



Linux Databases: DB2 vs. Oracle

Main Report

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Introduction

This is a report prepared by Branham Group Inc. that compares the two leading commercial database software packages for Linux: Oracle 9i version 9.2 Enterprise and IBM DB2 version 8.1.2 ESE. This comparison is based on cost of ownership, ease-of-use, reliability, and scalability. The following report will focus exclusively benefits, issues, and costs relevant to Linux based database installations. Where prices are quoted, they are for products listed as available for delivery to the continental US as of July 31, 2003 and are in US Dollars.

The modern database plays a critical role in any business, large or small. The ability to provide reliable, safe, and efficient data services to an organization is a high priority for any CEO or IT Manager. Meeting this need while responding to increasing budget pressure can be challenging. Because of its powerful, reliable, low-cost, and open nature, Linux-based database servers are the top choice of businesses to host their corporate data assets.

Due to the rapid growth of the Linux operating system in the datacenter, and in response to customer demand for a powerful Linux database, many vendors are starting to provide database software for Linux servers. IBM DB2 for Linux allows organizations to leverage the power and reliability of Linux with a database solution that is cost effective, efficient, and reliable.

Cost of Ownership

Establishing and operating a database service can be a large expenditure for any company. Funds are required to purchase the hardware that the database will run on, the license for the database software itself, maintenance costs, and staffing costs associated with configuring and maintaining the database. DB2 provides significant advantages to companies in terms of the Total Cost of Ownership (TCO) compared to Oracle. In most cases it costs companies, regardless of size, less to use DB2 for their database services. DB2 is less expensive to license, configure, administer and maintain. This comparison will not address the cost of support and maintenance contracts, which are difficult to reliably price using publicly available information and, for large clients, are often subject to large variance in price due to negotiations and the differing levels of support each enterprise may require. Support for database software may also be combined with support for other products from the same vendor, further complicating price estimates.

Licensing Costs

When establishing a database, one of the first costs that a company faces is the cost of licensing the database software. Most software licenses are based on the number of processors in the server and the various features that are enabled with the software. License costs often include charges for client access. The cost of these client access licenses can rapidly increase the cost of any large-scale installation. In particular, online systems that service a large number of users can face hefty licensing costs. In this section we will compare the licensing schemes and general pricing for both Oracle and DB2 software. Later in this document we will provide examples of licensing costs for some sample implementations. Database versions intended for development, embedded systems, testing, or evaluation are not considered in this report.

Oracle Licensing

Oracle has three primary production editions of its database software available for sale: Oracle Database Enterprise Edition, Oracle Database Standard Edition, and Oracle Database Special Edition. The enterprise edition of Oracle includes features for large-scale computing, including support for clustering and business intelligence features at additional cost.

The enterprise and standard editions of Oracle include a combination of processor count or user licenses to determine licensing costs. The standard per processor cost for the enterprise edition is \$40,000 USD or a requirement for at least 25 user access licenses per processor at \$800 USD per license (\$20,000 USD). The standard edition of Oracle is available for \$15,000 USD per processor or a requirement for at least 5 user access licenses per processor at \$300 USD per license (\$1,500 USD).

The addition of Oracle RAC technology for clustering requires the purchase of additional licenses. This feature is licensed at an additional cost of \$20,000 USD per processor or a requirement for the same number of user access licenses as the database software license at the cost of \$400 USD. This would equal an additional minimum cost of \$10,000 USD for the Enterprise edition.

Pricing information for most Oracle versions can be easily accessed through the Oracle website by potential clients. The website includes clear instructions on licensing options and information on license rules for most Oracle database software. One notable exception was Oracle Special Edition software, which did not have a clearly identified pricing structure available online and as such, cannot be fully compared to DB2 Express.

DB2 Licensing

IBM provides three primary editions of its database software to customers for use in production systems: DB2 Universal Database Enterprise, Workgroup, and Express version.

The enterprise server edition of DB2 is licensed on a processor count basis at a price of \$19,750 USD per processor. DB2 Workgroup Server Unlimited Edition is available for \$4,500 USD per server and DB2 Workgroup Server Edition (limited to 4-way) is available for a cost of \$500 USD per server and \$205 USD per user. DB2 Express is a fully functional version that can be installed on servers up to two processors in size and is licensed at a cost of \$499 USD per server and an additional charge of \$99 per named user.

