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Preface

Oracle Database 2 Day + Real Application Clusters Guide describes how to install, configure, and administer Oracle Clusterware and Oracle Real Application Clusters (Oracle RAC) on a two-node system using the Red Hat Linux system.

Note: For Linux operating systems other than Red Hat Linux, see *Oracle Real Application Clusters Installation Guide for Linux and UNIX*. For other operating systems, see the platform-specific Oracle RAC installation guide.

This guide covers topics that a reasonably knowledgeable Oracle database administrator (DBA) would need to know when moving from managing a single-instance Oracle Database environment to managing an Oracle RAC environment.

Audience

Oracle Database 2 Day + Real Application Clusters Guide is an Oracle RAC database administration guide for DBAs who want to install and use Oracle RAC. This guide assumes you have already read *Oracle Database 2 Day DBA*. This guide is intended for DBAs who:

- Want basic DBA skills for managing an Oracle RAC environment
- Manage Oracle databases for small- to medium-sized businesses

To use this guide, you should be familiar with the administrative procedures described in *Oracle Database 2 Day DBA*.

Note: Some DBAs may be interested in moving the data from their single-instance Oracle Database to their Oracle RAC database. This guide also explains the procedures for doing this.

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Related Documents

For more information, see the following in the Oracle Database 11g Release 1 documentation set:

- *Oracle Real Application Clusters Installation Guide for Linux and UNIX*
- *Oracle Real Application Clusters Administration and Deployment Guide*
- *Oracle Database 2 Day DBA*

Conventions

The following text conventions are used in this guide:

Convention	Meaning
boldface	Boldface type indicates graphical user interface elements associated with an action, or terms defined in text or the glossary.
<i>italic</i>	Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.
monospace	Monospace type indicates commands within a paragraph, URLs, code in examples, text that appears on the screen, or text that you enter.

Introduction to Oracle Database 2 Day + Real Application Clusters Guide

This chapter provides an overview of Oracle Real Application Clusters (Oracle RAC) environments. This chapter includes the following sections:

- [About This Guide](#)
- [About Oracle Clusterware and Oracle Real Application Clusters](#)
- [About Automatic Storage Management](#)
- [Tools for Installing, Configuring, and Managing Oracle RAC](#)

About This Guide

This is an Oracle RAC database administration, task-oriented guide that shows you how to configure and manage the environment for Oracle Clusterware and Oracle RAC. This guide also explains how to create an Oracle RAC database and how to perform routine Oracle RAC database administrative tasks.

The goal of this guide is to help you understand the basic steps required to install and maintain an Oracle RAC environment, including how to perform basic troubleshooting, performance monitoring, and backup and recovery activities. This guide is based on Red Hat Linux, but you do not need to be a Linux expert to use this guide.

What This Guide Is Not

This guide is not a comprehensive description of Oracle RAC. It describes concepts only when necessary for completing a particular task.

See Also:

- *Oracle Database Concepts*
- *Oracle Database Administrator's Guide*

Related Materials

This guide is part of a comprehensive set of learning materials for administering Oracle Databases, which includes a 2 Day DBA Oracle By Example (OBE) series (available on the Web) and Oracle University instructor-led classes.

Some of the chapters in this guide have an associated OBE lesson. The OBE lesson guides you through some of the tasks in the guide, or related tasks, and includes

annotated screenshots. In some cases, the OBE lesson provides additional information to help you complete a task.

At the end of a section, you might find a link to that chapter's associated OBE lesson. The home page for the 2 Day + Real Application Clusters Oracle By Example series is

<http://www.oracle.com/technology/obe/admin/db10gr2.html>

Oracle Real Application Clusters Documentation Overview

This guide describes how to install, configure, and manage Oracle RAC and Oracle Clusterware, and provides examples for how you could do this on a two-node cluster, using the Red Hat Linux operating system. This guide is for DBAs who have experience with single-instance Oracle environments and have read *Oracle Database 2 Day DBA*.

Useful Oracle RAC Guides

The following is a list of other useful Oracle RAC or related documentation:

- *Oracle Real Application Clusters Administration and Deployment Guide*
- *Oracle Clusterware Administration and Deployment Guide*
- *Oracle Real Application Clusters Installation Guide for Linux and UNIX* (or other operating system)
- *Oracle Clusterware Installation Guide for Linux* (or other operating system)

Note: Additional information for this release may be available in the Oracle Database 11g Release 1 (11.1) README or Release Notes. You can locate these documents on your Oracle product installation media.

About Oracle Clusterware and Oracle Real Application Clusters

Oracle RAC extends Oracle Database so that you can store, update, and efficiently retrieve data using multiple database instances on different servers at the same time. Oracle RAC provides the software that facilitates servers working together in what is called a cluster. The data files that make up the database must reside on shared storage that is accessible from all servers that are part of the cluster. Each server in the cluster runs the Oracle RAC software.

An Oracle Database database has a one-to-one relationship between datafiles and the instance. An Oracle RAC database, however, has a one-to-many relationship between datafiles and instances. In an Oracle RAC database, multiple instances access a single set of database files. The instances can be on different servers, referred to as **hosts** or **nodes**. The combined processing power of the multiple servers provides greater availability, throughput, and scalability than is available from a single server.

Each database instance in an Oracle RAC database uses its own memory structures and background processes. Oracle RAC uses Cache Fusion to synchronize the data stored in the buffer cache of each database instance. Cache Fusion moves current data blocks (which reside in memory) between database instances, rather than having one database instance write the data blocks to disk and requiring another database instance to reread the data blocks from disk. When a data block located in the buffer cache of one instance is required by another instance, Cache Fusion transfers the data block directly between the instances using the interconnect, enabling the Oracle RAC database to access and modify data as if the data resided in a single buffer cache.

Oracle RAC is also a key component for implementing the Oracle enterprise grid computing architecture. Having multiple database instances accessing a single set of datafiles prevents the server from being a single point of failure. Any packaged or custom application that ran well on a Oracle Database will perform well on Oracle RAC without requiring code changes.

You will learn more about the operation of the Oracle RAC database in a cluster, how to build the cluster, and the structure of an Oracle RAC database in other sections of this guide.

See Also:

- *Oracle Real Application Clusters Administration and Deployment Guide*
- *Oracle Clusterware Administration and Deployment Guide*

About Automatic Storage Management

With Oracle RAC, each instance must have access to the datafiles and recovery files for the Oracle RAC database. Using Automatic Storage Management (ASM) is an easy way to satisfy this requirement.

ASM is an integrated, high-performance database file system and disk manager. ASM is based on the principle that the database should manage storage instead of requiring an administrator to do it. ASM eliminates the need for you to directly manage potentially thousands of Oracle database files.

ASM groups the disks in your storage system into one or more disk groups. You manage a small set of disk groups and ASM automates the placement of the database files within those disk groups.

ASM provides the following benefits:

- **Striping**—ASM spreads data evenly across all disks in a disk group to optimize performance and utilization. This even distribution of database files eliminates the need for regular monitoring and I/O performance tuning.
- **Mirroring**—ASM can increase data availability by optionally mirroring any file. ASM mirrors at the file level, unlike operating system mirroring, which mirrors at the disk level. Mirroring means keeping redundant copies, or mirrored copies, of each extent of the file, to help avoid data loss caused by disk failures. The mirrored copy of each file extent is always kept on a different disk from the original copy. If a disk fails, ASM can continue to access affected files by accessing mirrored copies on the surviving disks in the disk group.
- **Online storage reconfiguration and dynamic rebalancing**—ASM permits you to add or remove disks from your disk storage system while the database is operating. When you add a disk to a disk group, ASM automatically redistributes the data so that it is evenly spread across all disks in the disk group, including the new disk. The process of redistributing data so that it is also spread across the newly added disks is known as **rebalancing**. It is done in the background and with minimal impact to database performance.
- **Managed file creation and deletion**—ASM further reduces administration tasks by enabling files stored in ASM disk groups to be managed by Oracle Database. ASM automatically assigns file names when files are created, and automatically deletes files when they are no longer needed by the database.

ASM is implemented as a special kind of Oracle instance, with its own System Global Area and background processes. The ASM instance is tightly integrated with the

database instance. Every server running one or more database instances that use ASM for storage has an ASM instance. In an Oracle RAC environment, there is one ASM instance for each node, and the ASM instances communicate with each other on a peer-to-peer basis. Only one ASM instance is required for each node regardless of the number of database instances on the node.

Oracle recommends that you use ASM for your database file storage, instead of raw devices or the operating system file system. However, databases can have a mixture of ASM files and non-ASM files.

See Also:

- *Oracle Database 2 Day DBA*
- *Oracle Database Storage Administrator's Guide*

Tools for Installing, Configuring, and Managing Oracle RAC

The following is a description of the tools used for installing, configuring, and managing an Oracle RAC database:

- Oracle Universal Installer (OUI)—OUI installs the Oracle Clusterware and the Oracle Database software with Oracle RAC. After you configure the nodes that you want to use in your cluster, OUI installs the Oracle software on the specified nodes using a network connection.
- Cluster Verification Utility (CVU)—The CVU is a command-line tool that you can use to verify a range of cluster and Oracle RAC components such as shared storage devices, networking configurations, system requirements, and Oracle Clusterware, as well as operating system groups and users. You can use the CVU for preinstallation as well as postinstallation checks of your cluster environment. The CVU is especially useful during preinstallation and during installation of Oracle Clusterware and Oracle RAC components. OUI runs the CVU after the Oracle Clusterware installation to verify your environment.
- Oracle Enterprise Manager—Oracle Enterprise Manager has both the Database Control and Grid Control graphical user interfaces (GUIs) for managing single-instance and Oracle RAC environments.
- Server Control (SRVCTL)—SRVCTL is a command-line interface that you can use to manage the resources defined in the Oracle Cluster Registry (OCR). These resources include the node applications, called **nodeapps**, that make up Oracle Clusterware, which includes the Oracle Notification Service (ONS), the Global Services Daemon (GSD), and the Virtual IP (VIP). Other resources that can be managed by SRVCTL include databases, instances, listeners, services, applications, and Oracle Enterprise Manager agents. Using SRVCTL you can start and stop nodeapps, databases, instances, listeners, and services, delete or move instances and services, add services, and manage configuration information.
- Cluster Ready Services Control (CRSCTL)—CRSCTL is a command-line tool that you can use to manage Oracle Clusterware daemons. These daemons include Cluster Synchronization Services (CSS), Cluster-Ready Services (CRS), and Event Manager (EVM). You can use CRSCTL to start and stop Oracle Clusterware and to determine the current status of your Oracle Clusterware installation.

See Also:

- *Oracle Real Application Clusters Administration and Deployment Guide*

Installing Oracle RAC on Different Operating Systems

If you plan to install and configure Oracle RAC on an operating system other than Red Hat Linux, you can still use this guide to obtain a general understanding about how to deploy Oracle RAC. You can also use this guide for deploying Oracle RAC on clusters with more than two nodes. For all environments that do not match the environment that this guide describes, modify the examples accordingly.

When installing Oracle RAC on a different platform or different operating system version than Red Hat Linux, refer to the installation and configuration guides for that platform. For example, if you are installing Oracle RAC on the Solaris operating system, then you would use the following guides:

- *Oracle Clusterware Installation Guide for Solaris Operating System*
- *Oracle Real Application Clusters Installation Guide for Solaris Operating System*

Oracle Clusterware and Oracle RAC do not support heterogeneous platforms in the same cluster. For example, you cannot have one node in the cluster running Red Hat Linux and another node in the same cluster running Solaris UNIX. All nodes must run the same operating system, that is, they must be binary compatible. Oracle RAC does not support machines having different chip architectures in the same cluster. However, you can have machines of different speeds and sizes in the same cluster.

See Also:

- ["Installing and Configuring Oracle Clusterware and Oracle RAC"](#)
- *Oracle Real Application Clusters Administration and Deployment Guide*

Preparing Your Cluster

This chapter contains the information that your system administrator and network administrator need to help you, as the DBA, configure the two nodes in your cluster. This chapter assumes a basic understanding of the Red Hat Linux operating system. In some cases, you may need to refer to details in *Oracle Real Application Clusters Installation Guide for Linux and UNIX*. In addition, you must have root privileges to perform the tasks in this chapter.

This chapter includes the following sections:

- [About Checking Requirements](#)
- [Preparing the Server](#)
- [Configuring the Network](#)
- [Preparing the Operating System and Software](#)
- [Configuring Installation Directories and Shared Storage](#)

About Checking Requirements

Before you begin your installation, you should check to make sure that your system meets the requirements for Oracle Real Application Clusters (Oracle RAC). The requirements can be grouped into the following three categories:

- [About Checking Hardware Requirements](#)
- [About Identifying Network Requirements](#)
- [Verifying Operating System and Software Requirements](#)

About Checking Hardware Requirements

Each node that you want to make part of your Oracle Clusterware, or Oracle Clusterware and Oracle RAC installation, must satisfy the minimum hardware requirements of the software. These hardware requirements can be categorized as follows:

- Physical memory (at least 1 gigabyte (GB) of RAM)
- Swap space (at least 2 GB of available swap space)
- Temporary space (at least 400 megabytes (MB))
- Processor type (CPU) that is certified with the version of the Oracle software being installed

Note: When you install the Oracle Database software, Oracle Universal Installer (OUI) automatically performs hardware prerequisite checks and notifies you if they are not met.

You will need at least 1.5 GB of available disk space for the Oracle Database home directory and 1.5 GB of available disk space for the Automatic Storage Management (ASM) home directory. You will also need 120 MB of disk available space for the Oracle Clusterware software installation. For best performance and protection, you should have multiple disks, each using a different disk controller.

An Oracle RAC database is a *shared everything* database. All datafiles, control files, redo log files, and the server parameter file (SPFILE) used by the Oracle RAC database must reside on shared storage that is accessible by all the Oracle RAC database instances. The Oracle RAC installation that is described in this guide uses ASM for the shared storage of the database files.

Oracle Clusterware achieves superior scalability and high availability by using the following components:

- **Voting disk**—Manages cluster membership and arbitrates cluster ownership between the nodes in case of network failures. The voting disk is a file that resides on shared storage. For high availability, Oracle recommends that you have more than one voting disk, and that you have an odd number of voting disks. If you define a single voting disk, then use mirroring at the file system level for redundancy.
- **Oracle Cluster Registry (OCR)**—Maintains cluster configuration information as well as configuration information about any cluster database within the cluster. The OCR contains information such as which database instances run on which nodes and which services run on which databases. The OCR also stores information about processes that Oracle Clusterware controls. The OCR resides on shared storage that is accessible by all the nodes in your cluster. Oracle Clusterware can multiplex, or maintain multiple copies of, the OCR and Oracle recommends that you use this feature to ensure high availability.

Note: Both the voting disks and the OCR must reside on shared devices that you configure before you install Oracle Clusterware and Oracle RAC.

These Oracle Clusterware components require the following additional disk space:

- Two Oracle Clusterware Registry files, 280 MB each, or 560 MB total disk space
- Three voting disk files, 280 MB each, or 840 MB total disk space

For voting disk file placement, ensure that each voting disk is configured so that it does not share any hardware device or disk, or other single point of failure. See ["Configuring Block Devices for Oracle Clusterware Files"](#) on page 2-19 for more information about configuring Oracle Clusterware files.

See Also:

- Your platform-specific Oracle Clusterware installation guide
- ["About Performing Platform-Specific Configuration Tasks"](#)
- ["Preparing the Server"](#)
- ["Configuring Installation Directories and Shared Storage"](#)

About Identifying Network Requirements

An Oracle RAC cluster comprises two or more nodes that are linked by a private interconnect. The interconnect serves as the communication path between nodes in the cluster. Each cluster database instance uses the interconnect for messaging to synchronize the use of shared resources by each instance. Oracle RAC also uses the interconnect to transmit data blocks that are shared between the instances.

Oracle Clusterware requires that you connect the nodes in the cluster to a private network by way of a private interconnect. The private interconnect is a separate network that you configure between cluster nodes. The interconnect used by Oracle RAC is the same interconnect that Oracle Clusterware uses. This interconnect should be a private interconnect, meaning it is *not* accessible to nodes that are not members of the cluster.

When you configure the network for Oracle RAC and Oracle Clusterware, each node in the cluster must meet the following requirements:

- Each node has at least two network interface cards, or **network adapters**. One adapter is for the public network and the other adapter is for the private network used by the interconnect. Install additional network adapters on a node if that node meets either of the following conditions:
 - Does not have at least two network adapters
 - Has two network interface cards but is using network attached storage (NAS). You should have a separate network adapter for NAS.

Note: For the most current information about supported network protocols and hardware for Oracle RAC installations, refer to the Certify pages on *OracleMetaLink*, which is located at

<https://metalink.oracle.com>

- You must have at least three IP addresses available for each node:
 1. An IP address with an associated host name (or network name) for the public interface.
 2. A private IP address with a host name for each private interface.

Note: Oracle recommends that you use private network IP addresses for the private interfaces (for example: 10.*.* or 192.168.*.*).

3. One virtual IP address with an associated network name. Select a virtual IP (VIP) address that meets the following requirements:
 - The VIP address and associated network name are currently unused.

- The VIP is on the same subnet as your public interface.
- Public interface names must be the same for all nodes. If the public interface on one node uses the network adapter `eth0`, then you must configure `eth0` as the public interface on *all* nodes.
- You should configure the same private interface names for all nodes as well. If `eth1` is the private interface name for the first node, then `eth1` should be the private interface name for your second node.
- For the private network, the end points of all designated interconnect interfaces must be completely reachable on the network. There should be no node that is inaccessible by other nodes in the cluster using the private network.

To determine what interfaces are configured on a node running Red Hat Linux, use the following command as the `root` user:

```
# /sbin/ifconfig
```

You may need to work with your system or network administrator to obtain IP addresses for each node.

See Also:

- ["Configuring the Network"](#)
- ["About Checking Requirements"](#)

Verifying Operating System and Software Requirements

Refer to *Oracle Clusterware and Oracle Real Application Clusters Installation and Configuration Guide* for your platform for information about exact requirements. These requirements can include any of the following:

- The operating system version
- The kernel version of the operating system
- Installed packages, patches, or patch sets
- Installed compilers and drivers
- Web browser type and version
- Additional application software requirements

If you are currently running an operating system version that is not supported by Oracle Database 11g Release 1 (11.1), then you must first upgrade your operating system before installing Oracle Real Application Clusters 11g.

To determine if the operating system requirements for Red Hat Linux have been met:

1. To determine which distribution and version of Linux is installed, run the following command at the operating system prompt as the `root` user:

```
# cat /etc/issue
```

2. To determine if the required errata level is installed, use the following procedure as the `root` user:

```
# uname -r  
2.6.9-42.EL
```

Like most software, the Linux kernel is updated to fix bugs in the operating system. These kernel updates are referred to as erratum kernels or **errata levels**.

The output in the previous example shows that the kernel version is 2.6.9, and the errata level (EL) is 22. Review the required errata level for your distribution. If the errata level is below the required minimum errata level, then install the latest kernel update for your operating system. The kernel updates are available from your operating system vendor.

3. To ensure there are no operating system issues affecting installation, make sure you have installed all the operating system patch updates and packages that are listed in *Oracle Clusterware and Oracle Real Application Clusters Installation Guide* for your platform. If you are using Red Hat Linux, you can determine if the required *packages*, or programs that perform specific functions or calculations, are installed by using the following command as the `root` user:

```
# rpm -q package_name
```

The variable `package_name` is the name of the package you are verifying, such as `setarch`. If a package is not installed, then install it from your Linux distribution media or download the required package version from your Linux vendor's Web site.

See Also:

- ["Installing Oracle RAC on Different Operating Systems"](#)
- ["Preparing the Server"](#)
- ["Preparing the Operating System and Software"](#)
- ["About Configuring the Operating System Environment"](#)
- ["About Performing Platform-Specific Configuration Tasks"](#)
- *Oracle Clusterware and Oracle Real Application Clusters Installation and Configuration Guide* for your platform

Preparing the Server

In this section, you will perform the following tasks:

- [Configuring Operating System Users and Groups](#)
- [Configuring Secure Shell](#)
- [Configuring SSH User Equivalency](#)
- [About Configuring the Operating System Environment](#)

See Also:

- ["Preparing the Operating System and Software"](#)
- ["About Configuring Kernel Parameters"](#)
- ["About Configuring the Operating System Environment"](#)
- ["About Performing Platform-Specific Configuration Tasks"](#)

Configuring Operating System Users and Groups

Depending on whether or not this is the first time Oracle software is being installed on this server, you may need to create operating system groups.

The following operating system groups are used when installing Oracle software:

- The OSDBA group (typically, `dba`) for Oracle Database authentication
- The Oracle Inventory group (typically, `oinstall`) for all installations
- (Optional) A separate OSASM group (for example, `asm`) for Automatic Storage Management (ASM) authentication. If this option is not chosen, then `dba` is the default OSASM group.

The following operating system users are required for all installations:

- A user that owns the Oracle software (typically, `oracle`)
- An unprivileged user (for example, the `nobody` user on Linux systems)

A single Oracle Inventory group is required for all installations of Oracle software on the system. After the first installation of Oracle software, you must use the same Oracle Inventory group for all subsequent Oracle software installations on that system. However, you can choose to create different users to own the Oracle software and use different operating system groups for authenticating administrative access to each software installation. If an operating system user (for example, `oracle`) is a member of an operating system group that is used for authenticating access to Oracle software (for example, the `dba` group), then that user has administrative access to the associated software.

By using different operating system groups for authenticating administrative access to each Oracle Database installation, members of the different groups have SYSDBA privileges for only one database, rather than for all the databases on the system. Also, if you configure a separate operating system group for ASM authentication, then you can have users that have SYSASM access to the ASM instances and do not have SYSDBA access to the database instances.

Note: If installing Oracle RAC on Microsoft Windows, Oracle Universal Installer automatically creates the `ORA_DBA` group for authenticating SYSDBA access. It does not create an `ORA_ASM` group for authenticating SYSASM access. Also, if you install the Oracle RAC software while logged in to an account with administrative privileges, you do not need to create a separate user for the installation.

To create the required operating system user and groups on Red Hat Linux:

1. To determine the groups that exist on your server, list the contents of the `/etc/group` file.

```
cat /etc/group
```
2. If this is the first time Oracle software has been installed on your server, and the Oracle Inventory group does not exist, then create the Oracle Inventory group by entering a command as the `root` user that is similar to the following:

```
/usr/sbin/groupadd oinstall
```
3. Create an OSDBA group by entering a command as the `root` user that is similar to the following:

```
/usr/sbin/groupadd dba
```
4. If the user that owns the Oracle software does not exist on your server, you must create the user. Select a user ID (UID) that is currently not in use on all the nodes in your cluster. The following command shows how to create the `oracle` user

and the user's home directory (`/home/oracle`) with the default group as `oinstall` and the secondary group as `dba`, using a UID of 200:

```
useradd -u 200 -g oinstall -G dba -d /home/oracle -r oracle
```

To determine which users have already been created on your server, list the contents of the `/etc/passwd` file.

```
cat /etc/passwd
```

5. Set the password for the `oracle` account using the following command. Replace `password` with your own password.

```
passwd oracle
```

```
Changing password for user oracle.
```

```
New UNIX password: password
```

```
retype new UNIX password: password
```

```
passwd: all authentication tokens updated successfully.
```

6. Repeat Step 1 through Step 4 on each node in your cluster as needed.
7. Verify that the attributes of the user `oracle` are identical on both `docrac1` and `docrac2`:

```
id oracle
```

The command output should be similar to the following:

```
uid=200(oracle) gid=500(oinstall) groups=500(oinstall),501(dba)
```

See Also:

- ["Configuring Installation Directories and Shared Storage"](#)
- ["About Automatic Storage Management"](#)

Configuring Secure Shell

When installing Oracle RAC on UNIX and Linux platforms, the software is installed on one node, and OUI uses secure communication to copy the software binary files to the other cluster nodes. OUI uses the Secure Shell (SSH) for the communication. Various other components of Oracle RAC and Oracle Clusterware also use SSH for secure communication.

To configure SSH, you must first create Rivest-Shamir-Adleman (RSA) keys and Digital Signature Algorithm (DSA) keys on each cluster node. After you have created the private and public keys, you copy the keys from all cluster node members into an authorized keys file that is identical on each node. When this is done, you then start the SSH agent to load the keys into memory.

See Also:

- *Oracle Database Advanced Security Administrator's Guide* for more information about data security using encryption keys
- ["Generating RSA and DSA Keys"](#)
- ["Adding the Keys to an Authorized Key File"](#)
- ["Configuring SSH User Equivalency"](#)

Generating RSA and DSA Keys

Create the RSA and DSA keys on each cluster node as the first step in configuring SSH.

To configure the RSA and DSA keys on Red Hat Linux:

1. Log out and then log back in to the operating system as the `oracle` user on `docrac1`.

Note: Do not use the `su` command to switch from the `root` user to the `oracle` user for these steps. You must completely exit your operating system session as the `root` user and start a new session as `oracle` for these steps to succeed.

2. Determine if a `.ssh` directory exists in the `oracle` user's home directory. If not, create the `.ssh` directory and set the directory permission so that only the `oracle` user has access to the directory, as shown here:

```
$ ls -a $HOME
$ mkdir ~/.ssh
$ chmod 700 ~/.ssh
```

3. Create the RSA-type public and private encryption keys. Open a terminal window and run the following command:

```
/usr/bin/ssh-keygen -t rsa
```

At the prompts:

- Accept the default location for the key file by pressing the **Enter** key.
- When prompted for a pass phrase, enter and confirm a pass phrase that is different from the `oracle` user's password.

This command creates the public key in the `/home/oracle/.ssh/id_rsa.pub` file and the private key in the `/home/oracle/.ssh/id_rsa` file.

Caution: To protect the security of your system, never distribute the private key to anyone.

4. Create the DSA type public and private keys on both `docrac1` and `docrac2`. In the terminal window for each node, run the following command:

```
/usr/bin/ssh-keygen -t dsa
```

At the prompts:

- Accept the default location for the key file by pressing the **Enter** key.
- When prompted for a pass phrase, enter and confirm a pass phrase that is different from the `oracle` user's password.

This command creates the public key in the `/home/oracle/.ssh/id_dsa.pub` file and the private key in the `/home/oracle/.ssh/id_dsa` file.

Caution: To protect the security of your system, never distribute the private key to anyone.

- Repeat Step 1 through Step 4 on each node that you intend to add to the cluster.

See Also:

- *Oracle Database Advanced Security Administrator's Guide* for more information about data security using encryption keys
- ["Configuring SSH User Equivalency"](#)
- ["Adding the Keys to an Authorized Key File"](#)

Adding the Keys to an Authorized Key File

After you have generated the keys, you copy the keys for each node to an `authorized_keys` file and copy this file to all nodes in the cluster.

To add the generated keys to an authorized keys file:

- On the local node, change directories to the `.ssh` directory in the `oracle` user home directory.

```
cd ~/.ssh
```

- Add the RSA and DSA keys to the `authorized_keys` file using the following commands, then list the contents of the `.ssh` directory:

```
$ cat id_rsa.pub >>authorized_keys
$ cat id_dsa.pub >>authorized_keys
$ ls
```

You should see the `id_dsa.pub` and `id_rsa.pub` keys that you generated, the `id_dsa` and `id_rsa` private key files, and the `authorized_keys` file.

- Use Secure Copy (SCP) or Secure FTP (SFTP) to copy the `authorized_keys` file to the `oracle` user `.ssh` directory on a remote node. The following example uses SCP to copy the `authorized_keys` file to `docrac2`, and the `oracle` user path is `/home/oracle`:

```
[oracle@docrac1 ~/.ssh]scp authorized_keys docrac2:/home/oracle/.ssh/
The authenticity of host 'docrac2(143.46.43.101)' can't be established.RSA key
fingerprint is 7z:ez:e7:f6:f4:f2:d1:a6:f7:4e:zz:me:a7:48:ae:f6:7e.
Are you sure you want to continue connecting (yes/no)? yes
oracle@docrac2's password:
```

You are prompted to accept an RSA or DSA key. Enter `yes`.

When prompted, provide the password for the `oracle` user, which should be the same on all the nodes in the cluster. (Note: This is the user password, not the newly specified pass phrase.) The `authorized_keys` file is then copied to the remote node.

- Using SSH, log in to the node where you copied the `authorized_keys` file, using the pass phrase you created. Then change to the `.ssh` directory, and using the `cat` command, add the RSA and DSA keys for the second node to `authorized_keys` file, as demonstrated here:

```
[oracle@docrac1 ~/.ssh]$ ssh docrac2
Enter passphrase for key '/home/oracle/.ssh/id_rsa':
[oracle@docrac2 oracle]$ cd .ssh
[oracle@docrac2 ssh]$ cat id_rsa.pub >> authorized_keys
[oracle@docrac2 ssh]$ cat id_dsa.pub >> authorized_keys
```

5. If you have more than two nodes in your cluster, repeat Step 3 and Step 4 for each node you intend to add to your cluster. Copy the most recently updated `authorized_keys` file to the next node, then add the public keys for that node to the `authorized_keys` file.
6. When you have updated the `authorized_keys` file on all nodes, use SCP to copy the complete `authorized_keys` file from the last node to be updated to all the other cluster nodes, overwriting the existing version on the other nodes, for example:

```
[oracle@docrac2 .ssh]scp authorized_keys docrac1:/home/oracle/.ssh/
The authenticity of host 'docrac1(143.46.43.100)' can't be established. RSA key
fingerprint is 7e:62:60:f6:f4:f2:d1:a6:f7:4e:zz:me:b9:48:dc:e3:9c.
Are you sure you want to continue connecting (yes/no)? yes
oracle@docrac2's password:
Warning: Permanently added 'docrac1,143.46.43.100' (RSA) to the list of known
hosts.
oracle@docrac1's password:
authorized_keys                                100% 1656    19.9MB.s    00:00
```

At this point, if you use SSH to log in to or run a command on another node, you are prompted for the pass phrase that you specified when you created the RSA and DSA keys.

See Also:

- *Oracle Database Advanced Security Administrator's Guide* for more information about data security using encryption keys
- ["Configuring Secure Shell"](#)
- ["Generating RSA and DSA Keys"](#)
- ["Configuring SSH User Equivalency"](#)

Configuring SSH User Equivalency

User equivalency exists in a cluster when the following occurs on *all* nodes in the cluster:

- A given user has the same user name, user ID (UID), and password.
- A given user belongs to the same groups.
- A given group has the same group ID (GID).

On Linux systems, to enable Oracle Universal Installer to use the `ssh` and `scp` commands without being prompted for a pass phrase, you must configure SSH user equivalency.

To configure user SSH equivalency on Red Hat Linux:

1. On the system where you want to run Oracle Universal Installer, log in to the operating system as the `oracle` user.
2. Start the SSH agent and load the SSH keys into memory using the following commands:

```
$ exec /usr/bin/ssh-agent $SHELL
$ /usr/bin/ssh-add
```

The `ssh-add` program prompts you to enter the pass phrase for each key that you generated when configuring SSH, for example:

```
[oracle@docrac1 .ssh]$ exec /usr/bin/ssh-agent $SHELL
[oracle@docrac1 .ssh]$ /usr/bin/ssh-add
Enter passphrase for /home/oracle/.ssh/id_rsa
Identity added: /home/oracle/.ssh/id_rsa (/home/oracle/.ssh/id_rsa)
Identity added: /home/oracle/.ssh/id_dsa (/home/oracle/.ssh/id_dsa)
```

These commands start the `ssh-agent` program on the node, and load the RSA and DSA keys into memory so that you are not prompted to use pass phrases when issuing SSH commands.

If you have configured SSH correctly, then you can now use the `ssh` or `scp` commands without being prompted for a password or a pass phrase.

Note: Do not close this terminal window until you have completed the Oracle Clusterware and Oracle RAC software installation. If you must close this terminal window before the installation is complete, repeat Step 2 before starting or continuing the software installation.

3. Complete the SSH configuration by using the `ssh` command to retrieve the date on each node in the cluster.

For example, in a two-node cluster, with nodes named `docrac1` and `docrac2`, you would enter the following commands:

```
$ ssh docrac1 date
$ ssh docrac2 date
```

The first time you use SSH to connect to one node from another node, you see a message similar to the following:

```
The authenticity of host 'docrac1(143.46.43.100)' can't be established.
RSA key fingerprint is 7z:ez:e7:f6:f4:f2:d1:a6:f7:4e:zz:me:a7:48:ae:f6:7e.
Are you sure you want to continue connecting (yes/no)? yes
```

Enter `yes` at the prompt to continue. You should not see this message again when you connect to this node from the other node. If you see any other messages or text, apart from the date, then the installation can fail.

If any node prompts for a password or pass phrase, then verify that the `~/ .ssh/authorized_keys` file on that node contains the correct public keys. Make any changes required to ensure that only the date is displayed when you enter these commands. You should also ensure that any parts of login scripts that generate output or ask any questions are modified so that they act only when the shell is an interactive shell.

After completing Step 1 through Step 3, each public host name for each node in the cluster should be registered in the `known_hosts` file for all other members of the cluster.

See Also:

- ["Configuring Secure Shell"](#)
- ["Configuring Operating System Users and Groups"](#)

About Configuring the Operating System Environment

On Red Hat Linux, you run Oracle Universal Installer (OUI) from the `oracle` account. Oracle Universal Installer obtains information from the environment variables

configured for the `oracle` user. Prior to running OUI, you should modify the `oracle` user environment variables to configure the following:

- Set the default file mode creation mask (`umask`) to 022 in the shell startup file on Linux and UNIX systems.
- Set the `ORACLE_BASE` environment variable to the location in which you plan to install the Oracle Database software. Refer to ["About Choosing an Oracle Base Directory"](#) on page 2-23 for more information about the `ORACLE_BASE` directory.

Also, if the `/tmp` directory has less than 400 MB of available disk space, but you have identified a different file system that has at least 400 MB of available space, you can set the `TEMP` and `TMPDIR` environment variables to specify the alternate temporary directory on this file system.

Prior to installing Oracle Clusterware, you can set the `ORACLE_HOME` variable to the location of the Oracle Clusterware home (also called the CRS home) directory. However, you must also specify the directory in which the software should be installed as part of the installation process. After Oracle Clusterware has been installed, the `ORACLE_HOME` environment variable will be modified to reflect the value of the Oracle Database home directory.

Note: Remove any `stty` commands from such files before you start the installation. On Linux systems, if there are hidden files (such as `logon` or `profile` scripts) that contain `stty` commands, when these files are loaded by the remote shell during installation, OUI indicates an error and stops the installation.

See Also:

- ["Configuring Operating System Users and Groups"](#)
- ["Preparing the Operating System and Software"](#)
- ["Configuring Installation Directories and Shared Storage"](#)
- ["About Setting the Time on Both Nodes"](#)
- ["About Performing Platform-Specific Configuration Tasks"](#)

Configuring the Network

Oracle Clusterware requires that you connect the nodes in the cluster to a private network by way of a private interconnect. Each node in the cluster must also be accessible by way of the public network.

To configure the network and ensure that each node in the cluster is able to communicate with the other nodes in the cluster:

1. Determine your cluster name. The cluster name should satisfy the following conditions:
 - The cluster name is globally unique throughout your host domain.
 - The cluster name is at least 1 character long and less than 15 characters long.
 - The cluster name consists of the same character set used for host names: underscores (`_`), hyphens (`-`), and single-byte alphanumeric characters (a to z, A to Z, and 0 to 9).

- If you use third-party vendor clusterware, then Oracle recommends that you use the vendor cluster name.
2. Determine the public node names, private node names, and virtual node names for each node in the cluster.
 - For the public node name, use the primary host name of each node. In other words, use the name displayed by the `hostname` command. This node name can be either the permanent or the virtual host name, for example: `docrac1`.
 - Determine a private node name or private IP address for each node. The private IP address is an address that is accessible only by the other nodes in this cluster. Oracle Database uses private IP addresses for internode, or instance-to-instance Cache Fusion communication. Oracle recommends that you provide a name in the format `public_hostname-priv`, for example: `docrac1-priv`.
 - Determine a virtual host name for each node. A virtual host name is a public node name that is used to reroute client requests sent to the node if the node is down. Oracle Database uses virtual IP addresses for client-to-database connections, so the VIP address must be publicly accessible. Oracle recommends that you provide a name in the format `public_hostname-vip`, for example: `docrac1-vip`.
 3. Identify the interface names and associated IP addresses for all network adapters by running the following command on each node:

```
# /sbin/ifconfig
```

From the output, identify the interface name (such as `eth0`) and IP address for each network adapter that you want to specify as a public or private network interface.

Note: When you install Oracle Clusterware and Oracle RAC, you will require this information.

4. On each node in the cluster, assign a public IP address with an associated network name to one network adapter, and a private IP address with an associated network name to the other network adapter.

The public name for each node should be registered with your domain name system (DNS). If you do not have an available DNS, then record the network name and IP address in the system hosts file, `/etc/hosts`. Use the `/etc/hosts` file on each node to associate the private network name for that host with its private IP address.

You can test whether or not an interconnect interface is reachable using a `ping` command.

5. On each node in the cluster, configure a third IP address that will serve as a virtual IP address. Use an IP address that meets the following requirements:
 - The virtual IP address and the network name must *not* be currently in use.
 - The virtual IP address must be on the *same* subnet as your public IP address.

The virtual host name for each node should be registered with your DNS. If you do not have an available DNS, then record the virtual host name and IP address in the system hosts file, `/etc/hosts`.

6. When you complete the network configuration, the IP address and network interface configuration should be similar to what is shown in the following table (your node names and IP addresses might be different):

Node	Node Name	Type	IP Address	Registered in
docrac1	docrac1	Public	143.46.43.100	DNS (if available, else the hosts file)
docrac1	docrac1-vip	Virtual	143.46.43.104	DNS (if available, else the hosts file)
docrac1	docrac1-priv	Private	10.10.10.11	Hosts file
docrac2	docrac2	Public	143.46.43.101	DNS (if available, else the hosts file)
docrac2	docrac2-vip	Virtual	143.46.43.105	DNS (if available, else the hosts file)
docrac2	docrac2-priv	Private	10.10.10.12	Hosts file

After you have completed the installation process, configure clients to use either the virtual IP address or the network name associated with the virtual IP address.

See Also:

- ["About Identifying Network Requirements"](#)
- Your platform-specific Oracle Clusterware installation guide

Verifying the Network Configuration

After you have configured the network, perform verification tests to make sure it is configured properly. If there are problems with the network connection between nodes in the cluster, the Oracle Clusterware installation will fail.

To verify the network configuration on a two-node cluster that is running Red Hat Linux:

1. As the `root` user, verify the configuration of the public and private networks. Verify that the interfaces are configured on the same network on both `docrac1` and `docrac2`.

In this example, `eth0` is used for the public network and `eth1` is used for the private network, which is used for Cache Fusion communications.

```
# /sbin/ifconfig

eth0      Link encap:Ethernet  HWaddr 00:0E:0C:08:67:A9
          inet addr: 143.46.43.100  Bcast:143.46.43.255  Mask:255.255.240.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:270332689  errors:0  dropped:0  overruns:0  frame:0
          TX packets:112346591  errors:2  dropped:0  overruns:0  carrier:2
          collisions:202  txqueuelen:1000
          RX bytes:622032739 (593.2 MB)  TX bytes:2846589958 (2714.7 MB)
          Base address:0x2840  Memory:fe7e0000-fe800000

eth1      Link encap:Ethernet  HWaddr 00:04:23:A6:CD:59
          inet addr: 10.10.10.11  Bcast: 10.10.10.255  Mask:255.255.240.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:21567028  errors:0  dropped:0  overruns:0  frame:0
          TX packets:15259945  errors:0  dropped:0  overruns:0  carrier:0
          collisions:0  txqueuelen:1000
          RX bytes:4091201649 (3901.6 MB)  TX bytes:377502797 (360.0 MB)
          Base address:0x2800  Memory:fe880000-fe8a0000
```



```

lo          Link encap:Local Loopback
            inet addr:127.0.0.1  Mask:255.0.0.0
            UP LOOPBACK RUNNING  MTU:16436  Metric:1
            RX packets:52012956 errors:0 dropped:0 overruns:0 frame:0
            TX packets:52012956 errors:0 dropped:0 overruns:0 carrier:0
            collisions:0 txqueuelen:0
            RX bytes:905082901 (863.1 MB)  TX bytes:905082901 (863.1 MB)

```

2. As the root user, verify that the `/etc/hosts` file on the node `docrac1` contains the host IP addresses, virtual IP addresses, and private network IP addresses from both nodes in the cluster, as follows:

```

# Do not remove the following line, or various programs
# that require network functionality will fail.
127.0.0.1      localhost.localdomain    localhost
143.46.43.100 docrac1.mycompany.com    docrac1
143.46.43.104 docrac1-vip.mycompany.com docrac1-vip
10.10.10.11    docrac1-priv

143.46.43.101 docrac2.mycompany.com    docrac2
143.46.43.105 docrac2-vip.mycompany.com docrac2-vip
10.10.10.12    docrac2-priv

```

If the `/etc/hosts` file is missing any of the preceding information, then edit the file to add the necessary information.

After the `/etc/hosts` file is configured on `docrac1`, edit the `/etc/hosts` file on `docrac2` so it contains the same information for the cluster IP addresses.

3. As the root user, verify the network configuration by using the `ping` command to test the connection from `docrac1` from `docrac2` and the reverse. As the root user, run the following commands on each node:

```

# ping -c 3 docrac1.mycompany.com
# ping -c 3 docrac1
# ping -c 3 docrac1-priv

# ping -c 3 docrac2.mycompany.com
# ping -c 3 docrac2
# ping -c 3 docrac2-priv

```

You will not be able to discover the nodes using the `ping` command for the virtual IPs (`docrac1-vip`, `docrac2-vip`) until after Oracle Clusterware is installed and running. If the `ping` commands for the public or private addresses fail, resolve the issue before you proceed.

4. Ensure that you can access the default gateway with a `ping` command. To identify the default gateway, use the `route` command, as described in the Red Hat Linux Help utility.

See Also:

- ["Checking the Settings for the Interconnect"](#)
- ["Configuring the Network"](#)
- ["About Identifying Network Requirements"](#)

Preparing the Operating System and Software

When you install the Oracle software on your server, Oracle Universal Installer expects the operating system to have specific packages and software applications installed.

This section covers the following topics:

- [About Setting the Time on Both Nodes](#)
- [About Configuring Kernel Parameters](#)
- [About Performing Platform-Specific Configuration Tasks](#)

You must ensure that you have a certified combination of the operating system and the Oracle Database software by referring to Oracle *MetaLink* certification, which is located at the following Web site

<https://metalink.oracle.com>

You can find this by clicking **Certify & Availability** and then selecting **1.View Certifications by Product**.

Note: Oracle Universal Installer verifies that your server and operating system meet the listed requirements. Check the requirements before you start Oracle Universal Installer, to ensure your server and operating system meet will meet the requirements.

See Also:

- ["Preparing the Server"](#)
- ["Verifying Operating System and Software Requirements"](#)

About Setting the Time on Both Nodes

Before starting the installation, ensure that the date and time settings on both nodes are set as closely as possible to the same date and time. Oracle strongly recommends using the Network Time Protocol (NTP) feature of most operating systems for this purpose.

NTP is a protocol designed to synchronize the clocks of servers connected by a network. When using NTP, each server on the network runs client software to periodically make timing requests to one or more servers, referred to as reference NTP servers. The information returned by the timing request is used to adjust the server's clock.

All the nodes in your cluster should use the same reference NTP server.

See Also:

- ["Preparing the Server"](#)
- ["Preparing the Operating System and Software"](#)
- Your platform-specific Oracle Clusterware installation guide

About Configuring Kernel Parameters

OUI checks the current settings for various kernel parameters to ensure they meet the minimum requirements for deploying Oracle RAC. For production database systems,

Oracle recommends that you tune the settings to optimize the performance of your particular system.

Note: If you find parameter settings or shell limit values on your system that are greater than the values mentioned in this section, then *do not* modify the parameter setting.

See Also:

- ["Preparing the Server"](#)
- ["Preparing the Operating System and Software"](#)
- Your platform-specific Oracle Clusterware installation guide

About Performing Platform-Specific Configuration Tasks

You may be required to perform special configuration steps that are specific to the operating system on which you are installing Oracle RAC, or for the components used with your cluster. The following list provides examples of operating-specific installation tasks:

- Configure the use of Huge Pages on SUSE Linux Enterprise Server 9 or Red Hat Enterprise Linux 4.
- Configure the hangcheck-timer module on Red Hat Linux 4.0 and SUSE 9 systems.
- Set shell limits for the `oracle` user on Red Hat Linux systems to increase the number of files and processes available to Oracle Clusterware and Oracle RAC.
- Start the Telnet service on Microsoft Windows.
- Create X library symbolic links on HP-UX.
- Configure network tuning parameters on AIX Based Systems.

See Also:

- ["Preparing the Server"](#)
- ["Preparing the Operating System and Software"](#)
- ["Installing Oracle RAC on Different Operating Systems"](#)
- Your platform-specific Oracle Clusterware installation guide

Configuring Installation Directories and Shared Storage

This section describes the storage configuration tasks that you must complete before you start Oracle Universal Installer. It includes information about the following tasks:

- [About Deciding on a Shared Storage Solution](#)
- [Configuring Block Devices for Oracle Clusterware Files](#)
- [Creating a Udev Permissions File for Oracle Clusterware](#)
- [About Choosing an Oracle Base Directory](#)
- [About Choosing an Oracle Clusterware Home Directory](#)

See Also:

- ["About Checking Requirements"](#)
- ["Configuring Operating System Users and Groups"](#)
- ["About Checking Hardware Requirements"](#)
- Your platform-specific Oracle Clusterware installation guide

About Deciding on a Shared Storage Solution

Each node in a cluster requires external shared disks for storing the Oracle Clusterware (Oracle Cluster Registry and voting disk) files, and Oracle Database files. The supported types of shared storage depend upon the platform you are using, for example:

- A supported cluster file system, such as Oracle Cluster File System 2 (OCFS2) for Microsoft Windows and Linux or General Parallel File System (GPFS) on IBM platforms
- Network file system (NFS), which is not supported on AIX Based Systems, Linux on POWER, or on IBM zSeries Based Linux
- Shared disk partitions consisting of block devices. Block devices are disk partitions that are mounted using the Linux file system. Oracle Clusterware and Oracle RAC write to these partitions directly.
- Automatic Storage Management for Oracle Database files (strongly recommended)

Note: Oracle Clusterware files cannot be stored in ASM.

