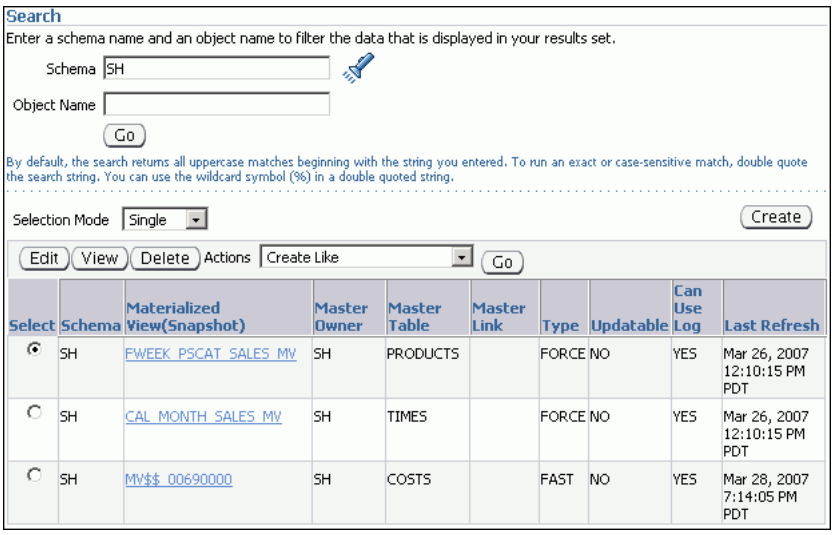
    The Operation Detail page appears.

    This page contains information (such as start date and time, run duration, CPU time used, and session ID) that you can use to troubleshoot the failure.

12. On the Schema subpage, verify that the access structure recommended by SQL Access Advisor is created.

    Depending on the type of access structure that is created, you can display the access structure using the Indexes page, Materialized Views page, or the Materialized View Logs page.

    In this example, a materialized view named `MV$$_00690000` is created in the `SH` schema.



12

Analyzing SQL Performance Impact

System changes, such as upgrading a database or adding an index, may cause changes to execution plans of SQL statements, resulting in a significant impact on SQL performance. In some cases, the system changes may cause SQL statements to regress, resulting in performance degradation. In other cases, the system changes may improve SQL performance. Being able to accurately forecast the potential impact of system changes on SQL performance enables you to tune the system beforehand in cases where the SQL statements regress, or to validate and measure the performance gain in cases where the performance of the SQL statements improves.

SQL Performance Analyzer enables you to forecast the impact of system changes on a SQL workload by:

- Measuring the performance before and after the change
- Generating a report that describes the change in performance
- Identifying the SQL statements that regressed or improved
- Providing tuning recommendations for each SQL statement that regressed
- Enabling you to implement the tuning recommendations when appropriate

This chapter contains the following sections:

See Also:

- *Oracle Database Performance Tuning Guide* to learn how to run SQL Performance Analyzer with the `DBMS_SQLPA` package

SQL Performance Analyzer Usage

You can use SQL Performance Analyzer to analyze the SQL performance impact of any type of system changes. Examples of system changes include the following:

- Database upgrade

  When performing a database upgrade, you may not be able to predict how the system will perform after the upgrade, or if an existing functionality may be adversely affected. For example, a database upgrade installs a new version of the optimizer, which has an effect on SQL performance. SQL Performance Analyzer enables you to compare the SQL performance between two versions of Oracle

Database. In this way, you can identify and tune SQL statements that may potentially regress after the database upgrade without affecting your production system.

- Application upgrade

  An application upgrade may involve changes to the database, such as redesigning tables, or adding and removing indexes. As is the case with database upgrades, it is difficult to predict how the system will perform after the changes, or if an existing functionality may be adversely affected. SQL Performance Analyzer enables you to compare the SQL performance between two versions of an application. Thus, you can tune SQL statements that may potentially regress after the upgrade.

- Changes to the operating system, hardware, and database configuration

  Changes to the operating systems (such as installing a new operating system), hardware (such as adding more CPU or memory), or database configuration (such as moving from a single instance database environment to Oracle Real Application Clusters) may have a significant effect on SQL performance. SQL Performance Analyzer enables you to determine the improvement or deterioration to SQL performance when making these changes.

- Schema change

  Changing a schema, such as altering indexes or creating new ones, almost inevitably affects SQL performance. SQL Performance Analyzer enables you to determine the effect on SQL performance when making a schema change.

- Database initialization parameter change

  Changing the value of a database parameter may produce unexpected results. For example, you may enable a specific initialization parameter to improve performance, but this change may produce unexpected results because the system constraints may have changed. SQL Performance Analyzer enables you to determine the effect on SQL performance when changing a database initialization parameter.

- SQL tuning

  Accepting recommendations from an advisor (such as ADDM, SQL Tuning Advisor, or SQL Access Advisor) may require you to tune problematic SQL statements. For example, SQL Tuning Advisor may recommend that you accept a SQL profile for a particular SQL statement. SQL Performance Analyzer enables you to measure the performance improvement that may be gained by tuning SQL statements as recommended by the advisors, and determine whether to accept these recommendations.

SQL Performance Analyzer Methodology

You can run SQL Performance Analyzer on a test system that closely resembles the production system, or on the production system itself. Performing a SQL Performance Analyzer analysis is resource-intensive, so performing the analysis on the production system may cause significant performance degradation.

Any global changes made on the system to test the performance effect may also affect other users of the system. For smaller changes, such as adding or dropping an index, the effect on other users may be acceptable. However, for systemwide changes, such as a database upgrade, using a production system is not recommended and should be considered only if a test system is unavailable. If a separate test system is available,

then running SQL Performance Analyzer on the test system enables you to test the effects of the changes without affecting the production system.

To ensure that SQL Performance Analyzer can accurately analyze the SQL performance impact, the test system should be as similar to the production system as possible. For these reasons, running SQL Performance Analyzer on a test system is recommended and is the methodology described here. If you choose to run SQL Performance Analyzer on the production system, then substitute the production system for the test system where applicable.