DB2 requires additional licensing costs for clustering over the basic cost of licensing the Enterprise version of the software. The use of the DB2 Data Partitioning Feature (DPF) requires an additional payment of \$7,500 USD per

processor.

Information on the cost of licensing DB2 software is available on the IBM website but is somewhat more difficult to access. Obtaining pricing information requires navigation to multiple screens and not all versions are listed in the same location or format. The requirement for combined processor and/or user license fees is not clearly stated in a manner obvious to a customer. This inconvenience is negated somewhat by the fact that IBM does offer an online quote service. This feature allows a potential customer to request a detailed quote based on their specific database requirements.

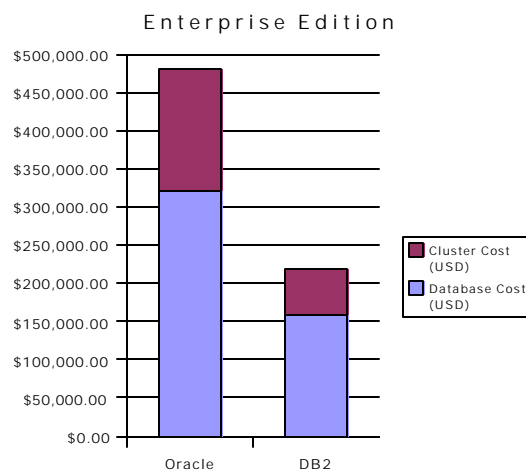
Licensing Cost Overview

While pricing information for DB2 licenses is more difficult to obtain, the prices are favorable when compared to Oracle for all sizes of companies and most scenarios.

Enterprise Version Comparison

For enterprise grade installations, DB2 is less expensive to license in the most realistic scenarios. Oracle is 150% to 220% more expensive in the selected scenarios below.

Based on the costing information available, Oracle comes closest to the cost of DB2 when comparing a single processor server that is licensed for 25 or fewer users. In this scenario, Oracle is \$20,000 USD while DB2 is available for \$19,750. This represents a negligible difference. However, as the number of users grows up to 50, the pricing advantage of DB2 expands. Beyond 50 users the Oracle pricing scheme favors the use of the per processor license at \$40,000 USD, at which point Oracle is over 50% more expensive than DB2.



When using a larger server such as two four-processor servers, for DB2 the

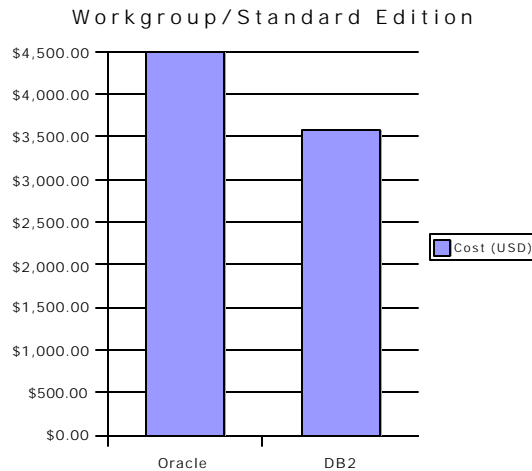
licensing costs for the Enterprise edition would be $8 \times \$19,750 = \$158,000$ USD and $8 \times \$7,500 = \$60,000$ USD for DPF resulting in a total of \$218,000 USD. For Oracle, the per processor based pricing would be $8 \times \$40,000 = \$320,000$ USD for the basic software and $8 \times \$20,000 = \$160,000$ USD for RAC. This raises the total price for Oracle to \$480,000 USD.

This is just over twice the cost of licensing the DB2 solution. Oracle becomes less expensive using the per-user option in this scenario, for under 65 users. However, this low user count is not realistic for an enterprise scale installation.

Standard/Workgroup Version Client/Server Comparison

Both vendors offer a Standard or Workgroup edition of their software that is tailored towards a small or medium sized business. In comparing these versions we will use a single dual-processor server servicing 15 users as the basis for the example.

