An Oracle White Paper
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Oracle Database: The Database of Choice for Deploying SAP Solutions

ORACLE®

Executive Overview

SAP and Oracle would like to announce that they have agreed to a long-term extension of SAP's global reseller and technical support relationship (May 24, 2017). For more than twenty years, SAP and Oracle have worked together to provide customers with a supported SAP/Oracle environment, running SAP applications and an Oracle database. During this extension new and existing SAP customers can continue to acquire Oracle licenses from SAP or Oracle to support their SAP business applications, and SAP and Oracle will continue to offer technical support for the combined Oracle/SAP offering.

Since 1988, Oracle has been the database of choice as one of the development platform for SAP applications. Today, many customers use the Oracle database to power their mission critical SAP applications. Deploying Oracle Database, within their IT architecture, SAP customers can leverage the power of the world's leading database to reduce their server and storage costs, eliminate idle redundancy and improve quality of service. **All SAP customers can enjoy a very large number of features and options already released with the Oracle Database 12*c* certification completed by SAP**.

In less than eighteen Months, SAP certified Oracle Exadata Database Machine, Exalogic, SPARC SuperCluster and more recently Oracle Database Appliance (ODA), Oracle Privat Virtual Machine (OVM) and Oracle Private Cloud Appliance (OPCA) in August 2014. Since June 10th 2011, SAP customers can use Oracle Exadata Database Machine, Oracle SuperCluster, Exalogic, ODA, OPCA and Oracle MiniCluster for their SAP applications. In this paper we'll focus more on Exadata for SAP which is an easy to deploy solution for hosting the Oracle database that delivers the highest level of database performance available, runs SAP unchanged, allows better support, provides fast and online migration, and can be used as an Oracle database consolidation platform for SAP and non-SAP applications.

Oracle Cloud IaaS is an attractive – based on value, security and performance – Enterprise Cloud platform which provides SAP customers a choice to run their SAP infrastructure on premise, or in the Cloud, including private, public, and mixed cloud scenarios.

Oracle and SAP have certified SAP NetWeaver- and SAP NetWeaver Business Warehouse-based applications to run on Oracle Cloud Infrastructure. Oracle Exadata Cloud Service and virtual machine instances on Oracle Cloud Infrastructure will be certified next..

Introduction

Oracle and SAP continue to satisfy the tens of thousands mutual SAP on Oracle database customers. The joint effort has always been characterized by a constant desire to provide mutual customers with efficient service and support solutions for their SAP application needs, in order to bring additional benefit to their businesses and to offer optimum protection of their investments. The Oracle database is always optimized for SAP Applications and with each new database release many new features are provided like just done with Oracle Exadata Database Machine that help customers cope with constant challenges such as, reducing storage costs, improving performance, minimizing downtime etc.

This paper will describe the most important technology and features supported by SAP and show the main identified differentiators which explain in detail why Oracle Database is the first choice for running SAP applications. Many features, such as Oracle Real Application Clusters (RAC), Data Guard, Table Partitioning etc. have been available in earlier Oracle database Releases, enhanced in the current **Oracle Database version 12c Release 2,** and can be used with Oracle Exadata Database Machine, SuperCluster, etc. There are even more new features and options certified with 12cR1 for SAP like **Oracle Database In-Memory**, Advanced Index Compression, ACFS Support on Oracle Exadata platform, Storage Snapshot Optimization, **Active Data Guard Far Sync**, **Database Vault**, etc. In December 2015, we certified two major features (**Hybrid Columnar Compression**, and Information Lifecycle Management) which can help reduce the cost of managing large amount of data, while also improving application and database performance. Last but not least, we certified **Oracle Multitenant** and **Flat Cubes for SAP BW.**

Database market share for Enterprise Applications

SAP and Oracle would like to announce that they have agreed to a long term extension of SAP's global Reseller and Technical Support relationship. For more than twenty years, SAP and Oracle have worked together to provide customers with a supported SAP/Oracle environment, running SAP applications and an Oracle database. During this extension new and existing SAP customers can continue to acquire Oracle licenses from SAP or Oracle to support their SAP business applications, and SAP and Oracle will continue to offer Technical Support for the combined Oracle/SAP offering.

SAP and Oracle will continue to provide customers with additional information and details concerning the Oracle/SAP relationship at www.oracle.com/sap and www.sap.com.

Analysts are unanimous in saying that the Oracle Database enjoys dominant market share for enterprise applications, including SAP.

More than two-thirds of all mid-size to large enterprise SAP customers in every industry entrust their application deployments to Oracle databases, and companies are running SAP applications with Oracle databases on all major operating systems.

Note that the larger the system (i.e. more users, more data) the higher the requirements in regards to storage saving, performance, security and high availability. Very large systems are almost exclusively based on Oracle.

Oracle dominates the SAP database market share across operating systems platforms including, the various flavors of Unix and Linux as well as Windows.

Oracle's market position has real advantages for customers considering database choices for their SAP system. A large installed base indicates that Oracle is able to meet the database needs of SAP customers across many industries and geographies.

It also means that a large group of customers have tested the SAP-Oracle combination in situations that no QA group at SAP could ever recreate. Both Oracle and SAP have learned from this experience in the field, and both products have been enhanced as a result. Customers now choosing Oracle for SAP will get the accumulated benefits of years of product testing in the real world. The impressively large customer base translates into several advantages:

- Proven technology

- Widest choice of solutions and systems from Oracle and partners

- Highest consulting expertise on the market

- Best cooperation with hardware and tool vendors

- Largest labor pool of people with combined Oracle – SAP skills

Oracle-SAP Technology Relationship
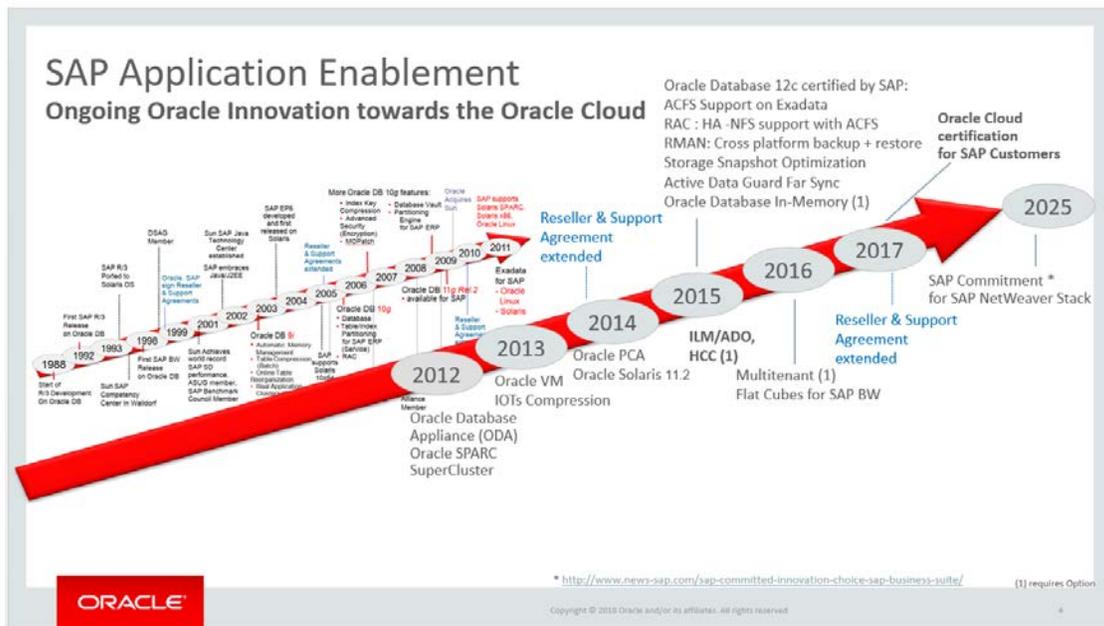
Figure 1: Milestones in SAP-Oracle Technology Relationship

Oracle has dedicated teams working with SAP in many different areas, including joint software development, pre-sales and technology evangelism, customer technical support and professional services. The long Oracle-SAP technology relationship started in 1988 when SAP R/3 development began.

The Oracle development team working at SAP HQ in Walldorf, Germany assists SAP in:

- Performance testing of each release with the Oracle database to ensure there is no degradation of response time, throughput and scalability between SAP versions.

- Fixing database bugs found during SAP functional testing, and including SAP enhancement requests in the database product roadmap

- Incorporating new Oracle features in SAP releases

- Optimize each new release of the DBMS and new versions of SAP applications

- Responding to escalated customer problems, when related to database issues

Oracle Database 12c for SAP Certification Status

Oracle Database 12c (including Oracle Grid Infrastructure 12c and Oracle Real Application Clusters 12c) is certified for NetWeaver-based SAP products.

To ensure sufficient overlap with Oracle Database 11*g*, which is available to SAP customers as a fully supported version (11.2.0.4) where Oracle Extended Support will available without additional costs until May 2017, SAP has certified Oracle Database 12.1.0.2, thereby breaking the "terminal release" custom (certification of Oracle Database release x.2, no certification of release x.1) valid to date.

New features included in phase 1 (base certification):

- Advanced Index Compression – Automatic Prefix Computation (higher compression rate, ease of use)

- Client-Server Network Compression (less network load between Application Servers and Database Instance[s])

- ACO Table Compression -- Support for > 255 columns

- Concurrent Execution of Union and Union All Branches (improves SAP BW performance)

- ACFS Support on Oracle Exadata (for SAP shared file system support [/sapmnt, etc.])