Analyzing the SQL performance effect of system changes using SQL Performance Analyzer is an iterative process that involves the following steps:

1. Capture the SQL workload that you want to analyze on the production system, as described in "Capturing and Transporting a SQL Workload" on page 12-3.
2. Transport the SQL workload from the production system to the test system, as described in "Capturing and Transporting a SQL Workload" on page 12-3.
3. Create a SQL Performance Analyzer task on the test system using the SQL workload as its input source, as described in "Following a Guided Workflow with SQL Performance Analyzer" on page 12-12.
4. Set up the environment on the test system to match the production system as closely as possible, as described in "Establishing the Initial Environment" on page 12-14.
5. Build the pre-change performance data by executing the SQL workload on the system before the change, as described in "Collecting SQL Performance Data Before the Change" on page 12-14.
6. Perform the system change on the test system, as described in "Making the System Change" on page 12-16.
7. Build the post-change performance data by executing the SQL workload on the system after the change, as described in "Collecting SQL Performance Data After the Change" on page 12-16.
8. Compare and analyze the pre-change and post-change versions of performance data, as described in "Comparing SQL Performance Before and After the Change" on page 12-17.
9. Generate and review a report to identify the SQL statements in the SQL workload that have improved, remain unchanged, or regressed after the system change.
10. Tune any regressed SQL statements that are identified, as described in Chapter 10, "Tuning SQL Statements".
11. Ensure that the performance of the tuned SQL statements is acceptable by repeating Step 5 through Step 10 until your performance goals are met.

This section contains the following topics:

- Capturing and Transporting a SQL Workload
- Setting Up the Database Environment on the Test System
- Executing a SQL Workload

Capturing and Transporting a SQL Workload

Before running SQL Performance Analyzer, capture a set of SQL statements on the production system that represents the SQL workload that you intend to analyze and

transport to the test system. The captured SQL statements should include the following information:

- SQL text
- Execution environment
  - SQL binds, which are bind values needed to execute a SQL statement and generate accurate execution statistics
  - Parsing schema under which a SQL statement can be compiled
  - Compilation environment, including initialization parameters under which a SQL statement is executed
- Number of times a SQL statement was executed

You can store captured SQL statements in SQL Tuning Sets and use them as an input source for SQL Performance Analyzer. Capturing a SQL workload using a SQL Tuning Set enables you to do the following:

- Store the SQL text and any necessary auxiliary information in a single, persistent database object
- Populate, update, delete, and select captured SQL statements in the SQL Tuning Set
- Load and merge content from various data sources, such as the Automatic Workload Repository (AWR) or the cursor cache
- Export the SQL Tuning Set from the system where the SQL workload is captured and import it into another system
- Reuse the SQL workload as an input source for other advisors, such as SQL Tuning Advisor and SQL Access Advisor

After you have captured the SQL workload into a SQL Tuning Set on the production system, you must transport it to the test system.

See Also:

- "Creating a SQL Tuning Set" on page 10-8
- *Oracle Database Performance Tuning Guide* for information about transporting SQL Tuning Sets

Setting Up the Database Environment on the Test System

Depending on the system change that you intend to analyze, you must set up the database environment on the test system before and after performing the system change. Before the system change, set up the database environment on the test system to match the database environment in the production system as closely as possible. In this way, SQL Performance Analyzer can more accurately forecast the effect of the system change on SQL performance.

For example, to test how changing a database initialization parameter will affect SQL performance, complete the following steps:

1. Set the database initialization parameter on the test system to the same value as the production system.
2. Build the pre-change SQL performance data.
3. Set the database initialization parameter to the new value you want to test.
4. Build the post-change SQL performance data.

5. Compare the two sets of performance data.

Similarly, to test the performance effect of a database upgrade from release 10*g* to release 11*g*, perform the following tasks:

1. Install Oracle Database 11*g* on the test system.
2. Revert the `OPTIMIZER_FEATURES_ENABLE` initialization parameter to the database version on the production system.
3. Build the pre-change SQL performance data.
4. Set the `OPTIMIZER_FEATURES_ENABLE` initialization parameter to the database version to which you are upgrading.
5. Build the post-change SQL performance data.
6. Compare the two sets of performance data.

See Also:

- *Oracle Database Reference* to learn about the `OPTIMIZER_FEATURES_ENABLE` initialization parameter

Executing a SQL Workload

After the SQL workload is captured and transported to the test system, and the initial database environment is properly configured, execute the SQL workload to build the pre-change performance data before making the system change. Executing a SQL workload runs each of the SQL statements contained in the workload to completion. During execution, SQL Performance Analyzer generates execution plans and computes execution statistics for each SQL statement in the workload. After the pre-change performance data is built, you can perform the system change.

After performing the system change, execute the SQL workload again to build the post-change performance data. SQL Performance Analyzer generates execution plans and computes execution statistics for each SQL statement in the workload a second time, resulting in a new set of performance data that can be used to compare to the pre-change version of the performance data.

Depending on its size, executing a SQL workload can be resource-intensive and cause a significant performance impact. When executing a SQL workload, you can choose to generate execution plans only, without collecting execution statistics. This technique shortens the time to run the execution and lessens the effect on system resources, but the results of the comparison analysis may not be as accurate. If you are running SQL Performance Analyzer on the production system, then consider executing the SQL workload using a private session to avoid affecting the rest of the system.

Running SQL Performance Analyzer

SQL Performance Analyzer enables you to analyze the effects of environmental changes on execution of SQL statements in SQL Tuning Sets. As explained in "Managing SQL Tuning Sets" on page 10-8, a SQL Tuning Set is a database object that includes one or more SQL statements along with their execution statistics and execution context. In addition to the performance analysis, SQL Performance Analyzer can invoke SQL Advisor and provide tuning recommendations.

SQL Performance Analyzer guides you through the SQL workload comparison by means of the following workflows:

- Optimizer Upgrade Simulation

Use this workflow to simulate a database upgrade and measure its effect on a workload.

- Parameter Change

  Use this workflow to determine how a database initialization parameter change will affect SQL performance.

- Guided Workflow

  Use this workflow to compare the performance of SQL execution on different databases.

In each of the preceding workflows, you must create a SQL Performance Analyzer task. A task is a container for the results of SQL replay trials. A replay trial captures the execution performance of a SQL Tuning Set under specific environmental conditions.

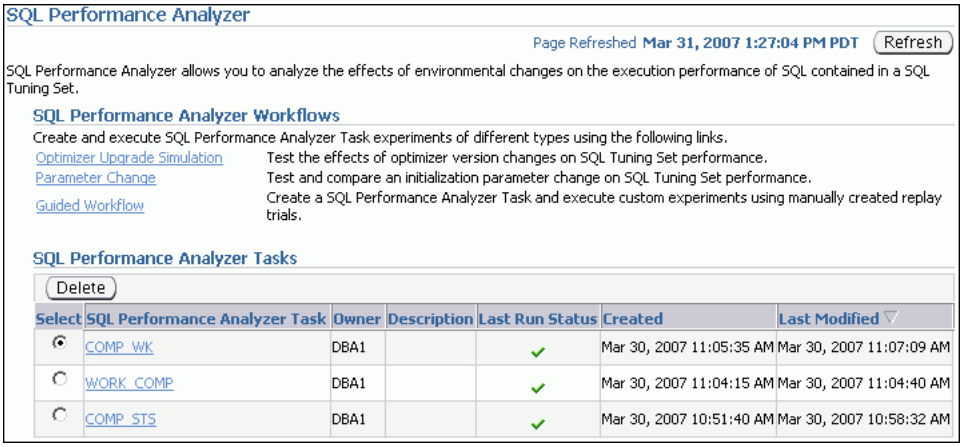
To run SQL Performance Analyzer:

1. On the Database Home page, click **Advisor Central**.

   The Advisor Central page appears.