For all installations, you must choose the storage option that you want to use for Oracle Clusterware files and Oracle Database files.

Note: For the most up-to-date information about supported storage options for Oracle RAC installations, refer to the Certify pages on *OracleMetaLink*

<https://metalink.oracle.com>

If you decide to use OCFS to store the Oracle Clusterware files, you must use the proper version of OCFS for your operating system version. OCFS2 works with Red Hat Linux and kernel version 2.6

The examples in this guide, which are based on Red Hat Linux, use shared disk partitions to store the Oracle Clusterware files and ASM to store the Oracle database files. The Oracle Clusterware and Oracle RAC software will be installed on disks local to each node, not on a shared file system.

The following section describes how to configure the shared disk partitions for the Oracle Clusterware files on Red Hat Linux.

See Also:

- Your platform-specific Oracle Clusterware installation guide if you are using a cluster file system or NFS
- ["Configuring Installation Directories and Shared Storage"](#)
- ["About Checking Hardware Requirements"](#)

Configuring Block Devices for Oracle Clusterware Files

With Oracle Clusterware release 10.2 and later, you can use block devices instead of raw devices with Red Hat Enterprise Linux 4.0. Oracle Clusterware files are configured by default to use direct I/O (`O_DIRECT`), which enables direct writes to the block devices.

Before you install Oracle Clusterware, you will need to configure 5 shared disk partitions:

- 1 partition which is 280 MB in size for storing the Oracle Cluster Registry (OCR)
- 1 partition which is 280 MB in size for storing a duplicate OCR file on a different disk, referred to as the OCR mirror
- 3 partitions which are 280 MB in size, 1 for each voting disk location

Note: When you create partitions using `fdisk` by specifying a device size, such as `+256M`, the actual device created may be smaller than the size requested, based on the cylinder geometry of the disk. This is due to current `fdisk` restrictions.

Oracle configuration software checks to ensure that devices contain a minimum of 256MB of available disk space. Therefore, Oracle recommends using at least 280MB for the device size. You can check partition sizes by using the command syntax `fdisk -s partition`.

To configure block devices if you are using Red Hat Enterprise Linux 4.0:

1. Log in to the operating system as the `root` user.
2. To identify the device name for the disks that you want to use, enter the following command on the first node in your cluster, for example, `docrac1`:

```
# /sbin/fdisk -l
```

You can create the required disk partitions either on new block devices that you added or on previously partitioned devices that have unpartitioned available space. To identify devices that have unpartitioned available space, examine the start and end cylinder numbers of the existing partitions and determine whether or not the device contains unused cylinders.

3. Create two disk partitions, each 280 MB in size, for the OCR and its mirror, and three partitions, each 280 MB in size, for the Oracle Clusterware voting disks.

To create partitions on a block device, as the `root` user, enter a command similar to the following, where `devicename` is the name of a block device:

```
# /sbin/fdisk devicename
```

Use the following guidelines when creating partitions:

- Use the `p` command to list the partition table of the device.

- Use the `n` command to create a partition.
- After you have created the required partitions on this device, use the `w` command to write the modified partition table to the device.
- Refer to the `fdisk` entry in the Linux Help system for more information about creating partitions.

The following example uses `fdisk` to create a 280 MB partition on the block device, `/dev/sda`, on the first node. This partition, or slice, will be used for the OCR disk. You will create another 280 MB partition on a different disk and disk controller for the OCR mirror. Each file should be on a different disk and disk controller. The bold text in the following example represents user-entered commands.

```
# /sbin/fdisk /dev/sda
The number of cylinders for this disk is set to 1024.
Command (m for help): p

Disk /dev/sdb: 1073 MB, 107341824 bytes
34 heads, 61 sectors/track, 1011 cylinders
Units = cylinders of 2074 * 512 = 1061888 bytes

    Device boot           Start       End       Blocks   ID  System
   -----
Command (m for help): n
Command action
   e  extended
   p  primary partition (1-4)
p
Partition number (1-4): 1
First cylinder (1-1011, default 1):
Using default value 1
Last cylinder of +size or +sizeM or +sizeK (1-1011): +280M

Command (m for help): w
The partition table has been altered!

Calling ioctl() to re-read partition table.
Syncing disks.
#
```

4. Enter the following command to create a 280 MB partition on the second block device, `/dev/sdb`. This partition will be used for the OCR mirror. Use the same prompts as shown in the previous example.

```
fdisk /dev/sdb
```

5. Use the `fdisk` command to create a 280 MB partition on the block device `/dev/sda`. This partition will be used for the voting disk file. Each voting disk file should be on a different disk and controller.

```
# /sbin/fdisk /dev/sda
The number of cylinders for this disk is set to 1024.
Command (m for help): n
Command action
   e  extended
   p  primary partition (1-4)
p
Partition number (1-4): 2
First cylinder (8-1024, default 8):
```

```
Using default value 8
Last cylinder of +size or +sizeM or +sizeK (8-1024, default 1024): +280M
```

```
Command (m for help): w
The partition table has been altered!
```

```
Calling ioctl() to re-read partition table.
Syncing disks.
#
```

6. Use the `fdisk` command to create a 280 MB partition on the block device `/dev/sdb`. This partition will be used for the voting disk file. Each voting disk file should be on a different disk and controller.

```
# /sbin/fdisk /dev/sdb
The number of cylinders for this disk is set to 1024.
Command (m for help): n
Command action
  e  extended
  p  primary partition (1-4)
p
Partition number (1-4): 2
First cylinder (8-1024, default 8):
Using default value 8
Last cylinder of +size or +sizeM or +sizeK (8-1024, default 1024): +280M
```

```
Command (m for help): w
The partition table has been altered!
```

```
Calling ioctl() to re-read partition table.
Syncing disks.
#
```

7. Use the `fdisk` command to create a 280 MB partition on the block device `/dev/sdc`. This partition will be used for the voting disk file.

```
# /sbin/fdisk /dev/sdc
```

When you run the command, use the same response as in Step 3, but specify a partition size of `+280M`.

8. On the node `docrac2`, as the `root` user, for each of the disks you used previously in Steps 3 through Step 7, you need to run the `partprobe` command. For example, if you configured disks `/dev/sda`, `/dev/sdb`, and `/dev/sdc` in the previous commands, then you would run the following commands:

```
# /sbin/partprobe /dev/sda
# /sbin/partprobe /dev/sdb
# /sbin/partprobe /dev/sdc
```

This forces the operating system on the other node in the cluster to refresh its kernel partition table for the shared storage device.

9. Change the ownership of the OCR partitions to the installation owner on all nodes in the cluster.

In the session where you run OUI, the OCR partitions must be owned by the installation owner (such as `oracle`) that performs the Oracle Clusterware installation. The installation owner must own the OCR partitions so that OUI can write to them. During installation, OUI changes ownership of the OCR partitions back to `root`.

See Also:

- ["About Deciding on a Shared Storage Solution"](#)
- ["About Checking Hardware Requirements"](#)
- ["Configuring Block Devices for Oracle Clusterware Files"](#)

Creating a Udev Permissions File for Oracle Clusterware

When you restart a Red Hat Enterprise Linux 4.0 system, ownership and permissions on block devices revert by default to the `root` user. If you are using block devices with this operating system for your Oracle Clusterware files, then you need to override this default.

To create a permissions file if you are using Red Hat Enterprise Linux 4.0:

1. Log in to the operating system as the `root` user.
2. Change to the `/etc/udev/permissions.d` directory.
3. Use a text editor to create a file named `49-oracle.permissions` to ensure correct ownership of the block devices when the operating system is restarted.

The following is an example of the contents of the `/etc/udev/permissions.d/49-oracle.permissions` file:

```
# OCR
sda1:root:oinstall:0640
sdb1:root:oinstall:0640
# Voting Disks
sda2:oracle:oinstall:0640
sdb2:oracle:oinstall:0640
sdc1:oracle:oinstall:0640
# ASM
sdd:oracle:dba:0660
sde:oracle:dba:0660
```

4. Save the file.
5. (Optional) After creating the `oracle.permissions` file, the permissions on the shared devices are set automatically the next time the system is restarted. To set permissions to take effect immediately, without restarting the system, use the `chown` and `chmod` commands:

```
chown root:oinstall /dev/sda1
chmod 640 /dev/sda1
chown root:oinstall /dev/sdb1
chown 640 /dev/sdb1
chown oracle:oinstall /dev/sda2
chmod 640 /dev/sda2
chown oracle:oinstall /dev/sdb2
chown 640 /dev/sdb2
chown oracle:oinstall /dev/sdc1
chown 640 /dev/sdc1
chown oracle:dba /dev/sdd
chown 660 /dev/sdd
chown oracle:dba /dev/sde
chown 660 /dev/sde
```

6. Repeat these steps on each node in the cluster.

About Choosing an Oracle Base Directory

Oracle Universal Installer (OUI) creates the Oracle base directory for you in the location you specify. The Oracle base directory (`ORACLE_BASE`) acts as a top-level directory for Oracle software installations. Optimal Flexible Architecture (OFA) guidelines recommend that you use a path similar to the following for the Oracle base directory:

```
/mount_point/app/oracle
```

In the preceding path example, the variable `mount_point` is the mount point directory for the file system where you intend to install the Oracle software.

The file system that you use for the Oracle base directory must have at least 1.5 GB of available disk space for installing the Oracle Database software. The path to the Oracle base directory must be the same on all nodes.

For Red Hat Linux systems, you can use the `df -h` command to determine the available disk space on each mounted file system. Choose a file system that has sufficient available space. For the sample installation described in this guide, the chosen mount point must have at least 3 GB of available space, for installing Oracle RAC and ASM in separate home directories. The examples in this guide use `/opt/oracle/11gR1` for the Oracle base directory.

See Also:

- ["About Checking Hardware Requirements"](#)
- ["About Deciding on a Shared Storage Solution"](#)
- ["Configuring Block Devices for Oracle Clusterware Files"](#)

About Choosing an Oracle Clusterware Home Directory

OUI installs Oracle Clusterware into a directory structure referred to as `CRS_home`. This home is separate from the home directories for other Oracle products installed on the same server. OUI creates the CRS home directory for you. Before you start the installation, you must have sufficient disk space on a file system for the Oracle Clusterware directory, and the `root` user must own the CRS home directory.

The file system that you use for the CRS home directory must have at least 120 MB of available disk space. The path to the CRS home directory must be the same on all nodes.

For Red Hat Linux, you can use the `df -h` command to determine the available disk space on each mounted file system. Choose a file system that has appropriate available space. For the examples in this guide, the directory `/crs` is used for the CRS home directory.

Note: Ensure the CRS home directory is not a subdirectory of the Oracle base directory.

See Also:

- ["About Checking Hardware Requirements"](#)
- ["About Deciding on a Shared Storage Solution"](#)
- ["Configuring Block Devices for Oracle Clusterware Files"](#)

Installing and Configuring Oracle Clusterware and Oracle RAC

This chapter explains how to install Oracle Real Application Clusters (Oracle RAC) using Oracle Universal Installer (OUI). You must install Oracle Clusterware before installing Oracle RAC. After your Oracle Clusterware is operational, you can use OUI to install the Oracle Database software with the Oracle RAC components.

The example Oracle RAC environment described in this guide uses Automatic Storage Management (ASM), so this chapter also includes instructions on how to install ASM in its own home directory.

This chapter includes the following sections:

- [Preparing the Oracle Media Installation File](#)
- [Installing Oracle Clusterware 11g](#)
- [Configuring Automatic Storage Management in an ASM Home Directory](#)
- [Installing the Oracle Database Software and Creating a Cluster Database](#)
- [Performing Postinstallation Tasks](#)
- [Converting an Oracle Database to an Oracle RAC Database](#)

Preparing the Oracle Media Installation File

Oracle Clusterware is installed as part of Oracle Database 11g. OUI installs Oracle Clusterware into a directory structure that is referred to as *CRS_home*. This home is separate from the home directories of other Oracle software products installed on the same server. Because Oracle Clusterware works closely with the operating system, system administrator access is required for some of the installation tasks. In addition, some of the Oracle Clusterware processes must run as the special operating system user, *root*.

The Oracle RAC database software is installed from the same Oracle Database 11g installation media. By default, the standard Oracle Database 11g software installation process installs the Oracle RAC option when OUI recognizes that you are performing the installation on a cluster. OUI installs Oracle RAC into a directory structure that is referred to as *Oracle_home*. This home is separate from the home directories of other Oracle software products installed on the same server.

To prepare the Oracle Media installation files:

1. If you have the Oracle Database software on CD or DVD, insert the distribution media for the database into a disk drive on your computer. Make sure the disk drive has been mounted at the operating system level.

If you do not have installation disks, but are instead installing from ZIP files, continue on to Step 2.

2. If the Oracle Database installation software is in one or more ZIP files, create a staging directory on one node, for example, `docrac1`, to store the unzipped files, as shown here:

```
mkdir -p /stage/oracle/11.1.0
```

3. Copy the ZIP files to this staging directory. For example, if the files were downloaded to a directory named `/home/user1`, and the ZIP file is named `11100_linux_db.zip`, you would use the following command to move the ZIP file to the staging directory:

```
cd /home/user1
cp 11100_linux_db.zip /stage/oracle/11.1.0
```

4. As the `oracle` user on `docrac1`, unzip the Oracle media, as shown in the following example:

```
cd /stage/oracle/11.1.0
unzip 11100_linux_db.zip
```

See Also:

- ["Configuring Installation Directories and Shared Storage"](#)
- ["Configuring Operating System Users and Groups"](#)

Installing Oracle Clusterware 11g

The following topics describe the process of installing Oracle Clusterware:

- [Configuring the Operating System Environment](#)
- [Verifying the Configuration Using the Cluster Verification Utility](#)
- [Using Oracle Universal Installer to Install Oracle Clusterware](#)
- [Completing the Oracle Clusterware Configuration](#)

Configuring the Operating System Environment

You run OUI from the `oracle` user account. Before you start OUI you must configure the environment of the `oracle` user. You must set the `ORACLE_BASE` environment variables to the directory in which you want the Oracle central inventory files located.

For example, if you want the central inventory files located on the mount point directory `/opt/oracle`, you might set `ORACLE_BASE` to the directory `/opt/oracle/11gR1`.

Prior to installing the Oracle Database software and creating an Oracle database, you should also set the `ORACLE_HOME` environment variable to the location in which you want to install the Oracle Database software. Optionally, you can also set the `ORACLE_SID` environment variable to the name you have chosen for your database.

To modify the user environment prior to installing Oracle Clusterware on Red Hat Linux:

1. As the `oracle` user, execute the following commands:

```
[oracle]$ unset ORACLE_HOME
```

```
[oracle]$ unset ORACLE_SID
[oracle]$ unset ORACLE_BASE
[oracle]$ export ORACLE_BASE=/opt/oracle/11gR1
```

2. Verify the changes have been made by executing the following commands:

```
[oracle]$ echo $ORACLE_SID

[oracle]$ echo $ORACLE_HOME

[oracle]$ echo $ORACLE_BASE
/opt/oracle/11gR1
```

To modify the user environment prior to installing Oracle Database on Red Hat Linux:

1. As the `oracle` user, modify the user profile in the `/home/oracle` directory on both nodes using the following commands:

```
[oracle] $ cd $HOME
[oracle] $ vi .bash_profile
```

Add the following lines at the end of the file:

```
export ORACLE_SID=sales
export ORACLE_BASE=/opt/oracle/11gR1
export ORACLE_HOME=/opt/oracle/11gR1/db
```

2. Read and implement the changes made to the `.bash_profile` file:

```
source .bash_profile
```

3. Verify the changes have been made by executing the following commands:

```
[oracle]$ echo $ORACLE_SID
sales
[oracle]$ echo $ORACLE_HOME
/opt/oracle/11gR1/db
[oracle]$ echo $ORACLE_BASE
/opt/oracle/11gR1
```

Verifying the Configuration Using the Cluster Verification Utility

If you have not configured your nodes, network, and operating system correctly, your installation of the Oracle Clusterware or Oracle Database 11g software will not complete successfully.

To verify your hardware and operating system setup:

1. As the `oracle` user, change directories to the staging directory for the Oracle Clusterware software, or to the mounted installation disk. In the following example, `staging_area` represents the location of the installation media (for example, `/home/oracle/downloads/11gR1/11.1.0` or `/dev/dvdrom`):

```
[oracle] $ cd /staging_area
```

2. Run the `runcluvfy.sh` script, as shown in the following example, where `docrac1` and `docrac2` are the name of the nodes in your cluster:

```
[oracle] $ ./runcluvfy.sh stage -pre crsinst -n docrac1,docrac2 -verbose
```

The preceding command instructs the Cluster Verification Utility (CVU) to verify that the system meets all the criteria for an Oracle Clusterware installation. It checks that all the nodes are reachable from the local nodes, proper user equivalence exists, connectivity exists between all the nodes through the public and private interconnects, the user has proper permissions to install the software, and that all system requirements (including kernel version, kernel parameters, memory, swap space, temporary directory space, and required software packages) are met.

See Also:

- ["About Checking Requirements"](#)
- ["Verifying the Network Configuration"](#)
- *Oracle Clusterware Administration and Deployment Guide* for more information about resolving the CVU errors

Using Oracle Universal Installer to Install Oracle Clusterware

As the `oracle` user on the `docrac1` node, install Oracle Clusterware. Note that OUI uses Secure Shell (SSH) to copy the binary files from `docrac1` to `docrac2` during the installation. Make sure SSH is configured before starting the installer.

Note: If you are installing Oracle Clusterware on a server that already has a single-instance Oracle Database 11g installation, then stop the existing ASM instances, if any. After Oracle Clusterware is installed, start the ASM instances again. When you restart the single-instance Oracle database and then the ASM instances, the ASM instances use the Cluster Synchronization Services Daemon (CSSD) instead of the daemon for the single-instance Oracle database.

To install Oracle Clusterware:

1. Use the following command to start OUI, where *staging_area* is the location of the staging area on disk, or the location of the mounted installation disk:

```
cd /staging_area/Disk1
./runInstaller
```

The Select a Product to Install window appears.

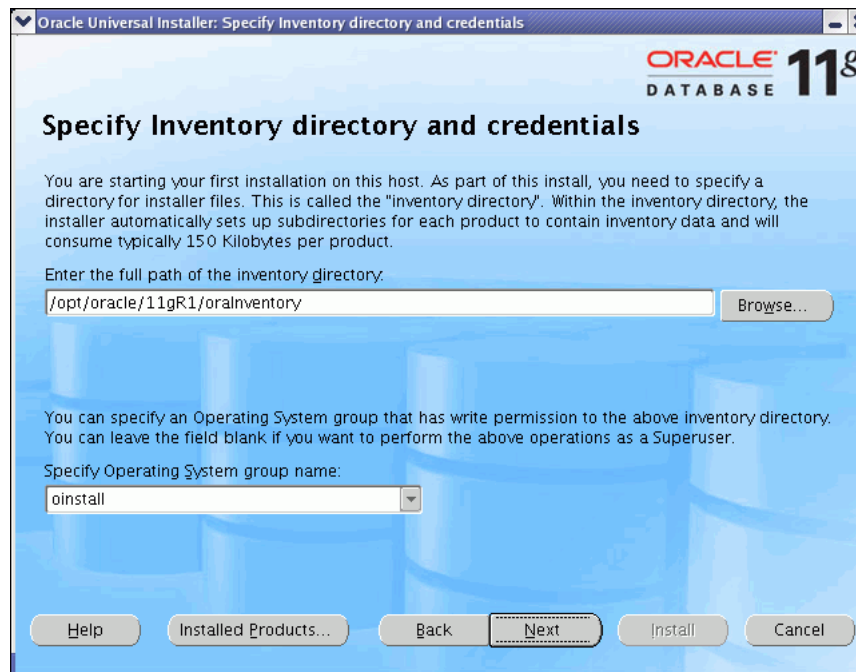
2. Select Oracle Clusterware from the list, then click **Next**.



If you have not installed any Oracle software previously on this server, the Specify Inventory directory and credentials window appears.

3. Change the path for the inventory location, if required. Select oinstall for the operating system group name. Click **Next**.

The path displayed for the inventory directory should be the oraInventory subdirectory of your Oracle base directory. For example, if you set the ORACLE_BASE environment variable to /opt/oracle/11gR1 before starting OUI, then the path displayed is /opt/oracle/11gR1/oraInventory.

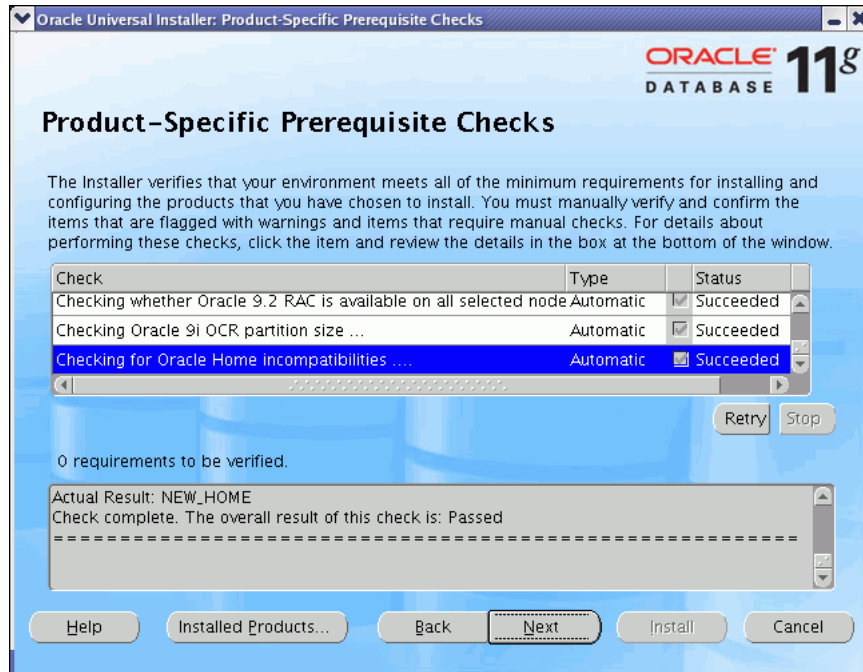


The Specify Home Details window appears.

4. Accept the default value for the Name field, which is the name of the Oracle home directory for this product. For the Path field, click **Browse**. In the Choose Directory window Go up the path until you reach the root directory (/), click **/crs**, then click **Choose Directory**.

After you have selected the path, click **Next**. The next window, Product-Specific Prerequisite Checks, appears after a short period of time.

5. When you see the message "Check complete. The overall result of this check is: Passed", as shown in the following screenshot, click **Next**.



The Specify Cluster Configuration window appears.

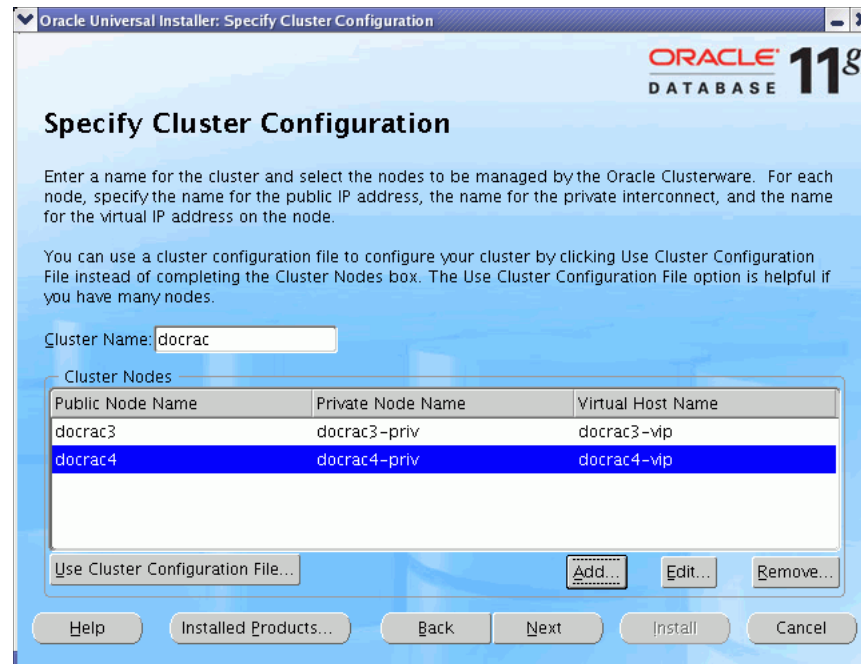
6. Change the default cluster name to a name that is unique throughout your entire enterprise network. For example, you might choose a name that is based on the node names' common prefix. This guide will use the cluster name `docrac`.

The local node, `docrac1`, appears in the Cluster Nodes section. If the private node name includes the domain name, click **Edit** and remove the domain name from the private node name. For example, if the private node name is `docrac1-priv.us.oracle.com`, edit the entry so that it is displayed as `docrac1-priv`.

When you have finished removing the domain name in the "Modify a node in the existing cluster" window, click **OK**.

7. When you are returned to the Specify Cluster Configuration window, click **Add**.
8. In the "Add a new node to the existing cluster" dialog window, enter the second node's public name (`docrac2.us.oracle.com`), private name (`docrac2-priv`), and virtual IP name (`docrac2-vip.us.oracle.com`), and then click **OK**.

The Specify Cluster Configuration window now displays both nodes in the Cluster Nodes.



Click **Next**. The Specify Network Interface Usage window appears.

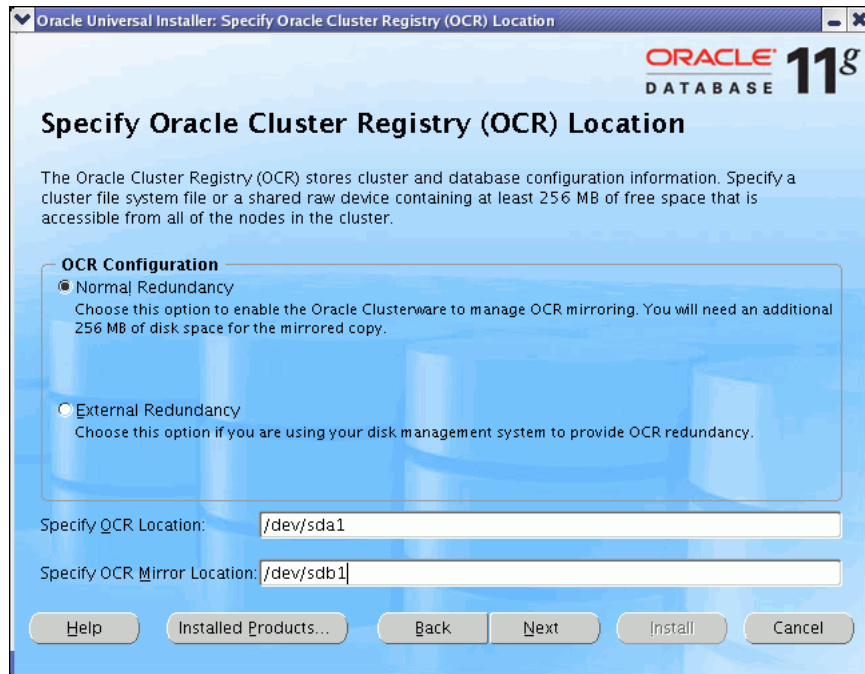
9. Verify `eth0` and `eth1` are configured correctly (proper subnet and interface type displayed), then click **Next**.

The Specify Oracle Cluster Registry (OCR) Location window appears.

10. Select **Normal Redundancy** for the OCR Configuration. You will be prompted for two file locations. In the Specify OCR Location field, enter the name of the device configured for the first OCR file, for example, `/dev/sda1`.

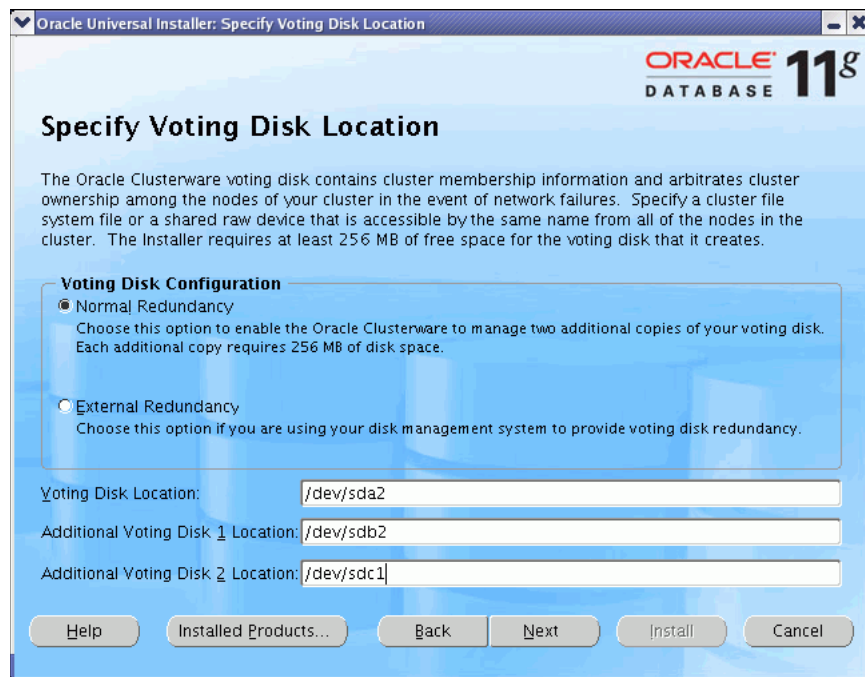
In the Specify OCR Mirror Location field, enter the name of the device configured for the OCR mirror file, for example `/dev/sdb1`. When finished, click **Next**.

During installation, the OCR data will be written to the specified locations.



The Specify Voting Disk Location window appears.

11. Select **Normal Redundancy** for the voting disk location. You will be prompted for three file locations. For the Voting Disk Location, enter the name of the device configured for the first voting disk file, for example, `/dev/sda2`. Repeat this process for the other two Voting Disk Location fields.

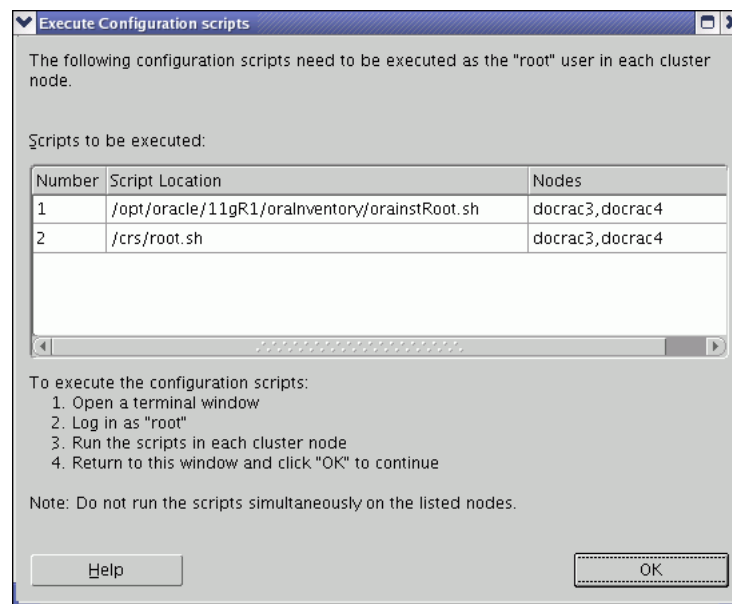


When finished, click **Next**. The OUI Summary window appears.

12. Review the contents of the Summary window and then click **Install**.

OUI displays a progress indicator during the installation process.

13. During the installation process, the Execute Configuration Scripts window appears. Do *not* click **OK** until you have run the scripts.



The Execute Configuration Scripts window shows configuration scripts, and the path where the configuration scripts are located. Run the scripts on all nodes as directed, in the order shown. For example, on Red Hat Linux you perform the following steps (note that for clarity, the examples show the current user, node and directory in the prompt):

- a. As the `oracle` user on `docrac1`, open a terminal window, and enter the following commands:

```
[oracle@docrac1 oracle]$ cd /opt/oracle/11gR1/orainventory
[oracle@docrac1 oraInventory]$ su
```

- b. Enter the password for the `root` user, and then enter the following command to run the first script on `docrac1`:

```
[root@docrac1 oraInventory]# ./orainstRoot.sh
```

- c. After the `orainstRoot.sh` script finishes on `docrac1`, open another terminal window, and as the `oracle` user, enter the following commands:

```
[oracle@docrac1 oracle]$ ssh docrac2
[oracle@docrac2 oracle]$ cd /opt/oracle/11gR1/orainventory
[oracle@docrac2 oraInventory]$ su
```

- d. Enter the password for the `root` user, and then enter the following command to run the first script on `docrac2`:

```
[root@docrac2 oraInventory]# ./orainstRoot.sh
```

- e. After the `orainstRoot.sh` script finishes on `docrac2`, go to the terminal window you opened in Step 15a. As the `root` user on `docrac1`, enter the following commands to run the second script, `root.sh`:

```
[root@docrac1 oraInventory]# cd /crs
[root@docrac1 crs]# ./root.sh
```

Note: Do not attempt to run the `root.sh` script on other nodes, or it might fail. Wait until the script finishes running on the local node.

At the completion of this script, the following message is displayed:

```
Format of 3 voting devices complete.
Startup will be queued to init within 30 seconds.
Adding daemons to inittab
Expecting the CRS daemons to be up within 600 seconds.
Cluster Synchronization Services is active on these nodes.
    docrac3
Cluster Synchronization Services is inactive on these nodes.
    docrac4
Local node checking complete. Run root.sh on remaining nodes to start CRS daemons.
```

- f. After the `root.sh` script finishes on `docrac1`, go to the terminal window you opened in Step 15c. As the `root` user on `docrac2`, enter the following commands:

```
[root@docrac2 oraInventory]# cd /crs
[root@docrac2 crs]# ./root.sh
```

After the `root.sh` script completes, return to the OUI window where the Installer prompted you to run the `oraInstRoot.sh` and `root.sh` scripts. Click **OK**.

The Configuration Assistants window appears. When the configuration assistants finish, OUI displays the End of Installation window.

14. Click **Exit** to complete the installation process, then **Yes** to confirm you want to exit the installer.

If you encounter any problems, refer to the configuration log for information. The path to the configuration log is displayed on the Configuration Assistants window.

Completing the Oracle Clusterware Configuration

After you have installed Oracle Clusterware, verify that the node applications are running. Depending on which operating system you use, you may need to perform some postinstallation tasks to configure the Oracle Clusterware components properly.

To complete the Oracle Clusterware configuration on Red Hat Linux:

1. As the `oracle` user on `docrac1`, check the status of the Oracle Clusterware targets by entering the following command:

```
/crs/bin/crs_stat -t
```

This command provides output showing if all the important cluster services, such as `gsd`, `ons`, and `vip`, are running on the nodes of your cluster.

Name	Type	Target	State	Host
ora....ac1.gsd	application	ONLINE	ONLINE	docrac1
ora....ac1.ons	application	ONLINE	ONLINE	docrac1
ora....ac1.vip	application	ONLINE	ONLINE	docrac1
ora....ac2.gsd	application	ONLINE	ONLINE	docrac2
ora....ac2.ons	application	ONLINE	ONLINE	docrac2
ora....ac2.vip	application	ONLINE	ONLINE	docrac2

Configuring Automatic Storage Management in an ASM Home Directory

This section explains how to install the ASM software in its own home directory. Installing ASM in its own home directory enables you to keep the ASM home separate from the database home directory (*Oracle_home*). By using separate home directories, you can upgrade and patch ASM and the Oracle Database software independently, and you can deinstall Oracle Database software without affecting the ASM instance.

As the `oracle` user, install ASM by installing the Oracle Database 11g Release 1 software on the `docrac1` node. Note that the Installer copies the binary files from `docrac1` to `docrac2` during the installation.

During the installation process, you are asked to configure ASM. You configure ASM by creating disk groups that become the default location for files created in the database. The disk group type determines how ASM mirrors files. When you create a disk group, indicate whether the disk group is a **normal redundancy** disk group (2-way mirroring for most files by default), or a **high redundancy** disk group (3-way mirroring), or an **external redundancy** disk group (no mirroring by ASM). Use an external redundancy disk group only if your storage system already provides mirroring at the hardware level, or if you have no need for redundant data. The default disk group type is normal redundancy.

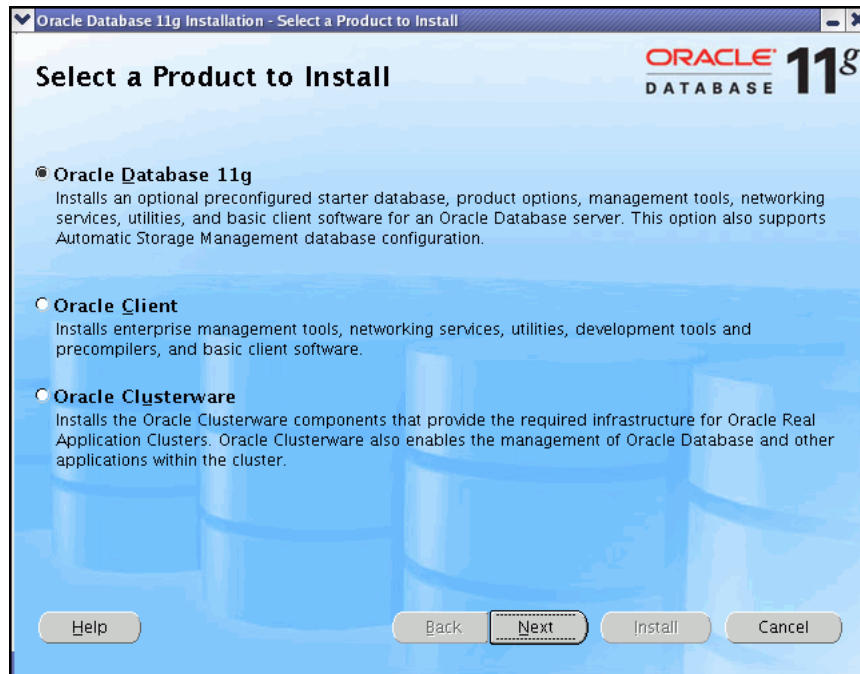
To install ASM in a home directory separate from the home directory used by Oracle Database:

1. Use the following commands to start OUI, where *staging_area* is the location of the staging area on disk, or the location of the mounted installation disk:

```
cd /staging_area/database
./runInstaller
```

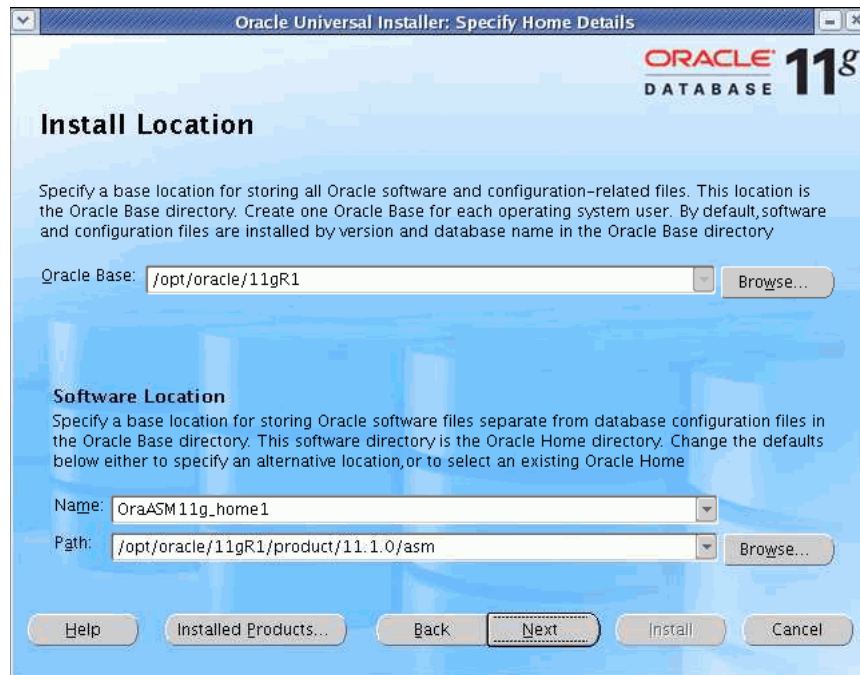
When you start Oracle Universal Installer, the Select a Product to Install window appears.

2. Select Oracle Database 11g from the list, then click **Next**.



The Select Installation Type window appears.

3. Select either Enterprise Edition or Standard Edition and then click **Next**.
4. In the Specify Home Details window, specify a name for the ASM home directory, for example, `OraASM11g_home`. Select a directory that is a subdirectory of your Oracle Base directory, for example, `/opt/oracle/11gR1/asm`. Click **Browse** to change the directory in which ASM will be installed.



After you have specified the ASM home directory, click **Next**.

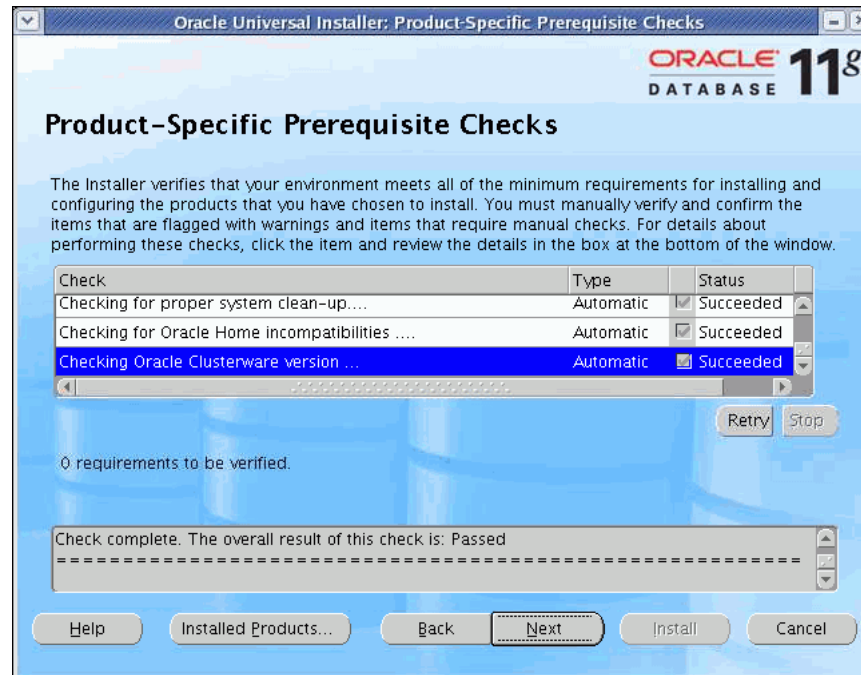
The Specify Hardware Cluster Installation Mode window appears.

5. Click **Select All** to select all nodes for installation, and then click **Next**.

If your Oracle Clusterware installation was successful, then the Specify Hardware Cluster Installation Mode window lists the nodes that you identified for your cluster, such as `docrac1` and `docrac2`.

After you click Next, the Product-Specific Prerequisites Checks window appears.

6. When you see the message "Check complete. The overall result of this check is: Passed", as shown in the following screenshot, click **Next**.

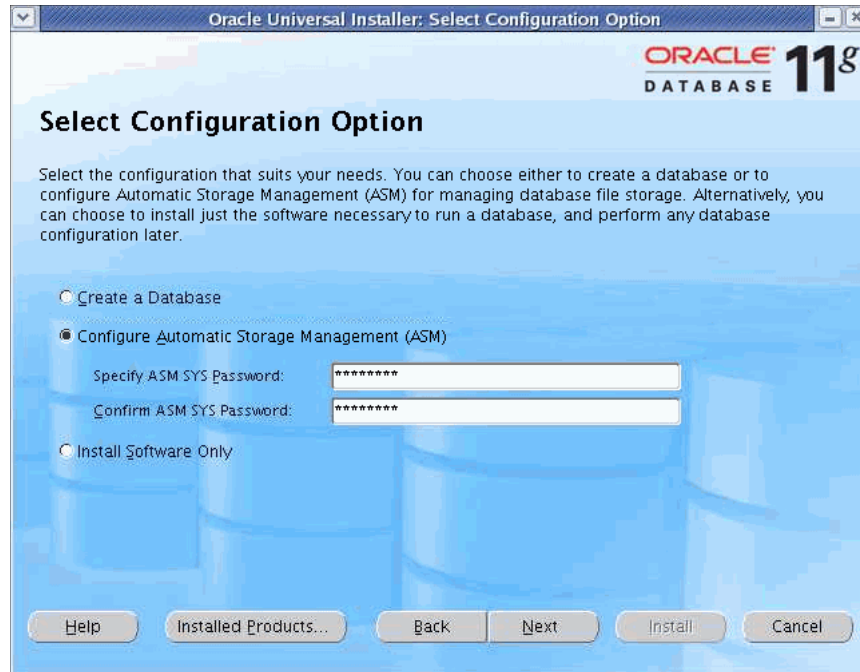


The Select Configuration Option window appears.

7. Select the **Configure Automatic Storage Management (ASM)** option to install and configure ASM. The ASM instance is managed by a privileged role called `SYSASM`, which grants full access to ASM disk groups.

Enter a password for the `SYSASM` user account. The passwords should be at least 8 characters in length and include at least one alphabetic and one numeric character.

Confirm the password by typing it in again in the Confirm ASM SYS Password field.



When finished, click **Next**.

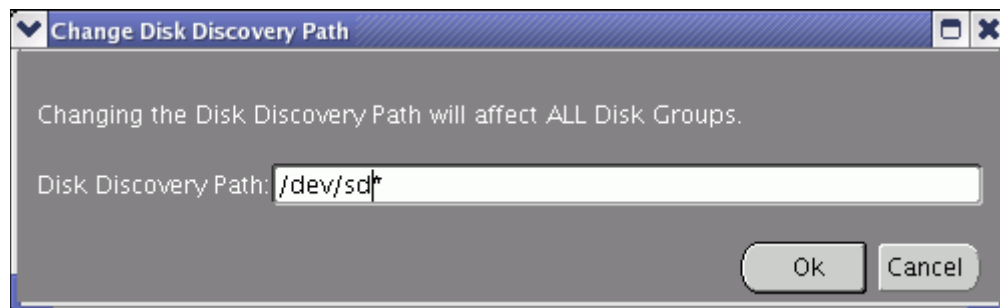
The Configure Automatic Storage Management window appears.

