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OPTIMIZED SOLUTIONS

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# Operating SAP Landscapes on Oracle Engineered Systems Using ITIL Best Practices

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## Executive Overview

As with all enterprise applications, deploying and maintaining sophisticated SAP landscapes can be complex and time-consuming. All the components must be integrated and validated to work together, including SAP applications and databases, operating systems, servers, networking, storage systems, and backup, virtualization, and management software. In order to ensure that SAP application service-level agreements (SLAs) are met, conventional solutions call for hiring information technology (IT) staff members with deep expertise in all these areas to troubleshoot, tune, and optimize the hardware and software.

Oracle® provides a complete hardware and software portfolio that comprises all the components of a well-built, well-engineered infrastructure for SAP. Taking the evolution of this infrastructure approach to its logical conclusion, Oracle now offers pre-tested and pre-integrated Oracle Engineered Systems that are designed to work together and are supported as a single stack. Characterized by extreme performance and highly integrated architectures, these systems are the ideal platform for cost-effective, high-performance, optimized and consolidated SAP solutions.

Oracle Engineered Systems constitute a new dimension in data center architectures and help IT staff to greatly improve data center operations for SAP landscapes. These systems can help IT staff to implement Information Technology Infrastructure Library® (ITIL®) best practices, fostering the modification of existing processes and the creation of much more cost-effective and efficient new tasks. This white paper describes deploying SAP on Oracle Engineered Systems with particular emphasis on compliance with ITIL best practices, or adopting the best practices as a standard. The impact of changing existing data center processes and creating new processes and organization is also discussed.

# Employing ITIL Best Practices for SAP Deployments on Oracle Engineered Systems

Organizations running SAP applications are heavily dependent upon efficient and productive IT operations, yet many IT workers do not understand that being directed to focus on service is a major objective for success and not a punishment. Lacking formalized processes to document problems and solutions, many IT departments face the same service problems repeatedly. Troubleshooting can be very time-consuming, whether due to system overloads, failed system changes, an inability to pinpoint errors affecting downstream processing, or a lack of central planning and monitoring. Recurring service outages increase costs, harm the IT provider's reputation, and can result in claims for damages. Outages can even curtail revenue and harm the corporate reputation with the public.

The solution for IT departments is to focus consistently on internal and external customer needs. This focus requires IT staff to manage infrastructure and operations for delivery of maximum performance, minimal costs, and fair, usage-based charges. In many organizations, existing IT infrastructure and processes have grown and evolved over the years until they are inefficient and heavily technology-driven rather than business-driven. IT departments must refresh infrastructure and processes with a focus on optimal service delivery.

## ITIL Best Practices

Designed to foster IT as a tool to facilitate business change, transformation, and growth, ITIL strives to align IT services to the needs of the business and provide a foundation for core business processes. ITIL is the most widely adopted approach for IT Service Management in the world, providing organizations with a practical framework for identifying, planning, delivering, and supporting IT services for businesses. The following sections outline recommended practices for availability, IT Service continuity, and change management.

## Availability Management

Availability Management is one of five components that comprise the ITIL Service Delivery area and is responsible for ensuring that application systems are up and available for use according to conditions outlined in Service Level Agreements (SLAs). The team responsible for Availability Management reviews requirements for business process availability. As part of that review, they ensure that the most cost-effective contingency plans are put into place and regularly tested to ensure that business needs are met. For example, vital e-commerce applications that support online ordering systems may have recovery requirements of thirty minutes or less. The essential nature of this service requires a more redundant infrastructure that costs more than a less critical, non-customer-facing application that can safely remain offline longer.

IT organizations that implement Availability Management processes benefit from having services available for use as specified in SLAs. These services are deployed on specific infrastructure according to their required availability. By prioritizing services depending on business need, IT staff can provision services with just the level of availability needed, avoiding unnecessary expense. In addition, following Availability Management processes helps to identify and correct potential service availability issues before they negatively impact services.

One way that Oracle Engineered Systems address Availability Management is through their unique architecture. Containing no single points of failure, Oracle Engineered Systems are designed to deliver maximum availability with fully redundant, hot-swappable components that can be replaced without interrupting production environments. This built-in redundancy dramatically reduces planned and unplanned downtime. In addition, the Oracle software integrated into Oracle Optimized Solutions, such as Oracle Real Application Clusters (Oracle RAC), Oracle Automatic Storage Management (ASM), and Oracle Data Guard, provides safeguards that can enable the system architecture to absorb errors without disrupting operations.

## Continuity Management

IT Service Continuity Management (ITSCM) manages risks that can seriously impact IT services. ITSCM ensures that the IT service provider can always meet minimum agreed service levels by reducing the risk from disaster events to an acceptable level and planning for the recovery of IT services. Implementing IT Service Continuity Management results in the proper management of risks, a reduction in the length of service interruptions, and greater confidence in service quality among customers and users.

Oracle Engineered Systems offer features that facilitate ITSCM adoption. Oracle Data Guard, for example, is the preferred solution for disaster recovery. Unlike traditional clustering applications, Oracle Data Guard provides functionality that can provide greater data protection and faster replication for valuable SAP applications than host-based mirroring or storage-based replication. Also included with Oracle Database, Oracle Recovery Manager (Oracle RMAN) is the native backup and recovery tool for Oracle Database. Oracle RMAN enables rapid disk-to-disk Oracle Database backups and the offloading of Oracle Database backups to a physical standby database that can be maintained at a remote disaster recovery site.

## Change Management

Change Management helps organizations to minimize the risk of changes to the IT environment and ensures that IT staff use standardized methods and procedures for efficient handling of all changes. Changes in IT infrastructure may occur in response to externally imposed requirements such as legislative changes, as a result of plans to improve efficiency and effectiveness, to enable or reflect business initiatives, or stem from efforts to improve programs, projects, or services.

Oracle Engineered Systems offer a number of features to help minimize the risk of IT changes within SAP environments, providing higher quality of service and helping to meet SLAs. Unlike conventional systems, administrators do not have to perform integration tasks on Oracle Engineered Systems. There is no need to search for third-party hardware drivers, or test whether certain operating system versions will run with the system hardware because Oracle Engineered Systems are pre-integrated, pre-tested, and optimized.

Once the systems are installed onsite, Oracle provides Oracle Engineered Systems bundle patches that extend the pre-engineered design concept to ongoing maintenance tasks. These bundle patches provide only the patches needed for the Oracle Engineered System. In SAP environments, SAP provides bundle patches based on those of the Oracle Engineered Systems. Oracle's innovative patch management functionality enables administrators to patch live systems, test the changes, and place them into production without disrupting services. Should a problem with patches arise, Oracle technologies enable rollbacks without the time-consuming process of patch removal.

# Building an SAP Landscape with Oracle Engineered Systems

Oracle Engineered Systems provide an innovative approach to SAP landscape requirements.

## Requirements of SAP Landscape Design: Simplicity, Reliability, and Performance

Modern SAP landscapes require three important design features:

- **Simplicity**. The landscape must be easy to set up, adapt, and operate with minimal total cost of ownership (TCO).
- **Reliability.** The SAP landscape must ensure continual service delivery and uninterrupted business operations in all situations.
- **Performance.** The landscape requires optimal performance that minimizes user transaction response and report generation times while enabling new business opportunities with superior, previously unattainable performance levels.

Typically, SAP infrastructure solutions address these requirements in one of two ways:

- **Traditional, high-end vertically scaled UNIX® servers.** These systems offer maximum availability and excellent performance but with relatively high costs.
- **Inexpensive, horizontally scalable x86 servers.** These commodity systems offer high performance at low cost, but they are so widely available in so many different configurations that it can be difficult to integrate and manage these systems. In addition, suitable measures must be taken to ensure availability.

## Oracle Engineered Systems

Oracle offers an alternative that combines the best of both worlds—Oracle Engineered Systems. Oracle Engineered Systems offer an optimized hardware architecture that provides an enhanced platform for SAP. Providing quality, performance, and rapid deployment, Oracle Engineered Systems are designed to meet the requirements of modern data centers. Easy to administer, reliable, powerful, and standardized, Oracle Engineered Systems tightly integrate functions not found in conventional data centers and this integration yields improved performance over traditional architectures.

Oracle Engineered Systems are pre-integrated, pre-tested, and pre-configured systems comprised of all the elements in Oracle's integrated infrastructure stack. The stack includes servers and storage, operating systems, database software, networking, and built-in virtualization features designed to simplify data center operations, ensure fast and easy SAP infrastructure deployment, and accelerate business innovation.

Optimized for Oracle Database and SAP applications, Oracle Engineered Systems reduce the time needed to get SAP landscapes up and running. Pre-integration, pre-configuration, and testing occurs at the factory to prepare the systems for SAP, while the SAP installations occur on the customer premises. Each system is tuned for a specific purpose, reducing customization efforts and minimizing the need for infrastructure changes. Deploying SAP on Oracle Engineered Systems can reduce the time and cost associated with purchasing, provisioning, deploying, and maintaining SAP infrastructure.

From an SAP perspective, deploying an Oracle Engineered System alters an SAP landscape very little. After deployment, the SAP processes remain the same and no adjustments to the SAP software are necessary. For

example, Figure 1 shows an Oracle Exadata Database Machine (Oracle Exadata) deployed within the basic structure of an SAP architecture.

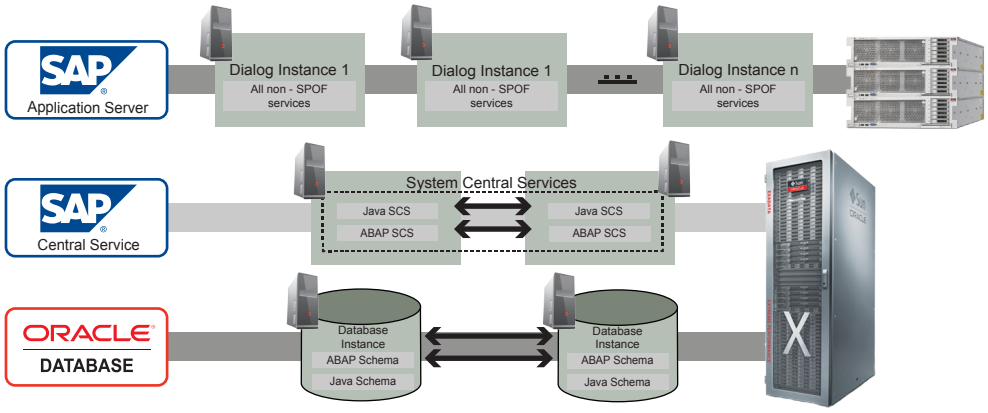


Figure 1. Oracle Exadata provides a platform for most of the components of an SAP landscape.

Two key components affect the performance of SAP systems—the application servers and the database. Application server performance depends primarily on the number and type of CPUs, RAM, and having the appropriate network connections. These elements must be suitably balanced in order to achieve maximum performance at an acceptable cost. In addition to CPUs, RAM, and network connections, database performance is dependent upon the configuration and performance of the underlying storage system, and this storage can have the greatest impact on system response time.

