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Oracle Database 11g 中 SPA 的应用

Botang 唐波

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ORACLE
Certified Master
Oracle Database 10g
Administrator

ACOUG
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MEMBER

SH'OUG
SHANGHAI ORACLE USERS GROUP
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福建省第一批 Oracle ERP 实施顾问。精通 Oracle 财务系统的 11i Financial Functional Fundation 、 9i Oracle Discoverer 、 Oracle 11i System Administrator Fundamentals 高端产品的实施配置。 2004 年 4 月到 2006 年 12 月在北京担任中国科学院 ARP 项目组数据仓库架构师，数据中心核心团队成员。参与完成该项目中的数据仓库设计、数据仓库建模、维度和立方开发、 ETL stream 过程，建立完善的数据仓库前台展示系统，利用 Oracle AS 应用服务器结合 Discoverer 进行前台展示。最终被中国科学院办公厅和中国科学院 ARP 项目管理办公室评为最佳技术实施顾问。

现任职于中国科学院某单位。被聘为高级工程师。目前一方面继续负责 Oracle ERP 大型分布式系统及其附属 RedFlag Linux 的运行维护；另一方面负责一套 30 万亿次运行 RedHat 的科学计算超级集群的运行维护。 8 小时外兼职 Redhat RHCI 和 Oracle WDP 讲师，福建省 RHCE/OCP/OCM 培训学员数量最多的讲师。

DBA 执行更改时面临的挑战

- 通过更改硬件或软件配置维护服务级别协议
- 提供用于测试的生产级别的工作量环境
- 有效预测和分析对 SQL 性能的影响

计划永远追不上变化

- 变化是导致不稳定的最常见原因。

- 企业生产系统很复杂。
- 实际工作量难以模拟。

- 在生产之前进行与实际情况相符的测试是不可能的。

可能！

- 抵制变化。
- 无法采纳有竞争力的新技术。

在变化中保持秩序。

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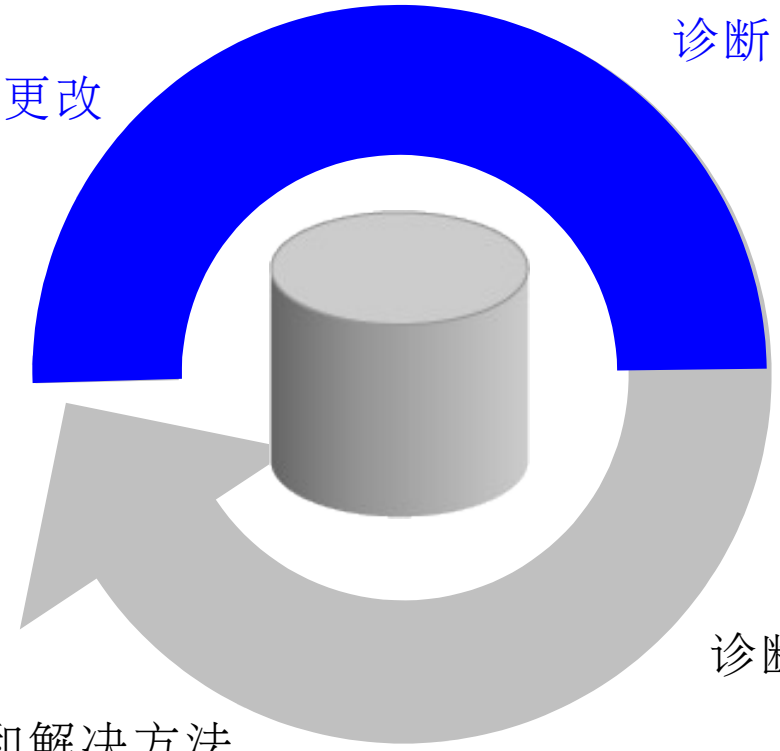
更改管理的生命周期

测试（数据库重放或 **SQL** 性能分析器）



诊断问题和解决问题（指导）

进行更改

设置测试环境
（快照备用）

生产预配

诊断问题

补丁程序和解决方法

实际测试

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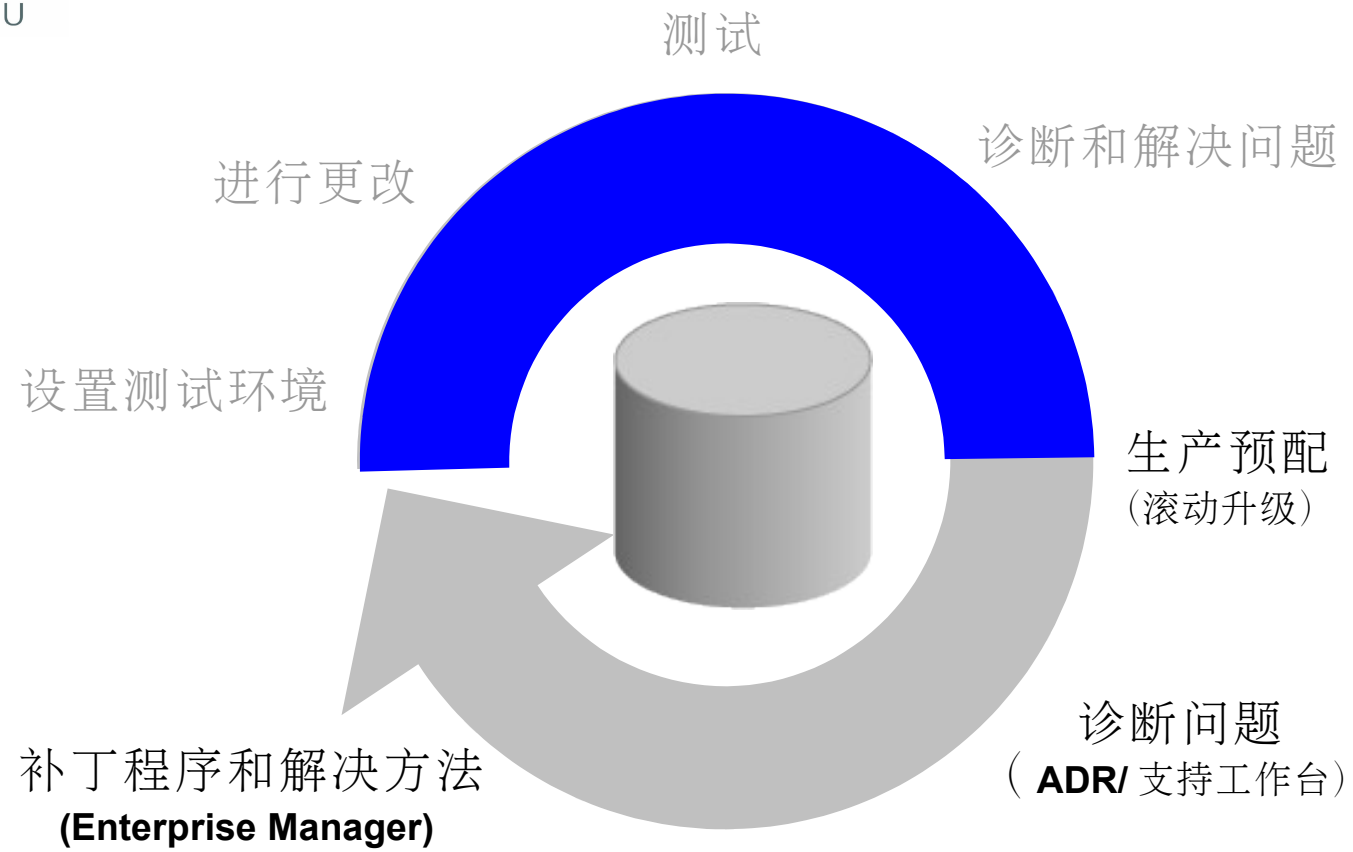
更改管理的生命周期



预配自动化

SQL 性能分析器

- 确定使用 **SQL** 性能分析器的优点
- 描述 **SQL** 性能分析器工作流阶段
- 使用 **SQL** 性能分析器确定数据库更改所带来的性能改进