- Oracle RAC -- HA-NFS support with ACFS (complete SAP HA solution for shared file system)

- RMAN: Cross Platform Backup and Restore (faster and easier heterogeneous platform migration)

- Storage Snapshot Optimization (no more begin/end backup for certain snapshot technologies)

- Active Data Guard Far Sync (high performance, zero data loss across large distance WAN)

- Online Reorganization Operations (Online Move Partition, Move Datafile Online, Rebuild Index-Organized Tables)

- Windows -- Support for Standard User for Services, Database Instances and Oracle Net Services

Phase 2: Oracle Database In-Memory certified on June 30, 2015

Oracle Database 12c Release 1 (12.1.0.2) was released and it included a new option called Oracle Database In-Memory (Database In-Memory), which accelerates analytics by orders of magnitude while simultaneously speeding up mixed-workload OLTP. This Oracle database release including Oracle Database In-Memory has been certified by SAP for use with SAP® solutions based on the SAP NetWeaver® 7.x technology platform.

Database In-Memory leverages a unique "dual-format" architecture that enables tables to be in memory simultaneously in a traditional row format and a new in-memory column format. The Oracle SQL Optimizer automatically routes analytic queries to the column format and OLTP queries to the row format, transparently delivering best-of-both-worlds performance. Oracle Database 12c automatically maintains full transactional consistency between the row and the column formats, just as it maintains consistency between tables and indexes today. For more information, see:

- **Benchmark Results Reveal the Benefits of Oracle Database In-Memory for SAP Applications**: http://www.oracle.com/technetwork/database/in-memory/overview/benefits-of-dbim-for-sap-apps-2672504.html

- SAP note: 2178980 - Using Oracle Database In-Memory with SAP NetWeaver based Products

- White paper: Using SAP NetWeaver with Oracle Database In-Memory

- Oracle Database In-Memory

- The new **SAP BW Flat Cube** design for BW InfoCubes is now available for Oracle Database 12c Release 1 with Oracle Database In-Memory as of SAP BW 7.40 SP15. For more details see SAP note 2335159

  ### Benefits for SAP BW customers:

  - Cost saving through higher performance and optimized integration of SAP BW and Oracle Database 12c technologies

  - Simplified data modeling and remodeling

  - Faster data loads

  - Performance improvements for queries accessing large amounts of data

- Oracle Exalogic or Oracle Exalogic Elastic Cloud is a combined hardware and software offering. It includes multiple Intel Xeon based servers (up to 30) and an integrated storage appliance using flash memory all connected through fully-redundant Infiniband connectivity with Oracle's operating systems to provide an pre-tested, pre-installed, tuned, optimized and factory assembled platform. Oracle Exalogic Elastic Cloud (physical and virtual deployment) was certified by SAP in March 2016. For more information, see SAP note "1617188 - SAP Software and Oracle Exalogic".

Phase 3 – Oracle Database 12c Automatic Data Optimization certified on December 24, 2015

- Hybrid Columnar Compression (HCC) for Oracle Exadata and Oracle SuperCluster

- Using SAP NetWeaver with Oracle Database 12*c* Automatic Data Optimization and Information Lifecycle Management (PDF)

  - This white paper shows implementation scenarios of Hybrid Columnar Compression for SAP BW and the migration of existing systems to HCC based on SAP tools.

Phase 4 – February 2017:

- Oracle Multitenant – an Oracle Database 12c Enterprise Edition option – introduces a new architecture that enables customers to easily consolidate multiple databases, without changing their applications. This new architecture delivers all the benefits of managing many databases as one, yet retains the isolation and resource prioritization of separate databases. In addition, Oracle Multitenant enables rapid provisioning and upgrades, and fully complements other options including Oracle Real Application Clusters and Active Data Guard. See SAP note 2336881.

December 2017:

As of December 18, 2017, Oracle Database 12c Release 2 (12.2.0.1) is certified for all NetWeaver-based SAP products and solutions.

In SAP environments, Oracle Database 12c Release 2 does not come with major new options or features, but with numerous improvements in performance, manageability, and platform support.

Please see SAP Notes:

- 2470660 Oracle Database Central Technical Note for 12c Release 2

- 2477382 Oracle Database Upgrade (12.2)

- 2477472 Oracle Database Upgrade with Grid Infrastructure (12.2)

- 2507228 Database Patches for 12.2.0.1

- 2573150 Exadata / Supercluster: Patches for 12.2.0.1

SAP Core Data Services for Oracle Database

With the most recent SAP NetWeaver version released in September 2014 and in accordance with SAP's "commitment to openness and innovation," SAP has begun to provide an Oracle-specific implementation of SAP's Core Data Services (CDS). This will allow SAP applications and application developers to push application functionality down to the database, i.e. to call procedures stored in the Oracle Database.

Oracle Exadata Database Machine for SAP Customers

Oracle Exadata Database Machine version X5-2 and earlier is certified by SAP and can be used with SAP NetWeaver 7.x or higher including all SAP products which are based on SAP NetWeaver 7.x like SAP ERP 6.0, SAP BW 7.x, SAP CRM 7.x etc. (for a complete list check the SAP Product Availability Matrix: http://www.service.sap.com/PAM).

The Oracle Exadata Database Machine is an easy to deploy solution for hosting the Oracle Database that delivers the highest levels of database performance available. The Exadata Database Machine is a "cloud in a box" composed of database servers, Oracle Exadata Storage Servers, an InfiniBand fabric for storage networking and all the other components required to host an Oracle Database. It delivers outstanding I/O and SQL processing performance for SAP Business Suite (i.e. SAP ERP 6.0, CRM 7.x), Business Warehouse (i.e. SAP BW 7.x) and consolidation of mixed workloads. Extreme performance is delivered for all types of database applications by leveraging a massively parallel grid architecture using Real Application Clusters and Exadata storage. Database Machine and Exadata storage delivers breakthrough performance with linear I/O scalability, is simple to use and manage, and delivers mission-critical availability and reliability.

The Exadata Storage Server is an integral component of the Exadata Database Machine. Several features of the product deliver extreme performance. Exadata storage provides database aware storage

services, such as the ability to offload database processing from the database server to storage, and provides this while being transparent to SQL processing and database applications. Hence just the data requested by the application is returned rather than all the data in the queried tables. Exadata Smart Flash Cache dramatically accelerates Oracle Database processing by speeding I/O operations. The Flash provides intelligent caching of database objects to avoid physical I/O operations. The Oracle Database on the Database Machine is the first Flash enabled database. Exadata storage provides an advanced compression technology), Exadata Hybrid Columnar Compression, that typically provides up to 10x and higher levels of data compression (planned to be supported by SAP with 12c). Exadata compression boosts the effective data transfer by an order of magnitude. The Oracle Exadata Database Machine is the world's most secure database machine. Building on the superior security capabilities of the Oracle Database, the Exadata storage provides the ability to query fully encrypted databases with near zero overhead at hundreds of gigabytes per second. The combination of these, and many other, features of the product are the basis of the outstanding performance of the Exadata Database Machine.

Extreme System Scalability and Growth with Elastic Configurations

The Exadata Database Machine uses a scale-out architecture for both database servers and storage servers.. As an Exadata Database Machine grows, database CPUs, storage, and networking can be added in a balanced fashion ensuring scalability without bottlenecks. The scale-out architecture accommodates any size workload and allows seamless expansion from small to extremely large configurations while avoiding performance bottlenecks and single points of failure. A high-bandwidth low-latency 40 Gb/second InfiniBand network connects all the components inside an Exadata Database Machine. Specialized database networking protocols run over the InfiniBand network and provide much lower latency and higher bandwidth communication than is possible using generic communication protocols. This enables both faster response time for OLTP operations, and higher throughput for Analytic workloads. External connectivity to the Exadata Database Machine is provided using standard 10 Gigabit Ethernet. Elastic configurations provide an extremely flexible and efficient mechanism to expand computing power and/or storage capacity of any given Exadata system. The starting configuration of an Exadata Database Machine consists of 2 database servers and 3 storage servers, which can be further elastically expanded by adding more database or storage severs as requirements grow.

Exadata Database Machine is the most versatile database platform. With Elastic Configurations, the system can be custom configured to meet any business use case. In addition to upgrading within a rack, multiple racks can be connected using the integrated InfiniBand fabric to form even larger configurations.

Exadata for SAP source of information

- For detailed information, possible configuration and size: https://www.oracle.com/engineered-systems/exadata/index.html

- Information about the prerequisites, minimum requirements and all the necessary steps to setup an SAP system on Oracle Exadata can be found in the SAP note [1590515 - SAP Software and Oracle Exadata](#) and the Best Practices Guide "SAP NetWeaver and Oracle Exadata Database Machine" (http://www.oracle.com/us/products/database/sap-exadata-wp-409603.pdf)

  - Excerpt of Customer stories: http://www.oracle.com/sap

- [ICT at Swiss Post now More Efficient Thanks to Oracle Exadata Database Machine (PDF)](#)
- [Granarolo: Oracle Exadata Database Machine Meets the Many Stringent Requirements (PDF)](#)
- [Oracle Exadata Database Machine at Wumart (PDF)](#)
- [Oracle Exadata Database Machine Helps AmerisourceBergen Run its Business at Peak Levels with SAP (PDF)](#)
- [Oracle Exadata Database Machine at Nagase (PDF)](#)
- [Lion Corporation Maximizes Revenue Opportunity and Supports Global Growth with Oracle (PDF)](#)Raiffeisen Informatik Center Steiermark

  - o Send an email to [saponoracle_de@oracle.com](#) for more information

Oracle Database Appliance (ODA) for SAP

- The Oracle Database Appliance is a complete plug-n-go highly available clustered database system. Pre-installed with Oracle Linux and Oracle appliance manager software, this appliance saves time and money by simplifying deployment, maintenance, and support of a highly available database solution.

