

# Oracle9i Database Release 2 New Features

*An Oracle White Paper  
May 2002*

# Oracle9i Database Release 2 New Features

## EXECUTIVE OVERVIEW

Oracle9i continues Oracle8i's focus on the Internet by providing a series of specific capabilities and product bundles targeted at Internet based environments. In addition, Oracle9i continues to add features and capabilities that extend existing investment in mission-critical infrastructure. Oracle9i has been designed with focus on certain key development areas. These areas are:

### KEY AREAS

- Application Development
- Internet Content Management
- Data Integration
- Availability
- Manageability
- Business Intelligence Platform
- Scalability and Performance
- Security
- Windows2000 Integration

### Application Development

Oracle9i continues to offer the best development platform for Internet and traditional application development. Key focus areas include:

- XML
- Enterprise Java Engine
- SQL and PL/SQL improvements
- Globalization

XML has arrived as a key technology for the next stage of evolution of the Internet. In the beginning, its core characteristics of self-description and ad-hoc extensibility offered the flexibility needed for transport of messages between various applications. Lately, the next generation of XML standards -- such as XML Schema -- have enabled unification of both document modeling and data modeling.

Today, most application data and web content is stored either in a relational database or the file system or a combination of both. XML is used mostly as an artifact for transport, generated from a database or a file system. However, as the volume of XML being transported grows, and developers consider the costs of constant regeneration of XML documents there arises the question whether these storage methods effectively accommodate XML content.

To provide a more native support for XML, the first release of Oracle9i Database introduced the XMLType datatype and associated XML specific behavior. In addition, built in XML generation and aggregation operators greatly increase the throughput of XML processing. With the second release of Oracle9i, we significantly add to XML support in the database server. This fully absorbs the W3C XML data model into the Oracle database, and provides new standard access methods for navigating and querying XML – creating a native integrated XML database within the Oracle RDBMS.

### **Key XML DB Technologies**

The key XML DB technologies can be grouped into two major classes – XMLType that provides a native XML storage and retrieval capability strongly integrated with SQL, and an XML Repository that provides foldering, access control, versioning etc. for XML resources.

### **XMLType**

The XMLType datatype stores XML content, and can be used as the datatype of a column. XMLType includes a number of useful methods to operate on XML content. XMLTypes can be stored with 2 storage options – LOB and Object-Relational storage. The former storage model maintains accuracy to the original XML (whitespaces and all), while the latter maintains DOM (Document Object Model) fidelity. XMLType achieves DOM fidelity by maintaining information that SQL or Java objects normally don't provide for, such as:

- Ordering of child elements and attributes
- Distinguishing between elements and attributes
- Unstructured content declared in the schema (e.g. content="mixed" or <any> declarations)
- Undeclared data in instance documents, such as processing instructions, comments, and namespace declarations
- Support for basic XML datatypes not available in SQL (Boolean, QName, etc.)
- Support for XML constraints (facets) not supported directly by SQL, such as strings constrained to regular expressions

Native XMLTYPE instances contain hidden columns that store this extra information that doesn't quite "fit" within the SQL object model. This information can be accessed via APIs in SQL or Java, such as ExtractNode.

Changing XMLTYPE storage from object relational to LOB (or vice versa) is also possible (via database import & export), and your application code will not have to change in response. This allows you to change XML storage when tuning your application, since each storage option has its own benefits.

### **XML Repository**

The second key aspect about XML DB is that it provides an Internet repository for managing XML data and documents. Important items of Repository functionality include:

