22

Monitoring Database Operations

This chapter describes how to monitor SQL and PL/SQL.

About Monitoring Database Operations

The SQL monitoring feature is enabled by default when the `STATISTICS_LEVEL` initialization parameter is either set to `TYPICAL` (the default value) or `ALL`.

> **See Also:**
>
> *Oracle Database Concepts* for a brief conceptual overview of database operations

About Database Operations

A database operation is a set of database tasks. A typical task might be a batch job or Extraction, Transformation, and Loading (ETL) processing job.

Database operations are either simple or composite.

Simple Database Operation

A **simple database operation** is a single SQL statement or PL/SQL subprogram. When the SQL Monitor feature is enabled, the database monitors simple database operations automatically when any of the following conditions is true:

- A SQL statement or PL/SQL subprogram has consumed at least 5 seconds of CPU or I/O time in a single execution.
- A SQL statement executes in parallel.
- A SQL statement specifies the `/*+ MONITOR */` hint.
- The event `sql_monitor` specifies a list of SQL IDs for the statements to be monitored. For example, the following statement forces instance-level monitoring for SQL IDs `5hc07qvt8v737` and `9ht3ba3arrzt3`:

```
ALTER SYSTEM SET EVENTS 'sql_monitor [sql: 5hc07qvt8v737|sql:
9ht3ba3arrzt3] force=true'
```

At each step of the SQL execution plan, the database tracks statistics by performance metrics such as elapsed time, CPU time, number of reads and writes, and I/O wait time. These metrics are available in a graphical and interactive report called the SQL monitor active report.

Composite Database Operation

A **composite database operation** is defined by the user. It includes all SQL statements or PL/SQL subprograms that execute within a database session, with the beginning and end points defined using the procedures `DBMS_SQL_MONITOR.BEGIN_OPERATION` and

`DBMS_SQL_MONITOR.END_OPERATION`. A composite database operation is uniquely identified by its name and execution ID, and can be executed multiple times.

> **Note:**
>
> A database session can participate in at most one database operation at a time.

Oracle Database automatically monitors a composite operation when either of the following conditions is true:

- The operation has consumed at least 5 seconds of CPU or I/O time.
- Tracking for the operations is forced by setting `FORCED_TRACKING` to `Y` in `DBMS_SQL_MONITOR.BEGIN_OPERATION`.

> **Note:**
>
> "Getting the Most Out of SQL Monitor" for a brief overview of SQL Monitor

Purpose of Monitoring Database Operations

For simple operations, Real-Time SQL Monitoring helps determine where a statement is spending its time.

You can also see the breakdown of time and resource usage for recently completed statements. In this way, you can better determine why a particular operation is expensive. Use cases for Real-Time SQL Monitoring include the following:

- A frequently executed SQL statement is executing more slowly than normal. You must identify the root cause of this problem.
- A database session is experiencing slow performance.
- A parallel SQL statement is taking a long time. You want to determine how the server processes are dividing the work.

In OLTP and data warehouse environments, a job often logically groups related SQL statements. The job can span multiple concurrent sessions. Database operations extend Real-Time SQL Monitoring by enabling you to treat a set of statements or procedures as a named, uniquely identified, and re-executable unit. Use cases for monitoring operations include the following:

- A periodic batch job containing many SQL statements must complete in a certain number of hours, but took longer than expected.
- After a database upgrade, the execution time of an important batch job increased. To resolve this problem, you must collect enough relevant statistical data from the batch job before and after the upgrade, compare the two sets of data, and then identify the changes.
- Packing a SQL tuning set (STS) took far longer than anticipated. To diagnose the problem, you need to know what was being executed over time. Because this issue cannot be easily reproduced, you need to monitor the process while it is running.

Related Topics

- Generating and Accessing SQL Monitor Reports
  By default, AWR automatically captures SQL monitoring reports in XML format.
- *Oracle Database Administrator's Guide*

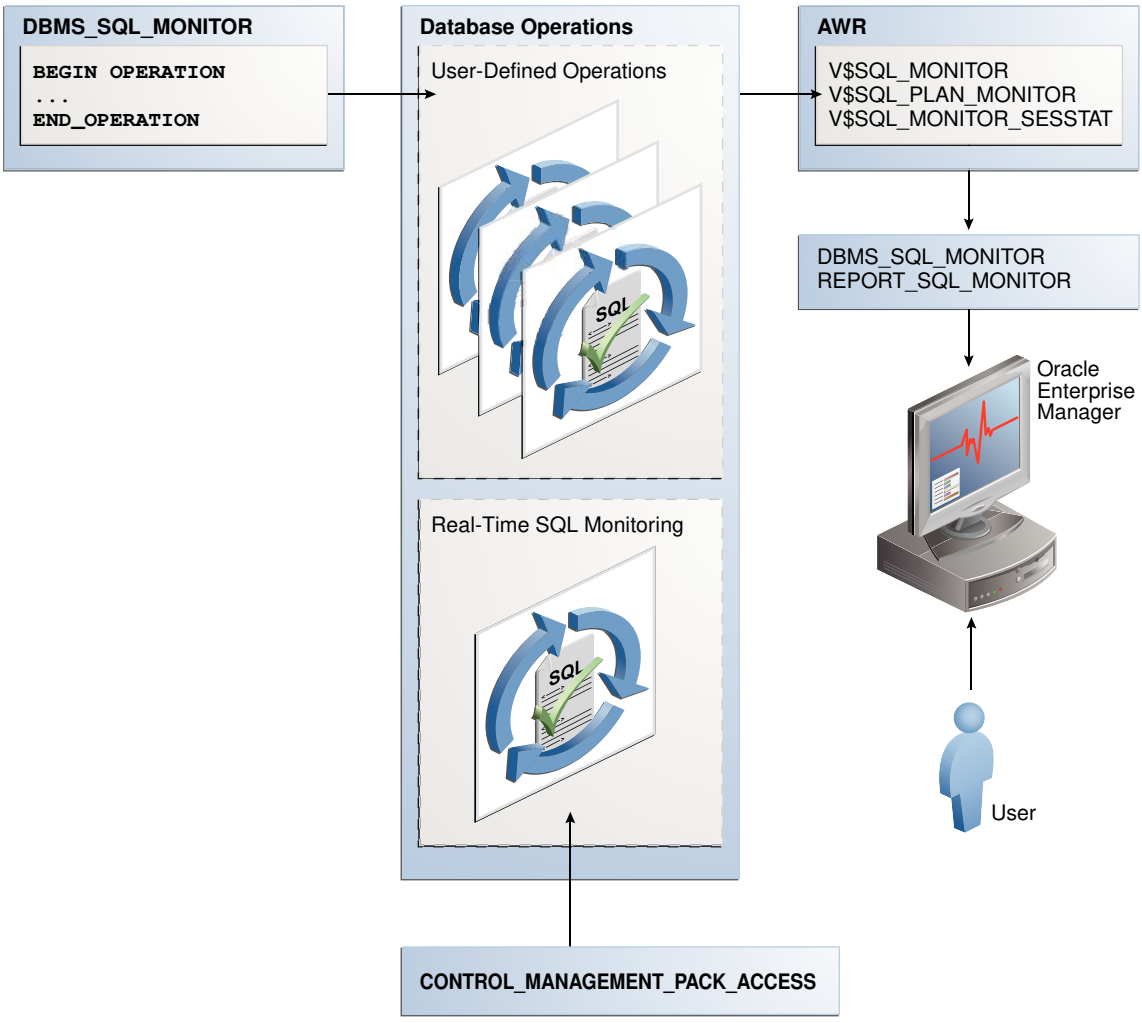
> **See Also:**
>
> Why Use SQL Monitor for a video demonstrating some uses of SQL Monitor

How Database Monitoring Works

Real-Time SQL Monitoring is a built-in database infrastructure that helps you identify performance problems with long-running and parallel SQL statements.