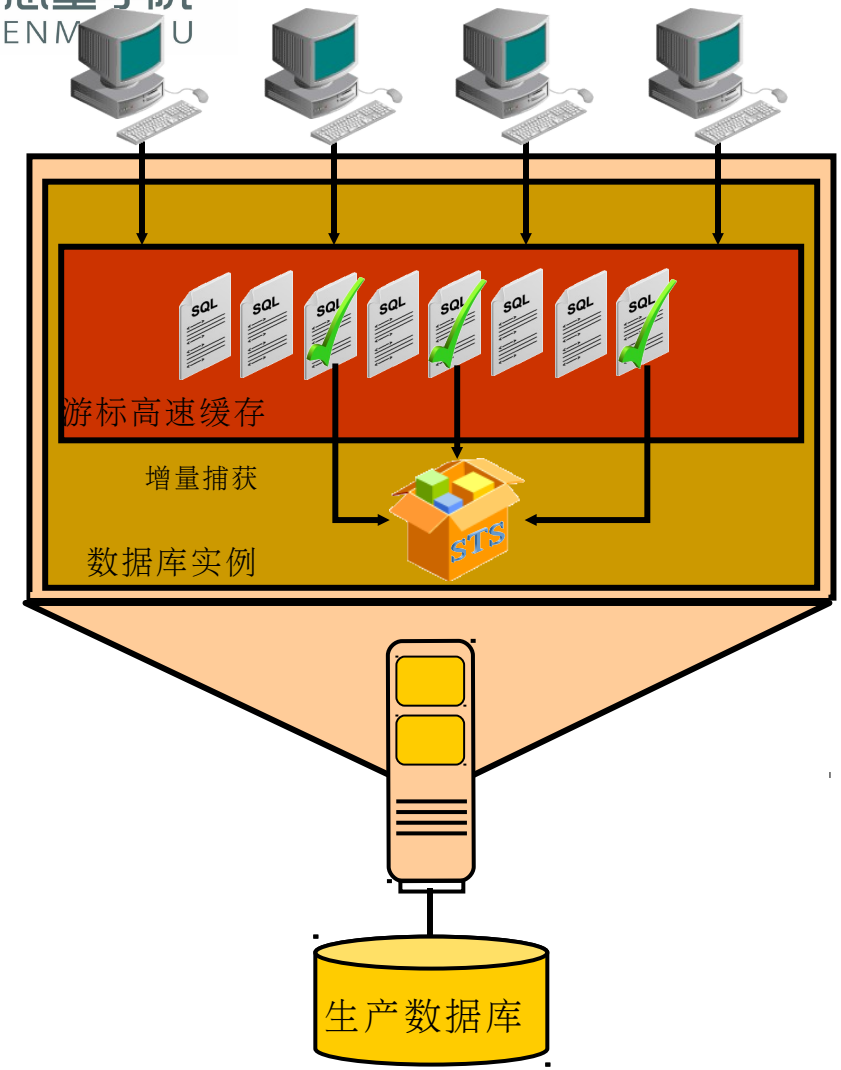
SQL 性能分析器：概览

- 11g 的新增功能
- 目标用户： DBA 、 QA 、应用程序开发人员
- 帮助预测系统更改对 SQL 工作量响应时间的影响
- 建立不同版本的 SQL 工作量性能（即 SQL 执行计划和执行统计信息）
- 以串行方式执行 SQL （不考虑并发性）
- 分析性能差异
- 提供对单个 SQL 的细粒度性能分析
- 与 SQL 优化指导集成在一起以优化回归

SQL 性能分析器：使用情形

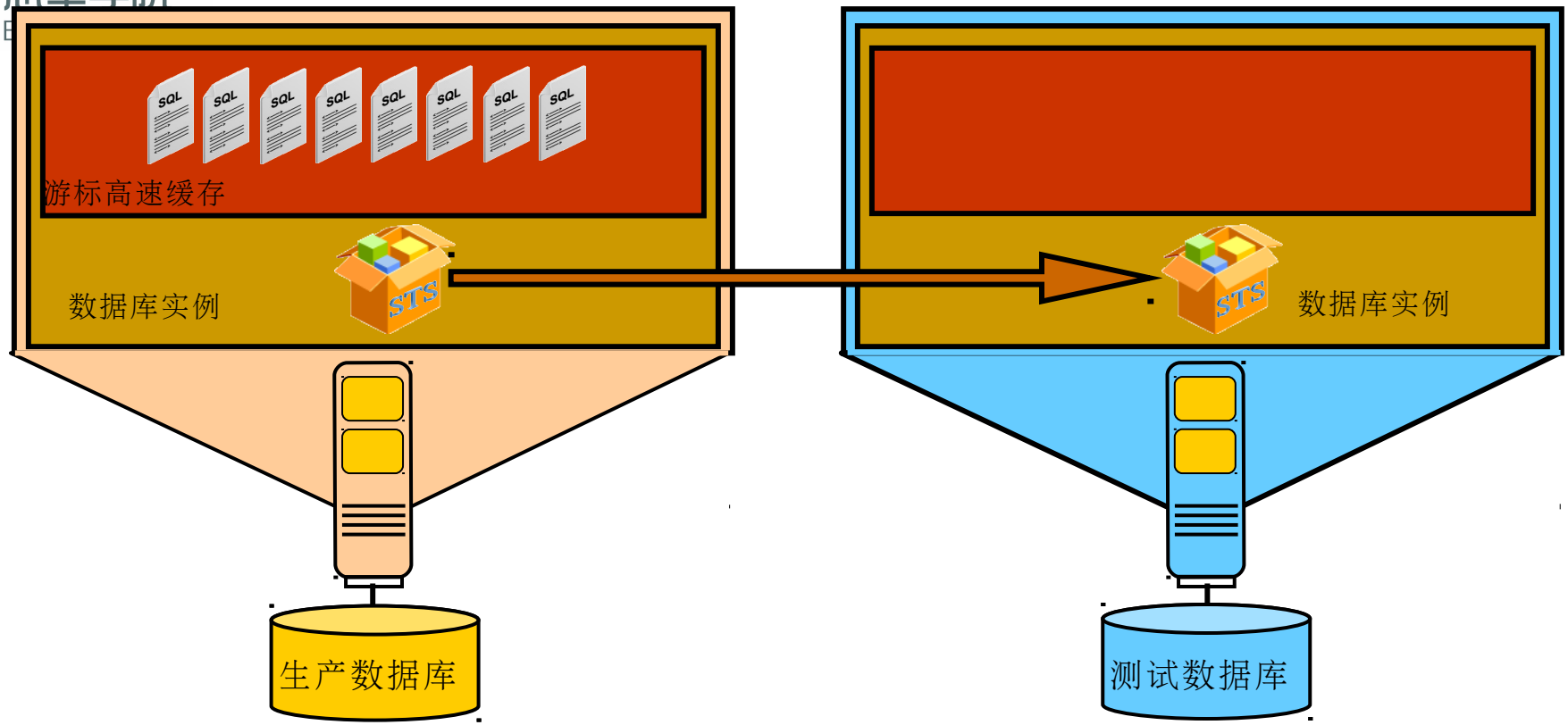
- 在以下情形中使用 SQL 性能分析器很有益：
  - 数据库升级
  - 实施优化建议
  - 更改方案
  - 收集统计信息
  - 更改数据库参数
  - 更改操作系统和硬件

使用模型：捕获 SQL 工作量



- SQL 优化集 (STS) 用于存储 SQL 工作量。包括:
  - SQL 文本
  - 绑定变量
  - 执行计划
  - 执行统计信息
- 增量捕获用于填充某个时间段内来自
  游标高速缓存的 STS 。
- STS 的过滤和排名功能可过滤掉不需
  要的 SQL 。