The tight integration of Oracle Engineered Systems exploits this storage system potential. Conventional solution architectures composed of individual components can quickly reach capacity limits, but Oracle Engineered Systems storage subsystems can provide far better scalability and performance due to their integration within the solution.

### Oracle Engineered Systems Management Tools

Oracle Engineered Systems can be managed using the comprehensive, centralized, and built-in management capabilities of Oracle Enterprise Manager. Integrated application-to-disk management provides intuitive and robust system health monitoring and performance views for all hardware and software components.

Oracle Enterprise Manager 12c is the management framework for Oracle environments including Oracle applications, Oracle databases, Oracle virtualization environments, and Oracle cloud deployments. Oracle Enterprise Manager supports Oracle hardware and Oracle Engineered Systems including Oracle Exalogic Elastic Cloud (Oracle Exalogic) and Oracle Exadata Database Machines (Oracle Exadata), and provides management functions for Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Database as a Service (DBaaS) environments.

Originally a database manager, Oracle Enterprise Manager evolved to be a comprehensive multifunction full-stack hardware and software manager featuring application-to-disk management with a broad set of cloud-enabling and management capabilities. Oracle Enterprise Manager Cloud Control 12c is a major upgrade focused on cloud life-cycle management. Oracle Enterprise Manager Ops Center 12c integrates detailed

hardware management support from the former Sun Ops Center for SPARC and x86-based Oracle Solaris 11 systems while also advancing management support for Oracle hardware, virtualization, and cloud environments, especially private clouds and IaaS. The combined Oracle Enterprise Manager 12c products illustrate continued support for Oracle Solaris and Oracle Linux while reinforcing key Oracle Enterprise Manager 12c messages such as application-to-disk management, converged hardware management, complete stack management, and total cloud control for systems.

Oracle Enterprise Manager is included with Oracle Engineered Systems. Oracle Enterprise Manager Ops Center 12c is included with Oracle SuperCluster.

### Oracle Engineered Systems Support

With a combination of high-performance industry-standard servers and storage and the best-integrated software, Oracle Engineered Systems offer the best performance, scalability, and reliability in the industry—backed by Oracle Support. Oracle is the only vendor to offer a single point of contact and complete integrated support for the entire Oracle technology stack—from applications to disk—with 24x7 hardware service, expert technical support, proactive tools, and software updates.

To ensure faster system provisioning and readiness, Oracle also offers life-cycle services that include planning, consulting, installation, configuration, production readiness, and patch provisioning. To further enhance performance and high availability, Oracle offers the industry's highest level of remote error monitoring with the fastest response times and patch provisioning.

### Oracle Engineered Systems in SAP Landscapes

As of this writing, there are four Oracle Engineered Systems certified for SAP. These are:

- Oracle Exadata
- Oracle Exalogic
- Oracle Database Appliance
- Oracle SuperCluster

Figure 2 illustrates where the different Oracle Engineered Systems can be deployed within the SAP landscape, with descriptions in the sections that follow.

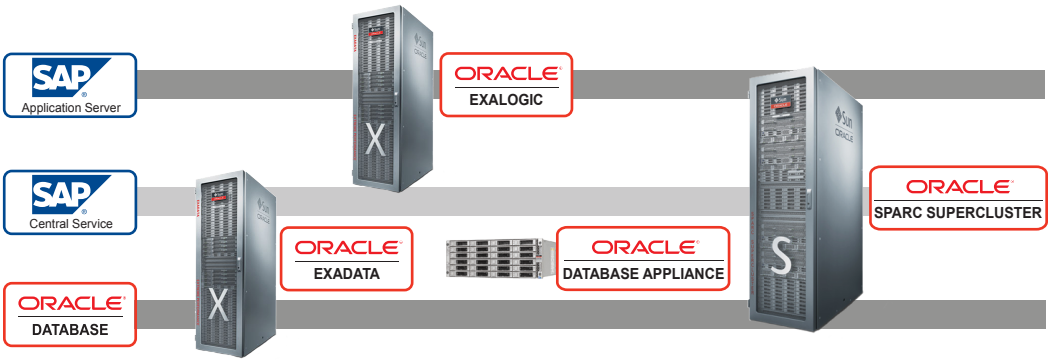


Figure 2. Different Oracle Engineered Systems can be used as platforms for SAP landscape components. (Oracle SuperCluster can support the entire landscape.)

## Oracle Exadata Database Machine

Oracle Exadata offers a fully integrated platform for hosting databases. As an out-of-the-box solution, everything is pre-installed, tuned, and optimized, eliminating tedious provisioning work and enabling databases to be deployed rapidly into production.

### Oracle Exadata Storage Servers

Oracle's built-in Exadata Storage Servers provide the unique technology that boosts Oracle Exadata performance. The exponential growth in file volumes makes it increasingly difficult for conventional storage arrays to transfer terabytes of data quickly and efficiently over the storage network. To address this challenge, Oracle Exadata Storage Servers offer enormous bandwidth and massive parallelization. Oracle Exadata delivers raw data throughput of up to 100 GB per second and up to 1,500,000 database I/O operations per second (IOPS) for each rack of storage servers. Oracle Exadata Storage Servers are contained in Oracle Exadata and Oracle SuperCluster and are not included in Oracle Database Appliance or Oracle Exalogic Elastic Cloud.

Oracle Exadata Smart Flash Cache built into Oracle Exadata Storage Servers accounts for much of this performance increase. The Oracle Exadata Smart Flash Cache transparently and automatically caches 'hot' data to fast solid-state storage, improving query response times and throughput. Oracle Database users on Oracle Exadata can define guidelines at the database table, index, and segment level so that certain data is retained in the flash memory. Tables can be copied into and out of the flash memory using a simple command, without moving the table into different tablespaces, files, or LUNs as required by conventional storage systems.

### Extreme Scalability

Certified for SAP in 2011, Oracle Exadata is available in four different sizes. Eighth, quarter, half, and full rack configurations are provided to meet any SAP application requirement and scale easily as business needs change. All versions can be upgraded online and guarantee a smooth upgrade path as processing requirements grow. These systems are available with either 600 GB high performance SAS hard disks or 3 TB high capacity SAS hard disks. Multiple Oracle Exadata systems can be connected using the integral InfiniBand fabric to form larger single system image configurations. Each InfiniBand link provides 40 Gb per second of bandwidth—many times higher than that of conventional storage or server networks.

## Oracle Exalogic Elastic Cloud

The Oracle Exalogic Elastic Cloud (Oracle Exalogic) (see Figure 3) consists of software, firmware, and hardware on which companies can host Oracle business applications, Oracle Fusion Middleware, and software products from Oracle partners, such as the SAP NetWeaver Application Server from SAP. Oracle Exalogic meets the highest standards of reliability, availability, scalability and performance for a wide range of time- and business-critical workloads. Running Oracle Linux, Oracle Solaris, and Java™ applications on Oracle Exalogic dramatically improves application performance without code modifications. Unlike conventional business application platforms and private clouds composed of different components from different providers, Oracle Exalogic also reduces operating costs over the lifetime of the application.

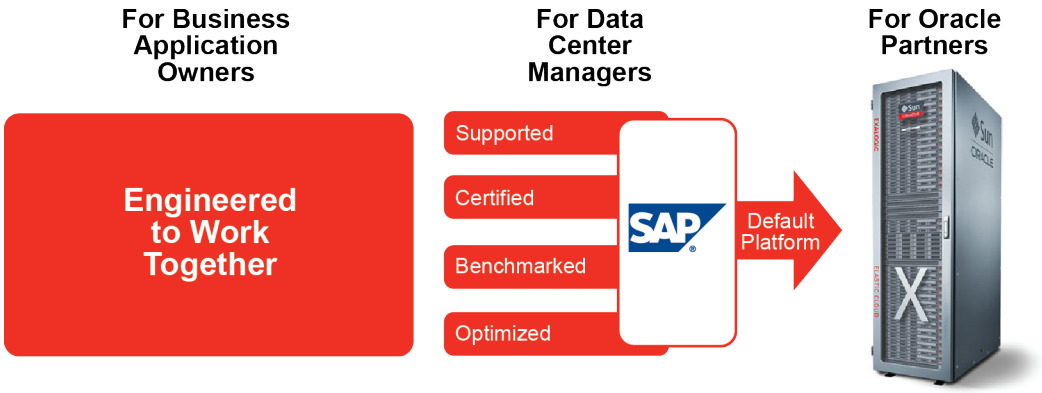


Figure 3. Oracle Exalogic Elastic Cloud reduces costs over the application lifetime.

Oracle Exalogic is a secure, reliable, open standards-based platform, utilizing best-of-breed components and technologies. A culmination of Oracle's extensive research and design efforts, Oracle Exalogic benefits from best practices acquired and refined by Oracle and its customers after deploying thousands of systems.

Before integrating and installing solutions in the data center, IT architects must invest significant time and resources to aggregate application requirements, research available products and technologies, evaluate multiple vendor proposals, and select and order components. After installation, administrators must test and apply firmware, software patches, and device drivers. They also must tune and optimize performance, maintain the system through constant changes, and thoroughly document procedures and operations.

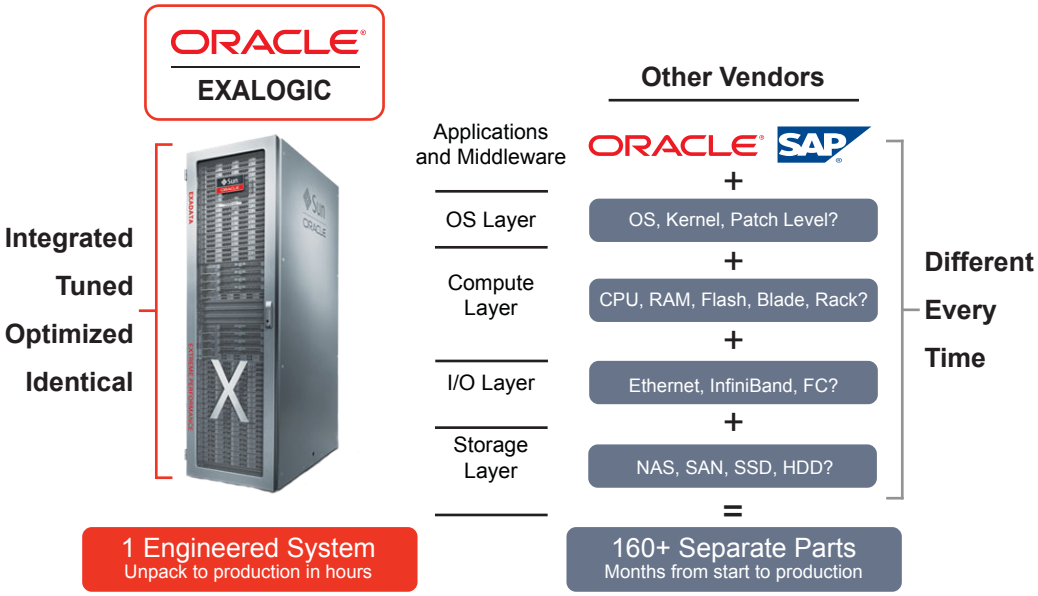


Figure 4. Deploying Oracle Exalogic Elastic Cloud is vastly simpler than a conventional third-party solution.