For DB2, the per-server licensing costs would be \$4,500 USD while the user based license would cost $\$500 + (15 \times \$205) = \$3,575$ USD. In this case it would be less expensive to license DB2 by the user count. For Oracle, the per processor licensing costs would be $2 \times \$15,000 = \$30,000$ USD while the user based license would cost $15 \times \$300 = \$4,500$ USD. In this case both Oracle and DB2 are less expensive to license by user count. In this example the DB2 software is 25% more expensive to license than Oracle. The Oracle software would become less expensive to license at less than five users, but Oracle imposes a user count limit of a minimum of five users. In all of the scenarios identified as fitting within the licensing terms, DB2 software was less expensive than Oracle, with the price difference increasing as system size and user counts increase.



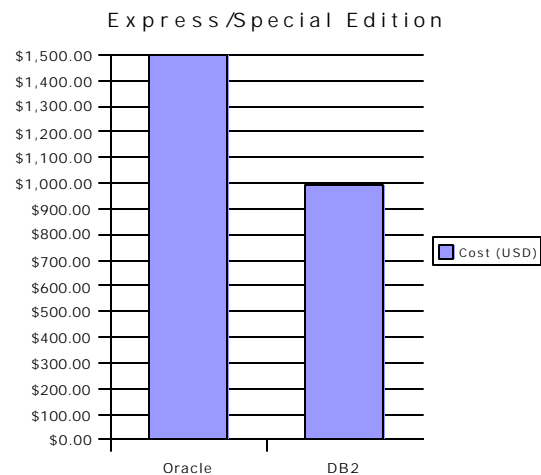
Standard/Workgroup Version Internet Comparison

Small or medium size business could also use the Standard and Workgroup editions of DB2 and Oracle to power Internet based applications. In this case the user based license modes become impractical. The sheer number of unique users forces database software to be licensed based on processor counts. In this example we will compare DB2 and Oracle running a database for an Internet application on a 2 processor server.

For DB2 the per-server licensing costs would be \$4,500 USD while for Oracle the per processor licensing costs would be $2 \times \$15,000 = \$30,000$ USD. This shows that for this example application, Oracle would be over 6x more expensive to license.

Special Edition/Express Comparison

Since pricing information for Oracle Special Edition was limited, only the specific configurations of the software based on marketing information from IBM and Oracle are compared. If a 5-user system is compared, it would cost \$994 USD to license DB2, while Oracle would cost \$1,500 USD to license. This means a 50% surcharge if a company chooses to license Oracle.



Licensing Summary

In most of the scenarios looked at in this section, DB2 licenses ranged from nearly the same price for a simple installation to under 1/3 of the price of Oracle licenses. The structure of the Oracle licenses indicates that this price difference continues to grow as more processors are installed on servers and as installations become more complex. The DB2 licensing structure and price list offers a clear advantage to companies seeking to purchase database software.

Administration Costs

In this section, the relative costs of administering DB2 and Oracle database software will be compared. These comparisons are based on information

obtained from DB2 and Oracle DBAs regarding the amount of time and number of steps required for various administrative tasks. These time differences will be reviewed in order to derive a qualitative comparison of the administration cost over time.

Installation Activities

The activities involved in the installation of a single instance of a database server were compared. It took an experienced Oracle DBA 21 minutes to install a single instance starting with a basic Linux installation. A DB2 DBA was able to install the database software in only 6 minutes starting from an identical Linux installation. This means that for a basic stand-alone installation, Oracle will take over three times as long to install and result in three times the administration costs.

Exact timing data for a cluster specific installation tasks for DB2 or Oracle are not available at this time. However, information regarding the steps required for the installation of both database software packages in a clustered environment was reviewed. Both DB2 and Oracle require significant configuration changes to both the database software and the underlying Linux system. These changes are similar in magnitude and will be considered equivalent. However, Oracle requires that some additional software modules be installed in the form of the Shared Disk Subsystem and Real Application Cluster software. Given the size of these software packages it is likely that these installations will at least double the amount of time required to complete an Oracle installation.

It is important to note that the additional software (RAC) used by Oracle requires a significantly higher level of skill to install than the relatively straightforward installation of clustering under DB2. DB2 clustering is part of the software package and is enabled through 8 individual steps.

