Oracle Database 10*g* vs. Microsoft SQL Server 2000: Technical Overview

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INTRODUCTION

In order to survive and remain competitive, today's modern organizations must focus on:

- Improving their efficiency and productivity

- Better understanding their business, their customers and their partners

- Seizing new opportunities and enabling change

For the modern business, information is the most valuable asset it has at its disposal in its effort to drive competitiveness. Organizations that can effectively use their business information are the ones most likely to profit and survive in today's tough economic climate. How effectively an organization can use its information depends on what it has at the heart of its information infrastructure. Data is just bits and bytes on a file system. Only a database can turn the bits and bytes of data into business information.

To further address these business needs, Oracle Database 10*g* is the first infrastructure software designed for grid computing, one that effectively pools large numbers of low cost, standardized servers and storage into a flexible, on-demand computing resource that meets all computing needs. From small and medium businesses to enterprise shops, Oracle Database 10*g* allows existing applications to be run on these new computing infrastructures, thereby protecting your investment in existing applications. Customers can quickly and easily create a computing infrastructure from inexpensive, off-the-shelf components like server blades and commodity storage and grow this infrastructure as their business grows. Oracle's 10*g* platform then delivers the required performance, scalability, reliability and security needed to run mission critical applications on these low cost environments. Oracle's 10*g* platform offers high performance and scalability because all computing resources can be flexibly allocated to applications as needed.

The Oracle Database has been designed to provide the most complete and low cost solution for any business information management requirement, and is the only solution available today that can:

- Provide proven performance, scalability, and capacity on demand for any business requirement.

- Guarantee that critical business information is available when needed.

- Secure and protect the privacy of sensitive business information.

- Reduce the time it takes for a business to make better business decisions.

- Enable an organization to develop and deploy business solutions quickly.

- Reduce costs for managing, deploying and maintaining the information

This paper illustrates how the Oracle Database delivers on each of these value propositions by highlighting key enabling technologies and measurable proof points.

To more clearly portray the uniqueness of the Oracle Database's strengths, comparisons will also be made against Microsoft's SQL Server 2000.

PROVIDE PROVEN PERFORMANCE, SCALABILITY, AND CAPACITY ON DEMAND FOR ANY BUSINESS REQUIREMENT

Business Value

Successful businesses need the ability to scale their infrastructure as they grow. A scalable system avoids the need to build an entirely new system with new software and hardware components each time the system has reached its capacity limits. The system continues running the same software and only requires hardware resources to be added as required to support the increase in activity. Applications do not need to be rebuilt or redesigned when resources are added. This is the essence of the Grid computing architecture that effectively pools any number of servers and storage into a low-cost, flexible, on-demand computing resource for all computing needs.

If a business cannot implement transparently scalable solutions, every attempt to grow will meet with increased costs, as well as inevitable time and availability delays. When a system becomes overloaded, the lack of resources will result in a degradation of performance when the workload exceeds the system's limitations. In this way, a lack of scalability can directly affect overall performance and a business's ability to grow.

A typical example is a retailer's Web site accessing catalog data. If the number of concurrent users accessing the web site exceeds the anticipated demand and if the system is not scalable then the response time degrades rapidly to reach unacceptable levels. Statistics have shown that the average customer visiting a web site will wait no more than 20 seconds before losing patience and going elsewhere, often to a competitor. A lack of scalability means customer dissatisfaction, just as unacceptable levels of performance will invariably lead to lost customers – a cost no business can afford.

Oracle Database versus SQL Server 2000

The Oracle Database is the only information management solution that is proven to scale to meet all business requirements on all hardware platforms, from single processor and mid-range multiprocessor systems to large scale SMP, MPP, mainframe, and clustered environments. This proven scalability unlocks the full potential of any hardware and operating system investment and ensures any organization will be able to meet all business requirements in the future.

SQL Server only runs on the Windows platform, so any future growth of a business is then also limited to the Windows platform! Outgrowing Windows means a huge investment of time and money to upgrade all the hardware and software systems to Unix or Linux, migrate the data to a more scalable database, and rewrite all the applications to run against the new database. With Oracle, you never need to worry about outgrowing your hardware, since Oracle data and applications are fully compatible and portable across all hardware and operating systems platforms.

Oracle – Fast and Scalable

Oracle delivers a TPC-C benchmark at 1,008,144 tpmC on a single 64 CPU SMP machine, compared to SQL Server 2000 delivering 786,646 tpmC on the same machine [1]. This benchmark comparison shows the scalability of SQL Server 2000 to be very poor on large SMP machines compared to Oracle: on large systems, Oracle delivers an additional 200,000+ tpmC, compared to SQL Server 2000 on identical hardware. Historically, Microsoft has never focused on scaling on high end SMP boxes. More than 99% of all SQL Server installations are on 4 CPU or smaller machines.[2] To support more than 8 CPUs requires the use of Windows DataCenter, which adds to the overall cost of the configuration. **On identical 4 CPU machines, Oracle on Linux outperforms SQL Server 2000 on Windows 2003, and delivers that performance at a lower cost.[3]**

In addition to TPC benchmarks, Oracle also runs real-world applications benchmarks such as those on Oracle Applications and SAP. As of this publication:

- Oracle holds the top four SAP 2-tier Assemble to Order ATO benchmarks[4] with a record of 34,260 orders per hour.

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[1] Source: Transaction Processing Council, as of Feb. 19, 2004, HP Integrity Superdome - http://tpc.org/

[2] Source: http://www.alwayson-network.com/comments.php?id=2413_0_1_0_C

[3] Oracle 4-CPUs on Linux: www.tpc.org
Microsoft 4-CPUs on Windows 2003:
http://tpc.org/tpcc/results/tpcc_result_detail.asp?id=103042401

[4] SAP Benchmark — Certification Number 2001018 Oracle 8.1.7, 128 way, Sparc64 560Mhz, 128GB, Solaris8, 2-tier.
http://us.fujitsu.com/news/2001_07/20010716_01.html

- Oracle holds the top two SAP 3-tier Assemble to Order ATO benchmarks, SQL Server does not have any SAP 3-tier ATO benchmark results recorded.[5]

- Oracle holds the top seven SAP SD 2-tier results.[6]

- Oracle holds the top three results for the SAP SD Parallel benchmark, while SQL Server has not been able to publish any.[7]

Oracle Database outperforms SQL Server on all of these very important, and according to SAP, most popular benchmarks. Clearly, Oracle is more capable of fully exploiting available processing power than SQL Server.

Why is Oracle Database the Fastest and Most Scalable?

Platform Independence for Unconstrained Change

The Oracle Database provides unique portability across all major platforms, and ensures that your applications will run without modification even after changing platforms. This is because the Oracle code base is identical across platforms, so you have identical feature functionality across all platforms, for complete application transparency. No more re-writing of applications when you have to change hardware/software platforms as you outgrow your systems. Because of this unique portability, Oracle does not lock you into a single operating system; you can easily upgrade to a more powerful operating system as your requirements change. No need to modify your data or modify your applications because you have outgrown the system you were running on. Oracle grows with your business.

