ORACLE9I NEW FEATURES SUMMARY

An Oracle White Paper
May 2001

ORACLE®

Oracle9*i* New Features Summary

Oracle9*i* New Features Summary

Oracle9*i* - The eBusiness Platform

Oracle9*i* continues Oracle8*i*s focus on the Internet by providing a series of specific capabilities and product bundles targeted at eBusiness environments. In addition, Oracle9*i* continues to add features and capabilities that extends existing investment in mission-critical infrastructure. Oracle9*i* has been designed with focus on certain key development areas. These areas are:

Key infrastructure areas

- Availability

- Scalability and Performance

- Security

- Development Platform

- Manageability

- Windows2000 Integration

Key application areas

- Internet Content Management

- *e*Business Integration

- Packaged Applications

- Business Intelligence Platform

Achieving Continuous Data Availability

Oracle9*i* dramatically extends Oracle's leadership in Internet database availability, critical for any eBusiness application. Key focus areas in Oracle9*i* include:

- Providing an industry leading zero data loss data protection environment

- Reducing offline maintenance requirements with support for more online operations

- Providing fast and precise repair of damaged databases

- Enabling end-users to identify and correct their own mistakes.

Industry Leading Data Protection Environment

Oracle9i includes many new features to improve data protection. Significant enhancements to the existing (physical) Standby product have been added and a framework that provides monitoring, automation and control is included.

Many of the tasks associated with managing a standby database are automated, including initial instantiation, failover, and graceful primary-to-secondary switch-over and switch back. Administrators can also optionally specify the log apply delay by which each standby site lags the production environment (for increased protection from human errors or corruption), and choose a zero data loss mode in which online redo log data is synchronously sent to the standby site.

LogMiner has also been enhanced in Oracle9*i* to provide comprehensive SQL based Log Analysis. LogMiner now supports index organized and clustered tables, chained rows, direct loads, scalar object types, LOB, LONG data types and DDLs. LogMiner also displays the primary key, and supports queries on the logs based on content of change (for example, show all changes to employee 'Smith'). A new graphical user interface as well as other database features also make the product easier to both learn and use.

Online Data Evolution

Oracle9*i* contains a new online reorganization and redefinition architecture that allows much more powerful reorganization capabilities. Administrators can now perform a variety of online operations to table definitions, including online reorganization of heap-organized tables. Essentially, Oracle9*i* now allows an online "create table as select" operation.

In this new architecture the contents of the table are copied into a new table. While the contents are copied, the updates to the original table are tracked by the database. After the copy completes, the updates are applied to the new table. Once the updates are applied, indexes can be created on the new table. After the indexes are created, any additional updates are applied and the result table replaces the original table. The table is only locked in exclusive mode at the beginning and end of the operation, when the dictionary data is updated.

Using this new architecture, any physical attribute of the table can be changed online. The table can be moved to a new location. The table can be partitioned. The table can be converted from one organization (e.g. heap) to another (e.g. index organized).

Additionally, many logical attributes can be changed. Column names, types, and sizes can be changed. Columns can be added, deleted, or merged. The primary restriction is that the primary key of the table cannot be modified.

Oracle9*i* now also supports online create, rebuild, etc. of secondary indexes on index organized tables. Indexes can now be created online and analyzed at the same time. Secondary indexes support efficient usage of block hints.

Administrators are also able to rapidly quiesce the database in order to perform operations that demand no active transactions. Also, with Oracle9*i* the buffer cache and shared pool can be resized dynamically. Lastly, Oracle9*i* can also validate the structure of an object (Analyze Validate) while the object is online and accessed by users.

Precision Database Repair

Oracle8*i* contained very complete recovery capabilities. Oracle9*i* extends these capabilities by making them more powerful and precise.

Oracle9*i* includes better prevention and improved handling of disk corruption. Should a block corruption need to be repaired via media recovery, a new block media recovery feature allows recovery of only the corrupt blocks while the remainder of the table is online. Oracle9*i* is able to restore the database to a consistent state after log corruption is detected during recovery. LogMiner allows redo entries after the corruption point to be retrieved and applied. Trial recovery allows recovery to proceed after a corrupted database block is detected so that the administrator can determine if the corruption is an isolated event. If more corruption is found, the recovery can be backed out.

Oracle9*i* can also recover from crashes more quickly using a new two-pass recovery algorithm that ensures that only the blocks that need be processed are read from and written to the datafiles. A new time-based mean time to recover (MTTR) parameter also makes it much easier to set a limit on crash recovery time. Recovery Manager backup and restore operations can now restart where they left off after a failure. Oracle9*i* also includes improved diagnosability features to quickly capture the state of a failed instance and allow diagnostics after recovery on the failed state. For multi-node systems, Oracle9*i* provides much faster failure detection and reconfiguration for Oracle9*i* Real Application Clusters, reducing downtime due to a system fault. Oracle Fail Safe for Windows has been enhanced to take advantage of multi-node clusters, using the enhanced functionality of Windows 2000. This allows for configurations where multiple databases on multiple nodes share a common backup node, reducing the cost of providing redundancy to multiple applications.

Self Service Error Correction

Oracle9*i* contains very powerful techniques for handling human errors. Oracle9*i* contains capabilities that can empower end users to correct their own mistakes in a much more precise, efficient, and easy manner. To correct errors, end-users need to be able to identify the error by viewing change history, and they need to be able to back out the error by restoring data as it existed before the error.

Oracle9*i* provides both these capabilities. These capabilities are available at the SQL level so that applications can invoke them like any other normal SQL operation, without needing the intervention of an administrator.