8. In the Configure Automatic Storage Management window, the Disk Group Name defaults to **DATA**. You can enter a new name for the disk group, or use the default name.

Check with your system administrator to determine if the disks used by ASM are mirrored at the storage level. If so, select **External** for the redundancy. If the disks are not mirrored at the storage level, then choose **Normal** for the redundancy.

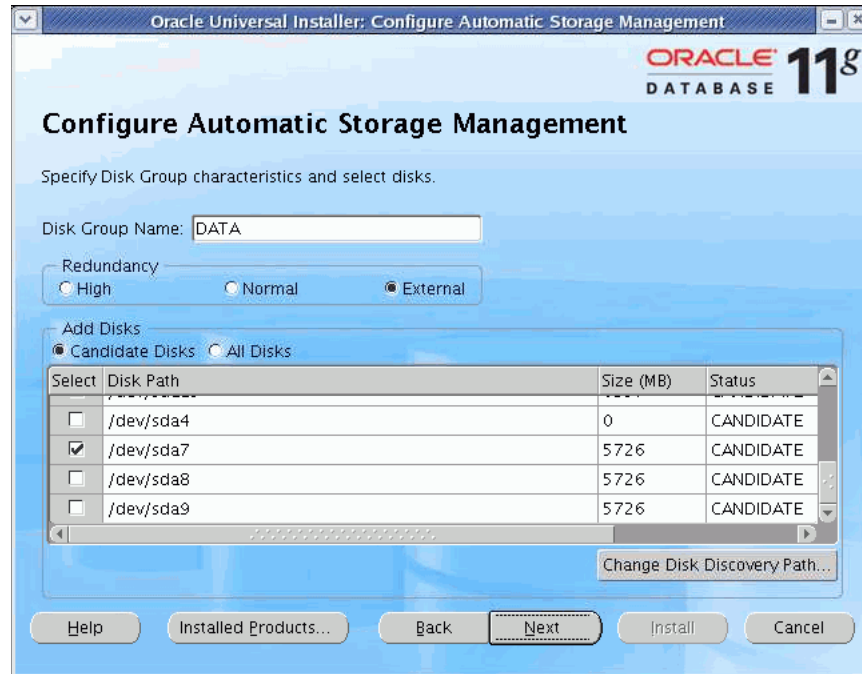
9. At the bottom right of the Add Disks section, click **Change Disk Discovery Path** to select any devices that will be used by ASM but are not listed.

In the Change Disk Discovery Path window, enter a string to use to search for devices that ASM will use, such as `/dev/sd*`, and then click **OK**.



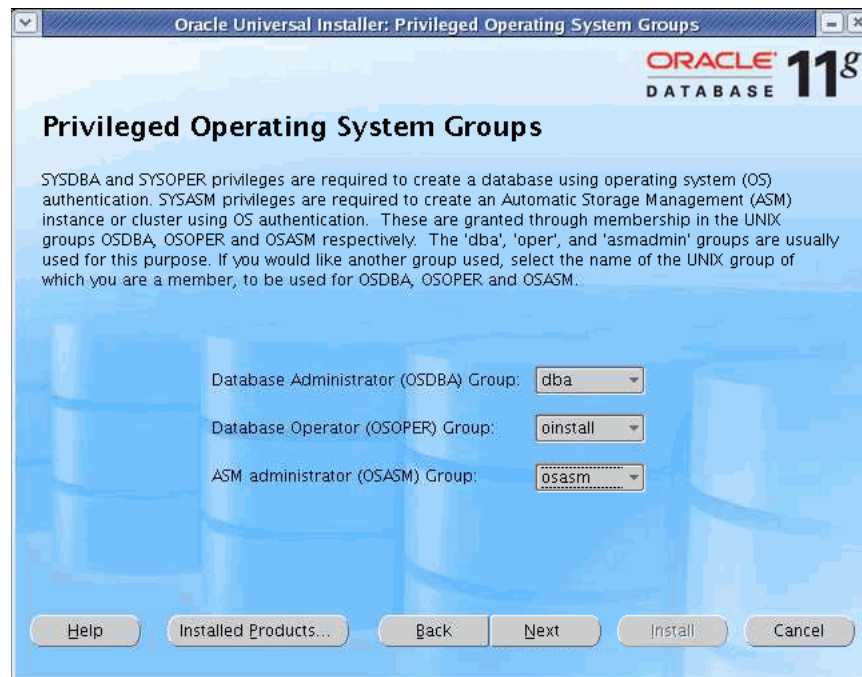
You are returned to the Configure Automatic Storage Management window.

10. Select the disks to be used by ASM, for example, `/dev/sdd` and `/dev/sde`.



After you have finished selecting the disks to be used by ASM, click **Next**. The Privileged Operating Systems Groups window appears.

11. Select the name of the operating system group you created in the previous chapter for the OSDBA group, the OSASM group, and the database operator group. If you choose to create only the `dba` group, then you can use that group for all three privileged groups. If you created a separate `asm` group, then use that value for the OSASM group.



After you have supplied values for the privileged groups, click **Next**. The Oracle Configuration Manager Registration window appears.

12. The Oracle Configuration Manager Registration window enables you to configure the credentials used for connecting to Oracle*MetaLink*. You can provide this information now, or configure it after the database has been installed. Click **Next** to continue.

OUI displays the Summary window.

13. Review the information displayed in the Summary window. If any of the information appears incorrect, then click **Back** to return to a previous window and change it. When you are ready to proceed, click **Install**.

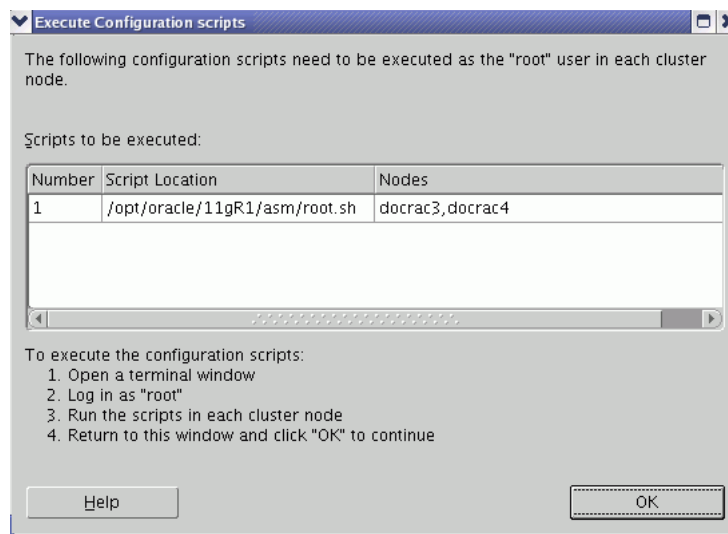
OUI displays a progress window indicating that the installation has started.

14. The installation takes several minutes to complete. During this time, OUI configures ASM on the specified nodes, and then configures a listener on each node.

After ASM has been installed, OUI runs the Configuration Assistants. When the assistants have finished successfully, click **Next** to continue.

The Execute Configuration Scripts window appears.

15. Run the scripts as instructed in the Execute Configuration scripts window. For the installation demonstrated in this guide, only one script, `root.sh`, must be run, and it must be run on both nodes.



The following steps demonstrate how to complete this task on a Linux system (note that for clarity, the examples show the user, node name, and directory in the prompt):

- a. Open a terminal window. As the `oracle` user on `docrac1`, change directories to the ASM home directory, and then switch to the `root` user:

```
[oracle@docrac1 oracle]$ cd /opt/oracle/11gR1/asm
[oracle@docrac1 oracle]$ su
```

- b. Enter the password for the `root` user, and then run the script specified in the Execute Configuration scripts window:

```
[root@docrac1 oracle]# ./root.sh
```

- c. As the `root.sh` script runs, it prompts you for the path to the local `bin` directory. The information displayed in the brackets is the information it has obtained from your system configuration. Press the **Enter** key each time you are prompted for input to accept the default choices.
- d. After the script has completed, the prompt appears. Open another terminal window, and enter the following commands:

```
[oracle@docrac1 oracle]$ ssh docrac2
Enter the passphrase for key '/home/oracle/.ssh/id_rsa':
[oracle@docrac2 oracle]$ cd /opt/oracle/11gR1/asm
[oracle@docrac2 asm]$ su
Password:
```

- e. Enter the password for the `root` user, and then run the script specified in the Execute Configuration scripts window:

```
[root@docrac2 asm]# ./root.sh
```

- f. Accept all default choices by pressing the **Enter** key.
- g. After you finish executing the script on all nodes, return to the Execute Configuration Scripts window and click **OK** to continue.

OUI displays the End of Installation window.

- 16. Review the information in the End of Installation window. The Web addresses displayed are not used in this guide, but may be needed for your business applications.
- 17. Click **Exit**, and then click **Yes** to verify that you want to exit the installation.

Verifying Your ASM Installation

Verify that all the database services for ASM are up and running.

To verify ASM is operational following the installation:

- 1. Change directories to the `bin` directory in the CRS home directory:

```
cd /crs/bin
```

- 2. Run the following command as the `oracle` user, where `docrac1` is the name of the node you want to check:

```
./srvctl status asm -n docrac1
ASM instance +ASM1 is running on node docrac1.
```

The example output shows that there is one ASM instance running on the local node.

- 3. Repeat the command shown in Step 2, substituting `docrac2` for `docrac1` to verify the successful installation on the other node in your cluster.

Installing the Oracle Database Software and Creating a Cluster Database

The next step is to install the Oracle Database 11g Release 1 software on the `docrac1` node. OUI copies the binary files from `docrac1` to `docrac2`, the other node in the cluster, during the installation process.

Before you start OUI you must configure the environment of the `oracle` user. You must set the `ORACLE_SID`, `ORACLE_BASE`, and `ORACLE_HOME` environment variables to the desired values for your environment.

For example, if you want to create a clustered database named `sales` and install the Oracle Database software in the `/opt/oracle/11gR1/db` directory, you would set `ORACLE_SID` to `sales`, `ORACLE_BASE` to the directory `/opt/oracle/11gR1`, and `ORACLE_HOME` to the directory `/opt/oracle/11gR1/db`. See "[Configuring the Operating System Environment](#)" on page 3-2 for more information on configuring the environment variables.

To install Oracle Database on your cluster:

1. As the `oracle` user, use the following commands to start OUI, where `staging_area` is the location of the staging area on disk, or the location of the mounted installation disk:

```
cd /staging_area/database
./runInstaller
```

When you start Oracle Universal Installer, the Select a Product to Install window appears.

2. Select Oracle Database 11g from the list, then click **Next**.

The Select Installation Type window appears.

3. Select either Enterprise Edition or Standard Edition. The Enterprise Edition option is selected by default. When finished, click **Next**.

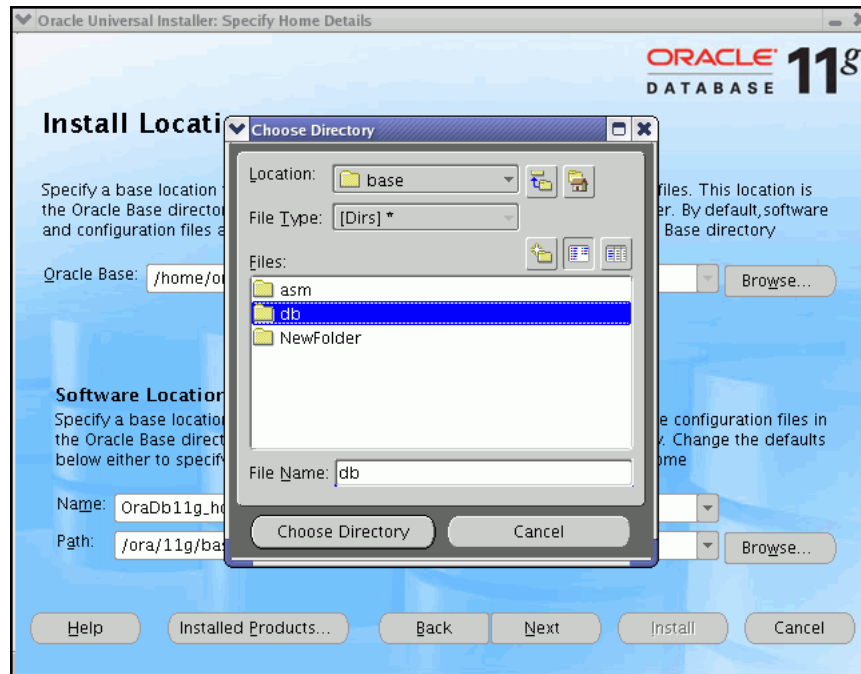
The Install Location window appears.

4. Specify a name for the Oracle home, for example, `OraDb11g_home`.

5. Select an Oracle home directory that is a subdirectory of your Oracle base directory, for example, `/opt/oracle/11gR1/db_1`.

You can click **Browse** to change the directory in which the Oracle Database software will be installed. After you have selected the directory, click **Choose Directory** to close the Choose Directory window.

If the directory does not exist, you can type in the directory path in the File Name field, and then click **Choose Directory**. If a window appears asking if you want to create the directory, click **Yes**.



After you have verified the information on the Install Location window, click **Next**.

The Specify Hardware Cluster Installation Mode window appears.

6. Select the nodes on which the Oracle Database software will be installed. You can also click **Select All** to select all available nodes. After you have selected the nodes on which to install the Oracle Database software, click **Next**.

The Product-Specific Prerequisite Checks window appears.

Note: In the Product-Specific Prerequisite Checks window, you might see a warning that says the host IP addresses are generated by the dynamic host configuration protocol (DHCP), which is not a recommended best practice. You can ignore this warning.

7. When you see the confirmation message that your system has passed the prerequisite checks, click **Next**.

The Select Configuration Option window appears.

8. In the Select Configuration Option window, accept the default option of **Create a Database** and click **Next**.

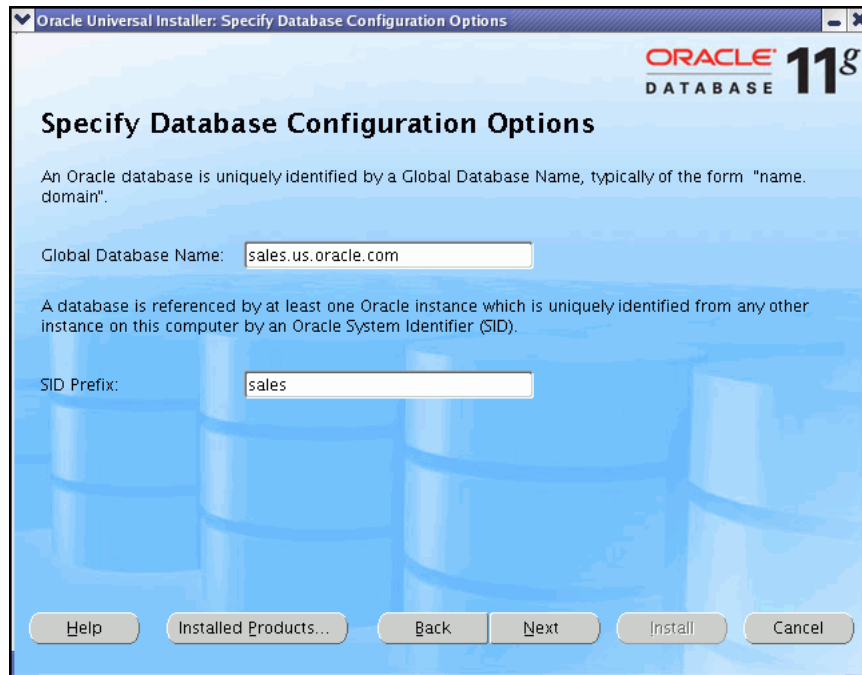
The Select Database Configuration window appears.

9. Select one of the following different types of databases to be created:
 - General Purpose
 - Transaction Processing
 - Data Warehouse
 - Advanced (for customized database creation)

The **General Purpose** database type is selected by default. Select the type of database that best suits your business needs. For the example used by this guide, the default value is sufficient. After you have selected the database type, click **Next**.

The Specify Database Configuration Options window appears.

- In the Global Database Name field, enter a fully qualified name for your database, such as `sales.mycompany.com`. Ensure that the SID field contains the first part of the database name, for example, `sales`.



After you have entered the database name and SID, click **Next**. The Specify Database Config Details window appears.

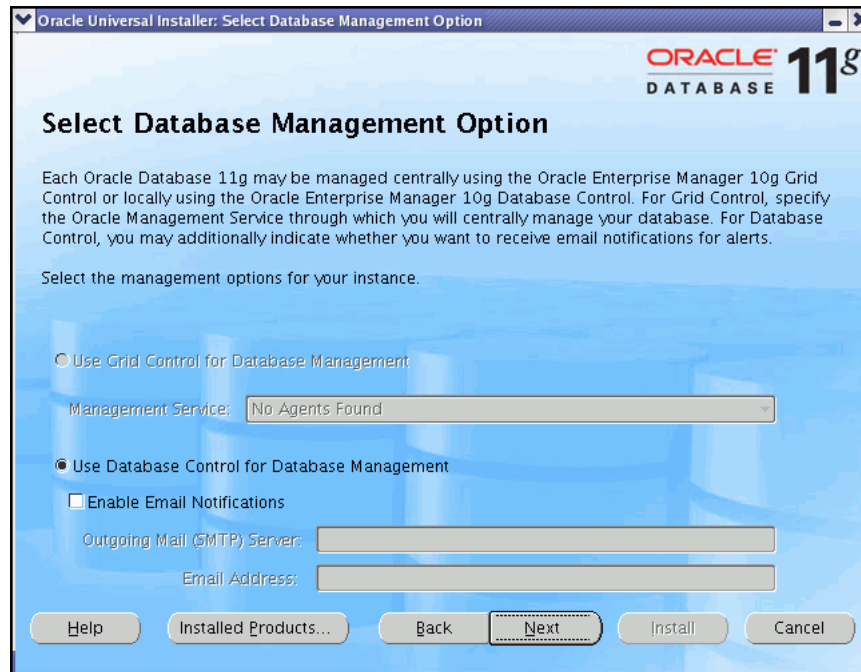
Note: The value for the system identifier (SID) will be used as a prefix for the instance names. Thus if the SID is set to `sales`, the instance names will be `sales1`, `sales2`, and so on.

- Check the settings on each of the tabs. If you are not sure what values to use, then accept the default values. On the Sample Schemas tab, if you want sample data and schemas to be created in your database, then select the **Create database with sample schemas** option. When finished, click **Next** to continue.

The Select Database Management Option window appears.

- By default, the **Use Database Control for Database Management** option is selected instead of the Use Grid Control for Database Management option. The examples in this guide use Database Control, which is the default value.

Do not select the option Enable Email Notifications if your cluster is not connected to a mail server.



After you have made your selections, click **Next**.

The Specify Database Storage Option window appears.

13. If you configured ASM on the cluster, select the option **Automatic Storage Management (ASM)** for the database storage. Otherwise, select File System and enter the location of your shared storage, then click **Next**.

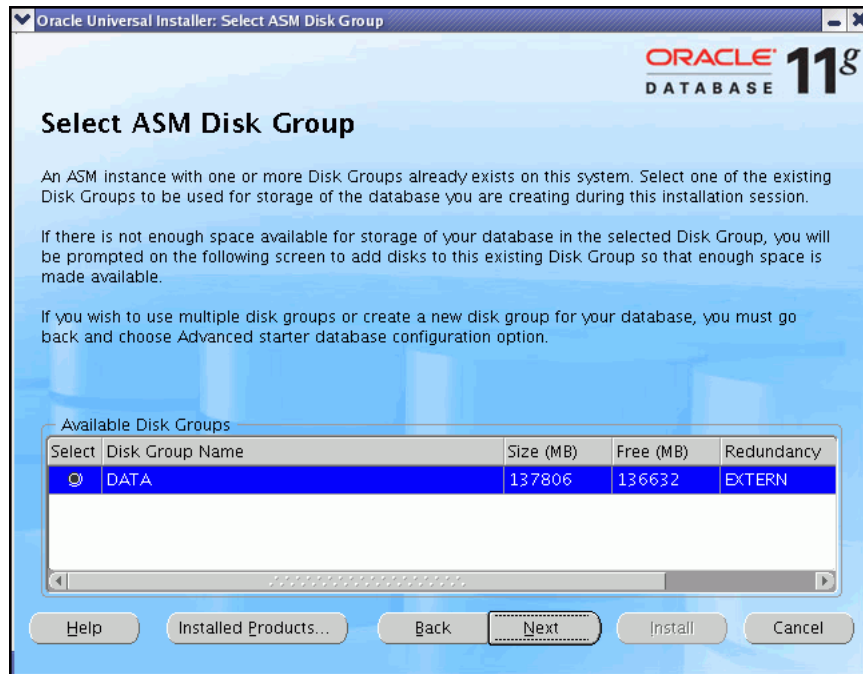
The Specify Backup and Recovery Options window appears.

14. Select the default option **Do not enable Automated backup**, and then click **Next**. You can modify the backup settings at a later time.

If you selected ASM as your storage solution, the Select ASM Disk Group window appears.

Note: If you want to use ASM as the backup area, you must create an additional ASM disk group when configuring ASM.

15. The Select ASM Disk Group window shows you where the database files will be created. Select the disk group that was created during the ASM installation, and then click **Next**.



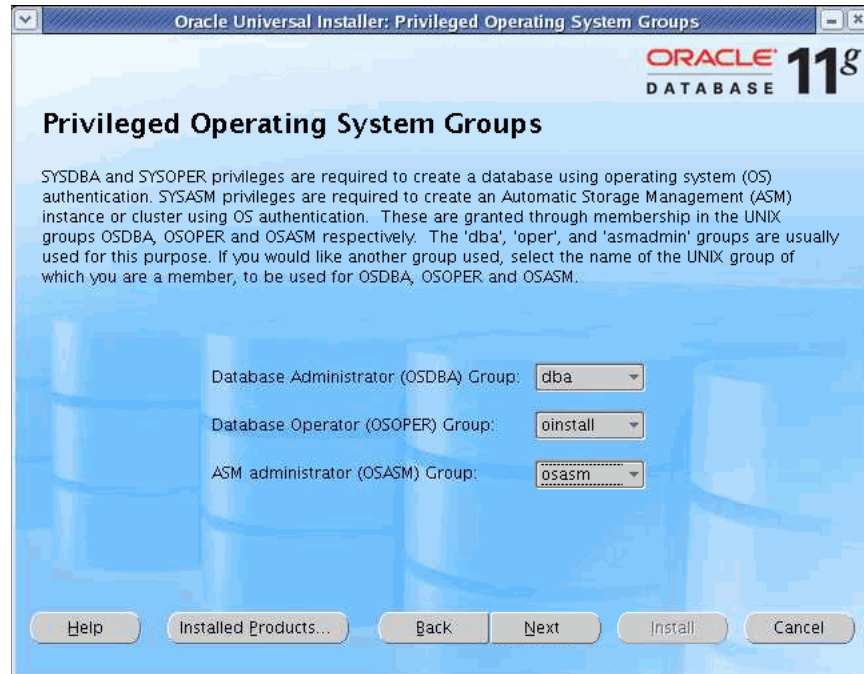
The Specify Database Schema Passwords window appears.

- Assign and confirm a password for each of the Oracle database schemas.

Unless you are performing a database installation for testing purposes only, do *not* select the Use the same password for all the accounts option, as this can compromise the security of your data. Each password should be at least 8 characters in length and include at least one alphabetic, one numeric, and one punctuation mark character.

When finished entering passwords, click **Next**. OUI displays the Privileged Operating System Groups window.

- Select the name of the operating system group you created in the previous chapter for the OSDBA group, the OSASM group, and the database operator group. If you choose to create only the dba group, then you can use that group for all three privileged groups. If you created a separate asm group, then use that value for the OSASM group.



After you have supplied values for the privileged groups, click **Next**. The Oracle Configuration Manager Registration window appears.

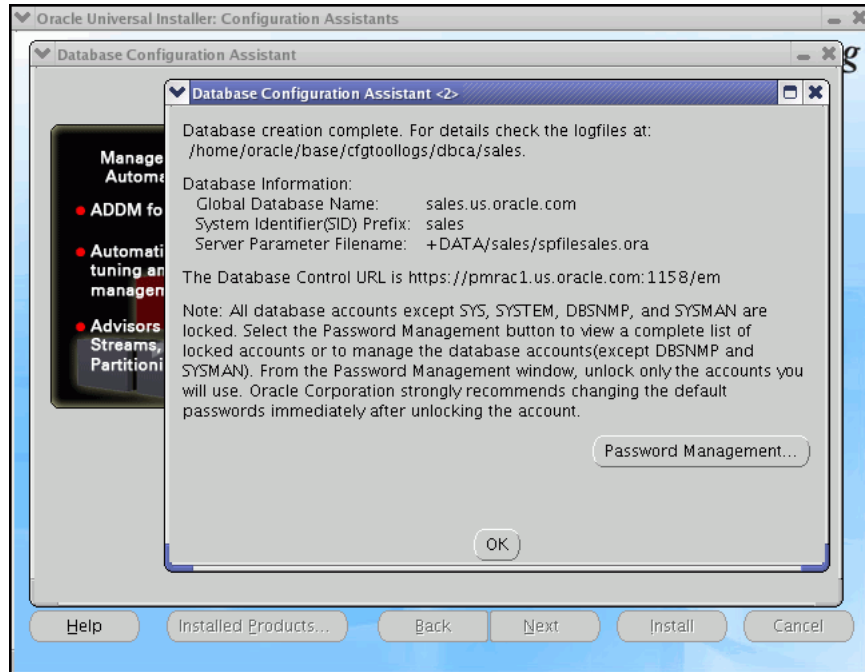
18. The Oracle Configuration Manager Registration window enables you to configure the credentials used for connecting to *OracleMetaLink*. You can provide this information now, or configure it after the database has been installed. Click **Next** to continue.

OUI displays the Summary window.

19. Review the information displayed in the Summary window. If any of the information is incorrect, click **Back** to return to a previous window and correct it. When you are ready to proceed, click **Install**.

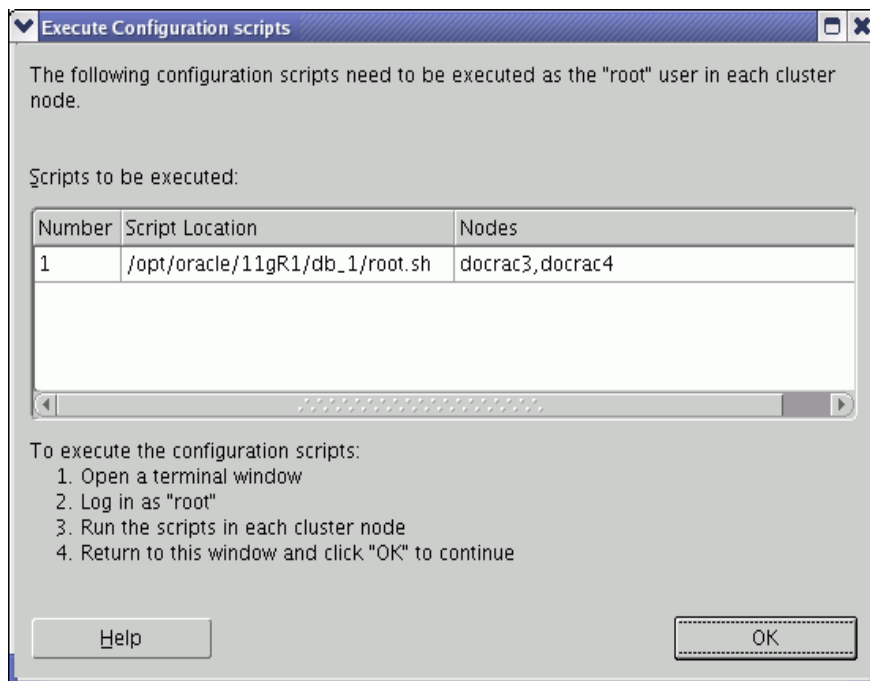
OUI displays a progress indicator to show that the installation has begun. This step takes several minutes to complete.

20. As part of the software installation process, the `sales` database is created. At the end of the database creation, you will see the Oracle Database Configuration Assistant (DBCA) window with the URL for the Database Control console displayed.



Make note of the URL, and then click **OK**. Wait for DBCA to start the cluster database and its instances.

21. After the installation, you are prompted to perform the postinstallation task of running the `root . sh` script on both nodes.



On each node, run the scripts listed in the Execute Configuration scripts window before you click **OK**. Perform the following steps to run the `root . sh` script:

- a. Open a terminal window. As the `oracle` user on `docrac1`, change directories to your Oracle home directory, and then switch to the `root` user by entering the following commands:

```
[oracle@docrac1 oracle]$ cd /opt/oracle/11gR1/db_1
[oracle@docrac1 db_1]$ su
```

- b. Enter the password for the `root` user, and then run the script specified in the Execute Configuration scripts window:

```
[root@docrac1 db_1]# ./root.sh
```

- c. As the `root .sh` script runs, it prompts you for the path to the local `bin` directory. The information displayed in the brackets is the information it has obtained from your system configuration. Press the **Enter** key each time you are prompted for input to accept the default choices.

- d. After the script has completed, the prompt appears. Enter the following commands:

```
[oracle@docrac1 oracle]$ ssh docrac2
[oracle@docrac2 oracle]$ cd /opt/oracle/11gR1/db_1
[oracle@docrac2 db_1]$ su
```

- e. Enter the password for the `root` user, and then run the script specified in the Execute Configuration scripts window:

```
[root@docrac2 db_1]# ./root.sh
```

- f. Accept all default choices by pressing the **Enter** key.

After you finish executing the script on all nodes, return to the Execute Configuration scripts window and click **OK**.

OUI displays the End of Installation window

22. Click **Exit** and then click **Yes** to verify that you want to exit OUI.

See Also:

- ["Configuring Automatic Storage Management in an ASM Home Directory"](#)
- ["Configuring the Operating System Environment"](#)
- ["Verifying Your Oracle RAC Database Installation"](#)
- ["Recommended Postinstallation Tasks"](#)
- ["About Downloading and Installing RDBMS Patches"](#)
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about configuring disk groups in ASM

Verifying Your Oracle RAC Database Installation

At this point, you should verify that all the database services are up and running.

To verify the Oracle RAC database services are running:

1. Log in as the `oracle` user and go to the `CRS_home/bin` directory:

```
[oracle] $ cd /crs/bin
```

- Run the following command to view the status of the applications managed by Oracle Clusterware:

```
[oracle] $ ./crs_stat -t
```

The output of the command should show that the database instances are available (online) for each host.

Name	Type	Target	State	Host
ora....SM1.asm	application	ONLINE	ONLINE	docrac1
ora....C1.lsnr	application	ONLINE	ONLINE	docrac1
ora....ac1.gsd	application	ONLINE	ONLINE	docrac1
ora....ac1.ons	application	ONLINE	ONLINE	docrac1
ora....ac1.vip	application	ONLINE	ONLINE	docrac1
ora....SM2.asm	application	ONLINE	ONLINE	docrac2
ora....C2.lsnr	application	ONLINE	ONLINE	docrac2
ora....ac2.gsd	application	ONLINE	ONLINE	docrac2
ora....ac2.ons	application	ONLINE	ONLINE	docrac2
ora....ac2.vip	application	ONLINE	ONLINE	docrac2
ora.sales.db	application	ONLINE	ONLINE	docrac2
ora....s1.inst	application	ONLINE	ONLINE	docrac1
ora....s2.inst	application	ONLINE	ONLINE	docrac2

Configuring the Operating System Environment for Database Management

After you have installed the Oracle RAC software and created a cluster database, there are two additional tasks to perform to configure your operating system environment for easier database management:

- Updating the `oratab` File
- Reconfiguring the User Shell Profile

Updating the `oratab` File

Several of the Oracle Database utilities use the `oratab` file to determine the available Oracle homes and instances on each node. The `oratab` file is created by the `root.sh` script and is updated by Oracle Database Configuration Assistant when creating or deleting a database.

The following is an example of the `oratab` file:

```
# This file is used by ORACLE utilities. It is created by root.sh
# and updated by the Database Configuration Assistant when creating
# a database.

# A colon, ':', is used as the field terminator. A new line terminates
# the entry. Lines beginning with a pound sign, '#', are comments.
#
# Entries are of the form:
# $ORACLE_SID:$ORACLE_HOME:<N|Y>:
#
# The first and second fields are the system identifier and home
# directory of the database respectively. The third field indicates
# to the dbstart utility that the database should, "Y", or should not,
# "N", be brought up at system boot time.
#
# Multiple entries with the same $ORACLE_SID are not allowed.
#
#
+ASM1:/opt/oracle/11gR1/asm:N
sales:/opt/oracle/11gR1/db_1:N
sales1:/opt/oracle/11gR1/db_1:N
```

To update the `oratab` file on Red Hat Linux after creating an Oracle RAC database:

1. Open the `/etc/oratab` file for editing by using the following command on the `docrac1` node:

```
vi /etc/oratab
```

2. Add the `Oracle_sid` and `Oracle_home` for the local instance to the end of the `/etc/oratab` file, for example:

```
sales1:/opt/oracle/11gR1/db_1:N
```

3. Save the file and exit the vi editor.
4. Modify the `/etc/oratab` file on each node in the cluster, adding in the appropriate instance information.

Note: In a single-instance database, setting the last field of each entry to `N` disables the automatic startup of a database when the server it runs on is restarted. For an Oracle RAC database, these fields are set to `N` because Oracle Clusterware starts the instances and processes, not the `dbstart` utility.

Reconfiguring the User Shell Profile

There are several environment variables that can be used with Oracle RAC or Oracle Database. These variables can be set manually in your current operating system session, using shell commands such as `set` and `export`.

You can also have these variables set automatically when you log in as a specific operating system user. To do this, modify the Bourne, Bash, or Korn shell configuration file (for example `.profile` or `.login`) for that operating system user.

To modify the oracle user's profile for the bash shell on Red Hat Linux:

1. As the `oracle` user, open the user profile in the `/home/oracle` directory for editing using the following commands:

```
[oracle] $ cd $HOME
[oracle] $ vi .bash_profile
```

2. Modify the following lines in the file so they point to the location of the newly created Oracle RAC database:

```
export ORACLE_BASE=/opt/oracle/11gR1
export ORACLE_HOME=/opt/oracle/11gR1/db_1
export PATH=$PATH:$ORACLE_HOME/bin
```

3. On each node, modify the `.bash_profile` file to set the `ORACLE_SID` environment variable to the name of the local instance. For example, on the host `docrac1` you would add the following line to the `.bash_profile` file:

```
export ORACLE_SID=sales1
```

On the host `docrac2` you would set `ORACLE_SID` to the value `sales2`.

4. Read and implement the changes made to the `.bash_profile` file on each instance:

```
source .bash_profile
```

5. On each client computer, configure user access to use a service name, such as `sales`, for connecting to the database.

See Also:

- *Oracle Database Net Services Administrator's Guide* for information on configuring client access to the cluster database
- ["Configuring the Operating System Environment for Database Management"](#)
- ["Configuring the Operating System Environment"](#)
- *Oracle Real Application Clusters Installation Guide for Linux and UNIX* for information about configuring environmental variables on Linux systems

Performing Postinstallation Tasks

After you have installed the Oracle RAC software, there are additional tasks that you can perform before your cluster database is ready for use. These steps are recommended, but are not required.

This section contains the following topics:

- [About Verifying the Oracle Clusterware Installation](#)
- [About Backing Up the Voting Disk](#)
- [About Downloading and Installing RDBMS Patches](#)
- [Verifying Oracle Enterprise Manager Operations](#)
- [Recommended Postinstallation Tasks](#)

About Verifying the Oracle Clusterware Installation

After the Oracle Clusterware installation is complete, OUI automatically runs the `cluvfy` utility as a Configuration Assistant to verify that the Clusterware installation has been completed successfully.

If the CVU reports problems with your configuration, correct these errors before proceeding.

See Also:

- *Oracle Clusterware Administration and Deployment Guide* for more information about using the CVU and resolving configuration problems

About Backing Up the Voting Disk

After your Oracle Database 11g with Oracle RAC installation is complete, and after you are sure that your system is functioning properly, make a backup of the contents of the voting disk. Use the `dd` utility, as described in the section ["About Backing Up and Recovering Voting Disks"](#) on page 5-2.

Also, make a backup copy of the voting disk contents after you complete any node additions or deletions, and after running any deinstallation procedures.

See Also:

- ["About Backing Up and Recovering Voting Disks"](#)

About Downloading and Installing RDBMS Patches

Periodically, Oracle issues bug fixes for its software called **patches**. **Patch sets** are a collection of bug fixes that were produced up to the time of the patch set release. Patch sets are fully tested product fixes. Application of a patch set affects the software residing in your Oracle home.

Ensure that you are running the latest patch set of the installed software. You might also need to apply patches that are not included in a patch set. Information about downloading and installing patches and patch sets is covered in [Chapter 10, "Managing Oracle Software and Applying Patches"](#).

See Also:

- ["Configuring the Enterprise Manager Patch Interface"](#)

Verifying Oracle Enterprise Manager Operations

When you create an Oracle RAC database and choose Database Control for your database management, the Enterprise Manager Database Control utility is installed and configured automatically.

To verify Oracle Enterprise Manager Database Control has been started in your new Oracle RAC environment:

1. Make sure the `ORACLE_SID` environment variable is set to the name of the instance to which you want to connect, for example `sales1`. Also make sure the `ORACLE_HOME` environment variable is set to the location of the installed Oracle Database software.

```
$ echo $ORACLE_SID
sales
$ export ORACLE_SID=sales1
$ echo $ORACLE_HOME
/opt/oracle/11gR1/db_1
```

2. Go to the `Oracle_home/bin` directory.
3. Run the following command as the `oracle` user:

```
./emctl status dbconsole
```

The Enterprise Manager Control (EMCTL) utility displays the current status of the Database Control console on the current node.

4. If the EMCTL utility reports that Database Control is not started, use the following command to start it:

```
./emctl start dbconsole
```

5. Repeat Step 1 through Step 3 for each node in the cluster.

See Also:

- [Oracle Database 2 Day DBA](#)
- ["Configuring the Enterprise Manager Patch Interface"](#)
- ["Oracle RAC and Enterprise Manager"](#)

Recommended Postinstallation Tasks

Oracle recommends that you complete the following tasks after installing Oracle RAC:

- [About Backing Up the root.sh Script](#)
- [About Configuring User Accounts](#)

About Backing Up the root.sh Script

Oracle recommends that you back up the `root.sh` script after you complete an installation. If you install other products in the same Oracle home directory, OUI updates the contents of the existing `root.sh` script during the installation. If you require information contained in the original `root.sh` script, then you can recover it from the `root.sh` backup copy.

About Configuring User Accounts

The `oracle` user operating system account is the account that you used to install the Oracle software. You can use different operating system accounts for accessing and managing your Oracle RAC database.

See Also:

- ["Installing the Oracle Database Software and Creating a Cluster Database"](#)
- ["Performing Postinstallation Tasks"](#)
- *Oracle Database Administrator's Reference for Linux and UNIX* for more information about setting up optional operating system user accounts that can be used to manage the database

Converting an Oracle Database to an Oracle RAC Database

You can use `rconfig`, or Oracle Enterprise Manager to assist you with the task of converting a single-instance database installation to an Oracle RAC database. The first of these, `rconfig`, is a command line utility. Oracle Enterprise Manager Grid Control database administration option, Convert to Cluster Database, provides a GUI conversion tool.

This section contains the following topics:

- [Preparing for Database Conversion](#)
- [Overview of the Database Conversion Process Using Grid Control](#)
- [Overview of the Database Conversion Process Using `rconfig`](#)

Preparing for Database Conversion

Before you start the process of converting your database to a cluster database, your database environment must meet certain prerequisites:

- The existing database and the target Oracle RAC database must be on the same release of Oracle Database 11g and must be running on the same platform.
- The hardware and operating system software used to implement your Oracle RAC database must be certified for use with the release of the Oracle RAC software you are installing.
- You must configure shared storage for your Oracle RAC database.
- You must verify that any applications that will run against the Oracle RAC database do not need any additional configuration before they can be used successfully with the cluster database. This applies to both Oracle applications and

database features, such as Oracle Streams, and applications and products that do not come from Oracle.

- Backup procedures should be available before converting from a single-instance Oracle Database to Oracle RAC.
- For archiving in Oracle RAC environments, the archive log file format requires a thread number.
- The archived redo log files from all instances of an Oracle RAC database are required for media recovery. Because of this, if you archive to a file and you do not use a cluster file system, or some other means to provide shared file systems, then you require a method of accessing the archived redo log files from all nodes on which the cluster database has instances.

Note: Before using individual Oracle Database 11g database products or options, refer to the product documentation library, which is available in the DOC directory on the 11g Release 1 (11.1) installation media, or on the OTN Web site at <http://www.oracle.com/technology/documentation>

Overview of the Database Conversion Process Using Grid Control

The following list provides an outline of the process of converting a single-instance database to an Oracle RAC database using Oracle Enterprise Manager Grid Control:

- Complete the prerequisite tasks for converting to an Oracle RAC database:
 - Oracle Clusterware and Oracle Database software is installed on all target nodes.
 - Oracle Clusterware is started.
 - The Oracle Database binary is enabled for Oracle RAC on all target nodes.
 - Shared storage is configured and accessible from all nodes.
 - User equivalency is configured for the operating system user performing the conversion.
 - Enterprise Manager agents are configured and running on all nodes, and are configured with the cluster and host information.
 - The database being converted has been backed up successfully.
- Access the Database Home page for the database you want to convert.
- Go to the Server subpage and select Convert to Cluster Database.
- Provide the necessary credentials.
- Select the host nodes that will contain instances of the new database.
- Provide listener and instance configuration information.
- Specify the location of the shared storage to be used for the datafiles.
- Submit the job.
- Complete the post-conversion tasks.

See Also: *Oracle Real Application Clusters Installation Guide for Linux and UNIX*, or for a different platform, for a complete description of this process

Overview of the Database Conversion Process Using `rconfig`

The following list provides an outline of the process of converting a single-instance database to an Oracle RAC database using the `rconfig` utility:

- Complete the prerequisite tasks for converting to an Oracle RAC database.
 - Oracle Clusterware and Oracle Database software is installed on all target nodes.
 - Oracle Clusterware is started.
 - The Oracle Database binary is enabled for Oracle RAC on all target nodes.
 - Shared storage is configured and accessible from all nodes.
 - User equivalency is configured for the operating system user performing the conversion.
 - The database being converted has been backed up successfully.
- Modify the parameters in the `Oracle_home/assistants/rconfig/sampleXMLs/ConvertToRAC.xml` file as appropriate for your environment, then save the file.
- Run the `rconfig` command, supplying the name of the modified `ConvertToRAC.xml` file as input.
- Complete the post-conversion tasks.

See Also: *Oracle Real Application Clusters Installation Guide for Linux and UNIX*, or for a different platform, for a complete description of this process

Administering Database Instances and Cluster Databases

Web-based Oracle Enterprise Manager Database Control and Grid Control interfaces let you manage Oracle Real Application Clusters (Oracle RAC) databases. The Enterprise Manager console is a central point of control for the Oracle environment. Use the Database Control console to initiate cluster database management tasks. Use the Grid Control console to administer multiple Oracle RAC databases and cluster nodes.

This chapter describes how to administer your Oracle RAC environment. It explains the startup and shutdown tasks for database components and how to administer parameters and parameter files in Oracle RAC. This chapter includes the following sections:

- [About Oracle RAC Database Management](#)
- [Oracle RAC and Enterprise Manager](#)
- [Starting and Stopping Oracle RAC Databases and Database Instances](#)
- [About Oracle RAC Initialization Parameters](#)
- [About Administering Storage in Oracle RAC](#)
- [Exploring Your Cluster Database: Oracle By Example Series](#)

About Oracle RAC Database Management

Oracle RAC is technology that links one or more individual computers so that they function as one system. Oracle RAC enables each computer that is a member of a cluster, or node, to share access to the Oracle database. If one cluster node fails or is taken offline, then the other cluster nodes continue operating and the entire Oracle RAC database remains available. This means that two or more inexpensive computers can appear to applications as if they were a single, much more powerful and more expensive, computer.

To increase the performance of a two-node Oracle RAC database, you can add cluster nodes. Each additional node can help speed up application processing, support more users or processes, or both. In addition, you can also add cluster nodes to increase the availability and reliability of a two-node RAC database. The more nodes that your Oracle RAC environment has, the less the impact of the loss of any individual node on the database.

Note: If you are using Oracle Database Standard Edition, your cluster must adhere to the license restrictions. See *Oracle Database Licensing Information* for specific details on these restrictions.

An Oracle RAC database requires three components: cluster nodes, shared storage, and Oracle Clusterware. Although you can choose how many nodes your cluster should have and what type of shared storage to use, this guide describes one specific configuration for a two-node cluster. This two-node configuration uses Automatic Storage Management (ASM) for storage management and Recovery Manager (RMAN) for the backup and recovery strategy.

Most administration tasks are the same for Oracle single-instance and Oracle RAC databases. This guide provides additional instructions for some of the database administration tasks specific to Oracle RAC, as well as some recommendations for managing Oracle RAC databases.

See Also:

- *Oracle Database 2 Day DBA*
- [Chapter 9, "Adding and Deleting Nodes and Instances"](#)

Oracle RAC and Enterprise Manager

The Web-based Oracle Enterprise Manager Database Control console and the Oracle Enterprise Manager Grid Control console let you manage Oracle RAC databases. Enterprise Manager is a central point of control for the Oracle environment that you access by way of a graphical user interface (GUI). You can use Enterprise Manager to create and modify services, and to start and stop the cluster database instances and the cluster database. Use Enterprise Manager Database Control for cluster database management tasks. Use Enterprise Manager Grid Control to administer your entire Oracle RAC environment, not just the Oracle RAC database.

