



Manageability Study

Comparative Management Cost Study of Oracle Database 10g and Microsoft SQL Server 2000

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Executive Summary

As previously published by Progressive Strategies, the Edison Group has performed a Comparative Management Cost Study (CMCS) comparing Oracle Database 10g and Microsoft SQL Server 2000. This effort came about as a result of our review of the pre-release announcements from Oracle Corporation regarding the features and manageability benefits they promised to deliver in their new flagship product, Oracle Database 10g. Oracle claims that, with the release of Oracle Database 10g, the company is delivering a state-of-the-art product with the latest high-performance and high-availability functionality that also has ease of maintenance equal to or greater than that offered by its rivals, including Microsoft SQL Server 2000.

The Edison Group challenged Oracle to allow Oracle Database 10g to undergo a thorough analysis process in order to objectively validate these claims. Oracle accepted our challenge, and the results are published in this document.

The Edison Group set up a laboratory environment for analyzing a suite of standard RDBMS administrative tasks and measured their respective management efficiency (time taken to complete tasks) and complexity based on a proprietary manageability metric. Using the management efficiency results the Edison Group calculated the annual costs that businesses can save due to the enhanced DBA productivity that would result from using the product with superior manageability.

The study results show that Oracle Database 10g does in fact, live up to the claims that initiated this inquiry across the main areas of interest. The study revealed that over the course of installing, maintaining, and operating a database:

- Database administrators (DBAs) can perform typical administrative functions in 30% less time when using Oracle Database 10g compared to Microsoft SQL Server 2000.
- Oracle Database 10g requires 20% fewer steps for the same set of standard RDBMS administrative tasks than Microsoft SQL Server 2000 based on the Edison Group's metric for complexity assessment.
- Businesses can save approximately \$32,600 per DBA per year by using Oracle Database 10g in place of Microsoft SQL Server 2000.

There are numerous ways to interpret the significance of these savings, depending upon the size of the organizations involved and the relative importance attached to higher productivity in these organizations. No

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matter which accounting approach is employed, a productivity increase of 30% and a complexity differential of 20% is quite significant.

The main areas where the manageability of the two products differed were backup & recovery management and performance diagnostics & tuning. Oracle Database 10g's automatic backup management and human-error recovery features contributed significantly to Oracle's advantage over SQL Server. Oracle took 50% less time and 56% fewer steps than SQL Server in backup & recovery tasks.

The area in which Oracle Database 10g demonstrated a significant advantage was in performance diagnostics, query tuning and system optimization. This is the area where DBAs spend a considerable amount of their time. Oracle's new proactive performance diagnostic and automatic SQL tuning solutions were mainly responsible for Oracle's advantage in this category. In this area, Oracle Database 10g required 76% less time and was 38% less complex than Microsoft SQL Server 2000.

The Edison Group was able to validate Oracle's claim about the manageability of its latest release, Oracle Database 10g, with this study. With Oracle Database 10g, DBAs can expect to reduce their daily workload and businesses their cost of managing enterprise database systems.

About This Report

This report documents the results of a head-to-head product comparison of the database administration functions of Oracle Database 10g and Microsoft SQL Server 2000. The study focuses on the use of human resources. Its objective is to reveal the comparative database administration costs of operating the two products.

Common database management tasks were performed in Oracle Database 10g and Microsoft SQL Server 2000 and compared for their ease of use. For both products, their native management tools — Oracle Enterprise Manager 10g Database Control for Oracle and Microsoft Enterprise Manager for SQL Server — were used in the study. The purpose is to objectively measure (in quantitative and qualitative terms), the relative manageability of Oracle Database 10g and Microsoft SQL Server 2000, and to project over the course of a year the expected savings in management cost due to the administrative efficiency of one product over the other.

Who Should Read this Report?

This report will be useful for corporate decision makers, technical end users (DBAs/System Administrators), and independent software vendors (ISVs). It will also be of particular interest to small and medium businesses with critical database requirements but limited IT resources to manage them.

Methodology Overview

This Comparative Management Cost Study (CMCS), conducted by the Edison Group, compares the ease of use or manageability of Oracle Database 10g and Microsoft SQL Server 2000 and assesses their relative cost of management to a business. It represents a product-specific application of a proprietary, general-purpose methodology developed by the Edison Group for making product management cost comparisons. The result is a summary definition of the annual costs that will be incurred by any corporate IT department or ISV running either of these two products.

In the course of this study, Oracle Database 10g and Microsoft SQL Server 2000 were compared against a set of methodology metrics in order to determine which of the two products is easier to operate for businesses with real-world database management requirements. The Test

Administration Workload Task Areas that we used to perform this study fall into the following four categories:

- Database Setup and Configuration
- Day-to-Day Database Administration
- Backup and Recovery
- Performance Diagnostics and Tuning

Task categories were divided into individual tasks that logically map into their respective area. To determine the overall manageability of a given task for a given product, each task was broken down into steps to assess the complexity and usability involved.

Next, tasks were weighted against workload weighting constants. These weightings were used to determine the relative importance of a given task as measured against all of the tasks required to manage the entire product administration lifecycle. In other words, simple tasks that occur relatively infrequently were given a proportionately lower weighting than complex tasks that occur on a regular basis.

Finally, the results were tallied and the CMCS metrics for each product were substituted into manageability cost formulas to determine the projected human resources cost of operating both products, based on median DBA salary.

Contents of this Report

The following is a brief overview of the sections contained in this document, to provide for quick reference.

- **Rationale Behind this Report** – a discussion of the reasons the Edison Group engaged in this research.
- **The Methodology Defined** – this section explains the criteria used in the study, including how we weighted and calculated the results and a description of the workloads evaluated.
- **Test Results** – presents the results of each set of tests, providing summary findings and a discussion of their relevance to business operations.
- **Conclusion** – summarizes our findings.
- **Appendices** – provide details on the test platform, clarification of architectural and terminology issues, the detailed test results, a discussion of our Complexity Calculation Formula, a detailed list of the actual steps performed and their individual timings, and a glossary of task areas.

Rationale Behind This Comparison

In the last several years, the Edison Group has conducted research on behalf of several vendors in the RDBMS industry. Most recently we created a white paper comparing the management tools for Microsoft SQL Server 2000 with those of IBM DB2 Universal Database 8.1. When we saw claims asserting that the next version of Oracle's flagship database (Oracle Database 10g) would offer significant management ease of use, we were intrigued and, as a result, we challenged this assertion with our contacts at Oracle. In response, Oracle agreed to support research that would allow the Edison Group to demonstrate to our own satisfaction the veracity of these claims.

Oracle's support included providing access to the test methodology used in product development that allowed Oracle to make these claims, membership in the beta program for access to Oracle Database 10g beta code, and early delivery of release code for final testing, as well as technical support where needed.

The Edison Group reviewed the methodology and modified it to reflect changes in the later beta code for Oracle Database 10g and to account for recommended practices for Microsoft SQL Server 2000. To this end, the Edison Group also consulted Oracle and SQL Server database administrators and engineers for independent validation of the study methodology. Once this was done, the Edison Group's analysts performed and documented the evaluations contained in this paper. The conclusions in this report are our own, based upon the research we performed.

If you work for or own a small- to mid-size business and run real-world, data-driven back office or Internet/e-commerce applications with commercial production transaction, data storage, and/or reporting requirements, chances are that your day-to-day business operation depends on either an Oracle or a SQL Server database. With the latest release of the Oracle Database 10g product, Oracle is offering a state-of-the-art RDBMS that promises small business customers all of the industrial-strength features and functions found in past Oracle products, with an ease of maintenance that Oracle claims will meet or exceed the point-and-click simplicity of administering a Microsoft SQL Server 2000 database. According to Oracle, the new product comes pre-configured and instrumented in a manner that is simpler to install, run, and maintain than Microsoft SQL Server 2000. The Edison Group's interest in validating this claim is the primary motivation behind the execution of this study and the development of this paper.