- Access Control Lists (ACLs): Create high-performance access control lists for any XMLType object, and define your own privileges in addition to the system-defined ones.
- Foldering: Enable folders to map resources (XML files) into database structures and enable hierarchy traversal; also, use XMLTypes or views to map rows into URLs (via ALTER TABLE ENABLE FOLDERING), providing access control, modification date tracking, and other metadata management for those rows.
- WebDAV and FTP Access: Access any foldered XMLType row via WebDAV and FTP (Note that XMLType can manage arbitrary binary data as well, including any file format).
- SQL Repository Search: Operators like UNDER\_PATH and DEPTH, allow applications to search folders, file metadata like owner and creation date, as well as file contents via SQL, and enable the SQL optimizer to choose the best execution plan.
- Hierarchical Index: XML DB provides a special hierarchical index designed to speed pathname resolution and folder search. Additionally, you can automatically map hierarchical data in relational tables into folders, where the hierarchy is defined by existing relational information.
- Navigational API: Use JNDI (in addition or instead of JDBC) to access repository objects via a pathname, rename, delete, and copy files.
- Servlet Access: Users manipulating XML data in the Oracle server can use the servlet API to process XML via Java.

#### **Key XML DB Benefits**

The integration of a native XML capability within the database brings a number of benefits.

- Users today manage structured data as tables and unstructured data as files or BLOBs, and have to subject their applications to different paradigms for managing different kinds of data. Systems channel application development down either the unstructured path (making document access transparent but table access complex) or the structured one (vice versa). XML DB provides a unique ability to store and manage both structured and unstructured data, under a standard W3C XML data model. XML DB provides complete transparency and interchangeability between the XML and SQL metaphors. You can perform XML operations over table data and SQL operations over XML documents. This opens up the database for a new class of 'XML-shaped' content.
- XML DB provides valuable Repository functionality – foldering, access control, FTP and WebDAV protocol support with versioning – enabling applications to retain the file abstraction when manipulating XML data brought into Oracle.
- Users today face a performance barrier in storing and retrieving complex XML. XML DB provides superior performance and scalability for XML operations
- XML DB provides better management of unstructured XML data through piecewise updates, indexing, search, multiple views on the data, managing intra-document and inter-document relationships and so on.
- XML DB enables data and documents from disparate systems to be accessed (e.g. through gateways, external tables) and combined into a standard data model. This integrative aspect reduces the complexity of developing applications that must deal with data from different stores.

In summation, Oracle9i Release 2's XML DB functionality is a high-performance XML storage and retrieval technology available with the Oracle9i Release 2 database. It fully absorbs the W3C XML data model into the Oracle

Database, 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.

#### **Open server-side pl/sql and java debugging**

Oracle9i Database provides JSWP compliant debugging of Java and PL/SQL in the database, with debugging from any JDB compliant tool such as JDeveloper (IASV2).

#### **JDK 1.3 Support**

The Oracle9i Database Java Virtual Machine has been brought up to JDK 1.3.1 compliance. It now has JDBC support for TIMESTAMP datatype and statement pooling. It provides thin JDBC support for PL/SQL index tables, NUMBER conversions routines and optimized statement execution time. It has implemented all Java methods for NUMBER and DATE, and has J2EE 1.3 compliance for Oracle JMS. SQLJ improvements include TIMESTAMP, specific data sources and offline parsing. Java publishing improvements include the LOADJAVA capability.

#### **PL/SQL, C and C++ Development**

- Multi-Language Debugging - integrated PL/SQL & Java debugging, designed for all deployment scenarios, initial support for JDeveloper & JDB, built on top of standard JDWP protocol
- PL/SQL Associative Arrays - replaces large volume of sort/search code, proves to be significantly faster than explicitly coded hash
- Collection/Record Performance improvements
- PL/SQL Object Types now support NCHAR datatypes and character semantics.
- Faster String Operations Under UTF-8
- Insert/Update using a whole record:
  - includes bulk operations on table of record
  - facilitates schema independence
  - enables shorter code for common cases
- Enhancements to UTL\_FILE package.