Typical systems pieced together from different components cannot compare with the Oracle Exalogic system design. Figure 4 contrasts an Oracle Exalogic with other vendors' piecemeal solutions. Only Oracle is able to tightly integrate the entire system and tune and optimize Oracle middleware and applications for optimal performance on Oracle hardware. Oracle Exalogic comes with a range of exclusive diagnosis and configuration tools that accelerate production deployment and reduce ongoing maintenance and administration costs. These tools ensure that Oracle Exalogic consistently delivers maximum performance and reliability, and takes less time to install and manage than competing platforms.

## Oracle Database Appliance

For many companies, ensuring 24x7 access to information and protecting databases against planned and unplanned downtime can present a challenge. Without skilled database and system administrators on staff, it can be risky to try to manually create database system redundancy. To reduce risks and uncertainty, Oracle Database Appliance is designed for simplicity, and helps customers to ensure higher availability for their application databases.

Oracle Database Appliance is a four rack unit (4RU) system containing two Oracle Linux Server nodes. Designed for business-critical requirements, the appliance features hot-swap-enabled and redundant components. The two server nodes are connected by an internal redundant Gigabit Ethernet (GbE) connection for cluster communication, and each node offers both Gigabit and 10 GbE external connectivity. The system storage can be double or triple mirrored, offering elastic usable database storage capacity. Internal solid-state disks provide for database redo protocols to increase performance. External NFS storage is supported for additional database files, data staging, and online backups.

Oracle Database Appliance offers customers a unique *pay-as-you-grow* license model and can run Oracle Database 11*g* Enterprise Edition and Oracle RAC to enable "active/active" or "active/passive" database server failover. As a result, companies can realize the performance and high availability demanded by business users and tie IT budget expenditures to business growth as needed.

The hallmark of Oracle Database Appliance lies in its simplicity. A single appliance contains server, storage and networking, designed and built as a complete system with no need for assembly or wiring. Simple to deploy, IT staff need only unpack the appliance, connect the network cables, install Oracle Appliance Manager, and the high-availability Oracle Database is ready for use in production environments.

## Oracle SuperCluster

Oracle Supercluster is the world's most efficient multi-purpose engineered system, providing an optimized platform for consolidating business-critical applications and rapidly provisioning cloud services. A number of factors contribute to the extreme efficiency, cost savings, and performance of Oracle SuperCluster. Among these factors are the processing power of the SPARC T-Series servers, the unbeaten scalability of Oracle Solaris 11, the database optimization of Oracle Exadata, the accelerated processing of Oracle Exalogic Elastic Cloud software, and the standardized system management of Oracle Enterprise Manager Ops Center 12*c*.

Oracle SuperCluster combines an advanced architecture with the fastest available technology. Built-in Oracle Exadata Storage Servers with Oracle Database Smart Flash Cache accelerate database performance as much as tenfold. The Oracle Exalogic software contained in the Oracle SuperCluster delivers extreme acceleration

for Java applications. Completely redundant components and a high-availability framework for automatic failover ensure recovery of business-critical applications.

## Availability Management

Oracle Engineered Systems can present IT staff with new and alternative tasks for data center systems administration and operations.

### Monitoring

Without the right tools, monitoring and managing virtualized SAP applications and services can be a challenge. Oracle Enterprise Manager Ops Center (Figure 5) allows IT administrators to actively manage and monitor infrastructure resources from virtually anywhere on the network. An advanced knowledge base facilitates the management of Oracle Solaris and Oracle Linux while enabling automated life-cycle processes. Oracle Enterprise Manager Ops Center also provides full life-cycle management of virtual guests, including resource management and mobility orchestration. This functionality facilitates monitoring and management for SAP administrators responsible for SAP environments within Oracle Solaris Zones.

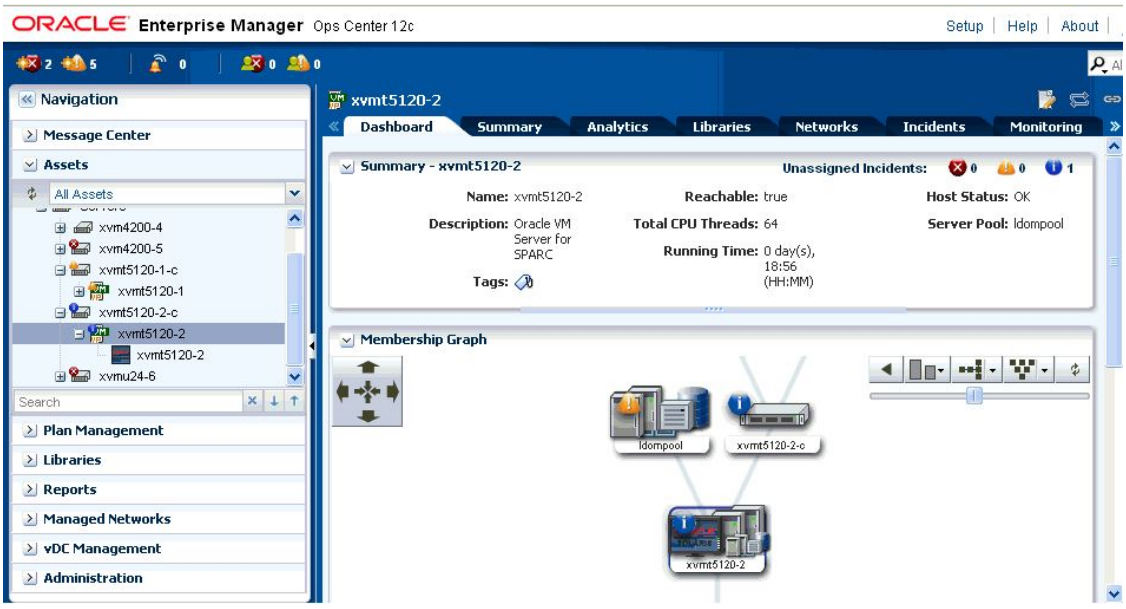


Figure 5. The Oracle Enterprise Manager Ops Center 12c dashboard allows administrators to actively monitor information.

Oracle Enterprise Manager Ops Center offers integrated and simplified management of virtual and physical environments. The application enables the management of virtual guests while facilitating the management of thousands of geographically distributed systems. Oracle Enterprise Manager Ops Center Lifecycle Management simplifies and accelerates compliance reporting and the discovery, provisioning, updating, monitoring, and reporting of physical and virtual resources through a standard browser-based interface.

Even in a mature 30-year-old industry, numerous IT analysts report that ongoing system maintenance still accounts for over two-thirds of IT budgets. Oracle provides integrated manageability that can change this equation dramatically. Oracle continually seeks to redefine IT operations with integrated management,

massively improving efficiency while reducing management complexity and administration costs. The unique configuration and patch management functions of Oracle Enterprise Manager Ops Center help ensure that systems remain up-to-date, providing more reliability and compliance in the data center.

Unlike third-party enterprise management software, Oracle Enterprise Manager Ops Center 12*c* continues to deliver manageability tightly integrated within Oracle's complete technology stack. Oracle Enterprise Manager and Oracle hardware, software, and services are developed, tuned, and optimized side by side, so that customers running Oracle software on Oracle platforms benefit from optimal hardware and software interaction.

## Managing Availability for SAP on Oracle Engineered Systems

There are potentially two single points of failure in SAP architecture, SAP Central Services and the database. Many organizations utilize their SAP applications for business-critical operations and cannot afford to have the applications offline for the period of time it would take to bring SAP back online. For that reason, these two SAP components require high availability measures for suitable protection.

Oracle Engineered Systems are designed to support fault-tolerant operation, continuing without interruption if an error occurs. Certified for SAP software, Oracle Exadata and Oracle SuperCluster can provide the required high availability for the database and SAP Central Services. In the event of several simultaneous errors, automatic failover can re-establish availability at another site, resulting in a brief period of downtime. In the event of a disaster, a third site can provide the required capacity for business continuance. Figure 6 shows a typical topology consisting of a primary site, a standby site, and a DR site.

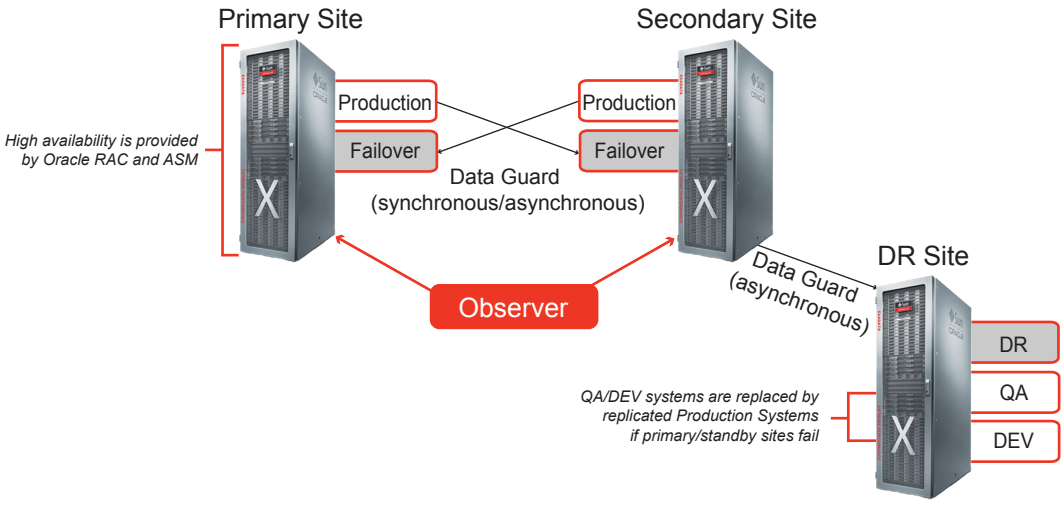


Figure 6. A three-site configuration provides disaster recovery capabilities if the primary and secondary sites fail.

The following sections describe automatic failover and disaster recovery, ensuring uninterrupted operation at the primary site.

## Traditional Failover Approaches

Oracle Engineered System architectures take an approach to system failover similar to typical clustered systems, but key differences allow these systems to guarantee higher overall availability. A conventional failover architecture is designed for a complete switch, or *failover*, to a second site as soon as an error occurs or a critical component of the SAP system becomes non-operational. For example:

- The SAP database server fails, causing the database to restart on a second server.
- The SAP database server operating system is restarted for maintenance purposes, causing the associated services to restart at a second site.