When you log in to Enterprise Manager using a client browser, the Cluster Database Home page appears. The Cluster Database Home page is similar to a single-instance Database Home page. However, on the Cluster Database Home page, Enterprise Manager displays the system state and availability of the entire Oracle RAC environment. This includes a summary about alert messages and job activity, as well as the status of and links to all the database and Automatic Storage Management (ASM) instances. By clicking the cluster name on this page you can view the Cluster Home page, to view the status of and alerts for the underlying cluster.

See Also:

- *Oracle Database 2 Day DBA*
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about monitoring Oracle RAC performance

Overview of Oracle Real Application Clusters: Oracle By Example Series

Oracle By Example (OBE) has a series of tutorials created for *Oracle Database 2 Day DBA*. Included in this series is an OBE tutorial that introduces you to the management of an Oracle RAC database using Enterprise Manager. To view this OBE tutorial, go to the following URL

http://www.oracle.com/technology/obe/10gr2_2day_dba/rac/rac.htm

Starting and Stopping Oracle RAC Databases and Database Instances

Typically, you start up and shut down the cluster database from the Enterprise Manager Cluster Database Home page. By using this page for cluster database startup and shutdown operations, you ensure that all the instances that belong to the Oracle RAC database are in a consistent state. This enables you to more easily manage an Oracle RAC database.

You can also start and stop individual instances in an Oracle RAC database. However, starting and stopping one instance in an Oracle RAC database does not stop or start other instances. To completely stop an Oracle RAC database, you must shut down all of its instances.

To start and stop an entire Oracle RAC database, assuming you are using a server parameter file (SPFILE):

1. Go to the following URL and log in to Enterprise Manager:

`http://hostname:portnumber/em`

For example, `http://docrac1.mycompany.com:1158/em`.

2. On the Cluster Database Home page, in the General section, click **Startup** if the database is down, or **Shutdown** if the database is started.

The Startup/Shutdown: Specify Credentials page appears.

3. Enter the cluster database host credentials for the database nodes. The host credentials are the user name and password for a user who is a member of the OSDBA or OSOPER operating system group.

The Startup/Shutdown: Select Operation page appears.

4. Click **Startup All** to start all the instances, or click **Shutdown All** to stop all the instances.

The Startup/Shutdown: Confirmation page appears.

5. Click **Yes**.

To start and stop individual instances, go to the Startup/Shutdown: Select Operation page and select the instance that you want to start or stop. Then start or stop the instance as needed.

Note: You can start up and shut down individual instances from each instance's home page. However, it is easier to perform instance startup and shutdown operations directly from the Startup/Shutdown: Select Operation page.

You can also start up and shut down instances using SQL*Plus or Server Control (SRVCTL).

See Also:

- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about using command-line interfaces to start and stop Oracle RAC database instances

About Oracle RAC Initialization Parameters

Managing initialization parameters for an Oracle RAC database is essentially the same as managing them for a single-instance Oracle database. Note the following differences for parameters in Oracle RAC databases:

- Parameters that are cluster-specific have the value Cluster Database in the Category column.
- Parameters that are the same on each instance in the Oracle RAC database are identified in the Instance column with an asterisk (*).
- Parameters that are set to different values on each instance of an Oracle RAC database are listed by instance number.

The administration of initialization parameters in an Oracle RAC environment is slightly different from single-instance database parameter administration. For example, if you change a parameter setting that is marked by an asterisk, which indicates that the parameter is a clusterwide database initialization parameter, then you change that parameter's setting for all the instances in your Oracle RAC database. If you change an initialization parameter prefixed with an instance name, or an instance-specific initialization parameter, then the change affects only that instance; the change does not affect the parameter's settings on other database instances.

This section contains the following topics:

- [Configuring Initialization Parameters for an Oracle RAC Database](#)
- [Editing Initialization Parameter Settings for an Oracle RAC Database](#)
- [About the Server Parameter File for Oracle Real Application Clusters](#)

See Also:

- *Oracle Database 2 Day DBA*
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about initialization parameters in an Oracle RAC environment

Configuring Initialization Parameters for an Oracle RAC Database

A server parameter file (SPFILE) is a type of repository for initialization parameters that is maintained on the server where the Oracle database server runs, or on shared storage for an Oracle RAC database. Initialization parameters stored in a server parameter file are persistent, in that any changes made to the parameters while an instance is running can persist across instance shutdown and startup.

An initialization parameter file is a text file that contains initialization parameter settings. In contrast to the SPFILE, this parameter file is not binary and does not need to be located on the database server. The text-based initialization parameter file can be read by the database, but it is not written to by the database.

By default, Oracle Database sets most parameters to a default value and this value is the same across all instances. However, many initialization parameters can also have different values on different instances as described in *Oracle Database Reference*. Other parameters *must* be either unique or identical across instances, as described in the following sections:

- [Parameters that Must Have Identical Settings on All Instances](#)
- [Parameters that Must Have Unique Settings on All Instances](#)

- [Parameters that Should Have Identical Settings on All Instances](#)

Parameters that Must Have Identical Settings on All Instances

Certain initialization parameters that are critical at database creation or that affect certain database operations must have the same value for every instance in an Oracle RAC database. Specify these parameter values in the SPFILE, or within the individual PFILES for each instance. The following list contains the parameters that must be identical on every instance:

- ACTIVE_INSTANCE_COUNT
- CLUSTER_DATABASE
- CLUSTER_DATABASE_INSTANCES
- COMPATIBLE
- CONTROL_FILES
- DB_BLOCK_SIZE
- DB_DOMAIN
- DB_FILES
- DB_NAME
- DB_RECOVERY_FILE_DEST
- DB_RECOVERY_FILE_DEST_SIZE
- DB_UNIQUE_NAME
- INSTANCE_TYPE (RDBMS or ASM)
- PARALLEL_MAX_SERVERS
- REMOTE_LOGIN_PASSWORD_FILE
- RESULT_CACHE_MAX_SIZE
- UNDO_MANAGEMENT

The setting for DML_LOCKS must be identical on every instance only if set to zero.

Parameters that Must Have Unique Settings on All Instances

Oracle RAC uses the INSTANCE_NUMBER parameter to distinguish among instances at startup. Oracle RAC uses the number value of the THREAD parameter to assign redo log groups to specific instances. To simplify administration, use the same number for both the THREAD and INSTANCE_NUMBER parameters for each instance.

If you use the ROLLBACK_SEGMENTS parameter to specify the names of the rollback segments to be used for storing the undo of each instance, then Oracle recommends you use the instance SID as part of each unique rollback segment name. If the parameter UNDO_MANAGEMENT is set to AUTO, automatic undo management mode is used by the Oracle RAC database, and the setting of the ROLLBACK_SEGMENTS parameter is ignored. When using automatic undo management, Oracle RAC generates unique names for the undo segments used by each instance.

If you use automatic undo management in your Oracle RAC database, then set the UNDO_TABLESPACE parameter to a different undo tablespace for each instance.

Parameters that Should Have Identical Settings on All Instances

Oracle recommends that you set the values for the following parameters to the same value on all instances. Although you can have different settings for these parameters on different instances, setting each parameter to the same value on all instances simplifies administration:

- `ARCHIVE_LAG_TARGET`

Different values for instances in your Oracle RAC database are likely to increase overhead because of additional automatic synchronization performed by the database processing.

When using Oracle Streams with your Oracle RAC database, the value should be greater than zero.

- `CONTROL_MANAGEMENT_PACK_ACCESS`

This parameter controls the use of the Diagnostics and Tuning Packs feature. You should set the value for this parameter on all instance to reflect whether or not you have not purchased the Diagnostics and Tuning Packs for your Oracle RAC database.

- `LICENSE_MAX_USERS`

This parameter determines a databasewide limit on the number of user accounts defined in the database and it is useful to have the same value on all instances of your database so you can see the current value no matter which instance you are using. Setting different values may generate additional warning messages during instance startup, or cause commands related to database user account management to fail on some instances.

- `LOG_ARCHIVE_FORMAT`

If you do not use the same value for all your instances, then you complicate media recovery. The recovering instance expects the required archive log file names to have the format defined by its own value of `LOG_ARCHIVE_FORMAT`, regardless of which instance created the archive log files.

Databases that support Oracle Data Guard, either to send or receive archive log files, must use the same value of `LOG_ARCHIVE_FORMAT` for all instances.

- `SPFILE`

If this parameter does not identify the same file to all instances, then each instance may act differently and unpredictably in failover, load-balancing, or standard operations. Additionally, a change you make to the `SPFILE` using an `ALTER SYSTEM SET` or `ALTER SYSTEM RESET` command is saved only in the `SPFILE` used by the instance where you run the command. Your change will not be reflected in instances using different `SPFILE`s.

If the `SPFILE` values are different in instances for which the values were set by the server, then you should restart the instances that are not using the default `SPFILE`.

- `UNDO_RETENTION`

By setting different values for `UNDO_RETENTION` in each instance, you are likely to reduce scalability and encounter unpredictable actions following a failover. Therefore, you should carefully consider whether or not you will accrue any benefits before you assign different values for this parameter to the instances in your Oracle RAC database.

Editing Initialization Parameter Settings for an Oracle RAC Database

You can use Enterprise Manager to view and edit the initialization parameter settings for your Oracle RAC database.

To view or modify the initialization parameters using Enterprise Manager:

1. On the Cluster Database Home page, while logged in as a SYSDBA user, click **Server**.

The Server page appears.

2. Select **Initialization Parameters** under Database Configuration.

The Initialization Parameters page appears.

3. Select either the **Current** or **SPFile** subpage to modify the parameter settings.

Modifying the Initialization Parameter for Oracle RAC Using the Current Tab

The Current subpage of the Initialization Parameters contains a list of configuration parameters for that instance and database. You can set these parameters to particular values to initialize many of the memory and process settings of an Oracle instance. When you modify initialization parameters using the Current tab, the changes are applied only to the running instances, not the SPFILE, unless the "Apply changes in current running instance(s) mode to SPFile" option is selected.

The Instance column shows the instances for which the parameter has the value listed in the table. An asterisk (*) indicates that the parameter has the same value for all remaining instances of the cluster database. For example, if `open_cursors = 200` for `docrac1` and `docrac2`, and `open_cursors = 275` for `docrac3`, then the Instance column for `open_cursors = 200` displays an asterisk, while displaying "docrac3" for `open_cursors = 275`. This shorthand saves space for cluster databases with many instances.

You can filter the Initialization Parameters page to show only those parameters that meet the criteria of the filter you enter in the Filter by name field. Optionally, you can select **Show All** to display on one page all parameters currently used by the running instance(s).

To modify parameter values using the Current tab:

1. On the Cluster Database Home page, while logged in as a SYSDBA user, click **Server**.

The Server page appears.

2. Select **Initialization Parameters** in the Database Configuration section.

The Initialization Parameters page appears.

3. Select **Current**.

4. Select a parameter from the **Select** column and do one of the following:

- Click **Add** to add the selected parameter to a different instance. Enter a new instance name and value in the newly created row in the table.
- Click **Reset** to reset the value of the selected parameter. Note that you may reset only parameters that do not have an asterisk in the Instance column. The value of the selected column is reset to the value of the remaining instances (that is, the row with the asterisk).

For example, select the parameter `OPEN_CURSORS`, then click **Add**. In the new entry for `OPEN_CURSORS`, select `docrac1` for the **Instance**, change the **Value** field to 250.

5. After you make changes to one or more of the parameters, click **Apply** to accept and invoke the changes.

Modifying the Initialization Parameter for Oracle RAC Using the SPFile Tab

Similar to the Current tab, you can Add or Reset parameters using the SPFile tab. When you modify initialization parameters using the SPFile tab, the changes are applied only to the SPFILE, not the currently running instances, unless the "Apply changes in SPFile mode to the current running instance(s)" option is selected.

Note that resetting parameters using the SPFile tab is different than resetting the same parameters using the Current tab: Reset deletes the selected parameter entry from the SPFILE and applies to both asterisk and nonasterisk parameters.

- If you reset a parameter with an asterisk in the Instance column, the entry will be deleted from both the SPFILE and the table. Only parameters without an asterisk (instance-specific parameters) will remain.
- If you reset the only entry for a nonasterisk parameter, it will be deleted from both the SPFILE and the table, but will be replaced by a *dummy* parameter with an empty value field and an asterisk in the Instance column; this enables you to specify a new value for the parameter, add new instance-specific entries for the parameter, and so on.

Resetting a parameter that is set for only one instance resets the value of that parameter.

To modify parameter values using the SPFile tab:

1. On the Cluster Database Home page, while logged in as a SYSDBA user, click **Server**.
The Server page appears.
2. Select **Initialization Parameters** in the Database Configuration section.
The Initialization Parameters page appears.
3. Select **SPFile**.
4. In the display, select a parameter from the **Select** column. Edit the entry to display to new value, then click **Apply** to apply the changes to the SPFILE.
5. For more information about each parameter, click the information icon in the Help column next to the parameter.

Example: Modifying the OPEN_CURSORS Parameter

Suppose that the `open_cursors` parameter has two entries in the SPFILE:

```
*.open_cursors = 200
docrac1.open_cursors = 250
```

If you click **Reset** for `*.open_cursors`, then Enterprise Manager deletes that entry from both the SPFILE and the displayed list of parameters, leaving only `docrac1.open_cursors = 250` displayed.

If you click **Reset** for `docrac1.open_cursors`, Enterprise Manager also deletes this parameter entry from both the SPFILE and the displayed list of parameters, but then a

new entry, `*.open_cursors = <EMPTY>` is added to the displayed list of parameters in place of the reset parameter.

See Also:

- *Oracle Database 2 Day DBA*
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about using a server parameter file in an Oracle Real Application Clusters environment

About Modifying the `SERVICE_NAMES` Parameter for Oracle RAC

The `SERVICE_NAMES` initialization parameter specifies one or more names by which clients can connect to the instance. The instance registers its service names with the listener. When a client requests a service, the listener determines which instances offer the requested service and routes the client to the appropriate instance.

In an Oracle RAC database, you should *not* modify this parameter directly. Instead, define services for your database and database instances using the Clustered Managed Database Services page in Enterprise Manager. If you need to change a service, you can use either Enterprise Manager or `SRVCTL`.

See Also:

- ["About Oracle Services"](#) on page 7-1

About the Server Parameter File for Oracle Real Application Clusters

When you create the database, Oracle creates an SPFILE in the file location that you specify. This location can be an ASM disk group, cluster file system file, or a shared raw device. In the environment described by this guide, the SPFILE is created on an ASM disk group.

All instances in the cluster database use the same SPFILE at startup. Oracle RAC uses a traditional parameter file only if an SPFILE does not exist or if you specify `PFILE` in your `STARTUP` command. Oracle recommends that you use an SPFILE to simplify administration, maintain parameter setting consistency, and to guarantee parameter setting persistence across database shutdown and startup events. In addition, you can configure RMAN to back up your SPFILE.

See Also:

- *Oracle Database 2 Day DBA*
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about using a server parameter file in an Oracle Real Application Clusters environment

About Administering Storage in Oracle RAC

Most administration tasks for managing storage are the same for Oracle single-instance and Oracle RAC databases. This section provides additional information for using Enterprise Manager to manage some of the storage structures of an Oracle RAC database.

This section describes the following topics:

- [About Automatic Undo Management in Oracle RAC](#)
- [About Automatic Storage Management in Oracle RAC](#)

- [About Administering Redo Logs in Oracle RAC](#)

About Automatic Undo Management in Oracle RAC

Oracle RAC automatically manages undo segments within a specific undo tablespace that is assigned to an instance. Only the instance assigned to the undo tablespace can modify the contents of that tablespace. However, each instance can read the undo data blocks created by any instance. Also, when performing transaction recovery, any instance can update any undo tablespace, as long as that undo tablespace is not currently being used by another instance for undo generation or transaction recovery.

You assign undo tablespaces in your Oracle RAC database by specifying a different value for the `UNDO_TABLESPACE` parameter for each instance in your SPFILE or individual PFILES. You cannot simultaneously use automatic undo management and manual undo management in an Oracle RAC database. In other words, all instances of an Oracle RAC database must operate in the same undo mode.

See Also:

- *Oracle Database 2 Day DBA* for more information about managing the undo data for your database

About Automatic Storage Management in Oracle RAC

ASM automatically optimizes storage to maximize performance by managing the storage configuration across the disks that ASM manages. ASM does this by evenly distributing the storage load across all the available storage within your cluster database environment. ASM partitions your total disk space requirements into uniformly sized units across all the disks in a disk group. ASM can also automatically mirror data to prevent data loss. Because of these features, ASM also significantly reduces your administrative overhead.

As in single-instance Oracle databases, using ASM in Oracle RAC does not require I/O tuning. The following topics describe ASM and ASM administration:

- [About ASM Components in Oracle RAC](#)
- [About Disk Group Configurations for ASM in Oracle RAC](#)
- [About Standalone ASM Disk Group Management](#)
- [About ASM Instance and Disk Group Management Using Enterprise Manager](#)

About ASM Components in Oracle RAC

When you create your database, Oracle Database creates one ASM instance on each node in your Oracle RAC environment if one does not already exist. Each ASM instance has either an SPFILE or PFILE type parameter file. For the environment described in this guide, the ASM instances use PFILES.

See Also:

- *Oracle Database 2 Day DBA*
- ["About Automatic Storage Management"](#)

About Disk Group Configurations for ASM in Oracle RAC

When you create a disk group for a cluster, or add new disks to an existing clustered disk group, you must prepare only the underlying physical storage on shared disks. The shared disk requirement is the only substantial difference between using ASM in

an Oracle RAC database compared to using it in a single-instance Oracle database. ASM automatically rebalances the storage load after you add or delete a disk or disk group.

In a cluster, each ASM instance manages the metadata updates to the disk groups for the node on which it is running. In addition, each ASM instance coordinates disk group metadata with other nodes in the cluster. As in single-instance Oracle databases, you can use Enterprise Manager, Oracle Database Configuration Assistant (DBCA), SQL*Plus, and SRVCTL to administer disk groups for ASM in an Oracle RAC environment.

See Also:

- *Oracle Database 2 Day DBA*
- *Oracle Database Storage Administrator's Guide* for information about how to use SQL*Plus to administer ASM instances

About Standalone ASM Disk Group Management

When you create a database using DBCA and you select the ASM storage option, DBCA creates the ASM instances for you if they do not already exist. You can also manage ASM instances and disk groups independently. You do not have to create a new database to modify ASM storage properties.

See Also:

- *Oracle Database 2 Day DBA*
- *Oracle Database Storage Administrator's Guide* for information about how to use the Automatic Storage Management command-line utility

About ASM Instance and Disk Group Management Using Enterprise Manager

You can perform administrative operations on ASM disk groups using Enterprise Manager such as adding and deleting them. You can also monitor ASM disk group performance as well as control disk group availability at the instance level. For example, some of the Oracle RAC-specific features for ASM that are provided by Enterprise Manager are the following:

- When you add a disk group, the disk group definition includes a check box to indicate whether or not the disk group is automatically mounted to all the cluster database instances.
- The default Disk Group Performance page displays instance-level performance details when you click a performance characteristic such as **Write Response Time** or **I/O Throughput**.
- When you mount and dismount ASM disk groups, you can use a check box to indicate which instances should mount or dismount a particular ASM Disk Group.

See Also:

- *Oracle Database Storage Administrator's Guide*
- *Oracle Database 2 Day DBA*

About Administering Redo Logs in Oracle RAC

Managing redo log files in Oracle RAC environments is similar to managing redo log files in single-instance Oracle Database environments. This section provides an

overview of some of the additional concepts and procedures for configuring redo log files in Oracle RAC environments.

See Also:

- *Oracle Database 2 Day DBA*
- *Oracle Database Storage Administrator's Guide*

About Redo Log Groups and Redo Threads in Oracle RAC Databases

Redo logs contain a record of changes that have been made to datafiles. In a single-instance Oracle database, redo logs are stored in two or more redo log file groups. Each of these groups contains a redo log file and possibly one or more mirrored copies of that file. In an Oracle RAC database, each instance requires its own set of redo log groups, which is known as a **redo thread**. Mirrored copies of the redo log files provide your system with extra protection against data loss that is due to hardware failures or data corruption. If a redo log file is unreadable, then the Oracle Database attempts to access its mirrored copy. You should place the redo log file mirrors on different disk devices from the primary redo log files.

Each instance's redo thread must contain at least two redo log groups. Oracle recommends that each of your instances has a redo thread that contains the same number of redo log groups and, as with single-instance Oracle databases, each group should contain the same number of members. For example, in an Oracle RAC database with two instances, each instance could have a redo thread that contains five redo log groups. This is a total of 10 redo log groups for the database. Each of these redo log groups could contain two members: a redo log and its mirrored copy. If you create your Oracle RAC database using DBCA, then your Oracle RAC database automatically implements a configuration that meets the Oracle recommendations.

In an Oracle RAC database, each instance writes and archives the redo log groups in its redo thread in the same manner that single-instance Oracle databases do. However, in recovery mode, the instance performing the recovery is able to read and process all the redo threads for the database, regardless of which instance generated the redo thread. This enables a running instance to recover the work completed by one or more failed instances. This also enables users to continue their work without waiting for the failed instance to be restarted. For example, assume that you have an Oracle RAC database with two instances, instance A and instance B. If instance A is down, then instance B can read the redo log files for both instance A and B to ensure a successful recovery.

In an Oracle RAC database, all the redo log files reside on shared storage. In addition, each instance must have access to the redo log files of all the other instances in the cluster. If your Oracle RAC database uses ASM, then ASM manages the shared storage for the redo log files and the access to those files.

See Also:

- *Oracle Database 2 Day DBA*
- *Oracle Database Storage Administrator's Guide*

Using Enterprise Manager to View and Create Online Redo Log Files

On the Redo Log Groups page, you can create additional redo log groups and add members to the redo log group. The Thread column identifies the instance, or redo thread, to which a redo log file belongs.

To access the redo log file groups Using Enterprise Manager:

1. On the Cluster Database Home Page, select **Server**.

The **Server** page appears.

2. In the Storage section, select **Redo Log Groups**.

See Also:

- *Oracle Real Application Clusters Administration and Deployment Guide* for additional information about redo threads in an Oracle RAC environment
- *Oracle Database Storage Administrator's Guide*
- *Oracle Database 2 Day DBA* for more information about creating online redo log files

Exploring Your Cluster Database: Oracle By Example Series

Oracle By Example (OBE) has a series of tutorials for Oracle RAC databases. This OBE takes you through the basic administrative tasks described in this chapter and includes annotated screenshots.

To view the Exploring Your Cluster Database OBE, go to the following URL

http://www.oracle.com/technology/obe/10gr2_db_vmware/manage/clusterintro/clusterintro.htm

Administering Oracle Clusterware Components

This chapter describes how to administer your Oracle Clusterware environment. It describes how to administer the voting disks and the Oracle Cluster Registry (OCR) in the following sections:

- [About Oracle Clusterware](#)
- [About Backing Up and Recovering Voting Disks](#)
- [Adding and Removing Voting Disks](#)
- [About Backing Up and Recovering the Oracle Cluster Registry](#)
- [About Changing the Oracle Cluster Registry Configuration](#)
- [About Troubleshooting the Oracle Cluster Registry](#)

About Oracle Clusterware

Oracle Real Application Clusters (Oracle RAC) uses Oracle Clusterware as the infrastructure that binds together multiple nodes that then operate as a single server. Oracle Clusterware is a portable cluster management solution that is integrated with Oracle Database. In an Oracle RAC environment, Oracle Clusterware monitors all Oracle components (such as instances and listeners). If a failure occurs, Oracle Clusterware automatically attempts to restart the failed component and also redirects operations to a surviving component.

Oracle Clusterware includes a high availability framework for managing any application that runs on your cluster. Oracle Clusterware manages applications to ensure they start when the system starts. Oracle Clusterware also monitors the applications to make sure that they are always available. For example, if an application process fails, then Oracle Clusterware attempts to restart the process based on scripts that you customize. If a node in the cluster fails, then you can program application processes that typically run on the failed node to restart on another node in the cluster.

Oracle Clusterware includes two important components: the voting disk and the OCR. The voting disk is a file that manages information about node membership, and the OCR is a file that manages cluster and Oracle RAC database configuration information.

The Oracle Clusterware installation process creates the voting disk and the OCR on shared storage. If you select the option for normal redundant copies during the installation process, then Oracle Clusterware automatically maintains redundant copies of these files to prevent the files from becoming single points of failure. The normal redundancy feature also eliminates the need for third-party storage

redundancy solutions. When you use normal redundancy, Oracle Clusterware automatically maintains two copies of the OCR file and three copies of the voting disk file.

About Backing Up and Recovering Voting Disks

High availability configurations have redundant hardware and software that maintain operations by avoiding single points of failure. When a component is down, Oracle Clusterware redirects its managed resources to a backup component.

The voting disk records node membership information. A node must be able to access more than half of the voting disks at any time. To avoid simultaneous loss of multiple voting disks, each voting disk should be on a storage device that does not share any components (controller, interconnect, and so on) with the storage devices used for the other voting disks.

For example, if you have five voting disks configured, then a node must be able to access at least three of the voting disks at any time. If a node cannot access the minimum required number of voting disks it is *evicted*, or removed, from the cluster. After the cause of the failure has been corrected and access to the voting disks has been restored, you can instruct Oracle Clusterware to recover the failed node and restore it to the cluster.

Backing Up Voting Disks

Because the node membership information does not usually change, you do not need to back up the voting disk every day. However, back up the voting disks at the following times:

- After installation
- After adding nodes to or deleting nodes from the cluster
- After performing voting disk `add` or `delete` operations

When you use the `dd` command for making backups of the voting disk, the backup can be performed while the Cluster Ready Services (CRS) process is active; you do not need to stop the `crsd.bin` process before taking a backup of the voting disk.

To make a backup copy of the voting disk:

1. Use the Linux `dd` command, as shown in the following example, where *voting_disk_name* is the name of the active voting disk and *backup_file_name* is the name of the file to which you want to back up the voting disk contents:

```
dd if=voting_disk_name of=backup_file_name
```

Perform this operation on every voting disk as needed.

2. If your voting disk is stored on a raw device, use the device name in place of *voting_disk_name*, for example:

```
dd if=/dev/sdd1 of=/tmp/voting.dmp
```

Recovering Voting Disks

If a voting disk is damaged, and no longer usable by Oracle Clusterware, you can recover the voting disk if you have a backup file.

To recover the voting disk from a backup:

1. Run the following command, where *backup_file_name* is the name of the voting disk backup file and *voting_disk_name* is the name of the active voting disk:

```
dd if=backup_file_name of=voting_disk_name
```

Adding and Removing Voting Disks

You can dynamically add and remove voting disks after installing Oracle RAC. Do this using the following commands where *path* is the fully qualified path for the additional voting disk.

To add or remove a voting disk:

1. Run the following command as the `root` user to add a voting disk:

```
crsctl add css votedisk path
```

2. Run the following command as the `root` user to remove a voting disk:

```
crsctl delete css votedisk path
```

Note: If your cluster is down, then you can use the `-force` option to modify the voting disk configuration when using either of these commands without interacting with active Oracle Clusterware daemons. However, you may corrupt your cluster configuration if you use the `-force` option while a cluster node is active.

About Backing Up and Recovering the Oracle Cluster Registry

Oracle Clusterware automatically creates OCR backups every 4 hours. At any one time, Oracle Clusterware always retains the latest 3 backup copies of the OCR that are 4 hours old, 1 day old, and 1 week old.

You cannot customize the backup frequencies or the number of files that Oracle Clusterware retains. You can use any backup software to copy the automatically generated backup files at least once daily to a different device from where the primary OCR file resides. The default location for generating backups on Red Hat Linux systems is `CRS_home/cdata/cluster_name` where *cluster_name* is the name of your cluster and *CRS_home* is the home directory of your Oracle Clusterware installation.

This section contains the following topics:

- [Viewing Available OCR Backups](#)
- [Backing Up the OCR](#)
- [About Recovering the OCR](#)

Viewing Available OCR Backups

Use the `ocrconfig` utility to view the backups generated automatically by Oracle Clusterware.

To find the most recent backup of the OCR:

1. Run the following command on any node in the cluster:

```
ocrconfig -showbackup
```

Backing Up the OCR

Because of the importance of OCR information, Oracle recommends that you use the `ocrconfig` utility to make copies of the automatically created backup files at least once a day.

In addition to using the automatically created OCR backup files, you should also export the OCR contents to a file before and after making significant configuration changes, such as adding or deleting nodes from your environment, modifying Oracle Clusterware resources, or creating a database. Exporting the OCR contents to a file lets you restore the OCR if your configuration changes cause errors. For example, if you have unresolvable configuration problems, or if you are unable to restart your cluster database after such changes, then you can restore your configuration by importing the saved OCR content from the valid configuration.

To export the contents of the OCR to a file:

1. Log in as the `root` user.
2. Use the following command, where `backup_file_name` is the name of the OCR backup file you want to create:

```
[root]# ocrconfig -export backup_file_name
```

About Recovering the OCR

There are two methods for recovering the OCR. The first method uses automatically generated OCR file copies and the second method uses manually created OCR export files.

This section contains the following topics:

- [Checking the Status of the OCR](#)
- [Restoring the OCR from Automatically Generated OCR Backups](#)
- [Recovering the OCR from an OCR Export File](#)

Checking the Status of the OCR

In event of a failure, before you attempt to restore the OCR, ensure that the OCR is unavailable.

To check the status of the OCR:

1. Run the following command:

```
ocrcheck
```

2. If this command does not display the message 'Device/File integrity check succeeded' for at least one copy of the OCR, then both the primary OCR and the OCR mirror have failed. You must restore the OCR from a backup.
3. If there is at least one copy of the OCR available, you can use that copy to restore the other copies of the OCR.

See Also:

- ["About the OCRCHECK Utility"](#)
- ["Repairing an OCR Configuration on a Local Node"](#)
- ["Replacing an OCR"](#)

Restoring the OCR from Automatically Generated OCR Backups

When restoring the OCR from automatically generated backups, you first have to determine which backup file you will use for the recovery.

To restore the OCR from an automatically generated backup on a Red Hat Linux system:

1. Log in as the `root` user.
2. Identify the available OCR backups using the `ocrconfig` command:

```
[root]# ocrconfig -showbackup
```

3. Review the contents of the backup using the following `ocrdump` command, where `file_name` is the name of the OCR backup file:

```
[root]# ocrdump -backupfile file_name
```

4. As the `root` user, stop Oracle Clusterware on all the nodes in your Oracle RAC cluster by executing the following command:

```
[root]# crsctl stop crs
```

Repeat this command on each node in your Oracle RAC cluster.

5. As the `root` user, restore the OCR by applying an OCR backup file that you identified in Step 1 using the following command, where `file_name` is the name of the OCR that you want to restore. Make sure that the OCR devices that you specify in the OCR configuration exist, and that these OCR devices are valid before running this command.

```
[root]# ocrconfig -restore file_name
```

6. As the `root` user, restart Oracle Clusterware on all the nodes in your cluster by restarting each node, or by running the following command:

```
[root]# crsctl start crs
```

Repeat this command on each node in your Oracle RAC cluster.

7. Use the Cluster Verification Utility (CVU) to verify the OCR integrity. Run the following command, where the `-n all` argument retrieves a list of all the cluster nodes that are configured as part of your cluster:

```
[root]# cluvfy comp ocr -n all [-verbose]
```

Recovering the OCR from an OCR Export File

The `ocrconfig -export` command creates a backup of the OCR, enabling you to restore the OCR using the `-import` option if your configuration changes cause errors.

To restore the previous configuration stored in the OCR from an OCR export file:

1. Place the OCR export file that you created previously using the `ocrconfig -export` command in an accessible directory on disk.

2. As the `root` user, stop Oracle Clusterware on all the nodes in your Oracle RAC cluster by executing the following command:

```
[root]# crsctl stop crs
```

Repeat this command on each node in your Oracle RAC cluster.

3. As the `root` user, restore the OCR data by importing the contents of the OCR export file using the following command, where `file_name` is the name of the OCR export file:

```
[root]# ocrconfig -import file_name
```

4. As the `root` user, restart Oracle Clusterware on all the nodes in your cluster by restarting each node, or by running the following command:

```
[root]# crsctl start crs
```

Repeat this command on each node in your Oracle RAC cluster.

5. Use the CVU to verify the OCR integrity. Run the following command, where the `-n all` argument retrieves a list of all the cluster nodes that are configured as part of your cluster:

```
[root]# cluvfy comp ocr -n all [-verbose]
```

Note: You cannot use the `ocrconfig` command to import an OCR backup file., only an OCR export file.

See Also:

- ["Viewing Available OCR Backups"](#)
- ["Backing Up the OCR"](#)

About Changing the Oracle Cluster Registry Configuration

This section describes how to administer the OCR. The OCR contains information about the cluster node list, which instances are running on which nodes, and information about Oracle Clusterware resource profiles for applications that have been modified to be managed by Oracle Clusterware.

This section contains the following topics:

- [Adding an OCR Location](#)
- [Replacing an OCR](#)
- [Repairing an OCR Configuration on a Local Node](#)
- [Removing an OCR](#)

Note: The operations in this section affect the OCR for the entire cluster. However, the `ocrconfig` command cannot modify OCR configuration information for nodes that are shut down or for nodes on which Oracle Clusterware is not running. Avoid shutting down nodes while modifying the OCR using the `ocrconfig` command.

Adding an OCR Location

You can add an OCR location after an upgrade or after completing the Oracle RAC installation. If you already have a mirror of the OCR, then you do not need to add an OCR location; Oracle Clusterware automatically manages two OCRs when you configure normal redundancy for the OCR. Oracle RAC environments do not support more than two OCRs, a primary OCR and a secondary OCR.

To add a primary or secondary OCR location:

1. Run the following command using either *destination_file* or *disk* to designate the target location of the primary OCR:

```
ocrconfig -replace ocr destination_file
ocrconfig -replace ocr disk
```

2. Run the following command using either *destination_file* or *disk* to designate the target location of the secondary OCR:

```
ocrconfig -replace ocrmirror destination_file
ocrconfig -replace ocrmirror disk
```

Note: You must be logged in as the `root` user to run the `ocrconfig` command.

Replacing an OCR

If you need to change the location of an existing OCR, or change the location of a failed OCR to the location of a working one, you can use the following procedure as long as one OCR file remains online.

To change the location of an OCR:

1. Use the `OCRCHECK` utility to verify that a copy of the OCR other than the one you are going to replace is *online*, using the following command:

```
ocrcheck
```

Note: The OCR that you are *replacing* can be either online or offline.

2. Use the following command to verify that Oracle Clusterware is running on the node on which the you are going to perform the replace operation:

```
crsctl check crs
```

3. Run the following command to replace the primary OCR using either *destination_file* or *disk* to indicate the target OCR location:

```
ocrconfig -replace ocr destination_file
ocrconfig -replace ocr disk
```

4. Run the following command to replace a secondary OCR using either *destination_file* or *disk* to indicate the target OCR location:

```
ocrconfig -replace ocrmirror destination_file
ocrconfig -replace ocrmirror disk
```

5. If any node that is part of your current Oracle RAC cluster is shut down, then run the following command on the stopped node to let that node rejoin the cluster after the node is restarted:

```
ocrconfig -repair
```

Repairing an OCR Configuration on a Local Node

You may need to repair an OCR configuration on a particular node if your OCR configuration changes while that node is stopped. For example, you may need to repair the OCR on a node that was shut down while you were adding, replacing, or removing an OCR.

To repair an OCR configuration:

1. Run the following command on the node on which you have stopped the Oracle Clusterware daemon:

```
ocrconfig -repair ocrmirror device_name
```

Note: You *cannot* perform this operation on a node on which the Oracle Clusterware daemon is running.

This operation changes the OCR configuration only on the node from which you run this command.

For example, if the OCR mirror is on a disk named `/dev/raw1`, then use the following command to repair its OCR configuration:

```
ocrconfig -repair ocrmirror /dev/raw1
```

Removing an OCR

To remove an OCR location, at least one OCR must be online. You can remove an OCR location to reduce OCR-related overhead or to stop mirroring your OCR because you moved the OCR to a redundant storage system, such as a redundant array of independent disks (RAID).

To remove an OCR location from your Oracle RAC cluster:

1. Use the OCRCHECK utility to ensure that at least one OCR other than the OCR that you are removing is online.

```
ocrcheck
```

Note: Do *not* perform this OCR removal procedure unless there is at least one active OCR online.

2. Run the following command on any node in the cluster to remove one copy of the OCR:

```
ocrconfig -replace ocr
```


This command updates the OCR configuration on all the nodes on which Oracle Clusterware is running.

About Troubleshooting the Oracle Cluster Registry

This section includes the following topics about troubleshooting the Oracle Cluster Registry (OCR):

- [About the OCRCHECK Utility](#)
- [Resolving Common Oracle Cluster Registry Problems](#)

About the OCRCHECK Utility

The OCRCHECK utility displays the data block format version used by the OCR, the available space and used space in the OCR, the ID used for the OCR, and the locations you have configured for the OCR. The OCRCHECK utility calculates a checksum for all the data blocks in all the OCRs that you have configured to verify the integrity of each block. It also returns an individual status for each OCR file as well as a result for the overall OCR integrity check. The following is a sample of the OCRCHECK output:

```
Status of Oracle Cluster Registry is as follows :
Version                :          2
Total space (kbytes)   :    262144
Used space (kbytes)    :     16256
Available space (kbytes) :   245888
ID                     : 1918913332
Device/File Name       : /dev/raw/raw1
                       : Device/File integrity check succeeded
Device/File Name       : /oradata/mirror.ocr
                       : Device/File integrity check succeeded
```

```
Cluster registry integrity check succeeded
```

The OCRCHECK utility creates a log file in the following directory, where *CRS_home* is the location of the installed Oracle Clusterware software, and *hostname* is the name of the local node:

```
CRS_home/log/hostname/client
```

The log files have names of the form *ocrcheck_nnnnn.log*, where *nnnnn* is the process ID of the operating session that issued the *ocrcheck* command.

Resolving Common Oracle Cluster Registry Problems

[Table 5–1](#) describes common OCR problems and their corresponding solutions.

Table 5–1 Common OCR Problems and Solutions

Problem	Solution
The OCR is not mirrored.	Run the <code>ocrconfig</code> command with the <code>-replace</code> option as described in the section "Replacing an OCR" on page 5-7.
An OCR mirror has failed and you must replace it. Error messages are being reported in Enterprise Manager or the OCR log file.	Run the <code>ocrconfig</code> command with the <code>-replace</code> option as described in the section "Adding an OCR Location" on page 5-7.

Table 5-1 (Cont.) Common OCR Problems and Solutions

Problem	Solution
An OCR has been incorrectly updated.	Run the <code>ocrconfig</code> command with the <code>-repair</code> option as described in the section "Repairing an OCR Configuration on a Local Node" on page 5-8.
You are experiencing a severe performance effect from OCR processing, or you want to remove an OCR for other reasons.	Run the <code>ocrconfig</code> command with the <code>-repair</code> option as described in the section "Repairing an OCR Configuration on a Local Node" on page 5-8.

See Also:

- ["About Verifying the Oracle Clusterware Installation"](#)
- ["Replacing an OCR"](#)
- ["Adding an OCR Location"](#)
- ["Repairing an OCR Configuration on a Local Node"](#)

Administering Backup and Recovery

This chapter describes how to back up and recover an Oracle Real Application Clusters (Oracle RAC) database.

This chapter contains the following sections:

- [Overview of Oracle RAC Database Backup and Recovery](#)
- [About the Flash Recovery Area in Oracle RAC](#)
- [About Archiving in Oracle RAC](#)
- [Credentials for Performing Enterprise Manager Backup and Recovery](#)
- [Performing Backups of Your Oracle RAC Database](#)
- [About Preparing to Restore and Recover Your Oracle RAC Database](#)
- [Recovering Your Oracle RAC Database](#)
- [About Managing Your Database Backup Files](#)
- [Displaying Backup Reports for Your Oracle RAC Database](#)
- [Performing Backups and Recovering Your Database: Oracle By Example Series](#)

See Also:

- *Oracle Database 2 Day DBA*
- *Oracle Database Backup and Recovery User's Guide* for more information about using the Recovery Manager utility

Overview of Oracle RAC Database Backup and Recovery

To protect your Oracle RAC database from hardware failures or disasters, you need to have a physical copy of the database files. The files protected by the backup and recovery facilities built into Oracle Enterprise Manager include datafiles, control files, server parameter files (SPFILEs), and archived redo log files. Using these files, your database can be reconstructed. The backup mechanisms that work at the physical level protect against damage at the file level, such as the accidental deletion of a datafile or the failure of a disk drive. **Database recovery** involves restoring, or copying, the damaged files from backup and performing media recovery on the restored files. **Media recovery** is the application of redo logs or incremental backups to a restored datafile in order to update it to the current time or some other specified time.

The Oracle Database flashback features, such as Oracle Flashback Drop and Oracle Flashback Table, provide a range of physical and logical data recovery tools as efficient, easy-to-use alternatives to physical and logical backup operations. The

flashback features enable you to reverse the effects of unwanted database changes without restoring datafiles from backup or performing media recovery.

The Enterprise Manager physical backup and recovery features are built on the Recovery Manager (RMAN) command-line client. Enterprise Manager makes available many of the RMAN features, and provides wizards and automatic strategies to simplify and further automate RMAN-based backup and recovery.

The Enterprise Manager Guided Recovery capability provides a Recovery Wizard that encapsulates the logic required for a wide range of file restoration and recovery scenarios, including the following:

- Complete restoration and recovery of the database
- Point-in-time recovery of the database or selected tablespaces
- Flashback Database
- Other flashback features of Oracle Database for logical-level repair of unwanted changes to database objects
- Media recovery at the block level for datafiles with corrupt blocks

If the database files are damaged or need recovery, Enterprise Manager can determine which parts of the database must be restored from a backup and recovered, including proactively detecting situations such as corrupted database files. Enterprise Manager guides you through the recovery process, prompting for needed information and performing the required recovery actions.

See Also:

- ["Performing Backups of Your Oracle RAC Database"](#)
- ["Recovering Your Oracle RAC Database"](#)
- ["About Managing Your Database Backup Files"](#)
- *Oracle Database 2 Day DBA*

About the Flash Recovery Area in Oracle RAC

Using a flash recovery area minimizes the need to manually manage disk space for your backup-related files and balance the use of space among the different types of files. Oracle recommends that you enable a flash recovery area to simplify your backup management.

The larger the flash recovery area is, the more useful it becomes. Ideally, the flash recovery area should be large enough to contain all the following files:

- A copy of all datafiles
- Incremental backups
- Online redo logs
- Archived redo log files that have not yet been backed up
- Control files and control file copies
- Autobackups of the control file and database initialization parameter file

The preferred configuration for Oracle RAC is to use Automatic Storage Management (ASM) for a recovery area using a different disk group for your recovery set than for your datafiles. Alternatively, you can use a cluster file system archiving scheme.

The location and disk quota must be the same on all instances. To accomplish this, Oracle recommends that you place the flash recovery area on the shared ASM disks. In addition, you must set the `DB_RECOVERY_FILE_DEST` and `DB_RECOVERY_FILE_DEST_SIZE` parameters to the same values on all instances.

To use the Flash Recovery feature, you must first configure the flash recovery area for each instance in your Oracle RAC cluster.

About Archiving in Oracle RAC

When you archive your redo log, you write redo log files to another location prior to their being overwritten. This location is called the archive log. These copies of redo log files extend the amount of redo data that can be saved and used for recovery. Archiving can be either enabled or disabled for the database, but Oracle recommends that you enable archiving.

When you use Oracle Database Configuration Assistant (DBCA) to create your Oracle RAC database, each instance is configured with at least two redo log files that are stored in the shared storage. If you use a cluster file system, then these files are shared file system files. If you do not have a cluster file system, then these files are raw devices. If you use ASM, then these files are stored on the ASM disk group.

Configuring Archiving for Your Oracle RAC Database

For Oracle Real Application Clusters, each instance has its own thread of redo. The preferred configuration for Oracle RAC is to configure the flash recovery area using an ASM disk group that is separate from the ASM disk group used for your datafiles. Alternatively, you can use a cluster file system archiving scheme.

To configure archiving for your Oracle RAC database:

1. On the Enterprise Manager Database Control Home page, while logged in as a SYSDBA user, select **Availability**.

The Availability subpage appears.

2. In the Backup/Recovery section, under the heading Setup, select **Recovery Settings**.

The Recovery Settings page appears.

3. In the Media Recovery section, select the **ARCHIVELOG mode** option.

4. In the **Log Archive Filename Format** field, accept the default value, or enter the desired format, then click **Apply**.

For clustered databases, the format for the archive log file name should contain the `%t` modifier, to indicate which redo log thread the archived redo log file belongs to. As a best practice, the format for the archive log file name should also include the `%s` (log sequence number) and `%r` (resetlogs identifier) modifiers.

5. If the archive log destination is the same for all instances, then in the **Archive Log Destination** field, change the value to the location of the archive log destination for the cluster database.

For example, you might set it to `+DATA` if using ASM, or to `/u01/oradata/arch` if you want local archiving on each node.

If you need to configure a different archive log destination for any instance, you must go to the Initialization Parameters page and modify the `LOG_ARCHIVE_DEST_1` parameter that corresponds to the instance for which you

want to configure the archive log destination. The Instance column should display the name of the instance, for example `docrac1`. Change the **Value** field to contain the location of the archive log destination for that instance.

6. If you want to configure more than one archive log destination for the database, on the Recovery Settings page, click **Add Another Row** under the Archive Log Destination field.
7. After you have finished configuring archiving, click **Apply**.
When prompted to restart the database, click **Yes**.
8. Enter the host and SYSDBA user credentials, then click **Continue**.
9. Wait a couple of minutes, then click **Refresh**.

If the database has been restarted, you are prompted to enter the login credentials.