The following figure gives an overview of the architecture for Real-Time SQL Monitoring.

Figure 22-1 Architecture for Database Operations Monitoring



As shown in the preceding graphic, the DBMS_SQL_MONITOR package defines database operations. After monitoring is initiated, the database stores metadata about the database operations in AWR, and the data in AWR and ASH. The database refreshes monitoring statistics in close to real time as each monitored statement executes, typically once every second. The database stores the operational data (the statements and metadata) in the SGA. After an operation completes, the database writes the SQL Monitor report to disk, where it can be queried using the DBA_HIST_REPORTS view.

Every monitored database operation has an entry in the V$SQL_MONITOR view. This entry tracks key performance metrics collected for the execution, including the elapsed time, CPU time, number of reads and writes, I/O wait time, and various other wait times. The V$SQL_PLAN_MONITOR view includes monitoring statistics for each operation in the execution plan of the SQL statement being monitored. You can access reports by using DBMS_SQL_MONITOR.REPORT_SQL_MONITOR, Oracle Enterprise Manager Cloud Control (Cloud Control).

See Also:

- "Generating and Accessing SQL Monitor Reports"
- *Oracle Database Reference* to learn about V$SQL_MONITOR, V$SQL_PLAN_MONITOR, and CONTROL_MANAGEMENT_PACK_ACCESS
- *Oracle Database PL/SQL Packages and Types Reference* to learn about the DBMS_SQL_MONITOR package

User Interfaces for Database Operations Monitoring

Real-Time SQL Monitoring is a feature of the Oracle Database Tuning Pack. Database operations are enabled when the CONTROL_MANAGEMENT_PACK_ACCESS initialization parameter is set to DIAGNOSTIC+TUNING (default).

Monitored SQL Executions Page in Cloud Control

The Monitored SQL Executions page in Cloud Control, also known as SQL Monitor, displays details of SQL execution. SQL Monitor is the recommended interface for reporting on database operations.

Statistics at each step of the execution plan are tracked by key performance metrics, including elapsed time, CPU time, number of reads and writes, I/O wait time, and various other wait times. These metrics enable DBAs to analyze SQL execution in depth and decide on the most appropriate tuning strategies for monitored SQL statements.

SQL Monitor Active Reports provide a flash-based interactive report that enables you to save data in an HTML file. You can save this file and view it offline.

Accessing the Monitored SQL Executions Page

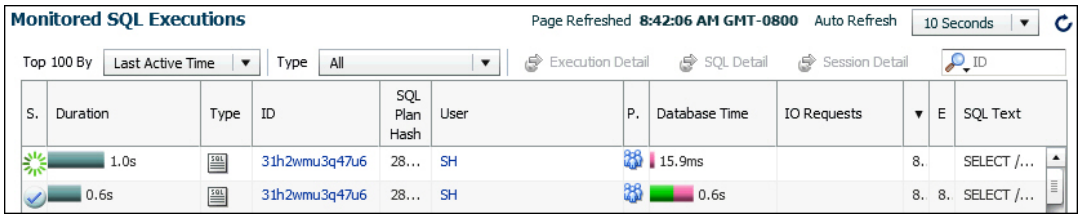
The Monitored SQL Executions shows information such as the SQL ID, database time, and I/O requests.

To access the Monitored SQL Executions page:

1. Log in to Cloud Control with the appropriate credentials.
2. Under the **Targets** menu, select **Databases**.
3. In the list of database targets, select the target for the Oracle Database instance that you want to administer.
4. If prompted for database credentials, then enter the minimum credentials necessary for the tasks you intend to perform.
5. From the **Performance** menu, select **SQL Monitoring**.

   The Monitored SQL Executions page appears.

Figure 22-2 Monitored SQL Executions



DBMS_SQL_MONITOR Package

The `DBMS_SQL_MONITOR` package defines the beginning and ending of a composite database operation, and generates a report of the database operations.

Table 22-1 DBMS_SQL_MONITOR

Subprogram	Description
`BEGIN_OPERATION`	This function starts a database operation in the current session. This function associates a session with a database operation. Starting in Oracle Database 12c Release 2 (12.2), you can use `session_id` and `session_num` to indicate the session in which to start monitoring.
`END_OPERATION`	This function ends a database operation in the current session. If the specified database operation does not exist, then this function has no effect.

Table 22-1 (Cont.) DBMS_SQL_MONITOR

Subprogram	Description
REPORT_SQL_MONITOR	This function builds a detailed report with monitoring information for a SQL statement, PL/SQL block, or database operation. For each operation, it gives key information and associated global statistics. Use this function to get detailed monitoring information for a database operation. The target database operation for this report can be: • The last database operation monitored by Oracle Database (default, no parameter). • The last database operation executed in the specified session and monitored by Oracle Database. The session is identified by its session ID and optionally its serial number (-1 is current session). • The last execution of a specific database operation identified by its sql_id. • A specific execution of a database operation identified by the combination sql_id, sql_exec_start, and sql_exec_id. • The last execution of a specific database operation identified by dbop_name. • The specific execution of a database operation identified by the combination dbop_name, dbop_exec_id. Use the type parameter to specify the output type: TEXT (default), HTML, ACTIVE, or XML.
REPORT_SQL_MONITOR_XML	This function is identical to the REPORT_SQL_MONITOR function, except that the return type is XMLType.
REPORT_SQL_MONITOR_LIST	This function builds a report for all or a subset of database operations that have been monitored by Oracle Database.
REPORT_SQL_MONITOR_LIST_XML	This function is identical to the REPORT_SQL_MONITOR_LIST function, except that it returns XMLType.

> **See Also:**
>
> *Oracle Database PL/SQL Packages and Types Reference* to learn about the DBMS_SQL_MONITOR package

Attributes of composite Database Operations

The DBMS_SQL_MONITOR.BEGIN_OPERATION function defines a database operation.

A composite database operation is uniquely identified by the following information:

- Database operation name

  This is a user-created name such as daily_sales_report. The operation name is the same for a job even if it is executed concurrently by different sessions or on different databases. Database operation names do not reside in different namespaces.

- Database operation execution ID

Two or more occurrences of the same database operation can run at the same time, with the same name but different execution IDs. This numeric ID uniquely identifies different executions of the *same* database operation.

The database automatically creates an execution ID when you begin a database operation. You can also specify a user-created execution ID.

Optionally, you can specify the session ID and session serial number in which to start the database operations. Thus, one database session can start a database operation defined in a different database session.

The database uses the following triplet of values to identify each SQL and PL/SQL statement monitored in the `V$SQL_MONITOR` view, regardless of whether the statement is included in a database operation:

- SQL identifier to identify the SQL statement (`SQL_ID`)
- Start execution timestamp (`SQL_EXEC_START`)
- An internally generated identifier to ensure that this primary key is truly unique (`SQL_EXEC_ID`)

You can use zero or more additional attributes to describe and identify the characteristics of a composite database operation. Every attribute has a name and value. For example, for database operation `daily_sales_report`, you might define the attribute `db_name` and assign it the value `prod`.

Related Topics

- *Oracle Database Reference*
- *Oracle Database PL/SQL Packages and Types Reference*

MONITOR and NO_MONITOR Hints

You can use the MONITOR and NO_MONITOR hints to control tracking for individual statements.