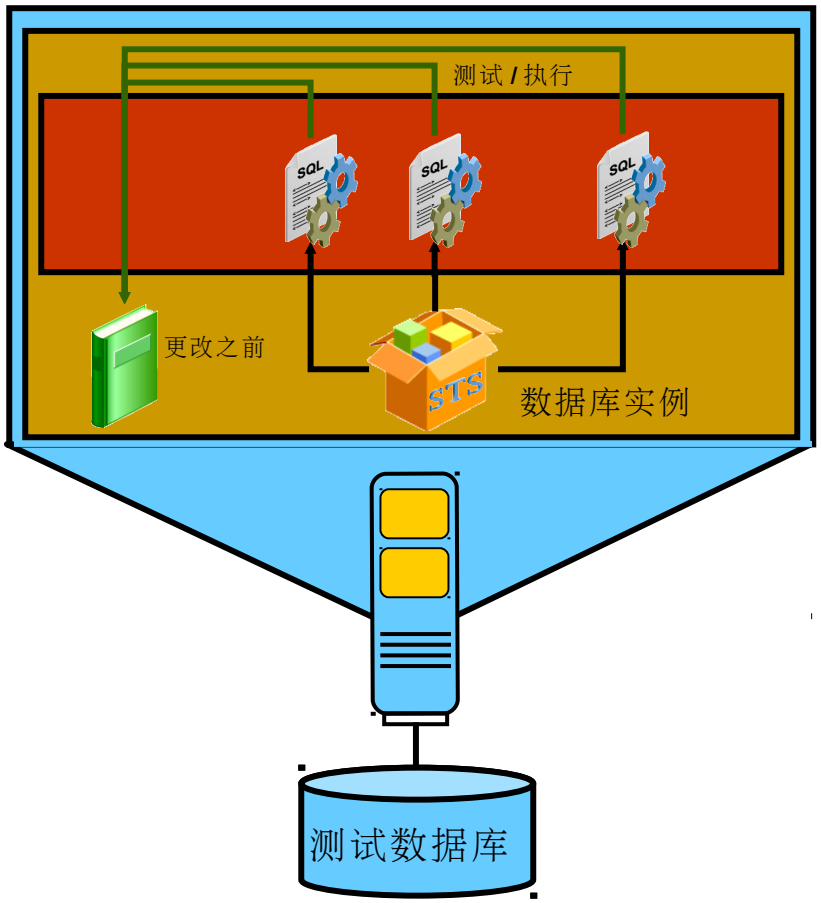
使用模型：传输到测试系统



- 将 SQL 优化集复制到登台表（“打包”）。
- 将登台表传送到测试系统（数据泵、DB 链接等）。
- 从登台表中复制 SQL 优化集（“解包”）。

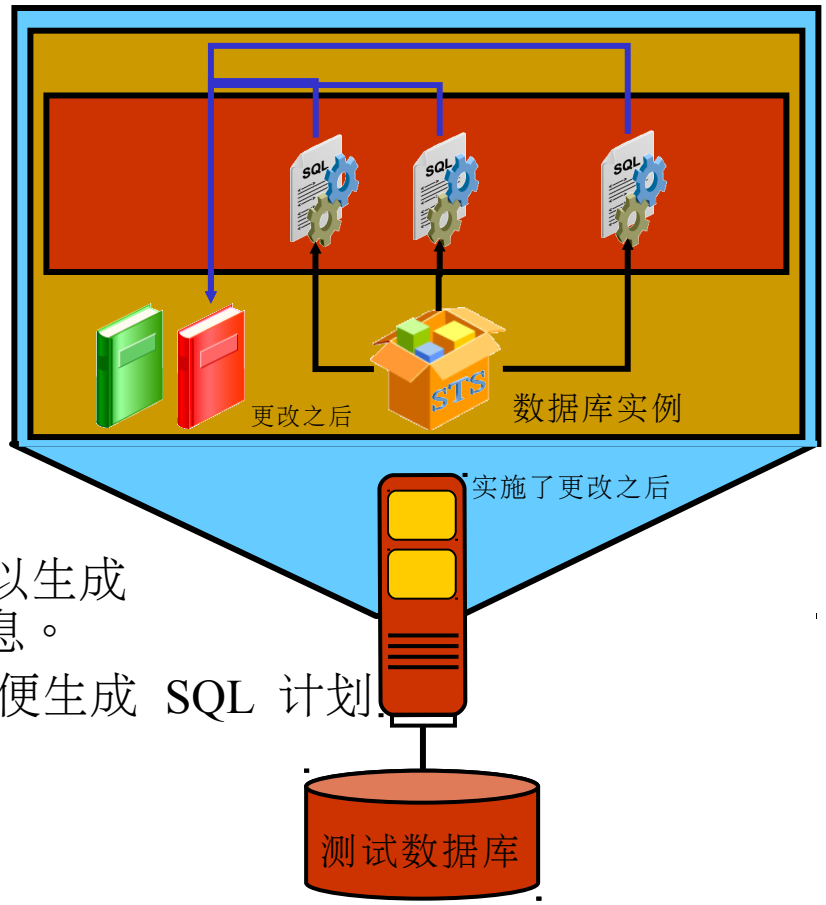
使用模型：在更改性能前建立

- 在更改之前， SQL 性能版本是 SQL 工作量性能基线。
- SQL 性能 = 执行计划 + 执行统计信息
- 测试 / 执行 STS 中的 SQL：
  - 生成执行计划和统计信息。
  - 以串行方式执行 SQL （无并行操作）。
  - 每个 SQL 只执行一次。
  - 跳过 DDL/DML 结果。
- 解释 STS 中的计划 SQL 以便仅生成 SQL 计划。



使用模型：在更改性能后建立

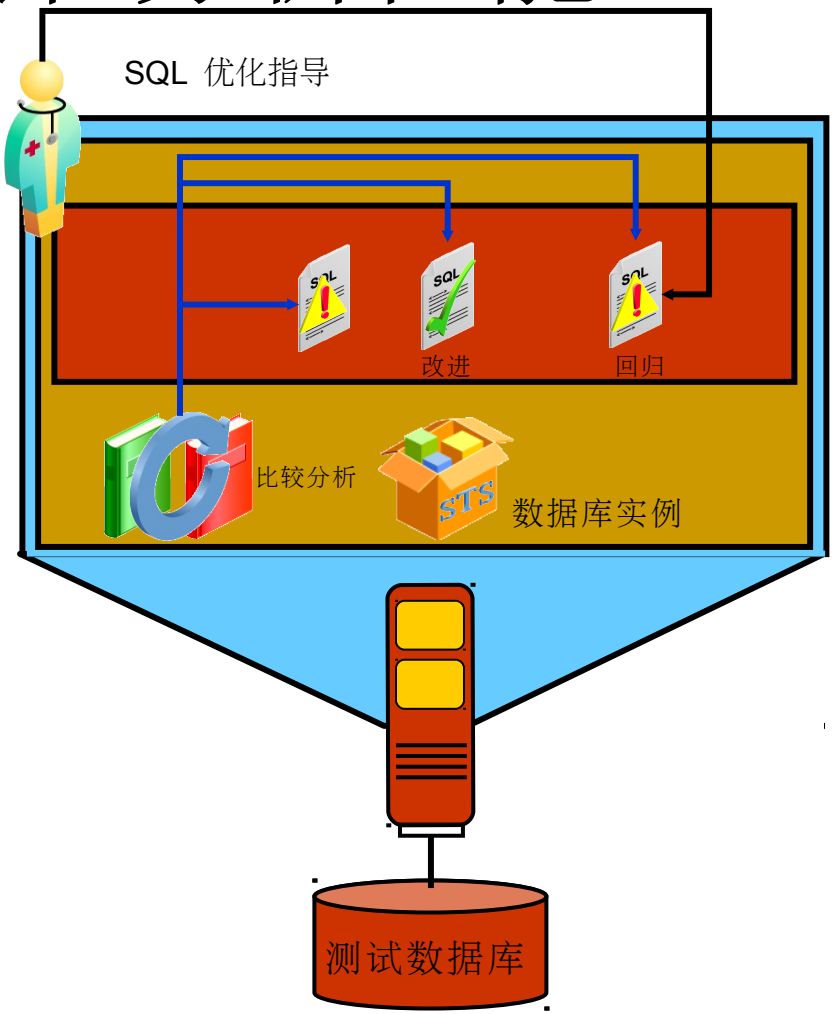
- 手动实施计划的更改：
  - 数据库升级
  - 实施优化建议
  - 更改方案
  - 收集统计信息
  - 更改数据库参数
  - 更改操作系统和硬件
- 在更改后重新执行 SQL：
  - 测试 / 执行 STS 中的 SQL 以生成 SQL 执行计划和执行统计信息。
  - 解释 STS 中的计划 SQL 以便生成 SQL 计划。



使用模型：比较和分析性能

- 依据用户指定的度量比较 SQL 性能：
  - elapsed_time, buffer_gets, disk_reads, ...
- 计算更改对单个 SQL 和 SQL 工作量的影响：
  - 对工作量的整体影响
  - 对工作量的纯 SQL 影响
- 使用 SQL 执行频率定义重要性权重。
- 检测改进、回归和未发生更改的性能。

- 检测执行计划中的更改。
- 建议运行 SQL 优化指导来优化回归 SQL 。
- 分析结果可用于植入 SQL 计划管理基线。



SQL 性能分析器：概要

1. 捕获 SQL 生产工作量。
2. 将 SQL 工作量传送至测试系统。
3. 建立“更改前”性能数据。
4. 进行更改。
5. 建立“更改后”性能数据。
6. 比较步骤 3 和步骤 5 的结果。
7. 优化回归的 SQL 。

SPA 中的 DML 处理方式

- 默认情况下 SPA 若涉及到 DML 语句则只有查询部分 Query 会被执行，但是貌似是从 11.2 开始可以执行完全的 DML 了，需要加入参数 EXECUTE_FULLDML, 但是该参数目前有一些 BUG:
- Bug 10428438 : WITH EXECUTE_FULLDML ROWS IS ALWAYS SET TO 0 11.2.0.1
- Bug 14635522 : SPA SHOULD CAPTURE AND REPLAY TRANSACTIONS 11.2.0.3

- By default, only the query portion of DMLs is executed. Using APIs, you can execute the full
- DML by using the EXECUTE_FULLDML task parameter.EXECUTE_FULLDML when set to
- TRUE executes DML statement fully, including acquiring row locks and modifying rows;
- When EXECUTE_FULLDML is set to FALSE (the default value is false) to execute only the
- query part of the DML without modifying data. When TRUE, SQL Performance Analyzer will
- issue a rollback following DML execution to prevent persistent changes from being made by the DML. So SPA does not make any change to the data in the tables.

- 执行方法如下：
  - execute DBMS_SQLPA.SET_ANALYSIS_TASK_PARAMETER(task_name => 'TASK_21137', -parameter => 'EXECUTE_FULLDML', value=> 'TRUE');

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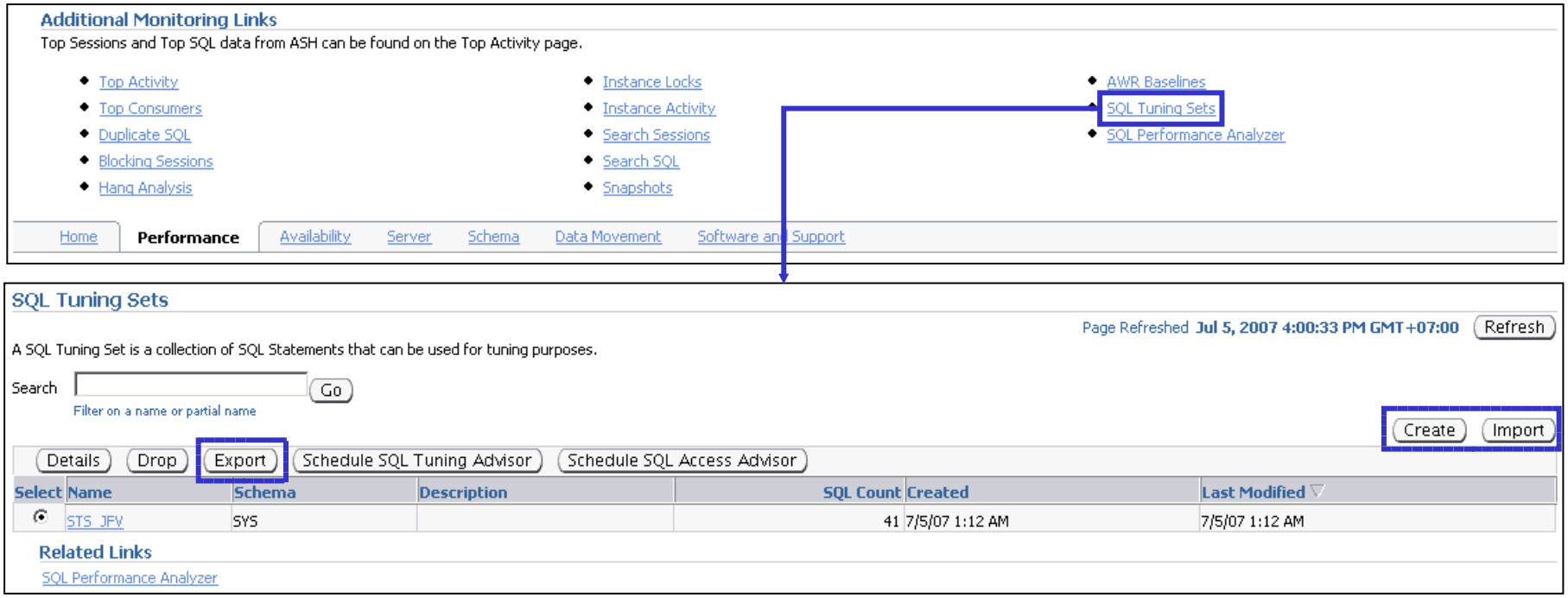
捕获 SQL 工作量