In addition, Oracle Database 10*g* allows you to fully leverage the power and performance of a grid architecture. Because of Oracle's unique portability, customers can move from their existing infrastructure to Grid computing at their own pace. At each step along the way they can achieve higher levels of efficiency, lower operating costs and a rapid return on investment. Any kind of system – mainframes, UNIX, Windows and Linux servers – can be used to build an enterprise Grid based on Oracle's 10*g* platform. Oracle software can even integrate applications and data held in non-Oracle systems into a Grid. SQL Server is of course limited to only the Windows platform, and has no technology for supporting a grid architecture.

Reduced Information Conflict for Increased Access

Oracle Database's unique multi-version read consistency model minimizes internal contention for data. By avoiding contention, the number of users who can simultaneously access data increases. SQL Server 2000's architecture can

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[5] http://www.sap.com/benchmark
[6] http://www.sap.com/benchmark
[7] http://www.sap.com/benchmark

only offer this level of concurrency at the price of data accuracy. <u>Oracle supports more concurrent users than SQL Server 2000, thus reducing the need for hardware upgrade costs</u>.

Utilize Commodity Hardware to Do More With Less

Real Application Clusters, breakthrough technology unique to Oracle, allows cheap, commodity hardware to be clustered together to provide a highly scalable but low-cost platform that supports more users online, without incurring the cost and time to re-develop or re-deploy existing business applications. Oracle Real Application Clusters is the only database available today for enabling grid computing, with Automatic Service Provisioning and integrated clusterware. Automatic Service Provisioning provides hands-free allocation of servers to workloads or services. Clients are automatically routed to the appropriate server with the lowest load. Integrated clusterware eliminates the need to purchase, install, configure and support costly 3rd party clusterware.

SQL Server 2000 has no clustered database architecture.

SQL Server 2000 has no clustered database architecture. In Aug. 2001, the earliest projected date of a true clustered database, according to Gordon Mangione, Microsoft Vice President of SQL Server, was the year 2003.[8] Now, a clustered database has fallen off the feature list for SQL Server yet again. According to the latest statements from Microsoft, clustering will be sometime in the future **after** the next release of SQL Server.[9] Even the next release has slipped scheduling again, so it's now planned at the earliest for the first half of the year 2005. So, real clustering, for SQL Server, is still years away. For several years, Microsoft has been recommending the use of federated databases as the only means to achieve real scalability with SQL Server 2000. This requires designing the applications and dividing the data across the federated group of databases. The loss of any one of these databases means that the applications are unable to run, so availability of data is greatly impacted. Additionally, any change to the data structure, the applications, or to the number of nodes requires re-designing the application as well as the layout of the data on the disks. This configuration only runs a TPC-C benchmark, or custom applications. It cannot run real world business applications without significant tailoring of the configuration and the applications, thereby greatly increasing the costs of development and deployment. More recently, Microsoft seems to be admitting to the unworkable nature of their federated architecture. They are now touting the concept of scaling up within an SMP box, as evidenced by their 32-CPU TPC-C benchmark on a Unisys machine. As stated earlier, Oracle significantly out-performs SQL Server on a 32-CPU SMP machine, and of course Oracle certainly scales beyond the 64-CPU limit of SQL Server.

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[8] SQL Server Magazine, August, 2001 - Foundation for the Future
[9] eWeek Magazine,Sept. 9, 2002, SQL Server Boss Gives a Sneak Peek - Gordon Mangione http://www.eweek.com/article2/0,3959,522725,00.asp

Further, with Oracle Real Application Clusters, an organization can start small, with low-cost commodity hardware, and grow quickly so it can immediately react to increased demand for business services, without the cost of additional application development and database administration efforts. This provides a high quality of service at a low cost, by leveraging inexpensive server blades and commodity storage in a grid environment. Oracle Real Application Clusters combined with Oracle Database 10*g* Standard Edition provides a low-cost solution with which SQL Server cannot compare.

GUARANTEE THAT CRITICAL BUSINESS INFORMATION IS AVAILABLE WHEN NEEDED

Business Value

Today's businesses are increasingly reliant on technology to provide competitive advantage, increase productivity, reduce costs and empower their users to make faster informed decisions. Increased reliance on technology introduces new challenges for businesses. Should applications become unavailable, entire businesses are exposed. Revenue and customers may be lost, penalties incurred, and bad press can have a lasting effect on both customers and stock prices. Providing continuous data availability is essential for today's businesses. It is not always easy to place a direct cost on downtime. Disgruntled customers, idle employees, and bad press are all costly, but not directly measured in terms of hard currency. Over recent years there have been various efforts to quantify the revenue cost of downtime, planned or unplanned. According to The Standish Group's DARTS studies, one minute of system downtime can cost an organization anywhere from $2,500 to $10,000 per minute. Using that metric, even 99.9 percent data availability can cost a company nearly $5 million dollars a year. (DARTS = Demand Assessment Requirements Tracking Study, an ongoing study by the Standish Group).

Oracle Database versus SQL Server 2000

Oracle Database is the most cost effective database for ensuring minimal downtime and zero data loss. It takes care of most scenarios that might lead to data unavailability, such as system failures, data failures, disasters, human errors, system maintenance operations and database maintenance operations. In addition, Oracle Real Application Clusters provides high availability for mission critical applications.

Oracle is the database that powers such businesses as Amazon.com and eBay, which depend on Oracle database's reliability to provide continuous service to their large customer base.

SQL Server 2000 does not provide equivalent functionality for high availability or data protection. To provide even a minimal approximation of some of the same functionality as Oracle Database, SQL Server 2000 requires more

hardware, additional third-party software or extensive custom development—all leading to increased cost of ownership.

Why Oracle Database Delivers the Highest Availability

System Failure Protection

Oracle database recovery allows the Database Administrator (DBA) to provide service level guarantees for the system, ensuring the database availability meets the business needs. Oracle Real Application Clusters and Oracle Failsafe provide continuous availability to a database in the event of a system failure. Automatic application failover masks the failure from the users so their work continues uninterrupted.

SQL Server has only minimal database functionality for recovering from system failures, such as normal crash recovery after a system failure and active-passive failover on a cluster using Microsoft Cluster Server. Beyond that, it doesn't provide any of the more powerful capabilities offered by Oracle such as Fast Start Time-Based recovery, Mean Time to Recover (MTTR), Real Application Clustering with Transparent Application Failover, file multiplexing, partitioned backups and partitioned recovery, etc. They provide the bare minimum system recovery capabilities, with no optimizations for fastest possible restart of the system. Every minute counts in terms of money while waiting for the system to restart!