The `MONITOR` hint forces real-time SQL monitoring for the query, even if the statement is not long-running. This hint is valid only when the parameter `CONTROL_MANAGEMENT_PACK_ACCESS` is set to `DIAGNOSTIC+TUNING`. The following query forces SQL Monitor to enable tracking:

```
SELECT /*+ MONITOR */  prod_id, AVG(amount_sold), AVG(quantity_sold)
FROM   sales
GROUP BY prod_id
ORDER BY prod_id;
```

The `NO_MONITOR` hint disables real-time SQL monitoring for the query, even if the query is long running. The following query forces SQL Monitor to disable tracking:

```
SELECT /*+ NO_MONITOR */  prod_id, AVG(amount_sold), AVG(quantity_sold)
FROM   sales
GROUP BY prod_id
ORDER BY prod_id;
```

> **Note:**
>
> *Oracle Database SQL Language Reference* to learn about the `MONITOR` and `NO_MONITOR` hints

Views for Monitoring and Reporting on Database Operations

You can obtain the statistics for database operations using `V$` and data dictionary view.

The following table summarizes these views.

Table 22-2 Views for Database Operations Monitoring

View	Description
`DBA_HIST_REPORTS`	This view displays metadata about XML reports captured in Automatic Workload Repository (AWR). Each XML report contains details about some activity of a component. For example, a SQL Monitor report contains a detailed report about a particular database operation. Important columns include: • The `REPORT_SUMMARY` column contains the summary of the report. • The `COMPONENT_NAME` column accepts the value `sqlmonitor`. • The `REPORT_ID` column provides the ID of the report, which you can specify in the `RID` parameter of `DBMS_AUTO_REPORT.REPORT_REPOSITORY_DETAIL` when generating the report. • The `KEY1` column is the is the SQL ID for the statement. • The `KEY2` column is the SQL execution ID for the statement AWR controls the retention period for SQL Monitor reports. Every SQL Monitor report in `DBA_HIST_REPORTS` is associated with an AWR `SNAP_ID`. Note that SQL Monitor reports are not exported or imported when you export or import the corresponding AWR data.
`DBA_HIST_REPORTS_DETAILS`	This view displays details about each report captured in AWR. Metadata for each report appears in the `DBA_HIST_REPORTS` view, whereas the actual report is available in the `DBA_HIST_REPORTS_DETAILS` view.

Table 22-2 (Cont.) Views for Database Operations Monitoring

View	Description
V$SQL_MONITOR	This view contains global, high-level information about simple and composite database operations. For simple database operations, monitoring statistics are not cumulative over several executions. In this case, one entry in V$SQL_MONITOR is dedicated to a single execution of a SQL statement. If the database monitors two executions of the same SQL statement, then each execution has a separate entry in V$SQL_MONITOR. For simple database operations, V$SQL_MONITOR has one entry for the parallel execution coordinator process and one entry for each parallel execution server process. Each entry has corresponding entries in V$SQL_PLAN_MONITOR. Because the processes allocated for the parallel execution of a SQL statement are cooperating for the same execution, these entries share the same execution key (the combination of SQL_ID, SQL_EXEC_START, and SQL_EXEC_ID). For composite database operations, each row contains an operation whose statistics are accumulated over the SQL statements and PL/SQL subprograms that run in the same session as part of the operation. The primary key is the combination of the columns DBOP_NAME and DBOP_EXEC_ID.
V$SQL_MONITOR_SESSTAT	This view contains the statistics for all sessions involved in the database operation. Most of the statistics are cumulative. The database stores the statistics in XML format instead of using each column for each statistic. This view is primarily intended for the report generator. Oracle recommends that you use V$SESSTAT instead of V$SQL_MONITOR_SESSTAT.
V$SQL_PLAN_MONITOR	This view contains monitoring statistics for each step in the execution plan of the monitored SQL statement. The database updates statistics in V$SQL_PLAN_MONITOR every second while the SQL statement is executing. Multiple entries exist in V$SQL_PLAN_MONITOR for every monitored SQL statement. Each entry corresponds to a step in the execution plan of the statement.
V$PQ_SESSTAT	After you have run a query or DML operation, you can use the information derived from V$PQ_SESSTAT to view the number of worker processes used, and other information for the session and system.

You can use the preceding V$ views with the following views to get additional information about the monitored execution:

- V$ACTIVE_SESSION_HISTORY
- V$SESSION
- V$SESSION_LONGOPS
- V$SQL
- V$SQL_PLAN

> **See Also:**
>
> *Oracle Database Reference* to learn about the `V$` views for database operations monitoring

Basic Tasks in Database Operations Monitoring

This section explains the basic tasks in database operations monitoring.

Basic tasks are as follows:

- "Enabling and Disabling Real-Time Monitoring of Database Operations"

  This task explains how you can enable automatic monitoring of database operations at the system and statement level.
- "Defining a Composite Database Operation"

  This section explains how you can define the beginning and end of a database operation using PL/SQL.
- "Generating and Accessing SQL Monitor Reports"

  This section explains how you can generate and interpret reports on a database operation.

Enabling and Disabling Real-Time Monitoring of Database Operations

Use initialization parameters to enable or disable monitoring.

Enabling Monitoring of Database Operations at the System Level

The SQL monitoring feature is enabled by default when the `STATISTICS_LEVEL` initialization parameter is either set to `TYPICAL` (the default value) or `ALL`. SQL monitoring starts automatically for all long-running queries.

Prerequisites

Because SQL monitoring is a feature of the Oracle Database Tuning Pack, the `CONTROL_MANAGEMENT_PACK_ACCESS` initialization parameter must be set to `DIAGNOSTIC+TUNING` (the default value).

Assumptions

This tutorial assumes the following:

- The `STATISTICS_LEVEL` initialization parameter is set to `BASIC`.
- You want to enable automatic monitoring of database operations.

To enable monitoring of database operations:

1. Connect SQL*Plus to the database with the appropriate privileges, and then query the current database operations settings.

For example, run the following SQL*Plus command:

```
SQL> SHOW PARAMETER statistics_level

NAME                                 TYPE        VALUE
------------------------------------ ----------- -----
statistics_level                     string      BASIC
```

2. Set the statistics level to `TYPICAL`.

   For example, run the following SQL statement:

```
SQL> ALTER SYSTEM SET STATISTICS_LEVEL='TYPICAL';
```

> **See Also:**
>
> *Oracle Database Reference* to learn about the `STATISTICS_LEVEL` and `CONTROL_MANAGEMENT_PACK_ACCESS` initialization parameter

Enabling and Disabling Monitoring of Database Operations at the Statement Level

When the `CONTROL_MANAGEMENT_PACK_ACCESS` initialization parameter is set to `DIAGNOSTIC+TUNING`, you can use hints to enable or disable monitoring of specific SQL statements.

The database monitors SQL statements or PL/SQL subprograms automatically when they have consumed at least 5 seconds of CPU or I/O time in a single execution. The `MONITOR` hint is useful to enforce monitoring of statements or subprograms that do not meet the time criteria.

Two statement-level hints are available to force or prevent the database from monitoring a SQL statement. To force SQL monitoring, use the `MONITOR` hint:

```
SELECT /*+ MONITOR */ SYSDATE FROM DUAL;
```

This hint is effective only when the `CONTROL_MANAGEMENT_PACK_ACCESS` parameter is set to `DIAGNOSTIC+TUNING`. To prevent the hinted SQL statement from being monitored, use the `NO_MONITOR` reverse hint.

Assumptions

This tutorial assumes the following:

- Database monitoring is currently enabled at the system level.
- You want to disable automatic monitoring for the statement `SELECT * FROM sales ORDER BY time_id`.

To disable monitoring of database operations for a SQL statement:

1. Execute the query with the `NO_MONITOR` hint.

For example, run the following statement:

```
SQL> SELECT * /*+NO_MONITOR*/ FROM sales ORDER BY time_id;
```

> **See Also:**
>
> *Oracle Database SQL Language Reference* for information about using the `MONITOR` and `NO_MONITOR` hints

Defining a Composite Database Operation

Defining a database operation involves supplying a name and specifying its beginning and end times.

Start a database operation by using the `DBMS_SQL_MONITOR.BEGIN_OPERATION` function, and end it by using the `DBMS_SQL_MONITOR.END_OPERATION` procedure.