The flashback query feature of Oracle9*i* allows data to be queried from a point in the past. Users set the date and time that they would like to view, and then any SQL query that they execute will operate on data as it existed at that point in time. This new capability uses Oracle's multiversion read-consistency capabilities to restore data by applying undo as needed. Administrators can now configure undo retention by simply specifying how long undo should be kept in the database. Using flashback query capabilities, a user can query the database as it existed this morning, yesterday, or last week. The speed of this operation depends only on the amount of data being queried and the number of changes to the data that need to be backed out.

Using LogMiner, the change history of a database can be queried from the logs. LogMiner now allows content based data filtering. For example, administrators can query just the changes to the customer John Smith. This capability enables change history to be queried at the row level. Since Redo and Undo are already maintained by the database for internal consistency, enabling these capabilities adds no overhead.

Scalability and Performance

Oracle9*i* allows eBusiness to scale to tens of millions of users performing millions of transactions per hour. Key focus areas include:

- Transparent cluster scalability and performance

- Scalable session state management

- Optimized features critical for eBusiness

Oracle9*i* Real Application Clusters - Cache Fusion

Oracle9i Real Application Clusters 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.

The Oracle9*i* Cache Fusion architecture utilizes the collective caches of all the nodes in the cluster to satisfy database requests. Query requests can now be satisfied by both the local cache or any of the other caches. This reduces disk

I/O. Update operations do not require disk I/O for synchronization since the local node can obtain the needed block directly from any of the cluster database node caches. Expensive disk I/Os are only performed when none of the collective caches contain the necessary data and when an update transaction performs a COMMIT operation that requires disk write guarantees. This implementation effectively expands the working set of the database cache and reduces disk I/O to dramatically speed up database operation. Oracle9*i* Cache Fusion directly ships data blocks from one node's cache to another node's cache in read/read, read/write, and write/write contention situations. This builds on the previous Oracle8*i* Cache Fusion implementation that handled read/write contention. Because the full Cache Fusion implementation in Oracle9*i* eliminates the latencies associated with disk based cache coordination, applications can now scale effectively without having to be cluster aware. This means that for the first time a cluster can be treated as a truly scalable single system.

Scalable Session State Management

New shared memory capabilities, improvements in Java session support, networking and shared server improvements substantially reduce the footprint required per user on Oracle9*i* - allowing more users to be hosted on the same or larger hardware platforms.

Optimized Features Critical For eBusiness

Specific performance improvements in Oracle9*i* are focused on improving performance in areas critical for eBusiness solutions.

Support for native compilation and improved optimization of PL/SQL improves the performance of many of today's business applications, often significantly. The addition of memory and CPU costs to the cost based optimizer's cost calculation algorithm results in better optimization plans, less resource usage, and faster overall performance. Latch contention in several areas has been eliminated or reduced and improves performance on large systems. General I/O improvements, including self tuning direct I/O, prefetching and skip/scan row source operations on indexes also improve performance in Data Warehouse and OLTP environments.

For Java, improved garbage collection, better native compilation, increased object sharing, and session pinning have all improved the performance of applications built in Java executing inside the database. JDBC and SQLJ performance improvements have also improved the performance of Java in the middle tier or on the client.

A new feature in Oracle Net Services, VI (Virtual Interface) Protocol support can achieve overall 10% performance improvement for the connections between application server and back end Oracle9*i* database. VI is an emerging communication protocol for clustered server environments. Unlike TCP/IP, VI

is a "thin" protocol specially designed for cluster environment, it places most of the messaging burden upon high-speed network hardware and frees the CPU for more important tasks.

In addition, specific network interface optimization, new improved virtual circuit I/O, and a unified event/wait model all substantially improve client/server communication performance. Improvement of up to 20% more throughput can be realized for shared server environment.

Distributed database performance has been improved by the rework of database/database communication using OCI. Improved distributed query optimization has also been built into the optimizer.

Connection load balancing for dedicated servers has been improved by allowing the listener to choose the least loaded instance under dedicated server configuration. This connection load balancing feature was previously only available to shared server configuration.

Providing an End-to-End Security Infrastructure

Oracle9*i* continues to provide the most secure application development and deployment platform in the industry. Key focus areas include:

- Strong, three-tier security

- Standards-based Public Key Infrastructure (PKI)

- Deep Data Protection

- Improved user and security policy management

- Data Encryption

- Oracle Label Security

- Oracle Internet Directory

Strong, Three-Tier Security

Three tier security is enhanced via proxy authentication, including credential proxy of X.509 certificates or Distinguished Names (DN), support for thick JDBC, connection pooling for 'application users' (thick and thin JDBC, OCI), and integration with Oracle Internet Directory. An extensible, secure application role provides context-based role enablement. For example, a secure application role can ensure that a user can only access the database through a middle tier. The result is that user identities are maintained securely through all tiers of an application, with centralized user and privilege management in Oracle Internet Directory**.**

Standards-based PKI

Standards-based PKI support of Oracle Advanced Security includes support for Public Key Certificate Standard (PKCS)#12 wallets, enabling existing PKI credentials to be shared by an Oracle Wallet, thus reducing PKI deployment costs and increasing interoperability. Wallets can be downloaded from Oracle Internet Directory to support mobile or 'hot-desked' users. Oracle PKI support provides integration with Oracle Wallets, Entrust Profile, and Microsoft Certificate Store enabling organizations to integrate their existing PKI infrastructures into Oracle9*i*.

Deep Data Protection

Hosting security is provided through Virtual Private Database (VPD) enhancements, fine-grained auditing, Oracle Label Security, a VPD-based product. VPD enhancements include partitioned application context (security enforcement depending on which application accesses data), and connection pooling via a 'global'- or shared - application context**,** as well as context retrieval from Oracle Internet Directory.