Automatic Backup and Recovery for Maximum Availability

Perform on-disk backups using the new Oracle Database 10*g* Recovery Area feature. This has many benefits. First, the Recovery Area is completely self-managing. Oracle server will automatically age out old backup and archive log files and will maintain only the current ones in the Recovery Area. Administrators no longer need to worry about keeping the Recovery Area size small by deleting old backups, nor do they need to keep track of the archive logs that are needed for recovery. Second, Recovery Area offers a unified storage location for all backup files, e.g., control files, archive logs, data files, flashback logs, etc. This speeds up the recovery process since all files needed for any recovery activity are located in one place and the database is aware of that location. Third, backup and recovery activity in the Recovery Area is very fast since disk access relative to tape access is extremely fast and efficient. On current disks, data anywhere on the disk can be accessed in a few milliseconds.

Online Maintenance Operations for Continuous Availability

Oracle Database server almost completely eliminates the need to bring down a database while an administrator is performing maintenance operations on the database. The online data redefinition feature improves data availability, database performance, response time and disk space utilization. Indexes can be added, rebuilt or de-fragmented. Tables can be relocated, de-fragmented,

reorganized or have their storage parameters changed. Schema evolution allows table definitions to be modified while the data table is in service. The Oracle Database recovery manager can make full or incremental backups of data while the database server is online. Additionally, table partitioning can be used to take just a portion of a table off-line, while the rest of the table is in-use, thus improving availability of the data even further.

SQL Server 2000 does not support the extensive set of online operations and recovery operations that Oracle Database does. It is missing online schema evolution, table partitioning, table reorganizations, table re-definitions and secondary index creations on index-organized tables. As a result, the data is unavailable while these operations are being performed. Since maintenance operations are done quite frequently and can take hours to complete, SQL Server 2000 applications can suffer significant data unavailability. Most modern businesses cannot afford to halt their business operations for an undetermined length of time while the tables are being reorganized. <u>Any amount of downtime can translate into lost productivity as well as revenue loss.</u>

Protection from User Errors

Users can make mistakes such as entering the wrong values or deleting the wrong set of rows. To recover from this type of mistake, in the past the database administrator had to go through a tedious process of restoring backups to retrieve the correct information. Oracle Database's unique Flashback technology provides the capability to allow an administrator or a user to view the database at a point-in-time in the past. Developers can use this feature to build self-service error correcting applications, empowering end-users to undo and correct their errors without delay.

Specifically, Flashback Database quickly rewinds an Oracle database to a previous time, to correct any problems caused by user errors. It eliminates the down time associated with restoring a backup, and makes it extremely easy to recover from unexpected errors.

Flashback Table provides the DBA the ability to recover a table or set of tables to a specified point in time quickly, easily and online. It restores the tables while automatically maintaining the associated attributes such as current indexes, triggers and constraints, to maintain data and transactional integrity.

Flashback Drop provides a safety net when dropping objects in Oracle. When a user drops a table, Oracle automatically places it into the "Recycle Bin". This is a virtual container where all dropped objects reside. Objects remain in the Recycle Bin until either Oracle needs to reclaim the space or the owner of the objects permanently removes them by issuing the PURGE command. As long as a dropped object remains in the recycle bin, it can be recovered using a simple SQL statement.

SQL Server 2000 does not have anything like this comprehensive technology. Therefore, SQL Server 2000 administrators have to get involved in diagnosing and correcting end user errors. They then need to perform a point-in-time recovery, which is a very tedious, time-consuming operation. <u>SQL Server 2000 has significantly higher administrative and downtime costs in recovering from end-user errors</u>.

Standby Databases

A common high availability technique is to maintain a separate standby database for disaster recovery purposes. Oracle Data Guard completely automates the task of setting up standby databases. It continually ships logs from the primary to the standby across the network and can immediately apply the data in the standby site. When the primary database becomes unavailable, applications can fail over to the standby databases transparently and continue processing. To perform system maintenance operations, it is easy to switch over to a standby database.

SQL Server 2000 does not offer a comparable standby solution, so it cannot fully protect you from site disasters. It has no ability to provide zero data loss mode, or multiple standby sites with delayed application times. Also, it does not provide the graceful switch over and switch back to and from the production site and the standby site.

SECURE AND PROTECT THE PRIVACY OF SENSITIVE BUSINESS INFORMATION

Business Value

The fact that modern organizations can derive exceptional competitive advantage from their business information is a double-edged sword. Competitors can use the very information that a business uses to ensure its competitiveness. In addition, the push towards more and more consolidated customer information being shared with larger numbers of users dramatically increases the requirement to protect the privacy of sensitive personal information. Also, as more and more users are brought online both inside and outside an organization, the ability to strongly authenticate and centrally manage a large user population becomes paramount.

Oracle Database versus SQL Server 2000

May 29, 2003, the Computer Security Institute's eighth annual Computer Crime and Security Survey reported that corporations lost nearly $202 million due to security breaches. More than ninety percent of large corporations and government agencies had detected computer security breaches within the last 12 months, and 75% acknowledged financial losses due to breaches, according to

the Computer Security Institute's fifth annual Computer Crime and Security Survey[10].

Oracle Database offers all the features and functionality required to secure and protect all important business information. It addresses all major security hazards, providing a wide choice of authentication and authorization mechanisms and protecting data from prying, even by the database administrator. It supports a number of different application architectures including two-tier, three-tier, Internet-based and hosting. Oracle has completed more independent security evaluations (17) than Microsoft. The one security evaluation SQL Server 2000 passed is the **obsolete** C2 certification. In contrast, Oracle's database is fully certified with industry standard security evaluations.

Oracle Database centralizes and simplifies administration of security within an enterprise. For large businesses with lots of users, databases, applications, passwords, access privileges and roles, Oracle Database offers the most cost effective solution for administering security.

Security is <u>not</u> a hallmark of Microsoft and SQL Server 2000 carries on that tradition. SQL Server 2000 lacks most key security features needed for enterprise use. As a result:

- SQL Server 2000 is unsuitable for many deployment scenarios.

- Developers have to compensate for the missing features by implementing them in their applications. This increases development costs and makes the application more difficult to maintain, and increases security risks. The cost of ownership is much lower if you build security *once*, instead of implementing it in every application that accesses data.

- The SQL Server 2000 database itself provides very little security, unlike Oracle where security is built into the data server.

- Compared to Oracle Database, administering security in a SQL Server 2000 environment costs more. Microsoft has recommended a federated or distributed database approach for scalability, yet this environment is the costliest in terms of enforcing security. It is much more difficult to enforce consistent security across many small, possible geographically distributed databases. In a single, centralized database installation, enterprise level security is implemented just once, and can be modified and maintained quickly and easily as needed.

Why Oracle Database Provides a Strong Security Infrastructure

User Security

Oracle Database integrates the power of database security with centralized user and privilege management in a directory. The key differentiators are

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[10] http://www.gocsi.com/press/20030528.html

- Reduced cost of administering users and other network entities across databases

- Consistent user management across heterogeneous platforms (including Windows platforms)

- Unified user model that serves the web applications and database security

- Integrates with existing security framework - Kerberos, PKI and passwords

Although SQL Server provides Kerberos support for Active Directory users in the more recent Windows platforms, the solution is limited to Windows platform. Oracle Database's solution will allow the customer invested in Active Directory to leverage our security features such as Oracle Label Security, Virtual Private Database and enhanced auditing capabilities for directory users.