To begin the operation in a different session, specify the combination of `session_id` and `serial_num`. The `BEGIN_OPERATION` function returns the database operation execution ID. If `dbop_exec_id` is null, then the database generates a unique value.

A single namespace exists for database operations, which means that name collisions are possible. Oracle recommends the following naming convention: *`component_name.subcomponent_name.operation name`*. For operations inside the database, Oracle recommends using `ORA` for the component name. For example, a materialized view refresh could be named `ORA.MV.refresh`. An E-Business Suite payroll function could be named `EBIZ.payroll`.

To create a database operation in the current session:

1. In SQL*Plus or SQL Developer, log in to the database as a user with the necessary privileges.
2. Start the operation by using `DBMS_SQL_MONITOR.BEGIN_OPERATION`.

   This function returns the database operation execution ID. The following example creates the operation named `ORA.sales.agg`, and stores the execution ID in a SQL*Plus variable:

   ```
   VARIABLE exec_id NUMBER;
   BEGIN
     :exec_id := DBMS_SQL_MONITOR.BEGIN_OPERATION ( dbop_name =>
   'ORA.sales.agg' );
   END;
   /
   ```

3. Execute the SQL statements or PL/SQL programs that you want to monitor.
4. End the operation by using `DBMS_SQL_MONITOR.END_OPERATION`.

   The following example ends operation `ORA.sales.agg`:

   ```
   BEGIN
     DBMS_SQL_MONITOR.END_OPERATION ( dbop_name => 'ORA.sales.agg', dbop_eid
   => :exec_id );
   ```

```
END;
/
```

Example 22-1 Creating a Database Operation

The following example illustrates how to use the `DBMS_SQL_MONITOR` package to begin and end a database operation in a different session. This example assumes the following:

- You are an administrator and want to monitor statements in a session started by user `sh`.
- You want to monitor queries of the `sh.sales` table and `sh.customers` table.
- You want these two queries to be monitored as a database operation named `sh_count`.

Table 22-3 Creating a Database Operation

SYSTEM Session	SH Session	DESCRIPTION

`SQL> CONNECT SYSTEM`
`Enter password: *********`
`Connected.`
	n/a	Start SQL*Plus and connect as a user with the administrator privileges.

n/a	`SQL> CONNECT sh`
	`Enter password: ******`
	`Connected.`
		In a different terminal, start SQL*Plus and connect as a user as user `sh`.

`SELECT SID, SERIAL#`
`FROM V$SESSION`
`WHERE USERNAME = 'SH';`
 	
`SID SERIAL#`
`---------- ----------`
`121 13397`
	n/a	In the `SYSTEM` session, query the session ID and serial number of the `sh` session.

`VARIABLE eid NUMBER`
 	
`BEGIN`
`:eid:=DBMS_SQL_MONITOR.BEGIN_OPERATION`
`('sh_count', null, null,`
`null, '121', '13397');`
`END;`
`/`
 	
`PRINT eid`
 	
`EID`
`----------`
`2`
	n/a	In the `SYSTEM` session, begin a database operation, specifying the session ID and serial number for the `sh` session.

Table 22-3 (Cont.) Creating a Database Operation

SYSTEM Session	SH Session	DESCRIPTION

n/a	`SELECT count(*)`
	`FROM sh.sales;`
	
	`COUNT(*)`
	`----------`
	`918843`
	
	`SELECT COUNT(*)`
	`FROM sh.customers;`
	
	`COUNT(*)`
	`----------`
	`55500`
		In the `sh` session, query the `sales` and `customers` tables. These SQL queries are part of the `sh_count` operation.

`BEGIN`
`DBMS_SQL_MONITOR.END_OPERATION`
`('sh_count',:eid);`
`END;`
`/`
	n/a	End the database operation by specifying the operation name and execution ID.

`COL DBOP_NAME FORMAT a10`
`COL STATUS FORMAT a10`
`COL ID FORMAT 999`
 	
`SELECT DBOP_NAME, DBOP_EXEC_ID AS ID,`
`STATUS, CPU_TIME, BUFFER_GETS`
`FROM V$SQL_MONITOR`
`WHERE DBOP_NAME IS NOT NULL`
`ORDER BY DBOP_EXEC_ID;`
 	
`DBOP_NAME ID STATUS CPU_TIME GETS`
`---------- -- ---------- -------- ----`
`sh_count 1 EXECUTING 24997 65`
	n/a	Query the metadata for the `sh_count` database operation. The status of the operation is `EXECUTING` because the session has not picked up the new session status.

n/a	`SELECT SYSDATE FROM DUAL;`	To collect changed session information, execute a query that performs a round trip to the database.

Table 22-3 (Cont.) Creating a Database Operation

SYSTEM Session	SH Session	DESCRIPTION

`COL DBOP_NAME FORMAT a10`
`COL STATUS FORMAT a10`
`COL ID FORMAT 999`
 	
`SELECT DBOP_NAME, DBOP_EXEC_ID AS ID,`
`STATUS, CPU_TIME, BUFFER_GETS`
`FROM V$SQL_MONITOR`
`WHERE DBOP_NAME IS NOT NULL`
`ORDER BY DBOP_EXEC_ID;`
 	
`DBOP_NAME ID STATUS CPU_TIME GETS`
`---------- -- ---------- -------- ----`
`sh_count 1 DONE 24997 65`
	n/a	The status of the operation is now updated to `DONE`.

Related Topics

- *Oracle Database PL/SQL Packages and Types Reference*

Generating and Accessing SQL Monitor Reports

By default, AWR automatically captures SQL monitoring reports in XML format.

The reports capture only SQL statements that are not executing or queued and have finished execution since the last capture cycle. AWR captures reports only for the most expensive statements according to elapsed execution time. The SQL Monitor retention policy is controlled by the AWR policy. You can change the retention policy using the `DBMS_WORKLOAD_REPOSITORY.MODIFY_SNAPSHOT_SETTINGS` procedure.

The Monitored SQL Executions page in Enterprise Manager Cloud Control (Cloud Control) summarizes the activity for monitored statements. You can use this page to drill down and obtain additional details about particular statements. The Monitored SQL Executions Details page uses data from several views, including the following:

- `GV$SQL_MONITOR`
- `GV$SQL_PLAN_MONITOR`
- `GV$SQL_MONITOR_SESSTAT`
- `GV$SQL`
- `GV$SQL_PLAN`
- `GV$ACTIVE_SESSION_HISTORY`
- `GV$SESSION_LONGOPS`
- `DBA_HIST_REPORTS`
- `DBA_HIST_REPORTS_DETAILS`

> **Note:**
>
> Starting in Oracle Database 19c, Oracle Database includes undocumented `V$` views that enable a database user *without* the `SELECT_CATALOG_ROLE` to see the plans and statistics for simple database operations (individual SQL and PL/SQL statements) executed within the session. A user without `SELECT_CATALOG_ROLE` cannot see SQL execution statistics and details for other users.