- The Oracle Database Appliance is a 4U rack-mountable system specifically designed to run Oracle database Enterprise Edition, with redundant and hot swappable components built-in to meet the high availability requirements. Each system has redundant server nodes, internal interconnects, storage controllers, power supply units and cooling fans. In addition, disk and flash storage are triple-mirrored and shared to ensure data availability and to provide accelerated database performance. Combining high availability and simplicity, the Oracle Database Appliance is the perfect clustered database solution for rapid deployment and maximum uptime.

Running SAP NetWeaver with Oracle Database Appliance

- Oracle Database Appliance is now certified by SAP. All SAP products based on SAP NetWeaver 7.x that are also certified for Oracle Database 11g Release 2 can now be used with the Oracle Database Appliance.

- The Oracle Database Appliance provides the following capabilities for an SAP environment:

- • Highly available active-active clustered database server for SAP Applications

- • Highly available file server for SAP required shared file systems such as /sapmnt

- • Complete clustering solution for SAP High Availability Resources such as Central Services for both ABAP and JAVA stack.

- For more information on the Oracle Database Appliance, see SAP Note [1760737](#) and the [Oracle White Paper](#).

Oracle Database Private Compute Appliance (PCA)

- Oracle Virtual Compute Appliance is an integrated, "wire once", software-defined converged infrastructure system designed for rapid deployment of both infrastructure hardware and application software. Whether running any Linux, Oracle Solaris, or Microsoft Windows, Oracle Virtual Compute Appliance supports a large range of OS versions hosted in a converged server, network, and storage environment to enable general purpose, business-, and mission-critical application deployments in medium-to-large data centers. High-performance, low-latency Oracle Fabric Interconnect with Oracle SDN—two products in the Oracle Virtual Networking family—allow automated configuration of the server and storage networks. The embedded Oracle Virtual Compute Appliance controller software automates the installation, configuration, and management of all the infrastructure components at the push of a button. The users need only to enter basic configuration parameters and then create virtual machines (VMs) manually or by leveraging Oracle VM Templates and Assembly Builder to get a full application up and running in as little as a couple of hours. With Oracle Enterprise Manager 12c, Oracle Virtual Compute Appliance is transformed into a powerful Cloud Services delivery platform.

- Oracle PCA is now certified for SAP and extends the list of Engineered Systems available for SAP customers. For more information check the SAP note 2052912

Oracle MiniCluster

Oracle MiniCluster is a simple and efficient engineered system designed to run SAP databases and applications with uncompromising security. Its simplicity, out-of-the-box performance and reliability, and small form factor make it an excellent choice for remote offices, small offices, and agile software development (DevOps) environments.
It is ideal for highly security-sensitive applications, such as managing patient medical records, processing financial transactions, handling secure communications, running mission-critical enterprise resource planning applications such as SAP, and hosting security-related services. The system integrates and automates hundreds of unique security technologies and controls, including memory-intrusion protection, comprehensive data protection, defense-in-depth access controls for compute, storage, and networks, and full-visibility monitoring and auditing of user and system activities. Oracle MiniCluster S7-2 incorporates fully redundant, high-performance, shared flash storage and active/active independent compute nodes with redundant network connectivity for a highly available architecture that is appropriate for extremely performance-sensitive, mission-critical applications.

Oracle MiniCluster S7-2 Supported with SAP

Oracle MiniCluster is certified for SAP environments. It can be used to run SAP applications as well as Oracle Database Server.

Supported SAP solutions and products:

- All SAP products supported on Oracle Solaris 11 SPARC are supported on Oracle MiniCluster.

- Please check the SAP Product Availability Matrix (PAM) for details regarding supported SAP product releases. The PAM also provides information about supported operating system releases and Unicode/non-Unicode configurations.

- Third-party databases and applications available on Solaris 11 are supported in the Application VMs.

Supported Oracle Database versions, features and options:

- Oracle Database 11*g* (11.2.0.4) with SAP Bundle Patch according to SAP Note 1974327.
- Oracle Database 12*c* (12.1.0.2 or higher) with SAP Bundle Patch according to SAP Note 2145628.
- The Database VMs support multi-node Oracle Real Application Clusters (RAC) and single instance databases.

- Oracle Database In-Memory is supported with SAP NetWeaver based products. See SAP Note 2178980 for more details.

- Supported Cluster Solution for SAP instances: Oracle Clusterware for the Enqueue Service (SCS/ASCS) and its related Replication Service (ERS) in the database VMs by using SAPCTL. See SAP Note 1496927 for more details.

- Limitations when running Oracle Database 12*c*. See SAP Note 1914631 for details.

- Minimum Oracle Client release 11.2.0.4. See SAP Note 819829 for choosing the supported Oracle Client depending on the Oracle Database release.

- Central Instance (CI) / Primary Application Server (PAS) installations in Oracle Database VMs are not supported.

MiniCluster and installation requirements:

- Minimum MiniCluster Configuration Utility version: 1.1.18.2.

- Role-separated authentication is not supported. Same OS user oracle:oinstall is required for both Grid Infrastructure (GI) and RDBMS software.

- Hybrid Columnar Compression (HCC) is not supported.

Featured Resource:

White paper: Configuring Oracle MiniCluster for SAP (PDF)

For more information on Oracle MiniCluster for SAP see SAP Note 2384855.

Oracle Advanced Compression

Advanced Compression Customers running SAP applications on Oracle Database 11g can already choose from a variety of compression features: Index Key Compression and Compressed Index-Organized Tables (IOTs) are standard database features. OLTP Compression for structured data and SecureFiles Compression for unstructured data are provided by Oracle Database 11g Advanced Compression. Oracle Database 12c Advanced Compression comes with many new features. Some of them are related to information lifecycle management support, which will be available for SAP customers as of certification wave 2.

Advanced Row Compression

Oracle's OLTP Table Compression uses a unique compression algorithm specifically designed to work with OLTP applications. The algorithm works by eliminating duplicate values within a database block, even across multiple columns. Compressed blocks contain a structure called a symbol table that maintains compression metadata. When a block is compressed, duplicate values are eliminated by first adding a single copy of the duplicate value to the symbol table. Each duplicate value is then replaced by a short reference to the appropriate entry in the symbol table. Through this innovative design, compressed data is self-contained within the database block as the metadata used to translate compressed data into its original state is stored in the block. When compared with competing compression algorithms that maintain a global database symbol table, Oracle's unique approach offers significant performance benefits by not introducing additional I/O when accessing compressed data.

In general, customers can expect to reduce their storage space consumption by a factor of 2 to 3 by using the OLTP Table Compression feature. That is, the amount of space consumed by uncompressed data will be two to three times larger than that of the compressed data. The benefits of OLTP Table Compression go beyond just on-disk storage savings. One significant advantage is Oracle's ability to read compressed blocks directly without having to first uncompress the block. Therefore, there is no measurable performance degradation for accessing compressed data. In fact, in many cases performance may improve due to the reduction in I/O since Oracle will have to access fewer blocks. Further, the buffer cache will become more efficient by storing more data without having to add memory.

The results achieved using OLTP compression in real world SAP BW customers are depicted in figure 2 that shows space saving up to 86% at table level.
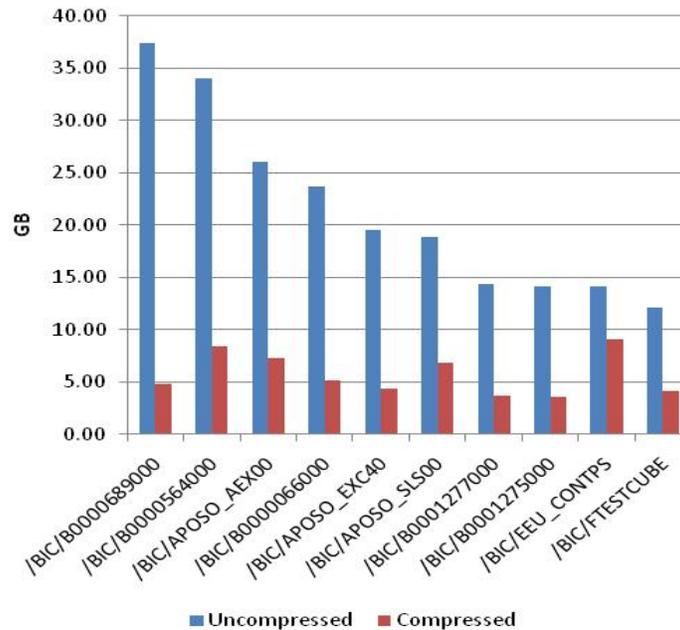
Figure 2: OLTP Table compression within SAP BW