#### **Globalization - Unprecedented Unicode Support**

A key to supporting a central multilingual database is superior Unicode enablement. With Oracle9i, Oracle was the first and currently the only major database vendor that conforms to the Unicode 3.0 standard. Oracle9i Database Release 2 now supports Unicode 3.1 for both UTF-8 and UTF-16 encodings. Oracle9i Database Release 2 also offers improved Unicode performance. In addition Oracle9i is the only database that supports the choice of Unicode as the database character set or Unicode columns in a non-Unicode database (via the National Character Set) or both. Other key differentiators in Oracle9i support of Unicode include:

- Surrogate support which allows support for an additional million characters
- Unicode enablement in all access interfaces, and applications
- Implicit and explicit interoperability between Unicode and non Unicode datatypes
- Character semantics so that string processing is intuitive

## Internet Content management

In Oracle9i Database Release 2, Oracle rounds out the content management platform that is part of the database. New features and capabilities include:

- Improvements to Oracle Text that enhance its manageability and scalability, plus new features to support XML searching.
- New formats supported by interMedia AVI, as well as improved image processing performance.
- Oracle Spatial performance improvements.
- New XML processing capabilities within the database through a brand new technology, Oracle XML DB.
- Workspace Manager – support for DDL operations on versioned tables, as well as improved concurrency of workspace operations.

## Availability

Oracle9i dramatically extends Oracle's leadership in Internet database availability, critical for any Internet application. Key focus areas in Oracle9i Database Release 2 availability include:

- Providing an industry leading data protection environment
- Upgrade applications and database with minimal downtime
- Enabling end-users to identify and correct their own mistakes

## Industry Leading Data Protection Environment

Oracle9i Database includes many features to improve data protection. A revolutionary improvement in Oracle9i Database Release 2 is the introduction of the new Oracle Data Guard in SQL Apply Mode capability. Oracle Data Guard keeps a real-time copy of data in a secondary or standby database to protect against corruptions, human errors and disasters. When using the Data Guard SQL Apply Mode, the secondary site is a *logical* copy of the production site, and is updated using information from the SQL statements that updated the primary site. The secondary or standby site is continuously open for reporting purposes, even while it is applying updates from the production site.

On catastrophe, the database will fail over to a local or remote standby site, and users can continue normal business operations against the standby database. Data Guard also provides a zero data loss capability for those businesses that can not tolerate the loss of ANY transactional data. It is possible to set a delay for the application of SQL changes to the standby database for human error protection. An Oracle Data Guard database is resilient to data corruptions, and leverages the fail over site for reporting, backups, and maintenance. It provides GUI based turnkey management, and generates significantly less network traffic and I/O than only using a remote mirroring technology for Standby databases.

In addition to the Data Guard - SQL Apply capability, Oracle9i Database Release 2 includes a number of enhancements to Oracle Data Guard. These include Data Guard Broker automation for switch over, network failure handling, support for multiple standby databases, and enforceable restrictions on unlogged operations on the primary site that would impact the Standby database.

LogMiner improvements include support for Large Objects (LOBs), LONGs, and parallel DML, as well as a multi-versioned dictionary and real time mining of online logs.

### **Speed up of application and database upgrades**

To minimize the impact on production use of the database system, Oracle9i Database Release 2 introduces new features to speed up the upgrading time for applications and database systems. These include the ability to rename CONSTRAINTS and COLUMNS, and a significant reduction in the recompilation of PL/SQL packages and procedures. It provides fast loading of wrapped source, knows to do nothing upon loading an unchanged package, view or synonym, removes double invalidations and does parallel compilation in dependency order.

### **End user self correction**

Oracle9i Database Release 2 now provides further support for Flashback Query, a feature introduced in Oracle9i Release 1. Now you can generate flashback information within a SQL statement, instead of just within a session. You can restore deleted rows, old values and the previous version of the table. You can also select a difference between two times.

### **Data Integration**

An important feature of any database management system is the ability to share information among multiple databases and applications. However, often customers are overwhelmed by the variety of options they encounter when selecting an information sharing solution. Some solutions are targeted for different purposes, and appear incompatible with other choices. Customers find no solution meets all their needs, and fear becoming limited by the solution they have implemented should their needs change. They want a single solution that meets all their information sharing needs.

Oracle9i Database Release 2 introduces a new information sharing feature, Oracle Streams. Oracle Streams enables the propagation of data, transactions and events in a data stream, either within a database, or from one database to another. Customers can use Streams to replicate data, implement message queuing and management, load changed data into data warehouses, send notifications of database events to subscribers, and provide high availability solutions to protect data.