Assumptions

This tutorial assumes the following:

- The user `sh` is executing the following long-running parallel query of the sales made to each customer:

```
SELECT c.cust_id, c.cust_last_name, c.cust_first_name,
       s.prod_id, p.prod_name, s.time_id
FROM   sales s, customers c, products p
WHERE  s.cust_id = c.cust_id
AND    s.prod_id = p.prod_id
ORDER BY c.cust_id, s.time_id;
```

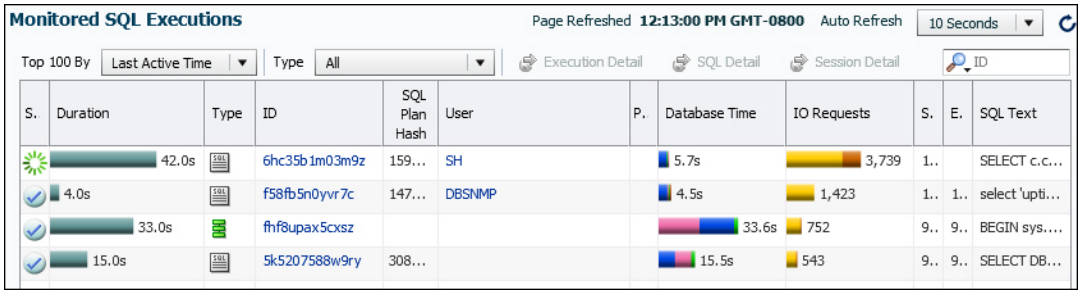
- You want to ensure that the preceding query does not consume excessive resources. While the statement executes, you want to determine basic statistics about the database operation, such as the level of parallelism, the total database time, and number of I/O requests.
- You use Cloud Control to monitor statement execution.

> **Note:**
>
> To generate the SQL monitor report from the command line, run the `REPORT_SQL_MONITOR` function in the `DBMS_SQLTUNE` package, as in the following sample SQL*Plus script:
>
> ```
> VARIABLE my_rept CLOB
> BEGIN
>   :my_rept :=DBMS_SQLTUNE.REPORT_SQL_MONITOR();
> END;
> /
> PRINT :my_rept
> ```

To monitor SQL executions:

1. Access the Monitored SQL Executions page, as described in "Monitored SQL Executions Page in Cloud Control".

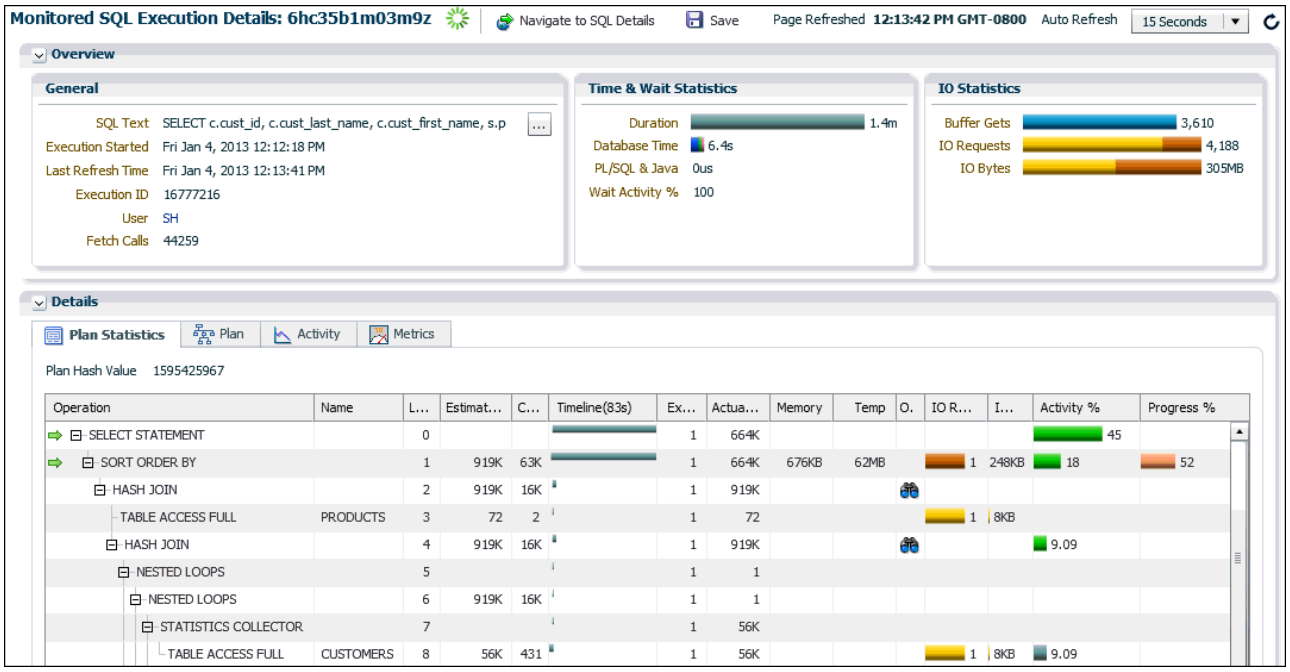
   In the following graphic, the top row shows the parallel query.



In this example, the query has been executing for 1.4 minutes.

2. Click the value in the SQL ID column to see details about the statement.

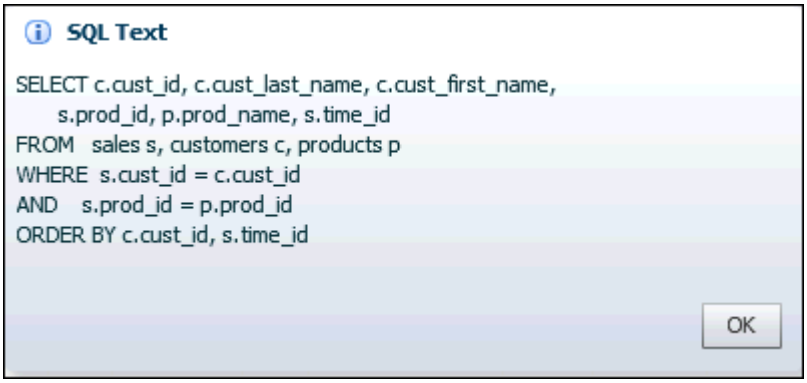
   The Monitored SQL Details page appears.



The preceding report shows the execution plan and statistics relating to statement execution. For example, the Timeline column shows when each step of the execution plan was active. Times are shown relative to the beginning and end of the statement execution. The Executions column shows how many times an operation was executed.

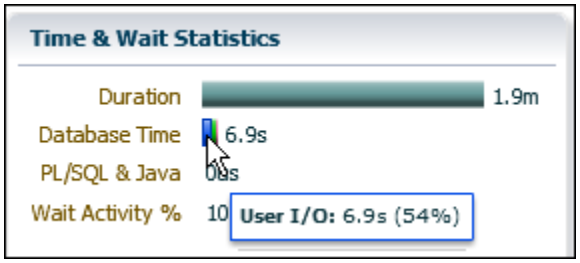
3. In the Overview section, click the link next to the SQL text.

   A message shows the full text of the SQL statement.



4. In the Time & Wait Statistics section, next to Database Time, move the cursor over the largest portion on the bar graph.

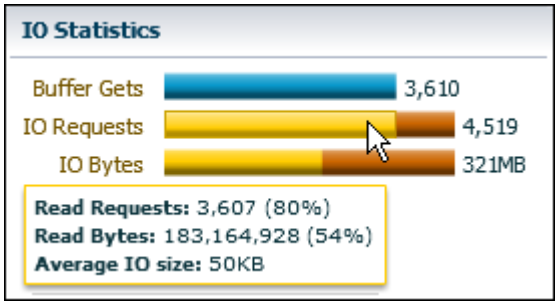
   A message shows that user I/O is consuming over half of database time.



   Database Time measures the amount of time the database has spent working on this SQL statement. This value includes CPU and wait times, such as I/O time. The bar graph is divided into several color-coded portions to highlight CPU resources, user I/O resources, and other resources. You can move the cursor over any portion to view the percentage value of the total.

5. In the Details section, in the IO Requests column, move the cursor over the I/O requests bar to view the percentage value of the total.

   A message appears.



   In the preceding graphic, the IO Requests message shows the total number of read requests issued by the monitored SQL. The message shows that read requests form 80% of the total I/O requests.