1. 在原始系统上创建 SQL 优化集 (STS)。
2. 创建登台表，并在登台表中上载 STS 。
3. 将登台表导出到测试系统。
4. 将登台表解包到测试系统上的 STS 。



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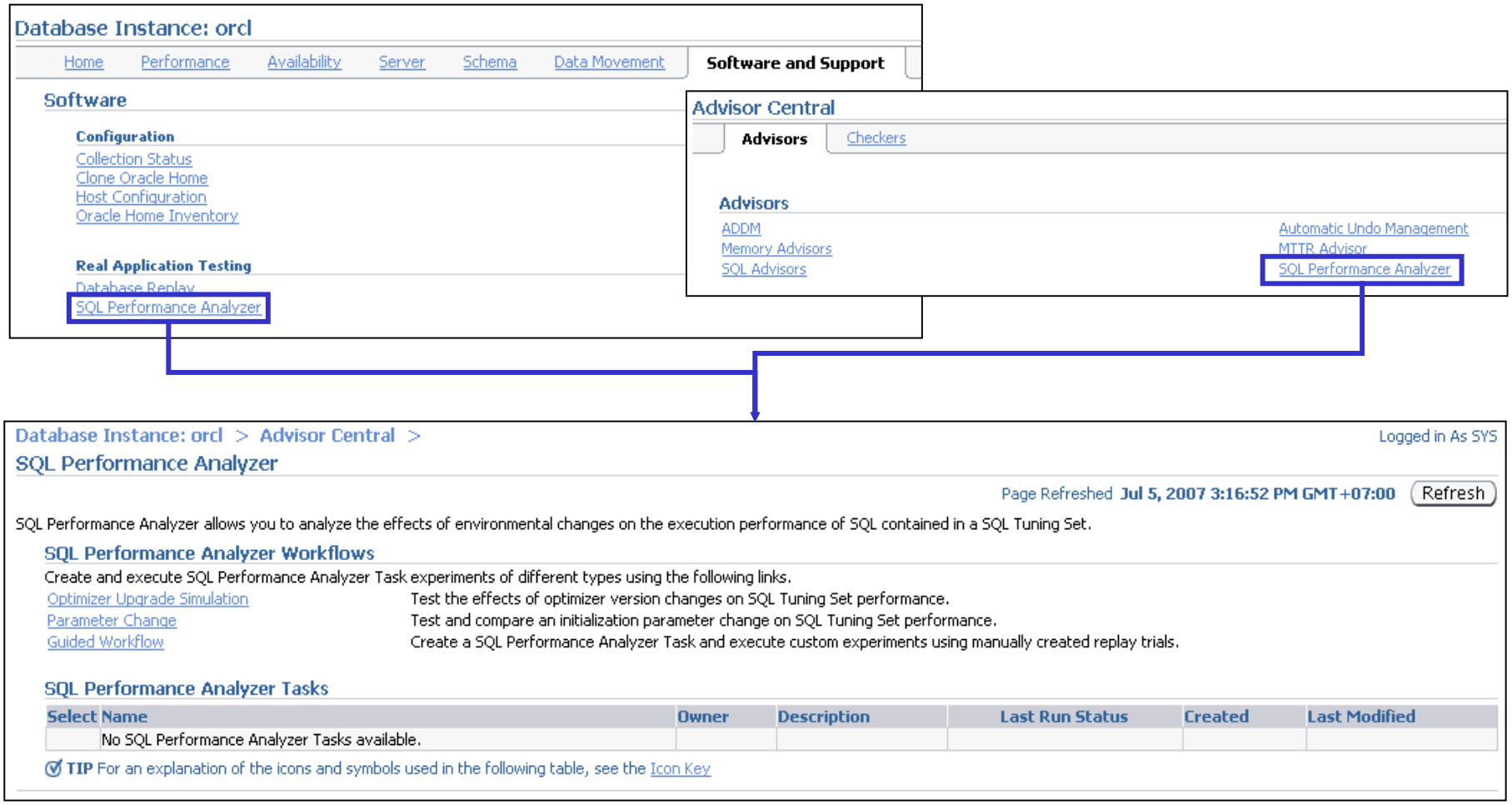
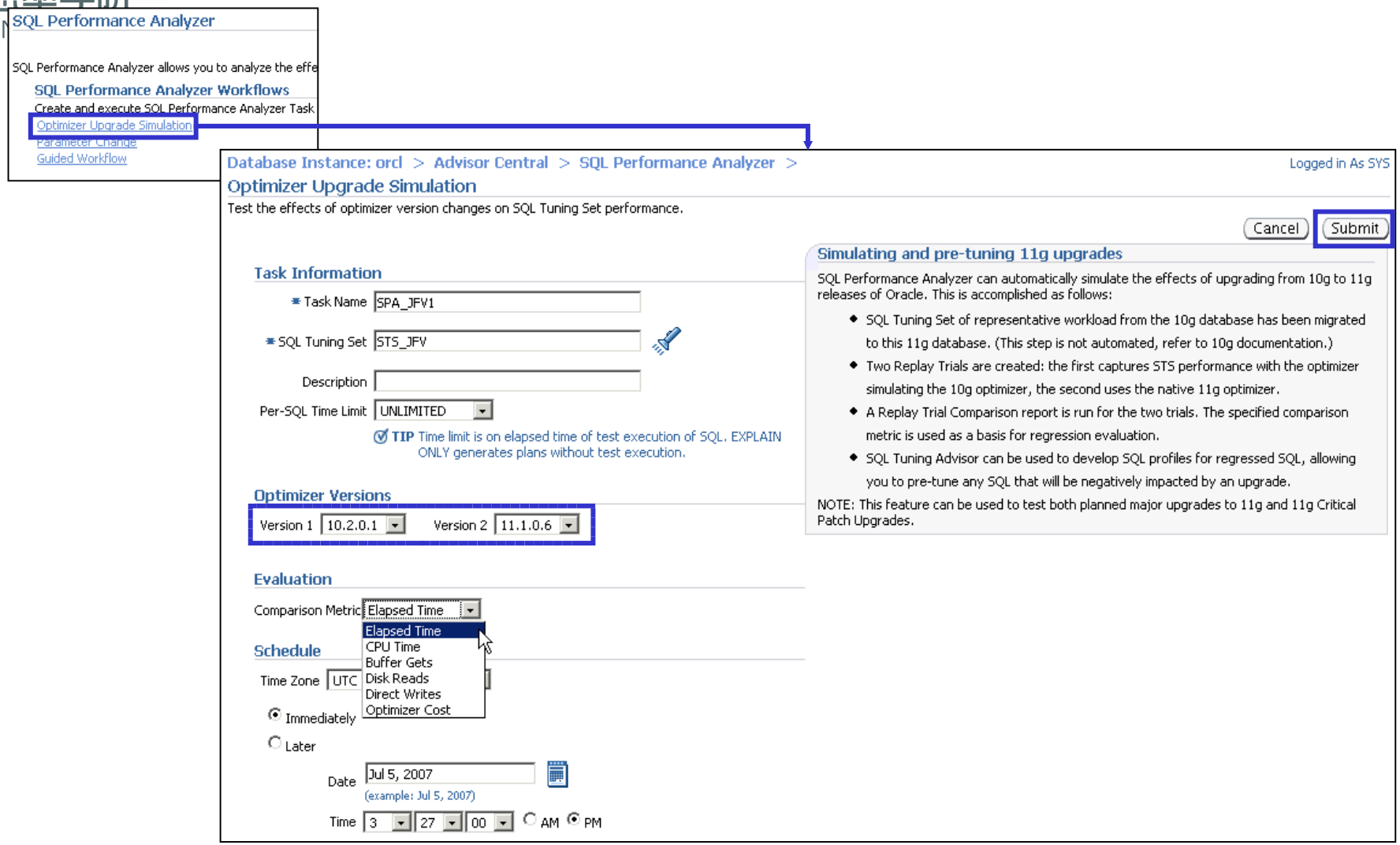
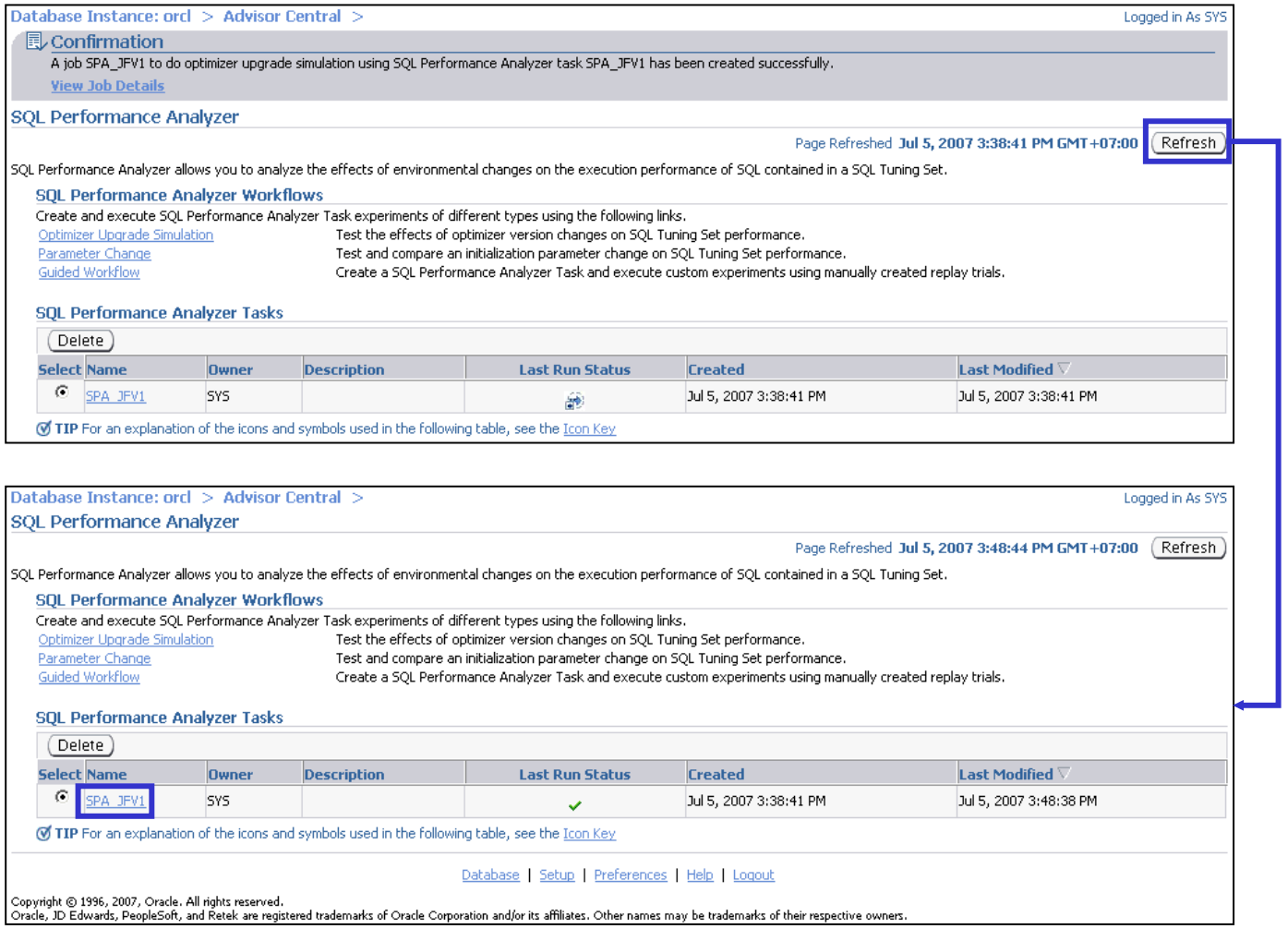
创建 SQL 性能分析器任务