The main thrust of this paper is to independently test these claims on a point-by-point basis, in order to arrive at a set of quantitative and qualitative manageability metrics that determine the truth of the following key Oracle assertions:

- That the new Oracle Database 10g is superior to Microsoft SQL Server 2000.
- That, specifically, Oracle Database 10g is less expensive to operate than Microsoft SQL Server 2000 in terms of Comparative Management Costs for businesses with transactional, analytical, and data warehousing workloads that require DBA support.

The Methodology Defined

For purposes of this study, the methodology is defined as a product manageability cost evaluation process whereby the two products in question are compared against a set of task-oriented objective and subjective metrics in order to derive an accurate set of analytical results. The outcome of this study determines the Comparative Management Cost (CMC) incurred by managing and operating either of these products in a production environment. The methodology employed to conduct this comparison consists of the following elements.

- **Workload Weighting:** The workload weighting is a set of constants that define the relative importance of a single task area in the workload, based on frequency of execution and measured against the entire set of task areas that compose this study.
- **The Study:** The study is the baseline checklist of standard database administration tasks routinely performed, which are quantitatively and qualitatively compared in order to objectively determine, on a task-by-task basis, which product is superior. This is measured primarily in terms of ease of administration and secondarily (for certain tasks only) in terms of system speed of execution — the wall clock time it takes for the system in question to complete a job once it has been submitted by a DBA. The function of this study is to apply a set of quantitative metrics, developed by the Edison Group, to a list of tasks typically regarded as qualitative in nature, in order to derive a meaningful set of CMCS statistics that can reveal the real difference in management costs for the two products in question.
- **Tasks:** A task is defined as a complete unit of work, composed of one or more steps, all of which effect a significant alteration on the state of

the database. Each task is measured for time and complexity. Time and complexity, as measured in the study, are defined as follows:

- **Time:** Defined as the amount of time it takes to perform a given task. For certain (asynchronous) tasks, when a job can be run in the background so that the DBA can use the time for accomplishing other tasks, time is measured strictly in terms of the time it takes the DBA to perform the steps to configure, initiate, and submit a given task.

For other (synchronous) tasks in the study that demand the DBAs full attention and prevent the accomplishment of other tasks (as in performing a hot recovery operation on a live database), time is measured to include both the time it takes for a DBA to configure/execute the task in question as well as the time it takes the system to complete the task. All time metrics are measured in wall clock time and are rounded up to the nearest ten seconds.

- **Complexity:** For the purposes of this study, complexity is measured using a proprietary metric devised by the Edison Group. It is defined as the number of computed *steps* it takes to complete a given task, where a step is defined as a task component that effects a change of state to the database. Creating a filegroup or tablespace is an example of step.

Because not all steps have the same inherent complexity, each step is further broken down into *increments* to account for the difference. An increment is a decision point that the user must make to complete a step. Increments are technically defined as a part of a step that will have a measurable effect on the state or execution path of that step in the task process, but which in and of itself does not effect a change upon the underlying database state until the step being executed is complete. For example, selecting Basic vs. Advanced Install and clicking the Next button in the Oracle installation wizard screen is an increment which effects an incremental change on the flow of the database installation process but does not change the state of the database.

Complexity is then measured in terms of number of steps but taking into account the following factors:

1. The number of increments it takes to complete each step.
2. Whether or not instrumentation for a given step is GUI-based or requires the use of a command line/scripting interface.
3. Whether or not the task requires a context switch between multiple interfaces in order to be completed. If a context

switch exists, then additional steps will be added to the total step count for a given task.

The above factors affect the complexity calculation as follows:

For every 6th increment taken to complete a step in a task, the step is increased by 1. So if a step has between 0-5 increments, it remains unchanged, if it has between 6-10, it is increased by 1, between 11-15, it is increased by 2, and so on. We decided to do this because while increments are secondary to steps in determining complexity, they do modify the relative complexity of a given step in the course of completing a task. In other words, steps with a low number of increments are simple, and steps with a high number of increments are complex.

The other modifiers (instrumentation and context switching) occur very infrequently in each of the products under review, but they were significant enough a factor that we needed to account for them in some meaningful way in order to generate a measure of complexity that accurately reflects our experience of using the two products.

Regarding instrumentation, if an operation could be executed entirely within a GUI interface, then the complexity/step value for that task would remain unmodified. If, on the other hand, a step required the use of a command line interface, this would increase the step count. For a simple single-line command operation, the step count was increased by 1, whereas if the operation required the user to write a script, the step value was increased by 2 or more, depending on how much work was required to write the script in question.

Lastly, we come to the matter of context switching. If a context switch was encountered during the course of completing a given task, then 2 or more steps were added to the step count for that task. The possible addition of more than 2 steps was allowed for as a judgment call on the part of the analyst performing the task under consideration. The reason tasks containing context switches were penalized is that we consider that the complexity of understanding the dependencies of relating and performing a single operation in two different environments in order to complete a single task is inherently more complex than performing a similarly complex task in a well-integrated environment, where all the operations can be accomplished in one place.

The workload for this CMCS was reduced to the basic set of atomic maintenance operations that effectively fulfill all fundamental database administration procedures. The reasoning behind this approach is that enterprise-class database configuration and administration is a non-trivial matter; we therefore set out to develop a (relatively) simple yet comprehensive evaluation process, establishing a CMCS methodology benchmark that we feel is realistic in its technical assessment, yet accessible to the large audience of non-technical decision makers who will read this document.

The evaluation of each task in the study workload was executed by measuring the product's performance in that workload task area against the methodology metrics. This was the process we used in order to test the assertion that the newly-released Oracle Database 10g is less expensive to operate than Microsoft's SQL Server 2000.

This CMCS Methodology has been derived from the following sources:

- The initial baseline workload task list for this paper was based upon research performed by Oracle. This initial baseline was then modified by the Edison Group and certain tasks were removed in order to compare both products on equal terms.
- The workload task weighting was based on a survey published by *Database Trends*.
- The baseline workload task list was checked for process consistency by Edison Group analysts against the pre-release Oracle Database 10g Administrators Guide.
- The baseline workload weighting and task list was further checked for consistency against Microsoft SQL Server 2000 Books Online documentation, and SQL Server best practices as published in the [Microsoft SQL Server 2000 Operations Guide](#).
- Independent professional Oracle and SQL Server database administrators and engineers were consulted as anonymous third-party verifiers of the methodology and workload tasks employed in the course of conducting this CMCS.

Workload Weighting

To view these results in terms of management costs, we recognized that the tasks in the workload have different levels of importance and complexity, and are performed at differing levels of frequency. For example, tuning a database or creating a new table is performed more frequently than creating a new database. In order to accurately account

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for this, we have used a weighted average of the workload test areas to measure each set of tasks according to their typical degree of use. Here are the weightings used for this CMCS.

Database Administration Workload Weighting	
Setup and Configuration	5%
Day to Day Administration	34%
Backup & Recovery	14%
Performance Tuning	26%
Other	21%
Total	100%

The Database Workload Weighting metrics in the table above came out of an article published in [Database Trends and Applications Online](#) in 2002. The “Other” category represents tasks that were not included in the study such as software license maintenance and database upgrades. We left this category in the weighting in order to acknowledge in the Comparative Management Costs (CMC) calculations that such activities are a necessary part of day-to-day business. Furthermore, in performing the CMC calculations for this analysis, it was presumed that both products required the same degree of “Other” tasks so as not to favor one product over the other. This approach renders the 21% of the workload weighting that falls into the “Other” category irrelevant to the outcome of this study.