> **See Also:**
>
> - Cloud Control Online Help for descriptions of the elements on the Monitored SQL Executions Details page, and for complete descriptions of all statistics in the report.
> - *Oracle Database Reference* to learn about `V$SQL_MONITOR` and related views for database operations monitoring
> - Why Use SQL Monitor for a video demonstrating useful features of the Monitored SQL Details report

Monitoring Database Operations: Scenarios

In these scenarios, you report on both simple and composite database operations.

Reporting on a Simple Database Operation: Scenario

In this scenario, a query is expected to complete in seconds, but is continuing to execute.

In this example, assume that you log in to the database as user `sh`, and then run the following query:

```
SELECT /*+ MONITOR */ s.prod_id, c.cust_last_name FROM sales s, customers c
ORDER BY prod_id
```

The query is not completing. Starting in Oracle Database 19c, low-privileged users such as `sh` can generate a SQL Monitor report for simple database operations (individual SQL and PL/SQL statements) in their session. To identify the source of the problem, you use SQL Monitor for diagnosis as follows:

1. Cancel the query.
2. Obtain a text report by invoking `DBMS_SQL_MONITOR.REPORT_SQL_MONITOR`:

```
SET LONG 1000000
VARIABLE my_rept CLOB;
BEGIN
  :my_rept := DBMS_SQL_MONITOR.REPORT_SQL_MONITOR(
                report_level => 'ALL',
                TYPE         => 'text');
END;
/
PRINT :my_rept
```

Partial sample output appears below:

```
SQL Text
------------------------------
SELECT /*+ MONITOR */ s.prod_id, c.cust_last_name FROM sales s, customers c
ORDER BY prod_id

Global Information
------------------------------
```

```
 Status              :  DONE (ERROR)
 Instance ID         :  1
 Session             :  SH (42:3617)
 SQL ID              :  d9w9dw5v007xp
 SQL Execution ID    :  16777217
 Execution Started   :  09/18/2018 14:08:13
 First Refresh Time  :  09/18/2018 14:08:13
 Last Refresh Time   :  09/18/2018 14:08:34

MY_REPT
------------------------------------------------------------------------------
 Duration            :  21s
 Module/Action       :  SQL*Plus/-
 Service             :  SYS$USERS
 Program             :  sqlplus@slc16iva (TNS V1-V3)
 Fetch Calls         :  1
Global Stats

MY_REPT
------------------------------------------------------------------------------
| Time(s)|Time(s)|Waits(s) |Calls | Gets |Reqs | Bytes | Reqs  | Bytes |
==============================================================================
|   21 |   11 |     10 |     1 |    204 |  233 |   3MB |  4568 | 909MB |
==============================================================================


SQL Plan Monitoring Details (Plan Hash Value=2036849021)
==============================================================================

MY_REPT
------------------------------------------------------------------------------
==============================================================================
| Id |             Operation              |      Name      |  Rows   | Cost |
Time    | Start  | Execs |   Rows   | Read | Read  | Write | Write |  Mem   | Tem
p  | Activity | Activity Detail |
|    |                                    |                | (Estim) |      | Ac
tive(s) | Active |       | (Actual) | Reqs | Bytes | Reqs  | Bytes | (Max) | (Ma
x) |   (%)    |   (# samples)   |
================================================================================
================================================================================
================================

MY_REPT
------------------------------------------------------------------------------------------
| 0 | SELECT STATEMENT                   |                |        |     |
     19 |     +2 |     1 |        0 |      |       |       |       |     . |
 . |          |         |
| 1 |   SORT ORDER BY                    |                |    51G |316M |
     20 |     +1 |     1 |        0 |      |       |  4496 | 908MB |  99MB | 909
MB |          |         |
| 2 |    MERGE JOIN CARTESIAN            |                |    51G |  2M |
     19 |     +2 |     1 |      50M |      |       |       |       |     . |
 . |          |         |
| 3 |     TABLE ACCESS FULL              | CUSTOMERS      |  55500 | 414 |
     20 |     +2 |     1 |       54 |    3 | 120KB |       |       |     . |
 . |          |         |
| 4 |     BUFFER SORT                    |                |   919K |316M |
     19 |     +2 |    54 |      50M |      |       |       |       |  28MB |
 . |          |         |
| 5 |      PARTITION RANGE ALL           |                |   919K |  29 |
      1 |     +2 |     1 |     919K |      |       |       |       |     . |
 . |          |         |
| 6 |       BITMAP CONVERSION TO ROWIDS  |                |   919K |  29 |
      1 |     +2 |    28 |     919K |      |       |       |       |     . |
 . |          |         |
| 7 |        BITMAP INDEX FAST FULL SCAN | SALES_PROD_BIX |        |     |
      1 |     +2 |    28 |     1074 |   32 | 512KB |       |       |     . |
 . |          |         |
==========================================================================================
```

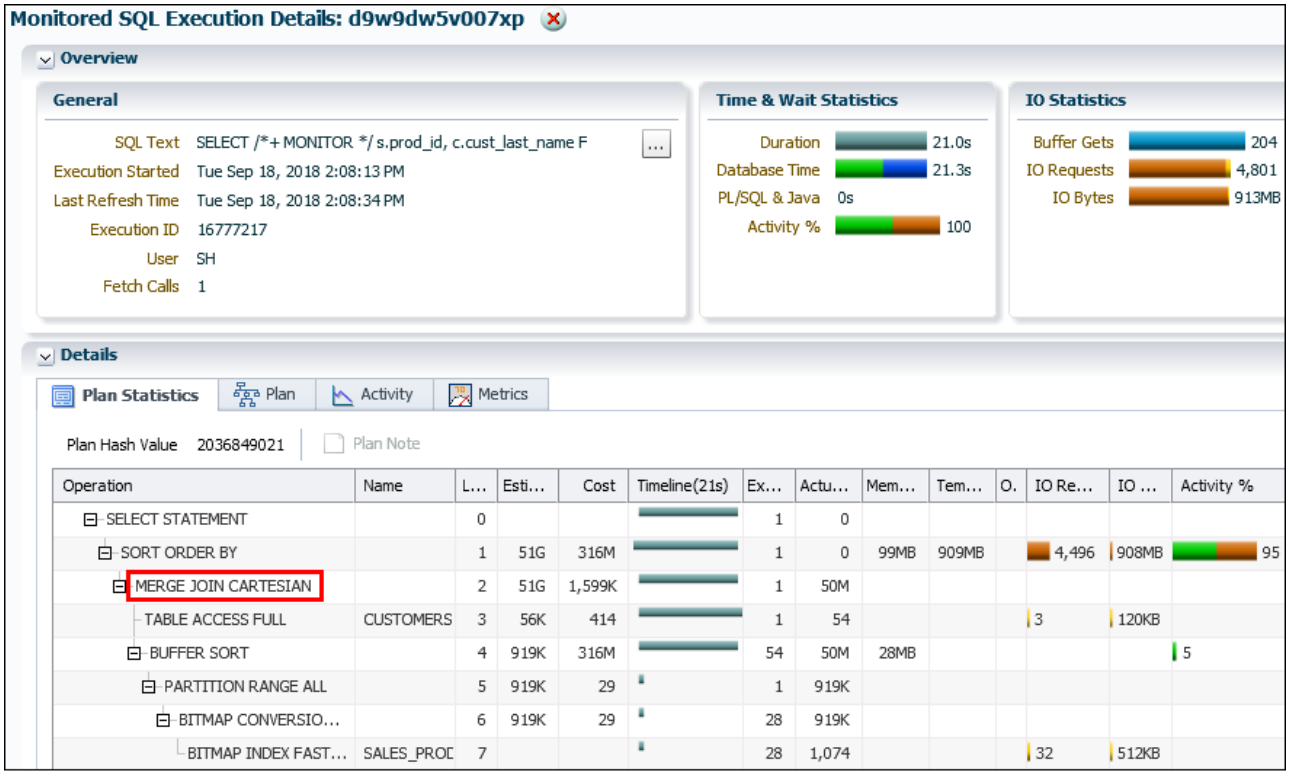
Because of the formatting, the preceding output is difficult to read. You decide to create an active SQL Monitor report, which is graphical.