Starting in Oracle Database 10*g*, our identity management infrastructure eases the task of provisioning users with certificates (for PKI integration). Oracle Certificate Authority is an optional component of Identity Management and this brings ease of use for PKI for Oracle Database customers.

Strong Authentication Lets You Know Who Accesses your System

Oracle has a long and proven history in providing strong authentication mechanisms to establish the user's identity. Our authentication services including Kerberos, PKI, RADIUS and DCE have always been industry standards compliant and in Oracle Database 10*g,* there are significant improvements in ease of use and performance.

Oracle's solution in this space is not positioned against the complete Windows Platform, but against SQL Server 2000 to ensure an apples to apples comparison. Our solution is superior because we integrate with any Kerberos Server - MIT compliant or Microsoft Key Distribution Server (MS KDC) while SQL Server 2000 integrates only with Microsoft KDC.

In the PKI space, Oracle's solution integrates with Microsoft Crypto API when on Windows platform but can work equally well on every other platform.

Virtual Private Database and Oracle Label Security Enable Security to be Built ONLY ONCE, *Inside* the Database

Oracle has been the industry leader in row level security for years. The Virtual Private Database (VPD) results in lower cost of ownership in developing and deploying applications. Row-level security can be built once, in the data server, rather than in each application that accesses data. Security is stronger, because it is enforced by the database, no matter how a user accesses data. That is, data is protected even from users who subvert the application security and execute

queries directly against the RDBMS. This feature is particularly useful for application service providers. They can offer "virtual private databases" and host multiple companies in a single database instance resulting in economies of scale. Oracle enables column relevant VPD policies. This means that row level security can be selectively enforced depending on which column a user attempts to access. Oracle Label Security provides VPD "out-of-the-box," as well as automatic label based access control, thus increasing the ease of deploying secure web-based business systems to customers, employees, and partners. Using Oracle Label Security customers can enable multilevel security and achieve highly granular access controls without any programming. For example, data can be labeled at various levels such as highly sensitive or confidential. Users can then be authorized to access different levels of data by specifying a user's security clearance in the database or the Oracle Internet Directory for enterprise wide management.

SQL Server 2000 has no comparable functionality to VPD or Oracle Label Security and would require extensive development effort to implement row-level security. Both VPD and Oracle Label Security have been evaluated against the international common criteria, the de-facto worldwide standard for security evaluations.

Encryption in the Database

 Encryption helps protect sensitive information such as credit card numbers. Unauthorized agents that break into a system cannot misuse private information. The cost (in time, money and lost credibility) of an illicit break in of a computer system is incalculable. Encryption of sensitive data in the database is not available in SQL Server 2000.

Network Encryption

Unlike Microsoft, Oracle provides the ability to natively encrypt network traffic using industry standard algorithms including AES, 3DES (2 Key and 3 Key), RC4 (up to 256 bits). There is no administrative overhead that is involved in implementing PKI for SSL based encryption. Enabling network encryption does not require incisive changes to currently deployed applications. Oracle's solution is cost effective, easy to implement and secure to the network encryption solutions offered by SQL Server 2000 (which is completely PKI based).

Fine Grained Auditing

Auditing helps deter unauthorized user behavior that may not otherwise be prevented. It is particularly useful for ensuring that authorized system users do not abuse their privileges while simultaneously preventing excessive logging of audit information. Oracle Database's fine-grained auditing capability enables organizations to define specific targeted audit policies that can immediately alert administrators. Audit policies specify the data access conditions that trigger the

audit event and can use a flexible event handler to notify administrators that the triggering event has occurred. SQL Server 2000 does not provide such a fine granularity of auditing functionality.

REDUCE THE TIME IT TAKES FOR A BUSINESS TO MAKE BETTER BUSINESS DECISIONS

Business Value

Good business intelligence operations are built on data repositories that handle geometrically increasing information requests because of a vastly expanded Internet audience. It also provides customers instant information regardless of where the data resides. Whether a business is small, medium or large, brick and mortar or dotcom, business intelligence systems will consistently encounter these two requirements. In fact, AMR Research has recently determined that the challenges of providing a growing population of users with instant information, supported invisibly by large amounts and sources of data, are driving the consolidation of data stores into larger data warehouses at a growth rate of 40% per year. This means that data warehouses will store larger volumes of data, support more users, and require faster performance—without losing quality of service. The core requirements for data warehousing—performance, scalability and manageability—remain key factors in the successful implementation of data warehouses.

Oracle Database versus SQL Server 2000

Oracle Database not only brings with it over 20 years of technical innovation in the core data warehousing requirement areas, it also changes the technology landscape for business intelligence servers. Oracle Database is a single, standards-based platform that addresses all of the server-side business intelligence and data warehousing requirements, including Extraction, Transformation and Loading (ETL), Online Analytical Processing (OLAP) and data mining. Oracle Database's capabilities eliminate the need for multiple engines in the business intelligence environment. This new business intelligence architecture provides numerous benefits:

- Rapid deployment: There is no longer any need to integrate multiple server components when implementing a business intelligence system.

- Reduced management costs: A single server means that all data is stored in one place, and is managed via a single tool. Moreover, there is no longer a need to manage the process of synchronizing the data stored in various servers; once new data is loaded into Oracle Database, it is accessible for all business intelligence needs.

- Better decision-making: With a single data store, all data in the business intelligence system is available to all business intelligence users more rapidly, since there is no need to percolate data from one server to another.

- Security: With all data in a single database, IT managers are assured of having consistent security for all business intelligence data regardless of how it is accessed.

- Availability: Oracle Database provides robust availability capabilities, which far exceed the availability characteristics of many other business intelligence products.

With Oracle Database, IT administrators have a simpler data warehouse environment to administer, and can then spend more time supporting business issues. The net result is a business intelligence system that focuses on providing timely, insightful information to support accurate business decisions.

Microsoft claims a fully integrated business intelligence platform, when in reality the OLAP data is kept in a separate data store. While SQL Server 2000 acts as the data warehouse repository, OLAP analyses are performed in the separate data store. This requires additional time in extraction of the data from SQL Server 2000 and storage of transformed analytical data in other data stores. Also, administrative and management overhead increases as the number of these business intelligence repositories expands.

Many IT professionals agree that Oracle provides a superior business intelligence solution. The 2003 Winter Corporation VLDB survey[11] results show the Oracle database is used by three of the top ten largest Decision Support Systems on Unix platforms while SQL Server 2000 of course is not even listed since SQL Server cannot support a Unix environment. In fact, the world's largest data warehouse (82 terabytes) uses a single Oracle database with IBM NUMA-Q server[12]. For Decision Support Systems, Oracle is the top choice.