Minimal Performance Overhead

As stated above, OLTP Table Compression has no adverse impact on read operations. There is additional work performed while writing data, making it impossible to eliminate performance overhead for write operations. However, Oracle has put in a significant amount of work to minimize this overhead for OLTP Table Compression. Oracle compresses blocks in batch mode rather than compressing data every time a write operation takes place. A newly initialized block remains uncompressed until data in the block reaches an internally controlled threshold. When a transaction causes the data in the block to reach this threshold, all contents of the block are compressed. Subsequently, as more data is added to the block and the threshold is again reached, the entire block is recompressed to achieve the highest level of compression. This process repeats until Oracle determines that the block can no longer benefit from further compression. Only transactions that trigger the compression of the block will experience the slight compression overhead. Therefore, a majority of OLTP transactions on compressed blocks will have the exact same performance as they would with uncompressed blocks.
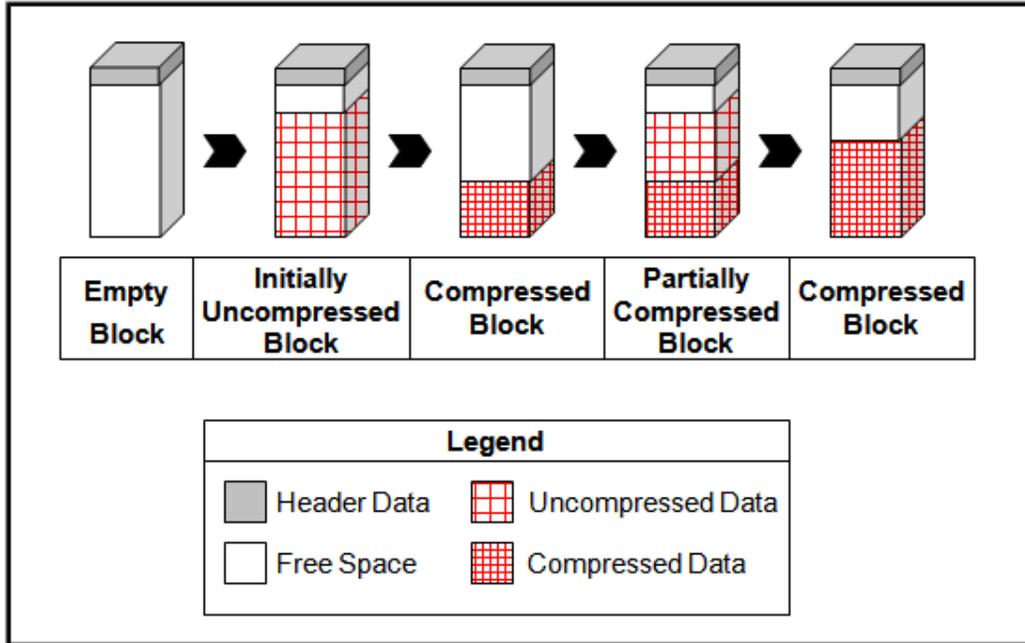
Figure 3: OLTP Table compression Process

In Oracle Database 11*g*, structured table data compression (OLTP compression) is not supported for tables with more than 255 columns. In Oracle Database 12*c* Advanced Compression, the **255-columns limit is removed**. On the surface this seems to be a minor improvement, how-ever tables having more than 255 columns are commonly found in almost all SAP systems.

Advanced Index Compression

Indexes are used extensively inside OLTP databases since they are capable of efficiently supporting a wide variety of access paths to the data stored in relational tables. It is very common to find a large number of indexes being created on a single table to support the multitude of access paths for OLTP applications, this can cause indexes to contribute a greater share to the overall storage of a database when compared to the size of the base tables alone.

Advanced Index compression is a new form of index block compression. Creating an index using Advanced Index Compression reduces the size of all supported unique and non-unique indexes -- while still providing efficient access to the indexes. Advanced Index Compression works well on all supported indexes, including those indexes that are not good candidates (indexes with no duplicate values, or few duplicate values, for given number of leading columns of the index) with the existing index Prefix Compression feature (see below).

Advanced Index Compression works at the block level to provide the best compression for each block, this means that users don't need knowledge of data characteristics – Advanced Index Compression

automatically chooses the right compression per block. The use of Advanced Index Compression requires the Oracle Advanced Compression option.

SecureFiles Compression

SecureFiles was a new feature in Oracle Database 11g that introduced a completely reengineered large object (LOB) data type to dramatically improve performance, manageability, and ease of application development.

SecureFile data is compressed using industry standard compression algorithms. Compression not only results in significant savings in storage but also improved performance by reducing IO, buffer cache requirements, redo generation and encryption overhead. If the compression does not yield any savings or if the data is already compressed, SecureFiles will automatically turn off compression for such columns. Compression is performed on the server-side and allows for random reads and writes to SecureFile data. SecureFiles compression provides significant storage savings for unstructured data depending on the degree of compression: LOW, MEDIUM (default) and HIGH, which represent a tradeoff between storage savings and latency.

SecureFiles compression handles in-line and out-of-line LOB data which are getting more and more important in SAP applications and are widely used in SAP products such as SAP CRM, SAP XI, SAP NetWeaver Portal, and even in SAP ERP. Almost all non-cluster tables in SAP ERP use out-of-line LOBS that are unique to Oracle database.

OLTP compression and SecureFiles compression lead Oracle to be able to compress each type of data related to SAP applications such as tables, indexes, and unstructured data. Using all 11g space optimizations the database size can be reduced up to a factor of 3.

	Without Compression	With Compression and Other Space Optimizations	Factor Space Savings
Database (fully reorganized)			
• ECC 6.0	4,782 GB	1,976 GB	2.4
• BI 7.0	1,413 GB	543 GB	2.6
• CRM 7.0	950 GB	334 GB	2.8
RMAN Backup (for compressed database)	2,817 GB	667 GB	4.2
Export Data Pump	973 GB	156 GB	6.2

Figure 4: Space savings achieved with 11.2 Compression and other space optimizations

Advanced Network Compression

Advanced Network Compression, also referred to as SQL Network Data Compression, can be used to compress the network data to be transmitted at the sending side and then uncompress it at the receiving side to reduce the network traffic. Advanced Network Compression reduces the size of the session data unit (SDU) transmitted over a data connection. Reducing the size of data reduces the time required to transmit the SDU. The benefits of Advanced Network Compression include:

- **Increased effective network throughput:** Compression allows transmission of large data in less time. SQL query response becomes faster due to the reduced transmission time. Constrained bandwidth environments can utilize this to reduce query response time.

- **Reduced bandwidth utilization:** Compression saves bandwidth by reducing the data to be transmitted, allowing other applications to use the freed-up bandwidth. This also helps in reducing the cost of providing network bandwidth.

Advanced Network Compression not only makes SQL query responses faster but also saves bandwidth. On narrow bandwidth connections, with faster CPU, it could significantly improve performance. The compression is transparent to client applications.

Data Guard Redo Transport Compression

Oracle Data Guard provides the management, monitoring and automation software infrastructure to create, maintain, and monitor one or more standby databases to protect enterprise data from failures, disasters, errors and data corruptions. Data Guard maintains synchronization of primary and standby databases using redo data (the information required to recover a transaction). As transactions occur in the primary database, redo data is generated and written to the local redo log files.

Data Guard Redo Transport Services are used to transfer this redo data to the standby site(s). With Advanced Compression, redo data may be transmitted in a compressed format to reduce network bandwidth consumption and in some cases reduce transmission time of redo data. Redo data can be transmitted in a compressed format when the Oracle Data Guard configuration uses either synchronous redo transport (SYNC) or asynchronous redo transport (ASYNC).

For more information about Oracle Data Guard, please visit http://www.oracle.com/technetwork/database/features/availability/dataguardoverview-083155.html

Recovery Manager (RMAN) Compression

The continuous growth in enterprise databases creates an enormous challenge to database administrators. The storage requirements for maintaining database backups and the performance of the backup procedures are directly impacted by database size. Advanced Compression includes RMAN compression technology that can dramatically reduce the storage requirements for backup data.

Due to RMAN's tight integration with Oracle Database, backup data is compressed before it is written to disk or tape and doesn't need to be uncompressed before recovery – providing an enormous reduction in storage costs and a potentially large reduction in backup and restore times.

There are three levels of RMAN Compression: LOW, MEDIUM, and HIGH. The amount of storage savings increases from LOW to HIGH, while potentially consuming more CPU resources.

Data Pump Compression

The ability to compress the metadata associated with a Data Pump job was first provided in Oracle Database 10g Release 2. In Oracle Database 11g, this compression capability has been extended so that table data can be compressed on export. Data Pump compression is an inline operation, so the reduced dump file size means a significant savings in disk space. Unlike operating system or file system compression utilities, Data Pump compression is fully inline on the import side as well, so there is no need to uncompress a dump file before importing it. The compressed dump file sets are automatically decompressed during import without any additional steps by the Database Administrator.

In the following compression example from the Oracle sample database, the OE and SH schemas were exported while simultaneously compressing all data and metadata. The dump file size was reduced by 74.67%.

Three versions of the gzip (GNU zip) utility and one UNIX compress utility were used to compress the 6.0 MB dump file set. The reduction in dump file size was comparable to Data Pump compression. Note that the reduction in dump file size will vary based on data types and other factors.

Full Data Pump functionality is available using a compressed file. Any command that is used on a regular file will also work on a compressed file. Users have the following options to determine which parts of a dump file set should be compressed:

- **ALL** enables compression for the entire export operation.

- **DATA-ONLY** results in all data being written to the dump file in compressed format.

- **METADATA-ONLY** results in all metadata being written to the dump file in compressed format. This is the default.

- **NONE** disables compression for the entire export operation.

Compression for Network Traffic

Data Guard provides the management, monitoring, and automation software infrastructure to create, maintain, and monitor one or more standby databases to protect enterprise data from failures, disasters, errors, and data corruptions. Data Guard maintains synchronization of primary and standby databases using redo data (the information required to recover a transaction). As transactions occur in the primary database, redo data is generated and written to the local redo log files. Data Guard Redo Transport Services are used to transfer this redo data to the standby site(s). With Advanced Compression, redo data may be transmitted in a compressed format to reduce network bandwidth consumption and in some cases reduce transmission time of redo data when the Oracle Data Guard configuration uses either synchronous redo transport (SYNC) or asynchronous redo transport (ASYNC).