See Also:

- ["About Archiving in Oracle RAC"](#)
- ["Configuring Initialization Parameters for an Oracle RAC Database"](#)
- ["Editing Initialization Parameter Settings for an Oracle RAC Database"](#)
- *Oracle Database 2 Day DBA*
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about configuring and managing archived redo log files for an Oracle RAC database

About Instance Access to Archived Redo Log Files

An instance does not need access to the archived redo log files from a different instance except when performing backup or recovery operations. When performing backup operations across instances, the archive log naming scheme that you use is important because when an instance writes to a log with a specific file name on its file system, that file must be readable by any instance that needs to access this archived redo log file.

Also, the backup and recovery strategy that you implement for your Oracle RAC database depends on how you configure the archiving destinations for each instance.

If you use ASM to store the archived redo log files for your Oracle RAC database, then each instance automatically has access to all the archived redo log files generated by the database. If you use shared storage or raw devices to store the archived redo log files on each node, then you must configure the operating system to grant access to those directories for each instance of the cluster database that needs access to them.

See Also:

- ["About Archiving in Oracle RAC"](#)
- ["Configuring Archiving for Your Oracle RAC Database"](#)
- *Oracle Database 2 Day DBA*
- *Oracle Database Storage Administrator's Guide*

Credentials for Performing Enterprise Manager Backup and Recovery

You must have the proper credentials to perform some of the configuration tasks for backup and recovery, and to schedule backup jobs and perform recovery. The following credentials may be required:

- The Oracle database administrator user you use when you log in to Enterprise Manager
- The host operating system user whose credentials you provide when performing backup and recovery tasks

To perform or schedule RMAN tasks, you must either log in to Enterprise Manager as a user with SYSDBA privileges, or provide host operating system credentials for a user who is a member of the dba group. The host operating system user must also have execute permission for the RMAN command-line client.

For tasks requiring host operating system credentials, a Host Credentials form appears at the bottom of the page used to perform the task. Enterprise Manager uses the credentials when it invokes RMAN to perform jobs you requested or scheduled.

The Host Credentials form always includes an option labeled Save as Preferred Credential. If you select this option before performing your action, then the provided credentials are stored persistently for the currently logged-in Oracle database user. The preferred credentials are reused by default whenever you log in as that user and perform operations requiring host credentials.

See Also:

- ["Configuring Operating System Users and Groups"](#)
- ["About Configuring User Accounts"](#)
- *Oracle Database 2 Day DBA*

About Configuring Backup Settings

Assuming you have a flash recovery area configured, you can configure a number of settings and policies that determine how backups are stored, which data is backed up, and how long backups are retained before being purged from the flash recovery area. You can also configure settings to optimize backup performance for your environment.

See Also:

- ["Configuring Archiving for Your Oracle RAC Database"](#)
- ["Overview of Oracle RAC Database Backup and Recovery"](#)
- *Oracle Database 2 Day DBA* for more information about configuring backup policy settings
- *Oracle Database 2 Day DBA* for more information about configuring backup settings

Performing Backups of Your Oracle RAC Database

When you use ASM to manage database files, Oracle recommends that you use RMAN for creating backups. You must have both database (SYSDBA) privileges and host operating system (OSDBA) credentials to perform backup and recovery operations.

If you log in to Enterprise Manager with `SYSDBA` privileges, any operating system user who has execute permission for the RMAN command-line client can perform backups of an Oracle RAC database. However, if you log in as a database user without `SYSDBA` privileges, then you must provide the name and password of an operating system user that is a member of the `OSDBA` group before you can perform the backup operation.

To back up an Oracle RAC database:

1. On the Cluster Database Home page, select **Availability**.
The Cluster Database Availability page appears.
2. In the Backup/Recovery section, under the heading Manage, select **Schedule Backup**.
3. Follow the backup procedures outlined in Chapter 9, "Performing Backup and Recovery" of *Oracle Database 2 Day DBA*.

See Also:

- ["Configuring Operating System Users and Groups"](#)
- ["Credentials for Performing Enterprise Manager Backup and Recovery"](#)
- *Oracle Database 2 Day DBA* for more information about configuring your database for backup and recovery
- *Oracle Database 2 Day DBA* for more information about performing and scheduling backups using Enterprise Manager Database Control

About Parallelism and Backups Across Multiple Channels

RMAN depends on server sessions, processes that run on the database server, to perform backup and recovery tasks. Each server session in turn corresponds to an RMAN channel, representing one stream of data to or from a backup device. RMAN supports parallelism, which is the use of multiple channels and server sessions to carry out the work of a single backup job or file restoration task.

Because the control file, `SPFILE`, and datafiles are accessible by any instance, the backup operation of these files is distributed across all the allocated channels. For backups of archived redo log files, the actions performed by RMAN depend on the type of archiving scheme used by your Oracle RAC database.

If you use a local archiving scheme, then each instance writes the archived redo log files to a local directory. When multiple channels are allocated that have access to the archived redo logs, for each archived redo log file, RMAN determines which channels have access to that archived redo log file. Then, RMAN groups together the archived redo log files that can be accessed by a channel and schedules a backup job using that channel.

If each node in the cluster writes the archived redo log file files to ASM, a clustered file system, or other type of shared storage, then each instance has access to all the archived redo log file files. In this case, the backup of the archived redo log file files is distributed across all the allocated channels.

See Also:

- ["About Archiving in Oracle RAC"](#)
- ["Performing Backups of Your Oracle RAC Database"](#)
- *Oracle Database 2 Day DBA* for more information about RMAN backups
- *Oracle Database 2 Day DBA* for more information about configuring backup device settings

Backing Up Archived Redo Log Files

Whether only one node or all nodes perform archive log backups, ensure that all archived redo log files for all nodes are backed up. If you use a local archiving scheme, then allocate multiple channels to provide RMAN access to all the archived redo log files.

You can configure RMAN to automatically delete the archived redo log files from disk after they have been safely backed up. This feature helps to reduce the disk space used by your Oracle RAC database, and prevent an unnecessary outage that might occur if you run out of available disk space.

To configure RMAN to automatically delete the archived redo log file files from disk after they have been safely backed up, when creating or scheduling your database backups:

1. Select **Also back up all archived logs** on disk if you are performing an online backup. There is no need to back up archived redo log files when performing an offline backup because the database is in a consistent state at the time of backup and does not require media recovery if you restore.
2. Select **Delete all archived logs from disk after they are successfully backed up** if you are using shared storage for your archived redo log files.

Note: Do not select **Delete all archived logs from disk after they are successfully backed up** if you are using a flash recovery area as your *only* archive log destination. In this case, archived redo log files that have been backed up are deleted automatically as space is needed for storage of other files.

See Also:

- ["Performing Backups of Your Oracle RAC Database"](#)
- ["About Archiving in Oracle RAC"](#)
- *Oracle Database 2 Day DBA*

About Preparing to Restore and Recover Your Oracle RAC Database

The Enterprise Manager Guided Recovery capability provides a Recovery Wizard that encapsulates the logic required for a wide range of restore and recovery scenarios. Enterprise Manager can determine which parts of the database must be restored and recovered, including proactively detecting situations such as corrupted database files. Enterprise Managers takes you through the recovery process, prompting for information and performing required file restoration and recovery actions.

The node that performs the recovery of an Oracle RAC database must be able to restore all the required datafiles. That node must also be able to either read all the required archived redo log files on disk or be able to restore the archived redo log files from backup files.

This section contains the following topics:

- [About Configuring Access to the Archive Log](#)
- [About Putting the Oracle RAC Database Instances into the Correct State](#)

About Configuring Access to the Archive Log

During recovery, as long as the archive log file destinations are visible from the node that performs the recovery, Oracle RAC can successfully access the archived redo log files during recovery.

If you do not use shared storage or a clustered file system to store the archived redo log files for your cluster database, then you need to make the archived redo log files available to the node performing the recovery.

About Putting the Oracle RAC Database Instances into the Correct State

Recovery of a failed instance in Oracle RAC is automatic. If an Oracle RAC database instance fails, then a surviving database instance processes the online redo logs generated by the failed instance to ensure that the database contents are in a consistent state. When recovery completes, Oracle Clusterware attempts to restart the failed instance automatically.

Media recovery is a manual process that occurs while a database is closed. A media failure is the failure of a read or write operation of a disk file required to run the database, due to a physical problem with the disk such as a head malfunction. Any database file can be vulnerable to a media failure. If a media failure occurs, then you must perform media recovery to restore and recover the damaged database files. Media recovery is always done by one instance in the cluster.

Before starting media recovery, the instance that will be performing the recovery should be started in MOUNT mode. The other instances should be started in NOMOUNT mode.

See Also:

- ["Starting and Stopping Oracle RAC Databases and Database Instances"](#)
- ["About Preparing to Restore and Recover Your Oracle RAC Database"](#)
- *Oracle Database 2 Day DBA*

Recovering Your Oracle RAC Database

This section discusses both instance recovery and media recovery. It contains the following topics:

- [Recovering the Oracle RAC Database Using Enterprise Manager](#)
- [Recovering the Parameter File from an Automatic File Backup](#)
- [About Restoring Archived Redo Log File Files](#)
- [About Performing Recovery Using Parallelism](#)

Recovering the Oracle RAC Database Using Enterprise Manager

When using Enterprise Manager and RMAN, the process of recovering and restoring an Oracle RAC database is essentially the same as for a single-instance Oracle databases, except that you access RMAN from the Availability page at the cluster database level, instead of at the instance level.

To use Enterprise Manager and RMAN to restore and recover an Oracle RAC database:

1. On the Cluster Database Home Page, select **Availability**.
The Cluster Database Availability page appears.
2. In the Backup/Recovery section, under the heading Manage, select **Perform Recovery**.
3. Follow the recovery procedures outlined in Chapter 9 of *Oracle Database 2 Day DBA*

See Also:

- ["About Preparing to Restore and Recover Your Oracle RAC Database"](#)
- ["Credentials for Performing Enterprise Manager Backup and Recovery"](#)
- *Oracle Database 2 Day DBA* for more information about performing user-directed recovery

Recovering the Parameter File from an Automatic File Backup

You can use Enterprise Manager to recover a lost or damaged server parameter file (SPFILE).

To recover an SPFILE for an Oracle RAC database:

1. Start the database in the MOUNT.
2. On the Cluster Database Home page, select **Availability**.
The Cluster Database Availability page appears.
3. In the Backup/Recovery section, under the heading Manager, select **Perform Recovery**.
When the database is not open, the Perform Recovery link takes you to the SPFILE restore page.
4. Specify the location of the flash recovery area, if configured.
5. In the Backup Information section, select **Use Other Backup Information** and **Use an Autobackup**.
6. On the Perform Recovery: Restore SPFILE page, specify a different location for the SPFILE to be restored to.
7. When finished selecting your options, click **Restore**, then click **Yes** to confirm you want to restore the SPFILE.
8. After the SPFILE is restored, you are prompted to login to the database again.

See Also:

- ["Starting and Stopping Oracle RAC Databases and Database Instances"](#)
- ["About the Server Parameter File for Oracle Real Application Clusters"](#)
- *Oracle Database Backup and Recovery User's Guide* for more information about recovering a server parameter file

About Restoring Archived Redo Log File Files

During a restore operation, RMAN automatically locates the most recent backups of the database that are available. A channel connected to a specific node attempts to restore files that were backed up only to that node. For example, assume that an archived redo log file with the sequence number 1001 is backed up to a device attached to the node `docrac1`, while the archived redo log file with sequence number 1002 is backed up to a device attached to the node `docrac2`. If you allocate channels that connect to nodes `docrac1` and `docrac2` for a restore operation, then the channel connected to `docrac1` restores log sequence 1001, but not log sequence 1002. The channel connected to `docrac2` can restore log sequence 1002, but not log sequence 1001.

If you use ASM or a clustered file system for storing the archived redo log files, then any instance can restore the archived redo log files.

See Also:

- ["About Archiving in Oracle RAC"](#)
- ["Configuring Archiving for Your Oracle RAC Database"](#)
- *Oracle Database Backup and Recovery User's Guide* for more information about restoring archived redo log file files

About Performing Recovery Using Parallelism

Oracle RAC automatically selects the optimum degree of parallelism for instance failure and media recovery.

When using Enterprise Manager and RMAN to perform the recovery, Oracle RAC automatically makes parallel the following three stages of recovery:

- **Restoring Datafiles**—When restoring datafiles, the number of channels you allocate in the RMAN recovery script effectively sets the parallelism that RMAN uses. For example, if you allocate five channels, you can have up to five parallel streams restoring datafiles.
- **Applying Incremental Backups**—Similarly, when you are applying incremental backups, the number of channels you allocate determines the potential parallelism.
- **Applying Archived Redo Log Files**—Using RMAN, the application of archived redo log files is performed in parallel. Oracle RAC automatically selects the optimum degree of parallelism based on available CPU resources.

See Also:

- ["Recovering Your Oracle RAC Database"](#)
- ["Overview of Oracle RAC Database Backup and Recovery"](#)
- *Oracle Database 2 Day DBA* for more information about incremental backups of datafiles
- *Oracle Database 2 Day DBA* for more information about configuring recovery settings

About Managing Your Database Backup Files

Managing RMAN backup files, with or without Enterprise Manager, consists of two tasks:

1. Managing the backup files for your database that are stored on disk or tape
2. Managing the record of those backup files in the RMAN repository

Enterprise Manager simplifies both backup file management tasks. Some of the other tasks involved in managing backup files include the following:

- Searching for backup files
- Validating the contents of backup sets or image copies
- Cross-checking a backup
- Deleting expired or obsolete backup files
- Marking backup files as available or unavailable

See Also:

- *Oracle Database 2 Day DBA* for more information about these topics and details on how to perform these tasks

Displaying Backup Reports for Your Oracle RAC Database

Backup reports contain summary and detailed information about past backup jobs run by RMAN, including backup jobs run through Enterprise Manager and the RMAN command-line client.

To view backup reports:

1. On the Cluster Database Home page, select **Availability**.
The Availability page appears.
2. In the Backup/Recovery section, under the heading Manage, select **Backup Reports**.
The View Backup Report page appears, with a list of recent backup jobs.
3. In the Search section, specify any filter conditions and click **Go** to restrict the list to backups of interest.

You can use the **Search** section of the page to restrict the backups listed by the time of the backup, the type of data backed up, and the status of the jobs (whether it succeeded or failed, and whether or not warnings were generated during the job).

4. To view detailed information about any backup, click the backup job name in the **Backup Name** column.

The Backup Report page is displayed for the selected backup job. This page contains summary information about this backup job, such as how many files of each type were backed up, the total size of the data backed up, and the number, size, and type of backup files created.

The Backup Report page also contains a Search section that you can use to quickly run a search for another backup job or backup jobs from a specific date range. The resulting report contains aggregate information for backup jobs matching the search criteria.

See Also:

- ["About Managing Your Database Backup Files"](#)
- ["Performing Backups of Your Oracle RAC Database"](#)
- ["Overview of Oracle RAC Database Backup and Recovery"](#)
- *Oracle Database 2 Day DBA*

Performing Backups and Recovering Your Database: Oracle By Example Series

Oracle By Example (OBE) has a series of tutorials for Oracle RAC databases. This OBE takes you through the basic administrative tasks described in this chapter and includes annotated screenshots.

To view the Performing Backups and Recovering Your Database OBE, go to the following URL

http://www.oracle.com/technology/obe/10gr2_db_vmware/ha/rman/rman.htm

Managing Database Workload Using Services

Using workload management, you can distribute the workload across database instances to achieve optimal database and cluster performance for users and applications. This chapter contains the following sections:

- [About Workload Management](#)
- [Creating Services](#)
- [Administering Services](#)
- [Configuring Clients for Failover](#)
- [Transparent Application Failover: Oracle By Example Series](#)

About Workload Management

To implement workload management for an Oracle Real Application Clusters (Oracle RAC) database, you can use a number of different features. This section contains the following topics:

- [About Oracle Services](#)
- [About the Database Resource Manager](#)
- [About Oracle RAC High Availability Framework](#)
- [About the Load Balancing Advisory](#)
- [About Connection Load Balancing](#)
- [About Runtime Connection Load Balancing](#)
- [About Fast Application Notification \(FAN\)](#)

You can deploy Oracle RAC and single-instance Oracle database environments to use workload management features in many different ways. Depending on the number of nodes and your environment's complexity and objectives, your choices for the optimal workload management and high availability configuration depend on a variety of considerations that this section describes.

About Oracle Services

Oracle Database 10g introduced an automatic workload management facility, called services. A service represents the workload of applications with common attributes, performance thresholds, and priorities. A single service can represent an application, multiple applications or a subset of a single application. A single service can be

associated with one or more instances of an Oracle RAC database, and a single instance can support multiple services. Services provide a single entity for managing applications that compete for the same resources, and they allow each workload to be managed as a single unit.

To manage workloads, you can define services that you assign to a particular application or to a subset of an application's operations. You can also use services to manage the workload for different types of work. For example, online users can use one service while batch processing can use a different service and reporting can use yet another service type.

When a user or application connects to a database, Oracle recommends that you use a service for the connection. Oracle Database automatically creates one database service when the database is created. For many installations, this may be all you need. For more flexibility in the management of the workload using the database, Oracle Database enables you to create multiple services and specify which database instances offer the services.

Services are integrated with the Database Resource Manager, which enables you to restrict the resources that are used by a service within an instance. In addition, Oracle Scheduler jobs can run using a service, as opposed to using a specific instance.

See Also:

- ["Creating Services"](#)
- ["Administering Services"](#)
- ["About Workload Management"](#)
- *Oracle Database 2 Day DBA*
- *Oracle Database Administrator's Guide*

About Configuring Services for High Availability

When you create a service, you define which instances typically support that service. These are known as the **preferred** instances for that service. You can also define other instances to support a service if the service's preferred instances fail. These are known as **available** instances for a service.

When you specify a preferred instance for a service, the service runs on that instance during standard operation. Oracle Clusterware attempts to ensure that the service always runs on all the preferred instances that have been configured for a service. If the instance fails, the service is randomly relocated to another preferred instance or one of the available instances. You can also manually relocate the service to an available instance. If you do not specify preferred or available instances when you create a service, then by default, every instance in the Oracle RAC database is a preferred instance for that service.

If a service fails over to an available instance, the service is not moved back to its preferred instance automatically. However, you can automate the relocation of a service to its preferred instance by using a callout. For more information about callouts, see ["About FAN Callouts"](#) on page 7-8. An example callout script for relocating services back to their preferred instances is available in the Oracle Real Application Clusters Sample Code section on Oracle Technology Network at http://www.oracle.com/technology/sample_code/products/rac/

You do not have to specify available instances for a service. However, if you configure a preferred instance for a service, but do not specify at least one available instance for

the service, then the service does not relocate to another instance if the preferred instance fails.

You can also specify an instance as Not Used. This setting means the service does not run on the instance, even if the preferred instance for the service fails.

See Also:

- ["About FAN Callouts"](#)
- ["Creating Services"](#)
- ["About Workload Management"](#)

About the Database Resource Manager

The Database Resource Manager controls database resources allocated to users, applications, and services. This approach ensures that users, applications, and services receive their share of the available database resources. The Database Resource Manager enables an Oracle RAC database running on one or more nodes to support multiple applications and mixed workloads with optimal efficiency.

The Database Resource Manager provides the ability to prioritize work within an Oracle database or your Oracle RAC environment. For example, high priority users, such as online workers, would get more resources to minimize response time, while lower priority users, such as batch jobs or reports, would get fewer resources, and could take longer to run. This allows for more granular control over resources.

Resources are allocated to users according to a resource plan specified by the database administrator. The following terms are used in specifying a resource plan:

- A *resource plan* specifies how the resources are to be distributed among various users (resource consumer groups).
- *Resource consumer groups* allow the administrator to group user sessions together by resource requirements. Resource consumer groups are different from user roles; one database user can have different sessions assigned to different resource consumer groups.
- *Resource allocation methods* are the methods or policies used by the Database Resource Manager when allocating for a particular resource. Resource allocation methods are used by resource consumer groups and resource plans. The database provides the resource allocation methods that are available, but the DBA determines which method to use.
- *Resource plan directives* are a means of assigning consumer groups to particular plans and partitioning resources among consumer groups by specifying parameters for each resource allocation method.
- *Subplans*, which the DBA can create within a resource plan, allow further subdivision of resources among different users of an application.
- *Levels* provide a mechanism to specify distribution of unused resources among available users. Up to eight levels of resource allocation can be specified.

The Database Resource Manager enables you to map a resource consumer group to a service so that users who connect using that service are members of the specified resource consumer group, and thus restricted to the resources available to that resource consumer group.

See Also:

- ["About Workload Management"](#)
- *Oracle Database Administrator's Guide* for more information about the Database Resource Manager

About Oracle RAC High Availability Framework

The Oracle RAC high availability framework enables Oracle RAC to maintain the database, components, and applications in a running state at all times. If an instance, component, or application fails, it can be automatically restarted to keep Oracle Database operating at full capacity.

Oracle Database focuses on maintaining service availability. In Oracle RAC, Oracle services are designed to be continuously available with workloads shared across one or more instances. The Oracle RAC high availability framework maintains service availability by storing the configuration information for each service in the Oracle Cluster Registry (OCR). Oracle Clusterware recovers and balances services across instances based on the service definition.

See Also:

- ["About Oracle Clusterware"](#)
- ["About Workload Management"](#)

About the Load Balancing Advisory

The Load Balancing Advisory provides information to applications or clients about the current service levels that the Oracle RAC database instances are providing. The Load Balancing Advisory makes recommendations to applications about which instance to direct application requests for a database service, in order to obtain the best performance based on the workload management directives that you have defined for that service.

The advice given by the Load Balancing Advisory takes into account the power of the server as well as the current workload of the service on the server. Enabling the Load Balancing Advisory helps improve the throughput of applications by not sending work to instances that are overworked, running slowly, not responding, or have failed.

The best way to take advantage of the Load Balancing Advisory is to use an integrated Oracle client, one that has the Runtime Connection Load Balancing feature. Due to the integration with Fast Application Notification (FAN), Oracle integrated clients are more aware of the current status of an Oracle RAC cluster. This prevents client connections from waiting or trying to connect to an instance that is no longer available. Also, when an instance is restarted, Oracle RAC uses FAN to notify the application's connection pool so that the connection pool can create connections to the recently started instance and take advantage of the additional resources that this instance provides.

You configure your Oracle RAC environment to use the Load Balancing Advisory by defining service-level goals for each service used. This enables the Load Balancing Advisory for that service and enables the publication of FAN load balancing events. There are two types of service-level goals for Runtime Connection Load Balancing:

- **Service Time**—The Load Balancing Advisory attempts to direct work requests to instances according to their response time. Load Balancing Advisory data is based on the elapsed time for work done by connections using the service, as well as available bandwidth to the service.

- Throughput—The Load Balancing Advisory measures the percentage of the total response time that the CPU consumes for the service. This measures the efficiency of an instance, rather than the response time.

If you do not select the Enable Load Balancing Advisory option, the service-level goal is set to None, which disables load balancing for that service.

See Also:

- ["About Fast Application Notification \(FAN\)"](#)
- ["About Connection Load Balancing"](#)
- ["Administering Services"](#)
- ["About Workload Management"](#)
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about integrated Oracle clients

About Connection Load Balancing

Oracle Net is a software component that resides on the client and on the Oracle database server. It establishes and maintains the connection between the client application and the server, and exchanges messages between them using industry standard protocols. For the client application and a database to communicate, the client application must specify location details for the database it wants to connect to, and the database must provide some sort of identification or address.

On the database server, the Oracle Net Listener, commonly known as the listener, is a process that listens for client connection requests. The configuration file for the listener is the `listener.ora`.

You can use Net Configuration Assistant (NETCA) to create a **net service name**, a simple name for the database service. The net service name resolves to the **connect descriptor**, which is the network address of the database and the name of the database service. The address portion of the connect descriptor is actually the protocol address of the listener. The client uses a connect descriptor to specify the database or instance to which the client wants to connect.

When a net service name is used, establishing a connection to a database instance takes place by first mapping the net service name to the connect descriptor. This mapped information is stored in one or more repositories of information that are accessed using naming methods. The most commonly used naming method is Local Naming, where the net service names and their connect descriptors are stored in a localized configuration file named `tnsnames.ora`.

When the client connects to the cluster database using a service, you can use the Oracle Net connection load balancing feature to spread user connections across all the instances that are supporting that service. There are two types of load balancing that you can implement: client-side and server-side load balancing.

In an Oracle RAC database, client connections should use both types of connection load balancing. When you create an Oracle RAC database using Oracle Database Configuration Assistant (DBCA), DBCA configures and enables server-side load balancing by default.

See Also:

- ["Configuring Oracle Net to Support Services"](#)
- *Oracle Database 2 Day DBA*

Client-Side Load Balancing

Client-side load balancing balances the connection requests across the listeners. When the listener receives the connection request, the listener connects the user to an instance that the listener knows provides the requested service.

Client-side load balancing is defined in your client connection definition by setting the parameter `LOAD_BALANCE=yes` in the `tnsnames.ora` file. When you set this parameter to `yes`, the Oracle client randomly selects an address from the address list, and connects to that node's listener. This balances client connections across the available listeners in the cluster.

When you create an Oracle RAC database using DBCA, the assistant creates a sample load balancing connection definition in the `tnsnames.ora` file.

Client-side load balancing includes connection failover. With connection failover, if an error is returned from the chosen address, Oracle Net Services will try the next address in the address list until either a successful connection is made or it has exhausted all the addresses in the list.

Server-Side Load Balancing

With server-side load balancing, the listener directs a connection request to the best instance currently providing the service by using information from the Load Balancing Advisory.

For each service, you can define the method that you want the listener to use for load balancing by setting the connection load balancing goal. You can use a goal of either long or short for connection load balancing. These goals have the following characteristics:

- **Short**—Connections are distributed across instances based on the amount of time that the service is used. Use the Short connection load balancing goal for applications that have connections of brief duration.
- **Long**—Connections are distributed across instances based on the number of sessions in each instance, for each instance that supports the service. Use the Long connection load balancing goal for applications that have connections of long duration. This is typical for connection pools and SQL*Forms sessions. Long is the default connection load balancing goal.

Any services created by using DBCA use the Long connection load balancing goal by default.

Note: If you did not use DBCA to create your database, or if you are using listener ports other than the default of 1521, then you must configure the `LOCAL_LISTENER` and `REMOTE_LISTENER` database initialization parameters for your cluster database.

About Runtime Connection Load Balancing

Runtime Connection Load Balancing is a feature of Oracle connection pools that can distribute client work requests across the instances in an Oracle RAC database based on the Load Balancing Advisory information. The connection allocation is based on the current performance level provided by the database instances as indicated by the Load Balancing Advisory FAN events. This provides load balancing at the transaction level, instead of load balancing at the time of the initial database connection.

With Runtime Connection Load Balancing, applications use Load Balancing Advisory information to provide better performance to users. The Oracle JDBC and Oracle Data

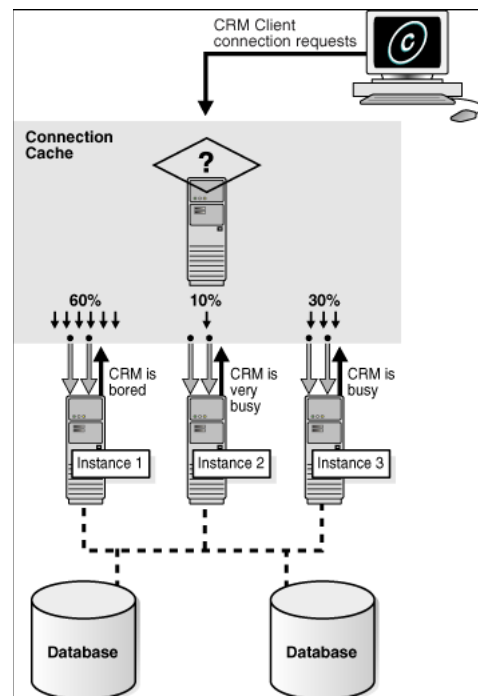
Provider for .NET (ODP.NET) client connection pools are integrated to take advantage of Load Balancing Advisory information. You must enable the client data source for Runtime Connection Load Balancing with a service that has the following configuration:

- The Load Balancing Advisory is enabled and the service-level goal is set to either Service Time or Throughput.
- The service connection load balancing goal is set to Short.

Figure 7-1, "Runtime Connection Load Balancing" illustrates Runtime Connection Load Balancing. In this illustration, the Oracle RAC database has three instances. Suppose that the Load Balancing Advisory indicates that Instance1 and Instance3 have the best performance, while Instance2 currently has less than optimal performance. When Runtime Connection Load Balancing is enabled on the implicit connection cache, the following process occurs:

1. A client requests a connection from the connection cache.
2. Runtime Connection Load Balancing selects the connection that belongs to the most efficient (best) instance from the connection cache. In Figure 7-1, there are three possible nodes to which the connection can be routed. Instance1, which has the least amount of CPU workload, is currently being assigned about 60 percent of the incoming connections. Instance2, which is currently overloaded, is only being assigned around 10 percent of the incoming connections. Instance3, which has a high workload, is being assigned around 30 percent of the incoming connections. The best instance to handle the connection request in this case would be Instance1.
3. The client receives the connection that would process the work request with the best response time.

Figure 7-1 Runtime Connection Load Balancing



About Fast Application Notification (FAN)

Fast Application Notification is a notification mechanism that Oracle RAC uses to notify other processes about cluster configuration and service-level information, including status changes such as UP or DOWN events. FAN UP and DOWN events can apply to instances, services, and nodes. FAN also publishes Load Balancing Advisory events.

For cluster configuration changes, the Oracle RAC high availability framework publishes a FAN event immediately when a change occurs regarding the state of the instances in the cluster. Instead of waiting for the application to query the database and detect a problem, applications can receive FAN events and react immediately.

FAN UP and DOWN events provide the following benefits:

- For DOWN events, the disruption to the application can be minimized because sessions that are connected to the failed instance or node can be terminated. Incomplete transactions can be terminated and the application user is immediately notified. Application users who request connections are directed to instances that are started and are providing the requested service.
- For UP events, when services and instances are started, new connections can be created so that the application can immediately take advantage of the extra resources.

About FAN Callouts

FAN callouts are server-side executable files that Oracle RAC runs immediately when high availability events occur. Some examples of how you can use FAN callouts to automate the actions performed when events occur in a cluster configuration are as follows:

- Starting and stopping server-side applications
- Relocating low-priority services when high-priority services come online
- Sending text or numeric messages to pagers
- Executing shell scripts

The executable files for FAN callouts are stored in the `racg/usrc0` subdirectory of the CRS home directory. If this subdirectory does not exist in your CRS home, then you must create this directory with the same permissions and ownership as the `CRS_home/racg/tmp` subdirectory.

A copy of the executable files used by FAN callouts should be available on every node that runs Oracle Clusterware. Example callout scripts are available in the Oracle Real Application Clusters Sample Code section on Oracle Technology Network at http://www.oracle.com/technology/sample_code/products/rac/

See Also:

- ["About Connection Load Balancing"](#)
- ["About the Load Balancing Advisory"](#)
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about configuring Fast Application Notification and FAN callouts

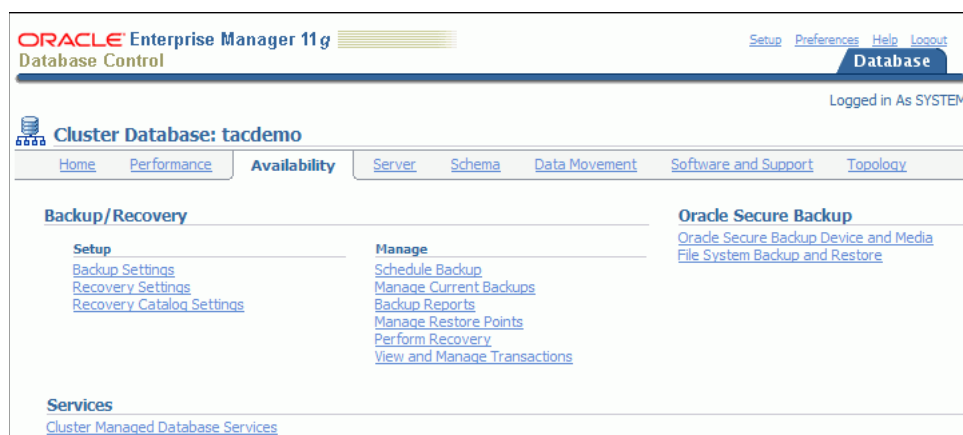
Creating Services

You can create a service using Oracle Enterprise Manager Database Control.

To create a service:

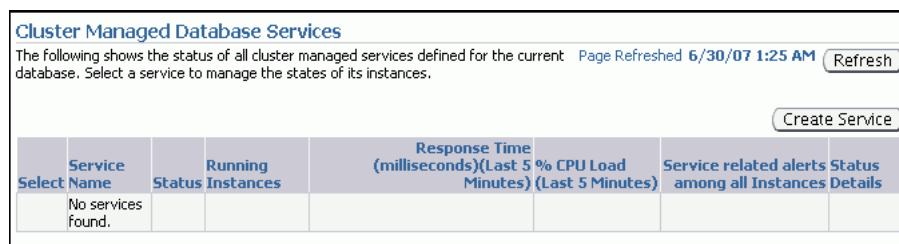
1. On the Cluster Database Home page, click **Availability**.

The Availability page appears.



2. Click **Cluster Managed Database Services** in the Services section. Enter or confirm the credentials for the Oracle RAC database and host operating system.

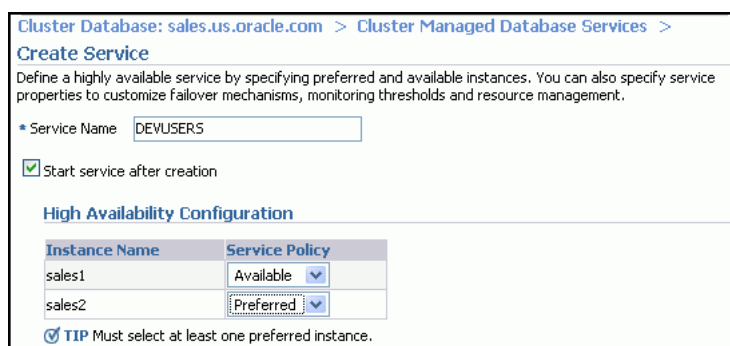
The Cluster Managed Database Services page appears.



3. Click **Create Service**.

The Create Service page appears.

4. Enter the name of your service in the Service Name field, for example, DEVUSERS.
5. Select **Start Service after creation** if you want the service to be started after it is created.



6. Choose whether the instance is a **Preferred** or **Available** instance for each instance displayed in the High Availability Configuration section for this service. If you do

not want the service to run on a particular instance, select **Not Used** for the Service Policy.

7. Select **Short** for Connection Load Balancing Goal if you want to distribute the connection workload based on elapsed time instead of the overall number of connections. Otherwise, choose **Long**.
8. Select **Enable Load Balancing Advisory** under the heading Notification Properties on the Create Service page to enable the Load Balancing Advisory for this service, as shown in the following screenshot. Choose a service-level goal of either **Service Time** or **Throughput**.

Connection Load Balancing Goal Short Long
Load balance connections based on elapsed time (Short) or number of sessions (Long).

Notification Properties

Enable Load Balancing Advisory
 Service Time Throughput
Enable advisory for load balancing based on service quality.

Enable Fast Application Notification (FAN) for OCI and ODP.NET Applications

Service Threshold Levels
If thresholds are specified, alerts will be published when the service elapsed response time and/or CPU time exceed the threshold.

	Warning	Critical
Elapsed Time Threshold (milliseconds)	<input type="text"/>	<input type="text"/>
CPU Time Threshold (milliseconds)	<input type="text"/>	<input type="text"/>

Resource Management Properties
Associate this service with a predefined consumer group or job class.

Consumer Group Mapping:

Job Scheduler Mapping:

[Database](#) | [Setup](#) | [Preferences](#) | [Help](#) | [Logout](#)

9. Select **Enable Fast Application Notification** under the heading Notification Properties if this service is used by an Oracle Call Interface (OCI) or ODP.NET application, and you want to enable FAN.
10. In the Service Threshold Levels section, you can optionally set the service-level thresholds by entering a value in milliseconds for Warning and Critical thresholds for the Elapsed Time and CPU Time metrics.
11. If you want to use a Resource Plan to control the resources used by this service, select the name of the consumer group from the Consumer Group Mapping list in the Resource Management Properties section. For example, you might choose the LOW_GROUP consumer group to give development users low priority to database resources.

Note: You cannot change the consumer group name for a service on the Edit Service page. This is because there may be several consumer groups associated with a given service. However, the Edit Service page contains a link to the Resource Consumer Group Mapping page, where you can modify the consumer group mapping for the service.

12. If this service is used by a specific Oracle Scheduler job class, you can specify the mapping by selecting the name from the Job Scheduler Mapping list in the Resource Management Properties.
13. Click **OK** to create the service.

See Also:

- ["About Workload Management"](#)
- ["About Connection Load Balancing"](#)
- ["About the Load Balancing Advisory"](#)
- ["About Fast Application Notification \(FAN\)"](#)
- ["Configuring Service-Level Thresholds"](#)
- ["Administering Services"](#)
- *Oracle Database Administrator's Guide*

Configuring Oracle Net to Support Services

Although Enterprise Manager configures Oracle Clusterware resources for the newly created service, it does not generate the corresponding entries in your `tnsnames.ora` file.

To configure Oracle Net Services to support the newly created service:

1. Determine if the listener on the local node recognizes the new service by using the following command:

```
lsnrctl status
```

You should see a list for the new service, similar to the following:

```
Service "DEVUSERS.oracle.com" has 1 instance(s).
  Instance "sales1", status READY, has 2 handler(s) for this service...
```

The displayed name for your newly created service, for example `DEVUSERS.oracle.com`, is the value you will use for the `SERVICE_NAME` parameter in the `tnsnames.ora` file.

2. Use a text editor to modify the `tnsnames.ora` file in the `Oracle_home/network/admin` directory on each node that contains an instance listed as a Preferred or Available instance for the service, and on each client that uses the service to connect to the database. Add an entry similar to the following, specifying the VIP address for each node:

```
DEVUSERS =
  (DESCRIPTION =
    (ADDRESS_LIST = Service
      (ADDRESS = (PROTOCOL = TCP) (HOST = docrac1-vip) (PORT = 1521))
      (ADDRESS = (PROTOCOL = TCP) (HOST = docrac2-vip) (PORT = 1521))
    (LOAD_BALANCE = yes)
    )
  (CONNECT_DATA = (SERVICE_NAME = DEVUSERS.oracle.com))
  )
```

In the previous example, the `ADDRESS_LIST` parameter contains one `ADDRESS` for each node that contains an instance configured as either Preferred or Available for the service.

3. Test the Oracle Net Services configuration by attempting to connect to the Oracle RAC database using SQL*Plus and the service name, for example:

```
$ sqlplus system/oracle@DEVUSERS
```

You should see a message indicating you successfully connected to the Oracle RAC database. If you get an error message, examine the `tnsnames.ora` file and verify the entry was typed in correctly and all the information is correct for your Oracle RAC environment.

4. Repeat these steps on the other nodes in your cluster that contain instances specified as either Preferred or Available for the newly created service.

Administering Services

You can create and administer services using Enterprise Manager. You can also use the `DBMS_SERVICE` PL/SQL package and the `SRVCTL` utility to perform most service administration tasks.

The following sections describe how to manage services for your cluster database:

- [About Service Administration Using Enterprise Manager](#)
- [Configuring Service-Level Thresholds](#)

About Service Administration Using Enterprise Manager

The Cluster Managed Database Services page is the master page for beginning all tasks related to services. To access this page, go to the Cluster Database Maintenance page, then click **Cluster Managed Database Services** in the Services section. You can use this page and links from this page to do the following:

- View a list of services for the cluster.
- View the instances on which each service is currently running.
- View the status for each service.
- Create or edit a service.
- Start or stop a service.
- Enable or disable a service.
- Perform instance-level tasks for a service.
- Delete a service.

See Also:

- ["Administering Services"](#)
- ["About Oracle Services"](#)
- ["Creating Services"](#)

Using the Cluster Managed Database Services Page

When managing services using Enterprise Manager, you use the Cluster Managed Database Services page.

On the Cluster Managed Database Services page you can perform the following tasks:

- View a list of services for the cluster, the instances on which each service is currently running, and the status for each service.

- Start or stop a service, or enable or disable a service.
- Access the Create Service and Edit Service pages.
- Access the Services Detail page to perform instance-level tasks for a service.
- Test the connection for a service.

To access the Cluster Managed Database Services page:

1. On the Cluster Database Home page, click the **Availability** tab.
2. On the Availability subpage, under the Services heading, click **Cluster Managed Database Services**.

The Cluster and Database Login page appears.

3. Enter credentials for the database and for the cluster that hosts the Oracle RAC database, then click **Continue**.

The Cluster Managed Database Services page appears and displays the services that are available on the cluster database instances.

See Also:

- ["About Service Administration Using Enterprise Manager"](#)
- ["About Oracle Services"](#)
- ["Creating Services"](#)

Using the Cluster Managed Database Services Detail Page

On the Cluster Managed Database Services detail page for a service you can perform the following tasks:

- View the status of a service on all of its Preferred and Available instances; the status can be Running, Stopped, or Disabled.
- Stop or start a service for an instance of a cluster database.
- Disable or enable a service for an instance of a cluster database.
- Relocate a service to manually rebalance the services across database instances.

To access the Cluster Managed Database Services detail page:

1. On the Cluster Database Home page, click the **Availability** tab.
2. On the Availability subpage, under the Services heading, click **Cluster Managed Database Services**.

The Cluster and Database Login page appears.

3. Enter credentials for the database and for the cluster that hosts the Oracle RAC database, then click **Continue**.

The Cluster Managed Database Services page appears and displays the services that are available on the cluster database instances.

4. Click the name of the service for which you want to view the details.

The Cluster Managed Database Service detail page for that service appears. In the following screenshot, the detail page for the DEVUSERS service is displayed.

Cluster Managed Database Service: DEVUSERS

The service has been configured to run on the following instances. A service may have been stopped on an instance if the instance was down or the service was disabled. Starting a service on a down instance will first bring up the down instance. Page Refreshed 6/30/07 2:50 AM [Refresh](#)

Service Status ✔ **Service is running on all preferred instances.**

% CPU Load (Last 5 Minutes) ✔ [0](#)

Transparent Application Failover (TAF) Policy **NONE**

Top Consumers [Details](#)

Service Properties [Edit](#)

Instances

[Enable](#) [Disable](#) [Start](#) [Stop](#) [Relocate](#)

Select	Instance Name	Service Status for Instance	Instance Status	Service Policy	Response Time (per user call) (microseconds)	CPU Time (per user call) (microseconds)	Status Details
<input checked="" type="radio"/>	sales2	↑ Running	↑	Preferred	✔ 0	✔ 0	✔
<input type="radio"/>	sales1	↓ Stopped	↑	Available	n/a	n/a	✔

See Also:

- ["About Service Administration Using Enterprise Manager"](#)
- ["About Oracle Services"](#)
- ["Creating Services"](#)

Configuring Service-Level Thresholds

When you create a service, you can specify thresholds for measuring the performance of the service. If the specified threshold value is exceeded by the service, the Automatic Workload Repository (AWR) raises an alert that is displayed by Enterprise Manager.

Performance-related statistics, wait events, and active sessions are monitored at the service level. Also, the AWR enables you to monitor performance using services. It records the service performance, including SQL execution times, wait classes, and resources consumed by a service.

You can specify values for the Elapsed Time Threshold or the CPU Time Threshold when you create a service. You can specify Warning and Critical threshold values for these metrics.

To modify service-level thresholds:

1. On the Cluster Database Home page, scroll down to the Instances section.
2. Click the name of the instance for which you want to modify the threshold values for these metrics.

The Cluster Database Instance Home page appears.

3. In the Related Links section at the bottom of the page, click **Metric and Policy Settings**.

The Metric and Policy Settings page appears.

4. Set the View to **All metrics**, then locate either the **Service Response Time** or the **Service CPU Time** threshold. Click the Edit icon for that threshold.

The Edit Advanced Settings page appears.

5. Enter a threshold value in milliseconds in the **Warning Threshold** or **Critical Threshold** field, then click **Continue**.

The Metric and Policy Settings page appears.

6. Edit the threshold values for another metric, or, if done, click **OK**.

See Also:

- ["About Oracle Services"](#)
- ["Creating Services"](#)
- *Oracle Database 2 Day DBA*

Configuring Clients for Failover

There are two central elements to consider when automating failover. First, clients that are connected at the time of failure must be quickly and automatically notified that a failure has occurred to avoid waiting for TCP/IP network timeouts before attempting to connect to the new production database (such timeouts range anywhere from 8 minutes to 2 hours, depending on operating system). Oracle RAC configurations utilize Fast Application Notification (FAN) to notify JDBC clients, OCI clients, and ODP.NET clients. FAN event notifications and callouts enable automatic and fast redirection of clients in the event of primary site failure.

The second central element of client failover, is the redirection of clients to the new instance after a failover has occurred, which can be implemented using services. When you create services in an Oracle RAC database, if an instance to which you have assigned a service becomes unavailable, Oracle RAC relocates the service to an available instance in the database. Users will be able to access the service independent of the instance providing it because, using listener registration, all listeners in the cluster are aware of which instances are currently providing a service when a connection request comes in.

This section deals with configuration FAN for application clients, and contains the following topics:

- [Configuring JDBC Client Failover](#)
- [Configuring OCI Client Failover](#)
- [Configuring ODP.NET Client Failover](#)

See Also:

- ["About Fast Application Notification \(FAN\)"](#)
- ["About Oracle Services"](#)

Configuring JDBC Client Failover

Your application can use the JDBC development environment for either thick or thin JDBC clients. You must use the JDBC Implicit Connection Cache to enable the FAN features of Fast Connection Failover and Runtime Connection Load Balancing. This section explains how to configure Java Database Connectivity (JDBC) client failover.

To configure client failover for JDBC clients:

1. Use the Cluster Managed Services page in Oracle Enterprise Manager Database Control or Oracle Enterprise Manager Grid Control to create new services. See ["Creating Services"](#) on page 7-8 for more information about creating services.