2. Click **SQL Performance Analyzer**.

   SQL Performance Analyzer page appears. A list of existing SQL Performance Analyzer tasks are displayed.



3. Do one of the following:

   - Proceed to "Performing an Optimizer Upgrade Simulation with SQL Performance Analyzer" on page 12-7.
   - Proceed to "Testing an Initialization Parameter Change with SQL Performance Analyzer" on page 12-10.
   - Proceed to "Following a Guided Workflow with SQL Performance Analyzer" on page 12-12.

   See Also:

   - *Oracle Database Performance Tuning Guide* for information about running SQL Performance Analyzer using APIs

Performing an Optimizer Upgrade Simulation with SQL Performance Analyzer

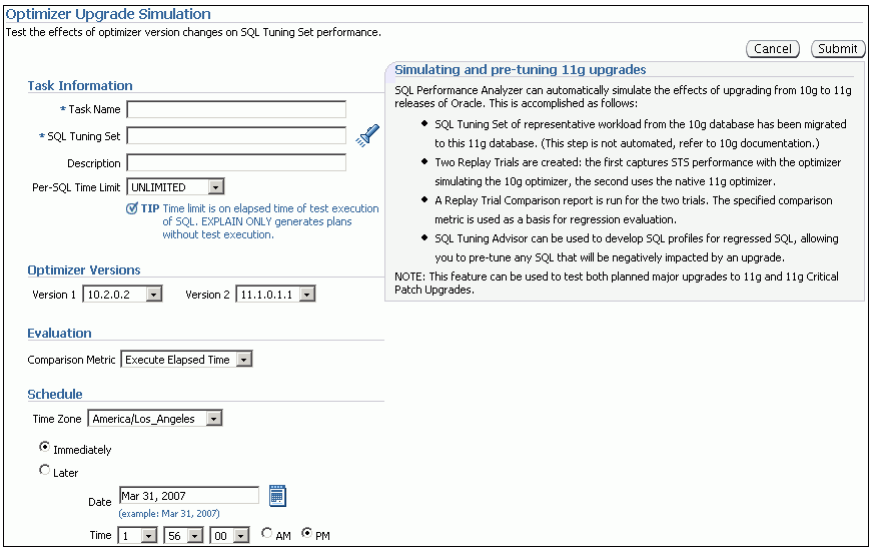
SQL Performance Analyzer can automatically simulate the effect of a database upgrade on SQL performance. The simulation is based on changing the `OPTIMIZER_FEATURES_ENABLE` initialization parameter. All SQL statements use the optimizer, which is a part of Oracle Database that determines the most efficient means of accessing the specified data. You could use SQL Performance Analyzer to compare the performance of SQL execution when using the 10.2.0.2 and 11.1.0.1 versions of the optimizer.

After you select a SQL Tuning Set and a comparison metric, SQL Performance Analyzer creates two replay trials. The first trial captures SQL performance by simulating the optimizer from the user-selected previous release, whereas the second trial uses the optimizer from the current release. The system-generated Replay Trial Comparison report evaluates SQL regression. If performance was degraded, then you can then use SQL Tuning Advisor to develop SQL profiles for regressed SQL.

To simulate an optimizer upgrade:

1. On the SQL Performance Analyzer page, click **Optimizer Upgrade Simulation**.

   The Optimizer Upgrade Simulation page appears.



2. In the **Task Name** field, enter the name of the task.

   For example, enter `111_UPG_OPT_COST`.

3. Select the SQL Tuning Set to use for the comparison. Do one of the following:

   - In **SQL Tuning Set**, enter the name the SQL Tuning Set that contains the SQL workload to be analyzed.
   - Click the search icon to search for a SQL Tuning Set, and then select the set.

     The tuning set now appears in the **SQL Tuning Set** field.

4. In the **Description** field, optionally enter a description of the task.

   For example enter the following text: `This task simulates an upgrade from 10.2.0.2 to 11.1.0.1.`

5. In the Per-SQL Time Limit list, select the time limit for SQL execution during the replay. Do one of the following:

- Select **UNLIMITED**.

  The execution will run each of the SQL statements in the SQL Tuning Set to completion and gather performance data. Collecting execution statistics provides greater accuracy in the performance analysis but takes a longer time.

- Select **EXPLAIN ONLY**.

  The task will generate execution plans only. This option shortens the execution time, but the performance analysis may not be as accurate.

- Select **Customize** and then enter the specified number of hours, minutes, or seconds.

6. In the Optimizer Versions section, select the optimizer versions for comparison in the **Version 1** and **Version 2** lists.

   In this example, the optimizer versions 10.2.0.2 and 11.1.0.1 are selected for comparison.

7. In the Comparison Metric list, select the comparison metric to use for the analysis. Do one of the following:

   - If you selected **EXPLAIN ONLY** in Step 5, then select **Optimizer Cost**.
   - If you selected **UNLIMITED** or **Customize** in Step 5, then select any of the following options:
     - **Elapsed Time**
     - **CPU Time**
     - **Buffer Gets**
     - **Disk Reads**
     - **Direct Writes**
     - **Optimizer Cost**

   To perform the comparison analysis by using more than one comparison metric, perform separate comparison analyses by repeating this procedure with different metrics.

8. In the Schedule section, do one of the following:

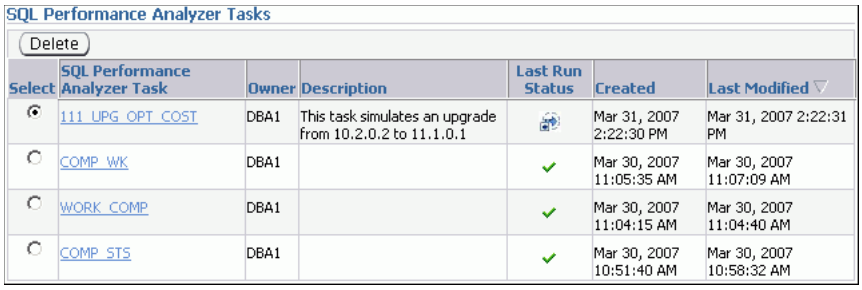
   a. Enter your time zone code in the **Time Zone** field or click the search icon to locate the code for your area.

   b. Select **Immediately** to start the task now, or **Later** to schedule the task to start at a time specified with the **Date** and **Time** fields.