Fine-grained auditing allows organizations to define audit policies, which specify the data access conditions that trigger the audit event, and use a flexible event handler to notify administrators that the triggering event has occurred. For example, an organization may allow HR clerks to access employee salary information, but audits access when salaries greater than $500K are accessed. The audit policy ("where SALARY > 500000") is applied to the EMPLOYEES table through an audit policy interface (a PL/SQL package). An audit column is used to reduce the incidence of false audits. For example, selecting all NAME and ADDRESS information will include individuals whose salary is greater than $500K; however, unless the SALARY column (that is, the audit column) is returned, no audit event is triggered.

Oracle9*i* captures the SQL text of the statement the user executed in audit tables. In conjunction with other database features such as LogMiner, fine-grained auditing can be used to recreate the records returned to a user. This may be especially important to organizations who have especially sensitive information they wish to share, for which they require strict accountability, such as intelligence or law enforcement agencies.

The event handler provides organizations with flexibility in determining how to handle a triggering audit event. A triggering audit event could be written into a special audit table for further analysis, or could activate a pager for the security administrator. The event handler allows organizations to fine-tune their audit response to appropriate levels of escalation. Fine-grained auditing can thus serve as an intrusion detection system for the database.

Improved Enterprise User Security

Improved user and security policy management is provided through Oracle Advanced Security's Enterprise User Security enhancements, including management of password-based users in Oracle Internet Directory, and password policy administration features such as retry limits. In order to facilitate migration from Oracle Names, Oracle's deprecated solution of centralized naming management, to LDAP naming, the Oracle Names LDAP Proxy feature is provided so that existing Oracle Names servers can be configured as proxy to the LDAP directory. Contexts for VPD can also be externalized and stored in Oracle Internet Directory for greater control and user scalability.

Data Encryption

Oracle stored data encryption enhancements include incorporation of a secure random number generator (RNG) into the DBMS_OBFUSCATION_TOOLKIT. Creation of secure cryptographic keys is a critical element in cryptography: weak, predictable or easily-guessed cryptographic keys leads to encryption that can be easily broken. The ability to generate random numbers for use as secure cryptographic keys greatly facilitates the use of stored data encryption in Oracle9*i.*

Oracle Label Security

Oracle Label Security is a fine-grained access control product. It adds a special tag (label) to data rows, providing sophisticated and flexible row label security. It is built on the Oracle9*i* Virtual Private Database technology. Oracle Label Security is based on labeling concepts used by government and defense organizations to protect sensitive information and provide data separation. Application hosting, health care and other industries can also take advantage of data labeling to help solve security requirements in the Internet Age. For example, in application hosting, a subscriber label can be used to separate data among subscribers in the same application. Oracle Label Security is enforced within the database, providing security even if the application is bypassed. Label provides a dimension of access control which is not easily achieved using existing application data. Oracle Label Security also includes a sophisticated policy management tool, to manage policies, labels, and user label authorizations. Oracle Label Security is an out-of-the-box Virtual Private Database solution.

Oracle Internet Directory

Oracle9i supports LDAP technology to centrally manage network naming, easing deployments whether customers have 1 or 100's of databases with tens or tens of thousands of users. Oracle9i supports Oracle Internet Directory and Microsoft Active Directory.

To aid the developer in exploiting LDAP server functionality, enhancements in several APIs have been made. The PL/SQL API (DBMS_LDAP package) to

LDAP permits any PL/SQL code to perform any LDAP operation. This API is now supported through all database operation modes (Muti-Threaded server and dedicated server). New API functions have also been added to provide asynchronous operations. Additional utilities to access directory structures have been added to the C API to LDAP. JNDI standard protocol extensions can now be recognized by Oracle Internet Directory.

Oracle database password verifiers for password-authenticated enterprise users are natively stored and validated in Oracle Internet Directory. For custom applications, or applications whose users are not natively known to the database, user passwords can also be encrypted using either standard or custom crypto schemes. Oracle Internet Directory supports an IETF LDAP standard for representing prefixed user passwords where the prefixes identify the crypto scheme used for hashing the password values. A default hashing mechanism may be chosen from a variety of standard schemes, including MD5, SHA-1, and Unix "crypt." Values hashed by external agents may also be stored. This is useful when external authentication service agents want to use custom crypto schemes.

Administration of Oracle Internet Directory replication server has also been improved with the provision of new replication queue management and reconciliation tools. The replication queue management tool allows administrators object-by-object control over the elements in the human intervention queue, for the purposes of retrying object processing at will and deletion of objects from the queue. The replication reconciliation tool permits administrators to detect and correct inconsistencies among directory replicas.

A new web-based Oracle Internet Directory Self-Service Administration Servlet enables users to administer their own personalized data over the Web. Directory administrators can restrict the set of attributes that users are allowed to self-administer, including group memberships. Extended support for ACLs governing user self-administration of membership allows authenticated users to add their own Distinguished Names (DNs) to membership of a LDAP group object or any object type that holds membership information, including roles and proprietary subscriber lists.

Several enhancements have also been made to increase availability of directory services. Certification with certain limited Oracle9i Real Application Clusters configurations improves availability both for the front end, where the LDAP directory service and replication processes reside, and the back end Oracle RDBMS, where the directory data is stored. Support for "logical hosts" in clusters allows fail-over to a different physical host within the same cluster and also transparently supports continued availability of directory replication. New procedures allow for multi-node topology reconfiguration and upgrade with no directory service downtime.