How Oracle Database Enables Timely Decision Making

Flexible Data Partitioning

Oracle Partitioning allows tables and indexes to be partitioned into smaller, more manageable units, providing database administrators with the ability to pursue a "divide and conquer" approach to data management. Four partitioning schemes - range, hash, composite, and list - are supported.

A typical usage of range partitioning for manageability is to support a 'rolling window' load process in a data warehouse. Suppose that a DBA loads new data into a table on a weekly basis. That table could be range-partitioned so that

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[11] Winter Corporation 2003 VLDB Survey, http://wintercorp.com/vldb/2003_TopTen_Survey/TopTenWinners.asp

[12] http://www-1.ibm.com/press/PressServletForm.wss?MenuChoice=pressreleases&TemplateName=ShowPressReleaseTemplate&SelectString=t1.docunid=1885&TableName=DataheadApplicationClass&SESSIONKEY=any&WindowTitle=Press+Release

each partition contains one week of data. The load process is simply the addition of a new partition. Adding a single partition is much more efficient than modifying the entire table, since the DBA does not need to modify any other partitions. Also, data in the other partitions continue to be available while the new partition is being built and added.

In contrast, SQL Server 2000 has no ability to do any kind of table or index partitioning whatsoever. So, they can't provide a "rolling window" operation for a data warehouse, nor can they do anything like hash partitioning. This greatly limits the types of operations that can be done efficiently with SQL Server.

Scalable ETL Infrastructure

Oracle Database provides a scalable infrastructure to improve the performance, scalability, and manageability of typical ETL operations. Not only does this infrastructure lower the time required to build and maintain the data warehouse, it effectively combines the ETL stages, eliminating the cost of additional storage for data staging. Some of the major Oracle Database ETL capabilities include:

- Transportable tablespace: Bulk transfer of large volumes of data is accomplished through simple and fast copying of necessary data files from the operational data store to the data warehouse. Now, with Oracle Database 10*g*, these transportable tablespaces can now *cross platforms*! That means you can quickly and easily move a large amount of data from one operating system and platform directly to another. This makes it much easier, for example, to move files from Windows to Linux, and vice versa. SQL Server 2000, running only on Windows, has no comparable capability.

- Change data capture: Change Data Capture provides the capability not only for capturing change data but also for publishing it and allowing applications to subscribe to the change data in a controlled fashion.

- External tables: External tables will commonly be used in the ETL process to combine data-transformations (via SQL) with data loading into a single step.

- MERGE and multi-table inserts: These DML commands allow for data to be populated into target tables in a more efficient fashion. SQL Server 2000 has no comparable capability.

- Table functions: Table functions provide the support for pipelined and parallel execution of complex data transformations implemented in any language supported by Oracle Database.

- Data Pump Export and Import: Oracle Data Pump is a new feature of Oracle Database 10g that provides high speed, parallel, restartable bulk data and metadata movement of Oracle database contents. With Data Pump Export and Import, any subset of database objects can be unloaded and

reloaded on the target platform. If moving across platforms with different file system syntax, it is now possible to change the definition of some objects as they are created at import time.

SQL Server 2000 has no comparable functionality for any of the above.

Oracle also provides a complete ETL solution with Oracle Warehouse Builder (OWB). OWB is a single design tool for all your data warehousing functionality that provides a complete, integrated and open solution that leverages the Oracle database in the design, deployment and management of enterprise data warehouses, data marts and business intelligence applications. OWB relies upon the Oracle Database for all data transformations, so it can fully leverage all of Oracle Database's enterprise level features. SQL Server 2000 does include an ETL tool called Data Transformation Services but it is limited in functionality and does not have any comparable level of integration with SQL Server.

Complete Summary Management

Summary management enhances query performance by storing pre-aggregated data and dynamically re-writing queries to use this data, thereby avoiding the overhead of scanning very large tables, often several gigabytes in size, at runtime. Oracle Database's robust summary management implementation allows the creation of dimensions, or summary hierarchies, so that only the most frequently used summary tables need be physically stored while less frequently used summary information can be derived based on stored summary tables. This reduces the amount of storage required for summary tables.

Another summary management feature that saves on storage requirements is the Summary Advisor tool. This tool provides summary table creation recommendations and is used to assess the cost effectiveness of each summary table already created or to be created.

SQL Server 2000 provides only rudimentary summary management functionality, with no subqueries, UNIONs, outer joins or functions such as AVG and STD supported in their indexed view definitions. As a result of these limitations, SQL Server 2000 requires more investment in storage hardware for summary management.

Data Compression

Data compression is also supported in the Oracle Database, for drastically reducing disk space and buffer cache requirements, as well as for improving query performance, due to reduced I/O level   Compression can be used on entire tables, table partitions and materialized views. SQL Server 2000 does not support any type of data compression.

Compressed Bitmapped Indexing

As most DSS queries rely essentially on set operations, the bitmapped index is one of the most useful and important indexing schemes in a DSS environment. Oracle Database uses a revolutionary technique for maintaining and compressing stored bitmap indexes. In addition, bitmapped join index and parallel bitmapped star join further improves query performance.

SQL Server 2000 does not support bitmapped indexing of any kind. Instead, it relies solely on the use of b-tree indexes to optimize query performance, even in a business intelligence environment. This not only imposes more runtime processing overhead, which means slower query performance, but also requires more storage hardware for the b-tree indexes.

In-place Data Analysis

Oracle Database eliminates the need to extract data from the data warehouse and load the data into another repository for analysis. Since advanced SQL analytic functions, an OLAP engine and a data mining engine are integrated into the Oracle Database engine, complex business intelligence analysis can be performed in-place. This enables real-time access to information that can play a critical role in better business decision making as well as reduces administration overhead and data storage costs. Microsoft's business intelligence solution requires maintaining a separate data store for OLAP data, thereby greatly increasing overhead, disk consumption, administration costs, and performance impact.

SQL Analytic Functions

Oracle Database provides SQL analytic functions that enhance both developer productivity and database performance. Basic business intelligence calculations such as moving averages, rankings and lead/lag comparisons can be done without requiring extensive programming. This makes it much faster and easier to develop Business Intelligence applications with much less coding. Key benefits are:

- *Improved Query Speed* - The processing optimizations supported by these functions enable significantly better query performance.

- *Enhanced Developer Productivity* - The functions enable developers to perform complex analyses with much clearer and more concise SQL code.

- *Minimized Learning Effort* - The analytic functions minimize the need to learn new keywords as the syntax leverages existing aggregate functions, such as SUM and AVG, so they can be used in extended ways.

- *Standardized Syntax* - As part of the ANSI SQL standard, these functions are

"Oracle's integrated data intensive functionality for business intelligence is clearly the right approach. Data intensive operations such as OLAP, ETL and data mining, are best performed closest to the data, within the database, instead of moving large volumes of data to multiple servers. This approach will reduce integration costs, improve manageability by reducing complexity, and allow for advanced functionality without specialized servers and skills."