Test Administration Workload

- **Database Setup and Configuration (Workload Task Category)**
 - Install database/software/out-of-box setup
 - Create new database/server instance
 - Set up proactive monitoring
- **Day-to-Day Database Administration (Workload Task Category)**
 - Create user with roles, privileges
 - Create tablespace/filegroup
 - Add space to database

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- Create table
- Create index
- Reclaim wasted space from tables with fragmented data
- Load data from text file
- **Backup and Recovery Tasks (Workload Task Category)**
 - Configure and perform full backup
 - Recover dropped table
 - Recover data file
 - Recover from erroneous transaction
- **Performance Diagnostics and Tuning Tasks (Workload Task Category)**
 - Diagnose performance problem
 - Fix performance problem (tune SQL statement)
 - Tune memory

Test Results¹

The table below presents the cumulative test results of the study. In summary, Oracle's claims for their new product held true, with Oracle Database 10g outperforming Microsoft SQL Server 2000.

Result Summary	Time (mins)		Complexity (steps)	
	SQL Server	Oracle	SQL Server	Oracle
Overall Total	81.7	53	50	30
% difference -- (SS - Oracle)/SS*	35%		40%	
DBA Workday Savings	30%		20%	

* SS: SQL Server

Oracle Database 10g took 35% less time and 40% fewer steps to complete all the tasks in the study. After adjusting the tasks for their prominence in a DBA workday (because not all tasks are performed with equal frequency as discussed in the Workload Weighting section of the report), the study revealed that a typical DBA will need 30% less time to perform common administrative functions with Oracle Database 10g than with Microsoft SQL Server 2000. As for product complexity, DBAs will require 20% fewer steps with Oracle Database 10g than with Microsoft SQL Server 2000 in the course of their typical workday.

***Note on complexity:** While both products were very easy to use, the results of this study have demonstrated a real breakthrough in manageability and ease of use for the new Oracle 10g database product. For a complete rundown of all of the numbers comprised in this report; see Appendix III - Detailed Test Results, containing the comprehensive numerical analysis derived from this study.*

¹ The times in all results tables are in minutes. Precision is 1/10th of a minute. Cumulative results are rounded in the tables used in the body of this paper.

Comparative Management Cost Savings

The core premise of any Comparative Management Cost Study is that the true cost of owning and operating complex systems like Oracle 10g and SQL Server only start to accrue after the product has been purchased. In most real-world business environments, the management costs will far outweigh the licensing and support costs throughout the life of the product. With this in mind, we estimated the annual costs that businesses can expect to save due to the DBA time savings that result from one product being easier to administer and operate than the other.

In order to compute cost savings, we used DBA salary figures published on Salary.com. For more information on these numbers, go to <http://www.salary.com>.

From Salary.com: The median total compensation including benefits for a typical Database Administrator in the United States is **\$108,837**. This basic market pricing report was prepared using our Certified Compensation Professionals' analysis of survey data collected from thousands of HR departments at employers of all sizes, industries and geographies.

If we insert the median DBA compensation salary found in the Salary.com survey into the formula below, we arrive at the following quantitative management cost (MC) saving calculation.

$$\text{Median DBA Salary} * (\text{DBA time savings}) = \$108,837 * 30\% = \$32,651.$$

This result can be interpolated to match to your company's DBA salary expenses by applying the above formula.

When multiplied across all of the DBAs in an organization, these management cost savings quickly grow into a figure that dwarfs the one-time licensing fee required to acquire a product of this nature.

Workload Category Test Results Synopsis

This section of the report delineates the Results Synopsis for each of the workload categories tested in this study. It will help the reader acquire a deeper understanding of how Oracle Database 10g and SQL Server really compare across the board.

Install DB/Software/Out-of-the-Box Setup (Results Synopsis)

This workload category addresses tasks relating to software installation and default out-of-box setup. Three tasks were performed in this area.

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The quantitative results synopsis for this area is documented in the table below.

Installation and Simple "Out-of-Box" Setup	Time (mins)		Complexity (steps)	
	SQL Server	Oracle	SQL Server	Oracle
Category Sub-Total	26.9	27.2	13	6
% difference -- (SS - Oracle)/SS*	-1%		54%	
DBA Workday Savings	0%		3%	

* SS: SQL Server

Qualitative Analysis

In this category, SQL Server won by a very small margin in terms of the amount of time it took to perform these tasks. However, as far as product complexity goes, the new and simplified installation process in Oracle Database 10g made it less complex than SQL Server in this workload category. Oracle 10g took 54% fewer computed steps than SQL Server, measured according to the complexity metric defined earlier. Given the relative infrequency of tasks in this category, this translates into only 3% fewer steps than SQL Server that a DBA must perform in a typical workday. This result marks a significant improvement in Oracle's product packaging and installation strategy. Performing the basic installation in the new Oracle Database 10g product was a simple matter. On a subjective note, while the number of decisions we had to make in order to install, patch, and configure SQL Server were quantitatively complex when compared to Oracle Database 10g, the installation routines of SQL Server gave us no problems. This comparison, however, strives to determine which of the two products currently presents the greatest simplicity to the user. Based on the results of this study, we must conclude that Oracle Database 10g is the simpler of the two database products to install. The primary reason that SQL Server lost in this area was because of the fact that the product required the application of SQL Server Service Pack 3, which is essentially the sole factor that tipped the outcome in Oracle's favor for this workload category.

Day-to-Day Database Administration (Results Synopsis)

The Ongoing Database Administration Workload Task Category relates to the routine database object maintenance operations such as creating users, tables, and indexes, as well as reorganizing data and loading information into the database from external sources. Six tasks were

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performed in this category. The quantitative results synopsis for this category is documented in the table below.

Day-to-Day Database Administration	Time (mins)		Complexity (steps)	
	SQL Server	Oracle	SQL Server	Oracle
Category Sub-Total	10.2	9.2	11	11
% difference -- (SS - Oracle)/SS*	10%		0%	
DBA Workday Savings	3%		0%	

* SS: SQL Server

Qualitative Analysis

In this workload category both the products were very competitive. In terms of the time metric within this workload category, both products were almost equally efficient in allowing administrators to complete the designated tasks quickly. Oracle took 10% less time than SQL Server, which translates to about 3% time savings in a DBA workday. Relative to complexity, as measured by number of steps taken to perform the tasks, Oracle Database 10g and Microsoft SQL Server 2000 were tied. While both products are well-designed and easy to manage on a day-to-day basis, Oracle Database 10g is slightly more efficient than SQL Server when it comes to routine day-to-day maintenance.

Backup and Recovery (Results Synopsis)

This task category addresses tasks relating to database backup and recovery management. Four tasks were performed in this category. The quantitative results synopsis for this category is documented in the table below.