优化程序升级模拟


SQL Performance Analyzer
SQL Performance Analyzer allows you to analyze the effe
SQL Performance Analyzer Workflows
Create and execute SQL Performance Analyzer Task
Optimizer Upgrade Simulation
Parameter Change
Guided Workflow
Database Instance: orcl > Advisor Central > SQL Performance Analyzer >
Logged in As SYS
Optimizer Upgrade Simulation
Test the effects of optimizer version changes on SQL Tuning Set performance.
Cancel
Submit
Task Information
Task Name SPA_JFV1
SQL Tuning Set STS_JFV
Description
Per-SQL Time Limit UNLIMITED
TIP Time limit is on elapsed time of test execution of SQL. EXPLAIN ONLY generates plans without test execution.
Optimizer Versions
Version 1 10.2.0.1
Version 2 11.1.0.6
Evaluation
Comparison Metric Elapsed Time
Elapsed Time
CPU Time
Buffer Gets
Disk Reads
Direct Writes
Optimizer Cost
Schedule
Time Zone UTC
Immediately
Later
Date Jul 5, 2007
(example: Jul 5, 2007)
Time 3 27 00 AM PM
Simulating and pre-tuning 11g upgrades
SQL Performance Analyzer can automatically simulate the effects of upgrading from 10g to 11g releases of Oracle. This is accomplished as follows:
SQL Tuning Set of representative workload from the 10g database has been migrated to this 11g database. (This step is not automated, refer to 10g documentation.)
Two Replay Trials are created: the first captures STS performance with the optimizer simulating the 10g optimizer, the second uses the native 11g optimizer.
A Replay Trial Comparison report is run for the two trials. The specified comparison metric is used as a basis for regression evaluation.
SQL Tuning Advisor can be used to develop SQL profiles for regressed SQL, allowing you to pre-tune any SQL that will be negatively impacted by an upgrade.
NOTE: This feature can be used to test both planned major upgrades to 11g and 11g Critical Patch Upgrades.

SQL 性能分析器：任务


Database Instance: orcl > Advisor Central >
Logged in As SYS
Confirmation
A job SPA_JFV1 to do optimizer upgrade simulation using SQL Performance Analyzer task SPA_JFV1 has been created successfully.
View Job Details
SQL Performance Analyzer
Page Refreshed Jul 5, 2007 3:38:41 PM GMT+07:00
Refresh
SQL Performance Analyzer allows you to analyze the effects of environmental changes on the execution performance of SQL contained in a SQL Tuning Set.
SQL Performance Analyzer Workflows
Create and execute SQL Performance Analyzer Task experiments of different types using the following links.
Optimizer Upgrade Simulation
Test the effects of optimizer version changes on SQL Tuning Set performance.
Parameter Change
Test and compare an initialization parameter change on SQL Tuning Set performance.
Guided Workflow
Create a SQL Performance Analyzer Task and execute custom experiments using manually created replay trials.
SQL Performance Analyzer Tasks
Delete
Select
Name
Owner
Description
Last Run Status
Created
Last Modified
SPA_JFV1
SYS
Jul 5, 2007 3:38:41 PM
Jul 5, 2007 3:38:41 PM
TIP For an explanation of the icons and symbols used in the following table, see the Icon Key
Database Instance: orcl > Advisor Central >
Logged in As SYS
SQL Performance Analyzer
Page Refreshed Jul 5, 2007 3:48:44 PM GMT+07:00
Refresh
SQL Performance Analyzer allows you to analyze the effects of environmental changes on the execution performance of SQL contained in a SQL Tuning Set.
SQL Performance Analyzer Workflows
Create and execute SQL Performance Analyzer Task experiments of different types using the following links.
Optimizer Upgrade Simulation
Test the effects of optimizer version changes on SQL Tuning Set performance.
Parameter Change
Test and compare an initialization parameter change on SQL Tuning Set performance.
Guided Workflow
Create a SQL Performance Analyzer Task and execute custom experiments using manually created replay trials.
SQL Performance Analyzer Tasks
Delete
Select
Name
Owner
Description
Last Run Status
Created
Last Modified
SPA_JFV1
SYS
Jul 5, 2007 3:38:41 PM
Jul 5, 2007 3:48:38 PM
TIP For an explanation of the icons and symbols used in the following table, see the Icon Key
Database | Setup | Preferences | Help | Logout
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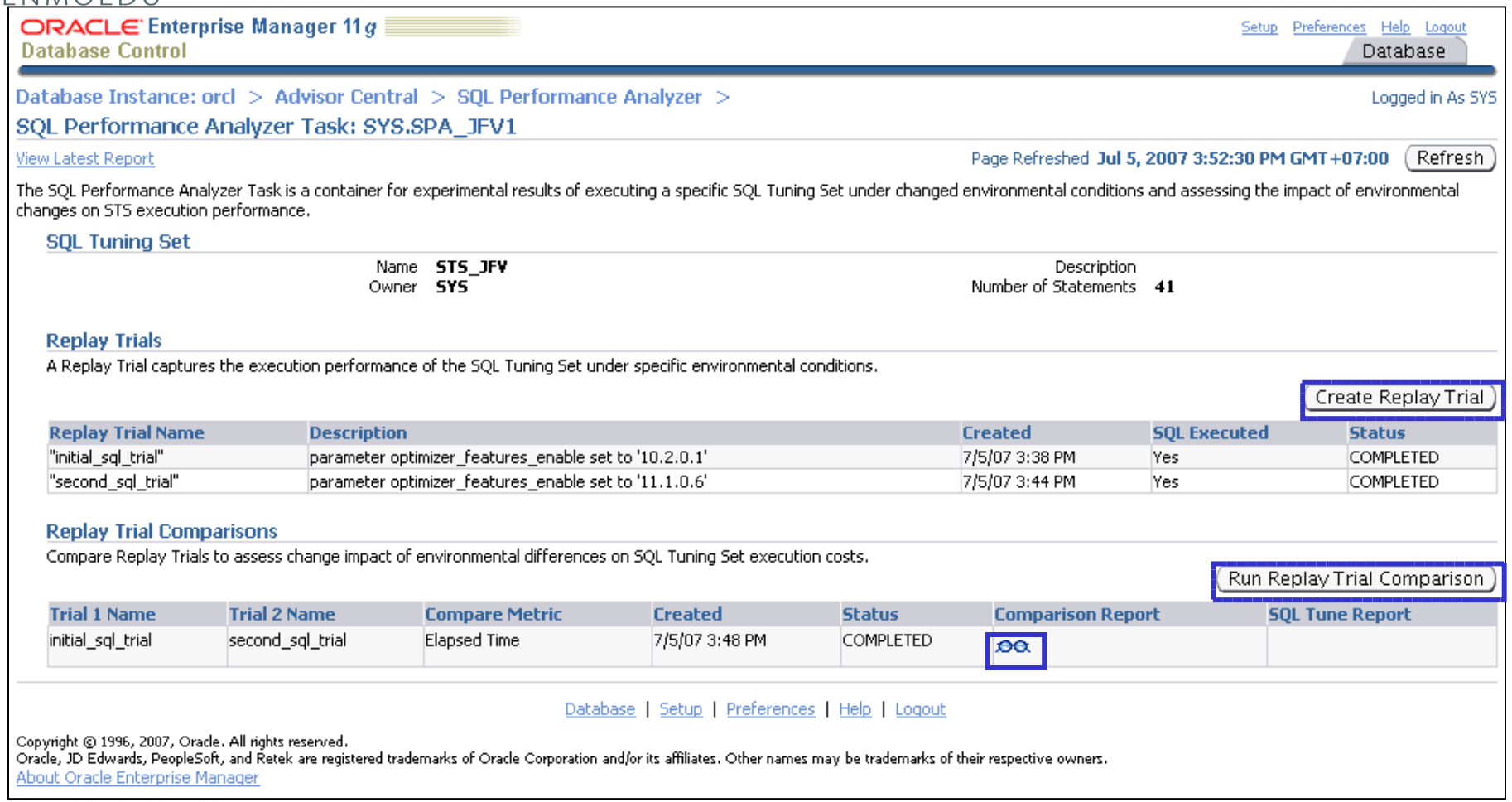
SQL 性能分析器任务页