Automatic Storage Management

Automatic Storage Management (ASM) was first released with Oracle Database 10g. For Oracle databases, ASM provided a significant simplification for file system and volume management. In addition to enhancing storage automation, ASM improved file system scalability, performance, and database availability. These benefits hold for both single-instance Oracle databases as well as for Oracle Real Application Clusters (Oracle RAC) database environments. Oracle Database 12c introduces several new capabilities in ASM.

ASM Overview

ASM is a feature of Oracle database providing an integrated cluster file system and volume manager at no additional cost. ASM lowers the Oracle database storage total cost of ownership and increases storage utilization while improving performance and availability as compared with traditional file system and volume management solutions. With ASM, less effort is required for managing your database storage environment.

ASM is easier to manage than conventional file systems, it optimizes the performance of your storage hardware, and is tightly integrated with the Oracle Database. Additionally, ASM eliminates the need for 3rd-party volume managers and file systems for managing the Oracle database files.
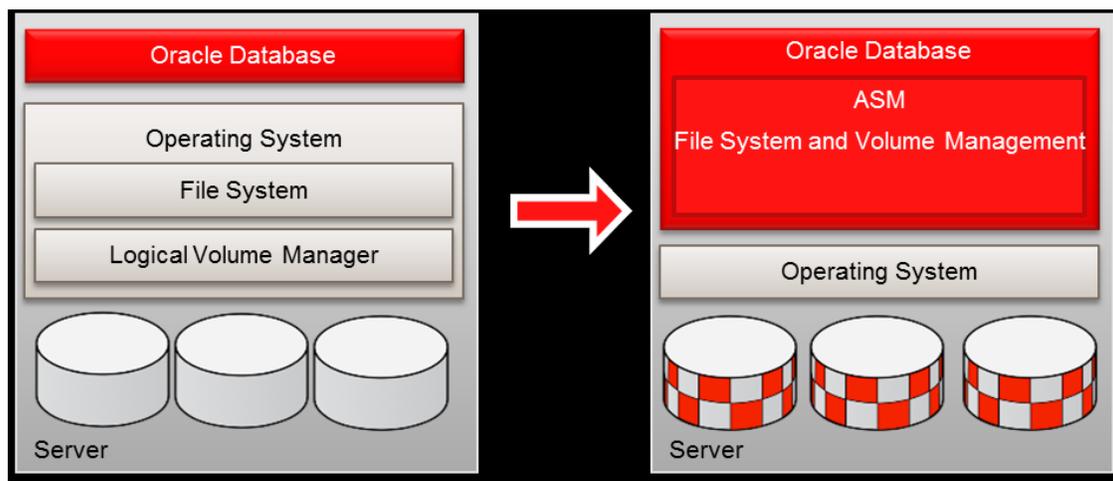
ASM brings significant key values to Oracle Database platforms. ASM improves manageability by simplifying storage provisioning, storage array migration, and storage consolidation. ASM provides flexible interfaces for management including the SQL*Plus, Oracle Enterprise Manager, and a UNIX-like command line interface called ASMCMD.

In addition to providing ease of management, ASM provides sustained best in class performance because of its innovative rebalancing feature. ASM distributes data evenly across all storage resources after storage configuration changes, providing an even distribution of IO and optimal performance. ASM scales to very large databases efficiently without compromising functionality or performance.

ASM is built to maximize database availability. ASM provides self-healing automatic mirror reconstruction and resynchronization, rolling upgrades and patching. ASM also supports dynamic and on-line storage reconfigurations in both single instance and Oracle RAC database configurations. ASM customers realize significant cost savings and achieve lower total cost of ownership because of features such as just-in-time provisioning, and clustered pool of storage making it ideal for database consolidation. ASM provides all of this without additional license or licensing fees.

In summation, ASM is a file system and volume manager optimized for Oracle database files providing:

- Simplified and automated storage management

- Increased storage utilization, uptime, and agility

- Delivering predictable performance and availability service levels

Oracle ASM has proven to be one of the fastest and most reliable storage platforms to run the Oracle Database. This makes Oracle Automatic Storage Management the preferred storage platform for SAP running on Oracle Real Application Clusters (RAC) as well as for SAP systems running on a single instance Oracle Database.

See http://scn.sap.com/docs/DOC-7971 for "Installation and Configuration Requirements for Oracle ASM with SAP" and "Best Practices for Migration of an SAP Database to Oracle ASM" white papers.

- SAP systems running on Oracle RAC or single instance can now move their databases to ASM. Customers can smoothly migrate their current file system based databases to ASM/ACFS.

- The migration to ASM can also be done through SAPInst. Based on SAPInst customers can either install a new SAP system and immediately create the database on ASM (single instance or RAC), or even use SAPInst to migrate the file system to ASM and at the same time migrate to RAC etc. For more information check the SAP note 1550133 – Oracle –Automatic Storage Management (ASM).

Oracle Automatic Storage Management Cluster File System

Oracle ACFS is designed as a general-purpose, standalone server and clusterwide file system that delivers support for all customer files. Users and applications can access and manage Oracle ACFS using native operating system file system application programming interfaces (APIs) and command-line interface (CLI) tools. Users can also manage Oracle ACFS with Oracle ASM Configuration Assistant (ASMCA).

Oracle ACFS supports large files with 64-bit file and file system data structure sizes leading to exabyte capable file and file system capacities on 64 bit platforms. Variable extent-based storage allocation and high-performance directories contribute to fast performance and shared disk configurations that provide direct storage paths to Oracle ACFS file data from each cluster member. File system integrity and fast recovery is achieved with Oracle ACFS metadata checksums and journaling. Oracle ACFS is designed as a multi-node, shared file system model that delivers coherent, cached, direct storage paths to Oracle ACFS file data from each cluster member.

Oracle ACFS files systems are typically configured for clusterwide access. File systems, files, and directories are visible and accessible from all cluster members and can be referenced by users and applications using the same path names from any cluster member. This design enables simplified application deployments across cluster members and facilitates both multiple instance cluster applications and high availability (HA) failover of unmodified standalone server applications.

Oracle ACFS presents single system file access semantics across cluster configurations. Applications and users on all cluster members are always presented with the same view of shared Oracle ACFS file data, supported by the Oracle ACFS clusterwide user and metadata cache coherency mechanism. Oracle ACFS 12.1.0.2 now supports the Oracle Exadata servers as well and can be used for /sapmnt, /usr/sap/trans etc.

Starting with Oracle Database 12c, Oracle ACFS supports Oracle database files in addition to general purpose files. This means that entire Oracle databases can be stored inside an ACFS file system. Oracle ACFS implements direct I/O bypassing the OS buffer cache to deliver high performance, similar to raw, for database files. However, general purpose files are still provided cached I/O suitable for non-database files that provide fast response time and high performance.

All databases stored on Oracle ACFS can now leverage the Advanced Data Services. Snapshots may be used for backup as well as provisioning sparse copies of databases for testing and other purposes. Snapshots can also be used to create read-write snapshots of Oracle Database Homes to simplify out-of-place patching. Oracle ACFS Replication compliments Oracle Data Guard and provides disaster recovery for non- database files. The Tagging feature may be used to simplify aggregate operations based on assigned tags. And, the Security, Encryption and Auditing feature may be used for more granular access control and security overall.

Real Application Clusters for SAP (RAC for SAP)

Oracle Database 10*g* comes with an integrated set of High Availability (HA) capabilities that help organizations ensure business continuity by minimizing the various kinds of downtime that can affect their businesses. These capabilities take care of most scenarios that might lead to data unavailability, such as system failures, data failures, disasters, human errors, system maintenance operations and data maintenance operations

The cornerstone of Oracle's high availability solutions that protects from system failures is Oracle Real Application Clusters (RAC). Oracle RAC is a cluster database with a shared cache architecture that overcomes the limitations of traditional shared-nothing and shared-disk approaches, to provide a highly scalable and available database solution for SAP applications.

RAC supports the transparent deployment of a single database across a cluster of active servers, providing fault tolerance from hardware failures or planned outages. RAC supports mainstream business applications of all kinds – these include popular packaged products such as SAP, as well as custom applications. RAC provides a very high availability for these applications by removing the single point of failure with a single server. In a RAC configuration, all nodes are active and serve production workload. If a node in the cluster fails, the Oracle Database continues running on the

remaining nodes. Individual nodes can also be shutdown for maintenance while application users continue to work.

A RAC configuration can be built from standardized, commodity-priced processing, storage, and network components. RAC also enables a flexible way to scale applications, using a simple scale-out model. When more processing power is needed by a particular application service, another server can be added easily and dynamically, without taking any of the active users offline. Based on customer configurations, SAP Dialog instances and connected users can be routed to dedicated nodes in the RAC cluster.