9. Click **Submit**.

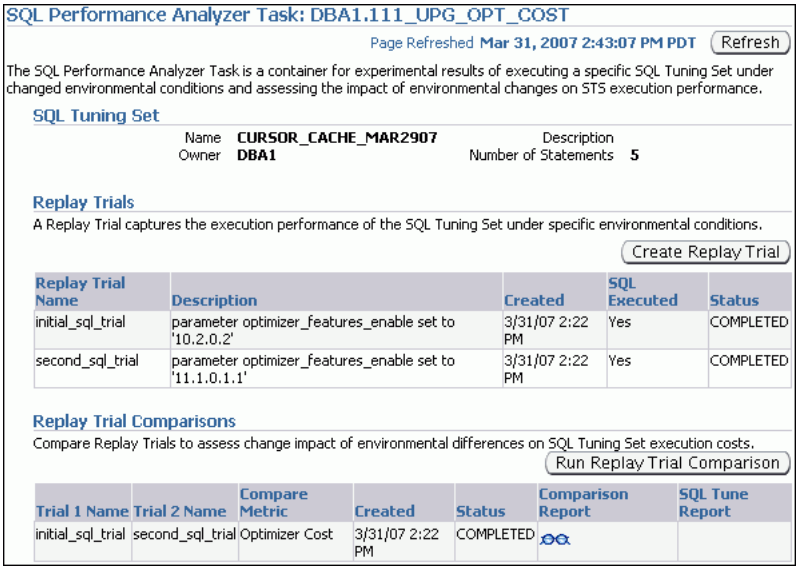
   A confirmation message appears.

   In the SQL Performance Analyzer Tasks table, the status icon of this task changes to an arrow while the execution is in progress. To refresh the status icon, click **Refresh**. After the task completes, the Status icon changes to a check mark.



10. In the SQL Performance Analyzer Tasks table, select the optimizer task and click the link in the **SQL Performance Analyzer Task** column.

    The SQL Performance Analyzer Task page appears.



    This page contains the following sections:

    - SQL Tuning Set

      This section summarizes information about the tuning set, including the name, owner, description, and number of statements in the set.

    - Replay Trials

      This section includes a table that lists the replay trials used in the SQL Performance Analyzer task.

    - Replay Trial Comparisons

      This section contains a table lists the results of the workload comparisons.

11. Click the icon in the **Comparison Report** column.

    The SQL Performance Analyzer Task Result page appears.

12. Review the results of the performance analysis, as described in "Reviewing the SQL Performance Analyzer Report" on page 12-19.

See Also:

- *Oracle Database Reference* for more information about the `OPTIMIZER_FEATURES_ENABLE` initialization parameter

Testing an Initialization Parameter Change with SQL Performance Analyzer

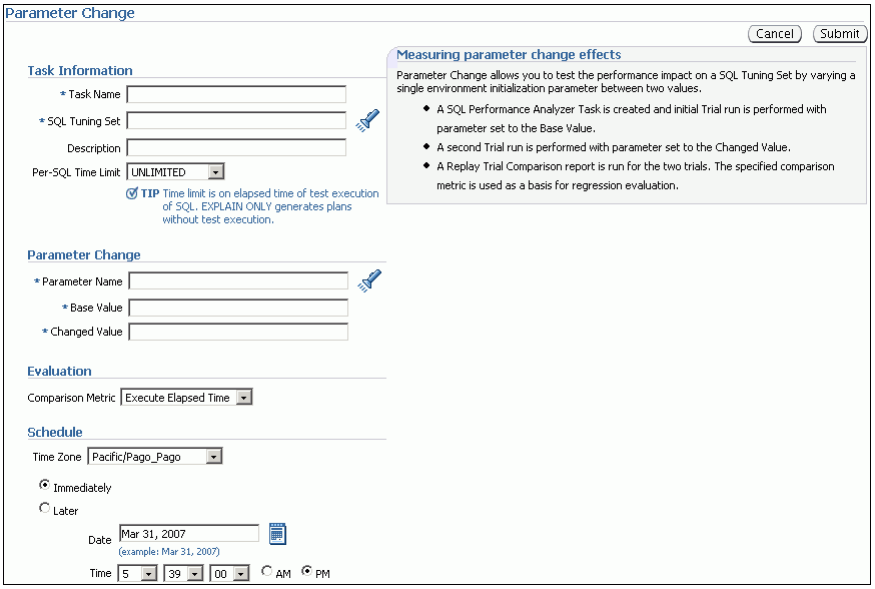
The Parameter Change workflow enables you to test the performance effect on a SQL Tuning Set when you vary a single environment initialization parameter between two values. For example, you can compare SQL performance when the sort area size is increased from 1 MB to 2 MB.

After you select a SQL Tuning Set and a comparison metric, SQL Performance Analyzer creates a task and performs a trial with the initialization parameter set to the original value. The Analyzer then performs a second trial with the parameter set to the new value. The system-generated Replay Trial Comparison report evaluates the regression.

To test an initialization parameter change:

1. On the SQL Performance Analyzer page, click **Parameter Change**.

   The Parameter Change page appears.



2. In the **Task Name** field, enter the name of the task.

   For example, enter `SORT_TIME`.

3. Select the SQL Tuning Set. Do one of the following:

   - In **SQL Tuning Set**, enter the name the SQL Tuning Set that contains the SQL workload to be analyzed.
   - Click the search icon to search for a SQL Tuning Set, and then select the set.

     The tuning set now appears in the **SQL Tuning Set** field.

4. In the **Description** field, optionally enter a description of the task.

   For example enter the following text: `Double the value of sort_area_size`.

5. In the Per-SQL Time Limit list, determine the time limit for SQL execution during the replay. Do one of the following:
   - Select **UNLIMITED**.

     The execution will run each of the SQL statements in the SQL Tuning Set to completion and gather performance data. Collecting execution statistics provides greater accuracy in the performance analysis but takes a longer time.
   - Select **EXPLAIN ONLY**.

     The task will generate execution plans only. This option shortens the execution time, but the performance analysis may not be as accurate.
   - Select **Customize** and then enter the specified number of hours, minutes, or seconds.
6. In the Parameter Change section, complete the following steps:
   a. In the **Parameter Name** field, enter the name of the initialization parameter whose value you want to modify, or click the Search icon to review the current parameter settings.

      For example, enter `sort_area_size`.
   b. In the **Base Value** field, enter the current value of the initialization parameter.

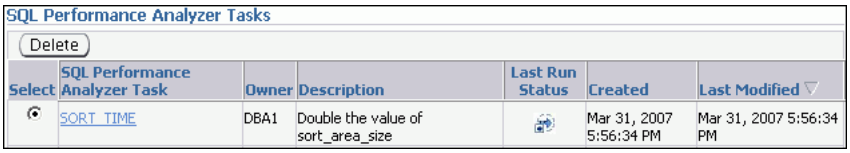
      For example, enter `1048576`.
   c. In the **Changed Value** field, enter the new value of the initialization parameter.