Backup & Recovery	Time (mins)		Complexity (steps)	
	SQL Server	Oracle	SQL Server	Oracle
Category Sub-Total	22.6	11.3	18	8
% difference -- (SS - Oracle)/SS*	50%		56%	
DBA Workday Savings	7%		8%	

* SS: SQL Server

Qualitative Analysis

This was the first workload category where the new features found in Oracle Database 10g began to demonstrate a distinct edge over Microsoft SQL Server 2000. Oracle Database 10g's automatic backup management and human-error recovery features were mainly responsible for Oracle's

significant advantage over SQL Server. These are state-of-the-art enhancements in manageability that mark a radical improvement over all past versions of the Oracle Database. In contrast, SQL Server has a relatively robust transaction logging architecture and is manageable as far as backup and recovery is concerned, but every operation needs to be manually configured post-installation. For time-critical operations of data file and point-in-time recovery, the database recovery configuration needs to be well-architected and regularly maintained in order to avoid costly database failures. In contrast, the new Flashback features of Oracle Database 10g that are built upon its multi-version read consistency architecture — which has been steadily evolving ever since Oracle 7 — have finally arrived, enabling a level of built-in database fault tolerance that simply does not exist in any competing product. In quantitative terms, the numbers speak for themselves. When you read the numbers prior to applying DBA workday weighting, the results are impressive. In this category Oracle required:

- 50% less time than SQL Server, and
- 56% fewer steps.

After applying DBA workday weightings, Oracle results in:

- 7% time savings in a typical DBA workday, and
- 8% fewer steps.

Thus, Oracle Database 10g proved itself to be substantially less complex than SQL Server by requiring 56% fewer steps. This was largely due to technical advancements in Oracle Database 10g, specifically the automated online recovery capabilities found in the new Flashback features that we used to recover a dropped table and a series of erroneous transactions in this workload area.

This section of the study demonstrates a clear advantage by virtue of the Oracle-recommended database backup configuration and Flashback recovery features found in their latest release.

Performance Tuning (Results Synopsis)

This task category addresses tasks relating to manual and automated systems performance diagnostics and tuning. Three tasks were performed in this area. The quantitative results synopsis for this category is documented in the table below.

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Performance Diagnostics and Tuning	Time (mins)		Complexity (steps)	
	SQL Server	Oracle	SQL Server	Oracle
Category Sub-Total	22	5.3	8	5
% difference -- (SS - Oracle)/SS*	76%		38%	
DBA Workday Savings	20%		10%	

* SS: SQL Server

Qualitative Analysis

Of all the areas of comparison, this was the category where Oracle Database 10g revealed its greatest strength. In terms of time and steps metrics, Oracle Database 10g as compared to SQL Server was:

- 76% more efficient in time, and
- 38% more efficient in steps.

Given that DBAs spend more than a quarter of their time performing performance diagnostic and tuning related functions, Oracle’s substantial advantage in this category translates into DBA workday savings of:

- 20% in time, and
- 10% in steps.

This is the category where the highest-paid DBA specialists and consultants spend most of their time and incidentally this is the segment of the study where Oracle Database 10g demonstrated a considerable advantage over SQL Server.

Oracle’s advantage in this category was mainly due to the new self-diagnostic engine (Automatic Database Diagnostic Monitor – ADDM) that proactively identifies and recommends remedies for performance problems encountered by the system, and the SQL Tuning Advisor that fully automates the complex task of application tuning. Whereas SQL Server does have features that facilitate SQL tuning such as the Index Tuning Wizard, its solution is not nearly as comprehensive as Oracle’s and focuses on just one aspect of application tuning. Moreover, in the area of performance diagnostics, SQL Server does not have anything that compares directly to the self-diagnostic capabilities of ADDM. ADDM and SQL Tuning Advisor together give Oracle a significant edge over SQL Server in the performance diagnostics & tuning category as aptly reflected in the time and complexity (steps) numbers above.

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When it comes to complexity, Oracle has succeeded in automating the involved art of performance diagnostics and tuning in such a way that the adoption of Oracle 10g will significantly reduce the management costs for any company. Upon completion of this section of our analysis, it became clear to us that Oracle 10g has set a new standard in the high-tech realm of automated database performance management.

Conclusion

After completing our tests and confirming the results with a group of independent third-party database professionals, we have concluded that Oracle's claims for Oracle Database 10g are valid. As a result, we can state with confidence that Oracle Database 10g can offer significant management savings when compared to Microsoft SQL Server 2000. In light of the fact that prior to this study the Edison Group regarded Microsoft SQL Server 2000 as the most SMB-friendly database product on the market, we feel that with the Oracle Database 10g, Oracle has raised the bar for RDBMS manageability, setting a new standard for ease of administration against which all competing products will soon be measured.

This study quantifiably demonstrates that Oracle Database 10g has not only attained equivalence but has in some areas shown superiority over Microsoft SQL Server 2000. Oracle 10g significantly reduces the DBA management workload as well as the complexity of administrative tasks compared to Microsoft SQL Server. This translates into more productive DBAs, more reliable systems and, most importantly, significant cost savings for businesses.

Appendix I - Test Platform Details

Below are the technical specifications of the lab computers used to conduct this CMCS.

- **Hardware Platform: OS/Hardware platform data points.**
 - OS: Microsoft Windows Server 2000 5.00.2195 (SP4)
 - Processors: Dual Intel Xeon 2.8 GHz CPUs w/512 K Cache, 533 MHz FSB
 - Memory: 1 GB DDR, 2x512 MB 266 MHz DIMMS
 - Storage: Three 36 GB, 10 K RPM, 1in (Ultra 320) SCSI Hot Plug Hard Drives
 - HD Configuration: On-board RAID 5, three drives connected via on-board RAID
- **Software Platforms: Relational database management software platform data points.**
 - *Oracle*
 - Oracle Database 10g Enterprise Database Release 10.0.1.0
 - Oracle Diagnostics and Tuning Pack
 - Oracle Enterprise Manager 10g Database Control (Bundled)
 - Database Configuration Assistant (Bundled)
 - SQL Plus (Bundled)
 - *Microsoft*
 - SQL Server 2000 Enterprise Edition
 - SQL Server Enterprise Manager (Bundled)
 - SQL Server Query Analyzer (Bundled)
 - SQL Server Profiler (Bundled)

Note: All comparisons were performed using the database management tools bundled with the products under consideration. Since this study was a comparison of the stock manageability features bundled with these two products, no third-party or add-on software was taken into consideration in the course of conducting this study.

Appendix II - Architectural and Terminology Discrepancies Requiring Clarification

Both Oracle Database 10g and Microsoft SQL Server 2000 are mainstream relational database management systems. Yet, relative to how these products have been designed to execute their respective database management functions, a few key architectural and terminological discrepancies should be clarified so that both Oracle and SQL Server users reading this report will have a clear understanding of the synonymous terms and tasks comprised within this comparison. (See Appendix VI for a Glossary of Terms)

In terms of disk resources, the physical definitions of what defines a database are essentially the same for both Oracle and SQL Server. From this perspective, a database is a repository of information contained in one or more data files logically organized into one or more tablespaces (in Oracle) or file groups (in SQL Server). Yet a deeper look into the logical structures that define the term “database” reveals a few interesting differences.

First of all, a distinct difference exists in how database users are defined in Oracle and in SQL Server. In Oracle, a user is an atomic entity. In SQL Server, a user has two elements: a global login and a local database user. This difference arises from the fact that Oracle is an open platform product designed to run on many operating systems, and as such cannot rely on the underlying operating system to behave in a certain way. In order to operate in a consistent manner across all supported platforms, it must implement and encapsulate all critical objects (such as users) and functions (such as authentication) that are required by the DBMS. By contrast, SQL Server has both the luxury and the liability of being totally dependent on Microsoft Windows. Given this tight coupling between SQL Server and Windows, SQL Server leverages many Windows features running in the background as operating system services (e.g., Active Directory) to accomplish various operations. Identity management of database users is the main area of significant differences between these products, which brings up the key difference in how these products logically define a database.