The failover process takes a certain amount of time, during which various components must be restarted on the second server (see Figure 6). During this period, the affected services are unavailable. For a large database underlying an SAP system, the failover time is often thirty minutes or more.

The elapsed time during failover constitutes an obvious weak point in the system. Assuming one scheduled failover every six months for maintenance, one unscheduled failover per year, and other failovers to restore services to the primary site, this can easily amount to three to four hours of downtime per year. The result is a theoretically achievable availability no higher than 99.95 percent, assuming that failover solves the underlying problems[1]. To guarantee higher availability, IT managers must deploy appropriate technologies.

Unlike conventional clustered systems, if simultaneous errors force an Oracle Engineered System to failover to a second site, Oracle designs the system for fast failover with minimal downtime. In addition, the primary and secondary sites can be synchronized using Oracle Data Guard, a method that protects data more thoroughly than a traditional cluster. Conventional clusters using host-based mirroring or storage-based replication for replicating data often write logical errors straight to all disks in the cluster. With Oracle Engineered Systems and Oracle Data Guard, a logical check is performed during the replication process, eliminating unintended error replication. This process can also be configured to replicate—but not apply—the last changes so that replicated data is much better protected than in a traditional cluster. The process used is described in more detail in the section titled *Providing High Availability with Two or More Data Centers* on page 14.

## Local High Availability

In order to reduce the likelihood of unplanned downtime for SAP landscapes, data center architects must consider certain factors. These factors include:

- The choice of appropriate hardware
- The use of Oracle's database cluster technology, Oracle RAC[2]
- The use of Oracle Automated Storage Management (Oracle ASM)[3]

[1] There are 8766 hours in a year (=365.25 days), so 4 hours correspond to approximately 0.05 percent.

[2] See SAP Note 527843 – Oracle RAC Support in the SAP Environment

Oracle Engineered Systems offer complete redundancy:

- All the servers, Oracle Exadata Storage Cells, and network components have dual-redundant, hot-swappable power supplies, hard disks, and fans[4]. These components can be replaced without interrupting operations. As a result, the mechanical parts most commonly affected by faults do not cause downtime.
- Data is distributed between the Oracle Exadata Storage Cells with the help of Oracle ASM. Oracle recommends a configuration with triple redundancy, storing data on three different storage cells[5], and providing protection against the failure of up to two cells. If a storage cell fails and a definable timeout is reached, then the system begins automatic restoration of triple redundancy on the remaining storage cells, provided there is sufficient free capacity.
- If one of the database servers in Oracle Exadata fails, Oracle RAC continues to operate without interruption. In an Oracle RAC environment, the Oracle Database runs on two or more systems in a cluster while concurrently accessing a single shared database. This configuration creates a single database system that spans multiple hardware systems and enables Oracle RAC to provide high availability and redundancy during a cluster node failure. Oracle RAC supports all database types, from read-only data warehouse systems to update-intensive online transaction processing (OLTP) systems.
- Two InfiniBand networks connect the Oracle Exadata components. If one of these networks fails, operation continues uninterrupted over the second.
- The external connection is provided by redundant 10 GB network connections, which ensure uninterrupted operation even if some network components fail.

The system can be connected to the power grid by two independent three-phase power supplies and every Oracle Exadata component is connected to both of these supplies. If one complete three-phase line fails, the components can still run on the remaining power supply. Having every Oracle Exadata component connected to two independent three-phase power supplies also protects against the failure of up to three separate phases on different lines.

These features enable the Oracle Exadata architecture to absorb errors without interrupting operation. Automatic failover to the second site therefore only occurs in the event of multiple errors such as the simultaneous failure of three storage cells, all database nodes, or all power lines.

Planned downtimes are handled by means of a suitable patching process. Thus, all the components of an Oracle Exadata bundle patch can be imported on a rolling basis. A more detailed description of this process can be found in the section titled *Patch Strategy* on page 20.

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[3] See SAP Note 1550133 – Oracle Automatic Storage Management (ASM)

[4] Note, however, that the Oracle Database Appliance does not contain Oracle Exadata Storage Cells.

[5] ASM also protects against so-called unrecoverable read errors. Traditional storage subsystems can only compensate for the failure of an entire hard disk, not individual disk sectors. This results in what is called an unrecoverable read error, where the system realizes that a particular sector has different content on two disks on the RAID network but it is not clear which sector contains the correct data. Errors of this type can only be prevented by performing checksums at file system level. In this case, this is accomplished by ASM.

## Providing High Availability with Two or More Data Centers

Oracle Data Guard is the tool of choice for ensuring high availability across multiple data centers. In an SAP context, the redo apply alternative (physical standby) is used. Oracle Data Guard offers management, monitoring, and automation procedures to set up and manage one or more standby databases and provides a loosely coupled architecture to ensure availability and data backup.

- Database changes are transferred directly from main memory, isolating the standby database from potential corruption in the primary database I/O.
- The standby database uses a different software code path from the primary database, protecting it from software and firmware errors in the primary database.
- Data consistency is logically and physically verified before it is imported into the standby database.
- Oracle Data Guard recognizes *silent corruptions* caused by hardware errors (memory, CPU, disk, NIC) and isolates the standby database from these errors.
- A standby database can be used for planned downtime on a rolling basis to minimize downtime and risk.

Oracle Data Guard can be operated in various modes shown in Table 1:

**TABLE 1. VARIOUS MODES OF OPERATION FOR ORACLE DATA GUARD**

| MODE | RISK OF DATA LOSS | TRANSPORT | IF NO ACKNOWLEDGEMENT FROM THE STANDBY DATABASE, THEN: |
|---|---|---|---|
| Maximum Protection | Zero data loss<br>Double failure protection | SYNC | Signal commit success to the application only after acknowledgment is received from a standby database that redo for that transaction is hardened to disk. |
| Maximum Availability | Zero data loss<br>Single failure protection | SYNC | Signal commit success to the application only after acknowledgment is received from a standby database or after `NET_TIMEOUT` threshold period expires – whichever occurs first |
| Maximum Performance* | Potential for minimal data loss | ASYNC | Primary never waits for standby acknowledgment to signal commit success to the application |

* Maximum performance mode is the Oracle Data Guard mode recommended for use with SAP.

Oracle Data Guard provides fast-start failover, a feature that supports automatic failover without manual intervention. The Oracle Data Guard Observer process continuously monitors the environment and executes an automatic failover in case of a failure. The Observer helps to protect against a split-brain scenario where the primary and the standby databases both try to function as the primary, and also guards against unwanted failovers.

Oracle Data Guard safeguards high availability across multiple data centers and is preferable to the previously mentioned remote mirroring approach. A comparison of the two approaches is available on the Oracle Data Guard and Remote Mirroring Solutions[6] page.

[6] http://www.oracle.com/technetwork/database/features/availability/dataguardremotemirroring-086151.html

## Providing High Availability for SAP Central Services with Oracle Engineered Systems

When running SAP software, Oracle Engineered Systems must ensure high availability for more services than just the database. These include SAP Central Services and required file systems in addition to the database. Oracle offers various technologies that can be combined to provide optimal availability for SAP services.

### Oracle Clusterware

Oracle Clusterware is an integral part of Oracle RAC and monitors all Oracle resources. In the event of an error, Oracle Clusterware automatically restarts the resources or relocates them to other machines. All critical SAP components, particularly SAP Central Services, can be placed under the control of Oracle Clusterware with the SAPCTL add-on. This allows the critical SAP Central Services on Oracle Engineered Systems to be monitored and operated from the same cluster framework that is used for the database. Oracle Clusterware is supported on systems running Oracle Solaris or Oracle Linux.

### Oracle Solaris Cluster

Supported on Oracle SuperClusters, Oracle Solaris Cluster software monitors non-Oracle resources. Oracle Solaris Cluster software can be used to provide high availability for SAP Central Services, additional SAP services, and non-Oracle databases such as MaxDB with the appropriate Oracle Solaris Cluster agents installed. Agents monitor an application to determine whether it is operating correctly and take action if a problem is detected.

With Oracle Solaris Cluster, applications benefit from higher availability, more localized failure containment, and faster failover. Capable of supporting both scalable and HA (failover) services, Oracle Solaris Cluster can be extended to provide DR services[7].

Oracle Solaris Cluster extends the industry-leading availability features of Oracle Solaris, which includes Predictive Self Healing, reliable networking, resource management, and built-in virtualization functionality. Oracle Solaris Cluster offers the best high availability platform for Oracle Solaris, extending its reach from a single node to multisystem, multisite, and global disaster recovery solutions. Oracle Solaris Cluster offers comprehensive and robust capabilities for keeping IT operations, including those running Oracle Database and Applications, up and running in the face of nearly every conceivable situation. Oracle Solaris Cluster offers a full range of single and multisystem high availability (HA) and disaster recovery (DR) capabilities in traditional and virtualized environments. As a mature and robust solution, Oracle Solaris Cluster offers a high degree of flexibility in how it can be deployed and the technologies it supports.

When planning a disaster recovery infrastructure, it is important to note that local clustering can provide a solid level of continuous service availability in the event of application, operating system, or hardware failure in a *single* datacenter, but it does not provide site-level disaster tolerance against disasters. Extending a cluster to another room or across a campus provides the next level of availability. *Campus clustering* enables

[7] See the Oracle white paper *Oracle Solaris and Oracle Solaris Cluster: Extending Oracle Solaris for Business Continuity*.

components, such as cluster nodes and shared storage, to be located up to 400 kilometers apart. In the event of a localized disaster such as a flood, fire, or building power outage, the surviving nodes can support the service for a failed node. This solution offers some site-level tolerance, but the short distance limits survivability of the cluster and its services for larger disasters like earthquakes or power grid outages.

### Oracle Solaris Cluster Geographic Edition

Oracle Solaris Cluster Geographic Edition (Geographic Edition) extends Oracle Solaris Cluster, offering the control and flexibility required when working with limited bandwidth over long distances. A layered extension of the Oracle Solaris Cluster software, Geographic Edition software protects applications from unexpected disruptions by using multiple clusters that are separated by long distances and composed of a redundant infrastructure that replicates data between the clusters. The clusters can be global clusters, zone clusters, or a combination of both.

Data replication software enables applications running on Geographic Edition to tolerate disasters by migrating services to a geographically separated secondary cluster if an earthquake, fire, or storm disables the cluster at the primary site. If a disaster occurs, the Geographic Edition cluster can continue to provide services by using the following levels of redundancy:

- A secondary cluster
- Duplicated application configuration on the secondary cluster
- Replicated data on the secondary cluster

Oracle Solaris Cluster and Oracle Solaris Cluster Geographic Edition are supported on all systems that run Oracle Solaris, including Oracle Exadata, Oracle Exalogic, and Oracle SuperCluster. Oracle Database Appliance runs Oracle Linux.