3. Create a SQL script containing the following commands:

```
SET FEEDBACK OFF
SET TERMOUT OFF
SET TRIMSPOOL ON
SET TRIM ON
SET PAGES 0
SET LINESIZE 1000
SET LONG 1000000
SET LONGCHUNKSIZE 1000000

SPOOL /tmp/long_sql.htm
SELECT DBMS_SQL_MONITOR.REPORT_SQL_MONITOR(
         report_level => 'ALL',
         TYPE         => 'active')
FROM   DUAL;
SPOOL OFF
```

4. In SQL*Plus, run the SQL script that you created in the preceding step.
5. Open the output HTML file in a browser, and then review the report:



The cause of the performance problem is shown in Line 2: a Cartesian join. The author of the query inadvertently left off the `WHERE` clause. Instead of returning around 1 million rows as it would for an inner join of `sales` and `customers`, the query returned 50 million rows before it was canceled. Sorting the joined data from the two tables is consuming most of the DB time (Line 1).

Reporting on Composite Database Operation: Scenario

This scenario uses `DBMS_SQL_MONITOR` to define a database operation and generates an active report.

Your goal is to group four queries of tables in the `sh` schema into an operation, and then generate a report.

1. In SQL*Plus, log on as an administrative user `SAM`. Begin an operation named `SHOP` (specifying `forced_tracking` to ensure that SQL Monitor tracks the SQL), run four queries, and then end the operation as follows:

```
VARIABLE exec_id NUMBER;
BEGIN
  :exec_id := DBMS_SQL_MONITOR.BEGIN_OPERATION ( dbop_name => 'SHOP',
forced_tracking => 'Y' );
END;
/

SELECT COUNT(*) FROM sh.sales;
SELECT COUNT(*) FROM sh.customers;

SELECT prod_id, cust_id
FROM   sh.sales
WHERE  prod_id < 26
ORDER BY prod_id;

SELECT cust_id, cust_first_name, cust_last_name, cust_city
FROM   sh.customers
WHERE  cust_id < 30000
ORDER BY cust_id;

BEGIN
  DBMS_SQL_MONITOR.END_OPERATION ( dbop_name => 'SHOP', dbop_eid
=> :exec_id );
END;
/
```

2. To obtain metadata about the operation, including its status and metadata, query `V$SQL_MONITOR` (sample output included):

```
COL STATUS FORMAT a10
COL DBOP_NAME FORMAT a10
COL CON_NAME FORMAT a5

SELECT STATUS, SQL_ID, DBOP_NAME, DBOP_EXEC_ID,
       TO_CHAR(ELAPSED_TIME/1000000,'000.00') AS ELA_SEC
FROM   V$SQL_MONITOR
WHERE  DBOP_NAME = 'SHOP';

STATUS     SQL_ID        DBOP_NAME  DBOP_EXEC_ID ELA_SEC
---------- ------------- ---------- ------------ -------
DONE                     SHOP                3  001.34
```

3. To obtain metadata about the SQL Monitor report, call `DBMS_SQL_MONITOR.REPORT_SQL_MONITOR` (sample output included):

> **Note:**
>
> As of Oracle Database 23ai, for `SELECT`s that do not require table access, `FROM DUAL` is now implicit when there is no `FROM` clause. `FROM DUAL` is supported but is no longer required. `SELECT <expr_list>;` is sufficient.

```
SET LONG 10000000
SET LONGCHUNKSIZE 10000000
SET PAGES 0
SELECT DBMS_SQL_MONITOR.REPORT_SQL_MONITOR(
  dbop_name => 'SHOP', type => 'TEXT', report_level => 'ALL') AS rpt
FROM DUAL;

SQL Monitoring Report

Global Information
------------------------------
 Status              :  DONE
 Instance ID         :  1
 Session             :  SAM (87:6406)
 DBOP Name           :  SHOP
 DBOP Execution ID   :  3
 First Refresh Time  :  10/03/2017 07:33:32
 Last Refresh Time   :  10/03/2017 07:34:24
 Duration            :  52s
 Module/Action       :  sqlplus@myhost (TNS V1-V3)/-
 Service             :  MYSERVICE
 Program             :  sqlplus@myhost (TNS V1-V3)

Global Stats
=========================================================
| Elapsed |   Cpu   |    IO    | Buffer | Read | Read  |
| Time(s) | Time(s) | Waits(s) |  Gets  | Reqs | Bytes |
=========================================================
|    1.36 |    1.34 |     0.02 |    202 |  583 |  27MB |
=========================================================
```

4. To generate an active HTML report, pass the name of the operation to `DBMS_SQL_MONITOR.REPORT_SQL_MONITOR`:

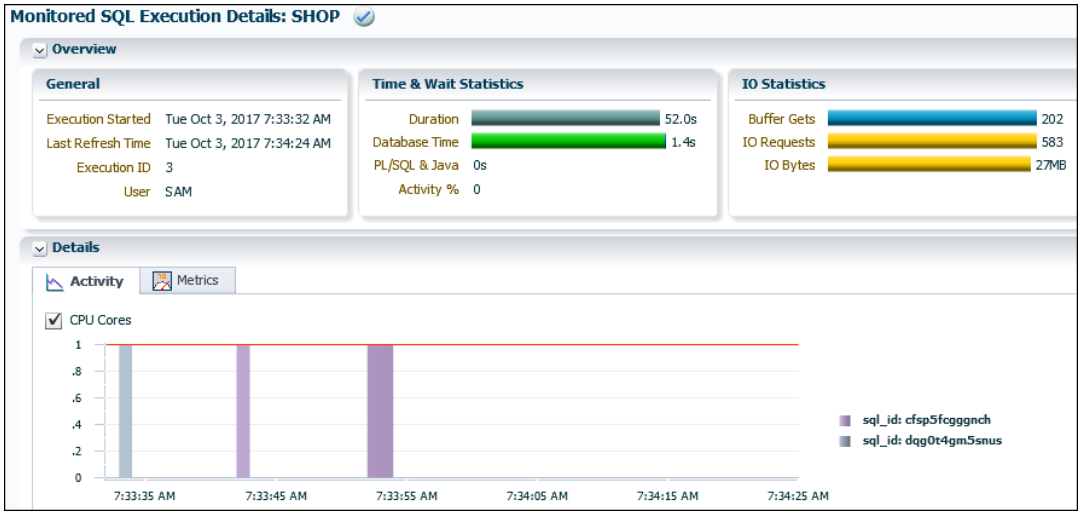
```
SET TRIMSPOOL ON
SET TRIM ON
SET PAGES 0
SET LINESIZE 1000
SET LONG 1000000
SET LONGCHUNKSIZE 1000000

SPOOL /tmp/shop.htm
SELECT
DBMS_SQL_MONITOR.REPORT_SQL_MONITOR(dbop_name=>'SHOP',report_level=>'ALL',T
```

```
YPE=>'active')
FROM   DUAL;
SPOOL OFF
```

The following graphic shows the active report:

Figure 22-3 SQL Monitor Report



See Also:

Oracle Database PL/SQL Packages and Types Reference to learn more about `DBMS_SQL_MONITOR`

Real-Time SQL Monitoring Across Multiple PDBs

The SQL Monitor can perform real-time monitoring independently across multiple PDB containers.

With Real-Time SQL Monitoring, containers do not need to obtain exclusive access to the CDB SGA in order to allocate, query or manage SQL Monitoring resources across the entire database instance. Processes in different containers can allocate, query and manage these resources concurrently and independently of each other. SQL statements, PL/SQL procedures and functions, and DBOPs (Database Operations) can be monitored independently across PDBs.