Several key enhancements have further increased LDAP server scalability and performance. Multi-process support for higher-concurrency LDAP access has

been improved through a more scalable directory meta-data cache coherency protocol. IETF compliant support for LDAP referral objects enables "partitioned" LDAP directories. This allows delegated administration of physical directory segments and is critical for service providers and enterprises hosting large directory for a federation of autonomous organizations. By employing parallelism, the capacity of bulk-load, bulk-delete, and bulk-modify tools have been enhanced to handle much larger data sets. Optimization of server-side caching at startup on group objects reduces LDAP server startup latency and improves performance of access control evaluations. Finally, the ability of Oracle Internet Directory to consult Access Control information has been enhanced significantly such that the evaluation decisions are made efficiently even when there are very large numbers of ACL policies to be consulted.

Development Platform for *e*Business Applications

Oracle9*i* continues to offer the best development platform for eBusiness and traditional application development. Key focus areas include:

- Enterprise Java Engine

- XML type and XDK

- SQL and PL/SQL improvements

Enterprise Java Engine (previously JServer)

With Oracle8*i* Release 3 (a.k.a. 8.1.7) already providing an impressive list of Java features, Java support in Oracle9*i* Database Release 1 primarily focuses on improving the performance of the embedded Java Virtual Machine, new JDBC and SQLJ functionality, enhancement to Java stored procedures and bug fixing for J2EE containers including the Servlet Engine, the JSP Engine and the EJB container.

Performance improvements of Oracle JVM include a new garbage collector algorithm providing improved session GC, a lighter-weight object model and object monitors.

New JDBC features include NCHAR support for storing Unicode data, exposure of object type inheritance to Java developers, multi-level collections, Transparent Application Failover, OCI Connection pooling and middle tier authentication through JDBC OCI, SQLJ Object types in SQLData representation, native XA support, new LOB APIs and new oracle.jdbc.* interfaces for Oracle extensions.

New SQLJ features include support for dynamic SQL statements in SQLJ, fetches from an untyped ResultSetIterator, optional direct generation of Oracle JDBC code and corresponding support for JDBC improvements and program logic.

Enhancement to Java Stored procedures includes support for returning multiple rows (REFCURSORS).

XML Support - XML Type and XDK

Oracle9*i* features a number of enhanced database operations to store XML in the databases via SQL and render traditional database data as XML. These are key areas of functionality required to support the focus areas of eBusiness Integration, Packaged Applications, and Internet Content Management. The two main areas of XML support in Oracle9*i* are:

- Built in XML Developer Kits (XDKs)

- Native XML type

With the Java XML Developer Kit (XDK) pre-loaded, and the C XDK linked into Oracle9*i*, developers are able to easily access World Wide Web Consortium (W3C)-based functionality that generate, manipulate, render and store XML-formatted data in Oracle9*i*. Also available in PL/SQL and C++, the XDKs offer XML/XSLT parsers, XML Schema processors, XML Class Generators, XML Transviewer Beans, and the XSQL Servlet, providing basic building block features that allow developers to quickly XML-enable their applications.

In addition, for developers who have requirements to store and retrieve large amounts of complex XML through their content management applications, XML type support in Oracle9*i* provides XPATH navigation capabilities to optimize performance.

SQL and PL/SQL improvements

SQL and PL/SQL have continued to be improved in Oracle9*i* to meet modern development requirements. In addition to native compilation, overall PL/SQL compilation has also been improved.

To increase the usefulness of Objects, inheritance, type evolution and dynamic method dispatch are all supported in Oracle9*i* - greatly reducing the maintenance cost of using objects in application development.

New ANSI requirements are also supported, including support for the CASE statement, ANSI compliant joins, and reserved name versioning. To aid migration to Oracle9*i* from non-Oracle databases, scrolling cursor support has been added.

Some other improvements to PL/SQL include:

- Integrated front-end for SQL compilation - this means PL/SQL immediately supports all SQL syntax changes (in SQL embedded in PL/SQL).

- SQL parallel query mechanism has been extended to stored procedures written in 3GL languages (PL/SQL, Java, as well as external routines).

Stored procedures can now pipeline (incrementally return) data to the calling SQL statement.

- Full support for ANSI style CASE statements and expressions

- Better support for compute intensive applications through native compilation support

- The SQL and PL/SQL runtime engines have been more tightly integrated to improve performance.

- Also, the overhead of calling PL/SQL procedures from SQL has been reduced.

Manageability

Management is one of the key areas of improvement for Oracle9*i*

There are five aspects to our approach taken with management in Oracle9*i*:

- Make the database self managing in certain key areas

- Streamline and improve the operational management of an Oracle9*i* database

- Provide tools and techniques that significantly simplify and reduce the task time required to administer Oracle9*i*

- Enable fine-grained, automatic resource management

- Provide an end-to-end system management solution that manages the entire Oracle stack, not just the database.

Self Managing Database

Oracle9*i* databases are capable of managing their own undo (Rollback) segments - no longer will administrators need to carefully plan and tune the number and sizes of rollback segments or bother about how to strategically assign transactions to a particular rollback segment. Oracle9*i* also allows administrators to allocate their undo space in a single undo tablespace with the database taking care of issues such as undo block contention, consistent read retention and space utilization.

Memory management is another area which has been given significant attention in Oracle9*i*. Traditionally, administrators have needed to shutdown the instance in order to grow or shrink System Global Area (SGA) components. Oracle9*i* introduces a dynamic memory management feature which allows for re-sizing of the buffer cache and shared pool dynamically. It also provides administrators with advisories to help them size the SGA for optimal database performance. Furthermore, Oracle9*i* provides for transparent management of working memory for SQL execution by self tuning the initialization runtime parameters controlling allocation of private memory. This feature helps low end users reduce the time

and effort required to tune memory parameters for their Data Warehouse and Reporting applications, while high end users are able to avoid memory tuning for individual work loads.