      For example, enter `2097152`.
7. In the Comparison Metric list, select the comparison metric to use for the analysis. Do one of the following:
   - If you selected **EXPLAIN ONLY** in Step 5, then select **Optimizer Cost**.
   - If you selected **UNLIMITED** or **Customize** in Step 5, then select any of the following options:
     - **Elapsed Time**
     - **CPU Time**
     - **Buffer Gets**
     - **Disk Reads**
     - **Direct Writes**
     - **Optimizer Cost**

   To perform the comparison analysis by using more than one comparison metric, perform separate comparison analyses by repeating this procedure with different metrics.
8. In the Schedule section, do one of the following:
   a. Enter your time zone code in the **Time Zone** field or click the search icon to locate the code for your area.
   b. Select **Immediately** to start the task now, or **Later** to schedule the task to start at a time specified with the **Date** and **Time** fields.
9. Click **Submit**.

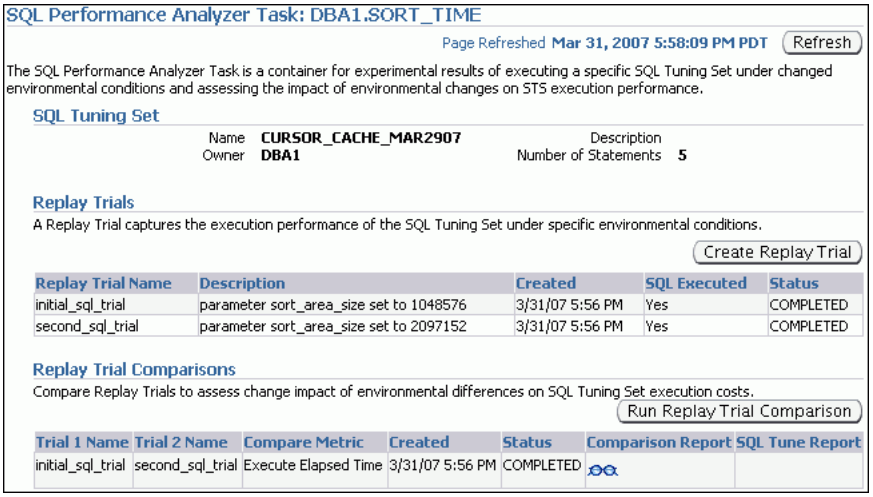
   A confirmation message appears.

In the SQL Performance Analyzer Tasks table, the status icon of this task changes to an arrow while the execution is in progress. To refresh the status icon, click **Refresh**. After the task completes, the Status icon changes to a check mark.



10. In the SQL Performance Analyzer Tasks table, select the optimizer task and click the link in the **SQL Performance Analyzer Task** column.

    The SQL Performance Analyzer Task page appears.



    This page contains the following sections:

    - SQL Tuning Set

      This section summarizes information about the tuning set, including the name, owner, description, and number of statements in the set.

    - Replay Trials

      This section includes a table that lists the replay trials used in the SQL Performance Analyzer task.

    - Replay Trial Comparisons

      This section contains a table lists the results of the workload comparisons.

11. Click the icon in the **Comparison Report** column.

    The SQL Performance Analyzer Task Result page appears.

12. Review the results of the performance analysis, as described in "Reviewing the SQL Performance Analyzer Report" on page 12-19.

Following a Guided Workflow with SQL Performance Analyzer

You can use the guided workflow to compare the performance of SQL statements before and after a variety of system changes that can impact the performance of the SQL workload.

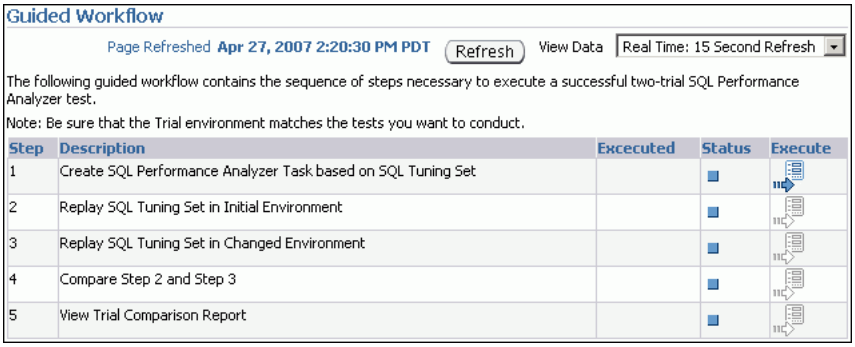
Tip: Before you can create a SQL Performance Analyzer task, capture the SQL workload to be used in the performance analysis into a SQL Tuning Set on the production system. Afterward, transport the workload to the test system where the performance analysis will be performed, as described in "Capturing and Transporting a SQL Workload" on page 12-3.

To initiate a guided workflow:

1. On the SQL Performance Analyzer page, click **Guided Workflow**.

   The Guided Workflow page appears.

   This page lists the required steps in the SQL Performance Analyzer task in sequential order. Each step must be completed in the order displayed before you can begin the next step.



2. Proceed to the next step, as described in "Creating a SQL Performance Analyzer Task Based on a SQL Tuning Set" on page 12-13.

Creating a SQL Performance Analyzer Task Based on a SQL Tuning Set

To run SQL Performance Analyzer, you must create a SQL Performance Analyzer task. The task requires you to select the SQL Tuning Set containing the workload to be used in the performance analysis.

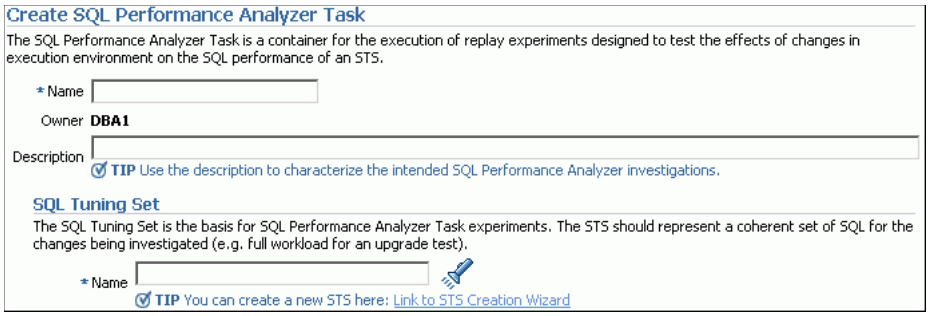
The SQL Tuning Set remains constant in the SQL Performance Analyzer task and is executed in isolation during each replay trial. Thus, performance differences between trials are caused by environmental differences.

Tip: Before you can create a SQL Performance Analyzer task based on a SQL Tuning Set, capture the SQL workload for the performance analysis in a SQL Tuning Set on the production system. Transport the set to the test system, as described in "Capturing and Transporting a SQL Workload" on page 12-3.