- • • • • Richard Winter, president, Winter Corporation

attractive for independent software vendors.[13]

In addition, Oracle Database 10g introduces a new SQL Model clause. The SQL Model clause is an important step forward in SQL calculation power. This new feature is a building block for complex number-crunching applications such as budgets and forecasts. Oracle users can leverage the Model clause in a wide range of areas, and business intelligence developers will find it especially valuable. An extension to the SQL SELECT statement, the SQL Model clause lets you treat query result sets as multidimensional arrays. You can then build sets of sophisticated interdependent formulas based on these arrays. Users can view relational data as multi-dimensional arrays and define formulas over the arrays with simple, concise notation.

The new syntax eliminates the complex SQL joins and unions needed for inter-row calculations in traditional SQL. Calculations are thus specified more easily and processed more efficiently, thereby saving on business intelligence development time.

None of these capabilities are in SQL Server 2000, so application development for comparable functionality requires extensive programming outside of standard SQL, thereby extending the development time. In addition, the complex application coding impedes performance since the operations are not performed in native SQL.

ENABLE AN ORGANIZATION TO DEVELOP AND DEPLOY BUSINESS SOLUTIONS QUICKLY

Business Value

Enterprises everywhere are developing Internet-based applications to take advantage of the ubiquity, affordability and the open standards of the Internet. However developing these applications is very challenging, placing numerous additional requirements on the development platform. Choosing the right development platform is critical to ensuring the success of these applications.

Oracle Database versus SQL Server 2000

Unlike other vendor solutions, the Oracle Database provides 100% support for all industry standards across all the major operating system and hardware architectures available today - from Linux to Windows to Unix to OS/390. The superior portability of Oracle Database empowers an organization to easily change its preferred hardware and operating system infrastructure, ensuring the right of an organization to choose the best price/performance offering from different vendors now and into the future. Any organization can leverage the Oracle Database to lower initial deployment costs and also remain flexible

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[13] ISO/IEC 9075-1:1999/Amd.1:2000(E)
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enough to meet future needs. The choice of Oracle as a database solution does not bind them to a particular hardware or operating system. This is particularly useful for independent software vendors because they can develop just once on Oracle Database and deploy anywhere.

SQL Server 2000 supports fewer hardware platforms than Oracle Database, and of course is limited to only the Windows operating system. Oracle supports all major hardware platforms and operating systems. SQL Server 2000 customers cannot develop once and deploy anywhere, due to their restriction to the Microsoft platform only.

In addition, surveys indicate that most major packaged application vendors support Oracle databases first. This is true across all categories, including ERP, CRM, Procurement and Supply Chain. There are also more packaged applications deployed on Oracle than SQL Server 2000 [14]. Due to the larger Oracle installed base, there are significantly more implementers with experience deploying packaged applications on Oracle than SQL Server 2000.

As a further point, a recent cost of ownership study done by Input Corporation shows that Oracle is half the cost of SQL Server for running packaged applications.[15]

Why Oracle Database Reduces Development Effort

Multi-Version Read Consistency Model

Oracle Database's unique multi-version read consistency model helps minimize programming time by reducing internal contention for data. This topic was discussed initially in the performance and scalability section of this paper, but it also applies in terms of reducing the coding effort required in developing applications. SQL Server 2000 's flawed architecture can only offer a comparable level of concurrency through application code, at the price of data accuracy, while lengthening both development time and code path.

Non-Escalating Row-Level Locking

Oracle Database's innovative method of row-level lock tracking eliminates the need for lock escalation, thus reducing the potential of deadlocks and increasing concurrency especially as the volume of transactions increases. In addition, application developers do not need to compensate for potential deadlock situations through application code, thereby reducing development time. SQL Server 2000's row-level locking model is constrained by the amount of

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[14] According to Giga Group, Goldman Sachs, and FactPoint reports, over 70% of SAP, Peoplesoft and Siebel applications are deployed on Oracle
[15] Input - Comparative Study of Relational Databases Underlying Packaged Applications--Oracle Database vs. Microsoft SQL Server
http://www.oracle.com/features/ow02/index.html?1113_ow_inputdata.html

available memory.[16] Thus, SQL Server 2000 relies on lock escalation to conserve memory usage, at the expense of data concurrency. This translates into decreased data availability, especially during peak usage periods, and more extensive application coding to avoid deadlock scenarios.

Java Development

With Oracle Database stored procedures in the database can be implemented in PL/SQL or industry standard Java, which can then be executed in compiled or interpreted mode. Java stored procedures can embed SQL statements using the SQLJ syntax, which simplifies database programming in Java (for productivity and concise code) or they can use the usual JDBC syntax, using the embedded JDBC driver. J2EE components running in the middle tier leverage Java stored procedures in the back-end database for handling data-bound and application-independent logic. These Java stored procedures can then leverage the J2EE functionality provided in the middle tier with Oracle Application Server. Application developers can choose the language in which they are most proficient or which is most suitable for a task. PL/SQL is more suitable for SQL intensive procedures while Java would be preferred for more algorithmic or complex (logic) procedures. Java stored procedures in the database enable your complex business logic to be located close to the data, to minimize overhead.

This leverages the existing knowledge base of your developers, so retraining is minimized and existing skill sets are easily transferred. Native compilation of stored procedures in either Java or PL/SQL enhances performance. Additionally, the Java Virtual Machine in the database allows your java development efforts to leverage the functionality of the robust architecture of Oracle. The Java applications have full access to all the XML, object, and multi-media data types resident in the database. This greatly simplifies database application development.

In addition, the Oracle Globalization Development Kit consists of a set of Java APIs that provide application developers with the framework to develop global Internet applications, with full Unicode 3.2 support.

Since SQL Server 2000 has no support for Java in the database, it does not support stored procedures in any language except their proprietary Transact-SQL language. There is also no capability for native compilation, so it lacks the key performance benefits of compilation of Java or PL/SQL stored procedures.

Message Queuing

Advanced Queuing is a unique database integrated message queuing feature built on the Oracle Streams information integration infrastructure. With Advanced Queuing, message queuing operations can be performed similar to

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[16] SQL Server 2000 Performance and Reliability presentation, http://www.microsoft.com/usa/centralregion/sql10.ppt

SQL operations from the Oracle database. Message queuing functionality allows applications on the Oracle database to communicate asynchronously via messages in AQ queues. Integration with the database brings the unprecedented levels of functionality, operational simplicity, reliability, and security to message queuing.

SQL Server 2000 has no support for message queuing in the database at all. Microsoft only supports message queuing with a separate product, Microsoft Message Queue, which has no integration with SQL Server.

XML support

Oracle XML DB is a high-performance XML storage and retrieval technology. It fully absorbs the W3C XML data model into the Oracle server, and provides new standard access methods for navigating and querying XML. With XML DB, you get all the advantages of relational database technology and XML technology at the same time.

As part of the XML support in the database, Oracle supports a datatype called XMLType. XMLType is a native server data-type that is used to store and manage XML documents in columns or tables. This native support for XML content allows the database to understand that a column or table contains XML; in the same way that the DATE data-type allows the database to understand that a column contains a date. XMLType also provide methods that allow common operations such as schema validation and XSL Transformations to be performed on XML content.