## Continuity Management

Beyond the availability of the infrastructure, two aspects of IT Service Continuity Management are designed to ensure the continued operation of an SAP landscape in the event of multiple errors.

- **Disaster recovery.** In the highly unlikely event that provisions for high availability—redundantly configured systems, use of Oracle RAC and other clustering technologies, and more—fail, then the IT organization must declare that a disaster has occurred. At that time, they should invoke the disaster recovery plan that they created for just such a contingency. These plans are unique to each organization and should be put into place ahead of time.
- **Backup recovery.** The long-term storage of backup data on separate media—usually tape—helps to ensure that the data can be restored if lost.

## Disaster Recovery

Oracle Data Guard is the preferred solution for disaster recovery. Able to supply multiple standby databases from one primary database with different configurations for different purposes, Oracle Data Guard also allows a break in the environment[8], a situation where the primary and standby environments may be completely different. For instance, Oracle Linux may be used on the primary side and another Linux distribution on the standby side. The following differences between the primary and standby environments are permissible, provided the same Oracle Database release and patch set are used on both sides:

- Hardware manufacturer
- Hardware configuration (e.g., number of CPUs, RAM)
- Processor (e.g., X86-64 AMD64 and X86-64 Intel)

It is not necessary for both the primary and standby databases to use Oracle RAC, or for both to use Oracle ASM. While Oracle RAC and ASM provide database mirroring, Oracle Data Guard performs database replication from site to site and knows whether or not a standby database is available.

Oracle Data Guard also facilitates the handling of logical errors—whether user or application—because database changes are made on a delayed basis. If there is only one standby database, administrators must factor in the time elapsed between the primary and standby database synchronization and add that amount of time when calculating the database rollback after failure of the primary database.

Oracle Flashback Database[9] is a feature within Oracle Database software that can be used to protect an SAP system from any logical mistakes. Offering the ability to "rewind" the database, Flashback Database enables administrators to set the database back to its state before the error occurred. The same functionality can be achieved using a database restore operation followed by point-in-time recovery, but using Flashback Database is typically much faster and simpler to accomplish. The several ways to use Flashback Database in SAP environments are described in SAP note 966117. Oracle Flashback Database technologies and Oracle Data Guard can also be used together[10] to provide enhanced data protection.

### Backup and Recovery With Oracle Recovery Manager

In the past, traditional backups frequently consisted of copying file systems during the backup process. This extremely simple method has been gradually refined so that continuously changing data can now be backed up consistently. Today's modern backup infrastructures can meet a wide range of requirements.

Oracle RMAN facilitates the backup and restoration of Oracle databases rationally, efficiently, and consistently. Integrated into Oracle Database, Oracle RMAN addresses the need for high-performance, easy-to-control database backup and recovery.

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[8] See MyOracle Note 413484.1: Data Guard Support for Heterogeneous Primary and Physical Standbys in Same Data Guard Configuration

[9] See SAP Note 0966117 – Oracle Flashback Database technology

[10] Please see Oracle white paper: Setup Flashback Database on Data Guard Physical Standby Database for SAP Customers

Oracle RMAN is designed to work intimately with the server, providing block-level corruption detection during backup and restore operations. Oracle RMAN optimizes performance and space consumption during backups with file multiplexing and compression, and operates with leading backup software systems via a supplied Media Management Library (MML) API.

Oracle RMAN brings rich functionality such as online and incremental backups, block media recovery, automated backup management tasks, and integration with third-party media management systems into the Oracle Data Guard portfolio. Oracle RMAN and Oracle Data Guard are part of Oracle's integrated high availability technology stack, enabling Oracle RMAN backups to be seamlessly offloaded to a physical standby database and allowing customers to gain more value out of their disaster recovery investment. Backups do not affect normal Oracle Data Guard operation—they can be performed while the standby database is in recovery or read-only mode. Backups can be used to recover either primary or standby database servers.

Oracle Data Guard and Oracle RMAN are designed with the Oracle Database architecture in mind. Together, they offer the most reliable and tightly integrated solution to achieve superior levels of Oracle Database availability (Figure 7). Created to support mission critical applications, Oracle Data Guard and Oracle RMAN are both fully supported features of the Oracle Database Enterprise Edition.

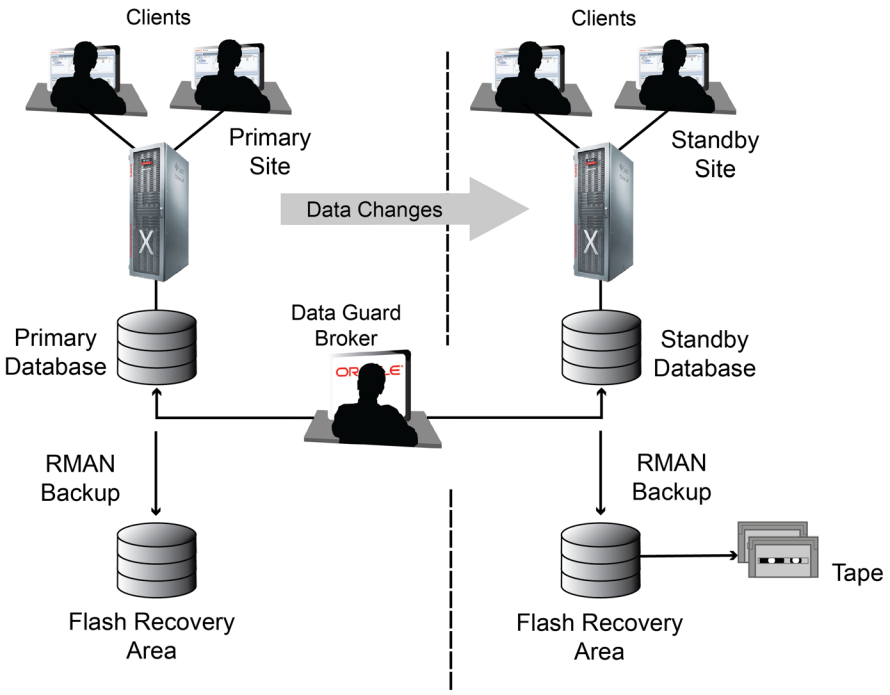


Figure 7. Oracle Data Guard and Oracle RMAN provide superior levels of Oracle Database availability.

The recommended backup frequency for Oracle RMAN is one backup per month. This time frame allows for optimum distribution of the files, which can then be stored as sets by Oracle RMAN backup. SAP's BR*Tools can be configured to integrate with Oracle RMAN backups. BR*Tools is a program package containing the following tools: BRBACKUP, BRARCHIVE, BRRESTORE, BRRECOVER, BRSPACE,

BRCONNECT and BRTOOLS. BRTOOLS is the menu program that can call all the other BR functional tools interactively. The integration of backup, restore, and recovery tools is illustrated in Figure 8.

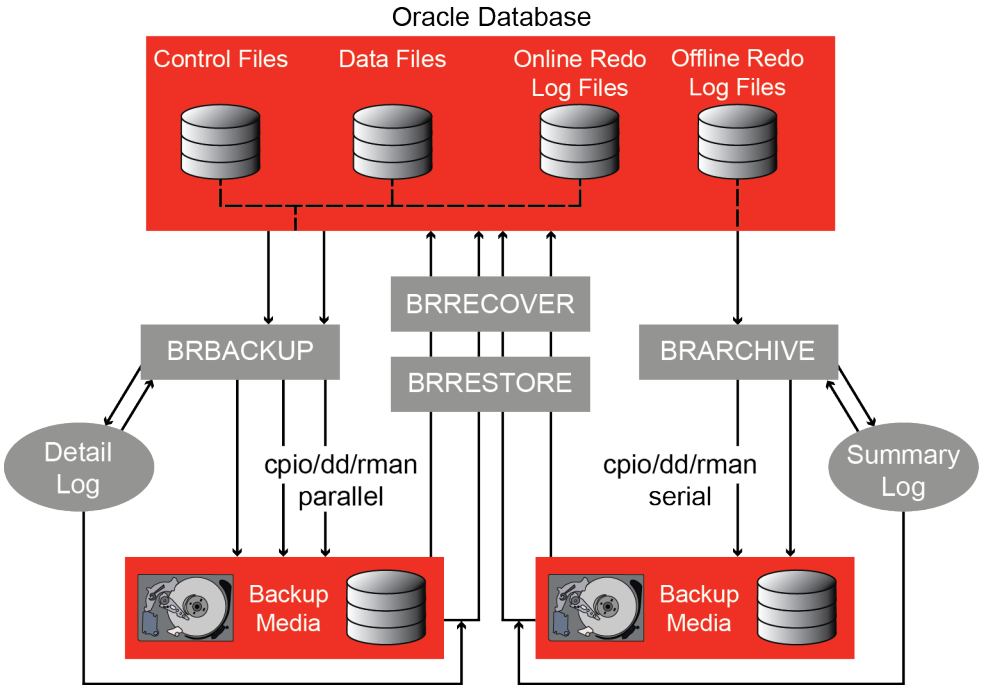


Figure 8. Integrating Backup, Restore, and Recovery Tools

When performing disk-to-disk backups, consider using Oracle RMAN because of the intuitive nature of Oracle RMAN and its tight integration with Oracle Database. Particularly for databases that must be available around the clock, implementing a disk-to-disk backup and restore methodology enables a highly available, 24/7/365 environment.

### Backing Up Oracle Engineered Systems

Although Oracle Engineered Systems include technologies like Oracle RAC and Oracle ASM to protect against server and hard disk errors, it is still important to perform regular backups to protect against system, media, and user errors. Those deploying Oracle Engineered Systems can choose from a range of backup and recovery technologies including disk-to-disk-to-tape, disk-to-disk, and disk-to-tape operations for SAP environments.

Oracle Engineered Systems offer a range of backup, restore, and disaster recovery solutions for short-term data protection and long-term archiving. Options vary according to the data type (structured or unstructured), the need for data protection, recovery time, performance, capacity, and service level requirements. For very fast backups to disk, Sun ZFS Storage Appliances can generate and store file system snapshots—the files are stored either locally or remotely on other Sun ZFS Storage Appliances. Alternatively, these file system snapshots can be stored on Oracle Exadata Storage Expansion Racks, which are linked directly to the InfiniBand fabric. This solution exploits the functionality of Oracle's Exadata Storage Server to restore data quickly and reliably.

- **Tape backup.** Oracle Secure Backup is a central tape management solution for the complete environment, including file systems and Oracle Database. Offering support for off-site tape storage or tape vaulting, Oracle Secure Backup shows what data was backed up and where, and when the backup media can be reused. Backups can also be encrypted for additional security.
- **Remote replication.** Oracle's Sun ZFS Storage Appliance has proven itself as a backup and recovery solution for Oracle Engineered Systems. The appliance's remote replication function offers a simple and effective automated solution for storing off-site copies of production data on local backups. Maintaining a copy of the primary data at a remote site can also significantly reduce the recovery time in a disaster scenario compared with traditional offline backup architectures.
- **Database backup.** Oracle Database structured data can be backed up to disk with Oracle RMAN or to tape with Oracle Secure Backup. Oracle RMAN is the native backup and recovery tool for the Oracle Database, offering easy backup and recovery management and optimized data protection. Integrated in Oracle Secure Backup, Oracle RMAN provides the fastest Oracle Database backup to hard disk or tape.