2. Enable fast connection failover for JDBC clients by setting the `DataSource` property `FastConnectionFailoverEnabled` to `TRUE`, as in the following example:

```
OracleDataSource ods = new OracleDataSource()
...
ods.setUser("hr");
ods.setPassword("hr_user_password");
ods.setConnectionCachingEnabled(true);
ods.setFastConnectionFailoverEnabled(true);
ods.setConnectionCacheName("MyCache");
ods.setConnectionCacheProperties(cp);
```

3. Set the `oracle.net.ns.SQLnetDef.TCP_CONNTIMEOUT_STR` property to a nonzero value on the data source (not on the implicit connection cache). When this property is set, if the JDBC client attempts to connect to a host that is unavailable, the connection attempt is bounded to the time specified for `oracle.net.ns.SQLnetDef.TCP_CONNTIMEOUT_STR`. After the specified time has elapsed and a successful connection has not been made, the client attempts to connect to the next host in the address list. Setting this property to a value of 3 seconds is sufficient for most installations.
4. Configure JDBC clients to use a connect descriptor that includes a list of the VIP addresses for each node in the cluster, and that connects to an existing service. The following example is for a two-node Oracle Real Application Clusters (Oracle RAC) cluster:

```
Sales_JDBC =
(DESCRIPTION =
  (ADDRESS=(PROTOCOL=TCP)(HOST=docrac1_vip)(PORT=1521))
  (ADDRESS=(PROTOCOL=TCP)(HOST=docrac2_vip)(PORT=1521))
  (LOAD_BALANCE = yes)
  (CONNECT_DATA =
    (SERVER = DEDICATED)
    (SERVICE_NAME = Sales_JDBC)
  )
)
```

Note: Do not configure Transparent Application Failover (TAF) with Fast Connection Failover for JDBC thick clients as TAF processing will interfere with FAN ONS processing.

If you are using a JDBC thin driver, you must include the complete connect descriptor in the URL because the JDBC thin driver does not use Oracle Net.

5. Configure a remote Oracle Notification Services (ONS) subscription on the JDBC client so that an ONS daemon is not required on the client, as in the following example:

```
ods.setONSConfiguration("docrac1_vip:6200,docrac2_vip:6200");
```

The remote ONS subscription must contain every host that the client application can use for failover. In addition, use Secure Sockets Layer (SSL) for all ONS communications, as in the following example:

```
ods.setONSConfiguration("nodes=docrac1_vip:6200,
docrac2_vip:6200 walletfile=/mydir/conf/Wallet");
```

See Also:

- ["Creating Services"](#)
- ["About Fast Application Notification \(FAN\)"](#)
- ["Configuring Clients for Failover"](#)
- *Oracle Database JDBC Developer's Guide and Reference* for more information about fast connection failover and configuring ONS
- *Oracle Real Application Clusters Administration and Deployment Guide* for information about configuring client failover

Configuring OCI Client Failover

This section explains how to configure Oracle Call Interface (OCI) clients for failover using FAN events.

To configure OCI client failover:

1. Use the Cluster Managed Services page in Oracle Enterprise Manager Database Control or Oracle Enterprise Manager Grid Control to create services for the OCI clients. See ["Creating Services"](#) on page 7-8 for more information about creating services.

You should configure the primary instance as preferred for that service. Under Service Properties, set the Transparent Application Failover Policy to Basic. For Notification Properties, choose "Enable Fast Application Notification for OCI and ODP.NET Applications".

See ["Administering Services"](#) on page 7-12 for more information about modifying services using Enterprise Manager.

2. Enable FAN for OCI clients by initializing the environment with the `OCI_EVENTS` parameter, as in the following example:

```
OCIEnvCreate(...OCI_EVENTS...)
```

3. Link the OCI client applications with thread library `libthread` or `libpthread`.
4. After Fast Application Notification has been enabled, clients and applications can register a callback that is invoked whenever a high availability event occurs, as shown in the following example:

```
OCIAttrSet(envhp, (ub4) OCI_HTYPE_ENV, (dvoid *)evtcallback_fn,
           (ub4) 0, (ub4)OCI_ATTR_EVTCBK, errhp);
OCIAttrSet(envhp, (ub4) OCI_HTYPE_ENV, (dvoid *)evtctx, (ub4) 0,
           (ub4)OCI_ATTR_EVTCTX, errhp);
```

After registering an event callback and context, OCI will call the registered function once for each high availability event.

See Also:

- ["Creating Services"](#)
- ["About Fast Application Notification \(FAN\)"](#)
- ["Configuring Clients for Failover"](#)
- *Oracle Call Interface Programmer's Guide* for more information about event notification and user-registered callbacks
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about configuring fast application notification for OCI clients.

Configuring ODP.NET Client Failover

When a connection to an Oracle instance is unexpectedly severed, Transparent Application Failover (TAF) seamlessly attempts to failover to another Oracle instance. Due to the delay that a failover can incur, the application may wish to be notified by a TAF callback. ODP.NET supports TAF callback through the Failover event of the `OracleConnection` object. To receive TAF callbacks, an event handler function must be registered with the `Failover` event of the `OracleConnection` object. Also the connection parameter `enlist` should be set to `false` for TAF to work.

The procedures for enabling ODP.NET are similar to the procedures for enabling JDBC in that you must set parameters in the connection string to enable FCF. This section explains how to configure Oracle Data Provider for .NET (ODP.NET) clients for failover using FAN events.

To configure ODP.Net client failover:

1. Use the Cluster Managed Services page in Oracle Enterprise Manager Database Control or Oracle Enterprise Manager Grid Control to create services for the ODP.NET clients. See ["Creating Services"](#) on page 7-8 for more information about creating services.

You should configure the primary instance as preferred for that service. Under Service Properties, set the Transparent Application Failover Policy to Basic. For Notification Properties, choose "Enable Fast Application Notification for OCI and ODP.NET Applications". Set the Connection Load Balancing Goal to Long.

2. Enable FCF for ODP.NET connection pools by subscribing to FAN high availability events. Do this by setting the `ha_events` connection string attribute to `true` at connection time. Note that this only works if you are using connection pools. In other words, do this if you have set the `pooling` attribute to `true`, as shown in the following example:

```
// C#
using System;
using Oracle.DataAccess.Client;
class HAEventEnablingSample
{
    static void Main()
    {
        OracleConnection con = new OracleConnection();

        // Open a connection using ConnectionString attributes
        // Also, enable "load balancing"
        con.ConnectionString =
            "User Id=scott;Password=password;Data Source=oracle;" +
            "Min Pool Size=10;Connection Lifetime=120;Connection Timeout=60;" +
```



```
"HA Events=true;Incr Pool Size=5;Decr Pool Size=2";

con.Open();

// Create more connections and carry out work against the DB here.

// Dispose OracleConnection object
con.Dispose();
}
}
```

See Also:

- ["Creating Services"](#)
- ["About Fast Application Notification \(FAN\)"](#)
- ["Configuring Clients for Failover"](#)
- *Oracle Data Provider for .NET Developer's Guide* for more information about event notification and user-registered callbacks
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about configuring fast application notification for ODP.NET clients.

Transparent Application Failover: Oracle By Example Series

When Oracle Net Services establishes a connection to an instance, the connection remains open until the client closes the connection, the instance is shut down, or a failure occurs. If you configure transparent application failover (TAF) for the connection, then Oracle RAC moves the session to a surviving instance when an outage occurs.

TAF can restart a query after failover has completed, but for other types of transactions, such as `INSERT`, `UPDATE`, or `DELETE`, the application must roll back the failed transaction and resubmit the transaction. You must reexecute any session customizations, in other words, `ALTER SESSION` statements, after failover has occurred.

Oracle By Example (OBE) has a series on the High Availability features of Oracle Database 11g Release 1. This OBE shows you how to use Enterprise Manager and PL/SQL to set up TAF in an Oracle RAC environment.

To view the Transparent Application Failover OBE tutorial, go to the following URL

http://www.oracle.com/technology/obe/10gr2_db_vmware/ha/rac/rac.htm

Monitoring Performance and Troubleshooting

Performance tuning for an Oracle Real Application Clusters (Oracle RAC) database is very similar to performance tuning for a single-instance database. Many of the tuning tasks that you perform on single-instance Oracle databases can also improve performance of your Oracle RAC database. This chapter focuses on the performance tuning and monitoring tasks that are unique to Oracle RAC.

This chapter includes the following sections:

- [About Monitoring Oracle RAC Database and Cluster Performance](#)
- [Viewing Other Performance Related Charts](#)
- [Viewing the Cluster Database Topology](#)
- [Monitoring Oracle Clusterware](#)
- [Troubleshooting Configuration Problems in Oracle RAC Environments](#)

See Also:

- *Oracle Database 2 Day DBA* for more information about basic database tuning
- *Oracle Database 2 Day + Performance Tuning Guide* for more information about general performance tuning
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about diagnosing problems for Oracle Real Application Clusters components
- *Oracle Clusterware Administration and Deployment Guide* for more information about diagnosing problems for Oracle Clusterware components

About Monitoring Oracle RAC Database and Cluster Performance

Both Oracle Enterprise Manager Database Control and Oracle Enterprise Manager Grid Control are cluster-aware and provide a central console to manage your cluster database.

From the Cluster Database Home page, you can do all of the following:

- View the overall system status, such as the number of nodes in the cluster and their current status. This high-level view capability means that you do not have to access each individual database instance for details if you just want to see inclusive, aggregated information.

- View alert messages aggregated across all the instances with lists for the source of each alert message. An **alert message** is an indicator that signifies that a particular metric condition has been encountered. A **metric** is a unit of measurement used to report the system's conditions.
- Review issues that are affecting the entire cluster as well as those that are affecting individual instances.
- Monitor cluster cache coherency statistics to help you identify processing trends and optimize performance for your Oracle RAC environment. Cache coherency statistics measure how well the data in caches on multiple instances is synchronized. If the data caches are completely synchronized with each other, then reading a memory location from the cache on any instance will return the most recent data written to that location from any cache on any instance.
- Determine if any of the services for the cluster database are having availability problems. A service is deemed to be a problem service if it is not running on all preferred instances, if its response time thresholds are not met, and so on. Clicking on the link on the Cluster Database Home page will open the Cluster Managed Database services page where the service can be managed.
- Review any outstanding Clusterware interconnect alerts.

Also note the following points about monitoring Oracle RAC environments:

- Performance monitoring features, such as Automatic Workload Repository (AWR) and Statspack, are Oracle RAC-aware.

Note: Instead of using Statspack, Oracle recommends that you use the more sophisticated management and monitoring features of the Oracle Database 11g Diagnostic and Tuning packs, which include AWR

- You can use global dynamic performance views, or GV\$ views, to view statistics across instances. These views are based on the single-instance V\$ views.

This section contains the following topics:

- [Automatic Database Diagnostic Monitor and Oracle RAC Performance](#)
- [Viewing ADDM for Oracle RAC Findings](#)
- [About the Cluster Database Performance Page](#)

Automatic Database Diagnostic Monitor and Oracle RAC Performance

The Automatic Database Diagnostic Monitor (ADDM) is a self-diagnostic engine built into the Oracle Database. ADDM examines and analyzes data captured in the Automatic Workload Repository (AWR) to determine possible performance problems in Oracle Database. ADDM then locates the root causes of the performance problems, provides recommendations for correcting them, and quantifies the expected benefits. ADDM analyzes the AWR data for performance problems at both the database and the instance level.

An ADDM analysis is performed as each AWR snapshot is generated, which is every hour by default. The results are saved in the database and can be viewed by using Enterprise Manager. Any time you have a performance problem, you should first review the results of the ADDM analysis. An ADDM analysis is performed from the

top down, first identifying symptoms, then refining the analysis to reach the root causes, and finally providing remedies for the problems.

For the cluster-wide analysis, Enterprise Manager reports two types of findings:

- Database findings: An issue that concerns a resource that is shared by all instances in the cluster database, or an issue that affects multiple instances. An example of a database finding is I/O contention on the disk system used for shared storage.
- Instance findings: An issue that concerns the hardware or software that is available for only one instance, or an issue that typically affects just a single instance. Examples of instance findings are high CPU load or sub-optimal memory allocation.

ADDM Performance Analysis			
Period Start Time Jun 29, 2007 11:48:20 AM PDT		Period Duration (minutes) 11.77	Instance All
Impact (%)	Finding	Affected Instances	Occurrences (last 24 hrs)
87.4	Top SQL by DB Time		1 of 6
87.2	Row Lock Waits	1 of 2	1 of 6

ADDM reports only the findings that are significant, or findings that take up a significant amount of instance or database time. Instance time is the amount of time spent using a resource due to a performance issue for a single instance and database time is the sum of time spent using a resource due to a performance issue for all instances of the database, excluding any Automatic Storage Management (ASM) instances.

An instance finding can be reported as a database finding if it relates to a significant amount of database time. For example, if one instance spends 900 minutes using the CPU, and the sum of all time spent using the CPU for the cluster database is 1040 minutes, then this finding would be reported as a database finding because it takes up a significant amount of database time.

A problem finding can be associated with a list of recommendations for reducing the impact of the performance problem. Each recommendation has a benefit that is an estimate of the portion of database time that can be saved if the recommendation is implemented. A list of recommendations can contain various alternatives for solving the same problem; you do not have to apply the recommendations.

Recommendations are composed of actions and rationales. You must apply all the actions of a recommendation to gain the estimated benefit of that recommendation. The rationales explain why the actions were recommended, and provide additional information to implement the suggested recommendation.

See Also:

- ["About Monitoring Oracle RAC Database and Cluster Performance"](#)
- ["About Workload Management"](#)
- *Oracle Database 2 Day + Performance Tuning Guide* for more information about configuring and using AWR and ADDM
- *Oracle Database Performance Tuning Guide* for more information about Automatic Database Diagnostic Monitor

Viewing ADDM for Oracle RAC Findings

By default, ADDM runs every hour to analyze snapshots taken by the AWR during that period. If the database finds performance problems, then it displays the results of the analysis under Diagnostic Summary on the Cluster Database Home page. The ADDM Findings link shows how many ADDM findings were found in the most recent ADDM analysis.

ADDM for Oracle RAC can be accessed in Enterprise Manager by the following methods:

- On the Cluster Database Home Page, under Diagnostic Summary, click the **ADDM Findings Link**.
- On the Cluster Database Performance, click the camera icons at the bottom of the Active Sessions Graph.
- In the Related Links section on the Cluster Database Home page or the Performance, click **Advisor Central**. On the Advisor Central page, select **ADDM**. Choose the option **Run ADDM to analyze past performance** and specify an appropriate time period, then click **OK**.

To view ADDM findings from the Cluster Database Home page:

1. On the Cluster Database Home page, under Diagnostic Summary, if a nonzero number is displayed next to ADDM Findings, then click this link.

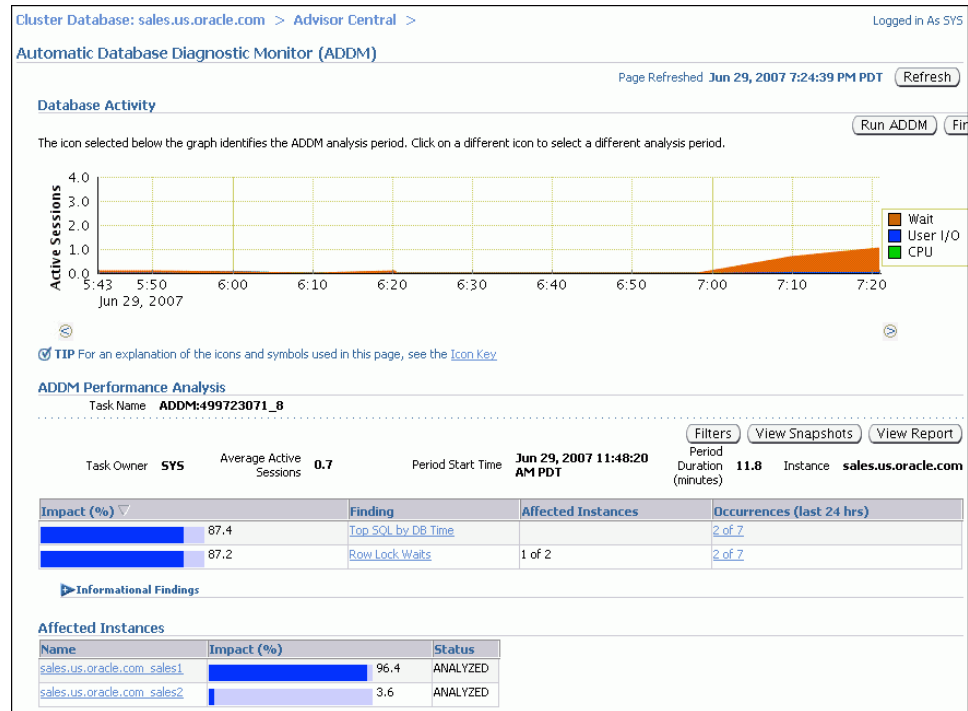


You can also view the ADDM findings per instance by viewing the Instances table on the Cluster Database Home page.

Instances							
Name	Status	Alerts	Policy Violations	Compliance Score (%)	ASM Instance	ADDM Findings	
sales.us.oracle.com_sales1		0 2	2 55 1	95	+ASM1 pmrac1.us.oracle.com 0 0	2	
sales.us.oracle.com_sales2		0 1	2 55 1	95	+ASM2 pmrac2.us.oracle.com 0 0	0	

When you select the number of ADDM Findings, the Automatic Database Diagnostic Monitor (ADDM) page for the cluster database appears.

2. Review the results of the ADDM run.



On the Automatic Database Diagnostic Monitor (ADDM) page, the Database Activity chart shows the database activity during the ADDM analysis period. Database activity types are defined in the legend based on its corresponding color in the chart. Each icon below the chart represents a different ADDM task, which in turn corresponds to a pair of individual Oracle Database snapshots saved in the Workload Repository.

In the ADDM Performance Analysis section, the ADDM findings are listed in descending order, from highest impact to least impact. The Informational Findings section lists the areas that do not have a performance impact and are for informational purpose only.

The Affected Instances chart shows how much each instance is impacted by these findings.

- (Optional) Click the Zoom icons to shorten or lengthen the analysis period displayed on the chart.
- (Optional) To view the ADDM findings in a report, click **View Report**.

The View Report page appears.

You can click **Save to File** to save the report for later access.

- On the ADDM page, in the Affected Instances table, click the link for the instance associated with the ADDM finding that has the largest value for Impact.

The Automatic Database Diagnostic Monitor (ADDM) page for that instance appears.

- In the ADDM Performance Analysis section, select the name of a finding. The Performance Findings Detail page appears.

7. View the available Recommendations for resolving the performance problem. Run the SQL Tuning Advisor to tune the SQL statements that are causing the performance findings.

About the Cluster Database Performance Page

The Cluster Database Performance page provides a quick glimpse of the performance statistics for a database. Enterprise Manager accumulates data from each instance over specified periods of time, called collection-based data. Enterprise Manager also provides current data from each instance, known as real-time data.

Statistics are rolled up across all the instances in the cluster database. Using the links next to the charts, you can get more specific information and perform any of the following tasks:

- Identify the causes of performance issues.
- Decide whether resources need to be added or redistributed.
- Tune your SQL plan and schema for better optimization.
- Resolve performance issues.

The following screenshot shows a partial view of the Cluster Database Performance page. You access this page by clicking the **Performance** tab from the Cluster Database Home page.



The charts on the Performance page are described in the following sections:

- [Viewing the Chart for Cluster Host Load Average](#)

- [Viewing the Chart for Global Cache Block Access Latency](#)
- [Viewing the Chart for Average Active Sessions](#)
- [Viewing the Database Throughput Chart](#)

Viewing the Chart for Cluster Host Load Average

The Cluster Host Load Average chart in the Cluster Database Performance page shows potential problems that are outside the database. The chart shows maximum, average, and minimum load values for available nodes in the cluster for the previous hour.

If the load average is higher than the average of the total number of CPUs across all the hosts in the cluster, then too many processes are waiting for CPU resources. SQL statements that are not tuned often cause high CPU usage. Compare the load average values with the values displayed for CPU Used in the Average Active Sessions chart. If the sessions value is low and the load average value is high, then this indicates that something else on the host, other than your database, is consuming the CPU.

You can click any of the load value labels for the Cluster Host Load Average chart to view more detailed information about that load value. For example, if you click the label **Average**, the Hosts: Average Load page appears, displaying charts that depict the average host load for up to four nodes in the cluster.

You can select whether the data is displayed in a summary chart, combining the data for each node in one display, or using tile charts, where the data for each node is displayed in its own chart. You can click **Customize** to change the number of tile charts displayed in each row or the method of ordering the tile charts.

For more information about changing the data displayed on the Hosts: Average Load page, refer to the Enterprise Manager online Help.

Viewing the Chart for Global Cache Block Access Latency

Each cluster database instance has its own buffer cache in its System Global Area (SGA). Using Cache Fusion, Oracle RAC environments logically combine each instance's buffer cache to enable the database instances to process data as if the data resided on a logically combined, single cache.

When a process attempts to access a data block, it first tries to locate a copy of the data block in the local buffer cache. If a copy of the data block is not found in the local buffer cache, a global cache operation is initiated. Before reading a data block from disk, the process attempts to find the data block in the buffer cache of another instance. If the data block is in the buffer cache of another instance, Cache Fusion transfers a version of the data block to the local buffer cache, rather than having one database instance write the data block to disk and requiring the other instance to reread the data block from disk. For example, after the `sales1` instance loads a data block into its buffer cache, the `sales2` instance can more quickly acquire the data block from the `sales1` instance by using Cache Fusion rather than by reading the data block from disk.

The Global Cache Block Access Latency chart shows data for two different types of data block requests: current and consistent-read (CR) blocks. When you update data in the database, Oracle Database must locate the most recent version of the data block that contains the data, which is called the **current block**. If you perform a query, only data committed before the query began is visible to the query. Data blocks that were changed after the start of the query are reconstructed from data in the undo segments, and the reconstructed data is made available to the query in the form of a **consistent-read block**.

The Global Cache Block Access Latency chart on the Cluster Database Performance page shows the **latency** for each type of data block request, that is the elapsed time it takes to locate and transfer consistent-read and current blocks between the buffer caches.

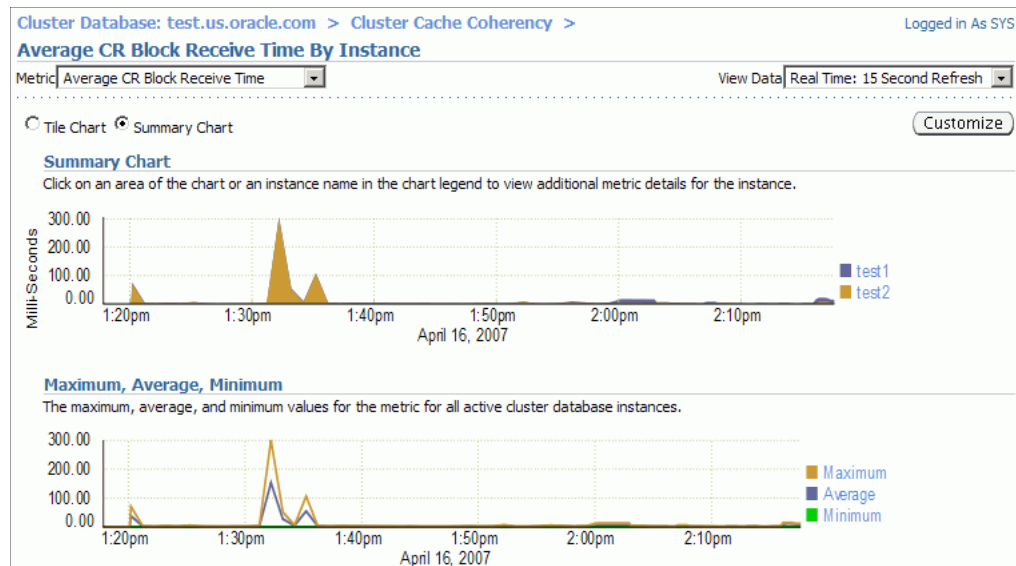
You can click either metric for the Global Cache Block Access Latency chart to view more detailed information about that type of cached block. For example, if you click the metric **Average Current Block Receive Time**, the Average Current Block Receive Time by Instance page appears, displaying a summary chart that depicts the average current block receive time for up to four nodes in the cluster. You can select whether the data is displayed in a summary chart or using tile charts. If you choose Summary chart, then, by default, the instances with the 4 highest receive times are displayed. If you choose Tile charts, then the data for each node is displayed in its own chart. You can customize which nodes are displayed in either the Summary or Tile chart display.

Also, on the Average Current Block Receive Time By Instance page or the Cluster Cache Coherency page, you can use the slider bar on the Active Session History chart to focus on a 5 minute window (time period) within the past 1 hour. This enables you to identify the top sessions, services, modules, actions, or SQL statements that were running during a period of high cache coherency activity.

At the top of the page, you can use the Metric list to change the metric displayed. The choices are:

- Average CR Block Receive Time
- Average Current Block Receive Time
- GC Current Blocks Received
- GC CR Blocks Received
- Physical Reads
- Global Cache Block Transfers

Each metric displays a monitoring page for that metric. On each metric monitoring page you can view the data for that metric in either a summary chart or using tile charts. You can also view the Maximum, Average, Minimum chart on the metric monitoring page to view the maximum, average, and minimum values for the metric for all active cluster database instances.



If the Global Cache Block Access Latency chart shows high latencies (high elapsed times), this can be caused by any of the following:

- A high number of requests caused by SQL statements that are not tuned.
- A large number of processes in the queue waiting for the CPU, or scheduling delays.
- Slow, busy, or faulty interconnects. In these cases, check your network connection for dropped packets, retransmittals, or cyclic redundancy check (CRC) errors.

Concurrent read and write activity on shared data in a cluster is a frequently occurring activity. Depending on the service requirements, this activity does not usually cause performance problems. However, when global cache requests cause a performance problem, optimizing SQL plans and the schema to improve the rate at which data blocks are located in the local buffer cache, and minimizing I/O is a successful strategy for performance tuning. If the latency for consistent-read and current block requests reaches 10 milliseconds, then your first step in resolving the problem should be to go to the Cluster Cache Coherency page for more detailed information.

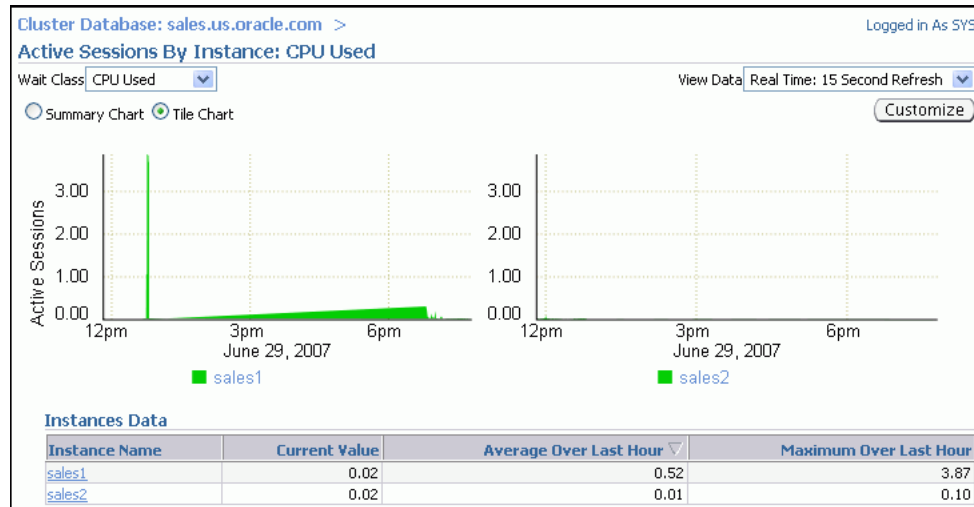
Viewing the Chart for Average Active Sessions

The Average Active Sessions chart in the Cluster Database Performance page shows potential problems inside the database. Categories, called wait classes, show how much of the database is using a resource, such as CPU or disk I/O. Comparing CPU time to wait time helps to determine how much of the response time is consumed with useful work rather than waiting for resources that are potentially held by other processes.

The chart displays the workload on the database or instance and identifies performance issues. At the cluster database level, this chart shows the aggregate wait class statistics across all the instances. For a more detailed analysis, you can click the clipboard icon at the bottom of the chart to view the ADDM analysis for the database for that time period.

Compare the peaks on the Average Active Sessions chart with those on the Database Throughput charts. If the Average Active Sessions chart displays a large number of sessions waiting, indicating internal contention, but throughput is high, then the situation may be acceptable. The database is probably also performing efficiently if internal contention is low but throughput is high. However, if internal contention is high and throughput is low, then consider tuning the database.

If you click the wait class legends beside the Average Active Sessions chart, you can view instance-level information stored in Active Sessions by Instance pages. You can use the Wait Class action list on the Active Sessions by Instance page to view the different wait classes. The Active Sessions by Instance pages show the service times for up to four instances. Using the Customize button you can select the instances that are displayed. You can view the data for the instances separately using tile charts, or you can combine the data into a single summary chart.



If you need to diagnose and fix problems that are causing the higher number of wait events in a specific category, you can select an instance of interest and view the wait events, as well as the SQL, sessions, services, modules, and actions that are consuming the most database resources.

See Also:

- ["About Monitoring Oracle RAC Database and Cluster Performance"](#)
- ["About Oracle Clusterware and Oracle Real Application Clusters"](#)
- *Oracle Database 2 Day + Performance Tuning Guide*
- *Oracle Database 2 Day DBA* for more information about tuning a database and instance

Viewing the Database Throughput Chart

The last chart on the Performance page monitors the usage of various database resources. By clicking the Throughput tab at the top of this chart you can view the Database Throughput chart.

The Database Throughput charts summarize any resource contention that appears in the Average Active Sessions chart, and also show how much work the database is performing on behalf of the users or applications. The Per Second view shows the number of transactions compared to the number of logons, and the amount of physical reads compared to the redo size per second. The Per Transaction view shows the amount of physical reads compared to the redo size per transaction. Logons is the number of users that are logged on to the database.

You can also obtain information at the instance level by clicking one of the legends to the right of the charts to access the Database Throughput by Instance page. This page shows the breakdown of the aggregated Database Throughput chart for up to four instances. Using the Customize button you can select the instances that are displayed. You can view the data for the instances separately using tile charts, or you can combine the data into a single summary chart. You can use this page to view the throughput for a particular instance, which may help you diagnose throughput problems.

You can drill down further on the Database Throughput by Instance page to see the sessions of an instance consuming the greatest resources. Click an instance name legend just under the chart to go to the Top Sessions subpage of the Top Consumers page for that instance.

Top Consumers												Switch Database
												Collected From Jun 29, 2007 8:13:15 PM
Overview Top Services Top Modules Top Actions Top Clients Top Sessions												
<input type="button" value="Kill Session"/> <input type="button" value="View"/> <input type="button" value="Disable SQL Trace"/> <input type="button" value="Enable SQL Trace"/>												
Select	SID	DB User	CPU (1/100 sec)	PGA Memory (bytes)	Physical Reads	Logical Reads	Hard Parses	Total Parses	Disk Sorts	user commits	Status	Program
<input checked="" type="radio"/>	52	SH	0	1802544	0	1273089	0	0	0	0	ACTIVE	sqlplus@pmrac1.us.oracle.com (TNS V1-V3)
<input type="radio"/>	42	SH	0	688432	0	1239230	0	0	0	0	ACTIVE	sqlplus@pmrac1.us.oracle.com (TNS V1-V3)
<input type="radio"/>	36	SH	0	688432	0	1237202	0	0	0	0	ACTIVE	sqlplus@pmrac1.us.oracle.com (TNS V1-V3)
<input type="radio"/>	69	SH	0	1540400	0	1206816	0	0	0	0	ACTIVE	sqlplus@pmrac1.us.oracle.com (TNS V1-V3)
<input type="radio"/>	62	SYSTEM	3	2908348	0	94	0	0	0	1	ACTIVE	OMS
<input type="radio"/>	55	SYS	1	1671472	0	36	0	4	0	0	ACTIVE	racgimon@pmrac1.us.oracle.com (TNS V1-V3)

For more information about the information on this page, refer to the Enterprise Manager Help system.

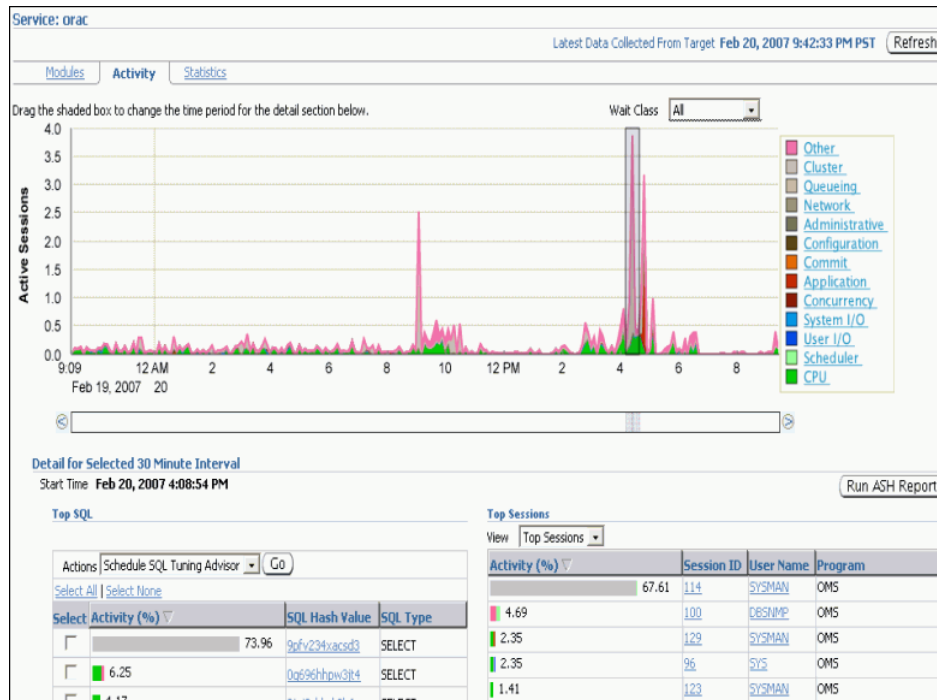
See Also:

- ["About Monitoring Oracle RAC Database and Cluster Performance"](#)
- ["About Oracle Clusterware and Oracle Real Application Clusters"](#)
- *Oracle Database 2 Day + Performance Tuning Guide*
- *Oracle Database 2 Day DBA* for more information about tuning a database and instance

Viewing the Services Chart

The last chart on the Performance page monitors the usage of various database resources. By clicking the Services tab at the top of this chart you can view the Services chart.

The Services charts shows the top services being used by the active sessions. Only active services are shown. You can select one of the service legends to the right of the chart to go to the Service subpage of the Top Consumers page. The Activity subtab is selected by default. On this page you can view real-time data showing the session loads by wait classes for the service.

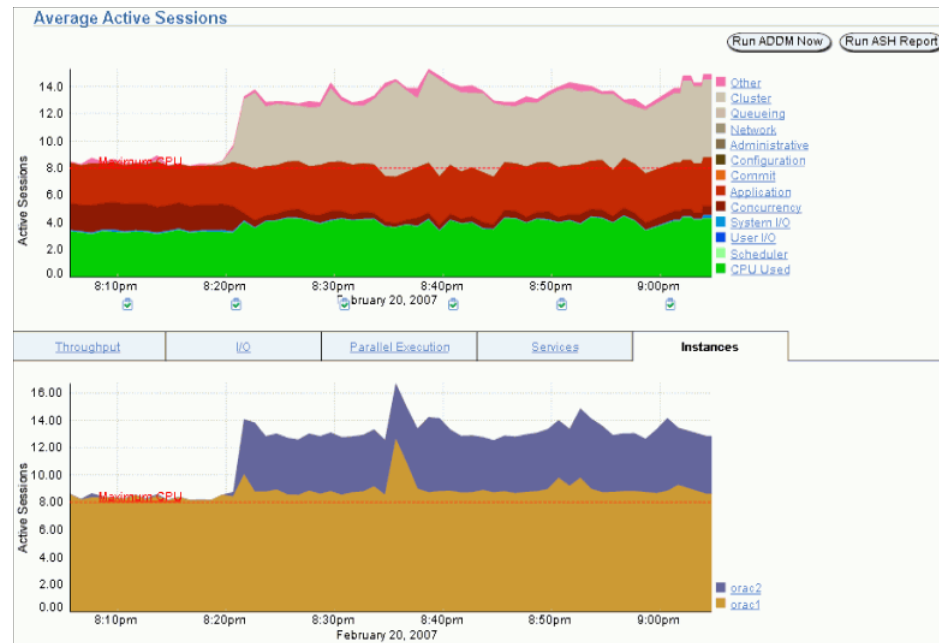


For more information about the information on this page, refer to the Enterprise Manager Help system.

Viewing the Active Sessions by Instance Chart

The last chart on the Performance page monitors the usage of various database resources. By clicking the Instances tab at the top of this chart you can view the Active Sessions by Instance chart.

The Active Sessions by Instance chart summarize any resource contention that appears in the Average Active Sessions chart. Using this chart you can quickly determine how much of the database work is being performed on each instance.



You can also obtain information at the instance level by clicking one of the legends to the right of the chart to access the Top Sessions page. On the Top Session page you can view real-time data showing the sessions that consume the greatest system resources.

For more information about the information on this page, refer to the Enterprise Manager Help system.

Viewing Other Performance Related Charts

In the Additional Monitoring Links and Additional Instance Monitoring Links section of the Cluster Database Performance page, there are links to other charts that are useful in evaluating the performance of your cluster database.

This section contains the following topics:

- [Accessing the Cluster Cache Coherency Page](#)
- [Accessing the Top Consumers Page](#)
- [Accessing the Top Sessions Page](#)
- [Accessing the Top Activity Page](#)
- [Accessing the Instance Activity Page](#)
- [Accessing the Top Segments Page](#)
- [Accessing the Database Locks Page](#)

See Also:

- ["About Monitoring Oracle RAC Database and Cluster Performance"](#)
- *Oracle Database 2 Day + Performance Tuning Guide*
- *Oracle Database 2 Day DBA* for more information about tuning a database and instance

Accessing the Cluster Cache Coherency Page

The Cluster Cache Coherency page contains summary charts for cache coherency metrics for the cluster.

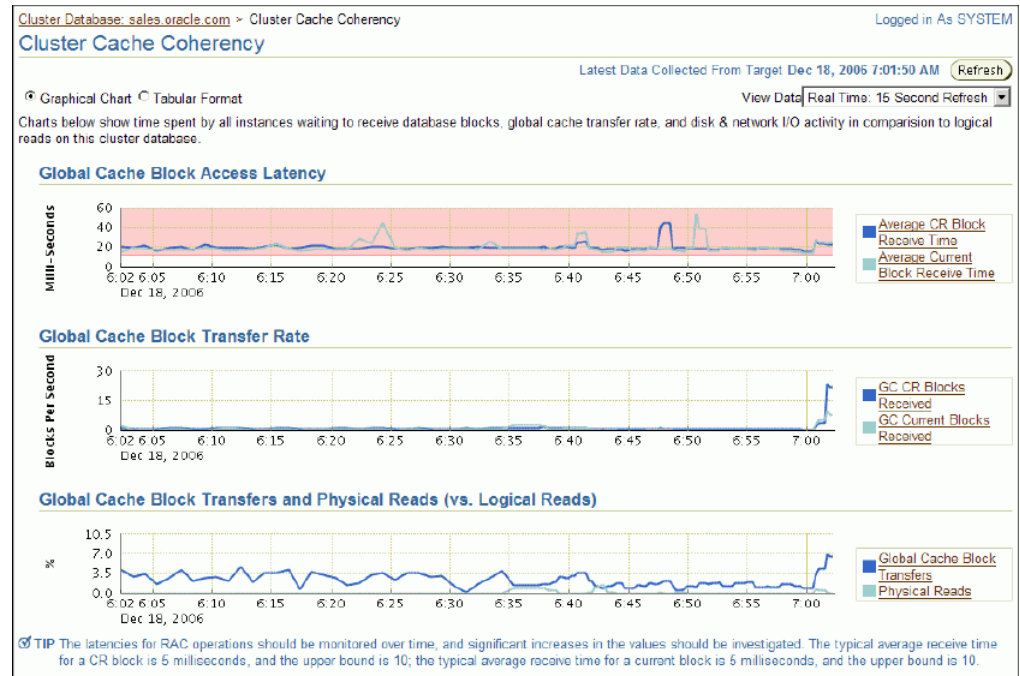
Table 8–1 provides a description of the Cluster Cache Coherency charts and the actions to perform to access more comprehensive information for problem resolution.

Table 8–1 Cluster Cache Coherency Charts

Name	Description
Global Cache Block Access Latency	<p>Shows the total elapsed time, or latency, for a block request. Click one of the legends to the right of the chart to view the average time it takes to receive data blocks for each block type (current or CR) by instance.</p> <p>On the Average Block Receive Time by Instance page, you can click an instance legend under the chart to go to the Block Transfer for Local Instance page, where you can identify which block classes, such as undo blocks, data blocks, and so on, are subject to intense global cache activity. This page displays the block classes that are being transferred, and which instances are transferring most of the blocks.</p> <p>Cache transfer indicates how many current and CR blocks for each block class were received from remote instances, including how many transfers incurred a delay (busy) or an unexpected longer delay (congested).</p>
Global Cache Block Transfer Rate	<p>Shows the total aggregated number of blocks received by all instances in the cluster by way of an interconnect.</p> <p>Click one of the legends to the right of the chart to go to the Global Cache Blocks Received by Instance page for that type of block. From there, you can click an instance legend under the chart to go to the Segment Statistics by Instance page, where you can see which segments are causing cache contention.</p>
Global Cache Block Transfers and Physical Reads	<p>Shows the percentage of logical read operations that retrieved data from the buffer cache of other instances by way of Direct Memory Access and from disk. It is essentially a profile of how much work is performed in the local buffer cache, rather than the portion of remote references and physical reads, which both have higher latencies.</p> <p>Click one of the legends to the right of the chart to go to the Global Cache Block Transfers vs. Logical Reads by Instance and Physical Reads vs. Logical Reads by Instance pages. From there, you can click an instance legend under the chart to go to the Segment Statistics by Instance page, where you can see which segments are causing cache contention.</p>

To access the Cluster Cache Coherency page:

1. On the Cluster Database Home page, select Performance.
The Performance subpage appears.
2. Click **Cluster Cache Coherency** in the Additional Monitoring Links section at the bottom of the page.
3. Alternatively, click either of the legends to the right of the Global Cache Block Access Latency chart.
The Cluster Cache Coherency page appears.



Accessing the Top Consumers Page

The Top Consumers page provides access to several tabs that enable you to view real-time or collection-based data for the services, modules, actions, clients, and sessions that are consuming the most system resources.

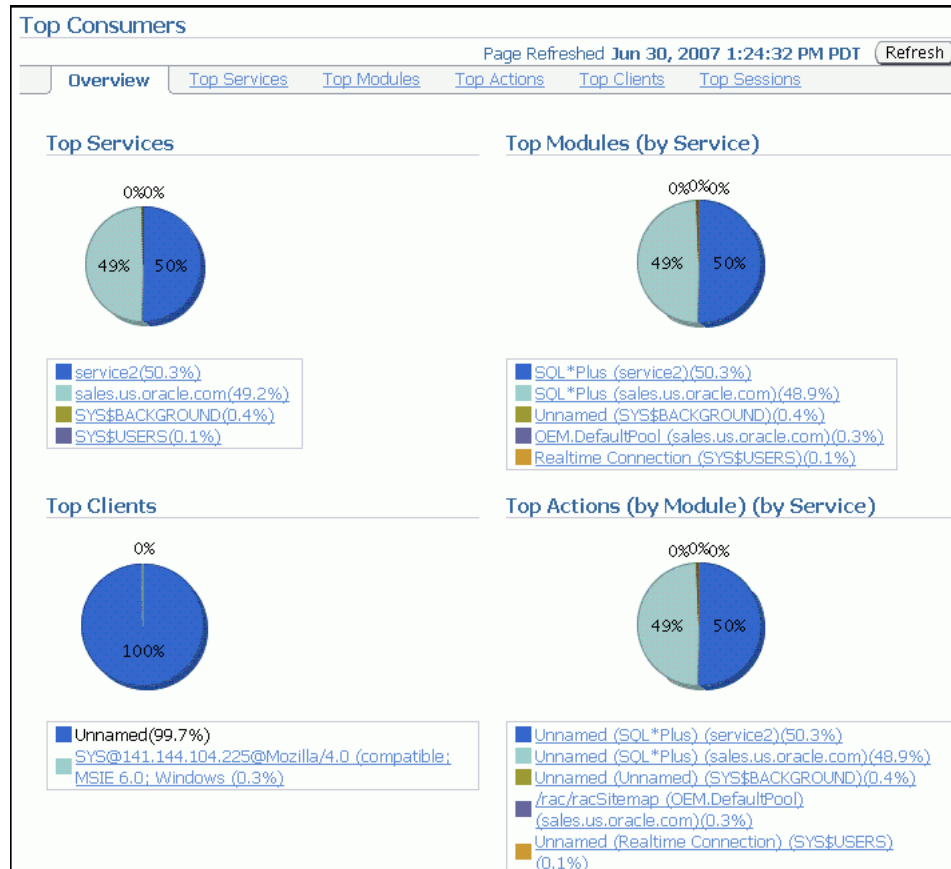
To access the Top Consumers page:

1. On the Cluster Database Home page, select Performance.

The Performance subpage appears.

2. Click **Top Consumers** in the Additional Monitoring Links section at the bottom of the page.

When accessed this way, the Top Consumers page initially displays the Overview tab by default, which shows aggregated summary data for the highest resource consumers.



- (Optional) Click the portion of a chart representing the consumer or click the link under the chart for that consumer to view instance-level information about that consumer.

The page that appears shows the running instances that are serving the consumer.

- (Optional) Expand the names in the Action or Module column to show data for individual instances.

See Also:

- ["About Monitoring Oracle RAC Database and Cluster Performance"](#)
- *Oracle Database 2 Day + Performance Tuning Guide*

Accessing the Top Sessions Page

The Top Sessions page shows a real-time summary list of sessions based on aggregated data. You can see which sessions have consumed the greatest amount of system resources, referred to as the top sessions, and then decide whether or not you want to stop the sessions.