Improved and Streamlined Operational Management

Other traditional management areas of the database are also improved. With the introduction of a persistent INIT.ORA feature in Oracle9*i*, parameter changes persist across multiple shutdowns. This feature also allows the administrator to startup the database from remote machines without a local copy of INIT.ORA. This is of immense help in database performance tuning as parameter changes made by performance management tools (Oracle Enterprise Manager) and internal self-tuning now persist across shutdowns.

Oracle9*i* also introduces the concept of "Oracle Managed Files" which simplifies database administration by eliminating the need for administrators to directly manage the files comprising an Oracle database. Oracle9*i* now internally uses standard file system interfaces to create and delete files as needed. While administrators still need to be involved in space planning and administration, this feature automates the routine task of creation and deletion of database files. With the introduction of default temporary tablespace, the SYSTEM tablespace is no longer used as the default storage location for temporary data. Oracle9*i* also allows for better control over database downtime by enabling administrators to specify the mean time to recover (MTTR) from system failures in number of seconds. This feature coupled with more dynamic initialization parameters help administrators further improve database availability.

Oracle9*i* also introduces a new capability called resumable space allocation, which allows an administrator to temporarily suspend a large operation, such as a batch update or data load. For example, such operations can be suspended if they start to encounter out of space errors, allowing the administrator to fix the problem, and then resume the operation from the point of interruption - all without disrupting normal database operation.

Oracle9*i* also supports databases created with multiple block sizes, and allows administrators to configure corresponding 'sub caches' within the buffer cache for each block size. This capability allows administrators to place objects in tablespaces of appropriate block size in order to improve I/O performance, and also allows tablespaces to be transported between different databases, for example, from an OLTP environment to a Data Warehousing environment.

Execution plans are cached in Oracle9*i* , allow administrators to investigate reported performance problems without needing to re-execute the offending queries.

To ease backup and recovery operations, Recovery Manager in Oracle9*i* enables one time backup configuration, automatic management of backups and archived

logs based on a user specified recovery window, restartable backups and restores, and test restore/recovery. Recovery Manager implements a recovery window, a new policy to control when backups expire. This allows administrators to establish a period of time during which it will be possible to discover logical errors and fix the affected objects by doing a database or tablespace point-in-time recovery. Recovery Manager will also automatically expire backups that are no longer required to restore the database to a point-in-time within the recovery window. These features are designed to reduce the time and effort spent by administrators in performing routine backup tasks by providing for automation for most commonly performed tasks. The new controlfile autobackup feature also allows for restoring/recovering a database even when a Recovery Manager repository is not available. Recovery Manger in Oracle9*i* also features enhanced reporting, a more user friendly interface and the ability to specify a highly flexible backup configuration to suit varied requirements depending on the nature of database and business needs.

Fine Grained, Automatic Resource Management

The Database Resource Manager, introduced in Oracle8*i*, has been significantly enhanced in Oracle9*i* to allow for more granular control over resources and adds features such as automatic consumer group switching, maximum active sessions control, query execution time estimation and undo pool quotas for consumer groups. Administrators are able to specify the maximum number of concurrently active sessions per consumer group. Once this limit is reached, Database Resource Manager queues all subsequent requests and runs them only after existing active sessions complete.

The automatic consumer group switching feature of Oracle9*i* allows the administrator to specify a certain criteria which, if met, will cause the Database Resource Manager to automatically switch the consumer group of a long running session, for instance, from a consumer group set up for OLTP operations to one more suited for batch processing. Administrators are also able to set a maximum estimated execution time for each consumer group. The Database Resource Manager then estimates the approximate query execution time for each operation before it begins and will either abort the operation if it exceeds the limit specified or switch the operation into a lower priority consumer group. With the Undo pool quota feature, administrators are now able to specify a maximum limit on the total amount of rollback data generated per consumer group. This prevents a rogue transaction from consuming excessive rollback space and thus impacting system operation.

Management Tools And Techniques

New features, tools and techniques are also provided to make what little an administrator has left to do a delight. In Oracle9*i*, Oracle Enterprise Manager continues to provide easy-to-use management tools that support the new

capabilities of the database and the entire eBusiness platform. Oracle Enterprise Manager's graphical interface makes it simple to adopt and manage critical new components such as Oracle Internet File System, Oracle Internet Directory, Oracle Internet Application Server, and Oracle Applications.

To further simplify management tasks, Oracle Enterprise Manager has been enhanced to include guided, expert diagnostics and problem resolution. Oracle has consolidated the wealth of expert knowledge and experience of its development and consulting teams into Oracle Enterprise Manager. Advice and recommendations about properly configuring an Oracle environment, effectively monitoring its performance, and quickly resolving problems has been incorporated directly into the Oracle Enterprise Manager management tools. For example, administrators can instantly display a set of overview charts that show the overall health of their system, with indicators that automatically alert administrators to potential problem areas. Drilldowns from these problem areas then quickly guide administrators through the proper steps required to diagnose and resolve the problems Oracle Enterprise Manager has detected.

All essential management functions are also web based so that administrators can manage their system directly from a web browser. Oracle Enterprise Manager can also publish detailed reports to a website, allowing administrators easy access to any systems management information.

End-to-end System Management Solution

In Oracle9*i*, Oracle Enterprise Manager also allows administrators to go beyond monitoring the performance of single targets, like a database. In this new release, administrators are able to monitor the response of their entire Oracle based system and ensure that they are meeting the required business service level agreements. This capability is critical to users such as Application Service Providers, eBusiness sites, or any business whose success depends on maintaining superior response time, performance, and availability of their IT systems. Oracle Enterprise Manager allows administrators to monitor service levels and be automatically alerted to any degradation in performance. Extensive service level reports are also available, giving a complete picture of the performance of the system.