The XMLType data-type can be used just like any other data-type. It can be used when creating a column in a relational table. It can be used when declaring PL/SQL variables, and when defining and calling PL/SQL procedures and functions. Since XMLType is an object type, it is also possible to create a table of XMLType.

The XMLType data type can also be used when defining views. Creating an XMLType view, or a relational view that includes an XMLType column, allows Oracle XML DB to be used to expose content stored in relational tables and external data sources as XML documents.

SQL Server 2000 has no support for a native XML datatype whatsoever. The only XML support it provides is storing the XML content in a BLOB.

Oracle's XML DB technology is superior to Microsoft's in terms of

- Native support for the XML data model and other XML standards

- XML DB provides an XML Repository for the database.

- Integrated SQL, XML, Java and Text processing that eliminates extra moving parts and provides high scalability

- Superior functionality and richness of programmatic access

- A comprehensive XML vision, including an XML Repository to support content-oriented XML.

Extended SQL capability

Oracle Database 10*g* introduces support for POSIX-compliant SQL regular expressions, which enhance search and replace capability in programming environments. This allows developers to write one-line queries that otherwise would take multiple lines of SQL code. SQL Server 2000 has no regular expression support.

Web based development

Furthermore, with the Oracle Database 10*g* release, Oracle offers a complete, web-based framework for application development called HTML DB. HTML DB is a declarative development tool built into the Oracle database that offers a framework for the development and deployment of database-centric web applications. Oracle HTML DB accelerates application development through built in features such as design themes, navigational controls, form handlers and flexible reports. Using only a web browser, you can assemble a sophisticated database driven web application in relatively little time. There is no client side tool installation required; all that is needed on the client is a browser.

With HTML DB, you can improve access through consolidation. If your organization relies on countless spreadsheets and personal databases for tracking of information and sharing of data, Oracle HTML DB can save you time and money while improving everyone's access to critical data. By combining the ease of use and productivity of a personal database with the scalability, availability and security of an enterprise database, Oracle HTML DB makes building data driven web applications fast, easy and secure. It also offers a complete hosted solution in a single Oracle database. Any organization looking to consolidate many small development projects can do so by hosting the Oracle HTML DB integrated development platform.

SQL Server 2000 has no web application development capability analogous to HTML DB.

REDUCE COSTS FOR MANAGING, DEPLOYING AND MAINTAINING INFORMATION

Business Value

In today's "round-the-clock" Internet economy, the importance of IT infrastructure to modern businesses needs no explanation. Enterprises are increasing their reliance on the Internet to reach new customers as well as to manage their operations more efficiently. A well-managed IT infrastructure, therefore, has become critical to the success of any business. A profitable business today not only needs reliable, high-performing applications to service its customers, but also must minimize its cost of operation to maximize

profitability. This coupled with ever increasing shortage of skills in this area can quickly lead to spiraling management costs and can even hinder an organization's ability to remain competitive.

Oracle Database versus SQL Server 2000

Recognizing these demands, Oracle has made improved manageability of its products one of the primary goals of Oracle 10*g*. The most significant manageability enhancement in Oracle is the complete integration of various components of the Oracle product stack. The components of Oracle Application Server and Oracle Database 10*g* not only integrate seamlessly with each other but can also be managed from a single point of control using Oracle Enterprise Manager. Oracle Enterprise Manager Grid Control is a fully web-based management console allowing DBA access from anywhere with zero client install and full firewall compatibility. In addition, the Oracle Database 10*g* has been significantly enhanced to simplify database administration and provide a high degree of self-management. From client to application server to database to host to network, Oracle has simplified, automated and centralized the monitoring and management of the complete business infrastructure, resulting in a higher quality of service and reduced management costs.

One of Microsoft's recommended implementation of SQL Server is either in a distributed database environment, or in a federated database architecture, where many different databases are connected together while a single application accesses data across all these databases. The cost of management goes up dramatically when there are 32 databases to manage, administer, maintain, backup and upgrade! (That's the number of databases Microsoft required to achieve a high TPC-C benchmark.)   Microsoft's approach is to distribute complexity. This would be a nightmare to implement in a real world business, compared to implementing and administering a single, more scalable database.

SQL Server 2000 lacks the depth of end-to-end management and self-management and tuning capabilities of the Oracle Database. For example, SQL Server Enterprise Manager does not allow for management and diagnostics of the entire system from a single console.

Built-in Expertise Reduces Overall Management

Manageability Infrastructure

Oracle Database 10*g* contains a new intelligent management infrastructure. It's composed of several new components, utilities, and advisors that automatically collect statistics about the database—such as SQL performance and space usage—and alert the DBA of potential problems while suggesting possible solutions. A new embedded and completely self-managing repository captures workload information and performance related statistics. The database then uses information contained in the repository for all self-management activities,

"Enterprise Manager 10g Grid Control has proven that it will provide us with a single, integrated solution for managing and monitoring all our applications and systems"

Warwick Calkin
National Manager, Telstra IT Infrastructure and Operations

Brian Moran, SQL Server Magazine editor says it all: "Microsoft sells ease of use and hesitates to point out that a SQL Server environment is often just as complex--and expensive--to manage as its UNIX counterparts.

SQL Server Magazine UPDATE News Editor, Jan. 2001

thereby reducing administrative costs. SQL Server has no intelligent management infrastructure or workload repository.

Easy Problem Diagnostics and Resolution

In Oracle Database 10*g*, a great development effort and focus has been put into making the database system self-managing. In the area of SQL tuning, the task of identifying high load SQL has been automated by providing a new manageability feature called the Automatic Database Diagnostics Monitor (ADDM). Briefly, ADDM continuously monitors the current system activity and load, collects and inspects system performance data, and determines potential performance bottlenecks.

Independent Software Vendors can use PL/SQL interface to embedded the ADDM capabilities in their application or use EM interface to remotely diagnose their customer databases.

ADDM provides a very easy and straightforward way for diagnosing and resolving all performance related problems, such that even novice users can easily use it. This power and ease of use of this feature makes it very essential for embedded database installations when those rare performance problems requiring user intervention do take place.

SQL Server 2000 has no analogous monitoring capability.

Automatic SQL Tuning

In Oracle Database 10*g*, the SQL tuning process has been automated by introducing a new component called Automatic SQL Tuning. Automatic SQL Tuning is based on newly added automatic tuning capability of the query optimizer, which is exposed via an advisor called SQL Tuning Advisor. The SQL Tuning Advisor takes resource intensive SQL statements identified by ADDM, and provides advice on how to improve their performance. The advice is in the form of one or more recommendations, each with a rationale and an estimated benefit obtained when implemented. The user is given an option to accept the advice, thus completing the tuning of respective SQL statements.

A very important point to make on this is that this capability can be used to tune 3rd party applications as well. SQL Tuning Advisor can be used to tune packaged applications without ever changing application code.