To access the Top Sessions page:

- On the Cluster Database Home page, select Performance.

The Performance subpage appears.

2. Click **Top Consumers** in the Additional Monitoring Links section at the bottom of the page.
3. On the Top Consumers page, click the **Top Sessions** subtab.

See Also:

- ["About Monitoring Oracle RAC Database and Cluster Performance"](#)
- *Oracle Database 2 Day + Performance Tuning Guide*

Accessing the Top Activity Page

The Top Activity page enables you to view the cluster database activity by waits, services and instances. Also, you can see the details for the Top SQL and Top Sessions for a specific 5 minute interval by moving the slider bar on the Top Activity chart.

In the Top SQL detail section, you can select problematic SQL statements and either schedule the SQL Tuning Advisor for those statements or create a SQL Tuning Set.

By default, the Top Sessions for the selected time period are shown. Using the View action list in this section you can change the display to one of the following:

- Top Sessions
- Top Services
- Top Modules
- Top Actions
- Top Clients
- Top Files
- Top Objects
- Top PL/SQL
- Top Instances

To access the Top Activity page:

1. On the Cluster Database Home page, select **Performance**.
The Performance subpage appears.
2. Click **Top Activity** in the Additional Monitoring Links section at the bottom of the page.
The Top Activity page appears.

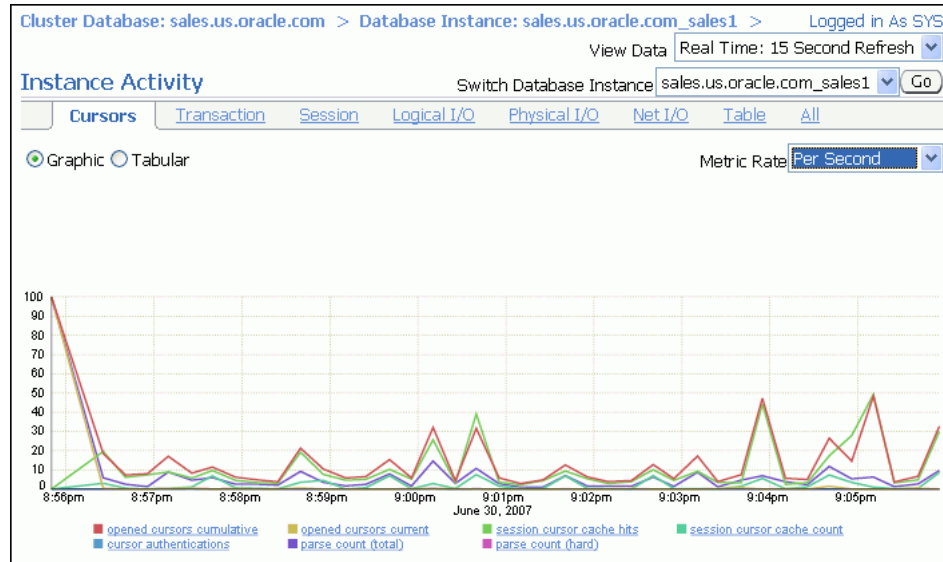
Accessing the Instance Activity Page

The Instance Activity page enables you to view instance activity for several metrics within general metric categories, such as cursors, transactions, sessions, logical I/O, physical I/O, and net I/O. You can view data for each second or transaction.

To access the Instance Activity page:

1. On the Cluster Database Home page, select **Performance**.
The Performance subpage appears.

- Click **Instance Activity** in the Additional Monitoring Links section at the bottom of the page.
- (Optional) Click a metric legend under the chart if in Graphic mode, or click a name in the summary table if in Tabular mode to access top sessions statistics for a particular metric.



- (Optional) Use the **Switch Database Instance** list to change the instance for which the data is displayed in the chart.

See Also:

- ["About Monitoring Oracle RAC Database and Cluster Performance"](#)
- Oracle Database 2 Day + Performance Tuning Guide*

Accessing the Top Segments Page

Collecting and viewing statistics at the segment level is an effective method for identifying frequently accessed tables or indexes in a database. The Top Segments page enables you to gather segment-level statistics to identify performance problems associated with individual segments. This page is particularly useful for Oracle RAC, because it also tracks the number of consistent-read and current blocks received by an object. A high number of current blocks received plus a high number of buffer waits may indicate potential resource contention.

To access the Top Segments page:

- On the Cluster Database Home page, select **Performance**.
The Performance subpage appears.
- Click **Top Segments** in the Additional Monitoring Links section at the bottom of the page.

You can view segments for all instances, or use a filter to see segments for a specific instance.

Top Segments

Latest Data Collected From Target **Jun 30, 2007 9:12:16 PM PDT** [Refresh](#)

This table contains statistics collected for each segment. Only the top 20 segments are listed based on the selected Order By statistic.

Order By: **GC Current Blocks Received** View Instance: **All** View Data: **Real Time: 15 Second Refresh**

Exclude segments owned by SYS (Recommended)

[Expand All](#) | [Collapse All](#)

Object Name	Type	Instance Name	GC Current Blocks Received	GC CR Blocks Received	GC Buffer Busy
▼ Top Segments					
▶ SYSMAN.MGMT_JOB_EXEC_IDX04	INDEX		2.0	0.0	0.0
▶ SYSMAN.MGMT_JOB_EXEC_IDX01	INDEX		2.0	0.0	0.0
▶ SYSMAN.MGMT_CURRENT_AVAILABILITY_PK	INDEX		1.0	2.0	0.0
▶ SYSMAN.MGMT_METRIC_DEPENDENCY	TABLE		1.0	1.0	0.0

See Also:

- ["About Monitoring Oracle RAC Database and Cluster Performance"](#)

Accessing the Database Locks Page

Use the Database Locks page to determine if multiple instances are holding locks for the same object. The page shows user locks, all database locks, or locks that are blocking other users or applications. You can use this information to stop a session that is unnecessarily locking an object.

To access the Database Locks page:

1. On the Cluster Database Home page, select **Performance**.

The Performance subpage appears.

2. Click **Database Locks** in the Additional Monitoring Links section at the bottom of the page.

Cluster Database: sales.us.oracle.com > Logged in As SYS

Database Locks Page Refreshed Jun 30, 2007 9:20:12 PM PDT [Refresh](#)

View: **Blocking Locks**

[Kill Session](#) [Session Details](#) [View Object](#) [View SQL](#)

[Expand All](#) | [Collapse All](#)

Select	Username	Sessions Blocked	Instance Name	Session ID	Serial Number	Process ID	SQL Hash Value	Lock Type	Mode Held	Mode Requested	Object Type	Object Owner	Object Name	ROWID	Time in current mode (seconds)
○	▼ Blocking Locks														
○	DBSNMP	1	sales1	54	454	6536	786h4uy3jmhfg	PS	SHARE	NONE					84934
○		0		50	4655	12867		PS	NONE	EXCLUSIVE					34
○	DBSNMP	1	sales1	58	255	20776	786h4uy3jmhfg	PS	SHARE	NONE					84934
○		0	sales2	50	4655	12867		PS	NONE	EXCLUSIVE					34

TIP A locked session is indented below the session blocking it.

See Also:

- ["About Monitoring Oracle RAC Database and Cluster Performance"](#)
- *Oracle Database Administrator's Guide*

Viewing the Cluster Database Topology

Using Database Control you can view a graphical representation of your cluster environment. Using the topology view you can quickly see the components that make up your cluster database environment, such as database instances, listeners, ASM instances, hosts, and interfaces.

After you click the topology chart to activate the controls, you can mouse over a component to see the status and configuration details for that component. If you select a component in the topology chart, you can then right-click that component to view a set of menu actions specific for that component.

To view the topology for your cluster database environment:

1. On the Cluster Database Home page, select **Topology**.

The Topology subpage appears.

2. (Optional) Move the mouse cursor over any component in the topology diagram to display information about that component in a popup box.
3. Select any component in the topology diagram to change the information displayed in the Selection Details section.
4. (Optional) Click **Legend** at the bottom of the page, on the left-hand side, to display the Topology Legend page.

This page describes the icons used in Cluster Topology and Cluster Database Topology.

5. (Optional) Right-click the currently selected component to view the menu actions available for that component.

Monitoring Oracle Clusterware

Using Enterprise Manager with Oracle Database 11g Release 1 you can monitor Oracle Clusterware. Some of the features now available include:

- Viewing the status of Oracle Clusterware on each node of the cluster
- Receiving notifications if there are any VIP relocations
- Monitoring the overall throughput across the private interconnect
- Receiving notifications if nodeapps go down or come up
- Viewing alerts if a database instance is using the public interface instead of the VIP
- Monitoring the Clusterware alert log for OCR or voting disk related issues, node evictions, and other clusterware errors

This section contains the following topics:

- [Accessing the Oracle Clusterware Information](#)
- [Reviewing the Oracle Clusterware Home Page](#)
- [About the Cluster Performance Page](#)
- [About the Cluster Targets Page](#)
- [About the Cluster Interconnects Page](#)
- [About the Cluster Topology Page](#)

Accessing the Oracle Clusterware Information

From the Cluster Database Home page, there are several ways to access Oracle Clusterware information.

To access Oracle Clusterware information:

1. From the Cluster Database Home page, in the General section, click the link next to **Cluster** to view the Cluster Home page.
Click the **Database** tab to return to the Cluster Database Home page.
2. Under Diagnostic Summary, click the number next to **Interconnect Alerts** to view the Interconnects subpage for the cluster.
Click the **Database** tab to return to the Cluster Database Home page.
3. In the High Availability section, click the number next to **Problem Services** to display the Cluster Home page.
Click the **Database** tab to return to the Cluster Database Home page.
4. Select **Topology**. Click one of the nodes in the graphical display to activate the controls. Click the **Interface** component. Right-click the Interface component, then choose **View Details** from the menu to display the Interconnects subpage for the cluster.

Reviewing the Oracle Clusterware Home Page

The Cluster Home page enables you to monitor the health and workload of your cluster. It provides a central place for general cluster state information and is updated periodically.

The various sections of the Cluster Home page provide information about the cluster environment and status of the hosts, targets, and clusterware components. For example, the Alerts and Diagnostic Summary sections warn you of errors and performance problems that are impacting the operation of your cluster. You can click the provided links to see more detail about the problem areas.

To monitor the general state of the cluster:

1. From the Cluster Database Home page, in the General section, click the link next to **Cluster**.

The Cluster Home page appears.

Cluster: pmrac_cluster
 Latest Data Collected From Target Jul 9, 2007 9:24:40 PM PDT (Refresh)

Home Performance Targets Interconnects Topology

General
 Status **Up** (Black Out)
 Hosts 2 (↑ 2)
 Availability (%) 100.0 (Last 24 hours)
 Cluster Name pmrac_cluster
 Oracle Clusterware Status Up (↑ 1 ↓ 1)
 Clusterware Version 11.1.0.6.0
 Clusterware Home /ora/11g/clusterware

Configuration
 View Operating Systems

Operating Systems	Hosts	OS Patches
Red Hat Enterprise Linux ES release 4 (Nahant Update 4) 2.6.9-42.ELsmp	2	Not available

Diagnostic Summary
 Interconnect Alerts 0

Cluster Databases
 View Cluster Databases only

Name	Status	Alerts	Policy Violations	Compliance Score (%)	Version
sales.us.oracle.com	⊕	1 5	15 162 2	93	11.1.0.6.0

Alerts
 Category All Critical 1 Warnings 0

Severity	Target Name	Target Type	Category	Name	Impact	Message	Alert Triggered
✖	pmrac_cluster	Cluster	Clusterware	Clusterware Status		Clusterware has problems on all hosts of this cluster. Verifying CRS integrity Check...	Jul 3, 2007 1:22:05 PM

Security
 Last Security Evaluation Jul 9, 2007 9:17:36 PM PDT Compliance Score (%) 71 Enterprise Security At a Glance

Job Activity
 Create Job OS Command Go
 Job executions scheduled to start no more than 7 days ago
 Status Submitted to the Cluster Submitted to any member

Job Type	Scheduled	Running	Suspended	Problem
OS Command	0	0	0	0

Critical Patch Advisories for Oracle Homes
 Current 0
 Patch Advisory information may be stale. Oracle MetaLink credentials are not configured.
 Affected Oracle Homes 0
 Oracle MetaLink Credentials Not Configured

Home Performance Targets Interconnects Topology

Hosts

Name	Status	Oracle Clusterware Status	Alerts	Policy Violations	Compliance Score (%)	CPU Util %	Mem Util %	Total IO/sec
pmrac1.us.oracle.com	⊕	⊕	0 0	5 1 0	76	2.36	98.06	137.9
pmrac2.us.oracle.com	⊕	⊕	0 0	5 0 0	82	1.67	79.6	121.9

Related Links
 Access Alert History All Metrics
 Blackouts Deployments Metric and Policy Settings
 Metric Collection Errors Monitoring Configuration Reports
 Target Properties

Database | Setup | Preferences | Help | Logout

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[About Oracle Enterprise Manager](#)

2. (Optional) Click the **Refresh** button to update the information displayed.

The date and time that data was last collected from the cluster is displayed to the left of the Refresh button.

3. Get a quick view of the cluster in the General section, which includes the following information:
 - Status of the cluster, Up or Down
Click the **Status** link to drill down to cluster availability details.
 - Number of hosts in the cluster
 - Cluster name
 - The status of Oracle Clusterware overall and by host
 - Oracle Clusterware version
 - Oracle Clusterware home directory.
4. In the Configuration section, use the **View** list to select which of the following information is displayed for the available hosts in the cluster:
 - Operating Systems (including Hosts and OS Patches)
 - Hardware (including hardware configuration and hosts)Click the links under **Host** or **OS Patches** for detailed information.
5. View the Diagnostic Summary section which contains the number of active Interconnect alerts. Click the number of alerts to view the Interconnects subpage.
6. Investigate the Cluster Databases table to view the cluster databases associated with this cluster, their availability, any alerts or policy violations on those databases, their security compliance score, and the database software version.
7. View the Alerts section, which includes the following items:
 - Category list
Optionally choose a category from the list to view only alerts in that category
 - Critical
This is the number of metrics that have crossed critical thresholds plus the number of other critical alerts, such as those caused by incidents (critical errors).
 - Warning
This is the number of metrics that have crossed warning thresholds
 - Alerts table
The Alerts table provides information about any alerts that have been issued along with the severity rating of each. Click the alert message in the Message column for more information about the alert.

When an alert is triggered, the name of the metric for which the alert was triggered is displayed in the Name column. The severity icon for the alert (Warning or Critical) is displayed, along with the time the alert was triggered, the value of the alert, and the time the metric's value was last checked.
8. View the date of the Last Security Evaluation and the Compliance score for the cluster in the Security section.

The compliance score is a value between 0 and 100 where 100 is a state of complete compliance to the security policies. The compliance score calculation for each target and policy combination to a great extent is influenced by the severity of the violation and importance of the policy, and to a lesser extent by the percentage of violating rows over the total number of rows tested.

9. Review the status of any jobs submitted to the cluster within the last 7 days in the Job Activity section.
10. Determine if there are patches to be applied to Oracle Clusterware by reviewing the Critical Patch Advisories for Oracle Homes section.

To view available patches, you must have first configured your *OracleMetaLink* Credentials as discussed in "[Configuring the Enterprise Manager Patch Interface](#)" on page 10-1.

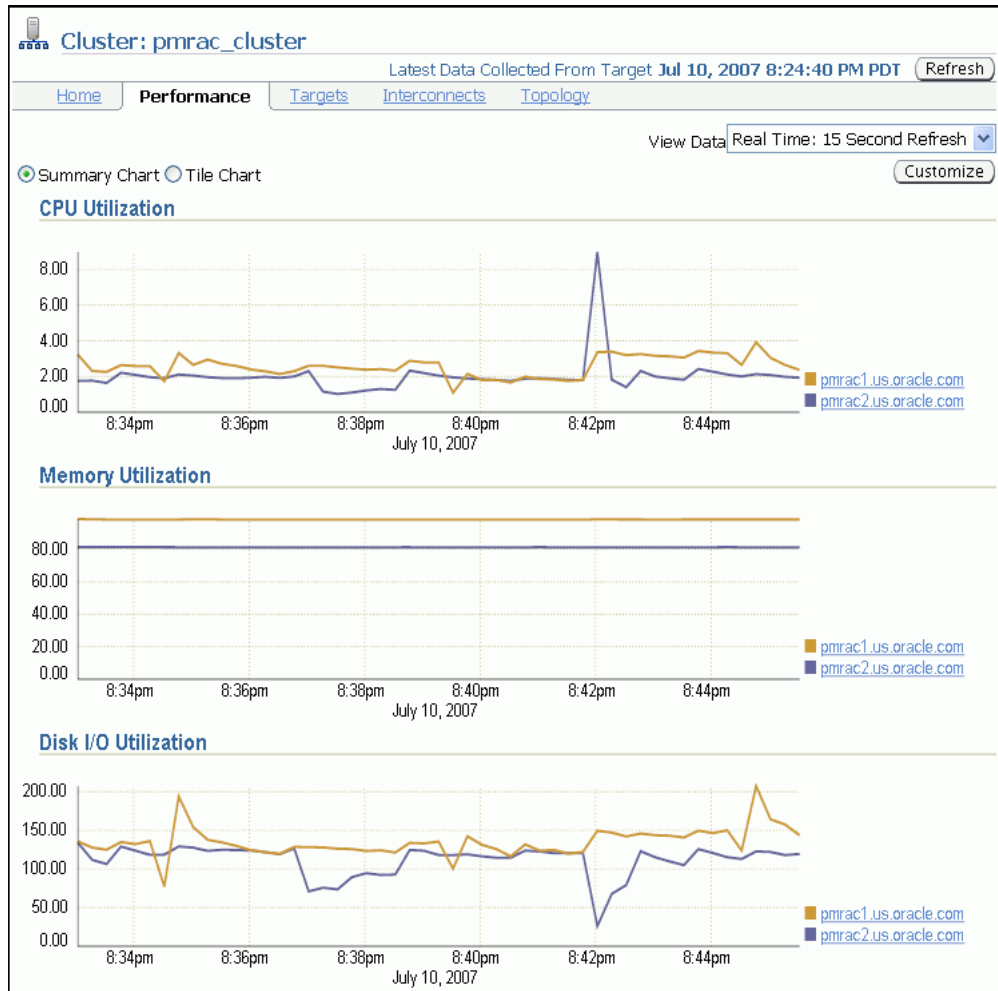
11. View basic performance statistics for each host in the cluster in the Hosts table at the bottom of the page.

Click any link in this table to view further details about that statistic.

12. Use the subtabs at the top of the page to view detailed information for Performance, Targets, Interconnects, or Topology.

About the Cluster Performance Page

The Cluster Performance page displays utilization statistics, such as CPU, Memory, and Disk I/O, during the past hour for all hosts of a cluster, which is part of the greater Enterprise Manager environment. With this information, you can determine whether you need to add or redistribute resources.



Using the charts on the Cluster Performance page, you can:

- View the CPU, Memory, and Disk I/O charts for the cluster across all hosts.
- View the CPU, Memory, and Disk I/O charts for each host individually by clicking the host name in the legend to the right of the chart.

The Cluster Performance page also contains a Hosts table. The Hosts table displays summary information for the hosts for the cluster, their availability, any alerts on those hosts, CPU and memory utilization percentage, and total input/output per second. You can click a host name in the Hosts table to go to the performance page for that host.

Name	Status	Oracle Clusterware Status	Alerts	Policy Violations	Compliance Score (%)	CPU Util %	Mem Util %	Total IO/sec
pmrac1.us.oracle.com			0 0	5 1 0	76	2.24	98.21	130.89
pmrac2.us.oracle.com			0 0	5 0 0	82	1.72	81.07	118.12

About the Cluster Targets Page

The Cluster Targets page provides a complete list of all targets on the cluster. The table includes the target name, type, host, and location, as well as the target's availability, warning and critical alerts, and last load time.

Cluster: pmrac_cluster								
Latest Data Collected From Target Jul 10, 2007 8:54:40 PM PDT Refresh								
Home Performance Targets Interconnects Topology								
Name	Host	Oracle Home	Availability	Alerts	Policy Violations	Compliance Score (%)	Type	Last Load Time
pmrac1.us.oracle.com:3938	pmrac1.us.oracle.com	/ora/11g/base/db		0 0	0 0 0		Agent	Jul 10, 2007 8:52:33 PM
+ASM1_pmrac1.us.oracle.com	pmrac1.us.oracle.com	/ora/11g/base/asm		0 0	0 0 0		Automatic Storage Management	Jul 10, 2007 8:54:12 PM
pmrac_cluster	pmrac1.us.oracle.com *	/ora/11g/clusterware		1 0	10 1 0	79	Cluster	Jul 10, 2007 8:53:40 PM
sales.us.oracle.com	pmrac1.us.oracle.com *	/ora/11g/base/db		1 5	15 162 2	93	Cluster Database	Jul 10, 2007 8:53:03 PM
sales.us.oracle.com_sales1	pmrac1.us.oracle.com	/ora/11g/base/db		1 2	2 55 1	95	Database Instance	Jul 10, 2007 8:55:17 PM
pmrac1.us.oracle.com	pmrac1.us.oracle.com	Not Applicable		0 0	5 1 0	76	Host	Jul 10, 2007 8:54:40 PM
LISTENER_PMRAC1_pmrac1.us.oracle.com	pmrac1.us.oracle.com	/ora/11g/base/asm		0 0	3 4 0	91	Listener	Jul 10, 2007 8:54:13 PM

Click a target name to go to the home page for that target. Click the links in the table to get more information about that particular item, alert, or metric.

The Hosts table displays the hosts for the cluster, their availability, any alerts on those hosts, CPU and memory utilization percentage, and total input/output per second.

About the Cluster Interconnects Page

The Cluster Interconnects page is useful for monitoring the interconnect interfaces, determining configuration issues, and identifying transfer rate-related issues, including excess traffic. This page helps determine the load added by individual instances and databases on the interconnect. Sometimes you can immediately identify interconnect delays that are due to applications outside Oracle.

You can use this page to perform the following tasks:

- View all interfaces that are configured across the cluster.
- View statistics for the interfaces, such as absolute transfer rates and errors.
- Determine the type of interfaces, such as private or public.
- Determine whether the instance is using a public or private network.
- Determine which database instance is currently using which interface.
- Determine how much the instance is contributing to the transfer rate on the interface.

Cluster: pmrac_cluster
Latest Data Collected From Target Jul 10, 2007 9:09:40 PM PDT (Refresh)

Home Performance Targets **Interconnects** Topology

The interconnect configuration and internode communication will influence the performance of cluster databases. The tables below show network interfaces on all hosts and network interfaces currently in use by cluster databases. It is important that cluster databases are configured to use a private interconnect for message and block transfers.

View Data: Manually

Private Interconnect Transfer Rate (MB/Sec) 0.105 *
Transfer rate on the private network in the last 5 minutes.

Interfaces by Hosts

View: Private

Expand All | Collapse All

Name	Type	Subnet	Interface Type	Total I/O Rate (MB/Sec) (Last 5 Minutes)	Total Error Rate (%) (Last 5 Minutes)
pmrac_cluster	Cluster				
pmrac1.us.oracle.com	Host				
eth1	Interface	10.10.8.0	Private	.1	0
pmrac2.us.oracle.com	Host				
eth1	Interface	10.10.8.0	Private	.11 *	0 *

Interfaces in Use by Cluster Databases

Expand All | Collapse All

Name	Target Type	Interface Name	Host Name	IP Address	Interface Type	Source	Transfer Rate (MB/Sec) (Last 5 Minutes)
sales	Cluster Database						
sales1	Database Instance	eth1	pmrac1.us.oracle.com	10.10.10.1	Private	Oracle Cluster Repository	.04
sales2	Database Instance	eth1	pmrac2.us.oracle.com	10.10.10.2	Private	Oracle Cluster Repository	.048 *

TIP The Transfer Rate is the estimated traffic contributed by the instance assuming uniform block size in the database.
TIP * indicates the data that is more than 10 minutes old.

The Private Interconnect Transfer Rate value shows a global view of the private interconnect traffic, which is the estimated traffic on all the private networks in the cluster. The traffic is calculated as the summary of the input rate of all private interfaces known to the cluster. For example, if the traffic rate is high, the values in the Total I/O Rate column in the Interfaces by Hosts table for private interfaces will also be high. If the values in this column are high, you should determine the cause of the high network usage. You can click a number to access the Network Interface Total I/O Rate page for historic statistics and metric values.

Using the Interfaces by Hosts table, you can drill down to the following pages:

- Host Home

- Hardware Details
- Network Interface Total I/O Rate
- Network Interface Total Error Rate

Using the Interfaces in Use by Cluster Databases table, you can view the Total Transfer Rate. This value shows the network traffic generated by individual instances for the interfaces they are using as interconnects. The values indicate how frequently the instances are communicating with other instances.

Using the Interfaces in Use by Cluster Databases table, you can drill down to the following pages:

- Cluster Database Home
- Cluster Database Instance Home
- Hardware Details
- Host Home
- Interface Type
- Transfer Rate

About the Cluster Topology Page

The Oracle Enterprise Manager Topology Viewer enables you to visually see the relationships between target types in your cluster. You can zoom in or out, pan, and see selection details. Individually distinct icons are used to represent system target types, and standardized visual indicators, such as frames around selections, are used across all target types.

The Topology Viewer populates icons based on your system configuration. If a listener is serving an instance, a line connects the listener icon and the instance icon. If a cluster database is configured to use ASM, the relationship between the cluster ASM and cluster database appears in the topology.

If the Show Configuration Details option is unchecked, the topology shows the monitoring view of the environment, which includes general information such as alerts and overall status. If you select the Show Configuration Details option, additional details are shown in the Selection Details page, which are valid for any topology view. For instance, the listener component would also show the machine name and port number.

You can click an icon and then the right mouse button to display a menu of available actions. Several actions go to pages related to the target type where you can perform monitoring or tuning tasks.

Refer to the Enterprise Manager Online Help for more information about the contents of this page.

See Also: ["Viewing the Cluster Database Topology"](#) on page 8-20

Troubleshooting Configuration Problems in Oracle RAC Environments

Problems can occur when attempting to complete the installation or database creation process manually instead of using the Oracle Database management tools. Other problems occur due to the database administrator or system administrator missing important operating system or cluster configuration steps prior to installation. Both Oracle Clusterware and Oracle Database components have subcomponents that you

can troubleshoot. The Cluster Ready Services Control (CRSCTL) command `check` enables you to determine the status of several Oracle Clusterware components at one time.

This section contains the following topics:

- [Using CRSCTL to Diagnose Cluster Issues](#)
- [Using the Cluster Verification Utility to Diagnose Problems](#)
- [Viewing Oracle RAC Database Alerts](#)
- [Viewing Oracle RAC Database Alert Log Messages](#)

See Also:

- ["Tools for Installing, Configuring, and Managing Oracle RAC"](#)
- ["About Verifying the Oracle Clusterware Installation"](#)

Using CRSCTL to Diagnose Cluster Issues

You can use CRSCTL commands as the `root` operating system user to diagnose problems with your Oracle Clusterware installation, or to enable dynamic debugging for Oracle Clusterware. This section contains the following topics:

- [Location of the Oracle Clusterware Alert Log](#)
- [Location of the Oracle Clusterware Component Log Files](#)
- [Checking the Status of the Oracle Clusterware Installation](#)
- [Running the Oracle Clusterware Diagnostics Collection Script](#)
- [Enabling Debugging of Oracle Clusterware Components](#)
- [Enabling Debugging for an Oracle Clusterware Resource](#)
- [Enabling and Disabling Oracle Clusterware Daemons](#)

See Also:

- ["Tools for Installing, Configuring, and Managing Oracle RAC"](#)
- ["Troubleshooting Configuration Problems in Oracle RAC Environments"](#)

Location of the Oracle Clusterware Alert Log

Oracle Clusterware posts alert messages when important events occur. For example, you might see alert messages from the Cluster Ready Services (CRS) daemon process when it starts, if it aborts, if the failover process fails, or if automatic restart of a CRS resource failed.

Enterprise Manager monitors the Clusterware log file and posts an alert on the Cluster Home page if an error is detected. For example, if a voting disk is not available, a CRS-1604 error is raised, and a critical alert is posted on the Cluster Home page. You can customize the error detection and alert settings on the Metric and Policy Settings page.

The location of the Oracle Clusterware log file is `CRS_home/log/hostname/alerthostname.log`, where `CRS_home` is the directory in which Oracle Clusterware was installed and `hostname` is the host name of the local node.

See Also:

- *Oracle Real Application Clusters Administration and Deployment Guide*
- ["Verifying the Configuration Using the Cluster Verification Utility"](#)

Location of the Oracle Clusterware Component Log Files

Oracle RAC uses a unified log directory structure to store all the Oracle Clusterware component log files. This consolidated structure simplifies diagnostic information collection and assists during data retrieval and problem analysis.

In each of the following log file locations, *hostname* is the name of the node, for example, *docrac2* and *CRS_home* is the directory in which the Oracle Clusterware software was installed.

The log files for the CRS daemon, *crsd*, can be found in the following directory:

CRS_home/log/hostname/crsd/

The log files for the CSS daemon, *cssd*, can be found in the following directory:

CRS_home/log/hostname/cssd/

The log files for the EVM daemon, *evmd*, can be found in the following directory:

CRS_home/log/hostname/evmd/

The log files for the Oracle Cluster Registry (OCR) can be found in the following directory:

CRS_home/log/hostname/client/

The log files for the Oracle RAC high availability component can be found in the following directories:

*CRS_home/log/hostname/racg/
Oracle_home/log/hostname/racg*

Each program that is part of the Oracle RAC high availability component has a subdirectory assigned exclusively for that program. The name of the subdirectory is the same as the name of the program.

Note: If any of the Oracle Clusterware components generates a core dump file, it is located in a subdirectory of the log directory for that component.

See Also:

- *Oracle Real Application Clusters Administration and Deployment Guide*
- ["Verifying the Configuration Using the Cluster Verification Utility"](#)

Checking the Status of the Oracle Clusterware Installation

Use the `CRSCTL check` command to display the status of an Oracle Clusterware component or daemon.

To determine the condition of your clusterware installation:

1. Log in to the operating system as the `root` user in a command window.
2. Use `CRSCTL` to check the status of Oracle Clusterware using the following command:


```
# crsctl check crs
```
3. Check the status of an individual Oracle Clusterware daemon using the following syntax, where *daemon* is `crsd`, `cssd`, or `evmd`:


```
# crsctl check daemon
```

See Also:

- *Oracle Real Application Clusters Administration and Deployment Guide*
- ["Verifying the Configuration Using the Cluster Verification Utility"](#)

Running the Oracle Clusterware Diagnostics Collection Script

The Oracle Clusterware Diagnostics Collection script collects diagnostic information for your Oracle Clusterware installation. The diagnostics provide additional information so that Oracle Support Services can resolve problems. It displays the status of the Cluster Synchronization Services (CSS), Event Manager (EVM), and the Cluster Ready Services (CRS) daemons.

To run the Oracle Clusterware Diagnostics Collection script:

1. In a command window, log in to the operating system as the `root` user.
2. Run the `diagcollection.pl` script from the operating system prompt as follows, where `CRS_home` is the home directory of your Oracle Clusterware installation:


```
# CRS_home/bin/diagcollection.pl --collect
```

See Also:

- *Oracle Real Application Clusters Administration and Deployment Guide*
- ["Verifying the Configuration Using the Cluster Verification Utility"](#)

Enabling Debugging of Oracle Clusterware Components

You can enable debugging for the Oracle Cluster daemons, Event Manager (EVM), and their modules by running `CRSCTL` commands.

To enable debugging of Oracle Clusterware components:

1. In a command window, log in to the operating system as the `root` user.
2. Use the following command to obtain the module names for a component, where *component_name* is `crs`, `evm`, `css` or the name of the component for which you want to enable debugging:


```
# crsctl lsmodules component_name
```


For example, viewing the modules of the `css` component might return the following results:

```
# crsctl lsmodules css
The following are the CSS modules ::
CSSD
COMMCRS
COMMNS
```

3. Use `CRSCTL` as follows, where *component_name* is the name of the Oracle Clusterware component for which you want to enable debugging, *module* is the name of module, and *debugging_level* is a number from 1 to 5:

```
# crsctl debug log component module:debugging_level
```

For example, to enable the lowest level of tracing for the `CSSD` module of the `css` component, you would use the following command:

```
# crsctl debug log css CSSD:1
```

See Also:

- *Oracle Real Application Clusters Administration and Deployment Guide*
- ["Verifying the Configuration Using the Cluster Verification Utility"](#)

Enabling Debugging for an Oracle Clusterware Resource

You can use `CRSCTL` commands to enable debugging for resource managed by Oracle Clusterware.

To enable debugging of an Oracle Clusterware resource:

1. In a command window, log in to the operating system as the `root` user.
2. Obtain a list of the resources available for debugging by running the following command:

```
# crs_stat
```

3. Run the following command to enable debugging, where *resource_name* is the name of an Oracle Clusterware resource, such as `ora.docrac1.vip`, and *debugging_level* is a number from 1 to 5:

```
# crsctl debug log res resource_name:debugging_level
```

See Also:

- *Oracle Real Application Clusters Administration and Deployment Guide*
- ["Verifying the Configuration Using the Cluster Verification Utility"](#)

Enabling and Disabling Oracle Clusterware Daemons

When the Oracle Clusterware daemons are enabled, they start automatically when the node is started. To prevent the daemons from doing this, you can disable them using `crsctl` commands.

To enable automatic startup for all Oracle Clusterware daemons:

1. In a command window, log in to the operating system as the `root` user.
2. Run the following CRSDCTL command:

```
# crsctl enable crs
```

To disable automatic startup for all Oracle Clusterware daemons:

1. In a command window, log in to the operating system as the `root` user.
2. Run the following CRSDCTL command:

```
# crsctl disable crs
```

See Also:

- *Oracle Real Application Clusters Administration and Deployment Guide*
- ["Verifying the Configuration Using the Cluster Verification Utility"](#)

Using the Cluster Verification Utility to Diagnose Problems

The Cluster Verification Utility (CVU) can assist you in diagnosing a wide variety of configuration problems. Refer to the example of using the CVU in ["Verifying the Configuration Using the Cluster Verification Utility"](#) on page 3-3.

This section contains the following topics:

- [Verifying the Existence of Node Applications](#)
- [Verifying the Integrity of Oracle Clusterware Components](#)
- [Verifying the Integrity of the Oracle Cluster Registry](#)
- [Verifying the Integrity of Your Entire Cluster](#)
- [Checking the Settings for the Interconnect](#)
- [Enabling Tracing](#)

Verifying the Existence of Node Applications

You use the CVU `comp nodeapp` command to verify the existence of node applications, namely the virtual IP (VIP), Oracle Notification Services (ONS), and Global Service Daemon (GSD), on all the nodes.

To verify the existence of node applications:

1. In a command window, log in to the operating system as the `root` user.
2. Use the `comp nodeapp` command of the CVU, using the following syntax:

```
cluvfy comp nodeapp [ -n node_list ] [-verbose]
```

where `node_list` represents the nodes to check.

3. If the `cluvfy` command returns the value of UNKNOWN for a particular node, the CVU cannot determine whether a check passed or failed. Determine if the failure was caused by one of the following reasons:
 - The node is down.

- Executable files that the CVU requires are missing in the `CRS_home/bin` directory or the `Oracle_home/bin` directory.
- The user account that ran the CVU does not have permissions to run common operating system executable files on the node.
- The node is missing an operating system patch or required package.
- The kernel parameters on that node were not configured correctly and the CVU cannot obtain the operating system resources required to perform its checks.

See Also:

- ["Troubleshooting Configuration Problems in Oracle RAC Environments"](#)
- *Oracle Clusterware Administration and Deployment Guide*

Verifying the Integrity of Oracle Clusterware Components

You use the CVU `comp crs` command to verify the existence of all the Oracle Clusterware components.

To verify the integrity of Oracle Clusterware components:

1. In a command window, log in to the operating system as the `root` user.
2. Use the `comp crs` command of the CVU, using the following syntax:

```
cluvfy comp crs [ -n node_list] [-verbose]
```

where `node_list` represents the nodes to check.

See Also:

- ["Troubleshooting Configuration Problems in Oracle RAC Environments"](#)
- *Oracle Clusterware Administration and Deployment Guide*

Verifying the Integrity of the Oracle Cluster Registry

You use the CVU `comp ocr` command to verify the integrity of the Oracle Clusterware registry.

To verify the integrity of the Oracle Clusterware registry:

1. In a command window, log in to the operating system as the `root` user.
2. Use the `comp ocr` command of the CVU, using the following syntax:

```
cluvfy comp ocr [ -n node_list] [-verbose]
```

where `node_list` represents the nodes to check.

See Also:

- ["Troubleshooting Configuration Problems in Oracle RAC Environments"](#)
- *Oracle Clusterware Administration and Deployment Guide*

Verifying the Integrity of Your Entire Cluster

You use the CVU `comp clu` command to check that all nodes in the cluster have the same view of the cluster configuration.

To verify the integrity of your Oracle RAC cluster:

1. In a command window, log in to the operating system as the `root` user.
2. Use the `comp clu` command of the CVU, using the following syntax:

```
cluvfy comp clu [-verbose]
```

See Also:

- ["Troubleshooting Configuration Problems in Oracle RAC Environments"](#)
- *Oracle Clusterware Administration and Deployment Guide*

Checking the Settings for the Interconnect

Cache Fusion enhances the performance of Oracle RAC by utilizing a high-speed interconnect to send data blocks to another instance's buffer cache. The high-speed interconnect should be a private network with the highest bandwidth to maximize performance.

For network connectivity verification, the CVU discovers all the available network interfaces if you do not specify an interface on the CVU command line.

To check the settings for the interconnect:

1. In a command window, log in to the operating system as the `root` user.
2. To verify the accessibility of the cluster nodes, specified by `node_list`, from the local node or from any other cluster node, specified by `srcnode`, use the component verification command `nodereach` as follows:

```
cluvfy comp nodereach -n node_list [ -srcnode node ] [-verbose]
```

When you issue the `nodecon` command as shown in the previous example, it instructs the CVU to perform the following tasks:

- Discover all the network interfaces that are available on the cluster nodes.
- Review the corresponding IP addresses and subnets for the interfaces.
- Obtain the list of interfaces that are suitable for use as VIPs and the list of interfaces to private interconnects.
- Verify the connectivity among all the nodes through those interfaces.

When you run the `nodecon` command in verbose mode, it identifies the mappings between the interfaces, IP addresses, and subnets.

3. To verify the connectivity among the nodes through specific network interfaces, use the `comp nodecon` command with the `-i` option and specify the interfaces to be checked with the `interface_list` argument:

```
cluvfy comp nodecon -n node_list -i interface_list [-verbose]
```

For example, you can verify the connectivity among the nodes `docrac1`, `docrac2`, and `docrac3`, through the specific network interface `eth0` by running the following command:

```
cluvfy comp nodecon -n docrac1, docrac2, docrac3 -i eth0 -verbose
```

See Also:

- ["Troubleshooting Configuration Problems in Oracle RAC Environments"](#)
- *Oracle Clusterware Administration and Deployment Guide*

Enabling Tracing

The CVU does not generate trace files unless you enable tracing. The CVU trace files are created in the `CRS_home/cv/log` directory. Oracle RAC automatically rotates the log files, and the most recently created log file has the name `cvutrace.log.0`. You should remove unwanted log files or archive them to reclaim disk space, if needed.

To enable tracing using CVU:

1. In a command window, log in to the operating system as the root user.
2. Set the environment variable `SRVM_TRACE` to `true`.

```
# set SRVM_TRACE=true; export SRVM_TRACE
```
3. Run the command that you want to trace.

See Also:

- ["Troubleshooting Configuration Problems in Oracle RAC Environments"](#)
- *Oracle Clusterware Administration and Deployment Guide*

Viewing Oracle RAC Database Alerts

Alert messages are displayed in Enterprise Manager. The Alerts table is similar to that shown for single-instance databases, but in a cluster database, it includes columns for the target name and target type. For example, if a user connected to the `sales1` instance exceeded their allotted login time, you would see an alert message with the following values:

- Target name: `sales_sales1`
- Target type: Database instance
- Category: Response
- Name: User logon time
- Message: User logon time is 10250 milliseconds
- Alert triggered: *Date and time when the alert condition occurred*

To view the alert messages for an Oracle RAC database:

1. On the Cluster Database Home page, scroll down to the section titled Alerts.

The section Related Alerts displays nondatabase alert messages, for example, alert messages for Oracle Net.
2. View the alerts for your database and database instances.

The following screenshot shows an example of the Alerts display for a clustered database named `docrac`.

▼ Alerts

Category: All Critical 0 Warnings 6

Previous 1-5 of 6 Next 1

Severity	Target Name	Target Type	Category	Name	Message	Alert Trigger
⚠	docrac_docrac1	Database Instance	Response	User Logon Time (msec)	User logon time is 10250 msec.	Sep 21, 2006 3:47:30 AM
⚠	docrac	Cluster Database	Invalid Objects by Schema	Owner's Invalid Object Count	3 object(s) are invalid in the SOE1 schema.	Aug 7, 2006 4:18:01 PM
⚠	docrac	Cluster Database	Invalid Objects by Schema	Owner's Invalid Object Count	16 object(s) are invalid in the CC schema.	Aug 7, 2006 4:18:01 PM
⚠	docrac	Cluster Database	Invalid Objects by Schema	Owner's Invalid Object Count	3 object(s) are invalid in the SOE schema.	Aug 7, 2006 4:18:01 PM

▶ Related Alerts

See Also:

- ["About Monitoring Oracle RAC Database and Cluster Performance"](#)
- ["Troubleshooting Configuration Problems in Oracle RAC Environments"](#)
- *Oracle Database 2 Day DBA*
- *Oracle Database 2 Day + Performance Tuning Guide*

Viewing Oracle RAC Database Alert Log Messages

An alert log is created for each instance in a cluster database.

To view the alert log for an Oracle RAC database instance:

1. On the Cluster Database Home page, scroll down to the Instances section.
2. Click the name of the instance for which you want to view the alert log.
The Cluster Database Instance Home page appears.
3. In the Diagnostic Summary section, click the **date string** link next to the heading Alert Log to display the alert log entries containing ORA- errors.
The Alert Log Errors page appears.
4. (Optional) Click **Alert Log Content** in the Related Links section to view all the entries in the alert log.

Enterprise Manager displays the most recent alert log entries by default, but you can specify search criteria to display to alert log entries for a range of dates.

The following screenshot shows an example of the alert log entries for the docrac1 instance of a cluster database named docrac.

ORACLE Enterprise Manager 10g Database Control Setup Preferences Help Logout

Database

Database Instance: [docrac_docrac1](#) > Most Recent Alert Log Entries

Search Criteria

Begin Date Time : : AM PM
(example: Sep 22, 2006)

End Date Time : : AM PM
(example: Sep 22, 2006)

Most Recent Alert Log Entries

Page Refreshed Sep 22, 2006 2:06:51 PM

This shows the last 100,000 bytes of the alert log. The log is constantly growing, so select the browser's Refresh button to see the most recent log entries.

Number of Lines Displayed **2,187**

```

Thu Aug 10 15:05:50 2006
Thread 1 advanced to log sequence 130
Current log# 1 seq# 130 mem# 0: +DATA/docrac/onlinelog/group_1.262.594989193
Current log# 1 seq# 130 mem# 1: +DATA/docrac/onlinelog/group_1.263.594989203
Thu Aug 10 21:02:03 2006
Thread 1 advanced to log sequence 131
Current log# 2 seq# 131 mem# 0: +DATA/docrac/onlinelog/group_2.264.594989215
Current log# 2 seq# 131 mem# 1: +DATA/docrac/onlinelog/group_2.265.594989225
    
```

See Also:

- *Oracle Real Application Clusters Administration and Deployment Guide*

Adding and Deleting Nodes and Instances

This chapter describes how to add nodes and instances in Oracle Real Application Clusters (Oracle RAC) environments. You can use these methods when configuring a new Oracle RAC cluster, or when scaling up an existing Oracle RAC cluster.

This chapter includes the following sections:

- [About Preparing Access to the New Node](#)
- [Extending the Oracle Clusterware Home Directory](#)
- [Extending the Automatic Storage Management Home Directory](#)
- [Extending the Oracle RAC Home Directory](#)
- [Adding an Instance to the Cluster Database](#)
- [Deleting an Instance From the Cluster Database](#)

Note: For this chapter, it is very important that you perform each step in the order shown.

See Also:

- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about adding and removing nodes from your cluster database

About Preparing Access to the New Node

To prepare the new node prior to installing the Oracle software, see [Chapter 2, "Preparing Your Cluster"](#).

It is critical that you follow the configuration steps in order for the following procedures to work. These steps include, but are not limited to the following:

- Adding the public and private node names for the new node to the `/etc/hosts` file on the existing nodes, `docrac1` and `docrac2`
- Verifying the new node can be accessed (using the `ping` command) from the existing nodes
- Running the following command on either `docrac1` or `docrac2` to verify the new node has been properly configured:

```
cluvfy stage -pre crsinst -n docrac3
```

Extending the Oracle Clusterware Home Directory

Now that the new node has been configured to support Oracle Clusterware, you use Oracle Universal Installer (OUI) to add a CRS home to the node being added to your Oracle RAC cluster. This section assumes that you are adding a node named `docrac3` and that you have already successfully installed Oracle Clusterware on `docrac1` in a nonshared home, where `CRS_home` represents the successfully installed Oracle Clusterware home. Adding a new node to an Oracle RAC cluster is sometimes referred to as cloning.

To extend the Oracle Clusterware installation to include the new node:

1. Verify the `ORACLE_HOME` environment variable on `docrac1` directs you to the successfully installed CRS home on that node.
2. Go to `CRS_home/oui/bin` and run the `addNode.sh` script.

```
cd /crs/oui/bin
./addNode.sh
```

OUI starts and first displays the Welcome window.

3. Click **Next**.

The Specify Cluster Nodes to Add to Installation window appears.