To create a task based on a SQL Tuning Set:

1. In the Guided Workflow page, click the **Execute** icon for the Create SQL Performance Analyzer Task based on SQL Tuning Set step.

   The Create SQL Performance Analyzer Task page appears.



2. In the **Name** field, enter the name of the task.
3. In the **Description** field, optionally enter a description of the task.
4. In the SQL Tuning Set section, do one of the following:
   - In **Name**, enter the name the SQL Tuning Set that contains the SQL workload to be analyzed.
   - Click the search icon to search for a SQL Tuning Set, and then select the set.

     The tuning set now appears in the **Name** field.
5. Click **Create**.

   The Guided Workflow page appears.

   The Status icon of this step has changed to a check mark and the **Execute** icon for the next step is now enabled.
6. Proceed to the next step, as described in "Establishing the Initial Environment" on page 12-14.

Establishing the Initial Environment

After selecting a SQL Tuning Set as the input source, establish the initial environment on the test system. This step is not included in the Guided Workflow page because you must perform it manually. For more information about setting up the database environment, see "Setting Up the Database Environment on the Test System" on page 12-4.

> **Tip:** Before you establish the initial environment, select a SQL Tuning Set, as described in "Creating a SQL Performance Analyzer Task Based on a SQL Tuning Set" on page 12-13.

To establish the initial environment:

1. On the test system, manually make any necessary environmental changes affecting SQL optimization and performance.

   These changes could include changing initialization parameters, gathering or setting optimizer statistics, and creating indexes.
2. Proceed to the next step, as described in "Collecting SQL Performance Data Before the Change".

Collecting SQL Performance Data Before the Change

After you have properly configured the initial environment on the test system, build the pre-change version of performance data by executing the SQL workload before

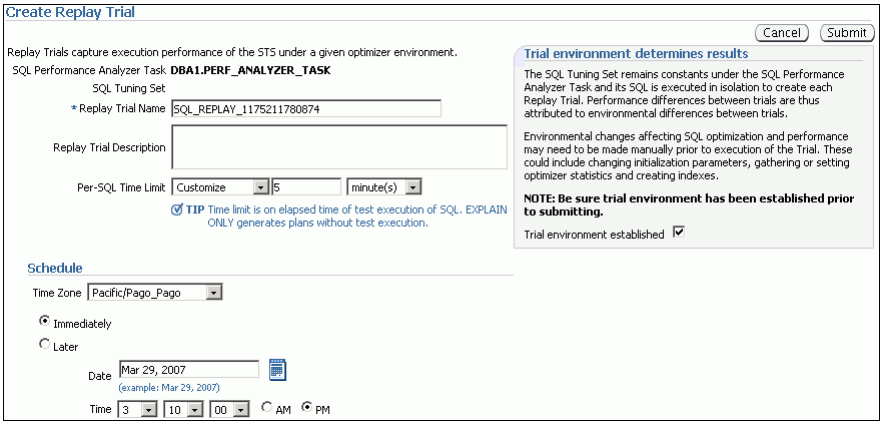
performing the system change. For more information about executing a workload, see "Executing a SQL Workload" on page 12-5.

> **Tip:** Before computing the pre-change version of performance data, establish the initial environment, as described in "Establishing the Initial Environment" on page 12-14.

To collect SQL performance data before the change:

1. On the Guided Workflow page, click the **Execute** icon for the Replay SQL Tuning Set in Initial Environment step.

   The Create Replay Trial page appears. A summary of the selected SQL Tuning Set containing the SQL workload is displayed.



2. In the **Replay Trial Name** field, enter the name of the replay trial.
3. In the **Replay Trial Description** field, enter a description of the replay trial.
4. In the Per-SQL Time Limit list, determine the time limit for SQL execution during the replay. Do one of the following:
   - Select **UNLIMITED**.

     The execution will run each of the SQL statements in the SQL Tuning Set to completion and gather performance data. Collecting execution statistics provides greater accuracy in the performance analysis but takes a longer time.
   - Select **EXPLAIN ONLY**.

     The task will generate execution plans only. This option shortens the execution time, but the performance analysis may not be as accurate.
   - Select **Customize** and then enter the specified number of minutes.
5. Ensure that the database environment on the test system matches the production environment as closely as possible, and select **Trial environment established**.
6. In the Schedule section, do one of the following:
   a. Enter your time zone code in the **Time Zone** field or click the search icon to locate the code for your area.
   b. Select **Immediately** to start the task now, or **Later** to schedule the task to start at a time specified with the **Date** and **Time** fields.
7. Click **OK**.

   The Guided Workflow page appears when the execution begins.

The status icon of this step changes to a clock while the execution is in progress. To refresh the status icon, click **Refresh**. Depending on the options selected and the size of the SQL workload, the execution may take a long time to complete. After the execution is completed, the Status icon will change to a check mark and the Execute icon for the next step is enabled.

8. Proceed to the next step, as described in "Making the System Change" on page 12-16.

Making the System Change

After computing the pre-change SQL performance data, perform the system change on the test system. This step is not included in the Guided Workflow page because you must perform it manually. Depending on the type of change, it may be necessary to reconfigure the environment on the test system to match the new environment for which you want to perform SQL performance analysis, as described in "Setting Up the Database Environment on the Test System" on page 12-4.

SQL Performance Analyzer can analyze the SQL performance impact of any type of system change. For example, you may want to test an application upgrade that involves changes such as database table redesign, adding or removing indexes, and so on. For examples of different types of system changes that can be analyzed by SQL Performance Analyzer, see "SQL Performance Analyzer Usage" on page 12-1.

> **Tip:** Before making the system change, build the pre-change version of performance data, as described in "Collecting SQL Performance Data Before the Change" on page 12-14.

To make the system change:

1. Make the necessary changes to the test system.
2. Proceed to the next step, as described in "Collecting SQL Performance Data After the Change" on page 12-16.

Collecting SQL Performance Data After the Change

After you have made the system change, build the post-change version of performance data by executing the SQL workload again. For more information about executing a workload, see "Executing a SQL Workload" on page 12-5.

> **Tip:** Before you can build the post-change version of performance data, make the system change, as described in "Making the System Change" on page 12-16.

To collect SQL performance after the change:

1. On the Guided Workflow page, click the **Execute** icon for the Replay SQL Tuning Set in Changed Environment step.

   The Create Replay Trial page appears.
2. In the **Replay Trial Name** field, enter the name of the execution.
3. In the **Replay Trial Description** field, enter a description of the execution.
4. In the Per-SQL Time Limit list, determine the time limit for SQL execution during the replay. Do one of the following:
   - Select **UNLIMITED**.