Although installation is a relatively minor expense over the life of a database solution, it can be significant in terms of a project plan and staffing levels. DB2 offers significant savings in terms of taking approximately 1/7th the amount of time to install and requiring far less specialized training.

Operations Costs

While hard to predict and quantify, the operating cost of a database over the entire lifetime of the installation represents the largest segment of its Total Cost of Ownership. In the continental US, the average DBA will earn approximately \$50-55,000 USD in salary and cost a company nearly \$75,000 USD once all of the employment costs are included. The cost can be significant and DBA expenses are a notable part of most companies' IT budgets. In this section we will look at the various tools that the two vendors provide to assist DBAs in maintaining their systems and how they impact the cost association with administering databases.

Oracle Overview

Oracle provides GUI based management tools for day-to-day administration tasks. These include dataspace allocation, table creation and removal, backup administration, performance monitoring, data transfer, and other common database administration activities. The default tools provided with Oracle are useful but require a fair degree of skill to operate. DBAs must be intimately familiar with the intricacies of Oracle and receive little guidance from the tools included in the base package. This increases the skill level required for a DBA to use Oracle database software and will subsequently increase salary costs. Additional tuning, diagnostic, transformation, and data extract utilities are available for Oracle, but they are purchased separately and are an additional cost over Oracle's already higher licensing costs. These are tools that are necessary for any serious database installation and would need to be purchased by any company running a database. Failure to acquire and use these utilities at extra cost would leave a company with a sub-optimal database and would be a waste of the sizable investment already made in software and hardware. It may also impact the reliability and availability of the database with serious impact on the company's operations.

Performance tuning and the debugging of database problems can be very tedious and time consuming. Oracle's performance and diagnostic tools provide the DBA with a wide range of information about their databases. Oracle provides a great deal of information about the condition of a database and makes provision for traditional guidance and help on improvements. As well, Oracle provides more detailed information on the specific thread, statement, procedure, etc. that is responsible for consuming processing

resources or memory. This provides a good starting point for investigating a performance problem. However, much of the details of planning and implementing improvements still remains with the DBA. This increases the amount of time a DBA must spend on optimization tasks and increases the cost of database operations.

When the number of steps required for common administration tasks were compared, Oracle required fewer individual steps to complete tasks such as view creation, user creation, and user deletion. However, the advantage that Oracle enjoys on these tasks is slim with the number of steps required, being very close to those required by DB2.

DB2 Overview

Packaged with DB2 is a complete set of GUI tools for maintenance and operational support of databases. Like Oracle, the DB2 tools provide wizards and screens for common database administration activities. However, DB2 takes the tools to a higher level with fewer steps required for most administration activities and the addition of intelligent autonomic features.

Autonomic computing is a term that is used to describe self-monitoring and self-healing software. Autonomic features are used to make software more reliable and easier to manage. IBM has made a significant investment in autonomic computing and includes a number of autonomic features in DB2 that have no direct peer in the 9i version Oracle software. DB2's autonomic features include a Configuration Advisor and a Health Monitor.

The autonomic Configuration Advisor allows expert advice and guidance to a novice DBA. The autonomic software is more than a simple help file or wizard, it delivers significant value by adapting to input and the conditions of the database as well as providing concrete information that enhances the skills of DBAs.

Once a database is configured the DB2 Health Monitor provides monitoring of key performance and reliability information. When the Health Monitor's advanced technology detects a situation that could be improved or that needs to be remedied it determines the best approach to make the required change. The tool then offers expert advice to the DBA and helps them to implement the

required changes.

DB2 includes several non-autonomic wizards that also help to manage administration costs. Included in DB2 are the Memory Visualizer and Index Advisor. While based on more traditional technology, both of these tools are effective in reducing the amount of time a DBA must spend configuring a database and as a result they reduce the cost of managing the database.

Hardware Costs

Neither Oracle nor DB2 offer significant differences in hardware requirements for equivalent servers. For most real-world implementations, differences in application design, database design, implementation, and specific network features will impact the performance more than the speed difference between these two products.