Oracle offers optimized solutions for Oracle Secure Backup that are specifically designed for network backups of heterogeneous clients, including Oracle Engineered Systems. Tape remains the cheapest and most reliable storage medium for backup, recovery, and long-term archiving. For SAP landscapes where longer storage periods and larger capacities are required, Oracle Secure Backup and tape storage can be used for backup, vaulting, and archiving.

## Change Management

Successful change management minimizes the impact of change-related incidents upon service quality, improves risk assessment, increases alignment of IT services to business requirements, and consequently improves day-to-day operations of the organization.

### Patch Strategy

The process of patching production systems is fundamental to change management. Oracle applies the same patch strategy for all SAP-approved Oracle Engineered Systems, so the same framework conditions, methods, and recommendations apply to all. For Oracle Engineered Systems, Oracle provides bundle patches[11], and in the case of Oracle Engineered Systems for SAP, these bundle patches are designed jointly with SAP. These SAP bundle patches contain:

- Hardware patches and firmware updates for switches or servers
- Operating system patches for the servers

[11] The latest SAP bundle patches are available in the SAP Software Distribution Center:
http://service.sap.com/oracle-download
Database Patches -> Oracle -> [Oracle DB Release] -> Exadata

- Patches for Oracle Exadata Storage Cells
- Patches for Oracle ASM
- Patches for the Oracle Database software

The bundle patches are designed for the requirements of SAP operation and are released on a quarterly basis. The patches are not sequentially dependent on one another, so only the most recent bundle patch needs to be applied. These SAP bundle patches are always based on an Oracle Engineered Systems bundle patch—for example, an Oracle Exadata bundle patch. The Oracle Engineered Systems bundle patches are distributed together with the SAP bundle patch[12].

Oracle generally follows the strategy of applying patches without required database downtime. In most cases, this is achieved by patching all nodes in sequence, or *rolling patching*. However, this concept is not possible for all patches. Experience shows that SAP bundle patches may contain database patches that require a database restart. As a result, there are recommendations for applying patches according to which system element is being patched:

- **Hardware patches** — Can usually be applied on a rolling basis
- **Operating system patches for the database servers** — Can usually be applied on a rolling basis
- **Patches for Oracle's Exadata Storage Cells** — Can usually be applied on a rolling basis
- **Patches for Oracle ASM** — Should be checked in the SAP bundle patch
- **Patches for the database software** — Should be checked in the SAP bundle patch

For Oracle patches that require a database restart with minimal downtime, Oracle and SAP have jointly developed a recommended approach for patching Oracle Exadata with minimal downtime. This process is approved for Oracle Database versions 11.2.0.3 or later and patches an inactive Oracle home while the production environment continues—handled by another Oracle home. This approach also facilitates fast rollback without the time-consuming process of patch removal[13].

## Tools for Patching

Separate tools are standard for patching databases in an SAP environment. For Oracle Database, the **`MOPatch`** tool, or *multiple Oracle patch* tool is the standard tool for patching Unix platforms as of Oracle Database release 10.2.0.2[14]. This same tool is used to patch Oracle Exadata systems. For a detailed description of the use of **`MOPatch`** for Oracle Exadata systems, refer to the descriptions of the bundle patches.

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[12] SAP Note 1591389 explains this for database release 11.2.0.2. The SAP Note for Release 11.2.0.3 is 1656654. SAP notes are issued for later releases according to their availability for Oracle Exadata.

[13] The procedure is detailed in SAP Note 1696869.

[14] See also SAP Note 1027012, which gives an overview of the use of MOPatch.

## Patching with Oracle Enterprise Manager Ops Center

Oracle Enterprise Ops Center uses a hosted metadata knowledge base, Oracle Knowledge Services, for patching Oracle Solaris, Oracle Linux, Red Hat Enterprise Linux, and SuSE Linux Enterprise operating systems. A high-performance, Oracle-specific function, customers can download Oracle Knowledge Services via a web service or install them in offline mode. The effective use of knowledge base metadata improves patch accuracy and reduces downtime. Containing advanced information on patches, **`rpm`**, and packet dependency, the knowledge base is compiled using unique methods known only to Oracle. Oracle Enterprise Ops Center downloads only the patches needed—not all new patches—saving both network bandwidth and computing resources. These patches and other actions—such as single or multiuser mode, and the restart option—are executed as needed.

## Patching with Oracle Data Guard

Both SAP and Oracle offer features for near zero downtime maintenance. In the database layer, many operations can be executed on a rolling basis, but operations that affect the complete database cluster cannot be performed in this fashion[15]. Note that while Oracle allows some database maintenance operations to be performed through a rolling implementation, in an SAP context they might be performed on a non-rolling basis. The patch notes published by SAP indicate on what basis an Oracle bundle patch can be imported. SAP and Oracle provide a special SAP Oracle Exadata bundle patch based on the Oracle Exadata bundle patch[16,17]. The familiar utility **`MOPatch`** is used.

Oracle Data Guard provides the Standby-First Patch Apply function that allows different database versions (patch statuses) to be used on the primary side and the standby side. This function can be used to import and validate a patch on a rolling basis starting with the standby side and is supported in an SAP environment. For more detailed information about this function and Oracle Data Guard in conjunction with Oracle Exadata in general, please refer to the Oracle white paper *Oracle Data Guard: Disaster Recovery for Oracle Exadata Database Machine*[18].

## Scaling

IT changes can include scaling the environment to accommodate the needs of the business. When administering an SAP landscape, it is important to adapt the landscape to changing application requirements and resources must be scaled and adapted accordingly.

### Upgrading an Oracle Engineered System

Oracle Engineered Systems are balanced systems designed for a particular field of application. Upgrades are provided as complete modules rather than individual components such as CPU or RAM. Only partially

[15] List of typical planned operations: http://docs.oracle.com/cd/E11882_01/server.112/e10803/schedule_outage.htm

[16] See MyOracle Support Note 1262380.1 Exadata Patching Overview and Patch Testing Guidelines

[17] See SAP Note 1591389 – Exadata 11.2.0

[18] http://www.oracle.com/technetwork/database/features/availability/maa-wp-dr-dbm-130065.pdf

populated racks can be upgraded (for example, Oracle Exadata eighth racks can be upgraded to quarter racks, half racks, and full racks). Up to eight racks can be connected to a complete system using the built-in InfiniBand fabric and larger configurations can be built with additional InfiniBand switches. Components from different product versions can be combined both when upgrading within a rack and when connecting different racks.

## Planning for Deployment of Oracle Engineered Systems

In most data centers there is a strict division between teams responsible for storage, networks, operating systems, and databases. While these components are separate elements in conventional solutions, they are combined within Oracle Engineered Systems. To gain the most benefit from their unique optimization and tight integration features, the systems should be tuned and managed together. To that end, IT staff must evaluate new and different ways to allocate tasks within existing data center management and operations.

The daily operation of Oracle Engineered Systems presents data center management with a combination of new Oracle technologies and new approaches for supporting different ITIL processes. These technologies and approaches must be addressed and incorporated into data center processes and organization when deploying Oracle Engineered Systems. The following section outlines typical operational responsibilities for an Oracle Engineered System using Oracle Exadata as an example since it is frequently used as an Oracle Database platform and Oracle Databases are a vital component of SAP landscapes.

### Operational Responsibilities

Most organizations typically manage their SAP landscapes using a highly trained core team with expertise in both Oracle Database and SAP software. Other teams provide expertise for areas lying outside the SAP team's core competency. Since most management tasks for Oracle Exadata are part of a database administrator's standard skills, the core team can manage Oracle Exadata. However, some system management tasks and job responsibilities are likely to change.

- **Storage:** With Oracle Exadata, the workload for storage administrators is significantly lower than that of a large SAN infrastructure, due to the use of Oracle ASM, self-managing disks, and flash cache in Oracle's preconfigured Exadata Storage Cells. If a component fails, the appropriate tool automatically issues an alert and orders any necessary replacement components. Patching is still required, but Oracle provides bundled patches for all of the Oracle Exadata components. Day-to-day storage administration mainly involves monitoring the backups—which can be automated—performing capacity planning, and everyday information life-cycle management tasks.
- **Operating system:** Oracle Exadata is designed purely for database operations, so the operating system management is much simpler than for a standalone server.
  - The operating system must not be modified, and no intervention is required on the Oracle Exadata Storage Cells apart from patching, which is performed by means of bundle patches that patch the database software simultaneously.
  - The Oracle Exadata Database Servers are loaded with only the Linux components required to operate the database. No other software—apart from management and monitoring agents—is installed on the systems. The necessary patches for these servers are included in the Oracle Exadata bundle patches. Other administrative tasks are limited to one-time Oracle Database setup tasks.

- **The InfiniBand network:** The preconfigured InfiniBand network in Oracle Engineered Systems only requires monitoring and infrequent patching using Oracle Enterprise Manager 12*c* with Oracle Exadata plug-ins. The InfiniBand switches can also be monitored through standard monitoring tools. Once configured, the InfiniBand network requires minimal attention. All the network administrator must do is maintain the connections between the Oracle Exadata and the public network using the associated Domain Name System (DNS) and Internet Protocols (IPs).

## New Operational Models for Oracle Exadata Administration

IT departments can distribute management responsibilities and tasks in different ways, depending on the planned scope of the Oracle Exadata system. The Oracle white paper *Operational Impact of Deploying an Oracle Engineered System (Exadata)* presents three variations on one possible scenario. These variations consist of management by multiple teams, a database machine administration team, or an Oracle Exadata administration team.

### Operational Model 1: Maintain Existing Procedures (Multiple Teams)

The first operational model retains the existing organizational structure, with different teams devoted to storage, networks, operating systems, and databases. In order to manage the different components within the Oracle Engineered Systems, the teams must share responsibilities and the various administrative activities must be carefully coordinated. The existing organizational structure in this model is very rigid, making any changes extremely difficult.

This traditional approach entails higher costs and provides limited agility. In the following situations, however, this approach is the most appropriate.

- Existing well-defined and well-organized processes enable effective administration of all aspects of the entire Oracle Database infrastructure.
- Business stakeholders are happy with the responsiveness of this operating model.
- Oracle Engineered Systems are adopted tactically for a small number of specific projects, with the majority of the Oracle environment likely to remain on traditional platforms.
- The Oracle Database Administrators (DBAs) are very highly specialized and have no administrative experience outside of pure DBA tasks.