Streams provides greater functionality and flexibility than traditional solutions for sharing information with other databases and applications. It satisfies the information sharing needs of most customers with a single integrated solution. This integrated solution allows customers to break the cycle of trading off one solution for another. They can utilize all the capabilities of Streams at the same time. Should their needs change, Oracle Streams will adapt to meet their requirements.

Oracle Streams provides a set of elements. Using these elements, users control putting information into a stream, the stream's flow or route from node to node, and the action as the stream terminates. By specifying the configuration of the elements acting on the stream, a user can address specific requirements.

The architecture of Oracle Streams is very flexible. Streams contains three basic elements:

- Capture
- Staging, including optional transformation
- Consumption

#### **Capture**

Streams supports capture of events (database changes, and application generated messages) into the staging area. These events are captured in two ways. Using implicit capture, the server automatically captures DML and DDL events at a source database. Explicit capture allows applications to explicitly generate events and place them in the staging area.

One of Oracle Streams' distinguishing features is support for log-based change capture. Capturing changes directly from the redo log files minimizes the overhead on the system. Streams can mine changed data from the redo log and deliver it to the capture process. The capture process then formats it into a Logical Change Record (LCR), and places it in a staging area for further processing. The capture process can intelligently filter LCRs based upon defined rules. Thus, only changes to desired objects are captured.

### **Staging**

Once captured, events are placed in a staging area. The staging area is a queue that provides a service to store and manage captured events. Staging provides a holding area with security, as well as auditing and tracking of LCR and user-messages.

Subscribers examine the contents of the staging area and determine whether or not they have an interest in the message representing that event. A subscriber can either be a user application, another staging area, (usually on another system), or the apply process. The subscriber can optionally evaluate a set of rules to determine whether or not the message meets the criteria set forth in the subscription. If so, then the message will be consumed by the subscriber.

As events are placed in the staging area, are removed from the staging area, or propagate between two staging areas, they can be transformed. Transformations can change data formats, column names, table names, or even subset columns. This powerful feature enables Streams to replicate not only identical objects, but also any object where the source and destination copies are related by a well-defined transformation.

### **Consumption**

Messages in a staging area are consumed by the apply engine, or they are explicitly dequeued and consumed by an application. Streams includes a flexible apply engine, that allows use of a standard or custom apply function. The standard apply function will directly apply the change represented by the LCR to the destination database. The custom apply function will pass the LCR to a user-defined function, allowing customers the greatest flexibility in applying the updates. Support for explicit dequeue allows application developers to use Oracle Streams to notify applications of changes to data, while still leveraging the change capture and propagation features of Oracle Streams. Explicit dequeue can also extract LCRs and user messages from the staging area, an important capability for message queuing applications.

Oracle Streams is an open information sharing solution. Each element supports industry standard languages and standards. Streams supports capture and apply from Oracle to non-Oracle systems. Changes can be applied to a non-Oracle system via a transparent gateway or generic connectivity. Streams also includes an API to allow non-Oracle data sources to easily submit or receive change records, allowing for heterogeneous data movement in both directions. In addition, messages can be sent to and received from other message queuing systems such as MQ Series via the Messaging Gateway.

With Oracle Streams, Oracle9i Database Release 2 can be used to satisfy the most demanding information sharing requirements. Complex distributed environments will benefit from a single solution to simplify their information sharing solutions. Simple distributed environments will benefit in the knowledge they can expand their environment as their needs change without having to learn and integrate new products. Developers and administrators will spend less time wrestling with their tools, and more time providing solutions.

### **Manageability**

Management is one of the key areas of improvement for Oracle9i, and continues to be a focus area for Release 2.