Real-Time SQL Monitoring can query and manage resources at both the PDB and CDB levels. You can query reports across ad-hoc time ranges, DBIDs (internal database identifiers) and CON_DBIDs (CDB identifiers). It manages the memory allocation for SQL Monitoring workload in each container within that container's PDB SGA. This enables the DBA to track and control memory resources at the container level.

When Real-Time SQL Monitoring is enabled on a PDB, the PDB's SQL Monitoring reports are saved to PDB dictionary tables on the CBD. This enables reports to be managed at the container level. It also means that when a CBD is migrated, its SQL Monitoring history can move with it.

SQL Monitor in-memory dictionary tables are now registered with the Automatic Workload Repository (AWR) Framework. This framework enables transfer and sharing of SQL Monitoring reports across containers and databases and with various other Oracle Database services. The AWR Framework also takes care of purging imported snapshots in PDB containers and SQL Monitor reports at both the PDB and CBD level.

Enabling or Disabling Real-Time SQL Monitoring on PDBs

To include a PDB in Real-time SQL Monitoring, set the value of AWR Export on the database.

Real-Time SQL Monitoring Across PDBs is disabled by default. To use this feature, you must enable it on each PDB that you want to monitor.

You can enable or disable it on each PDB by locally calling the `DBMS_WORKLOAD_REPOSITORY` subprogram `MODIFY_AWREXP_SETTINGS`.

> **See Also:**
>
> *PL/SQL Packages and Types Reference* describes `DBMS_WORKLOAD_REPOSITORY` and all subprograms.

You can also use the procedure `MODIFY_AWREXP_SETTINGS` on each PDB to enable or disable this feature on each PDB:

```
PROCEDURE modify_awrexp_settings(dbid IN NUMBER DEFAULT NULL, sqlmon_option
IN VARCHAR2 DEFAULT 'NO');
```

Specify whether to export SQL Monitor data. If you do not want to export SQL Monitor data, enter **NO** or press **Enter** to continue. Enter **YES** to export SQL Monitor data.

Querying Real-Time SQL Monitor Dictionary Tables and Imported Snapshots

Use the PL/SQL interface `DBMS_AUTO_REPORT` to gather information about SQL Monitor reports for a PDB, and also to manually refresh SQL Monitor content within the CDB.

`DBMS_AUTO_REPORT.REPORT_REPOSITORY_LIST_XML`

Generates an XML list of all reports from the repository that match the input criteria.

If the dbid and con_dbid parameters are not specified, the list report is generated for the container connected in this session.

`DBMS_AUTO_REPORT.REPORT_REPOSITORY_DETAIL_XML`

Retrieves the stored XML report whose report_id is passed as an input. This report can belong to any of the components registered with the report capture framework.

If dbid and con_dbid are not specified, the list report is generated for the container connected in this session.

`DBMS_AUTO_REPORT.REPORT_REPOSITORY_DETAIL`

Retrieves the stored report whose report_id is passed as an input. This report can belong to any of the components registered with the report capture framework.

If dbid and con_dbid are not specified, the list report is generated for the container connected in this session.

```
DBMS_ADBTASK_ADMIN.RUN_TASK_MANUAL('SQL MONITOR STAGE')
```

Runs a custom Autotask++ action to refresh SQL Monitor content within the connected container.

> **See Also:**
>
> The *PL/SQL Types and Packaging Reference* for more information about these APIs.

Views for Examining Real-Time SQL Monitoring

Views for examining Real-Time SQL Monitoring are available through the AWR Framework.

The following AWR ROOT, CDB, and PDB-level views are provided.

- `AWR_ROOT_REPORTS`
- `AWR_ROOT_REPORTS_DETAILS`
- `AWR_ROOT_REPORTS_TIMEBANDS`
- `AWR_CDB_REPORTS`
- `AWR_CDB_REPORTS_DETAILS`
- `AWR_CDB_REPORTS_TIMEBANDS`
- `AWR_PDB_REPORTS`
- `AWR_PDB_REPORTS_DETAILS`
- `AWR_PDB_REPORTS_TIMEBANDS`

> **See Also:**
>
> *The Oracle® Database Workspace Manager Developer's Guide* for more information about these functions.

Reporting Tools for Real-Time SQL Monitoring

The following APIs are available for generating reports about Real-Time SQL Monitoring

```
DBMS_AUTO_REPORT.REPORT_REPOSITORY_LIST_XML
```

This function generates an XML list report containing a list of all reports from the repository that match the input criteria.

If the `dbid` and `con_dbid` parameters are not specified, the list report is generated for the container connected to this session.

```
DBMS_AUTO_REPORT.REPORT_REPOSITORY_DETAIL_XML
```

This function retrieves the stored XML report whose `report_id` is passed as an input. The report can be on any of the components registered with the report capture framework.

If the `dbid`and `con_dbid` parameters are not specified, the list report will be generated for the container connected to this session.

`DBMS_AUTO_REPORT.REPORT_REPOSITORY_DETAIL`

This function retrieves the stored report whose `report_id` is passed as an input. This report can be on any of the components registered with the report capture framework.

If the `dbid` and `con_dbid` parameters are not specified, the list report is generated for the container connected to this session.

`DBMS_ADBTASK_ADMIN.RUN_TASK_MANUAL('SQL MONITOR STAGE')`

This function refreshes the SQL Monitor content within the connected container.

> **See Also:**
>
> See DBMS_AUTO_REPORT in the *Database PL/SQL Packages and Types Reference* for full descriptions, including parameters for these reports.

See

SQL History Monitoring and Reporting

As of Oracle Database 23ai, the database tracks and can report details on the history of queries in your current session.

History can be collected for all user-initiated queries. This includes non-parallel queries with less than five seconds execution time, which are not tracked in the Real-Time SQL Monitor unless tracking is forced by a hint or event. Each user can access and report on their own current session history. SYS users and DBAs can view and get query history reports for all current user sessions and can also turn this functionality on or off. Reporting is configurable, with options for selecting the reporting scope and detail level.

Only the top-level SQL issued by a database user are tracked and recorded in the history. Internal and recursive statements are excluded.

Real-Time SQL History Monitoring

When enabled, query history monitoring records the history for all user-issued SQLs (queries, DMLs, DDLs) in each user session, excluding background and recursive SQL. By default, the number of SQL statements recorded in SQL History per session is 50.

SQL History Reporting

APIs are provided to generate list and detail reports for query history per session.

Enabling and Viewing SQL History Monitoring and Reporting

When Real-Time SQL History Monitoring is enabled for viewing, a comprehensive view of query history is available.

SQL_HISTORY_ENABLED

The `SQL_HISTORY_ENABLED` initialization parameter can be set to `TRUE` or `FALSE` to enable or disable SQL history monitoring and reporting. This feature is disabled by default.

V$SQL_HISTORY

You can examine the monitored information via the V$SQL_HISTORY view.

> **See Also:**
>
> The *Oracle Database Reference* describes the SQL_HISTORY initialization parameter and the V$SQL_HISTORY view.

DBMS_SQLTUNE APIs for Query History and Reporting

The DBMS_SQLTUNE package includes APIs for retrieving query history data.

DBMS_SQLTUNE.REPORT_SQL_HISTORY_LIST

This API generates a query history list report for all executions in the given user session, or across sessions for a privileged user (one who has SYS user or DBA privileges).

DBMS_SQLTUNE.REPORT_SQL_HISTORY

This API generates a query history details report for a given execution. The detail level is configurarable. The user must have the required viewing privileges.

> **See Also:**
>
> See the DBMS_SQLTUNE chapter of the *Database PL/SQL Packages and Types Reference* for information about DBMS_SQLTUNE.REPORT_SQL_HISTORY_LIST and DBMS_SQLTUNE.REPORT_SQL_HISTORY.