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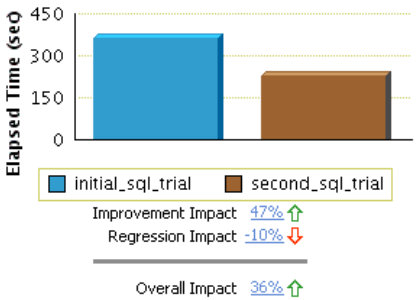
比较报表

SQL Performance Analyzer Task Result: SYS.SPA_JFV1

Task Name	**SPA_JFV1**	SQL Tuning Set Name	STS_JFV	Replay Trial 1	**initial_sql_trial**
Task Owner	**SYS**	STS Owner	**SYS**	Replay Trial 2	**second_sql_trial**
Task Description		Total SQL Statements	**41**	Comparison Metric	**Elapsed Time**
		SQL Statements With Errors	0		

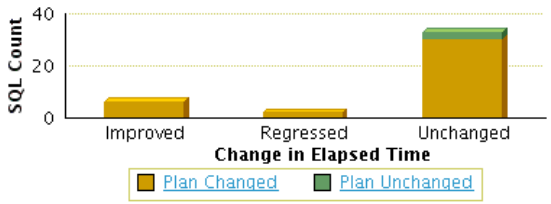
Global Statistics

Projected Workload Elapsed Time



Improvement Impact 47%
Regression Impact -10%
Overall Impact 36%

SQL Statement Count



Recommendations

Oracle offers two options to fix regressed SQL resulting from plan changes:

Use the better execution plan from SQL Trial 1 by creating SQL Plan Baselines.

Create SQL Plan Baselines

Explore alternate execution plans using SQL Tuning Advisor.

Run SQL Tuning Advisor

Top 10 SQL Statements Based on Impact on Workload

	SQL ID	Net Impact on Workload (%)	Elapsed Time		Net Impact on SQL (%)	% of Workload		Plan Changed
			initial_sql_trial	second_sql_trial		initial_sql_trial	second_sql_trial	
⇧	a1mcnqaa6q04d	8.320	31.413	1.135	96.390	8.630	0.490	Y
⇧	dx1c9zbr6w8h6	7.960	29.096	0.151	99.480	8.000	0.070	Y
⇧	qfw9mbv2h44ns	7.950	29.127	0.196	99.330	8.010	0.090	Y
⇧	21t61c8b39njg	7.930	29.009	0.161	99.440	7.970	0.070	Y
⇧	94jmd58x6ch6d	7.910	29.066	0.297	98.980	7.990	0.130	Y
⇧	2pq3srqh3qasz	6.470	23.708	0.168	99.290	6.520	0.070	Y
⇩	4nvxdshm1usna	-6.090	44.303	66.475	-50.050	12.180	28.890	Y
⇩	q4dzf4ak4rus2	-4.370	90.545	106.461	-17.580	24.890	46.270	Y
⇧	2kfsh5m3vk2dn	0.210	1.044	0.278	73.370	0.290	0.120	Y
⇧	dqpfj2a3vf83s	0.210	0.976	0.222	77.250	0.270	0.100	Y

比较报表

SQL Performance Analyzer Task Result: SYS.SPA_JFV1

Task Name	**SPA_JFV1**	SQL Tuning Set Name	STS_JFV	Replay Trial 1	**initial_sql_trial**
Task Owner	**SYS**	STS Owner	**SYS**	Replay Trial 2	**second_sql_trial**
Task Description		Total SQL Statements	**41**	Comparison Metric	**Elapsed Time**
		SQL Statements With Errors	0		

SQL Details: 4nvxdshm1usna

Parsing Schema **APPS** Execution Frequency **1** Schedule SQL Tuning Advisor

SQL Text

Single Execution Statistics

	Execution Statistic Name	Net Impact on Workload (%)	Execution Statistic Collected		Net Impact on SQL (%)	% of Workload	
			initial_sql_trial	second_sql_trial		initial_sql_trial	second_sql_trial
↓	Elapsed Time	-6.090	44.303	66.475	-50.050	12.180	28.890
↓	Parse Time	-5.920	0.060	0.120	-100.000	5.920	9.840
↓	CPU Time	-19.330	4.095	66.341	-1,520.050	1.270	30.590
↓	Buffer Gets	-32.050	522,950.000	15,295,217.000	-2,824.800	1.130	30.720
↑	Optimizer Cost	1.770	2,900.000	2,163.000	25.410	6.980	5.010
↑	Disk Reads	84.460	65,496.000	0.000	100.000	84.460	0.000
→	Direct Writes	0.000	0.000	0.000	0.000	0.000	0.000
→	Rows Processed	0.000	8.000	8.000	0.000	0.000	0.000

Problem Findings

The performance of this SQL has regressed.

Symptom Findings

The structure of the SQL execution plan has changed.

Information Findings

Plan Comparison

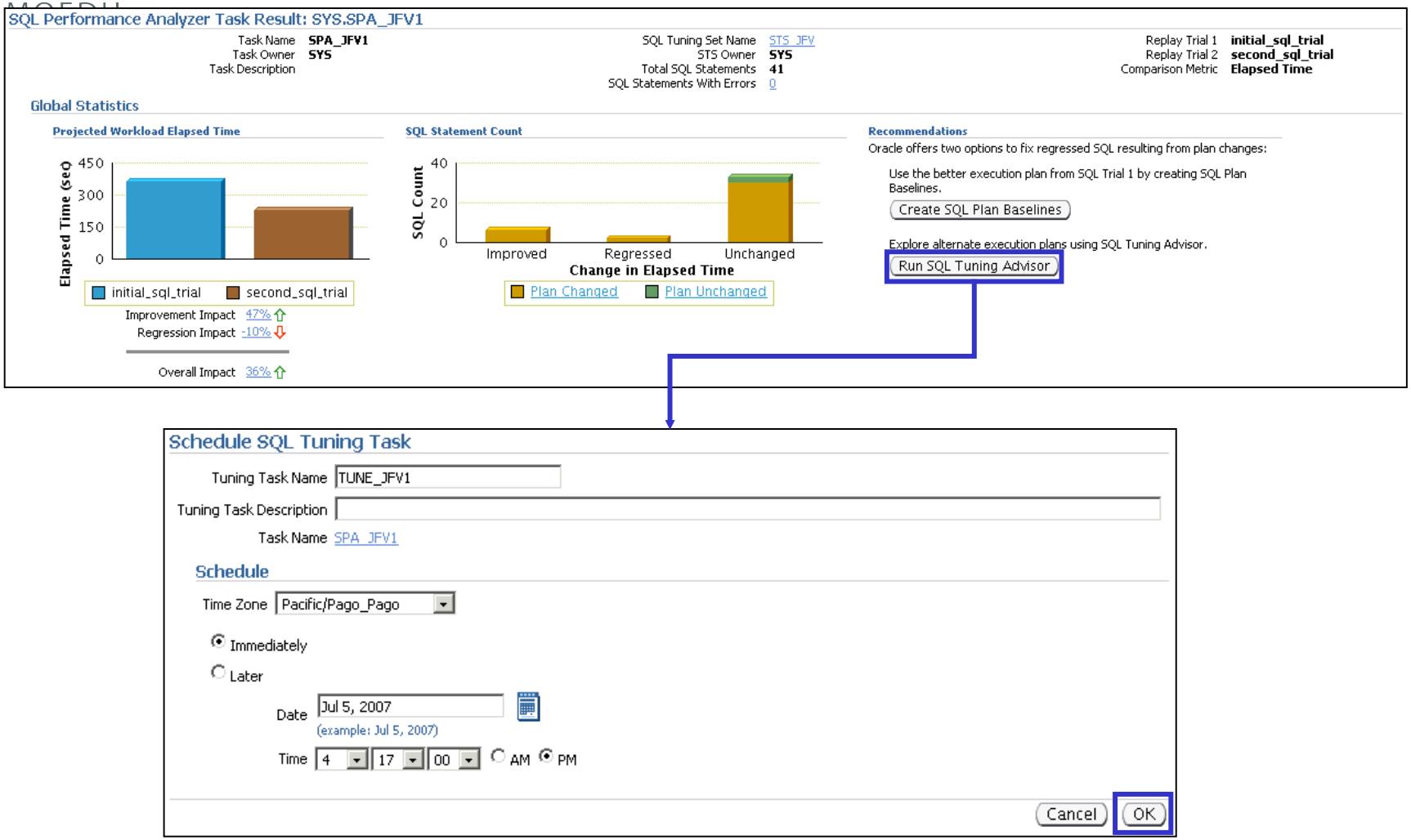
initial_sql_trial

Plan Hash Value **3480296**

Expand All | Collapse All

Operation	Line ID	Object	Rows	Cost	Predicate
SELECT STATEMENT	0		1	2,900	
HASH	1		1	2,900	
VIEW	2		1	2,899	
HASH	3		1	2,899	
FILTER	4				
HASH JOIN	5		1	2,754	"T2"."CH_FEATUREVALUE_02_ID"="...
HASH JOIN	6		1	2,610	"T2"."COUNTRY_CHANNEL_ID"="T4"...
HASH JOIN	7		1	2,466	"T1"."OUTLET_ID"="T2"."OUTLET_...
HASH JOIN	8		1	2,343	"T1"."PERIOD_ID"="T8"."VALUE_I...