There are two aspects to our approach taken with management in Oracle9i Database Release 2:

- Streamline and improve the operational management of an Oracle9i database
- Provide tools and techniques that significantly simplify and reduce the task time required to administer Oracle9i Database Release 2

### **Simplify Administration**

Automated memory management and automated space management were implemented as some of the self-managing improvements introduced in Oracle9i Release 1, along with automatic undo segment management. Now, to further simplify the operational management of the database, the SYSTEM tablespace can also be Locally Managed. This means that all the tablespaces in the Oracle9i Release2 database can be created as Locally Managed, thus simplifying the database administrator's task. In addition, the SPFILE configuration file can now be automatically backed up and restored, again to simplify the backup and restore processes of the system. Another new capability in this area allows Recovery Manager (RMAN) to automate the space management of archived log files, thus freeing the DBA from managing the space allocation of the archived logs.

Additionally, the management of I/O is a major administrative challenge. It becomes even more complex when using intelligent storage array products since the disk topology information for such devices is not easily available. Oracle9i Database Release 2 has the capability to show a complete mapping of database files to intermediate layers of logical volumes manager and actual physical devices. This information will help administrators determine the exact location of a data block on the disk and easily identify any hot spots.

### **Build In Product Intelligence**

In Oracle9i Database Release 2, Oracle continues to make the server more intelligent and self-managing, which frees the administrator from time-consuming tuning and diagnostics tasks. It provides a number of built-in, intelligent advisories for performance tuning. These built-in advisories show Shared Pool usage to improve parse time and minimize CPU usage, SQL execution memory for improvements in SQL execution time and to minimize unnecessary CPU and I/O use. For example, the Shared Pool Advisory provides information on the optimal size for the library cache on your specific system. The advisory information is displayed conveniently in Enterprise Manager and the library cache size can be changed dynamically directly from Enterprise Manager. In addition, there is an advisory for the Mean-Time-To-Recover setting, so the administrator can set time requirements to recover from a system crash, without jeopardizing run-time performance. The PGA advisory allows us to predict the result of altering PGA memory on the overall instance performance.

These advisories are ready "out-of-the-box", and allow the administrator to simulate a variety of "what-if" scenarios. They use minimal resources, and are available through the standard SQL interface. The advisors are available both through SQL or conveniently in EM. The EM view is easier to use, in that graphs instantly allow you to see the optimal trade-off point for resources. Also, you can immediately change the parameter setting directly from the advisors in EM. This unique technology has a patent pending.

### **Eliminate Complexity**

Performance tuning is made simpler with intelligent tuning features in Oracle9i Database Release 2. Now Oracle9i provides actual operation-level query execution statistics, as opposed to estimated statistics. This helps identify the most expensive SQL statements and their corresponding operations. It is now easier to identify tables, partitions and indexes that are heavily accessed, with the new access statistics provided in Oracle9i Release 2. Using these new statistics, Enterprise Manager now includes a new set of "Top Object" charts. These charts allow the DBA to easily

see which objects are the most heavily accessed and further simplifies the diagnosis of performance problems. In addition, a complete I/O topology is provided, showing a complete mapping of a file to logical volumes and physical devices. The volumes and devices are also displayed in Enterprise Manager.

### **Automate Functionality**

In Oracle9i Database Release 2, Enterprise Manager provides support for the new Release 2 features, making it easier and simpler for administrators to adopt these powerful capabilities. Enterprise Manager provides management and monitoring for critical new capabilities such as XML DB, Oracle Streams, DataGuard - SQL Apply Database, and database advisories. The Database Configuration Assistant (DBCA) now creates a locally managed SYSTEM tablespace, as well as XML DB configuration in the seed database, improved default init.ora for DSS databases, improved SGA sizing and support of CAA for Real Application Clusters. Enterprise Manager provides support for resumable statements and resource management control operations, and enhanced support for Backup and Recovery, Advanced Queueing, LogMiner, OLAP, Spatial. In the new release, Enterprise Manager also includes a new capability to clone a subset of data. For example, an administrator can easily clone a full production schema to a test or development site using a subset of the production data and scaling down parameters such as storage. Further new features in Oracle Enterprise Manager include: SQL Scratchpad for executing SQL and viewing results in a graphical table format and simplified operations on multiple objects (such as recompiling all invalid objects or disabling multiple constraints in one step).