In addition to service level reports, reporting capabilities throughout all of Oracle Enterprise Manager have been significantly enhanced. A comprehensive set of pre-defined reports are included that document the configuration and health of the entire Oracle environment. Reports can be generated, for example, on the configuration of databases, the performance of applications over the last week, or the current load on the system. Customized reports can also be generated using a site's own data or by mixing-and-matching the pre-defined report topics Oracle Enterprise Manager provides. These reports can be automatically generated and posted to a website for convenient access across the organization.

Windows Integration

Oracle9*i* 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

Integration With Windows 2000

Oracle9*i* supports better integration with Microsoft Transaction Services, Microsoft Message Queuing and Internet Information Services. The PKI infrastructure and single signon capabilities in Oracle9*i* have also been well integrated with Windows 2000, Active Directory and Microsoft Certificate Store.

In Oracle9*i*, the Oracle Plug-in for Microsoft IIS allows seamless high performance access to Oracle Java and PL/SQL web components in an IIS environment.

Oracle9*i* also provides an enhanced solution to allow the Oracle database to participate as a Resource Manager in Microsoft Transaction Server/COM+ Transactions environment.

Windows security (PKI, Microsoft Certificate Store) supports Oracle wallets in Registry/Active Directory and allows Oracle products to use Microsoft Certificate Store. In addition, Active Directory access through the PL/SQL API for LDAP is now enabled, facilitating tighter integration between data stored in Active Directory and data stored in Oracle RDBMS.

Customers who implement Oracle Internet Directory as their central Directory while using Active Directory to support their desktop environments can use Microsoft ADSI to access Oracle Internet Directory from the Windows desktop environment.

Meta-directory synchronization between Active Directory and Oracle Internet Directory facilitates centralized scheduling and configuration of Oracle and third party meta-directory components. Active Directory connectivity solutions that exploit these new features have been certified for specific third party products from vendors such as Siemens.

Development and Deployment on MS Windows Platform

For Windows developers, Oracle9*i* offers an enhanced native OLE DB provider. XML, Database Events and Oracle9*i* OCI extensions are supported through Oracle Objects for OLE..

Internet Content Management

Oracle9*i* allows customers to store, manage and aggregate all types of multimedia content into a single database. Oracle9*i* significantly enhances the capabilities of

the Oracle8*i* database to serve as a platform to create, manage and deliver Internet content. Key focus areas are:

- Storing and managing all types of Content - files, multimedia, e-mail ...

- Searching and indexing all types of content efficiently

- Content Syndication for Internet applications

- Organization of content for collaborative projects

- Location-enabled, mobile-ready content

Storing and Managing all types of Content

Oracle9*i* includes the version 1.2 release of the Internet File System (*i*FS), a revolutionary extension to the Oracle8*i* database. Oracle *i*FS provides the best of both the relational database and file system worlds. Organizations can install Oracle *i*FS and get, out of the box, a file system that has built-in capabilities not available in other file systems. Oracle *i*FS can store all content, from e-mail to web content to word processing documents, in the same folders. End users can access all this content through Windows, the web, FTP, and an e-mail client without any special client installation. Oracle *i*FS also gives the end user content management features—versioning, content-based searching using interMedia Text, multiple foldering of files, extensible file attributes, ACL-based security, and check in/check out—to better manage the process of creating and publishing file-based content. And, of course, all of this functionality has the ease of the file systems end users already know how to use.

Oracle *i*FS exposes all of its capabilities through Java, making it an excellent platform for building applications with content management applications. Developers can stop wasting time with systems integration, building special protocol servers, or coding the same content management features over and over again. All the inner workings of the file system are available to developers for customization, including extensive XML processing capabilities.

With Oracle9*i*, *i*FS adds more content management features, such as WebDAV, an emerging standard for Internet collaboration. Oracle *i*FS will also be surfacing into the file system interMedia's capabilities to index, search, and manipulate graphics, audio, and video.

Oracle9*i* includes enhancements to interMedia image, audio, and video support. Oracle9*i* greatly simplifies the ability to add multimedia formats, processing, and rendering by incorporating Java Advanced Imaging (JAI) into the database and providing support for the Java Media Framework (JMF) in interMedia. interMedia now supports PNG and EXIF image formats. It has a new browser-based version of the "clipboard" to insert, retrieve and annotate media objects in Oracle9*i*. Improvements to the image search capabilities and support for storage and delivery of streaming media with new streaming formats and plug-ins are also

part of Oracle9*i* . In addition, interMedia's audio, video and image media processing services are now accessible in native form through relational PL/SQL and JAVA interfaces.

Finally, interMedia's media data management capabilities are exposed through Oracle's Java IDE, JDeveloper , through powerful and easy to use Business Components for Java, and through Oracle Portal's reports and forms.

Content Syndication for Internet Applications

Oracle9*i* also includes an enhanced infrastructure for support of Internet service aggregation and content syndication for portals, exchanges, and other Internet applications through Dynamic Services. The Syndication Server includes a Content Syndication Manager to coordinate syndication execution flow and manage affiliates profiles, delivery policies, targeted offers; a Syndication Affiliate Profile Manager used to create, modify and remove user accounts and business-related information.; a Subscription Manager to manage subscriptions for customers, perform content updated (partial or full) and track subscription activities; and a Syndication System Administrator to assist administrator to supervise the system. It also provides a Performance Monitor to track down any performance-related issues, such as a network bottleneck due to a large amount of full content updates. The Syndication Server capabilities in Oracle9*i* supports the Internet Content Exchange (ICE) 1.0 protocol and includes adapters to allow for subscription and delivery from non-ICE compliant providers and syndicators.

Searching and Indexing

Oracle9*i* builds on the database's already powerful capabilities to search all kinds of content, including text and multimedia. Ultra Search in Oracle9*i* unifies search areas across heterogeneous corporate repositories, websites and groupware content. Ultra Search includes a web interface, web crawling and search administration facilities , as well as a programmable Java API, to provide a unified interface for enterprise and vertical portal search applications.