### Operational Model 2: Oracle Engineered Systems Administration Team

In the second operational model, an administration team draws on the existing Oracle DBAs as well as the server management team for managing all aspects of Oracle Engineered Systems. The administration team includes members with Oracle Engineered Systems expertise. The team's exact skills set depends on the mix of systems used. Team members most likely will see their current roles in the existing teams evolve, and acquire new skills from other team members. Note that specific traditional storage skills are not needed in the new team.

The importance of the team should be increased gradually as the Oracle Engineered Systems are rolled out. With the rollout of the first systems, the administration team primarily coordinates different experts from other teams. Over time the team members can handle more and more administrative tasks themselves.

In many cases, this is likely to be the most practical operating model and offers the best of both worlds as it enables Oracle Engineered Systems to be combined with existing systems from a management perspective. This is a suitable approach in the following scenarios.

- Large numbers of Oracle Engineered Systems are to be implemented and used for database and application consolidation.
- There is a well-defined structure in which multiple teams already provide effective administration of all aspects of the entire infrastructure.
- Business stakeholders are happy with the responsiveness of this operating model.
- The new Oracle Engineered Systems administration team has direct and timely access to specifically named personnel in existing support teams.

#### Operational Model 3: Oracle Exadata Database Machine Administration (DBMA) Team

The third model is focused on the Oracle Exadata Database Machine, particularly when there is a large number of centrally administered Oracle Exadata machines running SAP and non-SAP applications. It is not suitable for mixed Oracle Engineered Systems environments because it is geared to the particular needs of Oracle Exadata.

Most of the administrative work on an Oracle Exadata is database-centric. For this reason, the administration team should draw from the existing Oracle DBA team. The team can be augmented with a small number of administrative staff to handle the Oracle Exadata network and storage components. From a management perspective, the DBMA team will own the Oracle Exadata system. While Oracle Exadata expertise is developing and the DBMA team is evolving, some specialized assistance may be necessary from time to time.

This optimal approach enables the relative simplicity of Oracle Exadata to be reflected in a simpler, less costly, and more agile support organization. As Oracle pre-integrates and pre-tests all components together, the support team is able to focus more on business initiatives and outcomes, and less on technical administration.

If a single DBMA team is not possible, an eventual unified DBMA team might serve as a future goal. A single DBMA team is a suitable approach in the following scenarios.

- Oracle Exadata is the strategic database platform and will constitute a considerable portion of the Oracle consolidation footprint over time.
- The existing DBA team already manages the bulk of the Oracle Database infrastructure.
- There is a need for more agile database administration functions.

Creating a new team and assigning them ownership of the new technology might cause some discord among the existing technology support teams. IT staff must consider this possibility on a case-by-case basis. While creating a DBMA team requires some restructuring of the support organization, from an Oracle Exadata perspective there are major advantages to consider. The DBMA team could be created in one of two ways:

- **Cross-train team members.** Train some or all of the DBAs in areas such as Linux or Oracle Solaris, networks, and Oracle Exadata Storage Cells. Storage knowledge is the least significant since Oracle Exadata Storage Servers and Oracle Exadata Storage Server software is new technology to anyone and is

largely self-managing. Oracle University currently offers a workshop, *Oracle Exadata Database Machine Administration*, and a seminar, *Monitor Oracle Exadata*. For IT staff pursuing certification, an Oracle Certified Expert examination is available.

- **Add team members and cross-train.** Add at least one person with a background in Linux or Solaris, networks, and possibly storage systems to the DBA team, and then cross-train.

## Migration to Oracle Engineered Systems

Migrating an SAP environment to an Oracle Engineered System has the same requirements as a migration to any other platform, because the system is transparent to SAP. The only difference is Oracle Engineered Systems' exceptionally high performance. In SAP migrations, migrating the database demands particular attention. There are three alternative migration methods to be considered:

- **R3Load.** R3Load is used for importing and exporting database tables during installation, upgrade, and migration. It can be used for Oracle-to-Oracle migrations, as well as for other database migrations such as IBM DB2 or Microsoft SQL Server to Oracle Database.
- **Oracle-to-Oracle.** Designed for SAP environments, Oracle-to-Oracle replaces R3Load in migrating databases while providing features that facilitate and expedite the migration process. Please see the following sections for details.
- **Oracle-to-Oracle Online.** Oracle-to-Oracle Online is based on Oracle-to-Oracle migration principles and offers the advantage of minimal downtime during migrations. Please see the following sections for details.

### Oracle-to-Oracle

The Oracle-to-Oracle (O2O) migration package is designed to offer a fast, cheap, and reliable method to migrate Oracle databases either for a switch to another operating system, or to completely reorganize a database in combination with an Oracle software upgrade. The O2O migration covers every possible scenario in a switch to an Oracle Engineered Systems architecture.

Originally designed for the special needs of SAP systems, O2O may be used for non-SAP systems as well. Within an SAP migration, O2O takes the place of the R3Load tool, which performs the database migration. Once the O2O migration is completed, the same post migration steps should be performed as for an R3Load migration.

O2O migration has a number of extra benefits that simplify and accelerate the migration to Oracle Engineered Systems.

- O2O does not require any SAP-specific pre-migration tasks on the source system. There is no need to remove temporary SAP tables or to run special SAP Business Information Warehouse (BW) reports to prepare the system for migration.
- By design, O2O always comprises complete database reorganization on tables and indexes. Past migrations have shown that reorganizing a database releases up to 30% of space.
- O2O is fast. With appropriate hardware on the source side, it is possible to copy more than 1 TB per hour.

- Concurrently with a migration to Oracle Engineered Systems, O2O can activate other Oracle database technologies, like index and table compression or transparent data encryption for sensitive data.
- O2O only copies the table data and is therefore much faster than a normal copy, which also copies index data and the UNDO and TEMP tablespaces. Creating parallel indexes on Oracle Engineered Systems is much faster than copying.
- O2O is 100 percent risk free. The source system is read-only, so if the migration fails operations can proceed with the old system.
- The traditional exchange process in O2O uses dump files for small tables because the process is efficient only for small tables. Large tables that make up 95 percent of data volume are swapped directly between the databases. Figure 9 shows the large and small tables being moved from the source database to the target.
- The O2O Framework controls the entire process.

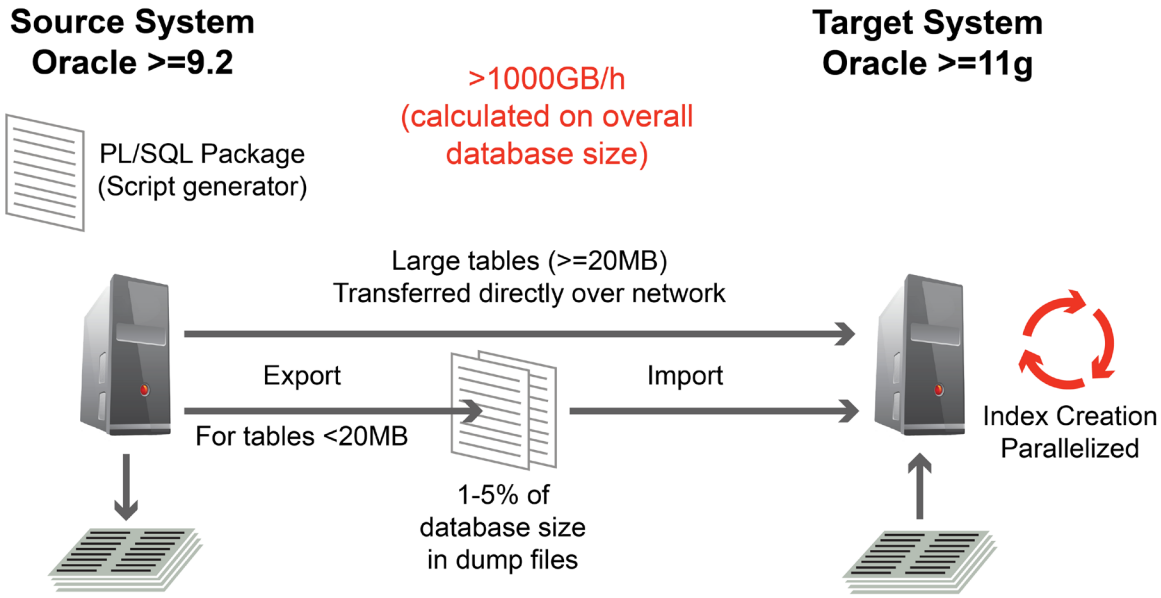


Figure 9. Moving the database from the source to the target system.

## Oracle-to-Oracle Online

Oracle-to-Oracle Online (Triple-O) migration offers a reliable way of migrating to an Oracle Engineered System platform with minimal downtime. Based on a multi-stage approach, it extends O2O concepts. While O2O requires downtime until database copying is complete, Triple-O requires only a very short downtime in which the source database is powered down and the target database is powered up.

In the first step, Triple-O makes a copy of the database but—unlike the O2O process—the database remains online and the SAP system continues in production. The duration of this step depends mainly on the size of the database and the available bandwidth between the source and target systems.

Database changes that have occurred since copying started are transferred to the target database using Oracle Golden Gate. The duration of this stage depends on the number of changes. Once all the changes have been transferred from the source to the target system, Oracle Golden Gate keeps the two systems synchronous and the system is ready for the database changeover. The target database is ready to take over SAP operations. If there are any other SAP changes required in addition to the database migration, these are performed now. In order to allow fallback to the old system, the target and source databases can now swap roles to keep the old database system synchronous for a period of time. A diagram of a Triple-O database migration using Oracle Golden Gate is shown in Figure 10 below.

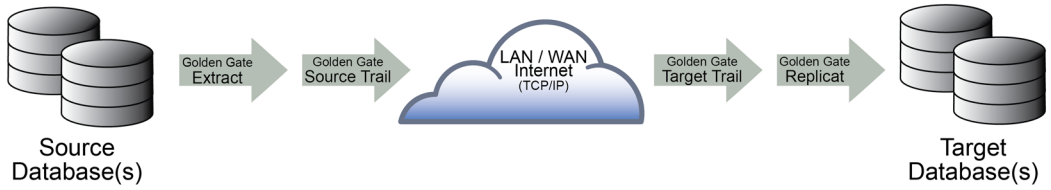


Figure 10. An example of Oracle Golden Gate database migration using the Triple-O approach.

For O2O migration, a distinction is made between the Golden Gate **`Extract`** and **`Replicat`** components, which are explained below. The Oracle Golden Gate **`Extract`** component extracts the data from the running source system after the first stage. For SAP environments, **`Extract`** can use two different procedures to do this:

- **Keep source data synchronized with another set of data. `Extract`** extracts transactional changes, such as inserts, updates, and deletes, made to data after the initial synchronization has taken place. Oracle Data Definition Language (DDL) changes and sequences are also extracted, if supported for the type of database being used. When processing transactional data changes, **`Extract`** obtains the data from heterogeneous sources and targets.
- **Log-based extraction.** When **`Extract`** is installed as a log-based implementation, it can read the transaction logs directly. **`Extract`** extracts all of the changes made to objects that are configured for synchronization, but only sends the data from committed transactions to the trail for propagation to the target system. When **`Extract`** extracts the commit record of a transaction, all of the log records for that transaction are written to the trail as a sequentially organized transaction unit, ensuring speed and data integrity.