The execution will run each of the SQL statements in the selected SQL Tuning Set to completion and gather performance data. Collecting execution statistics provides greater accuracy in the performance analysis but take a longer time to run.

- Select **EXPLAIN ONLY**.

  The task will generate execution plans only. This option shortens the execution time but the performance analysis may not be as accurate.

- Select **Customize** and then enter the specified number of minutes.

5. Ensure that the database environment on the test system is set up to match the production environment as closely as possible, and select **Trial environment established**.
6. In the Schedule section, complete the following steps:
   a. Enter your time zone code in the **Time Zone** field or click the search icon to locate the code for your area.
   b. Select **Immediately** to start the task now, or **Later** to schedule the task to start at a time specified using the **Date** and **Time** fields.
7. Click **OK**.

   The Guided Workflow page appears when the execution begins.

   The status icon of this step changes to an arrow icon while the execution is in progress. To refresh the status icon, click **Refresh**. Depending on the options selected and the size of the SQL workload, the execution may take a long time to complete. After the execution is completed, the Status icon will change to a check mark and the Execute icon for the next step is enabled.
8. Proceed to the next step, as described in "Comparing SQL Performance Before and After the Change" on page 12-17.

Comparing SQL Performance Before and After the Change

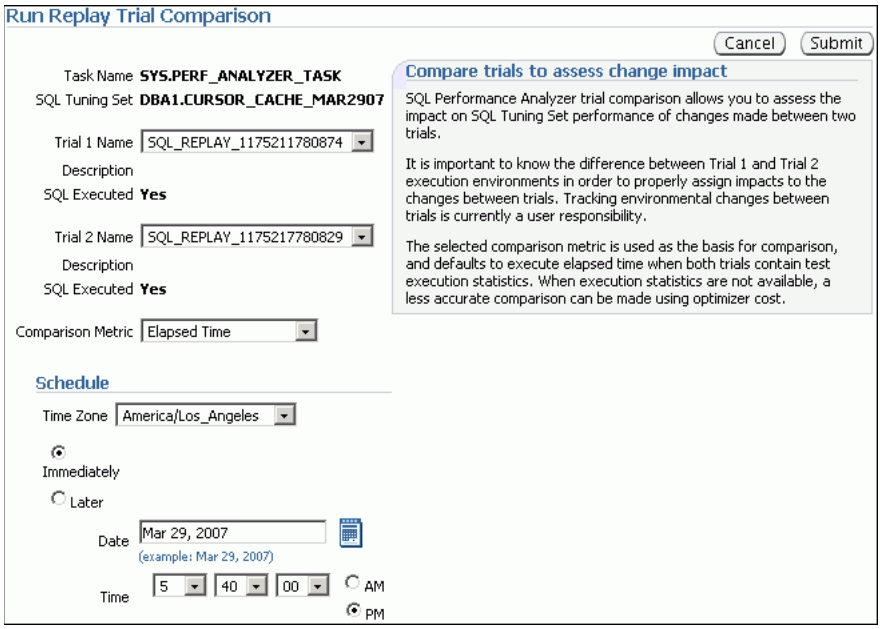
After the post-change SQL performance data is built, compare the pre-change version of performance data to the post-change version by running a comparison analysis.

> **Tip:** Before you can compare the pre-change version of performance data with the post-change version, build the post-change version of performance data, as described in "Collecting SQL Performance Data After the Change" on page 12-16.

To analyze SQL performance before and after the change:

1. On the Guided Workflow page, click the **Execute** icon for Compare Step 2 and Step 3.

   The Run Replay Trial Comparison page appears.



In this example, the `SQL_REPLAY_1175211780874` and `SQL_REPLAY_1175217780829` trials are selected for comparison.

2. To compare trials other than those listed by default, select the desired trials in the **Trial 1 Name** and **Trial 2 Name** lists.

   Note that you cannot compare a statistical trial with a trial that tests the explain plan only.

3. In the Comparison Metric list, select the comparison metric to use for the comparison analysis.

   The types of comparison metrics you can use include:

   - **Elapsed Time**
   - **CPU Time**
   - **Buffer Gets**
   - **Disk Reads**
   - **Direct Writes**
   - **Optimizer Cost**

   To perform the comparison analysis by using more than one comparison metric, perform separate comparison analyses by repeating this procedure with different metrics.

4. In the Schedule section, complete the following steps:

   a. Enter your time zone code in the **Time Zone** field or click the search icon to locate the code for your area.

   b. Select **Immediately** to start the task now, or **Later** to schedule the task to start at a time specified using the **Date** and **Time** fields.

5. Click **Submit**.

   The Guided Workflow page appears when the comparison analysis begins.

The status icon of this step changes to an arrow icon while the comparison analysis is in progress. To refresh the status icon, click **Refresh**. Depending on the amount of performance data collected from the pre-change and post-change executions, the comparison analysis may take a long time to complete. After the comparison analysis is completed, the Status icon changes to a check mark.

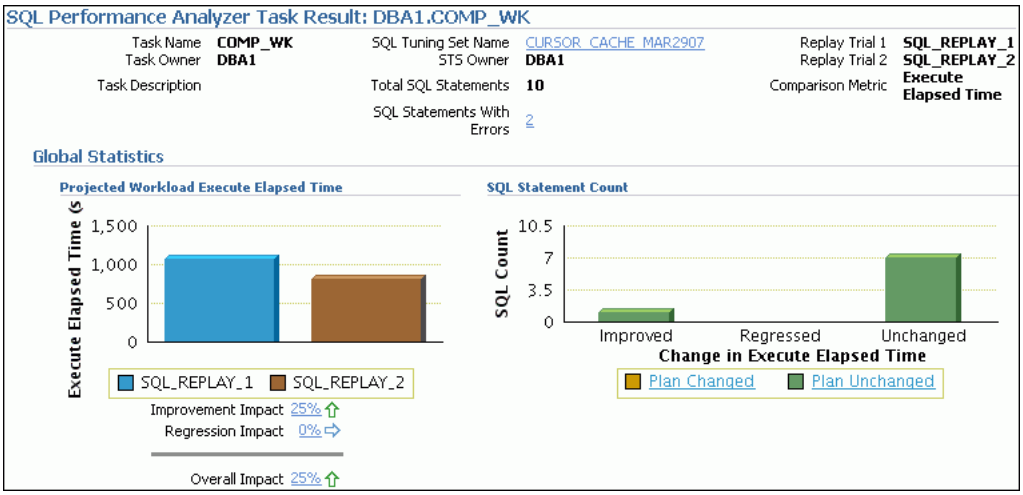
6. Click the **Execute** icon for View Trial Comparison Result.

   The SQL Performance Analyzer Task Result page appears.