There is only one significant difference that becomes apparent between Oracle and DB2 in terms of hardware costs. When deployed using RAC, Oracle will require additional network switching capacity and possibly additional hardware for the management of the cluster. This additional requirement is not present with DB2, which can work using one common network for handling requests and cluster management. While cost of this additional capacity is relatively minor, it does provide DB2 with an advantage when comparing hardware costs.

Cost Summary

When looking at purchasing database software, it is important that a company looks at all of the costs associated with acquiring and maintaining that software. The cost of purchasing licenses and hardware are only the first costs to consider. While difficult to quantify and predict, maintenance and administration cost may represent approximately 80% of the total ownership cost of most software.

DB2 offers clear advantages in all of these areas by providing low licensing costs and efficient management tools. From a costing perspective, these two features combined make DB2 a better choice than Oracle.

Ease of Use

Many DBAs favor DB2 because it requires fewer preparation steps than Oracle before the software is installed on a server. DB2 is also more efficient during the installation process, with fewer steps and less time required than the slower and more cumbersome Oracle setup. Once installed, DB2 allows common tasks to be completed quickly and easily. The advantage of DB2 is even greater when dealing with large database clusters. The benefit of DB2 is easier training, reduced training expenses, and reduced staffing costs.

Standalone Installation

During installation, DB2 saves time and effort by providing an easy-to-use setup procedure. DB2 takes half the steps and usually one-third the time to install compared to Oracle. Oracle requires additional steps to create specialized user ids on the server. DBAs must create special use disk mounting points and configure additional environment variables. These cumbersome tasks increase the expense of an installation, staff frustration, and the probability of installation failures.

Cluster Installation

Many modern datacenters operate clusters of database servers for increased performance and availability. Management of clusters with DB2 is more reliable, faster, and more efficient than on Oracle.

The installation of an Oracle database using Real Application Clusters (RAC) is far more complex and requires significantly more time than the DB2 counterpart. A clustered installation of Oracle RAC magnifies the slower, single instance installation and requires additional component installations. At least three major additional software components and a shared disk system must be installed and configured in order to operate an Oracle cluster; this is in addition to the complex base installation. DB2 simply requires that the installation be repeated on each node with a few simple steps to configure the cluster.

In addition, the Oracle RAC documentation is over 1000 pages in length. This is a considerably large amount of documentation for an administrator to search through for information. The size of the documentation also points to the complexity of using RAC technology.

Conversely, DB2 clustering is simple to configure and requires far less documentation. Administrators are much more likely to be successful in clustering database servers with the simple and clean installation of DB2.

Once configured, a cluster of DB2 servers is easier to manage due to DB2's intuitive and powerful GUI administration tools. These tools make managing a cluster of servers nearly as simple as managing a single standalone server.

Administration

The GUI based administration tools for DB2 allow for easier management of databases and result in lower operating costs.

For example, DB2 allows the DBA to quiesce a user, instance, or database from the GUI tool. Oracle DBAs, on the other hand, must open a console window and enter manual commands. This latter case increases the likelihood of an error and the possibility of an accidental outage.

DB2 also provides more tools for administration of databases. The configuration advisor and performance tools are only available for DB2 databases. Oracle does not have tools that duplicate this valuable functionality and rely on manual optimizations or wizards that are less capable.

Finally, DB2's autonomic features can recommend or even take corrective action in a range of situations such as table space becoming full or sub-optimal memory utilization. This feature improves the productivity of DBAs and reduces reliance on their specific skill sets.

Ease of Use Summary

Oracle and DB2 both provide similar tools for the administration of databases. These tools require a similar number of steps for most common tasks and provide guidance on performing those tasks. DB2 offers a more sophisticated set of setup and monitoring tools in the form of the Health Monitor and Configuration Monitor. The autonomic features of DB2 provide an advantage over Oracle and enhance the existing skills of the DBA. If a database installation requires clusters, Oracle RAC is more difficult to configure than DB2 clusters.

Reliability

Linux provides an organization with a reliable and high-performance operating system. Many Linux servers have uptime measured in months and years. We will look at a number of subjective and quantitative factors that indicate the reliability to be expected of both Oracle and DB2 software. Code quality represents an important means of determining the reliability of a software product. One means of determining the quality of a given product is to compare the types of bug fixes and patches that are released for a particular product. We will also look at the reliability of each product and the experience of the vendor in producing reliable systems.