In Oracle, databases are logically considered schemas. While there is no schema object in Oracle, all database are organized and identified as schemas. A schema in Oracle is defined as all of the objects that are

owned by a particular database user account. Oracle schemas are (typically) partitioned into one or more application-specific tablespaces. In SQL Server the logical definition of a database into a schema is not explicit, as it is in Oracle. Furthermore, while SQL Server does make it possible to allow one or more users to own one or more databases on a server, typically all databases on a SQL Server are owned by the *dbo* account, and the logical schema relationship between a user and a database is not emphasized. As far as SQL Server file groups are concerned, they are synonymous with Oracle tablespaces.

The preceding section has highlighted the main architectural and terminology discrepancies between the Oracle 10g and SQL Server. The overarching differences in the articulation of core product terminology, and the way the vendors advise companies to manage large-scale database installations using their products, is important in understanding the Comparative Management Costs that these products will exact for an IT organization. This is especially true in light of the self-maintaining database features that are now available in Oracle 10g.

Appendix III - Detailed Test Results

Task	Description	Time (mins)		Complexity (steps)	
		SQL Server	Oracle	SQL Server	Oracle
Installation and Simple "Out-of-Box" Setup Tasks					
1	Install db/software/out-of-box setup	12.7	20.2	5	2
2	Create 2nd database server/instance	13.2	6.5	6	3
3	Setup proactive monitoring	1	0.5	2	1
	Category Sub-Total	26.9	27.2	13	6
	% difference -- (SS - Oracle)/SS*	-1%		54%	
	DBA Workday Savings	0%		3%	
Day-to-Day Database Administration Tasks					
4	Create user with roles, privileges	0.7	0.7	1	1
5	Create tablespace/filegroup	0.8	0.5	2	1
6	Add space to database	0.5	0.5	1	1
7	Create table	0.5	0.7	1	1
8	Create index	0.5	0.5	1	1
9	Reclaim space due to fragmented data	3.7	2	3	2
10	Load data from text file	3.5	4.3	2	4
	Category Sub-Total	10.2	9.2	11	11
	% difference -- (SS - Oracle)/SS*	10%		0%	
	DBA Workday Savings	3%		0%	
Backup and Recover Tasks					
11	Configure and perform full backup	3.2	0	3	0
12	Recover dropped table	6.3	0.3	7	2
13	Recover data file	6.8	7.7	1	1
14	Recover from erroneous transaction	6.3	3.3	7	5
	Category Sub-Total	22.6	11.3	18	8
	% difference -- (SS - Oracle)/SS*	50%		56%	
	DBA Workday Savings	7%		8%	
Performance Diagnostics and Tuning Tasks					
15	Diagnose performance problem	12	2	3	1
16	Tune resource-intensive SQL	10	2	5	2
17	Tune memory	0	1.3	0	2
	Category Sub-Total	22	5.3	8	5
	% difference -- (SS - Oracle)/SS*	76%		38%	
	DBA Workday Savings	20%		10%	
Overall Total		81.7	5.3	50	30
	% difference -- (SS - Oracle)/SS*	35%		40%	
	Total DBA Workday Savings	30%		20%	

* SS: SQL Server

Appendix IV – Complexity Calculation Formula

Complexity is defined as the number of computed steps it takes to complete a given task. The formula used to compute complexity for each of the tasks in this study is as follows.

1. For every five increments contained in a step we increase the step value by 1. For example:
 - If a step has 0-5 increments, step value = step + 0,
 - If a step has 6-10 increments, step value = step + 1
 - If a steps has 11-15 increments, step value = step + 2
 - ... and so on.
2. The type of instrumentation offered to perform a given task modifies the tasks complexity.
 - If a task can be performed completely with a GUI, then step count = step count + 0.
 - If a task requires the use of a command line interface, then step count is modified as follows:
 - If the command line operation consists of a single line command, then step count = step count + 1.
 - If the command line operation requires writing a script, then step count = step count + 2 or more steps, depending on a subjective assessment of the complexity of the script.
3. If a task requires a context switch between different environments, then step count = step count + 2 or more steps, depending on a subjective assessment of the complexity of the context switch.

In the case of point-in-time recovery operations (task 12 and task 14), we exercised the right to assess step penalties that we consider exceptions to these rules, due to the open-ended subjective and analytical nature of the operations required to successfully complete those tasks.

Appendix V - Detailed Task Descriptions²

Installation and Simple “Out-of-Box” Setup

Task 1: Install database and management software, and create starter database

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Install DB Server & Management Software, Set up Networking configuration	1. Launch the Oracle Installer * Specify File Locations * Select Installation Type (Enterprise Edition) * Select Database Configuration (Create Starter Database, General Purpose) * Specify Database Configuration Options(DB Naming, DB Char Set, DB Examples) and keep defaults. * Select DB Management Option and keep defaults * Select DB File Storage Options and keep defaults * Select Backup and Recovery Options, Set Enable Automated Backups and keep defaults * Set Backup Job Credentials with the username and password of a user with at least backup operator privileges. * Specify Database Schema Passwords and use same password for all accounts. Install	20 min 10 sec	1. Launch the installer * Enter Computer Name * Installation Selection (Create new instance...) Client Tools * Enter User Information * Accept License Agreement * Installation Definition (Select Install Server and Client Tools) * Enter Instance Name * Setup Type (Typical) * Services Accounts (Use Same account for each service/Use a Domain User Account) * Authentication Mode (Mixed) * Enter username and password for OS user * Select authentication Mode * Enter Licensing Information Install 2. Apply SQL Server Service Pack * Unpack sql2ksp3.exe * Execute \sql2ksp3\setup.bat * Accept the License Agreement	12 min 40 Sec

² In the Task Description tables, “*” in the Step column, represents *increment* for the step. For more information on this metric refer to the section, The Methodology Defined.

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Task	Oracle		SQL Server	
	Step	Time	Step	Time
			* Select an instance to patch * Select Authentication Mode * Select Backward Compatibility Options * Choose Error Reporting Options Install	
Management framework setup	Part of the install	N/A	Part of the install	N/A

Metrics	Oracle	SQL Server
Time	20 min 10 sec	12 min 40 Sec
Steps	1	2
Increments	9	19
Adjusted Steps (Complexity)	2	5

Task 2: Create additional database server/instance

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Create a new database instance	1. Launch DBCA from the Start Menu * Create new database * Select General Purpose Database Template (this is selected by default) * Enter New Database Name and SID * Select Management Options and keep defaults (Use DB Control for DB Mgmt) * Enable Daily Backup by setting Start time, OS User Name and Password. * Set DB Credentials and Use Same password for all accounts. * Set storage options	6 min 30 sec	1. Launch the installer * Enter Computer Name * Installation Selection (Create new instance...) Client Tools * Enter User Information * Accept License Agreement * Installation Definition (Select Install Server and Client Tools) * Enter Instance Name * Setup Type (Typical) * Services Accounts (Use Same account for each service/Use a Domain User Account) * Authentication Mode (Mixed) * Enter username and password for OS user * Select authentication Mode * Enter Licensing Information	13 min 10 Sec

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Task	Oracle		SQL Server	
	Step	Time	Step	Time
	and keep defaults. * Select DB file locations and keep defaults. * Set recovery configuration and keep defaults * Specify Database Content and keep defaults * Configure Initialization Parameters and keep defaults * Specify Database Storage and keep defaults * Set Creation Options Finish		Install 2. Apply SQL Server Service Pack * Unpack sql2ksp3.exe * Execute \sql2ksp3\setup.bat * Accept the License Agreement * Select an instance to patch * Select Authentication Mode * Select Backward Compatibility Options * Choose Error Reporting Options Install 3. Register newly created instance in EM * Right click on SQL Server Group → New SQL Server Registration * Enter new instance name '<host name>\<instance name ' Finish.	