### **Business Intelligence Platform**

Oracle9i continues to raise the bar for providing the best platform support for business intelligence in medium to large scale enterprises, focusing especially on the challenges raised by the large volume of data and the need for near real time complex analysis in an Internet enabled environment. Additionally, Oracle9i provides the first true business-intelligence platform, with extended database support for online analytical processing (OLAP), Data-Mining, and Extraction, Transformation and Loading (ETL) operations. Key focus areas include:

- Scalability, performance, and manageability
- Complete business intelligence platform: Integrated ETL and Analysis capabilities

### **Scalability, Performance, and Manageability**

Performance, scalability, and manageability are basic requirements for business-intelligence applications. As in previous database releases, Oracle9i Database Release 2 offers considerable new enhancements in each of these areas.

Oracle9i Database Release 2 partitioning capabilities have been expanded to support composite range-list partitioning. This makes it much easier to do rolling window operations on a list of partitions, by partitioning first by a range value, say a month, with a sub partition with the list value. Now it is easy to do data maintenance operations such as backups by geographic region by month, for example. In addition, list partitioning now supports the concept of a “default” partition, so if a data row does not conform to the designated “list” of values, it can then be placed in the default partition, instead of causing an error to reject the data row. Applications don’t need to contain code to handle the exception case anymore.

In addition, parallel DML is now supported on non-partitioned data tables, greatly enhancing the performance of a large update operation.

### **Complete business intelligence platform**

Oracle9i for business intelligence goes far beyond the primary requirements of performance, scalability, and manageability. Oracle9i is designed to be a full data warehouse platform, leveraging the Oracle database as the scalable data engine for all operations on data warehousing data. Oracle9i Release 2 provides significant new functionality in Online Analytical Processing (OLAP), and Data Mining.

Regarding OLAP capability, Oracle9i challenges the traditional view of the analytic servers by offering an integrated relational - multidimensional database. Oracle9i Database eliminates the trade off between manageability versus performance and analytic power. Oracle9i simplifies the process and reduces the cost of maintaining data while retaining the ability to support complex analytical queries and provide excellent performance. Oracle9i accomplishes this by offering Oracle OLAP as an integrated part of the relational database.

There are many benefits to a fully integrated RDBMS-MDDS database as compared to separate, stand alone multidimensional databases. These include:

- Simplified management
- High availability
- Improved security
- Open access to both SQL and OLAP API clients
- Reduced information cycle time
- Improved data reliability

Oracle9i is the only database to provide access to both relational and multidimensional data through SQL and an OLAP API. Any OLAP value calculation can be queried by SQL.

Because the OLAP technology is part of the single database process, it enjoys the same scalability and reliability benefits of the Oracle database process including support for Real Application Clusters and Oracle Data Guard.

In Oracle9i all data - relational and multidimensional - is stored in Oracle data files. There are no separate multidimensional files to manage and administer. Additionally, a new data compression capability is leveraged by Oracle OLAP for further disk space savings.

By providing multidimensional technology in the Oracle database, Oracle solves the dilemma of power versus open access and manageability. Oracle9i OLAP provides the power of a multidimensional database while retaining the manageability of the Oracle database and the accessibility of SQL.

Oracle OLAP represents a fundamental change in OLAP server technology. Relational and multidimensional databases have converged to provide the analytic capability of a multidimensional database within the context of the Oracle database.

All of the advantages are gained while retaining the power of a dedicated OLAP server. The Oracle OLAP capability provides a complete set of analytic functions through a powerful OLAP API, multidimensional engine and OLAP data manipulation language.

The result is a system for high end analytic and planning applications that is less costly, is unbreakable, and supports existing SQL based query and reporting tools.

Oracle9i Database Release 2 also includes new data mining capabilities. Oracle9i Data Mining TM enables companies to build integrated business intelligence applications. Using data mining functionality embedded in Oracle9i Database,

application developers can automate the extraction and distribution of business intelligence for integration into other business applications. Oracle9i Data Mining is a priced option to the Oracle9i Database Enterprise Edition that embeds classification, prediction, associations and clustering data mining natively within the database. All model-building and scoring functions are accessible through a Java-based API.