4. Select the node or nodes that you want to add, for example, `docrac3`. Make sure the public, private and VIP names are configured correctly for the node you are adding. Click **Next**.
5. Verify the entries that OUI displays on the Summary window and click **Next**.

The Cluster Node Addition Progress window appears. During the installation process, you will be prompted to run scripts to complete the configuration.

6. Run the `rootaddNode.sh` script from the `CRS_home/install/` directory on `docrac1` as the `root` user when prompted to do so. For example:

```
[docrac1:oracle]$ su root
[docrac1:root]# cd /crs/install
[docrac1:root]# ./rootaddNode.sh
```

This script adds the node applications of the new node to the Oracle Cluster Registry (OCR) configuration.

7. Run the `orainstRoot.sh` script on the node `docrac3` if OUI prompts you to do so. When finished, click **OK** in the OUI window to continue with the installation.

Another window appears, prompting you to run the `root.sh` script.

8. Run the `CRS_home/root.sh` script as the `root` user on the node `docrac3` to start Oracle Clusterware on the new node.

```
[docrac3:oracle]$ su root
[docrac3:root]# cd /crs
[docrac3:root]# ./root.sh
```

9. Return to the OUI window after the script runs successfully, then click **OK**.

OUI displays the End of Installation window.

10. Exit the installer.

11. Obtain the Oracle Notification Services (ONS) port identifier used by the new node, which you need to know for the next step, by running the `ons.config`

script in the `CRS_home/opmn/conf` directory on the `docrac1` node, as shown in the following example:

```
[docrac1:oracle]$ cd /crs/opmn/conf
[docrac1:oracle]$ cat ons.config
```

After you locate the ONS port identifier for the new node, you must make sure that the ONS on `docrac1` can communicate with the ONS on the new node, `docrac3`.

12. Add the new node's ONS configuration information to the shared OCR. From the `CRS_home/bin` directory on the node `docrac1`, run the ONS configuration utility as shown in the following example, where `remote_port` is the port identifier from Step 11, and `docrac3` is the name of the node that you are adding:

```
[docrac1:oracle]$ ./racgons add_config docrac3:remote_port
```

You should now have Oracle Clusterware running on the new node. To verify the installation of Oracle Clusterware on the new node, you can run the following command as the `root` user on the newly configured node, `docrac3`:

```
[docrac1:oracle]$ opt/oracle/crs/bin/cluvfy stage -post crsinst -n docrac3
-verbose
```

See Also:

- ["Completing the Oracle Clusterware Configuration"](#)
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about adding and removing nodes from your cluster database

Extending the Automatic Storage Management Home Directory

To extend an existing Oracle RAC database to a new node, you must configure the shared storage for the new database instances that will be created on new node. You must configure access to the same shared storage that is already used by the existing database instances in the cluster. For example, the `sales` cluster database in this guide uses Automatic Storage Management (ASM) for the database shared storage, so you must configure ASM on the node being added to the cluster.

Because you installed ASM in its own home directory, you must configure an ASM home on the new node using OUI. The procedure for adding an ASM home to the new node is very similar to the procedure you just completed for extending Oracle Clusterware to the new node.

Note: If the ASM home directory is the same as the Oracle home directory in your installation, then you do not need to complete the steps in this section.

To extend the ASM installation to include the new node:

1. Ensure that you have successfully installed the ASM software on at least one node in your cluster environment. In the following steps, `ASM_home` refers to the location of the successfully installed ASM software.
2. Go to the `ASM_home/oui/bin` directory on `docrac1` and run the `addNode.sh` script.

3. When OUI displays the Node Selection window, select the node to be added (`docrac3`), and then click **Next**.
4. Verify the entries that OUI displays on the Summary window, and then click **Next**.
5. Run the `root.sh` script on the new node, `docrac3`, from the ASM home directory on that node when OUI prompts you to do so.

You now have a copy of the ASM software on the new node.

See Also:

- ["Verifying Your ASM Installation"](#)
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about adding and removing nodes from your cluster database

Extending the Oracle RAC Home Directory

Now that you have extended the CRS home and ASM home to the new node, you must extend the Oracle home on `docrac1` to `docrac3`. The following steps assume that you have already completed the previous tasks described in this section, and that `docrac3` is already a member node of the cluster to which `docrac1` belongs.

The procedure for adding an Oracle home to the new node is very similar to the procedure you just completed for extending ASM to the new node.

To extend the Oracle RAC installation to include the new node:

1. Ensure that you have successfully installed the Oracle RAC software on at least one node in your cluster environment. To use these procedures as shown, replace *oracle_home* with the location of your installed Oracle home directory.
2. Go to the *oracle_home/oui/bin* directory on `docrac1` and run the `addNode.sh` script.
3. When OUI displays the Specify Cluster Nodes to Add to Installation window, select the node to be added (`docrac3`), and then click **Next**.
4. Verify the entries that OUI displays in the Cluster Node Addition Summary window, and then click **Next**.

The Cluster Node Addition Progress window appears.

5. When prompted to do so, run the `root.sh` script as the `root` user on the new node, `docrac3`, from the Oracle home directory on that node.
6. Return to the OUI window and click **OK**. The End of Installation window appears.
7. Exit the installer.

After completing these steps, you should have an installed Oracle home on the new node.

See Also:

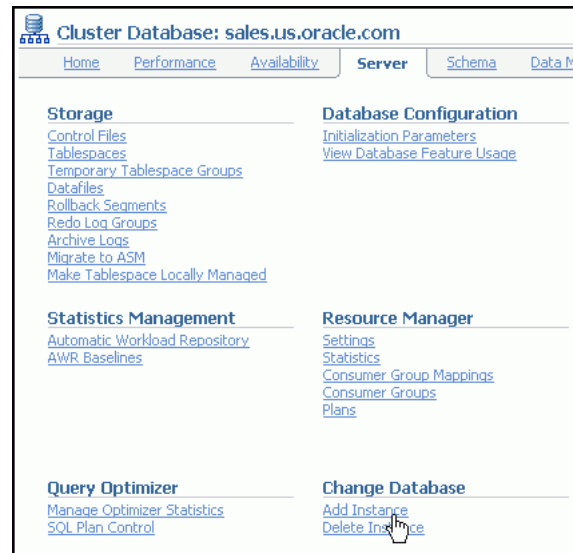
- ["Verifying Your Oracle RAC Database Installation"](#)
- *Oracle Real Application Clusters Administration and Deployment Guide* for more information about adding and removing nodes from your cluster database

Adding an Instance to the Cluster Database

You can use Enterprise Manager to add an instance to your cluster database. You must first configured the new node to be a part of the cluster and installed the software on the new node.

To add an instance to the cluster database:

1. From the Cluster Database Home page, click **Server**.
2. Under the heading Change Database, click **Add Instance**.



The Add Instance: Cluster Credentials page appears.

3. Enter the host credentials and ASM credentials, then click **Next**.

The Add Instance: Host page appears.

4. Select the node on which you want to create the new instance, verify the new instance name is correct, and then **Next**.

Add Instance: Host

Name of the database instance to be added: Cancel Back Step 2 of 3 Next

The following list of hosts have database software installed and are currently configured for this cluster. Select a host to which you want to add a database instance. This host should have access to the shared storage used by this database.

Select	Host	Existing Database Instances
<input type="radio"/>	pmrac1	sales1
<input checked="" type="radio"/>	pmrac2	

TIP You can clone an Oracle Home to a host where database software is not installed. [Clone Oracle Home](#)

After the selected host has been validated, the Add Instance: Review page appears.

5. Review the information, then click **Submit Job** to proceed.
A confirmation page appears.
6. Click **View Job** to check on the status of the submitted job.

The Job Run detail page appears.

7. Click your browser's Refresh button until the job shows a status of Succeeded or Failed.

If the job shows a status of Failed, you can click the name of the step that failed to view the reason for the failure.

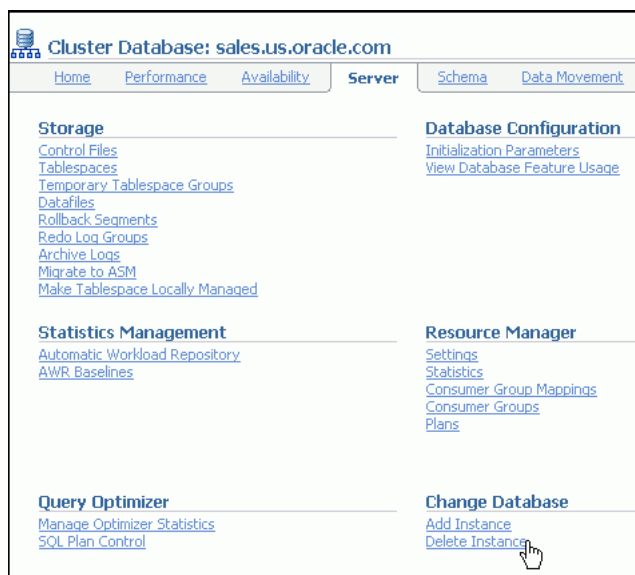
8. Click the **Database** tab to return to the Cluster Database Home page.

The number of instances available in the cluster database is increased by one.

Deleting an Instance From the Cluster Database

To delete an instance from the cluster:

1. From the Cluster Database Home page, click **Server**.
2. On the Server subpage, under the heading Change Database, click **Delete Instance**.

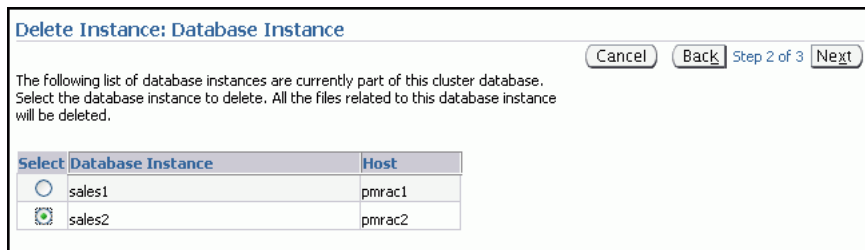


The Delete Instance: Cluster Credentials page appears.

3. Enter your cluster credentials and ASM credentials, then click **Next**.

The Delete Instance: Database Instance page appears

4. Select the instance you want to delete, then click **Next**.



The Delete Instance: Review page appears.

- Review the information, and if correct, click **Submit Job** to continue. Otherwise, click **Back** and correct the information.

A Confirmation page appears.

- Click **View Job** to view the status of the node deletion job.

A Job Run detail page appears.

- Click your browser's Refresh button until the job shows a status of Succeeded or Failed.

Jobs > Job Run: DELETEINSTANCE_SALES.US.ORACLE.COM_000023 >
 Execution: sales.us.oracle.com
 Page Refreshed Jun 28, 2007 1:48:01 PM PDT [Delete Run](#) [Edit](#) [View Definition](#)

Summary

Status	Succeeded	Type	Delete Instance
Scheduled	Jun 28, 2007 1:46:26 PM (UTC-07:00)	Owner	SYS
Started	Jun 28, 2007 1:46:26 PM (UTC-07:00)	Description	DeleteInstance Job:
Ended	Jun 28, 2007 1:47:33 PM (UTC-07:00)	Oracle Home	/ora/11g/base/db
Elapsed Time	67 seconds		
Notification	No		

Targets
 Status

[Expand All](#) | [Collapse All](#)

Name	Targets	Status	Started	Ended	Elapsed Time (seconds)
Execution: sales.us.oracle.com	sales.us.oracle.com	Succeeded	Jun 28, 2007 1:46:26 PM (UTC-07:00)	Jun 28, 2007 1:47:33 PM (UTC-07:00)	67
Step: delete_instance	sales.us.oracle.com_sales1	Succeeded	Jun 28, 2007 1:46:31 PM (UTC-07:00)	Jun 28, 2007 1:47:33 PM (UTC-07:00)	61

If the job shows a status of Failed, you can click the name of the step that failed to view the reason for the failure.

- Click the **Database** tab to return to the Cluster Database Home page.

The number of instances available in the cluster database is reduced by one.

Managing Oracle Software and Applying Patches

Oracle issues product fixes for its software called patches. When you apply the patch to your Oracle software installation, a small collection of files is replaced to fix certain bugs. OPatch is a utility supplied by Oracle that facilitates Oracle software patching.

A group of patches form a patch set. When you apply a patch set, many different files and utilities are modified. This results in a version change for your Oracle software, for example, from Oracle Database 11.1.0.1.0 to Oracle Database 11.1.0.2.0. To apply a patch set, use Oracle Universal Installer (OUI).

This chapter describes how to manage Oracle software and apply patches in Oracle Real Application Clusters (Oracle RAC) environments using Oracle Enterprise Manager and the OPatch utility.

This chapter includes the following sections:

- [Configuring the Enterprise Manager Patch Interface](#)
- [Obtaining the Patch](#)
- [Preparing to Use OPatch](#)
- [Applying Patches](#)
- [Applying Patch Sets](#)
- [Troubleshooting Patch Deployment](#)

See Also:

- *Oracle Universal Installer and OPatch User's Guide* for more information about using OPatch and applying patches to Oracle RAC
- *Oracle Database 2 Day DBA*

Configuring the Enterprise Manager Patch Interface

Enterprise Manager Database Control enables you to find the latest patch release on the Oracle*MetaLink* Web site, and to download it to your Oracle home. There are two steps in configuring the Enterprise Manager Patch interface:

- [About OracleMetaLink Credentials](#)
- [Running the Refresh_From_Metalink Job](#)

See Also:

- ["Oracle RAC and Enterprise Manager"](#) on page 4-2
- *Oracle Database 2 Day DBA*

About OracleMetaLink Credentials

To download patches from OracleMetaLink using Enterprise Manager, you can give Enterprise Manager Database Control (Database Control) your login credentials so that it can log in to OracleMetaLink automatically and search for patch releases. You must set these credentials before you can run the Patch Wizard in Database Control.

Refer to *Oracle Database 2 Day DBA* for instructions on setting your OracleMetaLink credentials.

See Also:

- ["Configuring the Enterprise Manager Patch Interface"](#) on page 10-1
- *Oracle Database 2 Day DBA*

Running the Refresh_From_Metalink Job

After you have configured the OracleMetaLink credentials, you can create a job to search for critical patch advisories for your installed software.

To create a job to search for critical patch advisories on OracleMetaLink:

1. On the Cluster Database Home page, scroll down to the section titled Critical Patch Advisories. Click **RefreshFromMetalink**.



When you click this link, Enterprise Manager creates the Refresh_From_Metalink_Job job, and then displays the Job Activity page.

2. On the Job Activity page, click **Edit** and then modify the scheduled execution time of the Refresh_From_Metalink_Job job to meet your business requirements. When finished, click **Save**.
3. Select the Refresh_From_Metalink_Job job and click **Create Like**.
4. Change the job name to Refresh_From_Metalink_Now, then click **Schedule**.
5. Select **Immediately** for the start time.
6. Select **One Time Only** for the Repeat interval, then click **Submit and Save**.

The Job Activity page appears.

7. Click **REFRESH_FROM_METALINK_NOW**.

The Job Run: REFRESH_FROM_METALINK_NOW page is displayed.

8. Refresh this page until the job status shows Succeeded.

9. Click the **Database** tab in the upper right-hand corner to return to the Cluster Database Home page.

See Also:

- ["Configuring the Enterprise Manager Patch Interface"](#) on page 10-1
- *Oracle Database 2 Day DBA*

Obtaining the Patch

You obtain patches and patch sets from *OracleMetalink*, which is the Oracle Support Services Web site, at

<https://metalink.oracle.com>

You can view available patch releases at *OracleMetalink* by using Enterprise Manager. Viewing these updates is the first step in the Patch Wizard, which you can use to download the patch to your Oracle home.

To start the Patch Wizard Using Enterprise Manager:

1. On the Cluster Database Home page, scroll down to the Instances section.
2. Click the link for the first instance in your cluster, for example, **sales.oracle.com_sales1**.

The Database Instance Home page for the sales1 instance appears.

3. Select **Software and Support** at the top of the page.
4. In the Database Software Patching section, click **Apply Patch**.

The Select Patches page appears.

5. Click Add Patch.

The Search and Select Patches page appears.

6. Select the **Search Metalink** option.
7. Specify the **Patch Type** and **Platform** for your cluster, then click **Go**.

The search results that match the criteria are displayed by the most recent patch (or patch set) at the top of the list.

8. Select a patch and click **View Details** to view the patch details. Select a patch and click **View ReadMe** to view the README file for the patch, which includes a description of the bug fixes included in the patch and patch installation instructions. Return to the Patch Wizard by clicking the Patch locator link on the View Patch Details page.

9. Select the patch you are interested in, or select the most recent patch set if you are doing a periodic software update, and then click **Next**.

The Patch: Select Destination page appears.

10. Select the targets to apply the patch to by moving the target names from the Available Targets list to the Selected Targets list, and then click **Next**.

The Patch: Set Credentials page appears.

11. In the **Username** and **Password** fields, enter the operating system user name and password to enable Enterprise Manager to stage the patch in your Oracle home directory. Enterprise Manager requires these credentials for job scheduling. After

you have entered the operating system credentials for each selected node, click **Next**.

The Patch: Stage or Apply page appears.

12. Enterprise Manager downloads the patch to the directory that is listed in the main box. Typically, this location is an Oracle home subdirectory called `EMStagedPatches/patchnumber`.

By default, Enterprise Manager only stages the patch. You can then manually apply the patch by following the directions given in the patch README file. The directions may include shutting down the database instances and your applications, or running scripts.

13. (Optional) Select the **Run Script to Apply Patch** option to have Enterprise Manager apply the patch for you. If you choose this option, you must modify the script displayed on this page so that it performs all the actions specified in the patch release notes.

Note: This step is supported only for databases that do not contain the Enterprise Manager repository or for patches that do not require the repository database to be shut down. For example, if you are applying a patch that affects only SQL*Loader, then you can use Enterprise Manager to apply the patch.

14. When you are finished, click **Next**.

The Patch: Schedule page appears.

15. Specify the time when you want the patch to be downloaded from *OracleMetaLink*. If you selected the option **Run Script to Apply Patch**, then the patch apply script will run at this time. Click **Next**.

The Patch: Summary page appears.

16. Review the summary information on this page. If you need to modify any of the information displayed, click **Back**. When you are ready to submit the job, click **Finish**.

See Also:

- ["Configuring the Enterprise Manager Patch Interface"](#) on page 10-1
- *Oracle Database 2 Day DBA*

Preparing to Use OPatch

Before you apply the patch to your Oracle RAC database, your ASM installation, or to your Oracle Clusterware installation, there are a few steps to perform:

- [Checking the ORACLE_HOME Environment Variable](#)
- [Performing a Backup](#)
- [Staging the Patch on Each Node](#)
- [Updating the PATH Environment Variable](#)
- [Configuring SSH User Equivalency](#)

See Also:

- ["Configuring the Enterprise Manager Patch Interface"](#) on page 10-1
- ["Obtaining the Patch"](#) on page 10-3
- *Oracle Database 2 Day DBA*

Checking the ORACLE_HOME Environment Variable

OPatch verifies if the Oracle home is present. You must ensure that the ORACLE_HOME environment variable is set to the Oracle home of the product you are trying to patch.

Check the respective vendor documentation for the details to set the environment variable.

To check the current setting of the ORACLE_HOME variable on Linux:

1. In a command window, log in to the operating system as the `oracle` user.
2. Use the `echo` command to display the current setting of the ORACLE_HOME environment variable.

```
echo $ORACLE_HOME
```

See Also:

- ["Preparing to Use OPatch"](#) on page 10-4
- ["Configuring the Operating System Environment"](#) on page 3-2
- *Oracle Database 2 Day DBA*

Performing a Backup

It is highly recommended to back up the software directory you are patching before performing any patch operation. This applies to Oracle RAC, ASM, or Oracle Clusterware software installation directories.

To back up the software installation:

1. Back up the software installed in the specified Oracle home using:
 - a. An operating system utility, such as `zip`, `cp -r`, `tar`, or `cpio`, to back up the software in the Oracle home directory that is being patched to disk.
 - b. The Oracle Secure Backup utility to back up the software in the Oracle home directory that is being patched to tape.

See Also:

- ["Preparing to Use OPatch"](#) on page 10-4
- ["Configuring the Operating System Environment"](#) on page 3-2
- *Oracle Universal Installer and OPatch User's Guide*

Staging the Patch on Each Node

If you use Enterprise Manager to download the patch, and you selected all the nodes in your cluster as targets for the patch, then the patch is automatically staged on those nodes.

If you manually downloaded the patch from *OracleMetaLink*, then you must copy the patch to each node.

See Also:

- ["Preparing to Use OPatch"](#) on page 10-4
- ["Obtaining the Patch"](#) on page 10-3
- *Oracle Database 2 Day DBA*

Updating the PATH Environment Variable

The `opatch` binary file is located in the `Oracle_home/OPatch` directory. You can either specify this path when executing OPatch, or you can update the `PATH` environment variable to include the `OPatch` directory.

To update the PATH environment variable on Red Hat Linux systems:

1. In a command window, log in to the operating system.
2. Use a shell command similar to the following to update the value of the `PATH` environment variable, where `/opt/oracle/11gR1/db_1` is the location of your Oracle home directory:

```
$ export PATH=$PATH:/opt/oracle/11gR1/db_1/OPatch
```

You could also modify the shell profile script for the current user to have this variable configured every time you log in.

See Also:

- ["Preparing to Use OPatch"](#) on page 10-4
- ["Configuring the Operating System Environment"](#) on page 3-2
- *Oracle Universal Installer and OPatch User's Guide*

Configuring SSH User Equivalency

Before you patch a system, make sure the user equivalency is working.

To test SSH user equivalency:

1. On the system where you want to run OPatch, log in as the `oracle` user.
2. Use the following command to test user equivalency:

```
[oracle@docrac1] $ ssh docrac2 date
```

If the date is returned, then user equivalency between the source and destination node has been configured.

3. If you see output similar to the following, then SSH user equivalency is not enabled:

```
Enter passphrase for key '/home/oracle/.ssh/id_rsa':
```

Enable SSH user equivalency before continuing with the patching operation.

To enable SSH user equivalency:

1. On the system where you want to run OPatch, open a command window and log in as the `oracle` user.

2. Start the SSH agent and load the SSH keys into memory using the following commands:

```
$ /usr/bin/ssh-agent $SHELL
$ /usr/bin/ssh-add
```

These commands start the `ssh-agent` on the local node, and load the RSA and DSA keys into the current session's memory so that you are not prompted to use pass phrases when issuing SSH commands.

3. At the prompt, enter the pass phrase for each key that you generated when configuring Secure Shell, for example:

```
[oracle@docrac1 .ssh]$ exec /usr/bin/ssh-agent $SHELL
[oracle@docrac1 .ssh]$ /usr/bin/ssh-add
Enter passphrase for /home/oracle/.ssh/id_rsa
Identity added: /home/oracle/.ssh/id_rsa (/home/oracle/.ssh/id_rsa)
Identity added: /home/oracle/.ssh/id_dsa (/home/oracle/.ssh/id_dsa)
```

4. To test if you have configured SSH correctly, run the following command. If you have configured SSH correctly, then you will not be prompted for a password or a pass phrase.

```
[oracle@docrac1] $ ssh docrac2 date
```

Note: Do not close this command window until you have completed the patch installation. If you must close the command window in which you enabled SSH user equivalency before the patch installation is complete, repeat Step 1 to Step 4 before starting the patch installation.

See Also:

- ["Configuring SSH User Equivalency"](#) on page 2-10
- ["Preparing to Use OPatch"](#) on page 10-4

Applying Patches

Patching in an Oracle RAC environment is slightly different compared to patching a single node. If OPatch detects a cluster, it uses Oracle Universal Installer (OUI) to query the software inventory to find the local node name and node list.

Before you install a patch, you must stop all the applications running from the software directory that is being patched. In an Oracle RAC cluster, you may have to shut down additional applications, depending upon which software is being patched. [Table 10–1](#) lists the applications to stop when patching Oracle software.

Table 10–1 Patching Oracle Home Directories

Oracle Home Directory	Applications to Stop
Oracle RAC Database	Oracle RAC database, Enterprise Manager Database Control, listener, and any other applications that are running from the Oracle RAC home directory

Table 10–1 (Cont.) Patching Oracle Home Directories

Oracle Home Directory	Applications to Stop
ASM	Oracle RAC database, any single-instance databases that use the same ASM instance as the cluster database, listener (if running from the ASM home directory), ASM, and any other applications that are running from the ASM home directory
Oracle Clusterware	Oracle RAC database, any single-instance databases that use the same ASM instance as the cluster database, ASM, all node applications, Oracle Clusterware, and any other applications that are running from the CRS home directory

You can patch Oracle RAC in three different ways:

- [All Node Patching](#)
- [Rolling Patching](#)
- [Minimum Downtime Patching](#)

All Node Patching

In all node patching, all the nodes in the cluster are initially shut down and the patch is applied on all the nodes. After all the nodes have been patched, then all the nodeapps on the nodes are restarted. This method is typically used for very critical patches and it leads to maximum downtime. OPatch uses this method if the patch cannot be applied in a rolling fashion, and you did not specify the `minimize_downtime` option.

To implement all node patching:

1. Stop all user applications that use the Oracle home directory.
2. If you are patching only the Oracle RAC home directory, shut down all Oracle RAC instances on all nodes in the cluster. To shut down all Oracle RAC instances for a cluster database, enter the following command in a command window, where `CRS_home` is the location of the CRS home directory and `sales` is the name of the database:


```
$ CRS_home/bin/srvctl stop database -d sales
```
3. If you are patching the ASM home or CRS home directory, stop all single-instance databases that are running on the group of nodes being patched if they use the ASM installation that you are patching.
4. If you are patching the ASM home directory, stop all user applications that use the ASM home directory on the group of nodes being patched.
5. If you are patching the ASM home or CRS home directory, you can use a single command to stop all the node applications on each node in the group. This command shuts down the Oracle RAC instances, the listener, the ASM instances, and the Oracle Clusterware node applications for the specified node. Use a command similar to the following, where `CRS_home` is the home directory of your Oracle Clusterware installation and `node_name` is the name of the node:


```
$ CRS_home/crs/bin/srvctl stop nodeapps -n node_name
```

Repeat the preceding command for each node in the cluster.

After you have stopped the nodeapps on each node in the cluster, use the `crs_stat` utility to verify that all the nodeapps were stopped on each node.


```
$ CRS_home/bin/crs_stat -t
```

6. If you are patching the CRS home directory, shut down the CRS daemons for all the nodes in the cluster by issuing the following command as the `root` user on each node, where `CRS_home` is the home directory of your Oracle Clusterware installation:

```
# CRS_home/bin/crsctl stop crs
```

Repeat this command on each node in the cluster.

7. Set your current directory to the directory where the patch is located, for example:

```
$ cd Oracle_home/EMStagedPatches/4519934/4519934
```

8. Make sure the `ORACLE_HOME` environment variable points to the software directory you want to patch, for example:

```
$ echo $ORACLE_HOME
/opt/oracle/11gR1/db_1
```

9. Run OPatch by entering the following command:

```
opatch apply
```

10. If you applied the patch to the CRS home directory, restart the CRS daemons on all nodes by issuing the following command as the `root` user on each node, where `CRS_home` is the home directory of your Oracle Clusterware installation:

```
# CRS_home/bin/crsctl start crs
```

Repeat this command on each node in the cluster.

11. If you stopped the nodeapps on each node, after the patch has been applied, restart the nodeapps on all nodes. To start the nodeapps, enter a command similar to the following where `CRS_home` is the home directory of your Oracle Clusterware installation and `docrac1` is one of the nodes in your cluster:

```
$ CRS_home/bin/srvctl start nodeapps -n docrac1
```

Repeat the preceding command for each node in the cluster.

After you have restarted the nodeapps on all nodes, use the `crs_stat` utility to verify that the nodeapps were restarted on each node.

```
$ CRS_home/bin/crs_stat -t
```

If any of the node applications did not restart, use the `SRVCTL` utility to restart them. For example, you can use commands similar the following to restart various node applications, where `CRS_home` is the home directory of your Oracle Clusterware installation:

```
$ CRS_home/bin/srvctl start instance -d sales -i "sales1"
$ CRS_home/bin/srvctl start listener -n docrac1
$ CRS_home/bin/srvctl start asm -n docrac1
```

12. Run any post-patch scripts that are mentioned in the patch instructions, for example:

```
$ sqlplus /nolog
SQL> connect sys/password@sales1 AS SYSDBA
SQL> @Oracle_home/cpu/CPUOct2007/catcpu.sql
SQL> @Oracle_home/rdbms/admin/utlrp.sql
```

```
SQL> exit
```

See Also:

- ["Obtaining the Patch"](#) on page 10-3
- ["Preparing to Use OPatch"](#) on page 10-4
- ["Applying Patches"](#) on page 10-7
- ["Applying Patch Sets"](#) on page 10-15
- ["Troubleshooting Patch Deployment"](#) on page 10-16
- *Oracle Universal Installer and OPatch User's Guide*

Rolling Patching

In rolling patching, one group of nodes is shut down, the patch is applied to those nodes, and the nodes are brought back up. This is performed group by group, separately, until all the nodes in the cluster are patched. This is the most efficient means of applying an interim patch to an Oracle RAC, ASM, or Oracle Clusterware installation. By patching groups of nodes individually, there is zero downtime for the cluster database because at least one instance is available at all times on a different node.

While most patches can be applied in a rolling fashion, some patches cannot be applied in this fashion. The README file for the patch indicates whether or not you can apply the patch using the rolling patch method. If the patch cannot be applied using the rolling patch method, then you must use either ["Minimum Downtime Patching"](#) on page 10-13 or ["All Node Patching"](#) on page 10-8 to apply the patch.

To apply a patch using the rolling patch method:

1. In a command window, change to the directory where the unzipped patch is staged on disk, for example:

```
$ cd Oracle_home/EMStagedPatches/4519934/4519934
```
2. Stop all user applications that use the Oracle RAC home directory for the group of nodes being patched. For example, to stop Enterprise Manager Database Control on the local node, use the following command, where *Oracle_home* is the home directory for your Oracle RAC installation:

```
$ Oracle_home/bin/emctl stop dbconsole
```
3. If you are patching the ASM home or CRS home directory, stop all single-instance databases that are running on the group of nodes being patched if they use the ASM software you are patching.
4. If you are patching the ASM home directory, stop all user applications that use the ASM home directory on the group of nodes being patched.
5. If you are patching only the Oracle RAC home directory, shut down all Oracle RAC instances in the group of nodes being patched. To shut down an instance for an Oracle RAC database, enter a command similar to the following example, where *CRS_home* is the home directory for your Oracle Clusterware installation, *sales* is the name of the database, and *sales1* is the name of the instance:

```
$ CRS_home/bin/srvctl stop instance -d sales -i "sales1"
```

Repeat the preceding command for each node in the group of nodes being patched.

6. If you are patching the ASM home or CRS home directory, you can use a single command to stop all the node applications on each node in the group. This command shuts down the Oracle RAC instances, the listener, the ASM instances, and the Oracle Clusterware node applications for the specified node. Use a command similar to the following, where *CRS_home* is the home directory of your Oracle Clusterware installation and *docrac1* is one of the nodes in the group:

```
$ CRS_home/crs/bin/srvctl stop nodeapps -n docrac1
```

Repeat the preceding command for each node in the group of nodes being patched.

After you have stopped the *nodeapps* on each node in the group, use the *crs_stat* utility to verify that all the *nodeapps* were stopped on the group of nodes being patched.

```
$ CRS_home/bin/crs_stat -t
```

7. If you are patching the CRS home directory, shut down the CRS daemons for the nodes in the group by issuing the following command as the *root* user on each node in the group, where *CRS_home* is the home directory of your Oracle Clusterware installation:

```
# CRS_home/bin/crsctl stop crs
```

Repeat this command on each node in the group of nodes being patched.

8. Make sure the *ORACLE_HOME* environment variable points to the software directory you want to patch, for example:

```
$ echo $ORACLE_HOME
/opt/oracle/11gR1/db_1
```

9. If you are patching nodes individually, use the following command to instruct OPatch to apply the patch to only the local node. If you run this command from the directory where the patch is located, you do not need to specify the patch ID.

```
$ opatch apply -local
```

If you are using a group of nodes, use a command similar to the following to instruct OPatch to apply the patch to the group of nodes being patched:

```
$ opatch apply -local_node docrac1 -remote_nodes docrac2,docrac3
```

10. If you applied the patch to the CRS home directory, restart the CRS daemons for the nodes in the first group by issuing the following command as the *root* user on each node in the group, where *CRS_home* is the home directory of your Oracle Clusterware installation:

```
# CRS_home/bin/crsctl start crs
```

Repeat this command on each node in the group.

11. If you stopped the *nodeapps* for the group of nodes, after the patch has been applied, restart the *nodeapps* on those nodes. To start the *nodeapps*, enter a command similar to the following where *CRS_home* is the home directory of your Oracle Clusterware installation and *docrac1* is one of the nodes in the group of nodes you recently patched:

```
$ CRS_home/bin/srvctl start nodeapps -n docrac1
```

Repeat the preceding command for each node in the group.

12. After you have restarted the nodeapps on each node in the group, use the `crs_stat` utility to verify that the nodeapps were restarted on each node in the group.

```
$ CRS_home/bin/crs_stat -t
```

If any of the node applications did not restart, use the `SRVCTL` utility to restart them. For example, you can use the following command to restart the `sales1` instance for the `sales` cluster database:

```
$ CRS_home/bin/srvctl start instance -d sales -i "sales1"
```

13. Restart all single-instance databases that use the ASM software and all user applications that use the Oracle home or ASM home on each node in the group of nodes you recently patched.
14. Repeat Step 2 through Step 8 for the next group of nodes.
15. If you are patching nodes individually, use a command similar to the following to instruct `OPatch` to apply the patch to only the next node to be patched. If you run this command from the directory where the patch is located, you do not need to specify the patch ID.

```
$ opatch apply -remote_nodes docrac2
```

If you are patching a group of nodes, use a command similar to the following to instruct `OPatch` to apply the patch to the group of nodes being patched:

```
$ opatch apply -remote_nodes docrac4,docrac5,docrac6
```

16. If you applied the patch to the CRS home directory, restart the CRS daemons for the nodes in the group you recently patched by issuing the following command as the `root` user on each node in the group, where `CRS_home` is the home directory of your Oracle Clusterware installation:

```
# CRS_home/bin/crsctl start crs
```

Repeat this command on each node in the group.

17. If you stopped the nodeapps for the group of nodes, after the patch has been applied, restart the nodeapps on those nodes. To start the nodeapps, enter a command similar to the following where `CRS_home` is the home directory of your Oracle Clusterware installation and `docrac1` is one of the nodes in the group of nodes you recently patched:

```
$ CRS_home/bin/srvctl start nodeapps -n docrac1
```

Repeat the preceding command for each node in the group.

18. After you have restarted the nodeapps on each node in the group, use the `crs_stat` utility to verify that the nodeapps were restarted on each node in the group.

```
$ CRS_home/bin/crs_stat -t
```

If any of the node applications did not restart, use the `SRVCTL` utility to restart them. For example, you can use the following command to restart the `sales2` instance for the `sales` cluster database:

```
$ CRS_home/bin/srvctl start instance -d sales -i "sales2"
```

19. Restart all single-instance databases that use the ASM software and all user applications that use the Oracle home or ASM home on each node in the group of nodes you recently patched.
20. If you have more than two groups of nodes to be patched, repeat Step 14 through Step 19 for each group of nodes until all the nodes in the cluster have been patched.
21. Run any post-patch scripts that are mentioned in the patch instructions, for example:

```
$ sqlplus /nolog
SQL> connect sys/password@sales1 AS SYSDBA
SQL> @Oracle_home/cpu/CPUOct2007/catcpu.sql
SQL> @Oracle_home/rdbms/admin/utlrp.sql
SQL> exit
```

See Also:

- ["Obtaining the Patch"](#) on page 10-3
- ["Preparing to Use OPatch"](#) on page 10-4
- ["Applying Patches"](#) on page 10-7
- ["Applying Patch Sets"](#) on page 10-15
- ["Troubleshooting Patch Deployment"](#) on page 10-16
- *Oracle Universal Installer and OPatch User's Guide*

Minimum Downtime Patching

In minimum downtime patching, one set of nodes is shut down and the patch is applied to those nodes. After the first set of nodes has been patched, the second set of nodes is shut down. The first set of nodes is then restarted and the patch is applied to the second set of nodes. After the patch has been applied to the second set of nodes, those nodes are restarted. This method leads to less downtime for Oracle RAC, compared to having all the nodes shut down at the same time.

When you use the minimum downtime patching method, the following actions occur:

- The local node is always patched first.
- The local node is used as a base to patch the other nodes.
- The user is prompted for the set of nodes to patch first from the remaining nodes.
- For each node in this first set, the user is asked to stop the instance and then the patch is propagated to that node before continuing to the next node. When the initial set of nodes has been patched, the user is asked to shut down the remaining nodes.
- After the local node is patched, the patch is propagated to the last set of nodes and the inventory is updated. The last instances are stopped on the remote nodes. You can then start up the patched nodes (the first set of nodes) before patching the remaining nodes.

To apply a patch to your cluster database using the minimum downtime method:

1. Change to the directory where the unzipped patch is staged on disk, for example:

```
$ cd Oracle_home/EMStagedPatches/4519934/4519934
```

2. Stop all user applications that use the Oracle RAC home directory for the group of nodes being patched. For example, to stop Enterprise Manager Database Control on the local node, use the following command, where *Oracle_home* is the home directory for your Oracle RAC installation:

```
$ Oracle_home/bin/emctl stop dbconsole
```

3. Shut down all Oracle RAC instances on the local node. To shut down an instance for an Oracle RAC database, enter a command similar to the following example, where *CRS_home* is the home directory for your Oracle Clusterware installation, *sales* is the name of the database, and *sales1* is the name of the instance:

```
$ CRS_home/bin/srvctl stop instance -d sales -i "sales1"
```

4. Make sure the `ORACLE_HOME` environment variable points to the software directory you want to patch, for example:

```
$ echo $ORACLE_HOME  
/opt/oracle/11gR1/db_1
```

5. Use the following command from within the patch directory:

```
$ opatch apply -minimize_downtime
```

If you run the `OPatch` command from the directory where the patch is staged on disk, you do not need to specify the patch ID.

`OPatch` asks if you are ready to patch the local node. After you confirm that the Oracle RAC instances on the local node have been shut down, `OPatch` applies the patch to the Oracle home directory on the local node. You are then asked to select the next nodes to be patched.

6. After you shut down the Oracle RAC instances on the other nodes in the cluster, you can restart the Oracle RAC instance on the local node. Then, instruct `OPatch` that you are ready to patch the remaining nodes.
7. After all the nodes have been patched, restart the Oracle RAC instances on the other nodes in the cluster. The following command shows how to start the *sales2* instance for the Oracle RAC database named *sales*:

```
$ CRS_home/bin/srvctl start instance -d sales -i "sales1"
```

8. Verify that all the `nodeapps` were restarted on the nodes in the cluster.

```
$ crs_stat -t
```

If any of the node applications did not restart, use the `SRVCTL` utility to restart them. For example, you can use commands similar the following to restart the listener on the *docrac1* node, where *CRS_home* is the home directory of your Oracle Clusterware installation:

```
$ CRS_home/bin/srvctl start listener -n docrac1
```

9. Run any post-patch scripts that are mentioned in the patch instructions, for example:

```
$ sqlplus /nolog  
SQL> connect sys/password@sales1 AS SYSDBA  
SQL> @Oracle_home/cpu/CPUOct2007/catcpu.sql  
SQL> @Oracle_home/rdbms/admin/utlrp.sql  
SQL> exit
```

See Also:

- "Obtaining the Patch" on page 10-3
- "Preparing to Use OPatch" on page 10-4
- "Applying Patches" on page 10-7
- "Applying Patch Sets" on page 10-15
- "Troubleshooting Patch Deployment" on page 10-16
- *Oracle Universal Installer and OPatch User's Guide*

Applying Patch Sets

Patch sets are a mechanism for delivering fully tested and integrated product fixes. All the fixes in a patch set have been tested and are certified to work with each other. Because a patch set includes only low impact patches, it does not require you to certify applications or tools against the server.

For instructions on applying the latest patch set to your Oracle RAC database and Oracle Clusterware installations on Red Hat Linux, search for "Oracle 11g release 1(11.1) Support Status and Alerts" documentation on the *OracleMetaLink* Web site.

This document provides a summary of the patch sets available for Oracle 11g Release 1. Using this document, you can easily locate and view the Patch Set Notes for your platform. The Oracle Database Patch Set Notes document contains the following information:

- System requirements and information about how to install or reinstall the patch set
- A list of all bugs fixed to date that are specific to Oracle Database for specified platform
- A list of known issues relating to Oracle Database for the specified platform

To locate the Patchset notes on *OracleMetaLink*:

1. Log in to *OracleMetaLink*.
2. Select the **Patches & Updates** tab.
3. Select **Quick Links to the Latest Patchsets, Mini Packs, and Maintenance Packs**.
4. Under the heading Latest Oracle Server/Tools Patchsets, select **Oracle Database**.

A list of operating systems appears.

5. Place your cursor over the entry that matches your operating system, or use the triangular arrows to search for your operating system.

When you place the cursor over the entry for your operating system, for example, Linux x86, a list of database versions appears.

6. Select **11.1.0**

The Advanced Search page appears.

7. Scroll to the bottom of this page to see the list of available patchsets.
8. Select the number in the Patch column for the patchset you want to view or download.

The Patchset description and download page appears.

9. Click **View Readme** to see the patchset notes.

On this page you can also click **Download** to download the patch to your computer.

See Also:

- ["Preparing to Use OPatch"](#)
- ["Applying Patches"](#)
- ["Troubleshooting Patch Deployment"](#)
- *Oracle Universal Installer and OPatch User's Guide*

Troubleshooting Patch Deployment

This section covers the following topics regarding troubleshooting patch deployment:

- [Updating the Node List for OPatch](#)
- [About OPatch Log and Trace Files](#)
- [Resolving the "Not a valid patch area" Error](#)
- [Resolving the "Unable to remove a partially installed interim patch" Error](#)

If you have problems applying a patch to your Oracle RAC database, review these solutions to common problems. If the problem you encountered is not listed, review the log and trace files.

See Also:

- *Oracle Universal Installer and OPatch User's Guide*
- ["Obtaining the Patch"](#)
- ["Preparing to Use OPatch"](#)
- ["Applying Patches"](#)
- *Oracle Database 2 Day DBA*

Updating the Node List for OPatch

If OPatch does not automatically detect Oracle RAC or its nodes, investigate the contents of the inventory and ensure they are complete.

To update the node list for OPatch:

If the list of nodes for your cluster is not complete, you can update it by using Oracle Universal Installer and the `-updateNodeList` flag, as demonstrated in the following example:

```
Oracle_home/oui/bin/runInstaller -updateNodeList
ORACLE_HOME=/opt/oracle/11gR1/db_1
CLUSTER_NODES=docrac1,docrac2,docrac3 -noClusterEnabled
```

See Also:

- ["Troubleshooting Patch Deployment"](#)
- *Oracle Universal Installer and OPatch User's Guide* for more information about Oracle product patching using OPatch

About OPatch Log and Trace Files

Logging and tracing is a common aid for debugging. OPatch maintains logs for all `apply`, `rollback`, and `lsinventory` operations. The log files are located in the `Oracle_home/cfgtoollogs/opatch` directory. Each log file will be tagged with the time stamp of the operation. Log files are named as `opatch_mm-dd-yyyy_hh-mm-ss.log`, where `mm-dd-yyyy` is the current date and `hh-mm-ss` is the current time. Each time you run OPatch, a new log file is created.

For example, if a log file is created on May 17, 2007 at 11:55 PM, then it will be named as follows:

```
opatch_05-17-2007_23-55-00.log
```

OPatch also maintains an index of the commands processed by OPatch and the log files associated with it in the `history.txt` file located in the `Oracle_home/cfgtoollogs/opatch` directory. A sample of the `history.txt` file is as follows:

```
Date & Time : Tue Apr 26 23:00:55 PDT 2007
Oracle Home : /opt/oracle/11gR1/db_1/
OPatch Ver. : 11.1.0.0.0
Current Dir : /scratch/oui/OPatch
Command    : lsinventory
Log File   :
/opt/oracle/11gR1/db_1/cfgtoollogs/opatch/opatch-2007_Apr_26_23-00-55-PDT_Tue.log
```

See Also:

- ["Troubleshooting Patch Deployment"](#)
- *Oracle Universal Installer and OPatch User's Guide*

Resolving the "Not a valid patch area" Error

You might get this error if the directory that the OPatch utility is using to do the patch does not match the template for what it is checking, or if the OPatch utility is run from an invalid directory.

The `Patch_Shiphome` directory should have the following structure:

- An `etc` directory that has the metadata files
- A `files` directory that has the patch files
- The `etc/config/inventory` file and the actions file under the same directory

To resolve the "Not a valid patch area" error:

- Perform one of the following actions:
 - a. Remove the patch shiphome directory and re-create it with the proper structure (by extracting the files again).
 - b. Start the OPatch utility from the directory where the patch to be installed has been unzipped and staged on disk.
 - c. Use the following command when starting OPatch:

```
opatch apply /Patch_Shiphome
```

where `Patch_Shiphome` is the location where the patch has been staged on disk.

See Also:

- ["Troubleshooting Patch Deployment"](#)
- *Oracle Universal Installer and OPatch User's Guide*

Resolving the "Unable to remove a partially installed interim patch" Error

If the patching process is interrupted, you might get the error "Unable to remove a partially installed interim patch" when you try to install the patch a second time.

To resolve the partially installed patch error:

1. Ensure that the environment variable `ORACLE_HOME` is set to the Oracle home directory you are attempting to patch.
2. Go to the `Oracle_home/.patch_storage/patch-id_timestamp` directory and run the `restore` command as follows:

```
Oracle_home/.patch_storage/patch-id_timestamp/restore.sh
```

3. Use the `Oracle_home/.patch_storage/patch-id_timestamp/make.txt` file (if available) to modify your operating system environment, as follows:

```
/bin/sh make.txt
```

4. Attempt to apply the patch again.

See Also:

- ["Troubleshooting Patch Deployment"](#)
- *Oracle Universal Installer and OPatch User's Guide*

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