Metrics	Oracle	SQL Server
Time	6 min 30 sec	13 min 10 Sec
Steps	1	3
Increments	13	21
Adjusted Steps (Complexity)	3	6

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Task 3: Set up pro-active monitoring for performance and space utilization

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Create task to monitor for performance problems and space issues	N/A		1. Go to * SQL Server Enterprise Manager → Management → SQL Server Agent → Alerts → New Alert... * Set Type: SQL Server performance condition alert, * Set Object: SQL Server: Databases, * Data File(s) Size (KB) *Set Alert if counter: "falls below" 100KB OK	30 secs
Set thresholds for each event, save event, and start monitoring database	1. Go to the Manage Metrics" page (EM home page, * Click on the "Manage Metrics" link). * Click the "Edit Threshold" button. This takes you to the "Edit Thresholds" page. * Set threshold for <i>Buffer Cache Hit (%)</i> . OK	30 sec	2. Go to * SQL Server Enterprise Manager → Management → SQL Server Agent → Alerts → New Alert... * Set Type: SQL Server performance condition alert, * Set Object: SQL Server: Buffer Manager, * Set Counter: Buffer Cache Hit Ratio *Set Alert if counter: "falls below" 80 OK	30 secs

Metrics	Oracle	SQL Server
Time	30 sec	1 min
Steps	1	2
Increments	3	10
Adjusted Steps (Complexity)	1	2

Installation and Simple "out-of-box" Setup Tasks Results Summary

Metrics	Oracle	SQL Server
Time	27 min 10 sec	26 min 50 sec
Steps	3	7
Increments	17	50
Adjusted Steps (Complexity)	6	13

Day-to-Day Database Administration

Task 4: Create user, assign roles/privileges

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Create User and Assign Role(s)/Privs	1. Navigate in EM to the <i>Administration</i> tab and... * Select Security→Users link. * Select the Create button and enter the username, password. * Select the default tablespace information for the new user. (The CONNECT role is granted by default) OK.	40 secs	1. Create New User Login: From SQL Server Enterprise Manager Navigate to the desired server and... Select Security → Logins → Right Click New Login... * Enter login account name, authentication method and pick the default db. * Select the Server Roles tab and grant any server level roles you desire to the user, * Select the Database Access Tab and choose the DB's that can be accessed by this user. OK.	50 secs

Metrics	Oracle	SQL Server
Time	40 sec	40 sec
Steps	1	1
Increments	3	3
Adjusted Steps (Complexity)	1	1

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Task 5: Create tablespace/filegroup

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Create table-space	1. Go to the EM <i>Administration</i> tab and... * Select the <i>Tablespaces</i> link. Click the Create button and enter tablespace name * Click the Add Button in the Datafile section * Enter datafile path/name, and size. Click <i>OK</i>	30 sec	1. From SQL Server Enterprise Manager → Databases * Select Database → Properties → * Click on the Filegroups tab * Add a new file group in the name column of the table Click OK 2. From SQL Server Enterprise Manager → Databases * Select Database → Properties → * Click on the Data Files tab *Add a new datafile by clicking the ellipses in the location column of the Database files table * Enter a datafile path/name, select a file group and set sizing information or keep the defaults Click OK	50 sec

Metrics	Oracle	SQL Server
Time	30 sec	50 sec
Steps	1	2
Increments	3	6
Adjusted Steps (Complexity)	1	2

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Task 6: Add more space to the database

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Add more space to the DB	1. Go to the EM <i>Administration TAB->Tablespaces</i> link. * Choose the <i>Add Datafile</i> option and click <i>GO</i> . * Enter new file name and size. Click <i>OK</i> .	30 sec	1. From SQL Server Enterprise Manager → Databases → highlight your Database * Select Database Properties * Click on the Data Files Tab: * Select an existing datafile and enter new space Allocated Click <i>OK</i> .	30 sec

Metrics	Oracle	SQL Server
Time	30 sec	30 sec
Steps	1	1
Increments	2	3
Adjusted Steps (Complexity)	1	1

Task 7: Create table

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Create table	1. Go to the EM <i>Administration Tab->Tables</i> link. * Click the <i>Create</i> button. (This launches the table creation wizard.) * Enter table name, 3 columns with data types (number, varchar2 and date) Click <i>OK</i> .	40 sec	1. From SQL Server Enterprise Manager → Tables * Select New Table * Enter 3 columns and data types (number, char and Date) * Click on the Save Icon. * Enter a table name and click <i>OK</i> Close the Create Table Window.	30 sec

Metrics	Oracle	SQL Server
Time	40 sec	30 sec
Steps	1	1
Increments	2	4
Adjusted Steps (Complexity)	1	1

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Task 8: Create index

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Create Index	1. Go to the EM <i>Administration</i> Tab -> <i>Indexes</i> link. * Click <i>Create</i> button. (This launches index creation page.) Enter index name, table name, and columns. Click <i>OK</i> .	30 sec	1. From SQL Server Enterprise Manager → Database → Tables ... * Select an existing table and right click * Select All Tasks → Manage Indexes... * Click on the New Button * Name the index, Select column names and sort order. Click <i>OK</i> and Close the dialog.	30 sec

Metrics	Oracle	SQL Server
Time	30 sec	30 sec
Steps	1	1
Increments	2	4
Adjusted Steps (Complexity)	1	1

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Task 9: Reclaim Lost Space due to Fragmented Data

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Determine if any tables in the application tablespace need to be reorganized.	1. Run Segment Advisor on the associated tablespace.	30 sec	N/A (In SS there is no automated mechanism to determine whether or not the internal file structure of a database need to be optimized.	
Execute shrink command	2. Accept Advice	1 min 30 sec	1. Create a Database maintenance plan to shrink a specific database... From SQL Server Enterprise Manager → Maintenance → Database Maintenance Plans → New Maintenance Plan... * Select the db to shrink * Select "Remove Unused space from Database Files and set size and free space parameters as desired * Set Database Integrity Parameters as Desired * Set Database Backup Parameters as Desired * Set Transaction Log Parameters as desired * Set Report Parameters as desired * Set Maintenance Plan History as Desired * Name the Shrink DB Maintenance Plan Finish 2. Execute Shrink DB Maintenance Plan Job... From SQL Server Enterprise Manager → Maintenance → Database Maintenance Plans → SQL Server Agent * (If not running) Start SQL Server Agent * Select Jobs * Right click on the newly created Shrink DB Maintenance and Select Start Job.	3 min 40 sec

Metrics	Oracle	SQL Server
Time	2 min	3 min 40 sec
Steps	2	2
Increments	0	11
Adjusted Steps (Complexity)	2	3

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Task 10: Load data from a text file

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Data Loading	1. Create SQL*Loader control file: based on Oracle documentation example. 2. Load data in the table: the command to run is: sqlldr <username>/password> control= <file name> Execute Script	4 min 20 sec	1. From SQL Server Enterprise Manager → Data Transformation Services →right click → New Package. * Create connection (Connection * MS ole db provider for SQL Server * Enter db name Click OK. 2. Create bulk insert task "Bulk Insert Task" and specify... * file source * table destination * specify file format (or format file) Execute	3 min 30 sec

Metrics	Oracle	SQL Server
Time	4 min 20 sec	3 min 30 sec
Steps	2	2
Increments	N/A	6
Command line scripting penalty	2	0
Adjusted Steps (Complexity)	4	2

Day-to-Day Database Administration Tasks Results Summary

Metrics	Oracle	SQL Server
Time	9 min 10 sec	10 min 10 sec
Steps	9	10
Increments	12	37
Adjusted Steps (Complexity)	11	11