This data mining infrastructure accessed through a Java API enables application developers and data analysts to extend the benefits of data mining to many users throughout an organization. By enabling applications driven by data mining embedded in the Oracle database, customers, ISVs and Oracle Applications can deliver advanced business intelligence that provides far greater value than any stand alone data mining tool.

### **Scalability and Performance**

Oracle9i Real Application Clusters, first introduced in Oracle9i Release 1, enables all applications to exploit cluster database availability, scalability and performance with *no application modifications*. Applications can treat Oracle9i Real Application Clusters as a single system and no longer need to be modified or partitioned to achieve near-linear cluster database scalability. This allows customers to horizontally scale the database tier as usage and demand continues to grow, without changes to the application. Furthermore, Oracle9i Real Application Clusters is self tuning and adapts to the changing nature of the database workload - dynamically shifts database resources across the cluster servers for optimal performance. This transparent scalability and high performance is delivered by a revolutionary technology called Cache Fusion. This architecture utilizes the collective caches of all the nodes in the cluster to satisfy database requests.

Oracle9i Release 2 introduces Real Application Clusters Guard II for improved high availability. It supports active/active configurations with the ability to define highly available database services. Services are configured at the Oracle Network level. The cluster can be configured with a single or multiple services as needed for workload management. With improvements to DBCA, NetCA and SRVCTL it is easy to configure fail over policies for these services. Event notification of instance failures provides fast notification for application servers and/or applications. Virtual IP address management delivers fast client detection of node failure without having to wait for TCP/IP time-outs. These improvements further refine the high availability characteristics of Real Application Clusters.

Now with Oracle9i Database Release 2, Real Application Clusters support a cluster file system for the Windows and Linux platforms. Storage management is as simple and straightforward on a cluster as on a single node. The cluster file system supports all database files including the Oracle home. This greatly simplifies the Oracle database installation and management.

In addition to these enhancements in availability and manageability, Oracle9i Database Release 2 includes internal improvements to performance and scalability that will benefit many applications transparently.

### **Security**

Oracle9i Database Release 2 continues to provide the most secure application development and deployment platform in the industry. Building on the significant security functionality introduced in Oracle9i Release 1, Release 2 provides a number of enhancements. Now, a username/password can be provided on a CREATE DATABASE statement, and a number of default accounts are locked and expired upon installation, providing additional security. A database administrator can issue a grant or revoke of object privileges on another user's objects, and you can audit SYS or SYSDBA operations. The Virtual Private Database capability supports fine-grained access control policies on tables, views, and now synonyms.

Additionally, Oracle9i Database Release 2 enhances the two security options. Now, Oracle Label Security supports data releasabilities in data labels and provides more sophisticated methods of controlling dissemination of data. Oracle

Advanced Security now supports the Advanced Encryption Standard (AES), accepts authorizations from a RADIUS server, and provides a User Migration Utility to migrate password-authenticated database users to Oracle Internet Directory for centralized management.

### **Windows Integration**

Oracle9i Database Release 2 continues Oracle's lead as the platform of choice for organizations deploying on Windows 2000. Key focus areas are:

- Close integration with Windows 2000
- Facilitated development and deployment on MS Windows platforms

Oracle9i Database Release 2 provides support for the Microsoft .Net environment with OLE DB .Net and ODBC .Net compliance. Improvements in the OLE DB driver provide better performance by reducing the number of round trips to the database, along with caching of metadata for query performance. These underlying improvements provide performance benefits for ADO, ADO .Net, and OLE DB .Net. With support for both OLE DB .Net and ODBC .Net, Oracle 9i Database Release 2 can participate fully in a Microsoft .Net environment, while providing the highest possible scalability and availability that Oracle9i is known for.

Additionally, Oracle provides support for the Microsoft Cluster Server environment with Oracle Fail Safe. Oracle9i Fail Safe for Release 2 provides support for Data Guard - both Redo Apply (physical) and SQL Apply (logical) modes, as well as multi-clusters management.