7. Review the results of the analysis, as described in "Reviewing the SQL Performance Analyzer Report" on page 12-19.

Reviewing the SQL Performance Analyzer Report

When a SQL Performance Analyzer task is completed, the resulting data is generated into a report. This section shows a sample of a SQL Performance Analyzer report. This sample report uses the elapsed time comparison metric to compare the pre-change and post-change executions of a SQL workload.

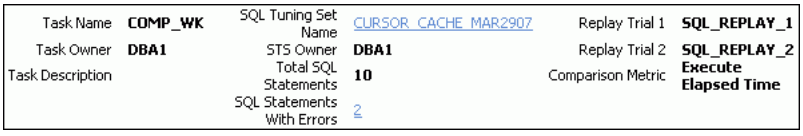


To review the SQL Performance Analyzer report:

1. Review the general information about the performance analysis, as described in "Reviewing the SQL Performance Analyzer Report: General Information" on page 12-19.
2. Review general statistics, as described in "Reviewing the SQL Performance Analyzer Report: Global Statistics" on page 12-20.
3. Optionally, review the detailed statistics, as described in "Reviewing the SQL Performance Analyzer Report: Global Statistics Details" on page 12-21.

Reviewing the SQL Performance Analyzer Report: General Information

The General Information section contains basic information and metadata about the workload comparison performed by SQL Performance Analyzer.



To review general information:

1. On the SQL Performance Analyzer Task Result page, review the information at the top of the page.

   This summary at the top of the page includes the following information:

   - The name, owner, and description of the SQL Performance Analyzer task
   - The name and owner of the SQL Tuning Set
   - The total number of SQL statements in the tuning set and the number of failing statements
   - The names of the replay trials and the comparison metric used

2. Optionally, click the link next to **SQL Tuning Set Name**.

   The SQL Tuning Set page appears.

   This page contains information the SQL ID, SQL text, and related information about every SQL statement in the set.

3. Click the link next to **SQL Statements With Errors** if errors were found.

   The SQL Performance Analyzer Task Result page appears.

   The Errors table reports all errors that occurred while executing a given SQL workload. An error may be reported at the SQL Tuning Set level if it is common to all statements executions in the SQL Tuning Set, or at the execution level if it is specific to a SQL statement or execution plan.

4. Review general statistics, as described in "Reviewing the SQL Performance Analyzer Report: Global Statistics" on page 12-20.

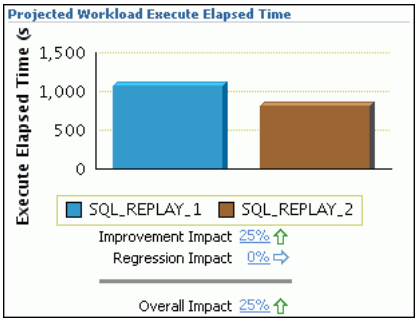
Reviewing the SQL Performance Analyzer Report: Global Statistics

The Global Statistics section reports statistics that describe the overall performance of the entire SQL workload. This section is a very important part of the SQL Performance Analyzer analysis because it reports on the impact of the system change on the overall performance of the SQL workload. Use the information in this section to understand the tendency of the workload performance, and determine how the workload performance will be affected by the system change.

To review the global statistics:

1. Review the chart in the Projected Workload Execute Elapsed Time subsection.

   The chart shows the two replay executions on the x-axis and the execute elapsed time (in seconds) on the y-axis.



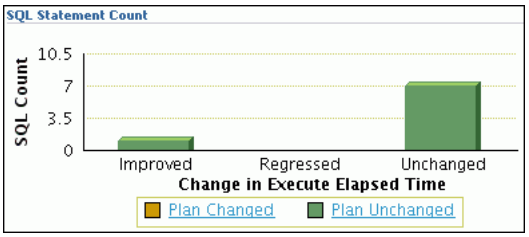
   The most important statistic is the overall impact, which is given as a percentage. The overall impact is the difference between the improvement impact and the

regression impact. You can click the link for any impact statistic to obtain more details, as described in "Reviewing the SQL Performance Analyzer Report: Global Statistics Details" on page 12-21.

In this example, the improvement impact is 25%, while the regression impact is 0%, so the overall impact of the system change is an improvement of 25%.

2. Review the chart in the SQL Statement Count subsection.

   The x-axis of the chart shows the number of SQL statements that are improved, regressed, and unchanged after the system change. The y-axis shows the number of SQL statements. The chart also indicates whether the explain plan was changed or unchanged for the SQL statements.

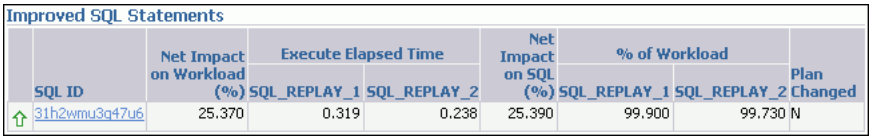


   This chart enables you to quickly weigh the relative performance of the SQL statements. You can click any bar in the chart to obtain more details, as described in "Reviewing the SQL Performance Analyzer Report: Global Statistics Details" on page 12-21.

   In this example, all SQL statements were either improved or unchanged after the system change. Most statements were unchanged.

Reviewing the SQL Performance Analyzer Report: Global Statistics Details

You can use the SQL Performance Analyzer Report to obtain detailed statistics for the SQL workload comparison. The details chart enables you to drill down into the performance of SQL statements that appears in the Result Summary section of the report. Use the information in this section to investigate why the performance of a particular SQL statement regressed.


Improved SQL Statements

SQL ID	Net Impact on Workload (%)	Execute Elapsed Time		Net Impact on SQL (%)	% of Workload		Plan Changed
		SQL_REPLAY_1	SQL_REPLAY_2		SQL_REPLAY_1	SQL_REPLAY_2	
31h2wmu3q47u6	25.370	0.319	0.238	25.390	99.900	99.730	N

To review the global statistics details:

1. Click the bar in any chart on the SQL Performance Analyzer Task Result page, or click the impact percentages in the Projected Workload Execute Elapsed Time subsection.

   A table including the detailed statistics appears. Depending on the table, the following columns are included:

   - SQL ID

     This column indicates the ID of the SQL statement.

   - Executions

     This column indicates the number of times this SQL statement was executed.

   - Net Impact on Workload (%)

This column indicates the impact of the system change relative to the performance of the SQL workload.

- Execute Elapsed Time

  This column indicates the total time (in seconds) of the SQL statement execution.

- Net Impact on SQL (%)

  This column indicates the local impact of the change on the performance of a particular SQL statement.

- % of Workload

  This column indicates the percentage of the total workload consumed by this SQL statement.

- Plan Changed

  This column indicates whether the SQL execution plan changed.

2. Click **SQL ID** for any SQL statement in the table.

   The SQL Details page appears.

   You can use this page to access the text of the SQL statement and obtain low-level details such as CPU time, buffer gets, and optimizer cost.

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