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Backup & Recovery

Task 11: Configure and Perform Full Database Online Backup

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Configuring for online backup	N/A (Oracle 10g recommended backups are configured and scheduled automatically upon database creation.)	0 min	1. Create a Database maintenance plan to backup a specific database... From SQL Server Enterprise Manager → Maintenance → Database Maintenance Plans → New Maintenance Plan... * Select the db to backup * Select Data Optimization Parameters as Desired * Set Database Integrity Parameters as Desired * Set Database Backup Parameters as Desired * Set Transaction Log Parameters as desired * Set Report Parameters as desired * Set Maintenance Plan History as Desired * Name the DB Maintenance Plan Finish	2 min 40 sec
Perform backup		0 min	2. Execute DB Maintenance Plan Job... From SQL Server Enterprise Manager → Maintenance → Database Maintenance Plans → SQL Server Agent * (If not running) Start SQL Server Agent * Select Jobs * Right click on the newly created DB Maintenance Plan and Select Start Job.	30 sec

Metrics	Oracle	SQL Server
Time	0	3 min 10 sec
Steps	0	2
Increments	0	11
Adjusted Steps (Complexity)	0	3

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Task 12: Recover Dropped Table

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Recover dropped table.	1. Recover table using "FLASHBACK TABLE <table name> TO BEFORE DROP" command.	20 sec	1. * Identify the time when the table was dropped. 2. Perform database point-in-time recovery... From EM → right click on Database → Restore Database * Select files and transaction logs to be restored * Check button for point-in-time recovery. * Select Transaction Log File and the time you want to recover up to. click OK. 3. Manually redo lost transactions.	6 min 20 sec

Metrics	Oracle	SQL Server
Time	20 sec	6 min 20 sec
Steps	1	3+
Increments	0	4+
Command line usage penalty	1	0
Adjusted Steps (Complexity)	2	7

*Note: Oracle 10g offers both command line and GUI interface to perform this operation. After deliberation, we determined that the simplicity of executing a single command on the SQL*Plus command line was the simplest way to perform this operation. Furthermore, after calculating complexity as defined above, it was determined that in purely technical terms, the command line and the GUI methods for executing this operation were of equal weight, though subjectively we felt that the command line operation was the simpler of the two means. For SQL Server this was a non-trivial operation with essentially the same process as was required in the recover from erroneous transaction as described in task 14. The fact that we were required to manually redo all lost transactions after the point in time when the table was dropped was a serious disadvantage. Because of this, we were forced to assess four manual operation penalty steps against SQL Server in this area. Two of these steps were assessed because in a*

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real world environment chances are reasonable that there will be multiple transactions executed on the database between the time of the error and the time of the recovery that will have to be manually recovered. The other two steps were assessed due to the lack of a native hot recovery architecture. In SQL Server, we were forced to shut down the database in order to complete the recovery operation. In Oracle, we were able to flash back the dropped table while the database was running and continue as if nothing had happened. This was one of two areas in the study where we actually assessed step penalties based on subjective criterion outside the scope of the methodology complexity definition specified at the outset of this paper.

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Task 13: Recover Data File

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Data file recovery: application data file of size 1.2 Gigs is lost.	1. Go to the EM <i>Maintenance</i> tab and Click on <i>Perform Recovery</i> link. This launches the Recovery Wizard. * Specify the datafile(s) you want to recover. * Specify the Recovery Location Review Recovery Parameters & Submit.	7 min 40 sec	1. From EM → Tools → Restore Database * Check the file recovery button * Select the file to be recovered. OK	6 min 50 sec

Metrics	Oracle	SQL Server
Time	7 min 40 sec	6 min 50 sec
Steps	1	1
Increments	2	2
Adjusted Steps (Complexity)	1	1

Note: The time to actually perform a datafile recovery in a real-world scenario varies greatly based on file size and the speed of the system performing the operation.

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Task 14: Recover from erroneous transaction

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Recovery scenario: Due to a human error, a transaction was submitted by mistake	<ol style="list-style-type: none"> Go to the tables page in EM (<i>Administration</i> → <i>Schema</i> → <i>Tables</i>), * Select the INVENTORIES table and * Select <i>Action</i> “Flashback by Rows Versions”, and click <i>Go</i> button. (This shows the operations performed on the INVENTORIES table.) Identify the operation performed (DELETE in this case) * Click on the <i>Transaction ID</i> link to see what other tables were affected by the same transaction. * Highlight the exact SQL needed to undo the entire transaction. Execute the undo SQL identified in step 2. * Copy the desired recovery SQL statement from EM Flashback by Rows Results. * Paste the Flashback statement into a iSQL*Plus/SQL*Plus Command Window. * Execute the Command. 	3 min 20 sec	<ol style="list-style-type: none"> * Identify the time when the erroneous transaction occurred. Perform database point-in-time recovery. From EM → right click on Database → Restore Database * Select files and transaction logs to be restored * Check button for point-in-time recovery. * Select Transaction Log File and the time you want to recover up to. Click OK. Manually redo lost transactions 	6 min 20 sec

Metrics	Oracle	SQL Server
Time	2 min 40 sec	6 min 20 sec
Steps	3	3+
Increments	7	4+
Context switch penalty	2	0
Adjusted Steps (Complexity)	5	7

Note: We found the necessity to cut and paste between different areas of the Oracle 10g Database Control Interface somewhat annoying. This was due to incomplete integration of the flashback transaction into the version of Oracle Enterprise Manager (EM) Database Control we used for this test. As a result of this incomplete integration, we assessed a 2 step context switch penalty against Oracle in this area. On the other hand, the relative accessibility and ease of use

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for a transaction recovery operation as tested here was a vast technical improvement over anything we have seen from any other vendor in the past. This feature allowed us to undo an erroneous transaction, using native software features, against a live database, in a finite period of time, within a finite period of steps, in a relatively straightforward manner, without having to shut down the system. On the other hand, while the GUI interface found in SQL Server was easier to use for about 80% of the operation, the fact that we were required to manually redo all lost transactions after the point in time up to which we recovered the database was a serious disadvantage. Because of this, we were forced to assess 4 manual operation penalty steps against SQL Server in this area. Two of these steps were assessed because in a real-world environment chances are reasonable that there will be multiple transactions executed between the time of the error and the time of the recovery that will have to be manually recovered. The other two steps were assessed because, due to the lack of a native hot recovery architecture in SQL Server, we were forced to shut down the database in order to complete the recovery operation. This was one of two areas in the study where we actually assessed step penalties based on subjective criterion outside the scope of the methodology complexity definition specified at the outset of this paper.

Backup & Recovery Task Summary

Metrics	Oracle	SQL Server
Time	11 min 20 sec	22 min 40 sec
Steps	6	10
Increments	9	21
Adjusted Steps (Complexity)	8	18

Performance Diagnostics & Tuning Tasks

Task 15: Diagnose performance problem

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Configure system to identify top resource consuming SQL	N/A	0	1. From EM launch SQL Profiler (it can also be launched from Startup Menu → Programs → Microsoft SQL Server → Profiler. In the Profiler * Start a trace event (File → New → Trace) and a dialog box appears. * Select the relevant events * Start the trace with output sent to a file. * Run a representative workload.	2+ mins
Identify resource intensive SQL	1. Go to the EM home page and review the last ADDM report.	2 min	1. Stop the trace event and view the trace file from SQL Profiler. * Analyze trace file for resource costs like CPU, duration, writes, etc., * Manually identify the top resource intensive SQL. 2. Repeat until Problem is Identified	10+ mins

Metrics	Oracle	SQL Server
Time	2 min	12+ min
Steps	1	3
Increments	0	6+
Adjusted Steps (Complexity)	1	3

Note: Oracle 10g has a new feature, the Automatic Workload Repository (AWR) that proactively captures performance statistics and SQL workloads. This obviates the need for manual configuration like that needed for SQL Server for performance diagnostics.