Contrary to Failover Cluster, where every SAP instance is connected to a single database instance, with an Oracle RAC cluster one or more SAP instances can be connected to one dedicated Oracle RAC instance from within the available instances. If one RAC node crashes, the users connected to the other nodes will not be affected since they are connected to a different database instance. The SAP dialog instances that were connected to the crashed database instance (node1) will be automatically reconnected to a surviving database instance (node2) within seconds. In case more than one SAP instance were connected to the crashed database instance, then the SAP instances concerned can be reconnected either to only one available RAC instance or to different RAC instances in order to split the workload.
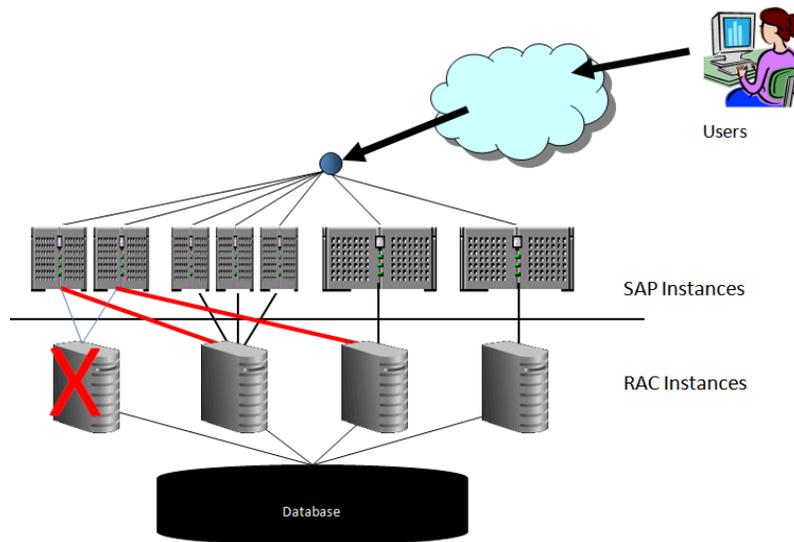
Figure 7: SAP workload distribution with RAC

High Availability for SAP Resources (through SAPCTL)

Oracle Clusterware can provide high availability for SAP resources just as it does for Oracle resources. Oracle has created an Oracle Clusterware tool, SAP Control (SAPCTL), to enable customers to easily manage SAP high availability resources. SAPCTL provides an easy-to-use interface to administer the resources, scripts, and dependencies of Oracle Clusterware and SAP high availability components. SAPCTL consolidates the functionality of the Oracle command-line tools by enabling SAP customers to easily manage the SAP Enqueue Service for ABAP and JAVA, the SAP Replication Service for

ABAP and JAVA, and the additional virtual IP addresses used by the SAP Enqueue Service for ABAP and/or JAVA. In addition to the critical SAP high availability components, namely the SAP Enqueue and SAP Replication Service, SAPCTL provides an interface for the protection of arbitrary number of SAP application instances. The SAP Central Instance (CI) or SAP application instances (DV) are possible candidates to run under SAPCTL supervision. The SAPCTL tool supports SAP Standalone Gateway (GW) and SAP WebDispatcher (W) as independent SAP instances as well. For more information check SAP Note 1496927 - Protection of SAP instances through Oracle Clusterware.

Data Guard for SAP

Successful high availability (HA) architectures prevent downtime and data loss by using redundant systems and software to eliminate single points of failure. The same principle applies to mission critical databases. Administrator error, data corruption caused by system or software faults, or complete site failure can impact the availability of a database thus SAP applications. Even a clustered database i.e. Real Application Clusters (RAC) running on multiple servers is exposed to single points of failure if not adequately protected. While a clustered database can provide excellent server HA, it is ultimately a tightly coupled system running a single database on shared storage.

The only way to prevent being impacted by (database related) single points of failure is to have a completely independent copy of a production database already running on a different system and ideally deployed at a second location, which can be quickly accessed if the production database becomes unavailable for any reason.

Oracle Data Guard ensures high availability, data protection, and disaster recovery for enterprise data. Oracle Data Guard provides a comprehensive set of services that create, maintain, manage, and monitor one or more standby databases to enable production Oracle databases to survive disasters and data corruptions. Oracle Data Guard maintains these standby databases as copies of the production database. Then, if the production database becomes unavailable because of a planned or an unplanned outage, Oracle Data Guard can switch any standby database to the production role, minimizing the downtime associated with the outage. Oracle Data Guard can be used with traditional backup, restoration, and cluster techniques to provide a high level of data protection and data availability. Oracle Data Guard transport services are also used by other Oracle features such as Oracle Streams and Oracle GoldenGate for efficient and reliable transmission of redo from a source database to one or more remote destinations.

Real-Time Data Protection and Availability for Oracle Database
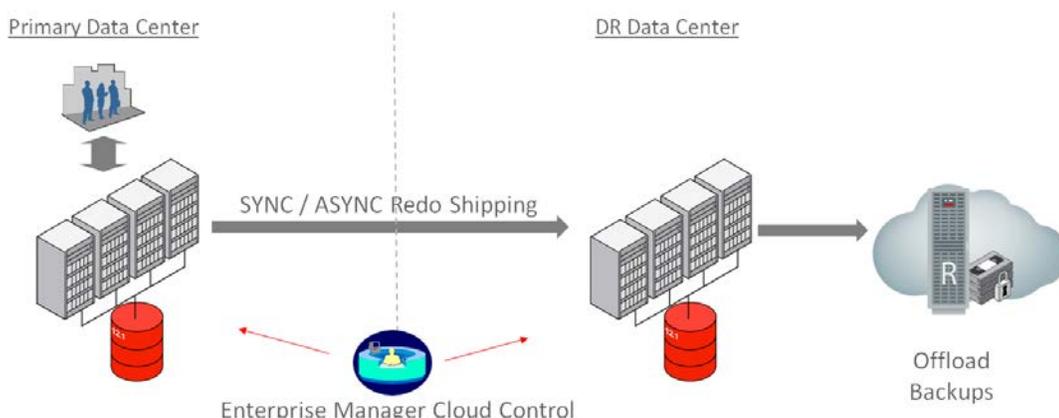
Oracle Active Data Guard (licensed option for Oracle Database Enterprise Edition) eliminates the high cost of idle redundancy by allowing reporting applications, ad-hoc queries, and data extract to be offloaded to read-only copies of the production database, but this feature cannot be used by SAP applications since the latter always need a database opened in read-write mode). SAP customers are used to offload for example reporting of SAP BW by using Snapshot Standby by converting a physical standby (recovery mode) into a read-write database through a single command. There are even more scenarios when to use Snapshot Standby to for example make a training system available within minutes etc. (Active) Data Guard's deep integration with Oracle Database and complete focus on real-time data protection and availability avoids compromises found in storage remote mirroring or other host-based replication solutions. Beyond reporting on read-only database, Active Data Guard offers:

- Physical block corruptions are repaired automatically wherever they occur, at either the primary or standby, preventing any interruption in service to users and eliminating manual intervention by administrators.

- Zero Data Loss protection can be implemented in configurations where primary and standby databases are separated by thousands of miles, without impacting primary database performance or requiring added complexity or high-cost proprietary storage or network devices. There is no longer a requirement to trade performance for data protection.

- Planned downtime is minimized and the risk of introducing many types of change to a production database environment is reduced using new automation that makes it much simpler and more reliable to perform database rolling upgrades.

Data Guard offers two choices of transport services: synchronous and asynchronous.

Synchronous redo transport requires a primary database to wait for confirmation from the standby that redo has been received and written to disk (a standby redo log file) before commit success is signaled to the application. Synchronous transport combined with the deep understanding of

transaction semantics by Data Guard apply services provides a guarantee of zero data loss if the primary database suddenly fails.

Although there is no physical limit to the distance between primary and standby sites, there is a practical limit to the distance that can be supported. As distance increases, the amount of time that the primary must wait to receive standby acknowledgement also increases, directly impacting application response time and throughput. There are two new synchronous transport options available in Oracle Database 12c designed to address this performance concern:

- **Fast Sync** provides an easy way of improving performance in synchronous zero data loss configurations. Fast Sync allows a standby to acknowledge the primary database as soon as it receives redo in memory, without waiting for disk I/O to a standby redo log file. This reduces the impact of synchronous transport on primary database performance by shortening the total round-trip time between primary and standby. Fast Sync can introduce a very small exposure to data loss should simultaneous failures impact both primary and standby databases before the standby I/O completes. The time interval, however, is so brief (both failures must occur within milliseconds of each other) and the circumstances so unique that there is a very low likelihood that this would occur. Fast Sync is included with Data Guard.

- **Far Sync** enables a zero data loss failover to a remote standby database even if it is located thousands of miles away, without affecting primary database performance or materially increasing cost or complexity. Far Sync is included with Active Data Guard.

  Asynchronous redo transport avoids any impact to primary database performance by acknowledging commit success to the application as soon as the local log-file write is complete; it never waits for the standby database to acknowledge receipt. This performance benefit comes with the potential for a small amount of data loss because can be no guarantee that at any moment in time all redo for committed transactions has been received by the standby.

Far Sync - Zero Data Loss Protection at any Distance

The impact that synchronous zero data loss protection has on database performance can lead to undesirable compromises. Customers with large distance between sites must compromise on protection and use asynchronous transport, accepting data loss in return for acceptable performance. Customers who absolutely require zero data loss must compromise on geo-protection and locate all sites within the same metropolitan area. Before Oracle Database 12c, the only viable option to achieve zero data loss across long distances is a 3-site architecture characterized by one or more of: expensive proprietary storage arrays, special purpose network devices, multiple Data Guard standby databases (local and remote), and complex administrative procedures.

Active Data Guard Far Sync, a new capability for Oracle Database 12c, eliminates compromise by extending zero data loss protection to any standby database located at any distance from a primary database, and doing so at minimal expense and without additional complexity.

Far Sync is a new type of Active Data Guard transport destination, referred to as a far sync instance, that receives redo synchronously from a primary database and forwards that redo asynchronously to as many as 29 remote destinations. A far sync instance is a light-weight entity that manages only a control

file and log files. It requires a fraction of the CPU, memory, and I/O of a standby database. It does not have user data files, nor does it run Redo Apply. Its only purpose is to transparently offload the primary database of the overhead of transmitting redo to remote destinations. Far Sync can also save network bandwidth by offloading the primary database of overhead from redo transport compression incurred when using Oracle Advanced Compression.