Vendor and Product History

Far from being “Unbreakable”, the Real Application Clusters component of Oracle has been directly linked to at least one serious day-long outage for the online airline booking system run by Orbitz. Despite Oracle's best support efforts, the recovery of the site required the heroic and risky decision to re-architect the online application. Full functionality was only restored once the application was changed to eliminate the RAC technology. Attempts to locate any similar events related to DB2 found no outage of equivalent public and serious nature that was attributable directly to DB2 technology.

There are other indications from the technology media that question the reliability of Oracle software. This includes the following two quotes from Infoworld and CNN respectively:

“Oracle is patching four security flaws in its database software...the most serious of which could allow an attacker to take complete control of a system running the software”-Infoworld²

“Despite the vendor’s claims, the Oracle 9i database is breakable”-CNN³

These quotes, amongst others, from respected mainstream media, give an indication that there may be some reliability problems with Oracle.

Oracle itself admits that it has little experience in large clusters of database servers using Linux or any other platform. Larry Ellison, the CEO of Oracle, in a keynote speech at the 2002 San Francisco Linux World stated, “We don't

have a lot of experience with real big production systems more than 16 nodes.” This should give any CEO or IT manager looking for a scalable, enterprise grade, Linux database solution pause when considering the many issues that Oracle’s lack of large-scale experience presents.

Patch History

An analysis of the code patches for DB2 and Oracle was performed in order to compare the relative reliability of each product. Patch history is useful since the patches for both products identify the type and seriousness of the defect that they address. Patch histories are also useful since they only address issues that have caused problems for companies using the product and therefore are indicative of the reliability issues that a customer can expect to encounter. In comparing these values, each fix is usually in response to a problem found by one or more customers and is equivalent to a DB2 APAR, or an Oracle TAR fix.

This analysis includes the first three patch sets which were made available for Oracle 9i R1 over a 6-month period. These three patch sets are compared to DB2 fix pack 5,6, and 7, which also occurred over a 6 month period. Oracle was found to have released more fixes for some essential parts of the software. Here are some specific examples:

- Oracle has had .4X more defects that affected database recovery processing⁴
- Oracle has had 6.7X more defects to fix incorrect result sets⁵
- Oracle has had 4.2X more defects that result in hangs⁶
- Oracle has had 3.3X more defects that cause data corruption⁷
- Oracle has had 3.7X more defects that would result in instance failures⁹

and perhaps most critical for companies involved in online activities

- Oracle has had 8.7X more defects related to security⁹

In addition to patches for Oracle, RAC technology has had 51 patches applied that relate to serious issues including data corruption, crashes, and performance problems. One particular defect would cause all of the nodes in a cluster to fail if one node failed.¹⁰

Reliability Summary

The reliability of DB2 is reflected in the lower number of patches required to solve problems which customers encounter. Oracle requires more patches and does not have the experience in large-scale systems, which would be required to produce reliable enterprise grade software. Based on the indicators that have been reviewed, DB2 is the more reliable choice.

Scalability

Scalability is very important to both growing companies who are looking to invest in database software and large companies looking to implement large systems. As the load that a database installation supports grows, it is important to be able to grow the database in an affordable and timely fashion. If a company is involved in online transactions they can be faced with the need to rapidly expand their database capabilities while preserving their original investment in software. In addition, the ability to add new nodes to an existing database cluster helps to preserve the investment in existing hardware. In this section we will compare aspects of the scalability of both DB2 and Oracle database software.

Linear scaling is important as database clusters grow. If a database does not scale in a linear manner, as nodes are added to a database cluster the effectiveness of each subsequent node is diminished. This means that a company faces a decreasing return on their investment in both hardware and software. Both Oracle and DB2 have published claims indicating that their database software scales in a linear fashion. In reviewing these claims we will be using data published by the Transaction Processing Performance Council (TPC) on their web site¹¹ as well as information provided by SAP on their website¹².