Oracle Database 10g cuts DBA time required for diagnosis and SQL tuning tasks by 76% compared to SQL Server 2000.[17] SQL Server 2000 has no comparable SQL Tuning Advisor capability, and also no capability to easily tune packaged applications.

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[17] Source: Comparative Management Cost Study of Oracle Database 10*g* and Microsoft SQL Server 2000, Progressive Strategies, April 2004
http://www.progstrat.com/index.html

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"Oracle 10g can potentially lower administration costs with features like automated tuning, storage management and easier administration with Oracle Enterprise Manager. "
Noel Yuhanna,
Forrester

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Removing Complexity

Provisioning storage for a single database instance, let alone an entire enterprise, can be complex. A lot of manual work has gone into mapping out an optimal layout of files and files systems. Oracle Database 10*g* introduces the concept of Automatic Storage Management (ASM) to remove that layer of complexity from the system.

ASM provides a vertically integrated files system and volume manager directly in the Oracle kernel, resulting in the type of 'virtualization' benefits (ease of manageability, higher availability) that storage area network systems provide, specialized for Oracle database files. As with a logical volume manager, ASM spreads its files across all available storage for optimal performance, and it can mirror as well, providing protection against data loss. ASM extends the concept of SAME (stripe and mirror everything) and yet it adds more flexibility in that it can do mirroring at the database file level instead of having to chose the mirroring at the entire disk level.

But more importantly, ASM eliminates the complexity associated with managing data and disks; it vastly simplifies the processes of setting up mirroring, adding disks, and removing disks. Rather than managing hundreds, possibly thousands of files (as in a vast data warehouse, for example) DBAs using ASM create and administer a larger-grained object, the disk group, which identifies the set of disks that will be managed as a logical unit. The automation of the file naming and placement of the underlying database files save the DBAs time and ensures best practice standards are followed. Of course, all additions and removals of disk can be done online, with no impact on service to the database. In addition, ASM then distributes I/O load across all available resources to optimize performance while removing the need for manual I/O tuning (spreading out the database files avoids hotspots). This means that upon adding a new disk, ASM will *automatically and transparently* begin using the disk by moving data onto it, for maximum utilization. No longer is there any need to take down the database while moving data to take advantage of additional storage. ASM helps DBAs manage a dynamic database environment by allowing them to grow (or shrink) the database size easily, online, and with no manual re-distribution of data.

SQL Server has no comparable functionality whatsoever to Oracle's Automatic Storage Management.

Space Management

Online Segment Shrink is a new Oracle Database 10*g* feature. Segments that undergo frequent insert and delete DML activity can become *internally fragmented* and develop unusable free space in the data blocks. This results in wasted space in the segment and it takes up much more space than is really needed. With Online Segment Shrink, segments with such wasted space, can have this space reclaimed by shrinking the segment. This operation is *online*

and *in-place*. This means that activity on the segment can continue when the shrink operation is being performed and that it does not need additional space for storing temporary data.

End-to-End Problem Diagnosis and Resolution

Starting from the point of the application user's experience, Oracle Enterprise Manager can drill down the application stack to diagnose problems at any point in the system: from application, middle-tier, database, host to network. Extensive monitoring, diagnostics and tuning tools allow administrators to quickly pinpoint and solve problems. Oracle Enterprise Manager's charts and graphical displays provide a complete view of the performance of the system. Problem areas are highlighted with visual alarms so potential performance issues are easily seen. Powerful diagnostics and tuning tools then enable diagnosis of the problem, whether it is in the application, middle-tier application server, database, host or network. As noted earlier, SQL Server Enterprise Manager is not capable of managing and diagnosing the entire stack from a single convenient console.

Real-Time Service Level Reporting

Oracle Enterprise Manager can generate business level service reports in real time, covering service levels like application response time or system availability. These reports make it easy to see where potential performance problems may be developing. They also provide a record of your system's service over time. Administrators can also be alerted automatically when a service level has degraded too much. SQL Server Enterprise Manager does not provide this comprehensive level of reporting.

Intelligent Workload Management

Oracle Database features a significantly enhanced Database Resource Manager with new capabilities such as automatic prioritization and proactive governance of any SQL statement. With its automatic prioritization feature, an Oracle database can detect long running operations and limit their resource consumption ensuring that the online users do not experience slow performance. Oracle Database Resource Manager also provides the ability to limit the number of concurrent long operations and prevent execution of highly resource intensive queries during certain times of the day. These capabilities allow for prioritization of work and provide almost unlimited system scalability without compromising performance.

SQL Server 2000 has no ability to prioritize work.

Lights-out Event Monitoring

Oracle Database 10*g* includes an advanced, server generated alert management system which has the ability to monitor itself and send out alerts to notify DBAs

of any impending problem in an efficient and timely manner. The monitoring activities take place at the same time the database performs its regular operations, it is much more efficient, reducing the monitoring resource overhead to negligible. This is in sharp contrast to monitoring tools available today, which regularly poll the database to evaluate the alert condition, thereby consuming a significant amount of system resources.

For example, an administrator can be emailed or paged if the overall application response time goes above a threshold or when resource use is too high on specific host. In fact, the administrator can setup fixit jobs so that the event can be handled without any human intervention. Of course, this reduces the cost of administration tremendously since fewer administrators will be required to manage a larger number of Oracle databases. SQL Server's event monitoring is much less comprehensive and flexible, and it requires regular polling at intervals, consuming extra resources. It also requires administrators to set up additional monitoring to completely cover the entire managed environment.

Automated Patch Distribution

Automated Patch Distribution eliminates the time consuming effort of determining which patches are applicable and required and the actual manual download of the patches. The administrator is provided with the correct and required patches delivered to his/her system for installation. With Oracle Enterprise Manager's built-in integration with Oracle Support's *MetaLink* facility, the DBA is alerted to new critical patches and flags all systems that require the patch. As patches are applied to a system, the patch inventory is automatically updated to keep track of the systems' correct patch level.

SQL Server 2000 has no patch distribution and tracking facility.

CONCLUSION

Oracle Database 10*g* is the first database designed for Enterprise Grid Computing. Oracle Database 10g continues to provide industry leading performance, scalability, resource utilization, manageability, availability, and consistency with emerging trends in technology. Oracle makes GRID the solution for your business.

The Oracle Database, backed by 25 years of technical innovation and experience, remains the number one database choice in the market.[18] With the Oracle Database, not only can immediate cost savings be realized, but the investment is also guaranteed for the future.

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[18] 2002 DBMS Market Share analysis, Gartner DataQuest, May 2003

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March 2004
Author: Sandra Cheevers
Contriubutors: Jenny Gelhausen, Barb Lundhild
Oracle Corporation
World Headquarters
500 Oracle Parkway
Redwood Shores, CA 94065
U.S.A.

Worldwide Inquiries:
Phone: +1.650.506.7000
Fax: +1.650.506.7200
www.oracle.com

Oracle Corporation provides the software that powers the Internet.