Take for example an existing Data Guard configuration that uses asynchronous transport between a primary in New York, and a standby in London. Upgrade to Active Data Guard and implement zero data loss by simply deploying a far sync instance at a third location within synchronous replication distance (estimated at 30-150 miles) of New York, (see figure 3). Any server that is compatible with the primary will suffice. No proprietary storage, no special network devices, no additional licensing, and no complex management are required. If the primary fails, the same failover command used in any Data Guard configuration or automatic failover using Fast-Start Failover will quickly transition the database in London to the primary role, with zero data loss.
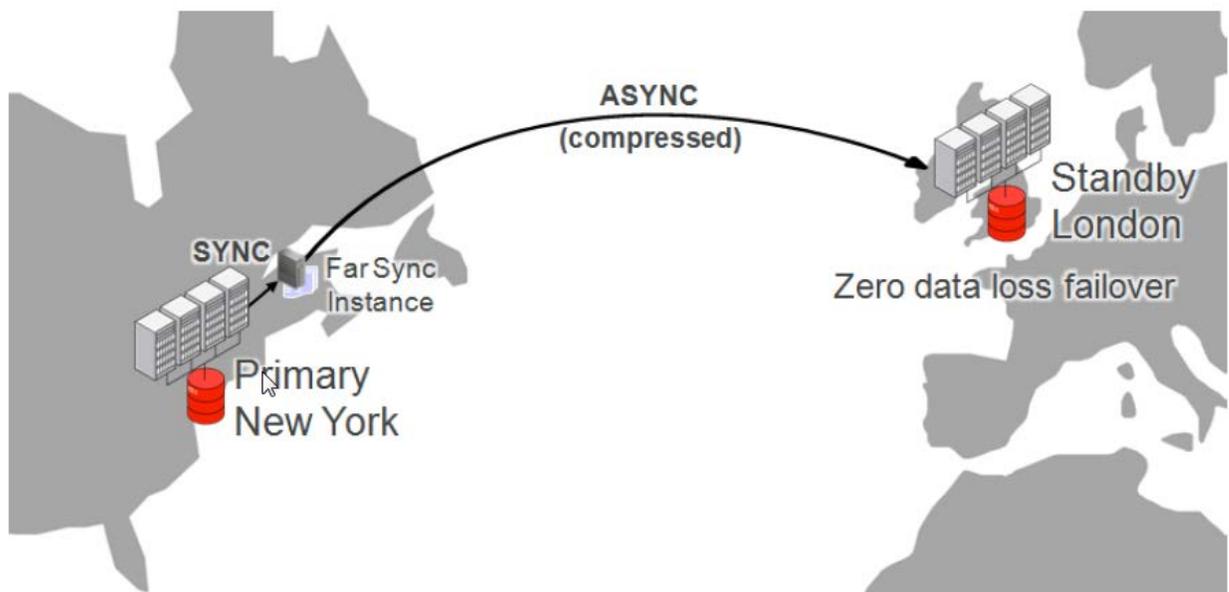
- Oracle Data Validation: One of the significant advantages of Data Guard is its ability to use Oracle processes to validate redo before it is applied to the standby database. Data Guard is a loosely coupled architecture where standby databases are kept synchronized by applying redo blocks, completely detached from possible data file corruptions that can occur at the primary database. Redo is also shipped directly from memory (system global area), and thus is completely detached from I/O corruptions on the primary. Corruption-detection checks occur at a number of key interfaces during redo transport and apply.

- Managing a Data Guard Configuration: Primary and standby databases and their various interactions may be managed by using SQL*Plus. Data Guard also offers a distributed management framework

called the Data Guard Broker, which automates and centralizes the creation, maintenance, and monitoring of a Data Guard configuration. Administrators may interact with the Broker using either Enterprise Manager Grid Control or the Broker's command-line interface (DGMGRL).

- Role Management Services: Data Guard Role Management Services quickly transition a designated standby database to the primary role. A switchover is a planned operation used to reduce downtime during planned maintenance, such as operating system or hardware upgrades. Regardless of the transport service (SYNC or ASYNC) or protection mode utilized, a switchover is always a zero data loss operation.

   A failover brings a standby database online as the new primary database during an unplanned outage of the primary database. A failover operation does not require the standby database to be restarted in order to assume the primary role. Also, as long as the database files on the original primary database are intact and the database can be mounted, the original primary can be reinstated and resynchronized as a standby database for the new primary using Flashback Database – it does not have to be restored from a backup.

- Fast-Start Failover: Fast-Start Failover allows Data Guard to automatically fail over to a previously chosen, standby database without requiring manual intervention to invoke the failover. A Data Guard Observer process continuously monitors the status of a Fast-Start Failover configuration. If both the Observer and the standby database lose connectivity to the primary database, the Observer attempts to reconnect to the primary database for a configurable amount of time before initiating a fast-start failover. Fast-start failover is designed to ensure that out of the three fast-start failover members - the primary, the standby and the Observer - at least two members agree to major state transitions to prevent split-brain scenarios from occurring. Once the failed primary is repaired and mounted, it must establish connection with the Observer process before it can open. When it does, it will be informed that a failover has already occurred and the original primary is automatically reinstated as a standby of the new primary database. The simple, yet elegant architecture of fast-start failover makes it excellent for use when both high availability and data protection is required.

- Automating Client Failover: The ability to quickly perform a database failover is only the first requirement for high availability. SAP Applications must also be able to quickly drop their connections from a failed primary database, and quickly reconnect to the new primary database.

   Effective SAP failover in a Data Guard context has three components:

   - Fast database failover

   - Fast start of database services on the new primary database

   - Fast notification of clients and fast reconnection to the new primary database

   In previous Oracle releases, one or more user-written database triggers were required to automate client failover, depending upon configuration. Data Guard 11g Release 2 simplifies configuration significantly by eliminating the need for user-written triggers to automate client failover. Role transitions managed by the Data Guard broker can automatically failover the database, start the

appropriate services on the new primary database, disconnect clients from the failed database and redirect them to the new primary database – no manual intervention is required.

- Easy conversion of a physical standby database to a reporting database – A physical standby database can be opened read/write for reporting purposes, and then flashed back to a point in the past to be easily converted back to a physical standby database. At this point, Data Guard automatically synchronizes the standby database with the primary database. This allows the physical standby database to be utilized for read/write reporting activities for SAP applications e.g. NetWeaver BI.

Real Application Testing

 Today, enterprises have to make sizeable investments in hardware and software to roll out infrastructure changes. For example, a data center may have an initiative to move databases to a low cost computing platform, such as Linux. Traditionally, this would require the enterprise to invest in duplicate hardware for the entire application stack, including web server, application server and database, to test their production applications. Organizations therefore find it very expensive to evaluate and implement changes to their data center infrastructure. In spite of the extensive testing performed, unexpected problems are frequently encountered when a change is finally made in the production system. This is because test workloads are typically simulated and are not accurate or complete representations of true production workloads. Data center managers are therefore reluctant to adopt new technologies and adapt their businesses to the rapidly changing competitive pressures.

Oracle Database 11g's Real Application Testing addresses these issues head-on with the introduction of two new solutions, Database Replay and SQL Performance Analyzer.

Database Replay

Database Replay provides DBAs and system administrators with the ability to faithfully, accurately and realistically rerun actual production workloads, including online user and batch workloads, in test environments. By capturing the full database workload from production systems, including all concurrency, dependencies and timing, Database Replay enables you to realistically test system changes by essentially recreating production workloads on the test system something that a set of scripts can never duplicate. With Database Replay, DBAs and system administrators can test:

- Database upgrades, patches, parameter, schema changes, etc.
- Configuration changes such as conversion from a single instance to RAC, ASM, etc.
- Storage, network, interconnect changes
- Operating system, hardware migrations, patches, upgrades, parameter changes

Faster deployment

Another major advantage of Database Replay is that it does not require the DBA to spend months getting a functional knowledge of the application and developing test scripts. With a few point and clicks, DBAs have a full production workload available at their fingertips to test and rollout any

change. This cuts down testing cycles from many months to days or weeks and brings significant cost savings to businesses as a result.

Database Replay consists of four three main steps:

- Capture workload in production including critical concurrency

- Replay workload in test with production timing

- Analyze and fix issues before production

SQL Performance Analyzer

Changes that affect SQL execution plans can severely impact application performance and availability. As a result, DBAs spend enormous amounts of time identifying and fixing SQL statements that have regressed due to the system changes. SQL Performance Analyzer (SPA) can predict and prevent SQL execution performance problems caused by environment changes. SQL Performance Analyzer provides a granular view of the impact of environment changes on SQL execution plans and statistics by running the SQL statements serially before and after the changes. SQL Performance Analyzer generates a report outlining the net benefit on the workload due to the system change as well as the set of regressed SQL statements. For regressed SQL statements, appropriate executions plan details along with recommendations to tune them are provided. SQL Performance Analyzer is well integrated with existing SQL Tuning Set (STS), SQL Tuning Advisor and SQL Plan Management functionality. SQL Performance Analyzer completely automates and simplifies the manual and time-consuming process of assessing the impact of change on extremely large SQL workloads (thousands of SQL statements). DBAs can use SQL Tuning Advisor to fix the regressed SQL statements in test environments and generate new plans. These plans are then seeded in SQL Plan Management baselines and exported back into production. Thus, using SQL Performance Analyzer, businesses can validate with a high degree of confidence that a system change to a production environment in fact results in net positive improvement at a significantly lower cost. Examples of common system changes for which you can use the SQL Performance Analyzer include:

- Database upgrade, patches, initialization parameter changes

- Configuration changes to the operating system, hardware, or database

- Schema changes such as adding new indexes, partitioning or materialized views

- Gathering optimizer statistics.