Multiple **`Extract`** processes can operate on different objects at the same time. For example, one process could continuously extract transactional data changes and stream them to a decision-support database, while another process performs batch extracts for periodic reporting. Alternatively, two **`Extract`** processes could extract and transmit to two apply processes with two trails in parallel to minimize target latency when the databases are large.

The **`Replicat`** process runs on the target system and reads the extracted data changes and DDL changes—if supported—that are specified in the **`Replicat`** configuration, and then applies them to the target database. Triple-O is used to synchronize changes. To maintain synchronization, **`Replicat`** applies extracted transactional changes to target objects using native database calls, statement caches, and local database access. Replicated DDL and sequences are also applied, if supported for the type of database that is being used. To preserve data integrity, **Replicat** applies the applied changes in the same order as those changes

were committed to the source database. Multiple **`apply`** processes with multiple **`Extract`** processes can be used in parallel to increase throughput. The **`apply`** process can be delayed so that it waits a specific amount of time before applying data to the target database.

There are other Golden Gate components used in conjunction with Triple-O in addition to these two key processes. Their function is described in the Golden Gate documentation.

## Conclusion

Oracle Engineered Systems deliver power and performance to SAP applications, with innovation and optimization at each layer of Oracle's end-to-end technology stack. Offering a new approach for operating SAP landscapes, Oracle Engineered Systems improve the methods by which availability, performance, and maintainability requirements are satisfied.

These changes enable IT staff to take a new approach to system management and maintenance within the current environment, facilitating an approach grounded in ITIL best practices. An Oracle Engineered System deployment provides an excellent opportunity to transform data center operations into a complete IT service provider geared toward business processes as well as growing industry trends in consolidation, virtualization, and cloud computing.

## For More Information

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## About the Authors

Jan Brosowski serves as a Principal System Architect in Oracle's Europe North Presales organization. For many years he has focused on SAP architectures and optimizing IT infrastructures for mid-size to large SAP customers. His latest contribution is in the area of using Oracle Engineered Systems as platforms for SAP architectures and integrating Oracle Engineered Systems into legacy SAP data centers.

A member of Oracle's Sales organization since 1997, Julian Lane works as a Solution Consultant. For the last three years he has focused on helping Oracle staff, partners, and customers to develop optimized solutions for managing Oracle systems. He is a subject matter expert in Oracle Engineered Systems operational management, publishing a number of white papers and presentations. In this capacity, he leads the Engineered Systems Operational Management (ESOM) Taskforce, an EMEA-wide virtual team that works across lines of business.

# APPENDIX A: Patching a Single System Without Creating a Profile

### Oracle Enterprise Manager Ops Center – Version 2.5 on 11g [Release 2.0 of 11.0]

Oracle Enterprise Ops Center further streamlines patch management by enabling administrators to patch a single system without creating a profile. This is done by selecting the required patches and launching a modification job.

The following set of screenshots outlines how to patch a single system without creating a profile. The first step is to select the patches (Figure 11) by entering the patch ID in the search box and confirm by clicking on **`Required`**.

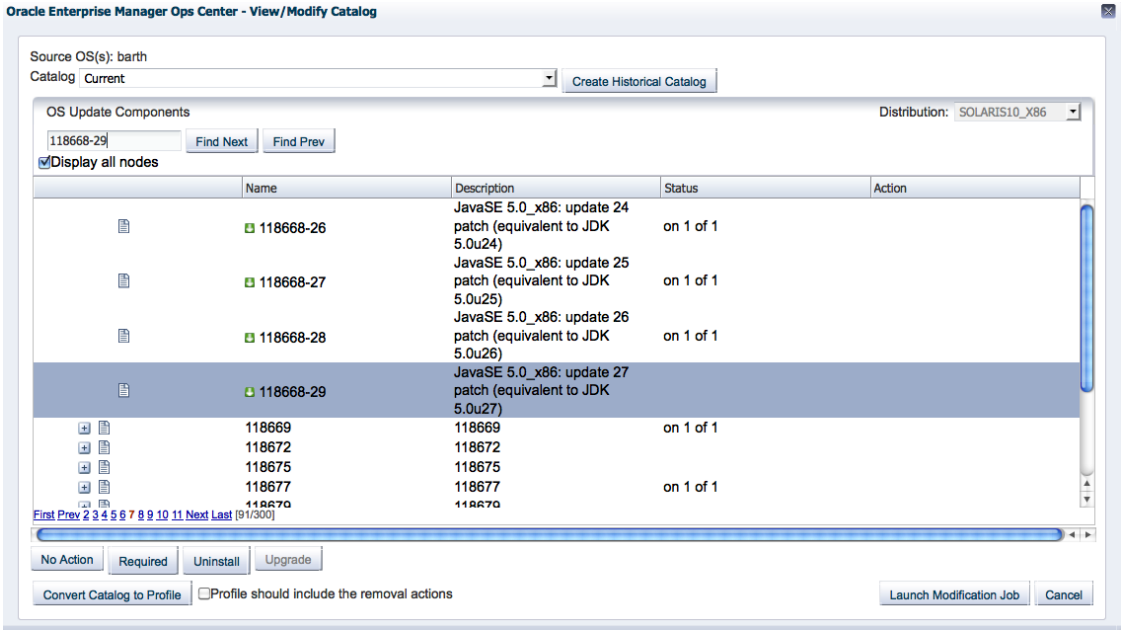


Figure 11. Select the patches to apply.

Once the selection process is complete, click on **`Launch Modification Job`** in the lower righthand corner of the screen (Figure 11).

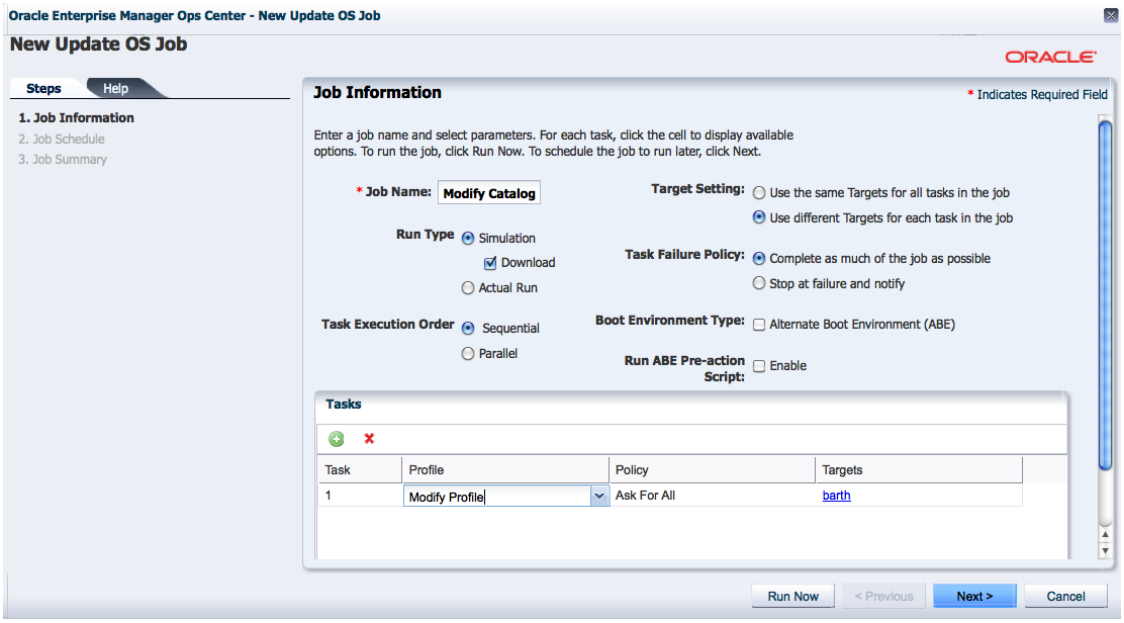


Figure 12. The Modify Profile task in the Tasks window.

The New Update OS Job screen comes up. To fill out with no simulation and no ABE integration of ad-hoc, simply select **`Actual Run`** and change the guideline to **`Yes To All`**. Click on **`Next>`**.

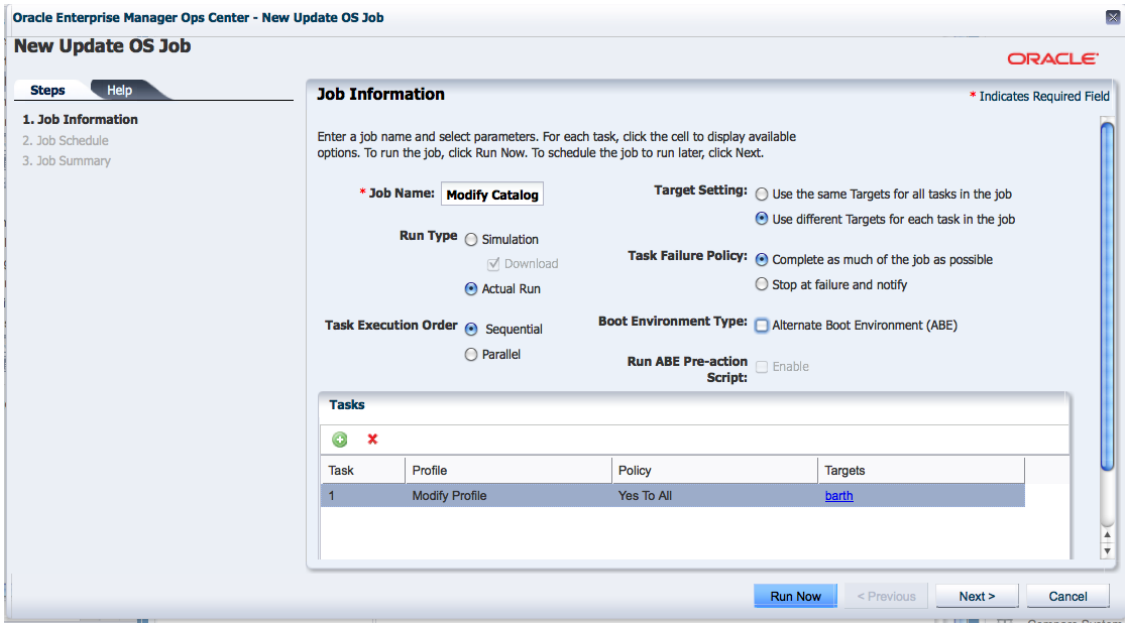


Figure 13. Running the patch job.

Click on **`Run Now`**.

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Operating SAP Landscapes on Oracle Engineered Systems Using ITIL Best Practices
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