优化回归语句


SQL Performance Analyzer Task Result: SYS.SPA_JFV1
Task Name SPA_JFV1
Task Owner SYS
Task Description
SQL Tuning Set Name STS_JFV
STS Owner SYS
Total SQL Statements 41
SQL Statements With Errors 0
Replay Trial 1 initial_sql_trial
Replay Trial 2 second_sql_trial
Comparison Metric Elapsed Time
Global Statistics
Projected Workload Elapsed Time
Elapsed Time (sec)
450
300
150
0
initial_sql_trial
second_sql_trial
Improvement Impact 47%
Regression Impact -10%
Overall Impact 36%
SQL Statement Count
SQL Count
40
20
0
Improved
Regressed
Unchanged
Change in Elapsed Time
Plan Changed
Plan Unchanged
Recommendations
Oracle offers two options to fix regressed SQL resulting from plan changes:
Use the better execution plan from SQL Trial 1 by creating SQL Plan Baselines.
Create SQL Plan Baselines
Explore alternate execution plans using SQL Tuning Advisor.
Run SQL Tuning Advisor

Schedule SQL Tuning Task
Tuning Task Name TUNE_JFV1
Tuning Task Description
Task Name SPA_JFV1
Schedule
Time Zone Pacific/Pago_Pago
Immediately
Later
Date Jul 5, 2007
(example: Jul 5, 2007)
Time 4 17 00 AM PM
Cancel
OK

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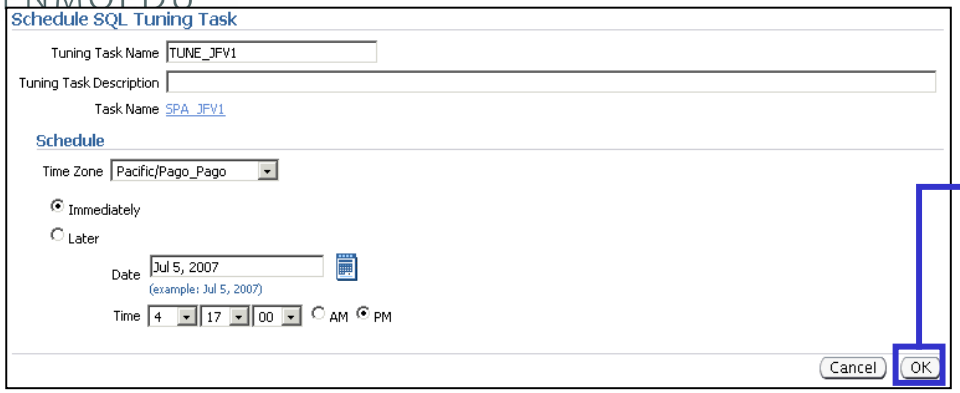
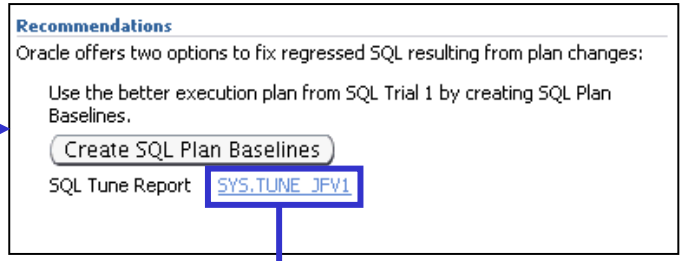
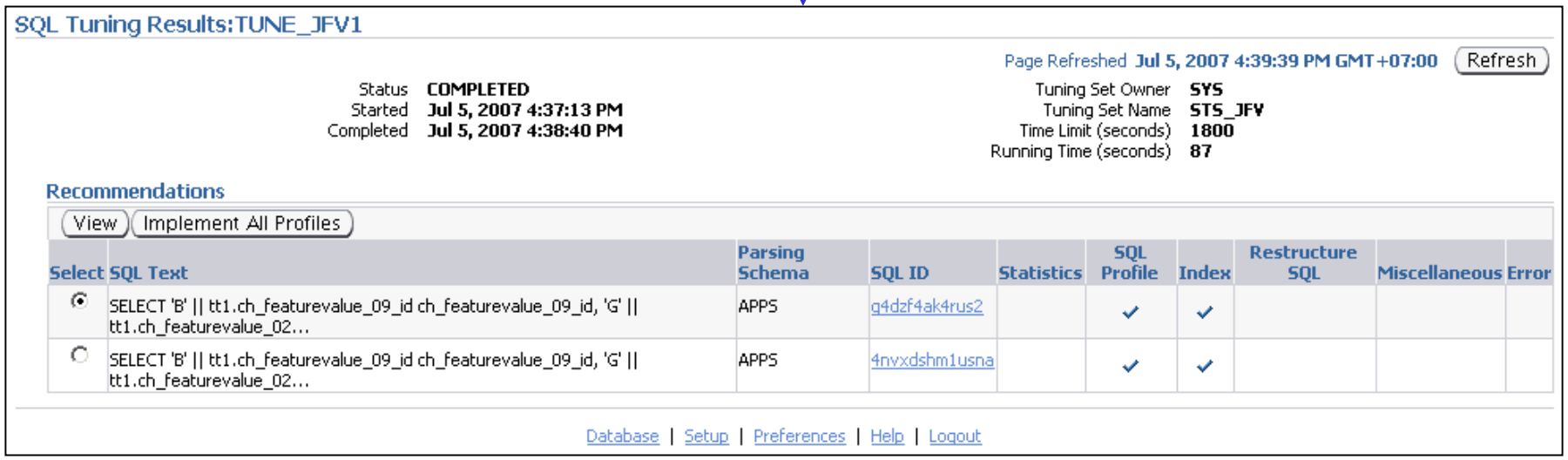
优化回归语句







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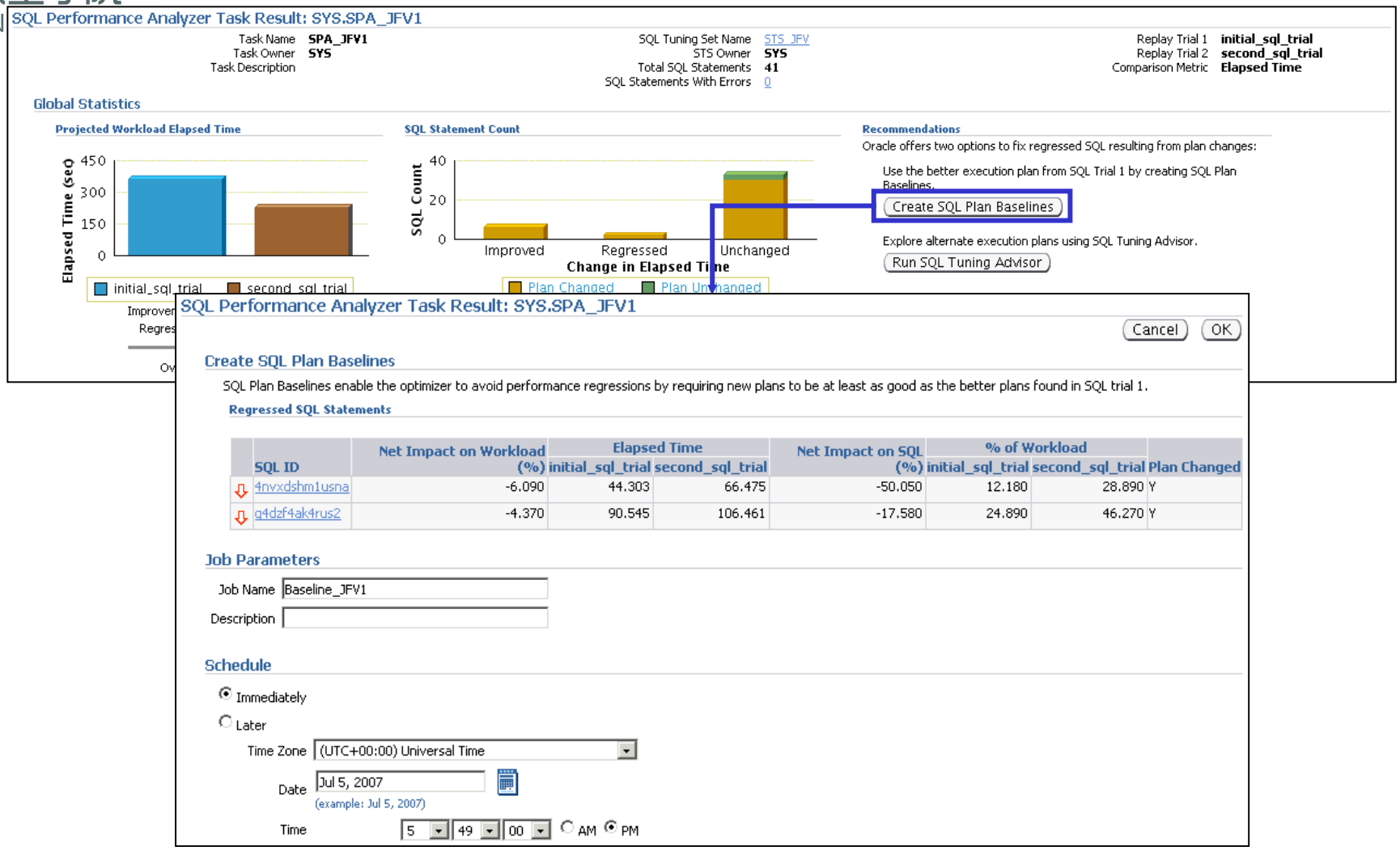
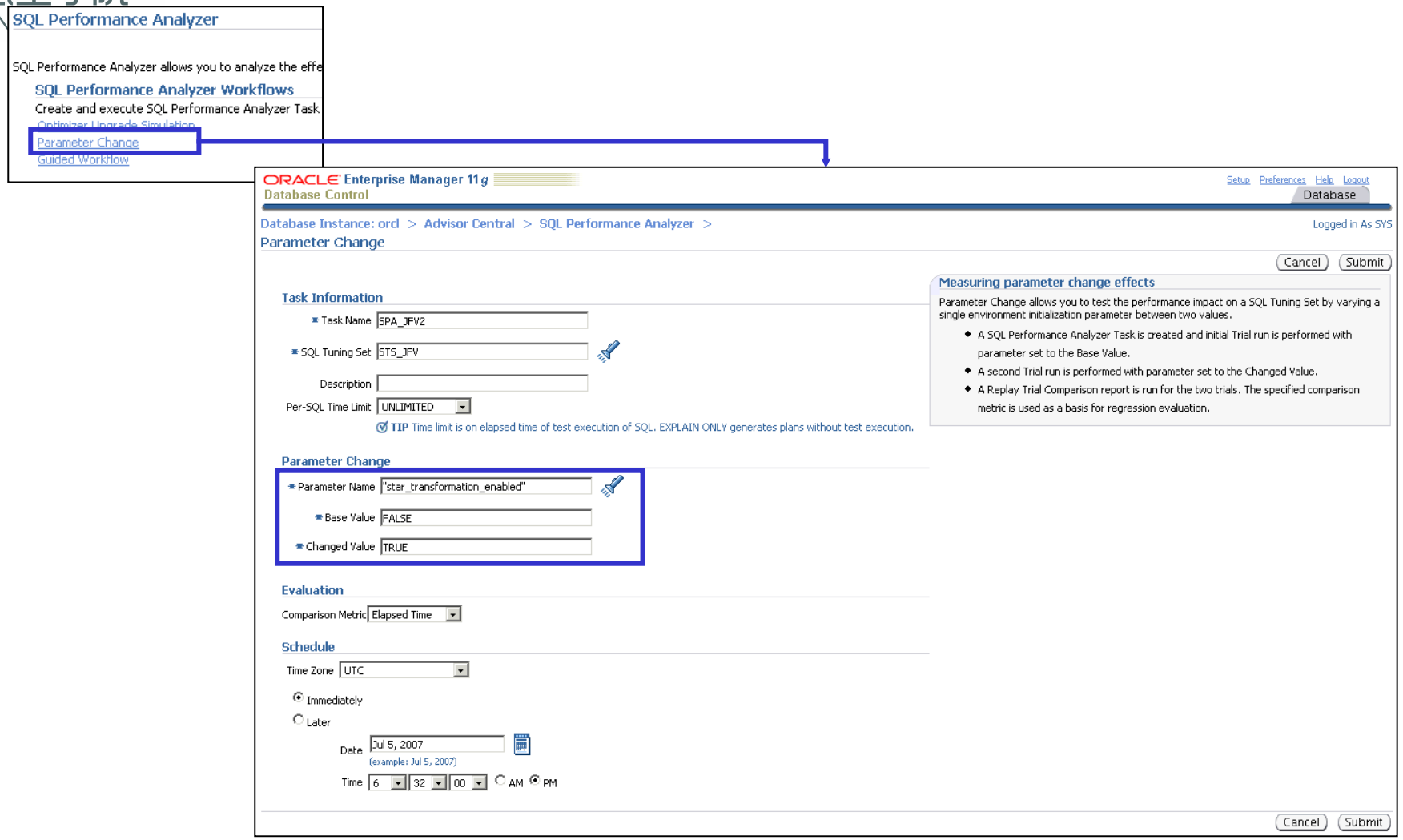
防止回归