The new self-diagnostic engine of Oracle 10g, Automatic Database Diagnostic Monitor (ADDM), proactively analyzes AWR to identify performance related issues and recommends appropriate remedies for them. In our test scenario, the cause of the performance problem was a bad SQL statement that was consuming too many resources. Given that SQL statements are often the predominant cause

of the performance problems; this was considered to be a realistic scenario. ADDM automatically and proactively identifies SQL statements that are overloading the system. This is why in Oracle a user needs to only look at the ADDM report to track performance issues. On the other hand, SQL Server has employed a more traditional model that requires visual analysis of trace files using its SQL Profiler tool. As a result, problem diagnostic in SQL Server took significantly longer than Oracle. It should, however, be noted that ADDM is a general solution that identifies all types of performance problems and not just SQL problems, whereas the method employed for SQL Server is specific to problem SQL identification.

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Task 16: Fix Performance Problem (Tune SQL Statement)

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Tuning SQL	1. From the ADDM report page, click on Run SQL Tuning Advisor button to tune resource-intensive SQL identified in the previous task. 2. Navigate to EM Advisor Central page * Click on the SQL Tuning Advisor task result * Accept SQL Tuning Advisor Recommendations.	2 mins	Depending on subjective performance problem analysis: 1. Open the SQL Server Query Analyzer and... * Paste Problem SQL into the Query Analyzer Editing pane. * Open the Index Tuning Wizard by going to the Query->Index Tuning Wizard Menu Item * Select the correct Server, the Database and the Tuning Mode. * Specify the Workload Option and choose Query Analyzer Selection * Adjust Advanced Options (if necessary) * Select the tables to tune. * Accept Index Tuning Wizard Recommendations Finish. 2. If the performance problem persists... * Rewrite poor performing SQL manually * Infer and apply optimizations based on output provided by the SQL Server Query Analyzer's execution plan tool.	10+ mins

Metrics	Oracle	SQL Server
Time	2 min	10+ min
Steps	2	2
Increments	2	9
Context switch penalty	0	2
Adjusted Steps (Complexity)	2	5

Note: For Microsoft SQL Server 2000, the process of tuning a poorly performing complex SQL Statement is mostly manual (index tuning being the only exception); therefore, given the fact that this task will almost always take a significant and variable period of time, we feel that 10+ minutes is a fair, conservative estimate of how long it would take an expert performance engineer to perform this task on Microsoft SQL Server 2000 against a wide range of

tunable queries encountered in a real world environment. On the other hand, Oracle Database 10g's SQL Tuning Advisor tunes SQL statements more comprehensively by looking at all aspects of SQL tuning as they apply to the Oracle database, e.g., index creation, query restructuring, statistics analysis, and SQL profiling. Hence, no manual tuning was required in Oracle's case. The only interaction with the user is in launching the advisor and accepting its recommendations, once they are generated. Since the actual tuning is carried out by the advisor in the background while a DBA is free to perform other activities, the time taken by the advisor to generate the recommendations was not included in the timing of this task.

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Task 17: Tune Memory

Task	Oracle		SQL Server	
	Step	Time	Step	Time
Tune memory	1. Check the latest ADDM report. 2. Change SGA_TARGET and/or PGA_Target based on ADDM advice.	1 min 20 sec	N/A (SS performs automated memory tuning)	0 min

Metrics	Oracle	SQL Server
Time	1 min 20	0
Steps	2	0
Increments	0	0
Adjusted Steps (Complexity)	2	0

Performance Tuning Task Summary

Metrics	Oracle	SQL Server
Time	5 min 20 sec	22 min (+)
Steps	6	4
Increments	0	10 (+)
Adjusted Steps (Complexity)	4	10

Appendix VI – Glossary of Task Areas/Tasks

Database Setup and Configuration (Workload Task Area): Database setup and configuration is a workload task area that encompasses all of the operations that a DBA would need to perform in order to accurately install and configure either product prior to using it in a real world application.

Install db/software/out-of-box setup: Install db/software/out-of-box setup is the workload task that identifies the process of installing and configuring either of these products for the first time.

Create new database server/instance: Create new database instance is the workload task that allows a DBA to create a second Database Server/Instance on a computer already running one or more instances of the RDBMS.

Set up proactive monitoring: Proactive monitoring is a tool that allows a DBA to identify problems with the RDBMS before they become performance or operational issues. Setting up monitoring is crucial in providing a highly reliable system.

Day-to-Day Database Administration (Workload Task Area): Day-to-Day Database Administration is the workload task area where all of the routine DBA operations of creating database users and objects (such as tables, indexes, triggers, procedures) as well as granting and revoking roles/privileges plus database table/tablespace/datafile sizing occur.

Create user with roles, privileges: Create user with roles, privileges setup is the workload task that allows DBAs to manage user security in the database.

Create tablespace/filegroup: Create tablespace setup is the workload task that allows DBAs to a new tablespace for use by a particular database instance or schema.

Add space to database: Add space to database is the workload task that allows a DBA to add data files to a filegroup/tablespace thus increasing the amount of space available to all of the objects contained in that database.

Create table: Create table is the workload task that allows DBAs to create a table object to store information inside a schema in the database.

Create index: Create index is the workload task that allows DBAs to create an index on a set of columns in a table that are heavily queried in order to speed the execution of queries run against that table.

Reclaim wasted space from tables with fragmented data: Reclaim wasted space from tables with fragmented data is the workload task that allows DBAs to pack/shrink the database after prolonged use in order to consolidate space and optimize performance.

Load data from text file: Load data from text file is the workload task that allows a DBA to load information from an external source such as a flat file or spreadsheet into one or more tables in the database.

Backup and Recovery Tasks (Workload Task Area): Backup and Recovery Tasks is the workload task area where all tasks pertaining to database backup and recovery are performed.

Configure and perform full backup: Configure and perform full backup is the workload task that allows DBAs to schedule and execute regular system backups as part and parcel of standard system fault tolerance operations.

Recover dropped table: Recover dropped table is the workload task that allows a DBA to recover a table that has been inadvertently dropped from the database by a DBA, developer or Power User in the course of working with the database.

Data file recovery: Data file recovery is the workload task that allows the DBA to recover a datafile from a backup copy in the event of a media failure.

Recover erroneous transaction: Recover erroneous transaction is the workload task that allows an DBA to undo a mistakenly executed transaction (insert, update, delete, select into..., sp_bad_proc(p_fubar)); in order to restore the object(s) ill effected by this transaction to the state it (they) was (were) in before the transaction was executed.

Performance Diagnostics and Tuning Tasks (Workload Task Area): Performance Diagnostics and Tuning Tasks is the workload task area where all performance related diagnostic, tuning and optimization tasks are performed.

Diagnose performance problem: Diagnose performance problem is the workload task that allows a DBA to analyze a poorly performing system in order to assess the performance problem as a prerequisite to performing the systems optimization functions (such as creating additional indexes, tuning a query/procedure, defragmenting tablespaces

or adjusting the servers memory configuration) required to bring the level of system performance to an optimal state.

Fix performance problem (tune SQL statement): Fix performance problem (tune SQL statement) is the workload task that allows DBAs to optimize a poorly running query/procedure so that it executes in an efficient manner.

Tune Memory: Tune memory is the workload task that allows DBAs to adjust server/instance system memory configuration parameters in order to efficiently support the load placed on the system by all of the applications that access that particular instance/server.