In order to meet the demands of eBusiness applications, Oracle Text indexing has been improved with a new index type designed to perform very fast search across volumes of short textual descriptions. This is ideal for catalog and metadata search as well as searching of auction data and resumes. With Oracle9*i*, text search of nested XML elements, search attribute values, XPath query syntax, and other advanced XML structures are also supported.

Media and document metadata can now also be extracted, indexed, and mapped to XML documents or database schema through Java APIs to interMedia Annotator. These APIs allow for programmatic invocation of metadata services by any application or scripting language that can use Java APIs including JAVAscript, VBscript, and Apple Script.

Collaborative projects

Oracle9*i* adds the ability to create shared workspaces to support collaborative, long duration projects. Workspaces support in-place, existing content and allow existing applications to run against the workspace view of the database transparently. Database content can be associated into a workspace and used for the purpose of a specific application while the underlying transaction database continues to run unaffected. Multiple, concurrent database-backed projects can coexist simultaneously against different versions of content.

Location-Enabled, Mobile-Ready Content

Oracle9*i* with Oracle Spatial enables Oracle-based applications for e-business, portals and wireless ASPs to readily incorporate location capability into their services. Oracle Spatial provides native data management, including storage, indexing, and proximity queries, for location information. Location information includes road networks, wireless service boundaries, and geocoded customer addresses. Oracle Spatial provides the robust, efficient management of location information demanded by the emerging online, wireless, and in-vehicle telematics markets.

Oracle9*i* and Oracle Spatial are now tightly integrated with Oracle9*i* Application Server. Oracle Spatial combined with Oracle9*i*AS Wireless provides an infrastructure that captures the mapping of services to areas of interest (or, regions) and clients to regions or addresses. Location information can be aggregated from a variety of remote sensing technologies and service providers, resulting in a single, seamless interface to the information. Applications built in this environment can then determine the locations of mobile business objects (services or clients) as well as the path taken by the mobile objects in a specified time window. Based on this type of information, developers can create innovative location-aware applications.

eBusiness Integration

Key focus areas are:

- Supporting millions of messages/hour in industry standard business messaging formats

- Distributed environment improvements

- Web Services support

Supporting Millions of Standard Business Messages Per Hour

Oracle9*i* also provides a standard infrastructure that makes it easier for customers to integrate storefronts, exchanges and portals with other backend and external systems.

XML based messaging over HTTP is supported in Advanced Queuing in Oracle9i, allowing external 'across firewall' systems to be more easily integrated. In addition, non-database, Internet based consumers are also supported, allowing for greater flexibility in non-heterogeneous environments. To enable messaging operations (such as enqueue and dequeue) to be performed across the Internet, a new XML based Internet Document Access Protocol (iDAP) is provided that allows message operations to also be requested across firewalls.

Oracle9i also provides a built-in message transformation architecture, with support for PL/SQL and XSLT based transformations, which can be executed at enqueue, dequeue and propagation operations.

Advanced Queuing agents can now also be defined in Oracle Internet Directory, providing a centralized, easy to manage, secure infrastructure for global messaging. In addition, global topic information can also be externalized in Oracle Internet Directory, providing a single place for the configuration and management for Advanced Queuing operations that span one or more systems.

To support messaging between heterogeneous environments, the Message Gateway is provided in Oracle9i, supporting propagation of messages from Oracle9i to other proprietary message systems, such as MQSeries and Tibco.

Distributed Environment Improvements

With Oracle9i , Advanced Replication has been enhanced to provide support for object datatypes in replicated tables, multi-tier, updatable materialized views, and fast refresh of many-to-many relationships in materialized view subqueries. Additionally the need to quiesce has been reduced, improving availability during typical schema maintenance activities.

With Oracle9i, the Oracle Transparent Gateways have been enhanced to provide result set support for stored procedures, support for piecewise selects and updates of LONGs and LOBs, support for the date-time datatype, and multi-threaded agent support, providing improved scalability.

Web Services Support

Oracle9i Dynamic Services is a new Java-based service-oriented framework supporting content aggregation and syndication for Internet applications. With Dynamic Services, developers can encapsulate application logic from Web sites, local databases, or other proprietary systems into services and easily incorporate these services into other applications. Services can be assembled for failover and other composite services. The Dynamic Services framework supports tracking and auditing of service execution events using Advanced Queuing and a centralized, managed service registry using Oracle Internet Directory.

Packaged Applications

Key focus areas are:

- Globalization - Expanding eBusiness to the World Market

- Providing tactical development features required by ISVs

Globalization - Expanding eBusiness to the World Market

Oracle9*i* support for developing and deploying multilingual applications on a single central database and middle-tier platform, significantly reduces the cost and overhead of maintaining global content.. Requirements for multi- geographic, multi-language applications includes named time zones and multilingual support through Unicode.

Unicode support has been greatly expanded in Oracle9*i* so that customers can easily find the right Unicode solution for their business globalization needs. Oracle9*i* provides an ideal platform for Unicode application development, deployment or hosting for multiple languages on a single database instance. Full Unicode 3.0 support includes the 2 most popular encoding forms of Unicode, UTF-8 and UTF-16 and surrogate support. Full surrogate support means an additional 1 million characters can be supported. Customers have the flexibility of developing fully globalized applications by setting up or migrating their entire database character set to UTF8 to support multiple languages simultaneously on a single database instance. Or with the new Unicode data type, UTF-8 or UTF-16 can be used to define columns that support one or more new languages incrementally, for an existing monolingual database. All access programming interfaces to Oracle9*i* are enabled for both UTF-16 and UTF-8, thus providing excellent native integration for applications written in these Unicode forms. If migrating an existing Oracle database to a new character set such as UTF8, the Character Set Scanner can quickly identify potential issues such as data loss allowing pro-active action such as expanding columns before loading the data.