We will first look at the scalability of Oracle. In reviewing both the SAP and TPC results, Oracle demonstrates an average scalability factor of 1.8X. This means that for each doubling of the number of nodes, the performance is only increased 1.8X. This is a cumulative loss and this means that for each doubling, 20% of the gain is lost. Projected onto larger clusters it also means that after 8 nodes, the addition of new nodes will actually reduce the performance of the cluster. In fact, this is likely why Oracle has not certified their RAC technology in clusters of over 8 nodes in size. This scaling is clearly not linear and means that companies using Oracle will be very limited in their ability to expand clusters.

DB2 presents itself as a much more scalable product. Through the use of well segmented design, DB2 reduces the requirement for communication between nodes. This reduces the overhead imposed by the clustering environment and makes DB2 scale in a much more linear fashion. When the DB2 results in a

series of TCP tests in 2000 on 7.1 Enterprise were compared it became evident that DB2s use of SMP resulted in very linear scaling. DB2 achieved a 93-98% scaling efficiency rating during those tests. This represents a very high efficiency and implies very linear scaling. In fact, DB2 is certified to scale up to 1000 nodes, 125X larger than Oracle.

DB2 provides linear scalability to customers, which helps them to better preserve their hardware investment. DB2 can be scaled up to 1,000 nodes as compared to Oracle, which is limited to 8. In summary, DB2 provides far more effective and powerful scalability than Oracle.

Conclusion

In this report we have looked at the cost, ease of use, reliability, and scalability of both Oracle and DB2 database software. When comparing the two packages, publicly available qualitative and quantitative data was considered in an effort to provide guidance on the merits and shortfalls of each product.

Oracle was a much more expensive product to license. Its prices varied from slightly higher than DB2 to over twice the cost of an equivalent DB2 license. In addition, the nature of Oracle's management tools, complex RAC configuration, and extensive documentation mean that labor costs for Oracle will likely be higher than for DB2. Review of both company and product history in terms of media reports, software patches, and select outage information indicated that Oracle had far more problems with code quality and as a result, may be a less reliable product for companies to use. Oracle was harder to use than DB2, requiring a higher degree of skill and effort on the part of the DBA. Although the number of steps in many common tasks were similar, DBAs did not have the benefit of the autonomic features which are available with DB2. Finally, much of the scalability information available indicated that Oracle would not scale as well as DB2.

In this comparison, given the information available at the time of the report, DB2 provides far greater value than Oracle. Indications are that DB2 is less expensive, easier to use, more reliable, and scales better than Oracle software. The only downside to DB2 that was apparent is the IBM website. Much of the pricing and documentation information is much harder to find and in some cases appears to not even be available, compared to Oracle's website.

References

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IBM, and DB2 are trademarks of International Business Machines

Linux is trademark of Linus Torvalds

LinuxWorld is a trademark of IDG

Orbitz is a trademark of Orbitz, LLC

Pricing information was vendor supplied for these versions:

Oracle 9.2.1.0 Enterprise Edition

IBM DB2 UDB V8.1.2 ESE (Enterprise)

¹ Orbitz: Oracle to blame for site outage
Linda Rosencrance
Computerworld
July 18, 2003

Orbitz Blames Oracle for Web Site Outage
Lisa Vaas
eWeek
July 17, 2003

² InfoWorld 2/18/2003 http://www.infoworld.com/article/03/02/18/HNoracleflaw_1.html

³ CNN 02/2003 <http://www.cnn.com/2002/TECH/industry/02/09/oracle.security.idg/>

⁴ Backup and recovery bugs listed as fixed

⁵ Incorrect results. Oracle delivered 67 fixes for wrong results in the listed time period

⁶ Patches for bugs resulting in hangs or spins

⁷ Patches for bugs resulting in corruption problems

⁸ Patches for bugs including crash recovery, memory leaks, and ORA-600 internal errors. Based solely on a count of defects and does not include pervasiveness of any given defect. As a result this report does not compare the likelihood that a particular defect will affect a given customer. This is not a guarantee that any given customer will experience more or fewer defects for a given product.

⁹ Patches for bugs which have been classified as security related.

¹⁰ Patches reported for Real Application Clusters

¹¹ www.tpc.org

¹² www.sap.com/benchmark