SQL Performance Analyzer Task Result: SYS.SPA_JFV1
Task Name SPA_JFV1
Task Owner SYS
Task Description
SQL Tuning Set Name STS_JFV
STS Owner SYS
Total SQL Statements 41
SQL Statements With Errors 0
Replay Trial 1 initial_sql_trial
Replay Trial 2 second_sql_trial
Comparison Metric Elapsed Time
Global Statistics
Projected Workload Elapsed Time
Elapsed Time (sec)
450
300
150
0
initial_sql_trial
second_sql_trial
SQL Statement Count
SQL Count
40
20
0
Improved
Regressed
Unchanged
Change in Elapsed Time
Plan Changed
Plan Unchanged
Recommendations
Oracle offers two options to fix regressed SQL resulting from plan changes:
Use the better execution plan from SQL Trial 1 by creating SQL Plan Baselines.
Create SQL Plan Baselines
Explore alternate execution plans using SQL Tuning Advisor.
Run SQL Tuning Advisor
SQL Performance Analyzer Task Result: SYS.SPA_JFV1
Cancel
OK
Create SQL Plan Baselines
SQL Plan Baselines enable the optimizer to avoid performance regressions by requiring new plans to be at least as good as the better plans found in SQL trial 1.
Regressed SQL Statements
SQL ID
Net Impact on Workload (%)
Elapsed Time initial_sql_trial
Elapsed Time second_sql_trial
Net Impact on SQL (%)
% of Workload initial_sql_trial
% of Workload second_sql_trial
Plan Changed
4nvxdshm1usna -6.090 44.303 66.475 -50.050 12.180 28.890 Y
q4dzf4ak4rus2 -4.370 90.545 106.461 -17.580 24.890 46.270 Y
Job Parameters
Job Name Baseline_JFV1
Description
Schedule
Immediately
Later
Time Zone (UTC+00:00) Universal Time
Date Jul 5, 2007
(example: Jul 5, 2007)
Time 5 49 00 AM PM

参数更改分析


SQL Performance Analyzer
SQL Performance Analyzer allows you to analyze the effe
SQL Performance Analyzer Workflows
Create and execute SQL Performance Analyzer Task
Optimizer Upgrade Simulation
Parameter Change
Guided Workflow
ORACLE Enterprise Manager 11g
Database Control
Setup Preferences Help Logout
Database
Database Instance: orcl > Advisor Central > SQL Performance Analyzer >
Logged in As SYS
Parameter Change
Cancel Submit
Task Information
Task Name SPA_JFV2
SQL Tuning Set STS_JFV
Description
Per-SQL Time Limit UNLIMITED
TIP Time limit is on elapsed time of test execution of SQL. EXPLAIN ONLY generates plans without test execution.
Measuring parameter change effects
Parameter Change allows you to test the performance impact on a SQL Tuning Set by varying a single environment initialization parameter between two values.
A SQL Performance Analyzer Task is created and initial Trial run is performed with parameter set to the Base Value.
A second Trial run is performed with parameter set to the Changed Value.
A Replay Trial Comparison report is run for the two trials. The specified comparison metric is used as a basis for regression evaluation.
Parameter Change
Parameter Name "star_transformation_enabled"
Base Value FALSE
Changed Value TRUE
Evaluation
Comparison Metric Elapsed Time
Schedule
Time Zone UTC
Immediately
Later
Date Jul 5, 2007
(example: Jul 5, 2007)
Time 6 32 00 AM PM
Cancel Submit

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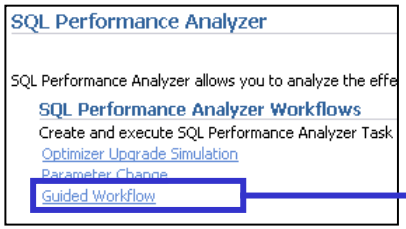
指导式工作流分析



Trial environment determines results

The SQL Tuning Set remains constants under the SQL Performance Analyzer Task and its SQL is executed in isolation to create each Replay Trial. Performance differences between trials are thus attributed to environmental differences between trials.

Environmental changes affecting SQL optimization and performance may need to be made manually prior to execution of the Trial. These could include changing initialization parameters, gathering or setting optimizer statistics and creating indexes.

NOTE: Be sure trial environment has been established prior to submitting.

☑ Trial environment established

Guided Workflow: SYS.SPA_JFV3

Page Refreshed **Jul 5, 2007 7:01:32 PM GMT+07:00** Refresh View Data Real Time: 15 Second Refresh

The following guided workflow contains the sequence of steps necessary to execute a successful two-trial SQL Performance Analyzer test.

Note: Be sure that the Trial environment matches the tests you want to conduct.

Step	Description	Excecuted	Status	Execute
1	Create SQL Performance Analyzer Task based on SQL Tuning Set	Jul 5, 2007 6:48:22 PM	✓	
2	Replay SQL Tuning Set in Initial Environment	Jul 5, 2007 6:56:23 PM	✓	
3	Replay SQL Tuning Set in Changed Environment	Jul 5, 2007 7:00:33 PM	✓	
4	Compare Step 2 and Step 3	Jul 5, 2007 7:00:58 PM	✓	
5	View Trial Comparison Report		■	

TIP For an explanation of the icons and symbols used in the following table, see the Icon Key

SQL 性能分析器： PL/SQL 示例

```
exec :tname:= dbms_sqlpa.create_analysis_task( -
                sqlset_name => 'MYSTS', task_name => 'MYSPA');
```

```
exec dbms_sqlpa.execute_analysis_task(task_name => :tname, -
   execution_type => 'TEST EXECUTE', execution_name => 'before');
```

```
select dbms_sqlpa.report_analysis_task(task_name => :tname,
   type=>'text', section=>'summary') FROM dual;
```

进行更改

```
exec dbms_sqlpa.execute_analysis_task(task_name => :tname, -
   execution_type => 'TEST EXECUTE', execution_name => 'after');
```

```
select dbms_sqlpa.report_analysis_task(task_name => :tname,
   type=>'text', section=>'summary') FROM dual;
```

```
exec dbms_sqlpa.execute_analysis_task(task_name => :tname,
              execution_type => 'COMPARE PERFORMANCE');
```

```
select dbms_sqlpa.report_analysis_task(task_name => :tname,
   type=>'text', section=>'summary') FROM dual;
```

SQL 性能分析器：数据字典视图

- Oracle Database 11g 中修改的视图：
  - DBA{USER}_ADVISOR_TASKS：显示有关分析任务的详细资料
  - DBA{USER}_ADVISOR_FINDINGS：显示分析结果
- Oracle Database 11g 中的新视图：
  - DBA{USER}_ADVISOR_EXECUTIONS：列出任务执行的元数据信息
  - DBA{USER}_ADVISOR_SQLPLANS：显示 SQL 执行计划列表
  - DBA{USER}_ADVISOR_SQLSTATS：显示 SQL 编译和执行统计信息的列表