Oracl*e9i* extends monolingual linguistic sorts so that you can now sort additional languages as part of one sort. For Asian language data or multilingual data, Oracle provides a sorting mechanism based on an ISO standard (ISO14651) and the Unicode 3.0 standard. Multilingual linguistic sorting for Asian languages are implemented in a three pass fashion based on the number of strokes, pinyin, or radicals. In addition, handling of canonical equivalence and surrogate codepoint pairs is also implemented with a capacity to define up to 1.1 million codepoints in one sort If customers have special needs that goes beyond the extensive set of linguistic sorts provided Oracle9*i*, they also have the flexibility of defining or customizing their own linguistic sorts by using the new easy-to-use GUI tool, Oracle Locale Builder.

The new datetime data types can store time data with sub-second precision. The datetime data types TSLTZ and TSTZ are time-zone-aware. Datetime values can be specified as local time in a particular region, rather than a particular offset. Using the time zone rules tables for a given region, the time zone offset for a

local time is calculated, taking into consideration Daylight Savings time adjustments, and used in further operations.

Oracle9*i* provides an extensive set of locale definitions including 57 languages, 88 territories and approximately 200 character sets. If customers need to customize any of these existing locale definitions, or create new one's, the new Oracle Locale Builder provides an easy-to-use graphical user interface through which one can easily view, modify and define the various locale-specific data.

Tactical Development Features

Oracle9*i* continues to be the best platform for ISV development, deployment, hosting and migration. Features such as updatable scrollable cursors as well as ANSI compliant CASE statements, datetime data types and join syntax facilitate migration of applications developed on other databases to Oracle9*i*. In addition, LONG data types can be easily converted to LOB data types via a simple ALTER TABLE command.

Enhancements to stored outlines and default column values allow for improved deployment and hosting of packaged applications. With stored outline editing, queries can be tuned without having to change the packaged application code. For the customer whose environment has unique characteristics that might cause an outline to yield a less than optimal execution plan, the ability to make minor adjustments to the outline enhances the ability to support specific customer needs. In this sense, stored outlines are made more adaptive as users can make finely tuned adjustments to the saved plan. Use of the SYS_CONTEXT function to generate default column values simplifies implementation of Virtual Private Database security feature, providing a more scalable infrastructure for managing hosted applications.

Packaged applications also benefit from the numerous development, availability, scalability and security features provided in Oracle9*i*.

Business Intelligence Platform

Oracle9*i* 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 eBusiness environment. Additionally, Oracle9*i* 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, Oracle9*i* offers considerable new enhancements in each of these areas.

Oracle9*i*s partitioning capabilities have been expanded to support list partitioning, and base partitioning capabilities have been extended to cover all data types available in Oracle8*i*, including index organized tables, objects and nested tables. This allows organizations to effectively store, manage and search very large amounts of any type of information.

Oracle9*i*s self-tuning memory not only simplifies the tuning of business-intelligence applications and ensure equitable distribution of memory among concurrent process's, but more importantly also improves query performance. Oracle9*i* also continues to improve query performance in other areas, with innovative new technologies such as considerable enhancements to materialized view's, and the introduction of bitmap join indexes.

Query response time continues to decrease with enhancements to materialized views. Now even more queries are capable of using a materialized view with the ability to create a materialized view based on a subset of data e.g. only regions EMEA and Asia. The time required to maintain the materialized views has been reduced with many more of them now able to use the fast refresh method. To assist management and usage, two new packages are available which advise why a query did not use a materialized view and what it is capable of.

Integrated ETL and Analysis Capabilities

However, Oracle9*i* for business intelligence goes far beyond the primary requirements of performance, scalability, and manageability. Oracle9*i* 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. Oracle9*i* provides ground-breaking new functionality in three areas: Extraction, Transformation and Loading (ETL), Online Analytical Processing (OLAP), and Data Mining.

To increase the efficiency and reduce time taken to load and refresh critical data warehouses, Oracle9*i* provides support for external tables, allowing data from external systems to be quickly loaded into the database. In addition, a new data capture facility will allow incremental changes from target sources to be captured and applied to the data warehouse automatically. Other data load capabilities provided to increase data load scalability and reduce complexity include multi table insert and upsert semantics. This new ETL functionality will also be leveraged by Oracle Warehouse Builder.

Oracle9*i* introduces Oracle OLAP, a scalable, high-performance OLAP calculation engine with fully integrated management and administration.

Leveraging Oracle Express Server technology and Oracle8i's analytic SQL capabilities, Oracle OLAP provides a robust platform for delivering analytic applications.

Oracle OLAP offers:

- A complete range of analytic functionality that supports the complete spectrum of reporting, analytical, and planning applications. OLAP functionality is available via the Oracle9*i* OLAP API.

- Performance previously unavailable to data warehouse based analytic applications. Enabling technology includes improvements to the relational database such as bitmap join indexes, grouping sets, WITH clause, SQL OLAP functions, and automatic memory management.

- A flexible and manageable data platform that eliminates the need for wholesale data replication. Oracle9*i* provides analysis capabilities directly against the relational database, thus eliminating the need to manage separate analytical database.

- The Oracle9*i* OLAP API.

Oracle9*i* also includes new data mining capabilities. Based on Oracle's Darwin product, Oracle9*i* provides a data mining engine which will enable customers to incorporate accurate, real-time recommendations and personalization functionality into their online operations. Oracle9*i* is the next step in tighter integration of data mining and the relational database, and includes in-database scoring along with the ability to manage data mining operations.

ORACLE