- SQL tuning actions, for example, creating SQL profiles

    Using SQL Performance Analyzer involves the following main steps:

- Capture SQL workload in production including statistics and bind variables

- Re-execute SQL queries in test environment

- Tune regressed SQL and seed SQL plans for production

Real Application Testing to validate Advanced Compression for SAP

The Oracle/SAP Development Team recently concluded comprehensive testing of SAP applications using both SQL Performance Analyzer and Database Replay. The testing consisted of SAP ERP and BW workloads running in-house on the ABAP stack. Further testing was undertaken at a large utilities customer running the SAP IS-U (Industry Specific Utilities) module. The objective was to use Real Application Testing to measure the effects of Advanced Compression for OLTP and SecureFiles on DML operations for SAP ERP. The testing activity consisted of using Database Replay to capture a production workload from a 10.2.0.4 SAP database. This workload was then replayed multiple times against both compressed and non-compressed Oracle Database 11*g* Release 2 databases.

Overall the test results were very instructive. Key findings are described as follows (note: results will vary according to your workload):

- No significant overhead observed during capture process

- Advanced Compression reduced database size by 50%

- Redo generated increased by ~25%

- Physical reads reduced by 60%

- CPU usage stayed flat

Conclusion

Real Application Testing proved a vital tool for validating upgrade from Oracle Database 10*g* Release 2 to 11*g* Release 2. The ability to test with production workloads and SQL statements is essential for testing business critical applications like SAP and this feature will significantly mitigate upgrade and change risk when used by experienced DBAs.

Oracle Advanced Security

Oracle Advanced Security helps customers address regulatory compliance requirements by protecting sensitive data from unauthorized disclosure on the network, backup media, or within the database. Oracle Advanced Security Transparent Data Encryption provides the industry's most advanced encryption capabilities for protecting sensitive information without requiring any changes to the existing application.

Prior to 11g Release 2 SAP customers could implement security features such as Column Encryption through Transparent Data Encryption (TDE) and Client Server Network Encryption, to secure the data transfer between SAP instances and the database server.

Unlike most database encryption solutions, TDE is completely transparent to existing applications with no triggers, views or other application changes required. Data is transparently encrypted when written to disk and transparently decrypted after an application user has successfully authenticated, and passed all authorization checks.

Tablespace Encryption

Starting with Oracle Database 11g it is possible to encrypt entire tablespaces. This makes it much easier to ensure that all relevant data is encrypted because everything stored in the tablespace gets encrypted automatically. Tablespace encryption means entire application tables can be transparently encrypted. Data blocks will be transparently decrypted as they are accessed by the database.

RMAN Backup Encryption (Oracle Secure Backup)

Lost or stolen tapes are frequently the cause for losing sensitive data. Oracle Secure Backup encrypts tapes and provides centralized tape backup management for the entire Oracle environment and protects Oracle database.

Oracle Secure Backup protects heterogeneous UNIX, Linux, Windows and Network Attached Storage (NAS) file system data and the Oracle database providing tape backup management for the entire Oracle environment:

- Oracle database to tape through integration with Recovery Manager (RMAN) supporting versions Oracle9i to Oracle Database 11g.

- Optimized Oracle database backups to tape provide unparalleled performance achieving 10-25% faster backups than comparable media management utilities with up to 30% less CPU utilization

- Backup encryption using AES128, AES192 or AES256 encryption algorithms

- File system data protection of local and distributed servers

- Policy-based tape backup management

Data Guard Secure Transmission of Redo Data

Because a lack of security can directly affect availability, Data Guard provides a secure environment and prevents tampering with redo data as it is being transferred to the standby database. To enable secure transmission of redo data, set up every database in the Data Guard configuration to use a password file, and set the password for the SYS user identically on every system. The following is a summary of steps needed for each database in the Data Guard configuration:

Create a password file for each database in the Data Guard configuration (Set the initialization parameter on each instance):

- REMOTE_LOGIN_PASSWORDFILE=EXCLUSIVE

- orapwd file=$ORACLE_HOME/dbs/orapw password=<passwd> entries=10

After you have performed these steps to set up security on every database in the Data Guard configuration, Data Guard transmits redo data only after the appropriate authentication checks using SYS credentials are successful. This authentication can be performed even if Oracle Advanced Security is not installed and provides some level of security when shipping redo data.

Secure Database exports with Encryption

For years Oracle customers have found the import / export utilities a convenient way to move small amounts of data from one database to another. Oracle Data Pump 11g provides the ability to encrypt data as it is written to the export file, providing additional protection for credit card numbers and other sensitive business data.

Oracle Data Pump can easily encrypt an entire export file using one of these three methods:

- Protected by the Transparent Data Encryption master encryption key

- Protected by a passphrase

- Protected by both passphrase and Oracle Transparent Data Encryption master encryption key

Using Oracle Transparent Data Encryption, Oracle Data Pump uses the Transparent Data Encryption master encryption key either from the Oracle Wallet or a Hardware Security Module (HSM).

Using a passphrase, Oracle Data Pump uses the passphrase supplied on the command line as the key for the encryption algorithm. This is beneficial if the export file is to be imported into another database, where the matching master encryption key is not available, but the temporary passphrase can be shared with the receiving site.

If using both passphrase and TDE master encryption key, the export file can be decrypted transparently if the TDE master encryption key is available, or by providing a passphrase. This is convenient when export files are to be imported back into the source database, and shipped off to other locations where the matching TDE master encryption key is not available, but the temporary passphrase can be shared with the receiving site.

Oracle Data Pump supports the AES encryption algorithm with key sizes ranging from 128 to 256.

Oracle Data Pump command line parameters can be used to specify the granularity of data encryption in the export file. For example, Data Pump can be instructed to encrypt all information or only those columns currently encrypted using Oracle Transparent Data Encryption.

SecureFiles Encryption

In 11g, Oracle has extended the encryption capability to SecureFiles and uses the Transparent Data Encryption (TDE) syntax. The database supports automatic key management for all SecureFile columns within a table and transparently encrypts/decrypts data, backups and redo log files. Applications require no changes and can take advantage of 11g SecureFiles using TDE semantics. SecureFiles supports the following encryption algorithms:

- 3DES168: Triple Data Encryption Standard with a 168-bit key size

- AES128: Advanced Encryption Standard with a 128 bit key size

- AES192: Advanced Encryption Standard with a 192-bit key size (default)

- AES256: Advanced Encryption Standard with a 256-bit key size

Database Vault

Outsourcing, application consolidation, and increasing concerns over insider threats have resulted in an almost mandatory requirement for strong controls on access to sensitive application data. In addition, regulations such as Sarbanes-Oxley (SOX), Payment Card Industry (PCI), and the Health Insurance Portability and Accountability Act (HIPAA) require strong internal controls to protect sensitive information such as financial, healthcare, and credit cards records. Oracle Database Vault enforces real-time preventive controls and separation-of-duty in the Oracle Database to secure the SAP application data.

Oracle Database Vault Protection for SAP enables SAP customers to prevent access to application data by privileged database users, enforce separation-of-duty, and provide stronger access control with multi-factor authorization. Database Vault enforces security controls even when a database user bypasses the application and connects directly to the database. Database Vault certification with SAP applications benefits customers by:

- Preventing privileged user access to application data using protection realms for the SAP ABAP stack and the SAP Java stack

- Enforcing separation of duty in the Oracle Database while allowing SAP administrators to perform their duties and protecting their SAP administration roles

- Provides SAP specific Database Vault protection policies for SAP BR*Tools

- Implements all Database Vault protections transparently and without any change to the SAP application code

Preventing Privileged User Access: Database administrators hold highly trusted positions within the enterprise. With Database Vault realms, enterprises increase security by preventing access to application data even if the request is coming from privileged users. This is especially important when a privileged account is compromised or accessed outside normal business hours or from an un-trusted IP address. The regular tools used by administrators to help manage and tune the Oracle database continue to work as before, but they can no longer be used to access SAP application data.

Enforcing Separation-of-Duty: Database Vault helps administrators manage operations more securely by providing fine-grained controls on database operations such as creating accounts, and granting privileges. For more information and White Paper see:
http://www.oracle.com/newsletters/sap/products/dbvault.html

Please, check SAP note "2218115 - Oracle Database Vault 12c" for installation and configuration details in SAP NetWeaver environment.

Oracle Expertise in the SAP environmentThe Solution Center SAP Support and Service offers SAP customers the following services:

- Advanced Customer Services (ACS)

- Advanced Customer Services (ACS) for Exadata SAP environments

- Performance Analysis and Tuning

- Development of concepts for Backup/Restore/Recovery, and High Availability, Administration

- Security concepts

- Optimizing of ABAP/4 programs (performance improvement)

- Migration service for customers, who want to use Oracle as the database for SAP applications (from Informix, MaxDB, DB2, or SQL Server to Oracle).

- Online and Offline migration services from "Oracle to Oracle" (e.g. Tru64 to HP_UX)

- Integration Products and Services

- Oracle Database: The Database of Choice for Deploying SAP Solutions

Conclusion

Oracle has a large and growing share of the database market used to deploy SAP. This is not by chance, both companies invest in making Oracle technology work well for SAP, and Oracle has a long track record of delivering the de facto standard database for enterprise applications. SAP customers continue to choose Oracle because of the Scalability, High Availability, Manageability and Security benefits they obtain.

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| Oracle is committed to developing practices and products that help protect the environment

Oracle Database: The Database of Choice for
Deploying SAP Solutions
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